

## FCC RADIO TEST REPORT

Applicant..... : Paul C. Buff, Inc.

Address..... : 2725 Bransford Ave., Nashville, TN 37204, USA

Manufacturer..... : Paul C. Buff, Inc.

Address..... : 2725 Bransford Ave., Nashville, TN 37204, USA

Factory..... : Mototech Electronics (DG) Co., Ltd

Address..... : No.99XiangRong Road, SongMuShan Village, DaLang Town, DongGuan, GuangDong, China

Product Name..... : HUB

Brand Name..... : BUFF

Model No. .... : HUB-X (X represents the N, C, S, F, etc.)

(For model difference refer to section 2)

FCC ID..... : OUEPCBHUB

Measurement Standard..... : 47 CFR FCC Part 15, Subpart C (Section 15.249)

Receipt Date of Samples.... : December 23, 2020

Date of Tested..... : December 25, 2020 to January 05, 2021

Date of Report..... : February 24, 2021

This report shows that above equipment is technically compliant with the requirements of the standards above. All test results in this report apply only to the tested sample(s). Without prior written approval of Dongguan Nore Testing Center Co., Ltd, this report shall not be reproduced except in full.



Prepared by

Alina Guo / Project Engineer



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## Revision History

**1. Summary of Test Result**

FCC Rules	Description of Test	Result	Remarks
§15.207 (a)	AC Power Conducted Emission	PASS	---
§15.249(a)/ 15.209	Radiated Emissions	PASS	---
§15.249(d)/ 15.205	Band Edge	PASS	---
§15.215(c)	20dB Bandwidth	PASS	---
§15.203	Antenna Requirement	PASS	---

## 2. General Description of EUT

Product Information	
Product name:	HUB
Main Model Name:	HUB-N
Additional Model Name:	HUB-X (X represents the N, C, S, F, etc.)
Model Difference:	These models have the same circuit schematic, construction, PCB Layout and critical components. The difference in model number and the ports to connect the product to the camera due to trading purpose.
S/N:	2012-5297
Brand Name:	BUFF
Hardware version:	0.5
Software version:	1.11.190
Rating:	DC 5V from USB Port DC 3.7V from internal battery
Typical arrangement:	Table-top
I/O Port:	N/A
Accessories Information	
Adapter:	N/A
Cable:	N/A
Other:	N/A
Additional information	
Note:	According to these model difference, all tests were performed on model HUB-N.
Remark:	All the information above are provided by the manufacturer. More detailed feature of the EUT please refers to the user manual.

Technical Specification (2.4G Function )	
Frequency Range:	2427-2457MHz
Modulation Type:	GFSK
Number of Channel:	16 (refer to following channel list for details)
Channel Space:	2MHz
Antenna Type:	Chip antenna
Antenna Gain:	3.5 dBi (Declared by manufacturer)

Channel List					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2427	7	2439	13	2451
2	2429	8	2441	14	2453
3	2431	9	2443	15	2455
4	2433	10	2445	16	2457
5	2435	11	2447		
6	2437	12	2449		

### 3. Test Channels and Modes Detail

Mode		Channel		Frequency (MHz)	Modulation	Data Rate (Mbps)
1	TX	Low	1	2427	GFSK	1
2	TX	Mid	9	2443	GFSK	1
3	TX	High	16	2457	GFSK	1
4.	Normal Mode	---	---	---	---	---

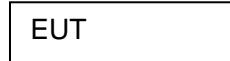
Note: TX mode means that the EUT was programmed to be in continuously transmitting mode.

### 4. Configuration of EUT

#### TX Mode



#### Normal Mode



### 5. Modification of EUT

No modifications are made to the EUT during all test items.

## 6. Description of Support Device

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

No.	Equipment	Brand	M/N	S/N	Cable Specification	Remarks
1.	Test fixture	---	---	---	----	Provided by manufacturer
2.	Adapter	HUWEI	HW-05020 0C01			Input: AC100-240V 50/60Hz, 0.5A Output: DC5V 2A

## 7. Test Facility and Location

Test Site	:	Dongguan Nore Testing Center Co., Ltd. (Dongguan NTC Co., Ltd.)
Accreditations and Authorizations	:	<p>The Laboratory has been assessed and proved to be in compliance with CNAS/CL01</p> <p>Listed by CNAS, August 13, 2018</p> <p>The Certificate Registration Number is L5795.</p> <p>The Certificate is valid until August 13, 2024</p> <p>The Laboratory has been assessed and proved to be in compliance with ISO17025</p> <p>Listed by A2LA, November 01, 2017</p> <p>The Certificate Registration Number is 4429.01</p> <p>The Certificate is valid until December 31, 2021</p> <p>Listed by FCC, November 06, 2017</p> <p>Test Firm Registration Number: 907417</p> <p>Listed by Industry Canada, June 08, 2017</p> <p>The Certificate Registration Number. Is 46405-9743A</p>
Test Site Location	:	Building D, Gaosheng Science and Technology Park, Hongtu Road, Nancheng District, Dongguan City, Guangdong Province, China

## 8. Applicable Standards and References

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

### Test Standards:

47 CFR Part 15, Subpart C, 15.249

ANSI C63.10-2013

### References Test Guidance:

N/A

## 9. Deviations and Abnormalities from Standard Conditions

No additions, deviations and exclusions from the standard.

