

FCC/IC - TEST REPORT

Report Number : **64.790.14.02064.01** Date of Issue: September 1, 2014

Model : mu-so

Product Type : WIRELESS MUSIC SYSTEM

Applicant : Naim Audio Ltd

Address : Southampton Road Salisbury Wiltshire SP1 2LN UK

Production Facility : CHIYU ELECTRONICS (SHEN ZHEN) CO.,LTD

Address : No. 101, Chi-Yu Road, Chi-Yu Industrial Zone, Fu-Yong Town, Bao-An Distict, ShenZhen, China

Test Result : ☒ **Positive** ☐ **Negative**



Total pages including Appendices : 69

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China

2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch
5F, Communication Building, 163 Pingyun Rd, Huangpu Ave. West Guangzhou, P.R.China

Telephone: +86 20 3832 0668

Fax: +86 20 3832 0478

Test site 2:

Company name: Neutron Engineering Inc ction,
Address: No.3, Jinshagang 1st Road, ShiXia,
Dalang Town, DongGuan, China.

Telephone: +86-769-83183000

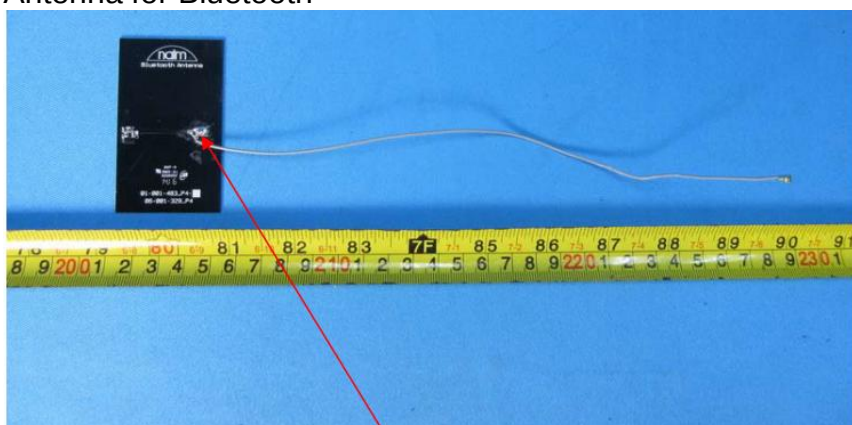
Fax: +86-769-83196000

FCC Registration
Number: 319330

IC egistration
Number: 4428B

3 Description of the Equipment Under Test

Product:	WIRELESS MUSIC SYSTEM
Model no.:	mu-so
FCC ID:	2ACURMUSO
IC ID:	12217A-MUSO
Brand Name:	NAIM
Options and accessories:	NIL
Rating:	100-240V~ 50/60Hz
RF Transmission Frequency:	Bluetooth BR/EDR/LE: 2402~2480MHz WIFI 802.11b/g: 2412~2462MHz
Modulation:	Bluetooth: GFSK WIFI: DSSS(CCK/QPSK/BPSK)
Antenna Type:	PCB
Antenna Gain:	Antenna for Bluetooth



Antenna Location

Antenna gain: 1.64dBi

Antenna for WIFI



Antenna Location – Antenna 1

Antenna gain: 2.51dBi



Antenna Location – Antenna 2

Antenna gain: 1.05dBi

Description of the EUT:

The Equipment Under Test (EUT) is a wireless speaker with Bluetooth and WIFI function.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2013 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 3 December 2010	General Requirements and Information for the Certification of Radio Apparatus
RSS-210 Issue 8 December 2010	RSS-210 — Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

All the test methods were according to Public Notice DA 00-705 -Frequency Hopper Spread Spectrum Test Procedure released by FCC on March 30, 2000, DTS procedures KDB 558074 v03r02 (June 5, 2014) and C63.10 (2009).

5 Summary of Test Results

Technical Requirements					
FCC Part 15 Subpart C, RSS-Gen, RSS-210					
Test Condition			Pages	Test Site	Test Result
§15.207	RSS-GEN A7.2.4	Conducted emission AC power port	11	Site 2	Pass
§15.247(b)(1)	RSS-210 A8.4	Conducted peak output power	16	Site 2	Pass
§15.247(a)(1)	RSS-210 A8.1(a) & RSSGEN 4.6.2	20dB bandwidth and 99% Occupied Bandwidth	18	Site 2	Pass
§15.247(a)(1)	RSS-210 A8.1(b)	Carrier frequency separation	22	Site 2	Pass
§15.247(a)(1)(iii)	RSS-210 A8.1(d)	Number of hopping frequencies	26	Site 2	Pass
§15.247(a)(1)(iii)	RSS-210 A8.1(c)	Dwell Time	29	Site 2	Pass
§15.247(a)(2)	RSS-210 A8.2(a)	6dB bandwidth	34	Site 2	Pass
§15.247(d)	RSS-210 A8.5	Spurious RF conducted emissions	41	Site 2	Pass
§15.247(d)	RSS-210 A8.5	Band edge	50	Site 2	Pass
§15.247(d) & §15.209 &	RSS-210 2.5 & RSSGEN 7.2.5 & RSSGEN 6.1	Spurious radiated emissions for transmitter and receiver	56	Site 2	Pass (Note 1)
§15.247(e)	RSS-210 A8.2(b)	Power spectral density*	61	Site 2	Pass
§15.203	RSSGEN 7.1.2	Antenna requirement	See note 2		Pass

Note 1: There are two antennas for WIFI module, one is for TX when another is for RX. TX and RX ports can be used interchangeably. This test was performed with the antenna whose gain is 2.51dBi.

Note 2: The EUT uses PCB layout antenna, the maximum antenna gain is 2.51dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2ACURMUSO, IC ID:12217A-MUSO complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules and RSS-210.

SUMMARY:

All tests according to the regulations cited on page 5 were

☒ - Performed

☐ - **Not** Performed

The Equipment Under Test

☒ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date: June 25, 2014

Testing Start Date: August 7, 2014

Testing End Date: September 1, 2014

- TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch -

Reviewed by:

Prepared by:



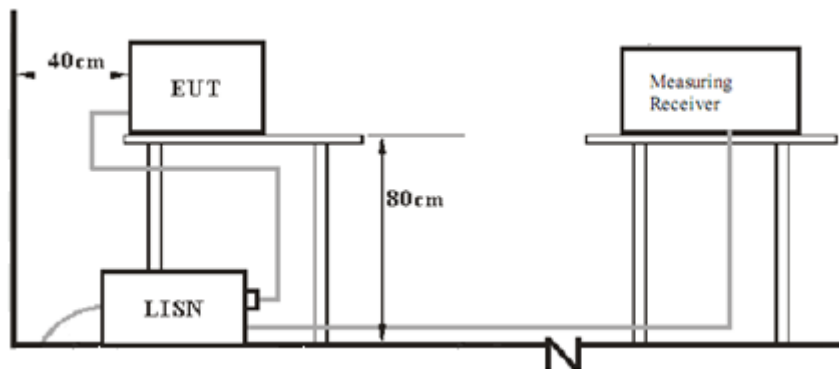
Tony Liu



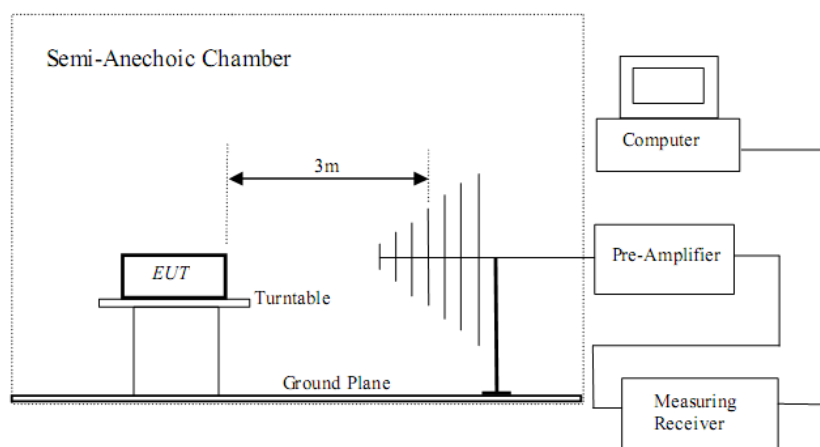
Celia Xiang

7 Test Setups

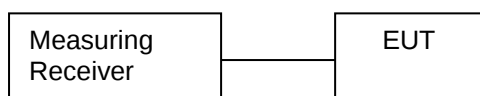
7.1 AC Power Line Conducted Emission test setups



7.2 Radiated test setups



7.3 Conducted RF test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
PC	ASUS	X80L	--

Test software: "BlueSuite 2.5" for Bluetooth and "Teraterm480" for WIFI are used to control the EUT in continues transmitting mode

The system was configured to hopping mode and non-hopping mode.

Hopping mode: typical working mode (normal hopping status).

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Limit

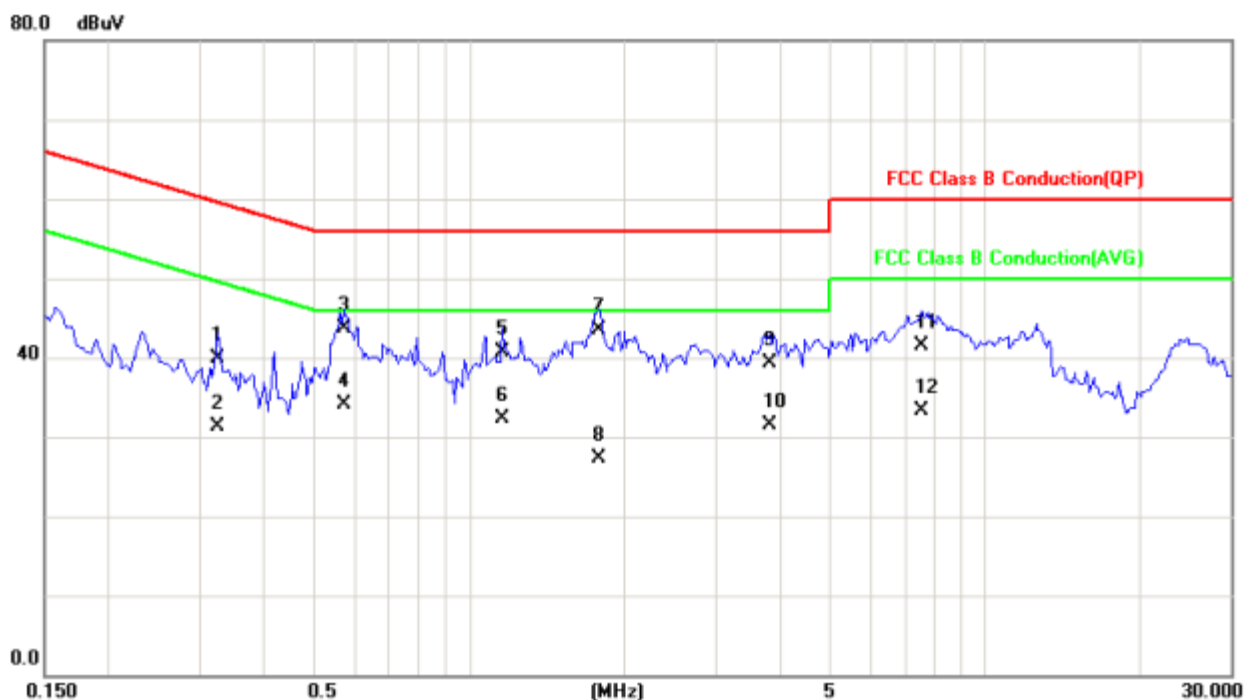
According to §15.207 & RSS-GEN A7.2.4, conducted emissions limit as below:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

Conducted Emission

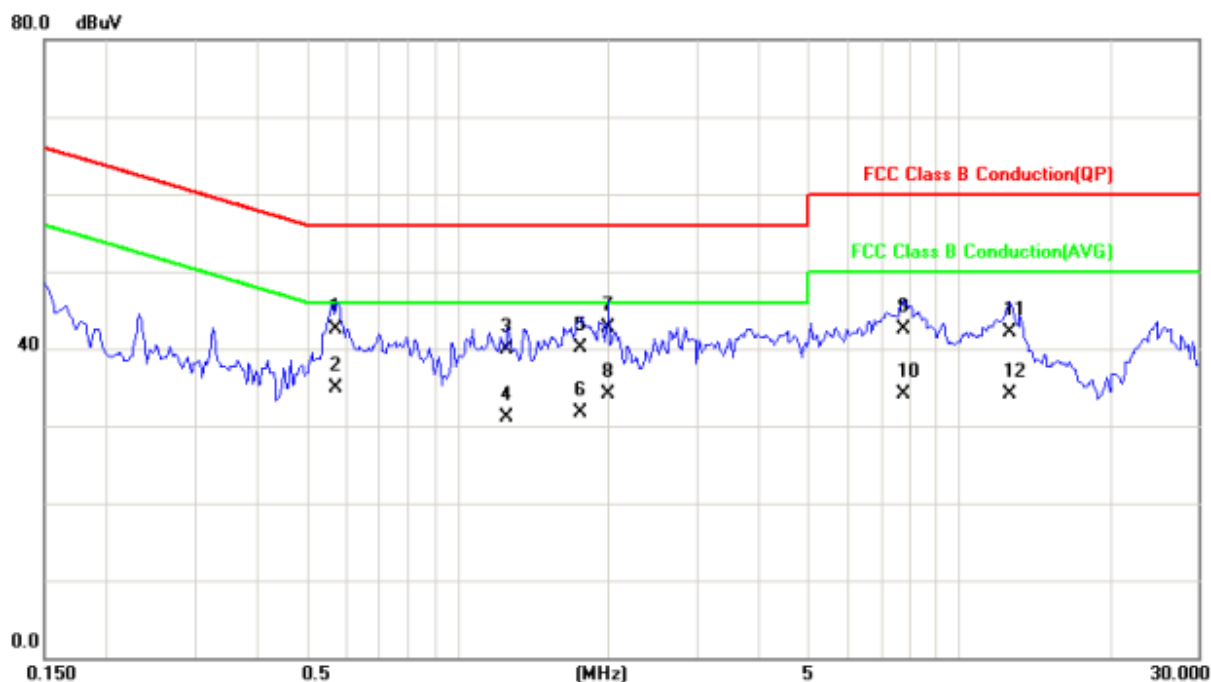
Product Type : WIRELESS MUSIC SYSTEM
 M/N : mu-so
 Operating Condition : Play music with WIFI function on.
 Test Specification : Live
 Comment : AC 120V/60Hz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.3257	30.23	9.60	39.83	59.56	-19.73	QP
2		0.3257	21.65	9.60	31.25	49.56	-18.31	AVG
3		0.5720	34.01	9.67	43.68	56.00	-12.32	QP
4	*	0.5720	24.50	9.67	34.17	46.00	-11.83	AVG
5		1.1656	31.02	9.70	40.72	56.00	-15.28	QP
6		1.1656	22.65	9.70	32.35	46.00	-13.65	AVG
7		1.7828	33.82	9.70	43.52	56.00	-12.48	QP
8		1.7828	17.70	9.70	27.40	46.00	-18.60	AVG
9		3.8242	29.54	9.81	39.35	56.00	-16.65	QP
10		3.8242	21.63	9.81	31.44	46.00	-14.56	AVG
11		7.5546	31.59	10.01	41.60	60.00	-18.40	QP
12		7.5546	23.37	10.01	33.38	50.00	-16.62	AVG

Conducted Emission

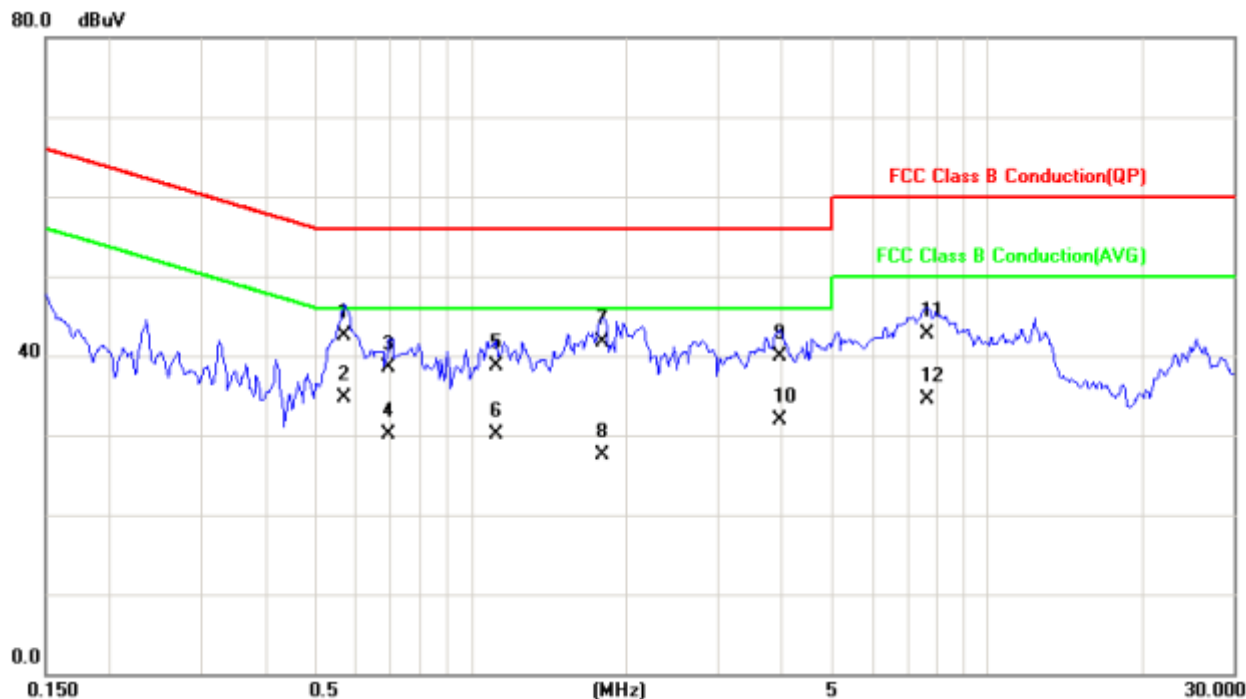
Product Type : WIRELESS MUSIC SYSTEM
 M/N : mu-so
 Operating Condition : Play music with WIFI function on.
 Test Specification : Neutral
 Comment : AC 120V/60Hz



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector
1		0.5757	32.84	9.65	42.49	56.00	-13.51	QP
2	*	0.5757	25.20	9.65	34.85	46.00	-11.15	AVG
3		1.2593	30.27	9.69	39.96	56.00	-16.04	QP
4		1.2593	21.49	9.69	31.18	46.00	-14.82	AVG
5		1.7671	30.29	9.72	40.01	56.00	-15.99	QP
6		1.7671	21.96	9.72	31.68	46.00	-14.32	AVG
7		2.0016	33.01	9.74	42.75	56.00	-13.25	QP
8		2.0016	24.40	9.74	34.14	46.00	-11.86	AVG
9		7.7382	32.52	9.99	42.51	60.00	-17.49	QP
10		7.7382	24.03	9.99	34.02	50.00	-15.98	AVG
11		12.6835	31.95	10.20	42.15	60.00	-17.85	QP
12		12.6835	23.83	10.20	34.03	50.00	-15.97	AVG

Conducted Emission

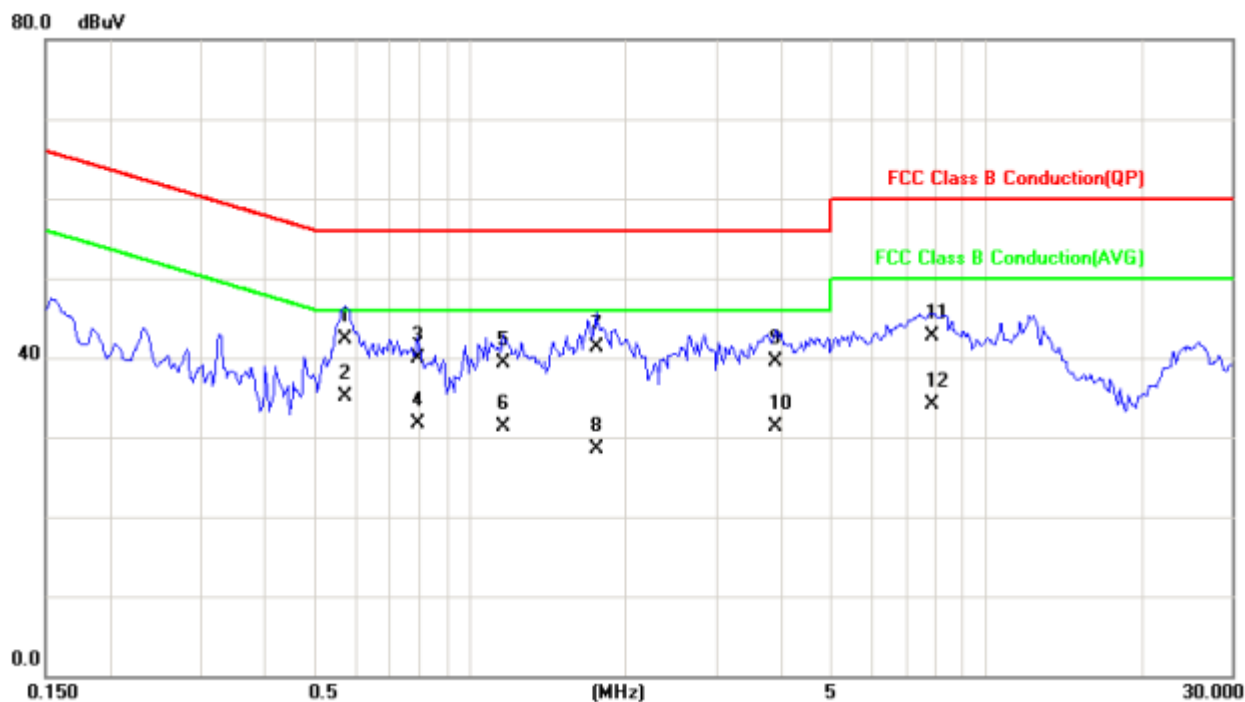
Product Type : WIRELESS MUSIC SYSTEM
 M/N : mu-so
 Operating Condition : Play music with Bluetooth function on.
 Test Specification : Live
 Comment : AC 120V/60Hz



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Over	
		MHz	Level	Factor	ment			Detector
			dBuV	dB	dBuV	dBuV	dB	
1		0.5680	32.86	9.68	42.54	56.00	-13.46	QP
2	*	0.5680	25.10	9.68	34.78	46.00	-11.22	AVG
3		0.6968	28.95	9.62	38.57	56.00	-17.43	QP
4		0.6968	20.56	9.62	30.18	46.00	-15.82	AVG
5		1.1226	29.02	9.70	38.72	56.00	-17.28	QP
6		1.1226	20.36	9.70	30.06	46.00	-15.94	AVG
7		1.7945	31.96	9.71	41.67	56.00	-14.33	QP
8		1.7945	17.70	9.71	27.41	46.00	-18.59	AVG
9		3.9687	30.05	9.81	39.86	56.00	-16.14	QP
10		3.9687	22.03	9.81	31.84	46.00	-14.16	AVG
11		7.6562	32.61	10.01	42.62	60.00	-17.38	QP
12		7.6562	24.58	10.01	34.59	50.00	-15.41	AVG

