FCC - TEST REPORT

Report Number	:	**709502228908-00B**	Date of Issue:	April 24, 2022

Model	:	CM-05
Product Type	:	Tubular motor
Applicant	:	Coulisse B.V.
Address	:	Vonderweg 48, 7468 DC Enter, THE NETHERLANDS
Production Facility	:	Ningbo Dooya Mechanical & Electronic Technology Co., Ltd.
Address	:	No.168 Shengguang Road, Luotuo, Zhenhai 315202 Ningbo, Zhejiang province, People's republic of China

Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	44

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch is a subcontractor to TÜV SÜD Product Service GmbH according to the principles outlined in ISO 17025.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch reports apply only to the specific samples tested under stated test conditions. Construction of the actual test samples has been documented. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. The manufacturer/importer is responsible to the Competent Authorities in Europe for any modifications made to the production units which result in non-compliance to the relevant regulations. TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and ourselves, extracts from the test report shall not be reproduced except in full without our written approval.

1 Table of Contents

1 Table of Contents 2
2 Details about the Test Laboratory 3
3 Description of the Equipment under Test 4
4 Summary of Test Standards 6
5 Summary of Test Results 7
6 General Remarks 8
7 Test Setups 9
8 Systems test configuration 12
9 Technical Requirement 13
9.1 Conducted Emission 13
9.2 Conducted peak output power 16
9.3 6dB bandwidth 19
9.4 Power spectral density 22
9.5 Spurious RF conducted emissions 25
9.6 Band edge 32
9.7 Spurious radiated emissions for transmitter 35
10 Test Equipment List 41
11 System Measurement Uncertainty 42
12 Photographs of Test Set-ups 43
13 Photographs of EUT 44

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

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 FCC Registration Number:	820234
Designation Number	CN1183
IC Company Number	25988
CAB identifier	CN0101
Telephone: Fax:	+86 21 6141 0123 +86 21 6140 8600

3 Description of the Equipment under Test

Description of the Equipment Under Test

Product:	Tubular motor
Model no:	CM-05
FCC ID:	ZY4CM05B
IC:	N/A
Options and accessories:	NA
Rating:	5 V DC
RF Transmission Frequency:	433.92MHz 2402~2480 MHz(BLE)
No. of Operated Channel:	2.4GHz BLE:40
Modulation:	For 433.92MHz: FSK For 2.4GHz BLE: GFSK
Antenna Type:	For 433.92MHz: line antenna For 2.4GHz BLE: line antenna
Antenna Gain:	For 433.92MHz: -4dBi For 2.4GHz BLE: 0dBi

Channel list:

Bluetooth Low Energy							
Ch	Fre(MHz)	Ch	Fre(MHz)	Ch	Fre(MHz)	Ch	Fre(MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

Description of the EUT:	The Equipment Under Test (EUT) is a Tubular motor which transmitted at 433.92MHz and support 2.4GHz BLE (support 1Mbps and 2Mbps data rate). we tested it and listed the worst data in this report.
Test sample no.:	SHA-638108-1

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.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C:2020	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10 (2013).

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

5 Summary of Test Results

Technical Requirements				
Test Condition		Pages	Test Site	Test Result
§15.207	Conducted emission AC power port	13-15	Site 1	Pass
§15.247 (b) (3)	Conducted peak output power	16-18	Site 1	Pass
§15.247(a)(1)	20dB bandwidth	---	---	N/A
§15.247(a)(1)	Carrier frequency separation	---	---	N/A
§15.247(a)(1)(iii)	Number of hopping frequencies	---	---	N/A
§15.247(a)(1)(iii)	Dwell Time	---	---	N/A
§15.247(a)(2)	6dB bandwidth	19-21	Site 1	Pass
§15.247(e)	Power spectral density	22-24	Site 1	Pass
§15.247(d)	Spurious RF conducted emissions	25-31	Site 1	Pass
§15.247(d)	Band edge	32-34	Site 1	Pass
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	35-40	Site 1	Pass
§15.203	Antenna requirement	See note 1		Pass

Remark 1: N/A – Not Applicable.
Note 1: The EUT uses a line antenna, which gain is -4dBi for 433.92MHz and 0dBi for 2.4GHz BLE. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: ZY4CM05B, complies with Section 15.203, 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

This report is only for the 2.4GHz BLE test report, for the 433.92MHz test report please refer to 709502228908-00A.

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.

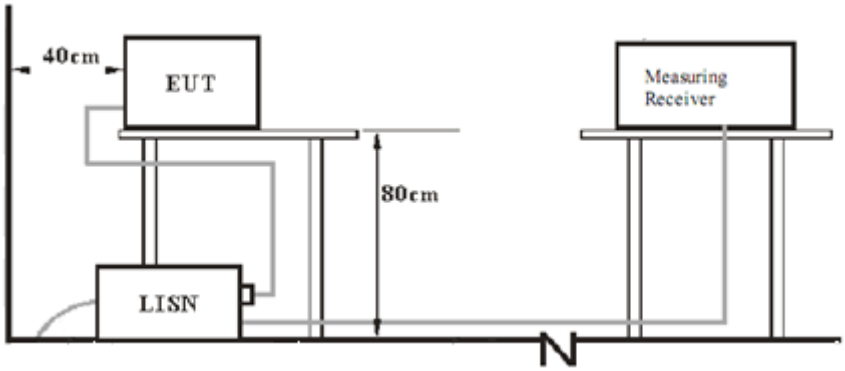
Sample Received Date:	March 1, 2022
Testing Start Date:	March 3, 2022
Testing End Date:	March 8, 2022

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

Reviewed by:	Prepared by:	Tested by:
Hui TONG	Jiaxi XU	Yan YANG
Review Engineer	Project Engineer	Test Engineer

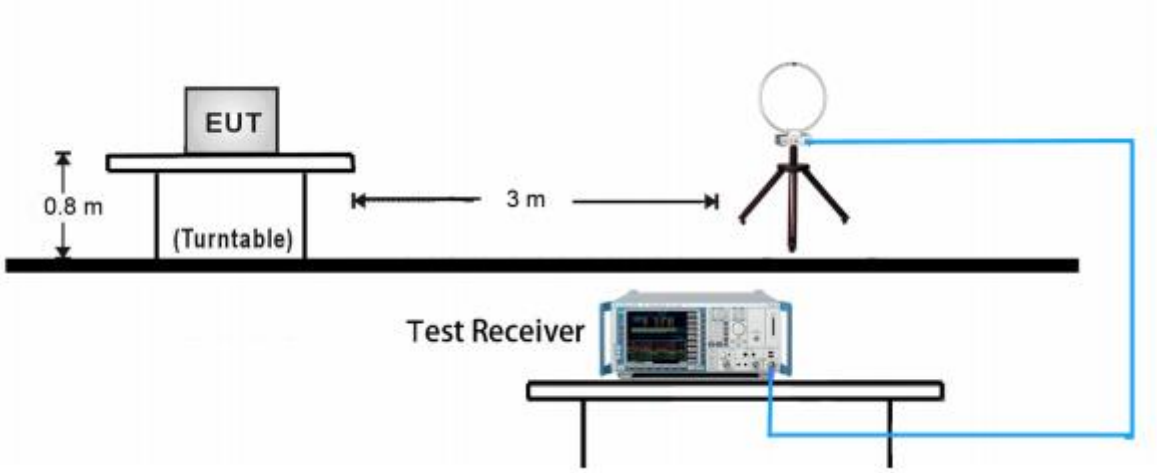
7 Test Setups

7.1 AC Power Line Conducted Emission test setups



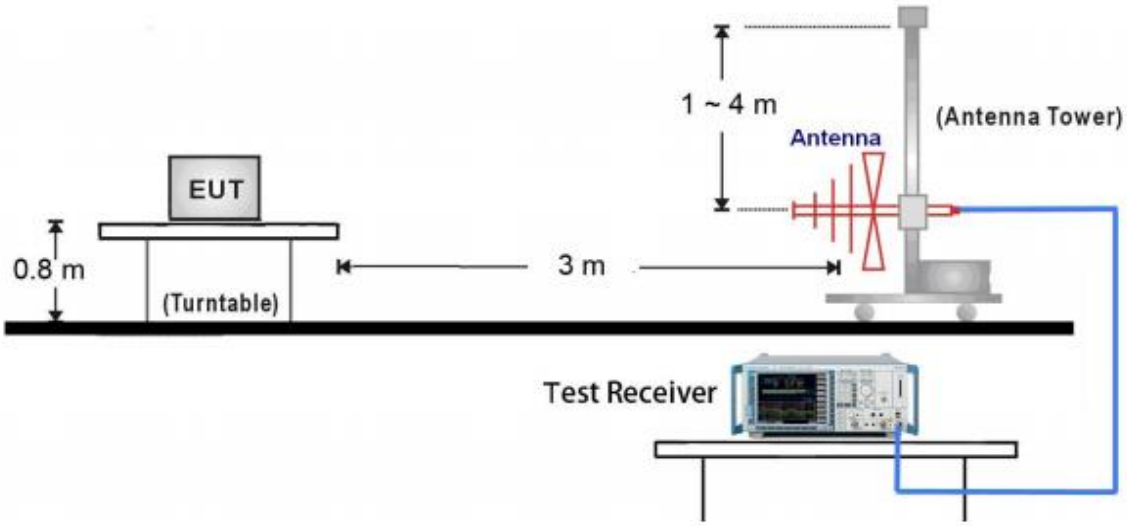
7.2 Radiated test setups

9kHz ~ 30MHz Test Setup:

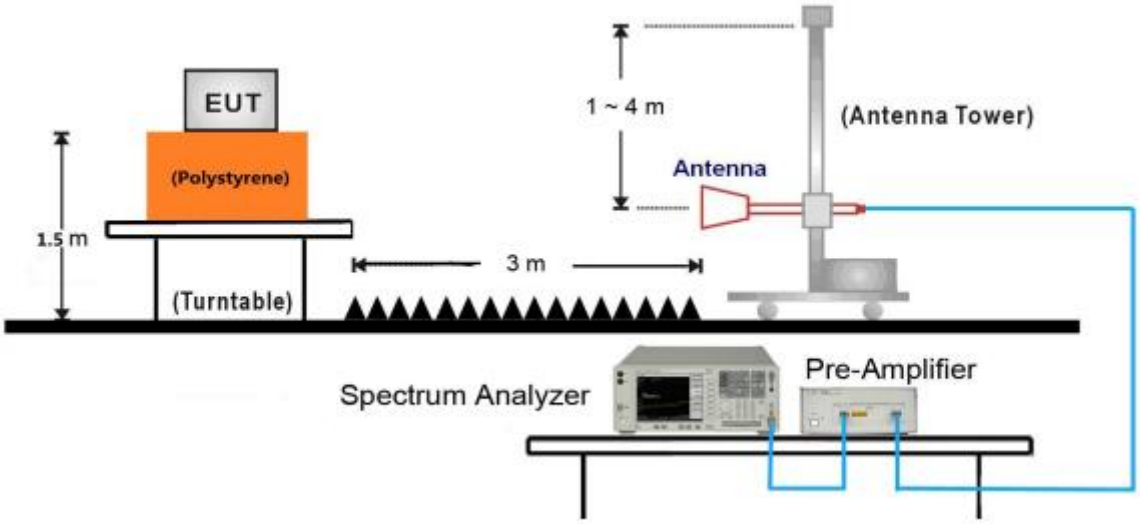


TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

30MHz ~ 1GHz Test Setup:

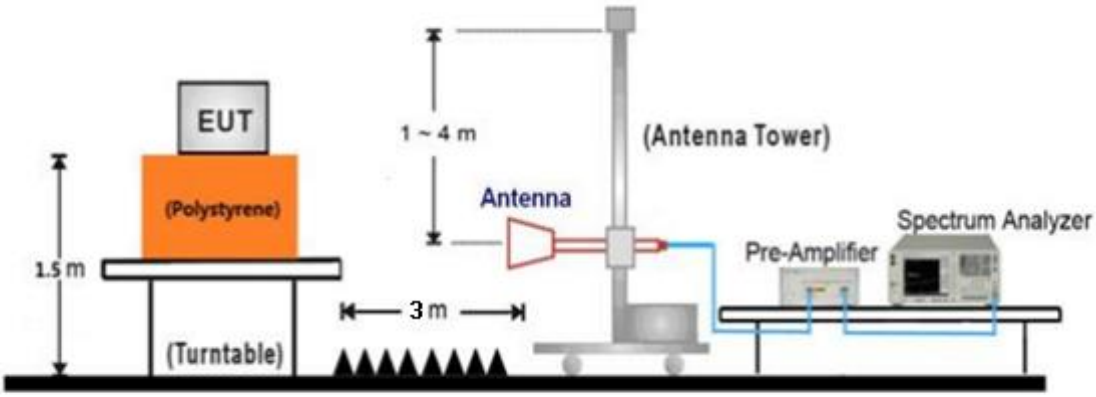


1GHz ~ 18GHz Test Setup:

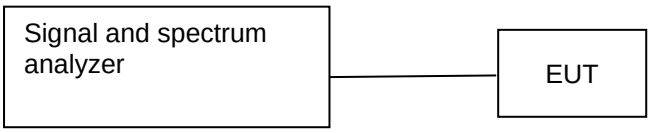


TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

18GHz ~ 40GHz Test Setup:



7.3 Conducted RF test setups



TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenove	T450S	SL 10H72007 JS

Test software: BlueNRG GUI v4.0.0

The system was configured to channel 0, 19, and 39 for the test.

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.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

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 an Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. An EMI test receiver is used to test the emissions from both sides of AC line

Limit

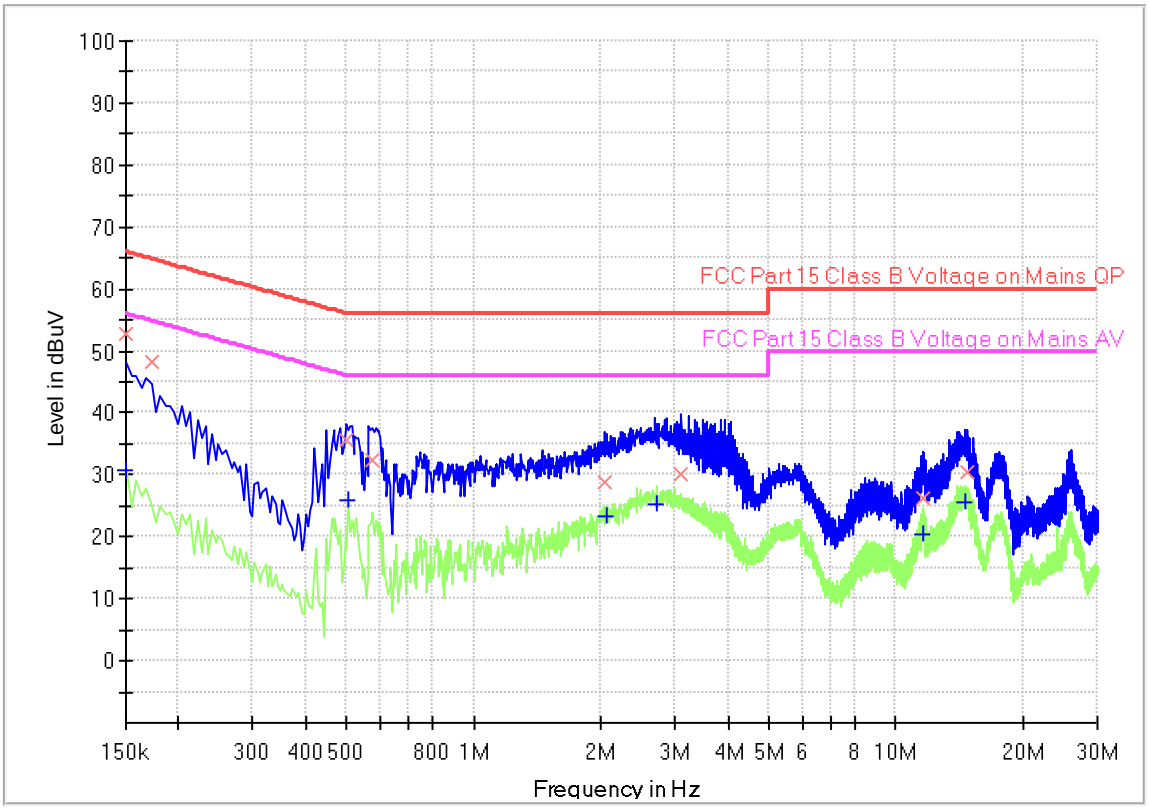
Frequency MHz	QP Limit dBµV	AV Limit dBµV
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Conducted Emission

Product Type	:	Tubular motor
M/N	:	CM-05
Operating Condition	:	Tx_2402MHz for BLE; 1Mbps
Test Specification	:	L-line
Comment	:	5VDC (powered by notebook whose input is 120V~ 60Hz)

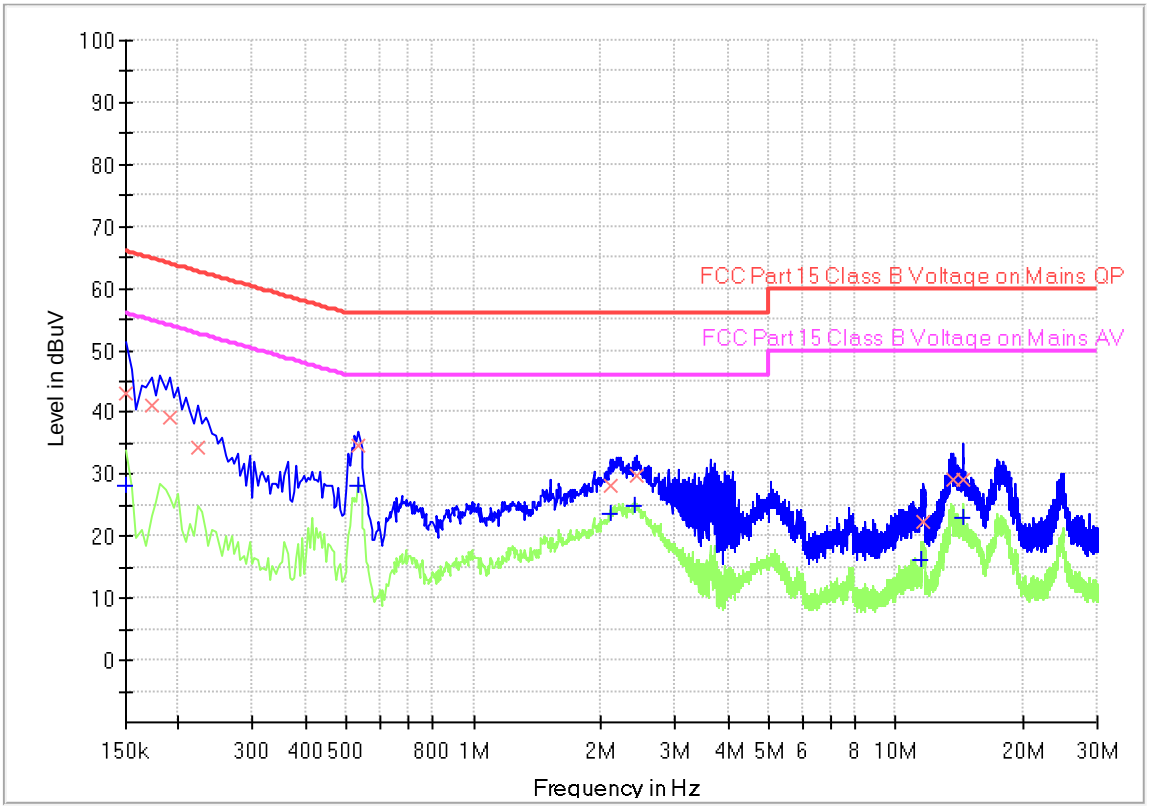


Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	---	30.85	56.00	25.15	1000.0	9.000	L1	19.5
0.150000	52.72	---	66.00	13.28	1000.0	9.000	L1	19.5
0.172500	48.31	---	64.84	16.53	1000.0	9.000	L1	19.5
0.501000	35.62	---	56.00	20.38	1000.0	9.000	L1	19.5
0.505500	---	26.04	46.00	19.96	1000.0	9.000	L1	19.5
0.577500	32.29	---	56.00	23.71	1000.0	9.000	L1	19.5
2.040000	28.77	---	56.00	27.23	1000.0	9.000	L1	19.5
2.067000	---	23.37	46.00	22.63	1000.0	9.000	L1	19.5
2.706000	---	25.31	46.00	20.69	1000.0	9.000	L1	19.5
3.106500	30.18	---	56.00	25.82	1000.0	9.000	L1	19.6
11.620500	---	20.47	50.00	29.53	1000.0	9.000	L1	19.7
11.620500	26.37	---	60.00	33.63	1000.0	9.000	L1	19.7
14.568000	---	25.56	50.00	24.44	1000.0	9.000	L1	19.8
14.694000	30.40	---	60.00	29.60	1000.0	9.000	L1	19.8

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Product Type	:	Tubular motor
M/N	:	CM-05
Operating Condition	:	Tx_2402MHz for BLE; 1Mbps
Test Specification	:	N-line
Comment	:	5VDC (powered by notebook whose input is 120V~ 60Hz)



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	---	28.33	56.00	27.67	1000.0	9.000	N	19.5
0.150000	42.91	---	66.00	23.09	1000.0	9.000	N	19.5
0.172500	41.12	---	64.84	23.72	1000.0	9.000	N	19.5
0.190500	39.15	---	64.01	24.86	1000.0	9.000	N	19.5
0.222000	34.30	---	62.74	28.44	1000.0	9.000	N	19.5
0.532500	---	28.10	46.00	17.90	1000.0	9.000	N	19.5
0.532500	34.68	---	56.00	21.32	1000.0	9.000	N	19.5
2.103000	28.23	---	56.00	27.77	1000.0	9.000	N	19.5
2.121000	---	23.51	46.00	22.49	1000.0	9.000	N	19.5
2.395500	---	25.02	46.00	20.98	1000.0	9.000	N	19.5
2.427000	29.82	---	56.00	26.18	1000.0	9.000	N	19.5
11.521500	---	16.08	50.00	33.92	1000.0	9.000	N	19.7
11.620500	22.24	---	60.00	37.76	1000.0	9.000	N	19.7
13.605000	29.01	---	60.00	30.99	1000.0	9.000	N	19.7
14.379000	---	22.88	50.00	27.12	1000.0	9.000	N	19.7
14.379000	29.19	---	60.00	30.81	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

9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
   RBW > the 6 dB bandwidth of the emission being measured, VBW≥3RBW, Span≥3RBW
   Sweep = auto, Detector function = peak, Trace = max hold.
2. Add a correction factor to the display.
3. Use a power meter to measure the conducted peak output power.