## 10. Test Conditions

No.	Test Item	Test Mode	Test Voltage	Tested by	Remarks
1.	AC Power Conducted Emission	4	AC 120V 60Hz	Ray	See note 1
2.	Radiated Emissions	1-4	AC 120V 60Hz, DC 3.7V	Ray	See note 1
3.	Band Edge	1-3	AC 120V 60Hz, DC 3.7V	Ray	See note 1
4.	20dB Bandwidth	1-3	AC 120V 60Hz, DC 3.7V	Ray	See note 1
5.	Antenna Requirement	---	---	---	See note 1

Note:

1. The testing climatic conditions for temperature, humidity, and atmospheric pressure are within: 15~35 °C, 30~70%, 86~106kPa
2. As the EUT can be operated multiple positions, all X,Y,Z axis were considered during the test and only the worst case X was recorded.
3. AC 120V 60Hz is come from input voltage of the ancillary equipment adapter.
4. Only the worst case was recorded in the report.

## 11. Measurement Uncertainty

No.	Test Item	Frequency	Uncertainty	Remarks
1.	Conducted Emission	150KHz ~ 30MHz	±2.52 dB	---
2.	Radiated Emission Test	9kHz ~ 30MHz	±2.60 dB	---
		30MHz ~ 1GHz	±4.68 dB	---
		1GHz ~ 18GHz	±5.14 dB	---
		18GHz ~ 40GHz	±5.14 dB	---

**Note:**

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The measurement uncertainty levels above are estimated and calculated according to CISPR 16-4-2.
3. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

## 12. Sample Calculations

Conducted Emission						
Freq. (MHz)	Reading Level (dBuV)	Correct Factor (dB)	Measurement (dBuV)	Limit (dBuV)	Over (dB)	Detector
0.1900	30.10	10.60	40.70	79.00	-38.30	QP

Where,

Freq. = Emission frequency in MHz  
 Reading Level = Uncorrected Analyzer/Receiver reading  
 Corrector Factor = Insertion loss of LISN + Cable Loss + RF Switching Unit attenuation  
 Measurement = Reading + Corrector Factor  
 Limit = Limit stated in standard  
 Margin = Measurement - Limit  
 Detector = Reading for Quasi-Peak / Average / Peak

Radiated Spurious Emissions and Restricted Bands						
Freq. (MHz)	Reading Level (dBuV)	Correct Factor (dB/m)	Measurement (dBuV/m)	Limit (dBuV/m)	Over (dB)	Detector
60.0700	45.88	-18.38	27.50	49.00	-21.50	QP

Where,

Freq. = Emission frequency in MHz  
 Reading Level = Uncorrected Analyzer/Receiver reading  
 Corrector Factor = Antenna Factor + Cable Loss - Pre-amplifier  
 Measurement = Reading + Corrector Factor  
 Limit = Limit stated in standard  
 Over = Margin, which calculated by Measurement - Limit  
 Detector = Reading for Quasi-Peak / Average / Peak

Note: For all conducted test items, the spectrum analyzer offset or transducer is derived from RF cable loss and attenuator factor. The offset or transducer is equal to the RF cable loss plus attenuator factor.

## 13. Test Items and Results

### 13.1 Conducted Emissions Measurement

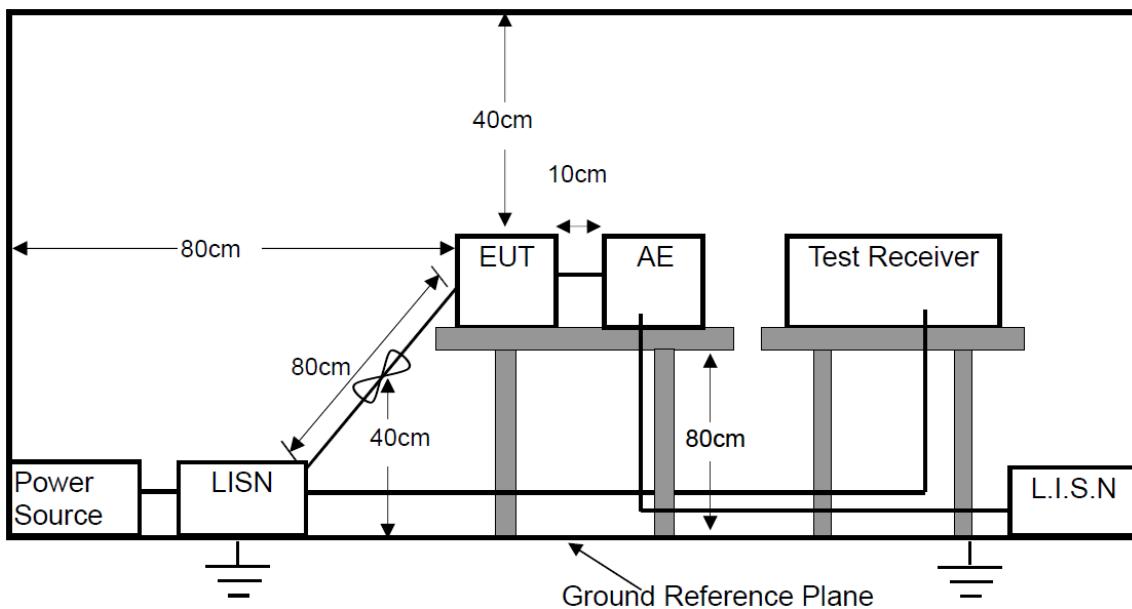
#### LIMIT

According to the requirements of FCC PART 15.207, the limits are as follows:

Frequency (MHz)	Quasi-peak	Average
0.15 to 0.5	66 to 56	56 to 46
0.5 to 5	56	46
5 to 30	60	50

Note: 1. If the limits for the average detector are met when using the quasi-peak detector, then the limits for the measurements with the average detector are considered to be met.  
2. The lower limit shall apply at the transition frequencies.  
3. The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5MHz.

