FCC CO-LOCATION RADIO TEST REPORT

for

Hybrid Security System

Model No.: HYGW-Gen2-V1

FCC ID: GX9HYGWGEN2

of

Applicant: CLIMAX TECHNOLOGY CO., LTD.
Address: No. 258, Sinhu 2nd Rd., Neihu District, Taipei City 114, Taiwan (R.O.C.)

Tested and Prepared

by

Worldwide Testing Services (Taiwan) Co., Ltd.

FCC Registration No.: TW1477, TW1072

Industry Canada filed test laboratory Reg. No.: 20037, 5107A

Report No.: W6R22209-22106-CLR

6F, NO. 58, LANE 188, RUEY-KUANG RD., NEIHU TAIPEI 114, TAIWAN, R.O.C.
TEL: 886-2-66068877 FAX: 886-2-66068879 E-mail: wts@wts-lab.com

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1 General Information

1.1 Notes

The purpose of conformity testing is to increase the probability of adherence to the essential requirements or conformity specifications, as appropriate.
The complexity of the technical specifications, however, means that full and thorough testing is impractical for both technical and economic reasons.
Furthermore, there is no guarantee that a test sample which has passed all the relevant tests conforms to a specification.
Neither is there any guarantee that such a test sample will interwork with other genuinely open systems.
The existence of the tests nevertheless provides the confidence that the test sample possesses the qualities as maintained and that is performance generally conforms to representative cases of communications equipment.

Laboratory disclaimer-
1. The test results of this test report relate exclusively to the item tested as specified in 1.5.
2. The test report may only be reproduced or published in full.
3. Reproduction or publication of extracts from the report requires the prior written approval of the Worldwide Testing Services(Taiwan) Co., Ltd.
4. Antenna gain is provided by applicant and laboratory issue relevant data and results.

Specific Conditions:
Usage of the hereunder tested device in combination with other integrated or external antennas requires at least additional output power measurements, spurious emission measurements, conducted emission measurements (AC supply lines) and radio frequency exposure evaluations for each individual configuration performed, for certification by FCC.
The test sample is able to work according IEEE 802.11 b/g/n.
This report is related to FCC Part 15 C (DSSS and OFDM device).

Tester:

Date	WTS-Lab.	Name	Signature
October 19, 2022		Sora Kuo	Sora

Technical responsibility for area of testing:

Date	WTS	Name	Signature
October 19, 2022		Kevin Wang	Kevin Wang

Registration number: W6R22209-22106-CLR
FCC ID: GX9HYGWGEN2

1.2 Testing laboratory

1.2.1 Location

10m OATS
No.5-1, Lishui, Shuang Sing Village, Wanli Dist.,
New Taipei City 207, Taiwan (R.O.C.)

3 meter semi-anechoic chamber
No.35, Aly. 21, Ln. 228, Ankang Rd., Neihu Dist.,
Taipei City 114, Taiwan (R.O.C.)
Tel: 886-2-6613-0228

Worldwide Testing Services (Taiwan) Co., Ltd.
6F., No. 58, Ln. 188, Ruiguang Rd., Neihu Dist.,
Taipei City 114 , Taiwan (R.O.C.)
Tel: 886-2-6606-8877

1.2.2 Details of accreditation status

Accredited testing laboratory
FCC filed test laboratory Reg. No.: TW1477, TW1072
Industry Canada filed test laboratory Reg. No.: 20037, 5107A

Test location, where different from Worldwide Testing Services (Taiwan) Co., Ltd. :

Name:	./.
Accredited number:	./.
Street:	./.
Town:	./.
Country:	./.

1.3 Details of approval holder

Name:	CLIMAX TECHNOLOGY CO., LTD.
Street:	No. 258, Sinhu 2nd Rd., Neihu District,
Town:	Taipei City 114,
Country:	Taiwan (R.O.C.)

1.4 Manufacturer: (if applicable)

Name:	./.
Street:	./.
Town:	./.
Country:	./.

1.5 Application details

Date of receipt of test item:	September 06, 2022
Date of test:	from September 07, 2022 to October 18, 2022

1.6 General information of Test item

Type of test item:	Hybrid Security System
Model number:	HYGW-Gen2-V1
Brand name:	Alarm.com
Multi-listing model number:	./.
Sample no.:	#02

Technical data

Frequency band:	2400 MHz – 2483.5 MHz

2.4 GHz Wifi

802.11b, g, n 20MHz

Frequency (ch 1):	2412 MHz
Frequency (ch 6):	2437 MHz
Frequency (ch 11):	2462 MHz

802.11n 40MHz

Frequency (ch 1):	2422 MHz
Frequency (ch 4):	2437 MHz
Frequency (ch 7):	2452 MHz
Number of Channels:	802.11b, g, n 20MHz: 11 802.11n 40MHz: 7
Operation modes:	Duplex
Modulation type:	DSSS / OFDM
Type of antenna:	Monopole antenna
Antenna gain:	ANT A: 2.92 dBi / ANT B: 2.37 dBi
Directional gain:	5.66 dBi

According to KDB 662911, Unequal antenna gains, with equal transmit powers. For antenna gains given by G_1, G_2, …, G_N dBi. If transmit signals are correlated, then Directional gain $=10\log[(10^{G1/20}+10^{G2/20}+\ldots+10^{GN/20})^2/N]$ dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

Emission designator:	Mode A (802.11b): DSSS: 14M0G1D Mode B (802.11g): OFDM: 18M0D1D Mode C (802.11n 20MHz): OFDM: 20M0D1D Mode D (802.11n 40MHz): OFDM: 38M4D1D

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Zigbee

Frequency (ch 11):	2405 MHz
Frequency (ch 18):	2440 MHz
Frequency (ch 25):	2475 MHz
Number of Channels:	15
Operation modes:	Duplex
Modulation type:	OQPSK
Type of antenna:	PIFA antenna
Antenna gain:	1.2389 dBi
Emission designator:	2M80G1D
Host device:	none
Fixed point-to-point operation:	☐ Yes / ☒ No
Power supply:	16~18Va.c.
Classification:	

Fixed Device	☒
Mobile Device (Human Body distance ＞ 20cm)	☐
Portable Device (Human Body distance ＜ 20cm)	☐
Modular Radio Device	☐

Duty Cycles

Mode	Ton (ms)	Ton+Toff (ms)	Duty cycle (%)	Duty Factor (dB)	1/T - VBW (KHz)
802.11 B	8.614	8.678	99.26%	0.03	0.12
802.11 G	1.442	1.530	94.24%	0.26	0.69
802.11n (20MHz)	1.346	1.442	93.33%	0.30	0.74
802.11n (40MHz)	0.950	0.998	95.18%	0.21	1.05

1.7 Test standards

Technical standard : 47 CFR PART 15 SUBPART C § 15.247 (2020-10)

2 Technical test

2.1 Summary of test results

No deviations from the technical specification(s) were ascertained in the course of the tests performed. ☒

or

The deviations were ascertained in the course of the tests performed. ☐

2.2 Test environment

Relative humidity content: 20 ... 75 %

Air pressure: 86 ... 103 kPa

Power supply: 16~18Va.c.

Extreme conditions parameters: ./.

