FCC Part 15 Subpart C Test Report

for DSSS System

Product Name : **Compact**
Model Name : **Compact 1.0**

Prepared for:
Octo Telematics S.P.A
Via Iamaro 51, 00173 Rome, Italy

Prepared by:
Unilab (Shanghai) Co., Ltd
FCC 2.948 register number is 714465
No.1350, Lianxi Rd. Pudong New District, Shanghai, China
TEL: +86-21-50275125
FAX: +86-21-50275126

Report Number : UL32620160812FCC002-2
Date of Report : 09-13-2016
Date of Test : 08-15-2016~09-12-2016

Notes：
The test results only relate to these samples which have been tested.
Partly using this report will not be admitted unless been allowed by Unilab.
Uniab is only responsible for the complete report with the reported stamp of Unilab.

Applicant:	Octo Telematics S.P.A Via lamaro 51, 00173 Rome, Italy
Manufacturer:	Octo Telematics S.P.A Via lamaro 51, 00173 Rome, Italy
Product Name:	Compact
Brand Name:	OCTO
Model Name:	Compact 1.0
FCC ID:	2AHR8-COMPACT01
IC	21405-COMPACT01
Serial Number:	N/A
EUT Voltage:	MIN: 6V, NOR: 12/24V, MAX: 32V
Date of Receipt:	08-12-2016
Date of Test:	08-15-2016~09-12-2016
Test Standard:	FCC CFR Tile 47 Part 15 Subpart C ANSI C 63.4: 2014 ANSI C 63.10: 2013 KDB 558074 D01 v03r05 RSS-GEN Issue 4 RSS-247 Issue 1
Test Result:	PASS

Prepared by : Wayne Wu
(Technical Engineer: Wayne Wu)

Reviewed by : Forest Cao
(Senior Engineer: Forest Cao)

Approved by : Eva Wang
(Supervisor: Eva Wang)

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1. GENERAL INFORMATION

1.1 EUT DESCRIPTION

Product Name:	Compact
Model Name:	Compact 1.0
Hardware Version:	A03
Software Version:	1.0
RF Exposure Environment:	Uncontrolled
BT 4.1 LE	
Frequency Range:	2402MHz~2480MHz
Type of Modulation:	GFSK
Channel Number:	40
Antenna Type:	Internal
Antenna Peak Gain:	2.5dBi

1.2 TEST MODE

Unilab has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation, which was shown in this test report is the worst test mode and defined as:

Test Mode	Test Voltage
Mode 1: Bluetooth V4.1 LE:GFSK	DC 12V

Note:
1. Regards to the frequency band operation: the lowest, middle and highest frequency of channel were selected to perform the test, then shown on this report.
2. For the radiated emission test, every axis (X, Y, Z) was verified, and show the worst result on this report.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.

2.1 EUT CONFIGURATION

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

2.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the

requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3 GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.4: 2014 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 13.1.4.1 of ANSI C63.4: 2014.

2.4 FCC PART 15.205 RESTRICTED BANDS OF OPERATIONS

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 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	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	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	2655 - 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			

1 Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

2 Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section

15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

2.5 Restricted Frequency Bands of RSS-GEN

Restricted bands, identified in Table 6, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:

(a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 6 except for apparatus complying under RSS-287;

(b) Unwanted emissions that fall into restricted bands of Table below shall comply with the limits specified in RSS-Gen; and

(c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

MHz	MHz	MHz	MHz	GHz
0.090-0.110	8.37625-8.38675	74.8-75.2	1718.8-1722.2	9.0-9.2
2.1735-2.1905	8.41425-8.41475	108-138	2200-2300	9.3-9.5
3.020-3.026	12.29-12.293	156.52475-156.52525	2310-2390	10.6-12.7
4.125-4.128	12.51975-12.52025	156.7-156.9	2655-2900	13.25-13.4
4.17725-4.17775	12.57675-12.57725	240-285	3260-3267	14.47-14.5
4.20725-4.20775	13.36-13.41	322-335.4	3332-3339	15.35-16.2
5.677-5.683	16.42-16.423	399.9-410	3345.8-3358	17.7-21.4
6.215-6.218	16.69475-16.69525	608-614	3500-4400	22.01-23.12
6.26775-6.26825	16.80425-16.80475	960-1427	4500-5150	23.6-24.0
6.31175-6.31225	25.5-25.67	1435-1626.5	5350-5460	31.2-31.8
8.291-8.294	37.5-38.25	1645.5-1646.5	7250-7750	36.43-36.5
8.362-8.366	73-74.6	1660-1710	8025-8500	Above 38.6

* Certain frequency bands listed in Table 6 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200- and 300-series of RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

3. TECHNIACL SUMMARY

3.1 SUMMARY OF STANDARDS AND TEST RESULTS

The EUT have been tested according to the applicable standards as referenced below:

Test Item	FCC	IC	Result
6 dB bandwidth	§15.247 (a)	RSS-247 §5.2	Pass
Power spectral density	§15.247 (e)	RSS-247 §5.2	Pass
Peak Output Power (Conduction)	§15.247 (b)(1)	RSS-247 §5.4	Pass
Spurious Emissions (Conduction)	§15.247 (d)	RSS-247 §5.5	Pass
Band edge measurement	§15.247 (d)	RSS-247 §5.5	Pass
Spurious Emissions (Radiation)	§15.247 (d) §15.35 (b) §15.209 (a)	RSS-247 §5.5	Pass
Restricted Bands of operation	§15.205	RSS-Gen §8.10	Pass

3.2 TEST UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Test item	Value (dB)
Conducted disturbance	3.4
Radiated disturbance	4.2
Conducted RF Measurement	1.1

3.3 TEST EQUIPMENT LIST

Equipment	Manufacturer	Model	Serial No.	Due Date
Receiver	Agilent	N9038A	MY51210142	11/05/2016
Power meter	R&S	NRP2	101607	02/17/2017
Loop Antenna	Schwarzbeck	FMZB1519	1519-020	03/24/2017
LISN	R&S	ENV216	100069	08/21/2016
3m Chamber & Accessory Equipment	ETS-LINDGREN	FACT-3	CT-0000336	11/26/2017
Microwave Preamplifier	EM Electronics	EM30180	3008A02425	02/26/2017
Power Splitter	Agilent	11667C/ 52401	MY53806148	02/26/2017
Biconilog Antenna	Schwarzbeck	VULB 9160	3316	09/19/2016
Horn Antenna	Schwarzbeck	BBHA9120D	942	09/19/2016
Horn Antenna	Schwarzbeck	BBHA9120D	943	09/19/2016
Horn Antenna(18-40GHz)	ETS	3116	00070497	09/19/2016
Directional coupler	ATM	C122H-10	C279710-02	/
RF cable	HUBER+SUHNER	SUCOFLEX 104	342800/4	/
Attenuator	Compliance Direction System	ATT-20	/	/
Wave Trap	Walnwright instrument	WRCT2402/2480-2400/2483.5-30/20SS	SN30	/

3.4 TEST FACILITY

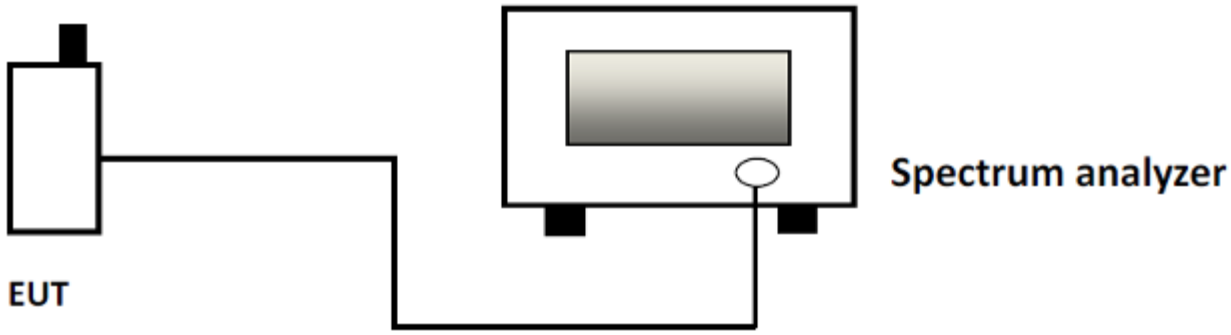
All test facilities used to collect the test data are located at No.1350, Lianxi Rd. Pudong New District, Shanghai, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4: 2014, CISPR 16-1-1 and other equivalent standards. The laboratory is compliance with the requirements of the ISO/IEC/E 17025.

3.5 TEST SETUP CONFIGURATION

The information contained within this report is intended to show verification of compliance of the EUT to the requirements of CFR 47 FCC Part 15.247.
Unilab has verified the construction and function in typical operation. All the test modes were carried out with the EUT in normal operation, which was shown in this test report.

4. 6 DB BANDWIDTH

4.1 TEST SETUP



4.2 LIMITS

Limit	≥500 kHz

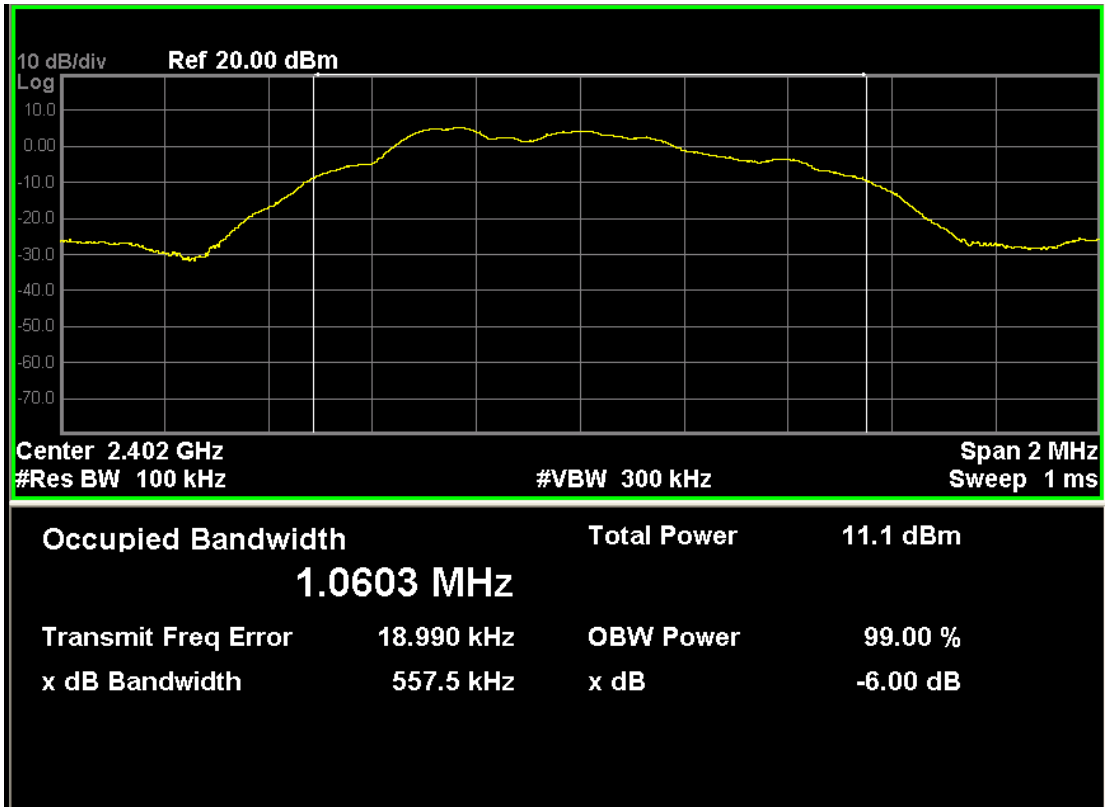
4.3 TEST PROCEDURE

Place the EUT on the table and set it in transmitting mode. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to spectrum analyzer. The loss between RF output port of the EUT and the input port of the tester will be taken into consideration.
The measurement will be conducted at three channels.
Bluetooth: Low (0), Middle (19) and High (39).
Using occupied BW measurement function of spectrum analyzer and settings are:
XdB = -6dB
RBW = 100 kHz
VBW ≥ 3 x RBW
Span = approximately 2 to 3 times the 6 dB bandwidth, centered on a channel
Sweep = auto
Detector function = peak
Trace = max hold

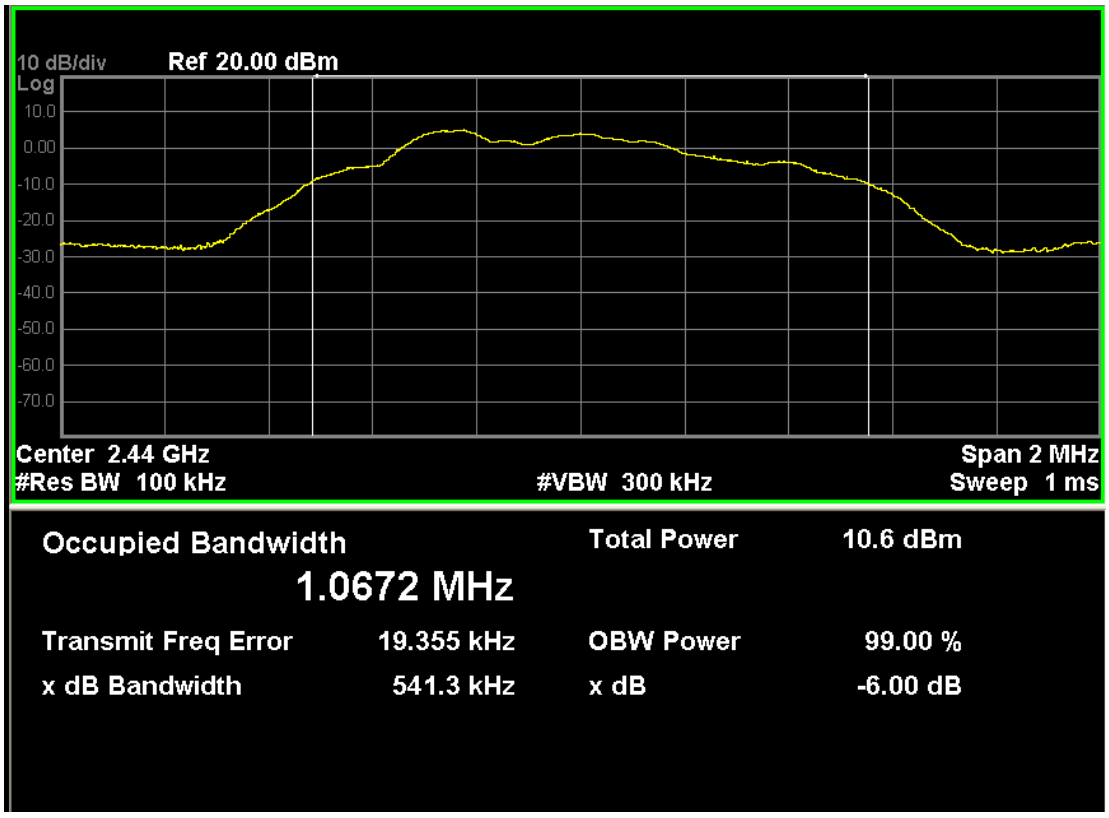
4.4 RESULTS & PERFORMANCE

Channel	Measured 6dB bandwidth (KHz)	Limit (MHz)	Result
Bluetooth V4.1 LE			
GFSK CH0	557.5	≥0.5	PASS
GFSK CH19	541.3	≥0.5	PASS
GFSK CH39	561.4	≥0.5	PASS

