FCC Test Report

Applicant	:	**Dongguan Suoai Electronics Co., LTD**
Address	:	**No.3, Huayu Street,Changlong Village,Huangjiang Town, Dongguan City,Guangdong, China**
Product Name	:	**mechanical keyboard**
Report Date	:	**Nov. 16, 2023**

Shenzhen Anbotek Compliance Laboratory Limited

Contents

TEST REPORT

Applicant	:	Dongguan Suoai Electronics Co., LTD
Manufacturer	:	Dongguan Suoai Electronics Co., LTD
Product Name	:	mechanical keyboard
Test Model No.	:	K21
Reference Model No.	:	K81 Pro, K108, K81, Hi9, Hi8, Hi75, F21, A75, GK600FS
Trade Mark	:	N/A
Rating(s)	:	Input: 5V⎓650mA (with DC 3.7V, 600mAh battery inside)
Test Standard(s)	:	**47 CFR Part 15.247**

The device described above is tested by Shenzhen Anbotek Compliance Laboratory Limited to determine the maximum emission levels emanating from the device and the severe levels of the device can endure and its performance criterion. The measurement results are contained in this test report and Shenzhen Anbotek Compliance Laboratory Limited is assumed full of responsibility for the accuracy and completeness of these measurements. Also, this report shows that the EUT (Equipment Under Test) is technically compliant with above listed standard(s) requirements.

This report applies to above tested sample only and shall not be reproduced in part without written approval of Shenzhen Anbotek Compliance Laboratory Limited.

Date of Receipt: Nov. 02, 2023

Date of Test: Nov. 02 ~ 14, 2023

Prepared By: Nian xiu Chen

(Nianxiu Chen)

Approved & Authorized Signer: Edward Pan

(Edward Pan)

Revision History

Report Version	Description	Issued Date
R00	Original Issue.	Nov. 16, 2023

1. General Information

1.1. Client Information

Applicant	:	Dongguan Suoai Electronics Co., LTD
Address	:	No.3, Huayu Street,Changlong Village,Huangjiang Town, Dongguan City,Guangdong, China
Manufacturer	:	Dongguan Suoai Electronics Co., LTD
Address	:	No.3, Huayu Street,Changlong Village,Huangjiang Town, Dongguan City,Guangdong, China
Factory	:	Dongguan Suoai Electronics Co., LTD
Address	:	No.3, Huayu Street,Changlong Village,Huangjiang Town, Dongguan City,Guangdong, China

1.2. Description of Device (EUT)

Product Name	:	mechanical keyboard
Test Model No.	:	K21
Reference Model No.	:	K81 Pro, K108, K81, Hi9, Hi8, Hi75, F21, A75, GK600FS (Note: All samples are the same except the model number and appearance color, so we prepare “K21” for test only.)
Trade Mark	:	N/A
Test Power Supply	:	AC 120V, 60Hz for Adapter/ DC 3.7V Battery inside
Test Sample No.	:	1-2-1(Normal Sample), 1-2-2(Engineering Sample)
Adapter	:	N/A
RF Specification		
Operation Frequency	:	2402MHz to 2480MHz
Number of Channel	:	79
Modulation Type	:	GFSK, π/4 DQPSK
Antenna Type	:	PCB Antenna
Antenna Gain(Peak)	:	0 dBi
Remark: (1) All of the RF specification are provided by customer. (2) For a more detailed features description, please refer to the manufacturer’s specifications or the User’s Manual.		

1.3. Auxiliary Equipment Used During Test

Title	Manufacturer	Model No.	Serial No.
Xiaomi 33W adapter	Xiaomi	MDY-11-EX	SA62212LA04358J

1.4. Operation channel list

Operation Band:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	**78**	**2480**
19	2421	**39**	**2441**	59	2461	-	-

1.5. Description of Test Modes

Pretest Modes	Descriptions
TM1	Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation.
TM2	Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.
TM3	Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,.
TM4	Keep the EUT in continuously transmitting mode (hopping) with π/4 DQPSK modulation.

1.6. Measurement Uncertainty

Parameter	Uncertainty
Conducted emissions (AMN 150kHz~30MHz)	3.4dB
Occupied Bandwidth	925Hz
Conducted Output Power	0.76dB
Conducted Spurious Emission	1.24dB
Radiated spurious emissions (above 1GHz)	1G-6GHz: 4.78dB; 6G-18GHz: 4.88dB 18G-40GHz: 5.68dB
Radiated emissions (Below 30MHz)	3.53dB
Radiated spurious emissions (30MHz~1GHz)	Horizontal: 3.92dB; Vertical: 4.52dB
The measurement uncertainty and decision risk evaluated according to AB/WI-RF-F-032. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.	

1.7. Test Summary

Test Items	Test Modes	Status
Antenna requirement	/	P
Conducted Emission at AC power line	Mode1,2	P
Occupied Bandwidth	Mode1,2	P
Maximum Conducted Output Power	Mode1,2	P
Channel Separation	Mode3,4	P
Number of Hopping Frequencies	Mode3,4	P
Dwell Time	Mode3,4	P
Emissions in non-restricted frequency bands	Mode1,2,3,4	P
Band edge emissions (Radiated)	Mode1,2	P
Emissions in frequency bands (below 1GHz)	Mode1,2	P
Emissions in frequency bands (above 1GHz)	Mode1,2	P
Note: P: Pass N: N/A, not applicable		

1.8. Description of Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

FCC-Registration No.:184111
Shenzhen Anbotek Compliance Laboratory Limited, EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No. 184111.

