China

FCC - TEST REPORT

Report Number	:	**708882003265-00**	Date of Issue:	July 10, 2020

Model	:	VWRK4
Product Type	:	Smart Audio Module
Applicant	:	Hangzhou Tuya Information Technology Co.,Ltd
Address	:	Room701,Building3,More Center,No.87 GuDun Road,Hangzhou,Zhejiang China
Production Facility	:	Newtronics Hangzhou Co.,Ltd
Address	:	No.15,Jiu zhou Road,Jiang Gan Science&Technology Economic Park Hangzhou

Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	57

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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. Shanghai Branch
No.16 Lane, 1951 Du Hui Road,
Shanghai 201108,
P.R. China

Test Firm Registration Number: 820234

Telephone: +86 21 6141 0123
Fax: +86 21 6140 8600

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3 Description of the Equipment Under Test

Product:	Smart Audio Module
Model no.:	VWRK4
FCC ID:	2ANDL- VWRK4
Options and accessories:	NA
Rating:	4.2V-5.5V
RF Transmission Frequency:	For 802.11b/g/n-HT20: 2412~2462 MHz (WiFi) For 802.11n-HT40: 2422~2452 MHz (WiFi) For 802.15.1:2402~2480 MHz (Classical Bluetooth +BLE4.2)
No. of Operated Channel:	2.4GHz WIFI: 11 for 802.11b/802.11g/802.11(H20) 7 for 802.11n(H40) 2.4GHz BLE: 40 2.4GHz Classical BLE:79
Modulation:	Direct Sequence Spread Spectrum (DSSS) for 802.11b Orthogonal Frequency Division Multiplexing (OFDM) for 802.11g/n For 2.4GHz BLE: GFSK For 2.4GHz Classical BLE: GFSK, π/4-DQPSK, 8DPSK
Antenna Type:	FPC antenna
Antenna Gain:	2.5dBi
Description of the EUT:	The Equipment Under Test (EUT) is a Smart Audio Module which support 2.4GHz WiFi, BLE and Classical Bluetooth. We tested it and listed the worst data in this report.

The sample's mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C	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; KDB 558074 D01 15.247 Meas Guidance v05r02 and C63.10 (2013).

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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	12-14	Site 1	Pass
§15.247(b)(1)		Conducted peak output power	15-19	Site 1	Pass
§15.247(a)(2)		6dB bandwidth	---	---	N/A
§15.247(a)(1)		20dB bandwidth	20-26	Site 1	Pass
§15.247(a)(1)		Carrier frequency separation	27-29	Site 1	Pass
§15.247(a)(1)(iii)		Number of hopping frequencies	30-32	Site 1	Pass
§15.247(a)(1)(iii)		Dwell Time	33-35	Site 1	Pass
§15.247(e)		Power spectral density*	---	---	N/A
§15.247(d)		Spurious RF conducted emissions	36-41	Site 1	Pass
§15.247(d)		Band edge	42-48	Site 1	Pass
§15.247(d) & §15.209 &		Spurious radiated emissions for transmitter and receiver	51-53	Site 1	Pass
§15.203		Antenna requirement	See note 1		Pass

Note 1: N/A=Not Applicable.
Note 2: The EUT uses a patch antenna, which gain is 2.5dBi. 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: 2ANDL-VWRK4, complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

This report is only for the 2.4GHz Classical Bluetooth test report, for the 2.4GHz BLE test report please refer to 708882003254-00 and 2.4GHz WiFi please refer to 708882003266-00

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 12, 2020

Testing Start Date: June 15, 2020

Testing End Date: July 4, 2020

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Reviewed by:	Prepared by:	Tested by:
Hui TONG	Jiaxi XU	Wenqiang LU
Review Engineer	Project Engineer	Test Engineer

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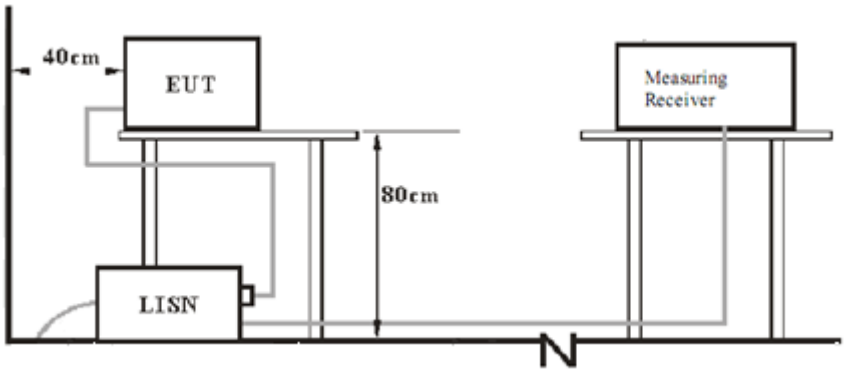
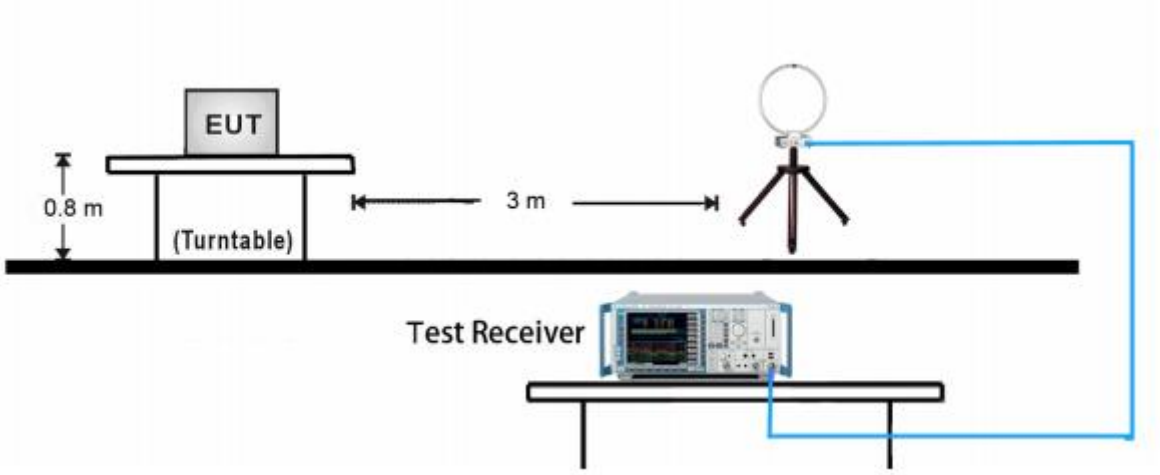
7 Test Setups

7.1 AC Power Line Conducted Emission test setups



7.2 Radiated test setups

9kHz ~ 30MHz Test Setup:



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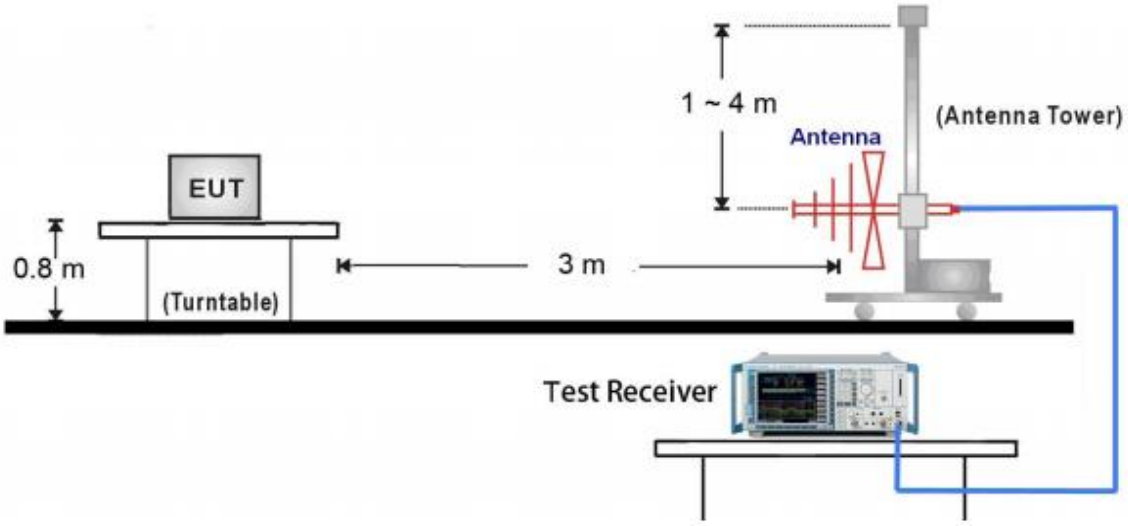
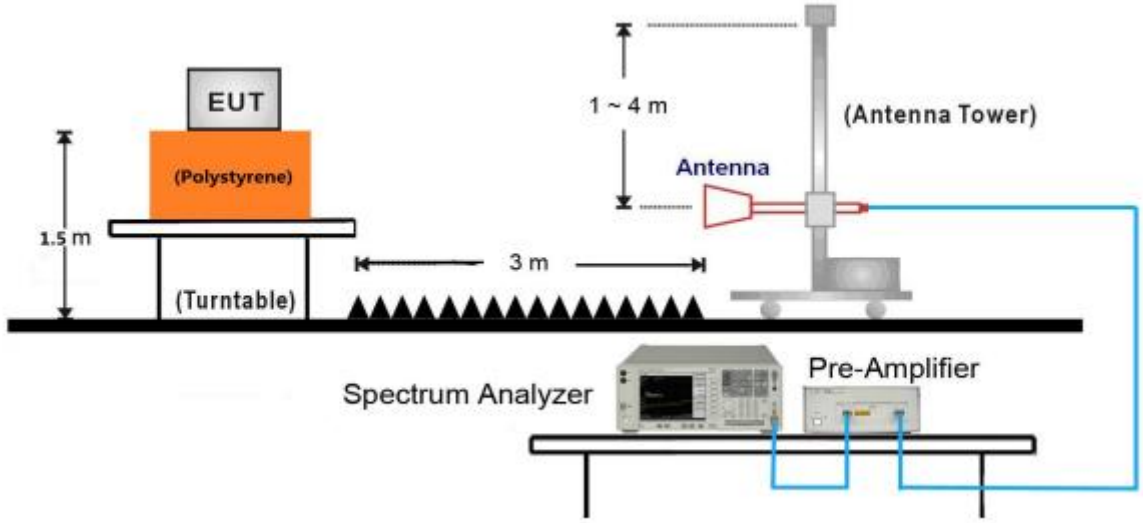
30MHz ~ 1GHz Test Setup:



1GHz ~ 18GHz Test Setup:



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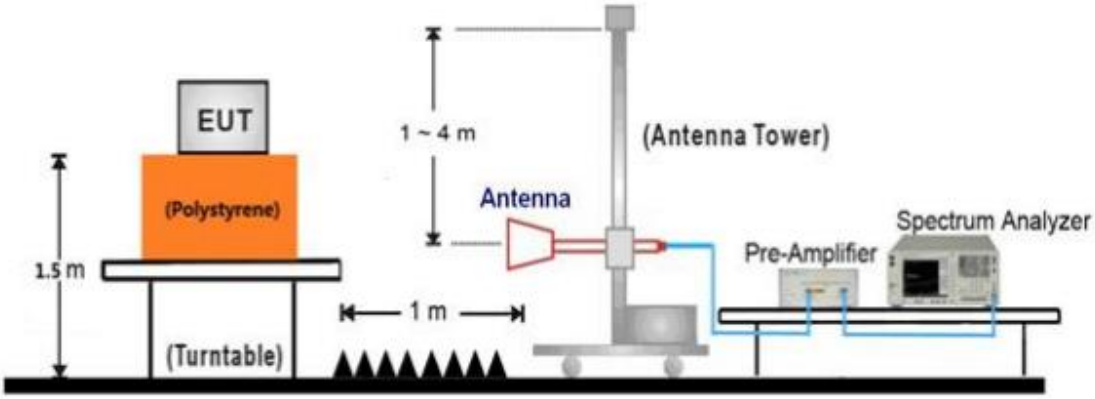
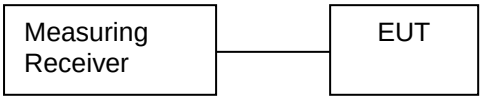
18GHz ~ 25GHz Test Setup:



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	Lenove	E470	Notebook

Test software: secure CRT, 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 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 dBµV	AV Limit dBµV
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

