

TÜV

FCC - TEST REPORT

Report Number	: 7095021999901-00 Date of Issue: <u>July 19, 2021</u>
Model	: MCCGQ02HL
Product Type	: Mi Door and Window Sensor 2
Applicant	: TianJin HuaLai Technology Co., Ltd.
Address	: No.10 JinPing Road, Ya An Street, Nankai District Tianjin, China
Manufacturer	: TianJin HuaLai Technology Co., Ltd.
Address	: No.10 JinPing Road, Ya An Street, Nankai District Tianjin, China
Test Result	: ■ Positive □ Negative
Total pages including Appendices	: 33

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Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch Company name:

No.16 Lane, 1951 Du Hui Road,

Shanghai 201108,

P.R. China

Test Firm FCC

Registration Number:

820234

Test Firm IC

Registration Number:

25988

Telephone: +86 21 6141 0123

Fax: +86 21 6140 8600



3 Description of the Equipment under Test

Description of the Equipment Under Test

Product: Mi Door and Window Sensor 2

Model no.: MCCGQ02HL

FCC ID: 2ANJHMCCGQ02HL

Options and accessories: NA

Rating: 3V DC

RF Transmission

Frequency:

2402~2480 MHz

No. of Operated Channel: 40

Modulation: 2.4GHz BLE: GFSK

Antenna Type: Integrated

Antenna Gain: 2.5dBi

Description of the EUT: The Equipment Under Test (EUT) is a Door and Window Sensor 2

which support 2.4GHz BLE (only support 1Mbps data rate). We

tested it and listed the worst data in this report.

Test sample no.: SHA-575541-1

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	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).



5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C						
Test Condition		Pages	Test		st Res	
Tool Condition		i agoo	Site	Pass	Fail	N/A
§15.207	Conducted emission AC power port					
§15.247 (b) (1)	Conducted peak output power	12-13	Site 1			
§15.247(a)(1)	20dB bandwidth					
§15.247(a)(1)	Carrier frequency separation					
§15.247(a)(1)(iii)	Number of hopping frequencies					
§15.247(a)(1)(iii)	Dwell Time					
§15.247(a)(2)	6dB bandwidth	14-15	Site 1			
§15.247(e)	Power spectral density	16-17	Site 1			
§15.247(d)	Spurious RF conducted emissions	18-21	Site 1			
§15.247(d)	Band edge	22-23	Site 1			
§15.247(d) & §15.209	Spurious radiated emissions for transmitter	24-29	Site 1			
§15.203	Antenna requirement	See note	e 1			

Remark 1: N/A – Not Applicable. Conducted emission is not apply for battery operated device. Note 1: The EUT uses an integrated antenna, which gain is 2.5dBi. In accordance to §15.203, It is considered sufficiently to comply with the provisions of this section.



6 General Remarks

Remarks

This test report is intended for FCC ID: 2ANJHMCCGQ02HL, complies with Section 15.203, 15.209, 15.247 of the FCC Part 15, Subpart C Rules.

SUMMARY:

All tests	according	to the	regulations	cited c	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: May 31, 2021

Testing Start Date: June 1, 2021

Testing End Date: June 18, 2021

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

Reviewed by: Prepared by: Tested by:

Hui TONG Review Engineer Jiaxi XU Project Engineer

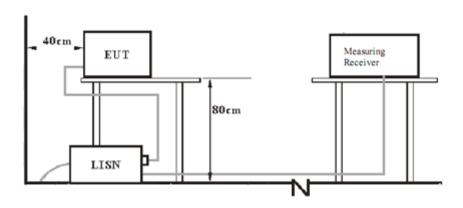
xi Xu

Jiahui DU Test Engineer



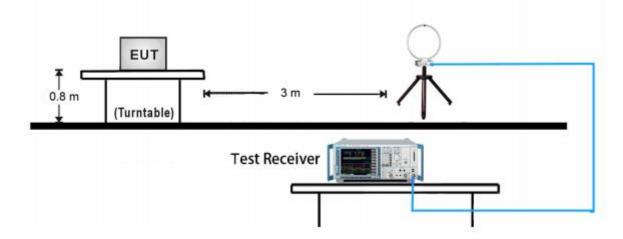
7 Test Setups

7.1 AC Power Line Conducted Emission test setups



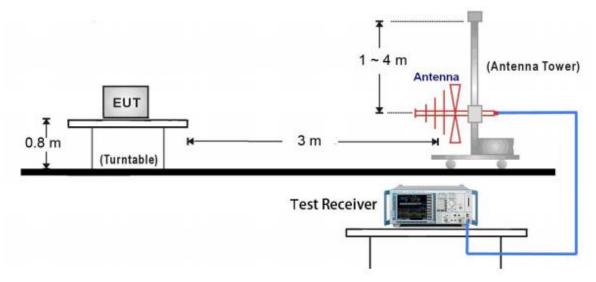
7.2 Radiated test setups

9kHz ~ 30MHz Test Setup:

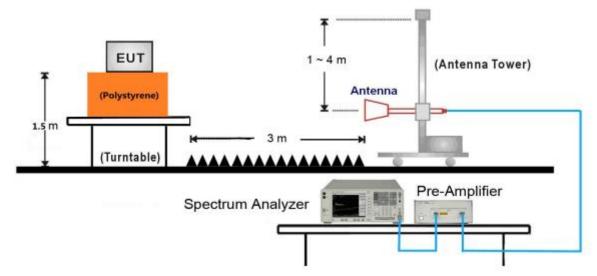




30MHz ~ 1GHz Test Setup:

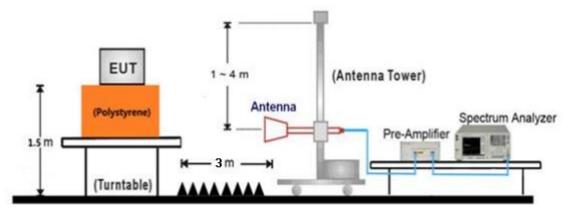


1GHz ~ 18GHz Test Setup:

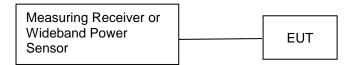




18GHz ~ 40GHz Test Setup:



7.3 Conducted RF test setups





8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenove	E470	PF-OU5TS7 17/09

Test software: BGTool

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 cycle and the highest transmit power.



9 Technical Requirement

9.1 Conducted peak output power

Test Method

- 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.

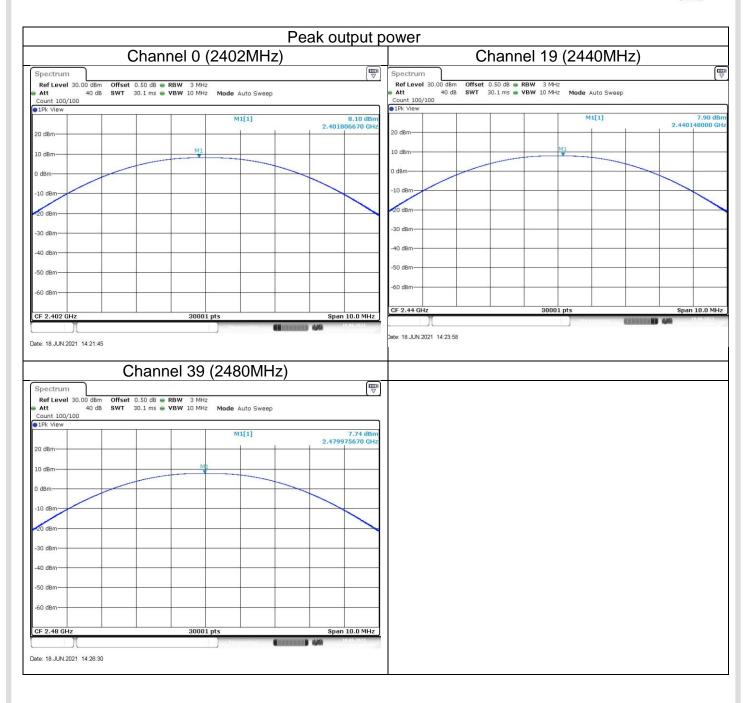
Limits

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

Test result as below table

	Conducted Peak	Data transmission	
Frequency	Output Power	rate	Result
MHz	dBm		
Low channel 2402MHz	8.10	1Mbps	Pass
Middle channel 2440MHz	7.90	1Mbps	Pass
High channel 2480MHz	7.74	1Mbps	Pass







9.2 6dB bandwidth

Test Method

- 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.

