



FCC/IC - TEST REPORT

Report Number	: 68.920.16.008.01	Date of Issue: <u>March 21, 2016</u>
Model	: R40X	
Product Type	: Bluetooth Speaker	
Applicant	: Shenzhen Difung Energy Technology Co., Ltd.	
Address	: 6F B of Dayou trade industrial Building, Tongfuyu Industrial Area, No.41, Shenzhen, Guangdong Province 518103, China	
Production Facility	: Shenzhen Difung Energy Technology Co., Ltd.	
Address	: 6F B of Dayou trade industrial Building, Tongfuyu Industrial Area, No.41, Shenzhen, Guangdong Province 518103, China	
Test Result	: <input checked="" type="checkbox"/> Positive <input type="checkbox"/> Negative	
Total pages including Appendices	: <u>41</u>	

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2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12&13, Zhiheng Wisdomland Business Park,
Nantou Checkpoint Road 2, Nanshan District,
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Telephone: 86 755 8828 6998
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FCC Registration No.: 502708
No.:

3 Description of the Equipment Under Test

Product: Bluetooth Speaker

Model no.: R40X

FCC ID: 2AHDH-R40X

Options and accessories: NIL

Rating: 3.7VDC, 1600mAh
(Supplied by the internal Li-ion rechargeable battery)
5VDC,1000mA (Charged by USB Port)

RF Transmission Frequency: 2402MHz-2480MHz

No. of Operated Channel: 79

Modulation: GFSK, $\pi/4$ -DQPSK, 8-DPSK

Antenna Type: PCB Antenna

Antenna Gain: 0dBi

Description of the EUT: The Equipment Under Test (EUT) is a Bluetooth Speaker operated at 2.4GHz

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2015 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

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 and C63.10 (2014).

5 Summary of Test Results

Technical Requirements			
FCC Part 15 Subpart C			
Test Condition		Pages	Test Result
§15.207	Conducted emission AC power port	10	Pass
§15.247(b)(1)	Conducted peak output power	13	Pass
§15.247(e)	Power spectral density*	--	N/A
§15.247(a)(2)	6dB bandwidth	--	N/A
§15.247(a)(1)	20dB bandwidth and 99% Occupied Bandwidth	15	Pass
§15.247(a)(1)	Carrier frequency separation	22	Pass
§15.247(a)(1)(iii)	Number of hopping frequencies	25	Pass
§15.247(a)(1)(iii)	Dwell Time	27	Pass
§15.247(d)	Spurious RF conducted emissions	30	Pass
§15.247(d)	Band edge	34	Pass
§15.247(d) & §15.209 &	Spurious radiated emissions for transmitter and receiver	37	Pass
§15.203	Antenna requirement	See note 2	Pass

Note 1: N/A=Not Applicable.

Note 2: The EUT uses a pcb antenna, which gain is 0dBi. 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: 2AHDH-R40X complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C,

This report is for the Bluetooth 2.1 + EDR part.

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.

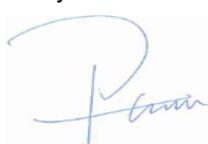
Sample Received Date: January 11, 2016

Testing Start Date: January 11, 2016

Testing End Date: January 26, 2016

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

Reviewed by:



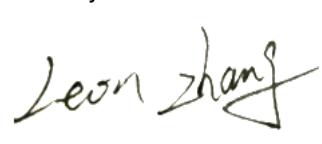
Phoebe Hu
EMC Project Manager

Prepared by:



Aaron Lai
EMC Project Engineer

Tested by:

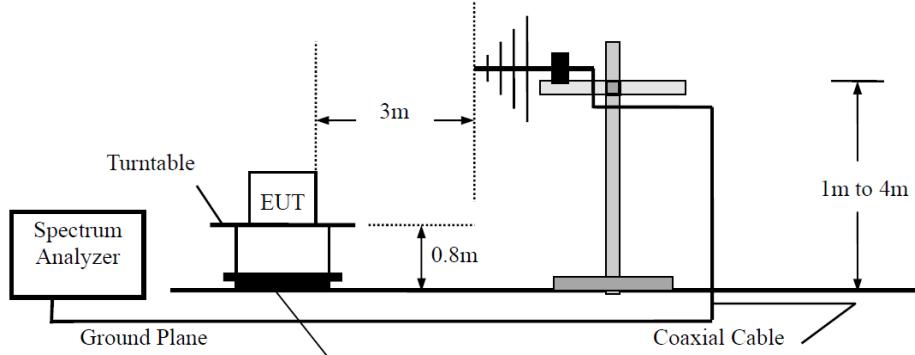


Leon Zhang
EMC Test Engineer

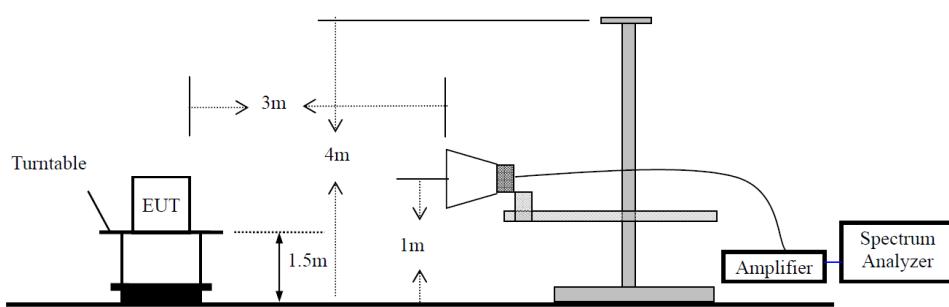
7 Test Setups

7.1 Radiated test setups

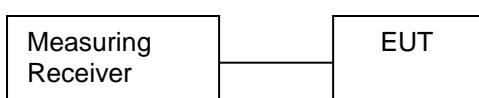
Below 1GHz



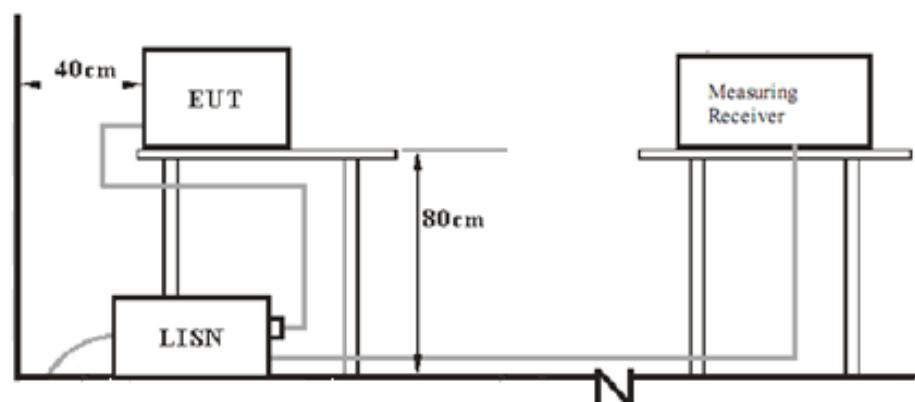
Above 1GHz



7.2 Conducted RF test setups



7.3 AC Power Line Conducted Emission test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

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

Test software: Blue test 3.0, which 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

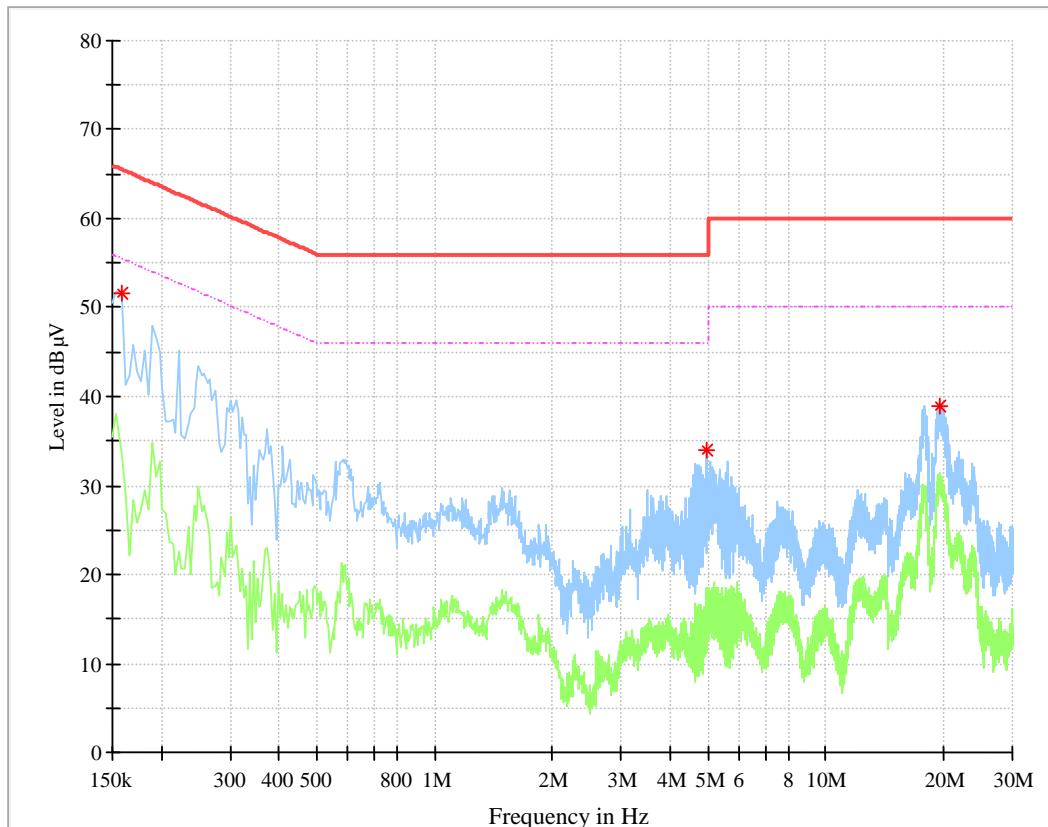
1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of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