Limits

According to §15.247 (b) (1), conducted peak output power limit as below:

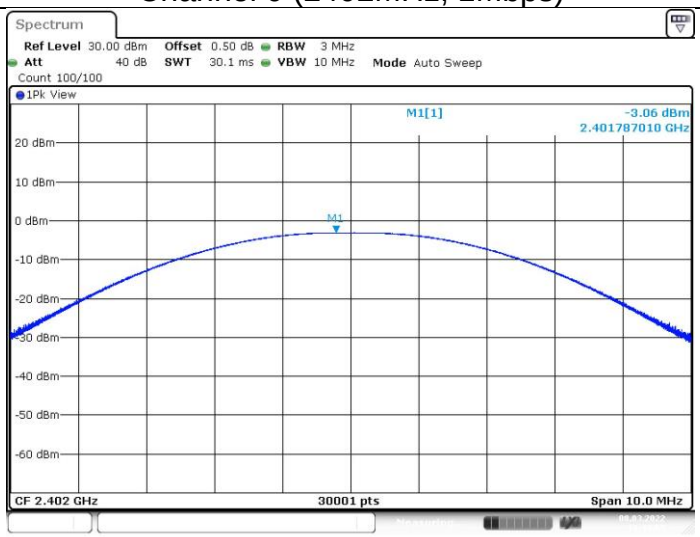
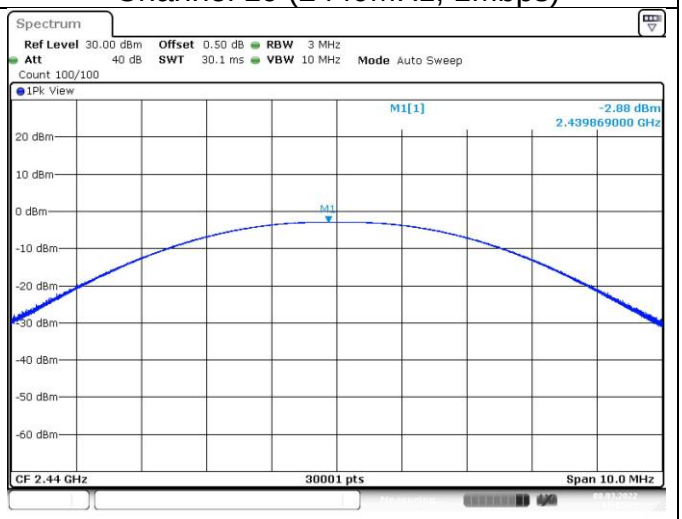
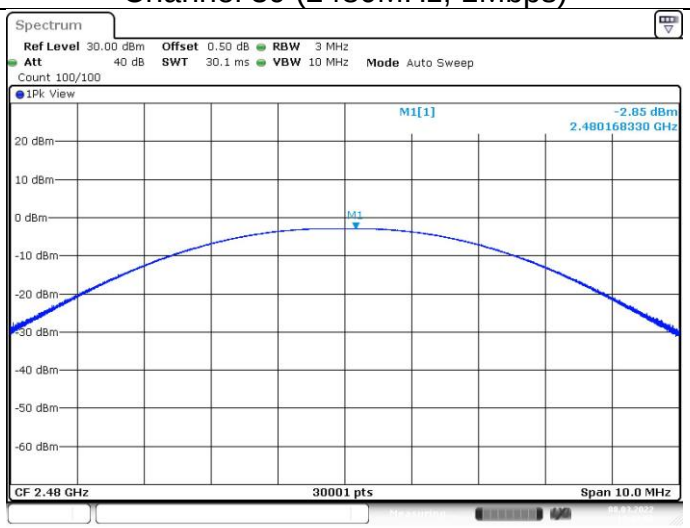
Conducted peak output power

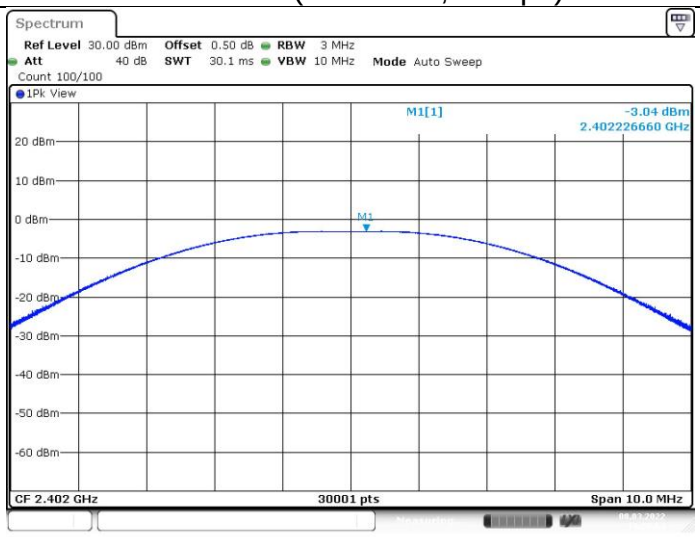
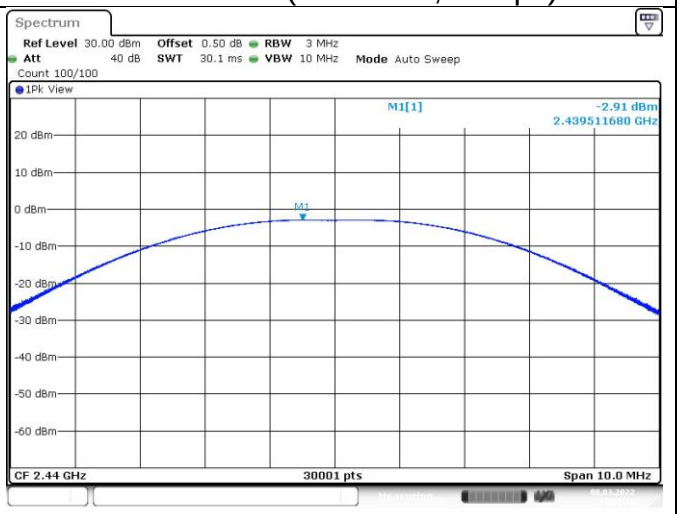
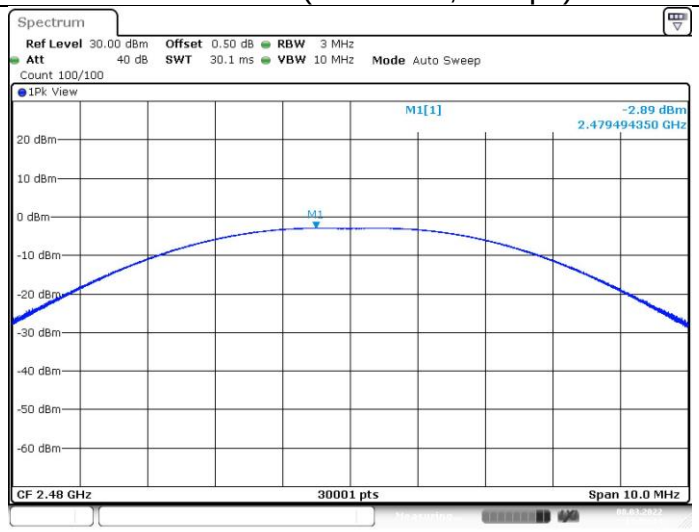
Frequency Range MHz	**Limit W**	**Limit dBm**
2400-2483.5	≤1	≤30

Test result as below table

Frequency	Conducted Peak Output Power	Data transmission rate	Result
MHz	dBm		
Low channel 2402MHz	-3.06	1Mbps	Pass
Middle channel 2440MHz	-2.88		Pass
High channel 2480MHz	-2.85		Pass
Low channel 2402MHz	-3.04	2Mbps	Pass
Middle channel 2440MHz	-2.91		Pass
High channel 2480MHz	-2.89		Pass

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Peak output power	
Channel 0 (2402MHz; 1Mbps)	Channel 19 (2440MHz; 1Mbps)
 Date: 8.MAR.2022 13:43:05	 Date: 8.MAR.2022 13:45:21
Channel 39 (2480MHz; 1Mbps)	
 Date: 8.MAR.2022 13:47:07	

Peak output power	
Channel 0 (2402MHz; 2Mbps)	Channel 19 (2440MHz; 2Mbps)
 Date: 8.MAR.2022 13:50:04	 Date: 8.MAR.2022 13:52:12
Channel 39 (2480MHz; 2Mbps)	
 Date: 8.MAR.2022 13:55:14	

9.3 6dB bandwidth

Test Method

1. Use the following spectrum analyzer settings:
   RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]
≥500

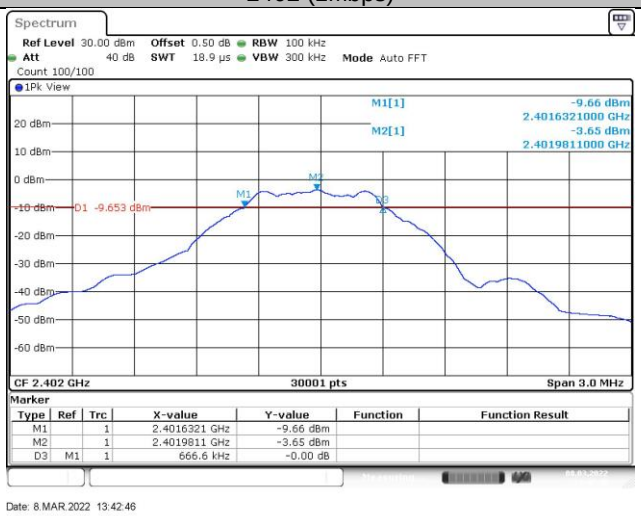
Test result

Frequency	6dB bandwidth	Data transmission rate	Result
MHz	kHz		
Top channel 2402MHz	667	1Mbps	Pass
Middle channel 2440MHz	664		Pass
Bottom channel 2480MHz	668		Pass
Top channel 2402MHz	1130	2Mbps	Pass
Middle channel 2440MHz	1128		Pass
Bottom channel 2480MHz	1128		Pass

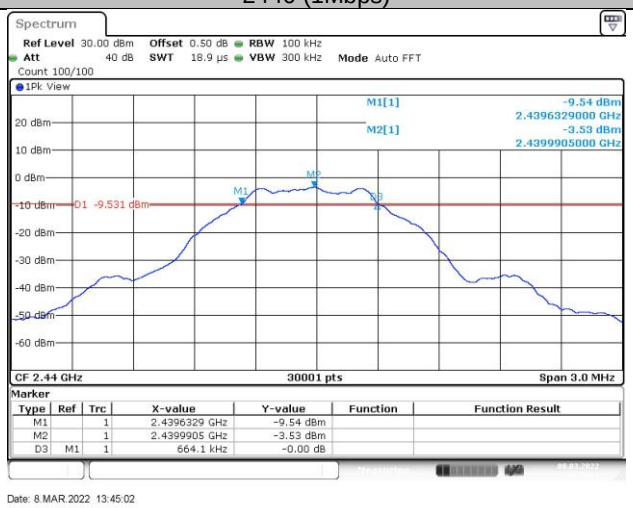
TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

