China

FCC - TEST REPORT

Report Number	:	**68.950.14.243.01**	Date of Issue:	December 8, 2014

Model	:	LF1
Product Type	:	Lumafit
Applicant	:	Zinc software Limited
Address	:	47 SLIEVEBLOOM PARK Drimnagh,Dublin 12,Ireland
Production Facility	:	Suga Electronics (Dongguan) Co., Ltd.
Address	:	No.8 Fulong Road, Qingxi Town 523640 Dongguan City, Guangdong Province, PEOPLE'S REPUBLIC OF CHINA

Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	39

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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
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Telephone: 86 755 8828 6998
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Test Site 2
Company name: Audix Technology (shenzhen) Co.,Ltd
No. 6, Ke Feng Rd, 52 Block Shenzhen Science and Industry Park,
Nantou, Shenzhen,
Guangdong,
China

Telephone: 86 755 2663 9496
Fax: 86 755 2663 2877

3 Description of the Equipment Under Test

Product:	Lumafit
Model no.:	LF1
FCC ID:	2ACUYLF1
Brand Name:	Lumafit
Options and accessories:	USB Cable
Rating:	5VDC(supplied by USB port) 3.7VDC(supplied by battery)
RF Transmission Frequency:	2402-2480MHz
No. of Operated Channel:	79
Modulation:	GFSK, π/4-DQPSK, 8DPSK
Duty Cycle:	33.41%
Antenna Type:	Ceramic Antenna
Antenna Gain:	0.5dBi
Description of the EUT:	The Equipment Under Test (EUT) is a Lumafit with Bluetooth function operating at 2.4GHz

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2014 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 (2009).

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5 Summary of Test Results

Technical Requirements				
FCC Part 15 Subpart C				
Test Condition		Pages	Test Site	Test Result
§15.207	Conducted emission AC power port	--	--	N/A
§15.247(b)(1)	Conducted peak output power	10	Site 2	Pass
§15.247(a)(2)	6dB bandwidth	---	---	N/A
§15.247(a)(1)	20dB bandwidth and 99% Occupied Bandwidth	12	Site 2	Pass
§15.247(a)(1)	Carrier frequency separation	19	Site 2	Pass
§15.247(a)(1)(iii)	Number of hopping frequencies	22	Site 2	Pass
§15.247(a)(1)(iii)	Dwell Time	24	Site 2	Pass
§15.247(e)	Power spectral density	---	---	N/A
§15.247(d)	Spurious RF conducted emissions	27	Site 2	Pass
§15.247(d)	Band edge	31	Site 2	Pass
§15.247(d) & §15.209 &	Spurious radiated emissions for transmitter and receiver	36	Site 2	Pass
§15.203	Antenna requirement	See note 2		Pass

Note 1: N/A=Not Applicable.

Note 2: The EUT uses a permanently ceramic antenna, which gain is 0.5dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2ACUYLF1, complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C.

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: November 14, 2014

Testing Start Date: November 17, 2014

Testing End Date: December 3, 2014

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Reviewed by:	Prepared by:	Tested by:
Phoebe Hu	Calvin Weng	Leo Li
EMC Project Manager	EMC Project Engineer	EMC Test Engineer

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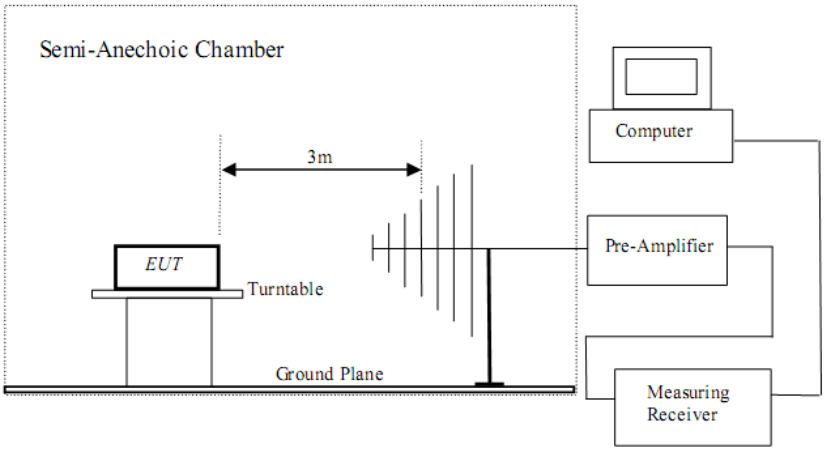
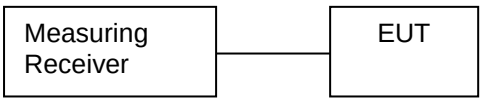
7 Test Setups

7.1 Radiated test setups



7.3 Conducted RF test setups



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8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
NoteBook	LENOVO	X240	---

Test software: Bluetest 3.exe, 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

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9 Technical Requirement

9.1 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) , conducted peak output power limit as below:

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

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Conducted peak output power

Bluetooth Mode GFSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-4.74	Pass
Middle channel 2441MHz	-4.82	Pass
High channel 2480MHz	-4.62	Pass

Bluetooth Mode π/4-DQPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-1.98	Pass
Middle channel 2441MHz	-2.02	Pass
High channel 2480MHz	-1.93	Pass

Bluetooth Mode 8DPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	-1.56	Pass
Middle channel 2441MHz	-1.58	Pass
High channel 2480MHz	-1.43	Pass

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9.2 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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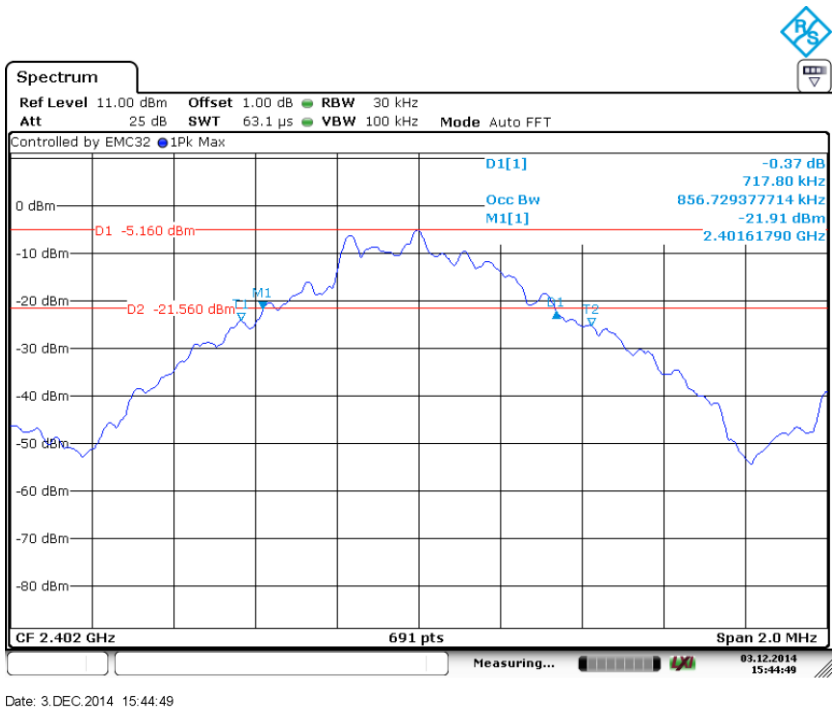
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode GFSK Modulation test result

Frequency MHz	20 dB Bandwidth kHz	99% Bandwidth kHz	Limit kHz	Result
2402	717.8	856.7	--	Pass
2441	709.1	793.1	--	Pass
2480	712.0	793.1	--	Pass



