TEST REPORT

APPLICANT	:	COUL International Limited
PRODUCT NAME	:	V1 Bluetooth Keyboard
MODEL NAME	:	V1
BRAND NAME	:	COUL
FCC ID	:	2ATWXV101
STANDARD(S)	:	47 CFR Part 15 Subpart C
RECEIPT DATE	:	2019-06-19
TEST DATE	:	2019-07-01 to 2019-07-09
ISSUE DATE	:	2019-07-19

Edited by: Zeng Xiaoying (Rapporteur)

Approved by: Peng Huarui (Supervisor)

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Change History		
Version	**Date**	**Reason for change**
1.0	2019-07-19	First edition

1. Technical Information

Note: Provide by applicant.

1.1. Applicant and Manufacturer Information

Applicant:	COUL International Limited
Applicant Address:	27/F World Wide House, 19 Des Voeux Road, Central, Hong Kong,China
Manufacturer:	Qian Hai Ku Er Ke Ji (Shenzhen) Limited
Manufacturer Address:	Qianhai Complex A201, Qianwan Road 1, Shenzhen, P.R.China

1.2. Equipment Under Test (EUT) Description

Product Name:	V1 Bluetooth Keyboard	
Serial No:	(N/A, marked #1 by test site)	
Hardware Version:	V3	
Software Version:	V4.0.8	
Equipment Type:	Bluetooth classic	
Modulation Type:	FHSS (GFSK(1Mbps)	
Operating Frequency Range:	The frequency range used is 2402MHz – 2480MHz (79 channels, at intervals of 1MHz);	
Antenna Type:	PCB Antenna	
Antenna Gain:	0 dBi	
Accessory Information:	Battery	
	Brand Name:	N/A
	Model No.:	BT-H003
	Serial No.:	(N/A, marked #1 by test site)
	Capacity:	1000mAh
	Rated Voltage:	3.7 V
	Charge Limit:	5 V

Note 1: We use the dedicated software to control the EUT into the test mode, and then use MT8852B base station to control the EUT continuous transmission.

Note 2: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

1.3. Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 15 Subpart C for the EUT FCC ID Certification:

No.	Identity	Document Title
1	47 CFR Part 15	Radio Frequency Devices

Test detailed items/section required by FCC rules and results are as below:

No.	Section	Description	Test Date	Test Engineer	Result
1	15.203	Antenna Requirement	N/A	N/A	**PASS**
2	15.247(a)(1) 15.247(h)	Hopping Mechanism	N/A	N/A	**PASS**
3	15.247(a)	Number of Hopping Frequency	Jul 01, 2019	Ouyang Feng	**PASS**
4	15.247(b)	Maximum Peak Conducted Output Power	Jul 01, 2019	Ouyang Feng	**PASS**
5	15.247(b)	Maximum Average Conducted Output Power	Jul 01, 2019	Ouyang Feng	**PASS**
6	15.247(a)	20dB Bandwidth	Jul 01, 2019	Ouyang Feng	**PASS**
7	15.247(a)	Carrier Frequency Separation	Jul 01, 2019	Ouyang Feng	**PASS**
8	15.247(a)	Time of Occupancy (Dwell time)	Jul 01, 2019	Ouyang Feng	**PASS**
9	15.247(d)	Conducted Spurious Emission	Jul 01, 2019	Ouyang Feng	**PASS**
10	15.207	Conducted Emission	Jul 04, 2019	Peng Xuewei	**PASS**
11	15.247(d)	Restricted Frequency Bands	Jul 06, 2019	Peng Xuewei	**PASS**
12	15.209, 15.247(d)	Radiated Emission	Jul 09, 2019	Peng Xuewei	**PASS**

Note 1: The tests were performed according to the method of measurements prescribed in ANSI C63.10-2013.

Note 2: The path loss during the RF test is calibrated to correct the results by the offset setting in the test equipments. The Ref offset 1.5dB means the cable loss is 1.5dB.

1.4. Environmental Conditions

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 – 35
Relative Humidity (%):	30 -60
Atmospheric Pressure (kPa):	86-106

2. 47 CFR Part 15C Requirements

2.1. Antenna requirement

2.1.1. 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.

2.1.2. Result: Compliant

The EUT has a permanently and irreplaceable attached antenna. Please refer to the EUT internal photos.

2.2. Hopping Mechanism

2.2.1. Requirement

According to FCC §15.247(a)(1), a frequency hopping spread spectrum 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.

According to FCC §15.247(h), the incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

2.2.2. Result: Compliant

The hopping mechanism of the EUT is in compliance with the document "***Bluetooth core specification v5.1***".

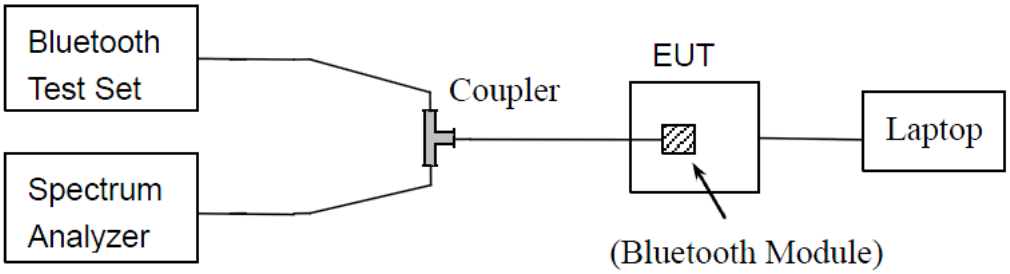
2.3. Number of Hopping Frequency

2.3.1. Requirement

According to FCC §15.247(a)(1)(iii), frequency hopping systems operating in the 2400MHz to 2483.5MHz bands shall use at least 15 hopping frequencies.

2.3.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.3.3. Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
Span = the frequency band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

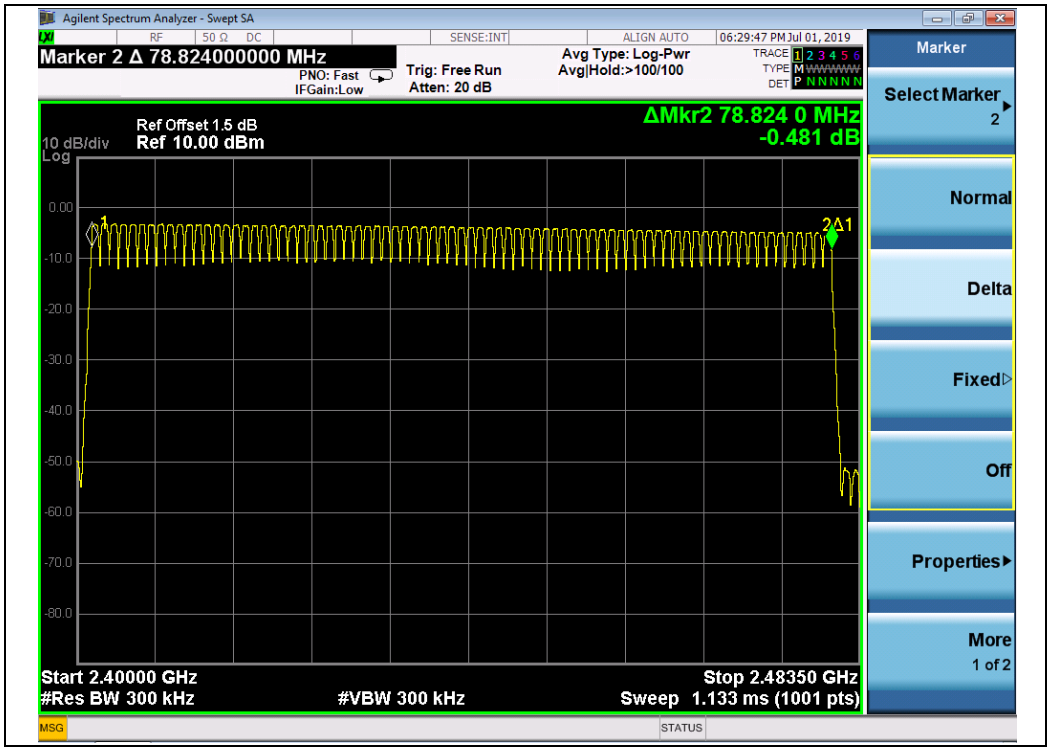
2.3.4. Test Result

The Bluetooth Module operates at hopping-on test mode; the frequencies number employed is counted to verify the Module's using the number of hopping frequency.

A. Test Verdict:

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	PASS

B. Test Plots:



(GFSK)

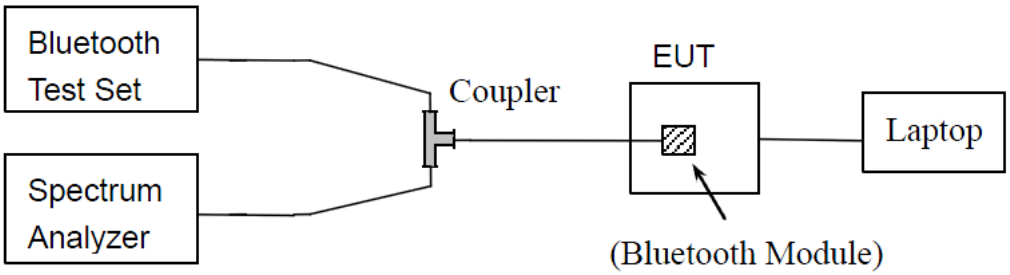
2.4. Maximum Peak Conducted Output Power

2.4.1. Requirement

According to FCC §15.247(b)(1), for frequency hopping systems that operates in the 2400MHz to 2483.5MHz band employing at least 75 hopping channels, the maximum peak output power of the intentional radiator shall not exceed 1Watt. For all other frequency hopping systems in the 2400MHz to 2483.5MHz band, it is 0.125Watts.

2.4.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.4.3. Test Result

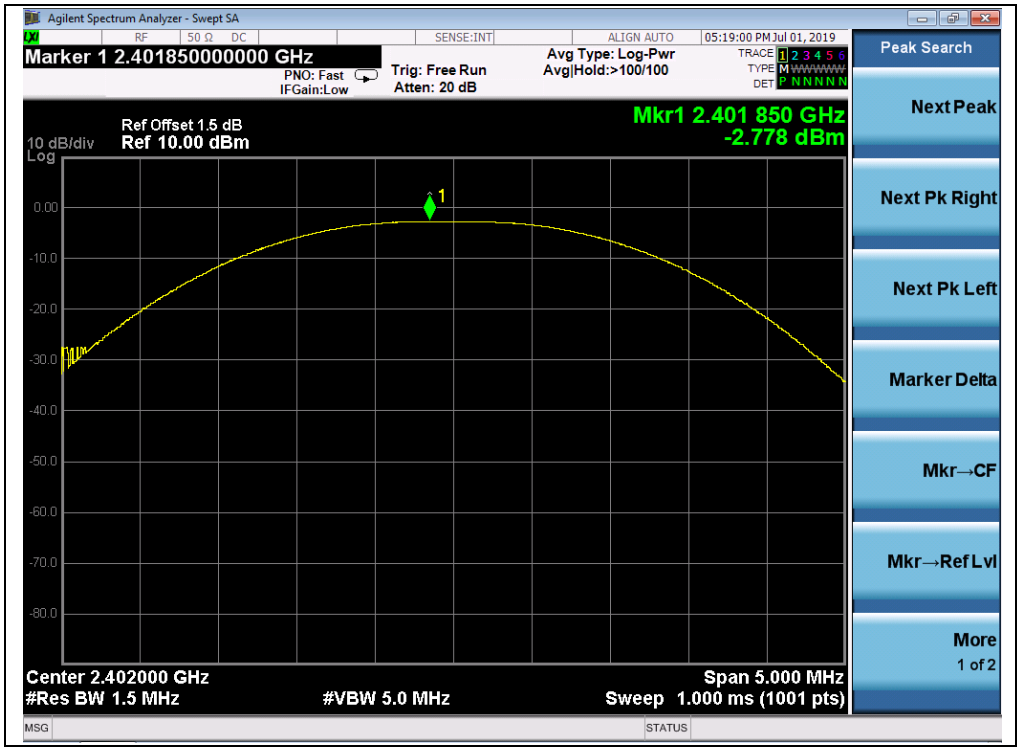
The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the module.