Limit

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

Conducted Emission

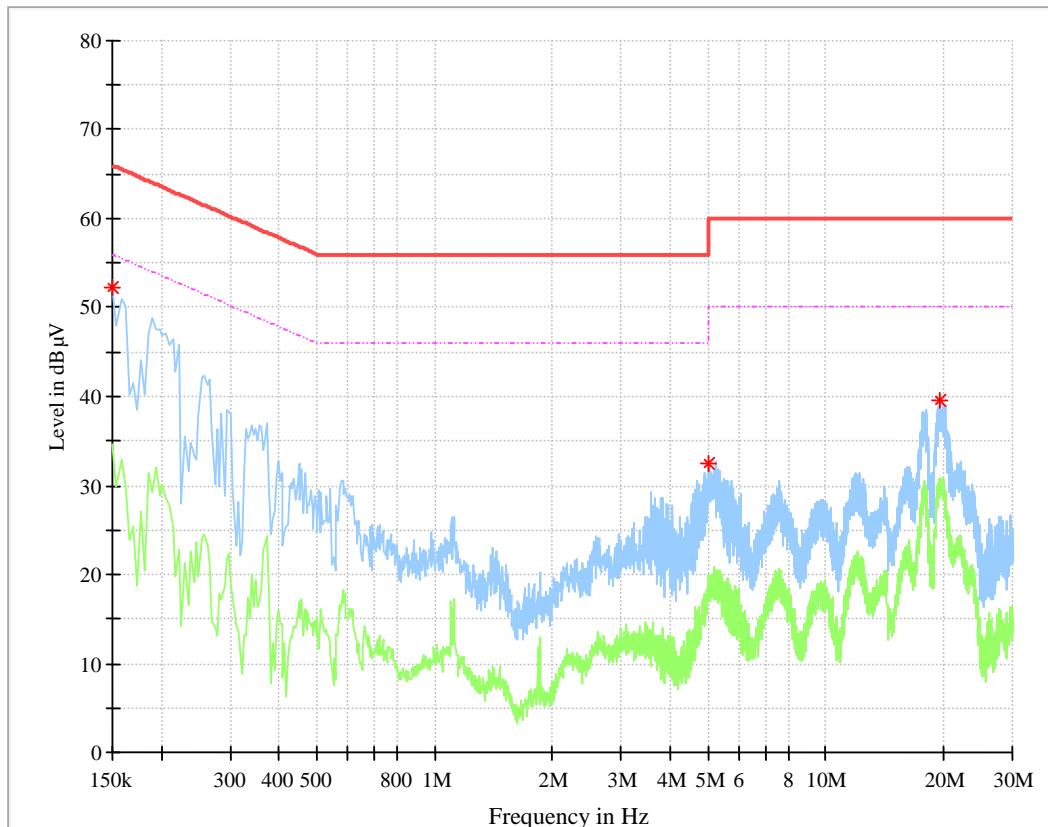
Product Type : Bluetooth Speaker
 M/N : R40X
 Operating Condition : Charging & TX
 Test Specification : Live
 Comment : AC 120V/60Hz



Frequency (MHz)	MaxPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Line
0.158000	51.71	---	65.57	13.86	L1
4.974000	33.90	---	56.00	22.10	L1
19.626000	39.01	---	60.00	20.99	L1

Conducted Emission

Product Type : Bluetooth Speaker
 M/N : R40X
 Operating Condition : Charging & TX
 Test Specification : Neutral
 Comment : AC 120V/60Hz



Frequency (MHz)	MaxPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Line
0.150000	52.29	---	66.00	13.71	N
5.038000	32.46	---	60.00	27.54	N
19.594000	39.52	---	60.00	20.48	N

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, $VBW \geq RBW$,
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

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

Conducted peak output power

GFSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	1.70	Pass
Middle channel 2441MHz	1.70	Pass
High channel 2480MHz	0.82	Pass

$\pi/4$ -DQPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	2.40	Pass
Middle channel 2441MHz	1.79	Pass
High channel 2480MHz	0.89	Pass

8DPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	2.39	Pass
Middle channel 2441MHz	1.30	Pass
High channel 2480MHz	2.34	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

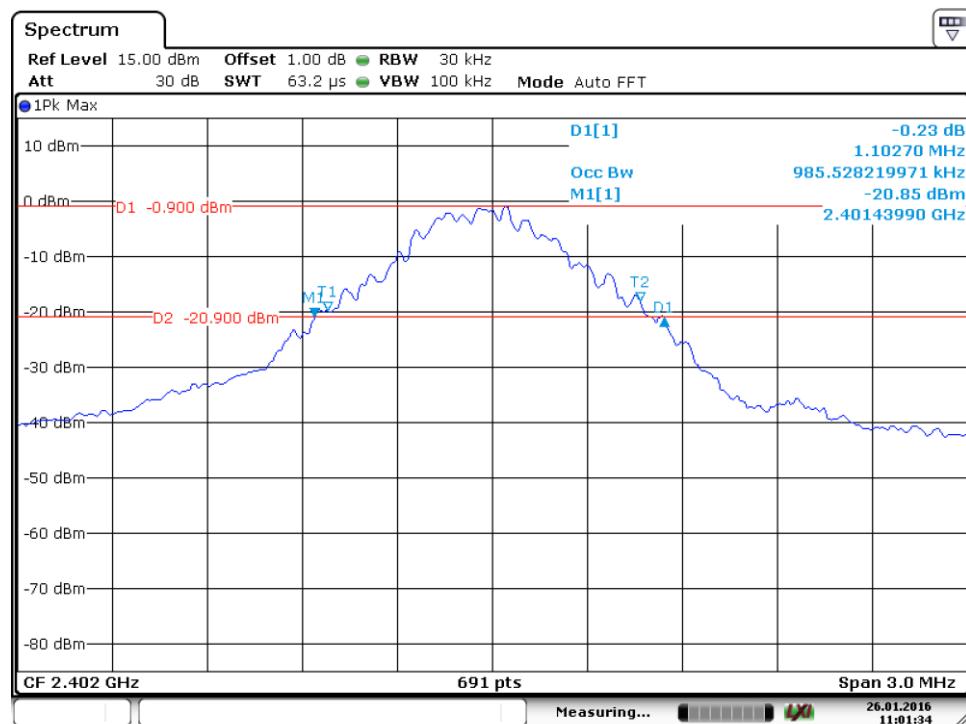
Limit [kHz]

N/A

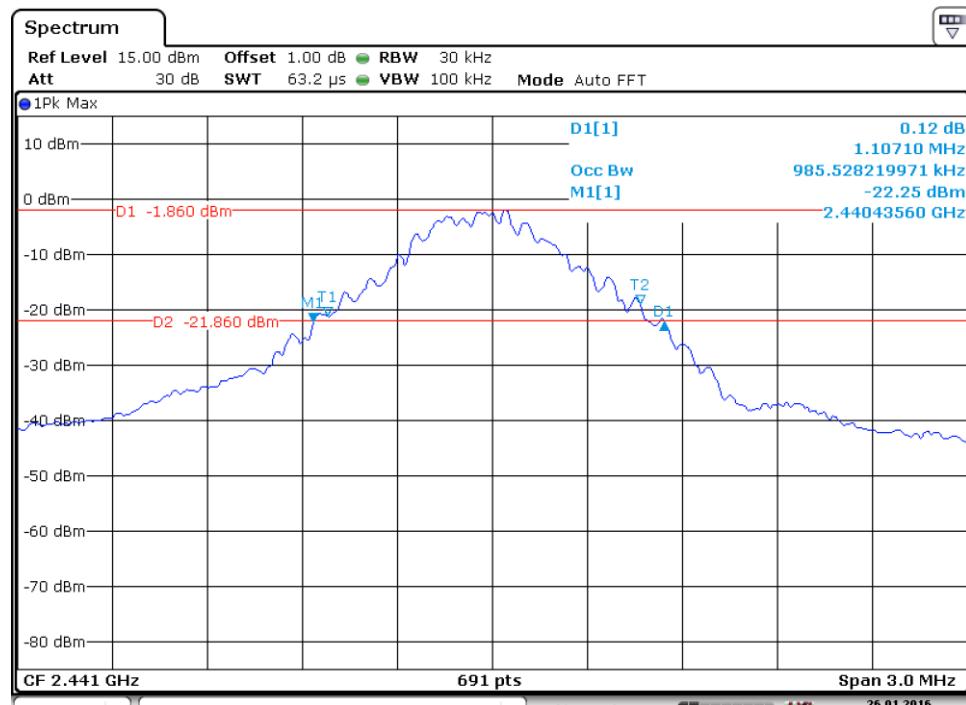
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode GFSK Modulation test result