2402MHz

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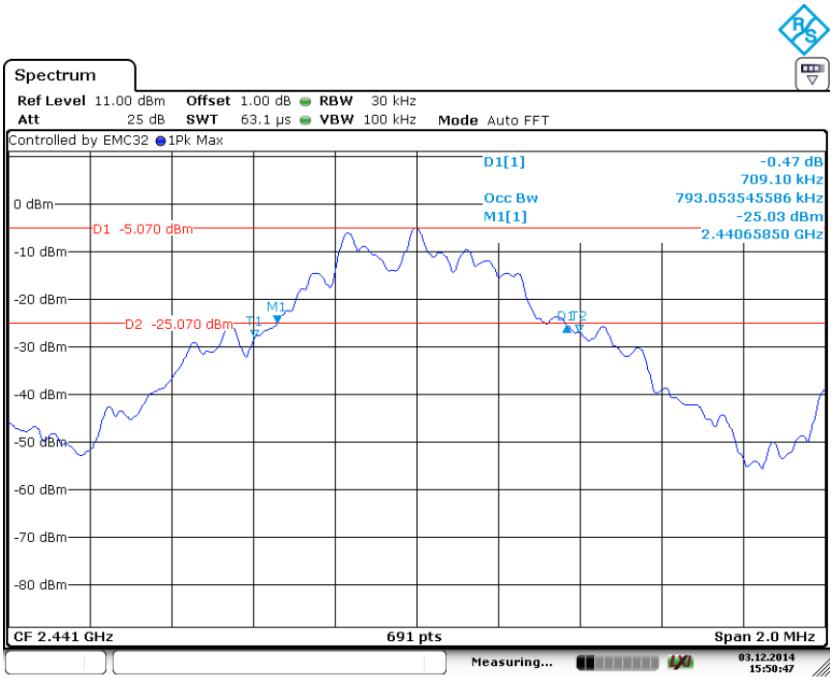
20 dB bandwidth and 99% Occupied Bandwidth



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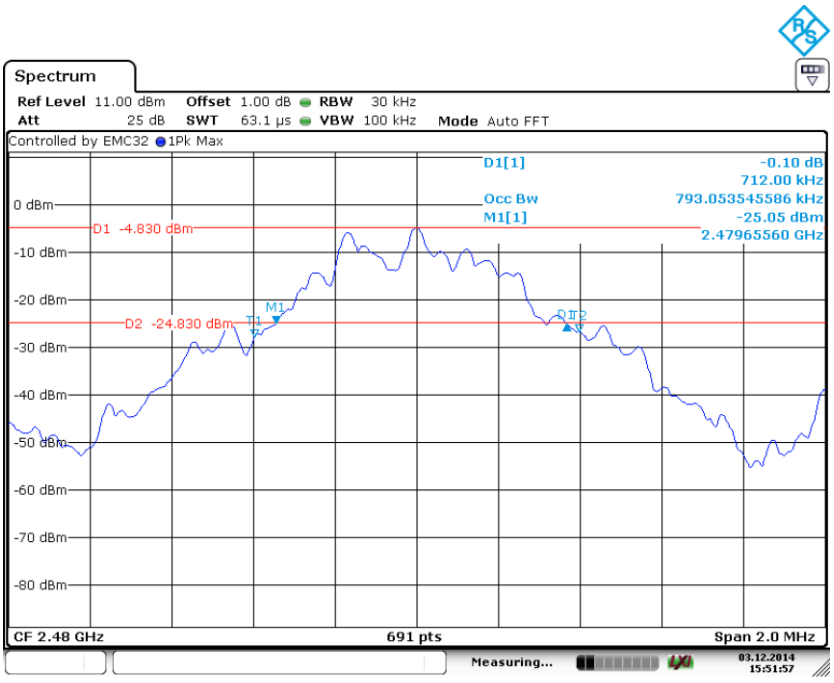
2441MHz



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2480MHz

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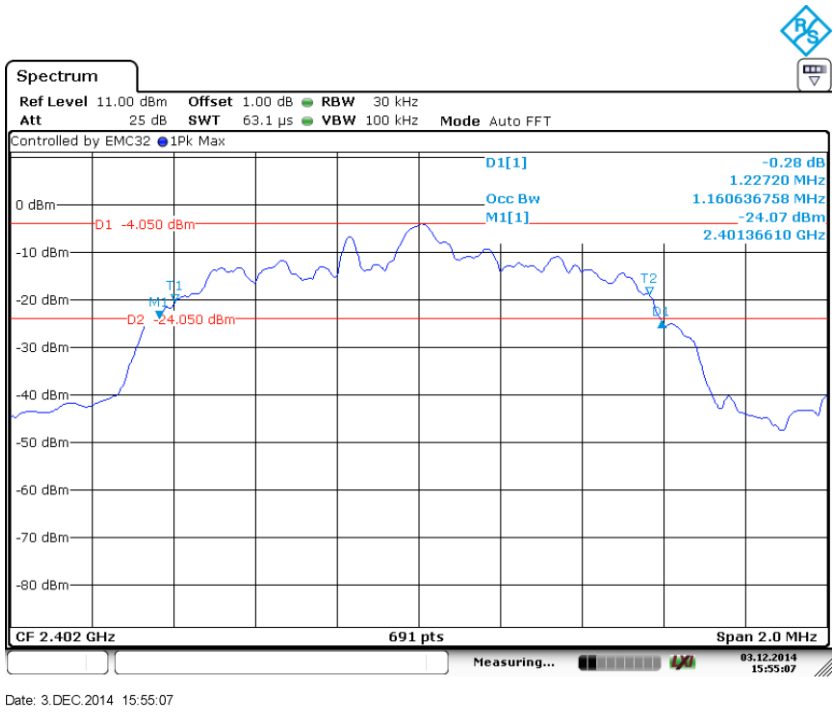
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode π/4-DQPSK Modulation test result

Frequency	20 dB Bandwidth	99% Bandwidth	Limit	Result
MHz	kHz	kHz	kHz	
2402	1227	1160.6	--	Pass
2441	1227	1160.6	--	Pass
2480	1227	1169.3	--	Pass



2402MHz

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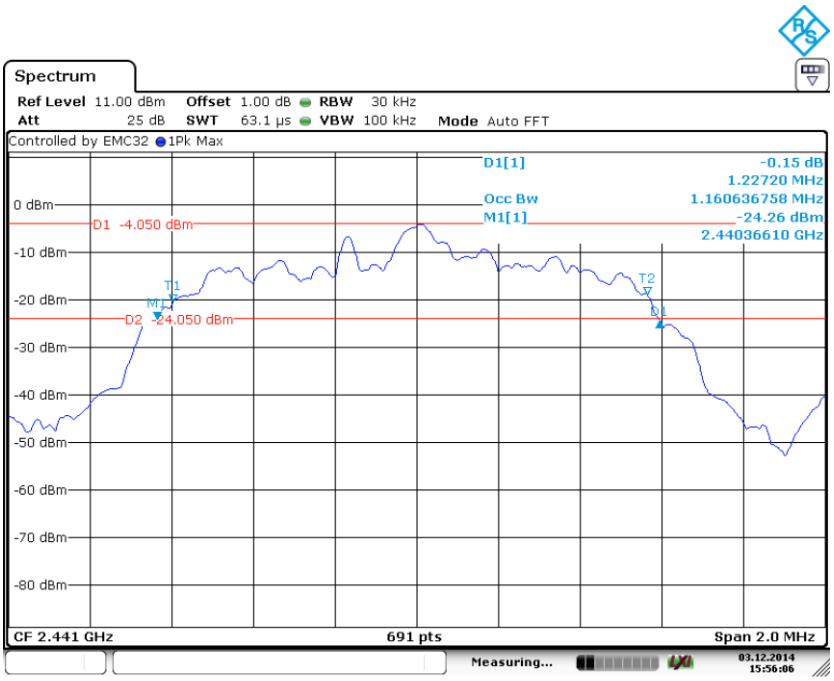

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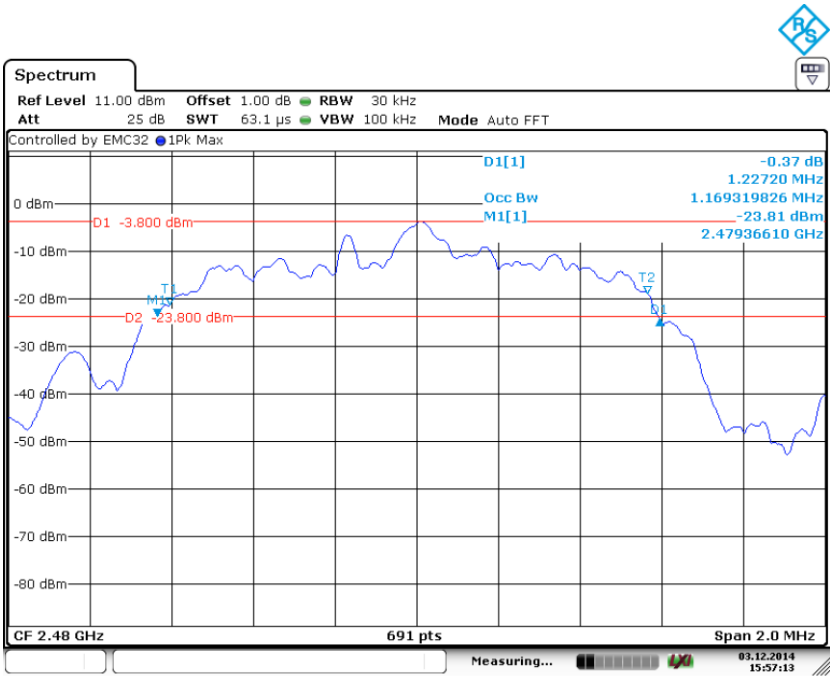
2441MHz



