

FCC PART 15B, CLASS B

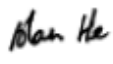
MEASUREMENT AND TEST REPORT

For

Shenzhen Rakwireless Technology Co.,Ltd.

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FCC ID: 2AF6B-RAK5860

Report Type: Original Report	Product Type: NB-IOT Module
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Report Number:	RSZ201210005-00
Report Date:	2021-01-18
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	NB-IOT Module
Tested Model	RAK5860
Voltage Range	DC3.3V from Testing Jig
Highest operating frequency	2200MHz
Date of Test	2021-01-11 to 2021-01-12
Sample number	RSZ201210005-EM-S1(Assigned by BACL, Shenzhen)
Received date	2020-12-10
Sample/EUT Status	Good condition
Adapter information	N/A

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A, B of the Federal Communication Commissions rules.

The objective of the manufacturer is to determine the compliance of the EUT with FCC Part 15 B.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR 16-4-2:2011, the expanded combined standard uncertainty of test at Bay Area Compliance Laboratories Corp. (Shenzhen) is shown as below. And the uncertainty will be taken into consideration for the test data recorded in the report

Parameter		uncertainty
Conducted Emissions		$\pm 1.95\text{dB}$
Radiated Emissions	Below 1GHz	$\pm 4.75\text{dB}$
	Above 1GHz	$\pm 4.88\text{dB}$

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in a manufacturer testing fashion.

EUT Exercise Software

No exercise software was used.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

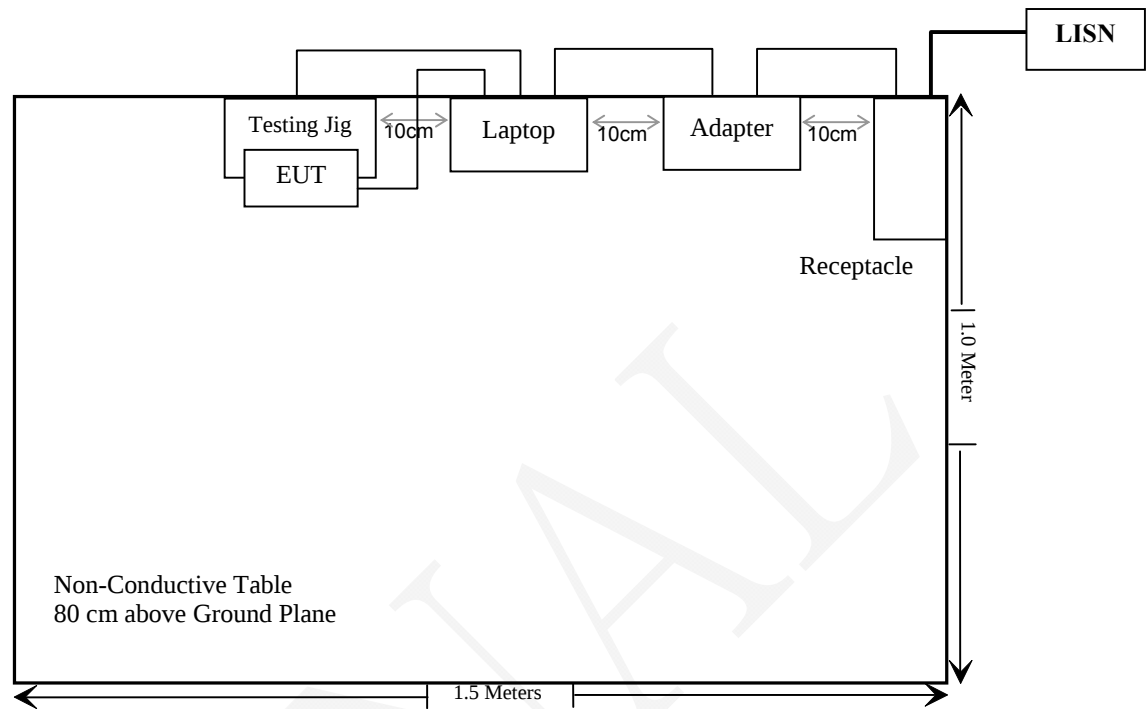
Manufacturer	Description	Model	Serial Number
Rakwireless	Testing Jig	RAK5005	RAK5005-0 V1.0
DELL	Laptop	Latitude E5430	11429208685
DELL	Adapter	DA130PE1-00	ADP-130DB B
DELL	Laptop	Latitude E6410	CFGY2 A00

