



TEST REPORT		
Report Number.:	90747-25-72-25-PP001	
Date of issue	2025-08-18	
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Address	No. 11, Wu Song Road, Dongcheng District Dongguan, Guangdong Province, 523117, People's Republic of China	
Applicant's name.....:	Shenzhen Frageway Technology CO.,LTD	
Address	Room 303,Building 2,No. 13 Tianyuan Road, Dongfang Community, Songgang Street, Bao'an District, Shenzhen	
Manufacturer's name	Shenzhen Frageway Technology CO.,LTD	
Address	Room 303,Building 2,No. 13 Tianyuan Road, Dongfang Community, Songgang Street, Bao'an District, Shenzhen	
Factory's name	Shenzhen Frageway Technology CO.,LTD	
Address	Room 303,Building 2,No. 13 Tianyuan Road, Dongfang Community, Songgang Street, Bao'an District, Shenzhen	
Standard(s).....:	FCC 47 CFR Part 15, Subpart C	
Test item description	TRUE WIRELESS EARBUDS	
Trade Mark.....:	N/A	
Model/Type reference.....:	TWSSQUPM52-CP, TWSSQUPM52-CTC, TWSSQUPM52-LC, TWSSQUPM52-ASST	
FCC ID.....:	2BH5P-TWSSQUPM52	
Date of receipt of test item ...:	2025-06-09	
Date (s) of performance of test	2025-06-10 to 2025-06-25	
Summary of Test Results	Pass	
The Summary of Test Results based on a technical opinion belongs to the standard(s).		
General disclaimer: This report shall not be reproduced except in full, without the written approval of SLG-CPC Testlaboratory Co., Ltd. The test results in the report only apply to the tested sample.		



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Modified Information

Report No.	Revision Data	Summary
90747-25-72-25-PP001	2025-08-18	Original Version

1 EUT TECHNICAL DESCRIPTION

Characteristics	Description
Product	TRUE WIRELESS EARBUDS
Model Number	TWSSQUPM52-CP, TWSSQUPM52-CTC, TWSSQUPM52-LC, TWSSQUPM52-ASST (All models are identical except for the model name and color; All tests were performed on model TWSSQUPM52-CP)
Device Type	Bluetooth V5.4
Data Rate	1Mbps for BT V5.4 GFSK modulation 2Mbps for BT V5.4 pi/4-DQPSK modulation
Modulation:	GFSK modulation for BT V5.4 (1Mbps) pi/4-DQPSK modulation for BT V5.4 (2Mbps)
Operating Frequency Range(s):	2402-2480MHz
Number of Channels:	79 channels
Transmit Power Max:	-2.07 dBm
Antenna Type	PCB Antenna
Antenna Gain	2.5 dBi
Power supply	Input: DC 5V 1A Charging box: DC 3.7V 200mAh Battery Capacity: DC 3.7V 25mAh

Note: for more details, please refer to the User's manual of the EUT.

2 SUMMARY OF TEST RESULT

FCC Part Clause	Test Parameter	Verdict	Remark
15.247(a)(1)	20 dB Bandwidth	PASS	
15.247(a)(1)	Carrier Frequency Separation	PASS	
15.247(a)(1)	Number of Hopping Frequencies	PASS	
15.247(a)(1)	Average Time of Occupancy (Dwell Time)	PASS	
15.247(b)(1)	Maximum Peak Conducted Output Power	PASS	
15.247(c)	Conducted Spurious Emissions	PASS	
15.247(d) 15.209	Radiated Spurious Emissions	PASS	
15.207	Conducted Emission	PASS	
15.203	Antenna Application	PASS	
15.247 (a) (1)/g/h	Frequency Hopping System	PASS	
NOTE1: N/A (Not Applicable)			
NOTE2: According to FCC KDB 558074 D01 15.247 Meas Guidance v05r02, the report use radiated measurements in the restricted frequency bands. In addition, the radiated test is also performed to ensure the emissions emanating from the device cabinet also comply with the applicable limits.			

RELATED SUBMITTAL(S) / GRANT(S):

This submittal(s) (test report) is intended for FCC ID: 2BH5P-TWSSQUPM52 filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

3 TEST METHODOLOGY

3.1 GENERAL DESCRIPTION OF APPLIED STANDARDS

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

FCC 47 CFR Part 15, Subpart C

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

3.2 MEASUREMENT EQUIPMENT USED

Equipment	Manufacturer	Model	S/N	Last Cal.	DUE Cal.
RF Connected Test					
Vector Signal Generator	Rohde & Schwarz	SMBV100B(6G)	101166	2025/04/16	1 year
Analog Signal Generator	Rohde & Schwarz	SMB100A(40G)	181333	2025/06/18	1 year
Signal Analyzer	Rohde & Schwarz	FSV40	101527	2025/03/26	1 year
Power Analyzer	Rohde & Schwarz	OSP-B157W8	N/A	2025/04/16	1 year
Wideband Radio Communication Tester	R&S	CMW270	101985	2025/04/18	1 year
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500	166898	2025/04/14	1 year
Temperature&Humidity test chamber	ESPEC	VC 4018	/	2025/03/26	1 year
Radiated Emission Test					
EMI Test Receiver	KEYSIGHT	N9010A	MY56070465	2024/12/03	1 year
EMI Test Receiver	Rohde & Schwarz	FSV40	101511	2025/01/10	1 year
Bilog Antenna	Schwarzbeck	VULB 9163	01335	2023/04/21	3 year
Broadband Antenna	Schwarzbeck	9162	139	2025/03/01	3 year
Power Amplifier	EMEC	EM330	060676	2025/03/11	3 year
Cable	Tuyue	F4309	L-400-NmNm-12000	2024/12/03	2 year
Horn Antenna	Schwarzbeck	BBHA9120D	1779	2025/03/28	3 year
Horn Antenna	Schwarzbeck	BBHA9170	00954	2022/09/13	3 year
Power Amplifier	Rohde & Schwarz	SCU08F2	008400019	2025/03/24	3 year
Power Amplifier	Rohde & Schwarz	SCU-18F	180118	2025/03/24	3 year
Power Amplifier	Rohde & Schwarz	SCU40A	100499	2023/06/21	3 year
Active Loop Antenna	ETS LINDGREN	6512	41623	2025/03/19	3 year
Test Software	Farad	EZ-EMC	Ver.CPC-3A1	/	/
Conducted Emission Test					
LISN	Schwarzbeck	NSLK 8127	8127-892	2025/03/17	1 year
EMI Test Receiver	R&S	ESR3	102124	2024/12/03	1 year
Triple loop	R&S	HM020	834206/006	2024/12/03	2 year
Pulse Limiter	R&S	ESH3-Z2	357.8810.52	2024/12/03	1 year
Test Software	Farad	EZ-EMC	Ver.CPC-3A1	/	/

3.3 DESCRIPTION OF TEST MODES

The EUT has been tested under its typical operating condition.

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

Test of channel included the lowest and middle and highest frequency to perform the test, then record on this report.

Those data rates (1Mbps for Bluetooth V5.4 GFSK modulation; 2Mbps for Bluetooth V5.4 pi/4-DQPSK modulation) were used for all test.

Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

Frequency and Channel list for Bluetooth V5.4

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	39	2441	...	...
1	2403	40	2442	76	2478
2	2404	41	2443	77	2479
...	...	...	...	78	2480
Note: $f_c = 2402\text{MHz} + (k-1) \times 1\text{MHz}$ $k=1$ to 79					

Test Frequency and channel for Bluetooth V5.4

Lowest Frequency		Middle Frequency		Highest Frequency	
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	39	2441	78	2480

4 FACILITIES AND ACCREDITATIONS

4.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

No. 11, Wu Song Road, Dongcheng District Dongguan, Guangdong Province, 523117, People's Republic of China

The sites are constructed in conformance with the requirements of ANSI C63.4, ANSI C63.10 and CISPR Publication 32.

4.2 LABORATORY ACCREDITATIONS AND LISTINGS

Site Description

EMC Lab. : Accredited by ISED, October 31 2023
CAB identifier: CN0126
Company Number: 27767

Accredited by A2LA, October 31 2023
The Certificate Registration Number is 6325.01

Accredited by FCC
Designation Number: CN1287
Test Firm Registration Number: 394054

Name of Firm : SLG-CPC Testlaboratory Co., Ltd.
Site Location : No. 11, Wu Song Road, Dongcheng District Dongguan, Guangdong Province, 523117, People's Republic of China

5 TEST SYSTEM UNCERTAINTY

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

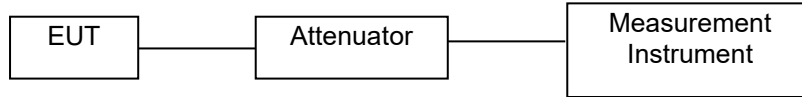
Parameter	Uncertainty
Radio Frequency	$\pm 1 \times 10^{-5}$
Maximum Peak Output Power Test	$\pm 1.0\%$
Conducted Emissions Test	3.68dB
Radiated Emission Test	4.80dB (below 1G) 3.26dB (above 1GHz)
Power Density	$\pm 0.9\%$
Occupied Bandwidth Test	$\pm 2.3\%$
Band Edge Test	$\pm 1.2\%$
Antenna Port Emission	$\pm 3\text{dB}$
Temperature	$\pm 3.2\%$
Humidity	$\pm 2.5\%$

Measurement Uncertainty for a level of Confidence of 95%

6 SETUP OF EQUIPMENT UNDER TEST

6.1 RADIO FREQUENCY TEST SETUP 1

The Bluetooth V5.4 component's antenna port(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The EUT is controlled by PC/software to emit the specified signals for the purpose of measurements.



6.2 RADIO FREQUENCY TEST SETUP 2

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10. The test distance is 3m. The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 32.

Below 30MHz:

The EUT is placed on a turntable 0.8meters above the ground in the chamber, 3 meter away from the antenna (loop antenna). The Antenna should be positioned with its plane vertical at the specified distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. The center of the loop shall be 1 m above the ground. For certain applications, the loop antenna plane may also need to be positioned horizontally at the the specified distance from the EUT.

Above 30MHz:

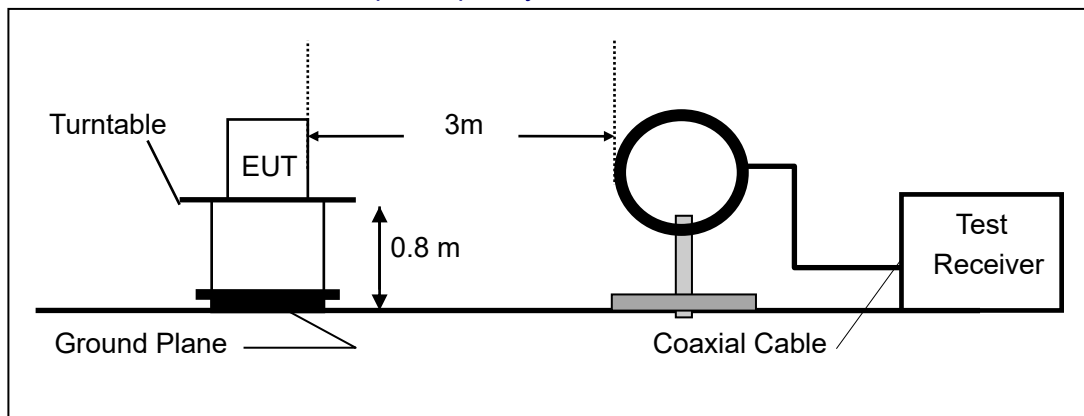
The EUT is placed on a turntable 0.8meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

Above 1GHz:

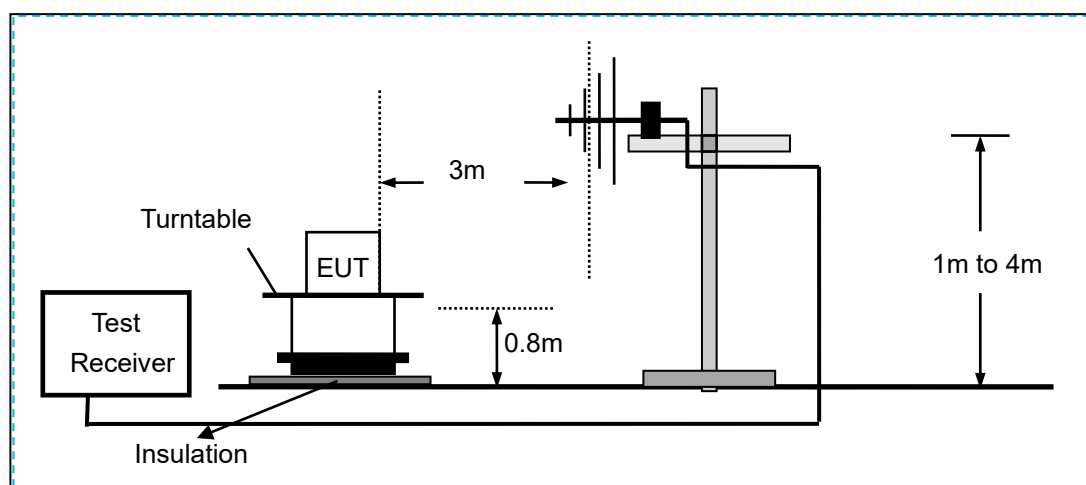
(Note: The testing follows the guidelines in Spurious Radiated Emissions of ANSI C63.10-2013.)

The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

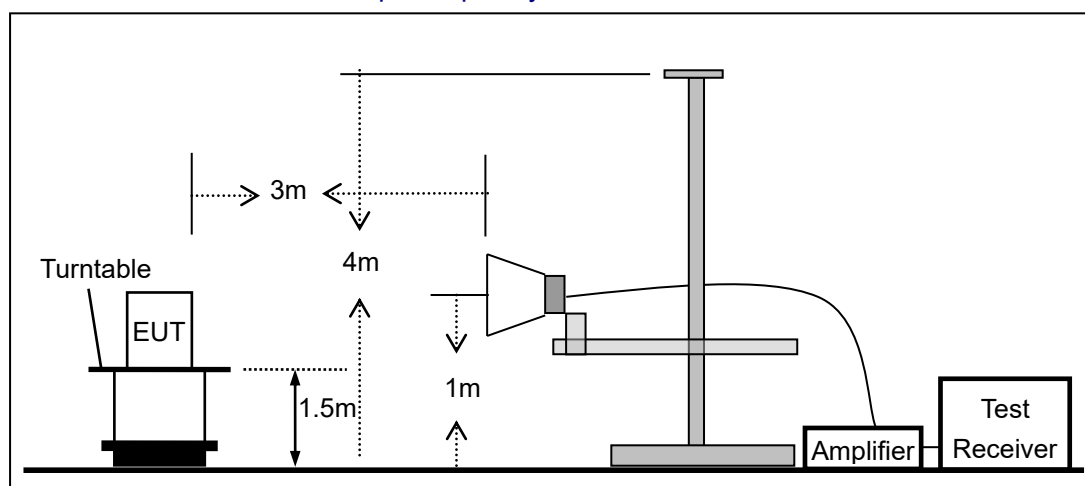
(a) Radiated Emission Test Set-Up, Frequency Below 30MHz



(b) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(c) Radiated Emission Test Set-Up, Frequency above 1000MHz

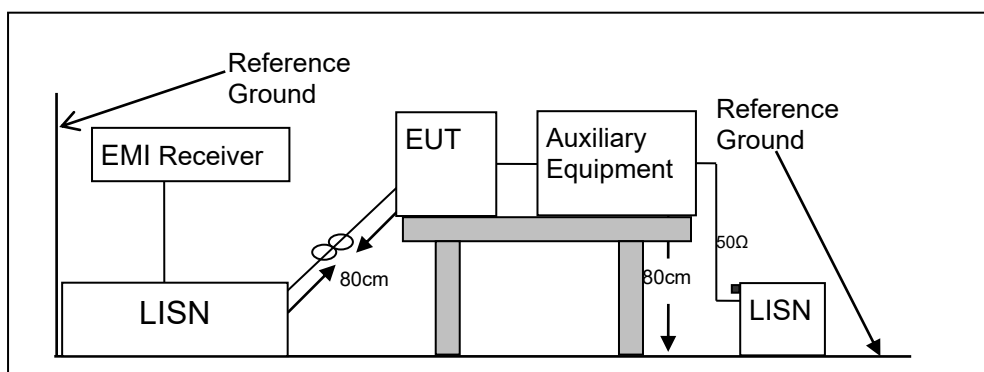


6.3 CONDUCTED EMISSION TEST SETUP

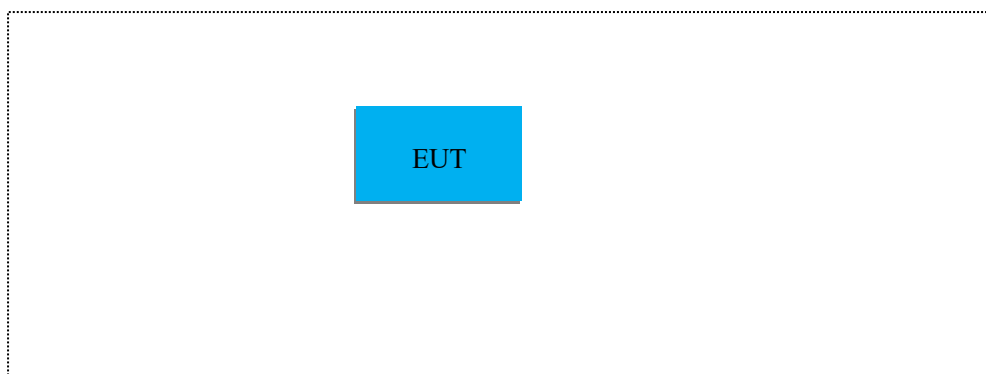
The mains cable of the EUT (Perfect Share Mini) must be connected to LISN. The LISN shall be placed 0.8m from the boundary of EUT and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance is between the closest points of the LISN and the EUT. All other units of the EUT and associated equipment shall be at least 0.8m from the LISN.