ISED-Registration No.: 8058A
Shenzhen Anbotek Compliance Laboratory Limited, EMC Laboratory has been registered and fully described in a report filed with the (ISED) Innovation, Science and Economic Development Canada. The acceptance letter from the ISED is maintained in our files. Registration 8058A.

Test Location
Shenzhen Anbotek Compliance Laboratory Limited.
1/F, Building D, Sogood Science and Technology Park, Sanwei community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.

1.9. Disclaimer

1. The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.
2. The test report is invalid if there is any evidence and/or falsification.
3. The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.
4. This document may not be altered or revised in any way unless done so by Anbotek and all revisions are duly noted in the revisions section.
5. Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.
6. The authenticity of the information provided by the customer is the responsibility of the customer and the laboratory is not responsible for its authenticity.

The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

1.10. Test Equipment List

Conducted Emission at AC power line						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due Date
1	L.I.S.N. Artificial Mains Network	Rohde & Schwarz	ENV216	100055	2023-10-12	2024-10-11
2	Three Phase V-type Artificial Power Network	CYBERTEK	EM5040DT	E215040DT001	2023-07-05	2024-07-04
3	EMI Test Receiver	Rohde & Schwarz	ESCI	100627	2023-10-12	2024-10-11
4	Software Name EZ-EMC	Farad Technology	ANB-03A	N/A	/	/

Occupied Bandwidth Maximum Conducted Output Power Channel Separation Number of Hopping Frequencies Dwell Time Emissions in non-restricted frequency bands						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due Date
1	DC Power Supply	IVYTECH	IV3605	1804D360510	2023-10-20	2024-10-19
2	Spectrum Analyzer	Rohde & Schwarz	FSV40-N	101792	2023-05-26	2024-05-25
3	MXA Spectrum Analysis	KEYSIGHT	N9020A	MY50531823	2023-02-23	2024-02-22
4	Oscilloscope	Tektronix	MDO3012	C020298	2023-10-12	2024-10-11
5	MXG RF Vector Signal Generator	Agilent	N5182A	MY47420647	2023-02-23	2024-10-22

Band edge emissions (Radiated) Emissions in frequency bands (above 1GHz)						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due Date
1	EMI Test Receiver	Rohde & Schwarz	ESR26	101481	2023-10-12	2024-10-11
2	EMI Preamplifier	SKET Electronic	LNPA-0118G-45	SKET-PA-002	2023-10-12	2024-10-11
3	Double Ridged Horn Antenna	SCHWARZBECK	BBHA 9120D	02555	2022-10-16	2025-10-15
4	EMI Test Software EZ-EMC	SHURPLE	N/A	N/A	/	/
5	Horn Antenna	A-INFO	LB-180400-KF	J211060628	2023-10-12	2024-10-11
6	Spectrum Analyzer	Rohde & Schwarz	FSV40-N	101792	2023-05-26	2024-05-25
7	Amplifier	Talent Microwave	TLLA18G40G-50-30	23022802	2023-05-25	2024-05-24

Emissions in frequency bands (below 1GHz)						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due Date
1	EMI Test Receiver	Rohde & Schwarz	ESR26	101481	2023-10-12	2024-10-11
2	Pre-amplifier	SONOMA	310N	186860	2023-10-12	2024-10-11
3	Bilog Broadband Antenna	Schwarzbeck	VULB9163	345	2022-10-23	2025-10-22
4	EMI Test Software EZ-EMC	SHURPLE	N/A	N/A	/	/

2. Antenna requirement

Test Requirement:	Refer to 47 CFR Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

2.1. Conclusion

The antenna is a **PCB Antenna** which permanently attached, and the best case gain of the antenna is **0dBi** . It complies with the standard requirement.

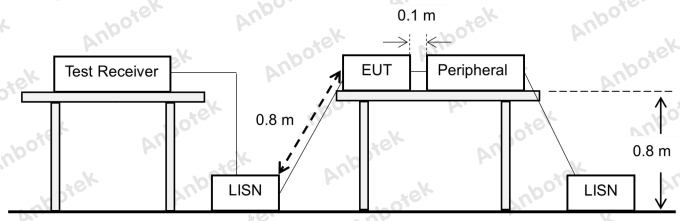
3. Conducted Emission at AC power line

Test Requirement:	Refer to 47 CFR 15.207(a), Except as shown in paragraphs (b)and (c)of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN).
Test Limit:	Frequency of emission (MHz) / Conducted limit (dBμV): Quasi-peak / Average 0.15-0.5: 66 to 56* / 56 to 46* 0.5-5: 56 / 46 5-30: 60 / 50 *Decreases with the logarithm of the frequency.
Test Method:	ANSI C63.10-2013 section 6.2
Procedure:	Refer to ANSI C63.10-2013 section 6.2, standard test method for ac power-line conducted emissions from unlicensed wireless devices

3.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.