External I/O Cable

Cable Description	Length (m)	From/Port	To
Un-shielded Detachable AC Cable	1.2	Receptacle	Adapter
Un-shielded Un-Detachable DC Cable	1.6	Adapter	Laptop
Un-shielded Detachable USB Cable	1.0	Laptop	Testing Jig
Un-shielded Detachable USB Cable	1.0	Laptop	EUT

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Results
§15.107	AC Line Conducted Emissions	Compliance
§15.109	Radiated Spurious Emissions	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2020/08/04	2021/08/03
Rohde & Schwarz	LISN	ENV216	101613	2020/08/04	2021/08/03
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2020/11/29	2021/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2020/11/29	2021/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2020/08/04	2021/08/03
Sonoma instrument	Pre-amplifier	310 N	186238	2020/08/04	2021/08/03
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2020/12/22	2023/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2020/11/29	2021/11/28
Unknown	Cable	Chamber Cable 4	EC-007	2020/11/29	2021/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Yijia	Temperature & Humidity Meter	TA218B	E0938	2020/10/14	2021/10/13
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2020/08/04	2021/08/03
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Sunol Sciences	Horn Antenna	DRH-118	A052604	2020/12/22	2023/12/21
Yijia	Temperature & Humidity Meter	TA218B	E0938	2020/10/14	2021/10/13
Insulted Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28

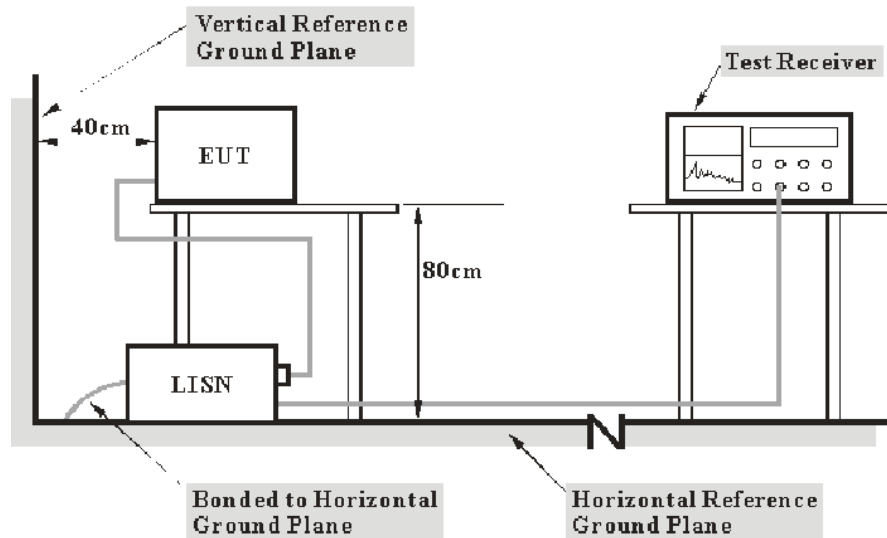
* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.107 – AC LINE CONDUCTED EMISSIONS

Applicable Standard

According to FCC §15.107

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with per ANSI C63.4-2014. The related limit was specified in FCC Part 15.107.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the device was connected to the first LISN and the other relevant equipments were connected to the second LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