Ground connections, where required for safety purposes, shall be connected to the reference ground point of the LISN and, where not otherwise provided or specified by the manufacturer, shall be of same length as the mains cable and run parallel to the mains connection at a separation distance of not more than 0.8m.

According to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-Peak and average detector mode.



6.4 BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM



6.5 SUPPORT EQUIPMENT

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

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

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

7 TEST REQUIREMENTS

7.1 20DB BANDWIDTH

7.1.1 Applicable Standard

According to FCC Part 15.247(a)(1) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.1.2 Conformance Limit

No limit requirement.

7.1.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.1.4 Test Procedure

The EUT was operating in Bluetooth V5.4 mode and controlled its channel. Printed out the test result from the spectrum by hard copy function.

The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.

Set to the maximum power setting and enable the EUT transmit continuously

Set RBW = 30 kHz.

Set the video bandwidth (VBW) = 100 kHz.

Set Span = approximately 2 to 3 times the 20 dB bandwidth

Set Detector = Peak.

Set Trace mode = max hold.

Set Sweep = auto couple.

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the markerdelta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation.

Measure and record the results in the test report.

Test Results

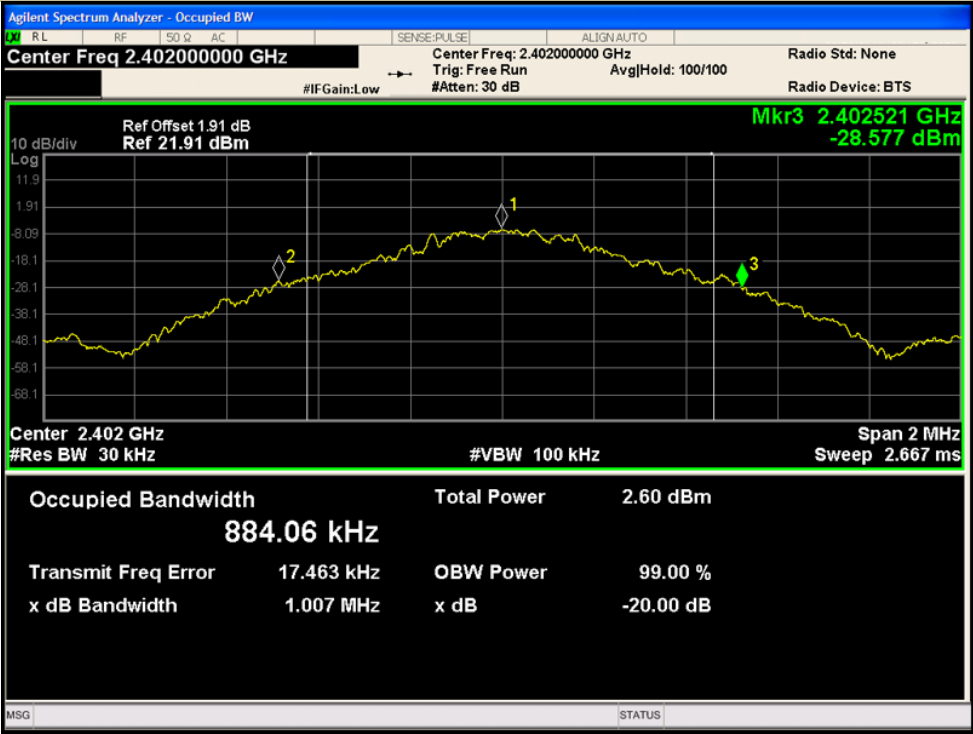
Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Modulation Mode	Channel Number	Channel Frequency (MHz)	Measurement Bandwidth (MHz)	Limit (MHz)	Verdict
GFSK	00	2402	1.007	N/A	PASS
	39	2441	0.983	N/A	PASS
	78	2480	1.005	N/A	PASS
pi/4-DQPSK	00	2402	1.288	N/A	PASS
	39	2441	1.288	N/A	PASS
	78	2480	1.282	N/A	PASS
Note: N/A (Not Applicable)					

Test Model

20dB Bandwidth
Bluetooth V5.4
Channel 0: 2402MHz

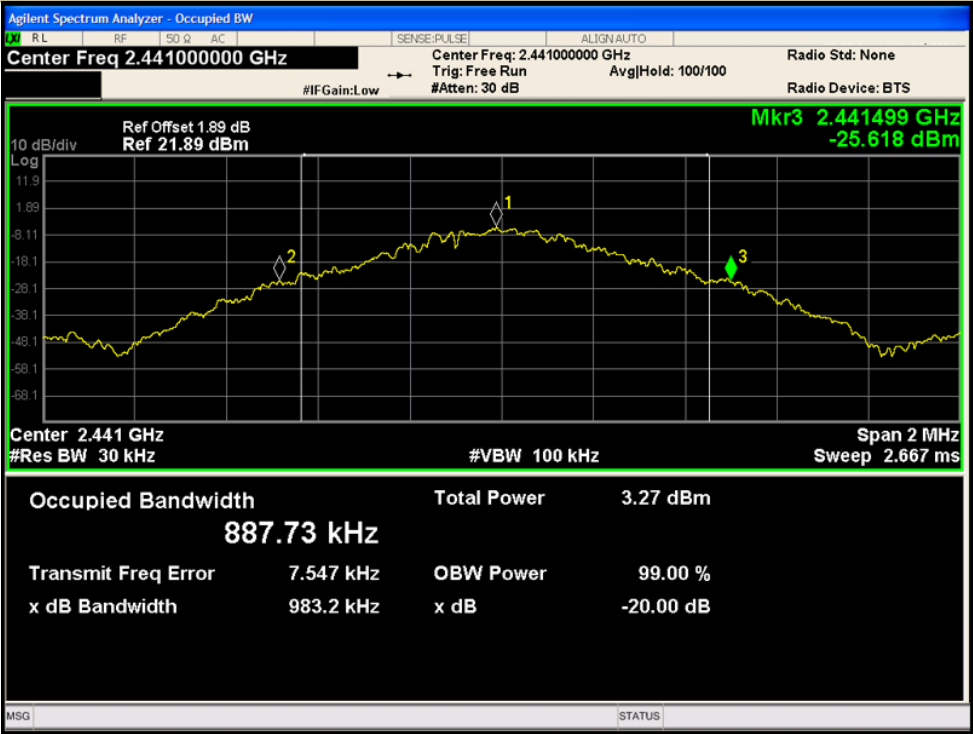
GFSK Modulation



Test Model

20dB Bandwidth
Bluetooth V5.4
Channel 39: 2441MHz

GFSK Modulation

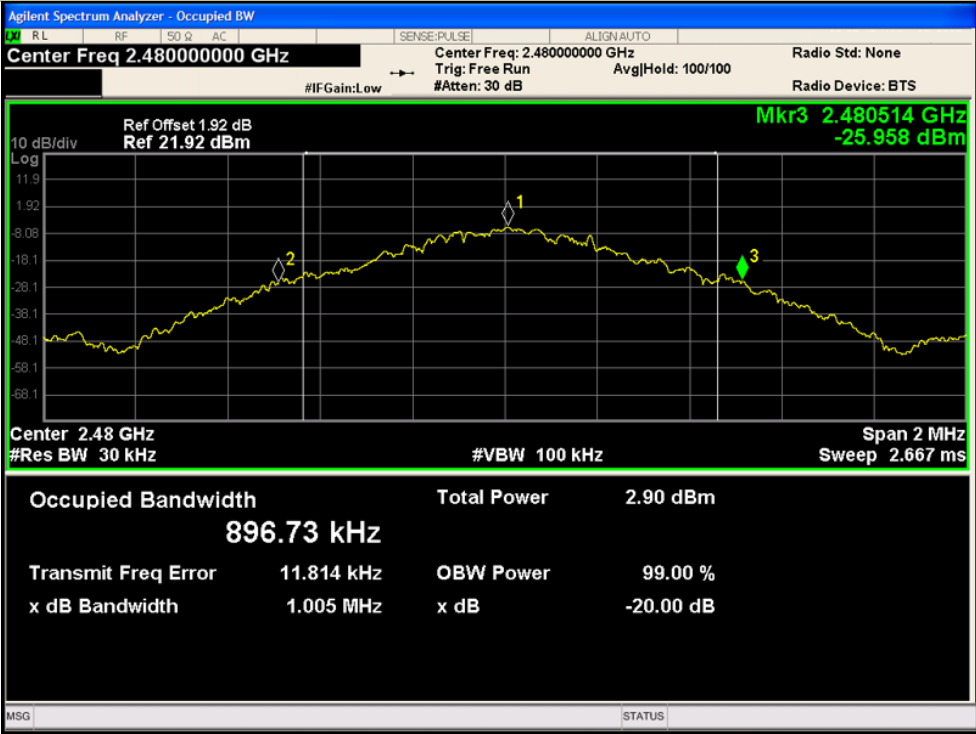


20dB Bandwidth

Test Model Bluetooth V5.4

Channel 78: 2480MHz

GFSK Modulation

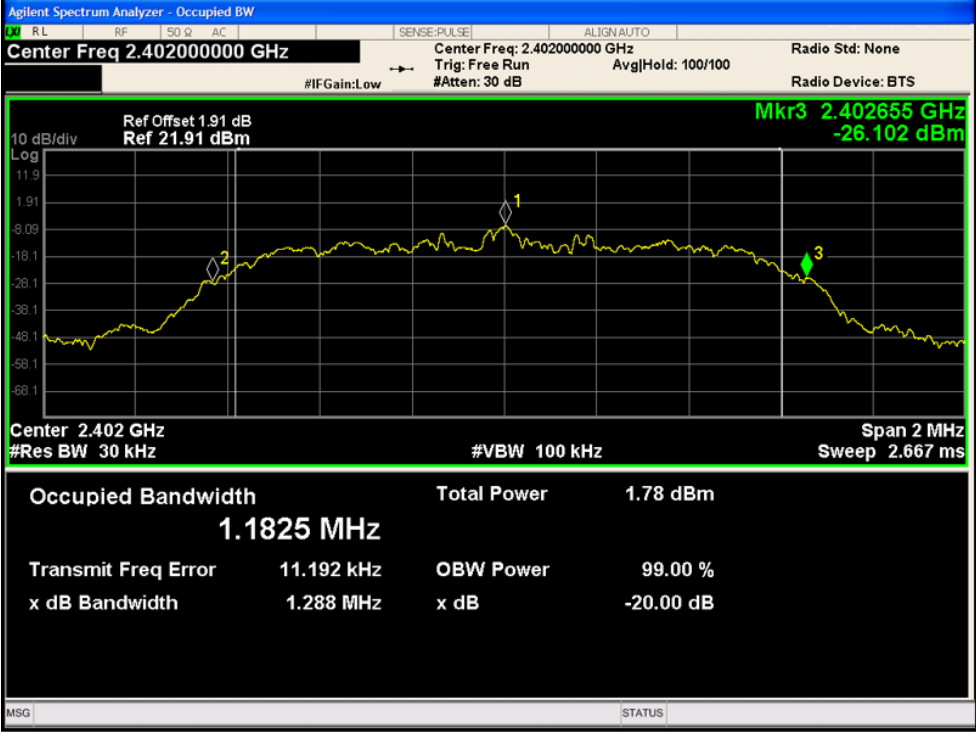


20dB Bandwidth

Test Model Bluetooth V5.4

Channel 0: 2402MHz

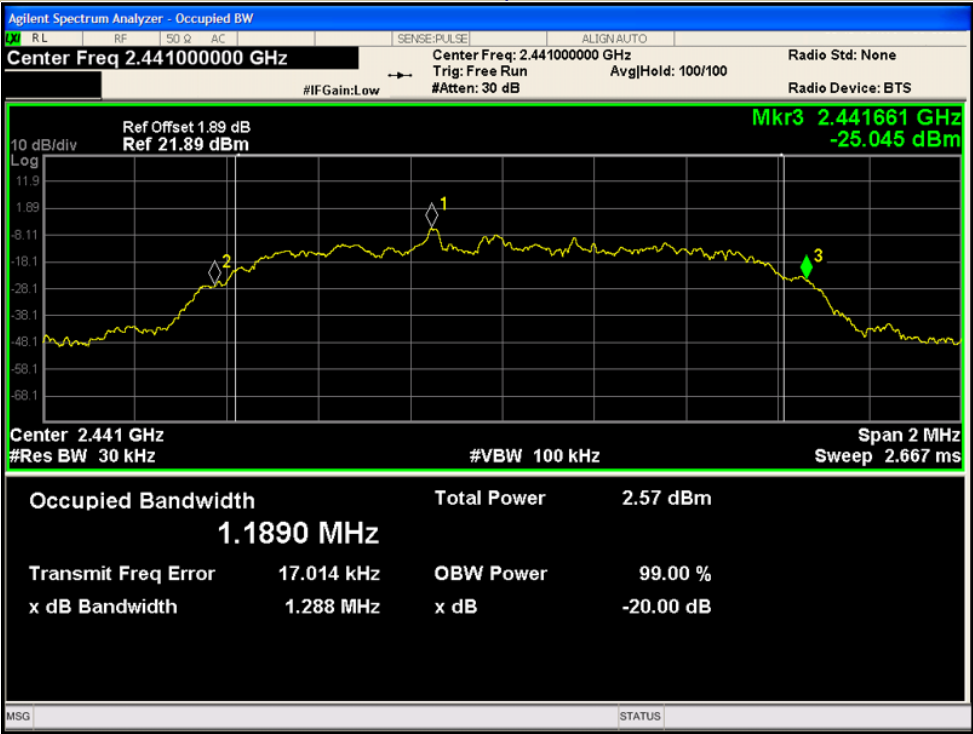
pi/4-DQPSK Modulation



Test Model

20dB Bandwidth
Bluetooth V5.4
Channel 39: 2441MHz

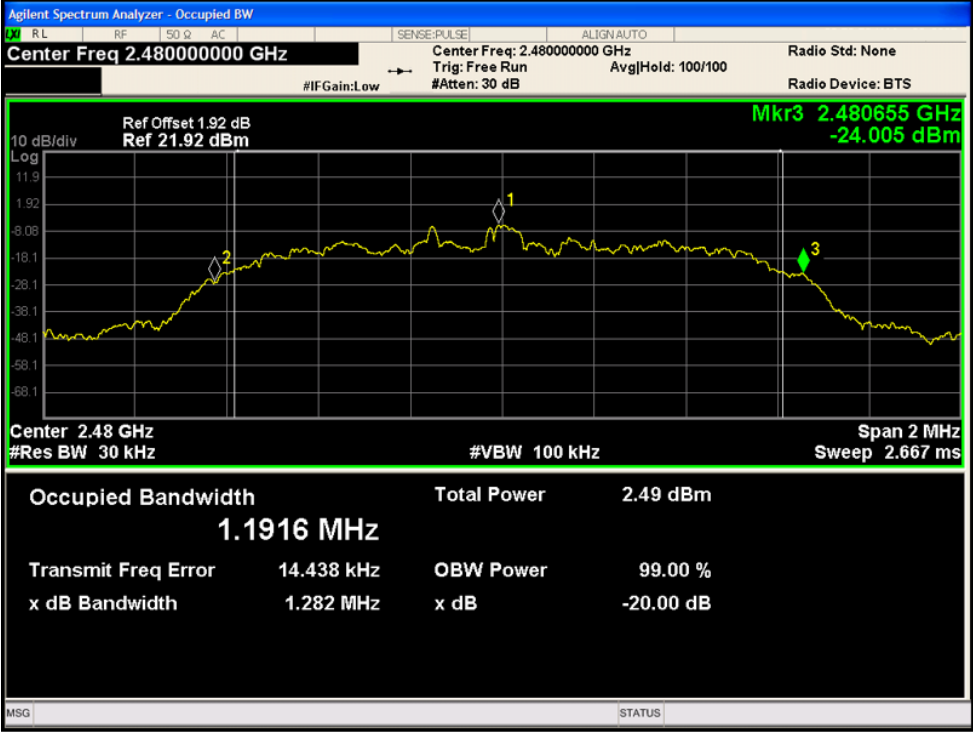
pi/4-DQPSK Modulation



Test Model

20dB Bandwidth
Bluetooth V5.4
Channel 78: 2480MHz

pi/4-DQPSK Modulation



7.2 CARRIER FREQUENCY SEPARATION

7.2.1 Applicable Standard

According to FCC Part 15.247(a)(1) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.2.2 Conformance Limit