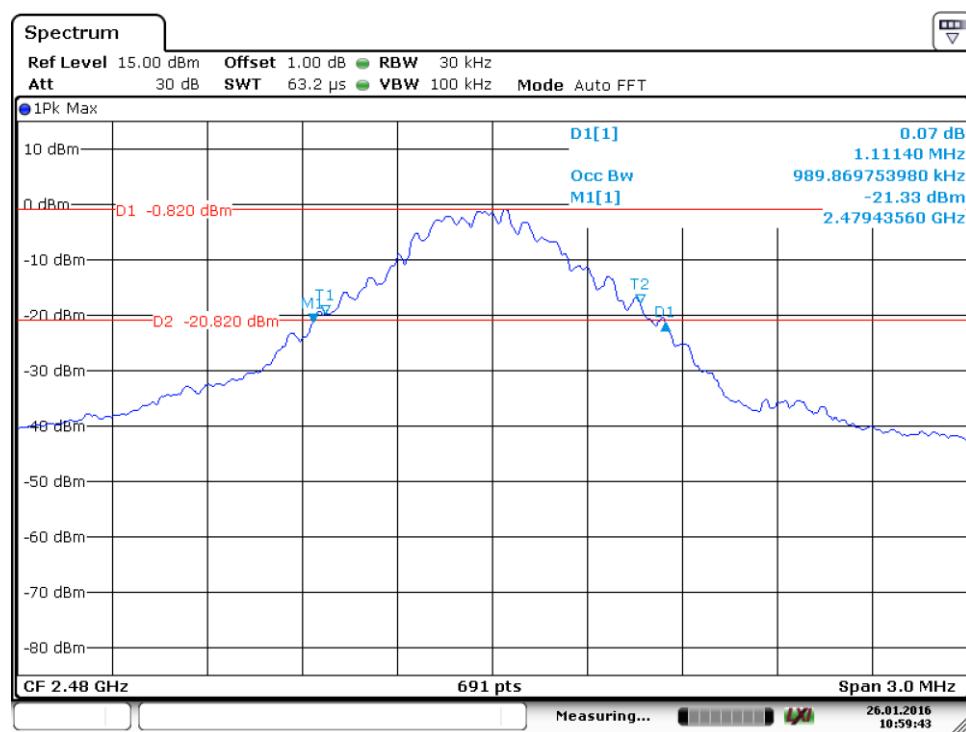
Frequency MHz	20 dB Bandwidth kHz	99% Bandwidth kHz	Limit kHz	Result
2402	1102.7	985.528	--	Pass
2441	1107.1	985.528	--	Pass
2480	1111.4	989.870	--	Pass



2402MHz



2441MHz



2480MHz

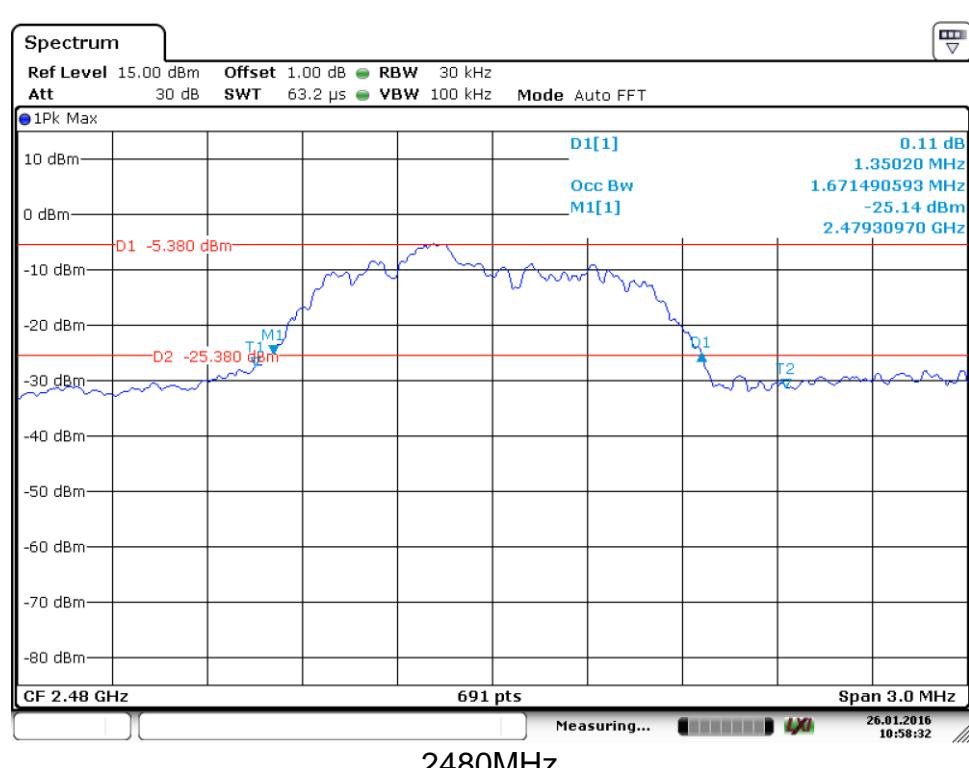
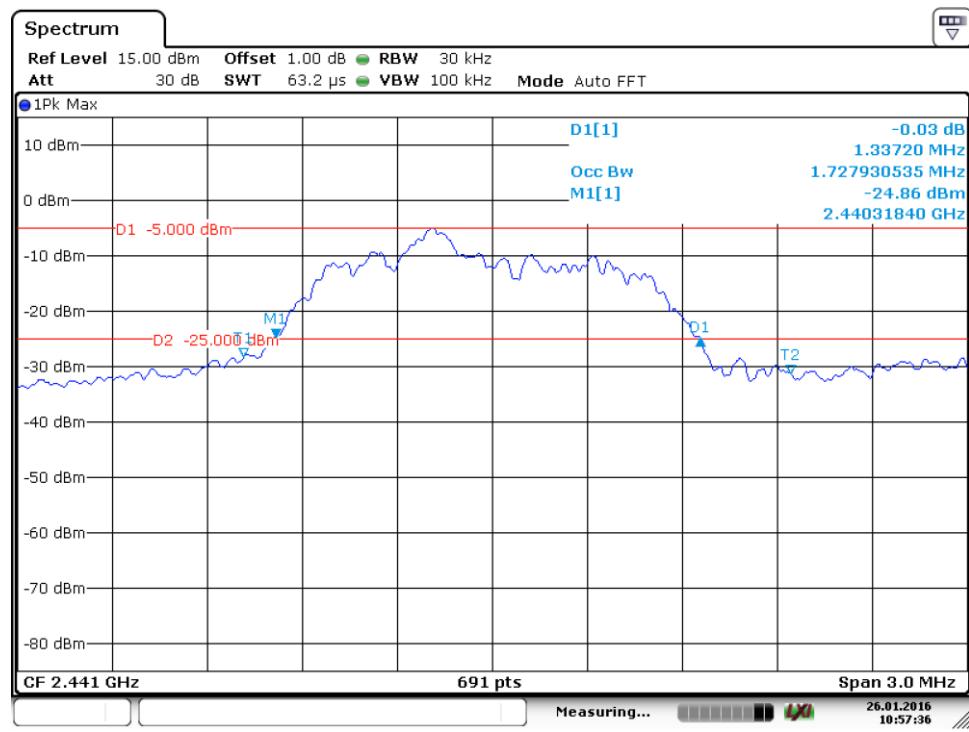
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode $\pi/4$ -DQPSK Modulation test result

Frequency MHz	20 dB Bandwidth kHz	99% Bandwidth kHz	Limit kHz	Result
2402	1354.6	1701.881	--	Pass
2441	1337.2	1727.931	--	Pass
2480	1350.2	1671.491	--	Pass