Test item Name	Uncertainty
Estimation Result of Uncertainty of Radiated Emission(3M) (Transmitter Radiated Emissions in Restricted Bands, Spurious Emissions (tx), Radiated Emission from Digital Part)	Expanded Uncertainty： 0.009-30 MHz：3.48 dB 30-1000 MHz：4.48 dB 1-18 GHz：4.15 dB 18-40 GHz：3.78 dB

The decision rule is: Measurement uncertainty is not included in the calculation of test results.

2.3 Test Equipment List

No.	Test equipment	Type	Serial No.	Manufacturer	Cal. Date	Next Cal. Date
ETSTW-RE 004	EMI TEST RECEIVER	ESI 40	832427/004	R&S	2022/9/16	2023/9/15
ETSTW-RE 030	Double-Ridged Guide Horn Antenna	3117	00035224	ETS-Lindgren	2022/5/23	2023/5/22
ETSTW-RE 062	Amplifier Module	CHC 2	None	KMIC	2022/5/13	2023/5/12
ETSTW-RE 142	Amplifier	8447D	2805A03378	Agilent	2022/5/13	2023/5/12
ETSTW-RE 152	Bi-log Hybrid Antenna	MCTD 2786B	BLB20J04029	ETC	2022/10/17	2023/10/16

2.4 General Test Procedure

POWER LINE CONDUCTED INTERFERENCE: The procedure used was ANSI STANDARD C63.10-2013 6.2 using a 50µH LISN (if necessary). Both lines were observed. The bandwidth of the spectrum analyzer was 10 kHz with an appropriate sweep speed.

RADIATION INTERFERENCE: The test procedure used was according to ANSI STANDARD C63.10-2013 6.3 employing a spectrum analyzer. For investigated frequency is equal to or below 1GHz, the RBW and VBW of the spectrum analyzer was 100 kHz and 100kHz respectively with an appropriate sweep speed. For investigated frequency is above 1GHz, both of RBW and VBW of the spectrum analyzer were 1 MHz with an appropriate sweep speed. The analyzer was calibrated in dB above a microvolt at the output of the antenna.

FORMULA OF CONVERSION FACTORS: The Field Strength at 3m was established by adding the meter reading of the spectrum analyzer (which is set to read in units of dBµV) to the antenna correction factor supplied by the antenna manufacturer. The antenna correction factors are stated in terms of dB.

Example:

Freq (MHz)	METER READING + ACF + CABLE LOSS (to the receiver) = FS
33	20 dBµV + 10.36 dB + 6 dB = 36.36 dBµV/m @3m

The EUT was placed on a table 80 cm high and with dimensions of 1m by 1.5m (non metallic table) and arranged according to ANSI C63.10-2013 6.2.2. The table used for radiated measurements is capable of continuous rotation. The spectrum was scanned from 30 MHz to the frequency specified as follows:

(1) If the intentional radiator operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(2) If the intentional radiator operates at or above 10 GHz and below 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 100 GHz, whichever is lower.
(3) If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.
(4) If the intentional radiator contains a digital device, regardless of whether this digital device controls the functions of the intentional radiator or the digital device is used for additional control or function purposes other than to enable the operation of the intentional radiator, the frequency range shall be investigated up to the range specified in paragraphs (a)(1)-(a)(3) of this section or the range applicable to the digital device, as shown in paragraph (b)(1) of this Section, whichever is the higher frequency range of investigation.

For hand-held devices, a exploratory test was performed with three (3) orthogonal planes to determine the highest emissions.

When an emission was found, the table was rotated to produce the maximum signal strength. At this point, the antenna was raised and lowered from 1m to 4m. The antenna was placed in both the horizontal and vertical planes.

When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.

The formula is as follows:
Average = Peak + Duty Factor
Duty Factor = 20 log (dwell time/T)
T = 100ms when the pulse train period is over 100 ms or the period of the pulse train.

Modified Limits for peak according to 15.35 (b) = Max Permitted average Limits + 20dB

ANSI STANDARD C63.10-2013 B.2.7: Any measurements that utilize special test software shall be indicated and referenced in the test report. During testing, test software ’EZ EMC’ was used for setting up different operation modes.

3 Test results (enclosure)

TEST CASE	Para. Number	Required	Test passed	Test failed
Spurious Emissions radiated – Transmitter operating	15.247(d): 15.209	☒	☒	☐

Note:

1. This EUT incorporates a MIMO function with IEEE 802.11b, 802.11g, and 802.11n. Physically, this EUT includes two transmitters and two receivers with two incoherent streams. This device uses multiplexing and also employ cyclic delay diversity to improve range and throughput, and this device simultaneously operates on two adjacent channels.
2. This EUT is 2*2 spatial MIMO (2Tx&2Rx) without beam forming function. That operates dual chain configuration. The Pre-test was performed to determine the worst case mode from all possible combinations between all available modulations, data rates, bandwidths, and spatial stream modes.

3.1 Transmitter Radiated Emissions in Restricted Bands

FCC Rules: 15.247 (d), 15.205, 15.209, 15.35
Radiated emission measurements were performed from 30 MHz to 26500 MHz.
For radiated emission tests, the analyzer setting was as followings:

Frequency ≦ 1 GHz, RBW:100 kHz, VBW: 100 kHz (Peak measurements)
Frequency ＞1 GHz, RBW: 1 MHz, VBW: 1 MHz (Peak measurements)
Frequency ＞1 GHz , RBW:1 MHz , VBW: 1/T (Average measurements)

Limits.

For frequencies below 1GHz:

Frequency of Emission (MHz)	Field strength (microvolts/meter)	Field Strength (dB microvolts/meter)
30 - 88	100	40.0
88 - 216	150	43.5
216 - 960	200	46.0
Above	500	54.0

For frequencies above 1GHz (Average measurements).

Guidance on Measurement of Digit Transmission Systems:
“If the emission is pulsed, modify the unit for continuous operation, use the setting shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation.”

The correction factor, based on the total channel dwell time in a 100 ms period, may be mathematically applied to a measurement made with an average detector, to further reduce the value.

Duty cycle correction = 20 log (dwell time/ 100ms)

3.2 Spurious Emissions (tx)

Spurious emission was measured with modulation (declared by manufacturer).

In any 100 kHz bandwidth outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB 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. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c))

FCC Rule: 15.247(c), 15.35
For out of band emissions that are close to or that exceed the 20 dB attenuation requirement described in the specification, radiated measurements were performed at a 3 m separation distance to determine whether these emissions complied with the general radiated emission requirement.

Limits:

For frequencies above 1GHz (Peak measurements).
Modified Limit for peak according to 15.35 (b) = Max Permitted average Limits + 20dB

For frequencies above 1GHz (Average measurements).
Max. reading – 20dB

Max. reading – 20 dB
Guidance on Measurement of Digit Transmission Systems:
“If the emission is pulsed, modify the unit for continuous operation, use the settings shown above, then correct the reading by subtracting the peak-average correction factor, derived from the appropriate duty cycle calculation.”

The correction factor, based on the total channel dwell time in a 100 ms period, may be mathematically applied to a measurement made with an average detector, to further reduce the value.