Frequency hopping systems operating in the 2400-2483.5MHz band shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

In case of an output power less than 125mW, the frequency hopping system may have channels separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

7.2.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.2.4 Test Procedure

■ According to FCC Part 15.247(a)(1)

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

VBW: Video (or average) bandwidth (VBW) $\geq$ RBW

Set the span = wide enough to capture the peaks of two adjacent channels

Set Sweep time = auto couple.

Set Detector = peak. Set Trace mode = max hold.

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Modulation Mode	Channel Number	Channel Frequency (MHz)	Measurement Bandwidth (kHz)	Limit (kHz)	Verdict
GFSK	0	2402	1006	>671	PASS
	39	2441	1009	>655	PASS
	78	2480	1003	>670	PASS
pi/4-DQPSK	0	2402	1157	>859	PASS
	39	2441	1380	>859	PASS
	78	2480	1054	>855	PASS
Note: Limit = 20dB bandwidth * 2/3					

Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 0: 2402MHz

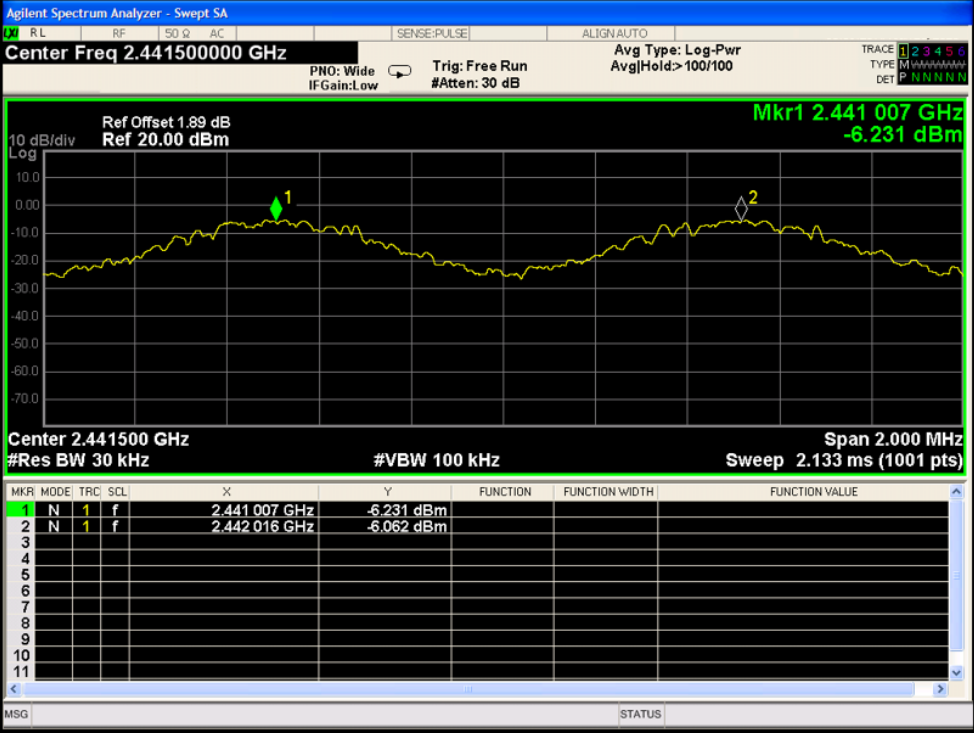
GFSK Modulation



Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 39: 2441MHz

GFSK Modulation



Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 78: 2480MHz

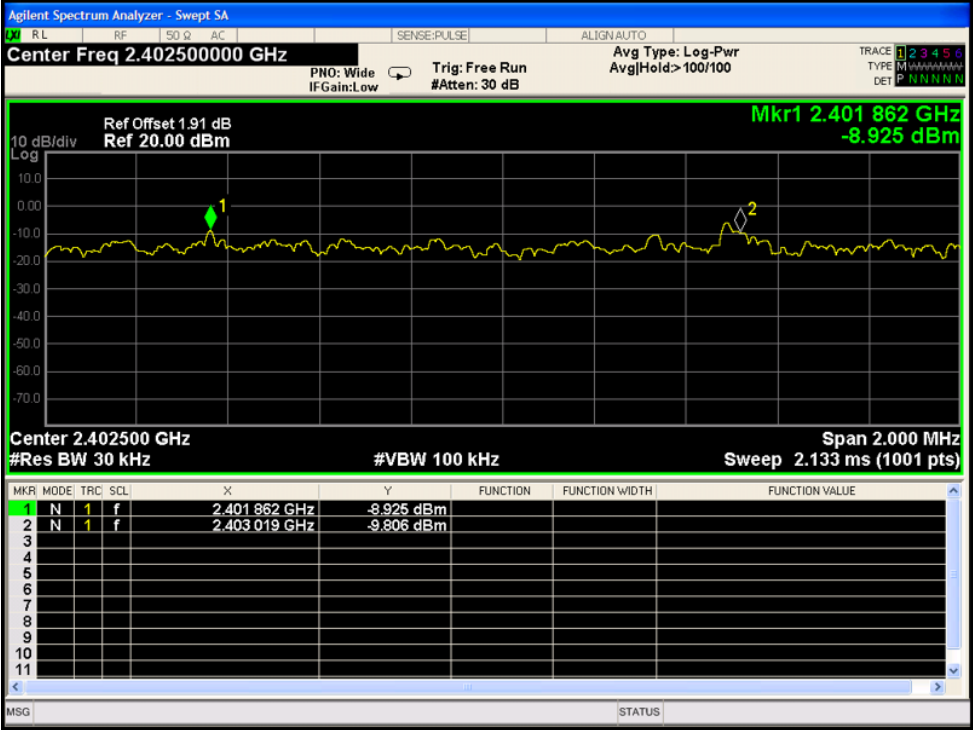
GFSK Modulation



Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 0: 2402MHz

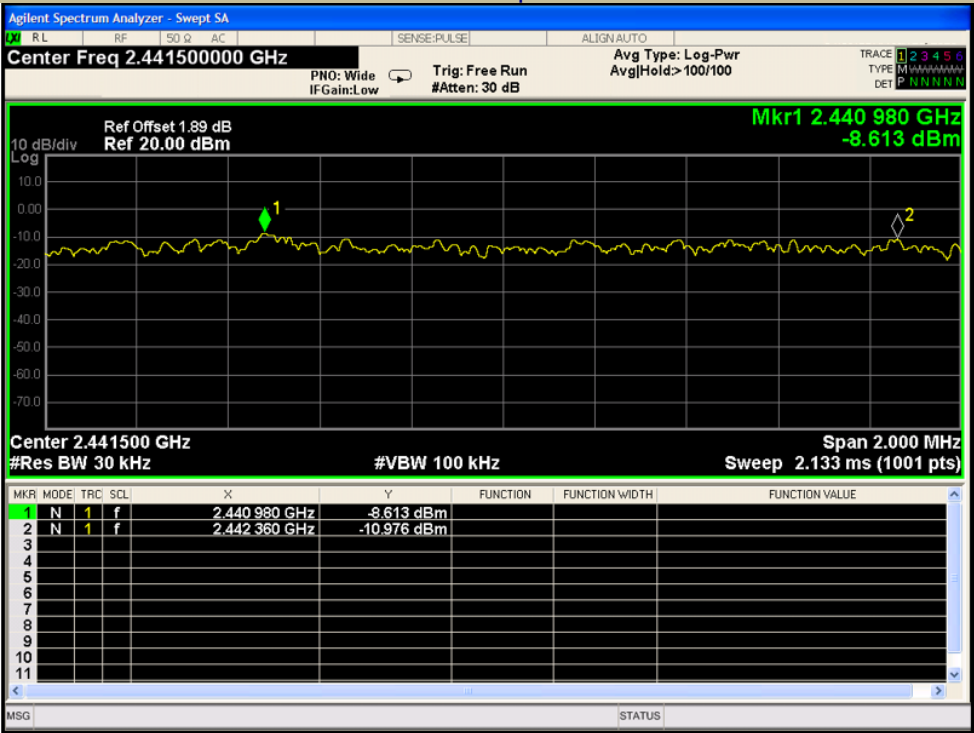
pi/4-DQPSK Modulation



Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 39: 2441MHz

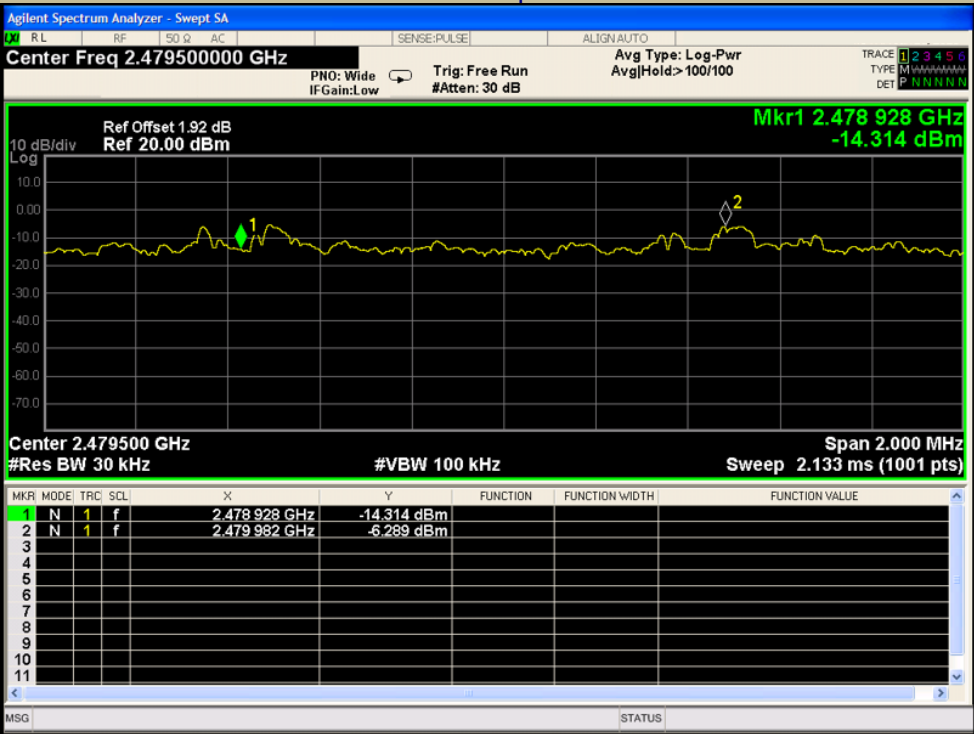
pi/4-DQPSK Modulation



Test Model

Carrier Frequency Separation
Bluetooth V5.4
Channel 78: 2480MHz

pi/4-DQPSK Modulation



7.3 NUMBER OF HOPPING FREQUENCIES

7.3.1 Applicable Standard

According to FCC Part 15.247(a)(1) (iii) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.3.2 Conformance Limit

Frequency hopping systems operating in the 2400-2483.5MHz band shall use at least 15 channels.

7.3.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.3.4 Test Procedure

■ According to FCC Part 15.247(a)(1)(iii)

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = the frequency band of operation (2400-2483.5MHz)

RBW $\geq$ 100KHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

Test Results

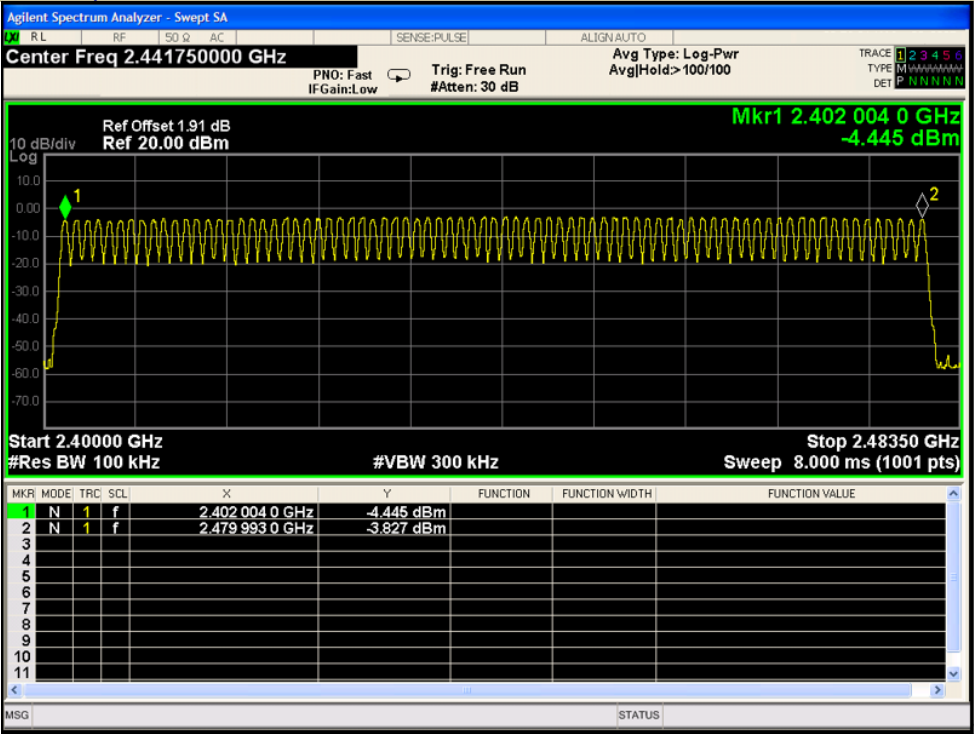
Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Modulation Mode	Hopping Channel Frequency Range	Quantity of Hopping Channel	Quantity of Hopping Channel limit
GFSK	2402-2480	79	> 15
pi/4-DQPSK	2402-2480	79	> 15