GFSK Mode

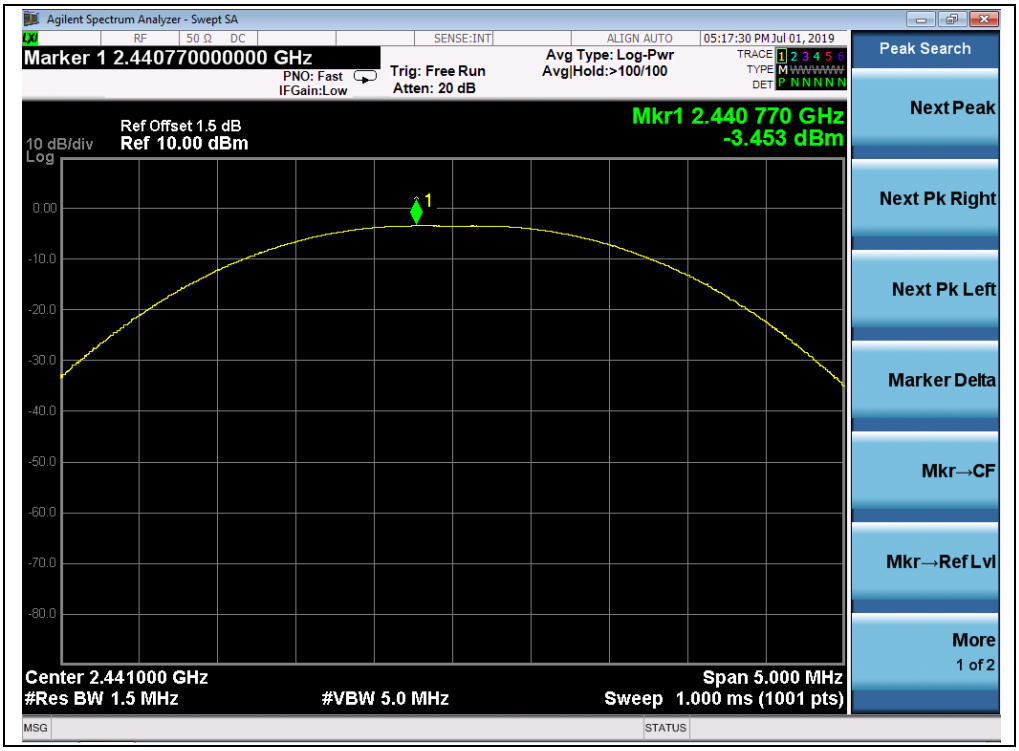
A. Test Verdict:

Channel	Frequency (MHz)	Measured Output Peak Power		Limit		Verdict
		dBm	W	dBm	W	
0	2402	-2.78	0.0005	20.96	0.125	PASS
39	2441	-3.45	0.0005			PASS
78	2480	-4.54	0.0004			PASS

B. Test Plots:



(GFSK, Channel 0, 2402MHz)



(GFSK, Channel 39, 2441MHz)

(GFSK, Channel 78, 2480MHz)

2.5. Maximum Average Conducted Output Power

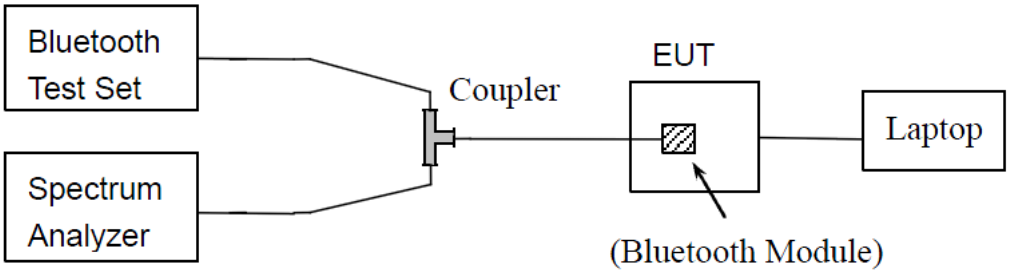
2.5.1. Requirement

According to FCC section 15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: The maximum average conducted output power of the intentional radiator shall not exceed 1 Watt.

2.5.2. Test Description

The measured output power was calculated by the reading of the USB Wideband Power Sensor and calibration.

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.5.3. Test procedure

The test procedure is according to section 8.3.2 in KDB 558074 D01.

2.5.4. Test Result

The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the module.

GFSK Mode

Channel	Frequency (MHz)	Measured Output Average Power		Limit		Verdict
		dBm	W	dBm	W	
0	2402	-3.95	0.0004	20.96	0.125	PASS
39	2441	-4.64	0.0003			PASS
78	2480	-5.72	0.0003			PASS

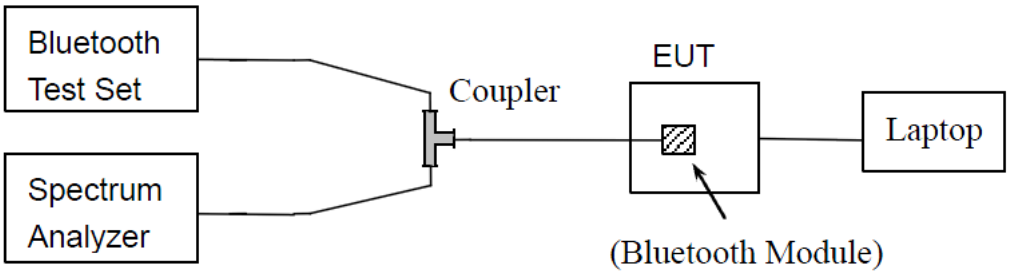
2.6. 20dB Bandwidth

2.6.1. Definition

According to FCC §15.247(a)(1), the 20dB bandwidth is known as the 99% emission bandwidth, or 20dB bandwidth (10*log1% = 20dB) taking the total RF output power.

2.6.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.6.3. Test Procedure

Use the following spectrum analyzer settings:
Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2.6.4. Test Result

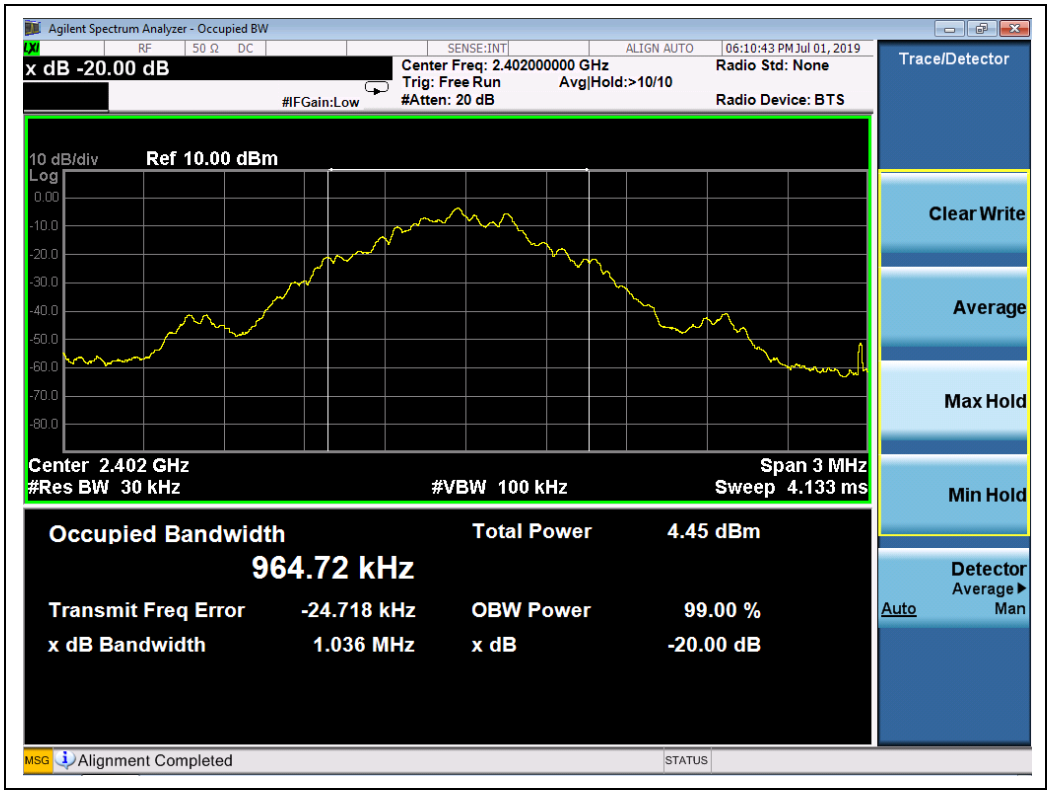
The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to record the 20dB bandwidth of the Module.

GFSK Mode

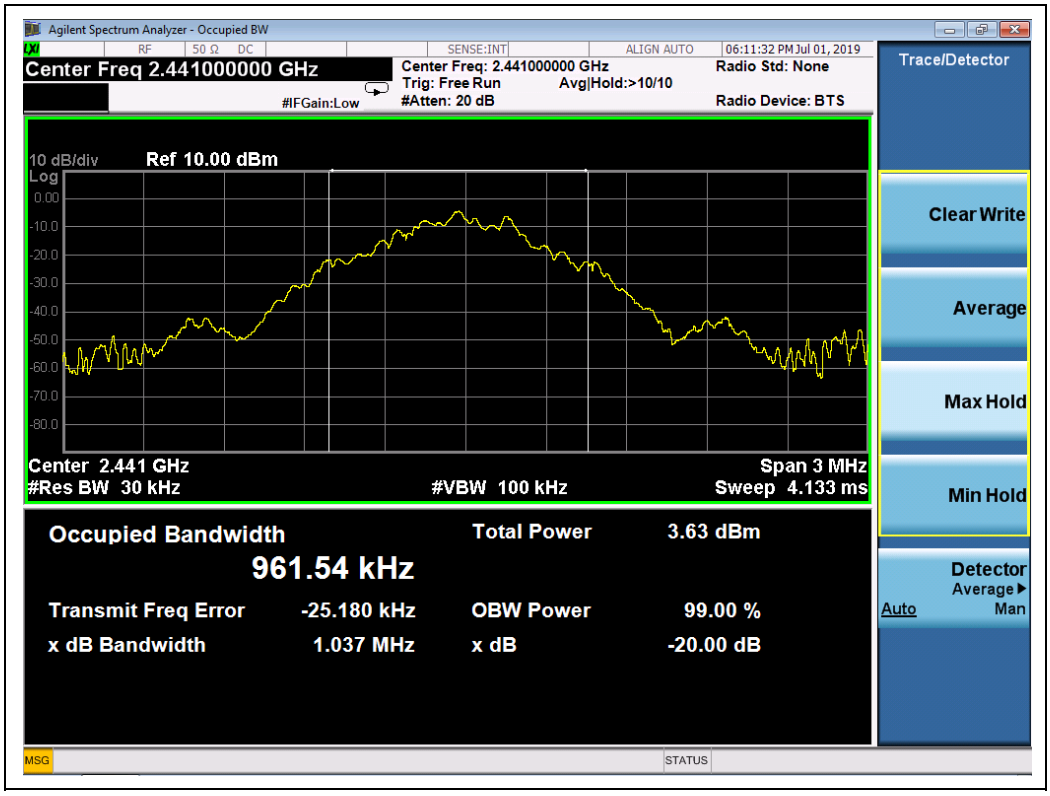
A. Test Verdict:

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	Result
0	2402	1.036	PASS
39	2441	1.037	PASS
78	2480	1.037	PASS

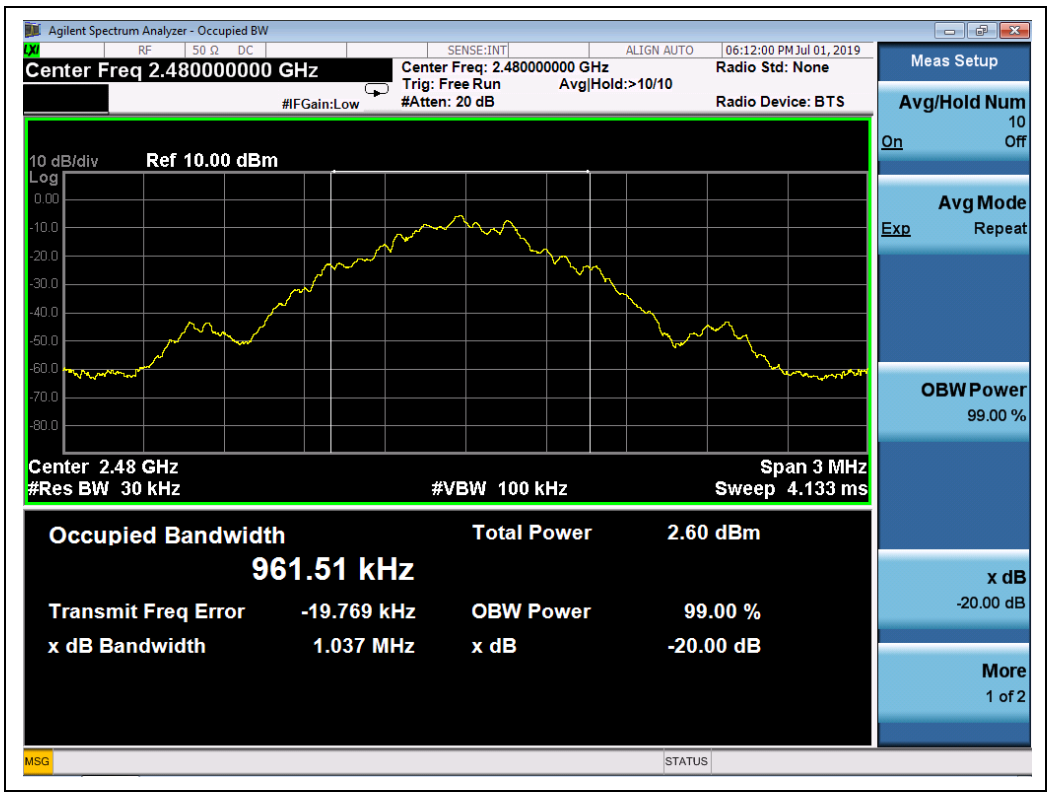
B. Test Plots:



(GFSK, Channel 0, 2402MHz)



(GFSK, Channel 39, 2441MHz)



(GFSK, Channel 78, 2480MHz)

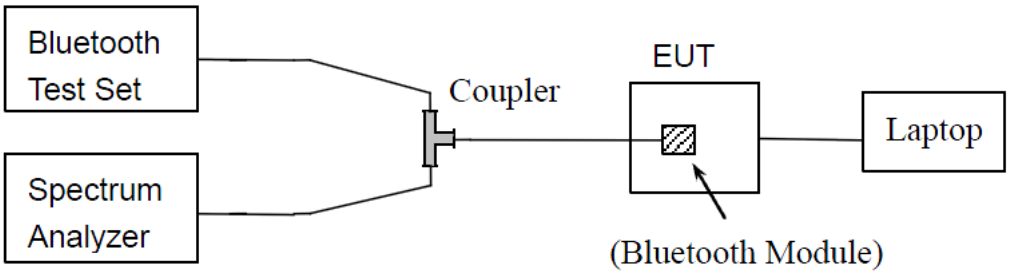
2.7. Carried Frequency Separation

2.7.1. Definition

According to FCC §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

2.7.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.7.3. Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span
Video (or Average) Bandwidth (VBW) ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

2.7.4. Test Result

The Bluetooth Module operates at hopping-on test mode. For any adjacent channels (e.g. the channel 39 and 40 as showed below), the Module does have hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of the hopping channel (refer to section 2.4.4), whichever is greater. So, the verdict is PASSING.