Conducted Emission

Product Type : WIRELESS MUSIC SYSTEM
 M/N : mu-so
 Operating Condition : Play music with Bluetooth function on.
 Test Specification : Neutral
 Comment : AC 120V/60Hz



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.5720	32.59	9.65	42.24	56.00	-13.76	QP
2	*	0.5720	25.50	9.65	35.15	46.00	-10.85	AVG
3		0.7945	30.25	9.67	39.92	56.00	-16.08	QP
4		0.7945	22.01	9.67	31.68	46.00	-14.32	AVG
5		1.1656	29.58	9.68	39.26	56.00	-16.74	QP
6		1.1656	21.69	9.68	31.37	46.00	-14.63	AVG
7		1.7594	31.67	9.72	41.39	56.00	-14.61	QP
8		1.7594	18.70	9.72	28.42	46.00	-17.58	AVG
9		3.9180	29.58	9.83	39.41	56.00	-16.59	QP
10		3.9180	21.49	9.83	31.32	46.00	-14.68	AVG
11		7.8516	32.61	10.00	42.61	60.00	-17.39	QP
12		7.8516	24.16	10.00	34.16	50.00	-15.84	AVG

9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured, VBW ≥ RBW,
Sweep = auto, Detector function = peak, Trace = max hold
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power

Limits

According to §15.247 (b) (1) and RSS-210 A8.4, conducted peak output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

Conducted peak output power

Bluetooth				
Frequency (MHz)	Mode	Measurement (dBm)	Limit	Result
2402	GFSK	3.80	$\leq 30\text{dBm}$	Pass
2441		3.79		Pass
2480		3.24		Pass
2402	8DPSK	2.67		Pass
2441		3.56		Pass
2480		3.10		Pass
2402	BLE	2.79		Pass
2440		2.56		Pass
2480		2.64		Pass

WIFI				
Frequency (MHz)	Mode	Measurement (dBm)	Limit	Result
2412	802.11b	7.10	$\leq 30\text{dBm}$	Pass
2437		7.22		Pass
2462		7.06		Pass
2412	802.11g	-1.02		Pass
2437		-1.33		Pass
2462		-1.04		Pass

9.3 20 dB Bandwidth and 99% Occupied Bandwidth

Test Method

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

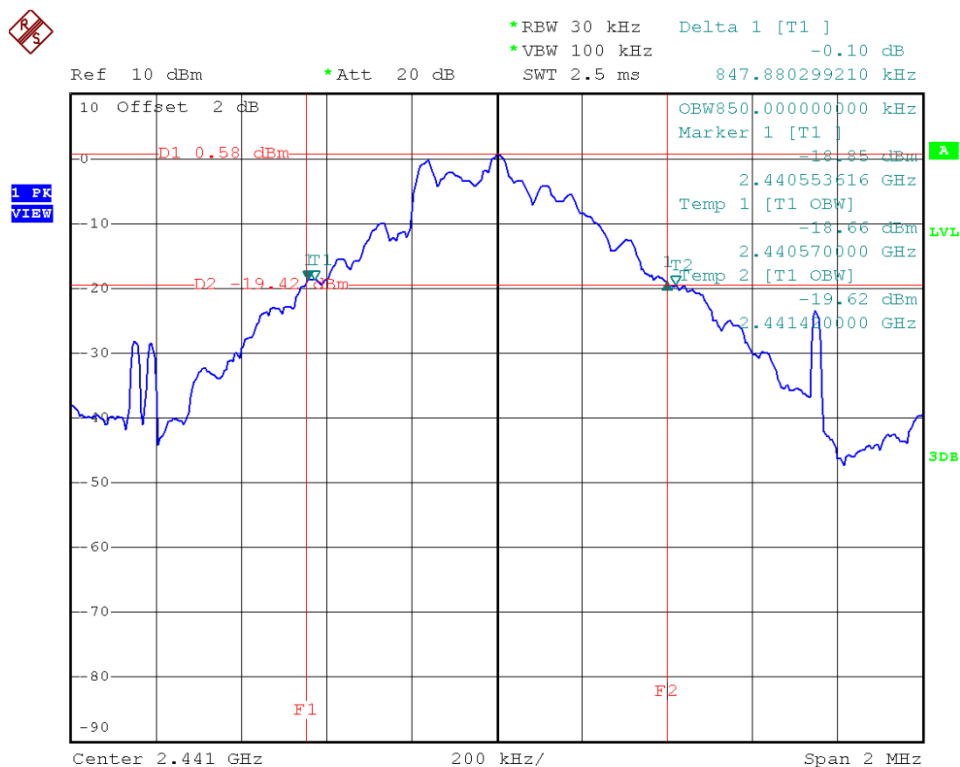
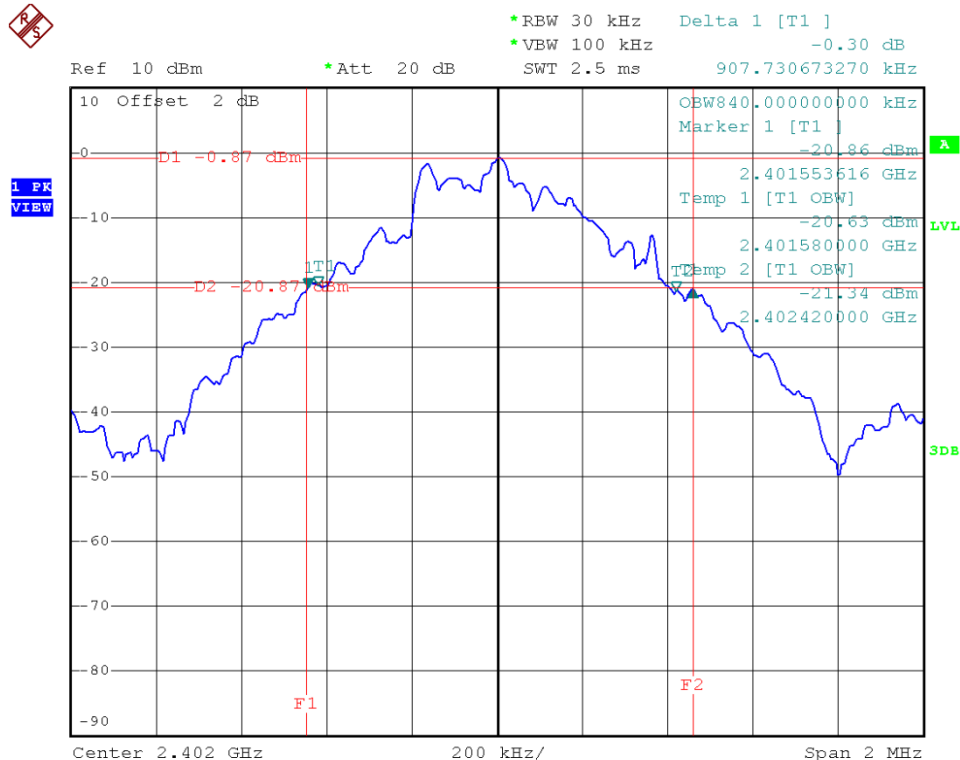
Limit

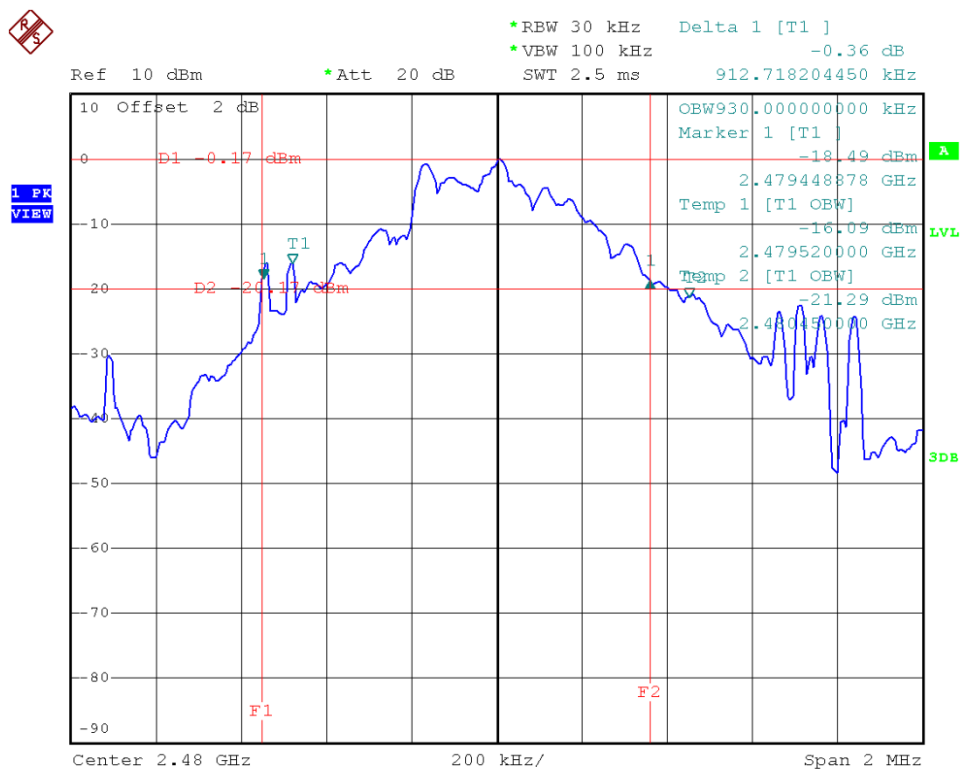
Limit [kHz]

N/A

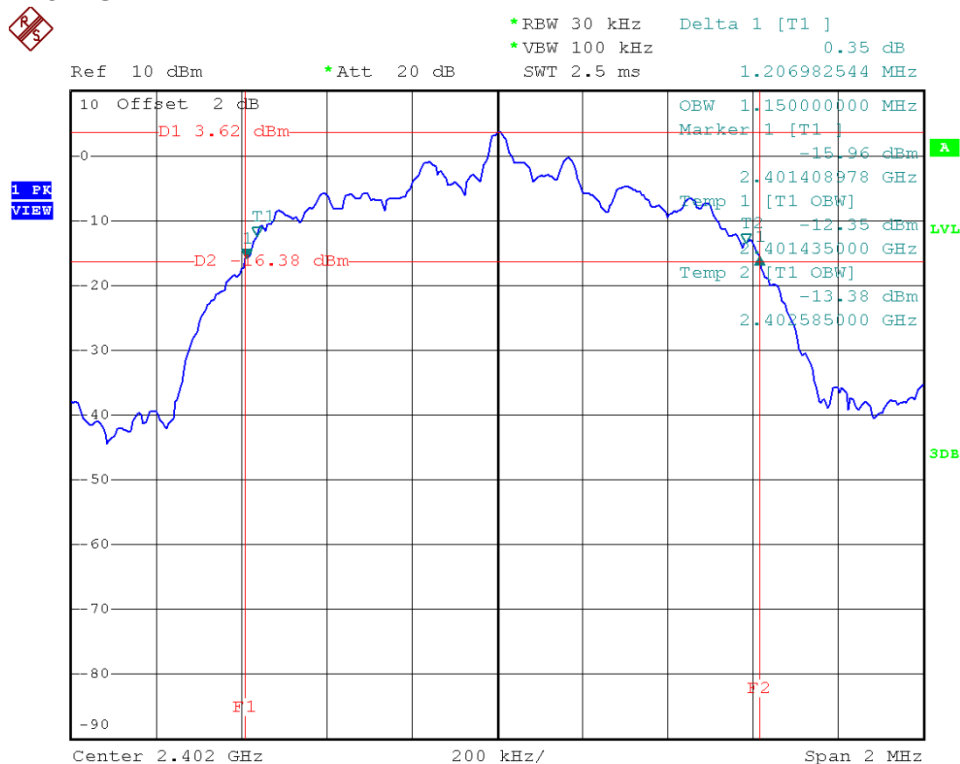
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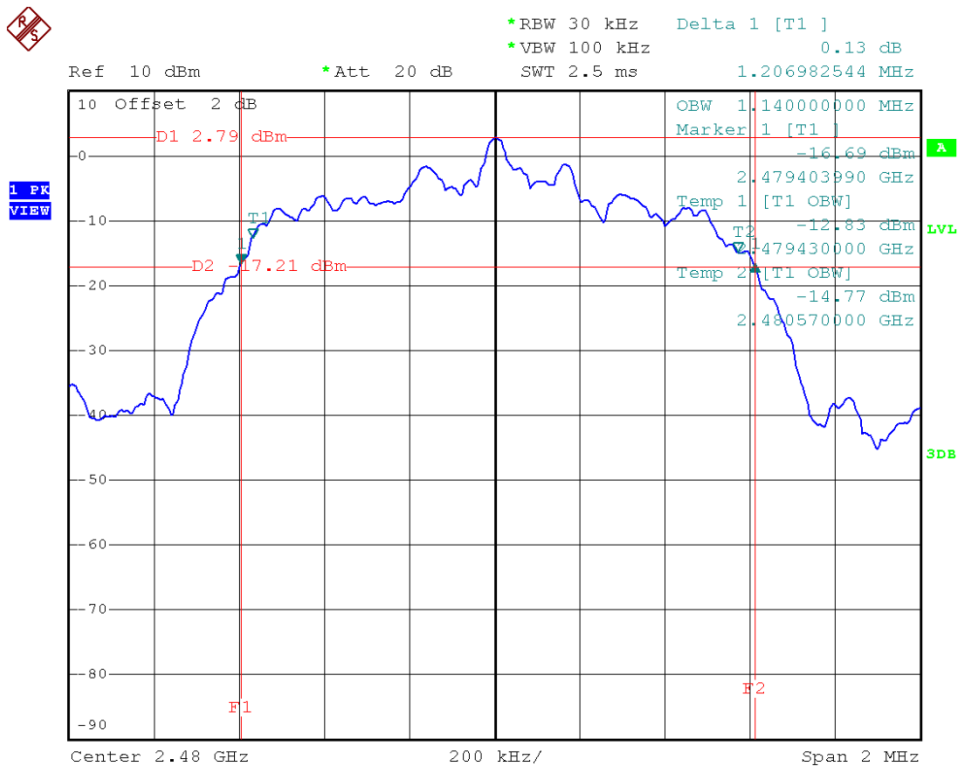
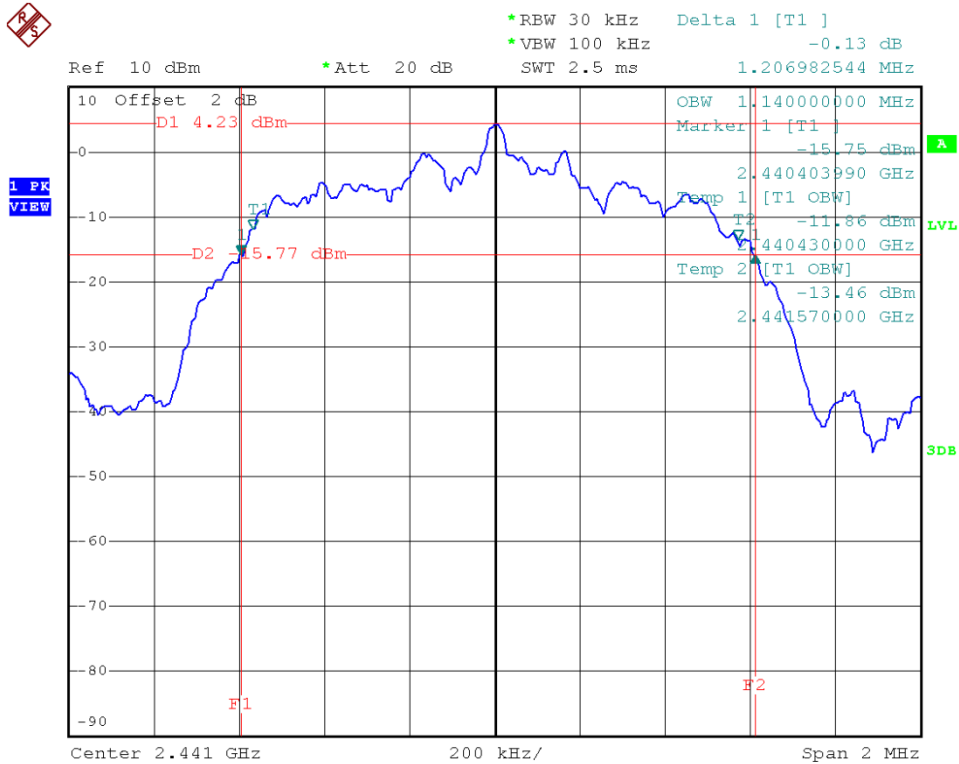
Bluetooth			
Frequency (MHz)	Mode	20 dB Bandwidth	99% Bandwidth
2402	GFSK	907.73	840
2441		847.88	850
2480		912.72	930
2402	8DPSK	1.207	1.15
2441		1.207	1.14
2480		1.207	1.14

Plots:
BT GFSK



BT 8DPSK





9.4 Carrier Frequency Separation

Test Method

1. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels, $RBW \geq 1\%$ of the span, $VBW \geq RBW$, Sweep = auto, Detector function = peak
2. By using the Max-Hold function record the separation of two adjacent channels.
3. Measure the frequency difference of these two adjacent channels by spectrum analyzer marker function.
4. Repeat above procedures until all frequencies measured were complete.

Limit

Limit
kHz

$\geq 25\text{KHz}$ or $2/3$ of the 20 dB bandwidth which is greater

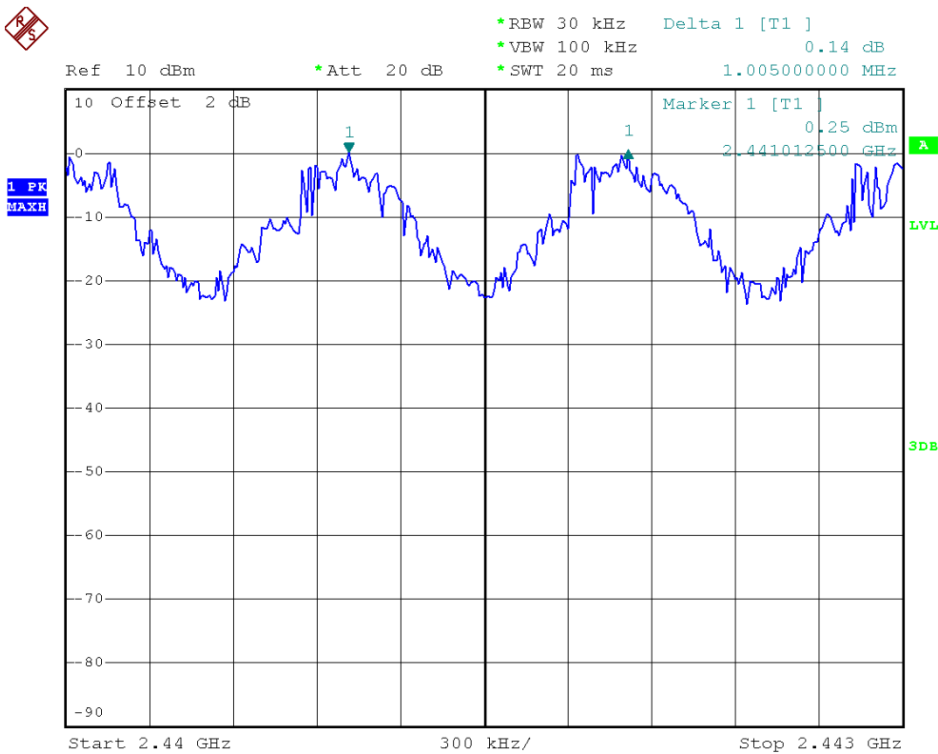
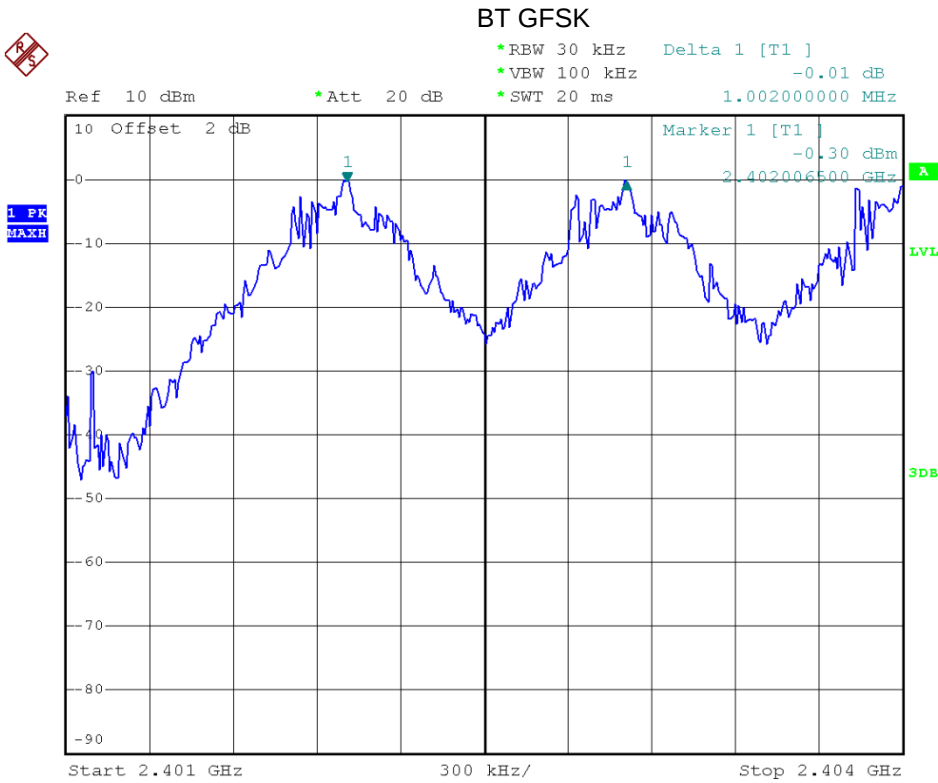
Result:

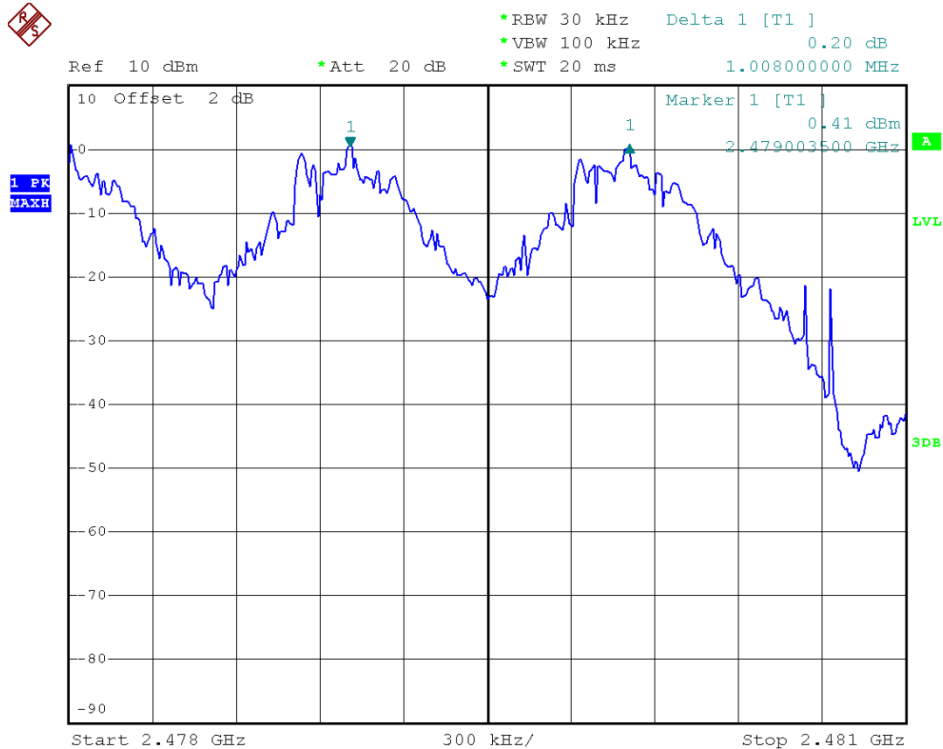
Frequency (MHz)	Mode	Carrier Frequency Separation (KHz)	2/3 of 20 dB Bandwidth(KHz)	Result
2402	GFSK	1.002	605.15	Pass
2441		1.005	565.25	Pass
2480		1.008	608.48	Pass
2402	8DPSK	1.004	0.80	Pass
2441		1.014	0.80	Pass
2480		1.005	0.80	Pass