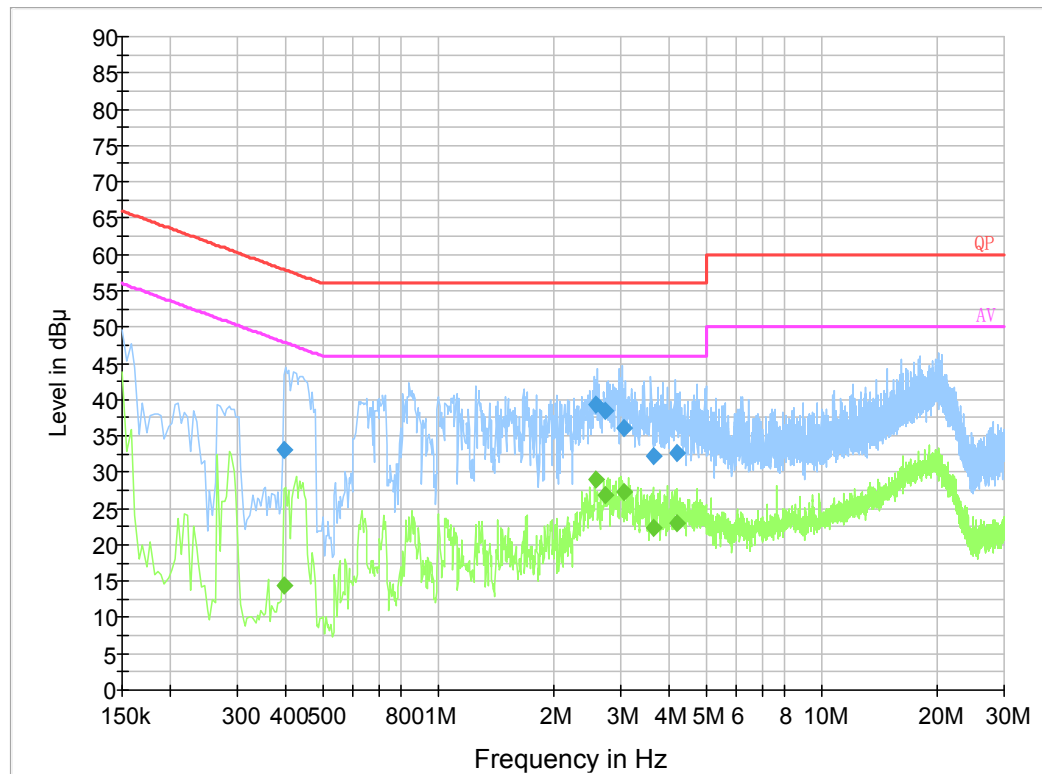
Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-01-11.