Test Model

Number Of Hopping Frequencies
Bluetooth V5.4
Span: 2400-2483.5MHz

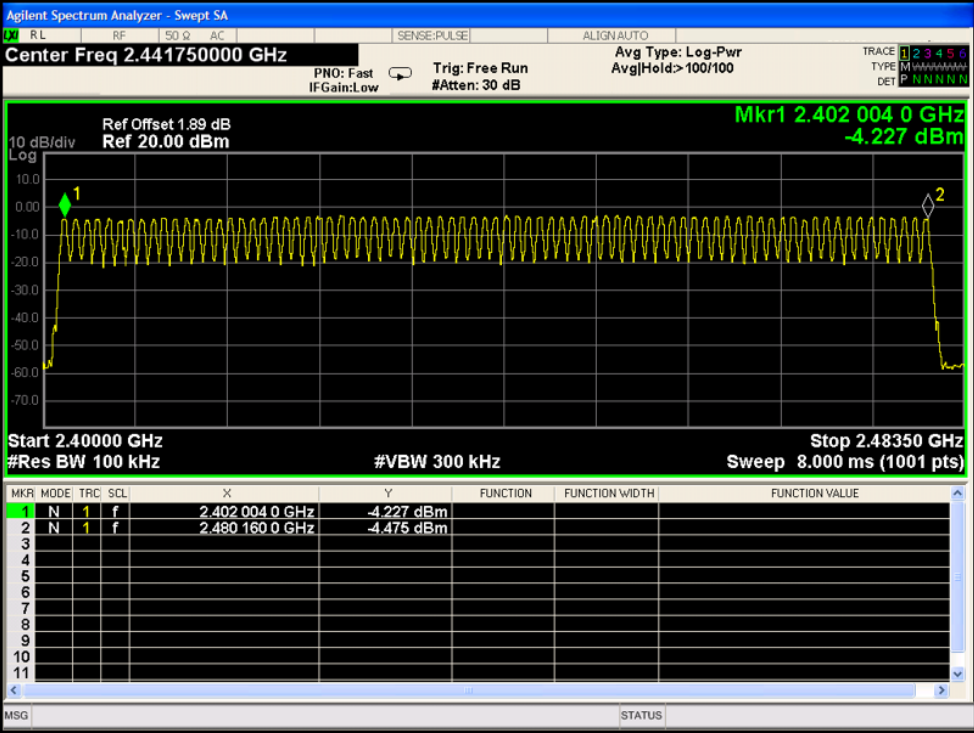
GFSK Modulation



Test Model

Number Of Hopping Frequencies
Bluetooth V5.4
Span: 2400-2483.5MHz

pi/4-DQPSK Modulation



7.4 AVERAGE TIME OF OCCUPANCY (DWELL TIME)

7.4.1 Applicable Standard

According to FCC Part 15.247(a)(1)(iii) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.4.2 Conformance Limit

For frequency hopping systems operating in the 2400-2483.5MHz band, the average time of occupancy on any channel shall not be greater than 0.4s within a period of 0.4s multiplied by the number of hopping channels employed.

7.4.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.4.4 Test Procedure

■ According to FCC Part 15.247(a)(1)(iii)

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = zero span, centered on a hopping channel

RBW = 1 MHz

VBW $\geq$ RBW

Sweep = as necessary to capture the entire dwell time per hopping channel

Detector function = peak

Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section.

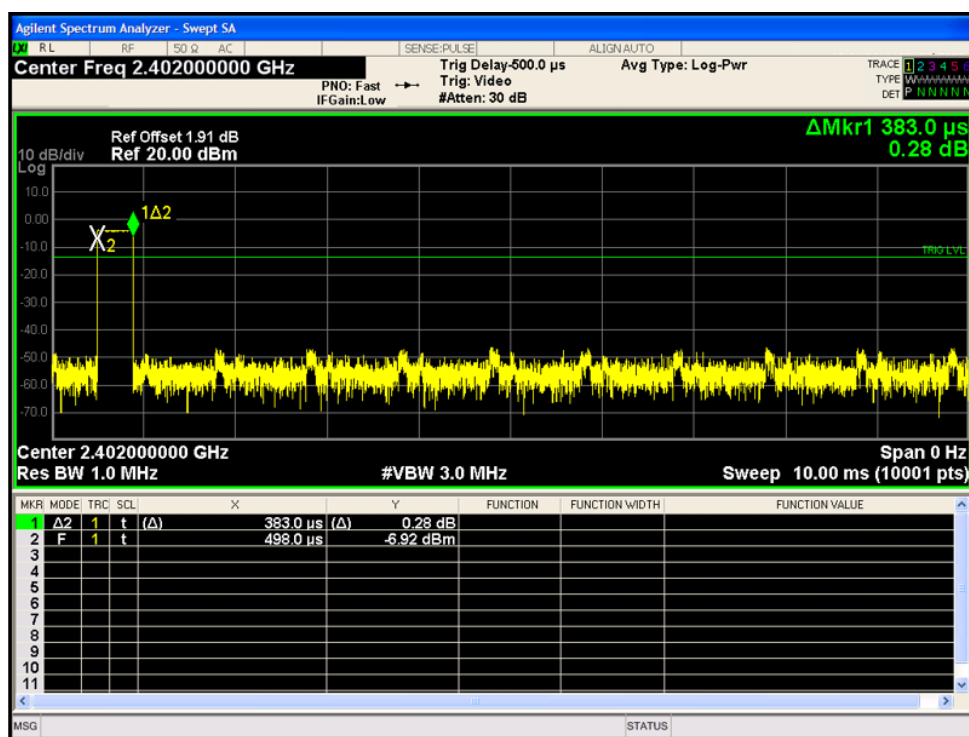
7.4.5 Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Bluetooth (GFSK, pi/4-DQPSK) mode have been tested, and the worst result(GFSK) was report as below:

Modulation Mode	Packet type	Frequency (MHz)	Pulse width (ms)	Dwell Time (ms)	Limit (ms)	Verdict
GFSK	DH1	2402	0.383	122.560	<400	PASS
	DH3	2402	1.639	262.240	<400	PASS
	DH5	2402	2.887	307.947	<400	PASS
Note: Dwell Time(DH1)=PW*(1600/2/79)*31.6 Dwell Time(DH3)=PW*(1600/4/79)*31.6 Dwell Time(DH5)=PW*(1600/6/79)*31.6						

	Average Time Of Occupancy (Dwell Time)	
Test Model	Bluetooth V5.4	
	CH 0: 2402MHz	GFSK DH1



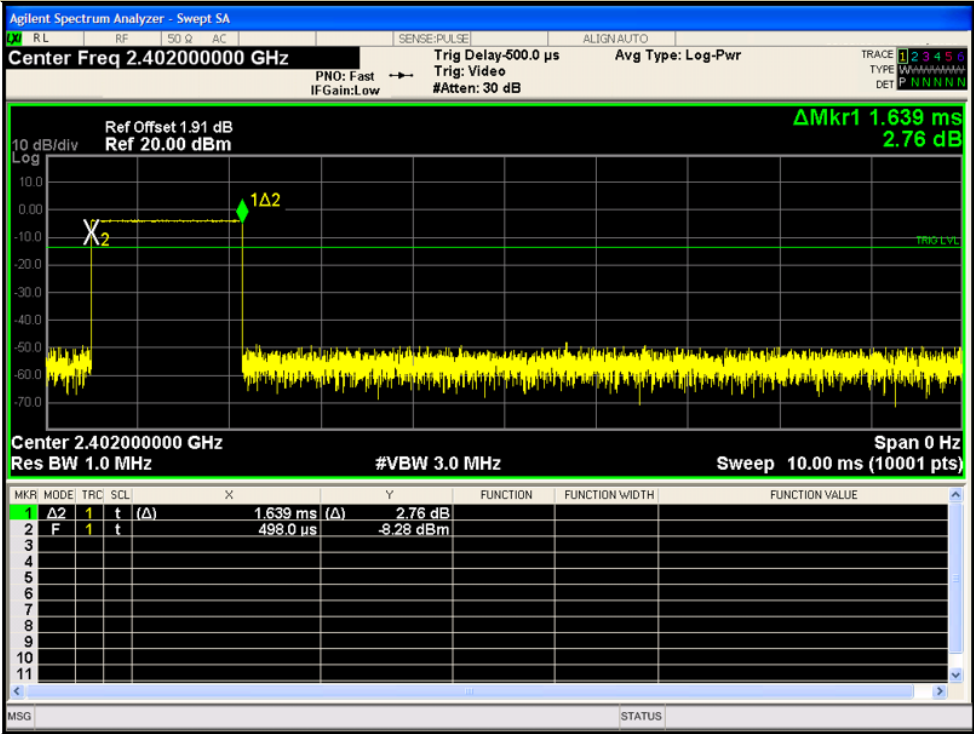
Average Time Of Occupancy (Dwell Time)

Test Model

Bluetooth V5.4

CH 0: 2402MHz

GFSK DH3



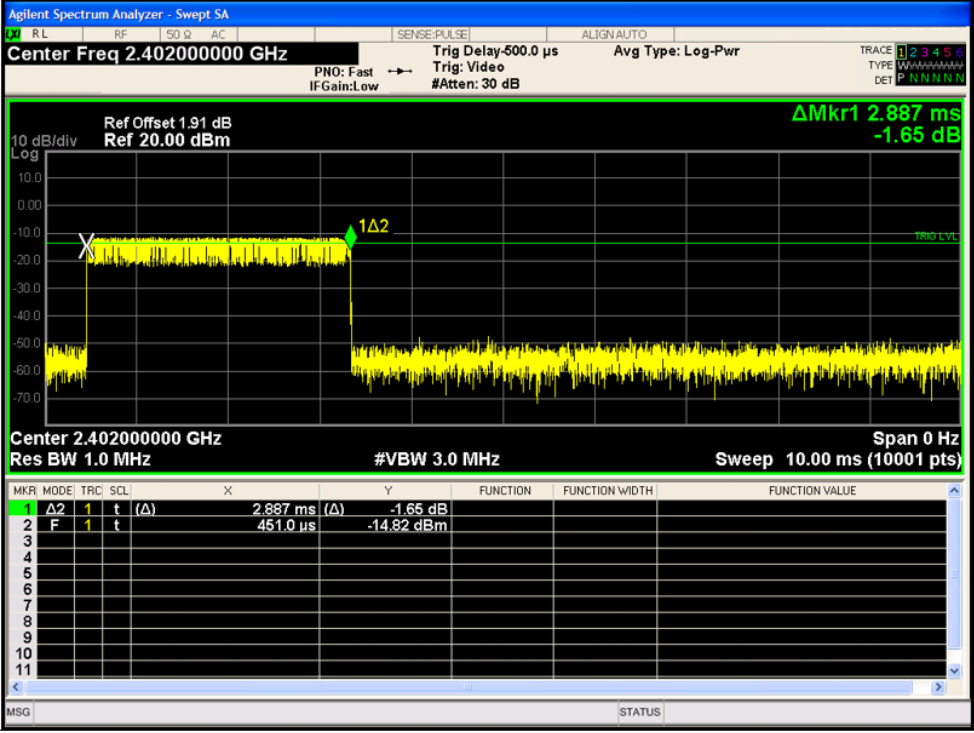
Average Time Of Occupancy (Dwell Time)

Test Model

Bluetooth V5.4

CH 0: 2402MHz

GFSK DH5



7.5 MAXIMUM PEAK CONDUCTED OUTPUT POWER

7.5.1 Applicable Standard

According to FCC Part 15.247(b)(1) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.5.2 Conformance Limit

The max For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

7.5.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.5.4 Test Procedure

■ According to FCC Part 15.247(b)(1)

As an alternative to a peak power measurement, compliance with the limit can be based on a measurement of the maximum conducted output power.

Use the following spectrum analyzer settings:

Set Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

Set RBW > the 20 dB bandwidth of the emission being measured

Set VBW ≥ RBW

Set Sweep = auto

Set Detector function = peak

Set Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission to determine the peak amplitude level.

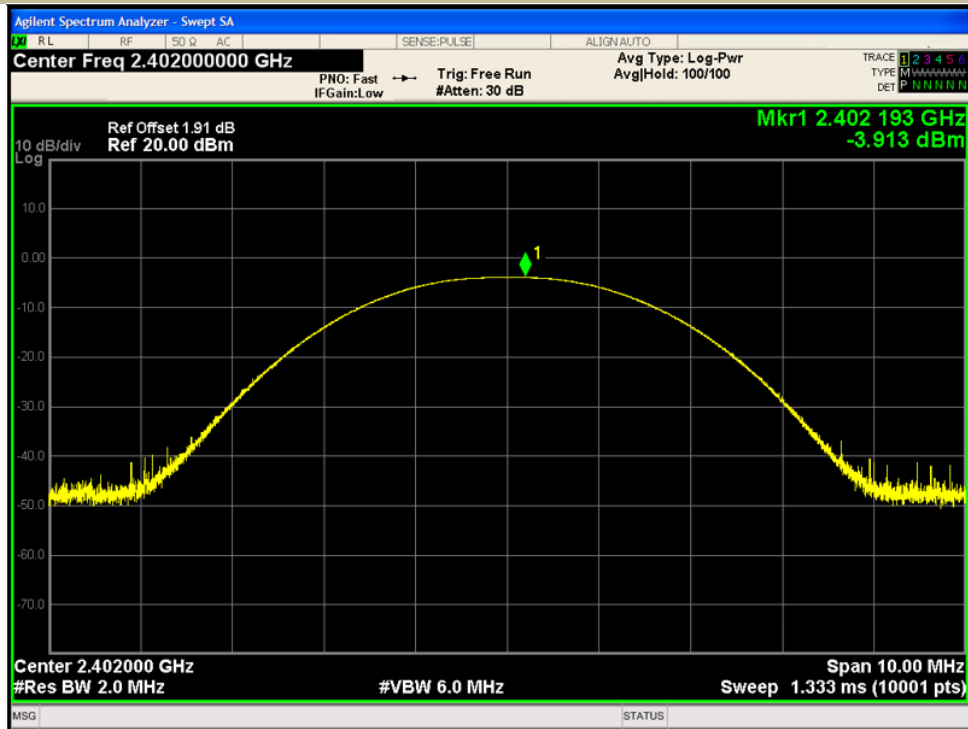
Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

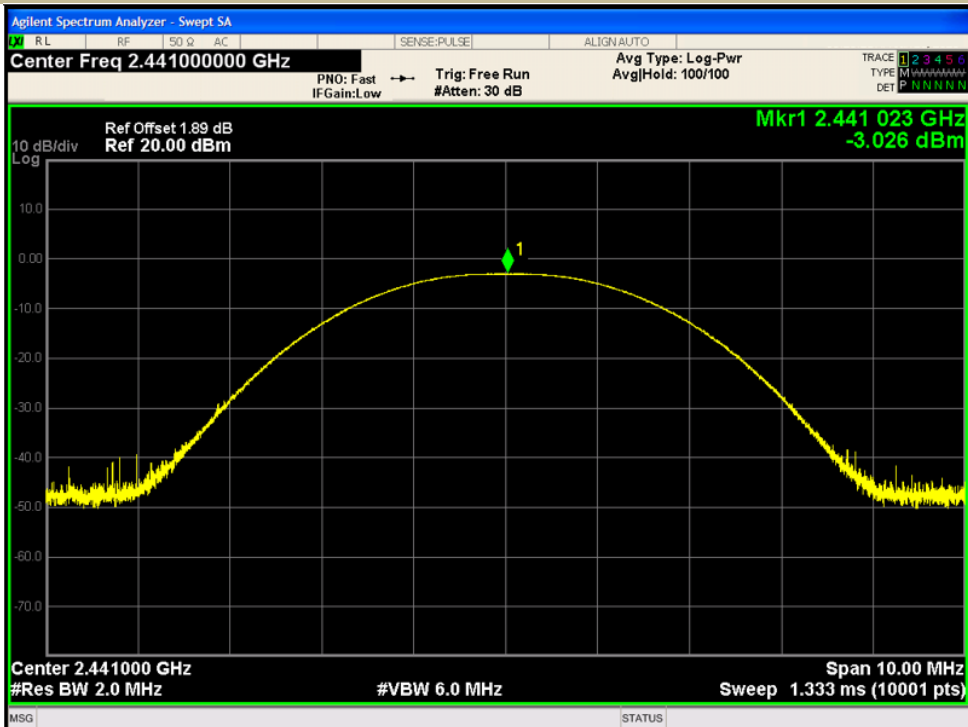
Operation Mode	Channel Number	Channel Frequency (MHz)	Measurement Level (dBm)	Limit (dBm)	Verdict
GFSK	0	2402	-3.91	21	PASS
	39	2441	-3.03	21	PASS
	78	2480	-3.62	21	PASS
pi/4-DQPSK	0	2402	-3.00	21	PASS
	39	2441	-2.07	21	PASS
	78	2480	-2.56	21	PASS