China

Plots:



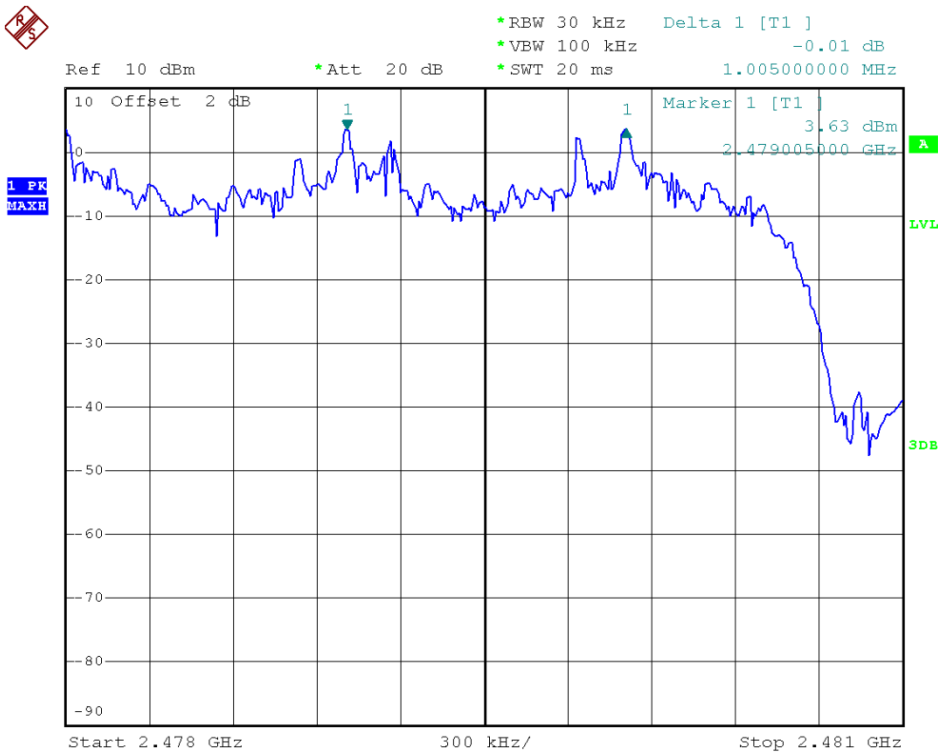
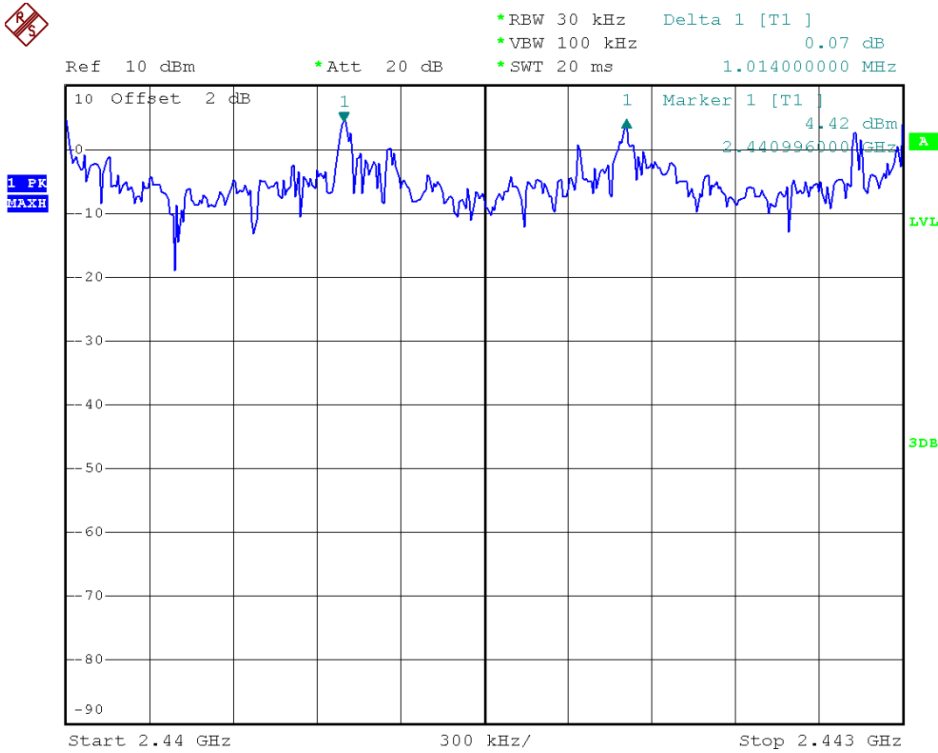


BT 8DPSK





China



9.5 Number of hopping frequencies

Test Method

1. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels, $RBW \geq 1\%$ of the span, $VBW \geq RBW$, Sweep = auto, Detector function = peak
2. Set the spectrum analyzer on Max-Hold Mode, and then keep the EUT in hopping mode.
3. Record all the signals from each channel until each one has been recorded.
4. Repeat above procedures until all frequencies measured were complete.

Limit

Limit
number

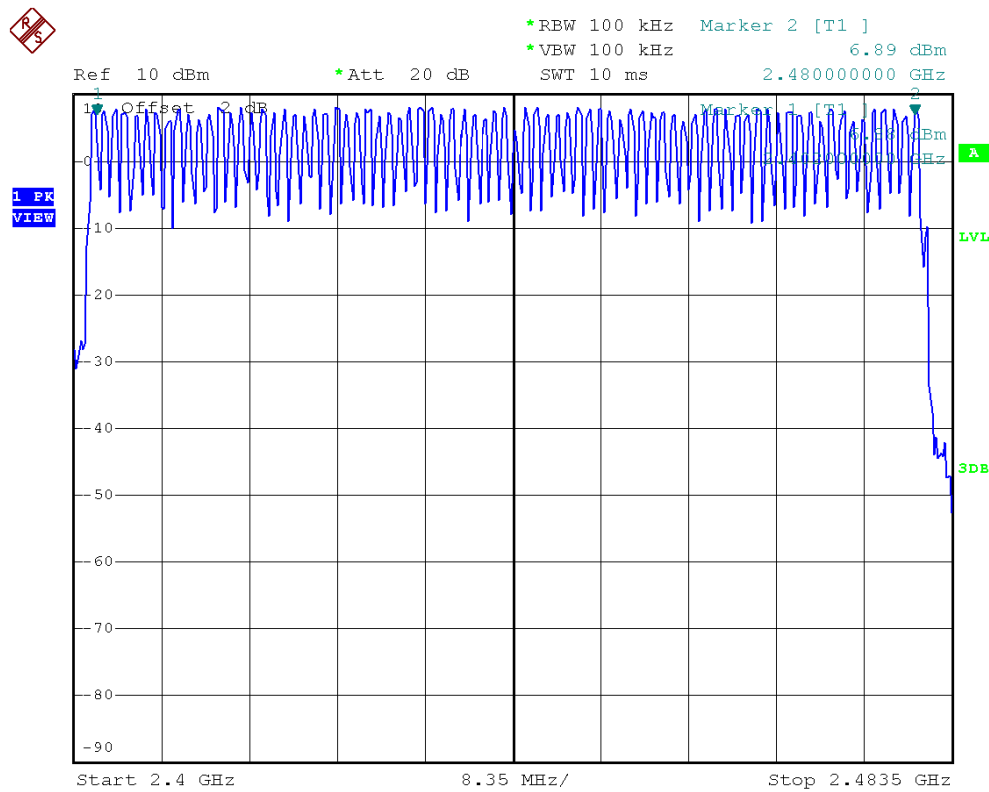
≥ 15

Number of hopping frequencies

Test result: The measurement was performed with the typical configuration (normal hopping status), and the total hopping channels is constant for the all modulation mode according with the Bluetooth Core Specification. Here GFSK modulation mode was used to show compliance.

Number of hopping frequencies	Result
79	Pass

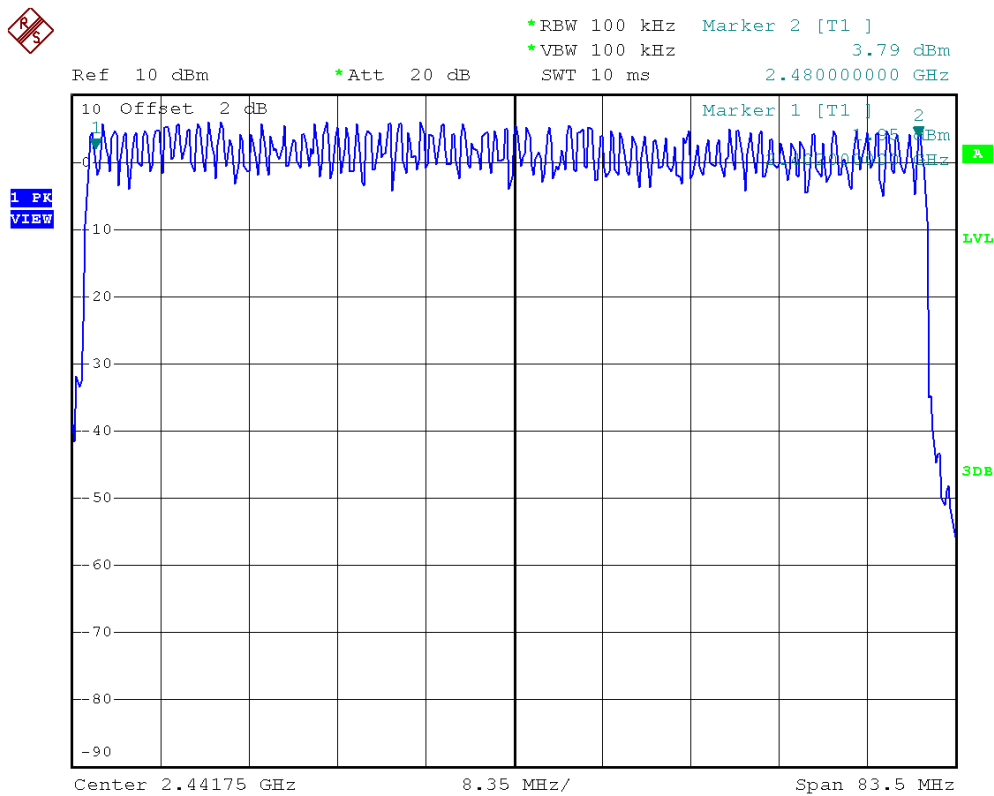
BT GFSK





China

BT 8DPSK



9.6 Dwell Time

Test Method

1. Connect EUT antenna terminal to the spectrum analyzer with a low loss cable.
Equipment mode: Spectrum analyzer
2. RBW: 1MHz; VBW: 1MHz; SPAN: Zero Span
3. Adjust the center frequency of spectrum analyzer on any frequency be measured.
4. Measure the Dwell Time by spectrum analyzer Marker function.
5. Repeat above procedures until all frequencies measured were complete.

Limit

According to §15.247(a)(1)(iii) & RSS-210 A8.1(c) The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Dwell Time

Dwell time

The maximum dwell time shall be 0,4 s.

According to the Bluetooth Core Specification, the worse result (DH5, 3DH5 mode) was reported to show compliance.

The Dwell Time = Burst Width * Total Hops. The detailed calculations are showed as follows:

The duration for dwell time calculation: 0.4 [s] * hopping number = 0.4 [s] * 79 [ch] = 31.6 [s*ch];

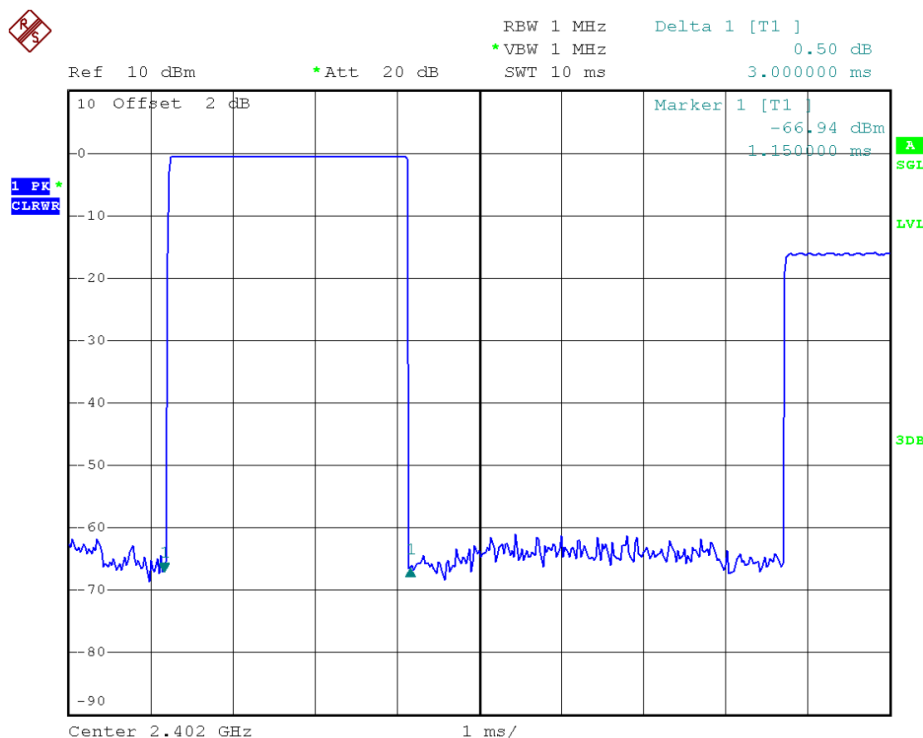
The burst width, which is directly measured, refers to the duration on one channel hop.

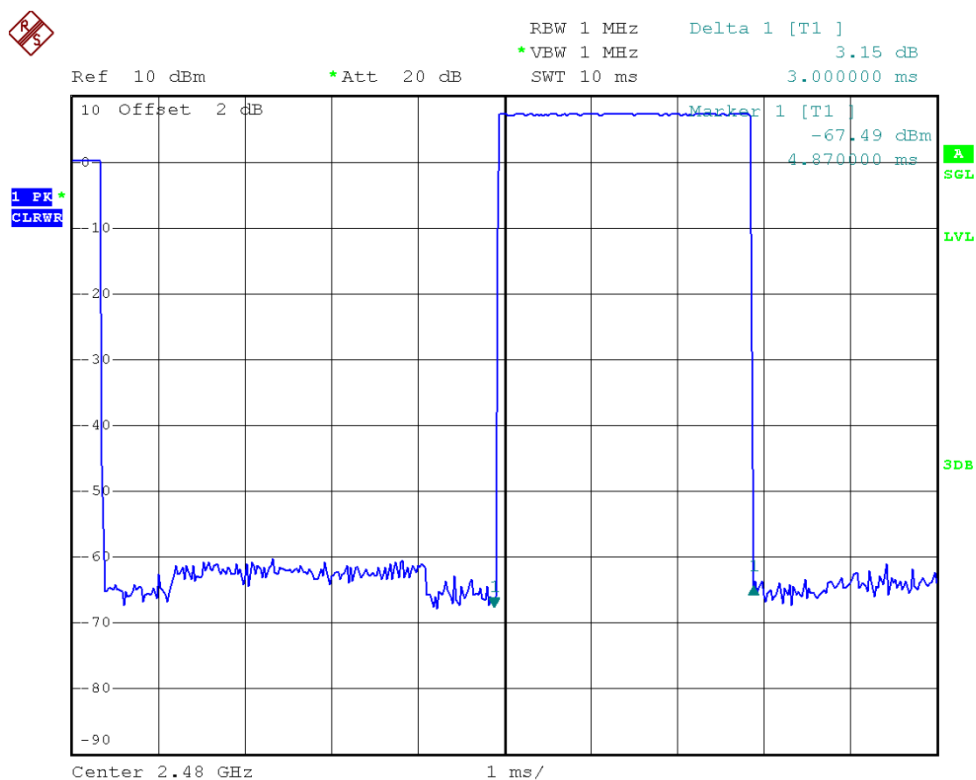
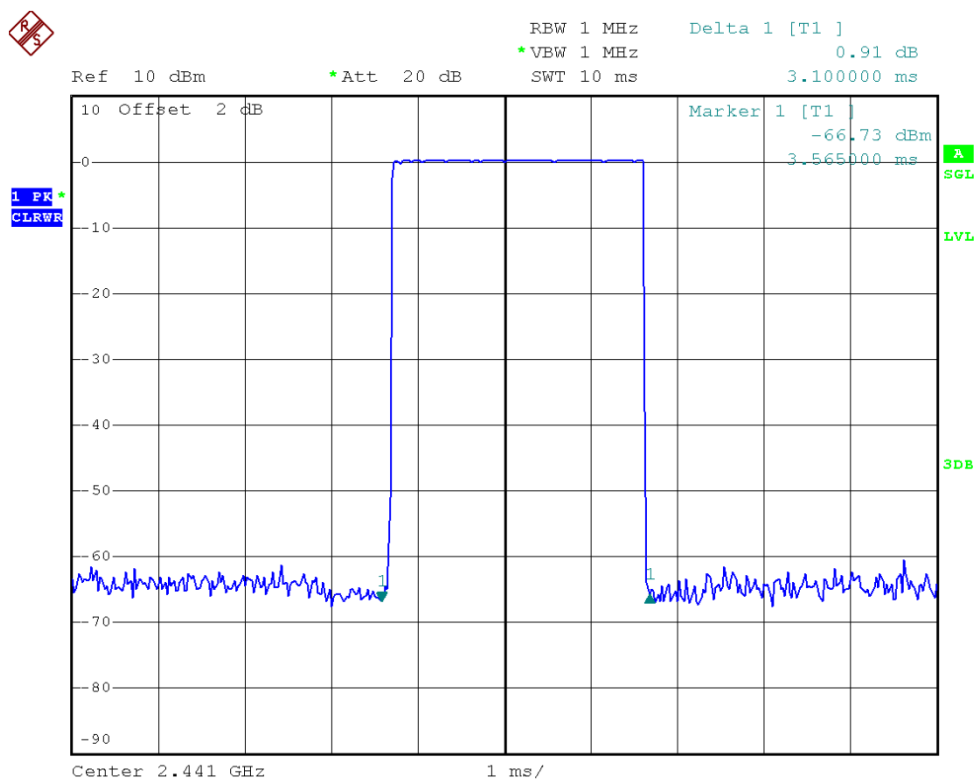
The maximum number of hopping channels in 31.6s for DH5=1600 / 6 / 79 *31.6=106.67

Test Result

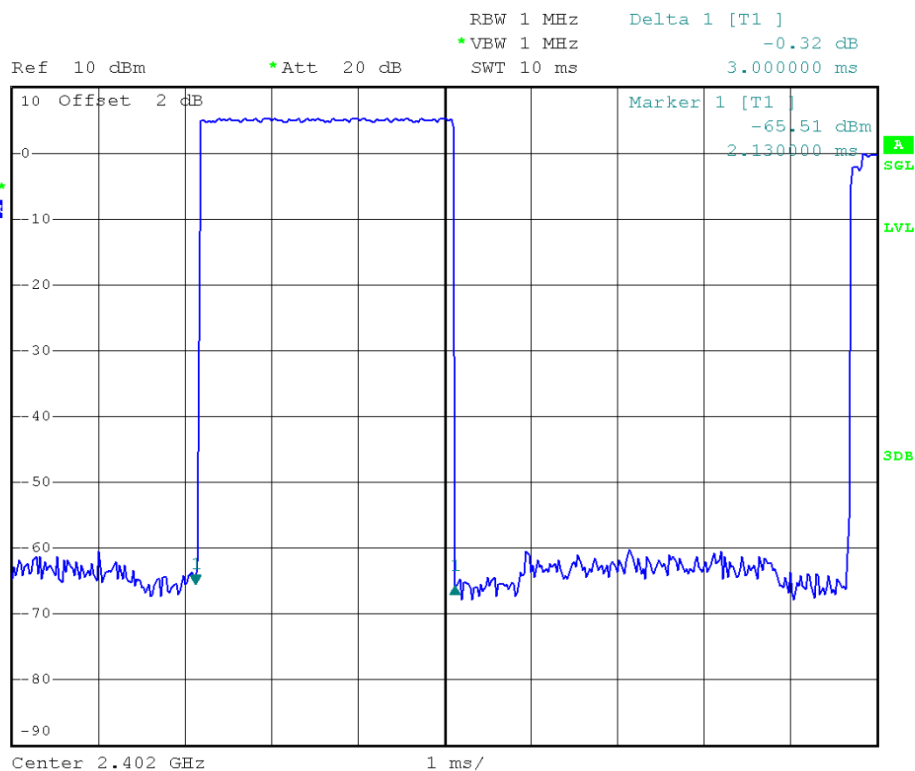
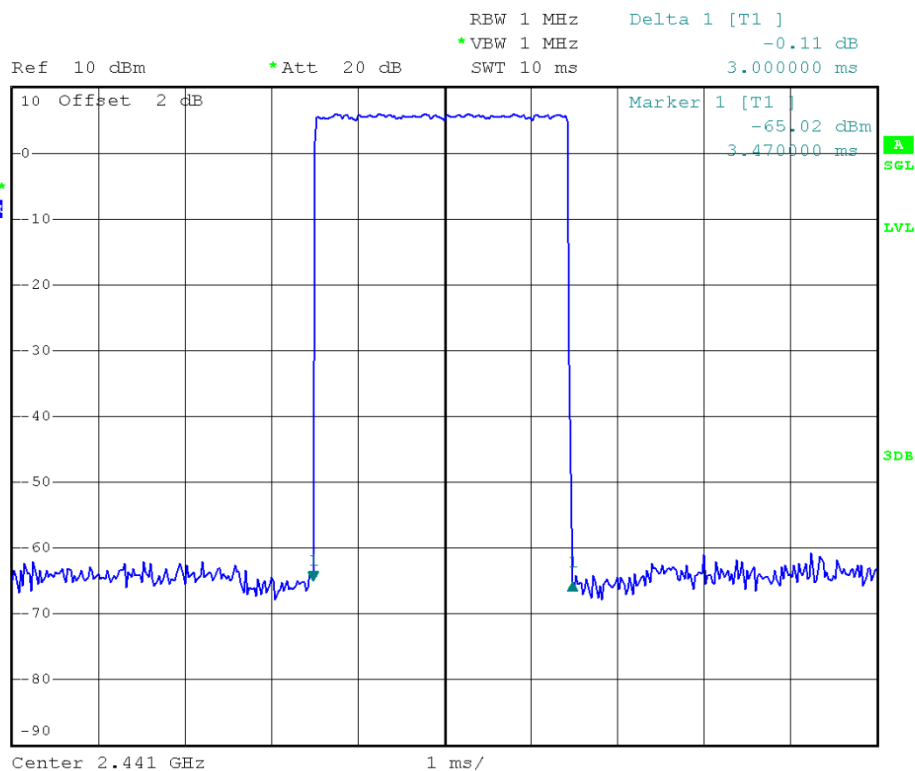
Modulation	Frequency (MHz)	Mode	Reading (ms)	Total Hops	Test Result (ms)	Limit (ms)	Result
GFSK	2402	DH5	3.0	106.67	320	< 400	Pass
	2441	DH5	3.1	106.67	331	< 400	Pass
	2480	DH5	3.0	106.67	320	< 400	Pass
8DPSK	2402	3DH5	3.0	106.67	320	< 400	Pass
	2441	3DH5	3.0	106.67	320	< 400	Pass
	2480	3DH5	3.0	106.67	320	< 400	Pass