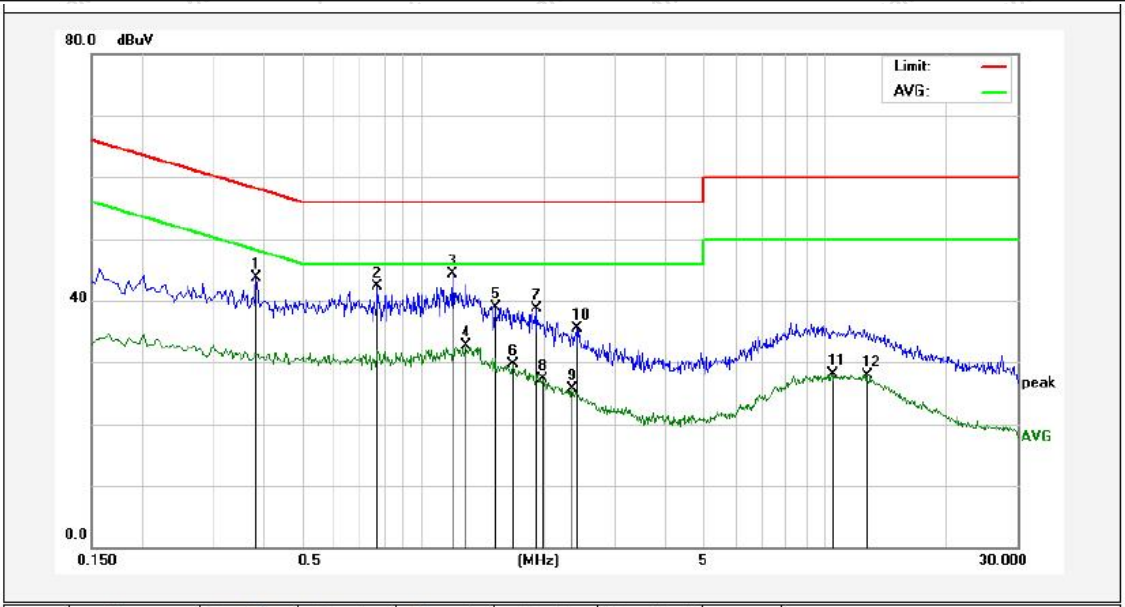
3.2. Test Setup



3.3. Test Data

Temperature:	23.1 °C	Humidity:	51.9 %	Atmospheric Pressure:	101 kPa

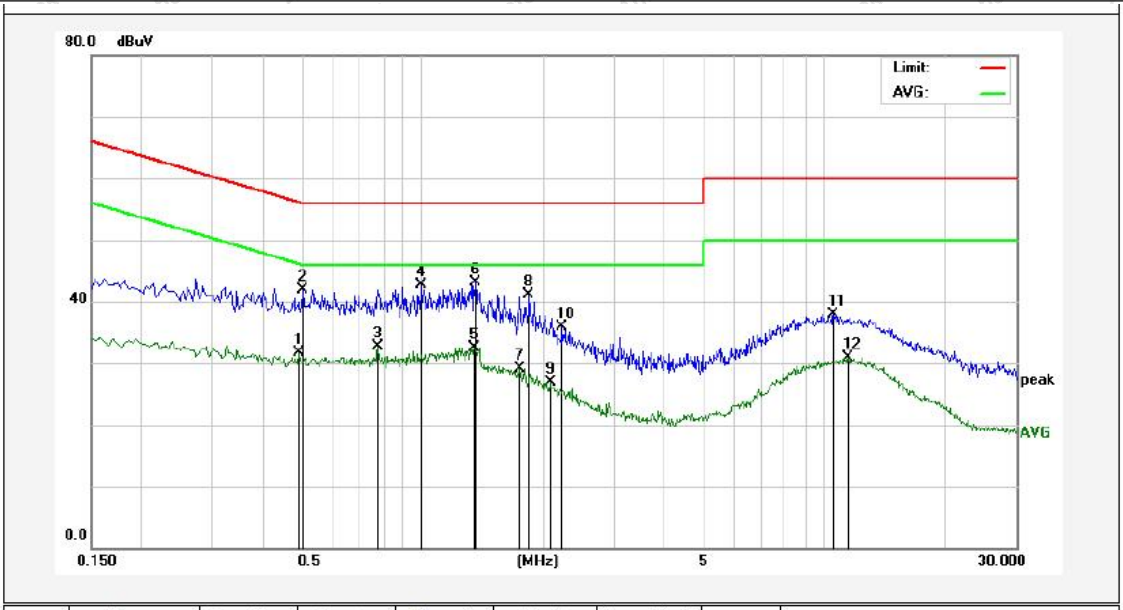
TM2 / Line: Line / Band: 2400-2483.5 MHz / BW: 1 / CH: H



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.3860	23.86	19.81	43.67	58.15	-14.48	QP	
2	0.7740	22.36	19.87	42.23	56.00	-13.77	QP	
3	1.1900	24.44	19.84	44.28	56.00	-11.72	QP	
4	1.2820	12.96	19.84	32.80	46.00	-13.20	AVG	
5	1.5180	19.16	19.84	39.00	56.00	-17.00	QP	
6	1.6740	9.79	19.84	29.63	46.00	-16.37	AVG	
7	1.9140	18.85	19.83	38.68	56.00	-17.32	QP	
8	1.9900	7.49	19.83	27.32	46.00	-18.68	AVG	
9	2.3540	5.84	19.83	25.67	46.00	-20.33	AVG	
10	2.4180	15.59	19.83	35.42	56.00	-20.58	QP	
11	10.3740	8.04	19.99	28.03	50.00	-21.97	AVG	
12	12.7020	7.80	20.09	27.89	50.00	-22.11	AVG	

Temperature:	23.1 °C	Humidity:	51.9 %	Atmospheric Pressure:	101 kPa

TM2 / Line: Neutral / Band: 2400-2483.5 MHz / BW: 1 / CH: H



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.4940	11.88	19.85	31.73	46.10	-14.37	AVG	
2	0.5060	22.12	19.85	41.97	56.00	-14.03	QP	
3	0.7780	12.89	19.86	32.75	46.00	-13.25	AVG	
4	0.9980	22.78	19.85	42.63	56.00	-13.37	QP	
5	1.3460	12.73	19.84	32.57	46.00	-13.43	AVG	
6	1.3540	23.26	19.84	43.10	56.00	-12.90	QP	
7	1.7500	9.24	19.84	29.08	46.00	-16.92	AVG	
8	1.8420	21.20	19.83	41.03	56.00	-14.97	QP	
9	2.0820	7.10	19.83	26.93	46.00	-19.07	AVG	
10	2.2340	16.00	19.83	35.83	56.00	-20.17	QP	
11	10.5500	17.90	20.01	37.91	60.00	-22.09	QP	
12	11.4580	10.84	20.03	30.87	50.00	-19.13	AVG	

Note:Only record the worst data in the report.