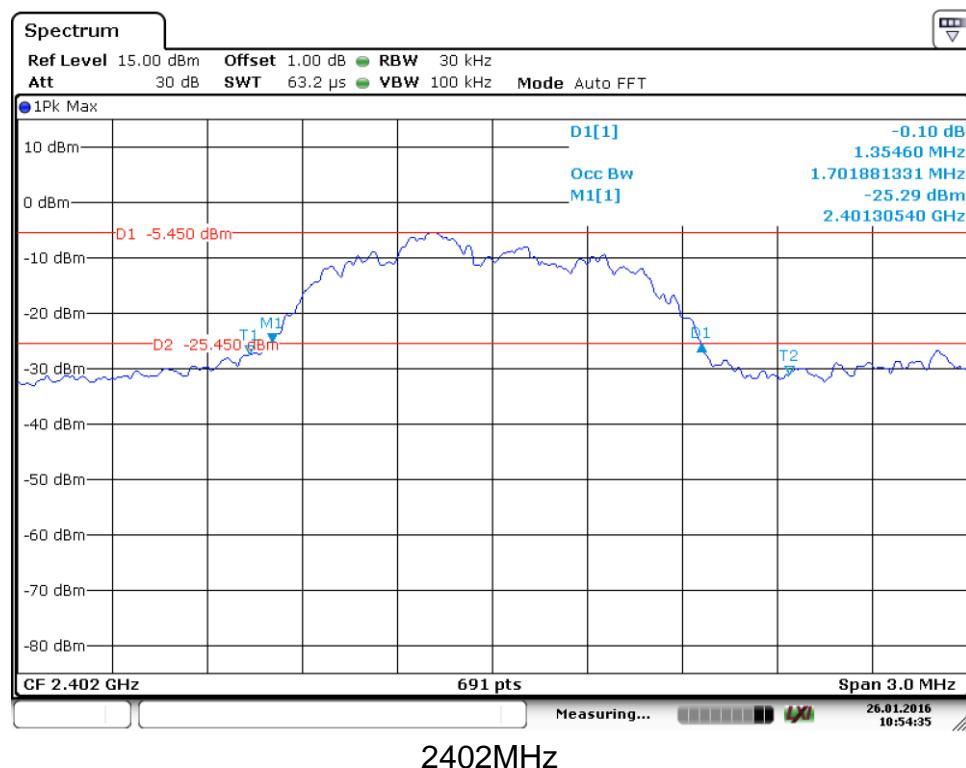
2402MHz



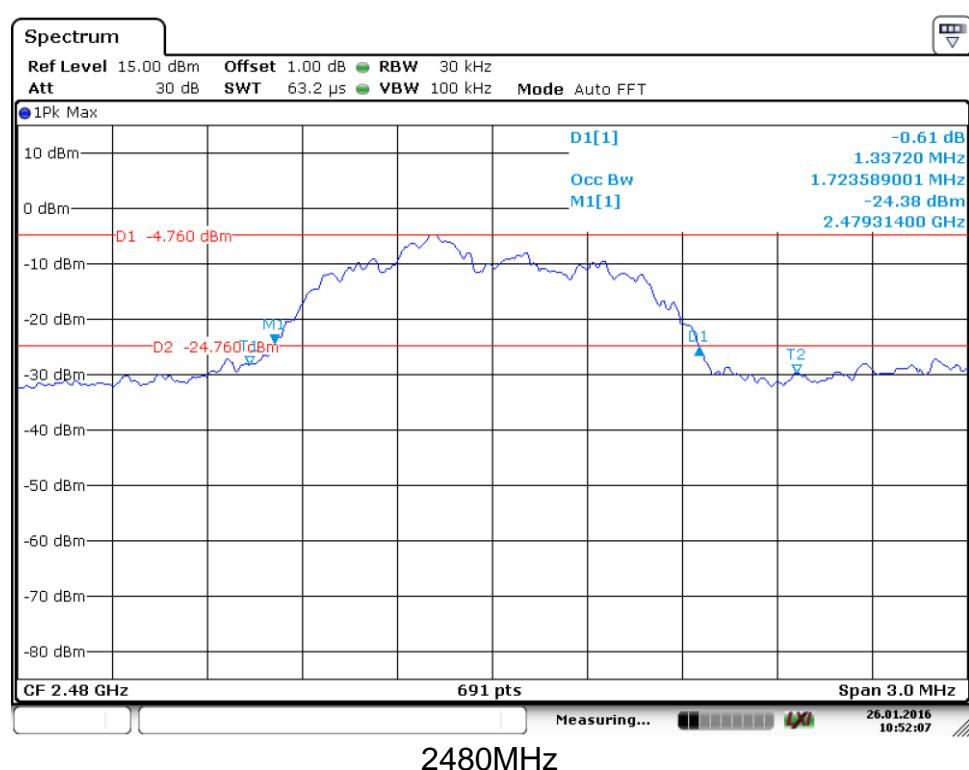
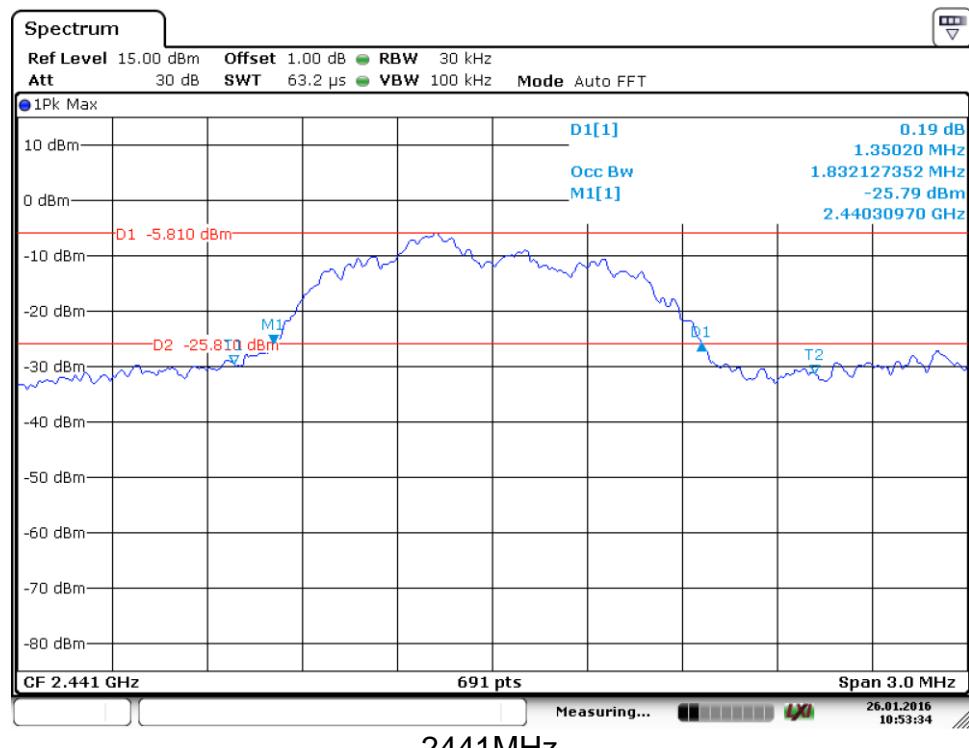
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode 8DPSK Modulation test result

Frequency MHz	20 dB Bandwidth kHz	99% Bandwidth kHz	Limit kHz	Result
2402	1354.6	1701.881	--	Pass
2441	1350.2	1832.127	--	Pass
2480	1337.2	1723.589	--	Pass



2402MHz



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

GFSK Modulation Limit

Frequency MHz	2/3 of 20 dB Bandwidth kHz
2402	735.13
2441	738.06
2480	740.93

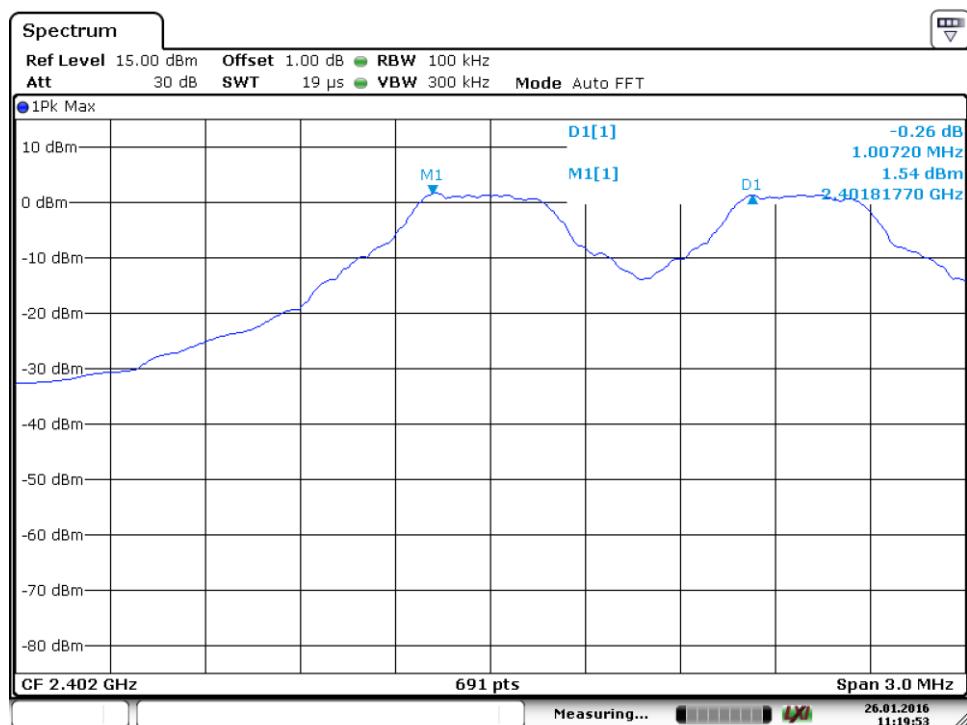
Carrier Frequency Separation

Test result: The measurement was performed with the typical configuration (normal hopping status), here GFSK modulation mode was used to show compliance.