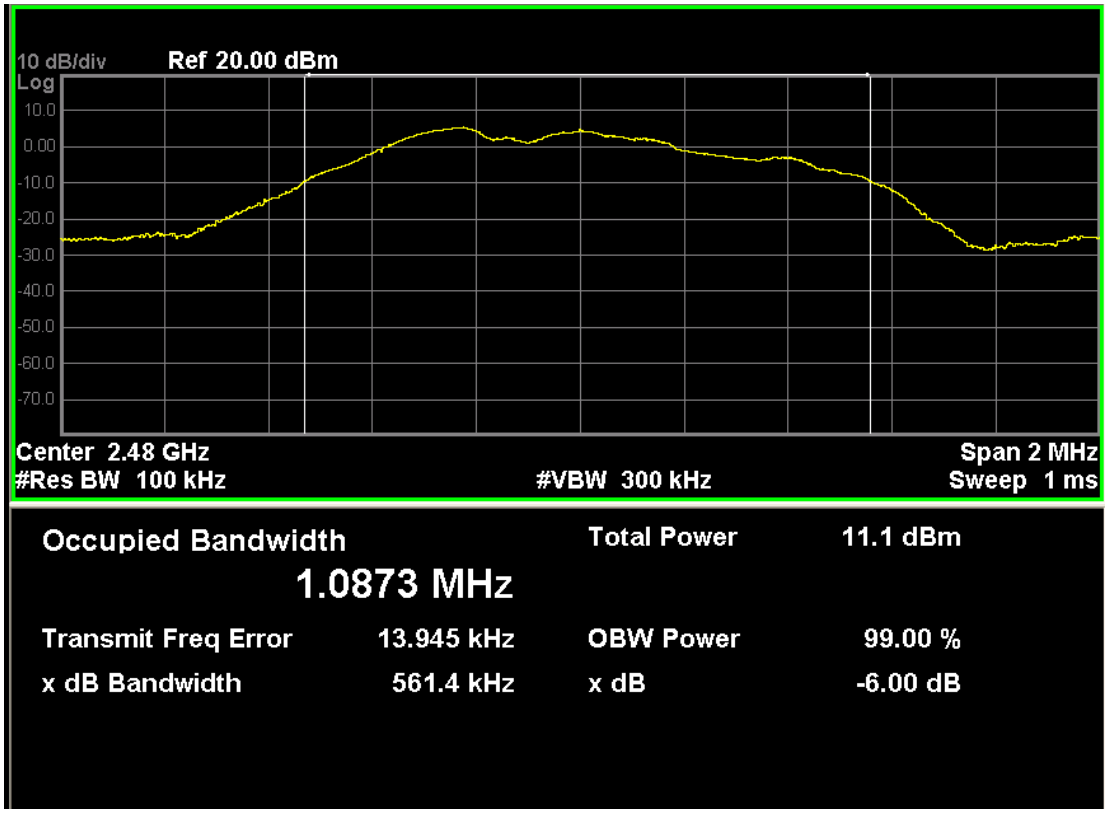
Bluetooth V4.1 LE:
GFSK channel 0



GFSK channel 19

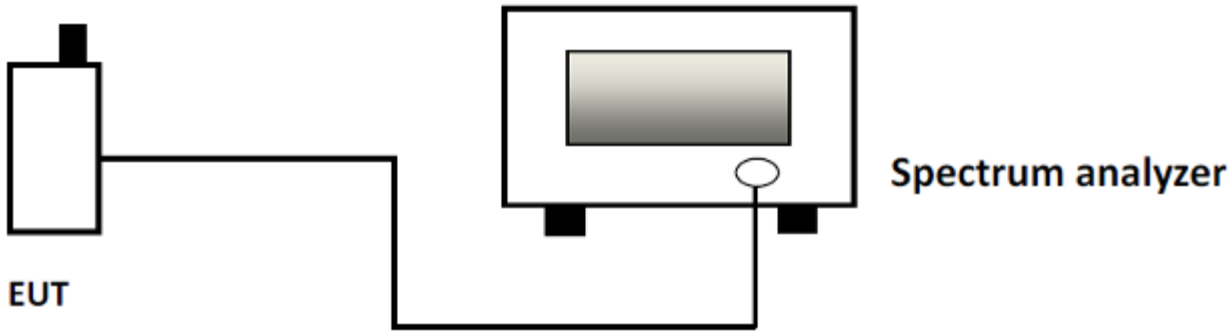


GFSK channel39



5. POWER SPECTRAL DENSITY

5.1 TEST SETUP



5.2 LIMITS

Limits	≤8dBm/3kHz

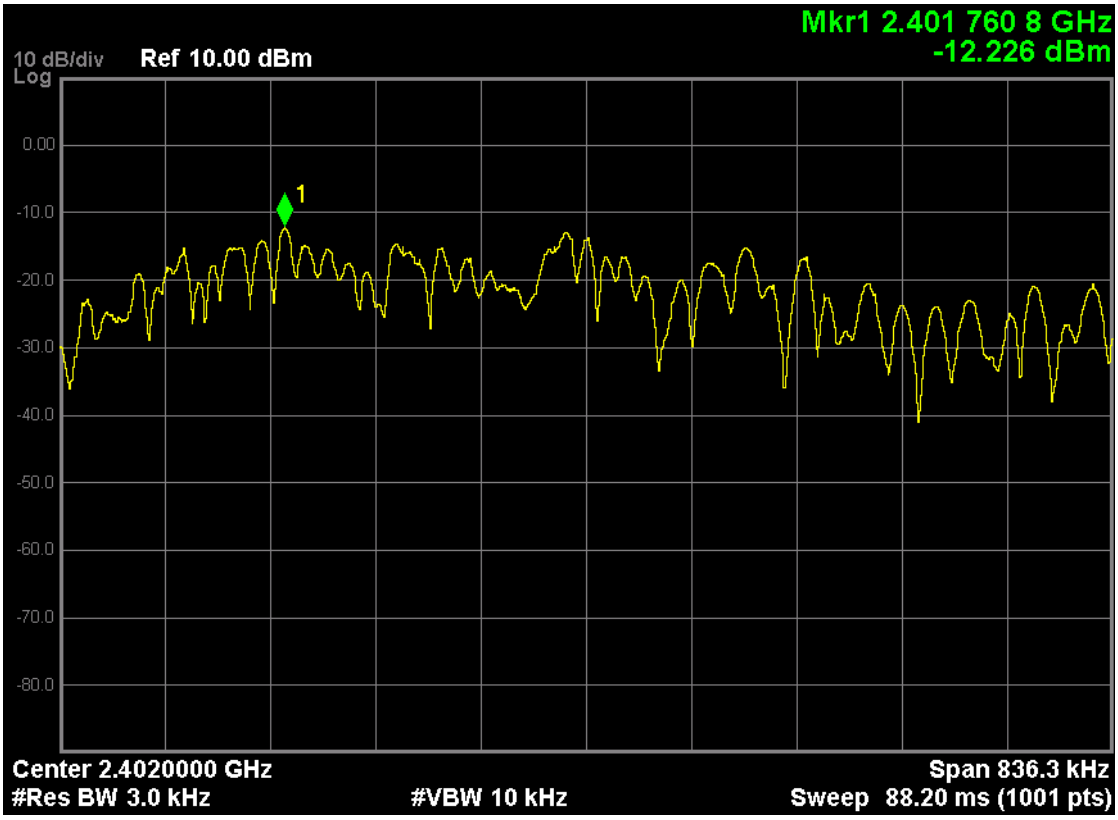
5.3 TEST PROCEDURE

Set analyzer center frequency to DTS channel center frequency.
Set the span to 1.5 times the DTS bandwidth.
Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
Set the VBW ≥ 3 x RBW.
Detector = peak.
Sweep time = auto couple.
Trace mode = max hold.
Allow trace to fully stabilize.
Use the peak marker function to determine the maximum amplitude level within the RBW.
If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

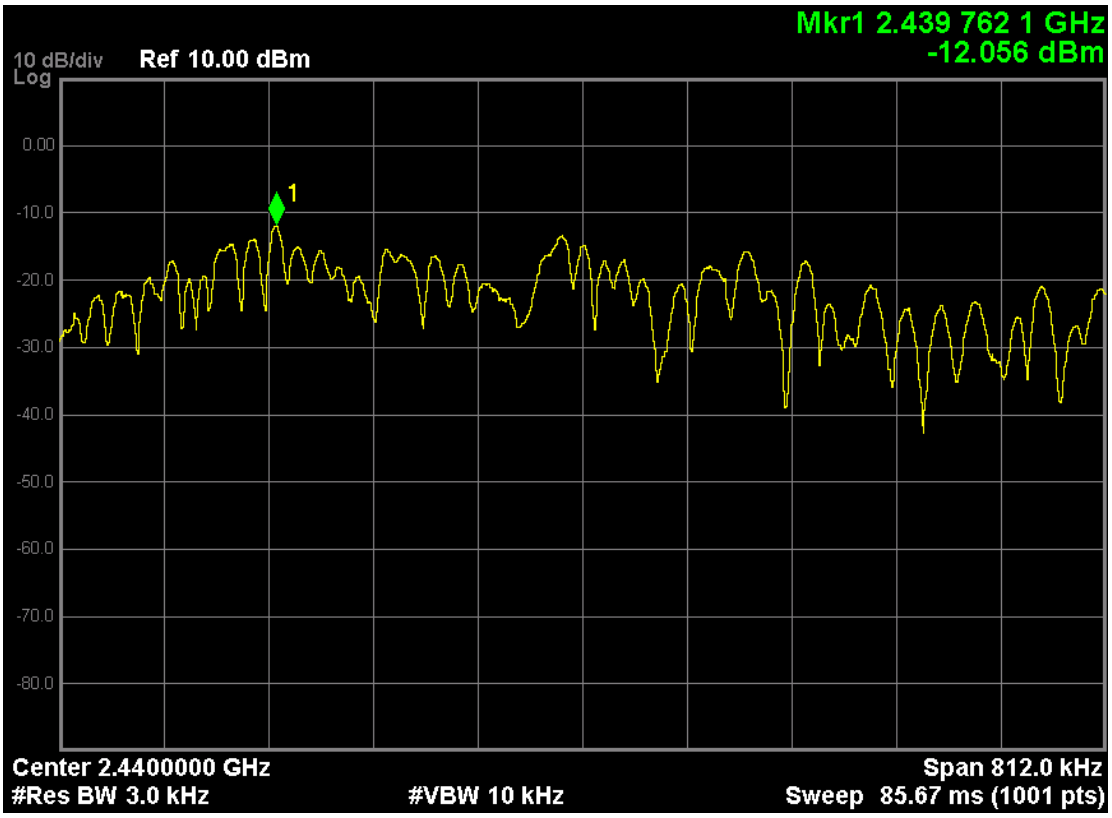
5.4 RESULTS & PERFORMANCE

Mode	Channel	Measured level (dBm/3KHz)	Limit (dBm/3KHz)	Result
Bluetooth V4.1 LE	CH0	-12.226	≤8.00	Pass
	CH19	-12.056	≤8.00	Pass
	CH39	-12.199	≤8.00	Pass

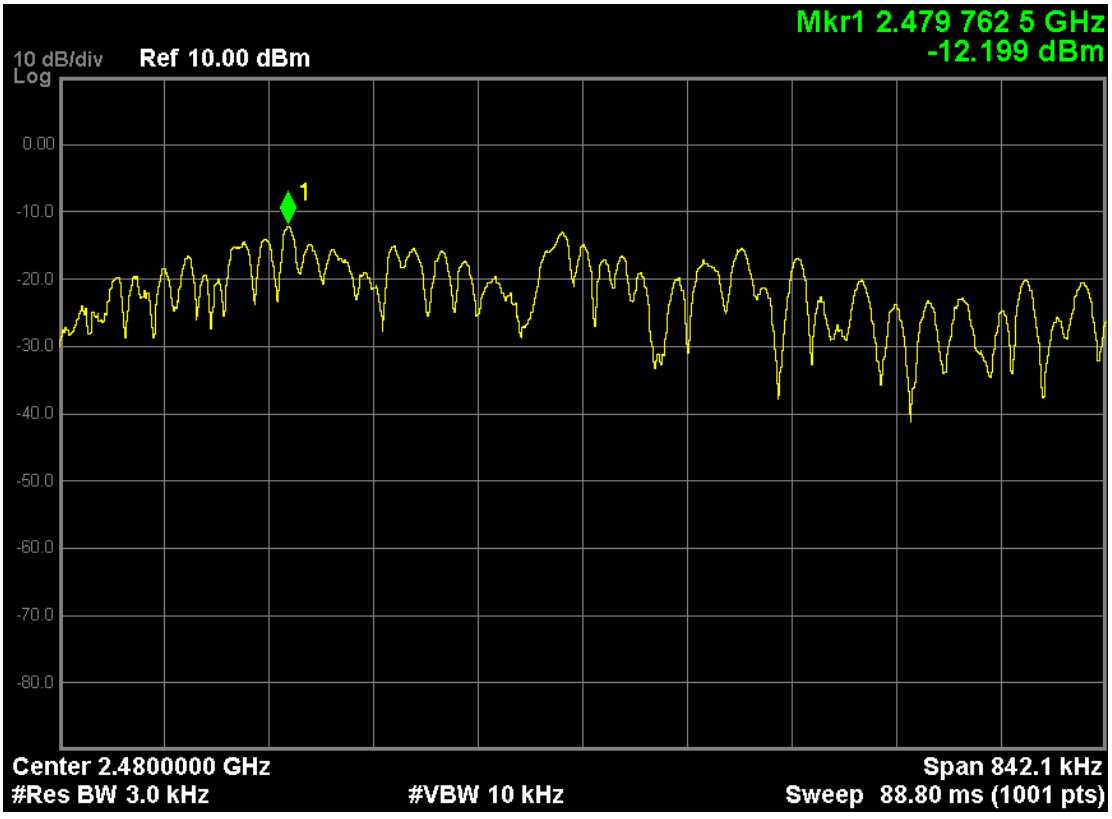
Bluetooth V4.1 LE
GFSK Channel 0



GFSK Channel 19

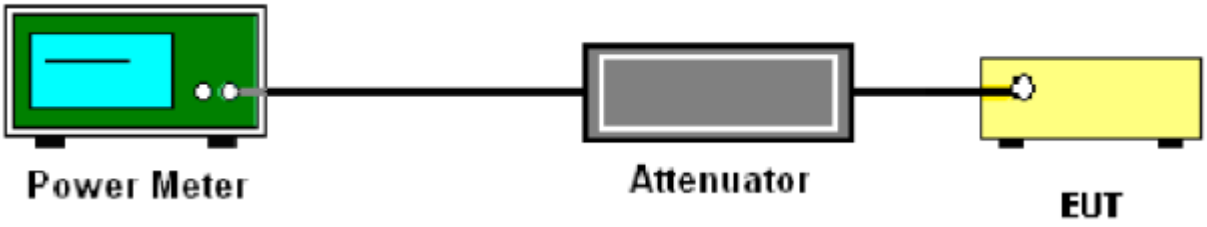


GFSK Channel 39



6. PEAK OUTPUT POWER (CONDUCTION)

6.1 TEST SETUP



6.2 LIMITS

Limits	<30dBm

6.3 TEST PROCEDURE

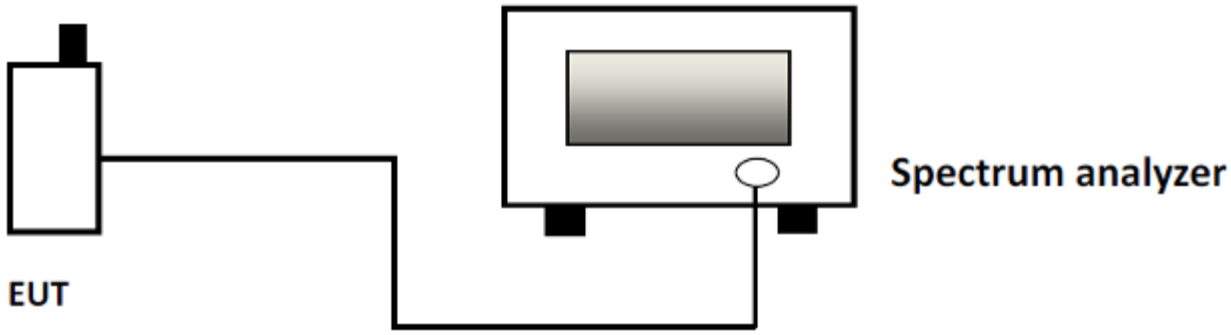
Place the EUT on the table and set it in transmitting mode. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to spectrum analyzer. The loss between RF output port of the EUT and the input port of the tester will be taken into consideration.
The measurement will be conducted at three channels.
Bluetooth: Low(0), Middle(19) and High (39).

6.4 RESULTS & PERFORMANCE

Bluetooth V4.1 LE			
Channel	Peak power (dBm)	Limit (dBm)	Margin (dB)
0 (2402MHz)	5.792	30	25.153
19 (2440MHz)	5.865	30	26.076
39 (2480MHz)	6.550	30	25.419

7. SPURIOUS EMISSIONS (CONDUCTION)

7.1 TEST SETUP



7.2 LIMITS

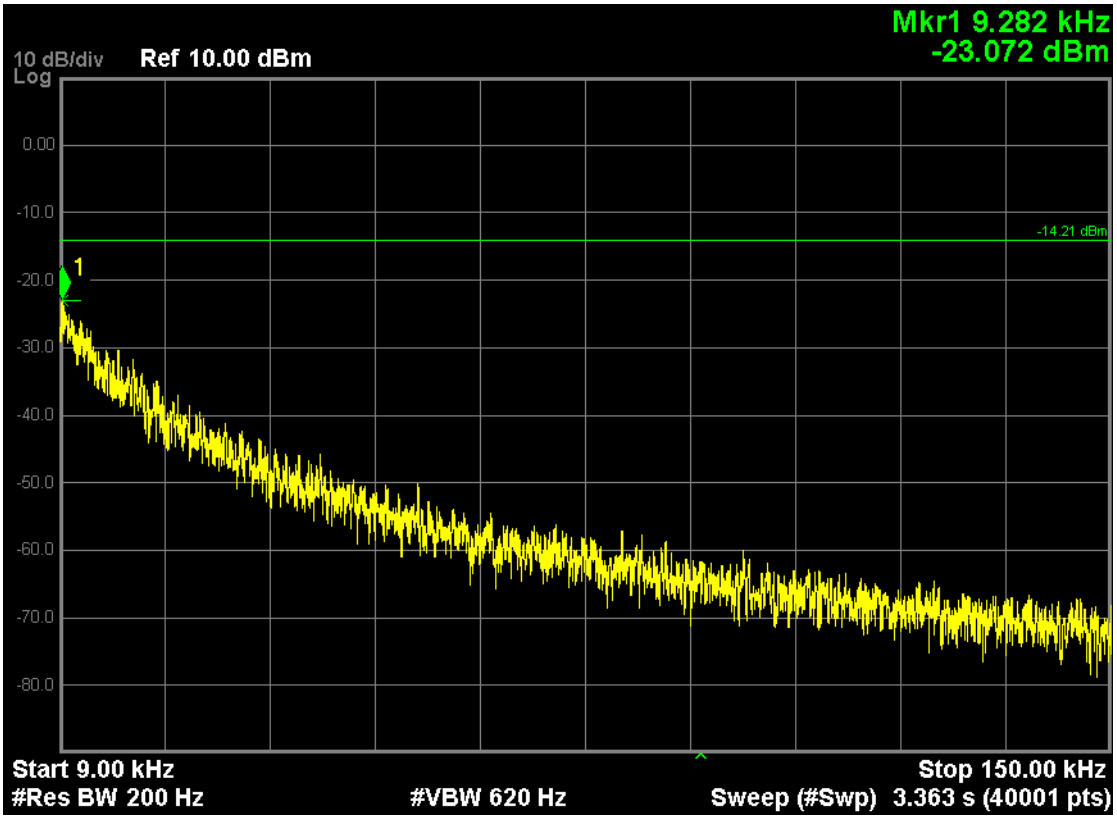
Limit	<(P-20dB)
Note: P is the highest level of the desired power	