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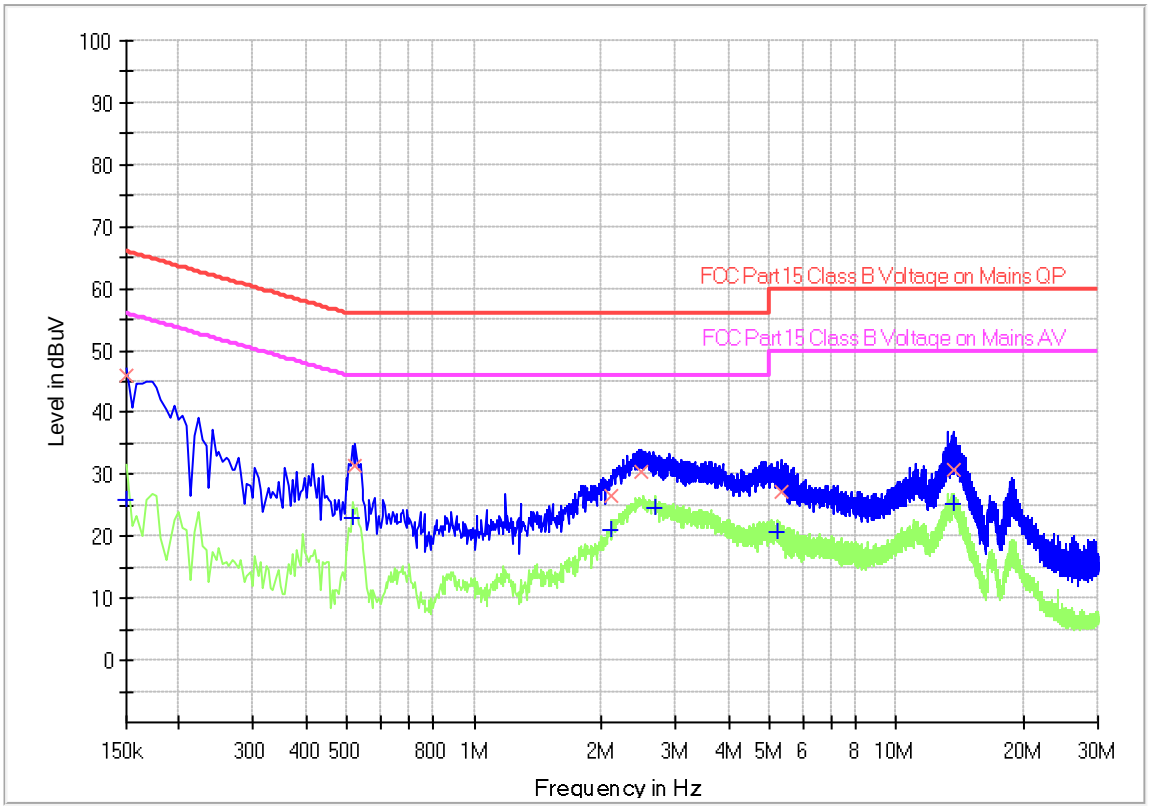
Conducted Emission

Product Type	:	Smart Audio Module
M/N	:	VWRK4
Operating Condition	:	Mode 1: Tx_2441MHz(8DPSK)
Test Specification	:	L-line
Comment	:	AC 120V/60Hz (powered by notebook)



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	---	26.01	56.00	29.99	1000.0	9.000	L1	19.5
0.150000	45.91	---	66.00	20.09	1000.0	9.000	L1	19.5
0.514500	---	22.99	46.00	23.01	1000.0	9.000	L1	19.4
0.523500	31.54	---	56.00	24.46	1000.0	9.000	L1	19.4
2.107500	---	21.11	46.00	24.89	1000.0	9.000	L1	19.5
2.112000	26.48	---	56.00	29.52	1000.0	9.000	L1	19.5
2.476500	30.37	---	56.00	25.63	1000.0	9.000	L1	19.5
2.683500	---	24.75	46.00	21.25	1000.0	9.000	L1	19.5
5.199000	---	20.85	50.00	29.15	1000.0	9.000	L1	19.6
5.334000	27.11	---	60.00	32.89	1000.0	9.000	L1	19.6
13.632000	---	25.16	50.00	24.84	1000.0	9.000	L1	19.7
13.731000	30.90	---	60.00	29.10	1000.0	9.000	L1	19.7

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

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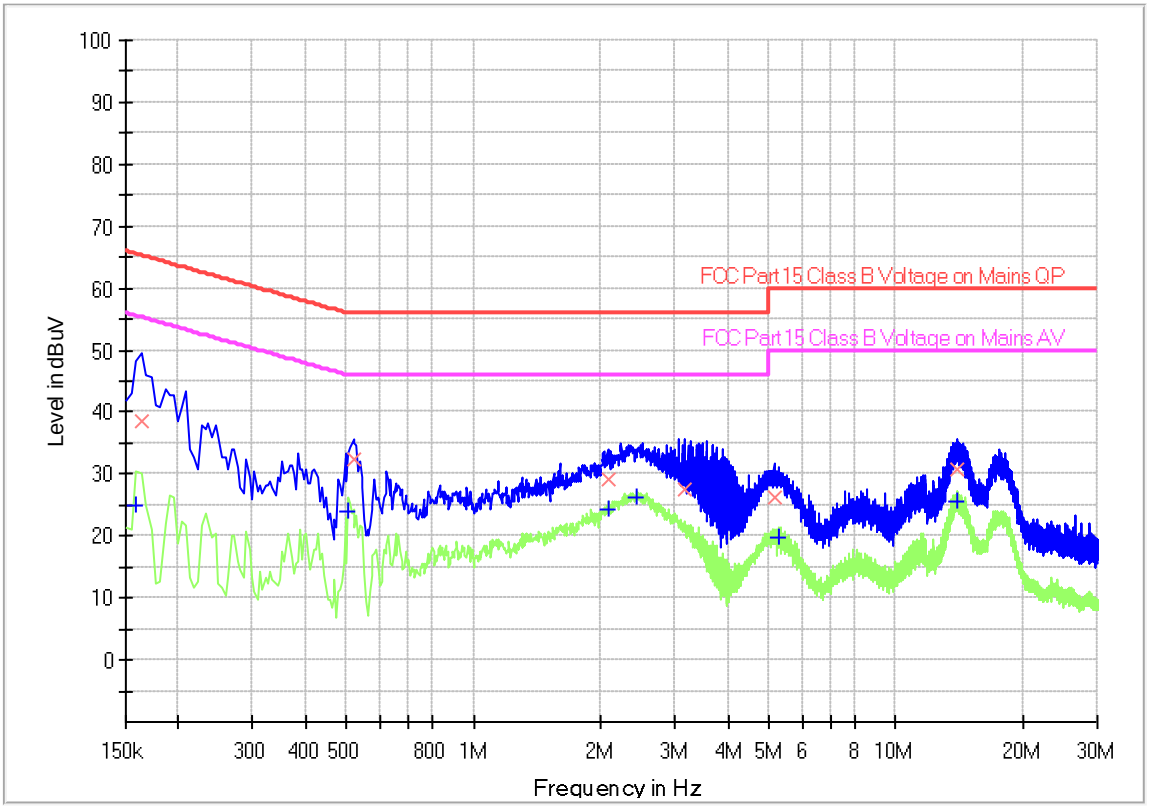
Product Type	:	Smart Audio Module
M/N	:	VWRK4
Operating Condition	:	Mode 1: 2441MHz(8DPSK)
Test Specification	:	N-line
Comment	:	AC 120V/60Hz (powered by notebook)



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.159000	---	24.93	55.52	30.59	1000.0	9.000	N	19.6
0.163500	38.46	---	65.28	26.82	1000.0	9.000	N	19.6
0.505500	---	24.07	46.00	21.93	1000.0	9.000	N	19.5
0.519000	32.51	---	56.00	23.49	1000.0	9.000	N	19.5
2.076000	29.18	---	56.00	26.82	1000.0	9.000	N	19.6
2.094000	---	24.31	46.00	21.69	1000.0	9.000	N	19.6
2.445000	---	26.10	46.00	19.90	1000.0	9.000	N	19.6
3.156000	27.66	---	56.00	28.34	1000.0	9.000	N	19.6
5.140500	26.11	---	60.00	33.89	1000.0	9.000	N	19.7
5.284500	---	19.65	50.00	30.35	1000.0	9.000	N	19.7
13.983000	---	25.56	50.00	24.44	1000.0	9.000	N	19.7
14.032500	30.63	---	60.00	29.37	1000.0	9.000	N	19.7

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

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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

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	7.83	Pass
Middle channel 2441MHz	7.58	Pass
High channel 2480MHz	7.19	Pass

Bluetooth Mode π/4-DQPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	7.40	Pass
Middle channel 2441MHz	7.03	Pass
High channel 2480MHz	6.67	Pass

Bluetooth Mode 8DPSK modulation Test Result

Frequency MHz	Conducted Peak Output Power dBm	Result
Low channel 2402MHz	7.79	Pass
Middle channel 2441MHz	8.24	Pass
High channel 2480MHz	7.15	Pass

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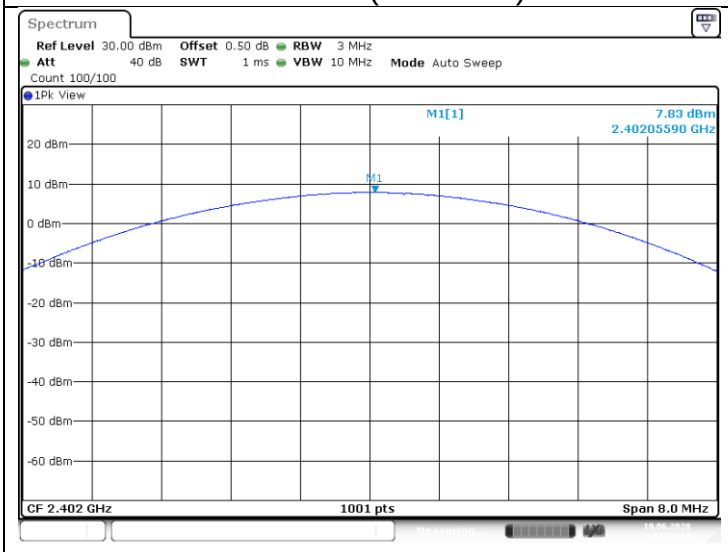
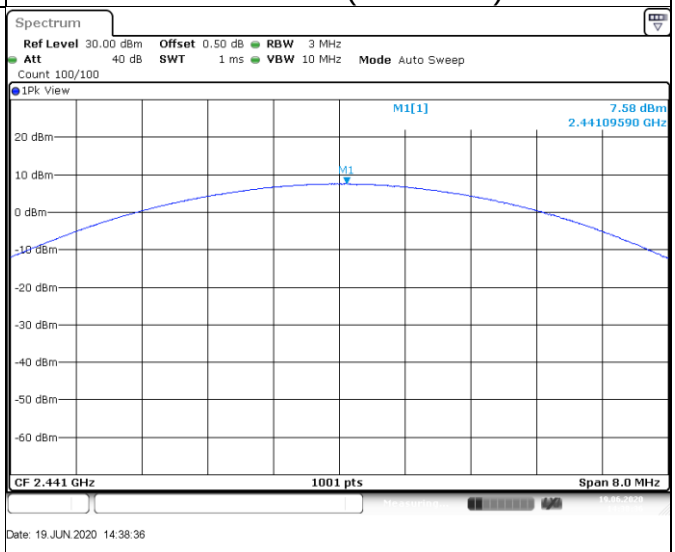
GFSK

Peak output power

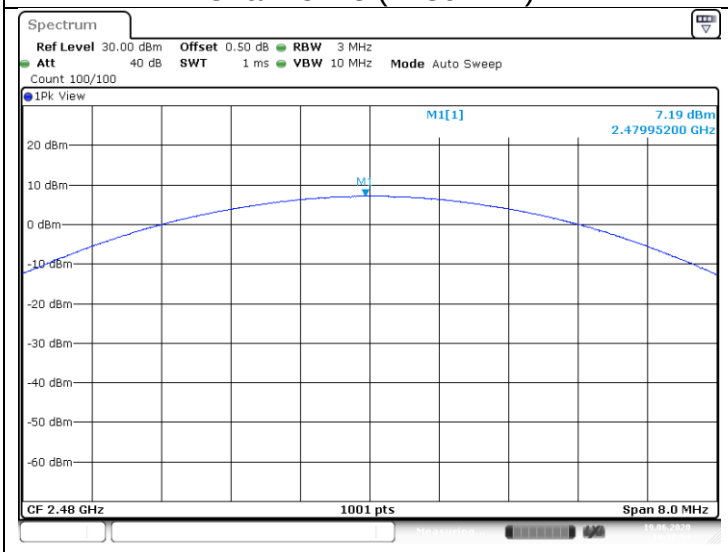
Channel 0 (2402MHz)



Channel 39 (2441MHz)



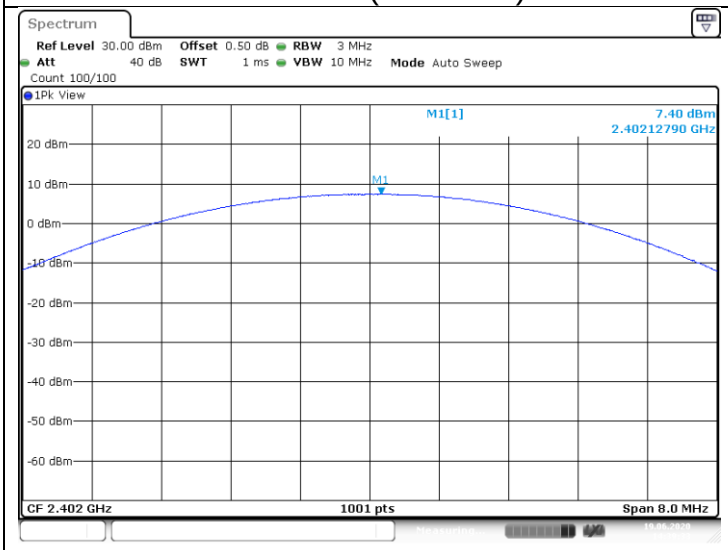
Channel 78 (2480MHz)