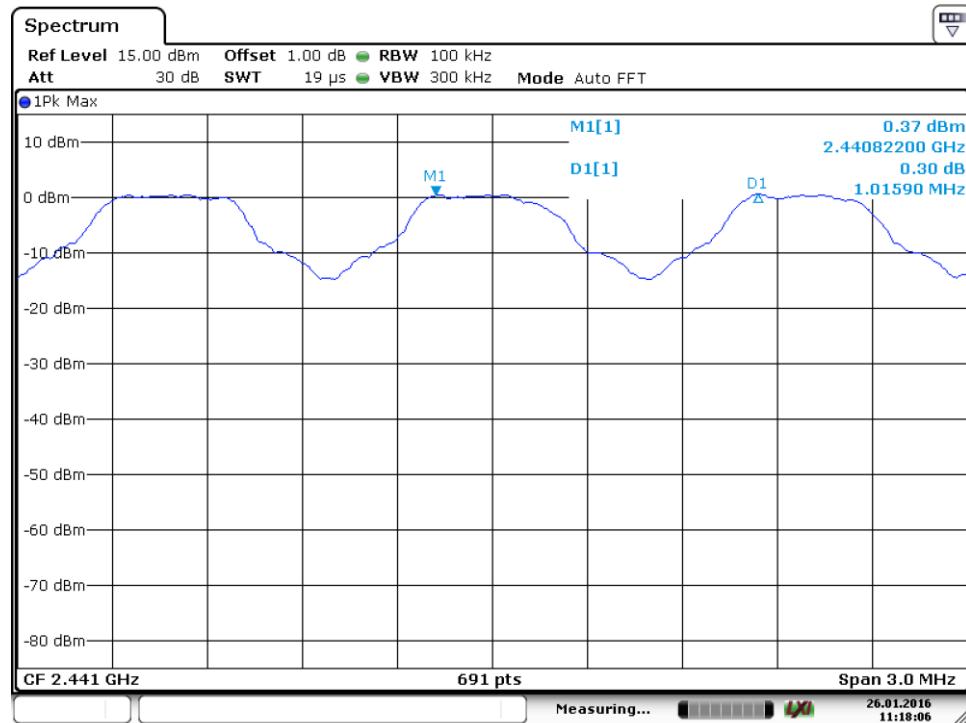
GFSK Modulation test result

Frequency MHz	Carrier Frequency Separation kHz	Result
2402	1007.2	Pass
2441	1015.9	Pass
2480	1000.0	Pass

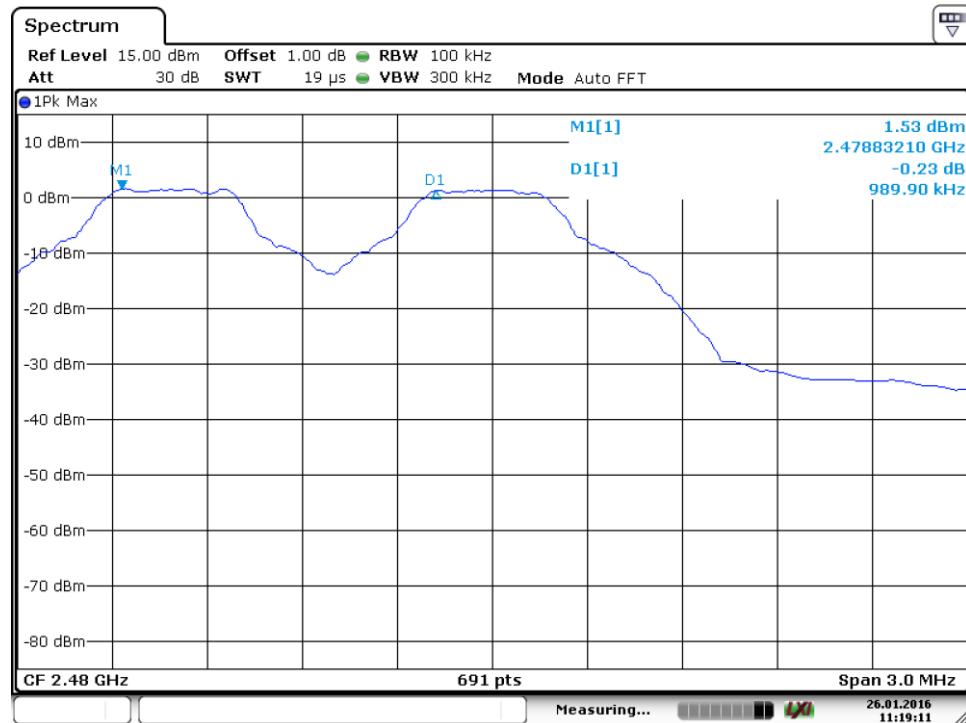
Low Channel



Middle channel



High Channel



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.

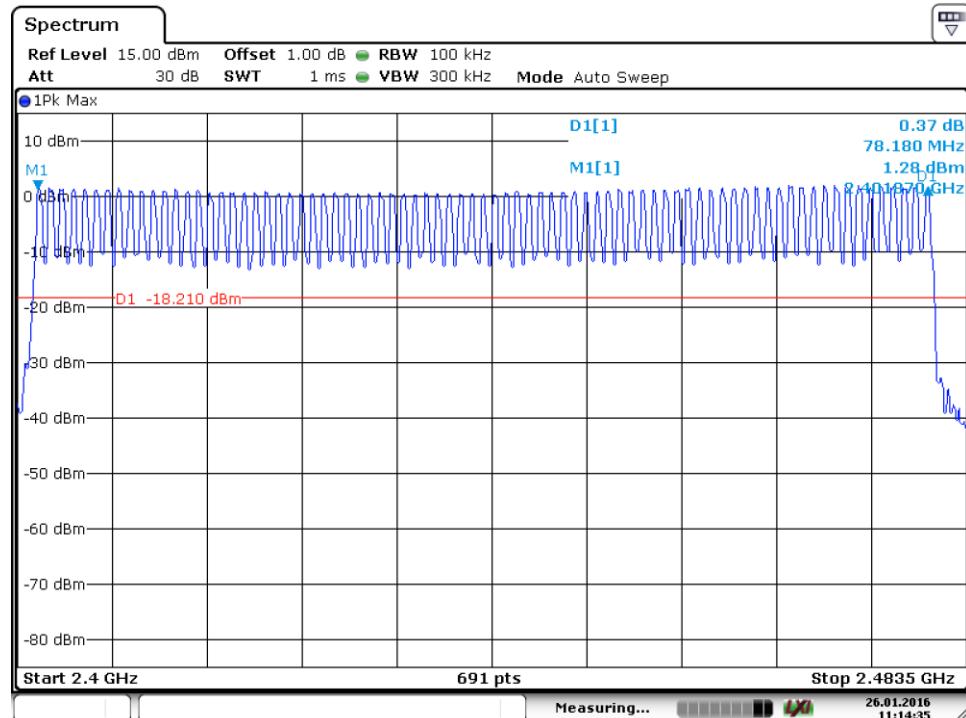
Limit

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



Date: 26.JAN.2016 11:14:35

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 to be measured.
4. Measure the Dwell Time by spectrum analyzer Marker function.
5. Repeat above procedures until all frequencies measured were complete.

Limit

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 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: $0.4 \text{ [s]} * \text{hopping number} = 0.4 \text{ [s]} * 79 \text{ [ch]} = 31.6 \text{ [s*ch]}$;

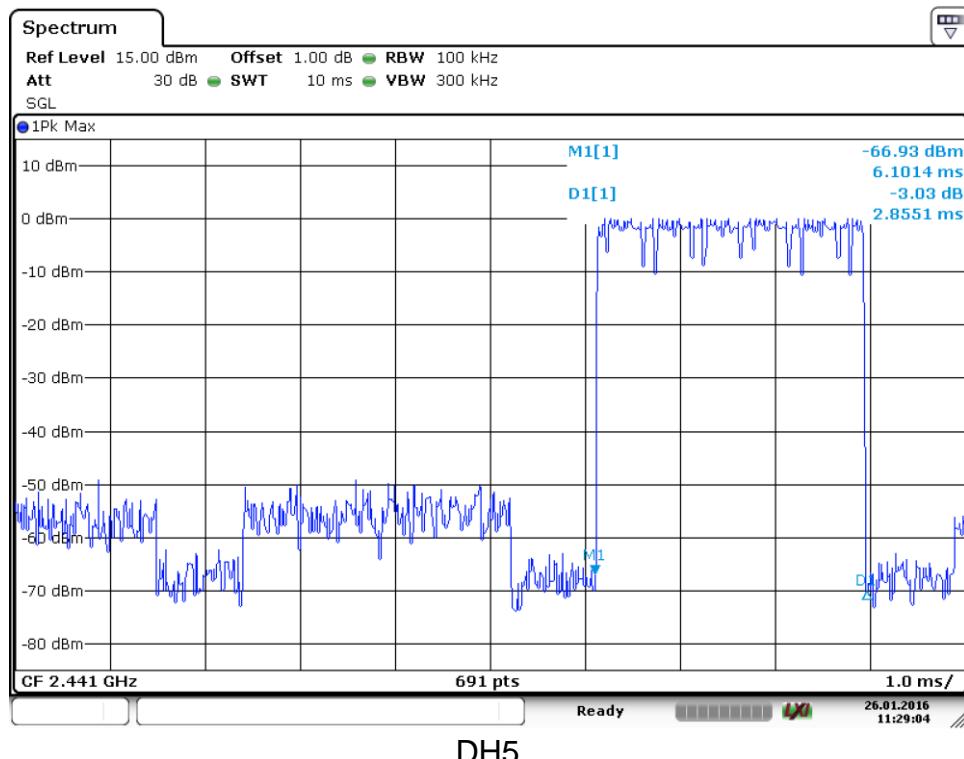
The burst width, which is directly measured, refers to the duration on one channel hop.