#### BLOCK DIAGRAM OF TEST SETUP



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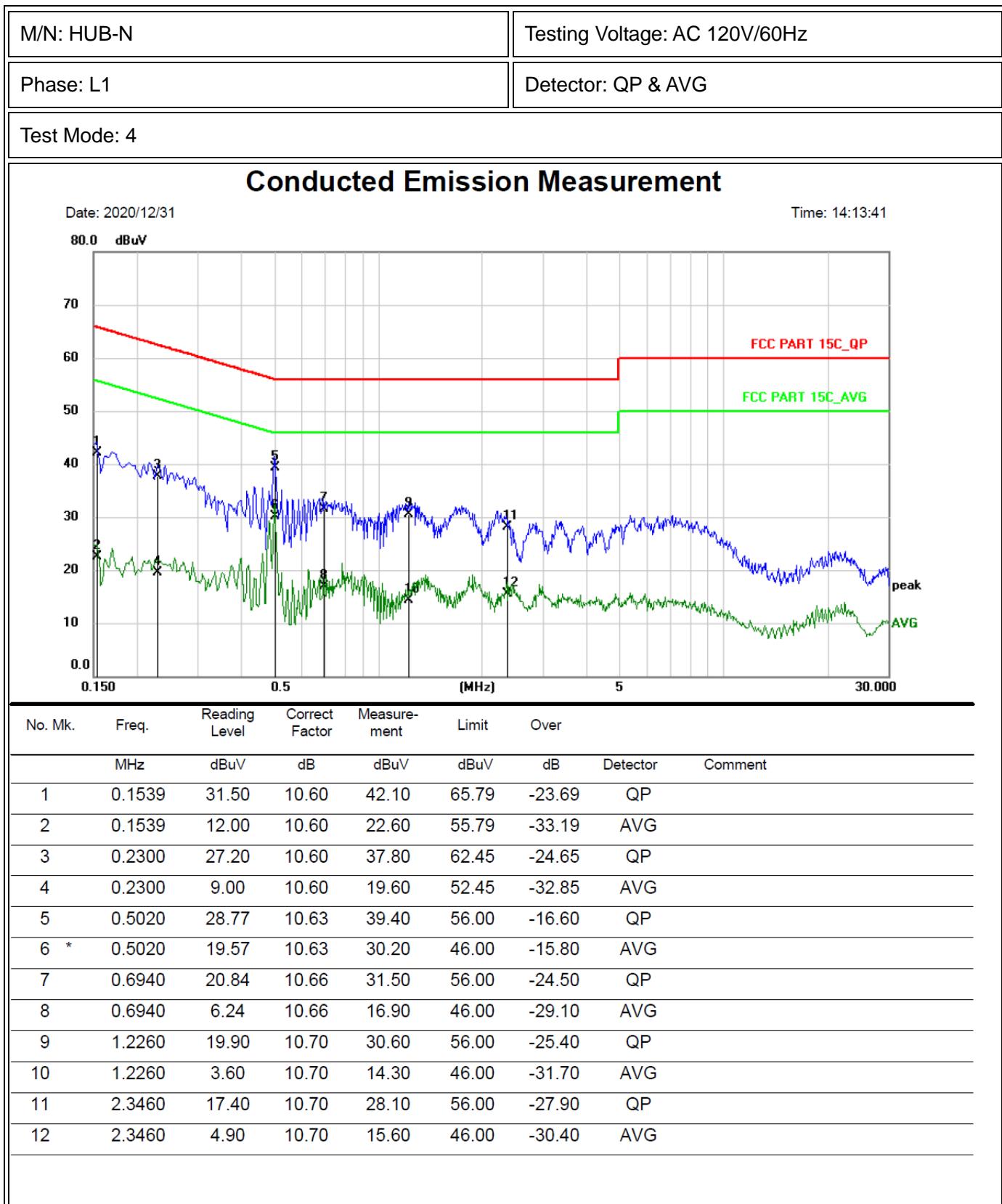
## TEST PROCEDURES