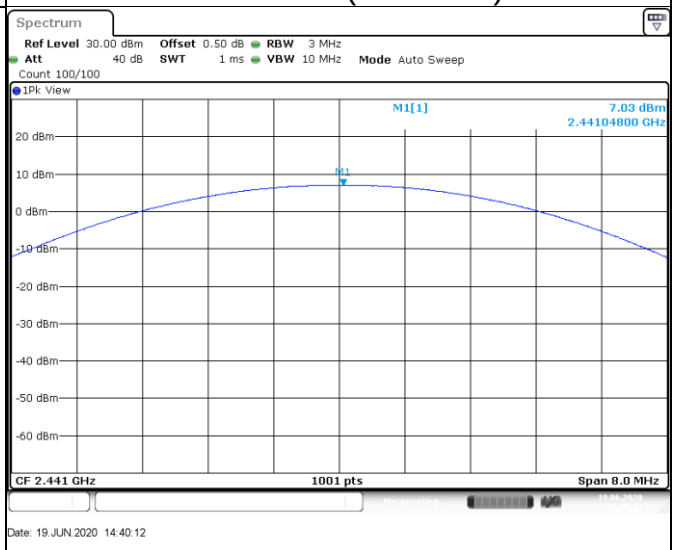
π/4-DQPSK

Peak output power

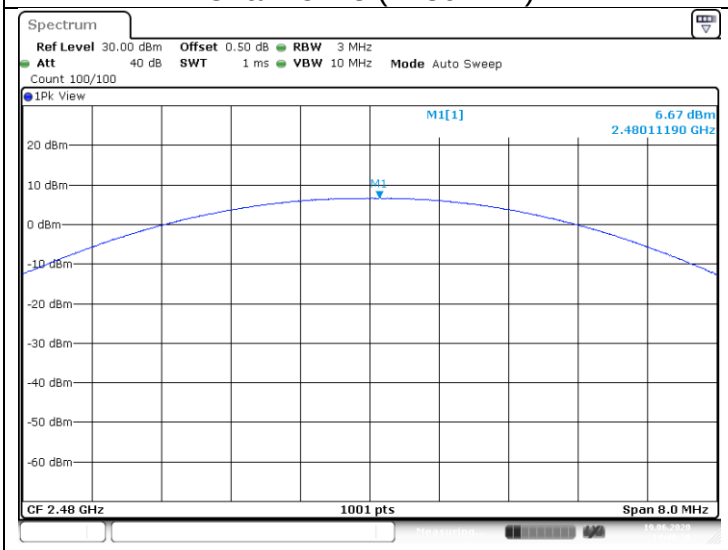
Channel 0 (2402MHz)



Channel 39 (2441MHz)



Channel 78 (2480MHz)



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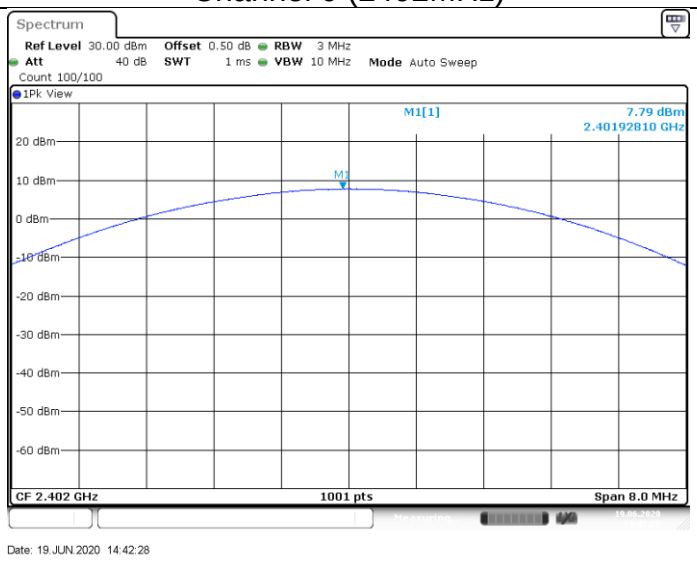
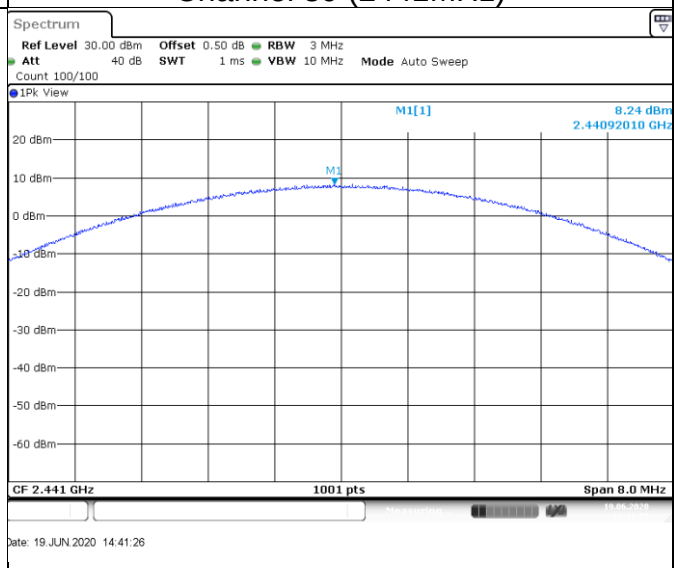
8DPSK

Peak output power

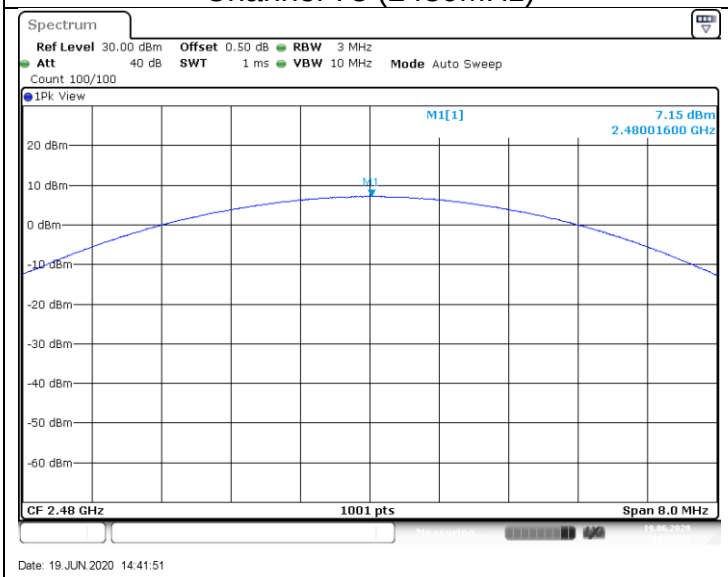
Channel 0 (2402MHz)



Channel 39 (2441MHz)



Channel 78 (2480MHz)



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9.3 20 dB 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

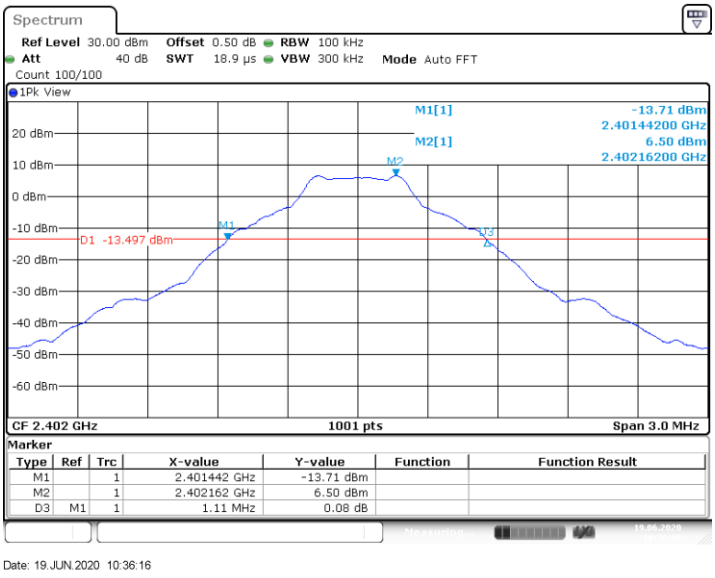
Limit [kHz]
N/A

20 dB bandwidth

Bluetooth Mode GFSK Modulation test result

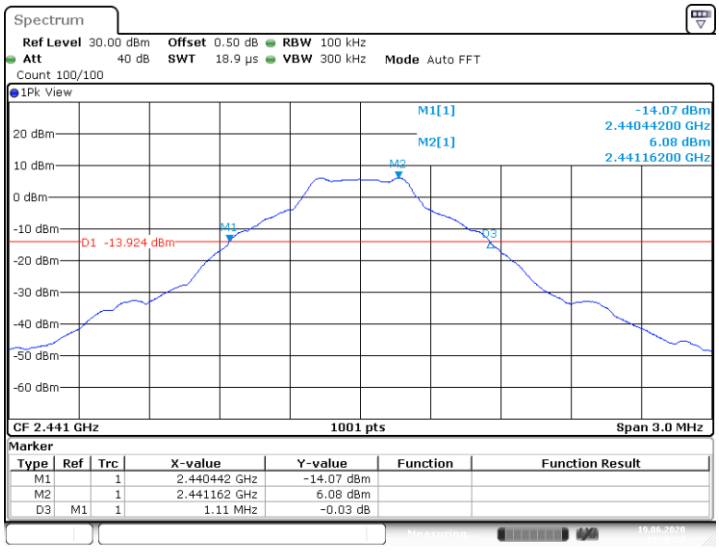
Frequency MHz	20 dB Bandwidth kHz	Limit kHz	Result
2402	1110	--	Pass
2441	1110	--	Pass
2480	1110	--	Pass

Low channel 2402MHz



Date: 19.JUN.2020 10:36:16

Mid channel 2441MHz



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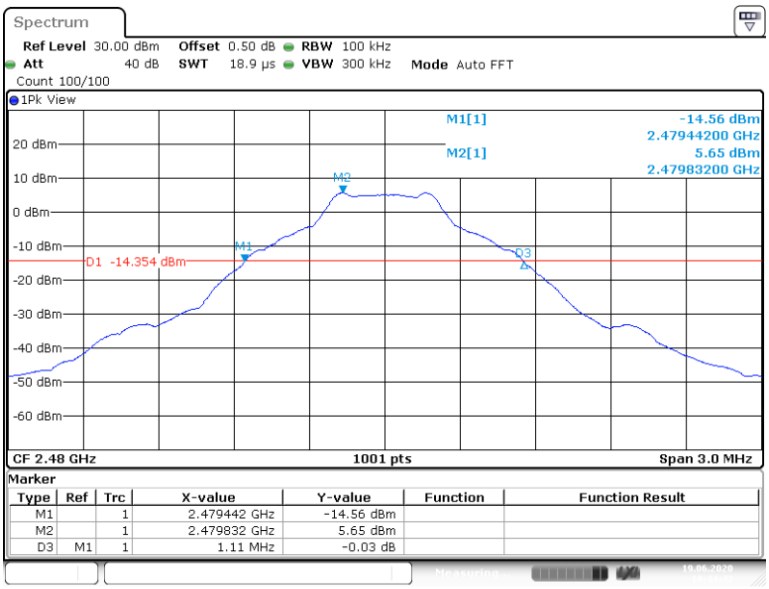
High channel 2480MHz



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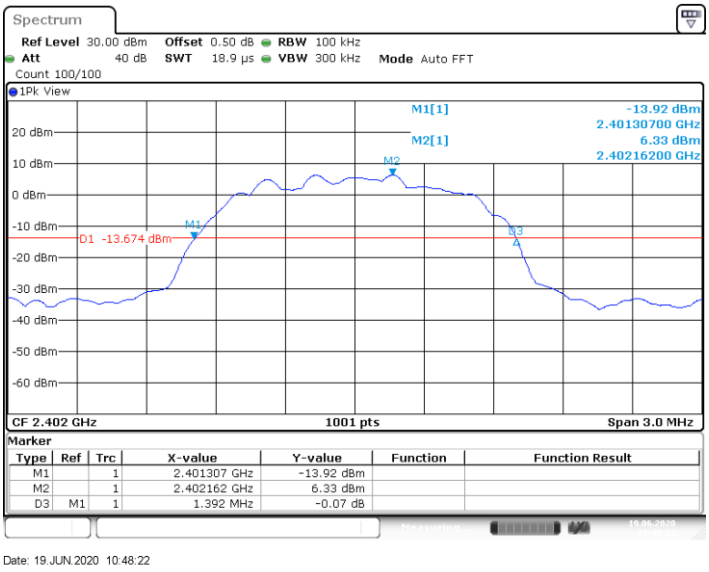
20 dB bandwidth Bandwidth