6dB Bandwidth

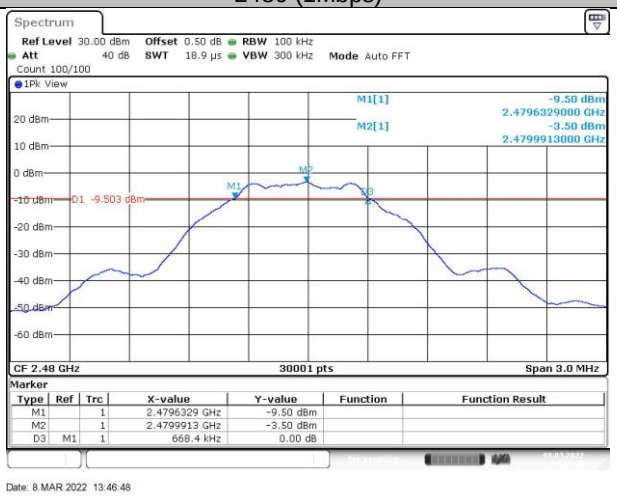
2402 (1Mbps)



2440 (1Mbps)



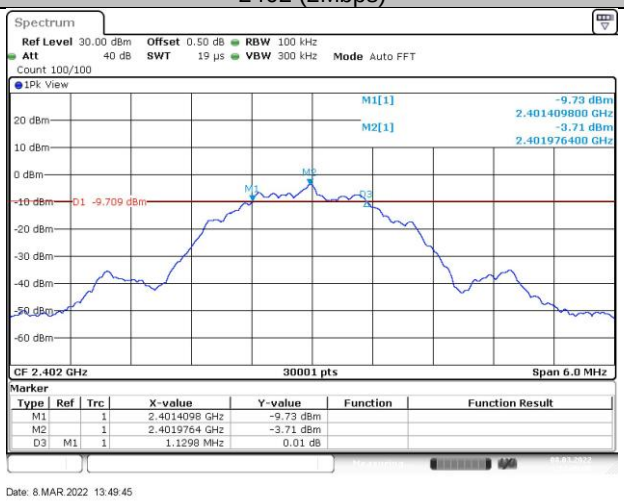
2480 (1Mbps)



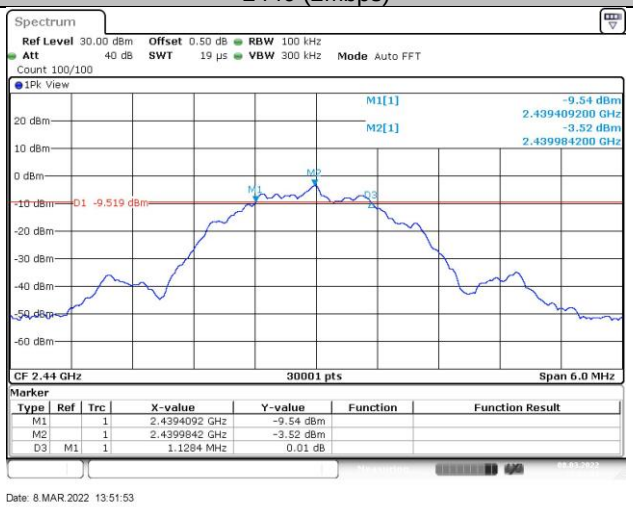
TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

6dB Bandwidth

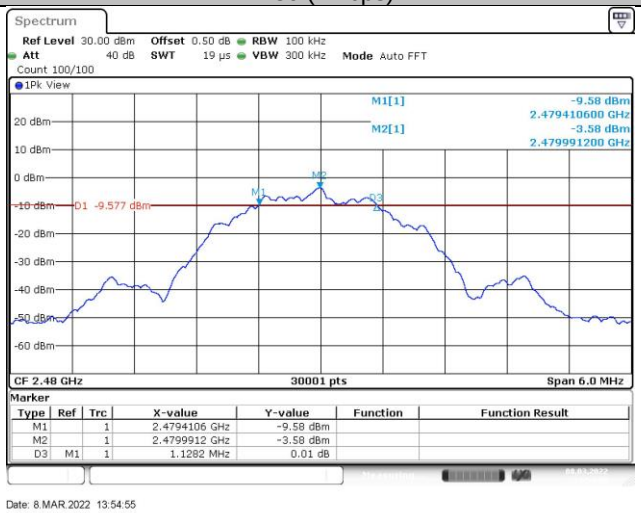
2402 (2Mbps)



2440 (2Mbps)



2480 (2Mbps)



9.4 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz,VBW≥3RBW,Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed.

Limit

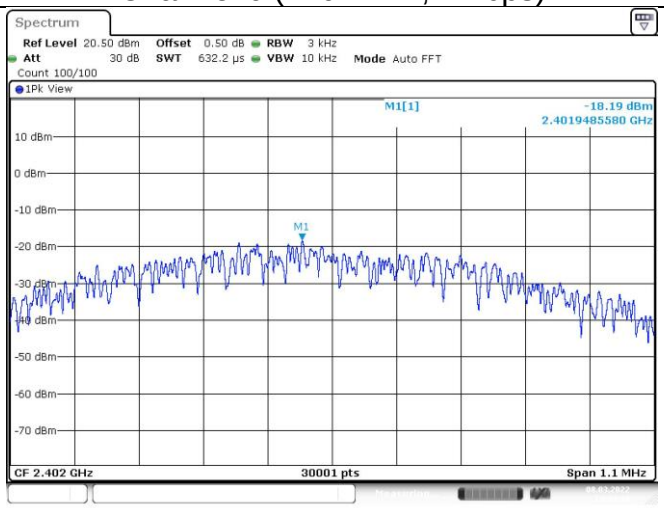
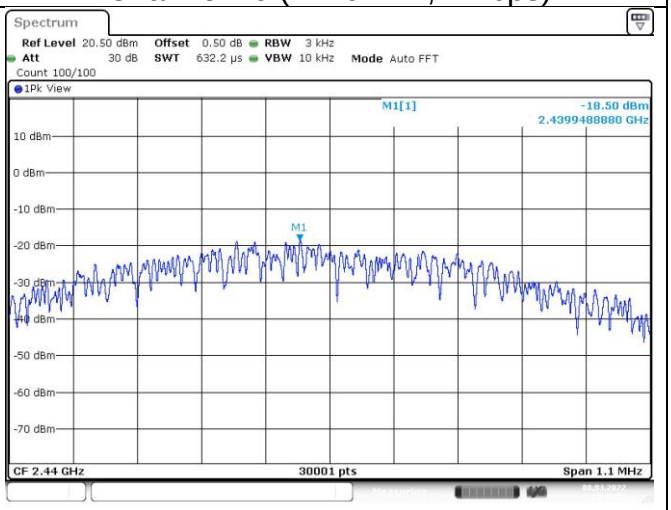
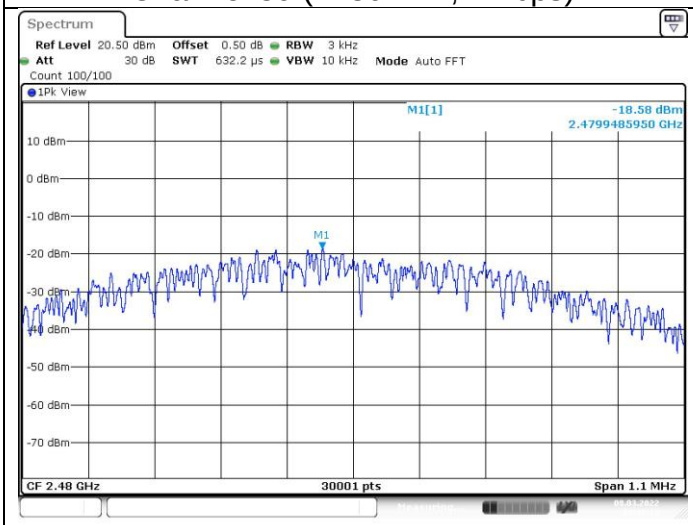
Limit [dBm/3kHz]
⩽8

Test result

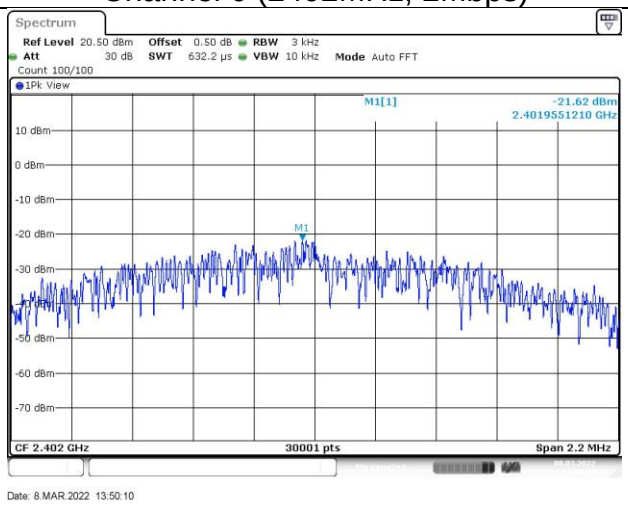
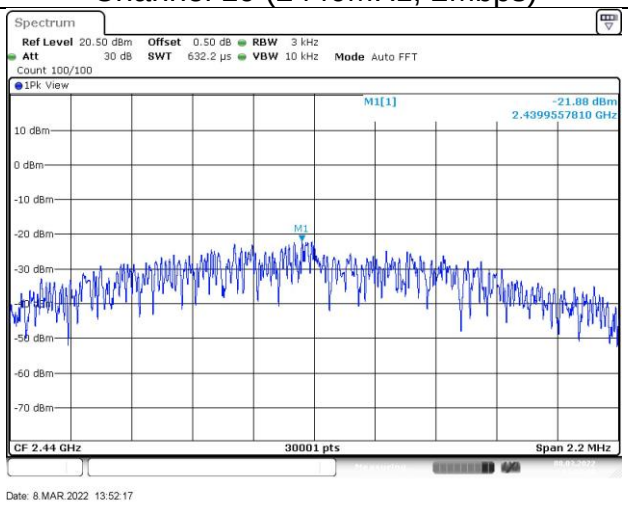
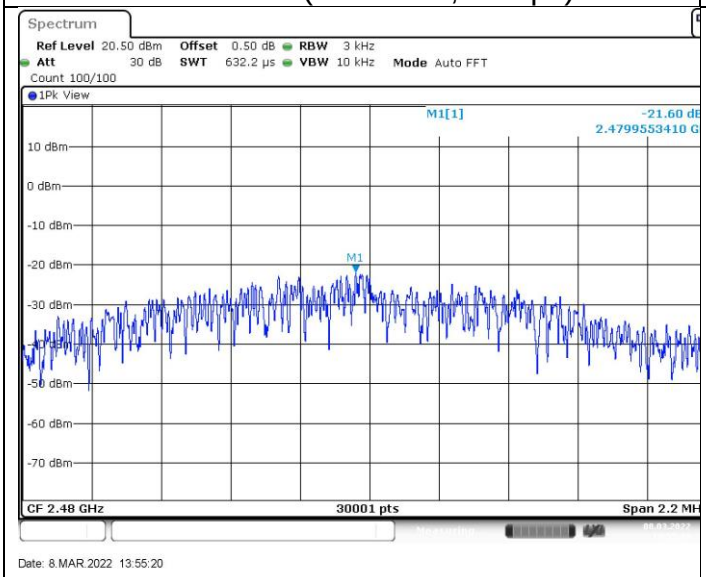
Frequency	Power spectral density	Data transmission rate	Result
MHz	**dBm/3KHz**		
Top channel 2402MHz	-18.19	1Mbps	Pass
Middle channel 2440MHz	-18.50		Pass
Bottom channel 2480MHz	-18.58		Pass
Top channel 2402MHz	-21.62	2Mbps	Pass
Middle channel 2440MHz	-21.88		Pass
Bottom channel 2480MHz	-21.60		Pass