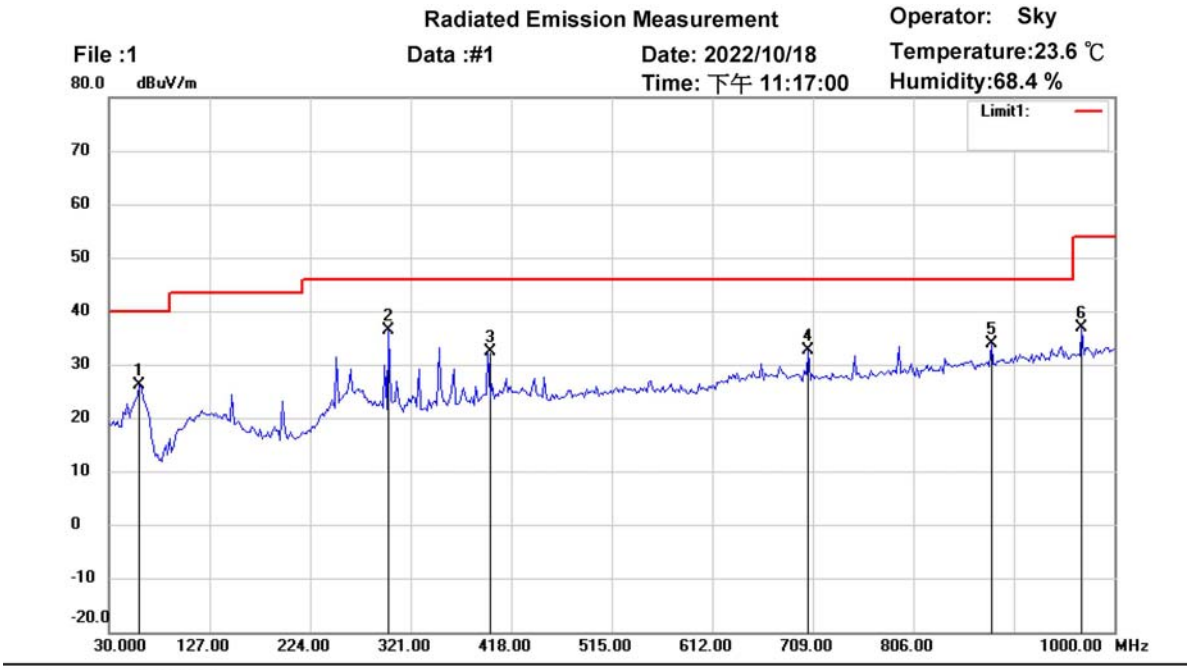
Duty Cycle correction = 20 log (dwell time/100ms)

SAMPLE CALCULATION OF LIMIT. All results will be updated by an automatic measuring system in accordance with point 2.3.

Calculation of test results:
Such factors like antenna correction, cable loss, external attenuation etc. are already included in the provided measurement results. This is done by using validated test software and calibrated test system according the accreditation requirements.

The peak and average spurious emission plots was measured with the average limits.
In the Table being listed the critical peak and average value and exhibit the compliance with the above calculated Limits.

If in the column's correction factor states a value then the max. Field strength in the same row is corrected by a value gained from the "Correction Factor".

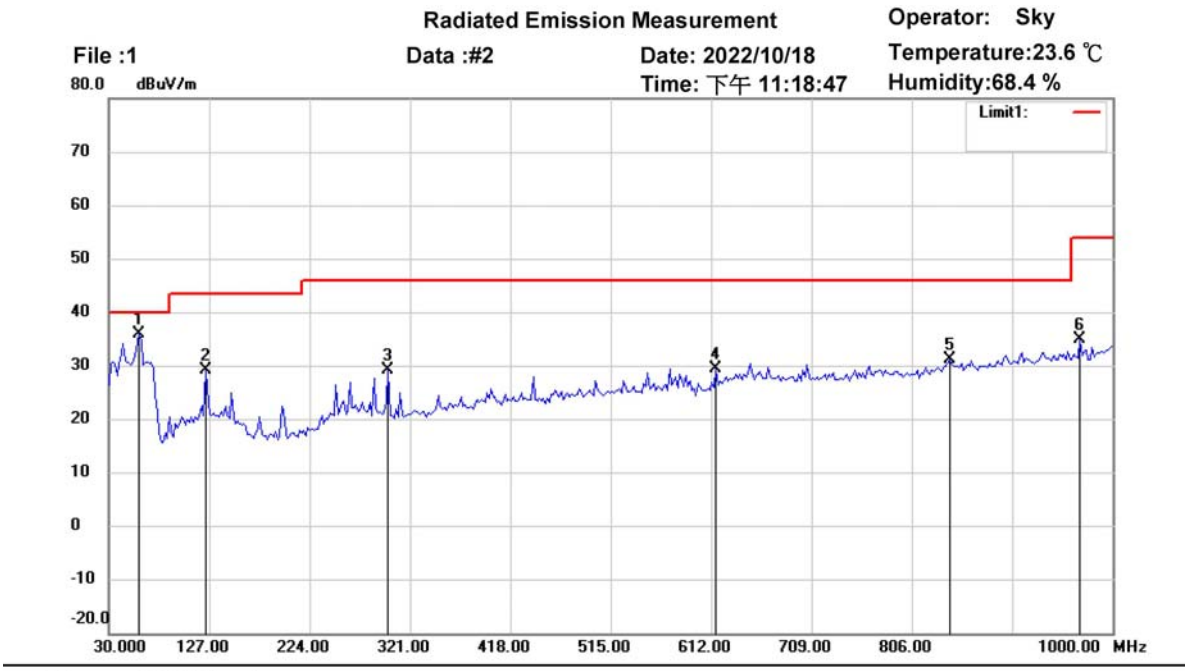


Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_30-1000MHz
EUT : W6R22209-22106
M/N:
Test Mode : Zigbee+WiFi
Note :

Polarization: Horizontal
Power : 18 Va.c.
Distance: 3m

Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment
	59.1583	37.59	peak	-11.37	26.22	40.00	114	102	-13.78	
*	300.2004	42.22	peak	-5.90	36.32	46.00	102	30	-9.68	
	395.4510	36.29	peak	-3.89	32.40	46.00	106	82	-13.60	
	704.5291	32.39	peak	0.20	32.59	46.00	124	55	-13.41	
	881.4228	30.38	peak	3.44	33.82	46.00	103	92	-12.18	
	968.8978	31.47	peak	5.32	36.79	54.00	117	6	-17.21	

Registration number: W6R22209-22106-CLR
FCC ID: GX9HYGWGEN2



Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_30-1000MHz
EUT : W6R22209-22106
M/N:
Test Mode : Zigbee+WiFi
Note :

Polarization: *Vertical*
Power : 18 Va.c.
Distance: 3m

Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment
*	59.1583	47.19	peak	-11.37	35.82	40.00	102	109	-4.18	
	123.3066	35.51	peak	-6.35	29.16	43.50	113	42	-14.34	
	300.2004	35.09	peak	-5.90	29.19	46.00	109	101	-16.81	
	617.0541	30.57	peak	-1.17	29.40	46.00	108	225	-16.60	
	842.5451	28.52	peak	2.63	31.15	46.00	100	6	-14.85	
	968.8978	29.48	peak	5.32	34.80	54.00	127	92	-19.20	