Bluetooth Mode π/4-DQPSK Modulation test result

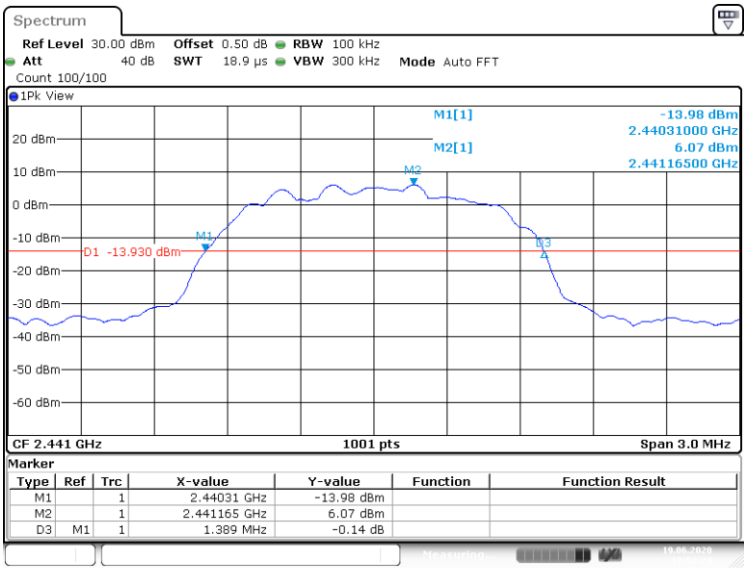
Frequency MHz	20 dB Bandwidth kHz	Limit kHz	Result
2402	1392	--	Pass
2441	1389	--	Pass
2480	1389	--	Pass

Low channel 2402MHz



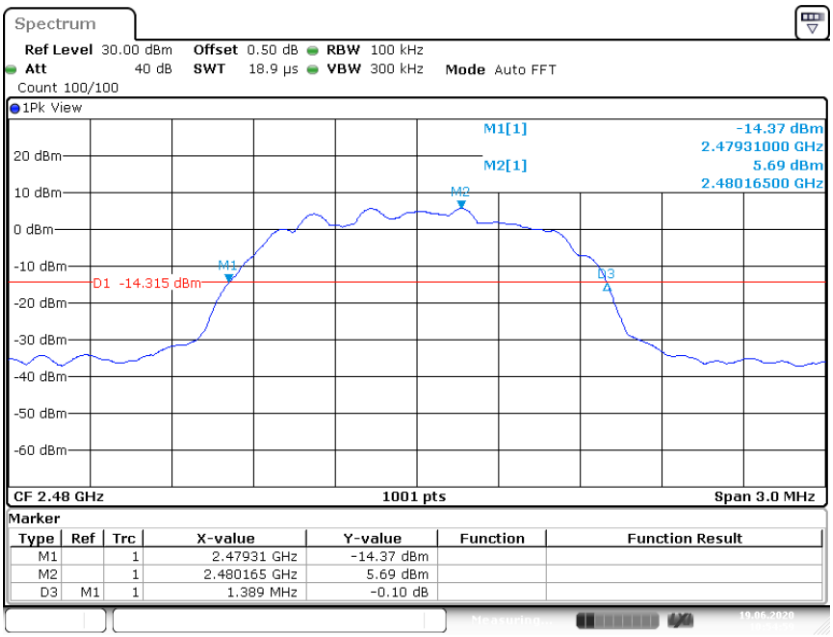
Date: 19.JUN.2020 10:48:22

Mid channel 2441MHz



Date: 19.JUN.2020 10:52:24

High channel 2480MHz

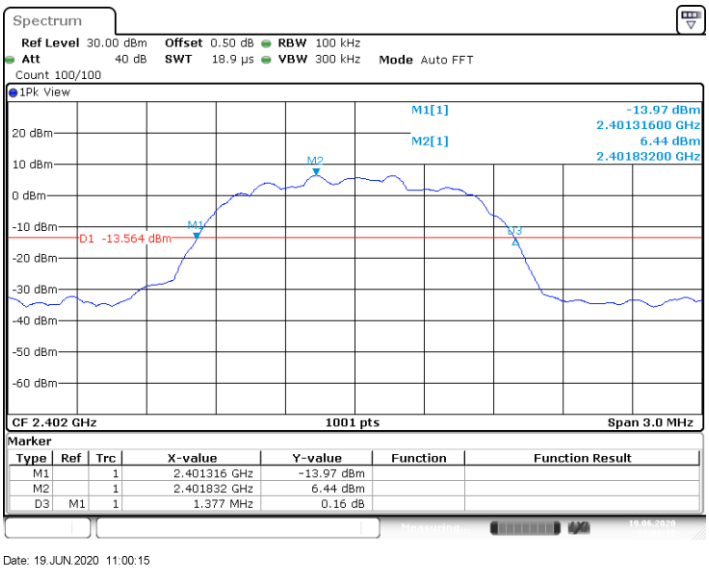


20 dB bandwidth Bandwidth

Bluetooth Mode 8DPSK Modulation test result

Frequency MHz	20 dB Bandwidth kHz	Limit kHz	Result
2402	1377	--	Pass
2441	1377	--	Pass
2480	1374	--	Pass

Low channel 2402MHz



Mid channel 2441MHz

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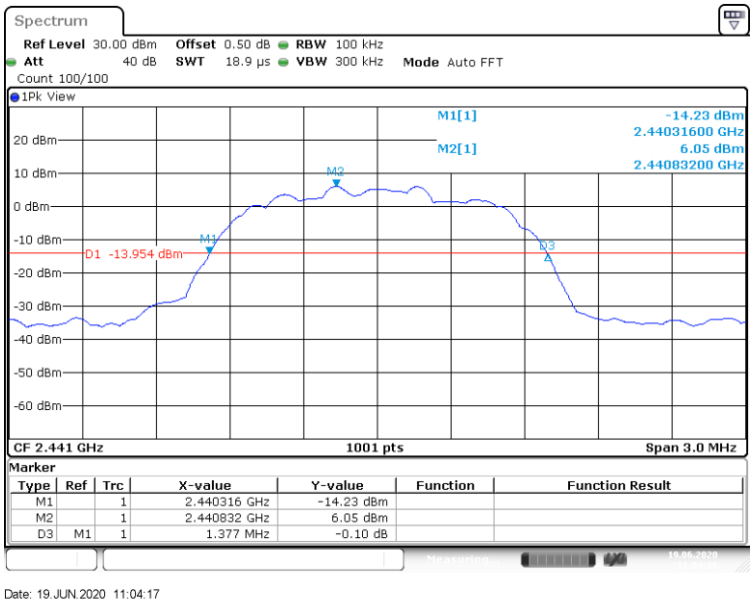
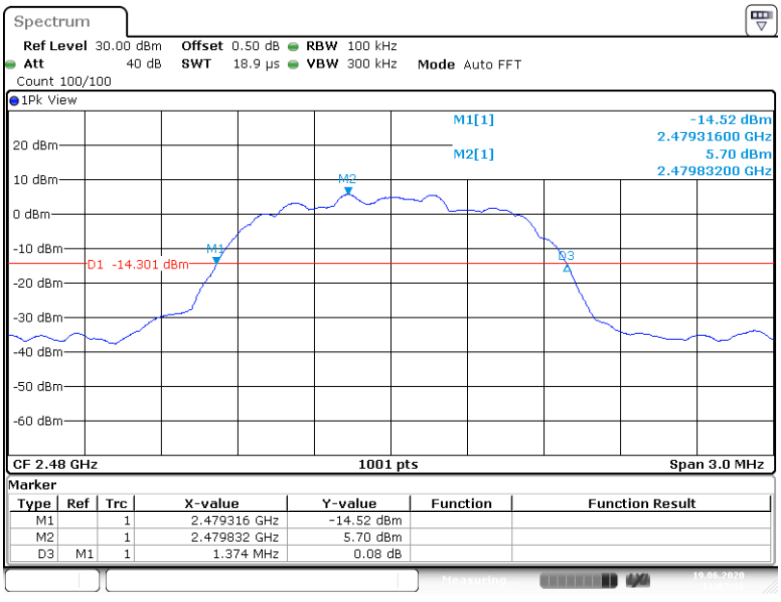


Date: 19.JUN.2020 11:04:17

High channel 2480MHz



Date: 19.JUN.2020 11:07:16

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 ≥ 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

Limit

Frequency MHz	2/3 of 20 dB Bandwidth kHz
2402	740 (GFSK)
2441	928(π/4-DQPSK)
2402	918(8DPSK)

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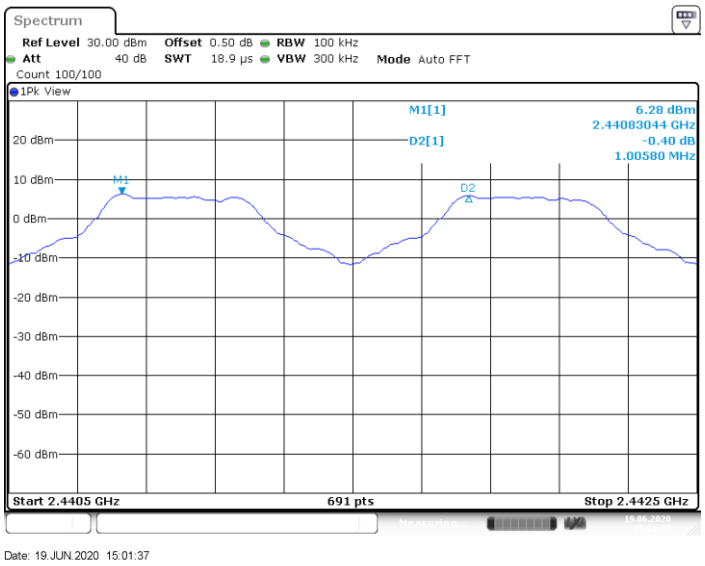
Carrier Frequency Separation

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

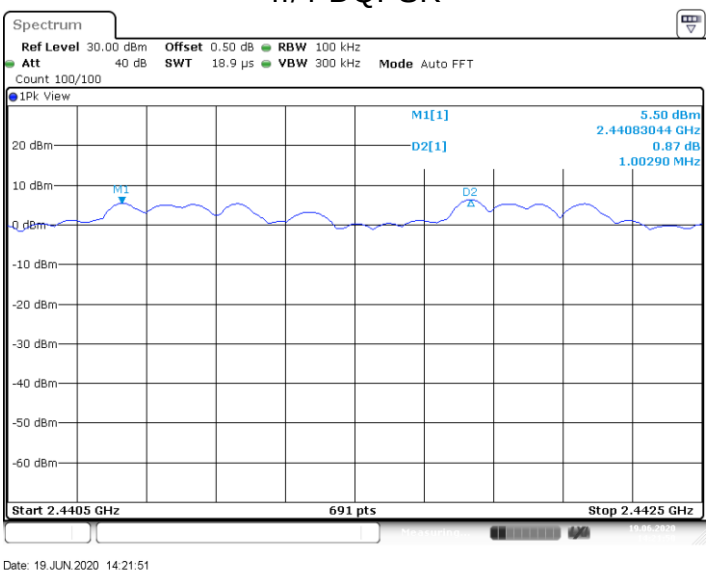
test result

Modulation	Frequency MHz	Carrier Frequency Separation kHz	Result
GFSK	2441	1005.8	Pass
π/4-DQPSK	2441	1002.9	Pass
8DPSK	2441	1101.4	Pass

GFSK



π/4-DQPSK



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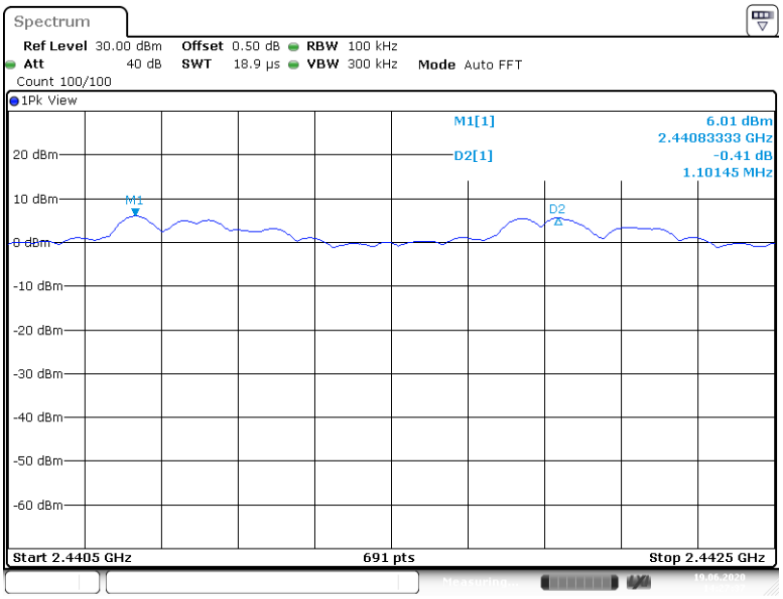
8DPSK



Date: 19.JUN.2020 14:27:37

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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 ≥ 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

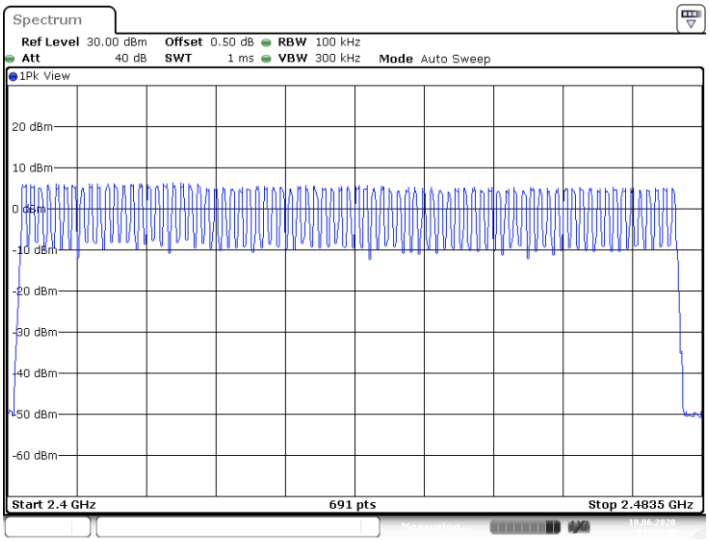
Limit number
⩾ 15

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.