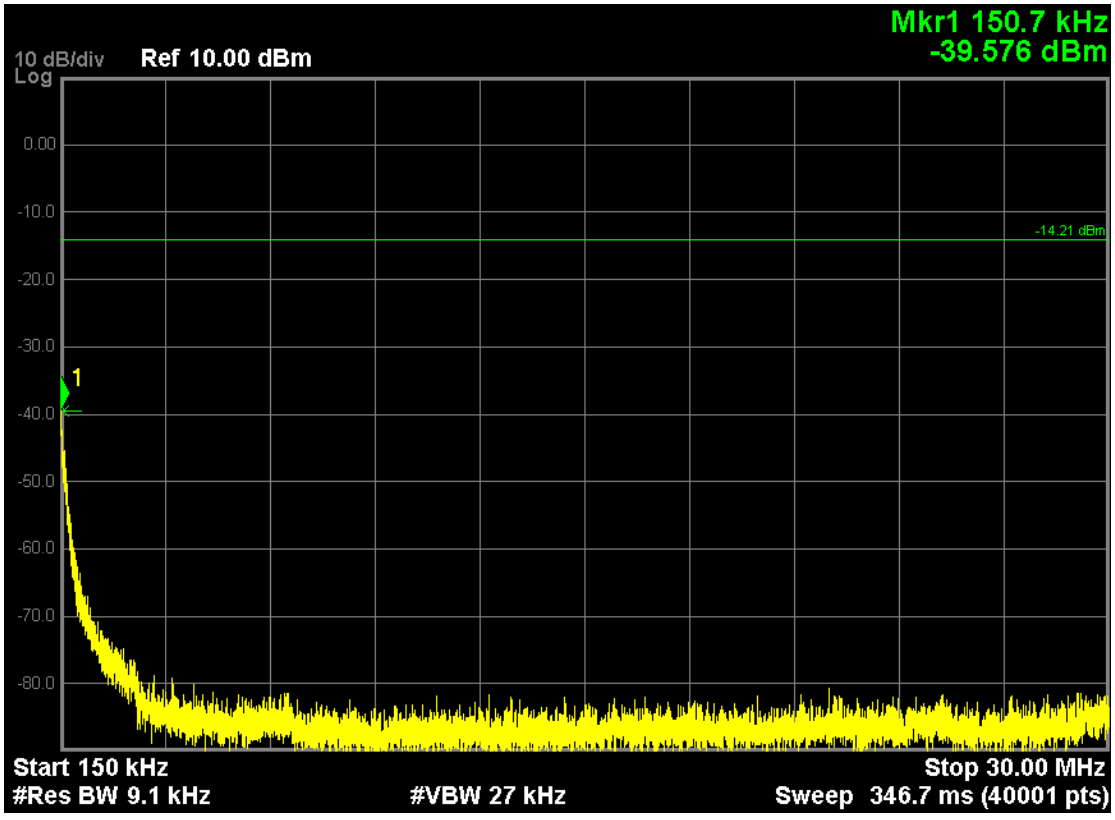
7.3 TEST PROCEDURE

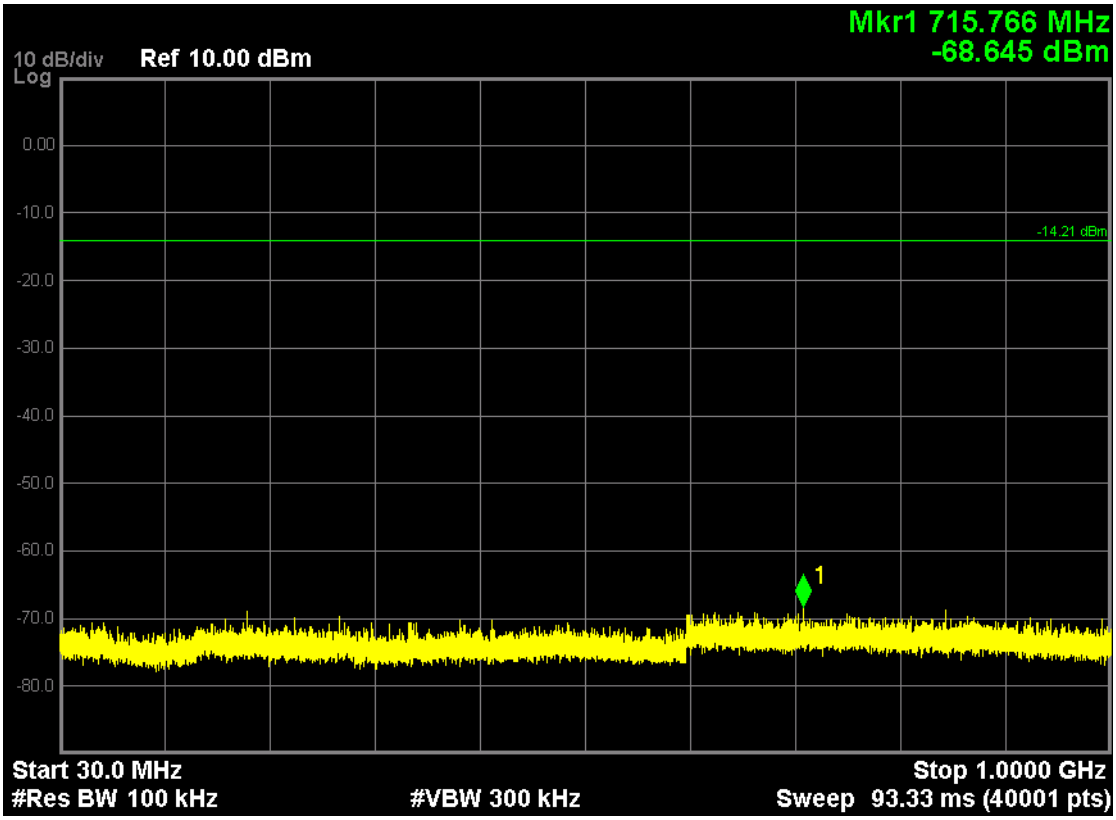
The EUT was connected to Spectrum Analyzer and Base Station via power divider. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 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. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.

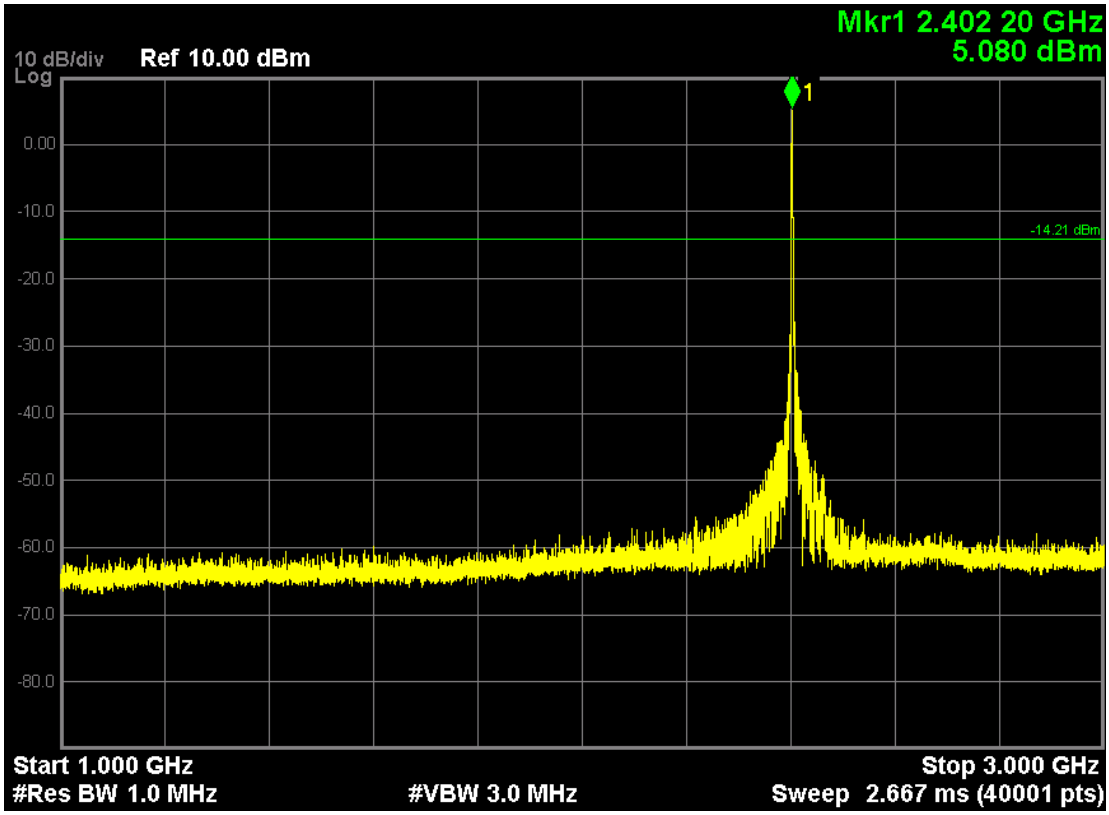
7.4 RESULTS & PERFORMANCE

Bluetooth V4.1 LE GFSK Channel 0

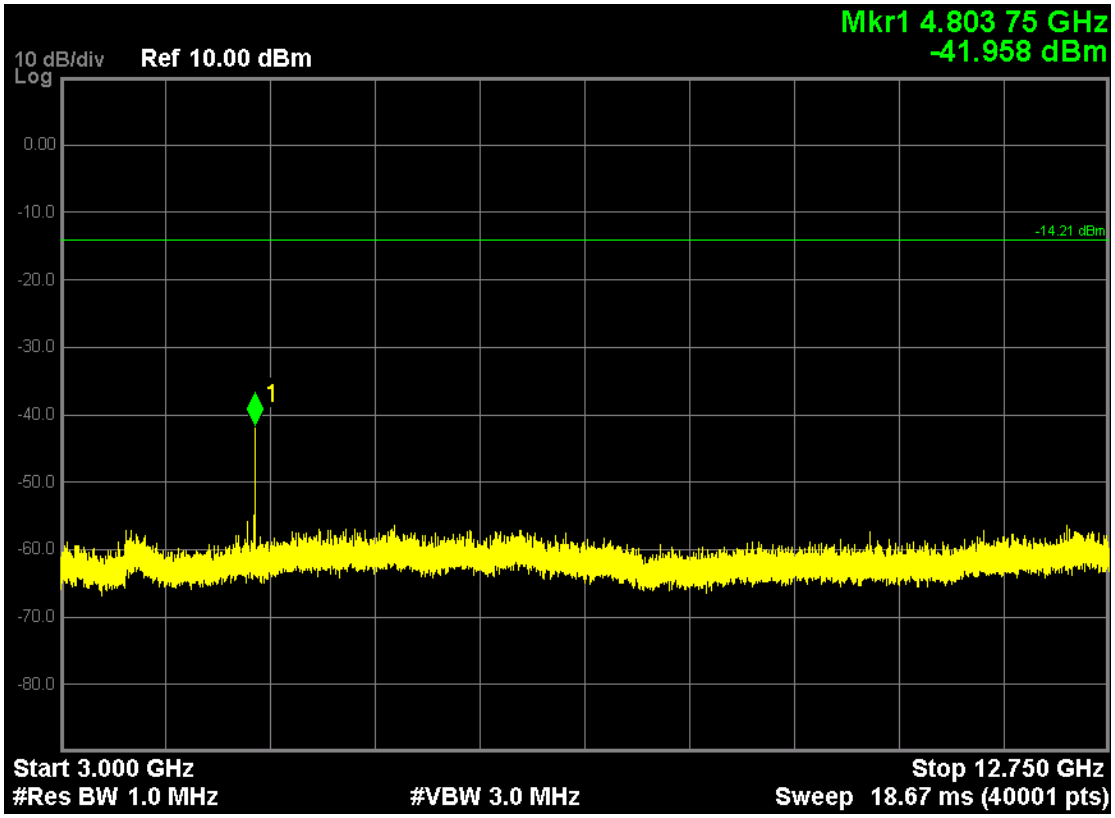


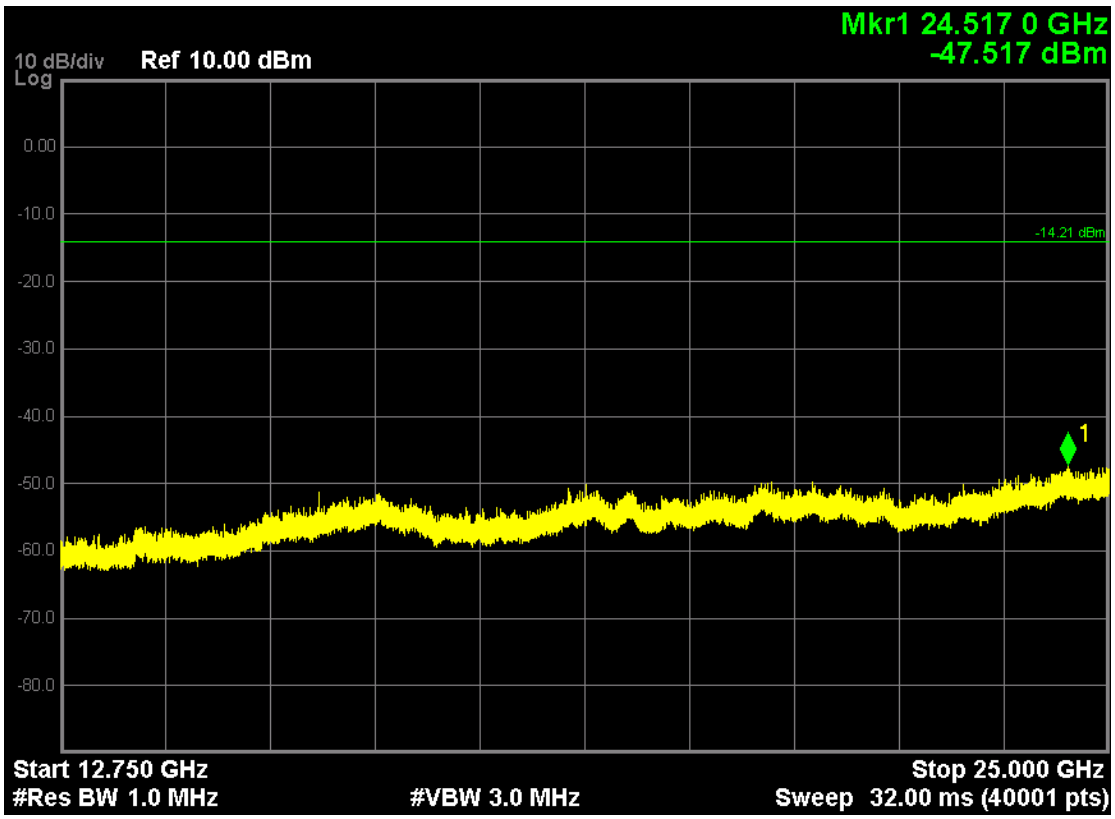




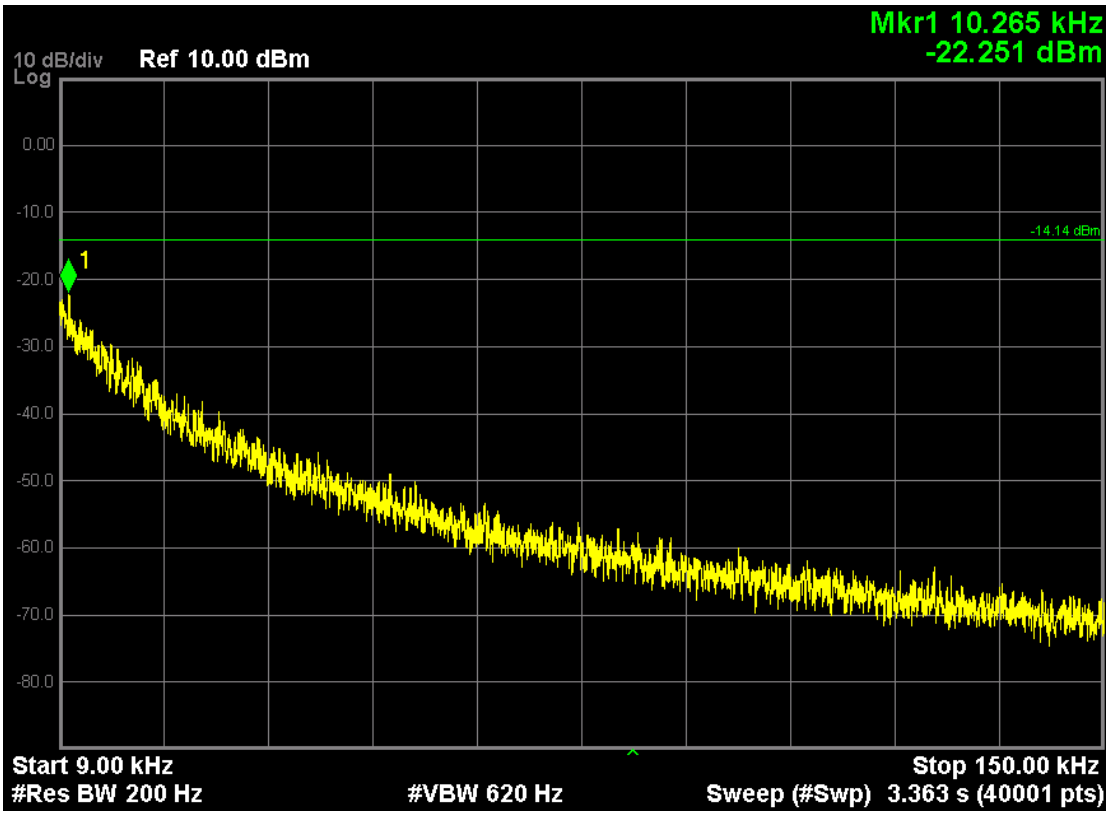


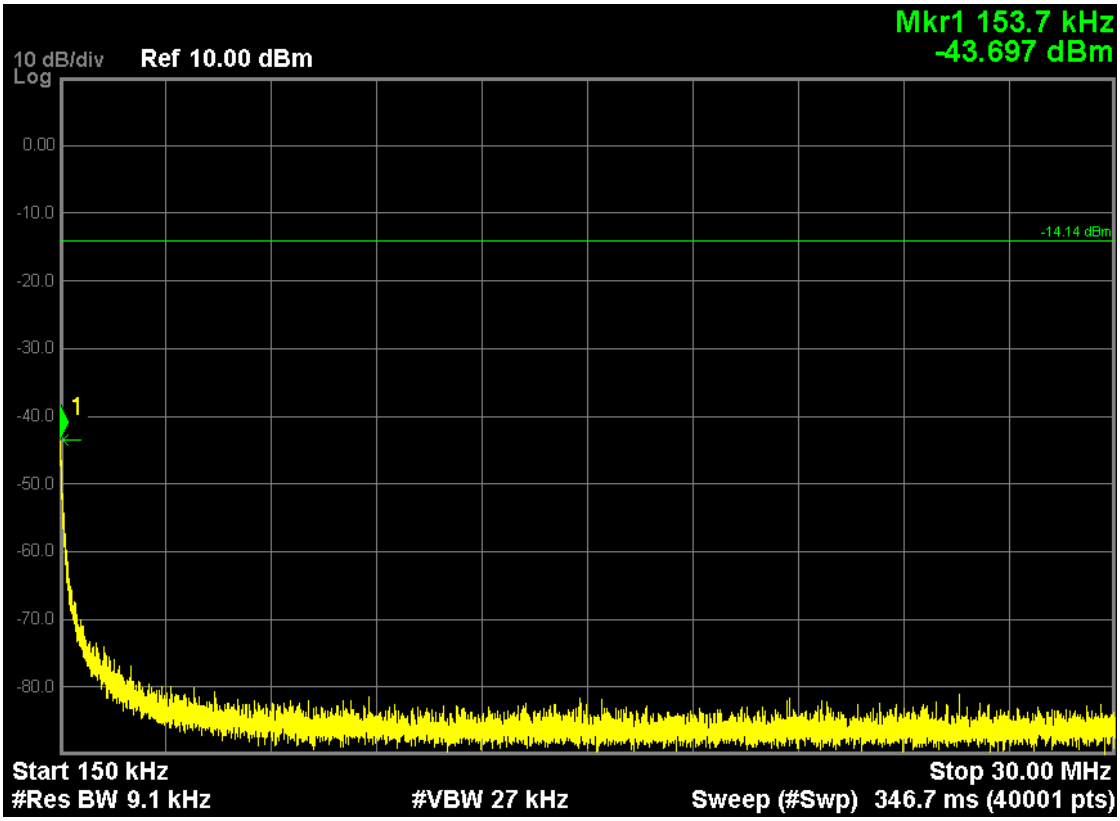
Note: The point mark1 is carrier.