Note: N/A

Test Model Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 0: 2402MHz GFSK

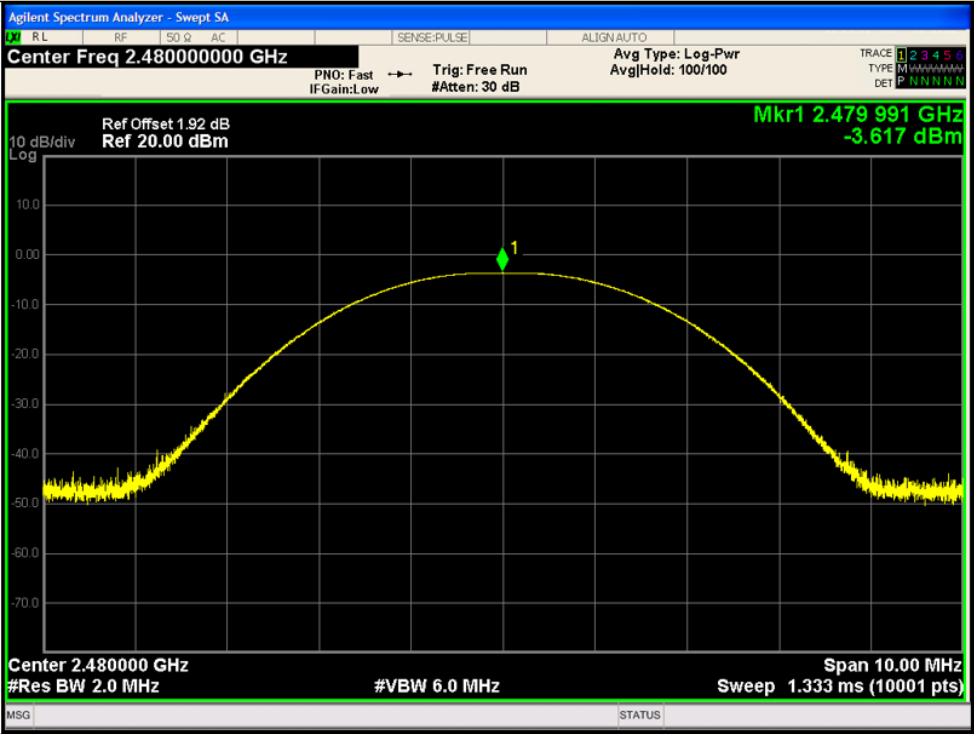


Test Model Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 39: 2441MHz GFSK



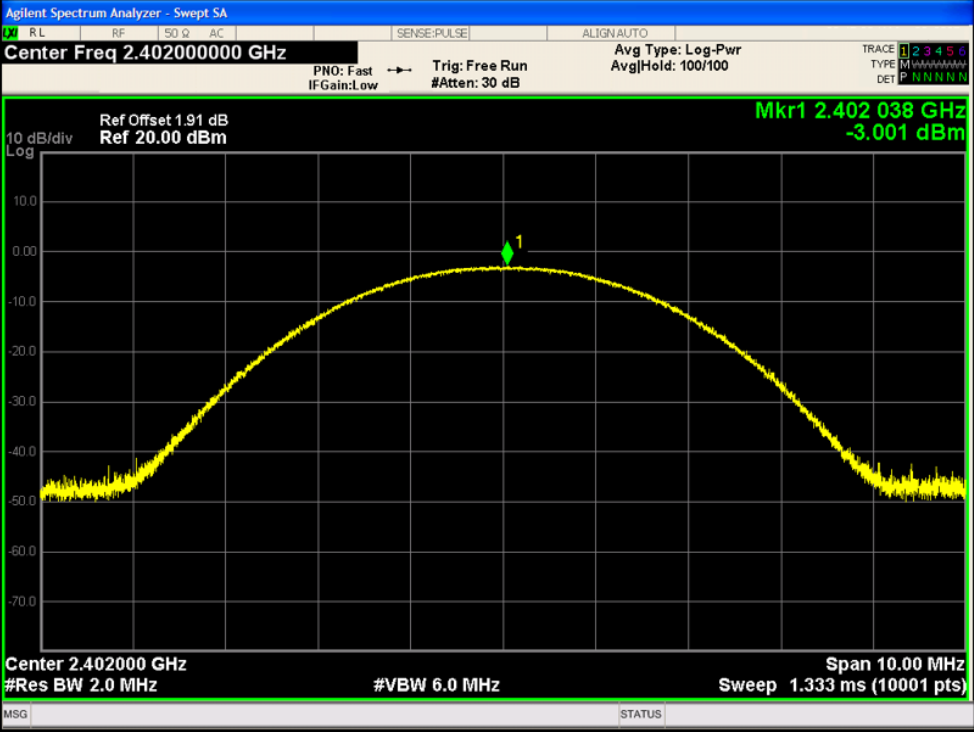
Test Model

Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 78: 2480MHzGFSK



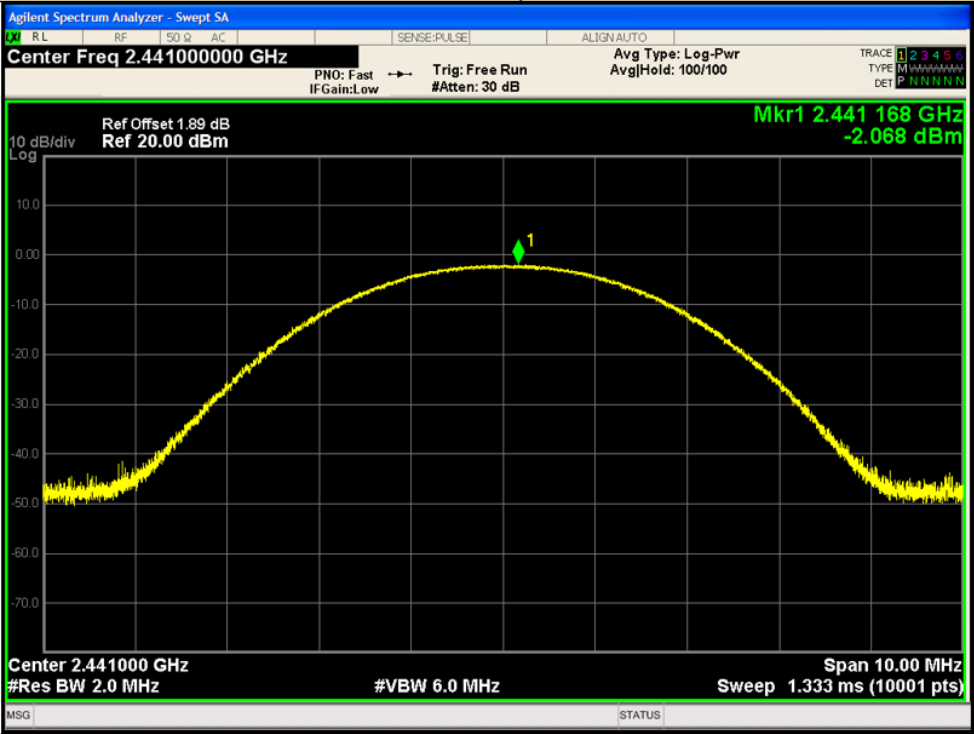
Test Model

Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 0: 2402MHzpi/4-DQPSK



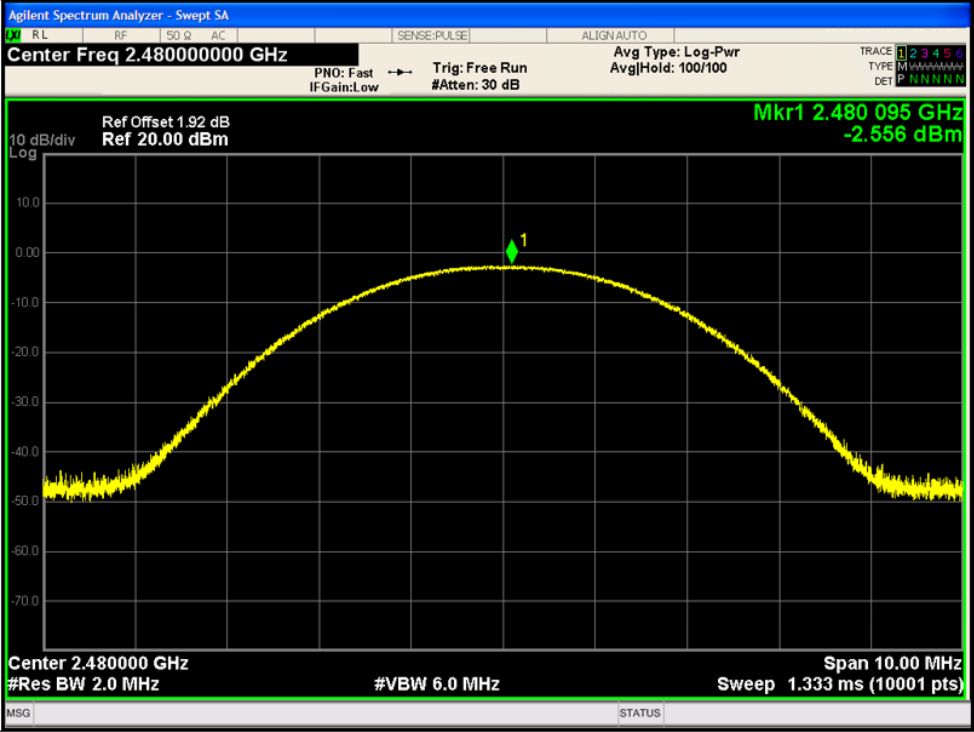
Test Model

Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 39: 2441MHzpi/4-DQPSK



Test Model

Maximum Peak Conducted Output Power
Bluetooth V5.4
Channel 78: 2480MHzpi/4-DQPSK



7.6 CONDUCTED SUPRIIOUS EMISSION

7.6.1 Applicable Standard

According to FCC Part 15.247(d) and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.6.2 Conformance Limit

According to FCC Part 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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, provided the transmitter demonstrates compliance with the peak conducted power limits.

7.6.3 Test Configuration

Test according to clause 6.1 radio frequency test setup 1

7.6.4 Test Procedure

The transmitter output (antenna port) was connected to the spectrum analyzer

■ Reference level measurement

Establish a reference level by using the following procedure:

Set instrument center frequency to DSS channel center frequency.

Set Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel.

Set the RBW = 100 kHz. Set the VBW $\geq 3 \times$ RBW.

Set Detector = peak. Set Sweep time = auto couple.

Set Trace mode = max hold. Allow trace to fully stabilize.

Use the peak marker function to determine the maximum Maximum conduceted level.

Note that the channel found to contain the maximum conduceted level can be used to establish the reference level.

■ Band-edge Compliance of RF Conducted Emissions

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band-edge, as well as any modulation products which fall outside of the authorized band of operation

Set RBW $\geq 1\%$ of the span=100kHz Set VBW $\geq$ RBW

Set Sweep = auto Set Detector function = peak Set Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. The marker-delta value now displayed must comply with the limit specified in this Section.

Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

■ Conduceted Spurious RF Conducted Emission

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.(30MHz to 25GHz). Set RBW = 100 kHz Set VBW $\geq$ RBW

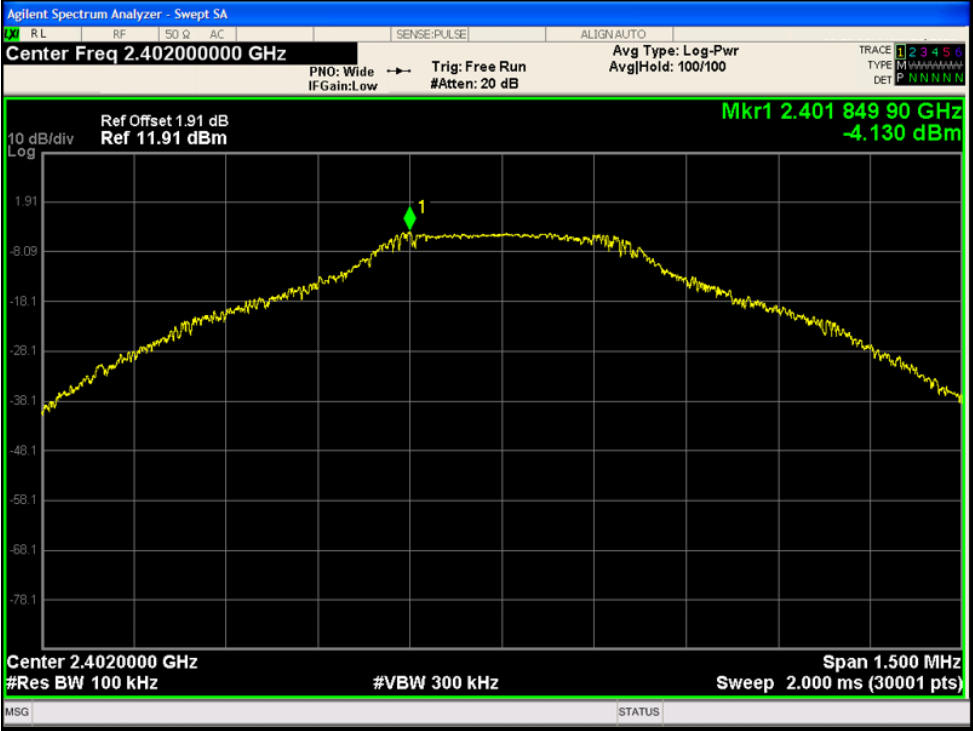
Set Sweep = auto Set Detector function = peak Set Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.