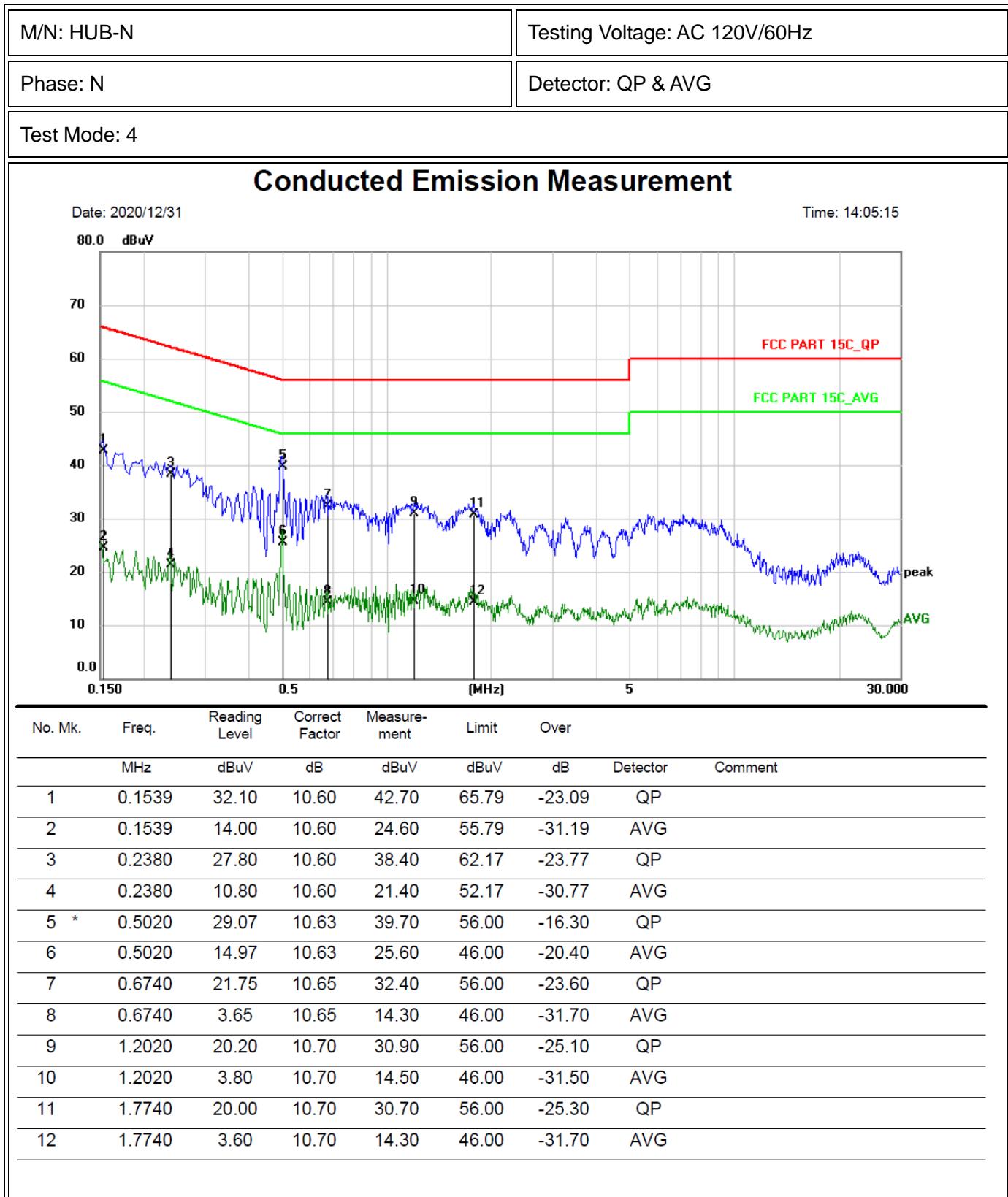
- a. The EUT was placed on a wooden table 0.8m height from the metal ground plan and 0.4m from the conducting wall of the shielding room and it was kept at 0.8m from any other grounded conducting surface.
- b. All I/O cables and support devices were positioned as per ANSI C63.10.
- c. Connect mains power port of the EUT to a line impedance stabilization network (LISN).
- d. Connect all support devices to the other LISN and AAN, if needed.
- e. Scan the frequency range from 150KHz to 30MHz at both sides of AC line for maximum conducted interference checking and record the test data.

## TEST RESULTS

PASS

Please refer to the following pages.





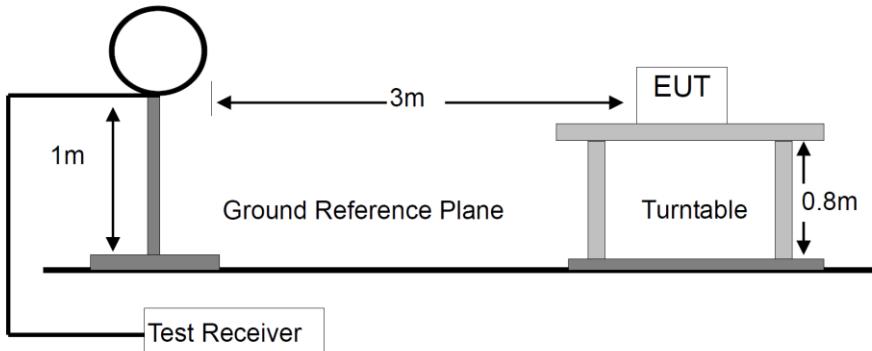
## 13.2 Radiated Spurious Emissions and Restricted Bands Measurement