Test Mode	Measured Channel Numbers	Carried Frequency Separation	20dB bandwidth (MHz)	Min. Limit	Verdict
GFSK	39 and 40	0.996	1.037	two-thirds of the 20dB bandwidth	PASS

(GFSK)

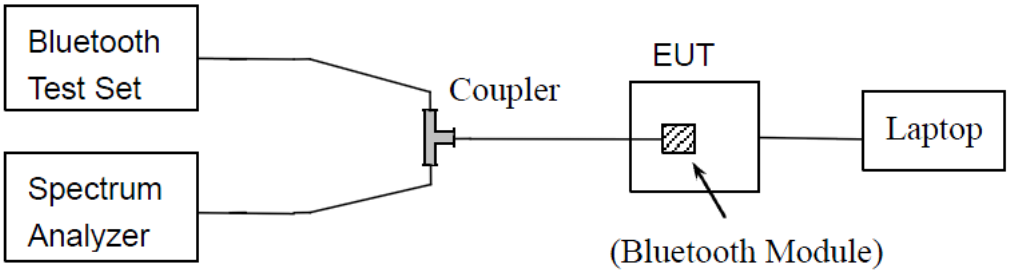
2.8. Time of Occupancy (Dwell time)

2.8.1. Requirement

According to FCC §15.247(a) (1) (iii), frequency hopping systems in the 2400 - 2483.5MHz band shall use at least 15 non-overlapping 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.

2.8.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.8.3. Test Procedure

Option 1:
DH1: Dwell time equal to Pulse time (ms) *(1600 / 2 /79)*31.6 Millisecond DH3: Dwell time equal to Pulse time (ms) * (1600 /4 /79) *31.6 Millisecond DH5: Dwell time equal to Pulse Time (ms)* (1600 / 6 /79) *31.6 Millisecond
AFH Mode:
DH1: Dwell time equal to Pulse time (ms) *(800 / 2 /20)*(0.4*20) Millisecond DH3: Dwell time equal to Pulse time (ms) * (800 / 4 /20)*(0.4*20) Millisecond DH5: Dwell time equal to Pulse Time (ms)* (800 / 6 /20)*(0.4*20) Millisecond

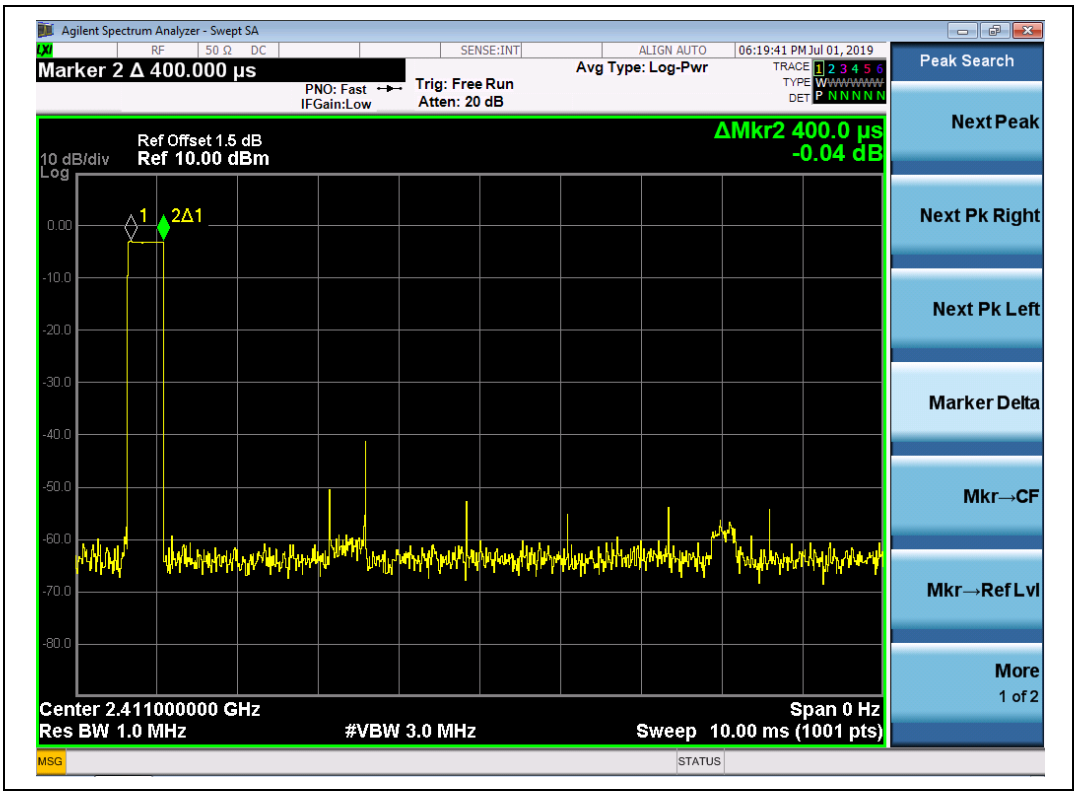
2.8.4. Test Result

GFSK Mode

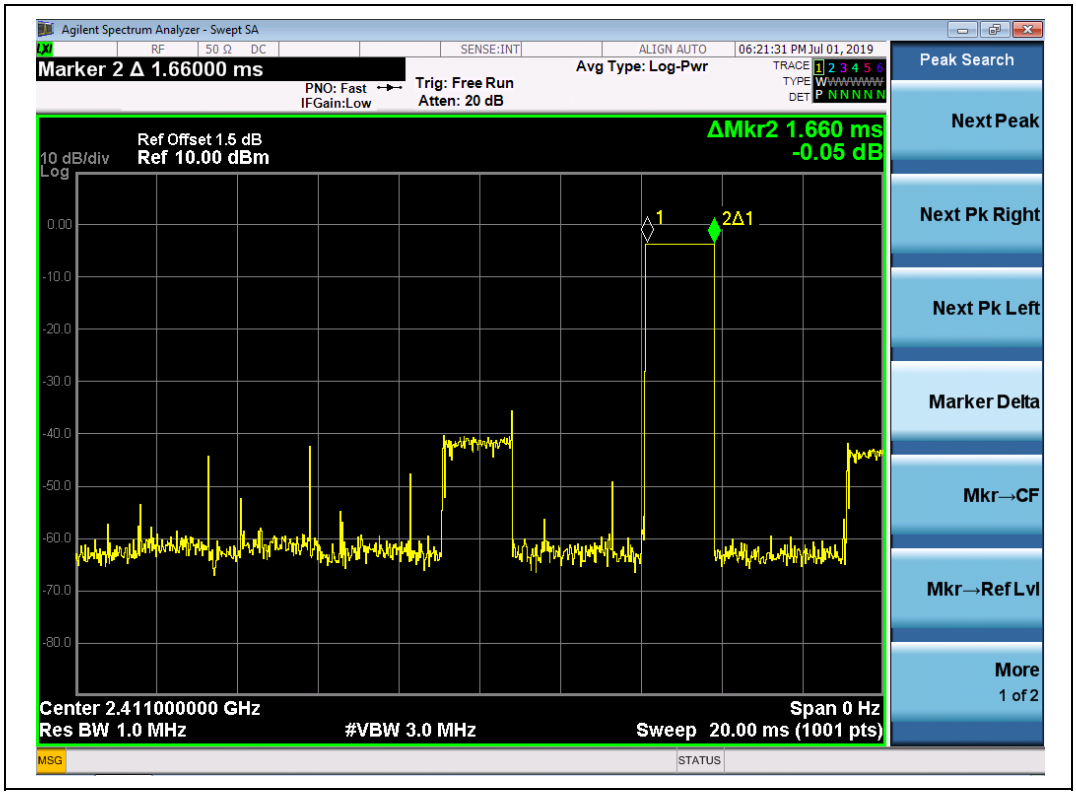
A. Test Verdict:

DH Packet	Pulse Width (ms)	Dwell Time (ms)		Limit (sec)	Verdict
		Normal Mode	AFH Mode		
DH1	0.40	128.00	64.00	0.4	PASS
DH3	1.66	265.60	132.80		PASS
DH5	2.91	310.40	155.20		PASS

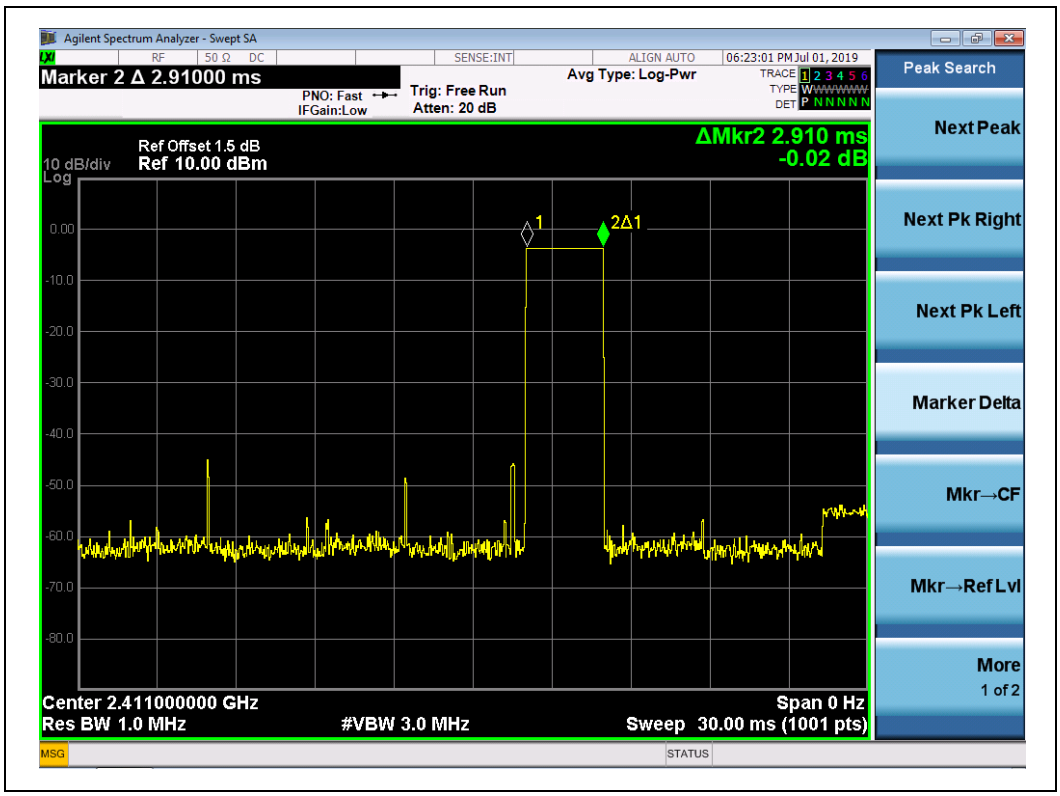
B. Test Plots:



(DH1, GFSK)



(DH3, GFSK)



(DH5, GFSK)

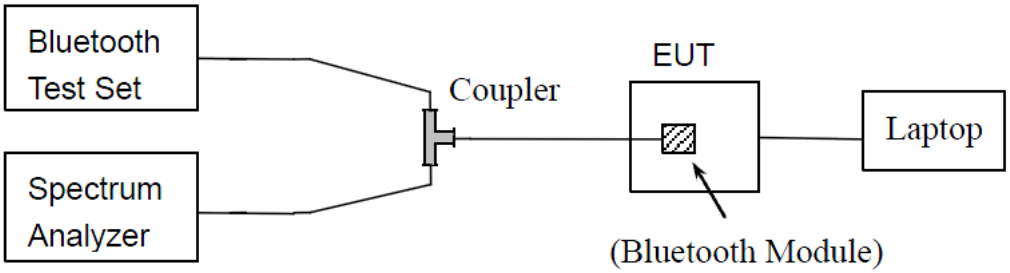
2.9. Conducted Spurious Emissions

2.9.1. Requirement

According to FCC §15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

2.9.2. Test Description

A. Test Setup:



The Bluetooth Module of the EUT is coupled to the Spectrum Analyzer (SA) and the Bluetooth Test Set through the coupler; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

2.9.3. Test Procedure

Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize.