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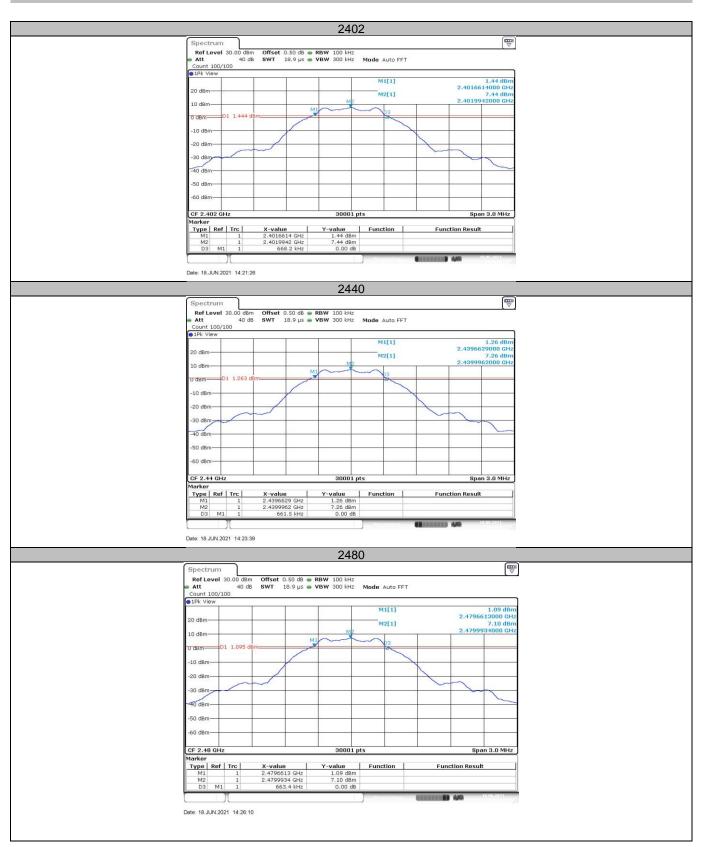
Limit [kHz]	
 ≥500	

Test result

Frequency	6dB bandwidth	Data transmission	Result
MHz	MHz	rate	rtooun
Top channel 2402MHz	0.668	1Mbps	Pass
Middle channel 2440MHz	0.662	1Mbps	Pass
Bottom channel 2480MHz	0.663	1Mbps	Pass



6dB Bandwidth





9.3 Power spectral density

Test Method

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

- 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.

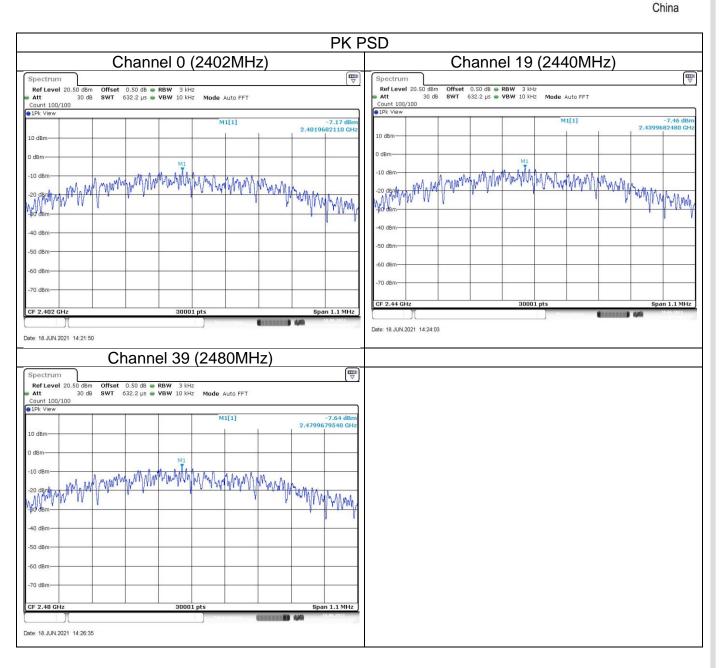
Limit

Limit [dBm/3kHz]	
≤8	_

Test result

	Power spectral	
Frequency	density	Result
MHz	dBm/3kHz	
Top channel 2402MHz	-7.17	Pass
Middle channel 2440MHz	-7.46	Pass
Bottom channel 2480MHz	-7.64	Pass