### LIMIT

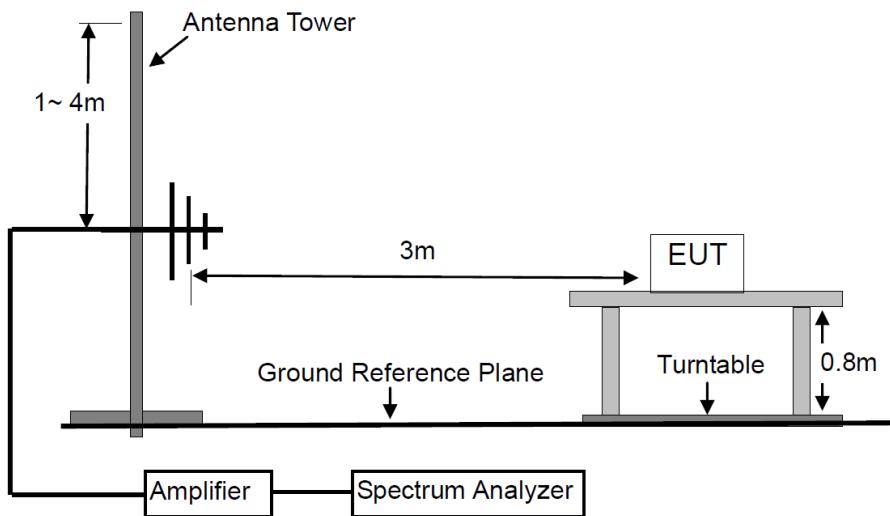
Frequency range MHz	Distance Meters	Field Strengths Limit (15.209)	
		μV/m	
0.009 ~ 0.490	300	2400/F(kHz)	
0.490 ~ 1.705	30	24000/F(kHz)	
1.705 ~ 30	30	30	
30 ~ 88	3	100	
88 ~ 216	3	150	
216 ~ 960	3	200	
Above 960	3	500	
Frequency range MHz	Distance Meters	Field Strengths Limit (15.249)	
		mV/m (Field strength of fundamental)	μV/m (Field strength of Harmonics)
902 ~ 928	3	50	500
2400 ~ 2483.5	3	50	500
5725 ~ 5875	3	50	500
24000 ~ 2425000	3	250	2500
Remark: (1) Emission level (dB) $\mu$ V = 20 log Emission level $\mu$ V/m (2) The smaller limit shall apply at the cross point between two frequency bands. (3) As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation. (4) The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. (5) §15.249(d) specifies that emissions which fall in the restricted bands, as defined in §15.205 comply with radiated emission limits specified in §15.209.			

## BLOCK DIAGRAM OF TEST SETUP

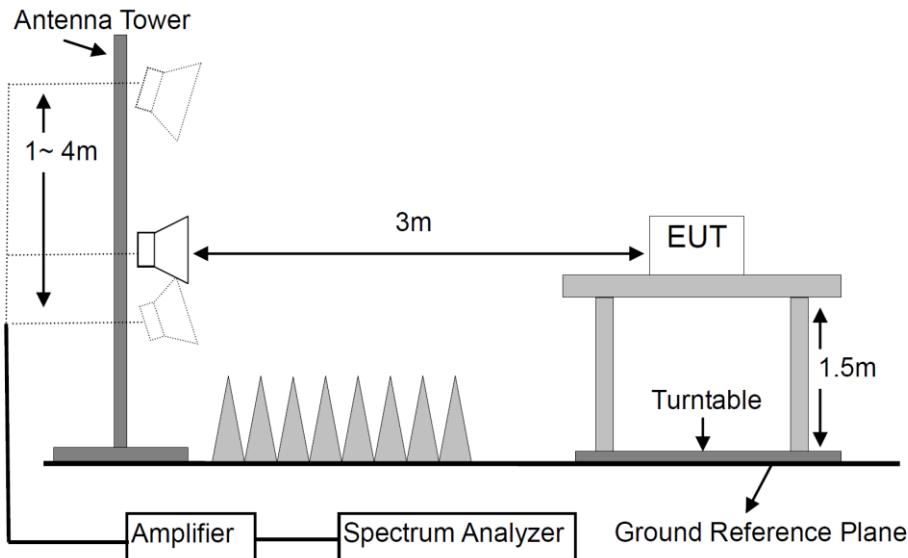
For Radiated Emission below 30MHz



For Radiated Emission 30-1000MHz



For Radiated Emission Above 1000MHz.



## TEST PROCEDURES

a. Below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.

b. For the radiated emission test above 1GHz:

The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.

f. A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Detector	Resolution Bandwidth	Video Bandwidth
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
	Average	1 MHz	10 Hz

---

## TEST RESULTS

PASS

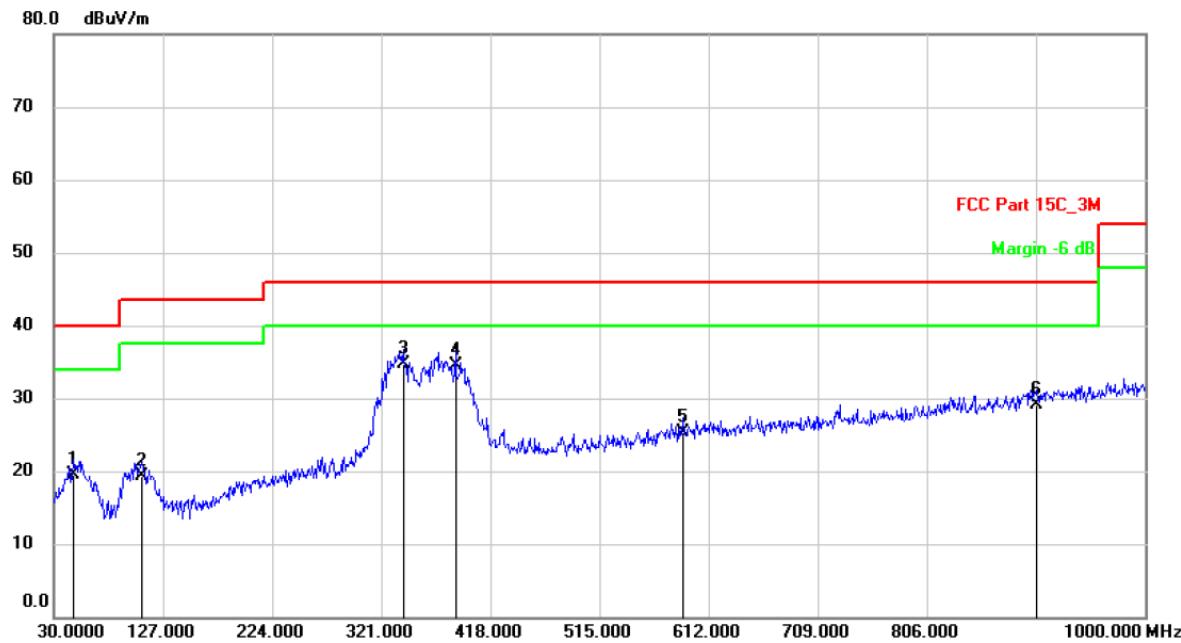
Please refer to the following pages.

