FCC Test Report

Test Report
On Behalf of
Gemstone Lights Canada LTD
For
Hub2 Controller
Model No.: GM03

FCC ID: 2BBFCGM03

Prepared For:	**Gemstone Lights Canada LTD** **#170 11080 50 ST SE, Calgary, Alberta, T2C 5T4, Canada**
Prepared By:	**Shenzhen DL Testing Technology Co., Ltd.** **101-201, Building C, Shuanghuan, No.8, Baoqing Road, Baolong Industrial Zone, Baolong Street, Longgang District, Shenzhen, Guangdong, China**
Date of Test:	**Apr. 19, 2024 ~ May 09, 2024**
Date of Report:	**May 09, 2024**
Report Number:	**DL-240604009-8ER**

Test Result Certification

Applicant's Name	:	Gemstone Lights Canada LTD
Address	:	#170 11080 50 ST SE, Calgary, Alberta, T2C 5T4, Canada
Manufacturer's Name	:	iPixel LED Light Co.,Ltd
Address	:	7F, Mingjinhai Complex Building, Tangtou Rd, Shiyan Town, Baoan, Shenzhen, China

Product Description

Trade Mark	:	Gemstone Lights
Product Name	:	Hub2 Controller
Model and/or type reference	:	GM03
Standards	:	FCC Part15 Subpart C 2017, Section 15.231 ANSI C63.10: 2013

Date of Test	:	
Date (s) of Performance of Tests	:	**Apr. 19, 2024 ~ May 09, 2024**
Date of Issue	:	**May 09, 2024**
Test Result	:	**Pass**

Testing Engineer : Randy Xie

Randy Xie

Technical Manager : Jack Bu

Jack Bu

Authorized Signatory : Jade Yang

Jade Yang

Contents

**** Modified History ****

Revision	Description	Issued Data	Remark
Revision 1.0	Initial Test Report Release	May 09, 2024	

1. Test Summary

1.1 Test Facility

Standard Section	Test Item	Result
15.203	Antenna Requirement	PASS
15.207	Conducted Emission	PASS
15.205/15.209/15.231(b)	Spurious Emission	PASS
15.231(c)	20dB Occupied Bandwidth	PASS
15.231(a)	Deactivation Testing	PASS
Remark: "N/A" is an abbreviation for Not Applicable.		

1.2 Information of the Test Laboratory

Shenzhen DL Testing Technology Co., Ltd.
Add.: 101-201, Building C, Shuanghuan, No.8, Baoqing Road, Baolong Industrial Zone, Baolong Street, Longgang District, Shenzhen, Guangdong, China

Testing Laboratory Authorization:
FCC Test Firm Registration Number: 854456
Designation Number: CN1307
IC Registered No.: 27485
CAB ID.: CN0118

1.3 Measurement Uncertainty

Measurement Uncertainty		
Parameter	Conditions	Uncertainty
Occupied Bandwidth	Conducted	±1.5%
Conducted Spurious Emission	Conducted	±2.17dB
Transmission Time	Conducted	±5%
Conducted Emissions	Conducted	±2.88dB
Transmitter Spurious Emissions	Radiated	±5.1dB

2. General Information

2.1. Description of Device (EUT)

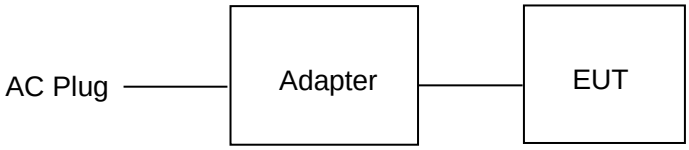
Product Name	:	Hub2 Controller	
Model No.	:	GM03	
Series Models	:	N/A	
Model Difference	:	N/A	
Trade Mark	:	Gemstone Lights	
Test Power Supply	:	DC 5V-24V	
Product Description	:	Operation Frequency:	433.917MHz
		Number of Channel:	1 Channels
		Modulation Type:	ASK
		Antenna Type:	FPC Antenna
		Antenna Gain(Peak):	3dBi
Note:			
1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual. 2. Antenna gain Refer to the antenna specifications. 3. The cable loss data is obtained from the supplier. 4. The test results in the report only apply to the tested sample.			

2.2. List of Channels

Channel	Freq. (MHz)	Note (Modulation Type)
01	433.917	ASK

2.3. Description of Test Setup

Operation of EUT during conducted testing and radiation testing:



The sample was placed (0.8m below 1GHz, 1.5m above 1GHz) above the ground plane of 3m chamber. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages. The worst case is X position

2.4. Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Trade Mark	Model/Type No.	Specification	Note
1	Hub2 Controller	Gemstone Lights	GM03	N/A	EUT
2	Adapter	N/A	S12B21-120A100-04	Input: AC100-240V, 50/60Hz, 0.5A Output: 12V/1A,	Accessory

Note:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.