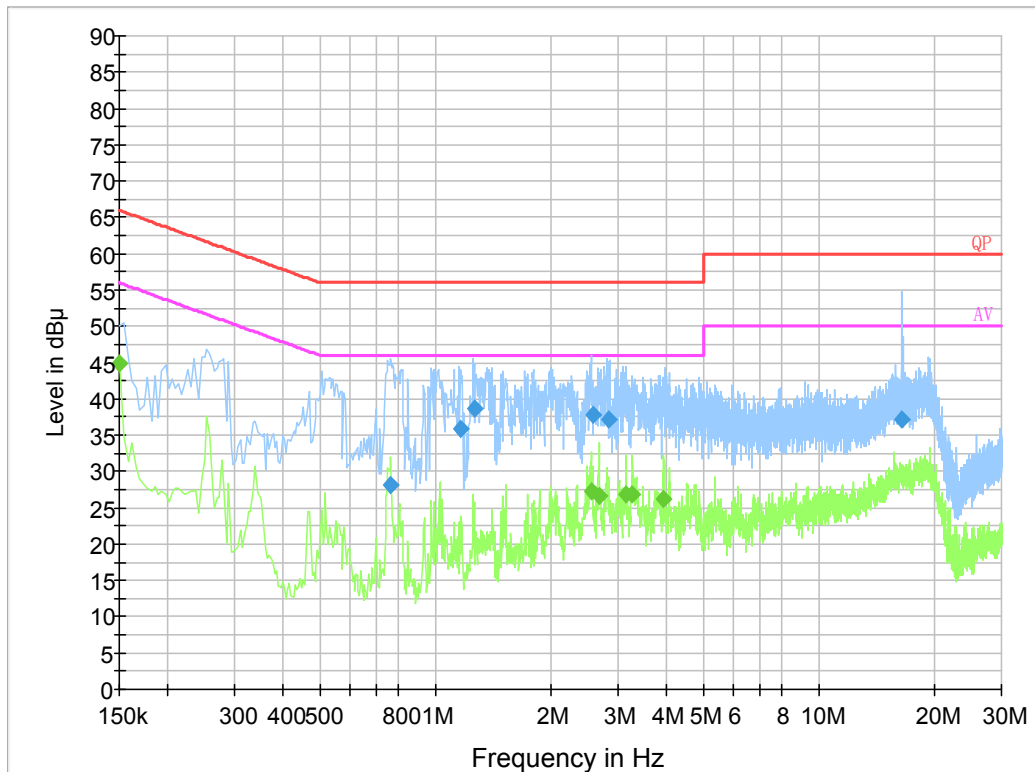
EUT Operation Mode: Working

AC 120V/60 Hz, Line**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.395970	33.2	9.000	L1	19.9	24.7	57.9
2.570850	39.2	9.000	L1	19.8	16.8	56.0
2.740330	38.4	9.000	L1	19.9	17.6	56.0
3.044550	36.1	9.000	L1	19.9	19.9	56.0
3.644030	32.2	9.000	L1	19.9	23.8	56.0
4.203570	32.6	9.000	L1	19.9	23.4	56.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.395970	14.4	9.000	L1	19.9	33.5	47.9
2.570850	29.0	9.000	L1	19.8	17.0	46.0
2.740330	26.9	9.000	L1	19.9	19.1	46.0
3.044550	27.3	9.000	L1	19.9	18.7	46.0
3.644030	22.4	9.000	L1	19.9	23.6	46.0
4.203570	23.1	9.000	L1	19.9	22.9	46.0

AC 120V/60 Hz, Neutral:**Final Result 1**

Frequency (MHz)	QuasiPeak (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.762510	28.2	9.000	N	19.8	27.8	56.0
1.160690	35.8	9.000	N	19.8	20.2	56.0
1.271190	38.7	9.000	N	19.8	17.3	56.0
2.579690	37.8	9.000	N	19.8	18.2	56.0
2.827850	37.2	9.000	N	19.9	18.8	56.0
16.547130	37.1	9.000	N	20.1	22.9	60.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	44.9	9.000	N	19.8	11.1	56.0
2.554000	27.2	9.000	N	19.8	18.8	46.0
2.678000	26.7	9.000	N	19.8	19.3	46.0
3.146000	26.9	9.000	N	19.9	19.1	46.0
3.278000	26.7	9.000	N	19.9	19.3	46.0
3.950000	26.3	9.000	N	19.9	19.7	46.0

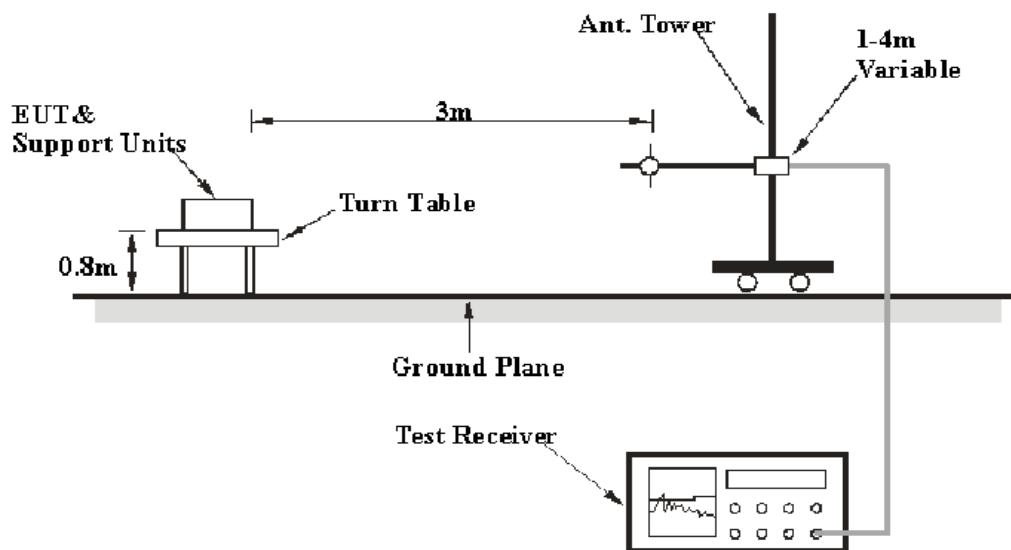
FCC §15.109 - RADIATED SPURIOUS EMISSIONS