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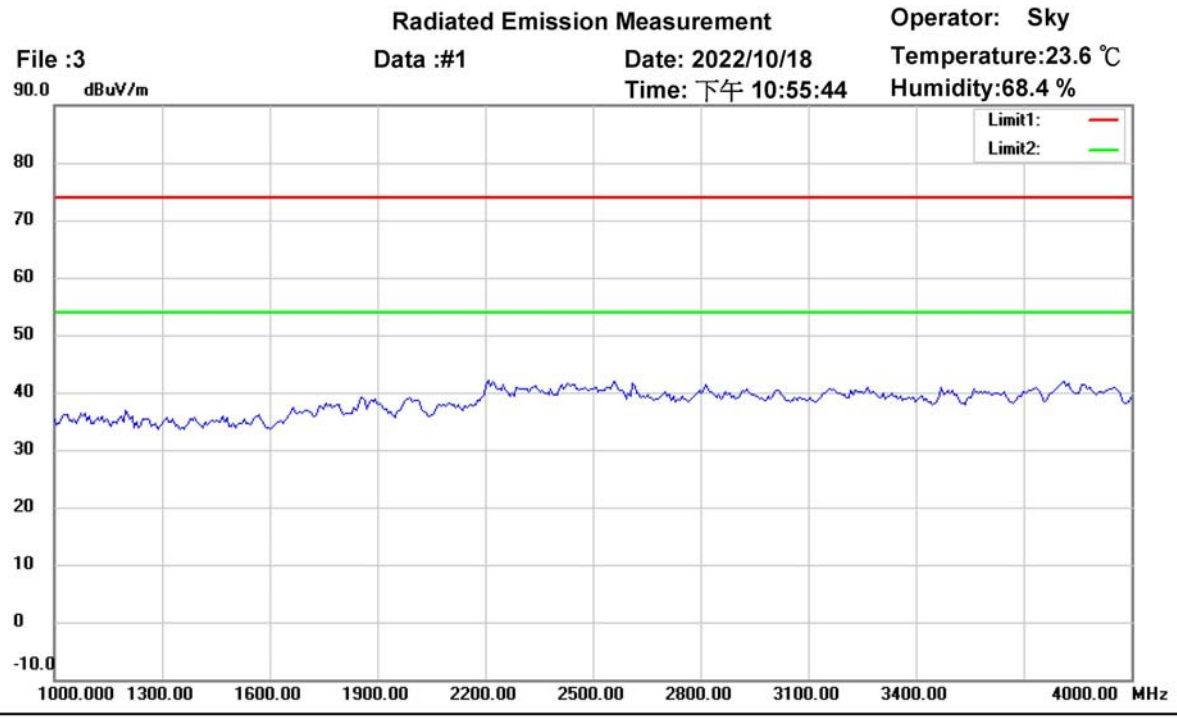

Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_Above 1GHz_PK
EUT : W6R22209-22106
M/N:
Test Mode : Zigbee+WiFi
Note :

Polarization: *Horizontal*
Power : 18 Va.c.
Distance: 3m

Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment

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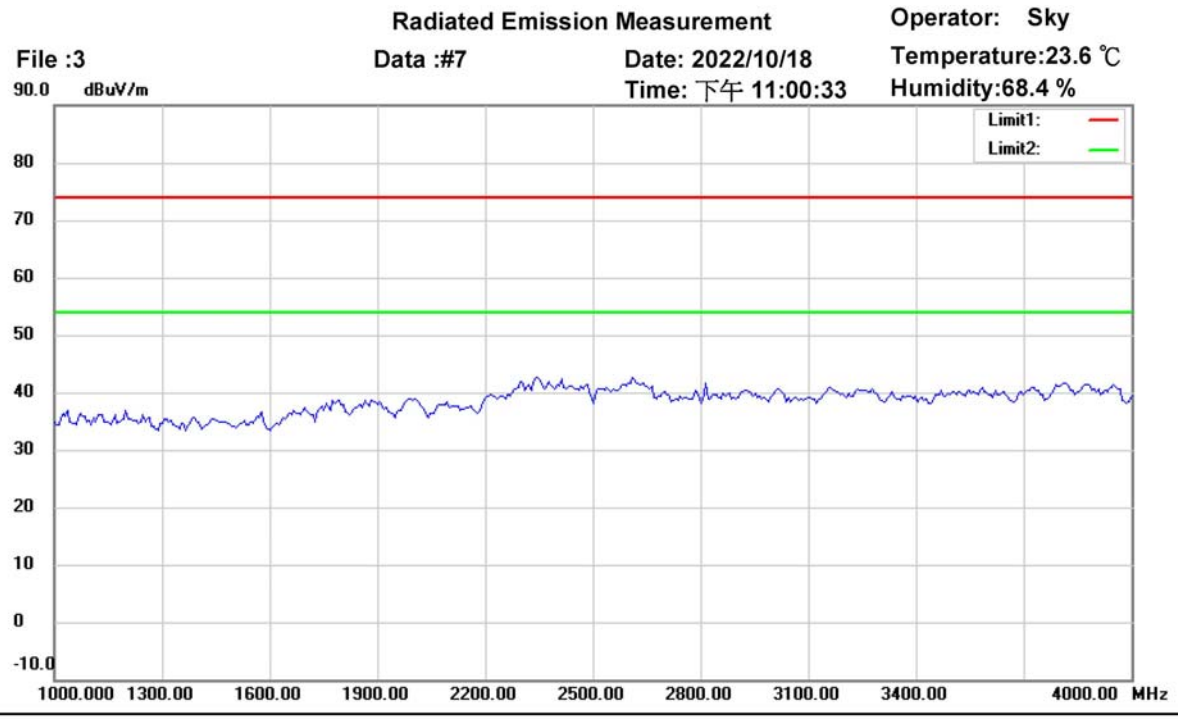

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Test Mode : Zigbee+WiFi
Note :

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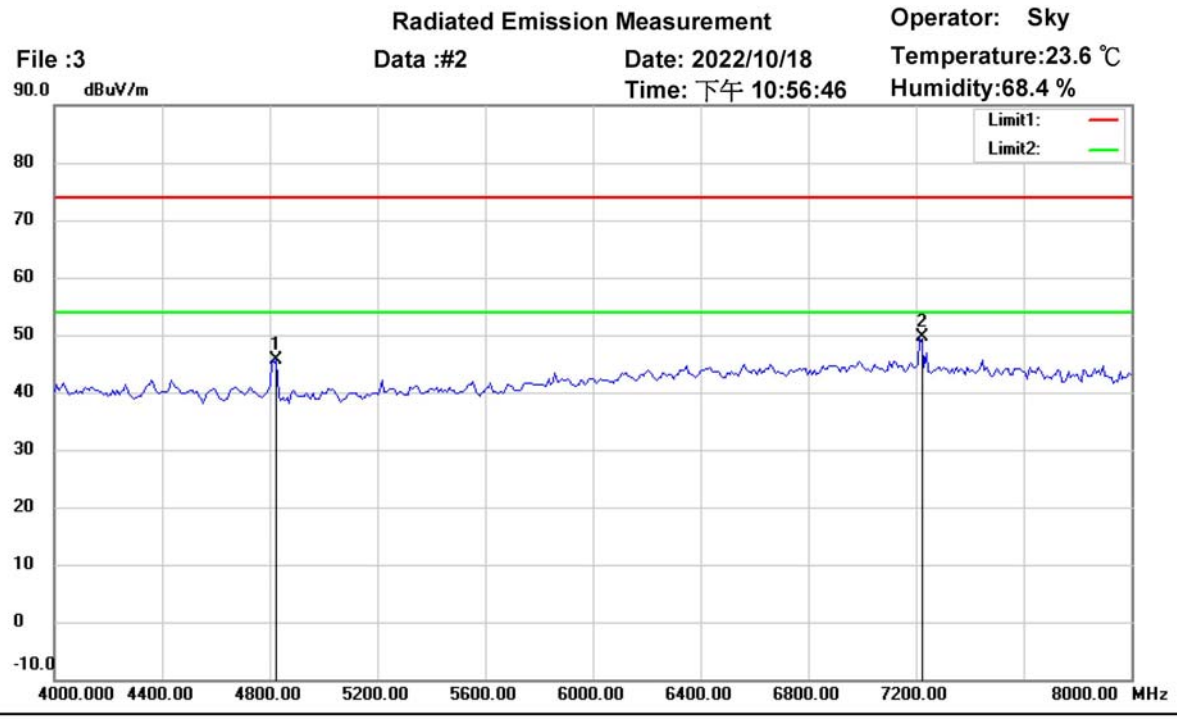