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2480MHz

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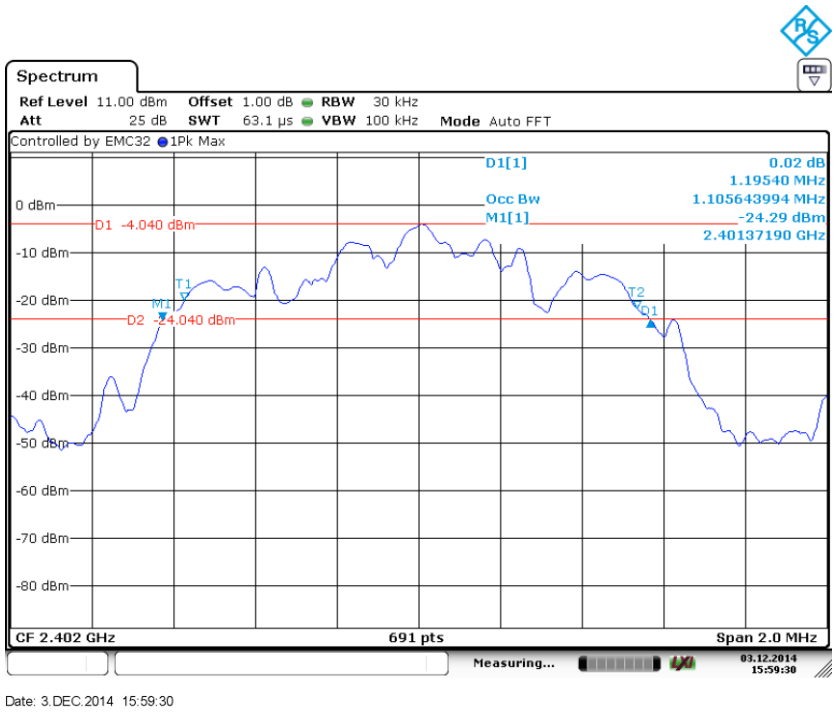
20 dB bandwidth and 99% Occupied Bandwidth

Bluetooth Mode 8DPSK Modulation test result

Frequency MHz	20 dB Bandwidth kHz	99% Bandwidth kHz	Limit kHz	Result
2402	1195.4	1105.6	--	Pass
2441	1198.3	1105.6	--	Pass
2480	1259	1105.6	--	Pass



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2402MHz

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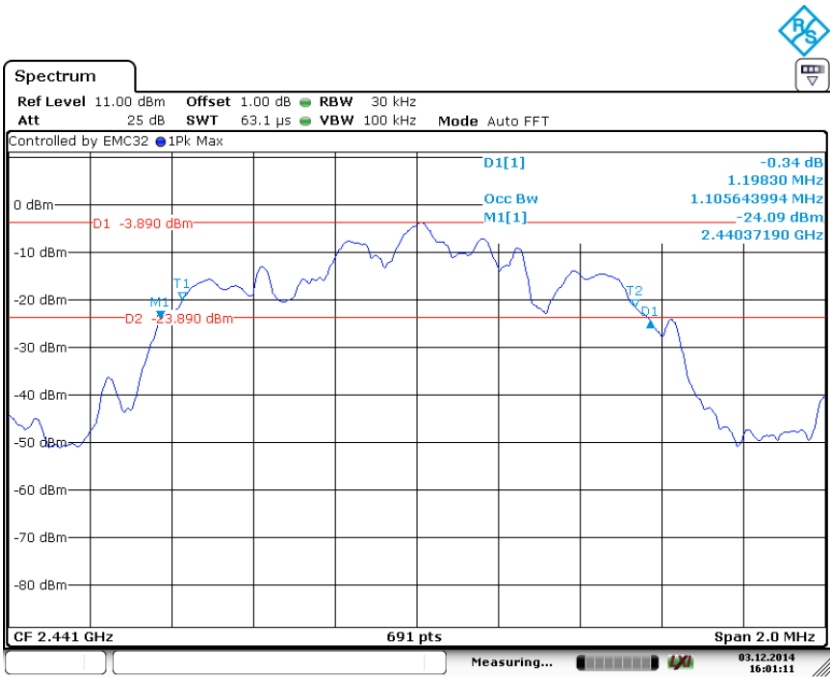

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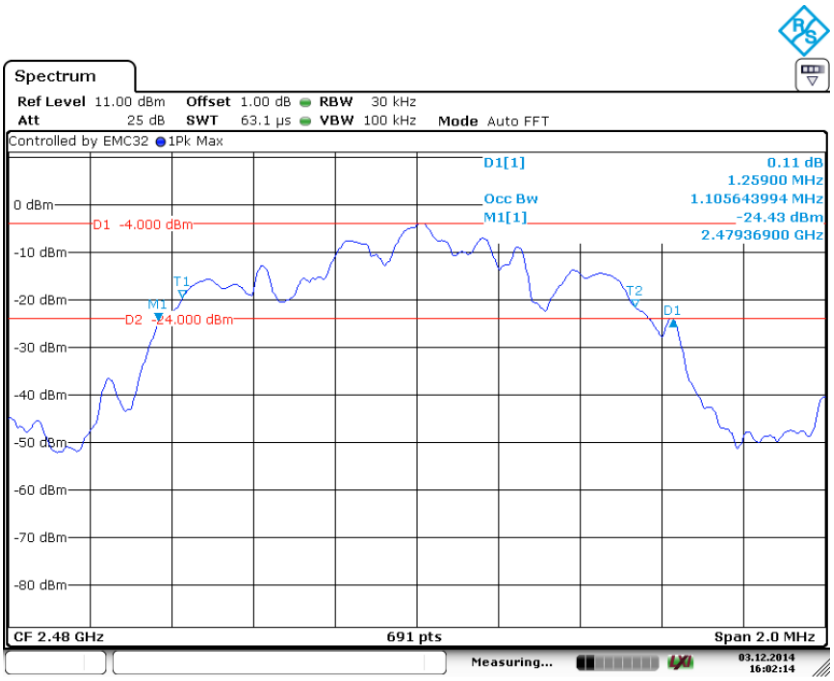
2441MHz



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2480MHz

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9.3 Carrier Frequency Separation

Test Method

1. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peaks of two adjacent channels, RBW ≥ 1% of the span, VBW) ≥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
≥25KHz or 2/3 of the 20 dB bandwidth which is greater

GFSK Modulation Limit

Frequency MHz	2/3 of 20 dB Bandwidth kHz
2402	478.5
2441	472.7
2480	474.7

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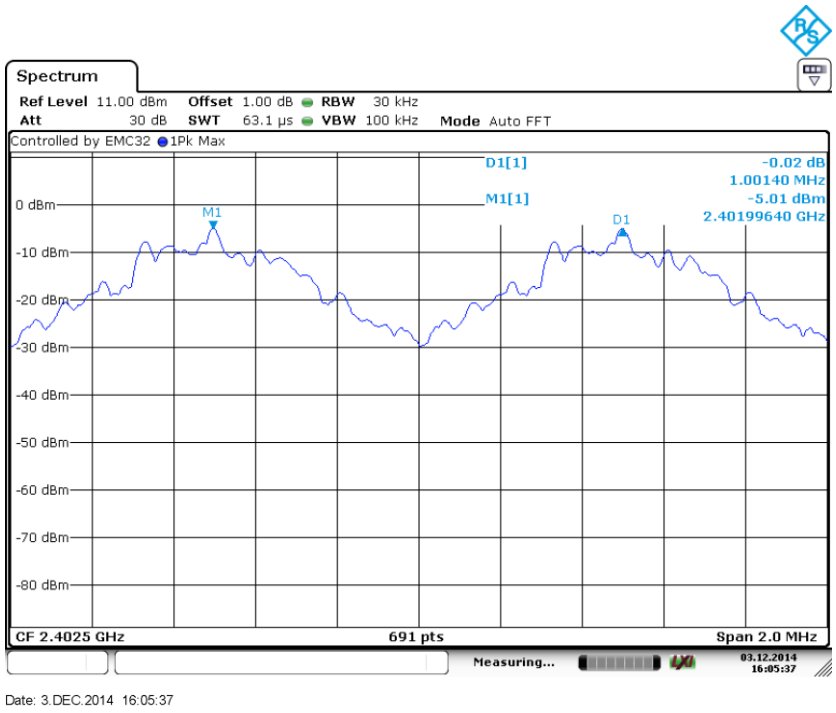
Carrier Frequency Separation