M/N: HUB-N	Testing Voltage: AC 120V/60Hz
Polarization: Horizontal	Detector: QP
Test Mode: 4	Distance: 3m

## Radiated Emission Measurement

Date: 2020/12/31

Time: 20:48:16



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over		
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	Comment
1		47.4600	27.05	-7.45	19.60	40.00	-20.40	QP	
2		108.5700	26.94	-7.54	19.40	43.50	-24.10	QP	
3	*	340.4000	39.02	-4.32	34.70	46.00	-11.30	QP	
4		386.9600	38.10	-3.60	34.50	46.00	-11.50	QP	
5		588.7199	24.92	0.38	25.30	46.00	-20.70	QP	
6		903.0000	23.00	6.20	29.20	46.00	-16.80	QP	

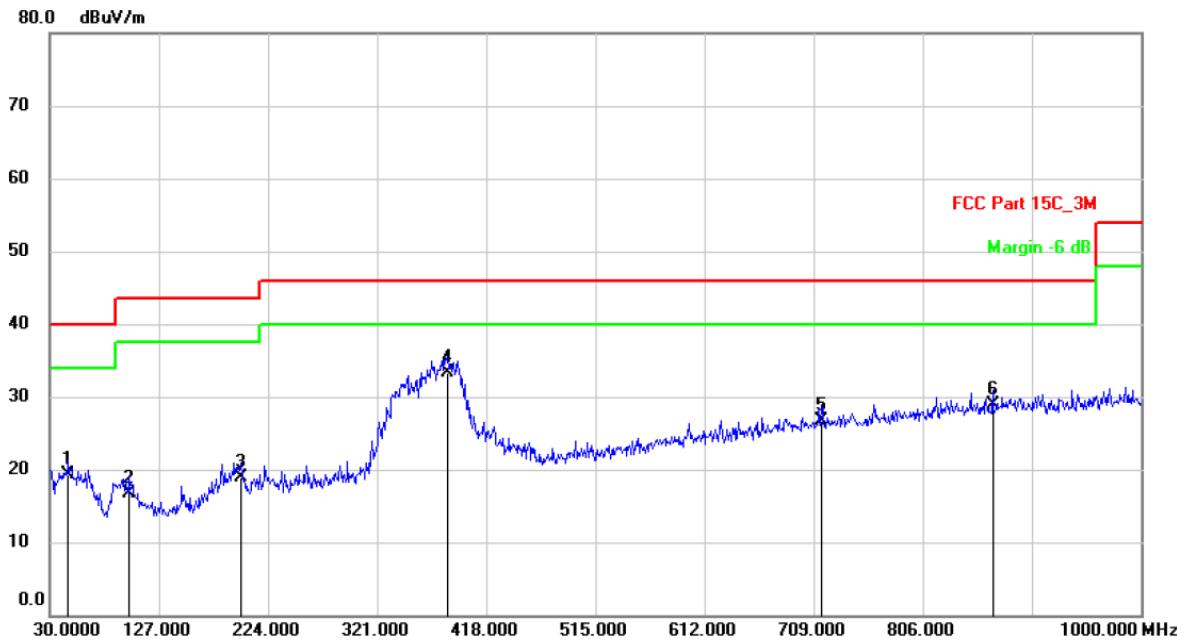
Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

M/N: HUB-N	Testing Voltage: AC 120V/60Hz
Polarization: Vertical	Detector: QP
Test Mode: 4	Distance: 3m

## Radiated Emission Measurement

Date: 2020/12/31

Time: 20:55:10



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over		
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	Comment
1		46.4900	26.86	-7.46	19.40	40.00	-20.60	QP	
2		100.8100	25.34	-8.54	16.80	43.50	-26.70	QP	
3		199.7500	27.65	-8.75	18.90	43.50	-24.60	QP	
4	*	384.0500	38.07	-4.67	33.40	46.00	-12.60	QP	
5		715.7900	24.33	2.47	26.80	46.00	-19.20	QP	
6		868.0800	24.09	4.91	29.00	46.00	-17.00	QP	