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	4825.651	46.44	peak	-0.69	45.75	74.00	150	133	-28.25	
*	7214.429	44.50	peak	5.23	49.73	74.00	150	104	-24.27	

Registration number: W6R22209-22106-CLR
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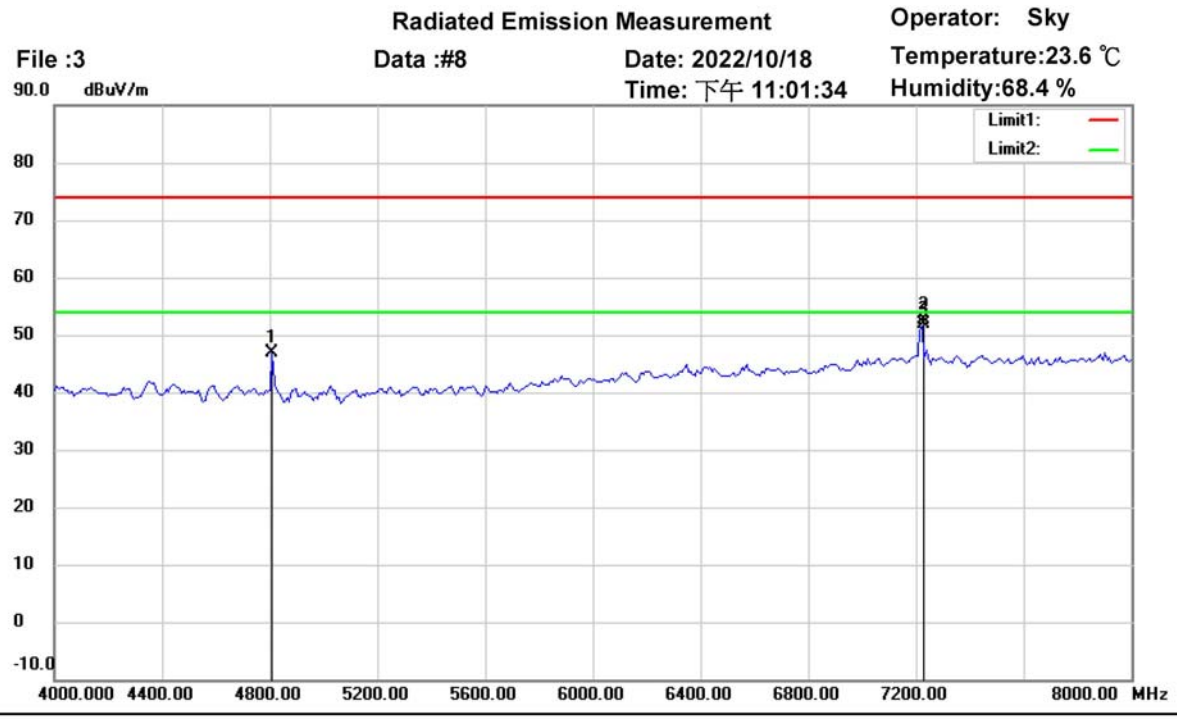

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Test Mode : Zigbee+WiFi
Note :

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	4809.619	47.66	peak	-0.73	46.93	74.00	150	305	-27.07	
	7222.445	47.29	peak	5.24	52.53	74.00	150	200	-21.47	
*	7222.445	46.69	AVG	5.24	51.93	54.00	150	200	-2.07	

Registration number: W6R22209-22106-CLR
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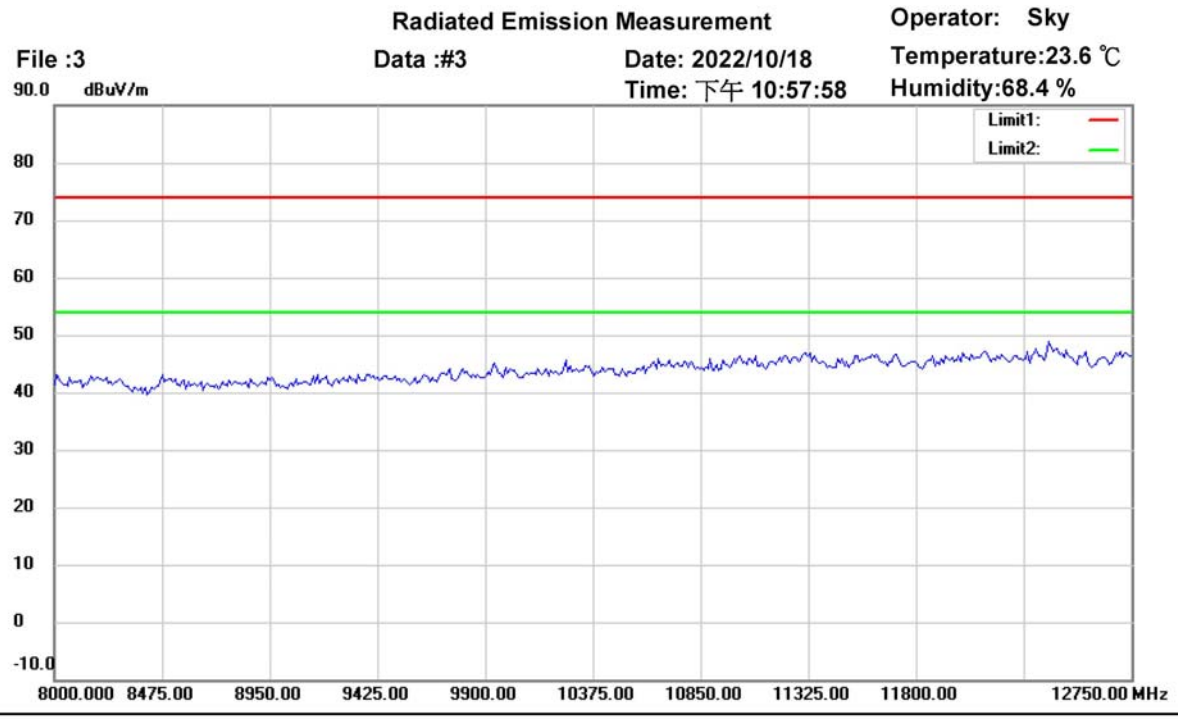