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	1001	Pass
2441	1004	Pass
2480	1001	Pass



2402MHz

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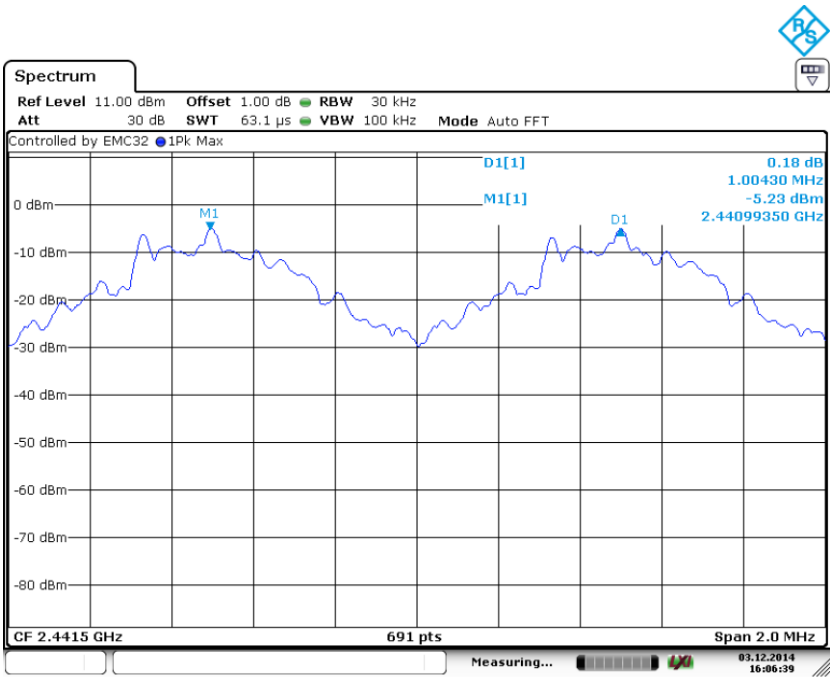

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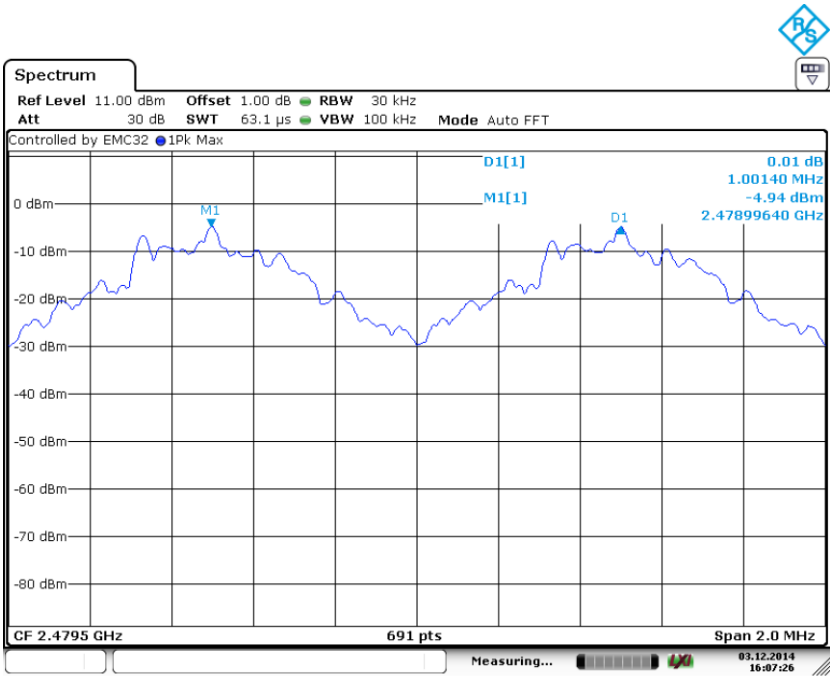
2441MHz



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2480MHz

9.4 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 ≥ 1% of the span, VBW) ≥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

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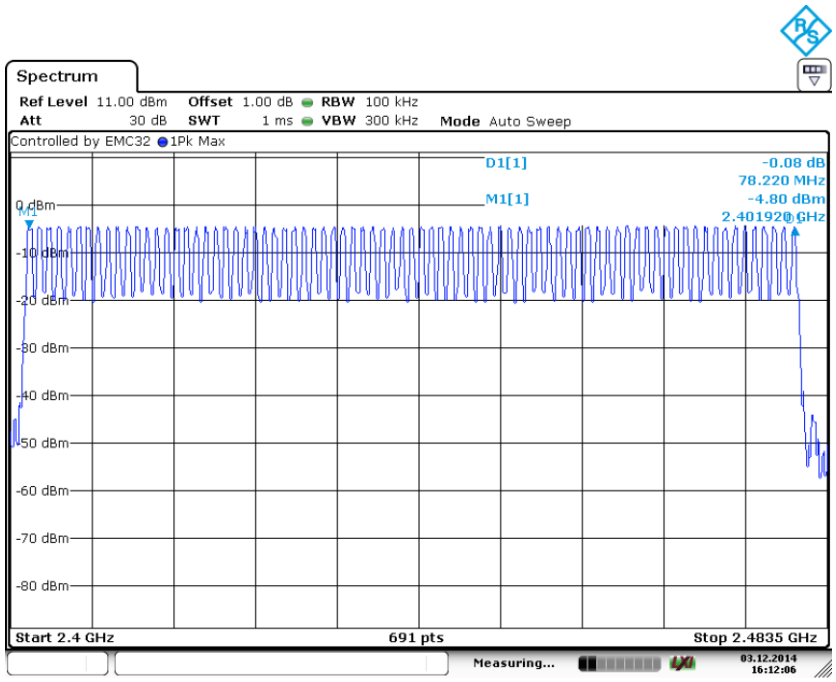
Number of hopping frequencies

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



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9.5 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) . 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.

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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 [s] * hopping number = 0.4 [s] * 79 [ch] = 31.6 [s*ch];

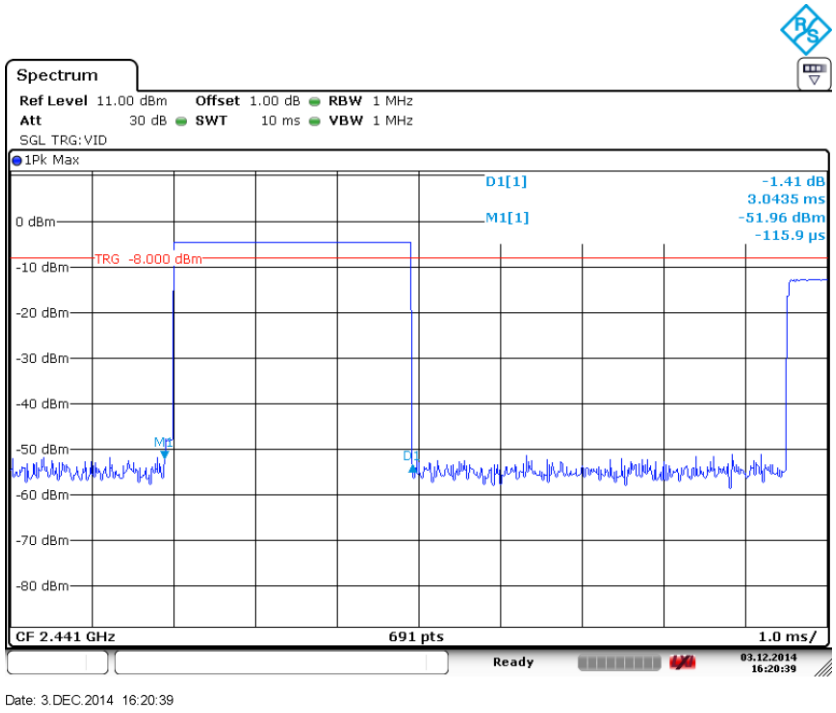
The burst width, which is directly measured, refers to the duration on one channel hop.