2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

3. For conducted measurements (20dB Bandwidth, Transmission Time, Duty Cycle), the antenna of EUT is connected to the test equipment via temporary antenna connector, the antenna connector is soldered on the antenna port of EUT, and the temporary antenna connector is listed in the Test Instruments.

2.5. Test Equipment List

Radiation test, Band-edge test and 20db bandwidth test equipment

Item	Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
1	Spectrum Analyzer (9kHz-26.5GHz)	Agilent	E4408B	MY50140780	Nov. 04, 2023	Nov. 03, 2024
2	Test Receiver (9kHz-7GHz)	R&S	ESRP7	101393	Nov. 04, 2023	Nov. 03, 2024
3	Bilog Antenna (30MHz-1GHz)	R&S	VULB9162	00306	Nov. 04, 2023	Nov. 03, 2024
4	Horn Antenna (1GHz-18GHz)	Schwarzbeck	BBHA9120D	02139	Nov. 04, 2023	Nov. 03, 2024
5	Horn Antenna (18GHz-40GHz)	A.H. Systems	SAS-574	588	Nov. 04, 2023	Nov. 03, 2024
6	Amplifier (9KHz-6GHz)	Schwarzbeck	BBV9743B	00153	Nov. 04, 2023	Nov. 03, 2024
7	Amplifier (1GHz-18GHz)	EMEC	EM01G8GA	00270	Nov. 04, 2023	Nov. 03, 2024
8	Amplifier (18GHz-40GHz)	Quanjuda	DLE-161	97	Nov. 04, 2023	Nov. 03, 2024
9	Loop Antenna (9KHz-30MHz)	Schwarzbeck	FMZB1519B	00014	Nov. 04, 2023	Nov. 03, 2024
10	RF cables1 (9kHz-1GHz)	ChengYu	966	004	Nov. 04, 2023	Nov. 03, 2024
11	RF cables2 (1GHz-40GHz)	ChengYu	966	003	Nov. 04, 2023	Nov. 03, 2024
12	Antenna connector	Florida RF Labs	N/A	RF 01#	Nov. 04, 2023	Nov. 03, 2024
13	Power probe	KEYSIGHT	U2021XA	MY55210018	Nov. 04, 2023	Nov. 03, 2024
14	Signal Analyzer 9kHz-26.5GHz	Agilent	N9020A	MY55370280	Nov. 04, 2023	Nov. 03, 2024
15	Test Receiver 20kHz-40GHz	R&S	ESU 40	100376	Nov. 04, 2023	Nov. 03, 2024
16	D.C. Power Supply	LongWei	PS-305D	010964729	Nov. 04, 2023	Nov. 03, 2024

Conduction Test equipment

Item	Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
1	843 Shielded Room	ChengYu	843 Room	843	Sep. 20, 2022	Sep. 19, 2025
2	EMI Receiver	R&S	ESR	101421	Nov. 04, 2023	Nov. 03, 2024
3	LISN	R&S	ENV216	102417	Nov. 04, 2023	Nov. 03, 2024
4	843 Cable 1#	ChengYu	CE Cable	001	Nov. 04, 2023	Nov. 03, 2024

5	10dB Attenuator	Schwarzbeck	VTSD9561F	00154	Nov. 04, 2023	Nov. 03, 2024

Other

Item	Name	Manufacturer	Model	Software version
1	EMC Conduction Test System	FALA	EZ_EMC	EMC-CON 3A1.1
2	EMC radiation test system	FALA	EZ_EMC	FA-03A2
3	RF test system	MAIWEI	MTS8310	2.0.0.0
4	RF communication test system	MAIWEI	MTS8200	2.0.0.0

3. Conducted Emission Test

3.1 Conducted Power Line Emission Limit

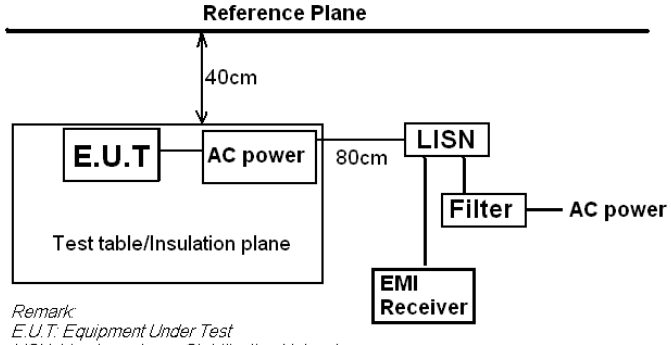
For unintentional device, according to § 15.107(a) Line Conducted Emission Limits is as following

Frequency (MHz)	Maximum RF Line Voltage (dBμV)			
	CLASS A		CLASS B	
	Q.P.	Ave.	Q.P.	Ave.
0.15 - 0.50	79	66	66-56*	56-46*
0.50 - 5.00	73	60	56	46
5.00 - 30.0	73	60	60	50

* Decreasing linearly with the logarithm of the frequency

For intentional device, according to §15.207(a) Line Conducted Emission Limit is same as above table.