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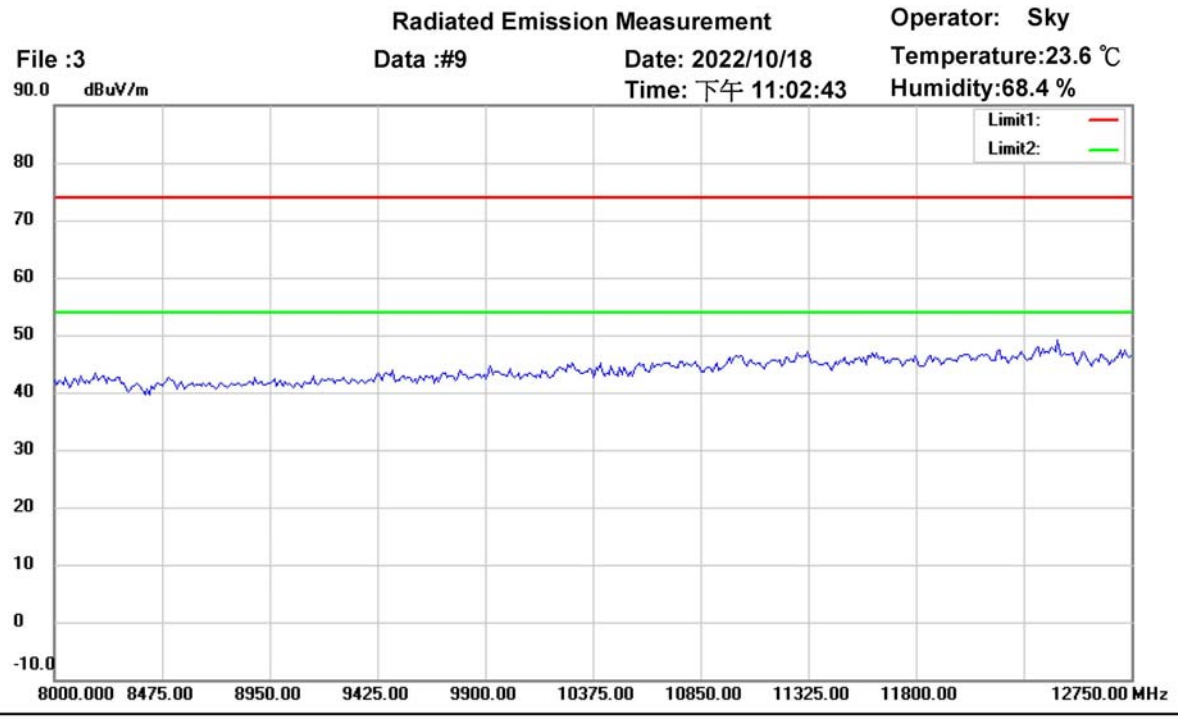

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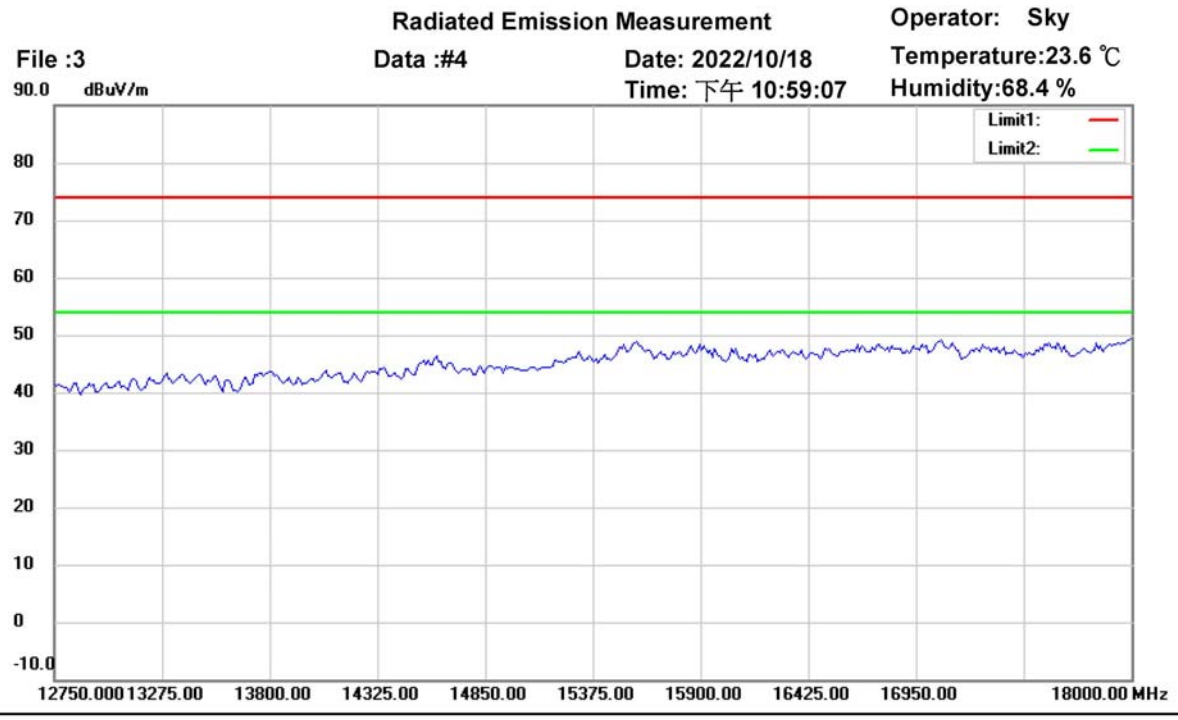