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

Test Result

Modulation	Mode	Reading (μs)	Total Hops	Test Result (ms)	Limit (ms)	Result
GFSK	DH5	3043	106.67	324.60	< 400	Pass
π/4-DQPSK	2DH5	3058	106.67	326.20	< 400	Pass
8-DPSK	3DH5	3058	106.67	326.20	< 400	Pass

GFSK Modulation



DH5

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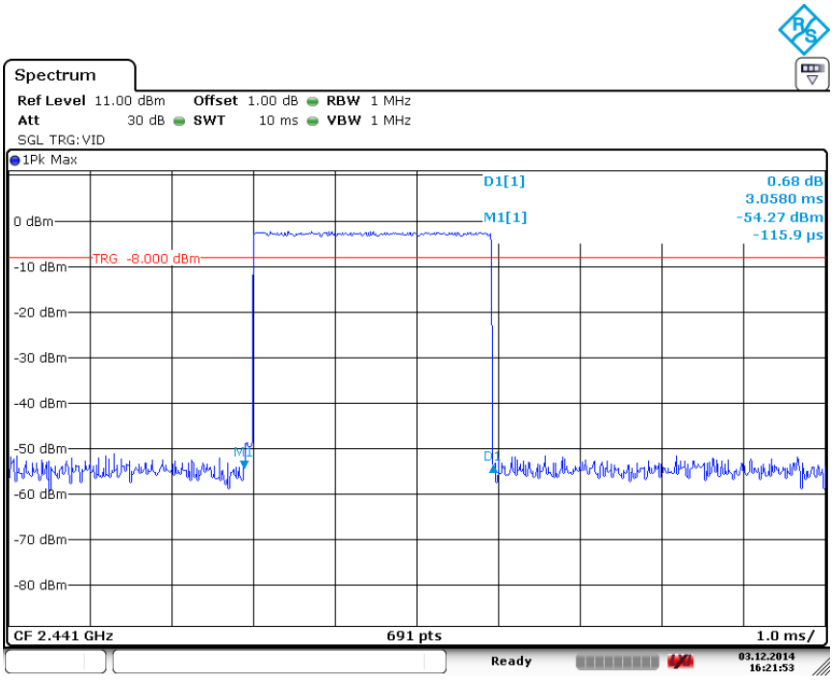
π/4-DQPSK Modulation



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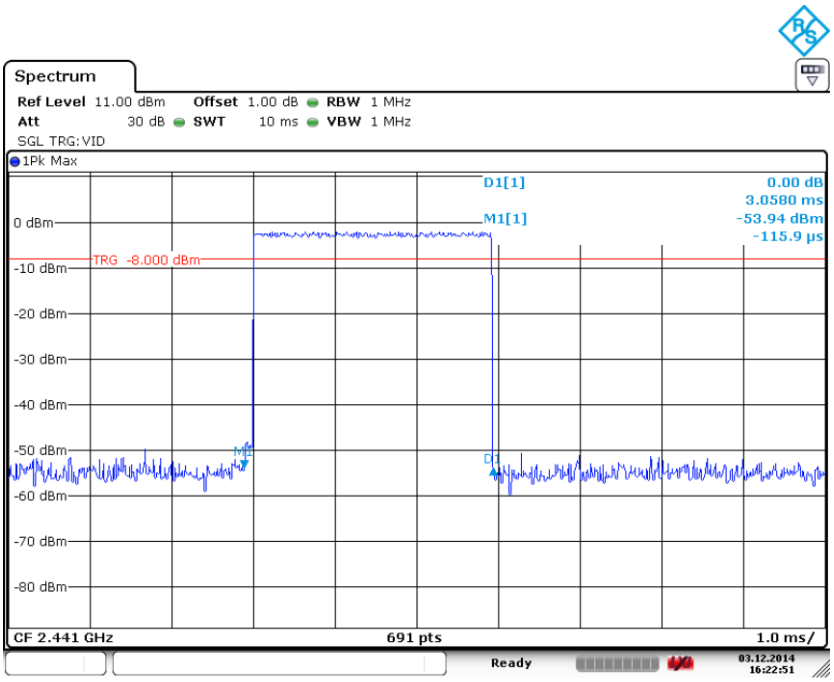
2DH5

8-DPSK Modulation



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3DH5

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9.6 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

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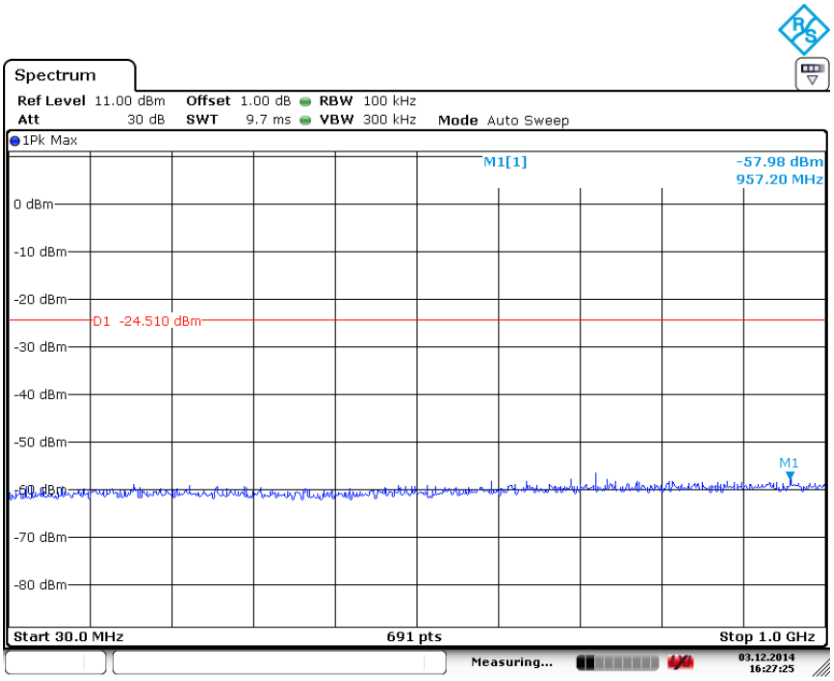
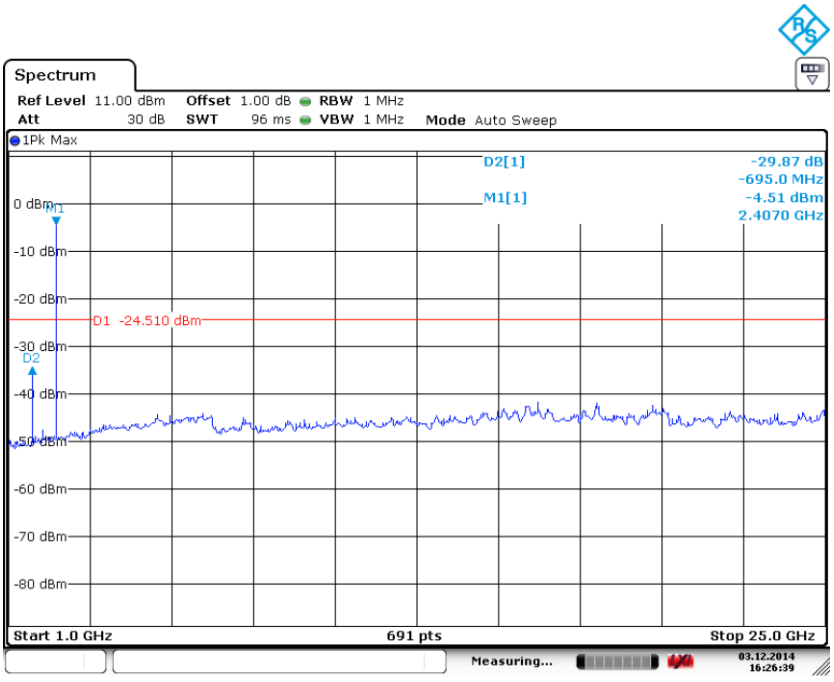
Spurious RF conducted emissions