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

Power spectral density

PK PSD	
Channel 0 (2402MHz; 1Mbps)	Channel 19 (2440MHz; 1Mbps)
 Date: 8.MAR.2022 13:43:10	 Date: 8.MAR.2022 13:45:27
Channel 39 (2480MHz; 1Mbps)	
 Date: 8.MAR.2022 13:47:12	

Power spectral density

PK PSD	
Channel 0 (2402MHz; 2Mbps)	Channel 19 (2440MHz; 2Mbps)
	
Channel 39 (2480MHz; 2Mbps)	
	

9.5 Spurious RF conducted emissions

Test Method

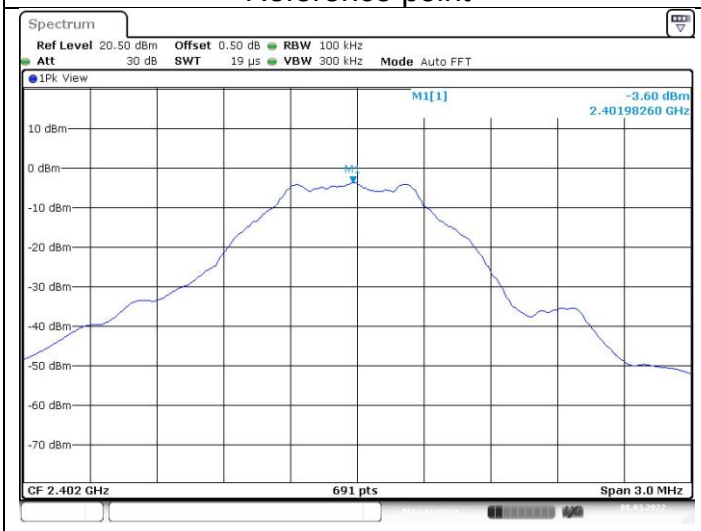
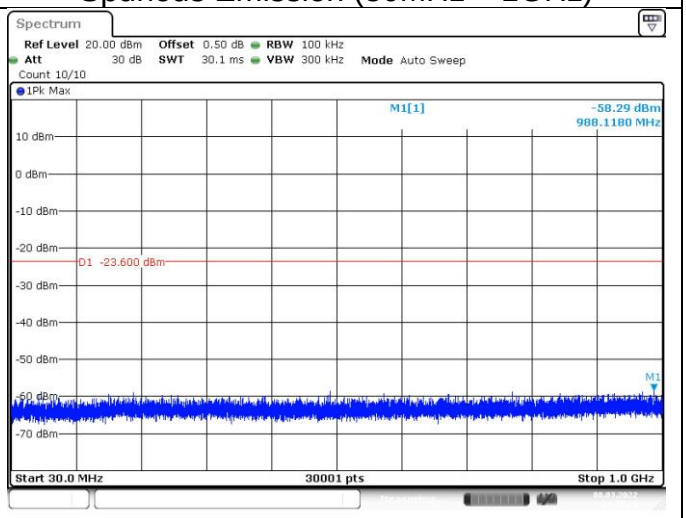
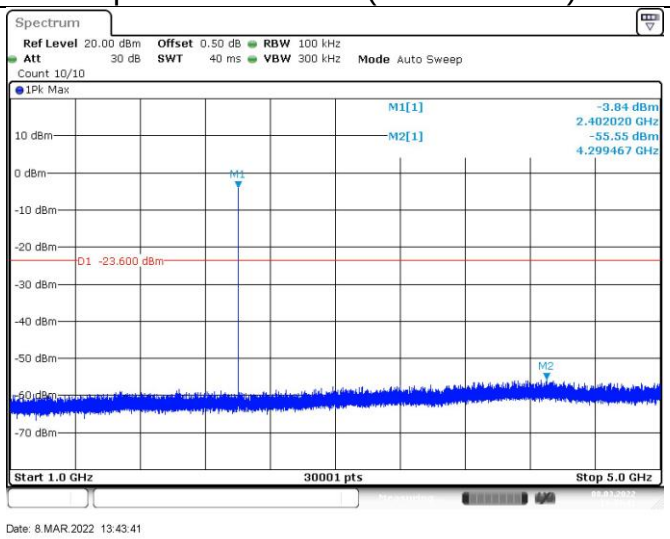
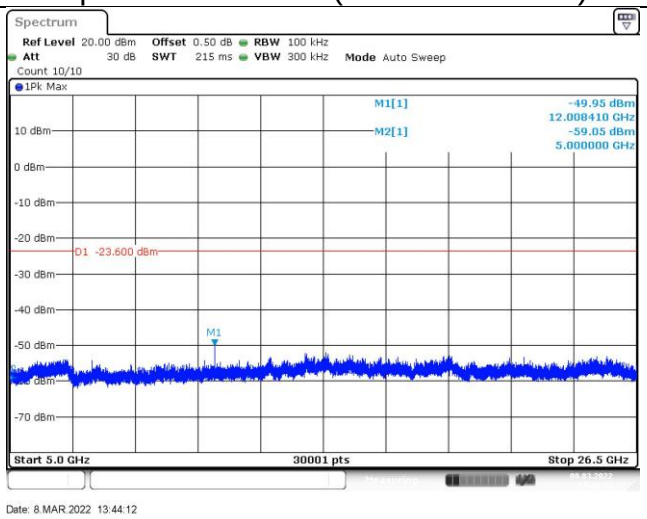
1. Establish a reference level by using the following procedure:
   a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
   b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
2. Use the maximum PSD level to establish the reference level.
   a. Set the center frequency and span to encompass frequency range to be measured.
   b. Use the peak marker function to determine the maximum amplitude level. Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements, report the three highest emissions relative to the limit.
3. Repeat above procedures until other frequencies measured were completed.

Limit

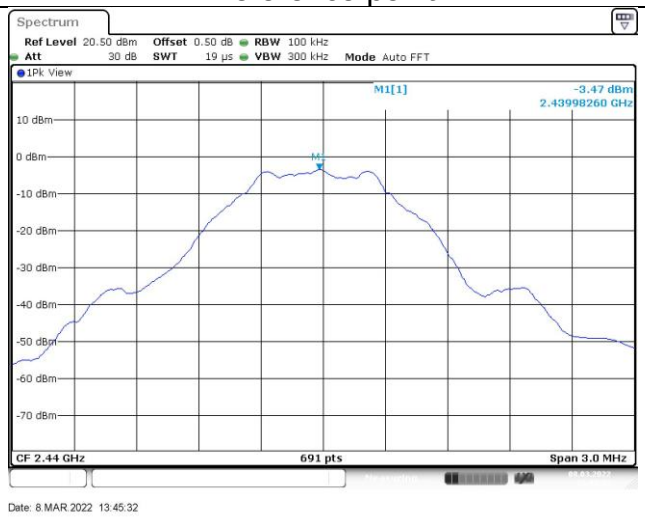
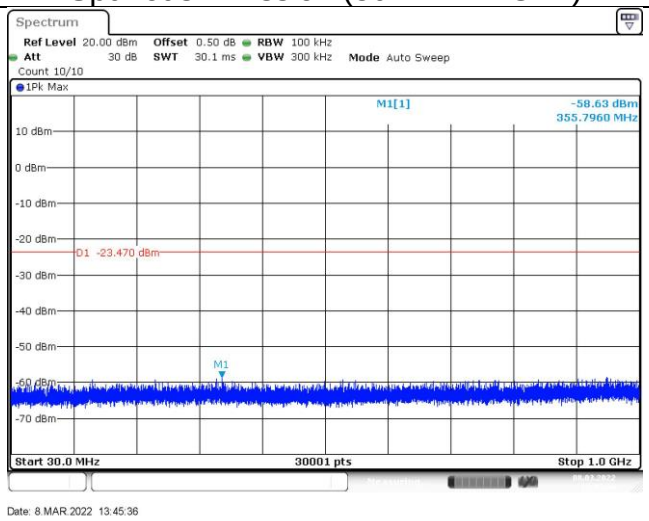
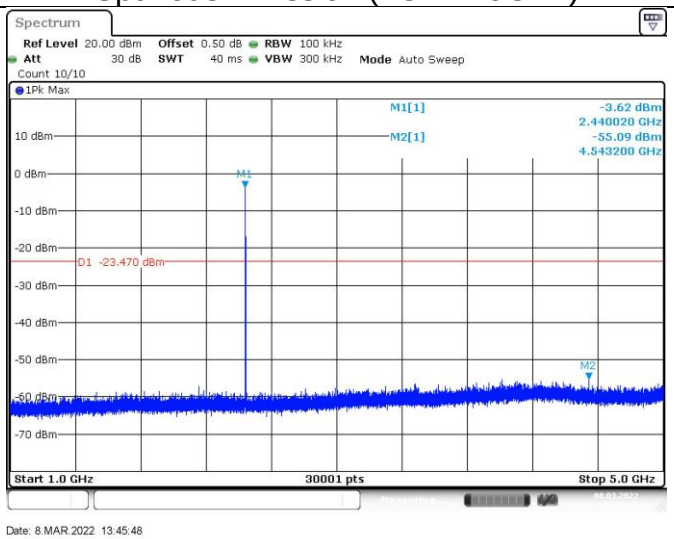
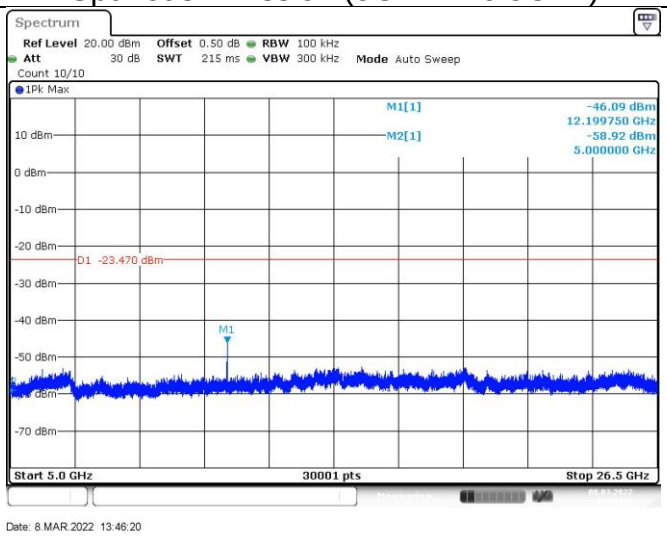
Frequency Range MHz	Limit (dBc)
30-25000	-20