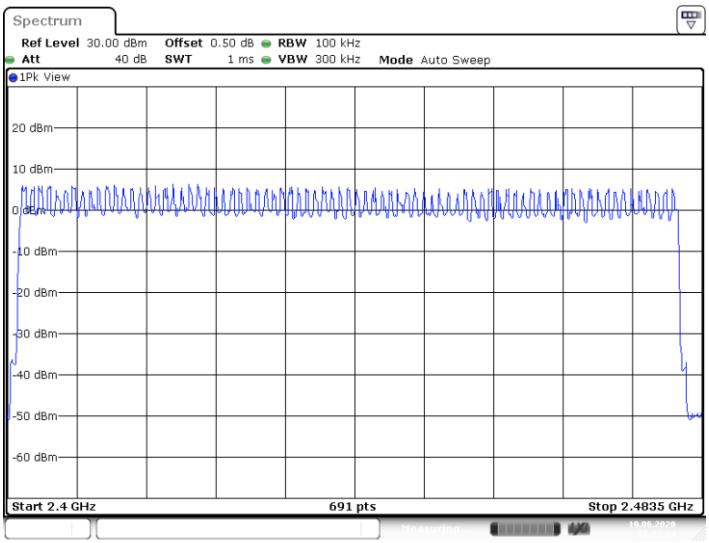
Number of hopping frequencies	Result
79	Pass

GFSK



Date: 19.JUN.2020 15:22:48

π/4-DQPSK Mode



Date: 19.JUN.2020 15:23:25

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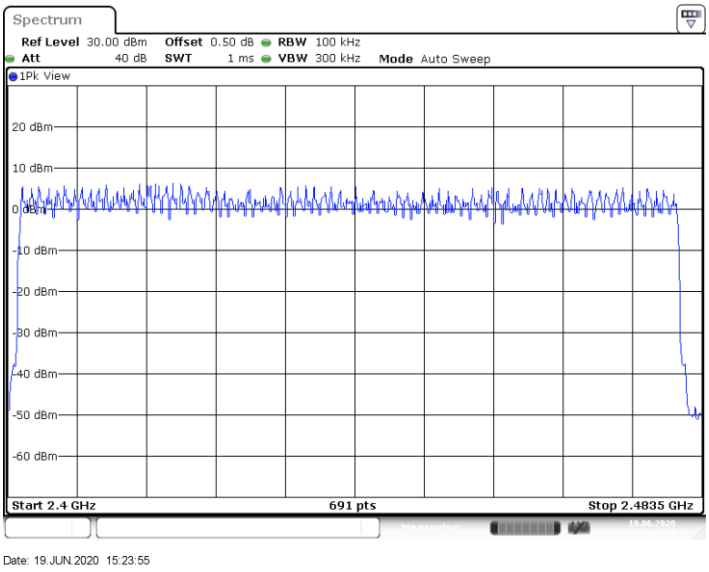
8DPSK Mode



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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

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

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.

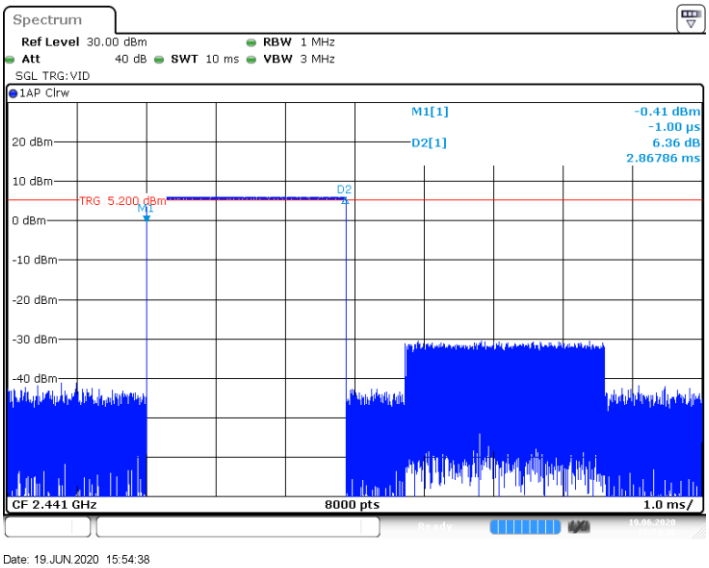
The maximum number of hopping channels in 31.6s for DH5=1600 / 6 / 79 *31.6=106.67

Test Result

Modulation	Mode	Reading (ms)	Total Hops	Test Result (ms)	Limit (ms)	Result
GFSK	DH5	2.87	106.67	306.14	< 400	Pass
π/4-DQPSK	2DH5	2.87	106.67	306.14	< 400	Pass
8-DPSK	3DH5	2.87	106.67	306.14	< 400	Pass

GFSK Modulation

DH5



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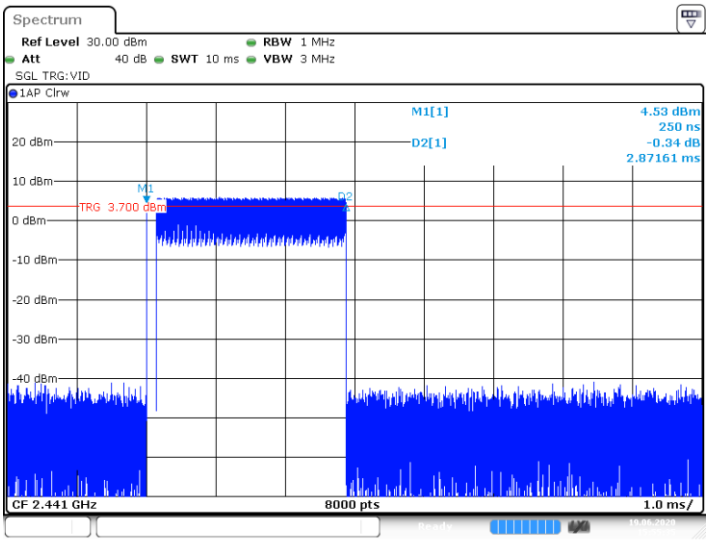
π/4-DQPSK Modulation

2DH5



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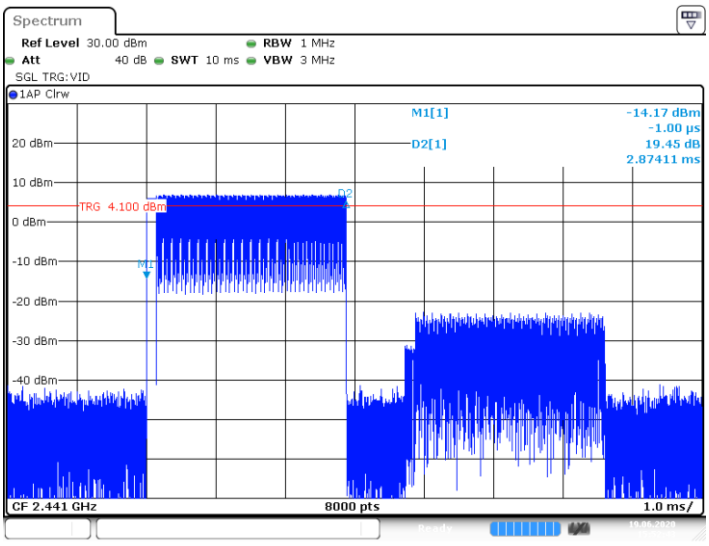
8-DPSK Modulation

3DH5



Date: 19.JUN.2020 15:52:43

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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

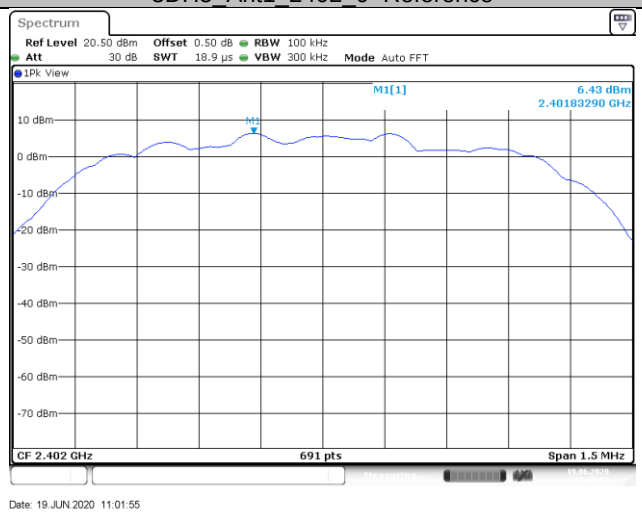
Frequency Range MHz	Limit (dBc)
30-25000	-20

Spurious RF conducted emissions

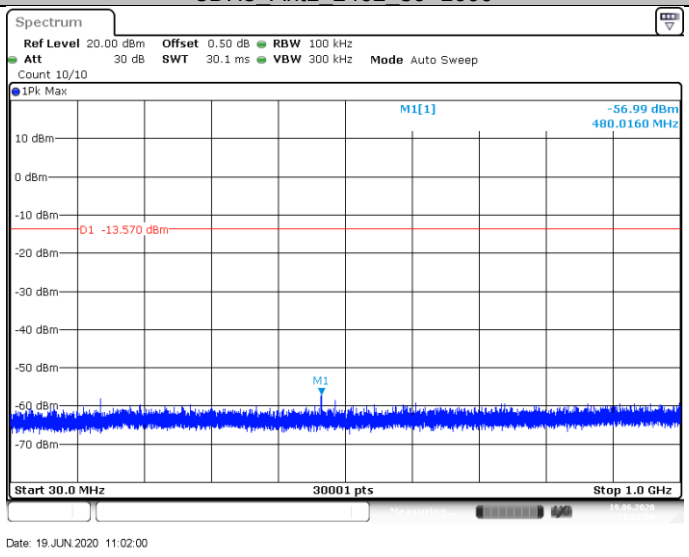
Only the worst case (which is subject to the maximum EIRP, 8DPSK mode) test result is listed in the report.

Test Mode	Antenna	Channel	FreqRange [MHz]	RefLevel [dBm]	Result [dBm]	Limit [dBm]	Verdict
3DH5	Ant1	2402	Reference	6.43	6.43	---	PASS
			30~1000	30~1000	-57.06	<=-13.57	PASS
			1000~5000	1000~5000	-55.81	<=-13.57	PASS
			5000~26500	5000~26500	-52.58	<=-13.57	PASS
		2441	Reference	6.04	6.04	---	PASS
			30~1000	30~1000	-55.42	<=-13.96	PASS
			1000~5000	1000~5000	-55.18	<=-13.96	PASS
			5000~26500	5000~26500	-51.98	<=-13.96	PASS
		2480	Reference	5.59	5.59	---	PASS
			30~1000	30~1000	-57.71	<=-14.41	PASS
			1000~5000	1000~5000	-55.62	<=-14.41	PASS
			5000~26500	5000~26500	-52.17	<=-14.41	PASS