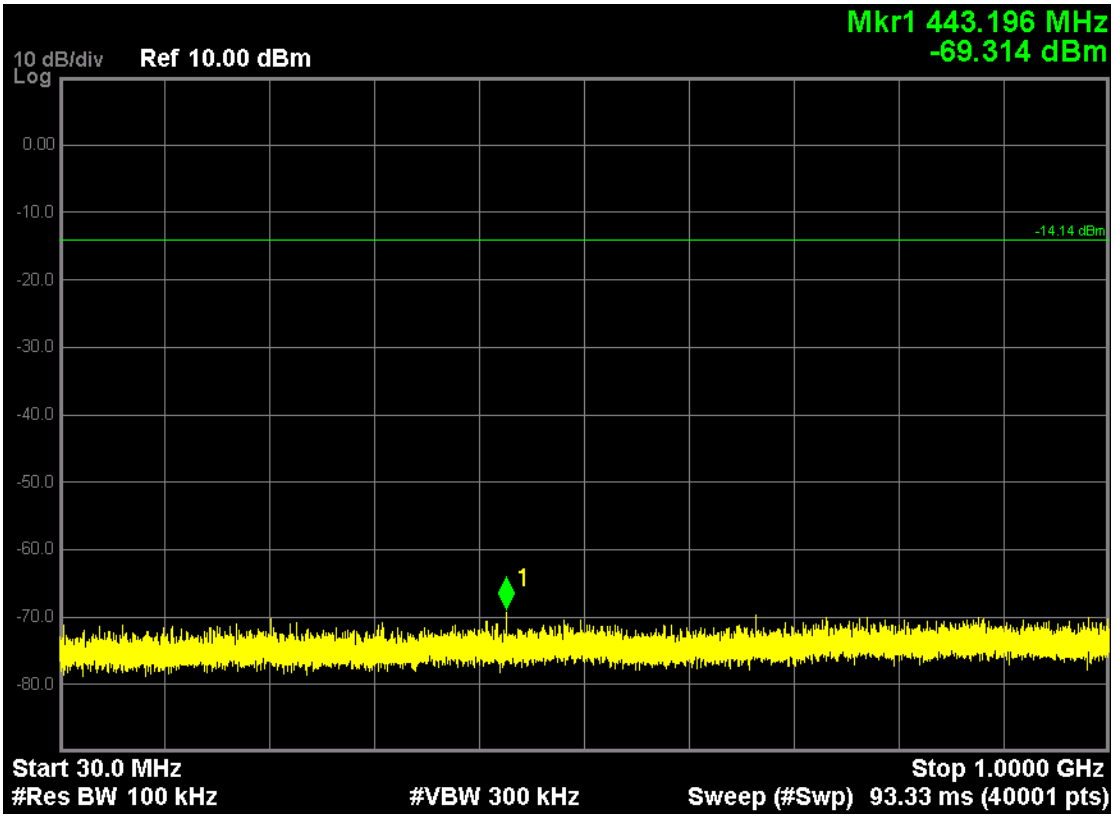

Mkr1 4.803 75 GHz
-41.958 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-14.21 dBm
1
Start 3.000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 12.750 GHz
Sweep 18.67 ms (40001 pts)

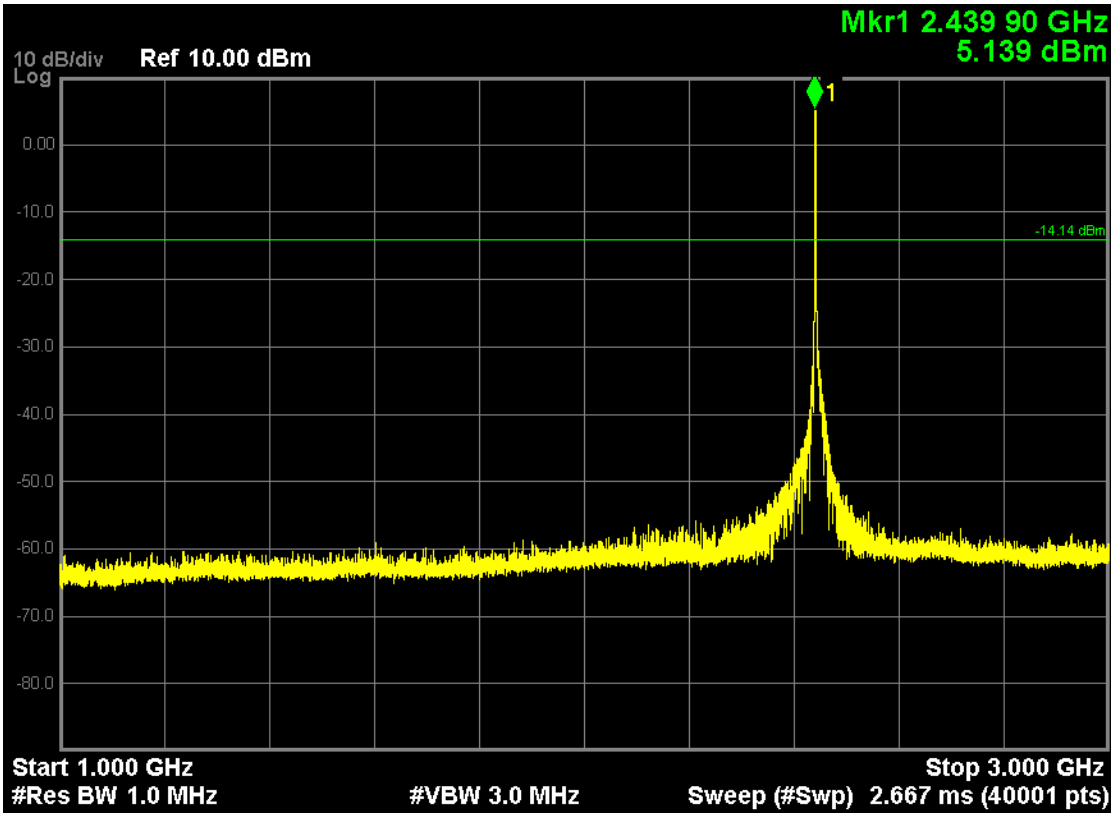

Mkr1 24.517 0 GHz
-47.517 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-14.21 dBm
1
Start 12.750 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.000 GHz
Sweep 32.00 ms (40001 pts)

Bluetooth V4.1 LE GFSK Channel 19

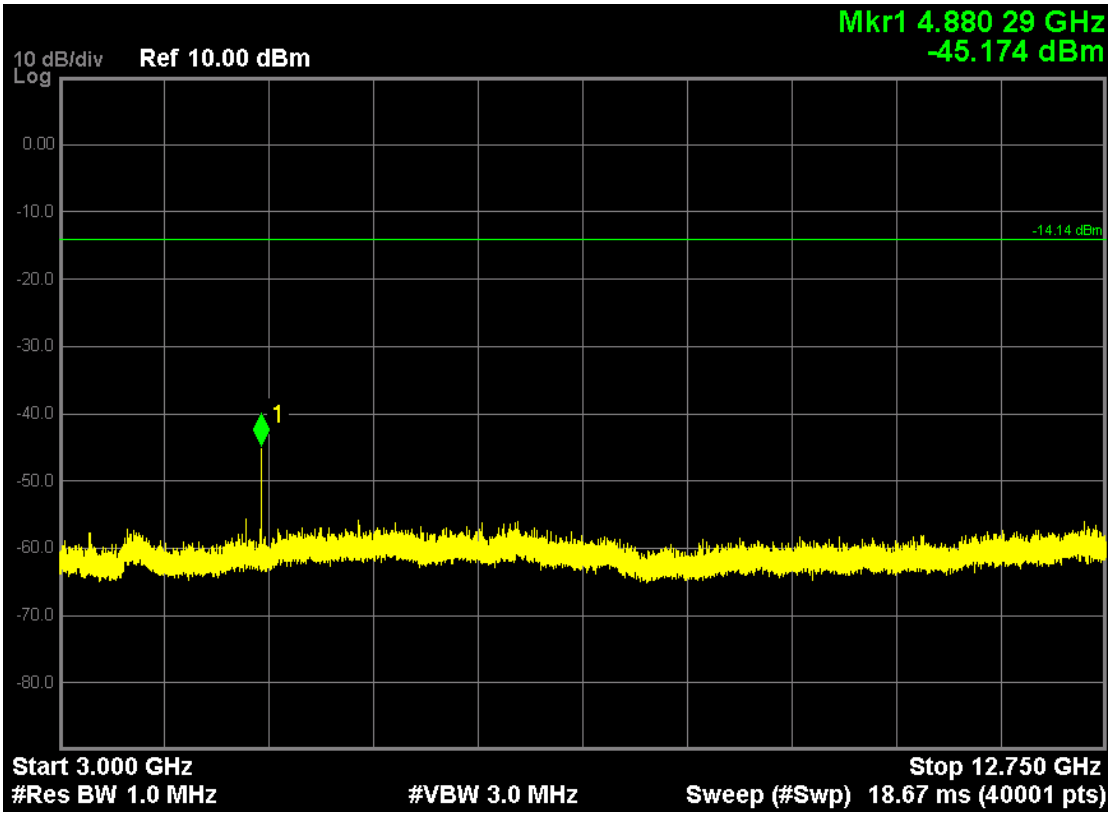


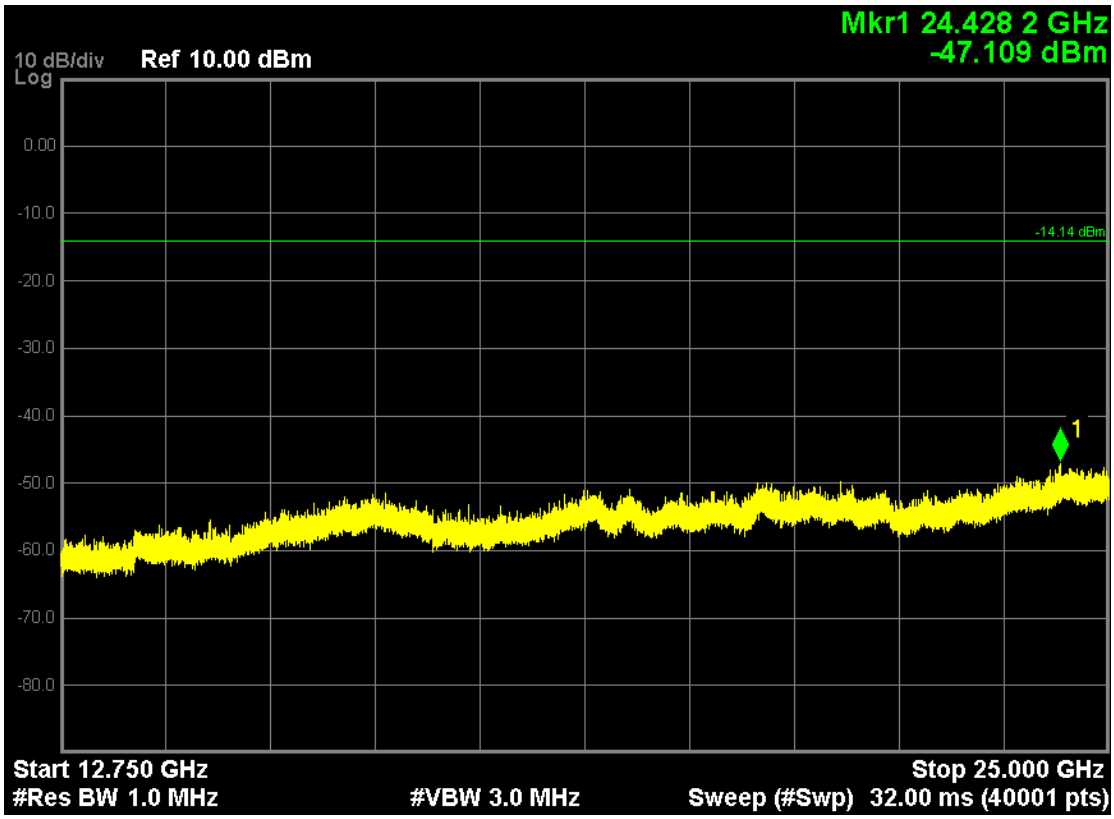




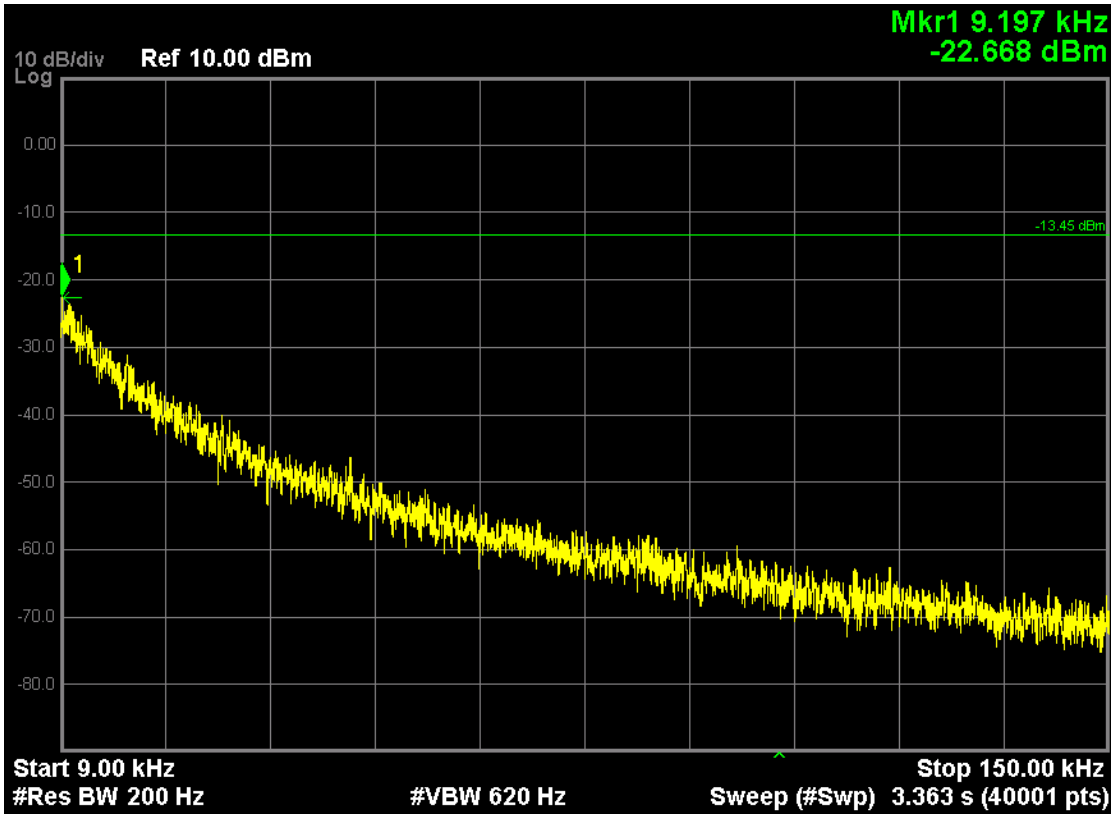


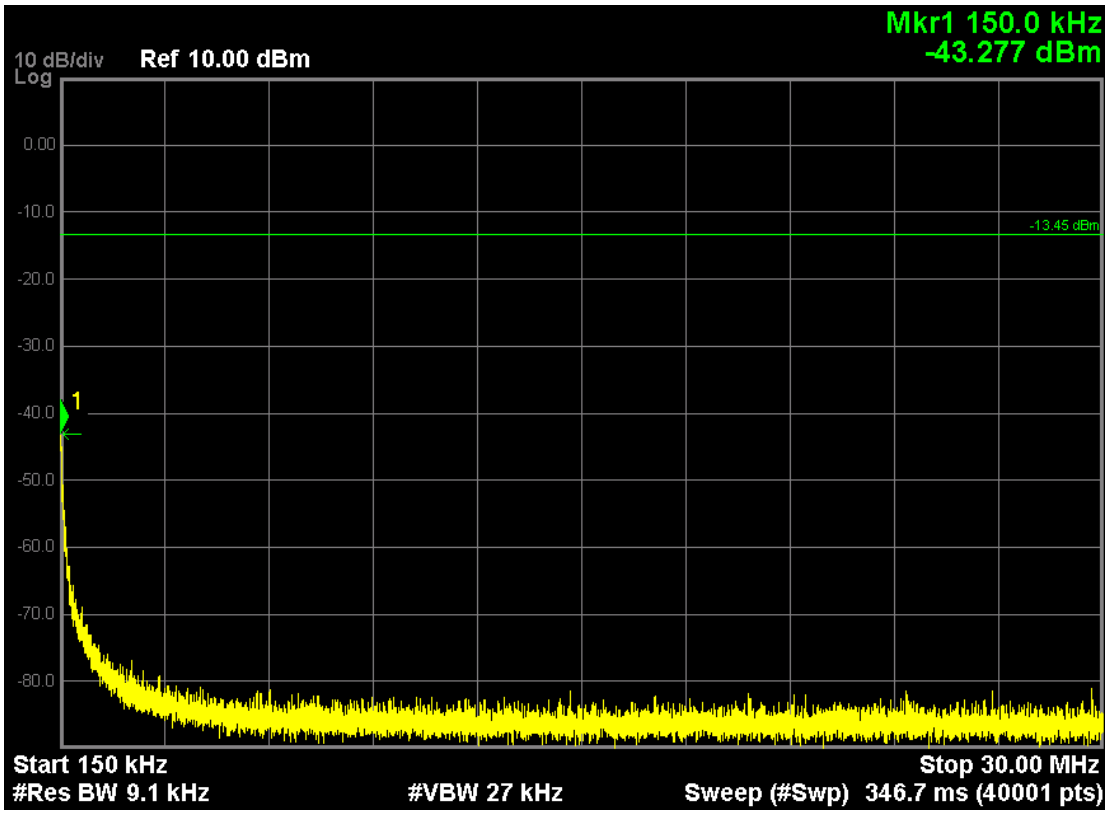
Note: The Mark1 point is carrier.