9.4 Spurious RF conducted emissions

Test Method

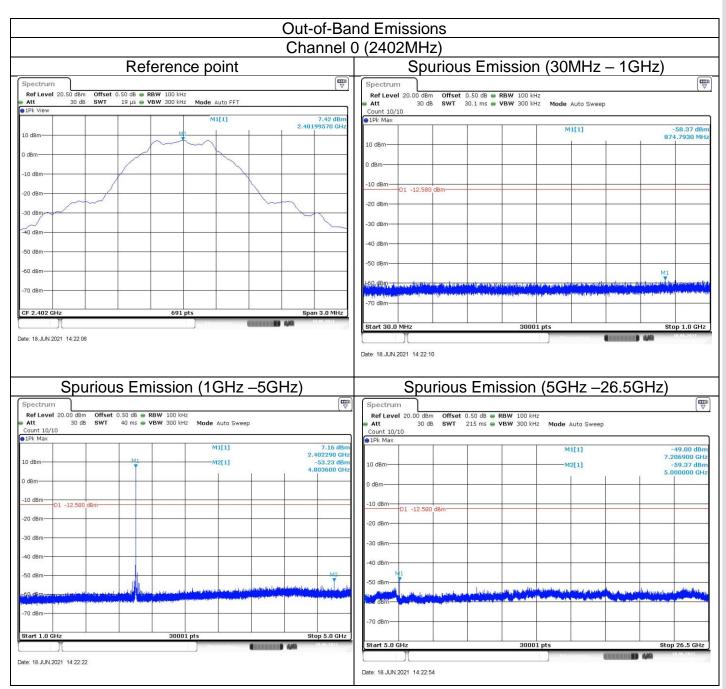
- 1. Establish a reference level by using the following procedure:
 - a. Set RBW=100 kHz. VBW≥3RBW. Detector =peak, Sweep time = auto couple, Trace mode = max hold.
 - b. Allow trace to fully stabilize, use the peak marker function to determine the maximum PSD level.
- 2. Use the maximum PSD level to 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