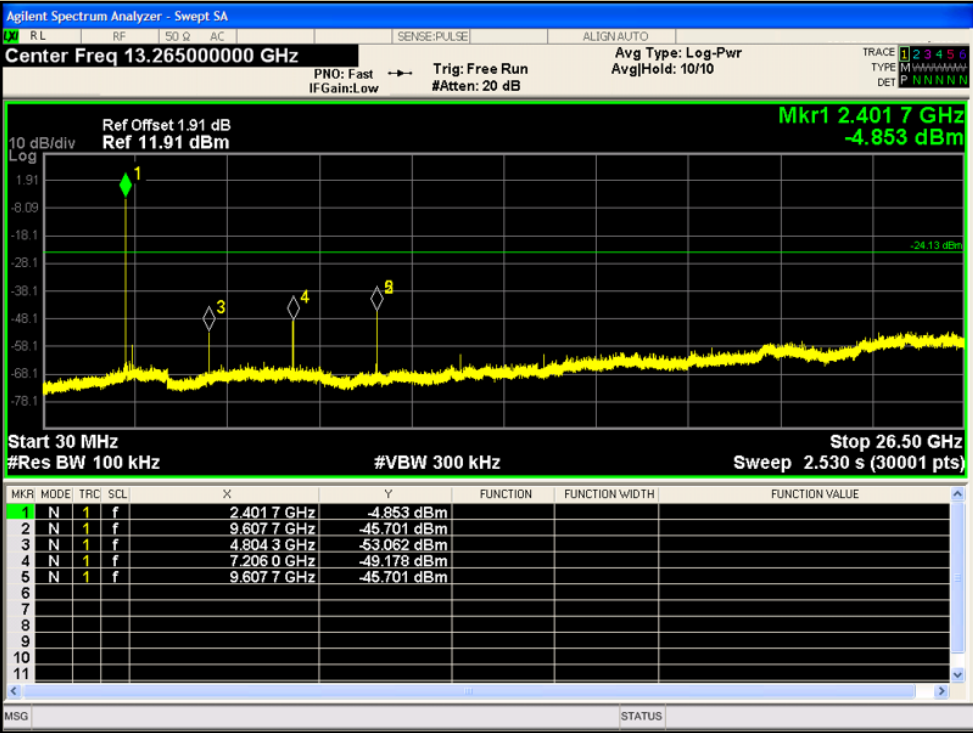
7.6.5 Test Results

Bluetooth (GFSK, pi/4-DQPSK) mode have been tested, and the worst result(GFSK) was report as below:

	Maximum Conduced Level RBW=100kHz	
Test Model	Bluetooth V5.4	
	Channel 0: 2402MHz	GFSK



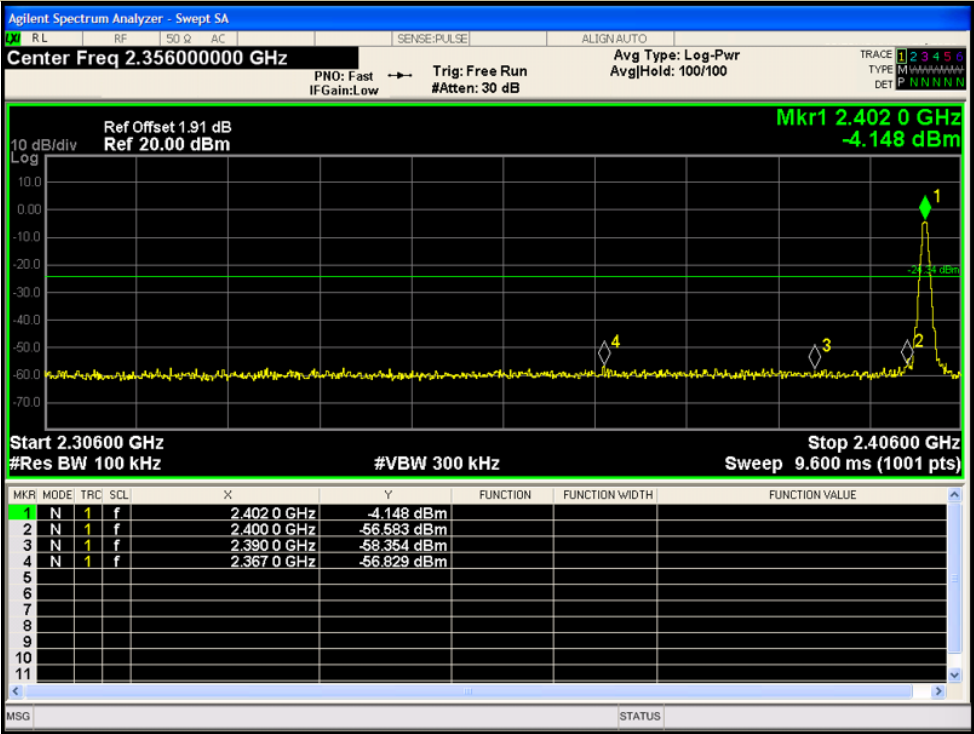
	Conduced Spurious RF Conducted Emission	
Test Model	Bluetooth V5.4	
	Channel 0: 2402MHz	GFSK



Test Model

Band-edge Conducted Emissions
Bluetooth V5.4
Channel 0: 2402MHz

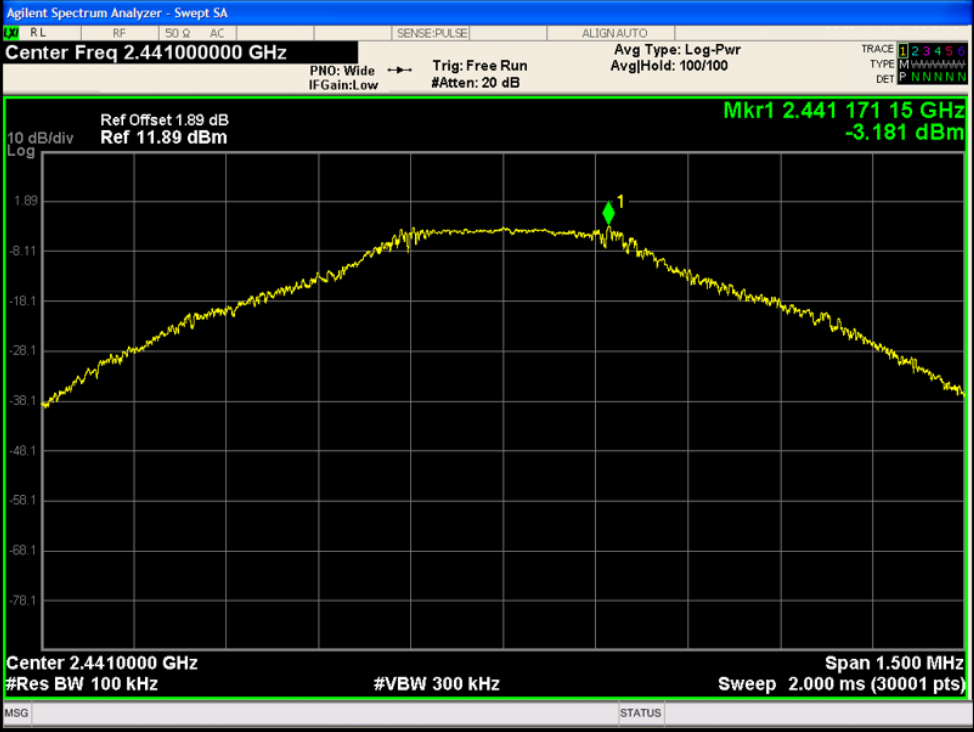
GFSK



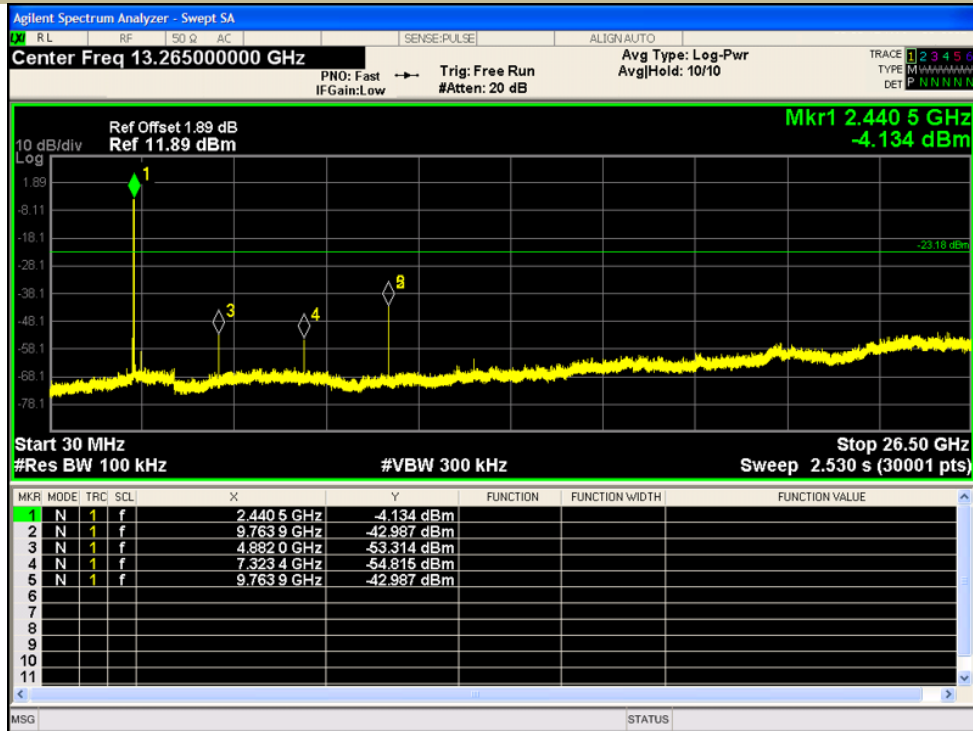
Test Model

Maximum Conducted Level RBW=100kHz
Bluetooth V5.4
Channel 39: 2441MHz

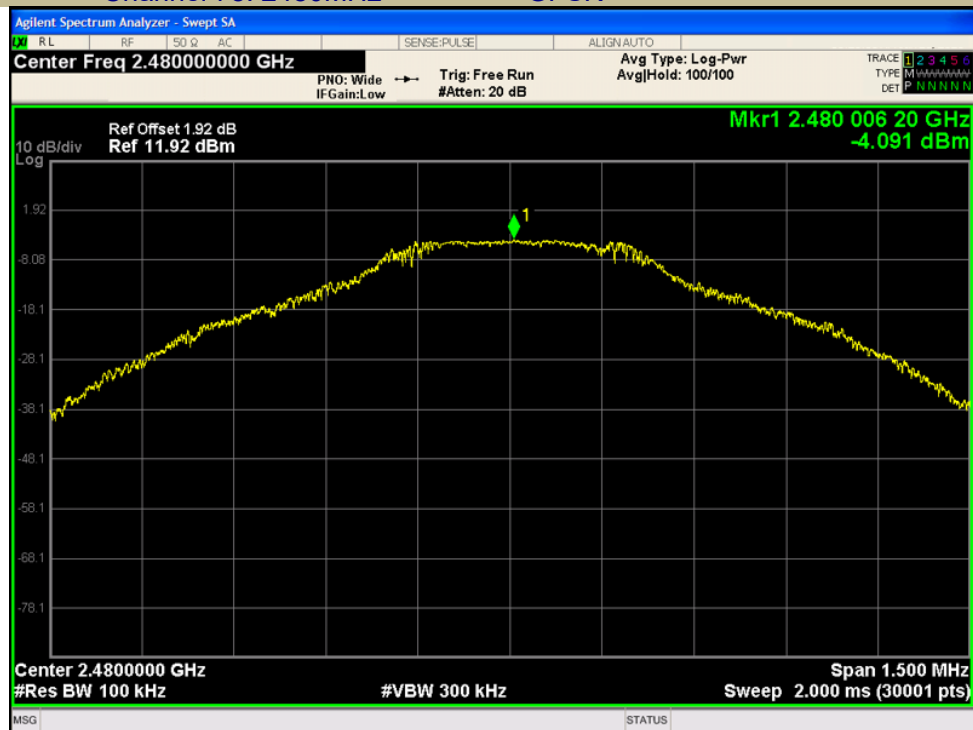
GFSK



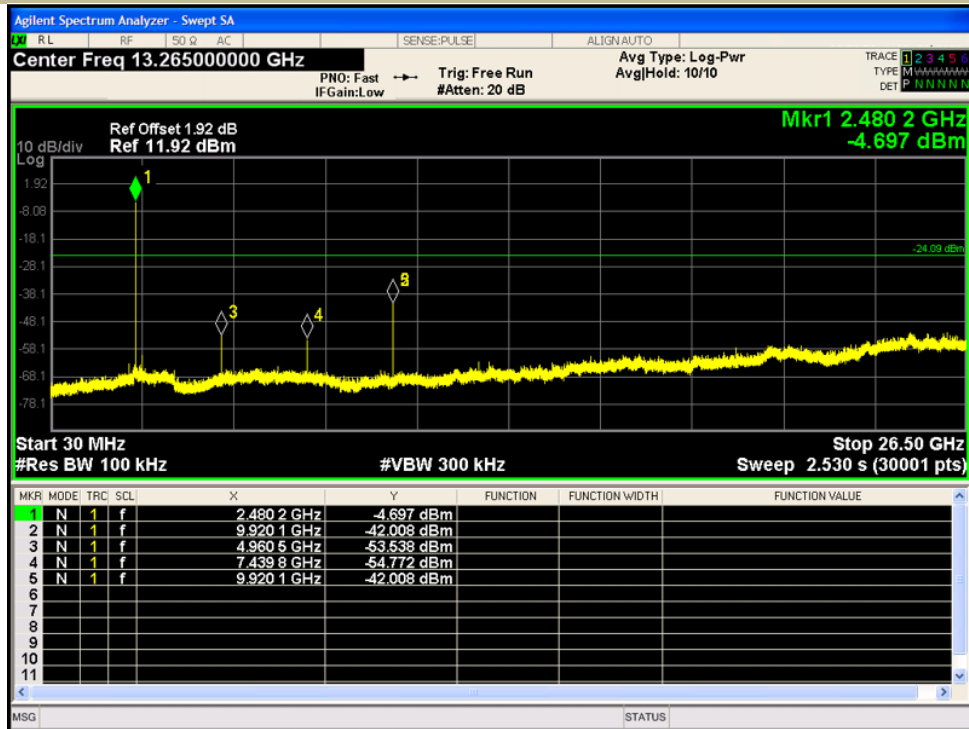
Test Model Conducted Spurious RF Conducted Emission
 Bluetooth V5.4
 Channel 39: 2441MHz GFSK



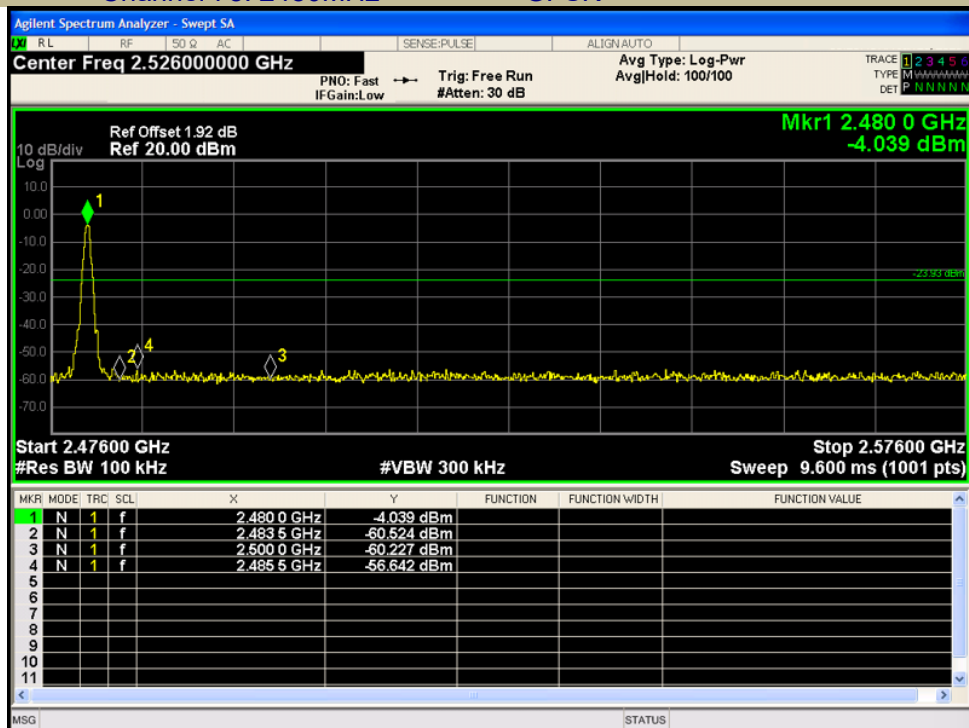
Test Model Maximum Conducted Level RBW=100kHz
 Bluetooth V5.4
 Channel 78: 2480MHz GFSK