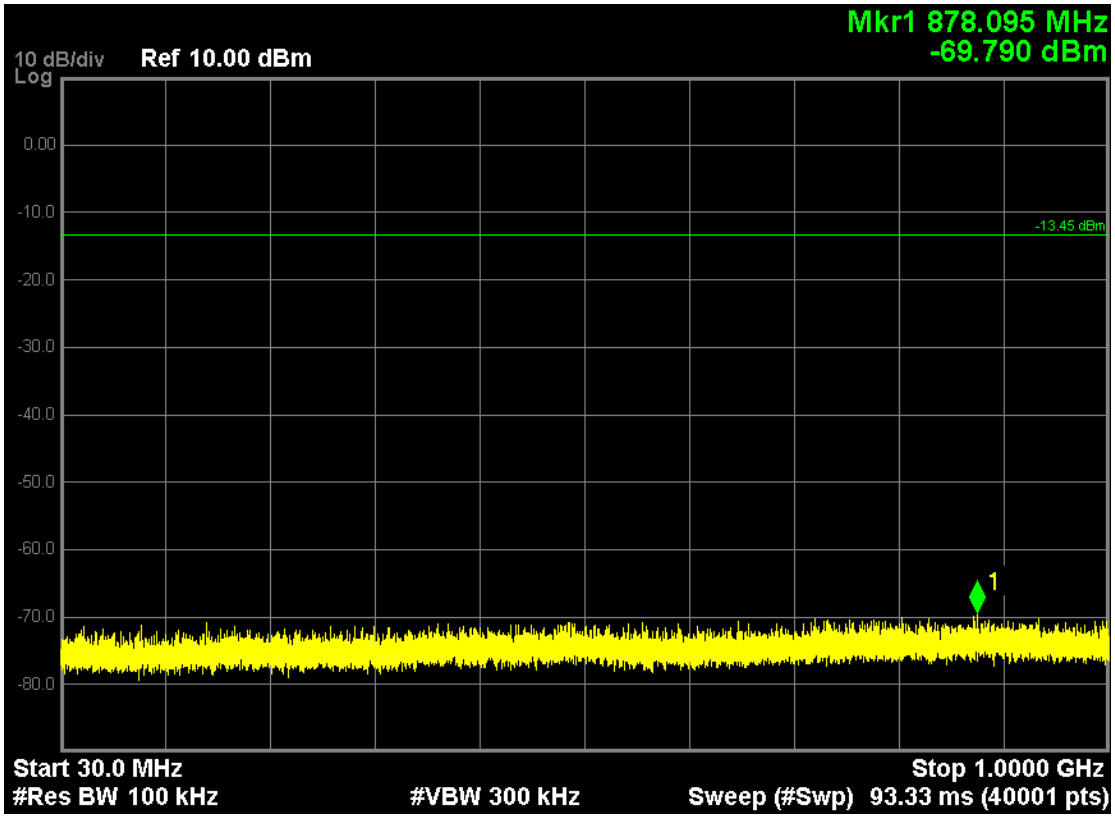

Mkr1 4.880 29 GHz
-45.174 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-14.14 dBm
1
Start 3.000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 12.750 GHz
Sweep (#Swp) 18.67 ms (40001 pts)

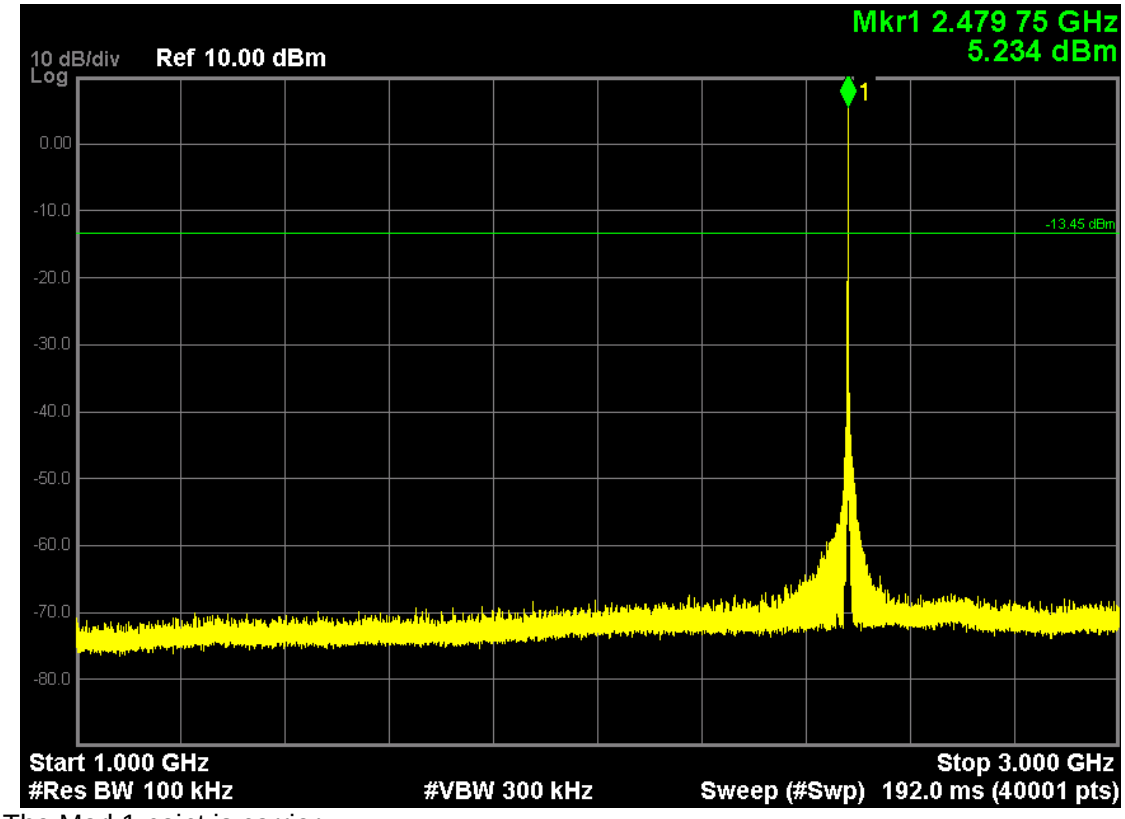

Mkr1 24.428 2 GHz
-47.109 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-14.14 dBm
1
Start 12.750 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.000 GHz
Sweep (#Swp) 32.00 ms (40001 pts)

Bluetooth V4.1 LE GFSK Channel 39

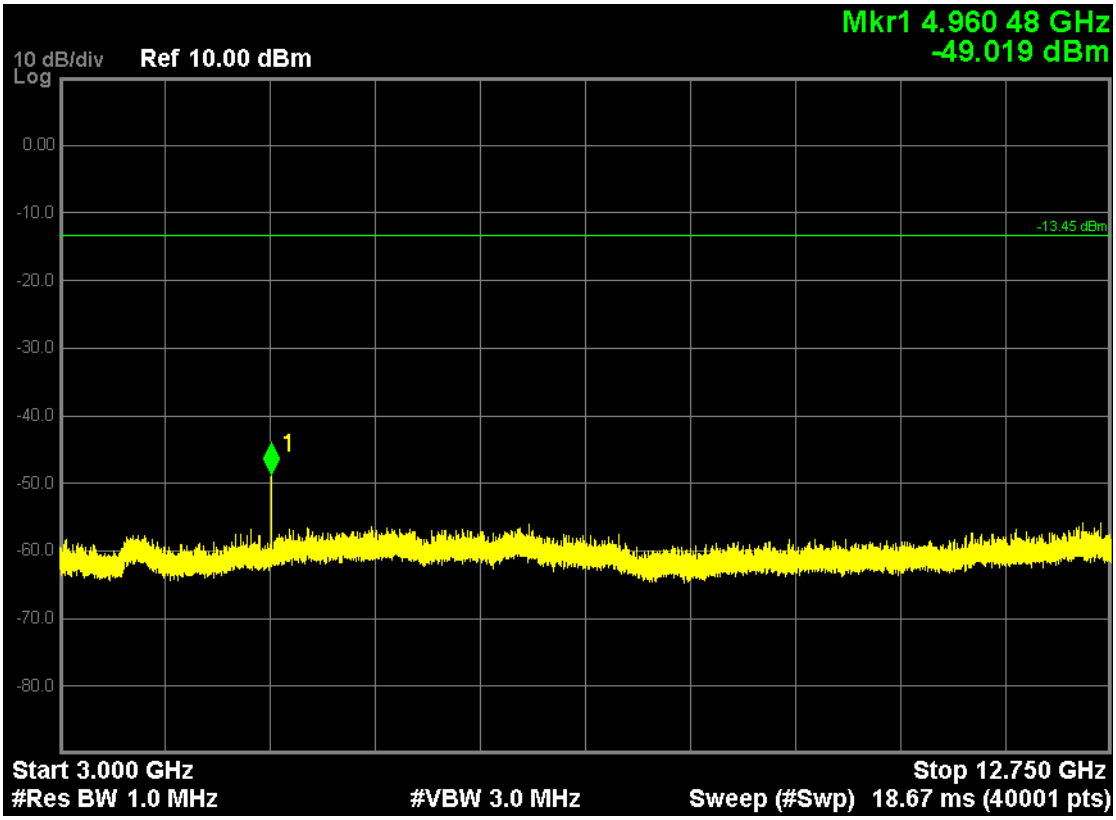


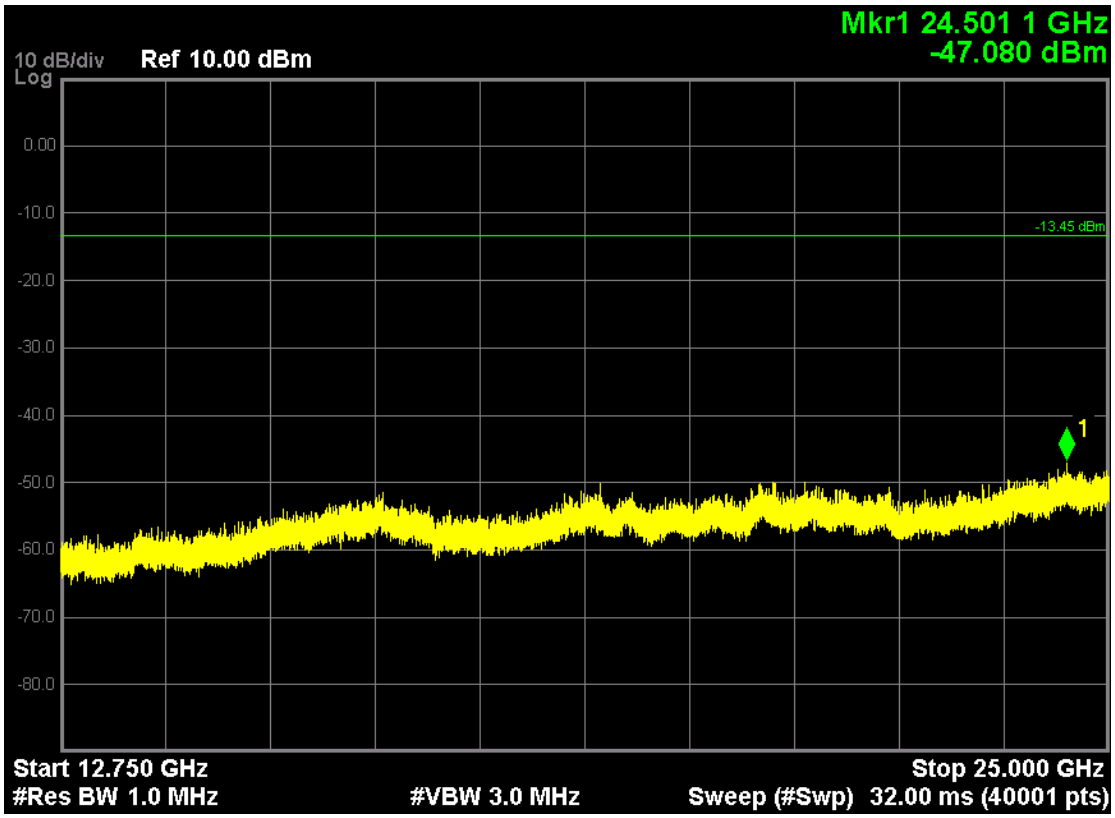






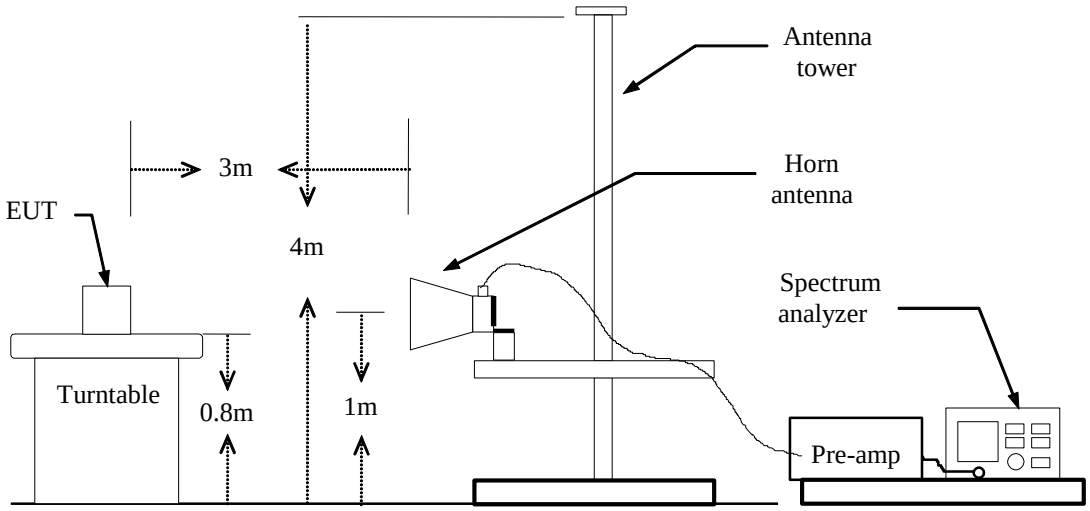
Note: The Mark1 point is carrier.


Mkr1 4.960 48 GHz
-49.019 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-13.45 dBm
1
Start 3.000 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 12.750 GHz
Sweep (#Swp) 18.67 ms (40001 pts)


Mkr1 24.501 1 GHz
-47.080 dBm
10 dB/div
Log
Ref 10.00 dBm
0.00
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-13.45 dBm
1
Start 12.750 GHz
#Res BW 1.0 MHz
#VBW 3.0 MHz
Stop 25.000 GHz
Sweep (#Swp) 32.00 ms (40001 pts)

8. BAND EDGE MEASUREMENT

8.1 TEST SETUP



8.2 LIMITS

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in 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 in15.209(a).