2.9.4. Test Result

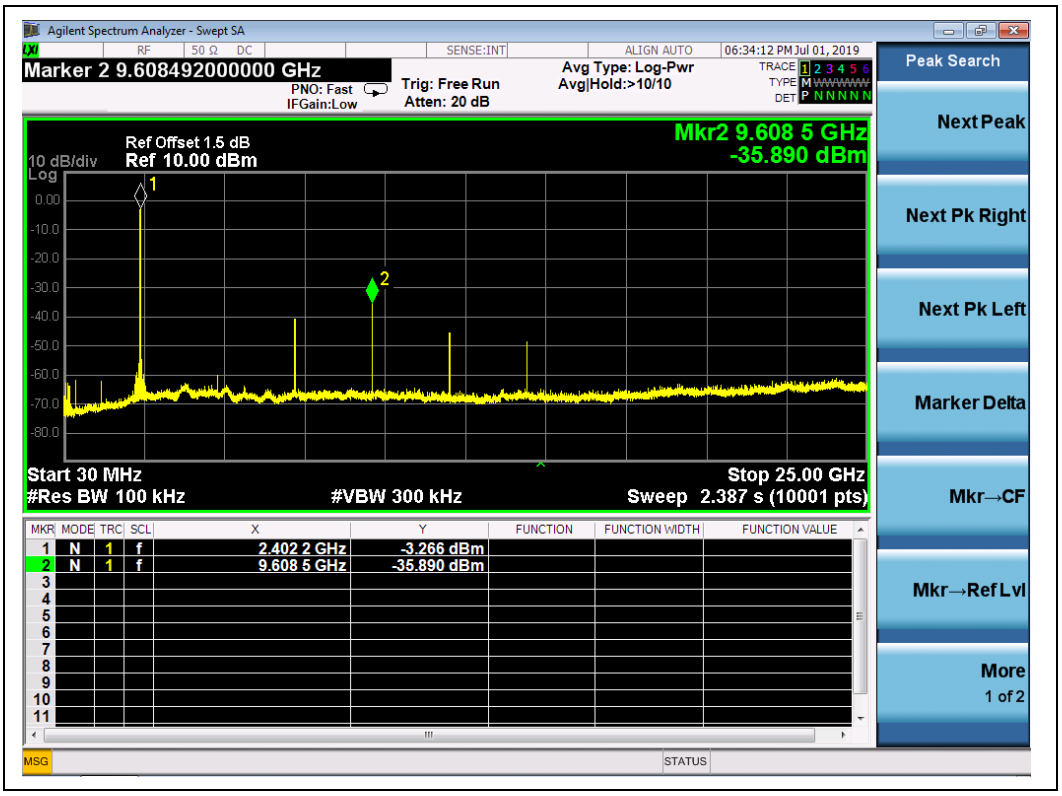
The Bluetooth Module operates at hopping-off test mode. The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions.

GFSK Mode

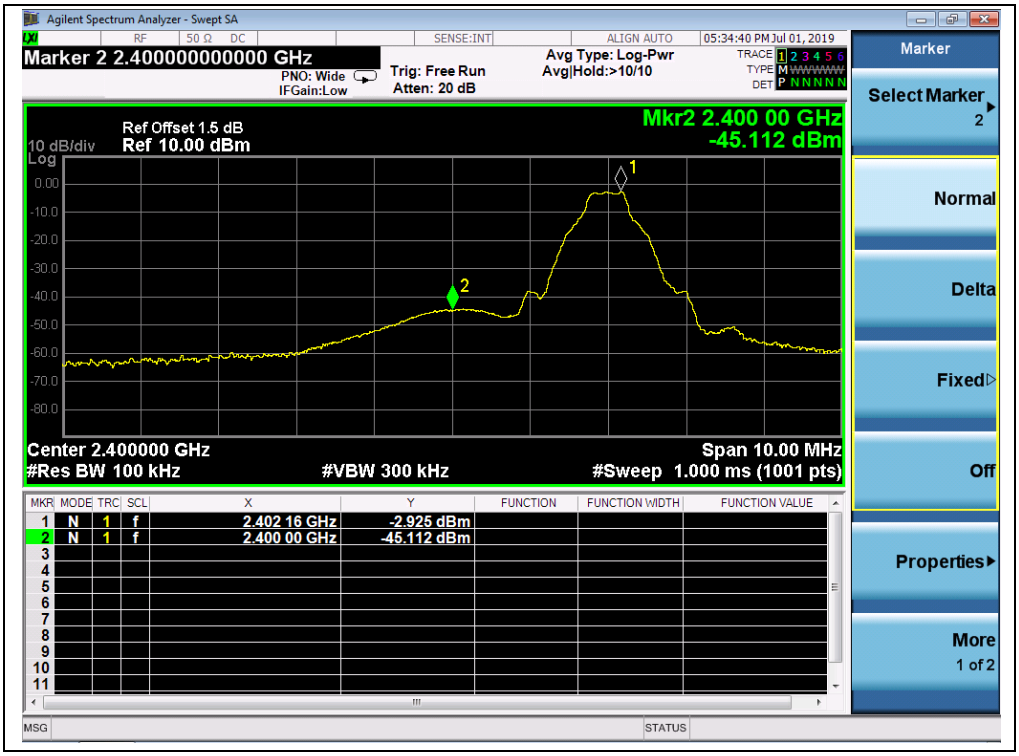
A. Test Verdict:

Channel	Frequency (MHz)	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
			Carrier Level	Calculated -20dBc Limit	
0	2402	-35.89	-3.27	-23.27	PASS
39	2441	-34.20	-4.49	-24.49	PASS
78	2480	-36.53	-5.10	-25.10	PASS

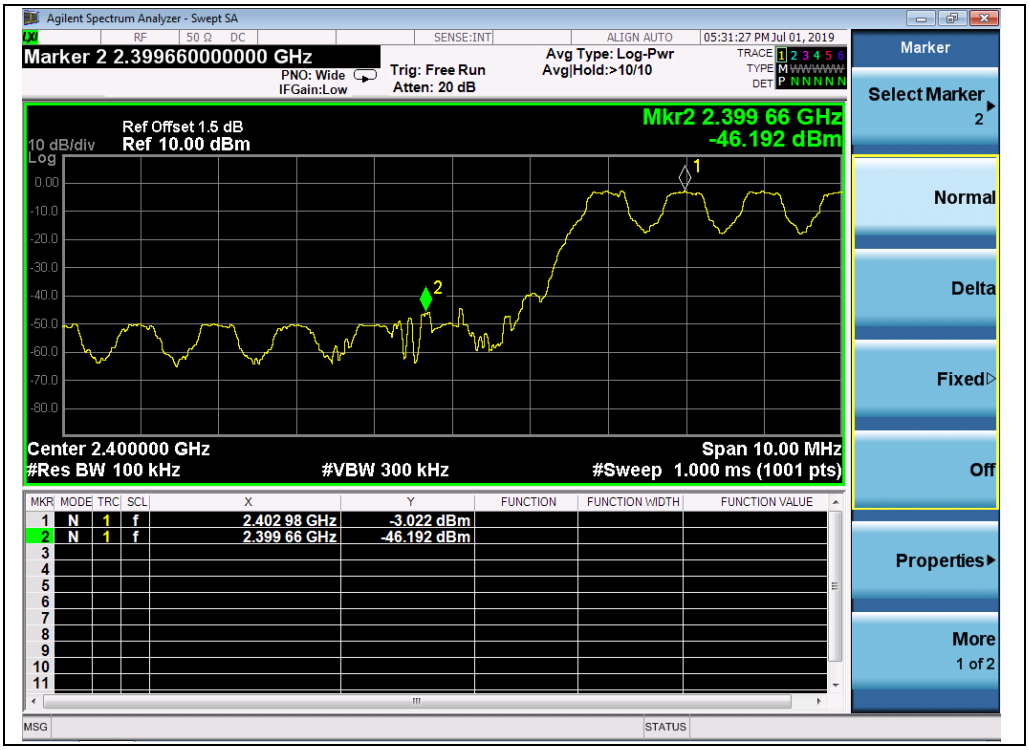
B. Test Plots:



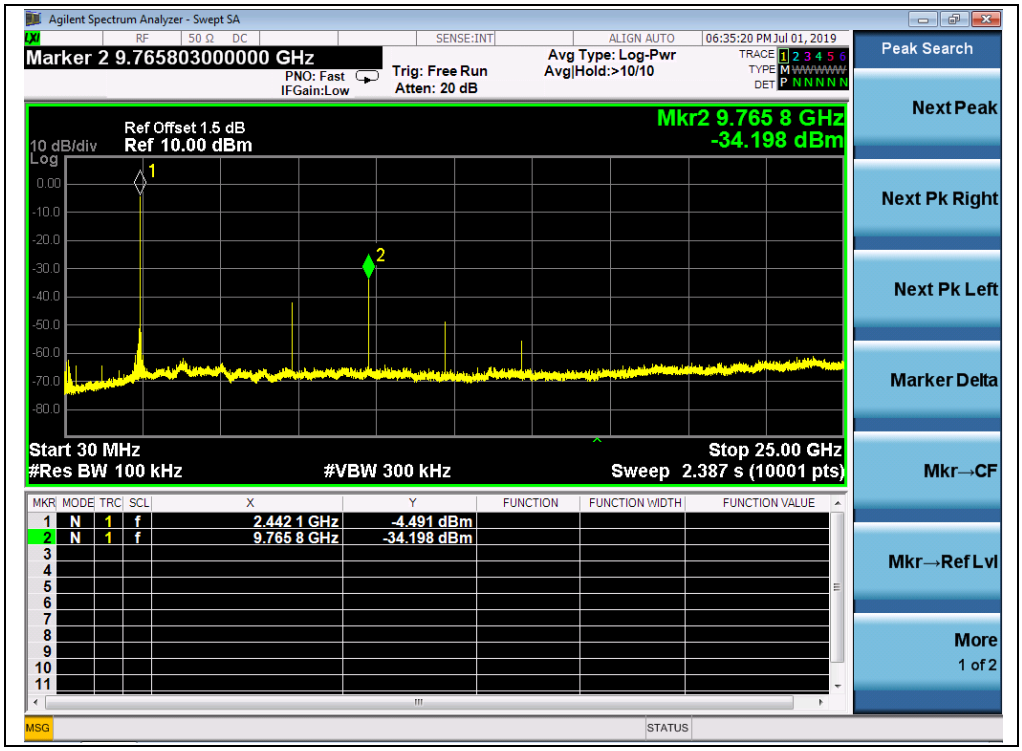
(Channel = 0, 30MHz to 25GHz, GFSK Mode)



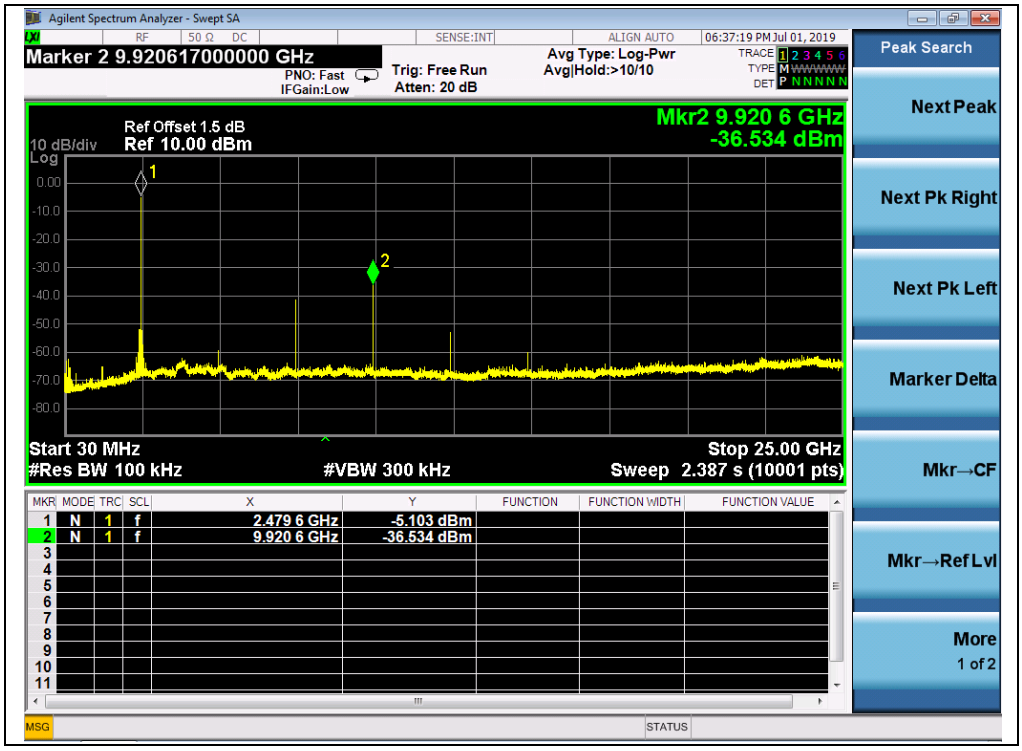
(Channel = 0, Band edge, GFSK Mode)