Applicable Standard

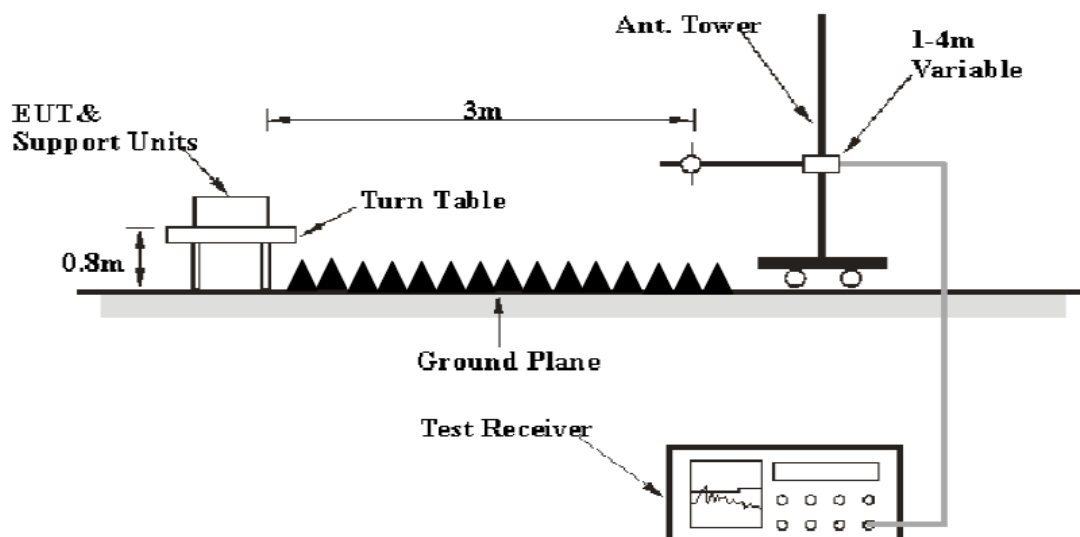
FCC §15.109

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.4-2014. The specification used was the FCC Part 15.109 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

During the radiated emission test, the EMI test receiver was set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Ave.