Spurious RF conducted emissions

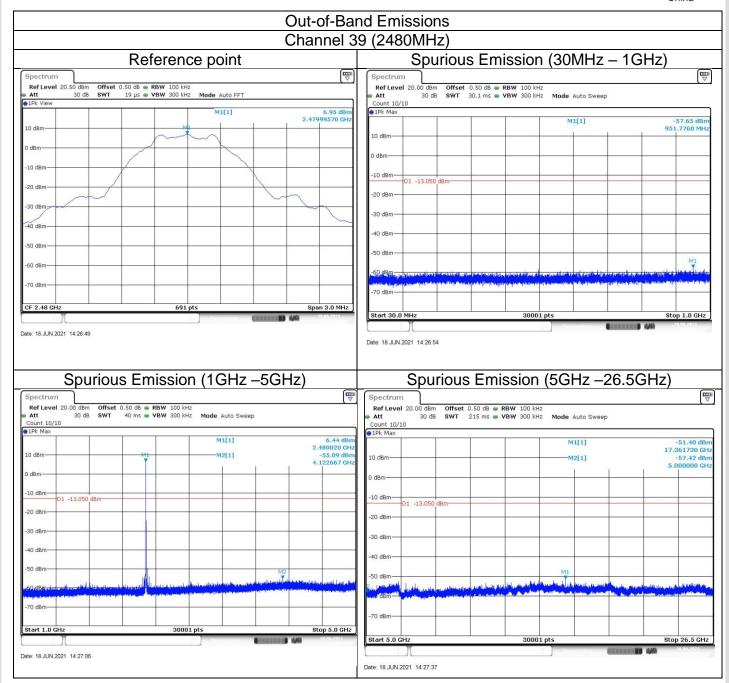




Out-of-Band Emissions Channel 19 (2440MHz) Spurious Emission (30MHz - 1GHz) Reference point Ref Level 20.50 dBm 30 dB Spectrum Ref Level 20.00 dBm
Att 30 dB
Count 10/10
1Pk Max Offset 0.50 dB ● RBW 100 kHz SWT 30.1 ms ● VBW 300 kHz Mode Auto Sweep 2,4399 M1[1] -58.68 dBr 437.1760 MH 0 dBn 0 dBm -10 dBr D1 -12.86 20 dBm -50 dBm CF 2.44 GHz Date: 18.JUN.2021 14:24:08 Date: 18.JUN.2021 14:24:13 Spurious Emission (1GHz -5GHz) Spurious Emission (5GHz -26.5GHz) Spectrum Ref Level 20.00 dBm Att 30 dB Count 10/10 0dBm Offset 0.50 dB • RBW 100 kHz 30 dB SWT 40 ms • VBW 300 kHz Mode Auto Sweep Mode Auto Sweep Count 10/10 ●1Pk Max M1[1] 7.08 dBn 2.439750 GH -55.54 dBn 4.198533 GH M2[1] M2[1] 0 dBn 0 dBm -10 dBm -10 dBm D1 -12.860 dB -20 dBn -30 dBm 30 dBn 40 dBm 40 dBn -50 dBm 70 dBm Date: 18.JUN.2021 14:24:25 Date: 18.JUN.2021 14:24:56



China





9.5 Band edge

Test Method

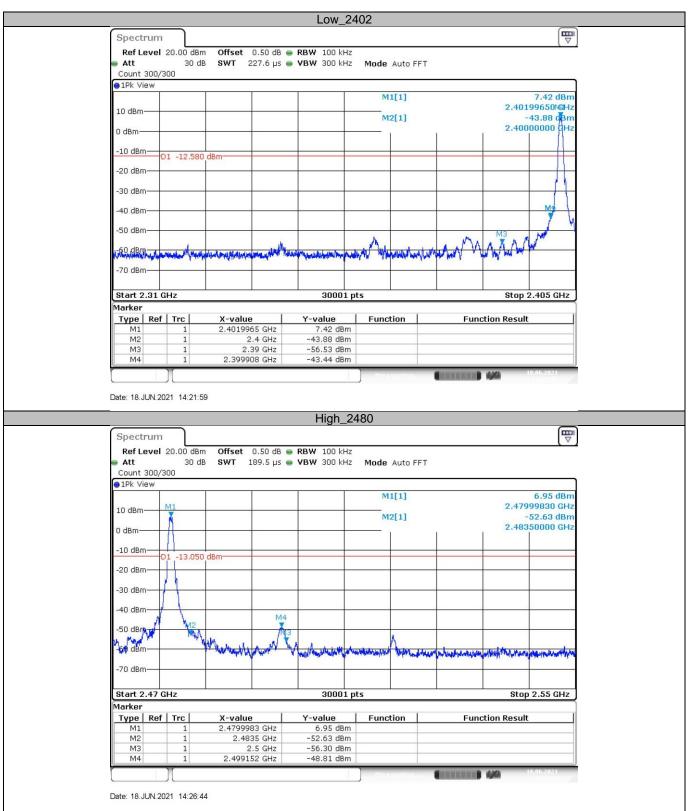
- 1 Use the following spectrum analyzer settings: Span = wide enough to capture the peak level of the in-band emission and all spurious RBW = 100 kHz, VBW≥RBW, Sweep = auto, Detector function = peak, Trace = max hold.
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the 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 China





9.6 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 \geq [3 × RBW].
- c) Detector = RMS (power averaging), if [span / (# of points in sweep)] \leq 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 section 15.205 and RSS-GEN 8.10 must comply with the radiated emission limits specified in section 15.209.