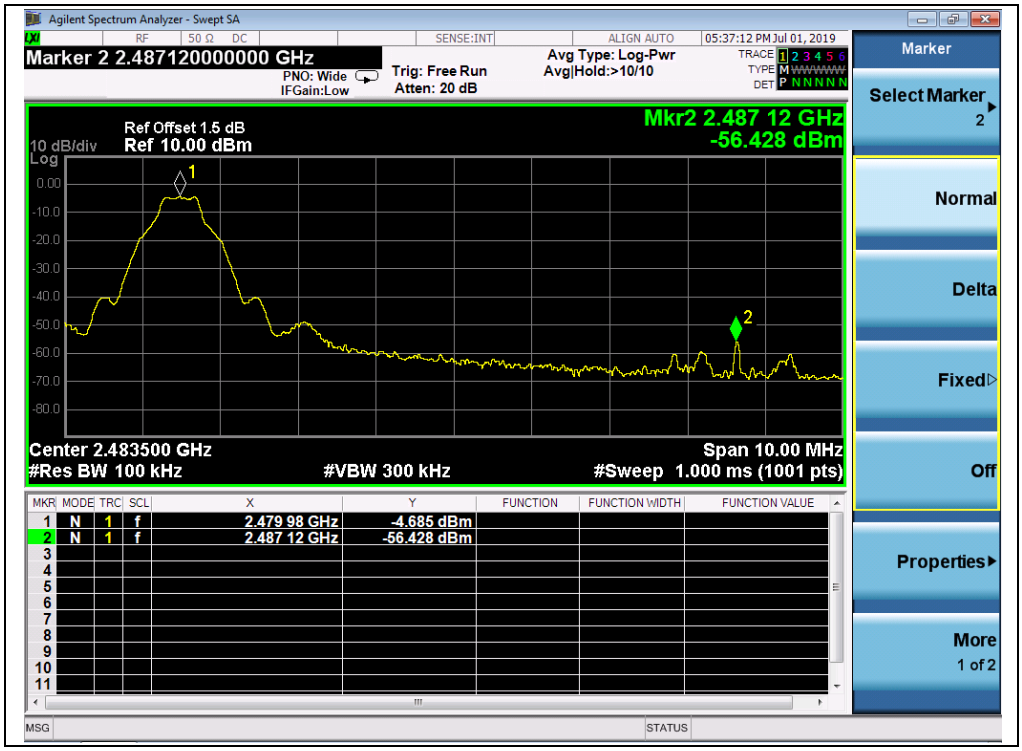
(Channel = 0, Band edge with hopping on, GFSK Mode)



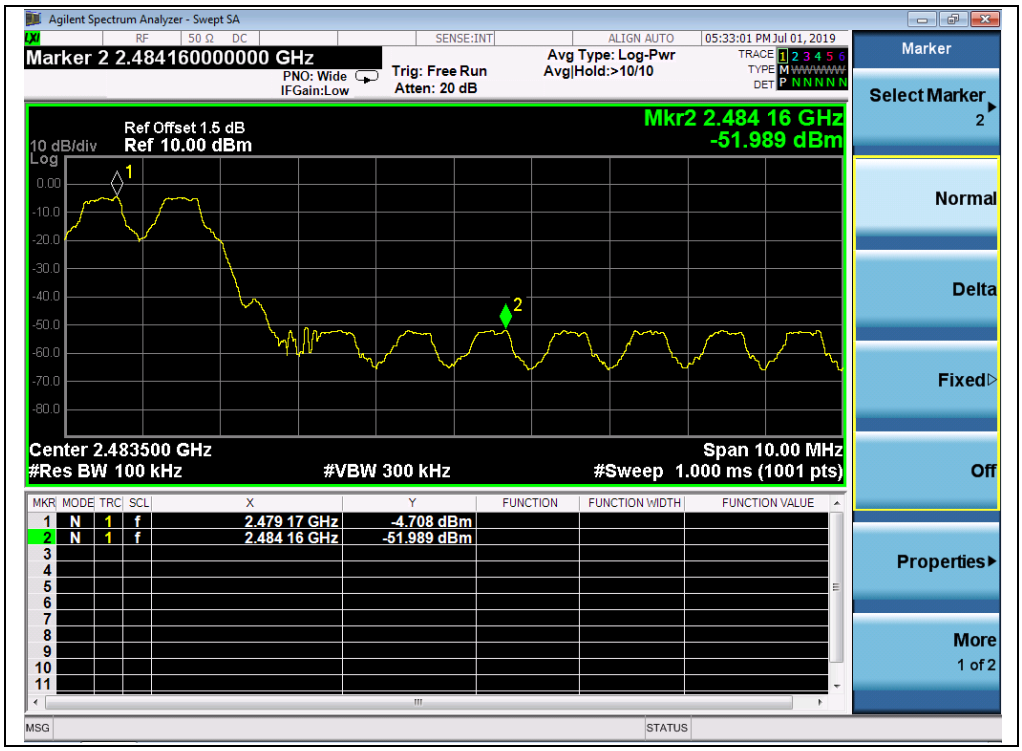
(Channel = 39, 30MHz to 25GHz, GFSK Mode)



(Channel = 78, 30MHz to 25GHz, GFSK Mode)



(Channel = 78, Band edge, GFSK Mode)



(Channel = 78, Band edge with hopping on, GFSK Mode)

2.10. Conducted Emission

2.10.1. Requirement

According to FCC section 15.207, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5- 30	60	50

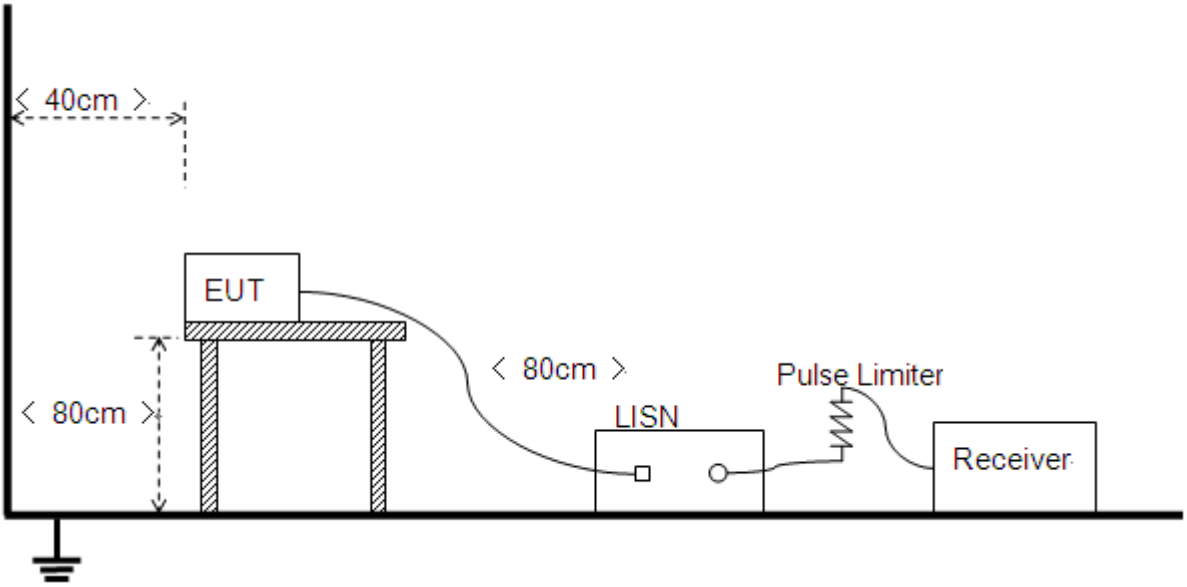
NOTE:

(a) The lower limit shall apply at the band edges.

(b) The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50MHz.

2.10.2. Test Description

A. Test Setup:



The Table-top EUT was placed upon a non-metallic table 0.8m above the horizontal metal reference ground plane. EUT was connected to LISN and LISN was connected to reference Ground Plane. EUT was 80cm from LISN. The set-up and test methods were according to ANSI C63.10: 2013.

The factors of the site are calibrated to correct the reading. During the measurement, the Bluetooth EUT is activated and controlled by the Bluetooth Service Supplier (SS) via a Common Antenna, and is set to operate under hopping-on test mode transmitting 339 bytes DH5 packages at maximum power.

2.10.3. Test Result

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

Note: Both of the test voltage AC 120V/60Hz and AC 230V/50Hz were considered and tested respectively, only the results of the worst case AC 120V/60Hz were recorded in this report.

A. Test setup:

Test Mode: EUT + PC + BT TX

Test voltage: AC 120V/60Hz

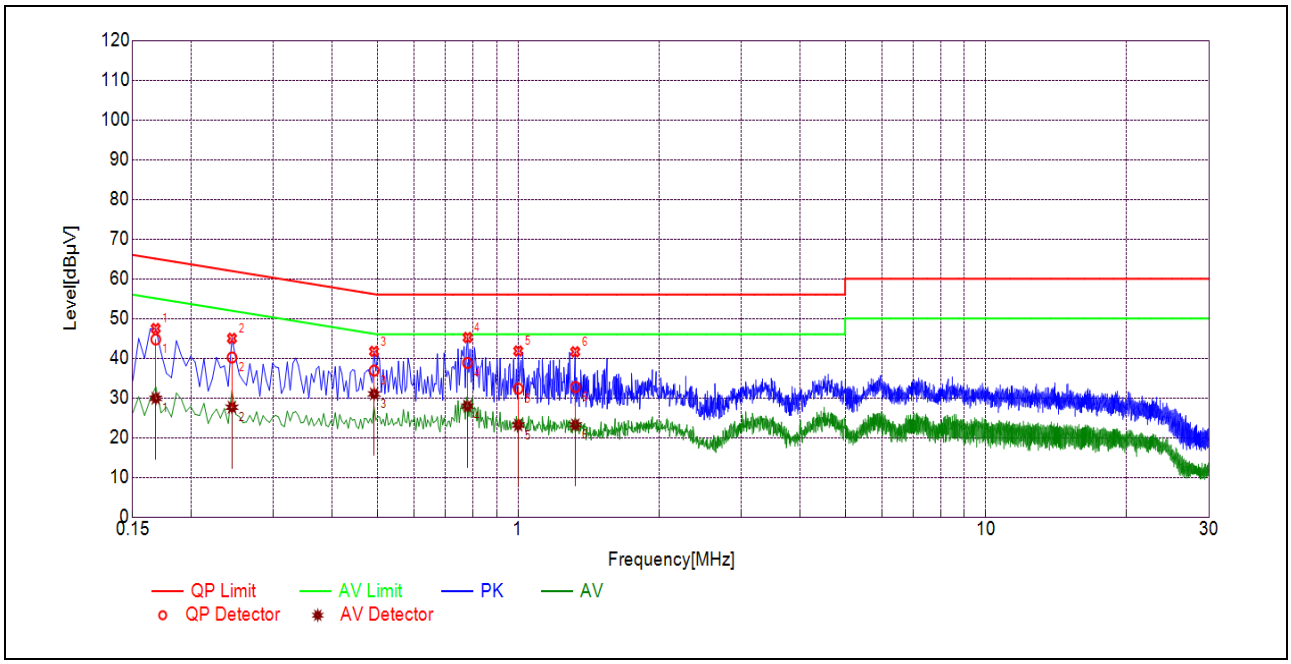
The measurement results are obtained as below:

E [dBμV] $= U_R + L_{Cable\ loss}$ [dB] + A_{Factor}

U_R: Receiver Reading

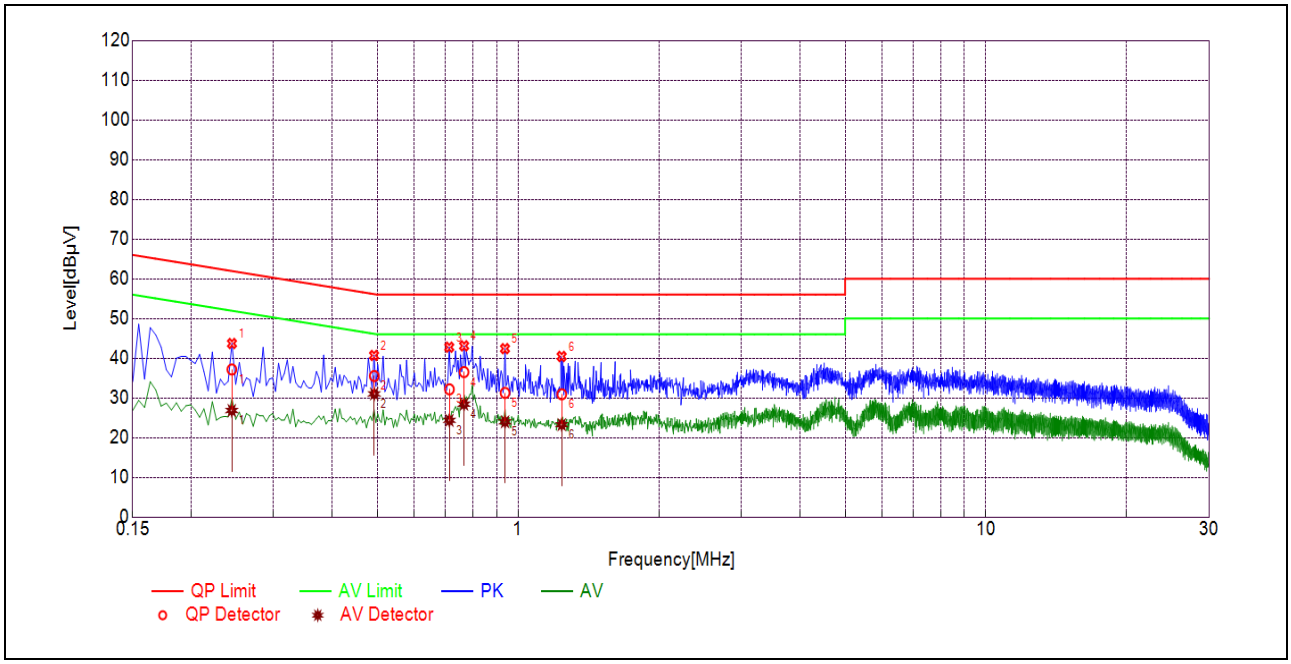
A_{Factor}: Voltage division factor of LISN