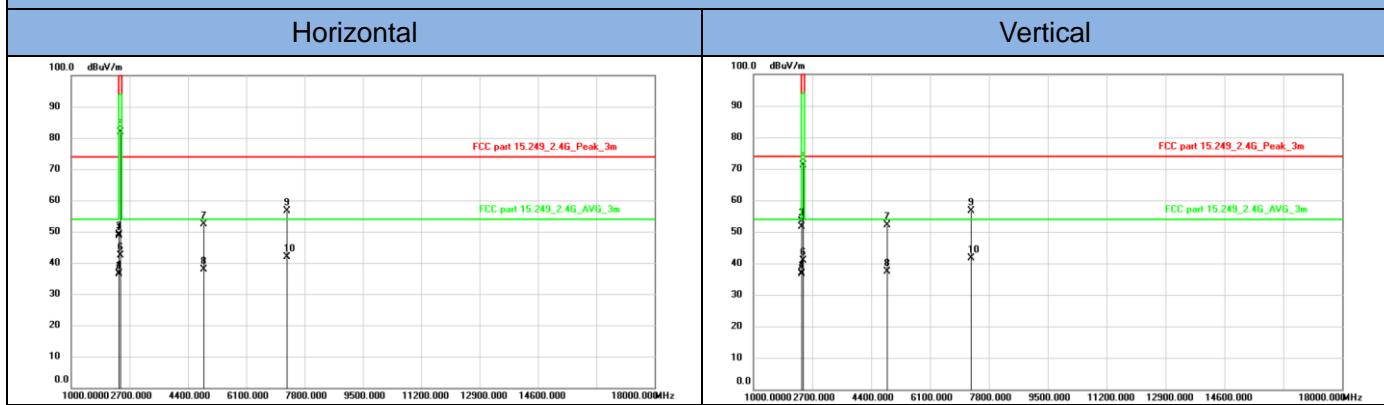
Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

Modulation: GFSK			Test Result: PASS				Test frequency range: 1-25GHz				
Freq. (MHz)	Ant. Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV/m)		Limit 3m (dBuV/m)		Margin (dB)		
		PK	AV		PK	AV	PK	AV	PK	AV	
<b>Operation Mode: TX Mode (Low)</b>											
2427	V	70.91	40.80	0.20	71.11	41.00	114.00	94.00	-42.89	-53.00	
4854	V	45.62	30.86	6.49	52.11	37.35	74.00	54.00	-21.89	-16.65	
7281	V	46.06	31.21	10.52	56.58	41.73	74.00	54.00	-17.42	-12.27	
---											
2427	H	81.65	42.13	0.20	81.85	42.33	114.00	94.00	-32.15	-51.67	
4854	H	45.96	31.37	6.49	52.47	37.86	74.00	54.00	-21.53	-16.14	
7281	H	46.12	31.27	10.52	56.64	41.79	74.00	54.00	-17.36	-12.21	
---											
<b>Operation Mode: TX Mode (Mid)</b>											
2443	V	71.04	41.11	0.24	71.28	41.35	114.00	94.00	-42.72	-52.65	
4886	V	45.75	30.54	6.62	52.37	37.16	74.00	54.00	-21.63	-16.84	
7329	V	46.00	30.78	10.55	56.55	41.33	74.00	54.00	-17.45	-12.67	
---											
2443	H	81.32	41.99	0.24	81.56	42.23	114.00	94.00	-32.44	-51.77	
4886	H	45.86	30.80	6.62	52.48	37.42	74.00	54.00	-21.52	-16.58	
7329	H	45.94	30.92	10.55	56.49	41.47	74.00	54.00	-17.51	-12.53	
---											
<b>Operation Mode: TX Mode (High)</b>											
2457	V	71.37	41.17	0.29	71.66	41.46	114.00	94.00	-42.34	-52.54	
4914	V	45.64	30.69	6.72	52.36	37.41	74.00	54.00	-21.64	-16.59	
7371	V	45.82	30.86	10.57	56.39	41.43	74.00	54.00	-17.61	-12.57	
---											
2457	H	81.69	41.32	0.29	81.98	41.61	114.00	94.00	-32.02	-52.39	
4914	H	45.57	31.10	6.72	52.29	37.82	74.00	54.00	-21.71	-16.18	
7371	H	46.17	30.88	10.57	56.74	41.45	74.00	54.00	-17.26	-12.55	
---											
Remark: Data of measurement within this frequency range shown "___" in the table above means the reading of emissions are attenuated more than 10dB below the permissible limits.											