3.2 Test Setup



Remark:
E.U.T: Equipment Under Test
LISN: Line Impedence Stabilization Network
Test table height=0.8m

3.3 Test Procedure

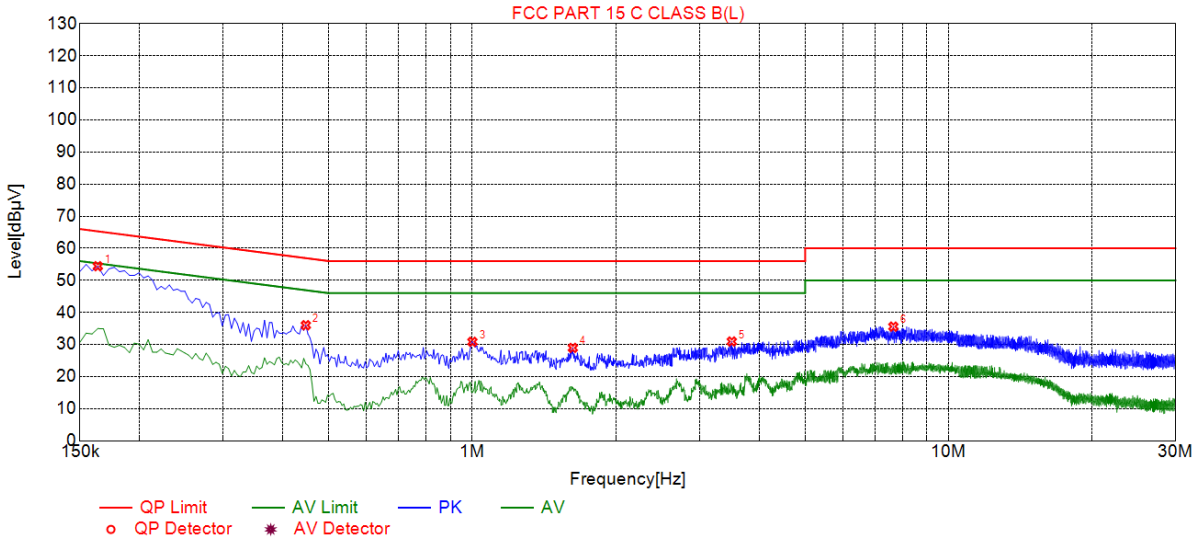
1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10.
2. Support equipment, if needed, was placed as per ANSI C63.10.
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.
4. If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.

3.4 Test Data

PASS

Only the worst result was reported as below.

Test Specification: Line



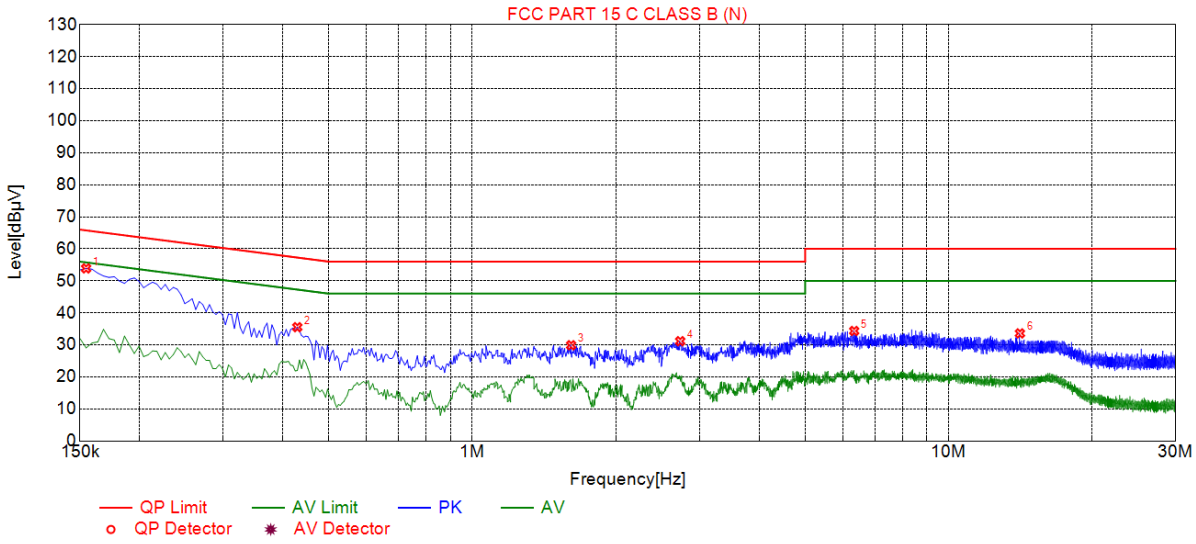
Suspected List								
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Type
1	0.1635	54.41	19.98	65.28	10.87	34.43	PK	L
2	0.4470	36.01	20.04	56.93	20.92	15.97	PK	L
3	1.0005	30.84	20.06	56.00	25.16	10.78	PK	L
4	1.6260	28.95	20.11	56.00	27.05	8.84	PK	L
5	3.5070	30.94	20.25	56.00	25.06	10.69	PK	L
6	7.6605	35.58	20.17	60.00	24.42	15.41	PK	L