B. Test Plots:



(L Phase)

NO.	Fre. (MHz)	Emission Level (dBµV)		Limit (dBµV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.1680	44.72	29.91	65.06	55.06	Line	PASS
2	0.2445	40.18	27.65	61.94	51.94		PASS
3	0.4922	36.87	31.02	56.13	46.13		PASS
4	0.7793	38.80	27.94	56.00	46.00		PASS
5	1.0005	32.34	23.17	56.00	46.00		PASS
6	1.3255	32.74	23.22	56.00	46.00		PASS



(N Phase)

NO.	Fre. (MHz)	Emission Level (dBµV)		Limit (dBµV)		Power-line	Verdict
		Quai-peak	Average	Quai-peak	Average		
1	0.2443	37.16	26.84	61.95	51.95	Neutral	PASS
2	0.4924	35.51	31.02	56.13	46.13		PASS
3	0.7130	32.16	24.36	56.00	46.00		PASS
4	0.7662	36.50	28.43	56.00	46.00		PASS
5	0.9376	31.27	23.99	56.00	46.00		PASS
6	1.2396	30.92	23.27	56.00	46.00		PASS

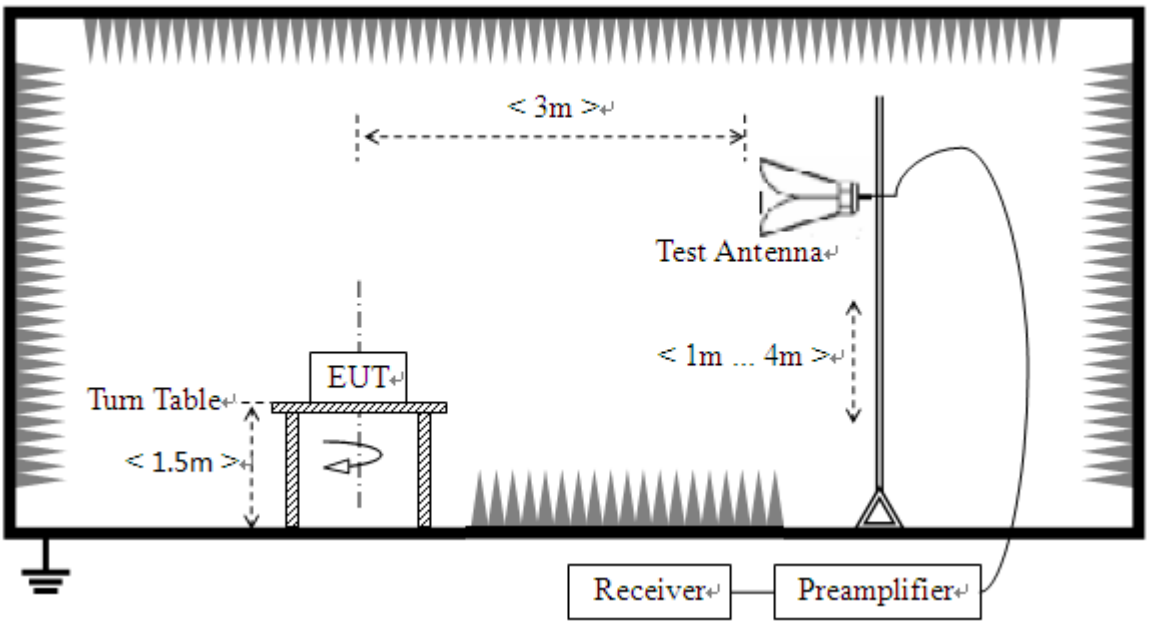
2.11. Restricted Frequency Bands

2.11.1. Requirement

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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).

2.11.2. Test Description

A. Test Setup:



The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading. During the measurement, the Bluetooth Module of the EUT is activated and controlled by the Bluetooth Service Supplier (SS) via a Common Antenna, and is set to operate under non hopping-on test mode transmitting 339 bytes DH5, 679 bytes 2DH5 and 1021 bytes 3DH5 packages at maximum power.
For the Test Antenna:

Horn Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the ground to determine the maximum value of the field strength.

2.11.3. Test Procedure

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1GHz, 100 KHz for f < 1GHz
VBW = 3 MHz for peak and 10Hz for average
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize.

2.11.4. Test Result

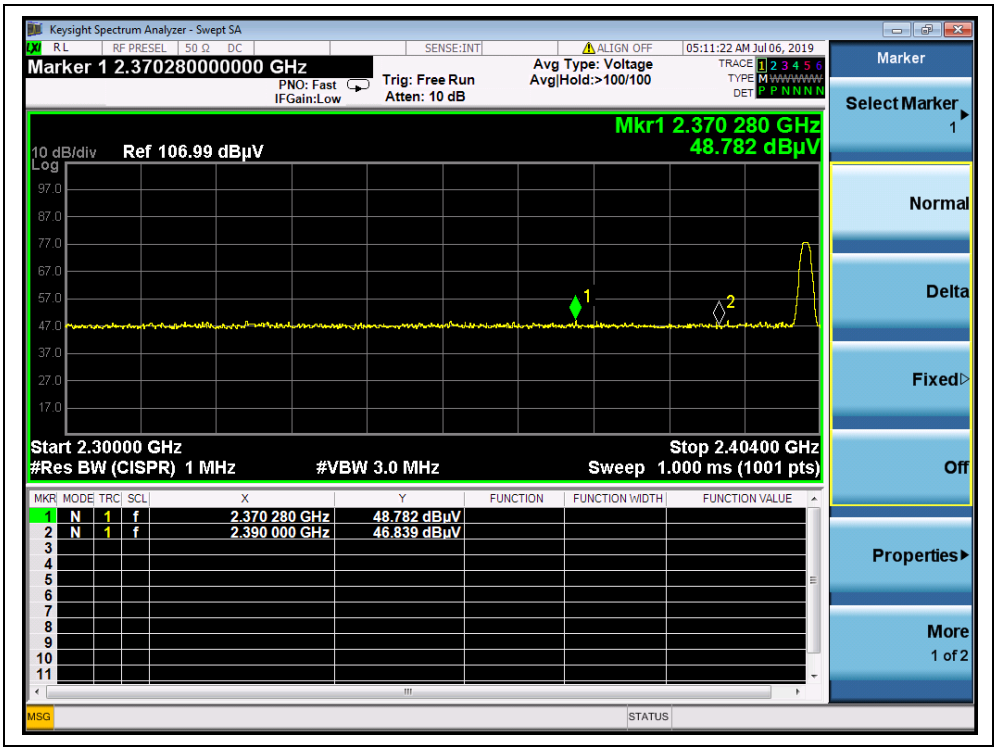
The lowest and highest channels are tested to verify Restricted Frequency Bands.
The measurement results are obtained as below:
E [dBμV/m] =U_R + A_T + A_{Factor} [dB]; AT =$L_{Cable\ loss}$ [dB]-G_{preamp} [dB]
AT: Total correction Factor except Antenna
UR: Receiver Reading
Gpreamp: Preamplifier Gain
AFactor: Antenna Factor at 3m
Note: Restricted Frequency Bands were performed when antenna was at vertical and horizontal polarity, and only the worse test condition (vertical) was recorded in this test report.

GFSK Mode

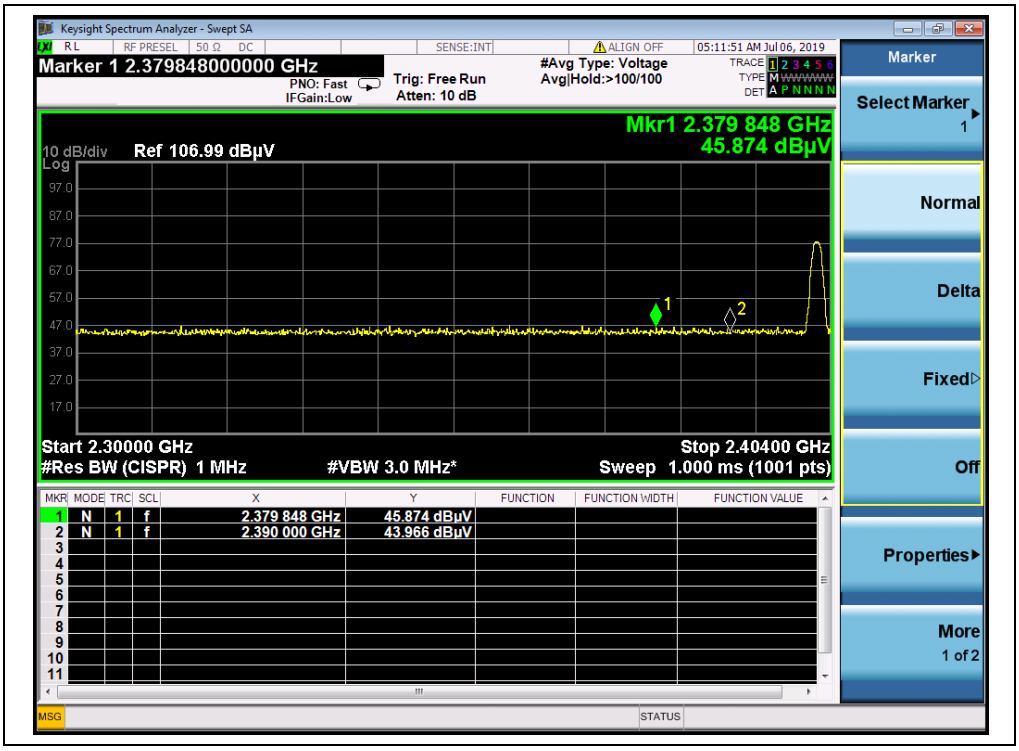
A. Test Verdict:

Channel	Frequency (MHz)	Detector PK/ AV	Receiver Reading U_R (dBuV)	A_T (dB)	A_{Factor} (dB@3m)	Max. Emission E (dBμV/m)	Limit (dBμV/m)	Verdict
0	2370.28	PK	48.78	-29.67	32.56	51.67	74	PASS
0	2379.85	AV	45.87	-29.67	32.56	48.76	54	PASS
78	2485.02	PK	47.85	-29.67	32.56	50.74	74	PASS
78	1486.23	AV	46.49	-29.67	32.56	49.38	54	PASS

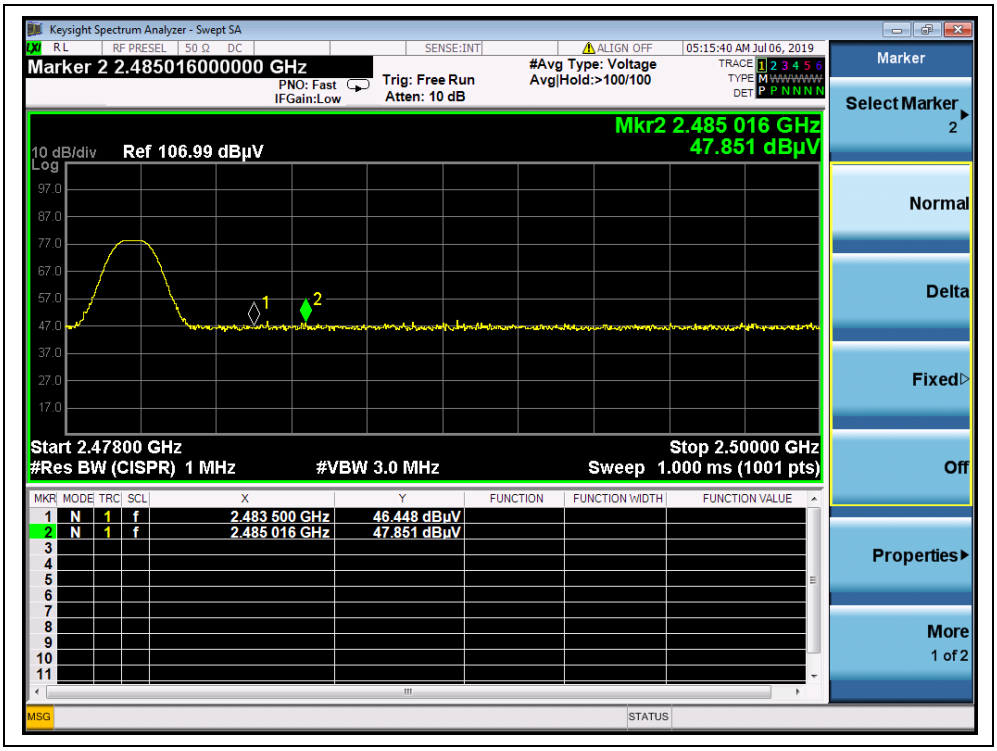
B. Test Plots:



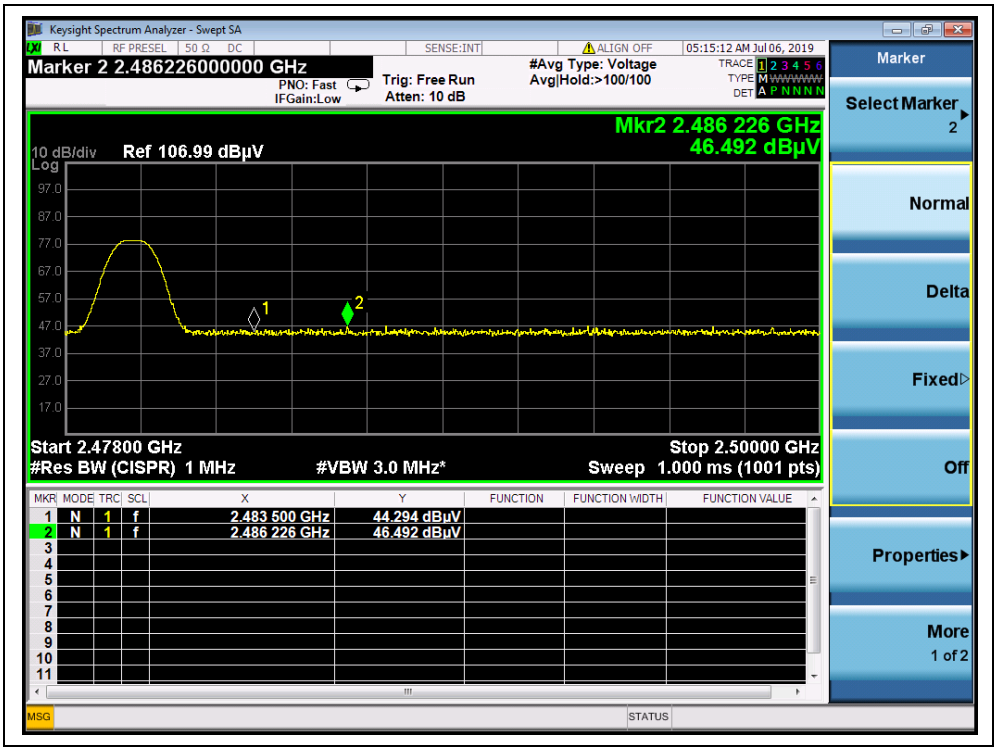
(Channel = 0, PEAK, GFSK)



(Channel = 0, AVERAGE, GFSK)



(Channel = 78, PEAK, GFSK)



(Channel = 78, AVERAGE, GFSK)

2.12. Radiated Emission

2.12.1. Requirement

According to FCC section 15.247(d), radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).
According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

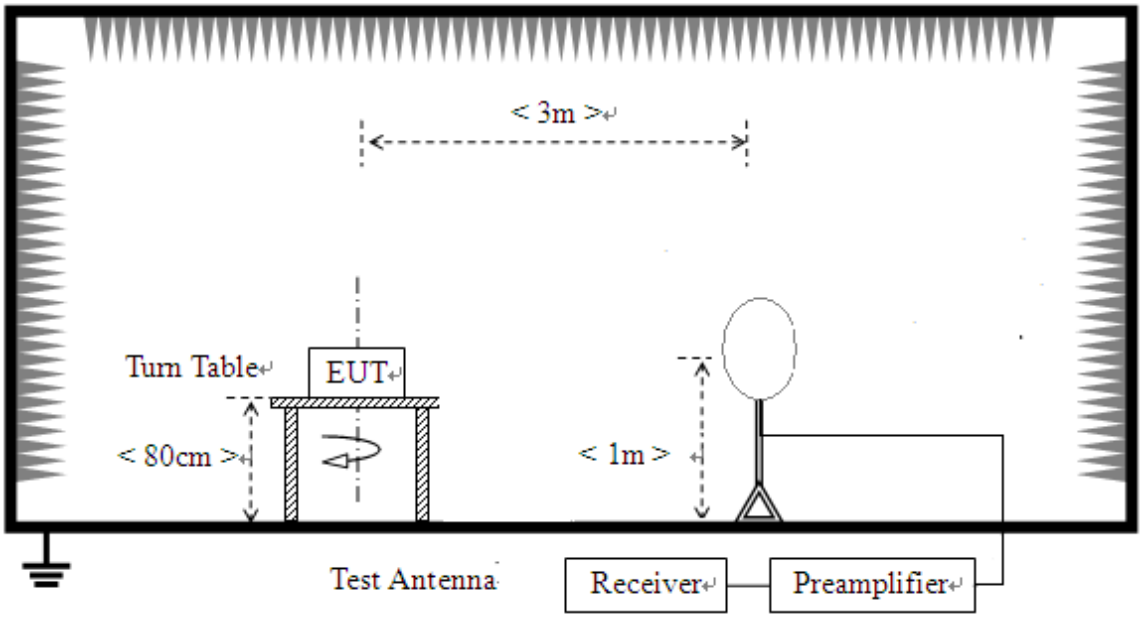
1. For Above 1000MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
2. For above 1000MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK)

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), also should comply with the radiated emission limits specified in Section 15.209(a)(above table)

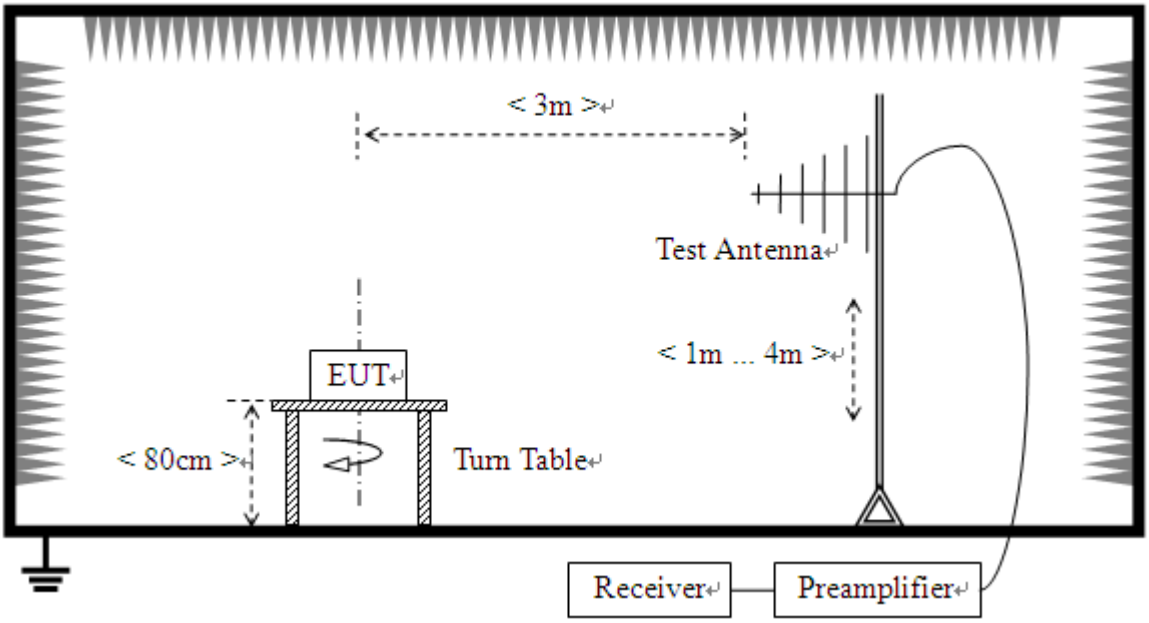
2.12.2. Test Description

A. Test Setup:

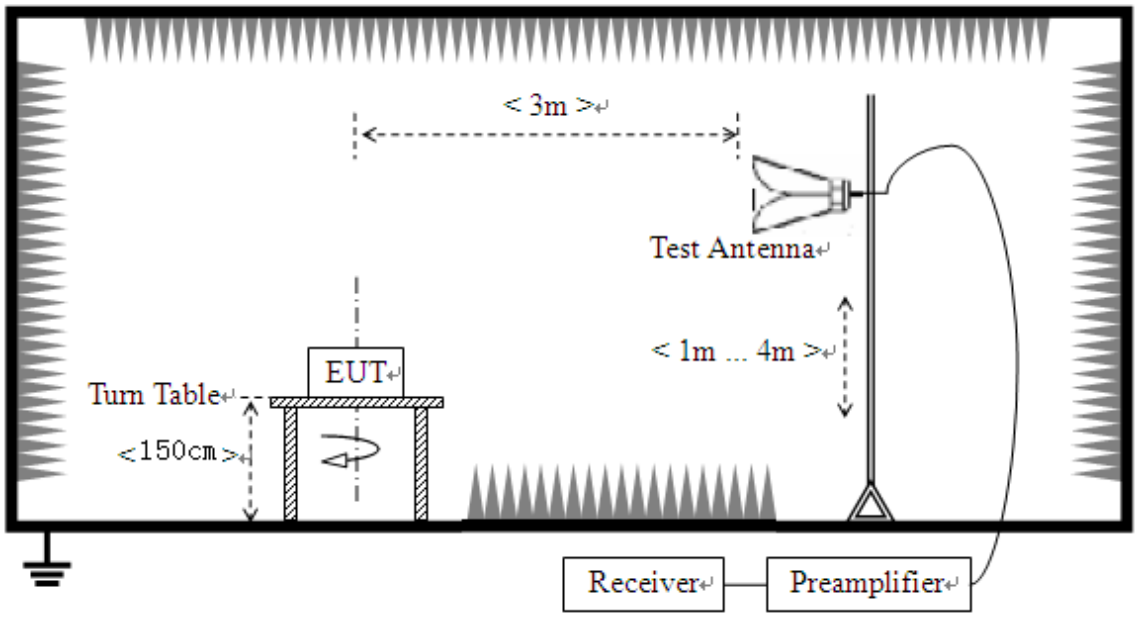
1) For radiated emissions from 9kHz to 30MHz



2) For radiated emissions from 30MHz to1GHz



3) For radiated emissions above 1GHz



The RF absorbing material used on the reference ground plane and on the turntable have a maximum height (thickness) of 30 cm (12 in) and have a minimum-rated attenuation of 20 dB at all frequencies from 1 GHz to 18 GHz.

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4dB according to the standards: ANSI C63.10 (2013). For radiated emissions below or equal to 1GHz, the EUT was set-up on insulator 80cm above the Ground Plane, For radiated emissions above 1GHz, The EUT was set-up on insulator 150cm above the Ground Plane. The set-up and test methods were according to ANSI C63.10.

The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading.

For the Test Antenna:

(a) In the frequency range of 9kHz to 30MHz, magnetic field is measured with Loop Test Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
(b) In the frequency range above 30MHz, Bi-Log Test Antenna (30MHz to 1GHz) and Horn Test Antenna (above 1GHz) are used. Place the test antenna at 3m away from area of the EUT, while keeping the test antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The test 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 test antenna elevation shall be that which maximizes the emissions. The test 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. The emission levels at both horizontal and vertical polarizations should be tested.

2.12.3. Test Procedure

Use the following spectrum analyzer settings:
Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2.12.4. Test Result

According to ANSI C63.10, because of peak detection will yield amplitudes equal to or greater than amplitudes measured with the quasi-peak (or average) detector, the measurement data from a spectrum analyzer peak detector will represent the worst-case results, if the peak measured value complies with the quasi-peak limit, it is unnecessary to perform an quasi-peak measurement.

The measurement results are obtained as below:

E [dBμV/m] $= U_R + A_T + A_{Factor}$ [dB]; $A_T = L_{Cable\ loss}$ [dB]$-G_{preamp}$ [dB]

A_T: Total correction Factor except Antenna

U_R: Receiver Reading

G_{preamp}: Preamplifier Gain

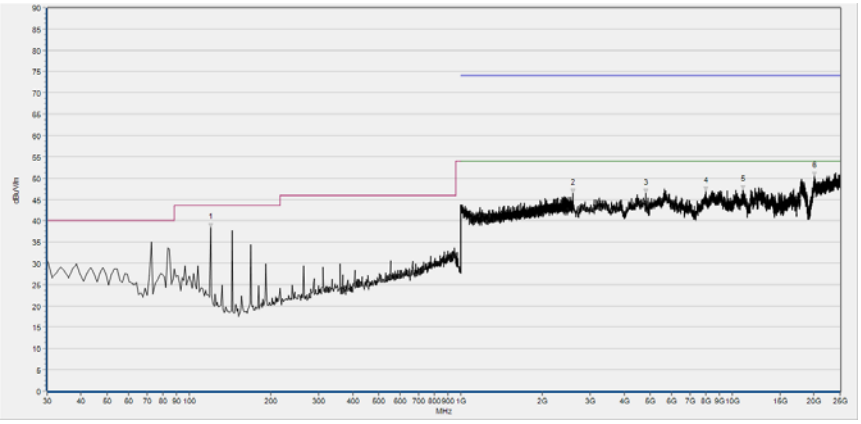
A_{Factor}: Antenna Factor at 3m

During the test, the total correction Factor AT and A_{Factor} were built in test software.