8.3 TEST PROCEDURE

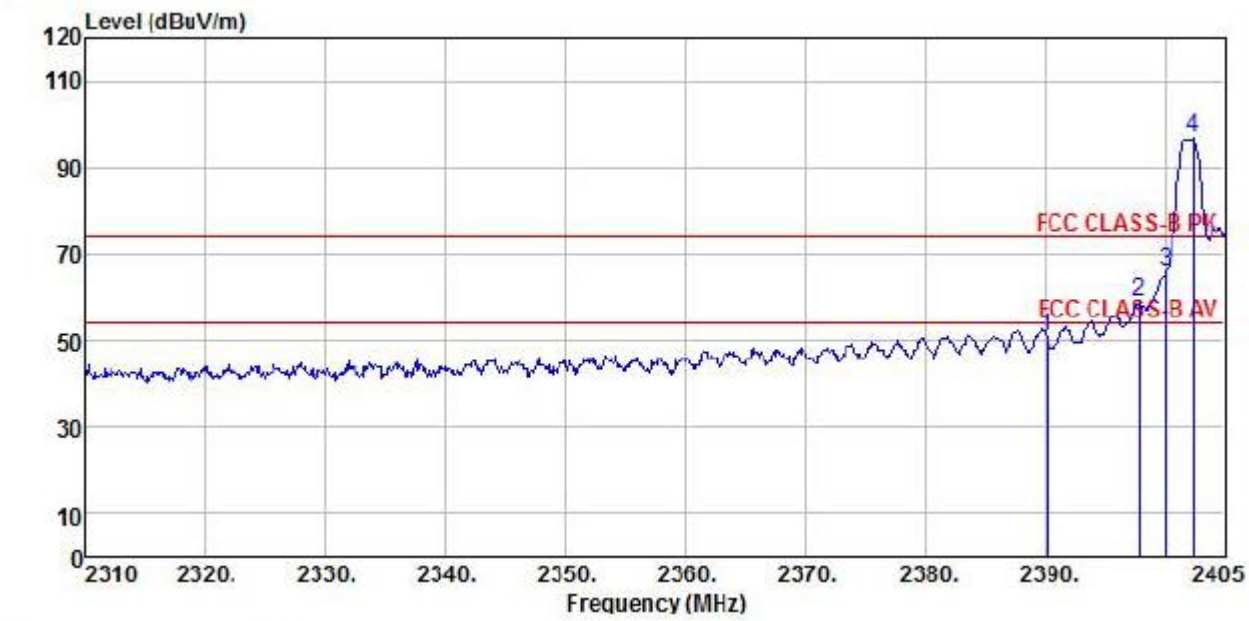
The EUT is placed on a turntable, which is 0.8m above the ground plane.
The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.
Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:
PEAK: RBW=VBW=1MHz / Sweep=AUTO
AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO
Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

8.4 RESULTS & PERFORMANCE

Radiated Band Edge:

Bluetooth V4.1 LE GFSK Channel 0

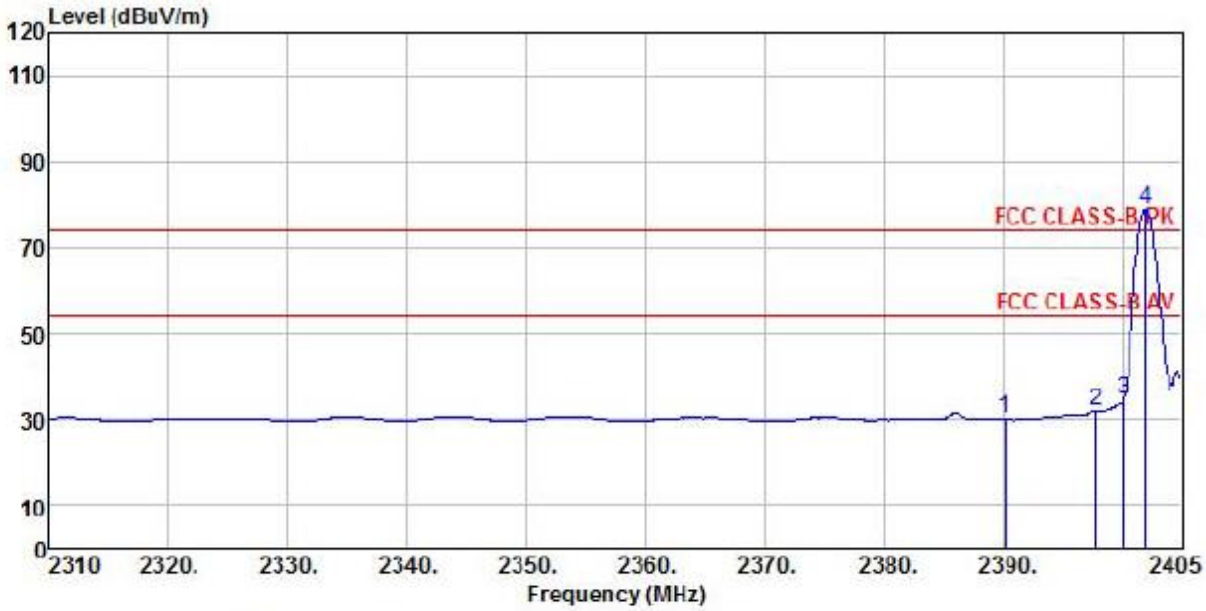
Detector mode: Peak Polarity: Horizontal



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.09	54.62	27.58	7.13	38.34	50.99	74.00	-23.01	Peak
2	2397.88	62.32	27.58	7.13	38.34	58.69	74.00	-15.31	Peak
3	2400.06	69.46	27.58	7.13	38.34	65.83	74.00	-8.17	Peak
4 pp	2402.34	100.70	27.54	7.13	38.34	97.03	74.00	23.03	Peak

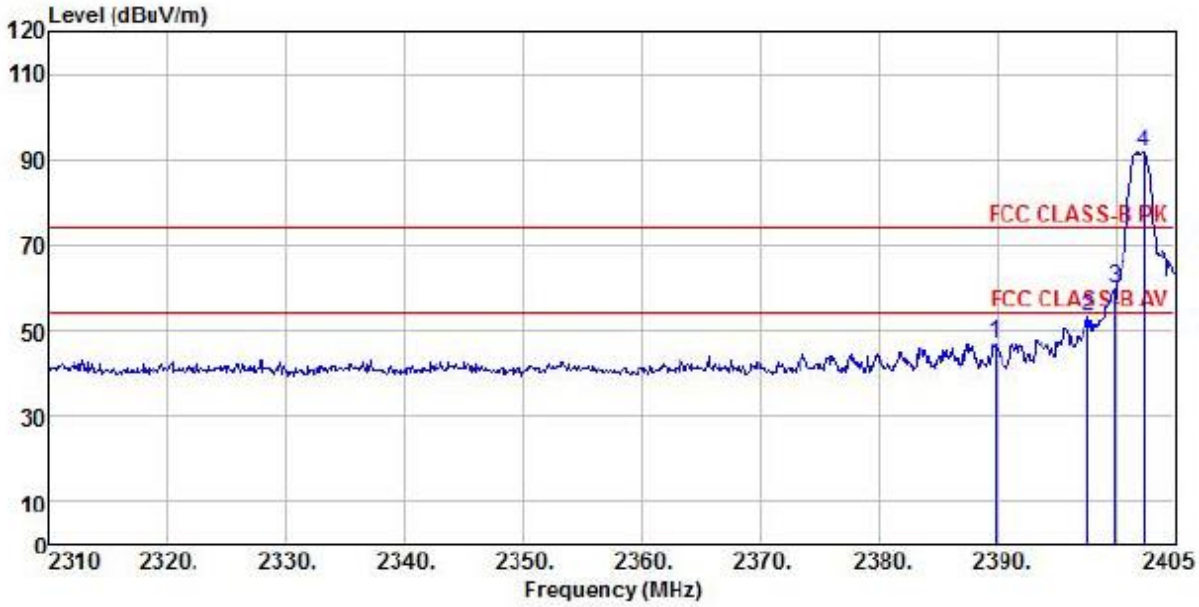
Detector mode: Average Polarity: Horizontal



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.09	33.66	27.58	7.13	38.34	30.03	74.00	-43.97	Peak
2	2397.78	35.56	27.58	7.13	38.34	31.93	74.00	-42.07	Peak
3	2400.06	38.26	27.58	7.13	38.34	34.63	74.00	-39.37	Peak
4 pp	2401.96	82.58	27.54	7.13	38.34	78.91	74.00	4.91	Peak

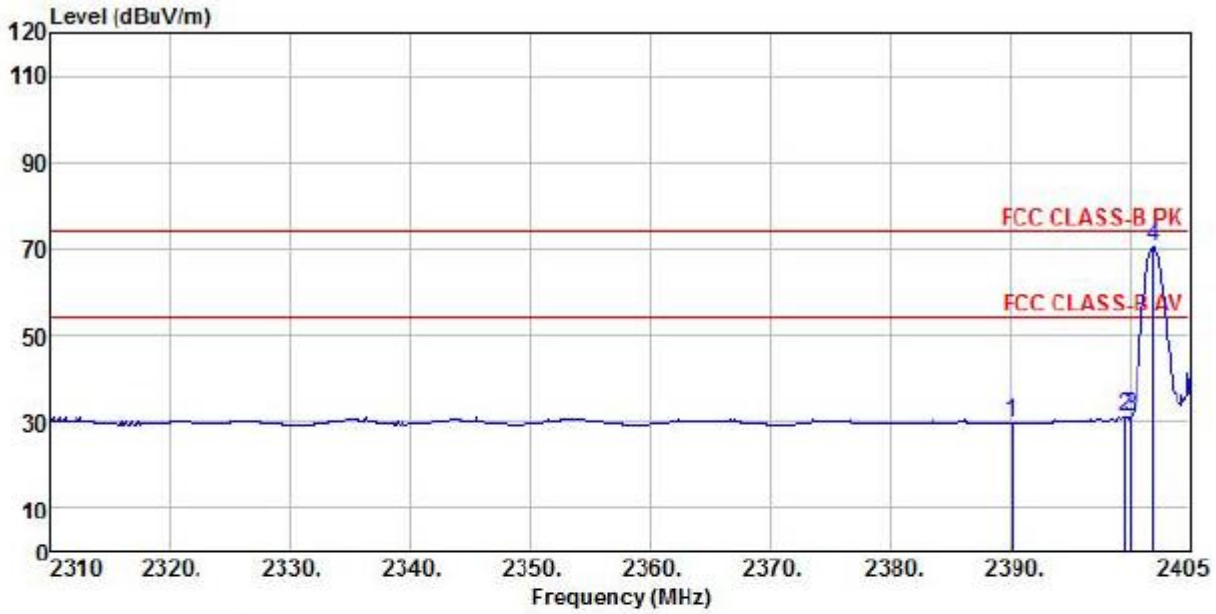
Detector mode: Peak Polarity: Vertical



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2389.80	50.64	27.58	7.13	38.34	47.01	74.00	-26.99	Peak
2	2397.69	56.71	27.58	7.13	38.34	53.08	74.00	-20.92	Peak
3	2399.87	63.43	27.58	7.13	38.34	59.80	74.00	-14.20	Peak
4 pp	2402.34	95.24	27.54	7.13	38.34	91.57	74.00	17.57	Peak

Detector mode: Average Polarity: Vertical

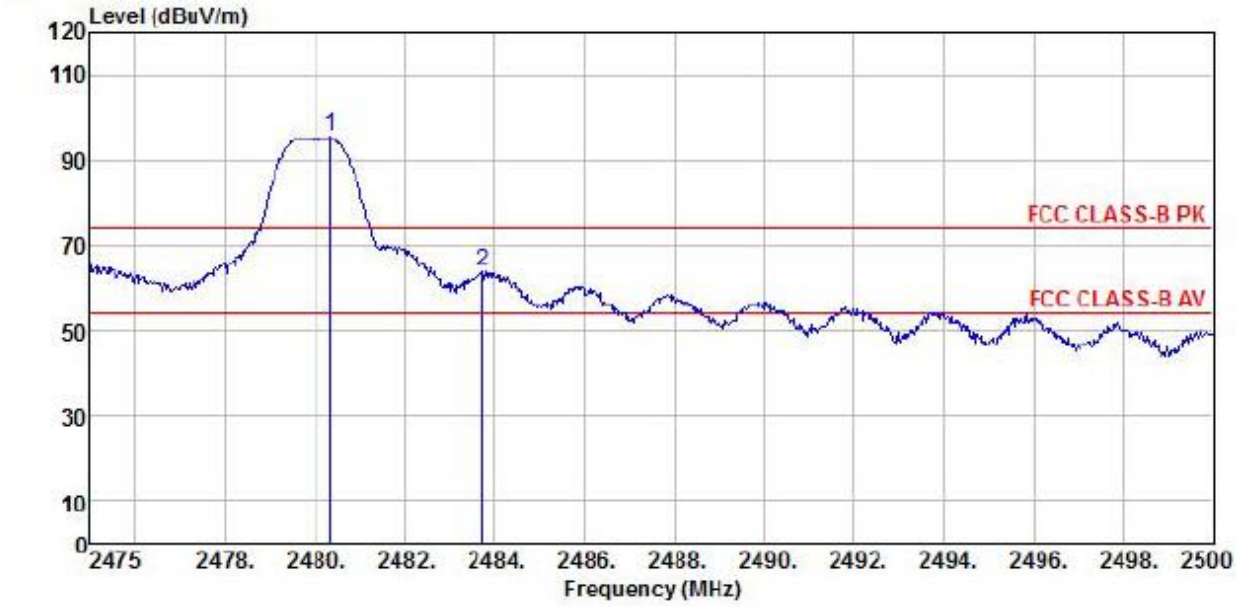


Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	ReadLevel	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	2390.09	33.18	27.58	7.13	38.34	29.55	74.00	-44.45	Peak
2	2399.59	34.62	27.58	7.13	38.34	30.99	74.00	-43.01	Peak
3	2400.06	34.75	27.58	7.13	38.34	31.12	74.00	-42.88	Peak
4 pp	2401.96	74.09	27.54	7.13	38.34	70.42	74.00	-3.58	Peak

Bluetooth V4.1 LE GFSK Channel 39

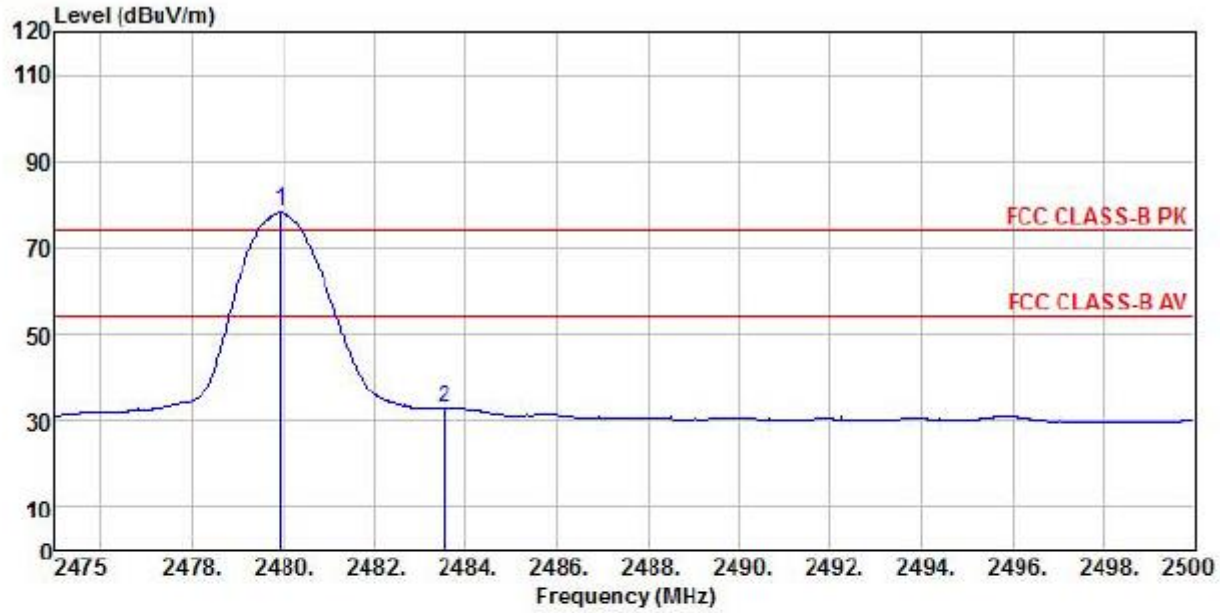
Detector mode: Peak Polarity: Horizontal



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	2480.35	98.98	27.52	7.41	38.31	95.60	74.00	21.60	Peak
2	2483.75	67.12	27.52	7.41	38.31	63.74	74.00	-10.26	Peak

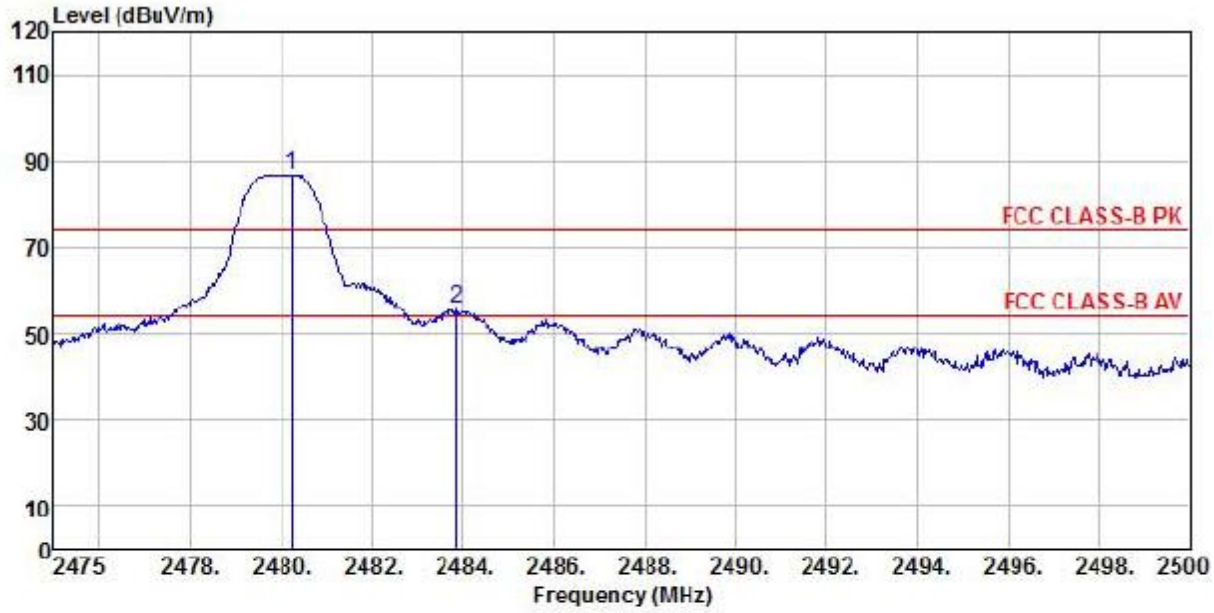
Detector mode: Average Polarity: Horizontal



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	2479.93	81.60	27.52	7.41	38.31	78.22	74.00	4.22	Peak
2	2483.53	36.09	27.52	7.41	38.31	32.71	74.00	-41.29	Peak