BT GFSK DH5





BT 8DPSK 3DH5

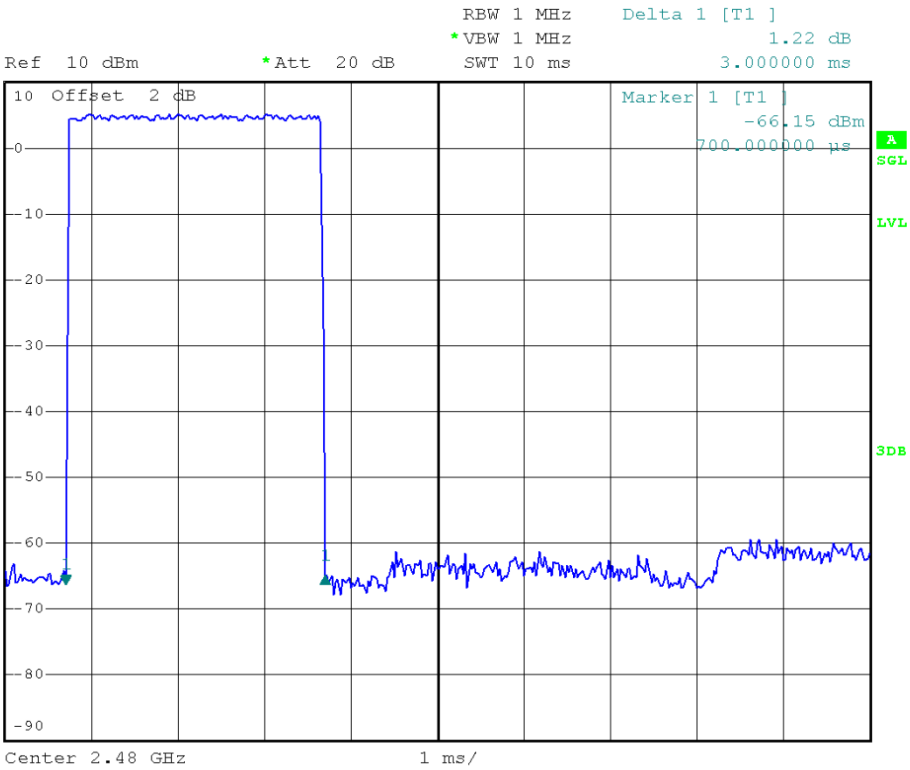
1 PK*
CLRWR1 PK*
CLRWR



China



1 PK*
CLRWR



9.7 6 dB Bandwidth

Test Method

5. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
6. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
7. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
8. Repeat above procedures until all frequencies measured were complete.

Limit

Limit [kHz]

≥ 500

Result:

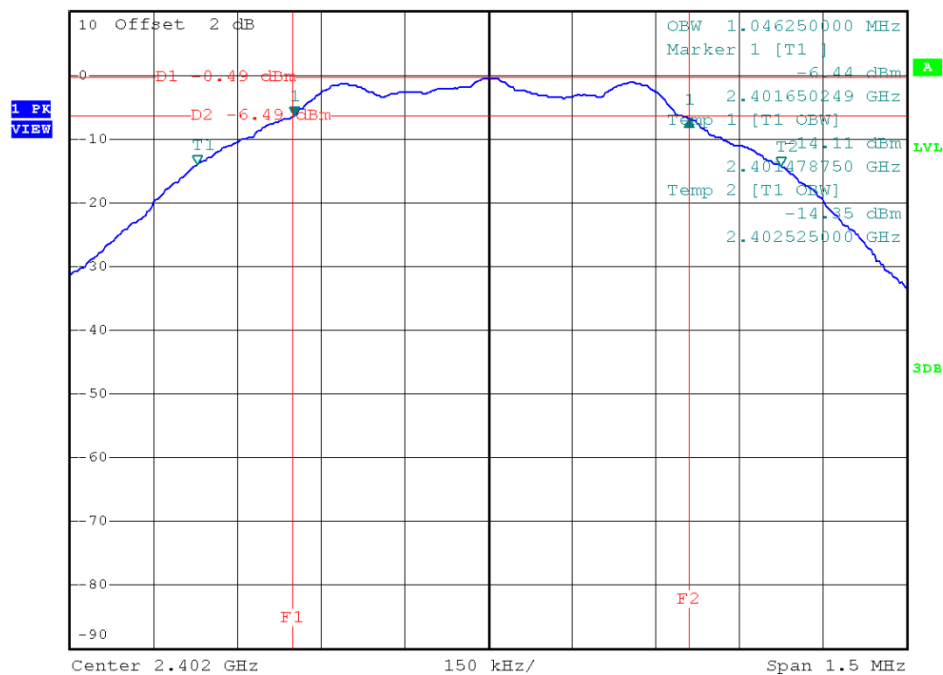
Bluetooth			
Frequency (MHz)	Mode	6 dB Bandwidth	Result
2402	BLE	710.72	Pass
2440		695.76	Pass
2480		703.24	Pass

WIFI			
Frequency (MHz)	Mode	6 dB Bandwidth	Result
2412	802.11b	11.12	Pass
2437		12.07	Pass
2462		12.07	Pass
2412	802.11g	16.06	Pass
2437		16.11	Pass
2462		16.31	Pass

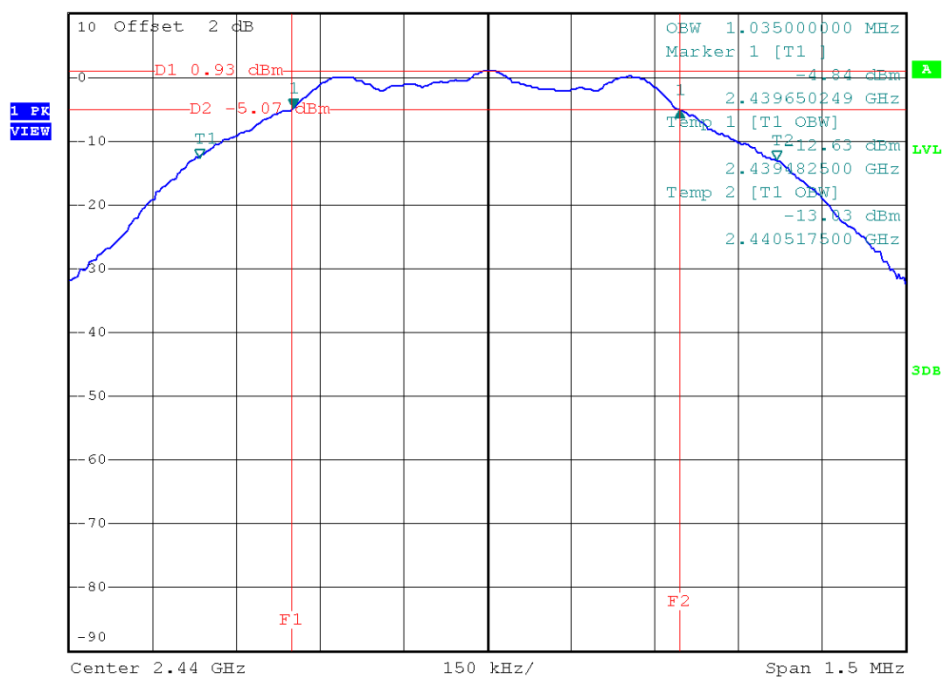


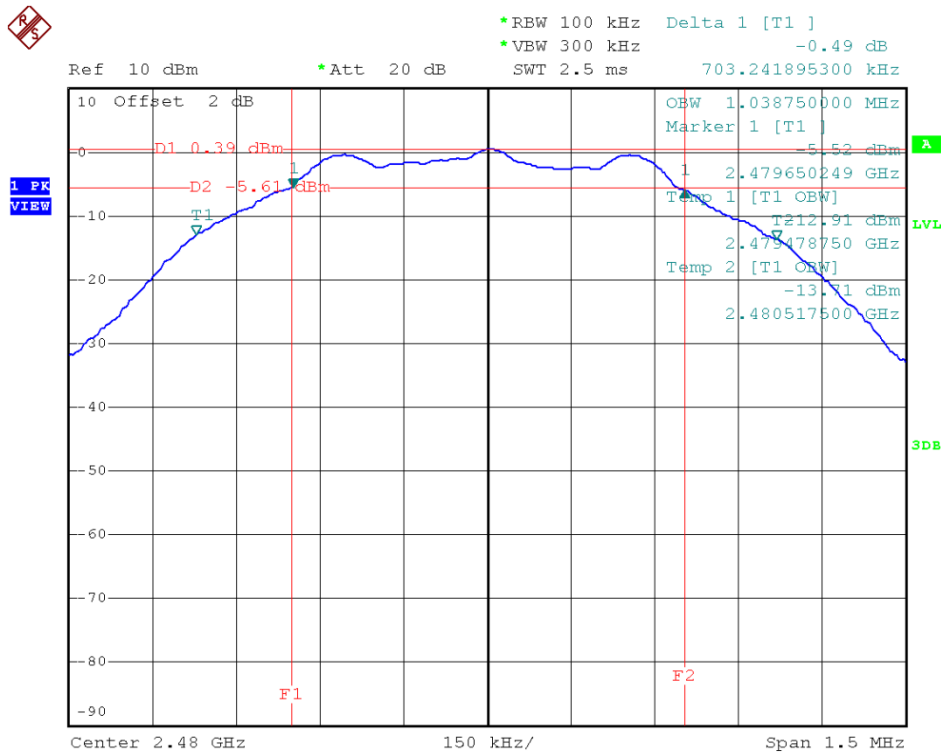
BLE

*RBW 100 kHz Delta 1 [T1]
 *VBW 300 kHz -0.42 dB
 Ref 10 dBm *Att 20 dB SWT 2.5 ms 710.723192060 kHz

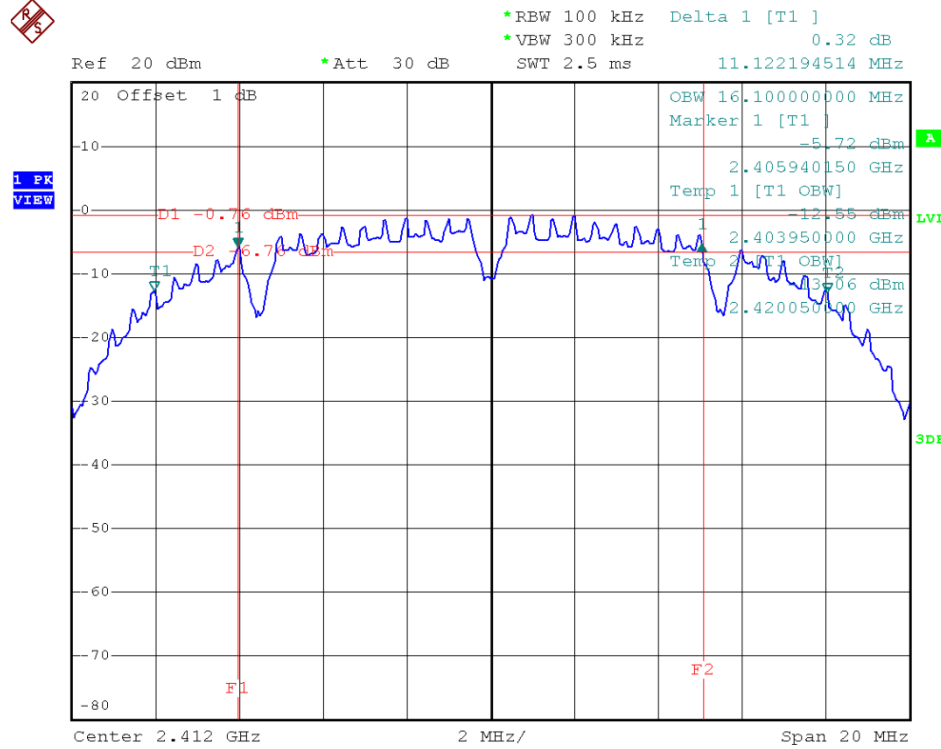


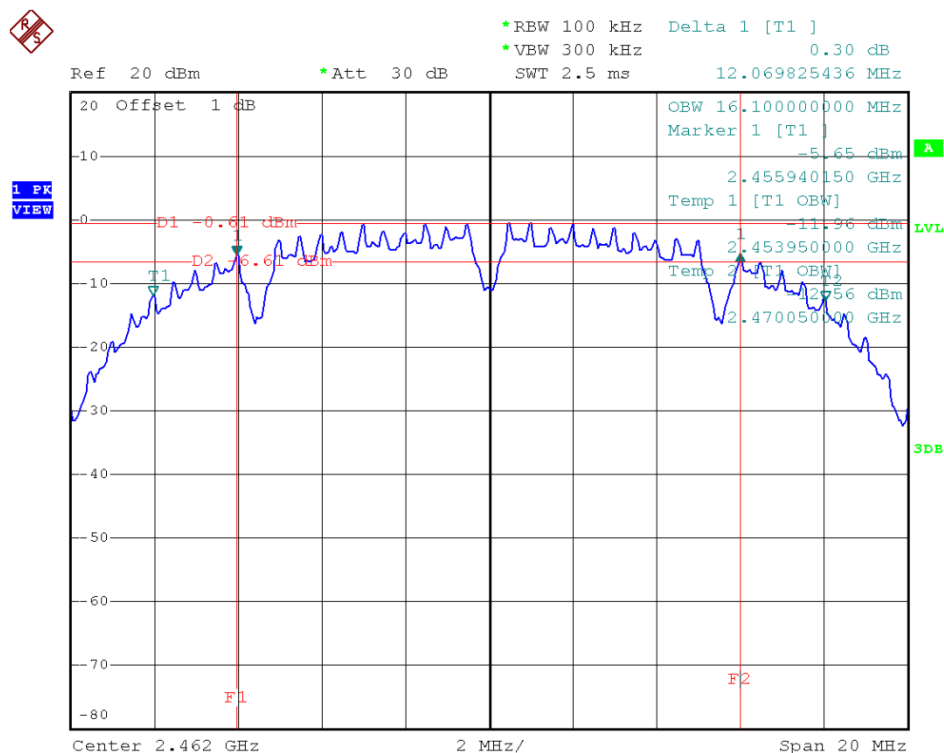
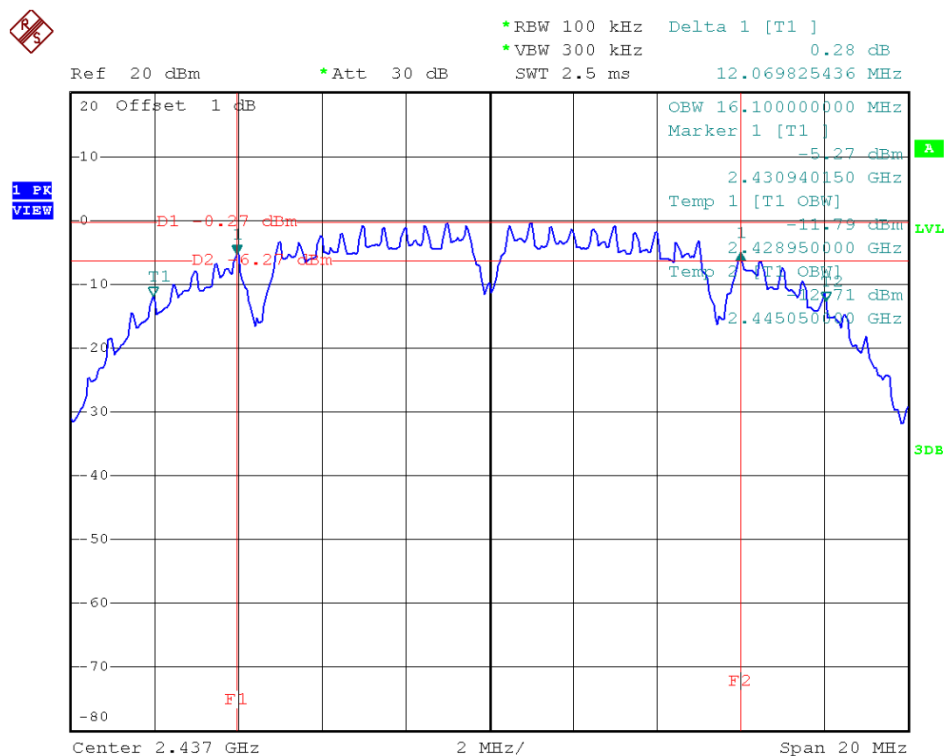
*RBW 100 kHz Delta 1 [T1]
 *VBW 300 kHz -0.33 dB
 Ref 10 dBm *Att 20 dB SWT 2.5 ms 695.760598540 kHz