3DH5_Ant1_2402_0~Reference



3DH5_Ant1_2402_30~1000



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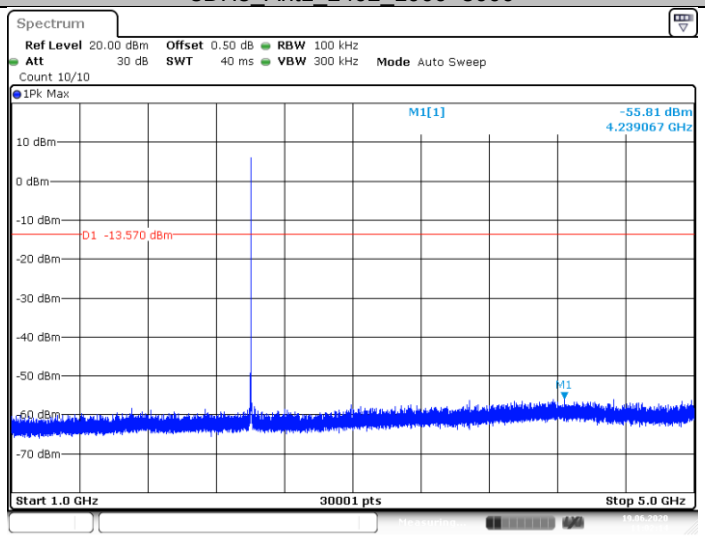
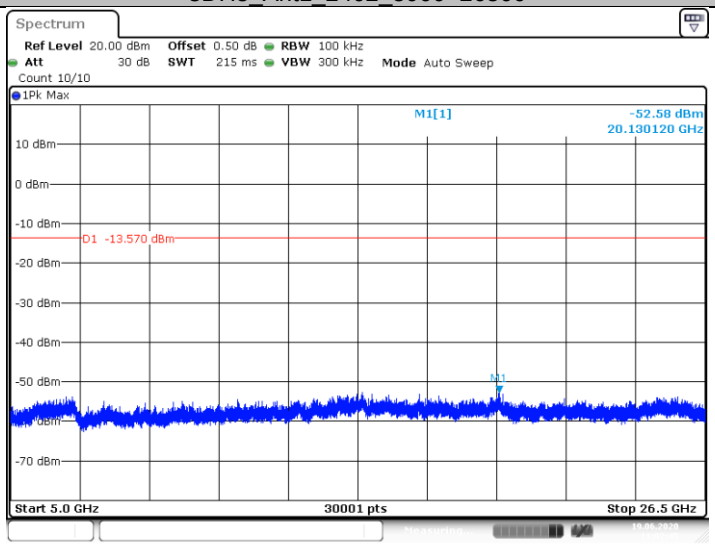
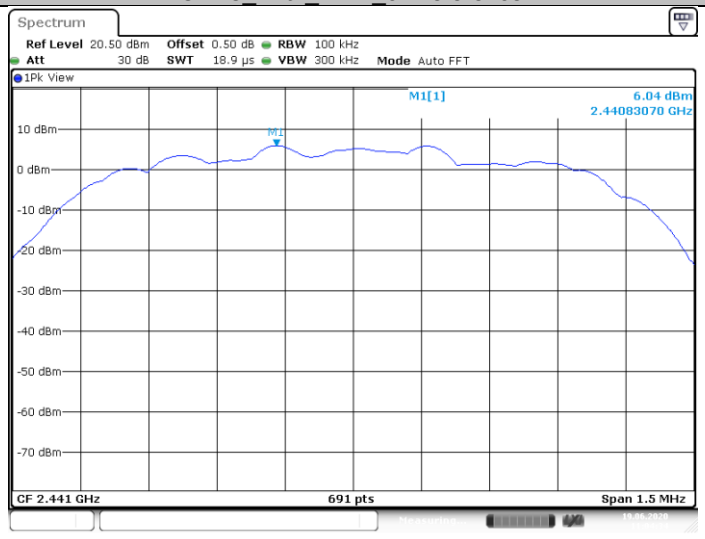
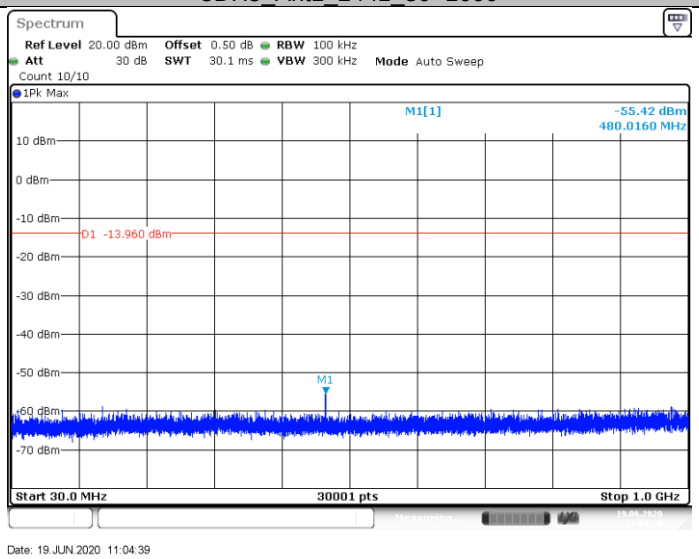
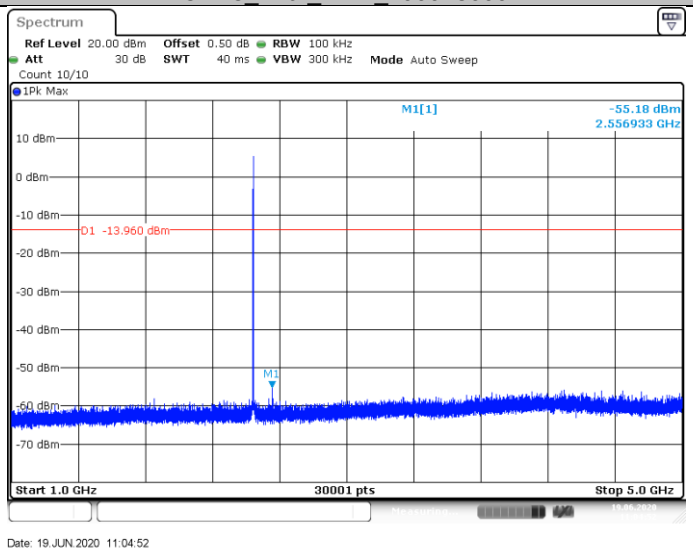
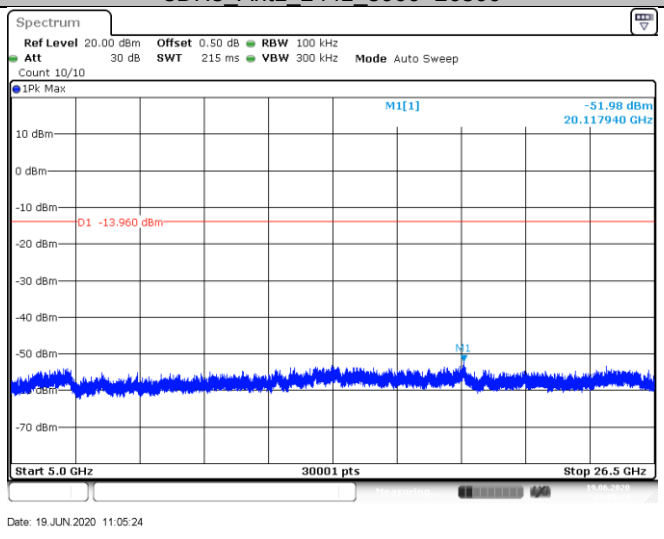
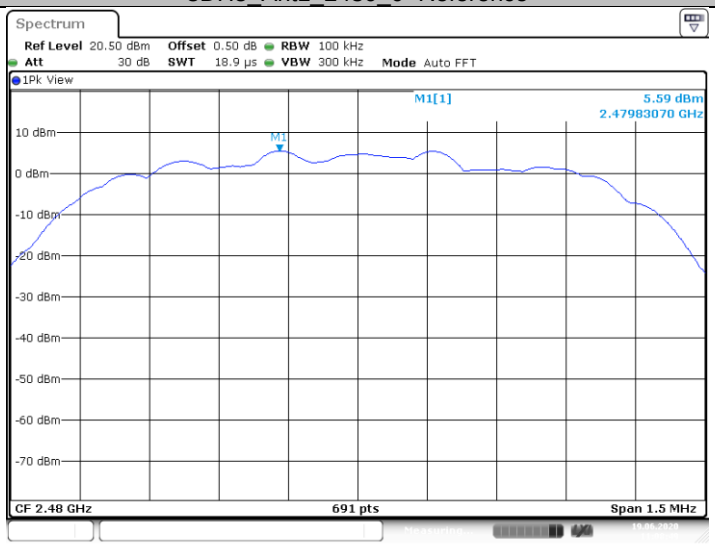
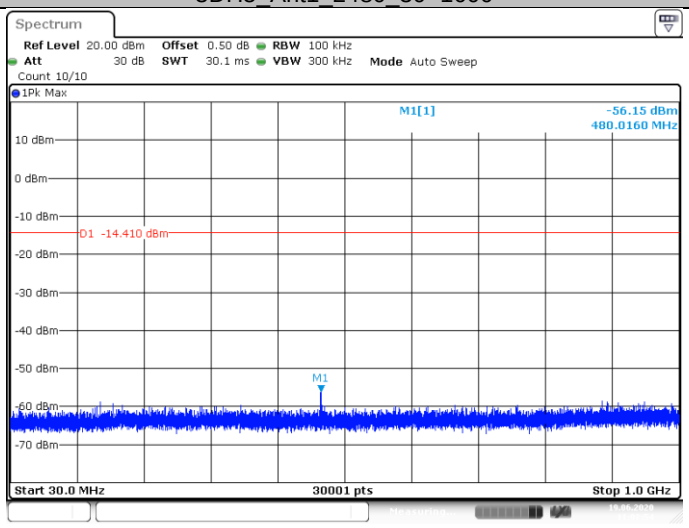
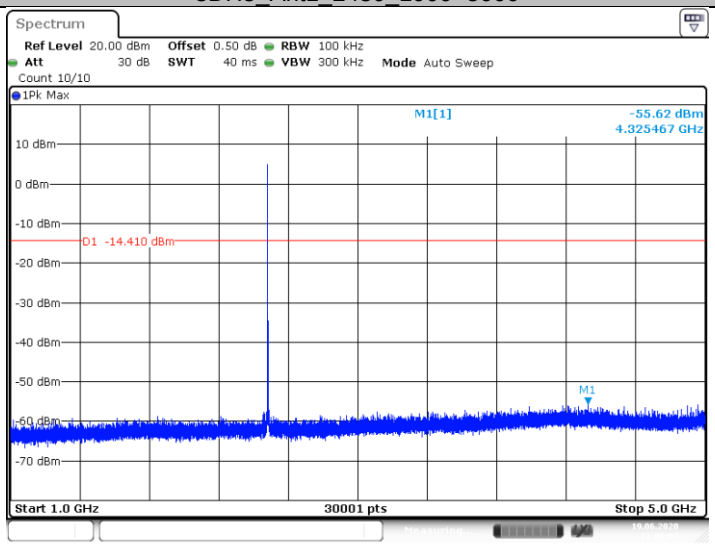
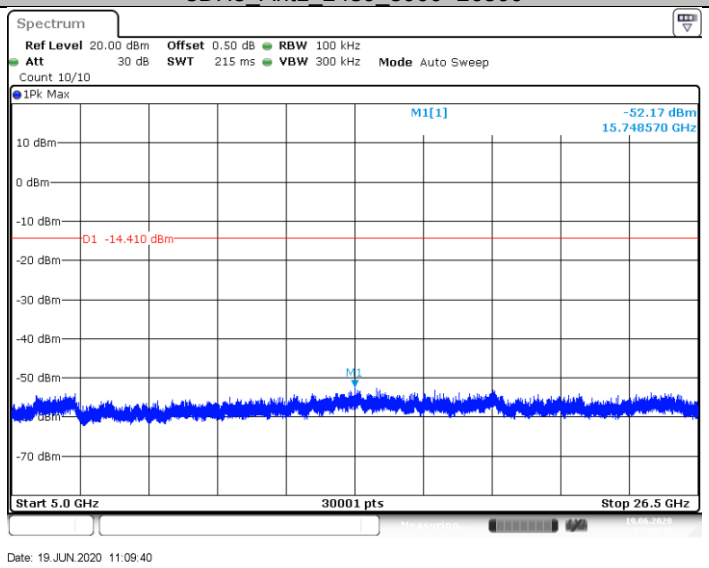
3DH5_Ant1_2402_1000~5000
 Date: 19.JUN.2020 11:02:13
3DH5_Ant1_2402_5000~26500
 Date: 19.JUN.2020 11:02:46
3DH5_Ant1_2441_0~Reference
 Date: 19.JUN.2020 11:04:33

3DH5_Ant1_2441_30~1000

3DH5_Ant1_2441_1000~5000

3DH5_Ant1_2441_5000~26500


3DH5_Ant1_2480_0~Reference

3DH5_Ant1_2480_30~1000

3DH5_Ant1_2480_1000~5000


3DH5_Ant1_2480_5000~26500


9.8 Band edge testing

Test Method

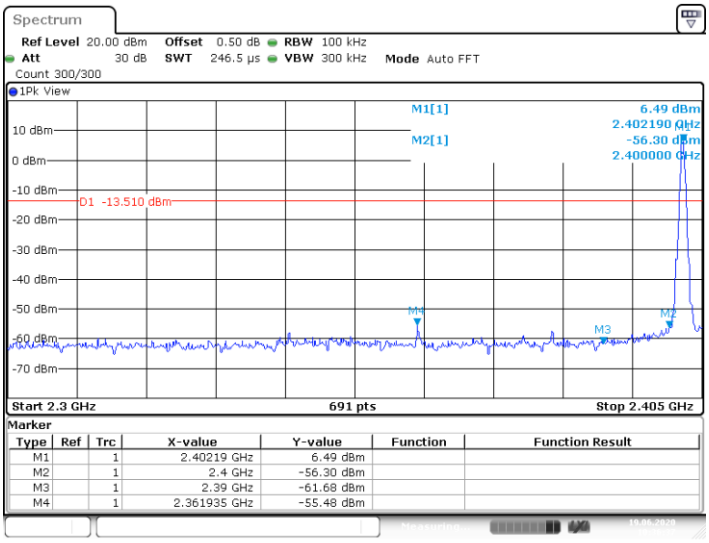
1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency
6. Set to the maximum power setting and enable the EUT hopping mode, repeat the test.