4. Occupied Bandwidth

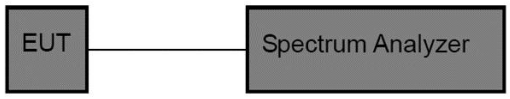
Test Requirement:	47 CFR 15.215(c)
Test Limit:	Refer to 47 CFR 15.215(c), intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.
Test Method:	ANSI C63.10-2013, section 7.8.7, For occupied bandwidth measurements, use the procedure in 6.9.2.
Procedure:	a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW. b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement. c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2. d) Steps a) through c) might require iteration to adjust within the specified tolerances. e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “−xx dB down” requirement; that is, if the requirement calls for measuring the −20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value. f) Set detection mode to peak and trace mode to max hold. g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value). h) Determine the “−xx dB down amplitude” using [(reference value) − xx]. Alternatively, this calculation may be made by using the marker-delta function of the instrument. i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j). j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined in step h). If a marker is below this “−xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the

	emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth. k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

4.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.

4.2. Test Setup



4.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

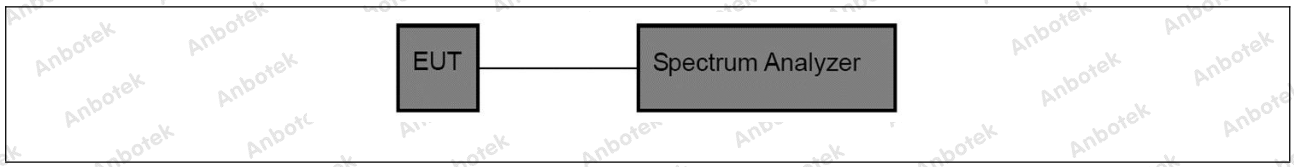
5. Maximum Conducted Output Power

Test Requirement:	47 CFR 15.247(b)(1)
Test Limit:	Refer to 47 CFR 15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
Test Method:	ANSI C63.10-2013, section 7.8.5
Procedure:	This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test: a) Use the following spectrum analyzer settings: 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel. 2) RBW > 20 dB bandwidth of the emission being measured. 3) VBW >= RBW. 4) Sweep: Auto. 5) Detector function: Peak. 6) Trace: Max hold. b) Allow trace to stabilize. c) Use the marker-to-peak function to set the marker to the peak of the emission. d) The indicated level is the peak output power, after any corrections for external attenuators and cables. e) A plot of the test results and setup description shall be included in the test report. NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

5.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.

5.2. Test Setup



5.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

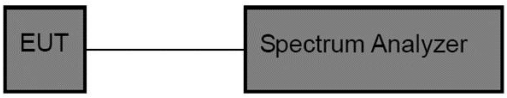
6. Channel Separation

Test Requirement:	47 CFR 15.247(a)(1)
Test Limit:	Refer to 47 CFR 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
Test Method:	ANSI C63.10-2013, section 7.8.2
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: Wide enough to capture the peaks of two adjacent channels. b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel. c) Video (or average) bandwidth (VBW) ≥ RBW. d) Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

6.1. EUT Operation

Operating Environment:	
Test mode:	3: TX-GFSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,. 4: TX-π/4-DQPSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with π/4 DQPSK modulation.

6.2. Test Setup



6.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

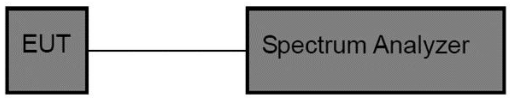
7. Number of Hopping Frequencies

Test Requirement:	47 CFR 15.247(a)(1)(iii)
Test Limit:	Refer to 47 CFR 15.247(a)(1)(iii), Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method:	ANSI C63.10-2013, section 7.8.3
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen. b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller. c) VBW ≥ RBW. d) Sweep: Auto. e) Detector function: Peak. f) Trace: Max hold. g) Allow the trace to stabilize. It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

7.1. EUT Operation

Operating Environment:	
Test mode:	3: TX-GFSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,. 4: TX-π/4-DQPSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with π/4 DQPSK modulation.

7.2. Test Setup



7.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

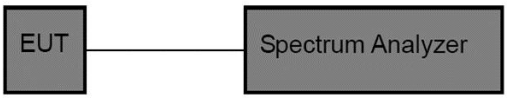
8. Dwell Time

Test Requirement:	47 CFR 15.247(a)(1)(iii)
Test Limit:	Refer to 47 CFR 15.247(a)(1)(iii), Fequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method:	ANSI C63.10-2013, section 7.8.4
Procedure:	The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings: a) Span: Zero span, centered on a hopping channel. b) RBW shall be <= channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel. c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel. d) Detector function: Peak. e) Trace: Max hold. Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time. Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation: (Number of hops in the period specified in the requirements) = (number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time) The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation. The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

8.1. EUT Operation

Operating Environment:	
Test mode:	3: TX-GFSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,. 4: TX-π/4-DQPSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with π/4 DQPSK modulation.