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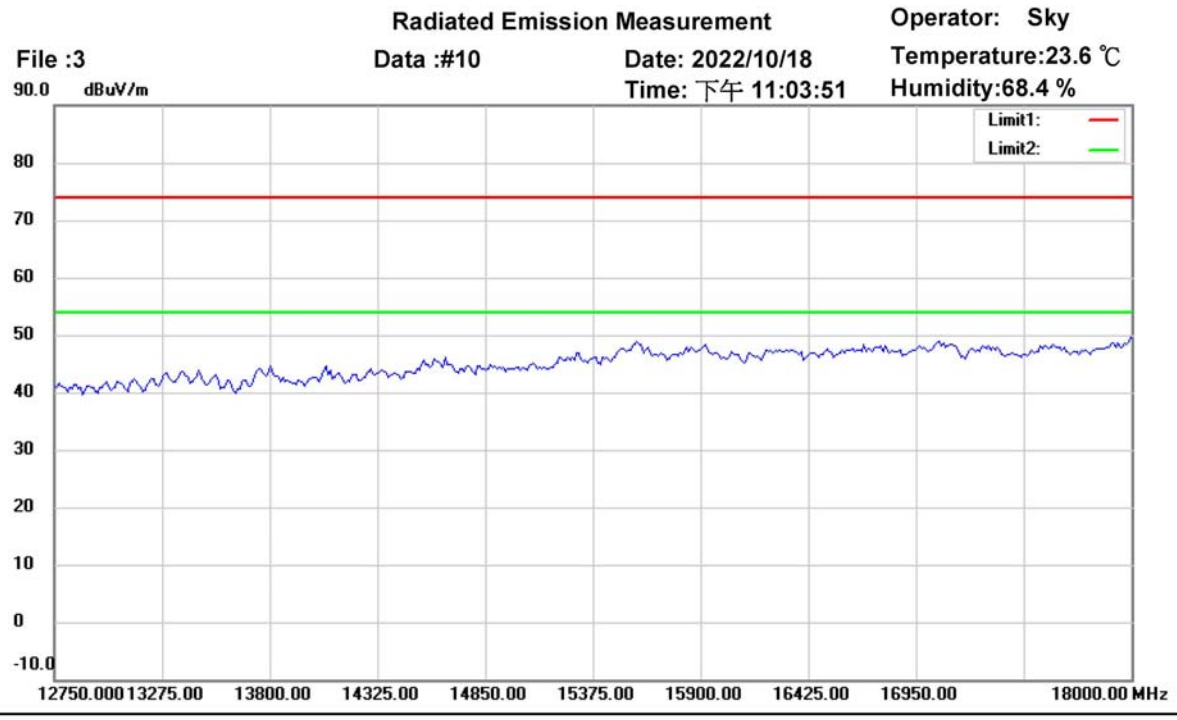

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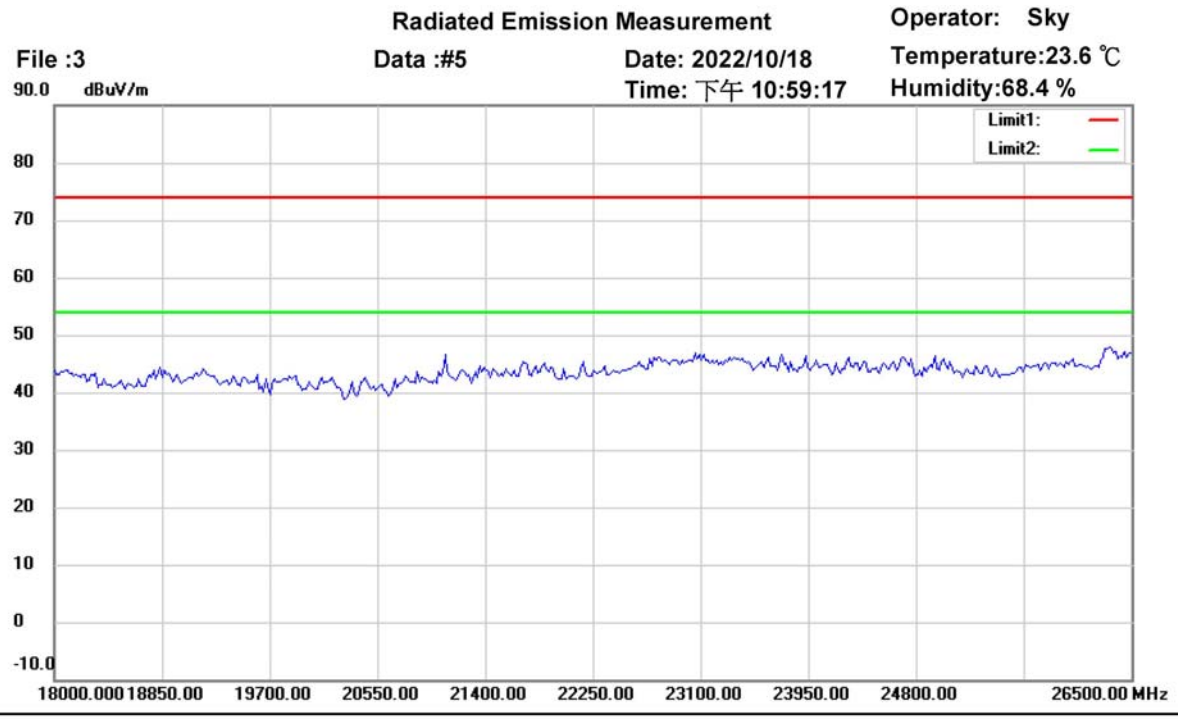
Polarization: *Vertical*
Power : 18 Va.c.
Distance: 3m

Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment

Registration number: W6R22209-22106-CLR
FCC ID: GX9HYGWGEN2

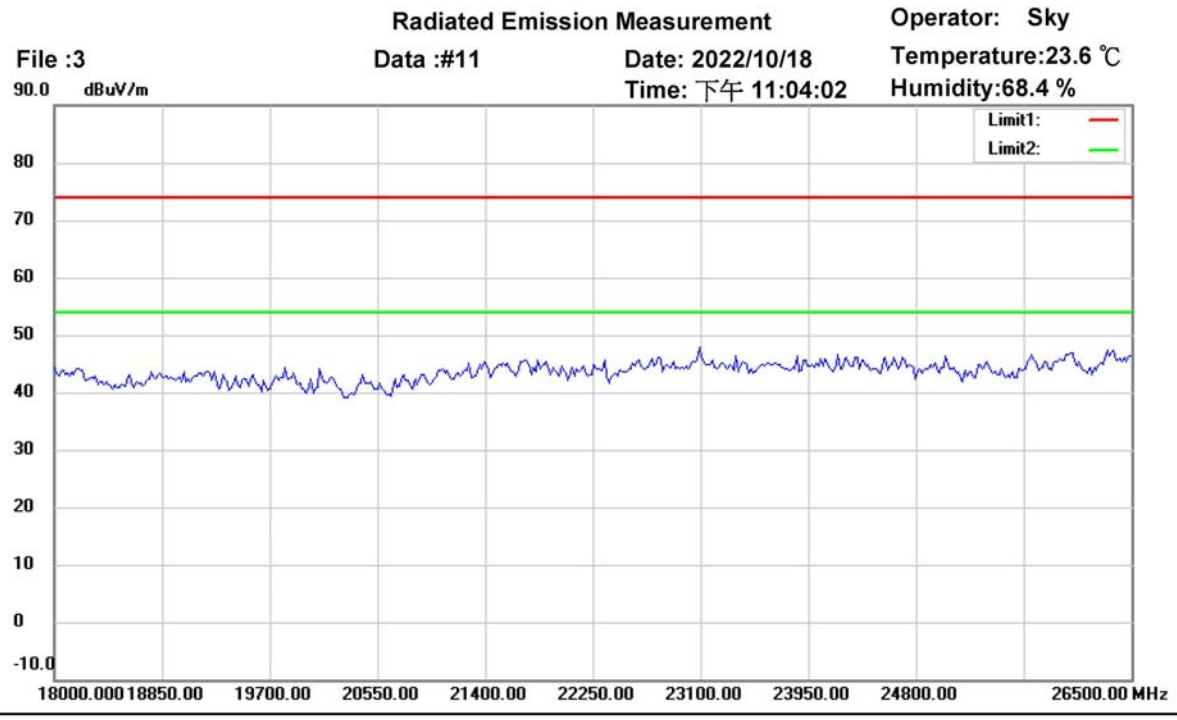


Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_Above 1GHz_PK
EUT : W6R22209-22106
M/N:
Test Mode : Zigbee+WiFi
Note :