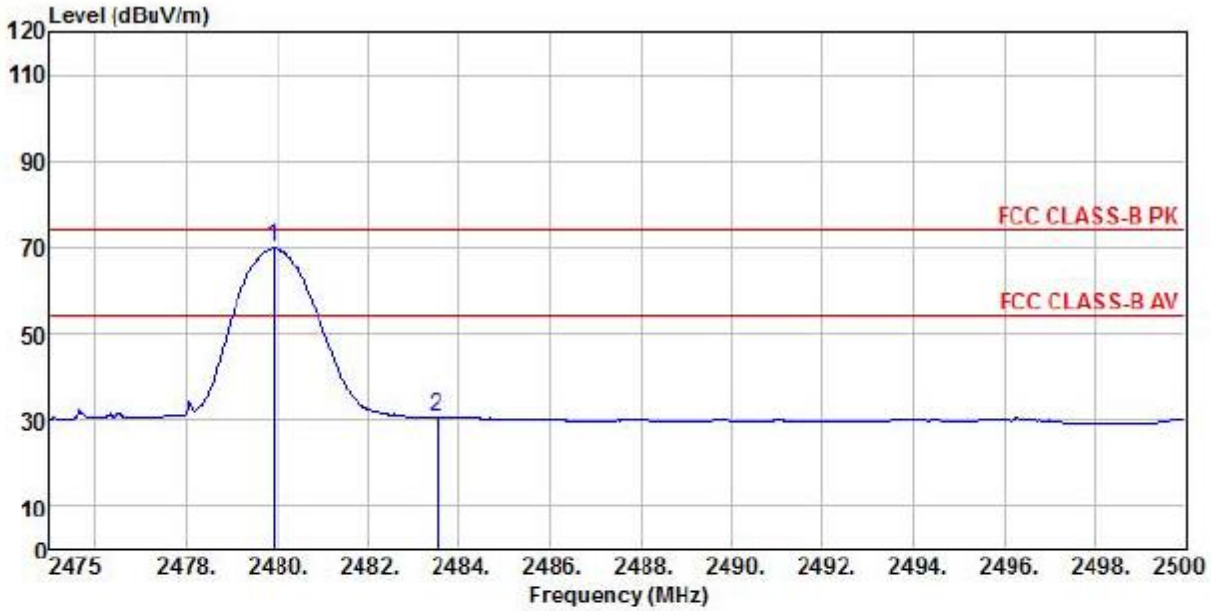
Detector mode: Peak Polarity: Vertical



Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	2480.25	90.32	27.52	7.41	38.31	86.94	74.00	12.94	Peak
2	2483.88	58.98	27.52	7.41	38.31	55.60	74.00	-18.40	Peak

Detector mode: Average Polarity: Vertical

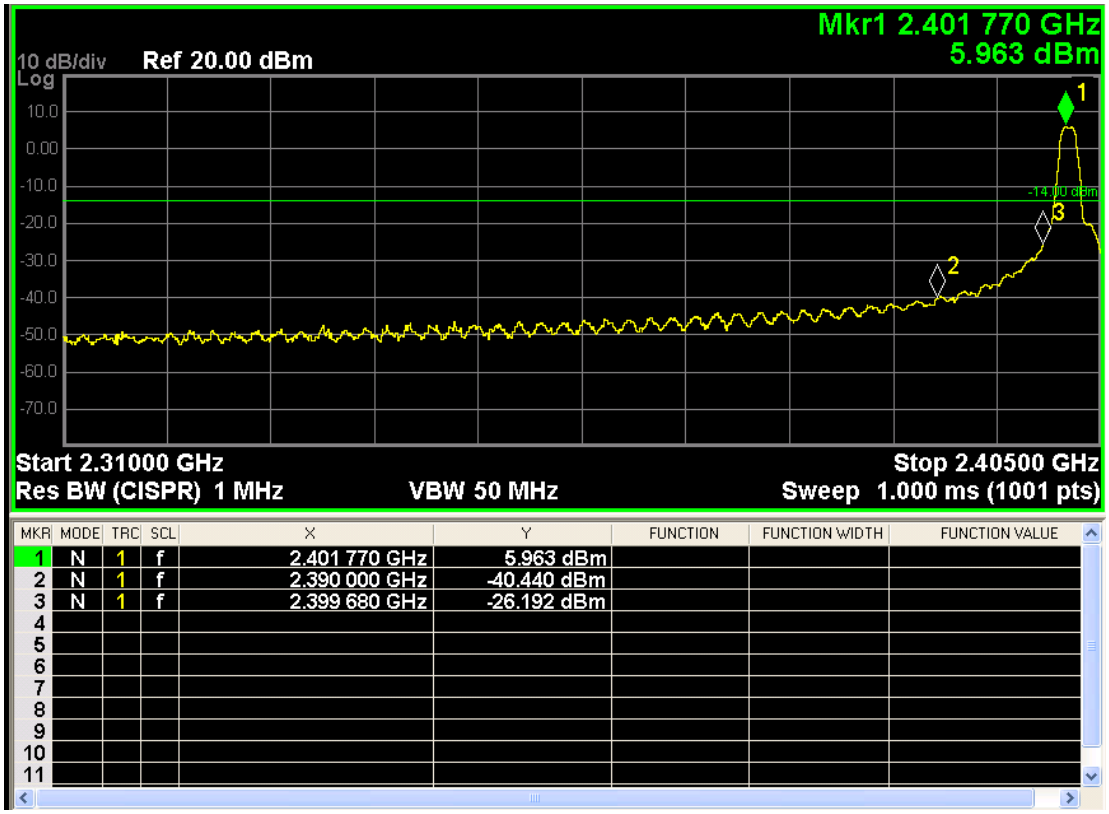


Site : chamber
Condition : FCC CLASS-B PK 3m BBHA9120D(942) VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.4℃ / 56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	2479.90	73.25	27.52	7.41	38.31	69.87	74.00	-4.13	Peak
2	2483.50	34.10	27.52	7.41	38.31	30.72	74.00	-43.28	Peak

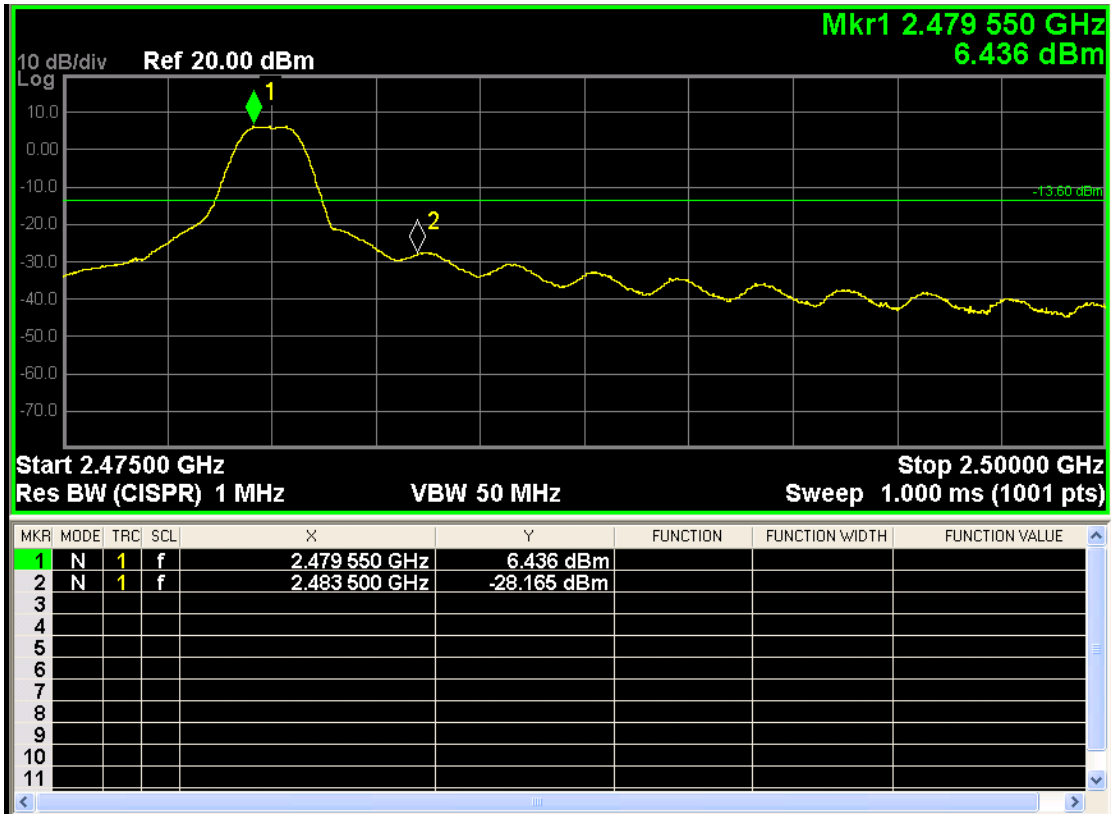
Conducted Band Edge:

Bluetooth V4.1 LE GFSK Channel 0



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.401 770 GHz	5.963 dBm			
2	N	1	f	2.390 000 GHz	-40.440 dBm			
3	N	1	f	2.399 680 GHz	-26.192 dBm			
4								
5								
6								
7								
8								
9								
10								
11								

Bluetooth V4.1 LE GFSK Channel 39

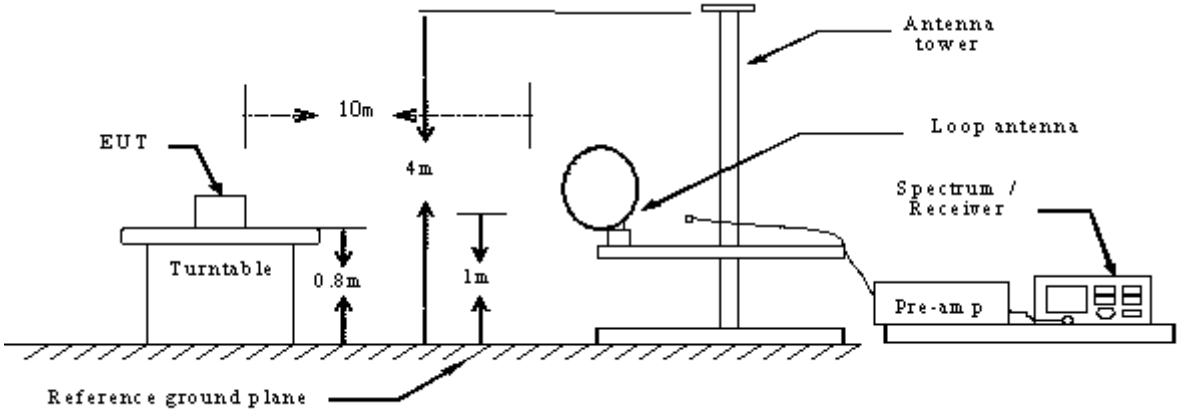


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.479 550 GHz	6.436 dBm			
2	N	1	f	2.483 500 GHz	-28.165 dBm			
3								
4								
5								
6								
7								
8								
9								
10								
11								

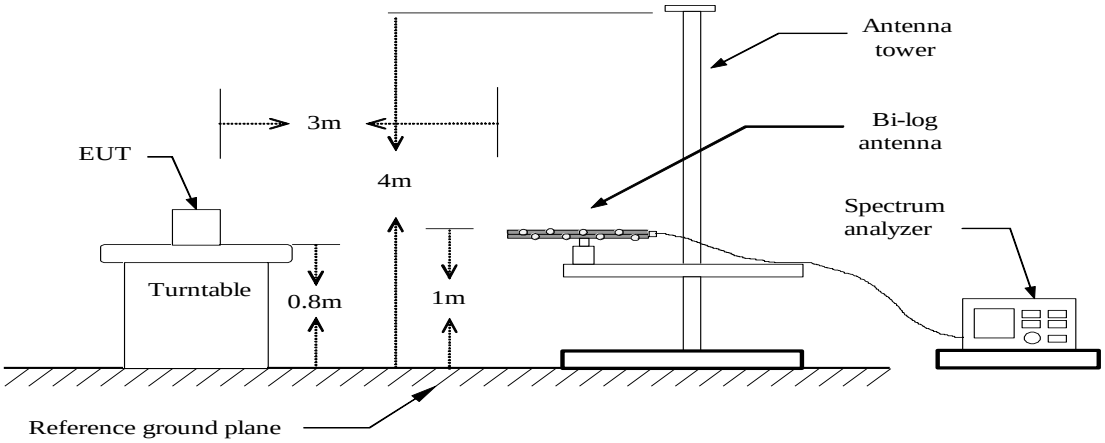
9. SPURIOUS EMISSIONS (RADIATION)

9.1 TEST SETUP

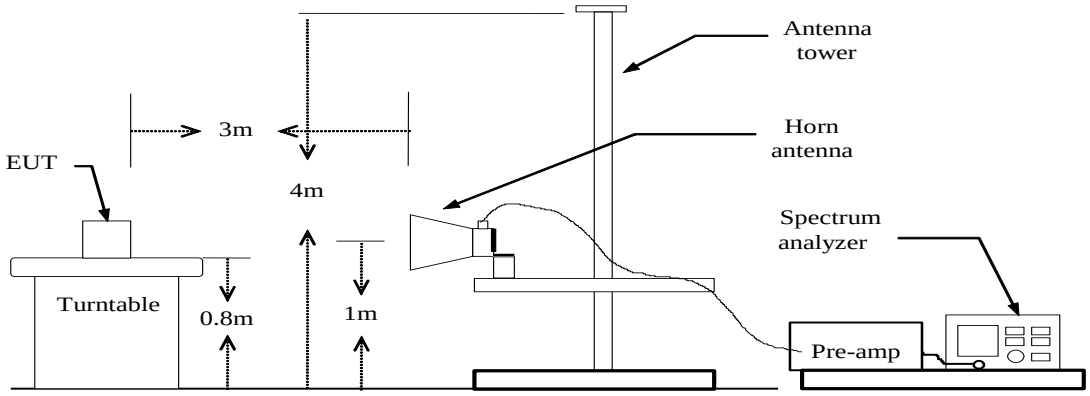
Radiated Spurious Measurement: below 30MHz



Radiated Spurious Measurement: below 1GHz



Radiated Spurious Measurement: above 1GHz



9.2 LIMITS

Frequency (MHz)	Limits (uV/m)	Limits(dBuV/m) At 3m	Measured Distance (m)
0.009-0.490	2400/F(KHz)	128.5-93.80	300
0.490-1.705	24000/F(KHz)	73.80-63.00	30
1.705-30.0	30	69.5	30
30~88	100	40	3
88~216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Notes: the calculate formula for below 30MHz
L2 = 20lg (L1) + 40lg (d1/d2)
L2: is the specified limit in dB microvolts per metre at distance d2.
L1: is the specified limit in microvolts per metre at distance d1.
For example:
L1 = 2400/9 (μV/m), d1 = 300 (m), d2 = 3 (m), so L2 as follows:
20lg（2400/9）+40lg(300/3) = 128.5(dBμV/m)

9.3 TEST PROCEDURE

Radiated Emission (9 kHz – 30 MHz) :
Spurious emissions from the EUT are measured in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna. The antenna was positioned 3 meters horizontally from the EUT. The RBW of the spectrum analyzer is set to 200Hz(measured frequency range was 9KHz~150KHz) or 9KHz(measured frequency range was 150KHz~30MHz).Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions. The emission limits are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz (these two bands employing a average detector).

Radiated Emission (30 MHz – 1000 MHz):
According to description of ANSI C63.4: 2014 sec.13.4, the preliminary radiated emissions measurement were carried out. The preliminary radiated measurements were performed at the measurement distance that specified for compliance to determine the emission characteristics of the EUT. The EUT configuration (in X, Y and Z axis), cable configuration and mode of operation were determined for producing the maximum level of emissions. These configurations were used for the final radiated emissions measurements. The measurement is carried out using a spectrum analyzer or receiver. The Quasi-peak detector is used and RBW is set to 120kHz.The antenna height and turn table rotation is adjusted until the maximum power value is founded on spectrum analyzer or receiver.

Radiated Emission (Above 1 GHz):

According to description of ANSI C63.4: 2014 sec.13.4, the preliminary radiated emissions measurement were carried out. The preliminary radiated measurements were performed at the measurement distance that specified for compliance to determine the emission characteristics of the EUT. The EUT configuration (in X, Y and Z axis), cable configuration and mode of operation were determined for producing the maximum level of emissions. These configurations were used for the final radiated emissions measurements. The measurement is carried out using a spectrum analyzer or receiver. The spectrum analyzer scans from 1GHz to 25GHz (higher than the 10^{th} harmonic of the carrier). The peak detector is used for Peak limit and RBW is set to 1MHz ,VBW ≥ 3RBW. The peak detector is used for Average limit and RBW is set to 1MHz ,VBW is not smaller than 1/T, T = to the shortest pulse width. The antenna height and turn table rotation is adjusted until the maximum power value is founded on spectrum analyzer or receiver.