Note1: All radiated emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.
Note2: For the frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit was not recorded.
Note3: For the frequency, which started from 25GHz to 40GHz, was pre-scanned and the result which was 20dB lower than the limit was not recorded.

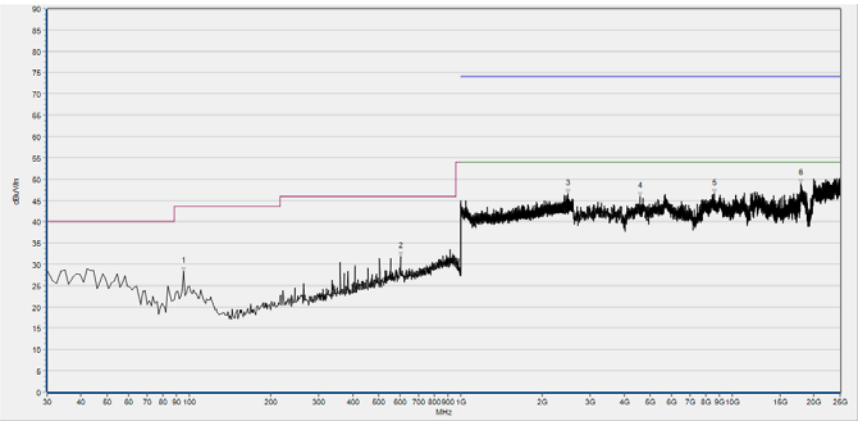
GFSK Mode

Plots for Channel = 0



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
119.837	38.36	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
2588.475	46.41	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
4803.746	46.40	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
7989.198	46.86	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
10958.756	47.20	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
20058.883	50.46	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS

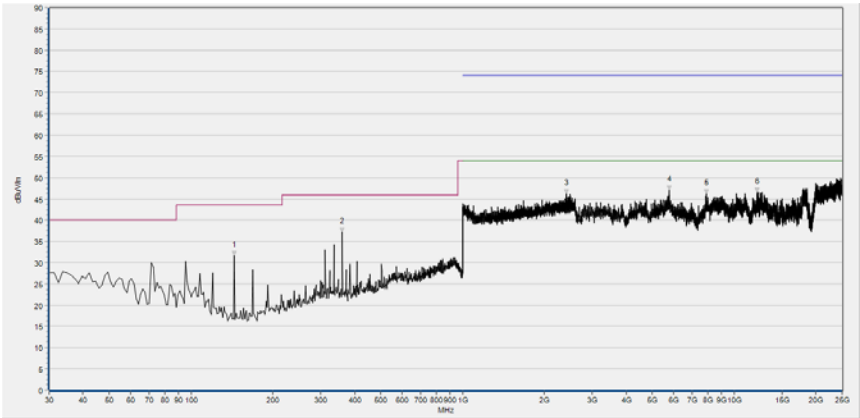
(30MHz to 25GHz, Antenna Horizontal, GFSK, channel 0)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
95.557	28.29	N/A	N/A	N/A	43.50	N/A	Vertical	PASS
600.588	31.91	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
2489.876	46.51	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
4579.705	45.92	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
8624.659	46.55	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
17969.194	49.00	N/A	N/A	74.00	N/A	54.00	Vertical	PASS

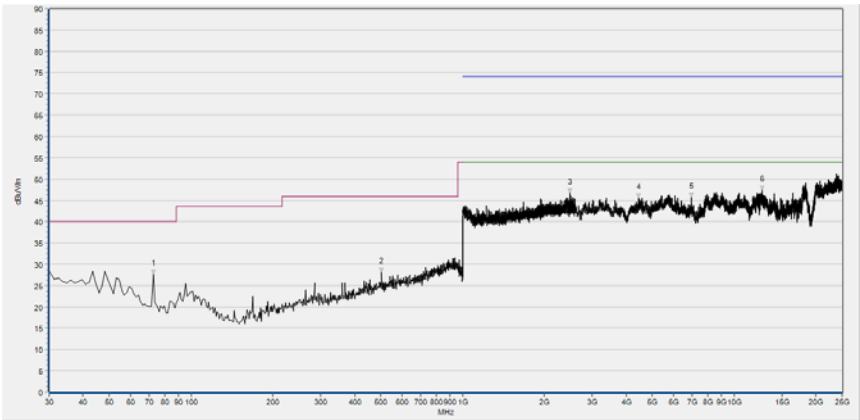
(30MHz to 25GHz, Antenna Vertical, GFSK, channel 0)

Plot for Channel = 39



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
144.118	31.62	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
360.213	37.14	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
2418.167	46.20	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
5752.864	47.03	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
7887.361	46.20	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
12135.988	46.65	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS

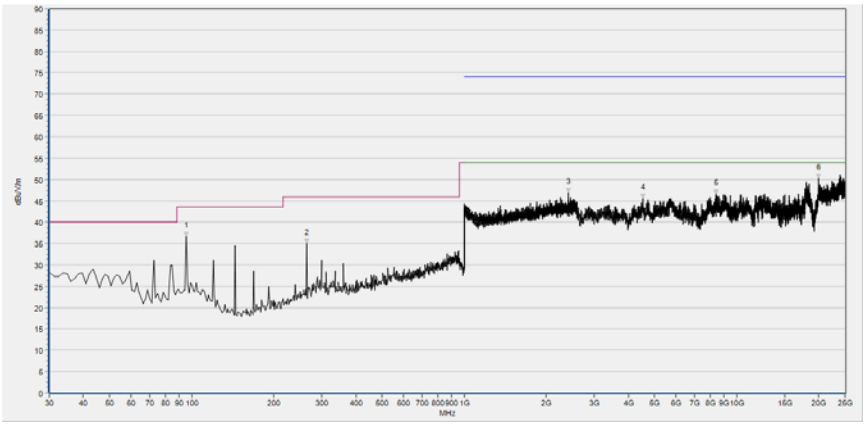
(30MHz to 25GHz, Antenna Horizontal, GFSK, channel 39)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
72.491	27.70	N/A	N/A	N/A	40.00	N/A	Vertical	PASS
503.467	28.16	N/A	N/A	N/A	46.00	N/A	Vertical	PASS
2486.675	46.69	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
4437.134	45.54	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
6954.537	45.68	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
12669.613	47.44	N/A	N/A	74.00	N/A	54.00	Vertical	PASS

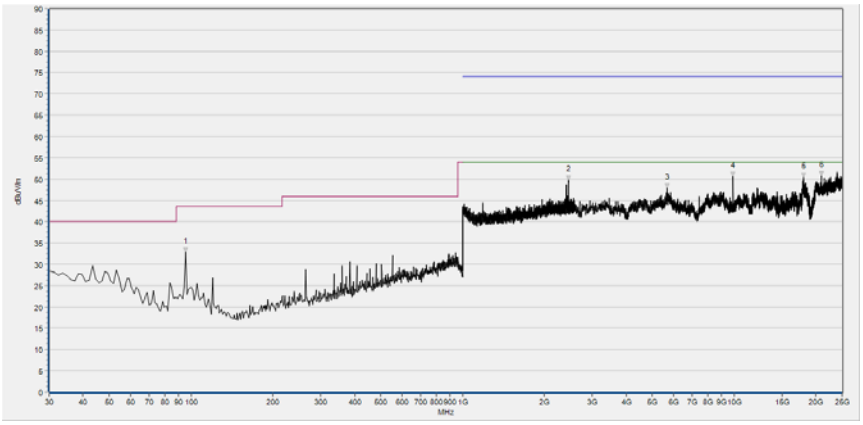
(30MHz to 25GHz, Antenna Vertical, GFSK, channel 39)

Plot for Channel = 78



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
95.557	36.66	N/A	N/A	N/A	43.50	N/A	Horizontal	PASS
264.305	35.08	N/A	N/A	N/A	46.00	N/A	Horizontal	PASS
2407.283	46.96	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
4518.603	45.57	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
8420.986	46.63	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS
20010.002	50.34	N/A	N/A	74.00	N/A	54.00	Horizontal	PASS

(30MHz to 25GHz, Antenna Horizontal, GFSK, channel 78)



Fre. (MHz)	Pk (dBμV/m)	QP (dBμV/m)	AV (dBμV/m)	Limit-PK (dBμV/m)	Limit-QP (dBμV/m)	Limit-AV (dBμV/m)	Antenna	Verdict
95.557	32.80	N/A	N/A	N/A	4.50	N/A	Vertical	PASS
2452.741	49.80	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
5679.542	47.87	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
9920.022	50.59	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
17985.488	50.45	N/A	N/A	74.00	N/A	54.00	Vertical	PASS
20942.826	50.70	N/A	N/A	74.00	N/A	54.00	Vertical	PASS

(30MHz to 25GHz, Antenna Vertical, GFSK, channel 78)

Annex A Test Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for test performed on the EUT as specified in CISPR 16-1-2:

Test items	Uncertainty
Number of Hopping Frequency	±5%
Peak Output Power	±2.22dB
20dB Bandwidth	±5%
Carrier Frequency Separation	±5%
Time of Occupancy (Dwell time)	±5%
Conducted Spurious Emission	±2.77 dB
Restricted Frequency Bands	±5%
Radiated Emission	±2.95dB
Conducted Emission	±2.44dB

This uncertainty represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2

Annex B Testing Laboratory Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Laboratory Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

3. Facilities and Accreditations

All measurement facilities used to collect the measurement data are located at FL.3, Building A, FeiYang Science Park, Block 67, BaoAn District, Shenzhen, 518101 P. R. China. The test site is constructed in conformance with the requirements of ANSI C63.10-2013 and CISPR Publication 22; the FCC designation number is CN1192, the test firm registration number is 226174.

4. Test Equipments Utilized

4.1 Conducted Test Equipments

Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
Bluetooth Base Station	6K00006210	MT8852B	Anritsu	2019.04.09	2020.04.08
Directional coupler	17041703	DTO-5-30	ShangHai Huaxiang	N/A	N/A
EXA Signal Analzyer	MY53470836	N9010A	Agilent	2019.04.09	2020.04.08
RF cable (30MHz-26GHz)	CB01	RF01	Morlab	N/A	N/A
Coaxial cable	CB02	RF02	Morlab	N/A	N/A
SMA connector	CN01	RF03	HUBER-SUHNER	N/A	N/A
Computer	T430i	Think Pad	Lenovo	N/A	N/A

4.2 Conducted Emission Test Equipments

Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
Receiver	MY56400093	N9038A	KEYSIGHT	2019.05.08	2020.05.09
LISN	812744	NSLK 8127	Schwarzbeck	2019.05.08	2020.05.09
Pulse Limiter (20dB)	9391	VTSD 9561-D	Schwarzbeck	2019.05.08	2020.05.09
Coaxial cable(BNC) (30MHz-26GHz)	CB01	EMC01	Morlab	N/A	N/A
PC Adapter	C517271EA1 000085	A1374	LITE-ON POWER TECHNOLOGY (DONGGUAN) Co., LTD	N/A	N/A
PC	C02FQ2PYD DQW	A1370	Apple	N/A	N/A

4.3 List of Software Used

Description	Manufacturer	Software Version
Test system	Tonscend	V2.6
Power Panel	Agilent	V3.8
MORLAB EMCR V1.2	MORLAB	V 1.0

4.4 Radiated Test Equipments

Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
Receiver	MY54130016	N9038A	Agilent	2018.08.04	2019.08.03
Test Antenna - Bi-Log	9163-519	VULB 9163	Schwarzbeck	2019.05.08	2020.05.09
Test Antenna - Loop	1519-022	FMZB1519	Schwarzbeck	2019.02.15	2020.02.14
Test Antenna – Horn	01774	BBHA 9120D	Schwarzbeck	2018.08.06	2019.08.05
Test Antenna – Horn	BBHA9170 #774	BBHA9170	Schwarzbeck	2018.08.02	2019.08.01
Coaxial cable (N male) (9KHz-30MHz)	CB04	EMC04	Morlab	N/A	N/A
Coaxial cable (N male) (30MHz-26GHz)	CB02	EMC02	Morlab	N/A	N/A
Coaxial cable (N male) (30MHz-26GHz)	CB03	EMC03	Morlab	N/A	N/A
1-18GHz pre-Amplifier	MA02	TS-PR18	Rohde& Schwarz	2019.05.08	2020.05.09
18-26.5GHz pre-Amplifier	MA03	TS-PR18	Rohde& Schwarz	2019.05.08	2020.05.09
Notch Filter	N/A	WRCG-2400-2483.5-60SS	Wainwright	2018.12.01	2019.11.30
Anechoic Chamber	N/A	9m*6m*6m	CRT	2017.11.19	2020.11.18

END OF REPORT