8.2. Test Setup



8.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

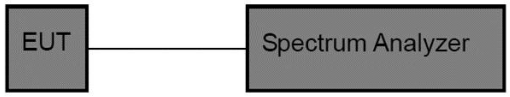
9. Emissions in non-restricted frequency bands

Test Requirement:	47 CFR 15.247(d), 15.209, 15.205
Test Limit:	Refer to 47 CFR 15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required.
Test Method:	ANSI C63.10-2013 section 7.8.8
Procedure:	Conducted spurious emissions shall be measured for the transmit frequency, per 5.5 and 5.6, and at the maximum transmit powers. Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered.

9.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation. 3: TX-GFSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with GFSK modulation,. 4: TX-π/4-DQPSK (Hopping): Keep the EUT in continuously transmitting mode (hopping) with π/4 DQPSK modulation.

9.2. Test Setup



9.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

Please Refer to Appendix for Details.

10. Band edge emissions (Radiated)

Test Requirement:	Refer to 47 CFR 15.247(d), 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)).`

Test Limit:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100 **	3
88-216	150 **	3
216-960	200 **	3
Above 960	500	3

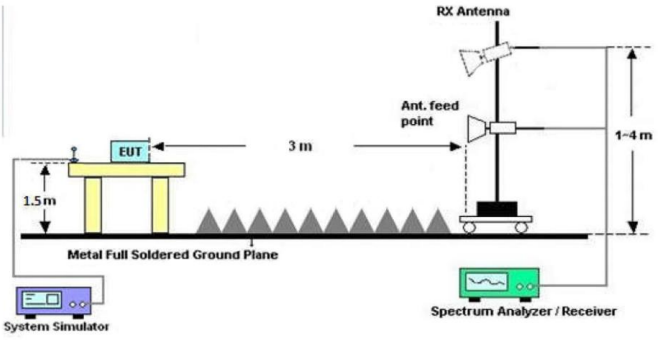
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.
In the emission table above, the tighter limit applies at the band edges.
The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

Test Method:	ANSI C63.10-2013 section 6.10
Procedure:	ANSI C63.10-2013 section 6.10.5.2

10.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.

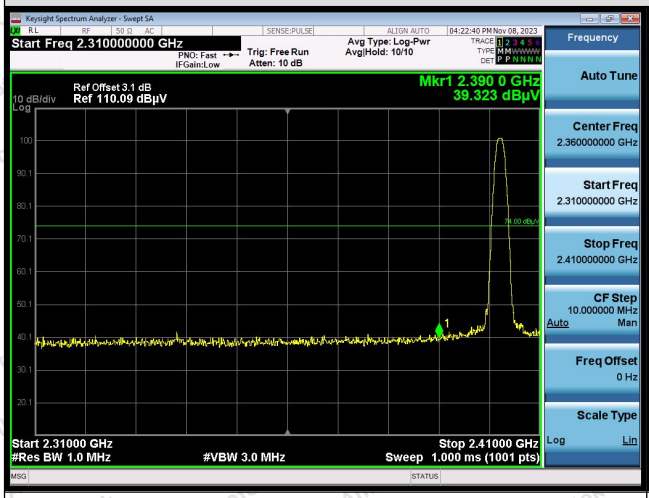
10.2. Test Setup



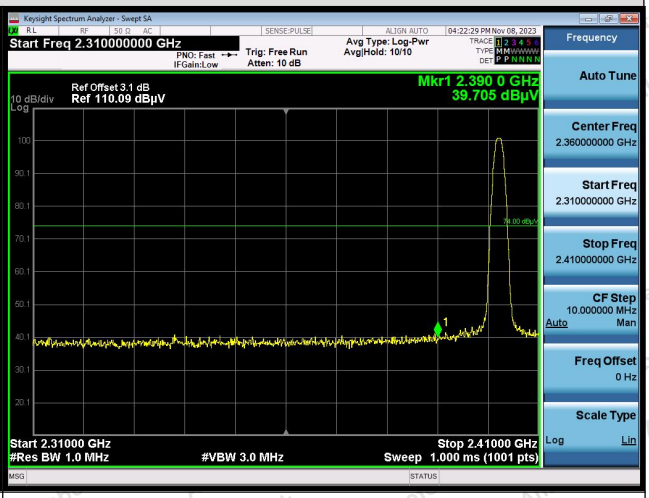
10.3. Test Data

Temperature:	26.3 °C	Humidity:	51 %	Atmospheric Pressure:	101 kPa

TM2 / CH: L

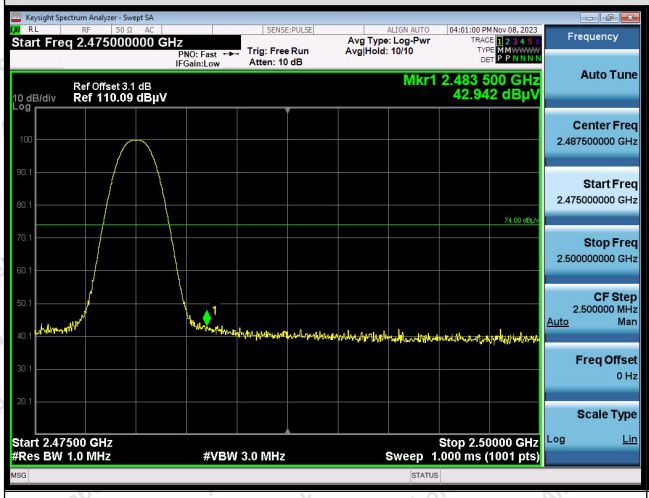


Peak Value(Vertical)