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

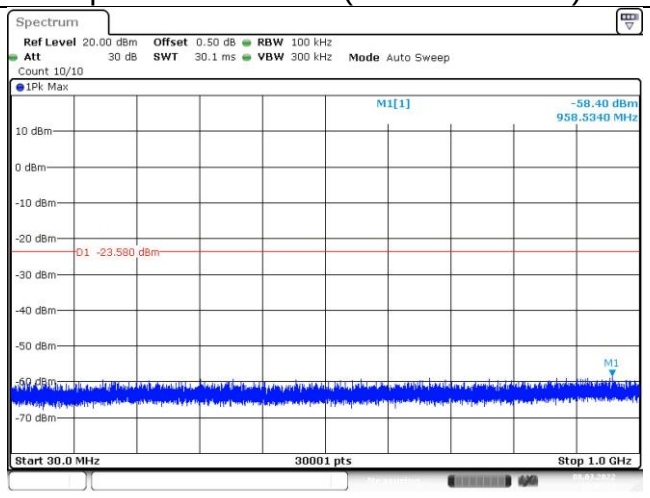
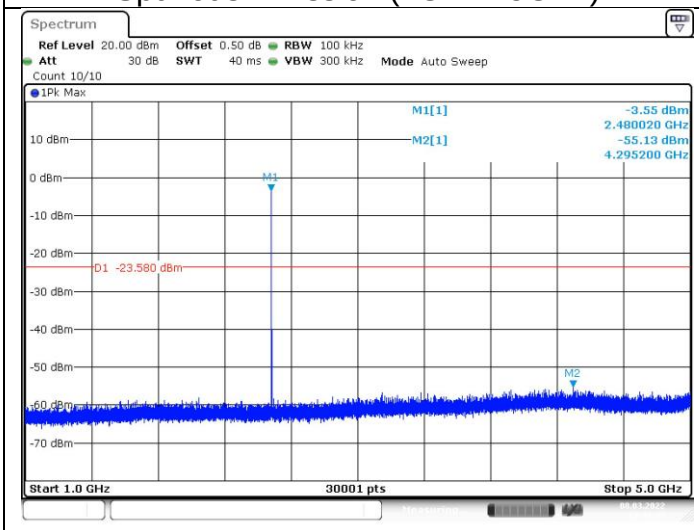
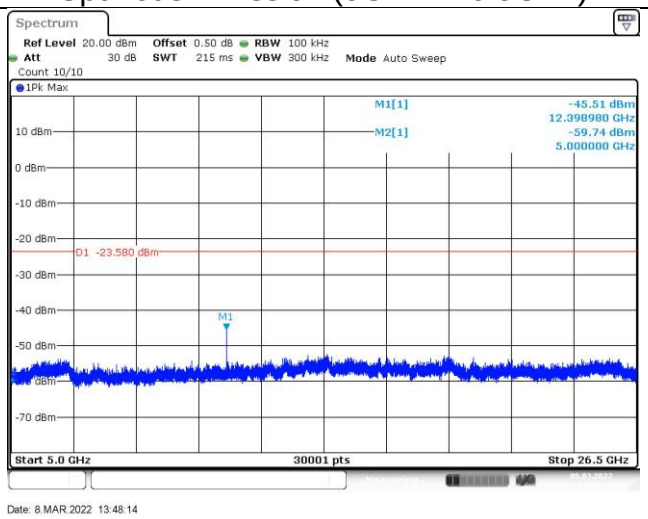
Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 0 (2402MHz; 1Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

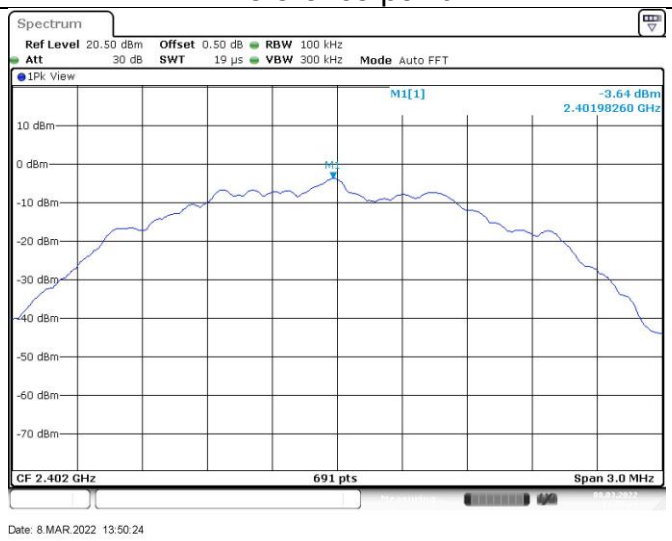
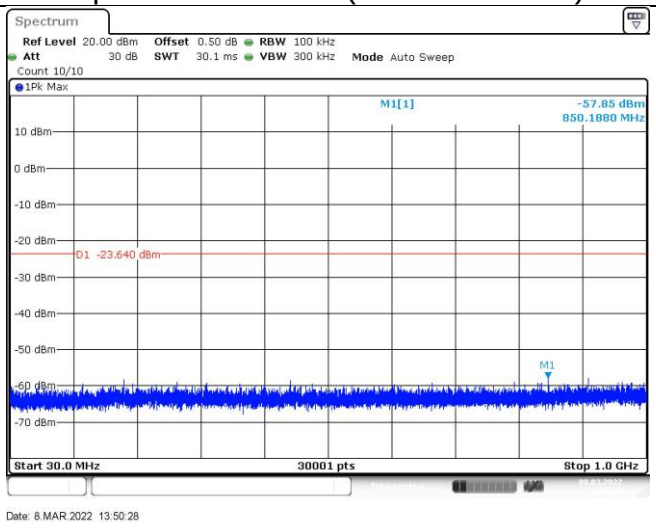
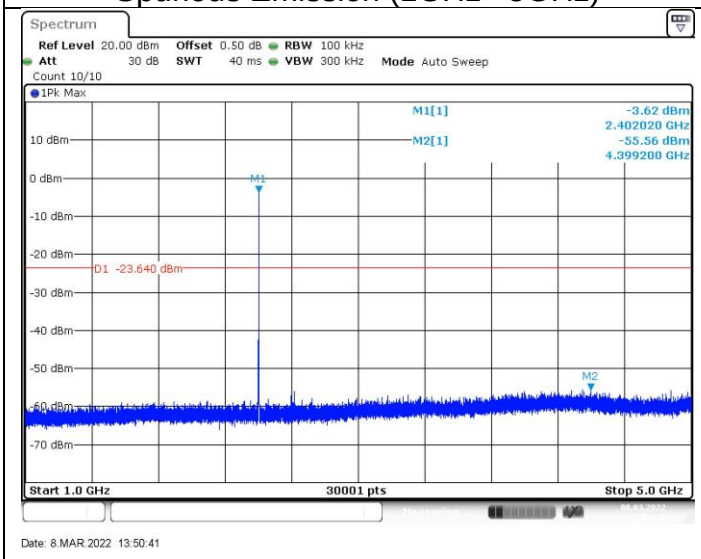
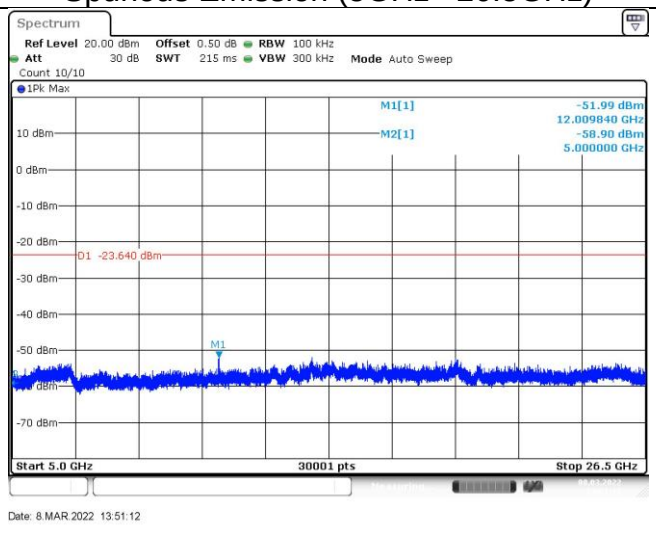
Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 19 (2440MHz; 1Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

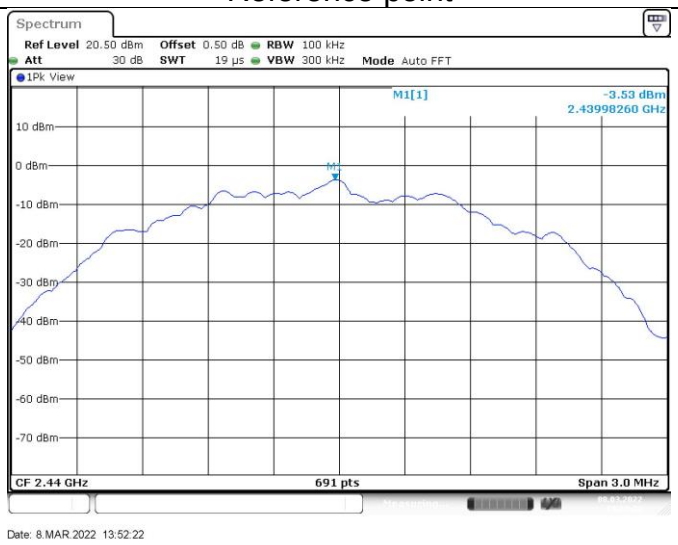
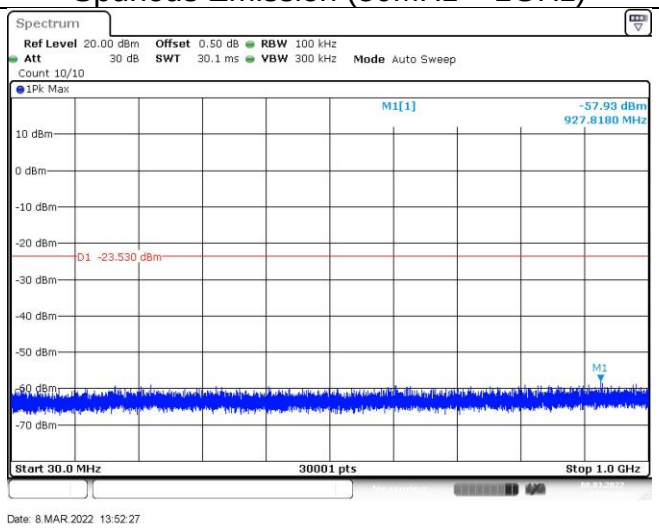
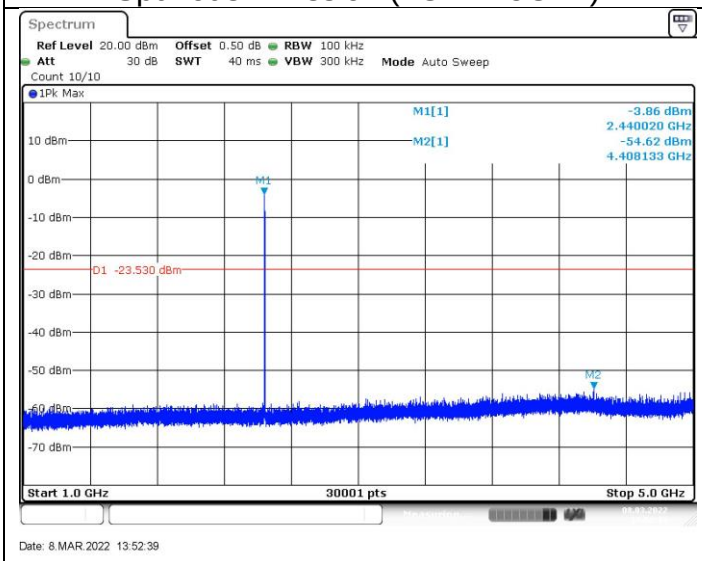
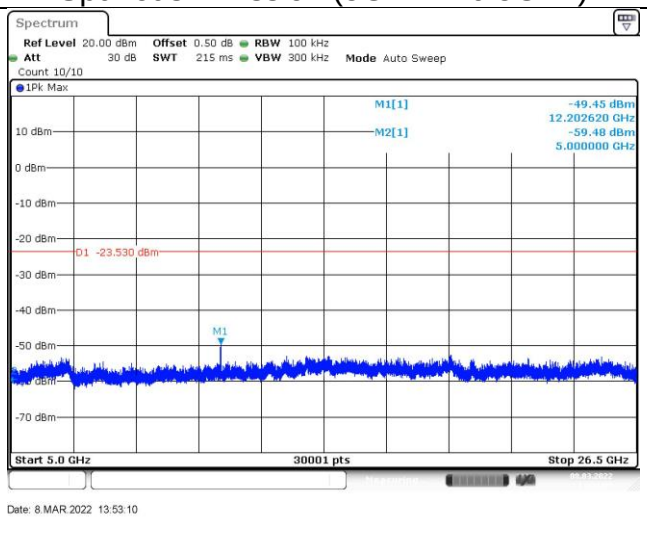
Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 39 (2480MHz; 1Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