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

Test Result

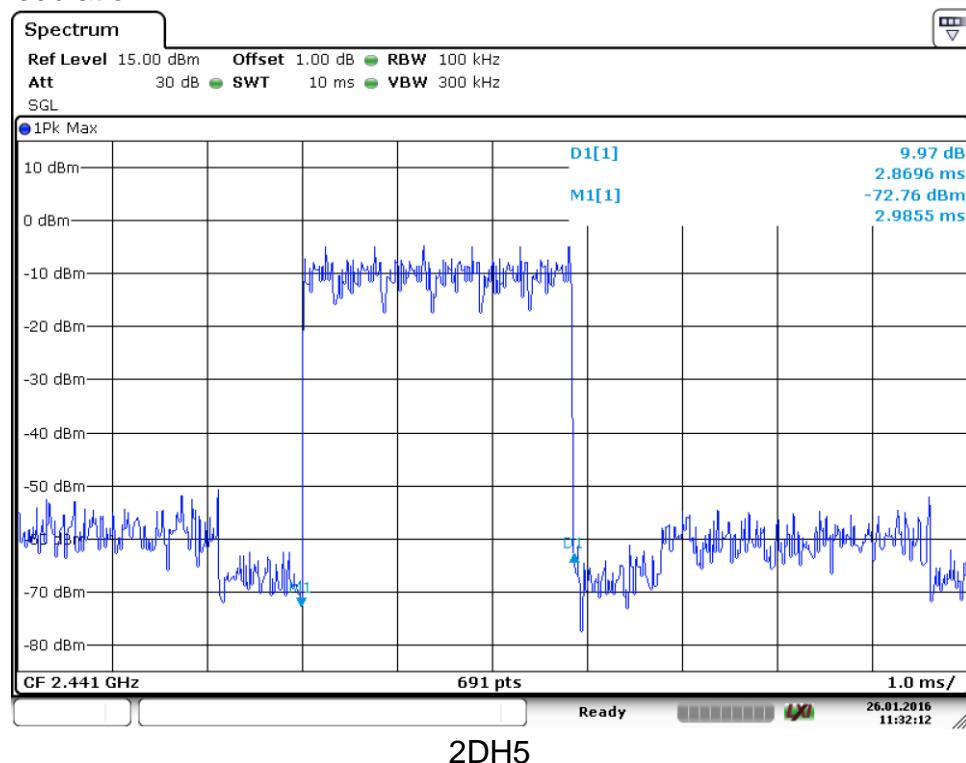
Modulation	Mode	Reading (ms)	Total Hops	Test Result (ms)	Limit (ms)	Result
GFSK	DH5	2.8551	107.44	306.75	< 400	Pass
$\pi/4$ -DQPSK	2DH5	2.9855	107.44	320.76	< 400	Pass
8-DPSK	3DH5	2.6957	107.44	289.63	< 400	Pass

GFSK Modulation

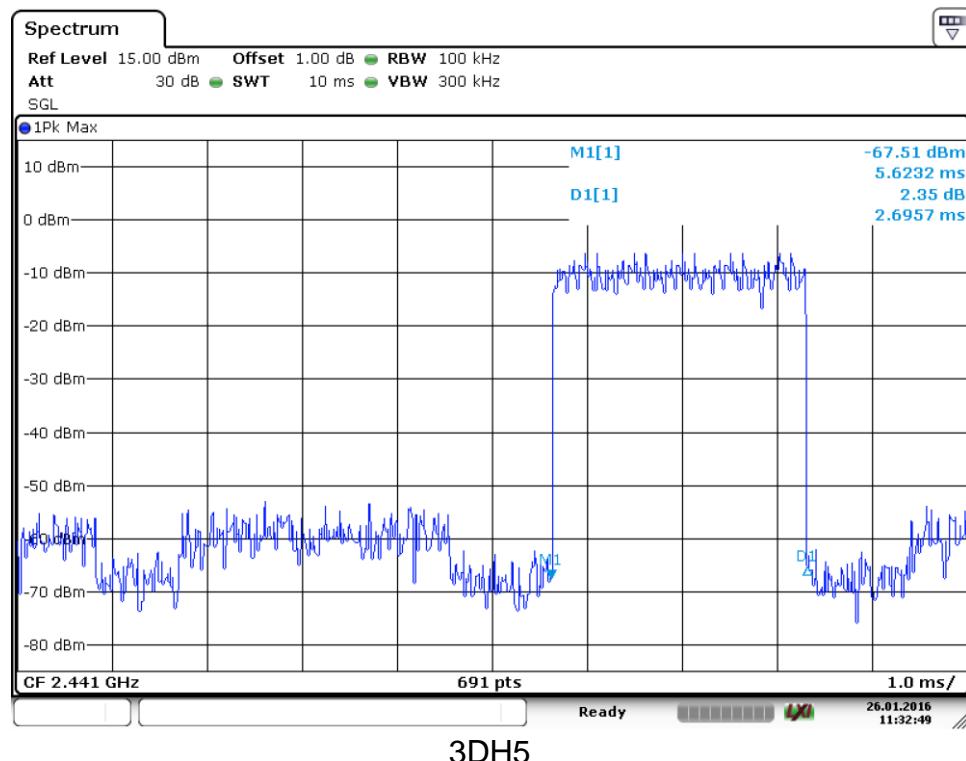


DH5

π/4-DQPSK Modulation



8-DPSK Modulation



9.7 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.

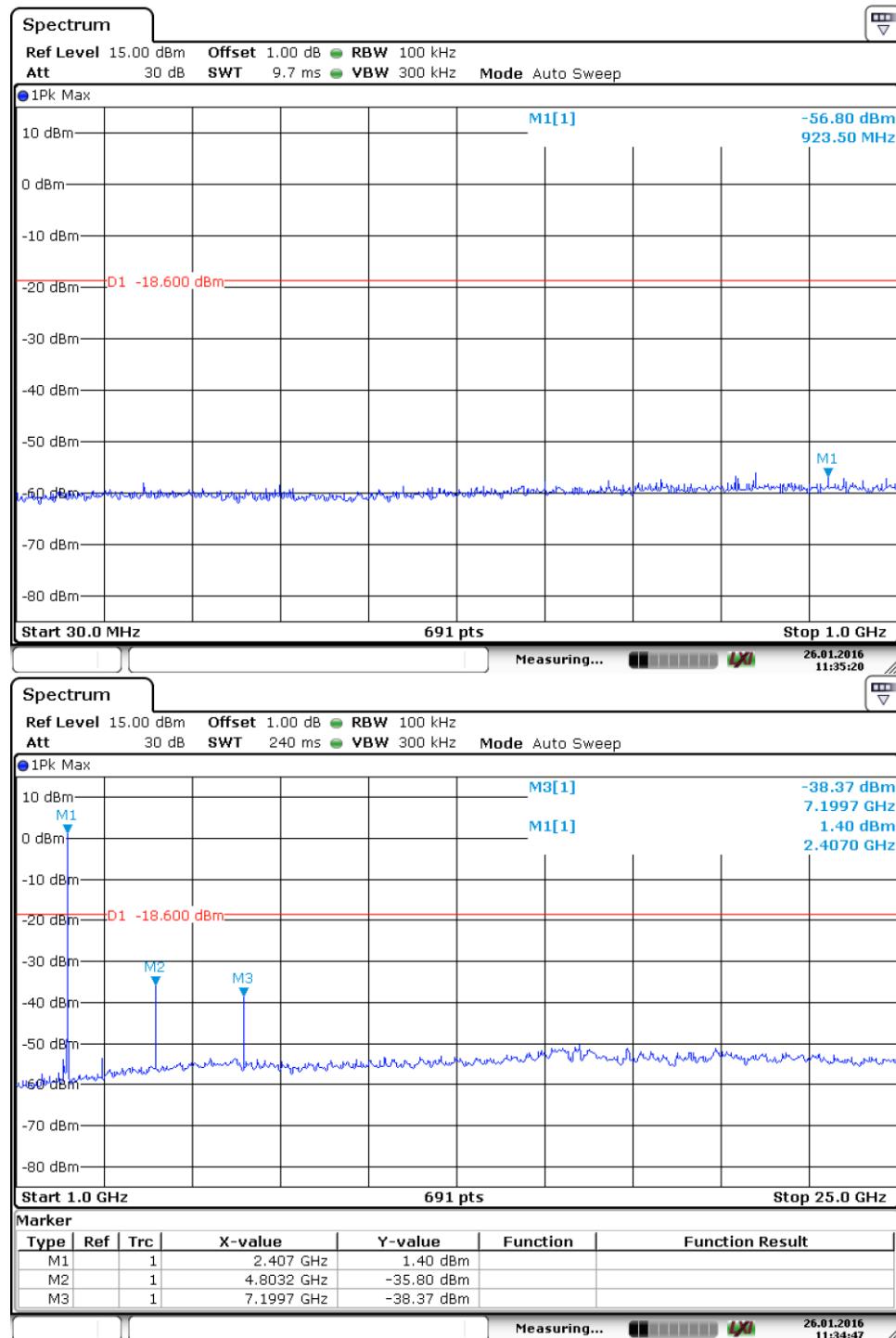
Limit

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

Remark: Only the worse case (which is subject to the maximum EIRP, GFSK mode) test result is listed in the report.