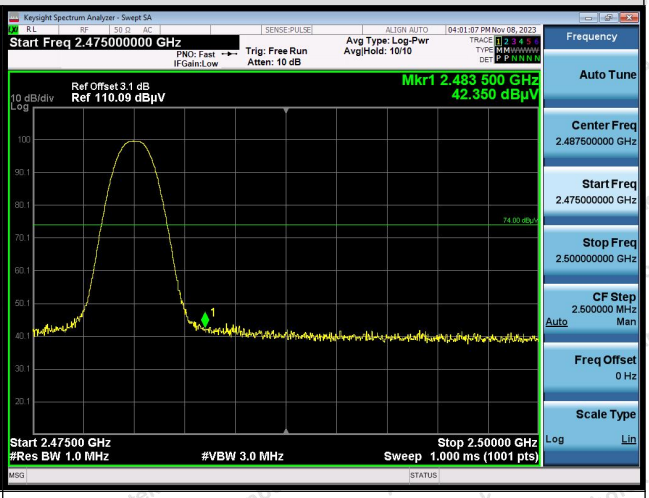


Peak Value(Horizontal)

TM2 / CH: H



Peak Value(Vertical)



Peak Value(Horizontal)

Average:

Test Mode	Peak Value (dBuV/m)	DCCF	Average Value (dBuV/m)	Limit (dBuV/m)	Polarization	Verdict
TM2 / CH: L	39.323	-2.23	37.090	54.00	Vertical	Pass
	39.705	-2.23	37.472	54.00	Horizontal	Pass
TM2 / CH: H	42.942	-2.23	40.709	54.00	Vertical	Pass
	42.350	-2.23	40.117	54.00	Horizontal	Pass

Remark:

1. During the test, pre-scan all modes, the report only record the worse case mode.
2. DCCF=20log(Duty Cycle)
3. Average Value=Peak Value+DCCF

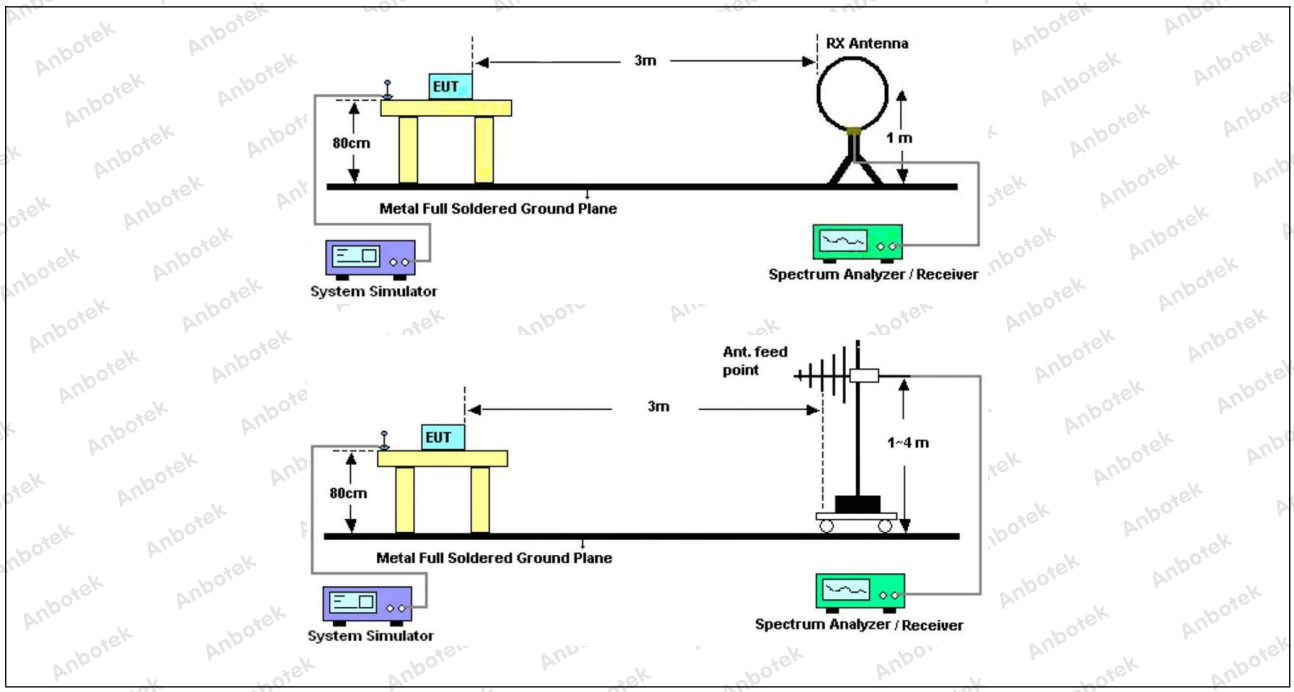
11. Emissions in frequency bands (below 1GHz)

<table>
<tr><td>Test Requirement:</td><td>Refer to 47 CFR 15.247(d), 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)).`</td></tr>
<tr><td>Test Limit:</td><td>
<table>
<tr><td>Frequency (MHz)</td><td>Field strength (microvolts/meter)</td><td>Measurement distance (meters)</td></tr>
<tr><td>0.009-0.490</td><td>2400/F(kHz)</td><td>300</td></tr>
<tr><td>0.490-1.705</td><td>24000/F(kHz)</td><td>30</td></tr>
<tr><td>1.705-30.0</td><td>30</td><td>30</td></tr>
<tr><td>30-88</td><td>100 **</td><td>3</td></tr>
<tr><td>88-216</td><td>150 **</td><td>3</td></tr>
<tr><td>216-960</td><td>200 **</td><td>3</td></tr>
<tr><td>Above 960</td><td>500</td><td>3</td></tr>
</table>
** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.
In the emission table above, the tighter limit applies at the band edges.
The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
</td></tr>
<tr><td>Test Method:</td><td>ANSI C63.10-2013 section 6.6.4</td></tr>
<tr><td>Procedure:</td><td>ANSI C63.10-2013 section 6.6.4</td></tr>
</table>