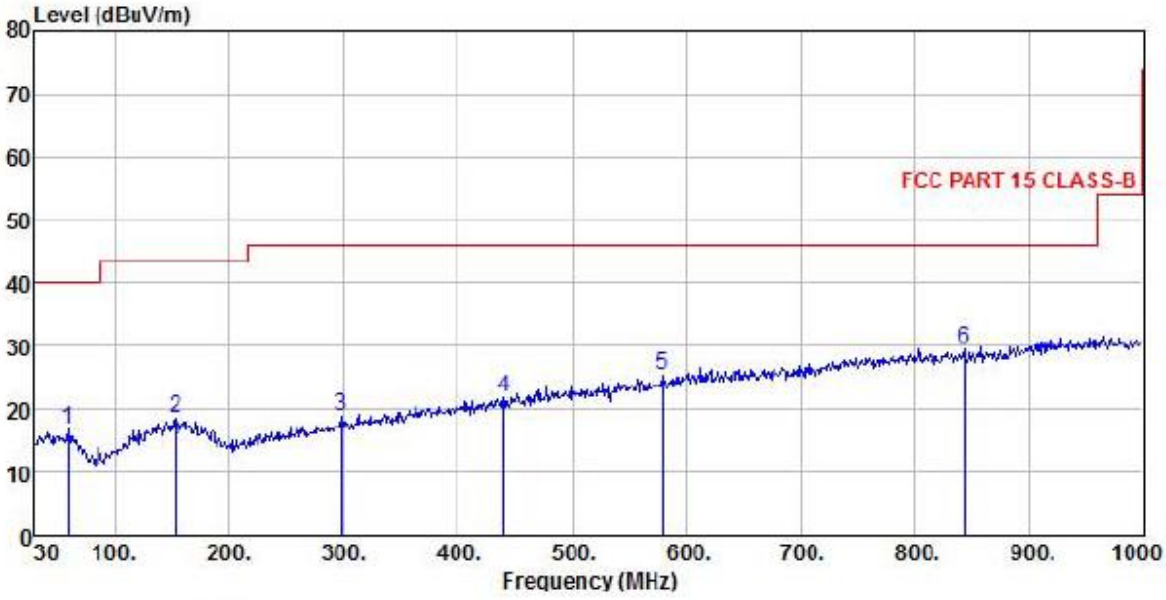
9.4 RESULTS & PERFORMANCE

From 9KHz to 30MHz:

The test data was 20dB lower than the permissible limit was not recorded in the report.
802.11b, traffic mode; Channel 1

From 30MHz to 1GHz:

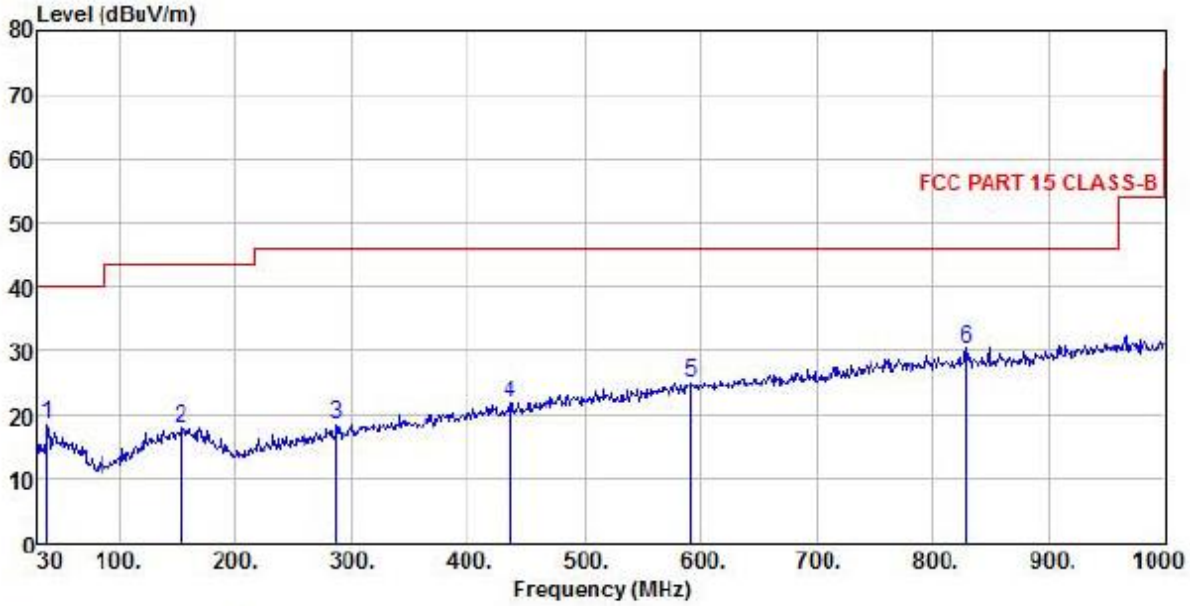
Bluetooth V4.1 LE GFSK Channel 0 Polarity: Horizontal



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	59.10	3.09	12.58	1.04	0.00	16.71	40.00	-23.29	Peak
2	153.19	3.02	13.89	1.65	0.00	18.56	43.50	-24.94	Peak
3	298.69	3.17	13.19	2.50	0.00	18.86	46.00	-27.14	Peak
4	440.31	2.65	16.21	2.86	0.00	21.72	46.00	-24.28	Peak
5	579.99	3.43	18.62	3.24	0.00	25.29	46.00	-20.71	Peak
6 pp	842.86	3.51	22.02	3.97	0.00	29.50	46.00	-16.50	Peak

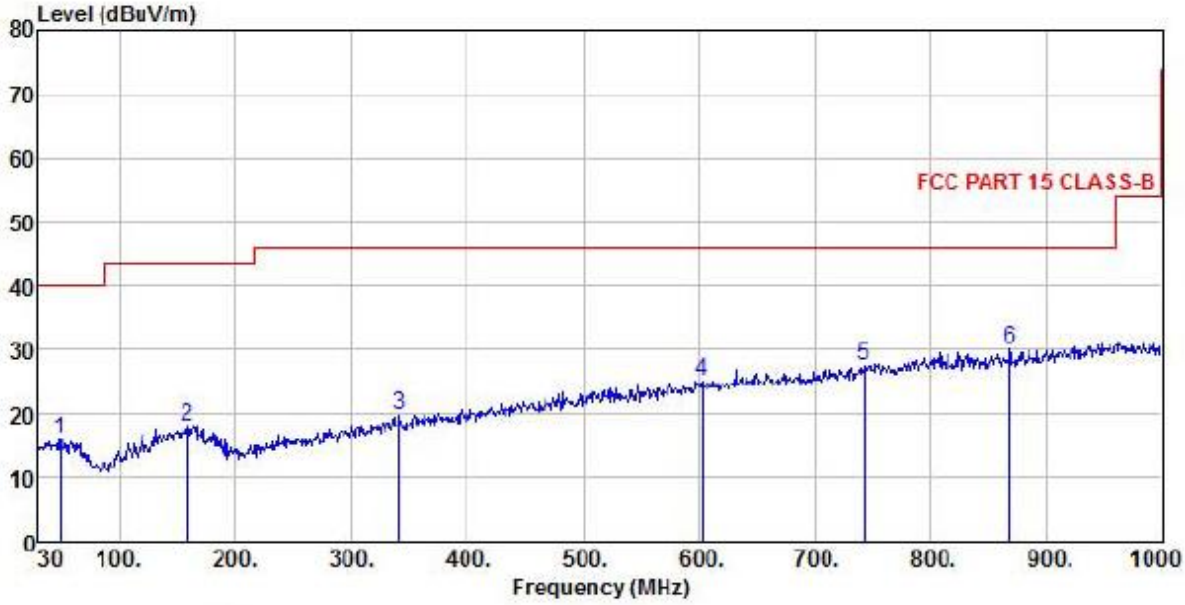
Bluetooth V4.1 LE GFSK Channel 0 Polarity: Vertical



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH0
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	37.76	5.29	12.51	0.79	0.00	18.59	40.00	-21.41	Peak
2	153.19	2.34	13.89	1.65	0.00	17.88	43.50	-25.62	Peak
3	286.08	3.43	12.92	2.24	0.00	18.59	46.00	-27.41	Peak
4	436.43	2.89	16.11	2.83	0.00	21.83	46.00	-24.17	Peak
5	591.63	2.69	18.94	3.33	0.00	24.96	46.00	-21.04	Peak
6 pp	829.28	4.52	21.95	3.94	0.00	30.41	46.00	-15.59	Peak

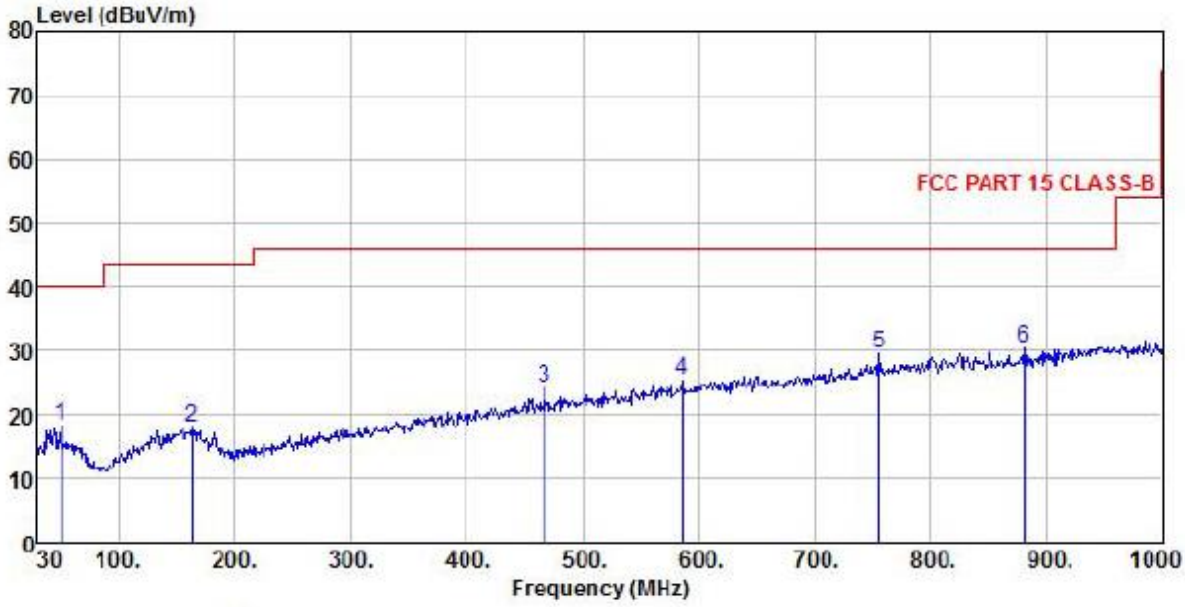
Bluetooth V4.1 LE GFSK Channel 19 Polarity: Horizontal



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH19
Memo :

	Freq	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	48.43	2.45	12.63	0.93	0.00	16.01	40.00	-23.99	Peak
2	159.01	2.49	13.88	1.68	0.00	18.05	43.50	-25.45	Peak
3	341.37	3.13	14.12	2.52	0.00	19.77	46.00	-26.23	Peak
4	602.30	2.63	19.16	3.35	0.00	25.14	46.00	-20.86	Peak
5	741.98	2.53	21.12	3.77	0.00	27.42	46.00	-18.58	Peak
6 pp	868.08	3.98	22.05	3.97	0.00	30.00	46.00	-16.00	Peak

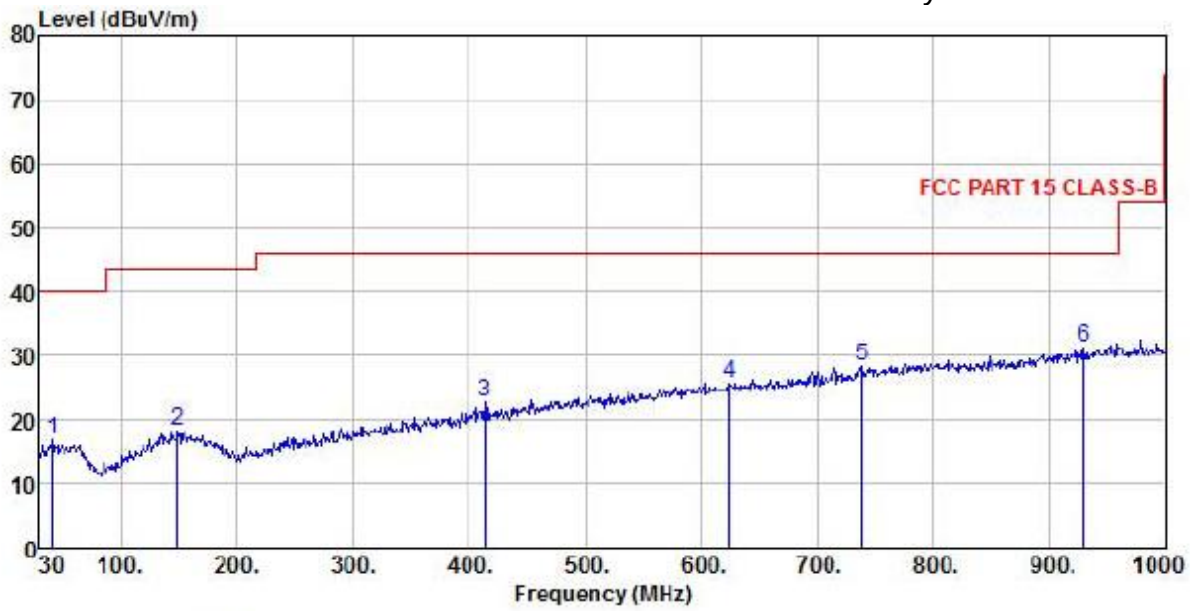
Bluetooth V4.1 LE GFSK Channel 19 Polarity: Vertical



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH19
Memo :

	Freq	ReadLevel	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	49.40	4.59	12.63	0.95	0.00	18.17	40.00	-21.83	Peak
2	163.86	2.47	13.66	1.74	0.00	17.87	43.50	-25.63	Peak
3	466.50	4.54	16.66	2.90	0.00	24.10	46.00	-21.90	Peak
4	585.81	3.35	18.78	3.29	0.00	25.42	46.00	-20.58	Peak
5	755.56	4.34	21.36	3.75	0.00	29.45	46.00	-16.55	Peak
6 pp	880.69	4.26	22.17	3.96	0.00	30.39	46.00	-15.61	Peak

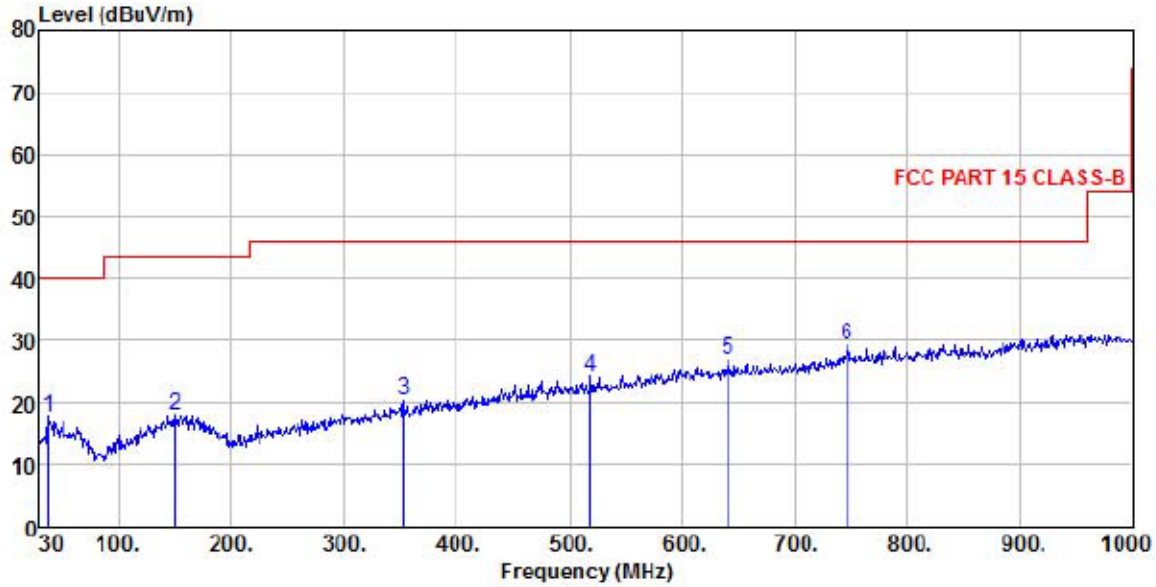
Bluetooth V4.1 LE GFSK Channel 39 Polarity: Horizontal



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 HORIZONTAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	ReadAntenna Level	Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	40.67	3.41	12.71	0.83	0.00	16.95	40.00	-23.05	Peak
2	148.34	2.85	13.79	1.63	0.00	18.27	43.50	-25.23	Peak
3	414.12	4.26	15.59	2.82	0.00	22.67	46.00	-23.33	Peak
4	624.61	3.13	19.22	3.44	0.00	25.79	46.00	-20.21	Peak
5	738.10	3.51	21.00	3.73	0.00	28.24	46.00	-17.76	Peak
6 pp	930.16	4.28	23.03	4.10	0.00	31.41	46.00	-14.59	Peak

Bluetooth V4.1 LE GFSK Channel 39 Polarity: Vertical



Site : chamber
Condition : FCC PART 15 CLASS-B 3m VULB9160 VERTICAL
EUT :
Model Name : R2301
Temp/Humi : 23.2℃ /56%
Power Rating: DC 12V
Mode : BT4.1 CH39
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1	37.76	4.42	12.51	0.79	0.00	17.72	40.00	-22.28	Peak
2	149.31	2.46	13.90	1.63	0.00	17.99	43.50	-25.51	Peak
3	353.01	3.53	14.28	2.59	0.00	20.40	46.00	-25.60	Peak
4	518.88	3.83	17.30	3.10	0.00	24.23	46.00	-21.77	Peak
5	641.10	3.84	19.47	3.53	0.00	26.84	46.00	-19.16	Peak
6 pp	746.83	4.18	21.23	3.79	0.00	29.20	46.00	-16.80	Peak

From 1GHz to 25GHz:
Only show the worst test data when EUT was operated on different mode.
EUT operation mode : BT GFSK(Ch0/Ch19/Ch38)

Bluetooth V4.1 LE GFSK Channel 0

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB)	Antenna Polarity	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector Type
2402	99.98	-3.55	Horizontal	96.43	/	/	Peak
4804	34.00	4.72	Horizontal	38.72	74	35.28	Peak
7206	37.28	10.83	Horizontal	48.11	74	25.89	Peak
2402	94.80	-3.55	Vertical	91.25	/	/	Peak
4804	32.92	4.72	Vertical	37.64	74	36.36	Peak
7206	35.93	10.83	Vertical	46.76	74	27.24	Peak

Note:
1, Total=Reading + Correct factor;
2, 2402 MHz was fundamental signal which can be ignored;
3, Average measurement was not performed if peak level were lower than the average limit;
4, Other harmonics are lower than background noise.

APPENDIX 1 PHOTOGRAPHS OF TEST SETUP

Please refer to the file named “Part 15C Setup Photos”.

APPENDIX 2 PHOTOGRAPHS OF EUT

Please refer to the files named “EUT External Photos” and “EUT Internal Photos”.

----End of the report----