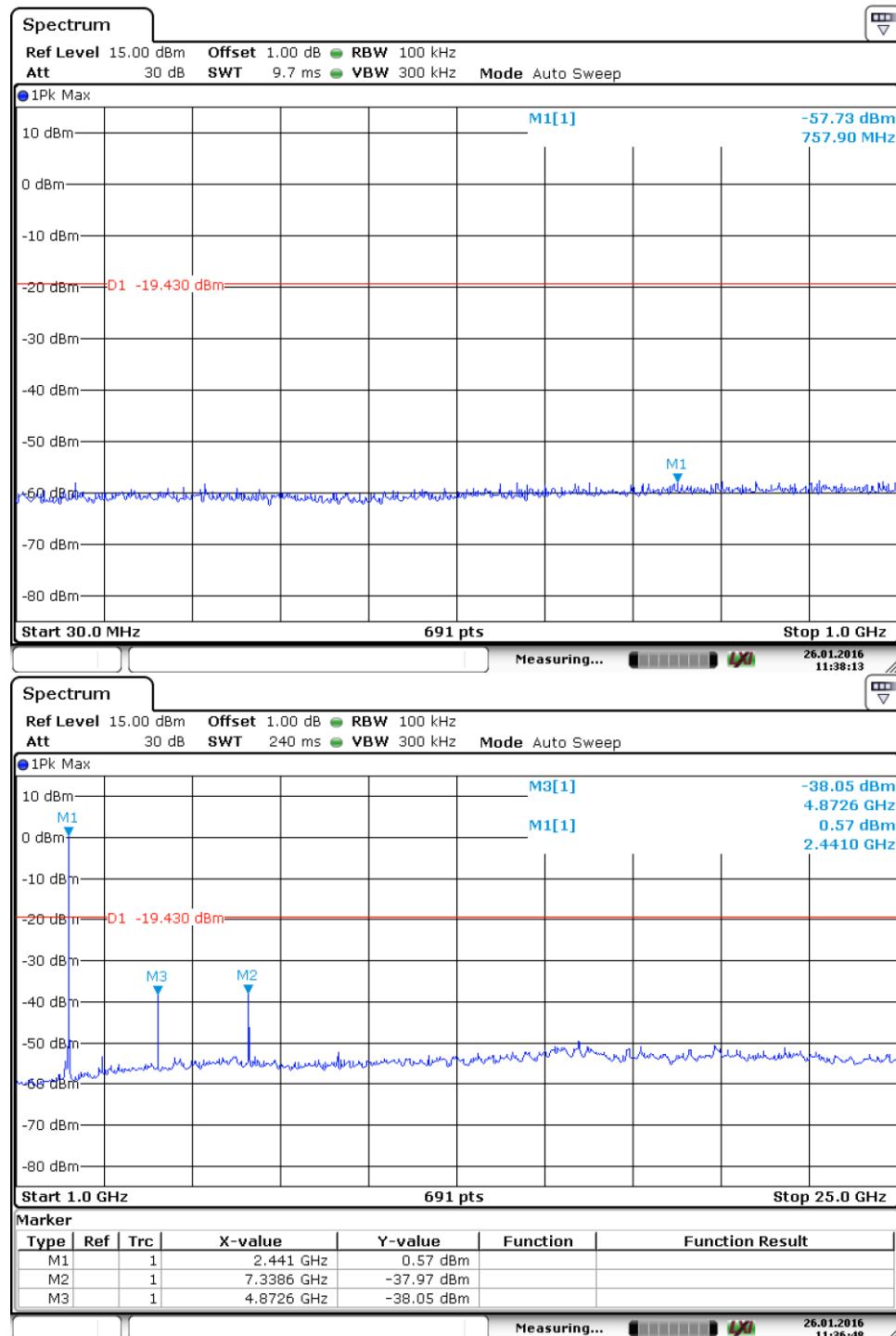
Spurious RF conducted emissions

GFSK Modulation:
2402MHz



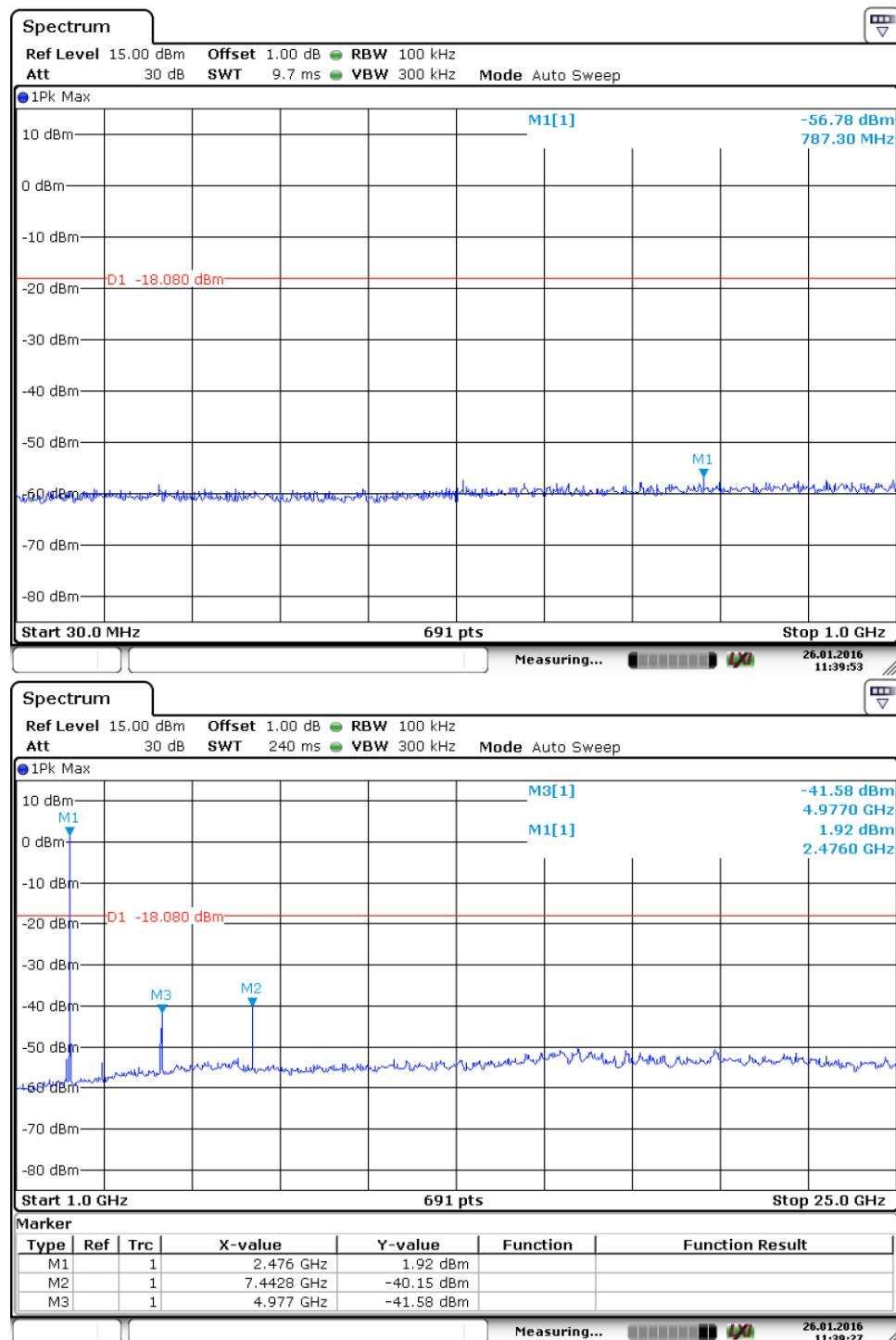


2441MHz





2480MHz



9.8 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.

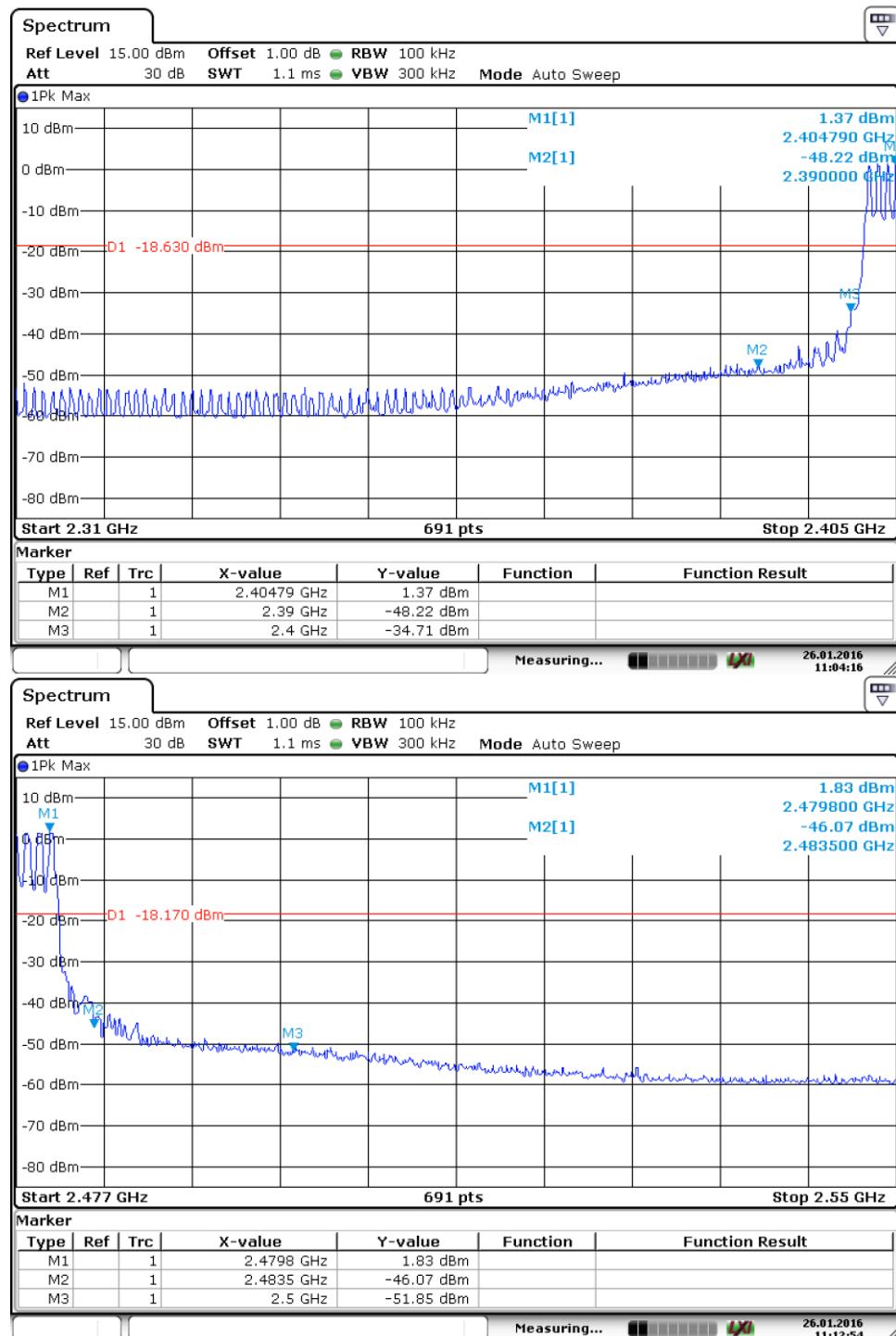
Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits.