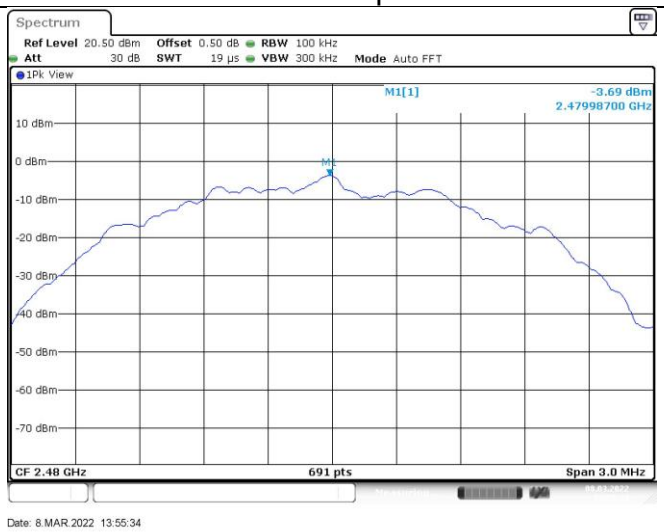
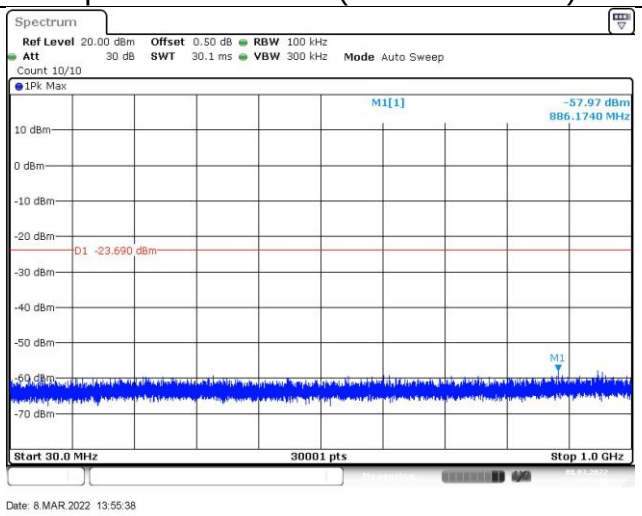
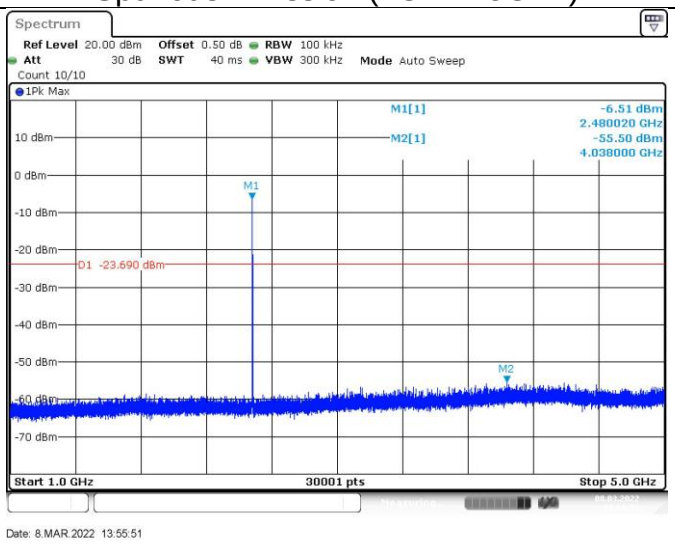
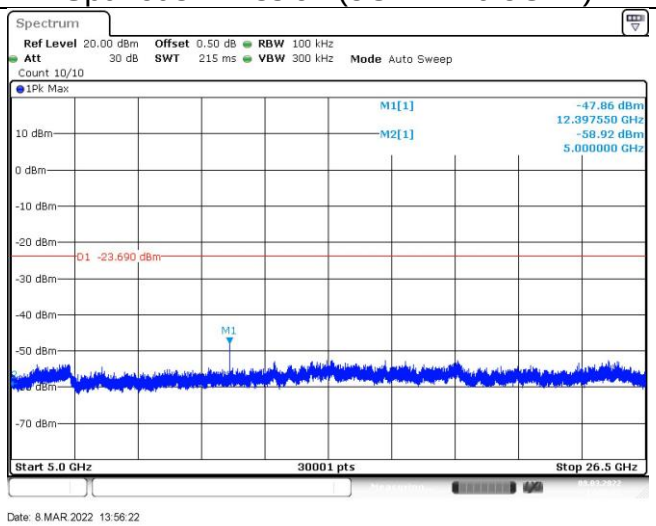
Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 0 (2402MHz; 2Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 19 (2440MHz; 2Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

Spurious RF conducted emissions

Out-of-Band Emissions	
Channel 39 (2480MHz; 2Mbps)	
Reference point	Spurious Emission (30MHz – 1GHz)
	
Spurious Emission (1GHz –5GHz)	Spurious Emission (5GHz –26.5GHz)
	

9.6 Band edge

Test Method

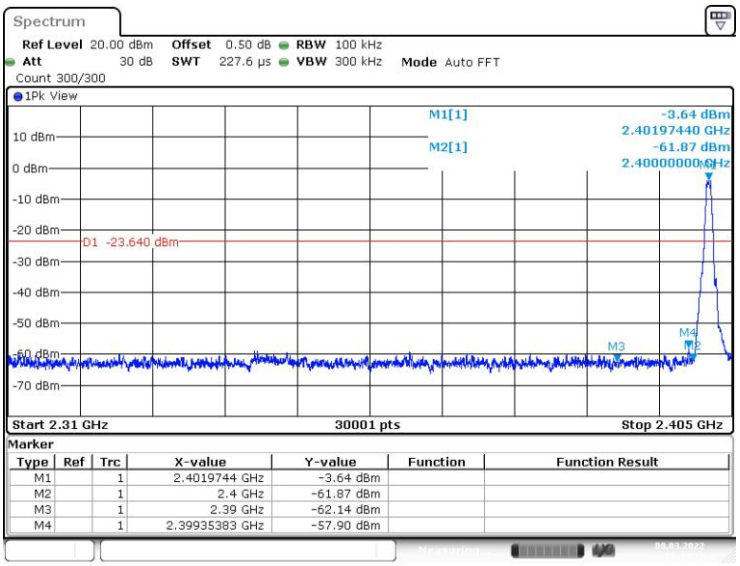
1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW≥RBW, Sweep = auto, Detector function = peak, Trace = max hold.
2 Allow the trace to stabilize, use the peak and delta measurement to record the result.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

Limit

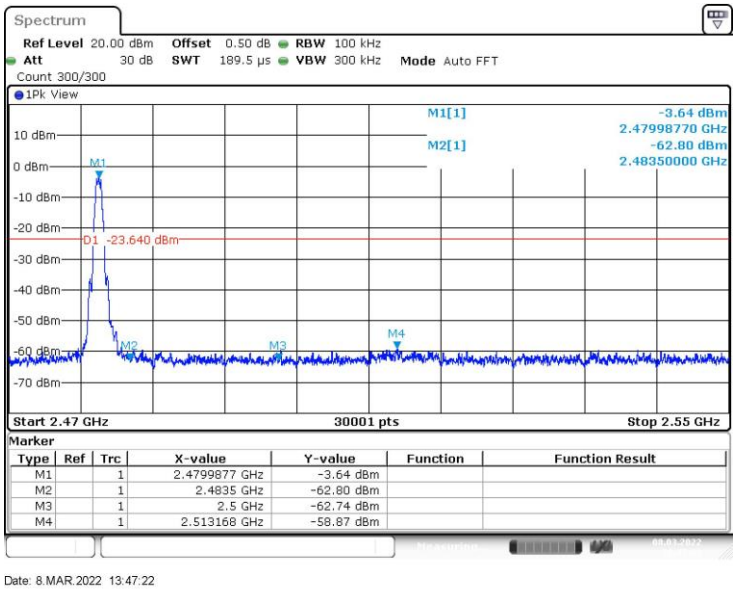
According to §15.247(d) and RSS-247 5.5, in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band 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) and RSS-Gen 8.10, must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)) and RSS-Gen.

Test result

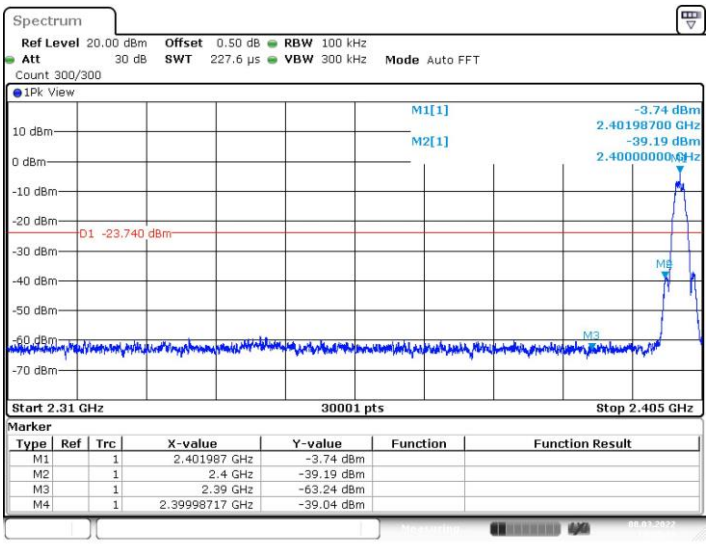
BLE_1M_Ant1_Low_2402

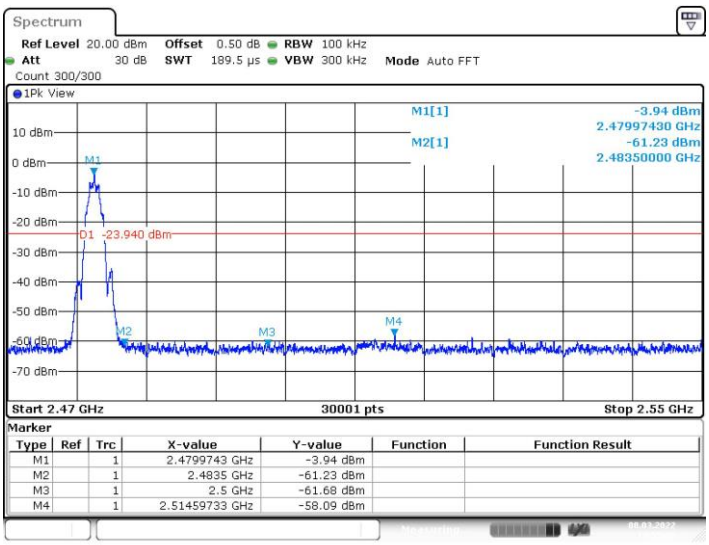


BLE_1M_Ant1_High_2480



Test result

BLE_2M_Ant1_Low_2402


BLE_2M_Ant1_High_2480


9.7 Spurious radiated emissions for transmitter

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 and RSS-GEN 8.10 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

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

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.

Pre-scan with three orthogonal axis and worst case as X axis. The only worse case test result is listed in the report.