Limit:

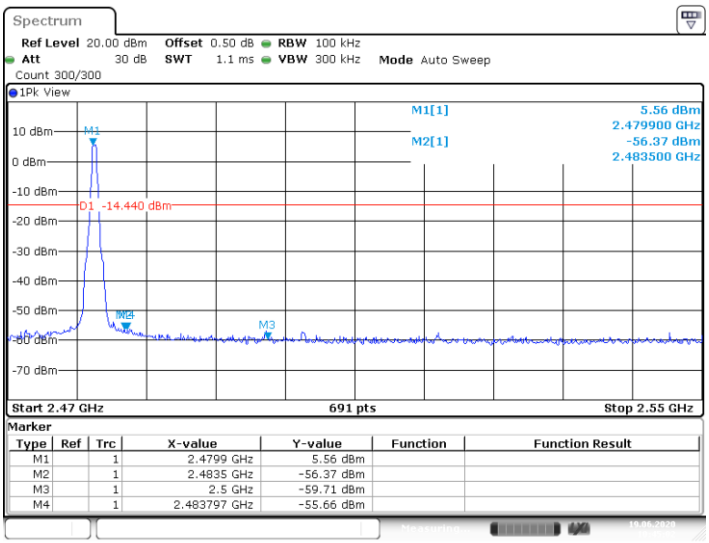
In any 100kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an 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 off mode:



Date: 19.JUN.2020 10:36:37



Date: 19.JUN.2020 10:45:03

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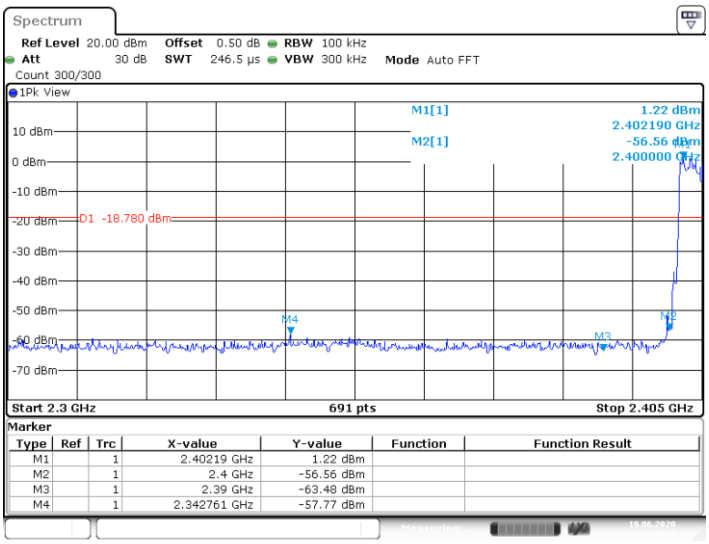
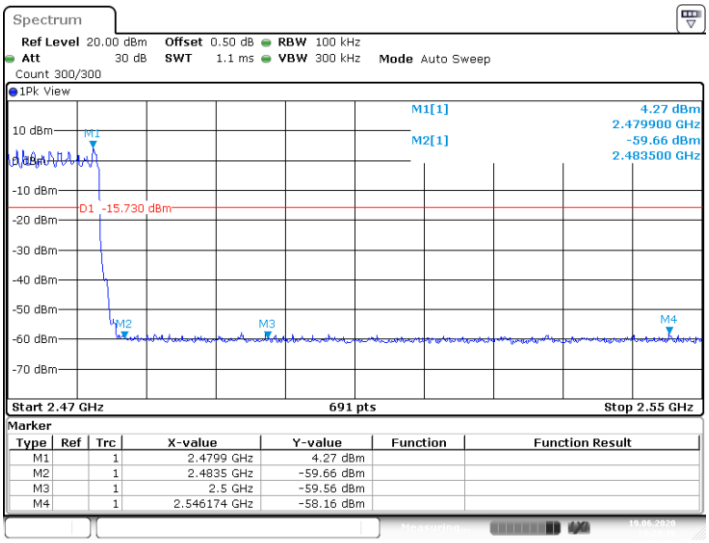
Hopping on mode:



Date: 19.JUN.2020 14:20:28



Date: 19.JUN.2020 14:24:16

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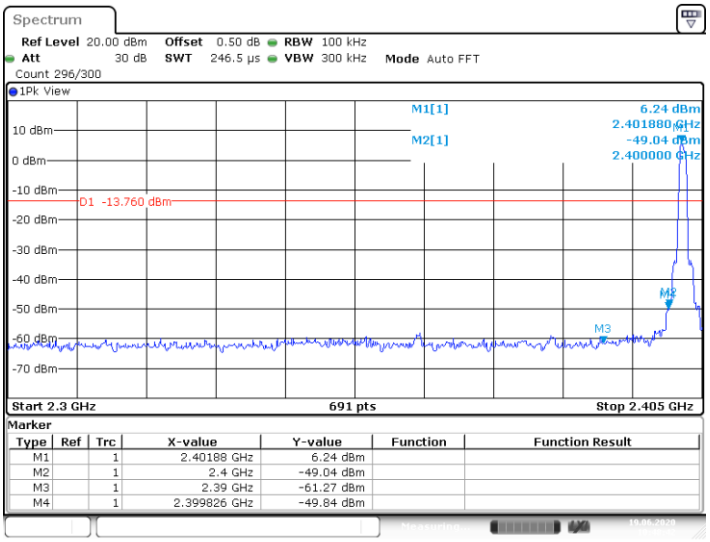
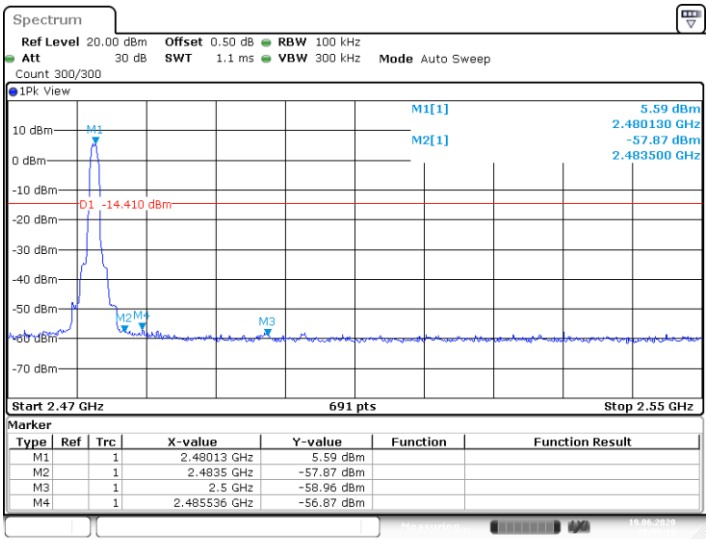
π /4-DQPSK Modulation Test Result:
Hopping off mode:

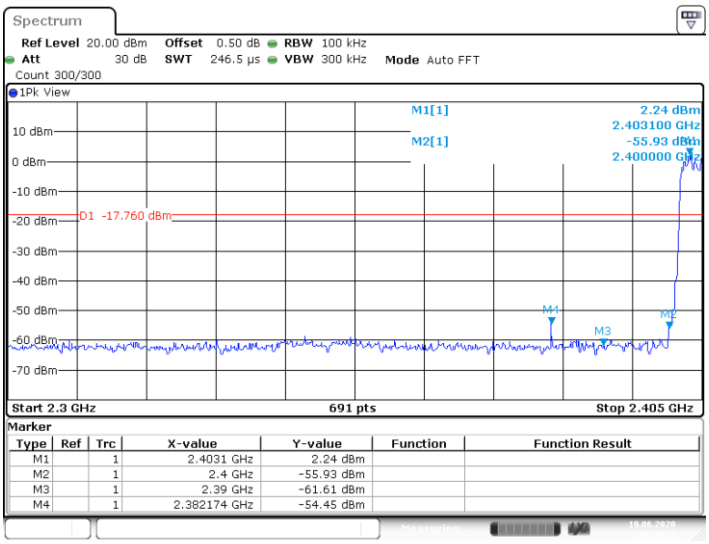


Date: 19.JUN.2020 10:48:42

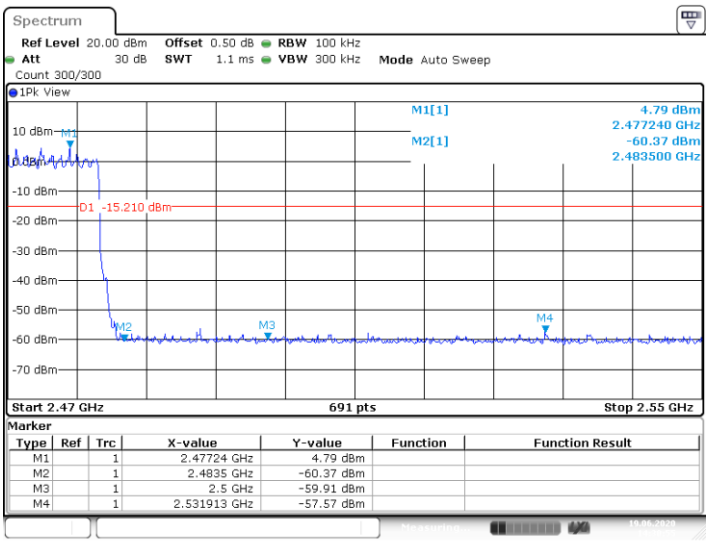


Date: 19.JUN.2020 10:55:19

Hopping on mode:



Date: 19.JUN.2020 14:26:22



Date: 19.JUN.2020 14:30:55

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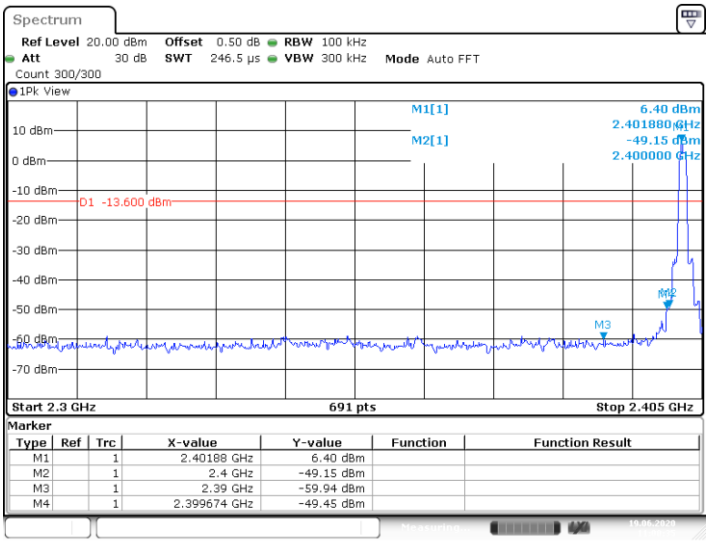
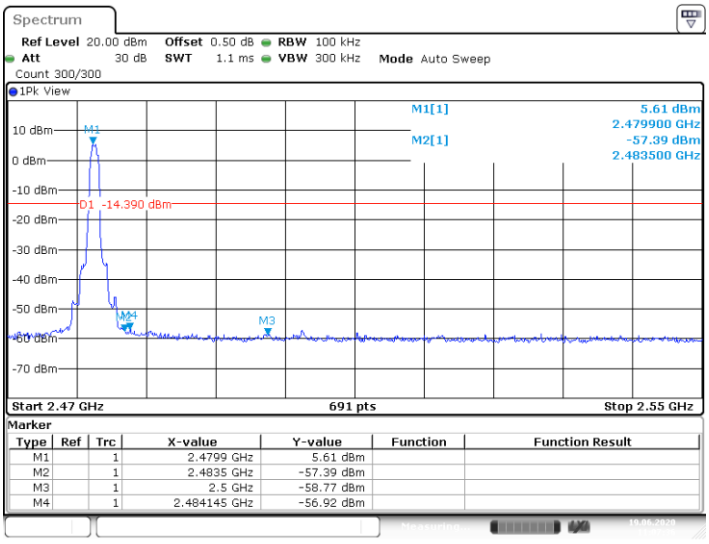
China

8DPSK Modulation Test Result:
Hopping off mode:

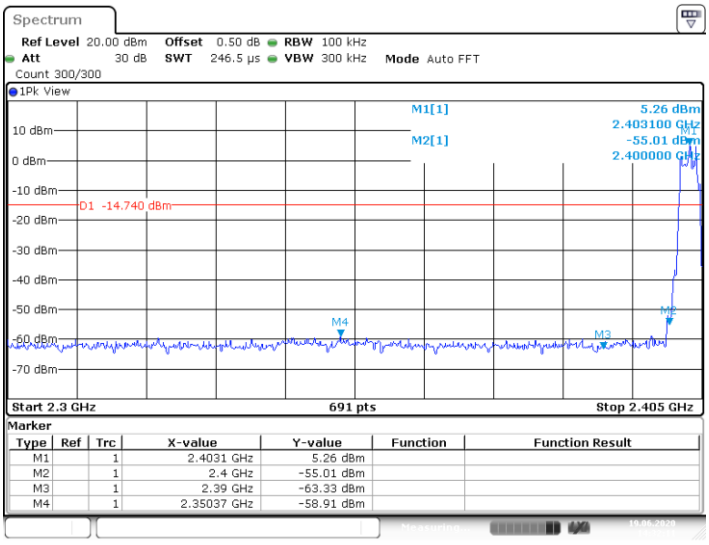


Date: 19.JUN.2020 11:00:36



Date: 19.JUN.2020 11:07:36

Hopping on mode:



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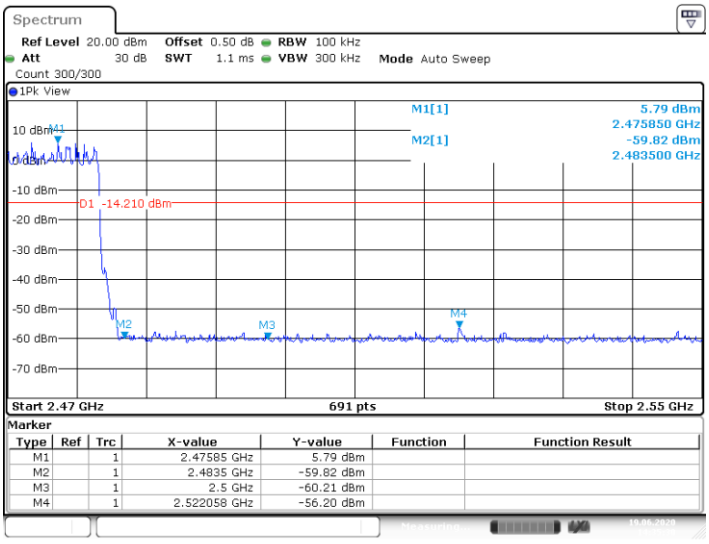