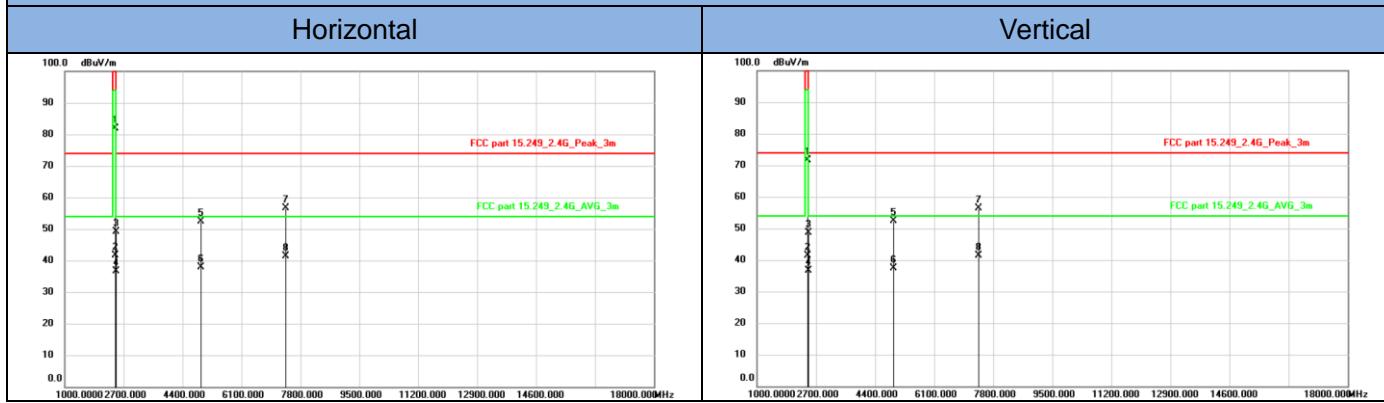
Band edge										
2390.000	H	48.64	36.36	0.09	48.73	36.45	74.00	54.00	-25.27	-17.55
2390.000	V	51.66	36.56	0.09	51.75	36.65	74.00	54.00	-22.25	-17.35
2398.000	H	48.93	36.40	0.13	49.06	36.53	74.00	54.00	-24.94	-17.47
2398.000	V	53.25	36.76	0.13	53.38	36.89	74.00	54.00	-20.62	-17.11
2483.500	H	48.72	36.38	0.34	49.06	36.72	74.00	54.00	-24.94	-17.28
2483.500	V	48.32	36.39	0.34	48.66	36.73	74.00	54.00	-25.34	-17.27

Note: Other band edge, the emissions are lower than 20dB below the allowable limit.

### Low channel



### High channel

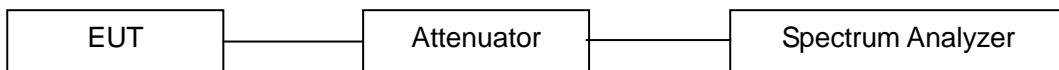


## 13.3 20dB Bandwidth Measurement

### LIMIT

There is no limit.

### BLOCK DIAGRAM OF TEST SETUP



### TEST PROCEDURES

The 20dB bandwidth of the emission was contained within the frequency band designated which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered, FCC Rule 15.215(c):

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer RBW was chosen so that the display was a result of the hopping channel modulation. For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. Use the spectrum 20dB down delta function to measure the bandwidth.

### TEST RESULTS

PASS

Please refer to the following table.

### GFSK

Channel	Frequency (MHz)	Data Rate (Mbps)	20dB Bandwidth (MHz)	Result
1	2427	1	0.744	PASS
9	2443	1	0.841	PASS
16	2457	1	0.971	PASS

### 2427MHz

### 2443MHz



### 2457MHz

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## 13.4 Antenna Requirement

### STANDARD APPLICABLE

According to of FCC part 15C section 15.203 and 15.240:

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, 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.

Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

### ANTENNA CONNECTED CONSTRUCTION

The antenna is chip antenna that no antenna other than furnished by the responsible party shall be used with the device, and the best case gain of the antenna is 3.5 dBi, Therefore, the antenna is consider meet the requirement.

## 14. Test Equipment List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Test Receiver	Rohde & Schwarz	ESCI7	100837	Mar. 13, 2020	1 Year
2.	Antenna	Schwarzbeck	VULB9162	9162-010	Mar. 23, 2020	1 Year
3.	Spectrum Analyzer	Rohde & Schwarz	FSU26	200409/026	Mar. 13, 2020	1 Year
4.	Spectrum Analyzer	Keysight	N9020A	MY54200831	Mar. 13, 2020	1 Year
5.	Spectrum Analyzer	Rohde & Schwarz	FSV40	101094	Mar. 13, 2020	1 Year
6.	Horn Antenna	Schwarzbeck	BBHA9170	9170-172	Mar. 22, 2019	2 Year
7.	Power Sensor	DARE	RPR3006W	15I00041SNO 64	Mar. 13, 2020	1 Year
8.	Communication Tester	Rohde & Schwarz	CMW500	149004	Mar. 13, 2020	1 Year
9.	Horn Antenna	COM-Power	AH-118	071078	Mar. 23, 2020	1 Year
10.	Pre-Amplifier	HP	HP 8449B	3008A00964	Mar. 13, 2020	1 Year
11.	Pre-Amplifier	HP	HP 8447D	1145A00203	Mar. 13, 2020	1 Year
12.	Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	Mar. 23, 2020	1 Year
13.	Test Receiver	Rohde & Schwarz	ESCI	101152	Mar. 14, 2020	1 Year
14.	L.I.S.N	Rohde & Schwarz	ENV 216	101317	Mar. 13, 2020	1 Year
15.	L.I.S.N	Rohde & Schwarz	ESH2-Z5	893606/014	Mar. 13, 2020	1 Year
16.	RF Switching Unit	Compliance Direction Systems Inc.	RSU-M2	38311	Mar. 13, 2020	1 Year
17.	Temperature & Humidity Chamber	REMAFEE	SYHR225L	N/A	Mar. 13, 2020	1 Year
18.	DC Source	Maynuo	MY8811	N/A	Mar. 13, 2020	1 Year
19.	Temporary antenna connector	TESCOM	SS402	N/A	N/A	N/A
20.	Chamber	SAEMC	9*7*7m	N/A	Jun. 20, 2019	2 Year
21.	Test Software	EZ	EZ_EMCA	N/A	N/A	N/A

Note: For photographs of EUT and measurement, please refer to appendix in separate documents.

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