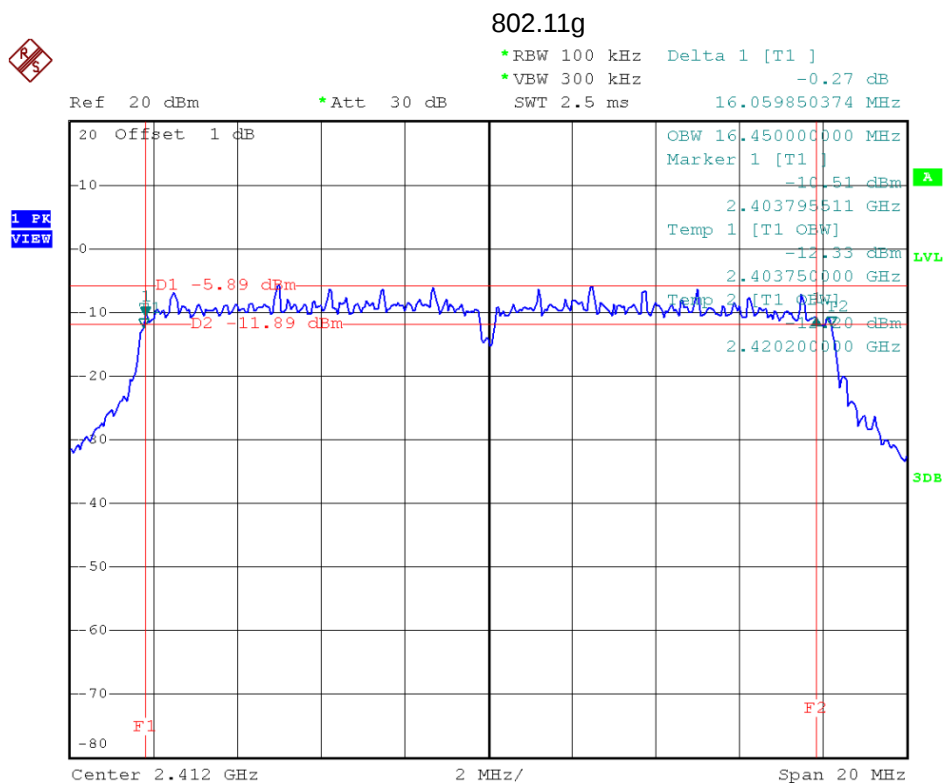




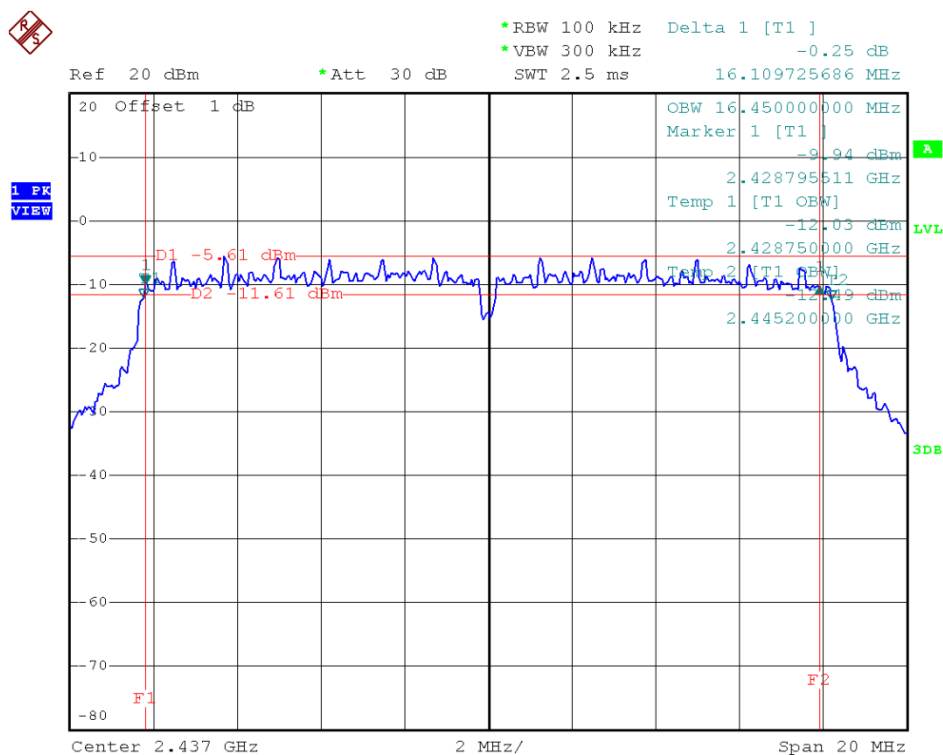
802.11b







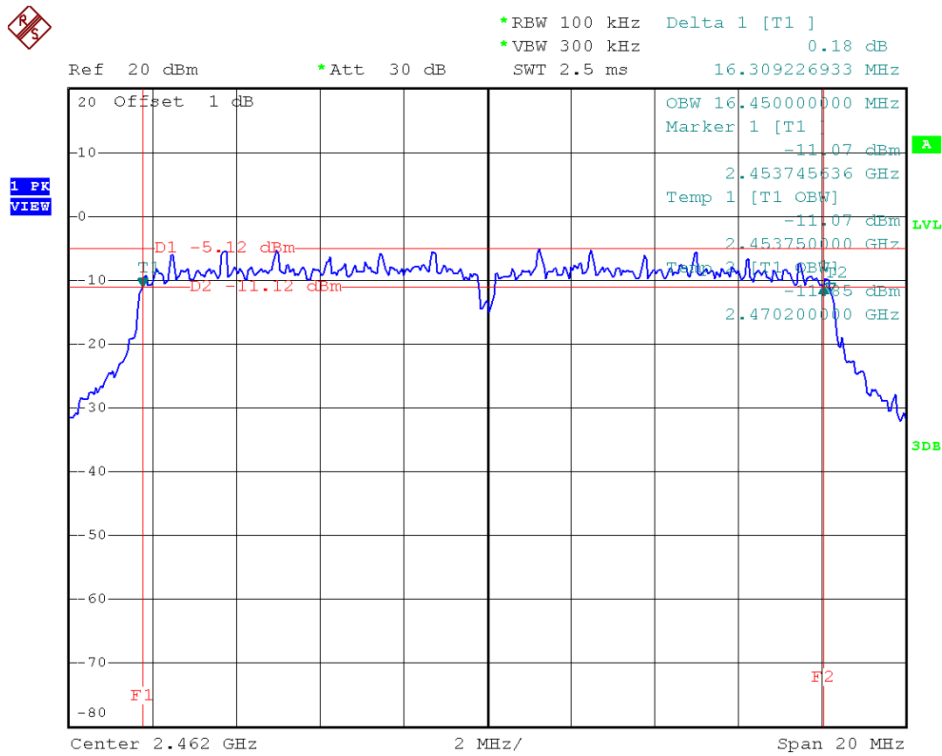
Date: 7.AUG.2014 11:51:28



Date: 7.AUG.2014 11:59:17



China





China

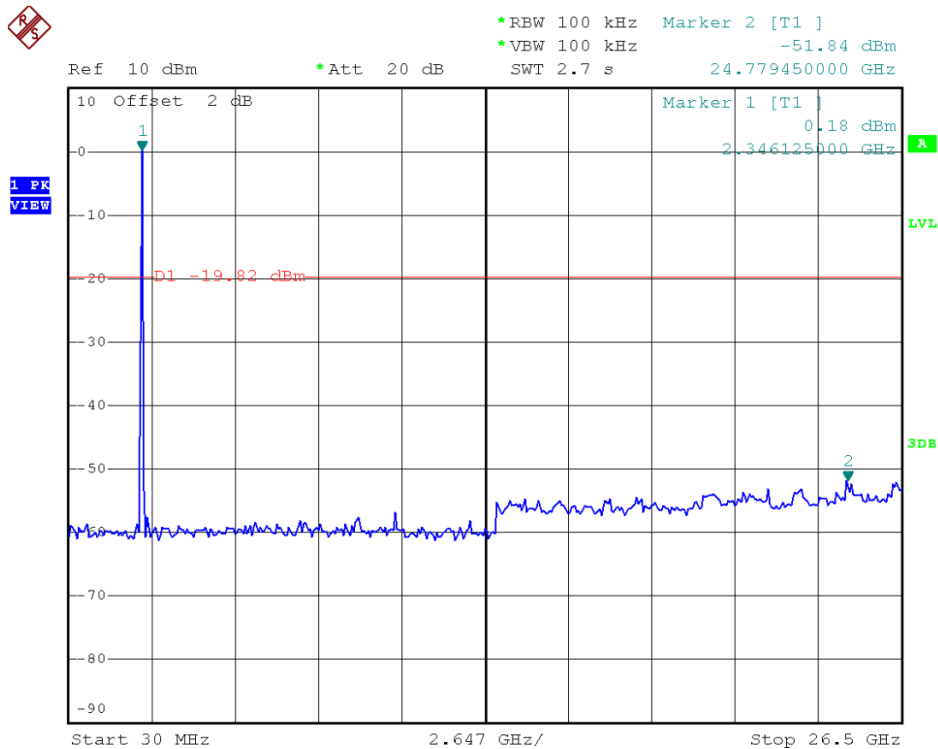
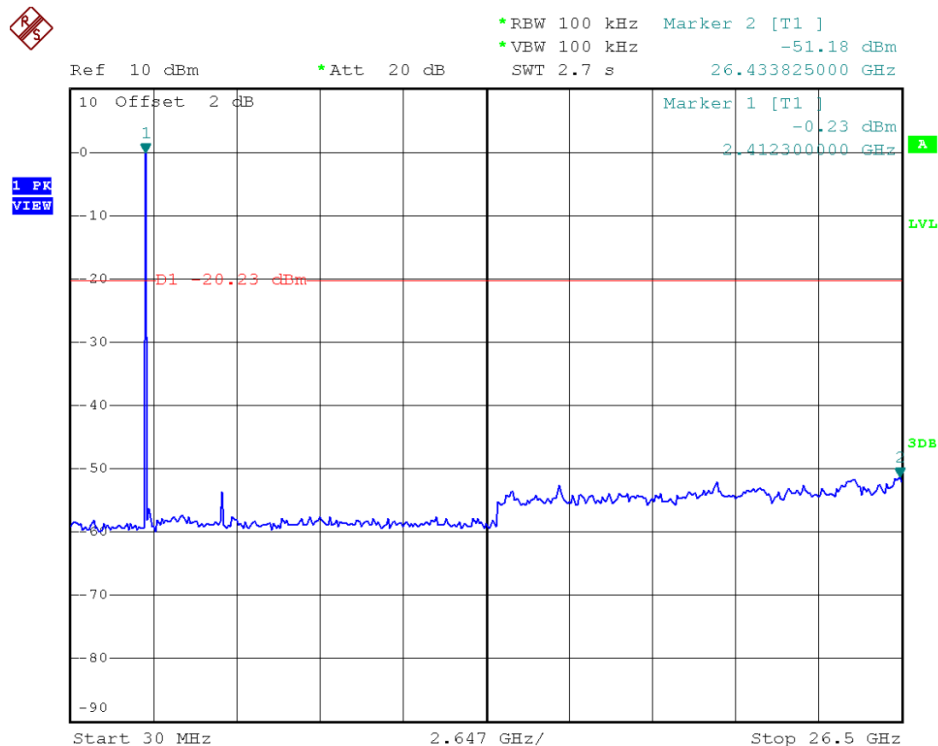
9.8 Spurious RF conducted emissions

Test Method

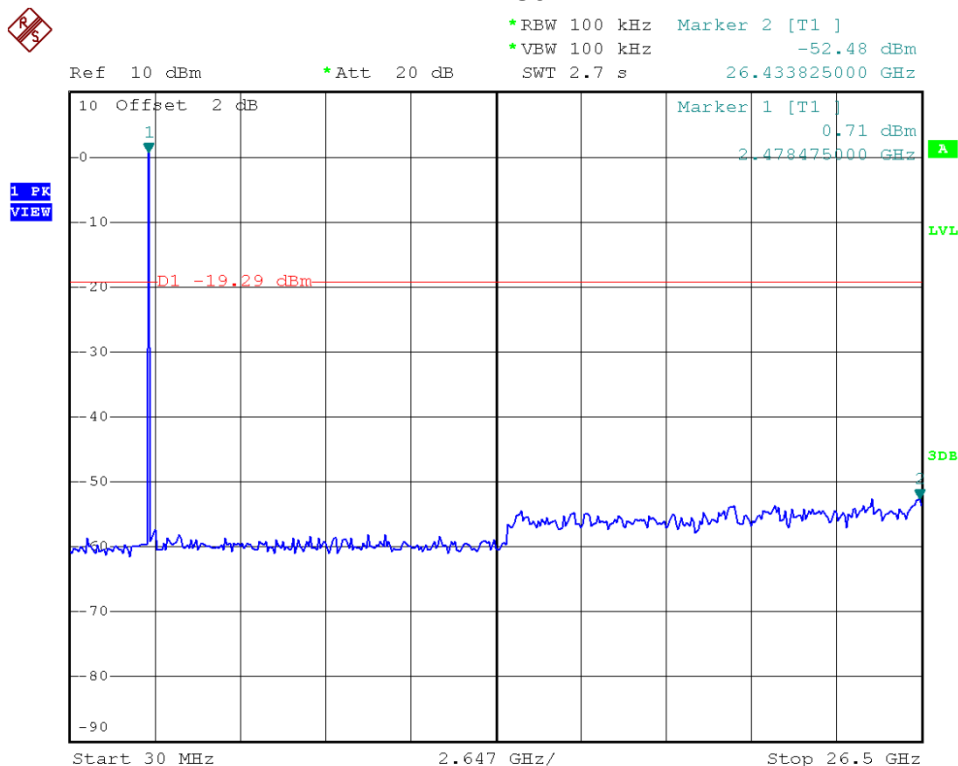
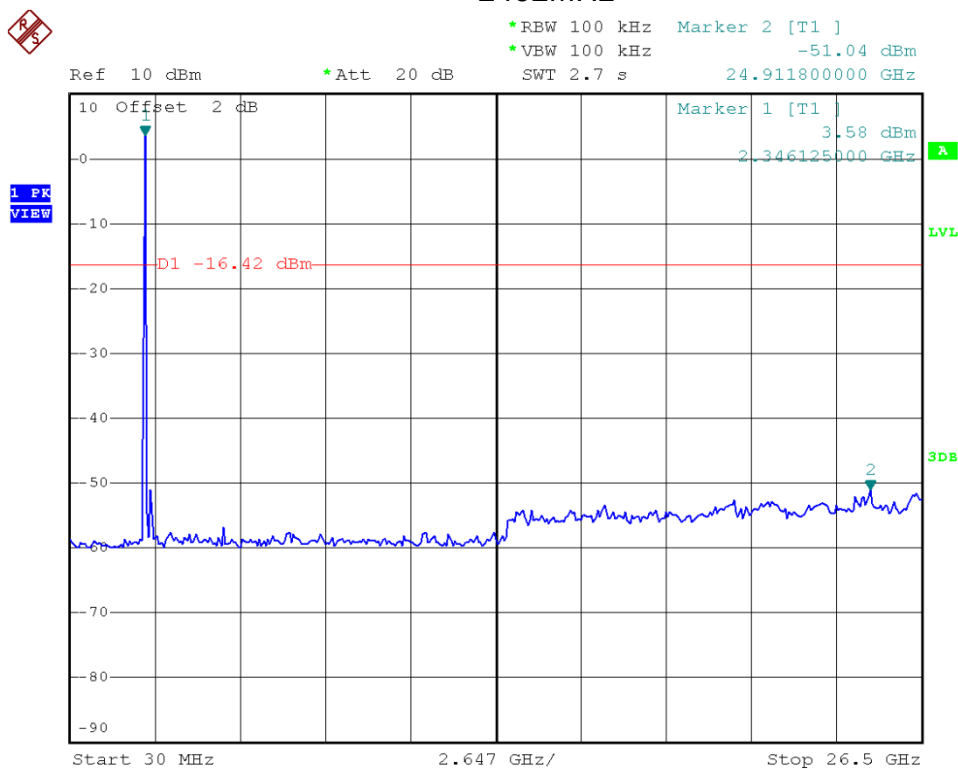
1. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
3. The level displayed must comply with the limit specified in this Section. Submit these plots.
4. Repeat above procedures until all frequencies measured were complete.

Limit

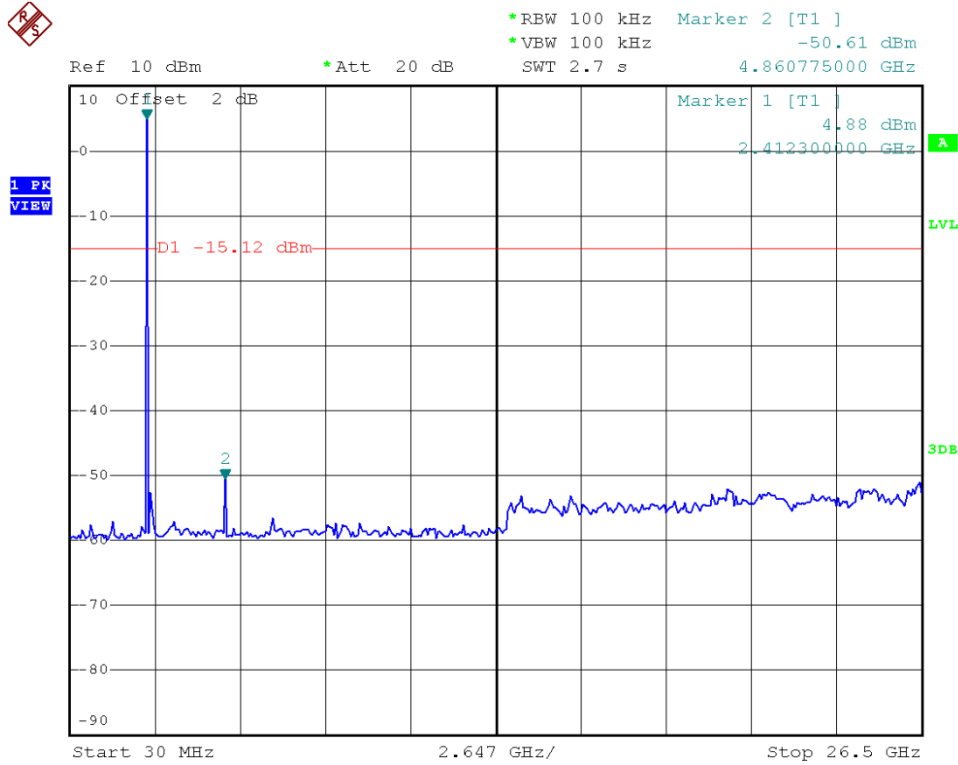
Frequency Range MHz	Limit (dBc)
30-25000	-20

Spurious RF conducted emissions**BT GFSK mode
2402MHz****2442MHz**

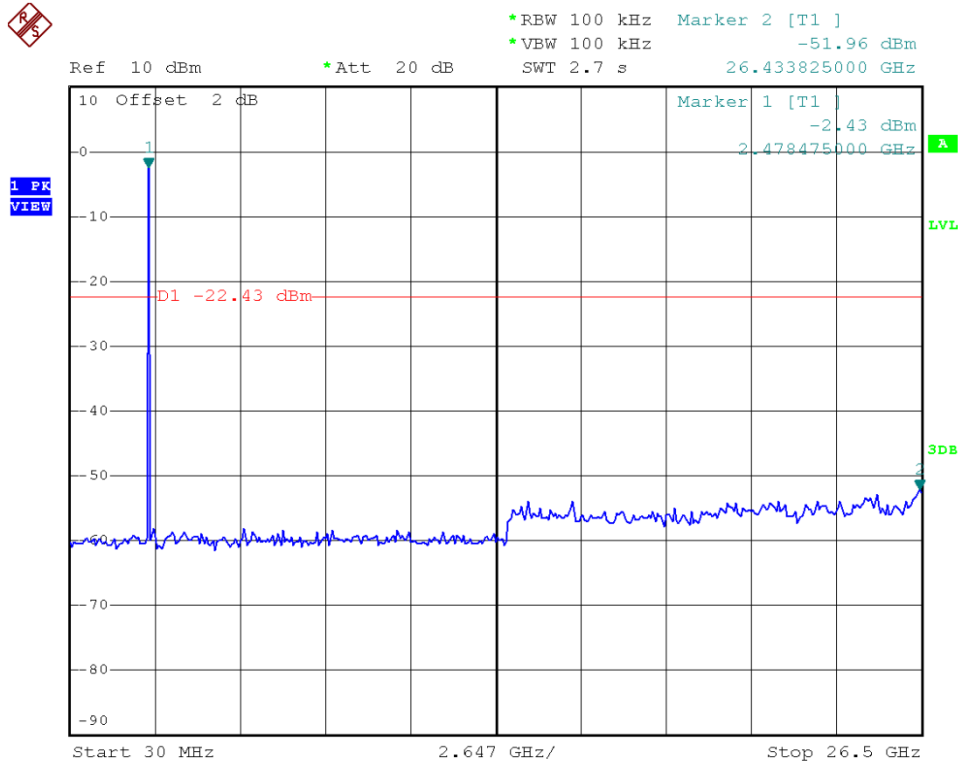
2480MHz

8DPSK
2402MHz

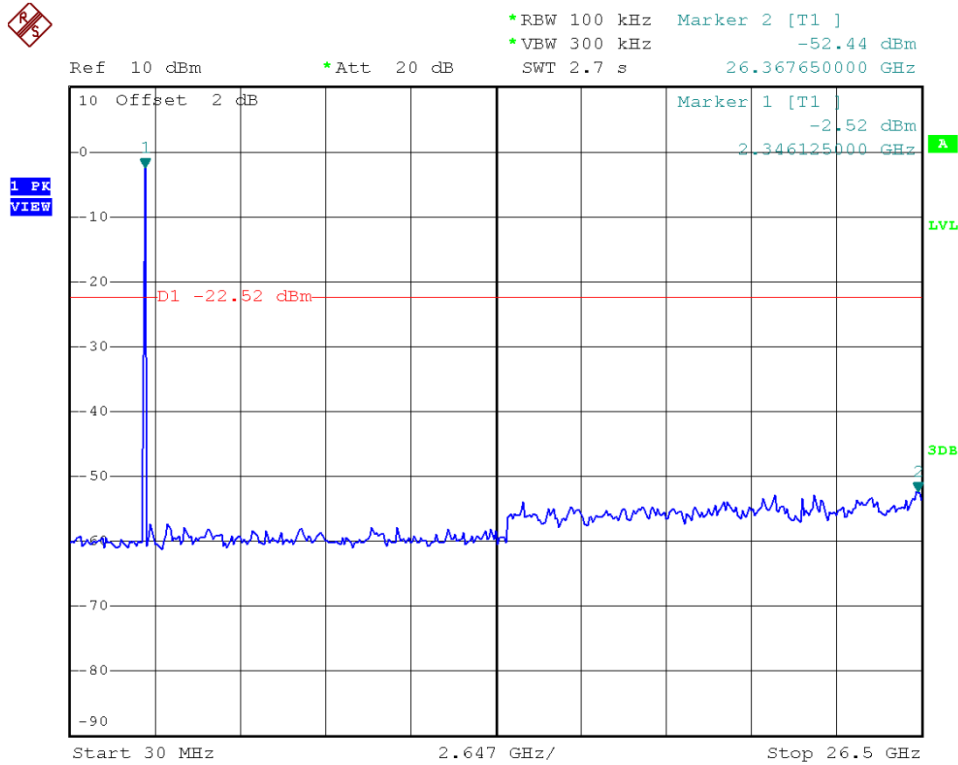
2441MHz



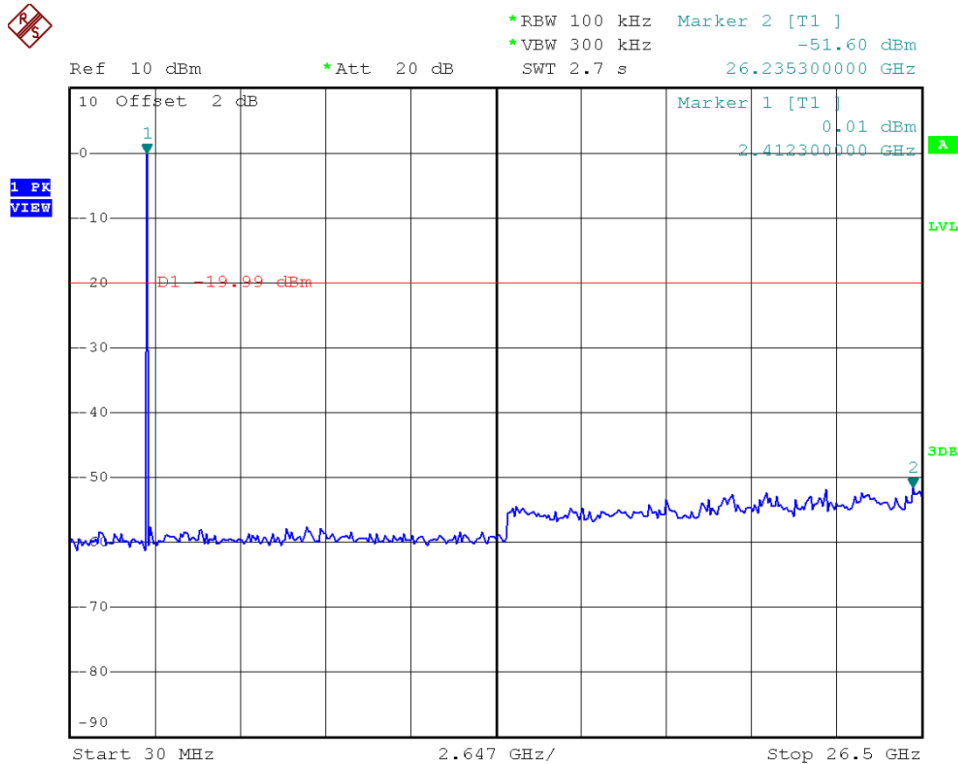
2480MHz



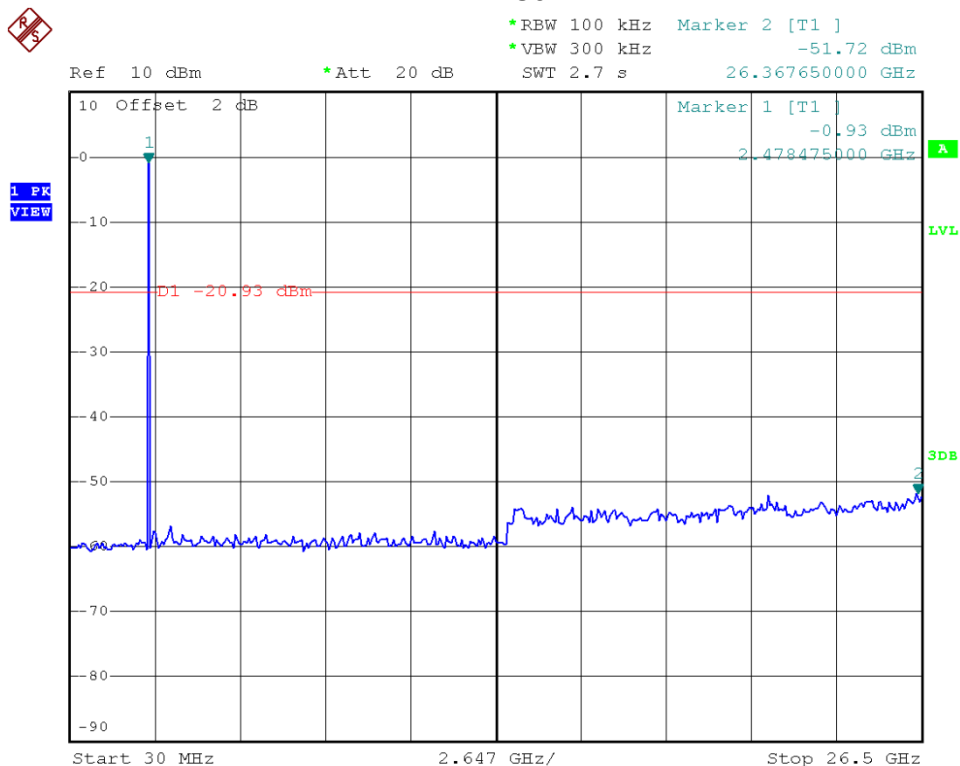
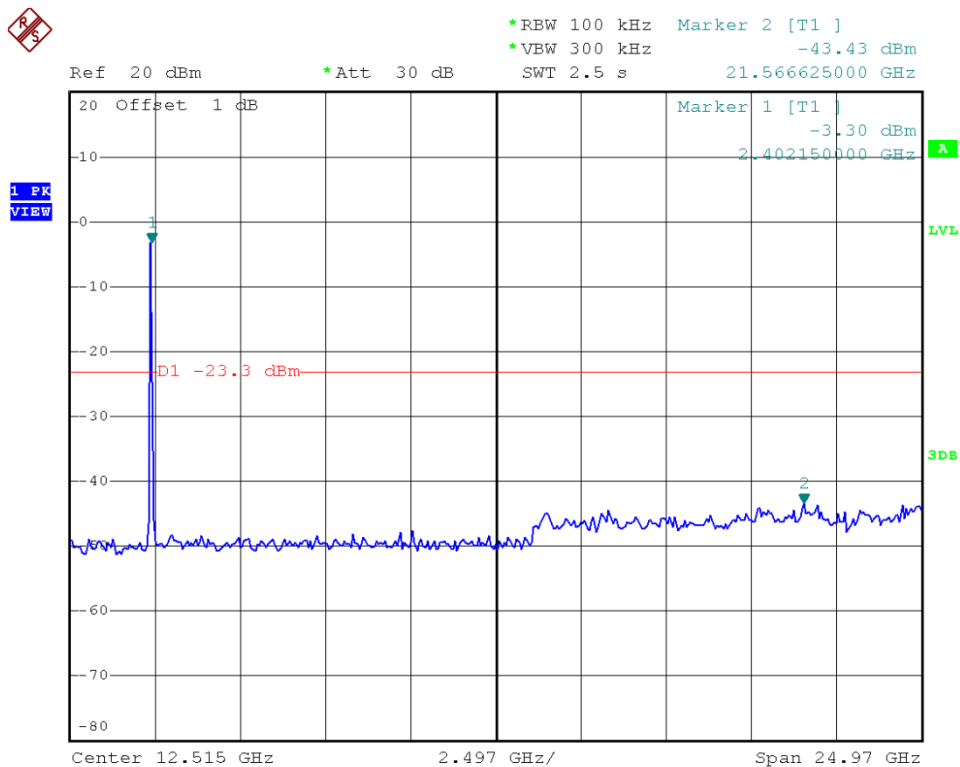
BLE
2402MHz