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

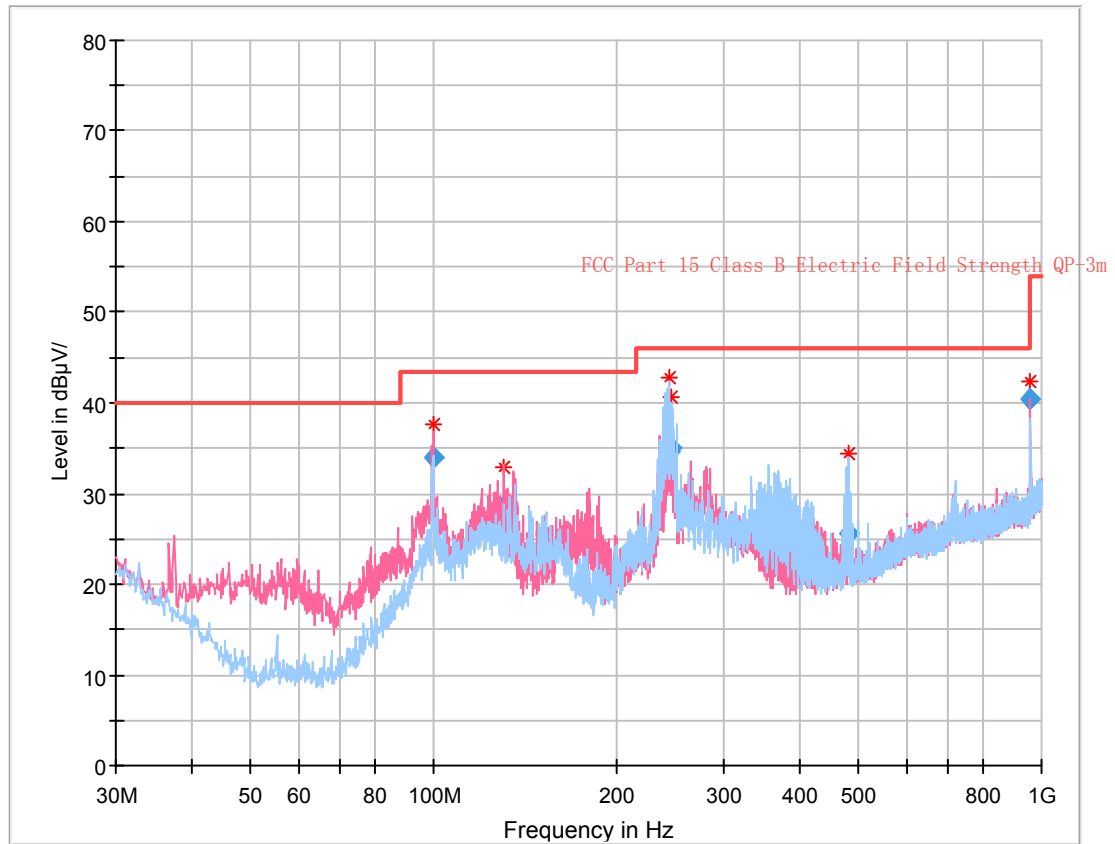
Test Data

Environmental Conditions

Temperature:	21~28.1 °C
Relative Humidity:	35~52 %
ATM Pressure:	100.9~101.0 kPa

The testing was performed by Kilroy Deng on 2021-01-11 for below 1GHz and Alan He on 2021-01-12 for above 1GHz.

EUT Operation Mode: Working

30 MHz – 1 GHz:**Final Result**

Frequency (MHz)	QuasiPeak (dB μV/m)	Limit (dB μV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
99.904125	33.91	43.50	9.59	103.0	V	349.0	-13.9
130.707375	28.69	43.50	14.81	148.0	V	85.0	-10.8
243.276625	34.61	46.00	11.39	218.0	H	357.0	-10.8
246.832500	35.00	46.00	11.00	234.0	H	128.0	-10.8
480.015500	25.61	46.00	20.39	177.0	H	132.0	-5.3
959.998000	40.41	46.00	5.59	107.0	V	49.0	2.4

1-11 GHz:

Frequency (MHz)	Measurement		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB μ V/m)	FCC Part 15B	
	Reading (dB μ V)	PK/QP/Ave.		Height (m)	Polar (H / V)			Limit (dB μ V/m)	Margin (dB)
1202.43	46.56	PK	251	2.3	H	-4.78	41.78	74	32.22
1202.43	32.18	Ave.	251	2.3	H	-4.78	27.40	54	26.60
1202.43	48.09	PK	226	1.7	V	-4.78	43.31	74	30.69
1202.43	33.82	Ave.	226	1.7	V	-4.78	29.04	54	24.96
2660.65	44.67	PK	246	2.5	H	0.32	44.99	74	29.01
2660.65	30.16	Ave.	246	2.5	H	0.32	30.48	54	23.52
2660.65	45.82	PK	358	1.7	V	0.32	46.14	74	27.86
2660.65	30.34	Ave.	358	1.7	V	0.32	30.66	54	23.34

***** END OF REPORT *****