11.1. EUT Operation

<table>
<tr><td colspan="2">Operating Environment:</td></tr>
<tr><td>Test mode:</td><td>1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation.
2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.</td></tr>
</table>

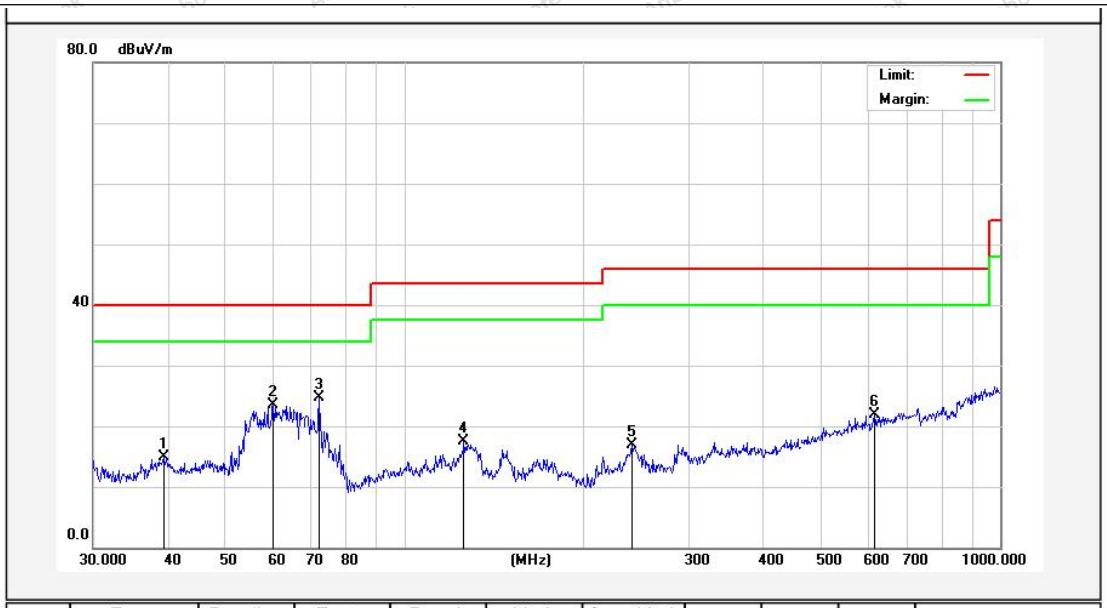
11.2. Test Setup



11.3. Test Data

Temperature:	24.3 °C	Humidity:	48 %	Atmospheric Pressure:	101 kPa

TM2 / Polarization: Horizontal / Band: 2400-2483.5 MHz / BW: 1 / CH: H



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Height (cm)	degree (deg)	Remark
1	39.4371	31.18	-16.30	14.88	40.00	-25.12	QP			
2	60.0691	41.03	-17.51	23.52	40.00	-16.48	QP			
3	72.0843	46.77	-22.15	24.62	40.00	-15.38	QP			
4	125.8864	40.51	-23.10	17.41	43.50	-26.09	QP			
5	240.8304	38.65	-21.65	17.00	46.00	-29.00	QP			
6	616.3718	32.47	-10.57	21.90	46.00	-24.10	QP			

Temperature:	24.3 °C	Humidity:	48 %	Atmospheric Pressure:	101 kPa

TM2 / Polarization: Vertical / Band: 2400-2483.5 MHz / BW: 1 / CH: H

No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Height (cm)	degree (deg)	Remark
1	30.0000	36.33	-17.96	18.37	40.00	-21.63	QP			
2	53.8818	47.46	-17.21	30.25	40.00	-9.75	QP			
3	72.0843	47.64	-19.94	27.70	40.00	-12.30	QP			
4	148.4410	39.33	-22.10	17.23	43.50	-26.27	QP			
5	241.6763	32.53	-18.23	14.30	46.00	-31.70	QP			
6	719.1995	32.95	-9.65	23.30	46.00	-22.70	QP			

Note:Only record the worst data in the report.

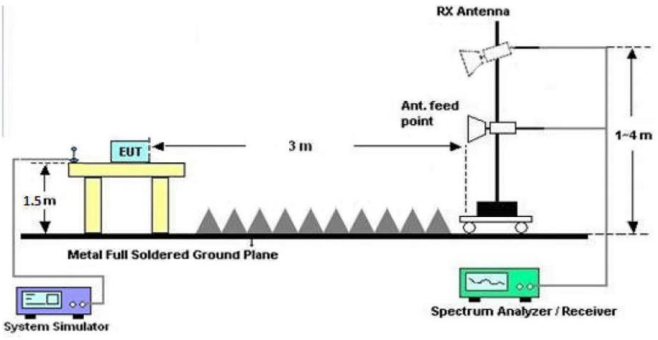
12. Emissions in frequency bands (above 1GHz)

Test Requirement:	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)).`
Test Limit:	Frequency (MHz) / Field strength (microvolts/meter) / Measurement distance (meters) 0.009-0.490 / 2400/F(kHz) / 300 0.490-1.705 / 24000/F(kHz) / 30 1.705-30.0 / 30 / 30 30-88 / 100 ** / 3 88-216 / 150 ** / 3 216-960 / 200 ** / 3 Above 960 / 500 / 3 ** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241. In the emission table above, the tighter limit applies at the band edges. The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9–90 kHz, 110–490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
Test Method:	ANSI C63.10-2013 section 6.6.4
Procedure:	ANSI C63.10-2013 section 6.6.4

12.1. EUT Operation

Operating Environment:	
Test mode:	1: TX-GFSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with GFSK modulation. 2: TX-π/4-DQPSK (Non-Hopping): Keep the EUT in continuously transmitting mode (non-hopping) with π/4 DQPSK modulation.