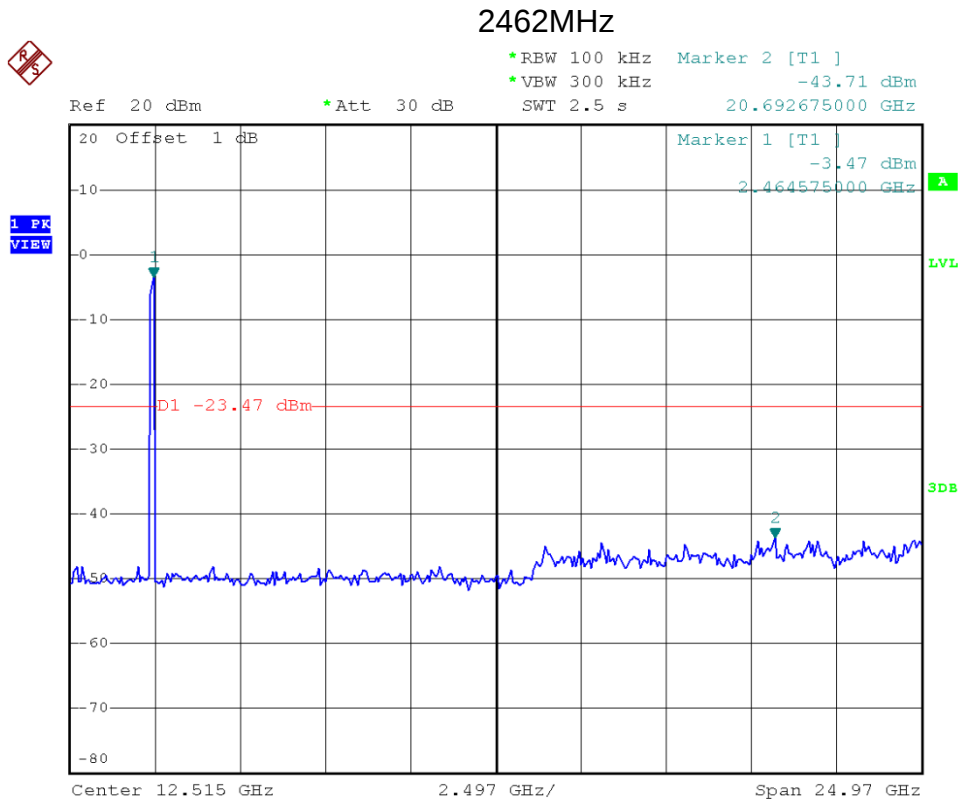
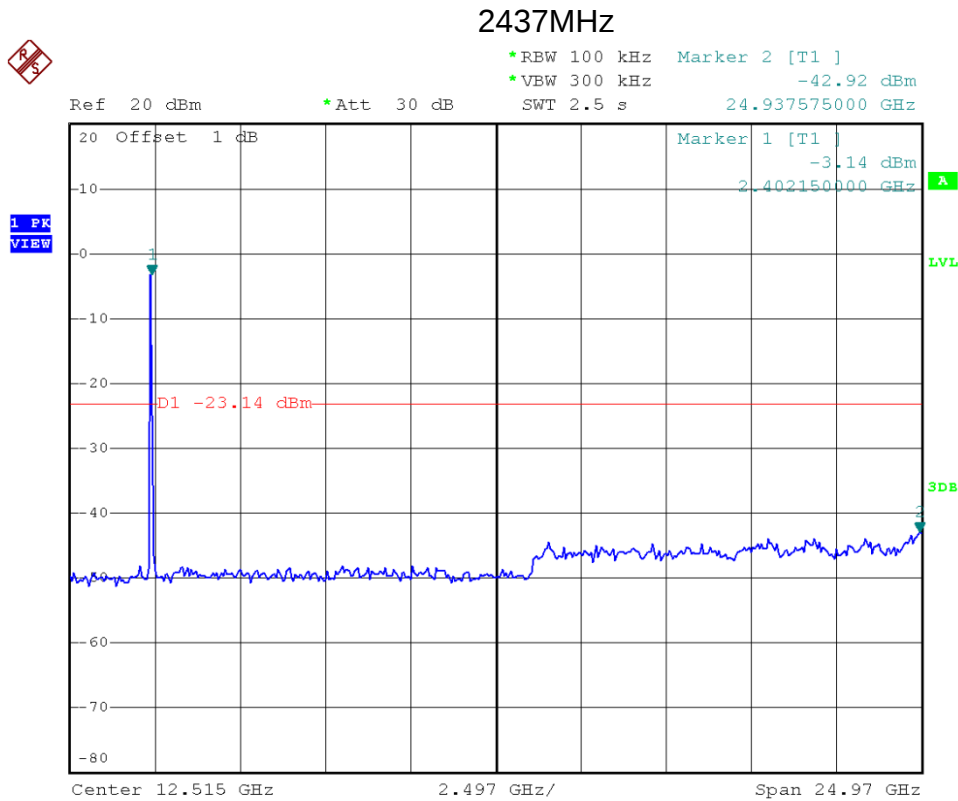


2440MHz

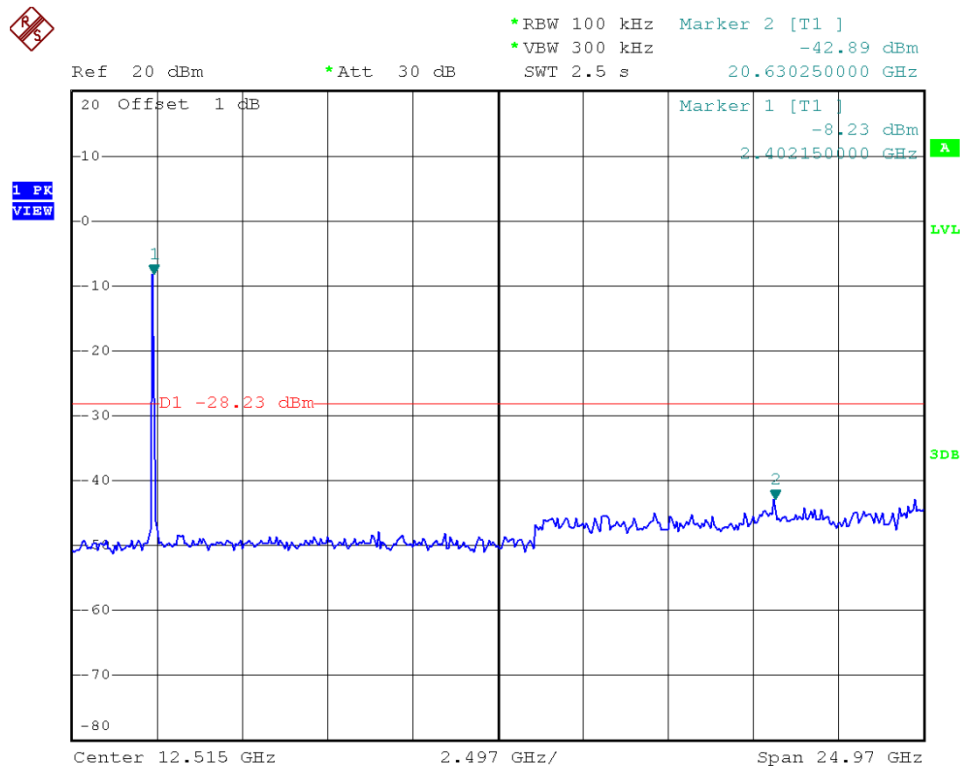


2480MHz

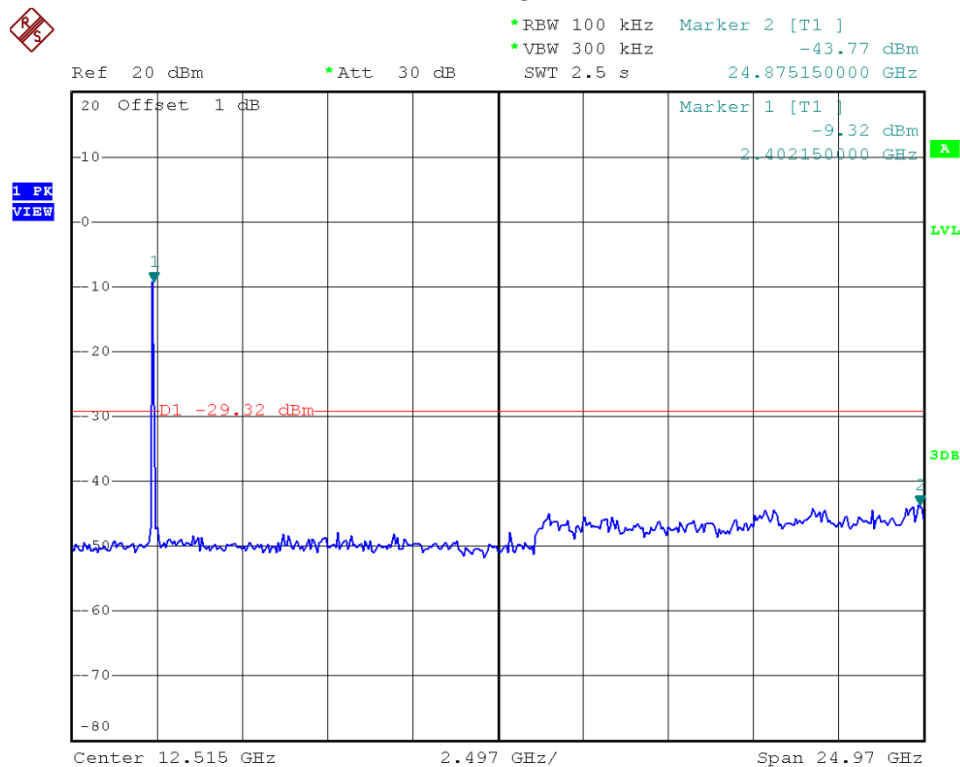
802.11b
2412MHz

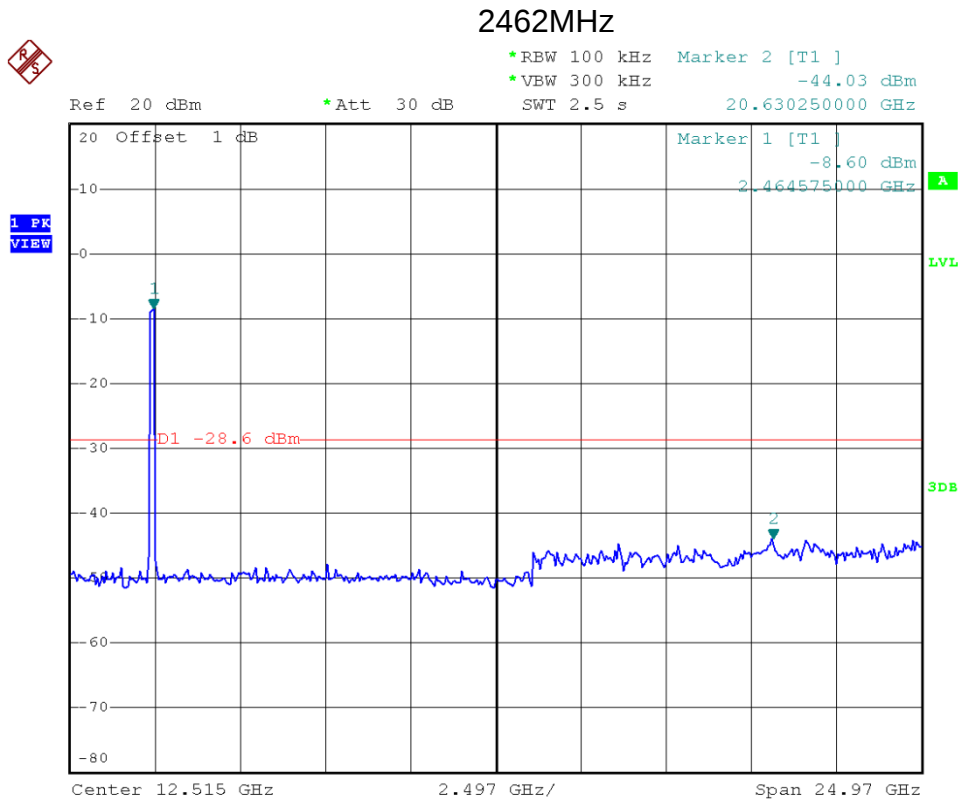


802.11g 2412MHz



2437MHz





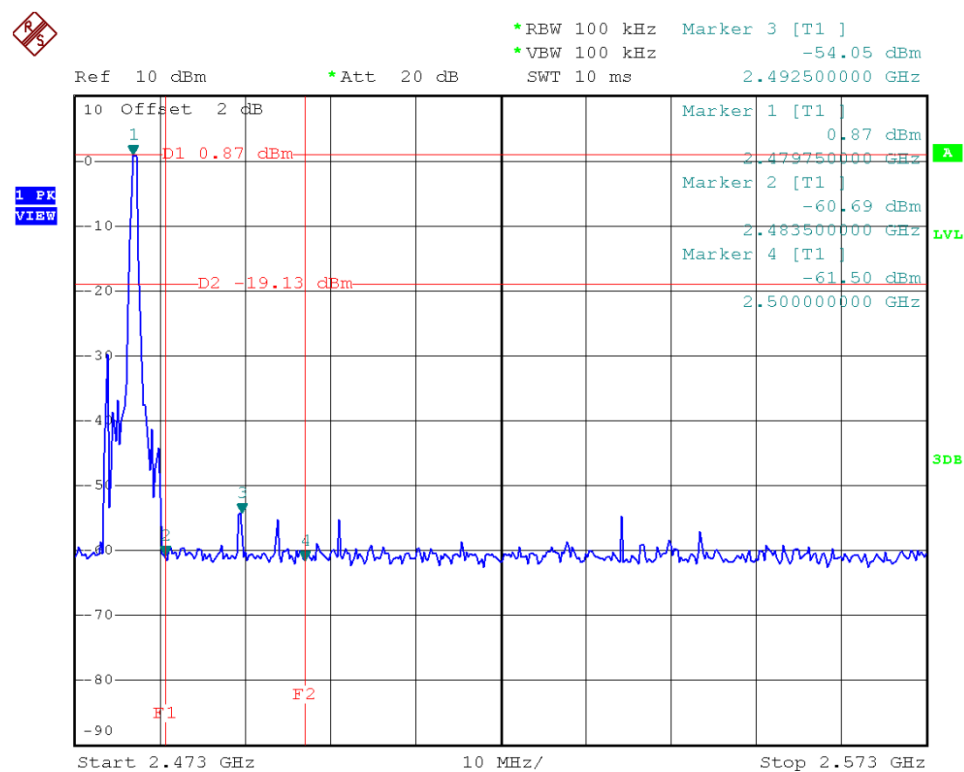
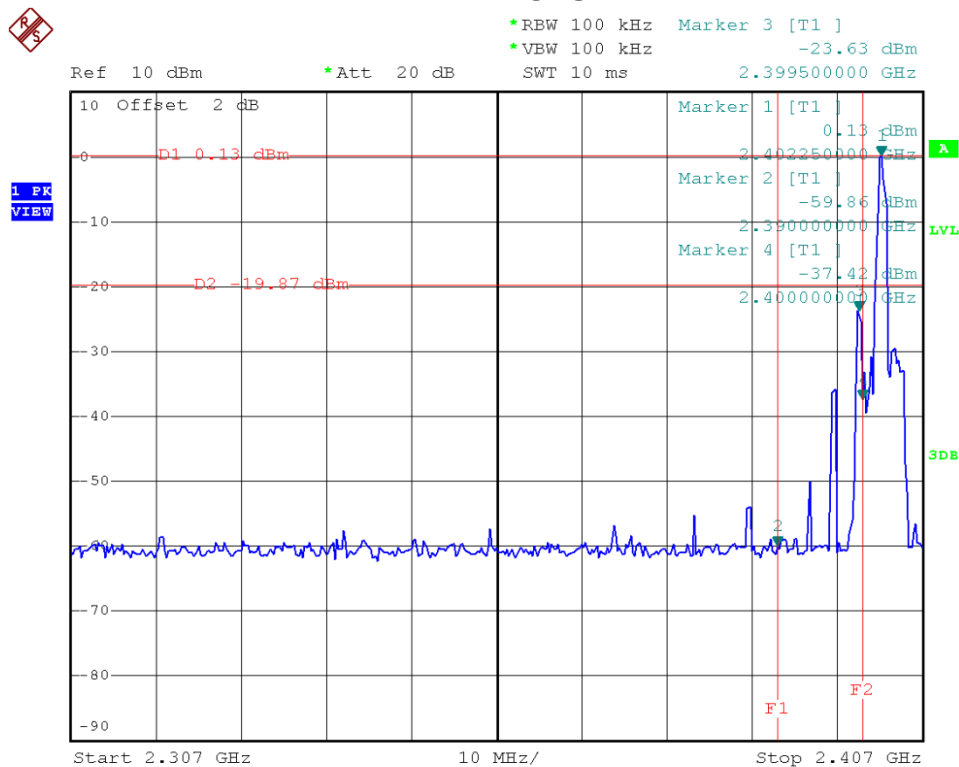
9.9 Band edge testing

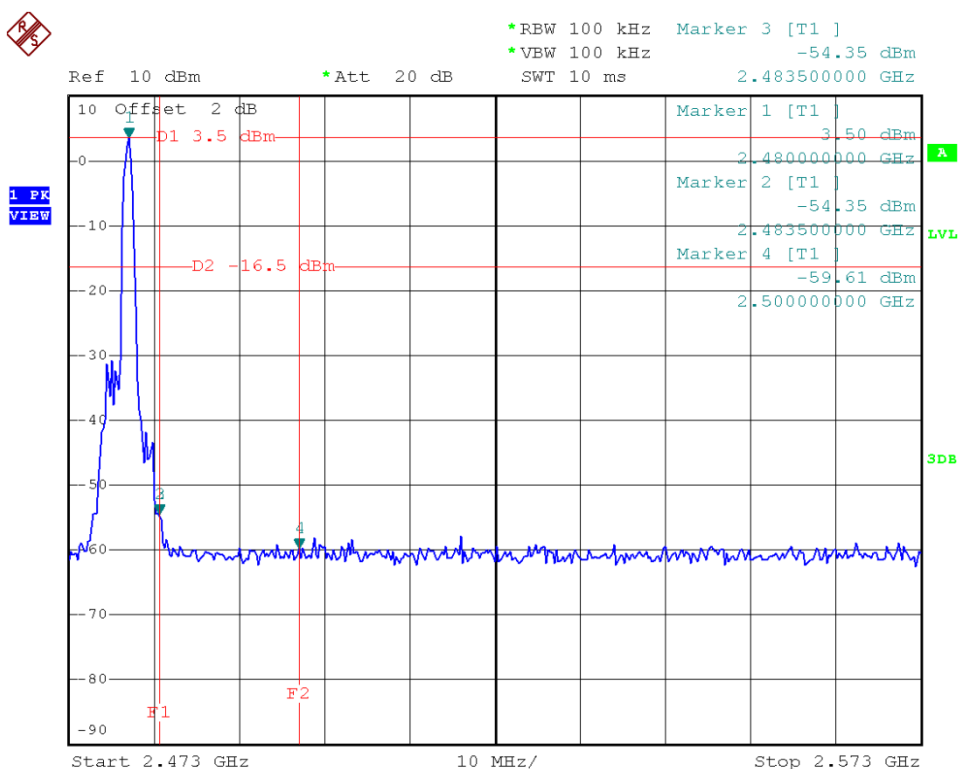
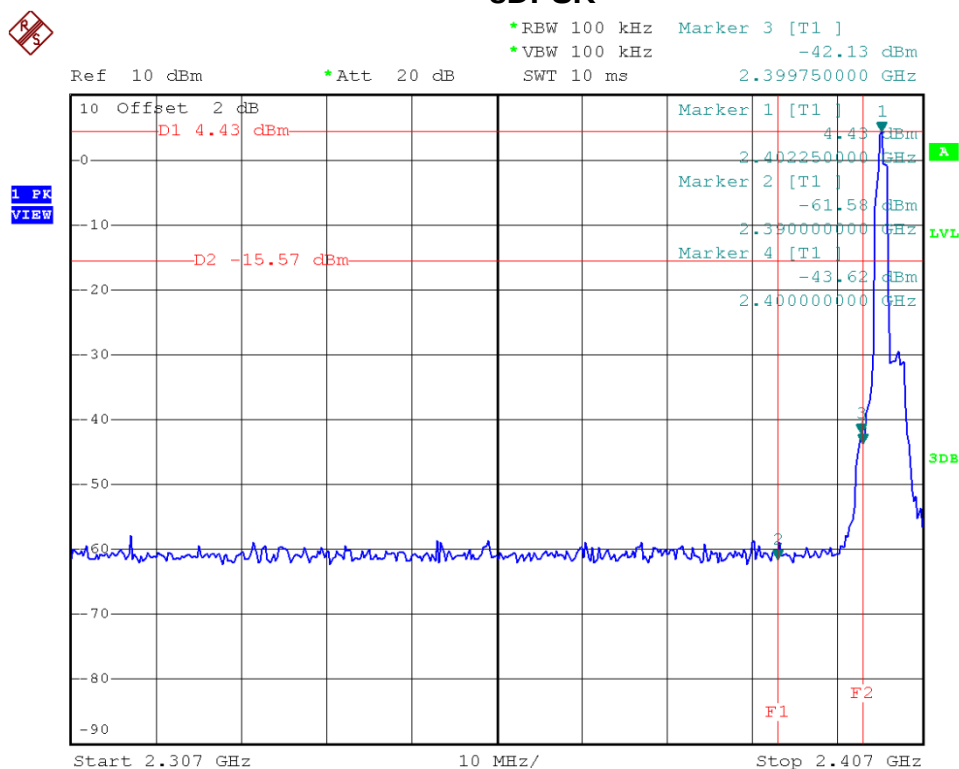
Test Method