Polarization: *Horizontal*
Power : 18 Va.c.
Distance: 3m

Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment

Registration number: W6R22209-22106-CLR
FCC ID: GX9HYGWGEN2



Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_Above 1GHz_PK
EUT : W6R22209-22106
M/N:
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Note :

Polarization: *Vertical*
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Registration number: W6R22209-22106-CLR
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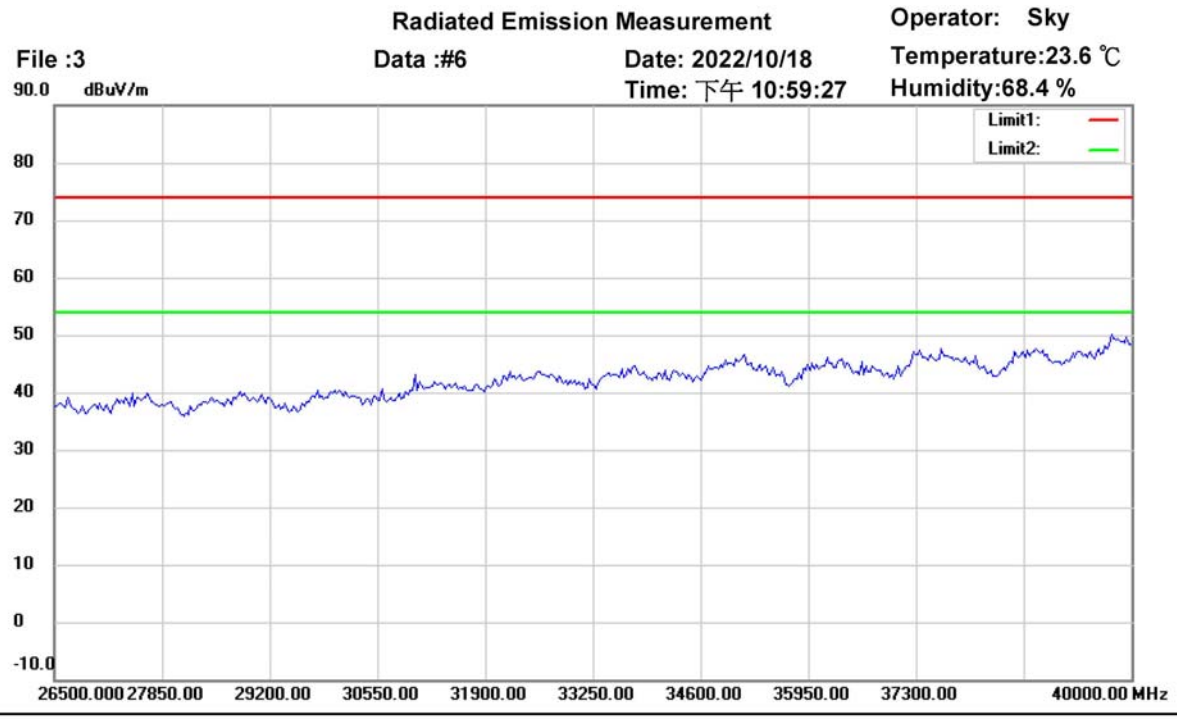

Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_Above 1GHz_PK
EUT : W6R22209-22106
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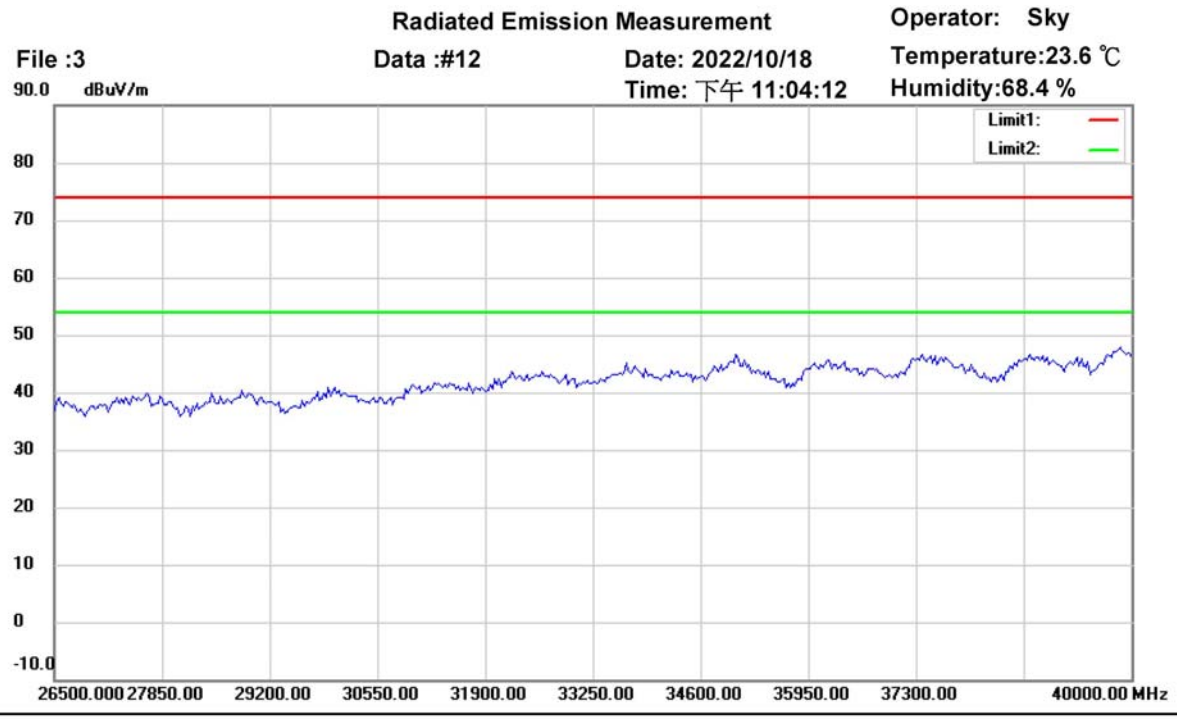
Registration number: W6R22209-22106-CLR
FCC ID: GX9HYGWGEN2



Site : 966 Chamber
Condition : FCC_part 15 RE-Class B_Above 1GHz_PK
EUT : W6R22209-22106
M/N:
Test Mode : Zigbee+WiFi
Note :

Polarization: *Vertical*
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Mk.	Frequency (MHz)	Reading (dBuV)	Detector	Corr. factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Ant.Pos (cm)	Tab.Pos (deg.)	Margin (dB)	Comment

Note

1. **Correction Factor = Antenna factor + Cable loss - Preamplifier**
2. **The formula of measured value as: Test Result = Reading + Correction Factor**
3. **Detector function in the form : PK = Peak, QP = Quasi Peak, AV = Average**
4. **All not in the table noted test results are more than 20 dB below the relevant limits.**
5. **After evaluated, the test result in this report adopt the worst case (Zigbee and WiFi) to measure.**

TEST RESULT (Transmitter): The unit DOES meet the FCC requirements.

Test equipment used: ETSTW-RE 004, ETSTW-RE 030, ETSTW-RE 062, ETSTW-RE 142, ETSTW-RE 152