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9.9 Spurious radiated emissions for transmitter and receiver

Test Method

1. The EUT was place on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
3. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. Use the following spectrum analyzer settings According to C63.10:

For Below 1GHz

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 to 120 kHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

For Peak unwanted emissions Above 1GHz:

Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW≥RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

Procedures for average unwanted emissions measurements above 1000 MHz

a) RBW = 1MHz.
b) VBW ≥ [3 × RBW].
c) Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ RBW / 2. Satisfying this condition can require increasing the number of points in the sweep or reducing the span. If the condition is not satisfied, then the detector mode shall be set to peak.
d) Averaging type = power (i.e., rms) (As an alternative, the detector and averaging type may be set for linear voltage averaging. Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.)
e) Sweep time = auto.
f) Perform a trace average of at least 100 traces if the transmission is continuous. If the transmission is not continuous, then the number of traces shall be increased by a factor of 1 / D, where D is the duty cycle. For example, with 50% duty cycle, at least 200 traces shall be averaged. (If a specific emission is demonstrated to be continuous—i.e., 100% duty cycle—then rather than turning ON and OFF with the transmit cycle, at least 100 traces shall be averaged.)
g) If tests are performed with the EUT transmitting at a duty cycle less than 98%, then a correction factor shall be added to the measurement results prior to comparing with the

emission limit, to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:
1) If power averaging (rms) mode was used in the preceding step e), then the correction factor is [10 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 3 dB shall be added to the measured emission levels.
2) If linear voltage averaging mode was used in the preceding step e), then the correction factor is [20 log (1 / D)], where D is the duty cycle. For example, if the transmit duty cycle was 50%, then 6 dB shall be added to the measured emission levels.
3) If a specific emission is demonstrated to be continuous (100% duty cycle) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

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 section15.205, must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength uV/m	Measured Distance Meters
0.009~0.490	2400/F (kHz)	300
0.490~1.705	24000/F (kHz)	30
1.705~30	30	30

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 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.

Pre-scan with three orthogonal axis and worst case as X axis. The only worse case (which is subject to the maximum EIRP, 8DPSK mode) test result is listed in the report.

Transmitting spurious emission test result as below:

Bluetooth Mode 8DPSK Modulation 2402MHz Test Result

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBµV/m		dBuV/m	
2385.5	43.5	Horizontal	74.0	PK	30.5	Pass
4804.7	40.2	Horizontal	74.0	PK	33.8	Pass
2384.4	42.7	Vertical	74.0	PK	31.3	Pass
4804.7	41.5	Vertical	74.0	PK	32.5	Pass

Bluetooth Mode 8DPSK Modulation 2441MHz Test Result

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBµV/m		dBuV/m	
4882.0	41.1	Horizontal	74.0	PK	32.9	Pass
4882.0	40.8	Vertical	74.0	PK	33.2	Pass

Bluetooth Mode 8DPSK Modulation 2480MHz Test Result

Frequency	Emission Level	Polarization	Limit	Detector	Margin	Result
MHz	dBuV/m		dBµV/m		dBuV/m	
2483.5	44.4	Horizontal	74.0	PK	29.6	Pass
4959.2	40.2	Horizontal	74.0	PK	33.8	Pass
2483.5	44.1	Vertical	74.0	PK	29.9	Pass
4959.8	40.1	Vertical	74.0	PK	33.9	Pass

Remark:

(1) Emission level= Original Receiver Reading + Correct Factor
(2) Correct Factor = Antenna Factor + Cable Loss -Amplifier gain
(3) Margin = limit – Corrected Reading

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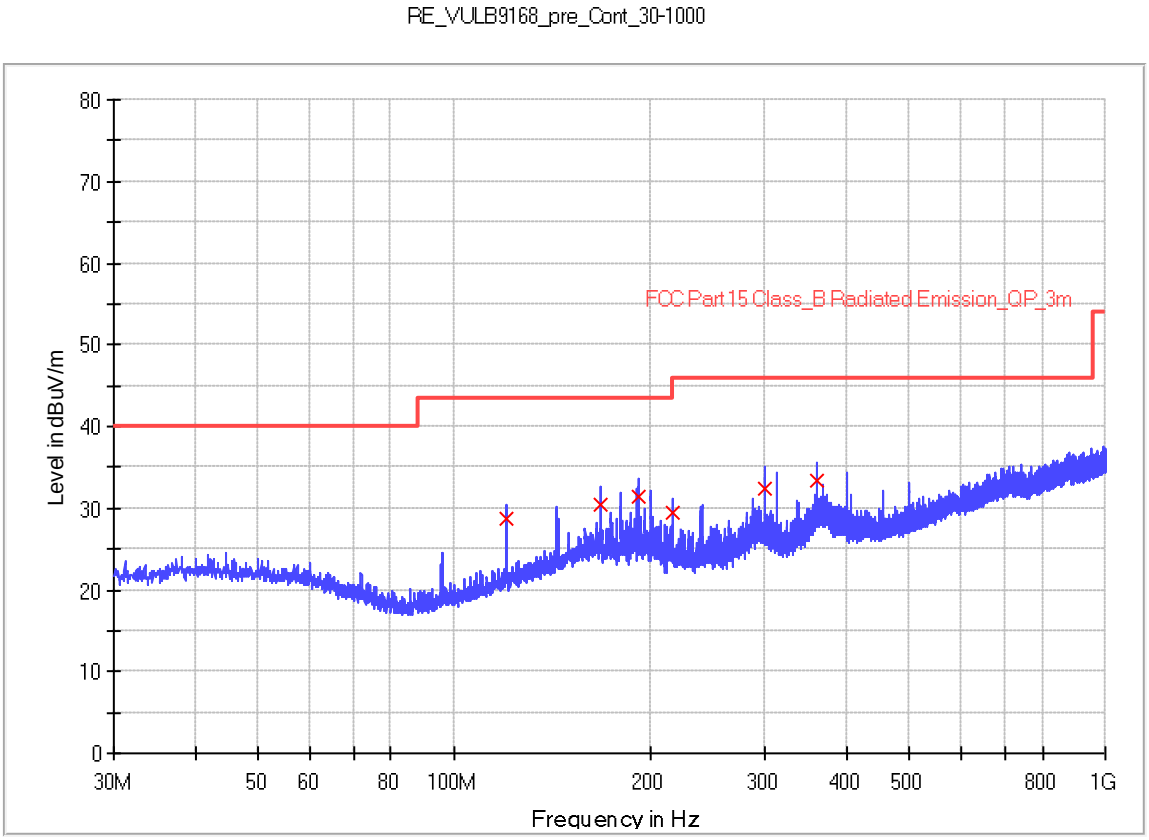
The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2020/06/15 - 14:23
Limit: FCC_Part15.209_RE(3m)_ClassB	Engineer: Jiaxi XU
Probe: VULB9168	Polarity: Horizontal
EUT: Smart Audio Module, Model no: VWRK4	Power: 120VAC, 60Hz
Note: Transmit by at channel 2441MHz. (8DPSK) Note: Pre-scan with three orthogonal axis and worst case as X axis	



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
120.000000	28.7	1000.0	120.000	100.1	H	359.0	13.5	14.8	43.5
168.040000	30.4	1000.0	120.000	100.1	H	359.0	14.9	13.1	43.5
191.440000	31.3	1000.0	120.000	100.1	H	359.0	12.2	12.2	43.5
215.960000	29.4	1000.0	120.000	100.1	H	359.0	12.3	14.1	43.5
300.000000	32.5	1000.0	120.000	100.1	H	359.0	15.0	13.5	46.0
359.960000	33.5	1000.0	120.000	100.1	H	359.0	16.5	12.5	46.0

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

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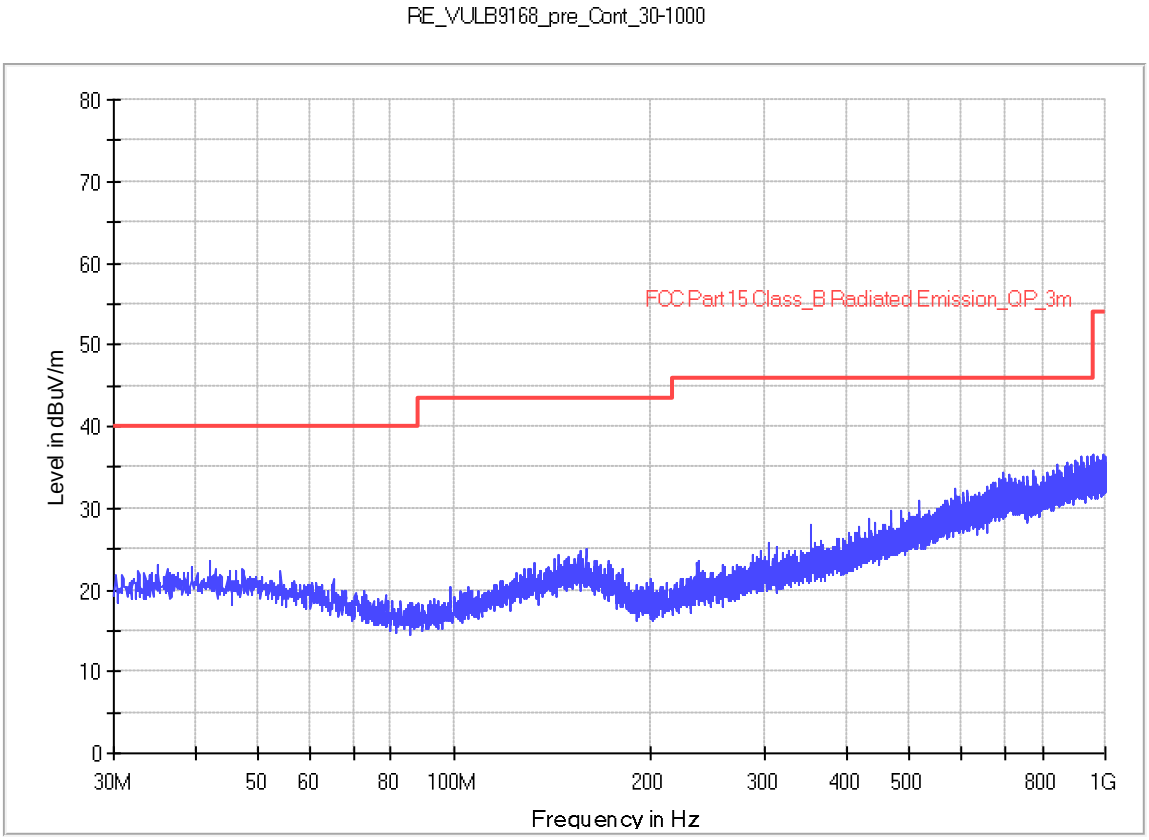
The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2020/06/15 - 14:43
Limit: FCC_Part15.209_RE(3m)_ClassB	Engineer: Jiaxi XU
Probe: VULB9168	Polarity: Verticall
EUT: Smart Audio Module, Model no: VWRK4	Power: 120VAC, 60Hz
Note: Transmit by at channel 2441MHz. (8DPSK) Note: Pre-scan with three orthogonal axis and worst case as X axis	



Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)
Note 2: The test trace is same as the ambient noise and the amplitude of the emissions are attenuated more than 20dB below the permissible (the test frequency range: 9kHz ~ 30MHz, 18GHz ~ 25GHz), therefore no data appear in the report.

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10 Test Equipment List

List of Test Instruments

Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2019-8-5	2020-8-4
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2019-8-5	2020-8-4
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2019-8-5	2020-8-4
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2019-3-16	2022-3-15
	Horn Antenna	Rohde & Schwarz	HF907	102393	2018-6-11	2021-4-1
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2019-8-5	2020-8-4
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2020-3-14	2021-3-13
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2018-1-29	2021-1-28
	3m Semi-anechoic chamber	TDK	9X6X6	----	2018-5-11	2021-5-10
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2019-8-5	2020-8-4
	LISN	Rohde & Schwarz	ENV216	101924	2019-8-5	2020-8-4

Measurement Software Information			
Test Item	Software	Manufacturer	Version
RE	EMC 32	Rohde & Schwarz	V9.15.00
CE	EMC 32	Rohde & Schwarz	V9.15.03

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:

Items	Extended Uncertainty
Conducted Disturbance at Mains Terminals	150kHz to 30MHz, LISN, ±3.16dB
Radiated Disturbance	30MHz to 1GHz, ±5.03dB (Horizontal) ±5.12dB (Vertical) 1GHz to 18GHz, ±5.49dB 18GHz to 25GHz, ±5.63dB
Carrier power conducted measurement	50MHz~18GHz, ±1.238dB
Spurious Emission Conducted Measurement	9kHz ~40GHz, ± 1.224dB

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12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.

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13 Photographs of EUT

Refer to the < External Photos > & < Internal Photos >.

THE END

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