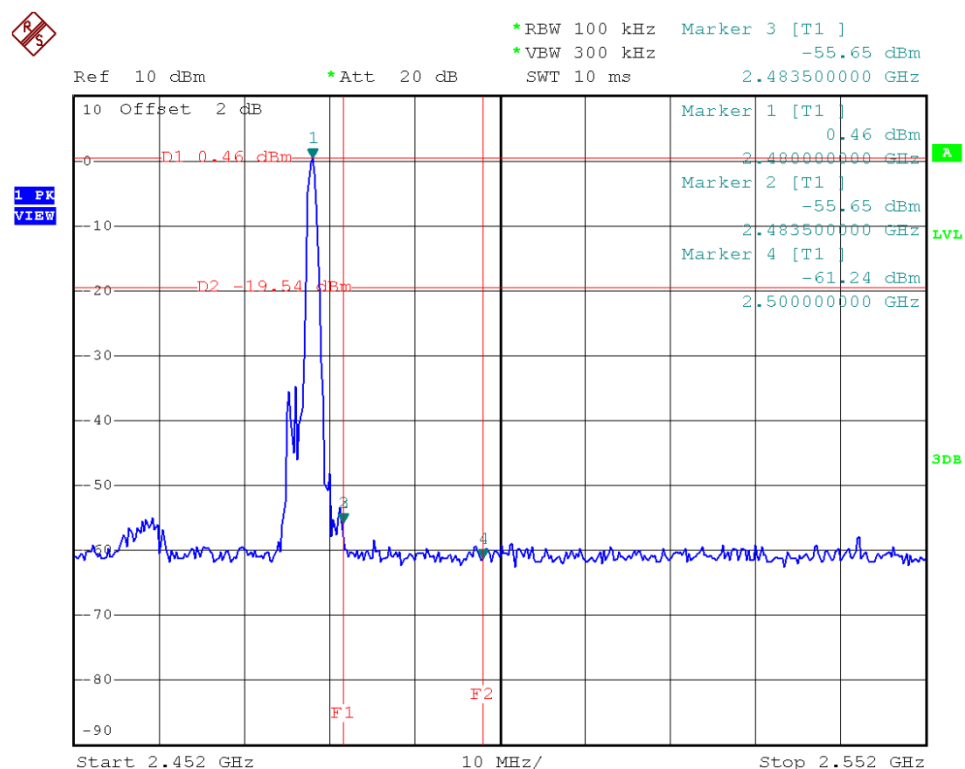
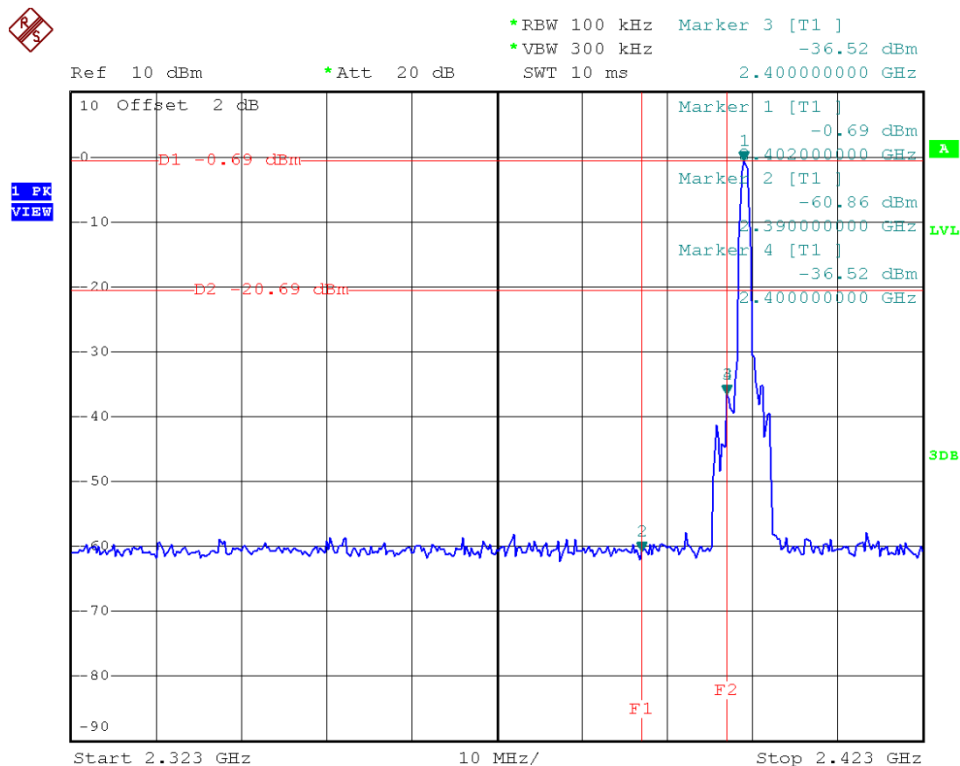
- 1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section. .
- 4 Repeat the test at the hopping off and hopping on mode, submit all the plots.

Limit:

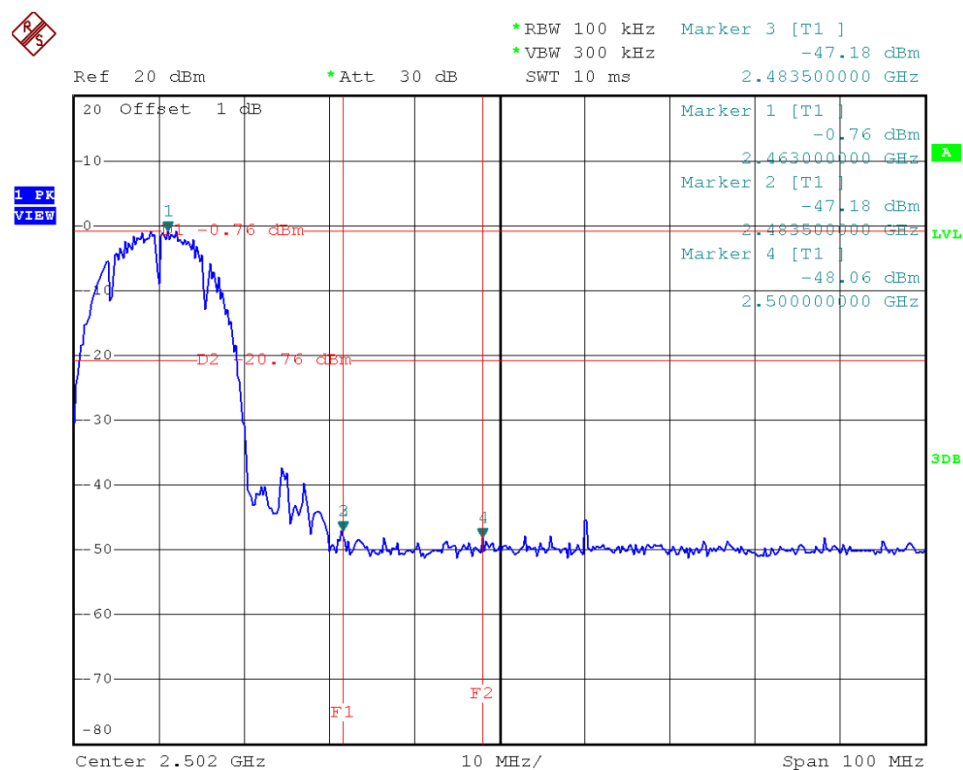
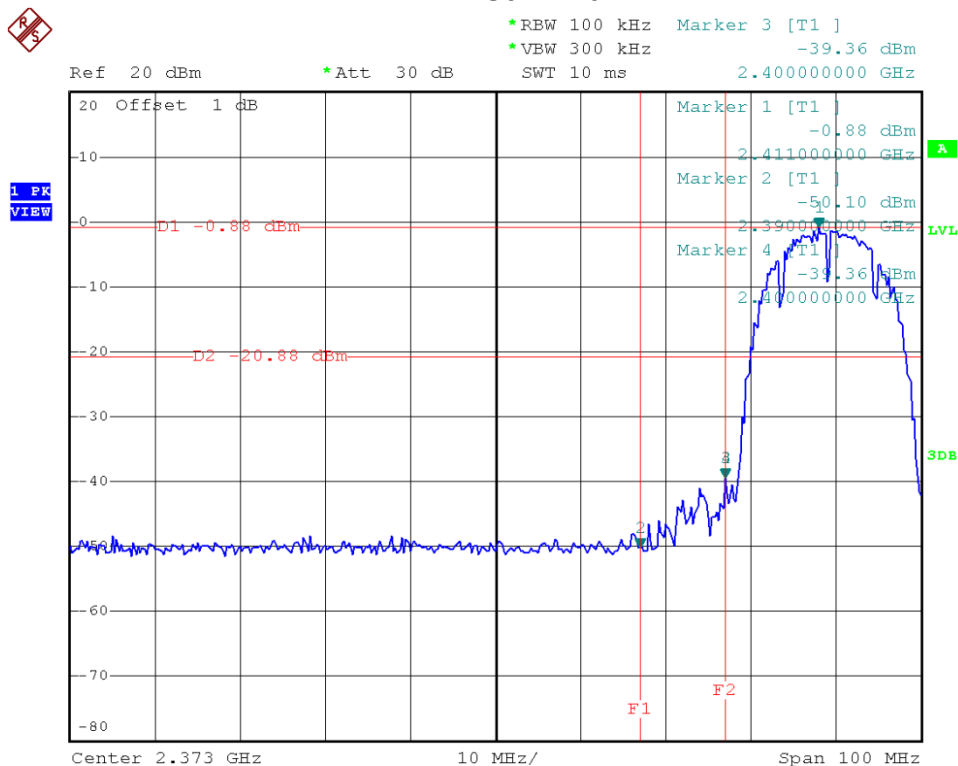
According to §15.247(d) and RSS-210 A8.5, in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen7.2.2, must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)) and RSS-Gen.

Band edge testing**BT GFSK**

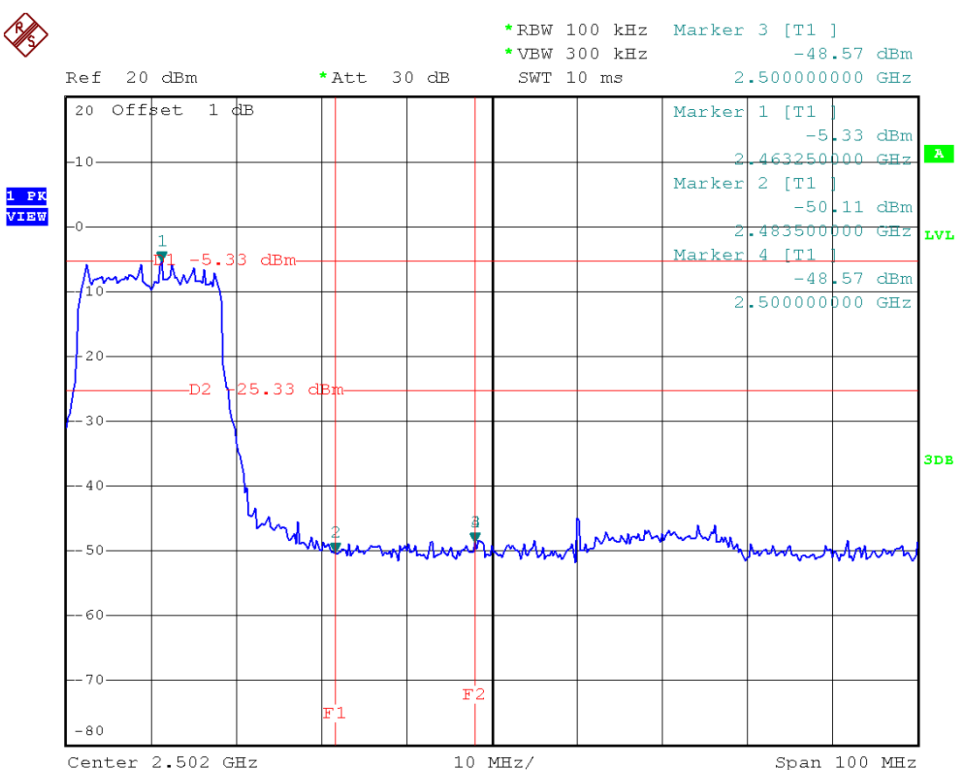
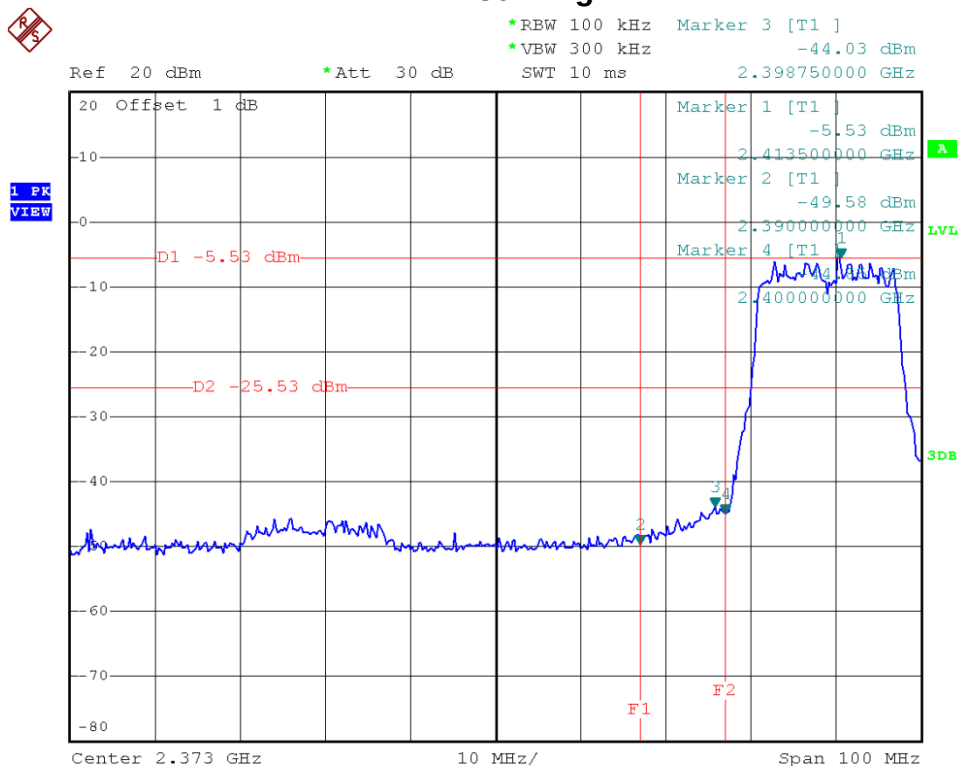
8DPSK

BLE

802.11b



802.11g



9.10 Spurious radiated emissions for transmitter and receiver

Test Method

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
3. Use the following spectrum analyzer settings:
Span = wide enough to fully capture the emission being measured, RBW = 1 MHz for $f \geq 1\text{GHz}$, 100 kHz for $f < 1\text{GHz}$, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Follow the guidelines in ANSI C63.4-2009 with respect to maximizing the emission by rotating the EUT, adjusting the measurement antenna height and polarization, etc.
The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, submit this data. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. 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 duty cycle 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 $20\log(\text{duty cycle}/100\text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

Limit

According to part 15.247(d), the radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Field Strength dBμV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

Spurious radiated emissions for transmitter and receiver

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

Only data of the worst case was reported.

Transmitting spurious emission test result as below:

BT GFSK - 2402MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBμV/m)	Detector	Antenna Polarity	Result
103.72	49.21	-15.64	33.57	43.5	QP	V	Pass
384.05	52.68	-10.88	41.8	46	QP	H	Pass
2390	26.24	33.35	59.59	74	PK	H	Pass
2390	15.81	33.35	49.16	54	AV	H	Pass
4804	78.58	-32.98	45.6	74	PK	H	Pass
4804	70.35	-32.98	37.37	54	AV	H	Pass
2390	26.55	33.35	59.9	74	PK	V	Pass
2390	15.84	33.35	49.19	54	AV	V	Pass
4804	82.54	-32.98	49.56	74	PK	V	Pass
4804	71.2	-32.98	38.22	54	AV	V	Pass

BT GFSK - 2441MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBμV/m)	Detector	Antenna Polarity	Result
288.02	54.95	-12.26	42.69	46	QP	H	Pass
103.72	51.06	-15.64	35.42	43.5	QP	V	Pass
4882	82.17	-32.95	49.22	74	PK	V	Pass
4882	70.84	-32.95	37.89	54	AV	V	Pass
4882	78.94	-32.95	45.99	74	PK	H	Pass
4882	69.96	-32.95	37.01	54	AV	H	Pass

BT GFSK - 2480MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBμV/m)	Detector	Antenna Polarity	Result
103.72	50.78	-15.64	35.14	43.5	QP	V	Pass
288.02	54.13	-12.26	41.87	46	QP	H	Pass
2483.5	28.71	33.37	62.08	74	PK	H	Pass
2483.5	16.75	33.37	50.12	54	AV	H	Pass
4960	79.18	-32.92	46.24	74	PK	H	Pass
4960	70.17	-32.92	37.25	54	AV	H	Pass
2483.5	28.39	33.37	61.76	74	PK	V	Pass
2483.5	16.42	33.37	49.79	54	AV	V	Pass
4960	82.94	-32.92	50.02	74	PK	V	Pass
4960	72.08	-32.92	39.16	54	AV	V	Pass

BLE - 2402MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
47.46	40.97	-13.09	27.88	40	QP	V	Pass
288.02	51.68	-12.26	39.42	46	QP	H	Pass
2390	26.09	33.35	59.44	74	PK	H	Pass
2390	15.74	33.35	49.09	54	AV	H	Pass
4804	79.10	-32.98	46.12	74	PK	H	Pass
4804	68.54	-32.98	35.56	54	AV	H	Pass
2390	27.04	33.35	60.39	74	PK	V	Pass
2390	15.73	33.35	49.08	54	AV	V	Pass
4804	83.16	-32.98	50.18	74	PK	V	Pass
4804	72.62	-32.98	39.64	54	AV	V	Pass

BLE - 2440MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
288.02	51.68	-12.26	39.42	46	QP	H	Pass
47.46	41.51	-13.09	28.42	40	QP	V	Pass
4880	82.05	-32.95	49.10	74	PK	V	Pass
4880	69.25	-32.95	36.30	54	AV	V	Pass
4880	79.07	-32.95	46.12	74	PK	H	Pass
4880	69.88	-32.95	36.93	54	AV	H	Pass

BLE - 2480MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
45.52	36.86	-12.82	24.04	40	QP	V	Pass
288.02	49.95	-12.26	37.69	46	QP	H	Pass
2483.5	28.41	33.37	61.78	74	PK	H	Pass
2483.5	17.01	33.37	50.38	54	AV	H	Pass
4960	76.08	-32.92	43.16	74	PK	H	Pass
4960	67.83	-32.92	34.91	54	AV	H	Pass
2483.5	28.10	33.37	61.47	74	PK	V	Pass
2483.5	17.00	33.37	50.37	54	AV	V	Pass
4960	82.05	-32.92	49.13	74	PK	V	Pass
4960	70.16	-32.92	37.24	54	AV	V	Pass

802.11b - 2412MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
45.52	37.45	-12.82	24.63	40	QP	V	Pass
288.02	49.79	-12.26	37.53	46	QP	H	Pass
2390	27.12	33.35	60.47	74	PK	H	Pass
2390	15.84	33.35	49.19	54	AV	H	Pass
4824	83.14	-32.97	50.17	74	PK	H	Pass
4824	70.65	-32.97	37.68	54	AV	H	Pass
2390	26.09	33.35	59.44	74	PK	V	Pass
2390	15.79	33.35	49.14	54	AV	V	Pass
4824	85.87	-32.97	52.90	74	PK	V	Pass
4824	72.43	-32.97	39.46	54	AV	V	Pass

802.11b - 2437MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
384.05	47.21	-10.88	36.33	46	QP	H	Pass
45.52	35.41	-12.82	22.59	40	QP	V	Pass
4874	84.25	-32.95	51.30	74	PK	V	Pass
4874	71.07	-32.95	38.12	54	AV	V	Pass
4874	85.64	-32.95	52.69	74	PK	H	Pass
4874	73.72	-32.95	40.77	54	AV	H	Pass

802.11b - 2462MHz Test Result

Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Detector	Antenna Polarity	Result
45.52	34.98	-12.82	22.16	40	QP	V	Pass
288.02	49.94	-12.26	37.68	46	QP	H	Pass
2483.5	23.56	33.37	55.57	74	PK	H	Pass
2483.5	13.73	33.37	45.74	54	AV	H	Pass
4924	83.22	-32.93	50.29	74	PK	H	Pass
4924	71.42	-32.93	38.49	54	AV	H	Pass
2483.5	29.41	33.37	61.42	74	PK	V	Pass
2483.5	13.72	33.37	45.73	54	AV	V	Pass
4924	84.12	-32.93	51.19	74	PK	V	Pass
4924	71.13	-32.93	38.20	54	AV	V	Pass

Remark:

- (1) QP Emission Level= Antenna Factor +Cable Loss + Reading
 PK Emission Level= Antenna Factor +Cable Loss - Amp. factor + Reading
 AV Emission Level= PK Emission Level+20log(dutycycle)
- (2) Data of measurement within this frequency range shown “-” in the table above means the reading of emissions are attenuated more than 20db below the permissible limits or the field strength is too small to be measured.
- (3) “*” means the emission(s) appear within the restrict bands shall follow the requirement of section 15.205.

Receiving emission test result as below:

Frequency (MHz)	Reading (dBUV)	Correct Factor (dB)	Emission Level (dBUV/m)	Limit (dBμV/m)	Detector	Antenna Polarity	Result
47.46	40.97	-13.09	27.88	40	QP	V	Pass
103.72	46.41	-15.64	30.77	43.5	QP	V	Pass
45.52	34.92	-12.82	22.10	40	QP	H	Pass
384.05	46.94	-10.88	36.06	46	QP	H	Pass
1000-25000	--	--	--	74	AV	H	Pass
1000-25000	--	--	--	74	PK	V	Pass

Remark:

- (1) QP Emission Level= Antenna Factor +Cable Loss + Reading
 PK Emission Level= Antenna Factor +Cable Loss - Amp. factor + Reading
 AV Emission Level= PK Emission Level+20log (duty cycle)
- (2) Data of measurement within this frequency range shown "--" in the table above means the reading of emissions are the noise floor or attenuated more than 20db below the permissible limits or the field strength is too small to be measured.
- (3) "*" means the emission(s) appear within the restrict bands shall follow the requirement of section RSS-Gen.

9.11 Power Spectral Density

Test Method

5. 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 = 3 kHz, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold
6. Allow the trace to stabilize. Set the marker on the peak of the maximum emission recorded.
7. The level displayed must comply with the limit specified in this Section. Submit these plots.
8. Repeat above procedures until all frequencies measured were complete.