Test result

Test mode: GFSK (1Mbps)					
Channel 0 (2402MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2383.5	42.82	74.00	31.18	Peak	Horizontal
4960.4	47.68	74.00	26.32	Peak	Horizontal
7206.7	48.12	74.00	25.88	Peak	Horizontal
2385.1	43.59	74.00	30.41	Peak	Vertical
4804.0	42.63	74.00	31.37	Peak	Vertical
7206.1	47.35	74.00	26.65	Peak	Vertical

Test mode: GFSK (1Mbps)					
Channel 19 (2440MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4879.9	42.25	74.00	31.75	Peak	Horizontal
7319.5	51.94	74.00	22.06	Peak	Horizontal
4879.4	43.63	74.00	30.37	Peak	Vertical
7319.5	49.55	74.00	24.45	Peak	Vertical

Test mode: GFSK (1Mbps)					
Channel 39 (2480MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.8	47.16	74.00	26.84	Peak	Horizontal
4959.9	42.50	74.00	31.50	Peak	Horizontal
7439.6	48.97	74.00	25.03	Peak	Horizontal
2483.6	45.39	74.00	28.61	Peak	Vertical
7439.0	50.59	74.00	23.41	Peak	Vertical

Test mode: GFSK (2Mbps)					
Channel 0 (2402MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2385.7	43.85	74.00	30.15	Peak	Horizontal
7204.4	49.10	74.00	24.90	Peak	Horizontal
4804.6	50.07	74.00	23.93	Peak	Horizontal
7206.1	52.33	74.00	21.67	Peak	Horizontal
2384.5	43.78	74.00	30.22	Peak	Vertical
4804.6	43.58	74.00	30.42	Peak	Vertical
7204.4	48.01	74.00	25.99	Peak	Vertical

Test mode: GFSK (2Mbps)					
Channel 19 (2440MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
4879.9	42.79	74.00	31.21	Peak	Horizontal
7318.9	48.51	74.00	25.49	Peak	Horizontal
4879.9	44.72	74.00	29.28	Peak	Vertical
7318.3	48.64	74.00	25.36	Peak	Vertical

Test mode: GFSK (2Mbps)					
Channel 39 (2480MHz)					
Frequency (MHz)	Measure Level (dBuV/m)	Limit (dBuV/M)	Margin (dB)	Detector	Polarization
2483.6	46.45	74.00	27.55	Peak	Horizontal
4960.4	42.83	74.00	31.17	Peak	Horizontal
7439.0	47.66	74.00	26.34	Peak	Horizontal
2483.6	45.21	74.00	28.79	Peak	Vertical
7438.5	49.59	74.00	24.41	Peak	Vertical

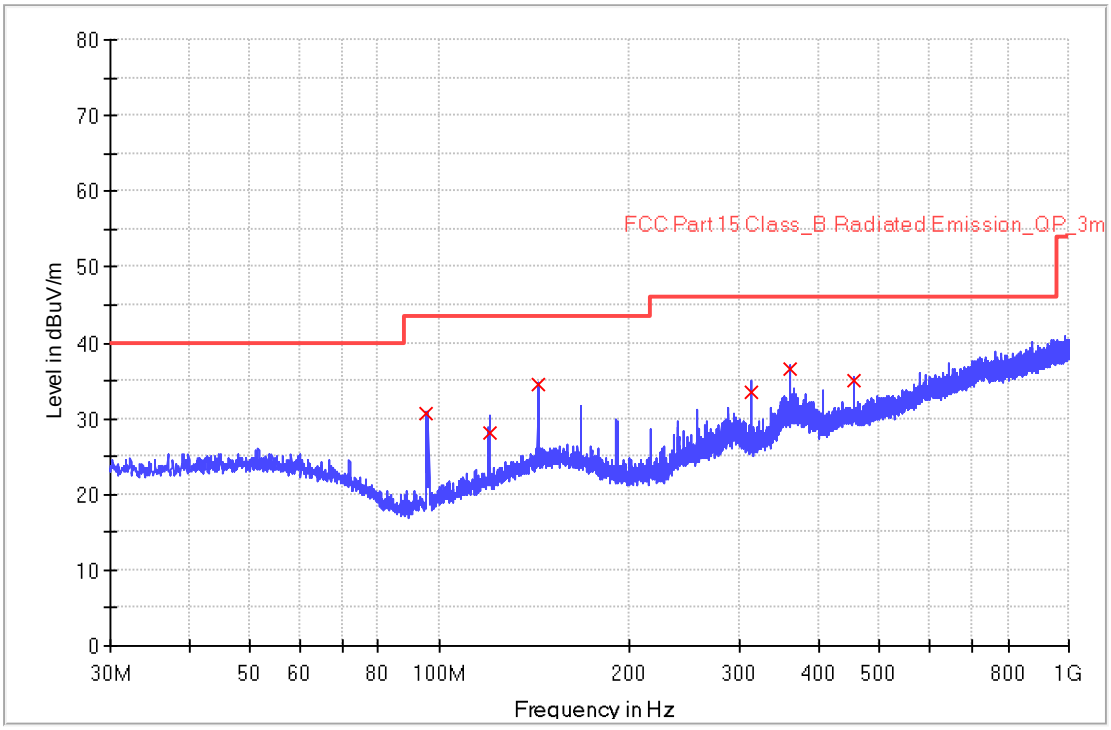
Remark:

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

The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2022/3/08 - 12:44
Limit: FCC_Part15.209_RE(3m) Class B	Engineer: Yan YANG
Probe: VULB9168	Polarity: Horizontal
EUT: Tubular motor, Model no: CM-05	Power: 5VDC (powered by notebook whose input is 120V~ 60Hz) 3.3VDC by debug board for BLE module
Note: Transmit by at channel 2402MHz. Note: Pre-scan with three orthogonal axis and worst case as X axis	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

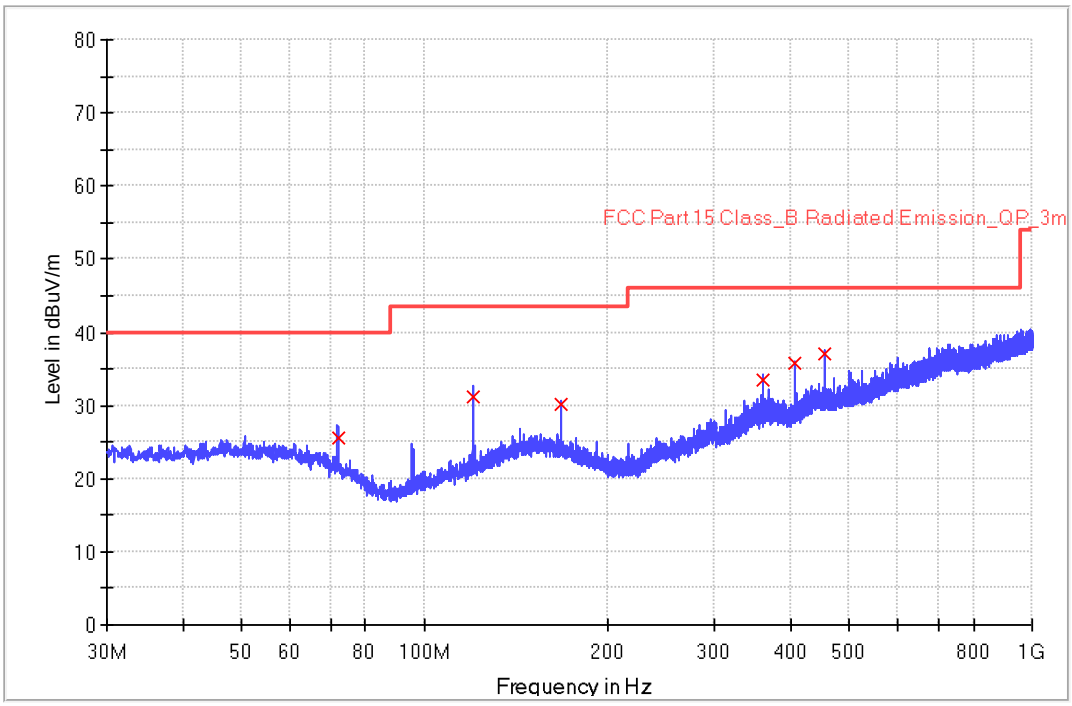
Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
95.440000	30.7	1000.0	120.000	200.0	H	228.0	15.5	12.9	43.5
119.960000	28.0	1000.0	120.000	230.0	H	9.0	18.1	15.5	43.5
143.840000	34.6	1000.0	120.000	212.0	H	0.0	20.5	8.9	43.5
311.960000	33.6	1000.0	120.000	134.0	H	57.0	21.9	12.5	46.0
360.000000	36.5	1000.0	120.000	121.0	H	126.0	23.0	9.5	46.0
455.960000	35.1	1000.0	120.000	150.0	H	193.0	25.9	10.9	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.

The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2022/3/08 - 12:51
Limit: FCC_Part15.209_RE(3m) Class B	Engineer: Yan YANG
Probe: VULB9168	Polarity: Vertical
EUT: Tubular motor Model no: CM-05	Power: 5VDC (powered by notebook whose input is 120V~ 60Hz) 3.3VDC by debug board for BLE module
Note: Transmit by at channel 2402MHz. Note: Pre-scan with three orthogonal axis and worst case as X axis	

RE_VULB9168_pre_Cont_30-1000



Limit and Margin

Frequency (MHz)	QuasiPeak (dBuV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)	Margin - QPK (dB)	Limit - QPK (dBuV/m)
71.960000	25.5	1000.0	120.000	110.0	V	239.0	18.2	14.5	40.0
119.960000	31.2	1000.0	120.000	105.0	V	134.0	18.1	12.3	43.5
168.000000	30.1	1000.0	120.000	134.0	V	45.0	20.4	13.4	43.5
360.000000	33.5	1000.0	120.000	105.0	V	1.0	23.0	12.5	46.0
408.000000	35.7	1000.0	120.000	106.0	V	47.0	24.2	10.3	46.0
455.960000	37.2	1000.0	120.000	100.0	V	104.0	25.9	8.8	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.

10 Test Equipment List

List of Test Instruments
Test Site1

	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE	CAL. DUE DATE
C	Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101091	2021-8-2	2022-8-1
RE	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2021-8-2	2022-8-1
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2021-8-2	2022-8-1
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2021-9-23	2024-9-22
	Horn Antenna	Rohde & Schwarz	HF907	102393	2021-3-15	2024-3-14
	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2021-8-2	2022-8-1
	Loop antenna	Rohde & Schwarz	HFH2-Z2	100443	2021-5-21	2022-5-20
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2020-9-23	2023-9-22
	3m Semi-anechoic chamber	TDK	9X6X6	----	2021-5-8	2024-5-7
CE	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2021-8-2	2022-8-1
	LISN	Rohde & Schwarz	ENV216	101924	2021-8-2	2022-8-1

Measurement Software Information			
Test Item	Software	Manufacturer	Version
C	Bluetooth and WiFi Test System	Shenzhen JS tonscend co.,ltd	2.6.77.0518
RE	EMC 32	Rohde & Schwarz	V10.50.40
CE	EMC 32	Rohde & Schwarz	V9.15.03

C - Conducted RF tests

- Conducted peak output power
- 6dB bandwidth and 99% Occupied Bandwidth
- Power spectral density*
- Spurious RF conducted emissions
- Band edge

11 System Measurement Uncertainty

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

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

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2007, clause 4.4.3 and 4.5.1.

12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600

13 Photographs of EUT

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

THE END

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch
3-13, No.151, Heng Tong Road, Shanghai, 200070, P.R. China
Phone: +86 21 61410123, Fax:+86 21 61408600