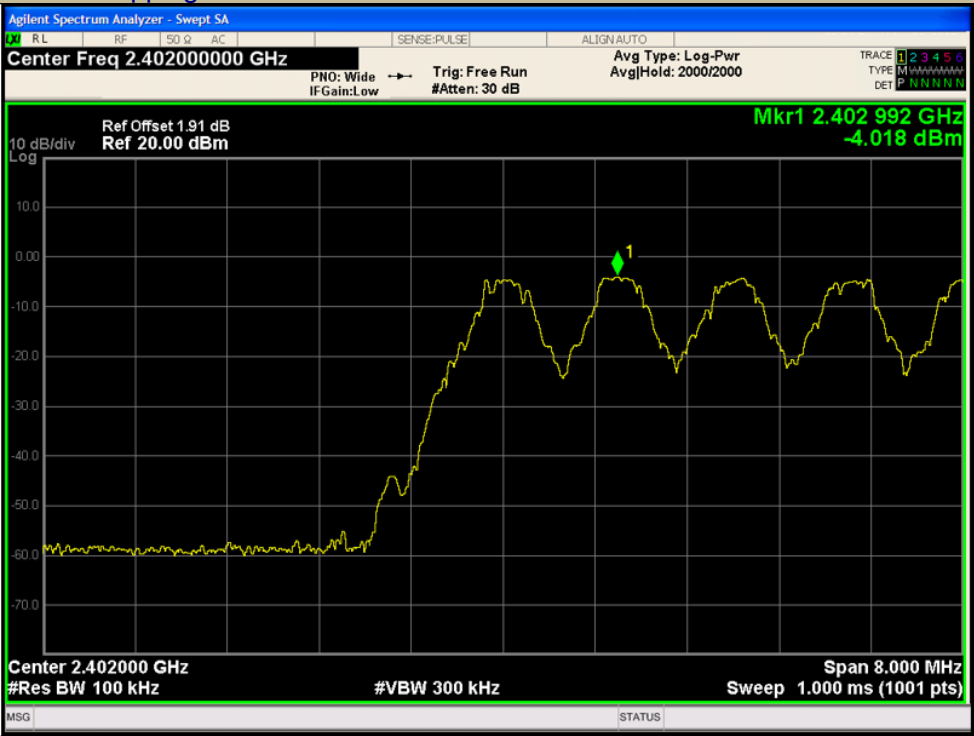
Test Model Conducted Spurious RF Conducted Emission
 Bluetooth V5.4
 Channel 78: 2480MHz GFSK



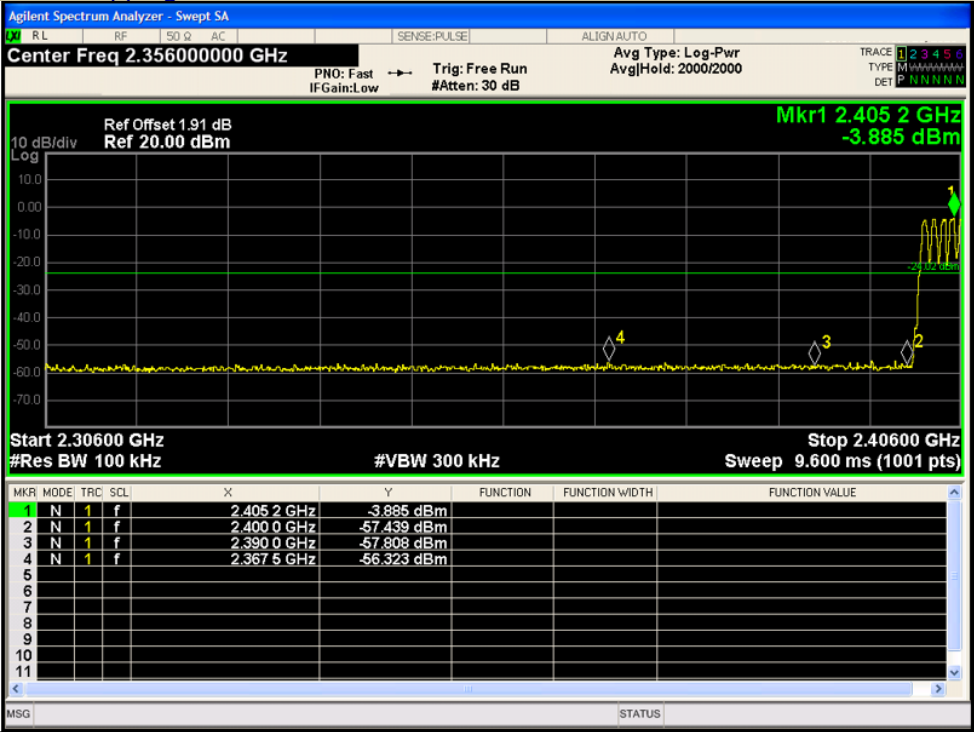
Test Model Band-edge Conducted Emissions
 Bluetooth V5.4
 Channel 78: 2480MHz GFSK



Test Model Maximum Conducted Level RBW=100kHz
Bluetooth V5.4
Hopping GFSK



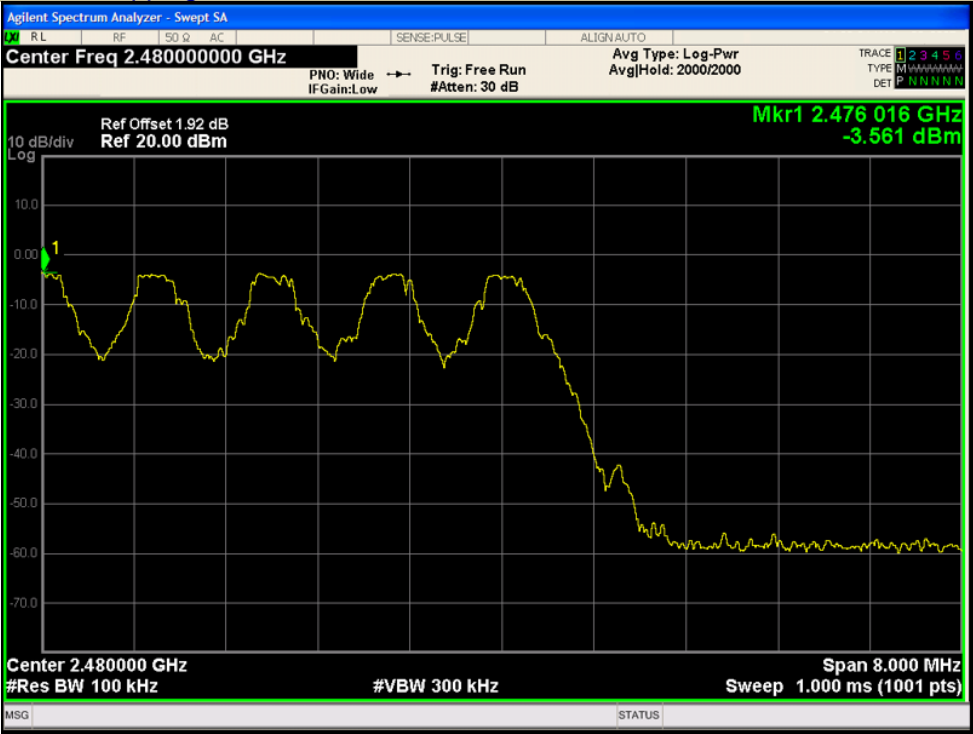
Test Model Conducted Spurious RF Conducted Emission
Bluetooth V5.4
Hopping GFSK



Test Model

Band-edge Conducted Emissions
Bluetooth V5.4
Hopping

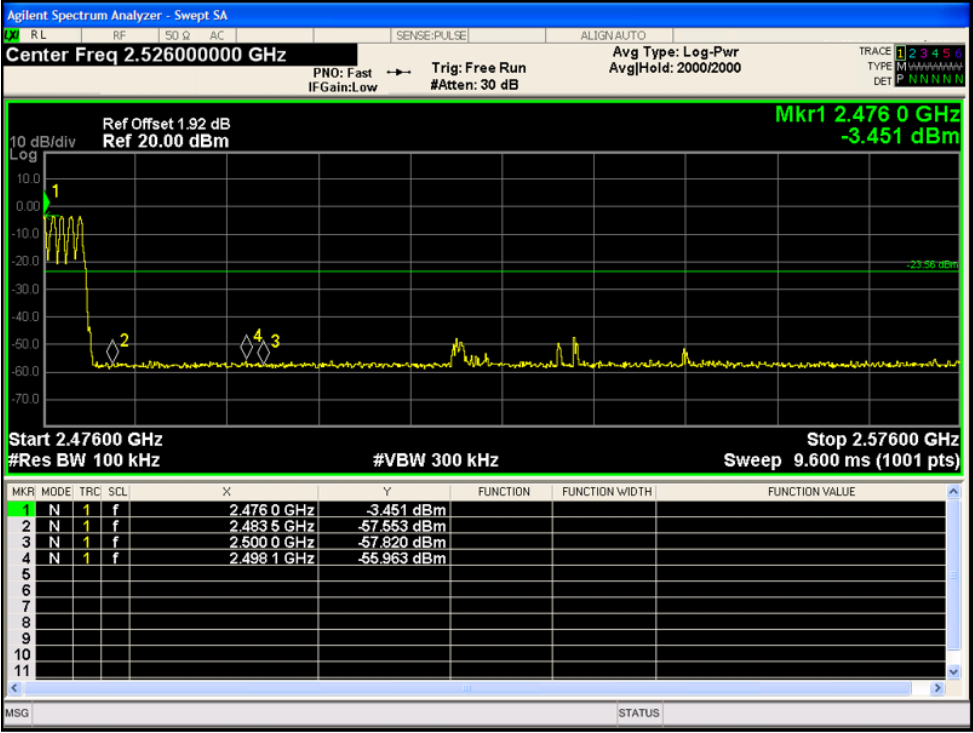
GFSK



Test Model

Band-edge Conducted Emissions
Bluetooth V5.4
Hopping

GFSK



7.7 RADIATED SPURIOUS EMISSION

7.7.1 Applicable Standard

According to FCC Part 15.247(d) and 15.209 and KDB 558074 D01 15.247 MEAS GUIDANCE v05r02

7.7.2 Conformance Limit

According to FCC Part 15.247(d): 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 FCC Part 15.205, Restricted bands

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

According to FCC Part 15.205, the level of any transmitter spurious emission in Restricted bands shall not exceed the level of the emission specified in the following table

Restricted Frequency(MHz)	Field Strength ($\mu\text{V/m}$)	Field Strength ($\text{dB}\mu\text{V/m}$)	Measurement Distance
0.009-0.490	2400/F(KHz)	20 log ($\mu\text{V/m}$)	300
0.490-1.705	24000/F(KHz)	20 log ($\mu\text{V/m}$)	30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

7.7.3 Test Configuration

Test according to clause 6.2 radio frequency test setup 2

7.7.4 Test Procedure

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

For Above 1GHz:

The EUT was placed on a turn table which is 1.5m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

For Below 1GHz:

The EUT was placed on a turn table which is 0.8m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

Span = wide enough to fully capture the emission being measured

RBW = 100 kHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

For Below 30MHz:

The EUT was placed on a turn table which is 0.8m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

Span = wide enough to fully capture the emission being measured

RBW = 9kHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

For Below 150KHz:

The EUT was placed on a turn table which is 0.8m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

Span = wide enough to fully capture the emission being measured

RBW = 200Hz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Follow the guidelines in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

Repeat above procedures until all frequency measured was complete.

7.7.5 Test Results

■ Spurious Emission below 30MHz (9KHz to 30MHz)

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
--	--	--	--	--	--	--	--

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible

limit has no need to be reported.

Distance extrapolation factor = $40\log(\text{Specific distance/ test distance})$ (dB);

Limit line = Specific limits(dBuV) + distance extrapolation factor

■ Spurious Emission Above 1GHz (1GHz to 25GHz)

Bluetooth (GFSK, pi/4-DQPSK) mode have been tested, and the worst result(GFSK) was report as below:

Both the left and right earphones were tested, with the worst results (left earphone) shown below:

Test mode: GFSK Frequency: Channel 0: 2402MHz

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
4804.00	V	50.86	38.80	74.00	54.00	-23.14	-15.20
7206.00	V	51.56	36.51	74.00	54.00	-22.44	-17.49
9608.00	V	52.36	38.92	74.00	54.00	-21.64	-15.08
12010.00	V	52.83	37.21	74.00	54.00	-21.17	-16.79
14412.00	V	50.30	36.88	74.00	54.00	-23.70	-17.12
4804.00	H	48.47	38.32	74.00	54.00	-25.53	-15.68
7206.00	H	52.65	37.65	74.00	54.00	-21.35	-16.35
9608.00	H	51.42	37.33	74.00	54.00	-22.58	-16.67
12010.00	H	50.25	38.49	74.00	54.00	-23.75	-15.51
14412.00	H	52.30	37.72	74.00	54.00	-21.70	-16.28

Test mode: GFSK Frequency: Channel 39: 2441MHz

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
4882.00	V	50.39	39.50	74.00	54.00	-23.61	-14.50
7323.00	V	49.87	40.68	74.00	54.00	-24.13	-13.32
9764.00	V	52.27	38.63	74.00	54.00	-21.73	-15.37
12205.00	V	49.57	40.96	74.00	54.00	-24.43	-13.04
14646.00	V	50.79	39.96	74.00	54.00	-23.21	-14.04
4882.00	H	50.01	38.11	74.00	54.00	-23.99	-15.89
7323.00	H	50.45	37.76	74.00	54.00	-23.55	-16.24
9764.00	H	48.93	36.38	74.00	54.00	-25.07	-17.62
12205.00	H	49.26	37.56	74.00	54.00	-24.74	-16.44
14646.00	H	48.57	40.40	74.00	54.00	-25.43	-13.60

Test mode: GFSK Frequency: Channel 78: 2480MHz

Freq. (MHz)	Ant.Pol. H/V	Emission Level(dBuV/m)		Limit 3m(dBuV/m)		Over(dB)	
		PK	AV	PK	AV	PK	AV
4960.00	V	45.79	38.28	74.00	54.00	-28.21	-15.72
7440.00	V	47.53	37.26	74.00	54.00	-26.47	-16.74
9920.00	V	48.88	37.42	74.00	54.00	-25.12	-16.58
12400.00	V	48.53	39.39	74.00	54.00	-25.47	-14.61
14880.00	V	48.93	39.82	74.00	54.00	-25.07	-14.18
4960.00	H	46.63	38.34	74.00	54.00	-27.37	-15.66
7440.00	H	46.38	38.28	74.00	54.00	-27.62	-15.72
9920.00	H	48.35	36.22	74.00	54.00	-25.65	-17.78
12400.00	H	47.13	39.04	74.00	54.00	-26.87	-14.96
14880.00	H	47.73	39.42	74.00	54.00	-26.27	-14.58

Note: (1) All Readings are Peak Value (VBW=3MHz) and Peak Value (VBW=10Hz).
 (2) Emission Level= Reading Level+Probe Factor +Cable Loss.