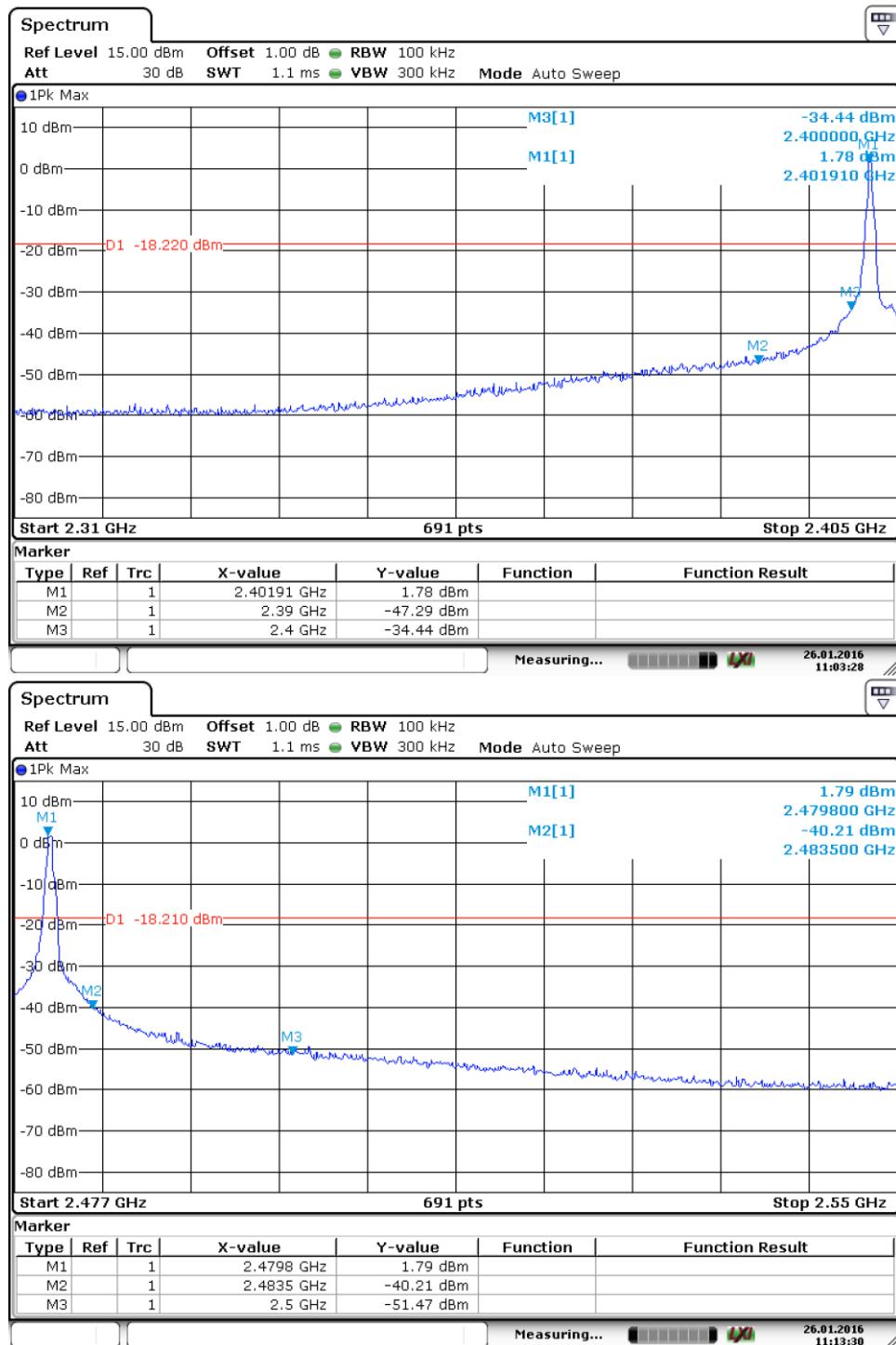
Band edge testing

GFSK Modulation Test Result:

Hopping on mode:



Hopping off mode:



9.9 Spurious radiated emissions for transmitter

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

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 dB μ V/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

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.

The only worse case (which is subject to the maximum EIRP, GFSK mode) test result is listed in the report.

Transmitting spurious emission test result as below:

GFSK Modulation 2402MHz Test Result

Frequency Band	Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
	MHz	dBuV/m		dB μ V/m		dBuV/m	
30-1000MHz	882.522222	30.51	H	46	QP	15.49	Pass
	865.008333	29.32	V	46	QP	16.68	Pass
1000-25000MHz	4804.033333	46.27	H	74	PK	27.73	Pass
	7201.033333	36.46	H	74	PK	37.54	Pass
	4804.033333	46.84	V	74	PK	27.16	Pass
	7279.233333	37.77	V	74	PK	36.23	Pass

GFSK Modulation 2441MHz Test Result

Frequency Band	Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
	MHz	dBuV/m		dB μ V/m		dBuV/m	
30-1000MHz	--	--	--	--	--	--	Pass
	--	--	--	--	--	--	Pass
1000-25000MHz	4881.666667	48.31	H	74	PK	25.69	Pass
	7322.866667	45.75	H	74	PK	28.25	Pass
	4881.666667	51.11	V	74	PK	25.82	Pass
	7322.866667	44.69	V	74	PK	22.61	Pass

GFSK Modulation 2480MHz Test Result

Frequency Band	Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
	MHz	dBuV/m		dB μ V/m		dBuV/m	
30-1000MHz	--	--	--	--	--	--	Pass
	--	--	--	--	--	--	Pass
1000-25000MHz	4959.866667	46.94	H	74	PK	27.06	Pass
	7429.966667	39.49	H	74	PK	34.51	Pass
	4959.866667	47.85	V	74	PK	26.15	Pass
	7471.900000	38.20	V	74	PK	35.80	Pass

Remark:

- (1) 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.

10 Test Equipment List

List of Test Instruments

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE
C	Signal Generator	Rohde & Schwarz	SMB100A	108272	2016-7-24
	Signal Analyzer	Rohde & Schwarz	FSV40	101030	2016-7-24
	Vector Signal Generator	Rohde & Schwarz	SMU 200A	105324	2016-7-24
	RF Switch Module	Rohde & Schwarz	OSP120/OS P-B157	101226/10085 1	2016-7-24
RE	EMI Test Receiver	Rohde & Schwarz	ESR 26	101269	2016-7-24
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9163	707	2016-8-14
	Horn Antenna	Rohde & Schwarz	HF907	102294	2016-7-24
	Pre-amplifier	Rohde & Schwarz	SCU 18	102230	2016-7-24
	3m Semi-anechoic chamber	TDK	9X6X6	----	2019-5-29
CE	EMI Test Receiver	Rohde & Schwarz	ESR 3	101782	2016-7-24
	LISN	Rohde & Schwarz	ENV4200	100249	2016-7-24
	LISN	Rohde & Schwarz	ENV216	100326	2016-7-24
	ISN	Rohde & Schwarz	ENY81	100177	2016-7-24
	ISN	Rohde & Schwarz	ENY81-CA6	101664	2016-7-24

C - Conducted RF tests

- Conducted peak output power
- 20dB bandwidth and 99% Occupied Bandwidth
- Carrier frequency separation
- Number of hopping frequencies
- Dwell Time
- 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	
Test Items	Extended Uncertainty
Uncertainty for Radiated Emission in 3m chamber 30MHz-1000MHz	Horizontal: 4.83dB; Vertical: 4.91dB;
Uncertainty for Radiated Emission in 3m chamber 1000MHz-18000MHz	Horizontal: 4.89dB; Vertical: 4.88dB;
Uncertainty for Conducted RF test with TS 8997	2.04dB
Uncertainty for Conducted Emission 150KHz-30MHz	U=3.5dB(k=2)