12.2. Test Setup



12.3. Test Data

Temperature:	24.3 °C	Humidity:	48 %	Atmospheric Pressure:	101 kPa

TM2 / CH: L						
Peak value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4804.00	28.62	15.27	43.89	74.00	-30.11	Vertical
7206.00	29.53	18.09	47.62	74.00	-26.38	Vertical
9608.00	30.85	23.76	54.61	74.00	-19.39	Vertical
12010.00	*			74.00		Vertical
14412.00	*			74.00		Vertical
4804.00	28.87	15.27	44.14	74.00	-29.86	Horizontal
7206.00	30.24	18.09	48.33	74.00	-25.67	Horizontal
9608.00	28.86	23.76	52.62	74.00	-21.38	Horizontal
12010.00	*			74.00		Horizontal
14412.00	*			74.00		Horizontal
Average value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4804.00	18.00	15.27	33.27	54.00	-20.73	Vertical
7206.00	18.56	18.09	36.65	54.00	-17.35	Vertical
9608.00	19.87	23.76	43.63	54.00	-10.37	Vertical
12010.00	*			54.00		Vertical
14412.00	*			54.00		Vertical
4804.00	17.22	15.27	32.49	54.00	-21.51	Horizontal
7206.00	19.30	18.09	37.39	54.00	-16.61	Horizontal
9608.00	18.17	23.76	41.93	54.00	-12.07	Horizontal
12010.00	*			54.00		Horizontal
14412.00	*			54.00		Horizontal

TM2 / CH: M						
Peak value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4882.00	28.64	15.42	44.06	74.00	-29.94	Vertical
7323.00	29.38	18.02	47.40	74.00	-26.60	Vertical
9764.00	29.86	23.80	53.66	74.00	-20.34	Vertical
12205.00	*			74.00		Vertical
14646.00	*			74.00		Vertical
4882.00	28.57	15.42	43.99	74.00	-30.01	Horizontal
7323.00	30.23	18.02	48.25	74.00	-25.75	Horizontal
9764.00	28.56	23.80	52.36	74.00	-21.64	Horizontal
12205.00	*			74.00		Horizontal
14646.00	*			74.00		Horizontal
Average value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4882.00	17.73	15.42	33.15	54.00	-20.85	Vertical
7323.00	18.66	18.02	36.68	54.00	-17.32	Vertical
9764.00	19.73	23.80	43.53	54.00	-10.47	Vertical
12205.00	*			54.00		Vertical
14646.00	*			54.00		Vertical
4882.00	17.13	15.42	32.55	54.00	-21.45	Horizontal
7323.00	18.86	18.02	36.88	54.00	-17.12	Horizontal
9764.00	18.68	23.80	42.48	54.00	-11.52	Horizontal
12205.00	*			54.00		Horizontal
14646.00	*			54.00		Horizontal

TM2 / CH: H						
Peak value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4960.00	28.91	15.58	44.49	74.00	-29.51	Vertical
7440.00	29.39	17.93	47.32	74.00	-26.68	Vertical
9920.00	30.41	23.83	54.24	74.00	-19.76	Vertical
12400.00	*			74.00		Vertical
14880.00	*			74.00		Vertical
4960.00	28.64	15.58	44.22	74.00	-29.78	Horizontal
7440.00	30.26	17.93	48.19	74.00	-25.81	Horizontal
9920.00	29.24	23.83	53.07	74.00	-20.93	Horizontal
12400.00	*			74.00		Horizontal
14880.00	*			74.00		Horizontal
Average value:						
Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	polarization
4960.00	18.85	15.58	34.43	54.00	-19.57	Vertical
7440.00	19.67	17.93	37.60	54.00	-16.40	Vertical
9920.00	20.28	23.83	44.11	54.00	-9.89	Vertical
12400.00	*			54.00		Vertical
14880.00	*			54.00		Vertical
4960.00	18.57	15.58	34.15	54.00	-19.85	Horizontal
7440.00	20.23	17.93	38.16	54.00	-15.84	Horizontal
9920.00	18.58	23.83	42.41	54.00	-11.59	Horizontal
12400.00	*			54.00		Horizontal
14880.00	*			54.00		Horizontal

Remark:

1. Result =Reading + Factor
2. “*” means the test results were attenuated more than 20dB below the permissible limits, so the results don't record in the report.
3. Only the worst case is recorded in the report.

APPENDIX I -- TEST SETUP PHOTOGRAPH

Please refer to separated files Appendix I -- Test Setup Photograph_RF

APPENDIX II -- EXTERNAL PHOTOGRAPH

Please refer to separated files Appendix II -- External Photograph

APPENDIX III -- INTERNAL PHOTOGRAPH

Please refer to separated files Appendix III -- Internal Photograph

---------- End of Report ----------