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

2402MHz



Date: 3.DEC.2014 16:27:25



Date: 3.DEC.2014 16:26:38

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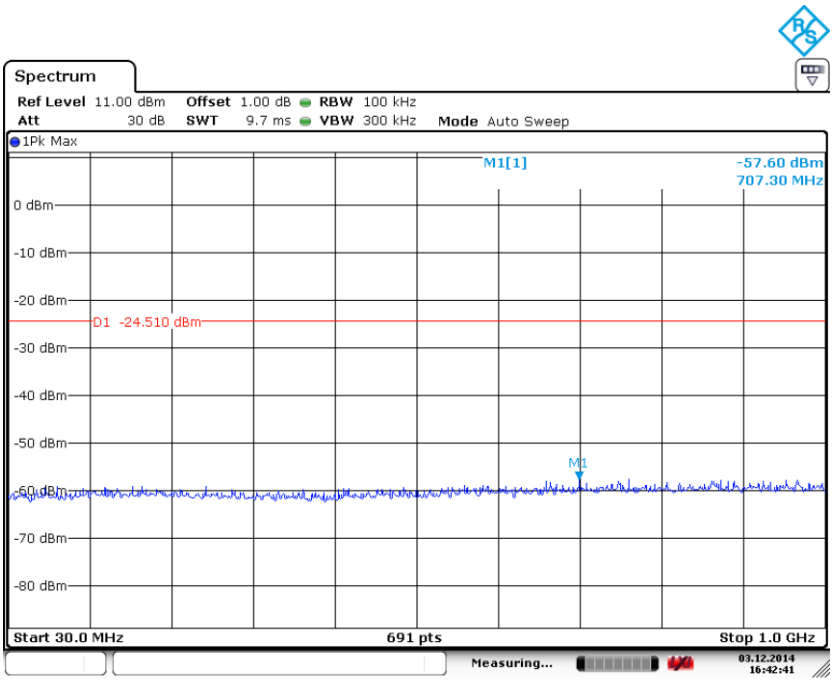
Spurious RF conducted emissions

2441MHz



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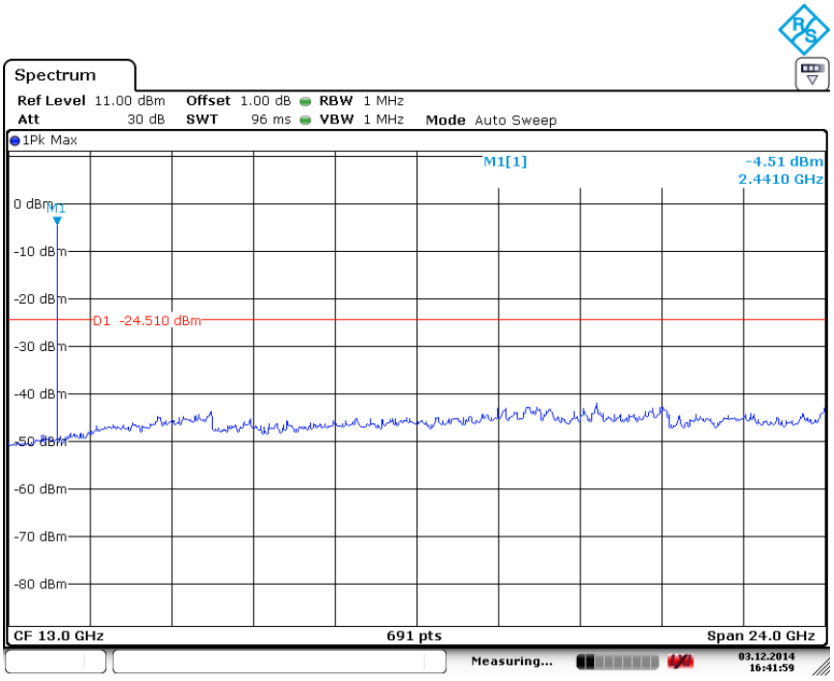

Date: 3.DEC.2014 16:42:00

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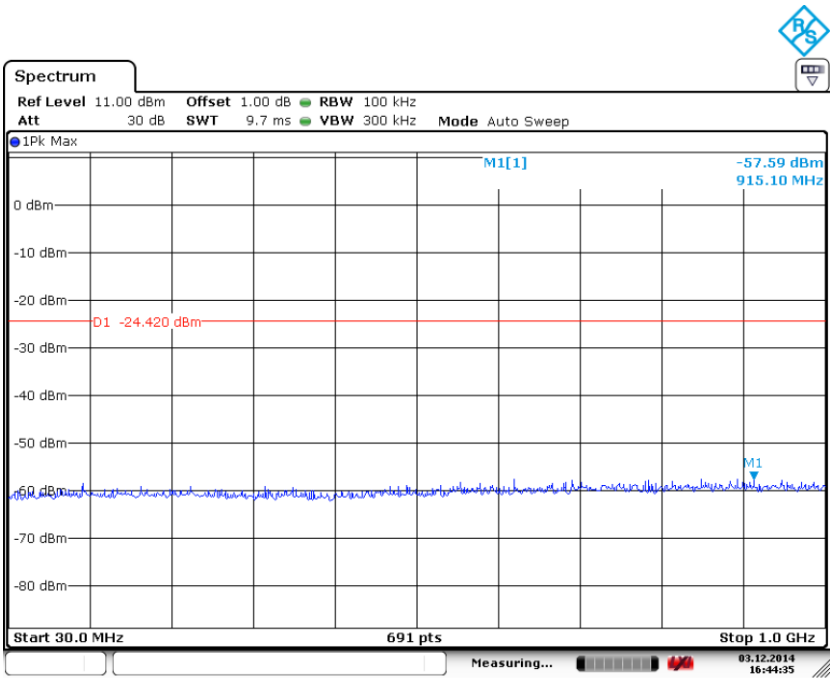
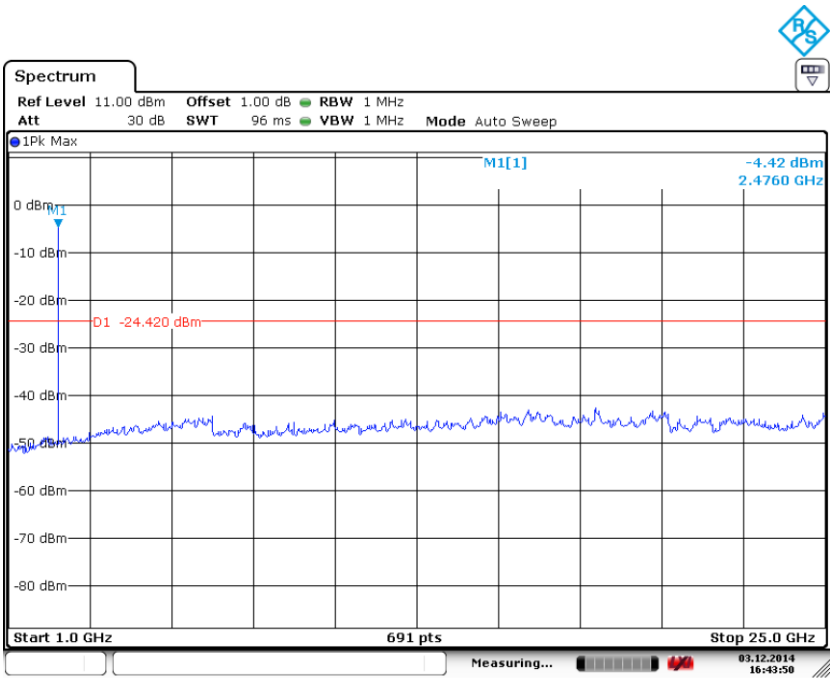
Spurious RF conducted emissions

2480MHz



Date: 3.DEC.2014 16:44:34



Date: 3.DEC.2014 16:43:50

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9.7 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≥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), 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 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), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

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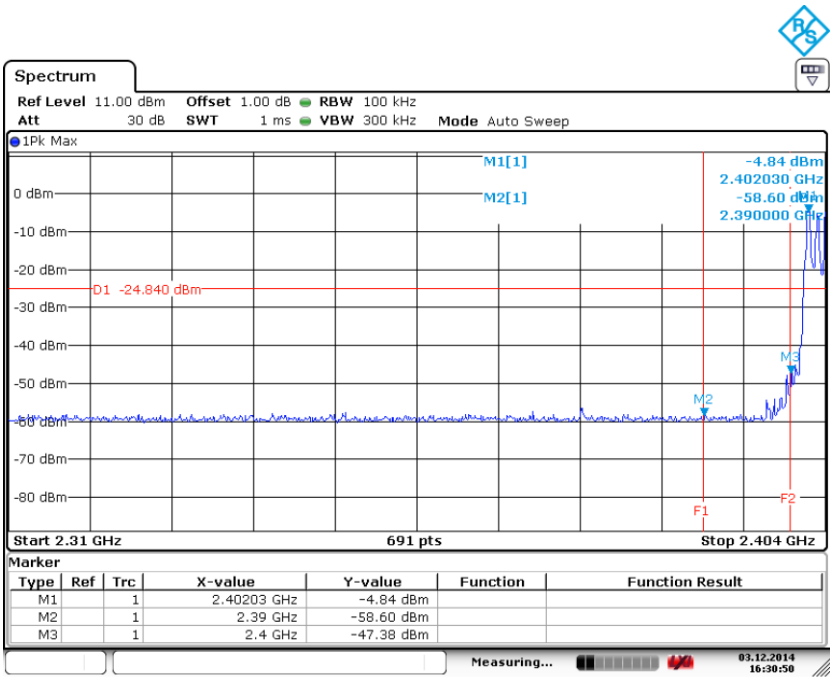
Band edge testing