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

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



Spurious radiated emissions for transmitter

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

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							
		Channel 0 (2	(402MHz)				
Frequency (MHz)	. , , , , , , , , , , , , , , , , , , ,						
2363.9	51.35	74.0	22.65	Peak	Horizontal		
2382.9	53.76	74.0	20.24	Peak	Horizontal		
2382.9	41.90	54.0	12.10	AV	Horizontal		
4803.4	48.61	74.0	25.39	Peak	Horizontal		
7206.7	51.84	74.0	22.16	Peak	Horizontal		
2383.1	51.13	74.0	22.87	Peak	Vertical		
4804.6	48.09	74.0	25.91	Peak	Vertical		
7206.7	54.45	74.0	19.55	Peak	Vertical		
7206.7	48.70	54.0	5.30	AV	Vertical		

Test mode: GFSK							
		Channel 19 (2440MHz)				
Frequency (MHz) Measure Limit (Margin (Db) Detector Polarization							
4879.4	48.51	74.0	25.49	Peak	Horizontal		
7318.9	54.08	74.0	19.92	Peak	Horizontal		
7318.9	48.20	54.0	5.80	AV	Horizontal		
4880.5	46.11	74.0	27.89	Peak	Vertical		
7320.6	55.25	74.0	18.75	Peak	Vertical		
7320.6	49.90	54.0	4.10	AV	Vertical		



Test mode: GFSK									
Channel 39 (2480MHz)									
Frequency (MHz) Measure Level (dBuV/m)		Limit (dBuV/M)	Margin (dB)	Detector	Polarization				
2484.7	56.12	74.0	17.88	Peak	Horizontal				
2484.7	40.50	54.0	13.5	AV	Horizontal				
2499.2	60.39	60.39 74.0 13.61			Horizontal				
2499.2	50.40	54.0	3.60	AV	Horizontal				
4959.3	49.14	74.0	24.86	Peak	Horizontal				
7439.6	53.66	74.00	20.34	Peak	Horizontal				
7439.6	47.80	54.00	6.20	AV	Horizontal				
2484.9	56.07	74.0	17.93	Peak	Vertical				
2484.9	40.00	54.0	14.00	AV	Vertical				
4960.4	46.81	74.00	27.19	Peak	Vertical				
7439.0	54.47	74.00	19.53	Peak	Vertical				
7439.0	48.70	54.00	5.30	AV	Vertical				

Remark:

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

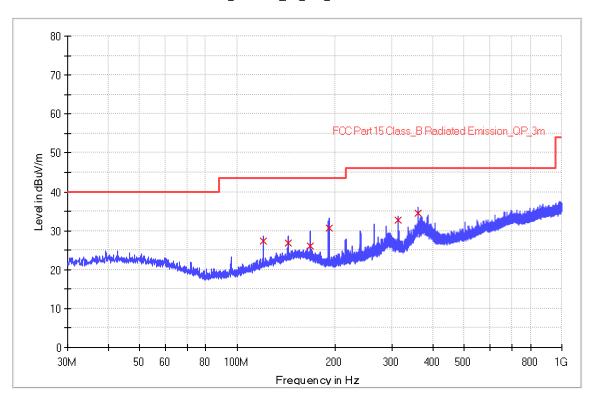


The worst case of Radiated Emission below 1GHz:

Note: Pre-scan with three orthogonal axis and worst case as X axis

Site: 3 meter chamber	Time: 2021/06/04 - 12:34	
Limit: FCC_Part15.209_RE(3m)_ClassB	Engineer: Jiahui DU	
Probe: VULB9168	Polarity: Horizontal	
EUT: Mi Door and Window Sensor 2,	Power: DC 3.0V	
Model no: MCCGQ02HL		
Note: Transmit by at channel 2402MHz.		

RE VULB9168 pre Cont 30-1000



Limit and Margin

Frequency	QuasiPeak	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.	Margin -	Limit -
(MHz)	(dBuV/m)	Time	(kHz)	(cm)		(deg)	(dB)	QPK	QPK
		(ms)						(dB)	(dBuV/m)
119.960000	27.3	1000.0	120.000	100.3	Н	359.0	13.5	16.2	43.5
143.920000	26.9	1000.0	120.000	100.3	Н	90.0	15.2	16.6	43.5
168.000000	26.2	1000.0	120.000	100.3	Н	245.0	14.9	17.3	43.5
191.960000	30.7	1000.0	120.000	100.3	Н	1.0	12.1	12.8	43.5
311.960000	32.7	1000.0	120.000	100.3	Н	270.0	15.3	13.3	46.0
360.000000	34.4	1000.0	120.000	100.3	Н	359.0	16.5	11.6	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.