Limit

Limit
PSD

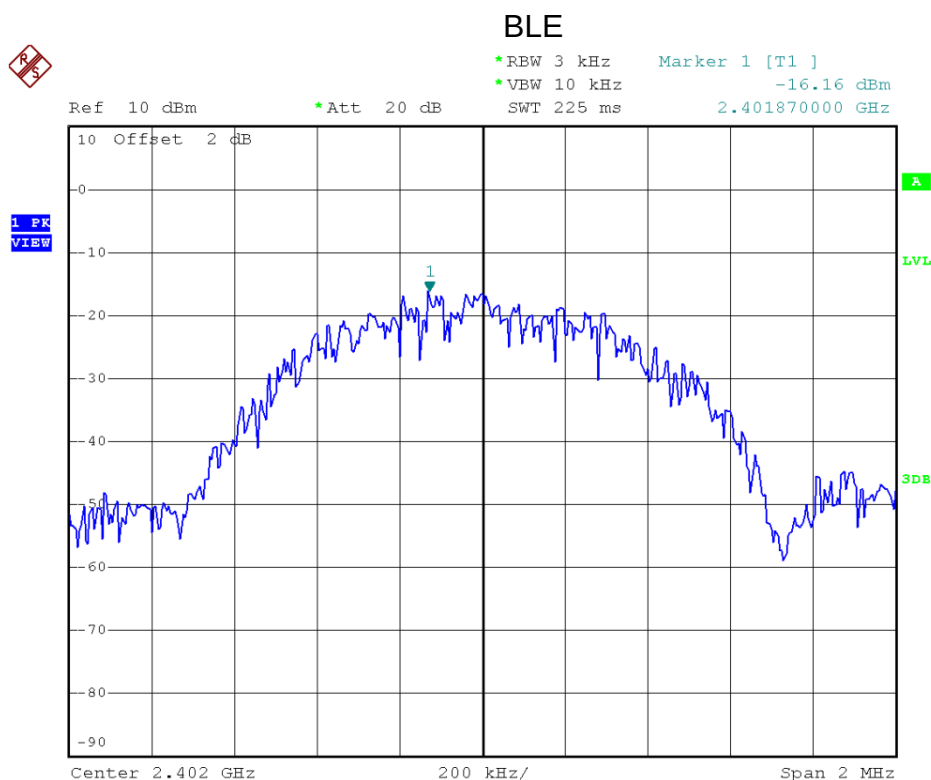
≤ 8dBm/3KHz

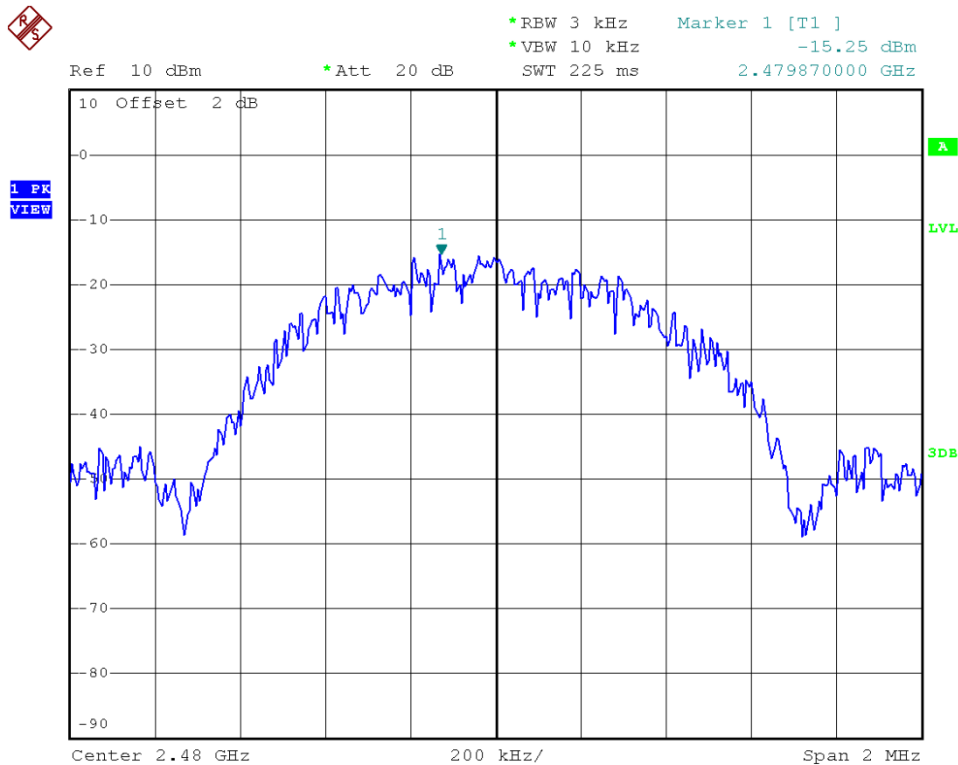
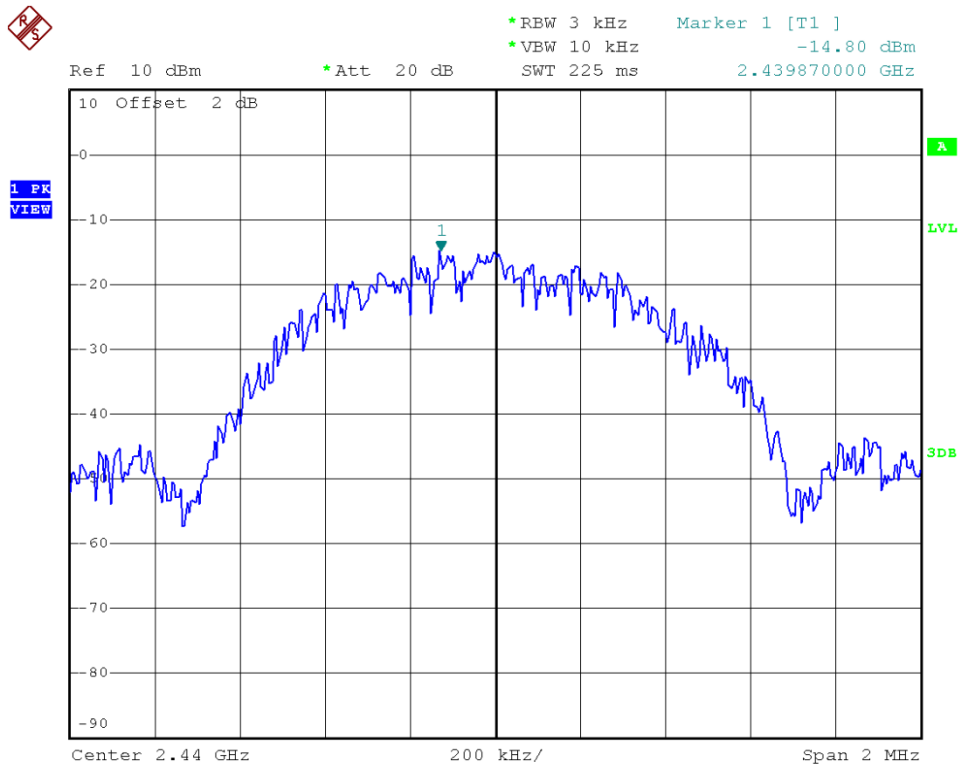
Power spectral density

Test result:

Frequency (MHz)	Mode	Measurement (dBm/3KHz)	Limit	Result
2402	BLE	-16.16	$\leq 8\text{dBm/3KHz}$	Pass
2440		-14.80		Pass
2480		-15.25		Pass
2412	802.11b	-15.10		Pass
2437		-14.31		Pass
2462		-14.14		Pass
2412	802.11g	-20.34		Pass
2437		-20.01		Pass
2462		-20.09		Pass

Plots:

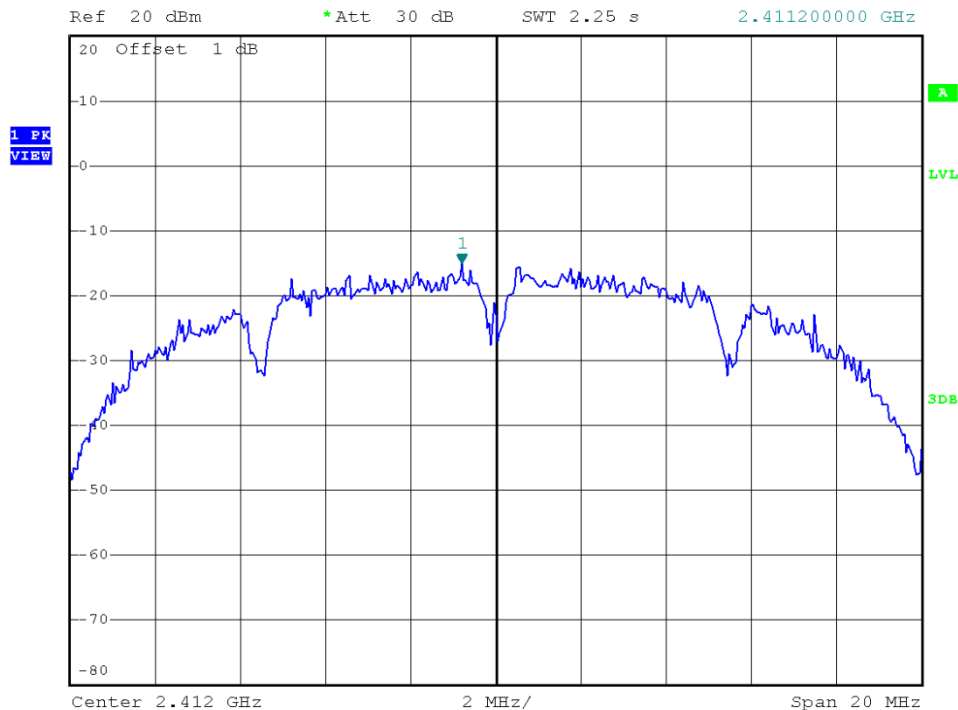




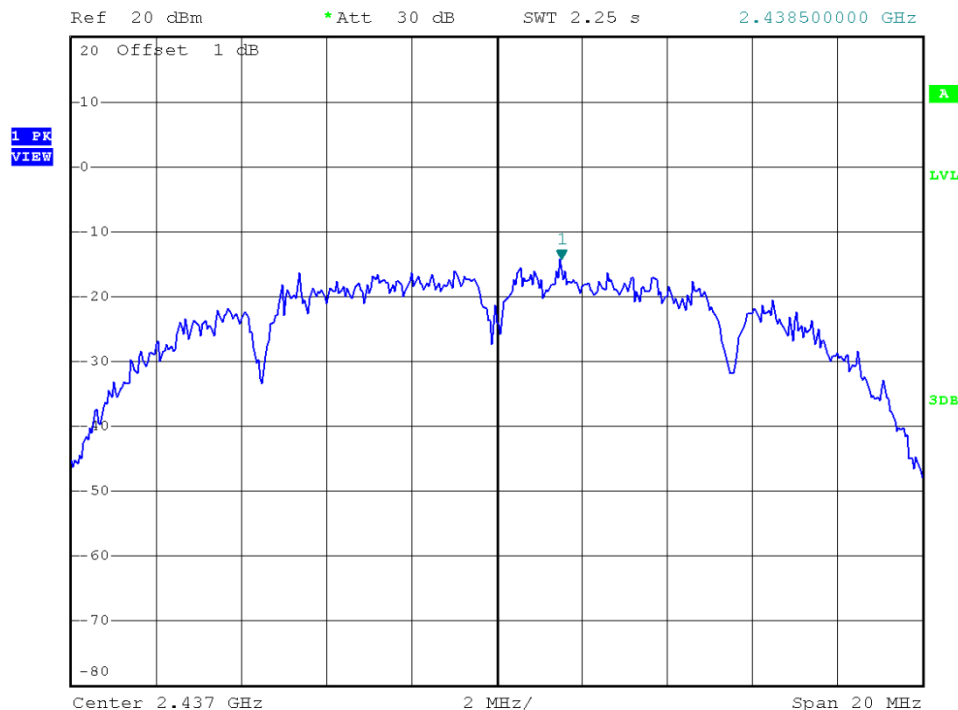
802.11b

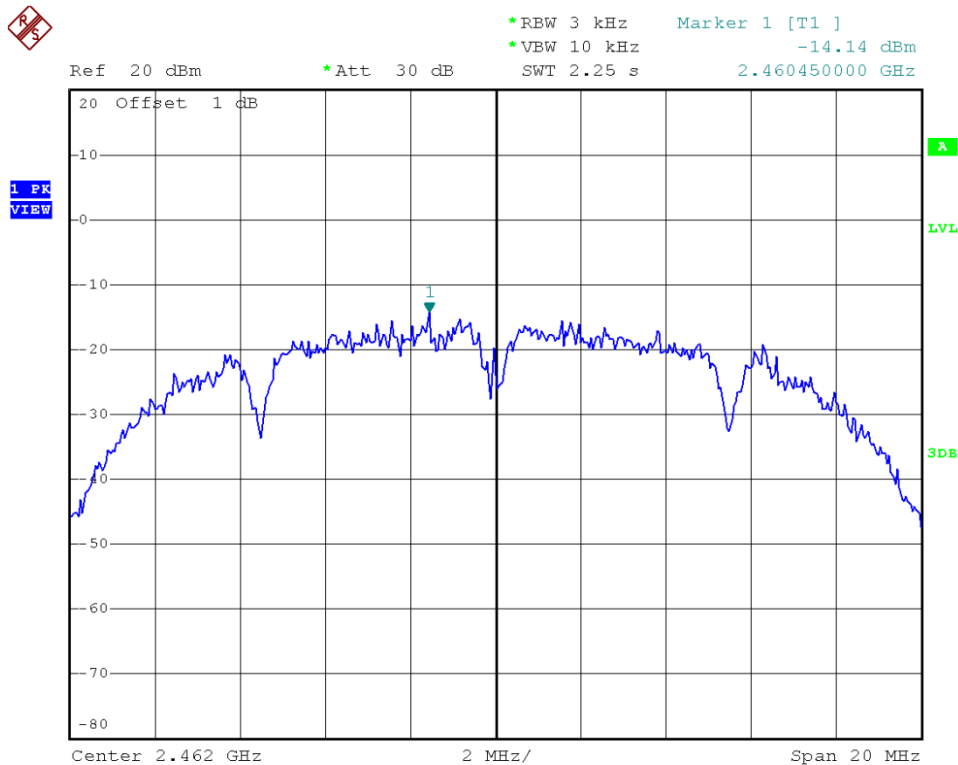


*RBW 3 kHz Marker 1 [T1]
*VBW 10 kHz -15.10 dBm
SWT 2.25 s 2.411200000 GHz

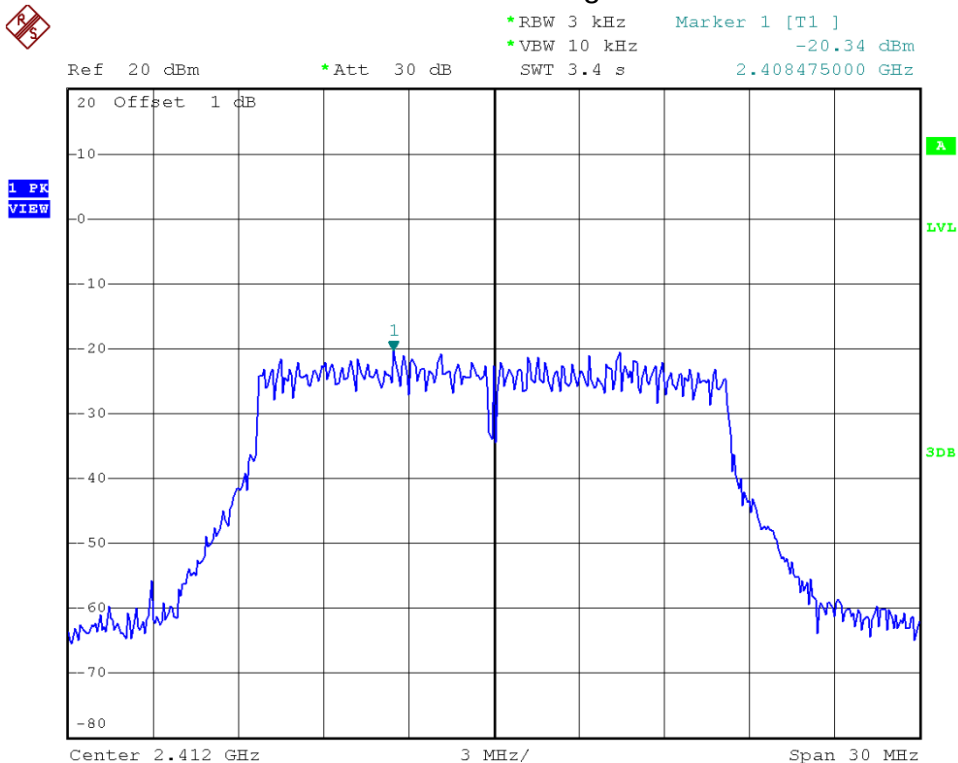


*RBW 3 kHz Marker 1 [T1]
*VBW 10 kHz -14.31 dBm
SWT 2.25 s 2.438500000 GHz



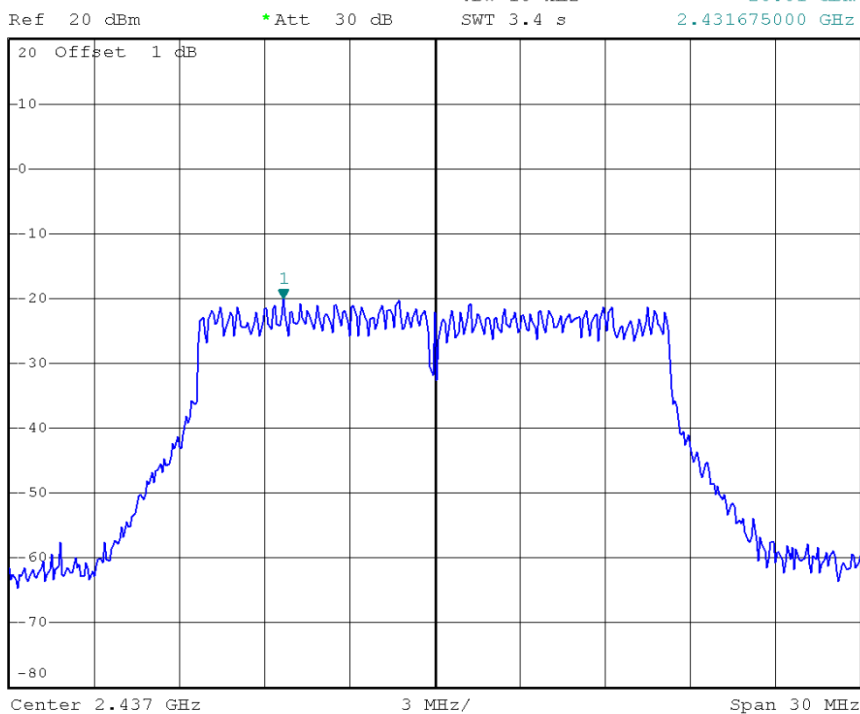


802.11g

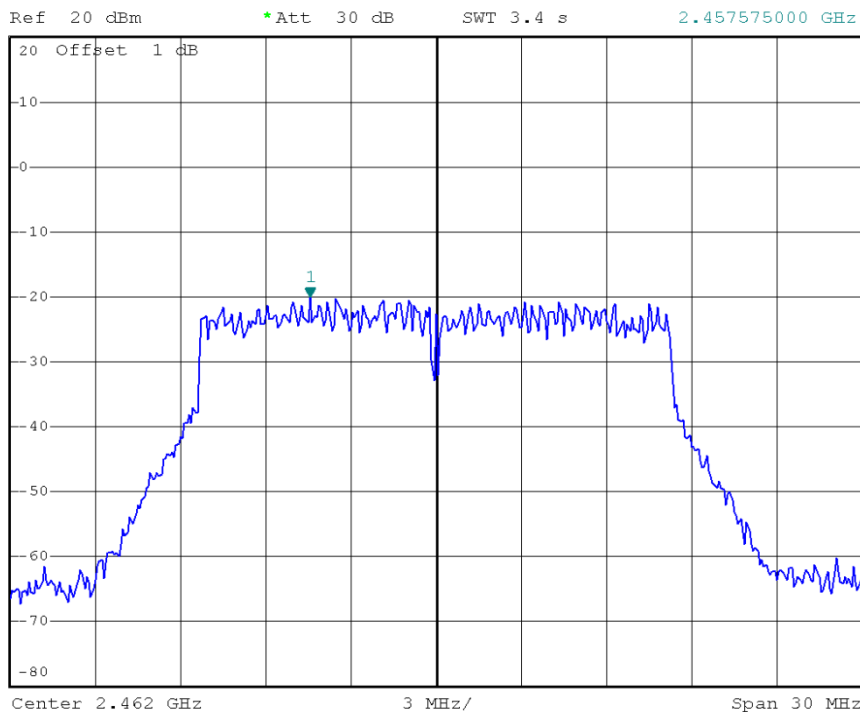




*RBW 3 kHz Marker 1 [T1]
*VBW 10 kHz -20.01 dBm
SWT 3.4 s 2.431675000 GHz



*RBW 3 kHz Marker 1 [T1]
*VBW 10 kHz -20.09 dBm
SWT 3.4 s 2.457575000 GHz





China

10 Test Equipment List

List of Test Instruments

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE	
CE	LISN	EMCO	3816/2	00052765	Mar. 29, 2015	☐
	LISN	R&S	ENV216	101447	Mar. 29, 2015	☒
	Test Cable	N/A	C_17	N/A	Mar. 14, 2015	☒
	EMI TEST RECEIVER	R&S	ESCS30	833364/017	Mar. 29, 2015	☒
	50Ω Terminator	SHX	TF2-3G-A	08122902	Mar. 29, 2015	☒
C	Spectrum Analyzer	R&S	FSP 40	100185	Nov. 11, 2014	☒
RE < 1 GHz	Antenna	Schwarbeck	VULB9160	9160-3232	Mar. 29, 2015	☒
	Amplifier	HP	8447D	2944A09673	Mar. 29, 2015	☒
	Receiver	AGILENT	N9038A	MY52130039	Aug. 23, 2015	☒
	Test Cable	N/A	C-01_CB03	N/A	Jul. 01, 2015	☒
	Controller	CT	SC100	N/A	N/A	☒
RE > 1 GHz	Antenna	ETS	3115	00075789	Mar. 29, 2015	☒
	Amplifier	Agilent	8449B	3008A02274	Mar. 29, 2015	☒
	Receiver	AGILENT	N9038A	MY52130039	Aug. 23, 2015	☒
	Test Cable	HUBER+SUHNER	C-48	N/A	Apr. 30, 2015	☒
	Controller	CT	SC100	N/A	N/A	☒
	Broad-Band Horn Antenna	Schwarzbeck	BBHA 9170	9170319	Feb. 22, 2015	☐
	Microwave Preamplifier With Adaptor	EMC INSTRUMENT	EMC26540 45	980039 & HA01	Feb. 22, 2015	☐
	Active Loop Antenna	R&S	HFH2-Z2	830749/020	Mar. 29, 2015	☐

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth
- 20dB bandwidth and 99% Occupied Bandwidth
- Carrier frequency separation
- Number of hopping frequencies
- Dwell Time
- Power spectral density*
- Spurious RF conducted emissions
- Band edge

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty

Items	Extended Uncertainty
Radiated spurious emission	4.32dB (30MHz-1GHz) 2.27dB (1GHz -25GHz)
Conducted spurious emission	2.10dB(30MHz-25GHz)
Bandwidth test	1×10^{-9}
Conducted emission	2.4dB

-- End of Report --