GFSK Modulation Test Result:
Hopping on mode:



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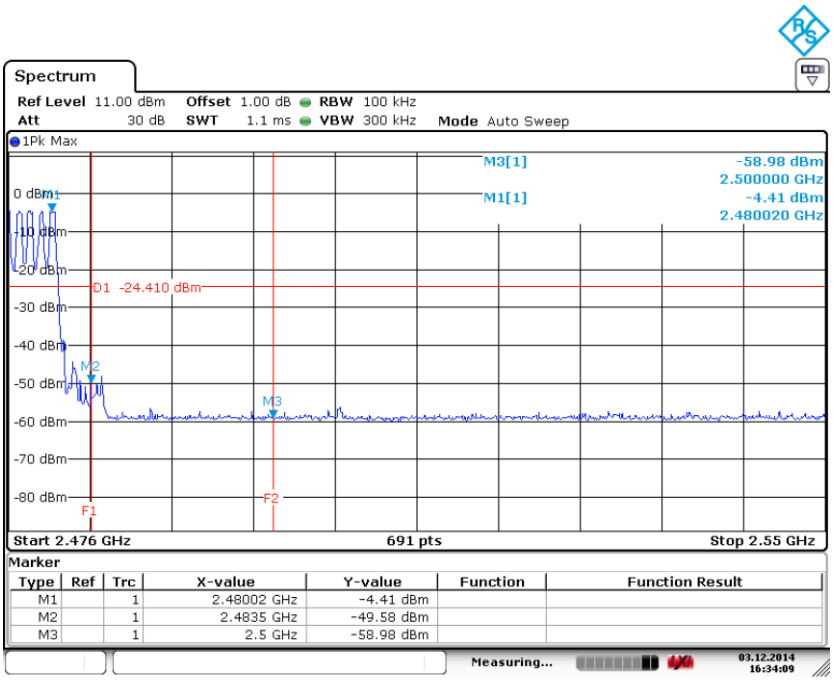

Date: 3.DEC.2014 16:34:09

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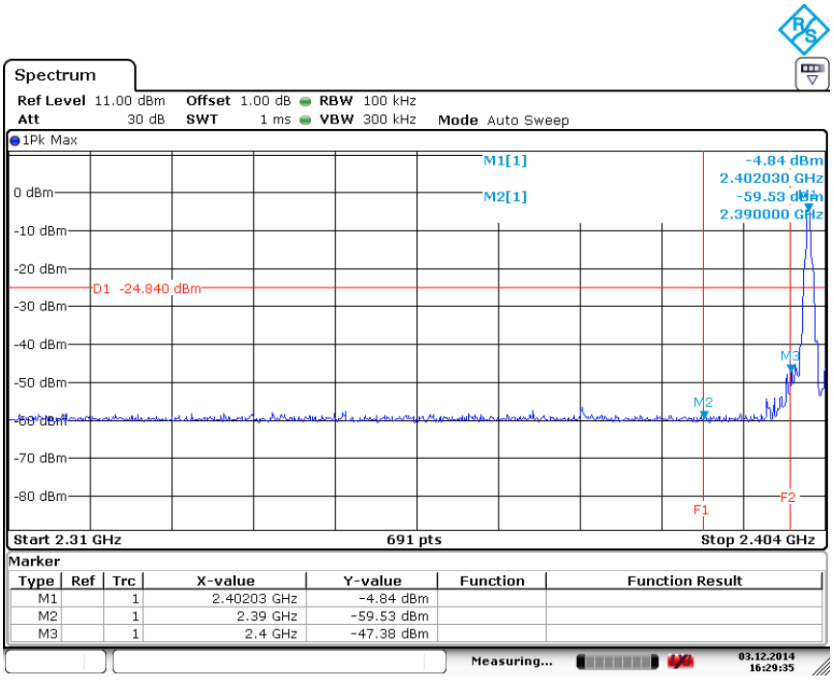
Band edge testing

Hopping off mode:



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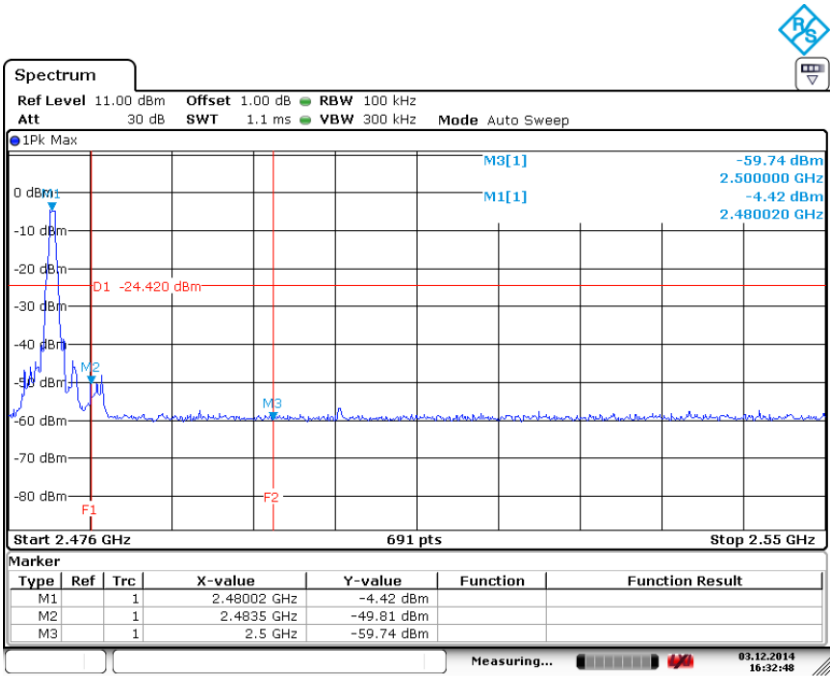

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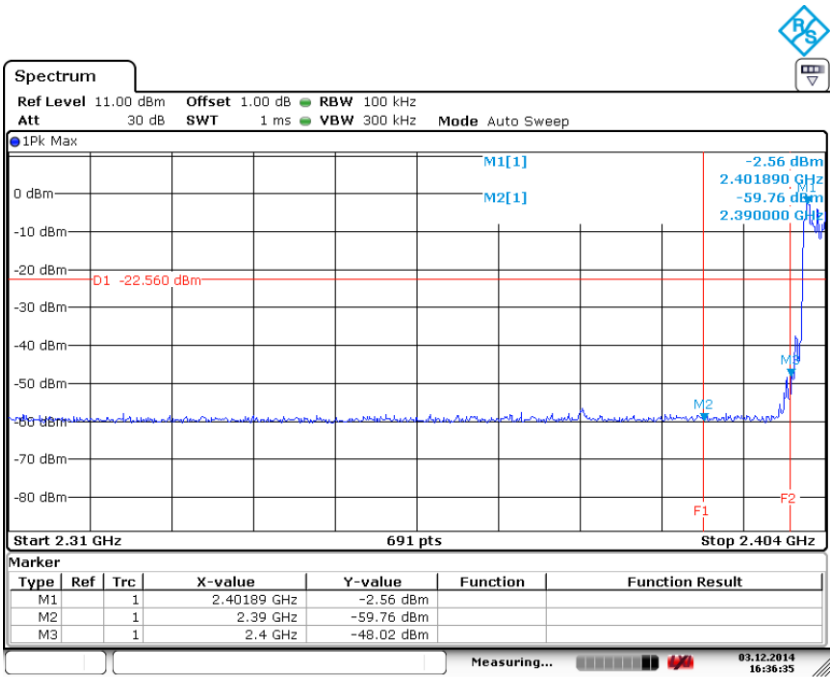
Band edge testing

8DPSK Modulation Test Result:
Hopping on mode:



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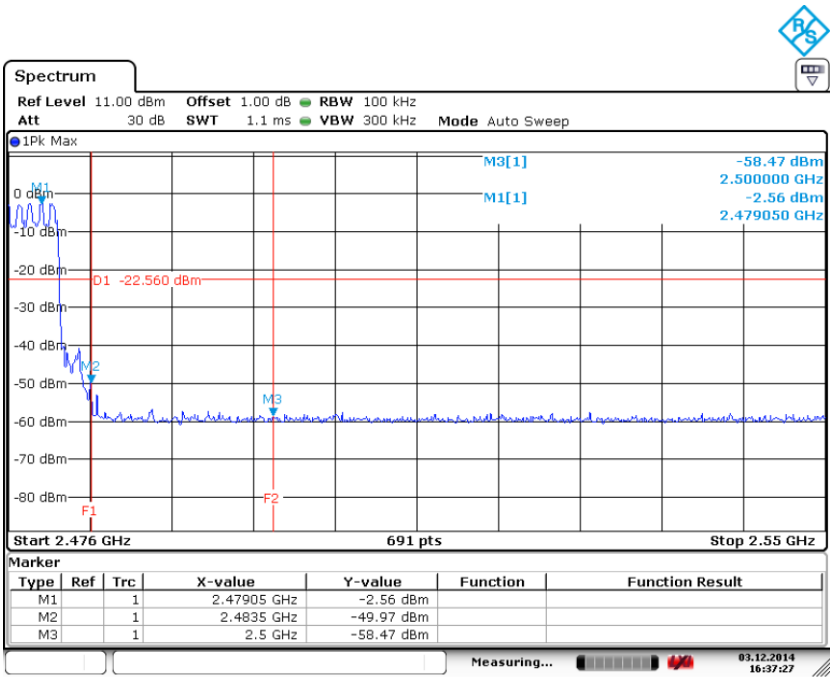

Date: 3.DEC.2014 16:37:27

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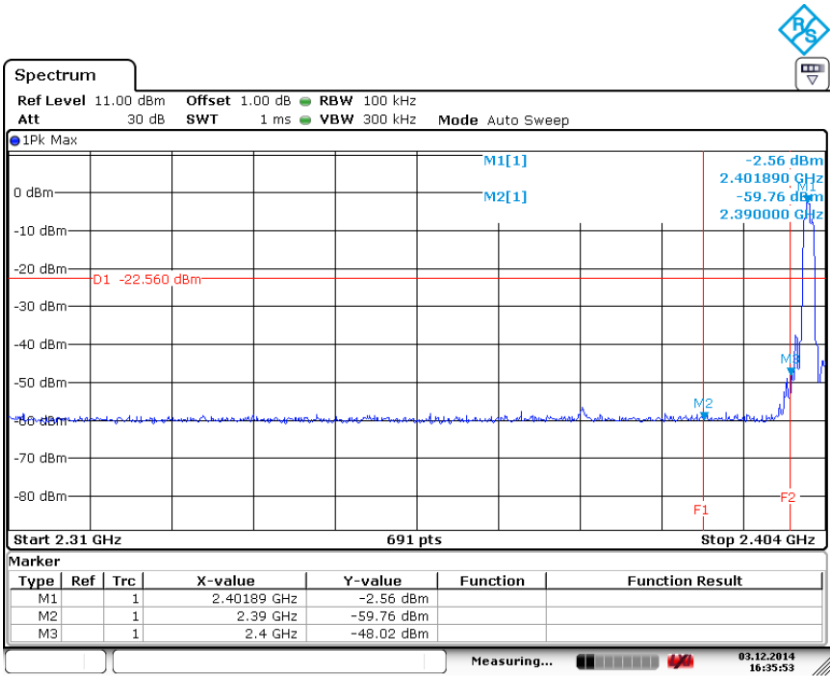
Band edge testing

Hopping off mode:



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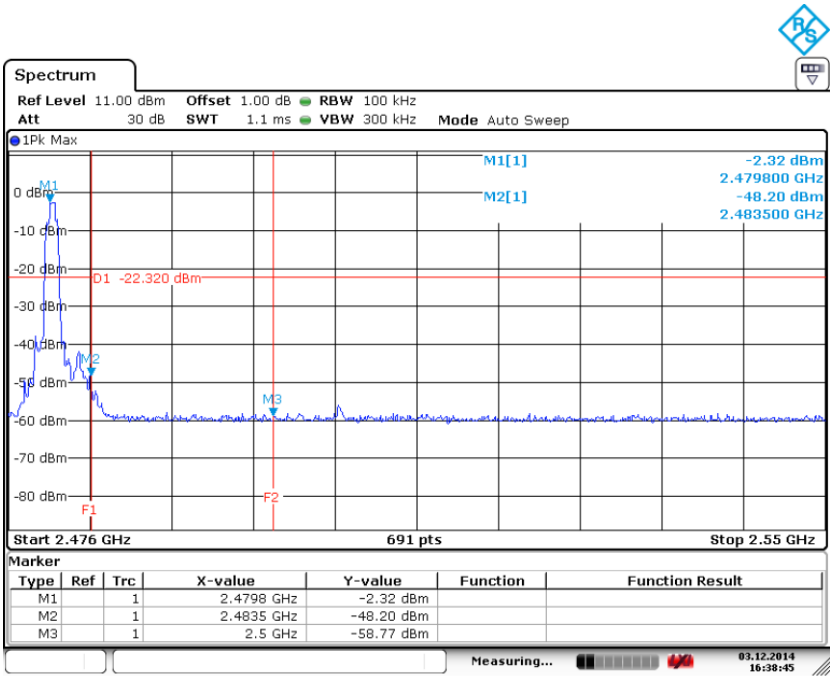

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9.8 Spurious radiated emissions for transmitter

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 ≥ 1GHz, 100 kHz for f < 1 GHz, VBW ≥ 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 20log(duty cycle/100 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 section15.205, 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

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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:

Bluetooth Mode GFSK Modulation 2402MHz Test Result

Frequency	Emission Level(PK)	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
637.4	30.79	Horizontal	46	QP	Pass
500.45	34.43	Vertical	46	QP	Pass
*4804	40.69	Horizontal	74	PK	Pass
*4804	45.01	Vertical	74	PK	Pass

Bluetooth Mode GFSK Modulation 2441MHz Test Result

Frequency	Emission Level(PK)	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
*4882	40.52	Horizontal	74	PK	Pass
*4882	42.59	Vertical	74	PK	Pass

Bluetooth Mode GFSK Modulation 2480MHz Test Result

Frequency	Emission Level(PK)	Polarization	Limit	Detector	Result
MHz	dBuV/m		dBµV/m		
*4960	41.80	Horizontal	74	PK	Pass
*4960	39.71	Vertical	74	PK	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.

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10 Test Equipment List

List of Test Instruments

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DUE DATE	
CE	Test Receiver	Rohde & Schwarz	ESHS10	838693/001	Nov.04, 15	☒
	L.I.S.N.#1	Rohde & Schwarz	ESH2-Z5	834066/011	Nov.04, 15	☒
	L.I.S.N.#3	Kyoritsu	KNW-242C	8-1920-1	May.07, 15	☐
	RF Cable	3D-2W	Fujikura	LISN Cable 1#	May.07, 15	☒
	Coaxial Switch	MP59B	Anritsu	M55367	May.07, 15	☒
	Passive Probe	ESH2-Z3	Rohde & Schwarz	299.7810.52	May.07, 15	☐
	Pulse Limiter	ESH3-Z2	Rohde & Schwarz	100341	May.07, 15	☐
C	Spectrum	Agilent	E4446A	US44300459	May.08, 15	☒
RE < 1 GHz	Test Receiver <1GHz	Rohde & Schwarz	ESVS10	834468/011	May.07, 15	☒
	Amplifier < 1 GHz	HP	8447D	2648A04738	May.07, 15	☒
	HF Cable	Hubersuhne	Sucoflex104	Room 2	May.08, 15	☒
	Bilog Antenna	Schaffner	CBL6111C	2598	Oct.25, 15	☒
RE > 1 GHz	Spectrum > 1GHz	Agilent	E4446A	US44300459	May.08, 15	☒
	Horn Antenna	EMCO	3115	9607-4877	Jun. 24, 15	☒
	Amp > 1 Ghz	HP	8449B	3008A08495	May.08, 15	☒
	HF Cable	Hubersuhne	Sucoflex104	Room1	May.08, 15	☒

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

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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	$1*10^{-9}$

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