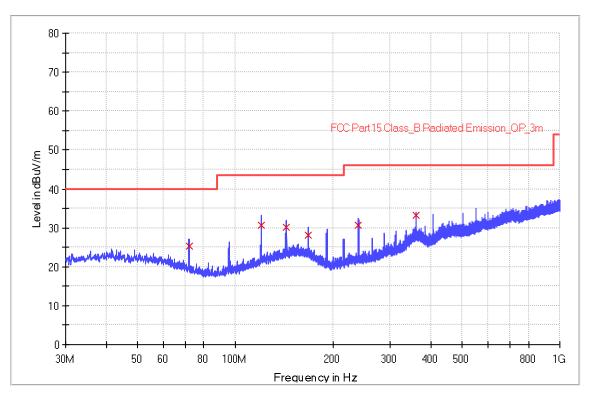


China

The worst case of Radiated Emission below 1GHz:

Site: 3 meter chamber	Time: 2021/06/04 - 12:58			
Limit: FCC_Part15.209_RE(3m)_ClassB	Engineer: Jiahui DU			
Probe: VULB9168	Polarity: Vertical			
EUT: Mi Door and Window Sensor 2,	Power: DC 3.0V			
Model no: MCCGQ02HL				
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

	9								
Frequency	QuasiPeak	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.	Margin -	Limit -
(MHz)	(dBuV/m)	Time	(kHz)	(cm)		(deg)	(dB)	QPK	QPK
		(ms)						(dB)	(dBuV/m)
71.960000	25.3	1000.0	120.000	100.3	٧	1.0	11.5	14.7	40.0
119.960000	30.7	1000.0	120.000	100.3	٧	90.0	13.5	12.8	43.5
143.960000	30.2	1000.0	120.000	100.3	٧	359.0	15.2	13.3	43.5
168.000000	28.0	1000.0	120.000	100.3	٧	180.0	14.9	15.5	43.5
239.920000	30.6	1000.0	120.000	100.3	٧	110.0	13.4	15.4	46.0
360.000000	33.1	1000.0	120.000	100.3	٧	359.0	16.5	12.9	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: $9kHz \sim 30MHz$, $18GHz \sim 25GHz$), 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
С	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
	EMI Test Receiver	Rohde & Schwarz	ESR3	101906	2020-8-4	2021-8-3
	Signal Analyzer	Rohde & Schwarz	FSV40	101091	2020-8-4	2021-8-3
	Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9168	961	2019-3-16	2022-3-15
	Double-ridged waveguide horn antenna	Rohde & Schwarz	HF907	102868	2021-3-15	2024-3-14
RE	Pre-amplifier	Rohde & Schwarz	SCU-18D	19006451	2020-8-4	2021-8-3
111	Loop antenna	Rohde & Schwarz	HFH2-Z2E	100933	2021-3-25	2022-3-24
	DOUBLE-RIDGED WAVEGUIDE HORN WITH PRE-AMPLIFIER (18 GHZ - 40 GHZ)	ETS-Lindgren	3116C-PA	002222727	2020-9-23	2021-9-22
	3m Semi-anechoic chamber	TDK	9X6X6		2021-5-8	2024-5-7
	EMI Test Receiver	Rohde & Schwarz	ESR3	101907	2020-8-4	2021-8-3
CE	LISN	Rohde & Schwarz	ENV216	101924	2020-8-4	2021-8-3

Measurement Software Information				
Test Item	Software	Manufacturer	Version	
С	Bluetooth and WiFi Test System	Shenzhen JS tonscend co.,ltd	2.6.77.0518	
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 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
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 40GHz, ±5.63dB
Carrier power conducted measurement	50MHz~18GHz, ±1.238dB
Spurious Emission Conducted Measurement	9kHz ~40GHz, ± 1.224dB



12 Photographs of Test Set-ups

Refer to the < Test Setup photos >.



13 Photographs of EUT

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

THE END