■ Spurious Emission in Restricted Band 2310-2390MHz and 2483.5-2500MHz Bluetooth (GFSK, pi/4-DQPSK, Hopping) mode have been tested, and the worst result(GFSK, Hopping) was report as below:

Both the left and right earphones were tested, with the worst results (left earphone) shown below:

Test mode: GFSK Frequency: Channel 0: 2402MHz

Frequency (MHz)	Polarity H/V	PK(dBuV/m) (VBW=3MHz)	Limit 3m (dBuV/m)	AV(dBuV/m) (VBW=10Hz)	Limit 3m (dBuV/m)
2310.00	H	47.56	74.00	36.40	54.00
2390.00	H	45.52	74.00	37.11	54.00
2310.00	V	46.69	74.00	38.62	54.00
2390.00	V	46.00	74.00	39.38	54.00

Test mode: GFSK Frequency: Channel 78: 2480MHz

Frequency (MHz)	Polarity H/V	PK(dBuV/m) (VBW=3MHz)	Limit 3m (dBuV/m)	AV(dBuV/m) (VBW=10Hz)	Limit 3m (dBuV/m)
2483.50	H	48.21	74.00	39.65	54.00
2500.00	H	45.50	74.00	37.37	54.00
2483.50	V	46.30	74.00	38.79	54.00
2500.00	V	48.54	74.00	38.03	54.00

Test mode: GFSK Frequency: Hopping

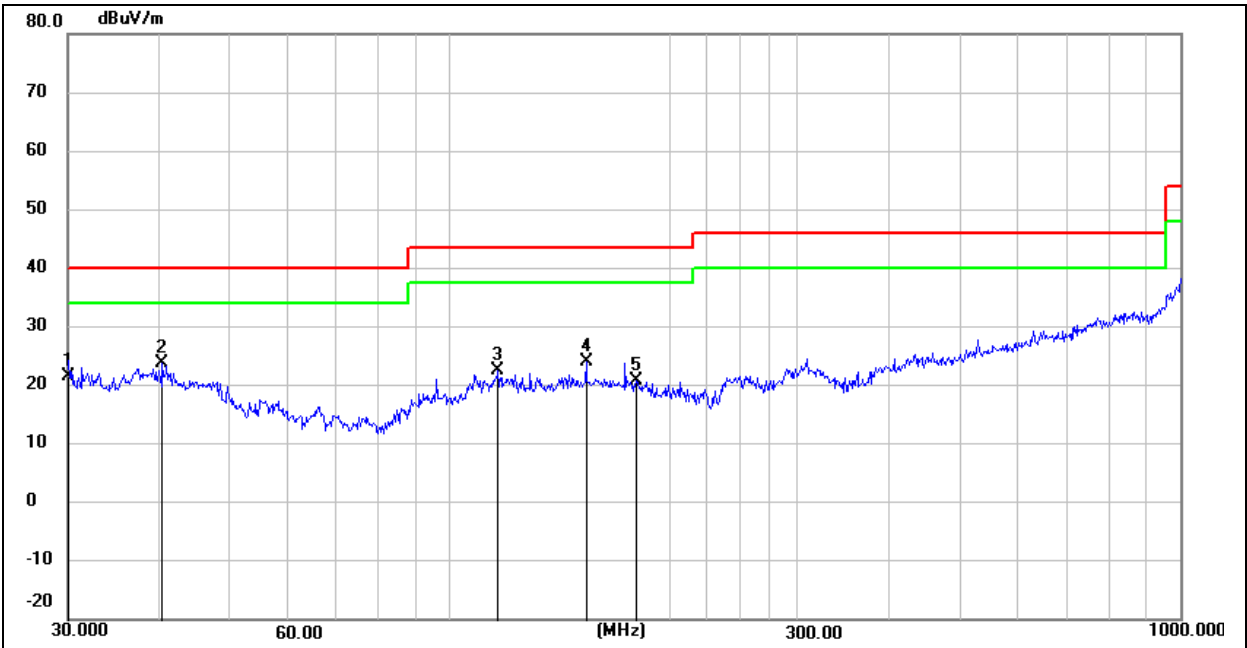
Frequency (MHz)	Polarity H/V	PK(dBuV/m) (VBW=3MHz)	Limit 3m (dBuV/m)	AV(dBuV/m) (VBW=10Hz)	Limit 3m (dBuV/m)
2390.00	H	47.16	74.00	38.18	54.00
2400.00	H	48.82	74.00	39.50	54.00
2483.50	H	48.08	74.00	38.70	54.00
2500.00	H	47.81	74.00	37.11	54.00
2390.00	V	46.04	74.00	38.06	54.00
2400.00	V	47.06	74.00	38.07	54.00
2483.50	V	47.23	74.00	38.94	54.00
2500.00	V	47.01	74.00	38.92	54.00

Note: (1) All Readings are Peak Value (VBW=3MHz) and Peak Value (VBW=10Hz).
 (2) Emission Level= Reading Level+Probe Factor +Cable Loss.

■ Spurious Emission below 1GHz (30MHz to 1GHz)
Bluetooth (GFSK, pi/4-DQPSK) mode have been tested, and the worst result (GFSK) Low Channel (2402MHz) was report as below:

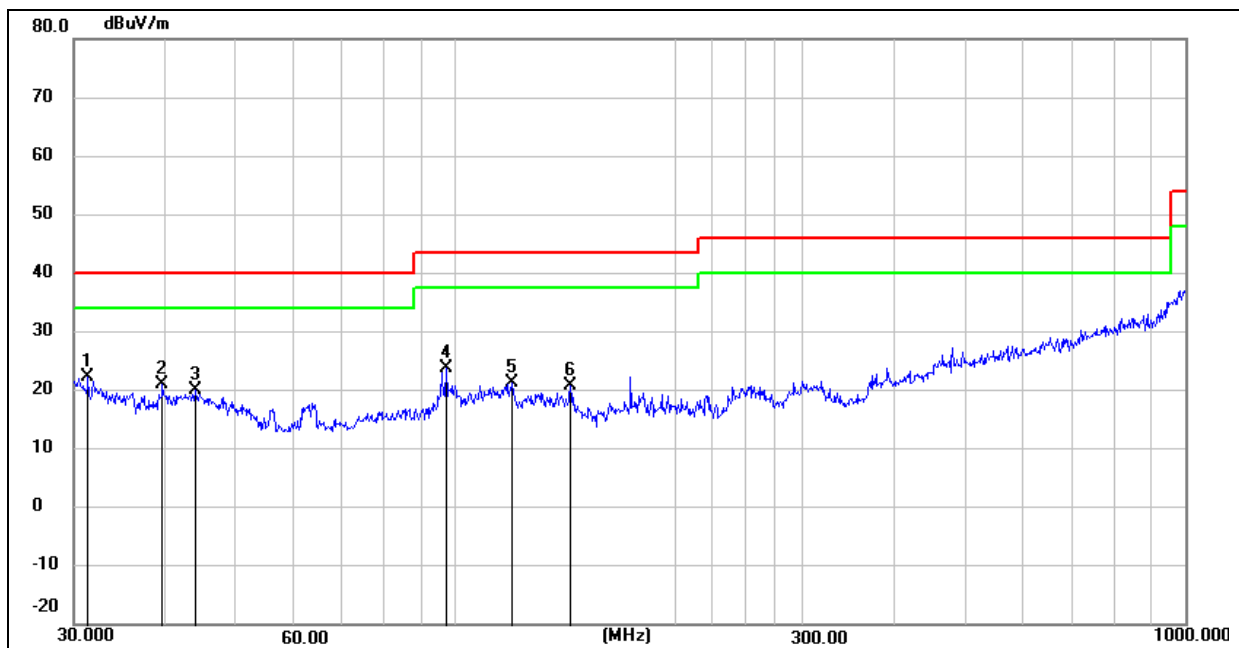
Both the left and right earphones were tested, with the worst results (left earphone) shown below:

Phase:	Vertical
Test Power :	DC 3.7V



No.	Frequency (MHz)	Reading Level (dBuV)	Correct Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark			
1	30.105100	21.20	0.26	21.46	40.00	-18.54	QP			
2	40.417000	28.86	-5.20	23.66	40.00	-16.34	QP			
3	116.540000	25.99	-3.52	22.47	43.50	-21.03	QP			
4	153.738400	27.87	-3.85	24.02	43.50	-19.48	QP			
5	180.016400	27.84	-6.96	20.88	43.50	-22.62	QP			
6	30.105100	21.20	0.26	21.46	40.00	-18.54	QP			

Phase:	Horizontal
Test Power :	DC 3.7V



No.	Frequency (MHz)	Reading Level (dBuV)	Correct Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark			
1	31.399200	23.40	-1.15	22.25	40.00	-17.75	QP			
2	39.714600	25.95	-5.02	20.93	40.00	-19.07	QP			
3	44.120000	26.61	-6.64	19.97	40.00	-20.03	QP			
4	97.114800	29.73	-5.96	23.77	43.50	-19.73	QP			
5	119.855500	24.58	-3.19	21.39	43.50	-22.11	QP			
6	143.829100	23.62	-2.91	20.71	43.50	-22.79	QP			

7.8 CONDUCTED EMISSION TEST

7.8.1 Applicable Standard

According to FCC Part 15.207(a)

7.8.2 Conformance Limit

Conducted Emission Limit		
Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	56	46
5.0-30.0	60	50
Note: 1. The lower limit shall apply at the transition frequencies 2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.		

Remark: Test results were obtained from the following equation:

Measurement (dB μ V) = LISN Factor (dB) + Cable Loss (dB) + Reading (dB μ V)

Margin (dB) = Measurement (dB μ V) - Limit (dB μ V)

7.8.3 Test Configuration

Test according to clause 6.3 conducted emission test setup

7.8.4 Test Procedure

The EUT was placed on a table which is 0.8m above ground plane.

Maximum procedure was performed on the highest emissions to ensure EUT compliance.

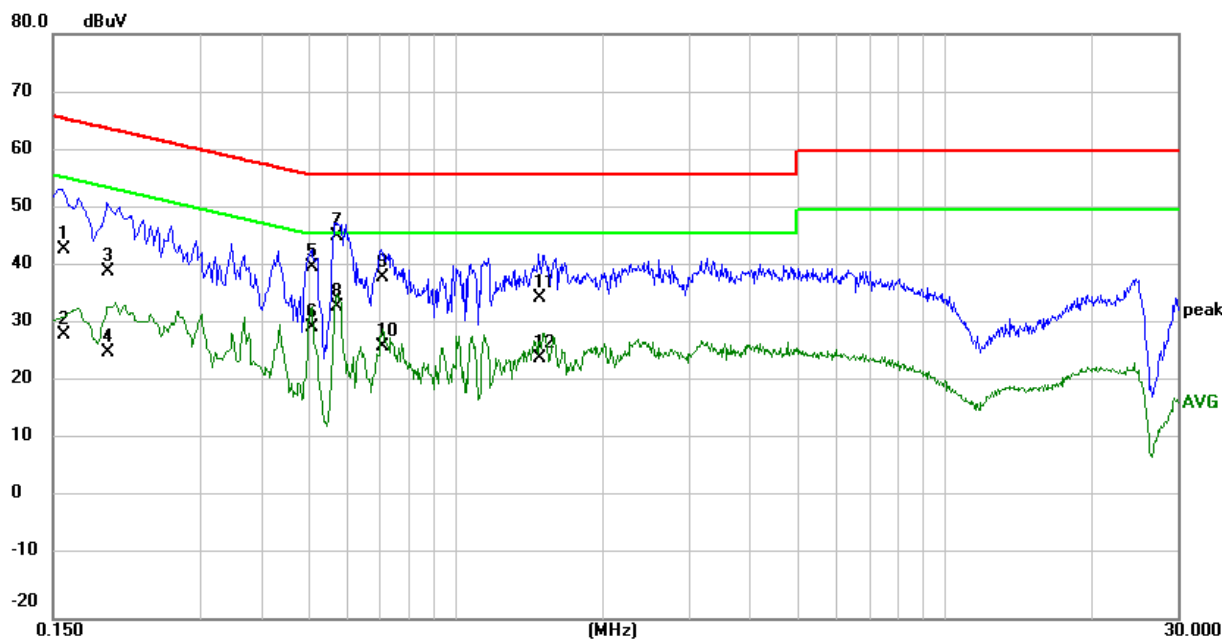
Repeat above procedures until all frequency measured were complete.

7.8.5 Test Results

Pass

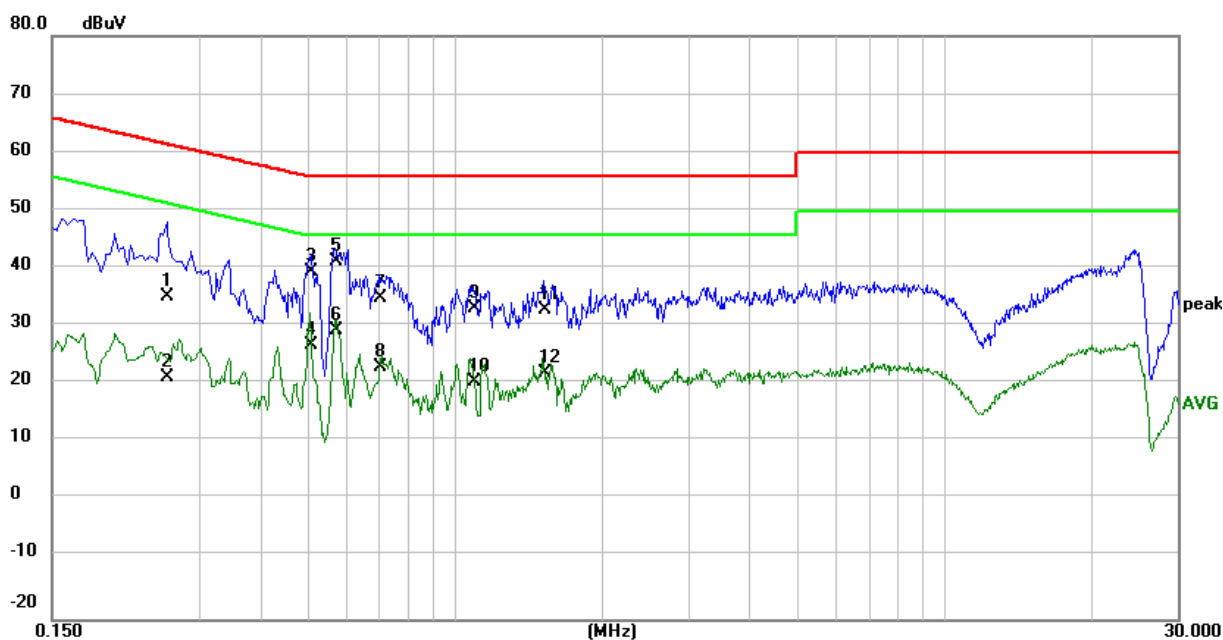
Conducted emission at both 120V & 240V is assessed, and emission at 120V represents the worst case. All the modulation modes were tested the data of the worst mode (GFSK) are recorded in the following pages and the others modulation methods do not exceed the limits.

Channel:	Middle	Phase :	L
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No.	Frequency (MHz)	Reading Level(dBuV)	Factor (dB)	Measure-ment(dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1580	33.17	9.90	43.07	65.57	-22.50	QP
2	0.1580	18.61	9.90	28.51	55.57	-27.06	AVG
3	0.1940	29.40	9.94	39.34	63.86	-24.52	QP
4	0.1940	15.60	9.94	25.54	53.86	-28.32	AVG
5	0.5100	30.37	9.90	40.27	56.00	-15.73	QP
6	0.5100	20.00	9.90	29.90	46.00	-16.10	AVG
7	0.5700	35.56	9.91	45.47	56.00	-10.53	QP
8	0.5700	23.54	9.91	33.45	46.00	-12.55	AVG
9	0.7060	28.38	9.93	38.31	56.00	-17.69	QP
10	0.7060	16.70	9.93	26.63	46.00	-19.37	AVG
11	1.4860	24.87	10.05	34.92	56.00	-21.08	QP
12	1.4860	14.55	10.05	24.60	46.00	-21.40	AVG

Channel:	Middle	Phase :	N
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No.	Frequency (MHz)	Reading Level(dBuV)	Factor (dB)	Measure-ment(dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.2580	25.43	9.93	35.36	61.50	-26.14	QP
2	0.2580	11.56	9.93	21.49	51.50	-30.01	AVG
3	0.5100	29.73	9.90	39.63	56.00	-16.37	QP
4	0.5100	17.28	9.90	27.18	46.00	-18.82	AVG
5	0.5700	31.47	9.91	41.38	56.00	-14.62	QP
6	0.5700	19.76	9.91	29.67	46.00	-16.33	AVG
7	0.7019	25.19	9.93	35.12	56.00	-20.88	QP
8	0.7019	13.35	9.93	23.28	46.00	-22.72	AVG
9	1.0900	23.30	10.07	33.37	56.00	-22.63	QP
10	1.0900	10.66	10.07	20.73	46.00	-25.27	AVG
11	1.5220	23.19	10.03	33.22	56.00	-22.78	QP
12	1.5220	12.43	10.03	22.46	46.00	-23.54	AVG

7.9 ANTENNA APPLICATION

7.9.1 Antenna Requirement

Standard	Requirement
FCC CRF Part 15.203	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

For intentional device, according to FCC 47 CFR Section 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. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

7.9.2 Result

PASS.

The EUT has 1 antenna: PCB Antenna for BT V5.4 with classic model, the gain is 2.5 dBi;

Note: ☒ Antenna use a permanently attached antenna which is not replaceable.
☐ Not using a standard antenna jack or electrical connector for antenna replacement
☐ The antenna has to be professionally installed (please provide method of installation)

which in accordance to section 15.203, please refer to the internal photos.

----- END OF REPORT -----

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