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

Test Specification: Neutral



Suspected List								
NO.	Freq. [MHz]	Level [dBµV]	Factor [dB]	Limit [dBµV]	Margin [dB]	Reading [dBµV]	Detector	Type
1	0.1545	53.88	20.03	65.75	11.87	33.85	PK	N
2	0.4290	35.53	20.05	57.27	21.74	15.48	PK	N
3	1.6125	29.89	20.11	56.00	26.11	9.78	PK	N
4	2.7330	31.15	20.21	56.00	24.85	10.94	PK	N
5	6.3375	34.35	20.22	60.00	25.65	14.13	PK	N
6	14.1270	33.59	19.96	60.00	26.41	13.63	PK	N

Remark: Margin = Limit – Level

Correction factor = Cable lose + LISN insertion loss

Level=Test receiver reading + correction factor

4. Radiated Emissions

4.1. Standard Applicable

According to §15.231(b), the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750 **	125 to 375 **
174 - 260	3,750	375
260 - 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

** linear interpolations

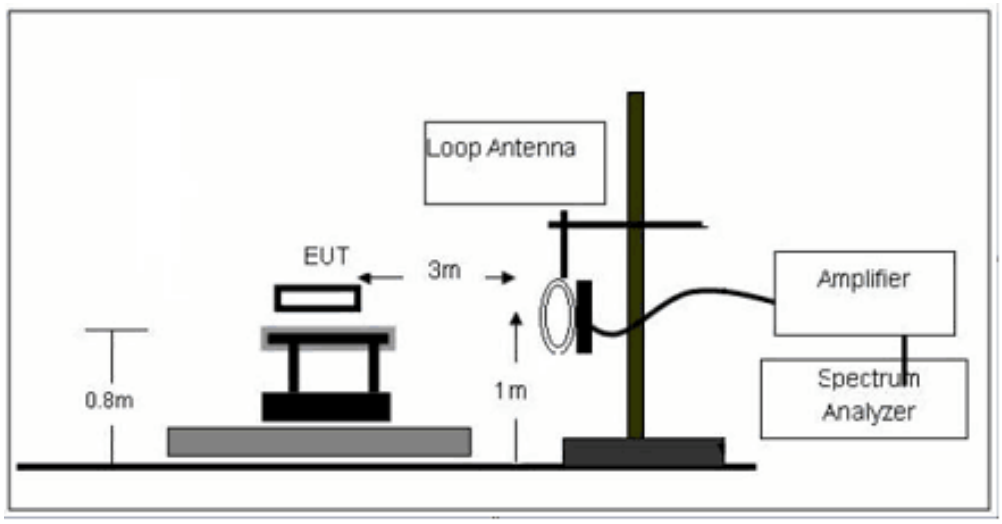
The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

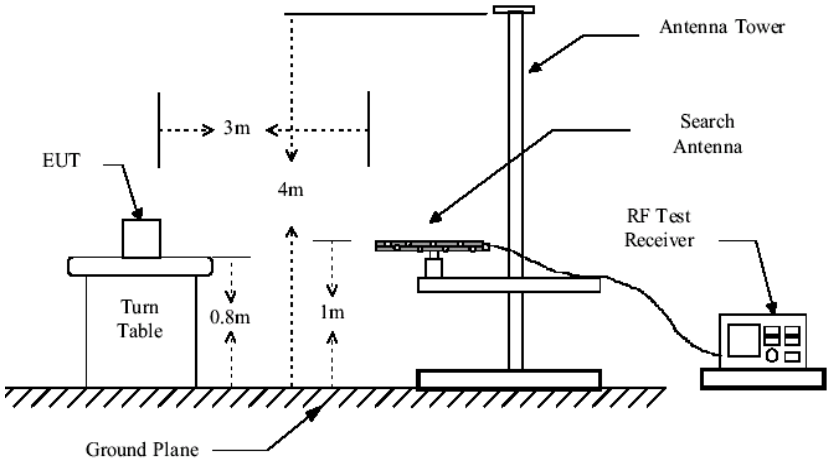
The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

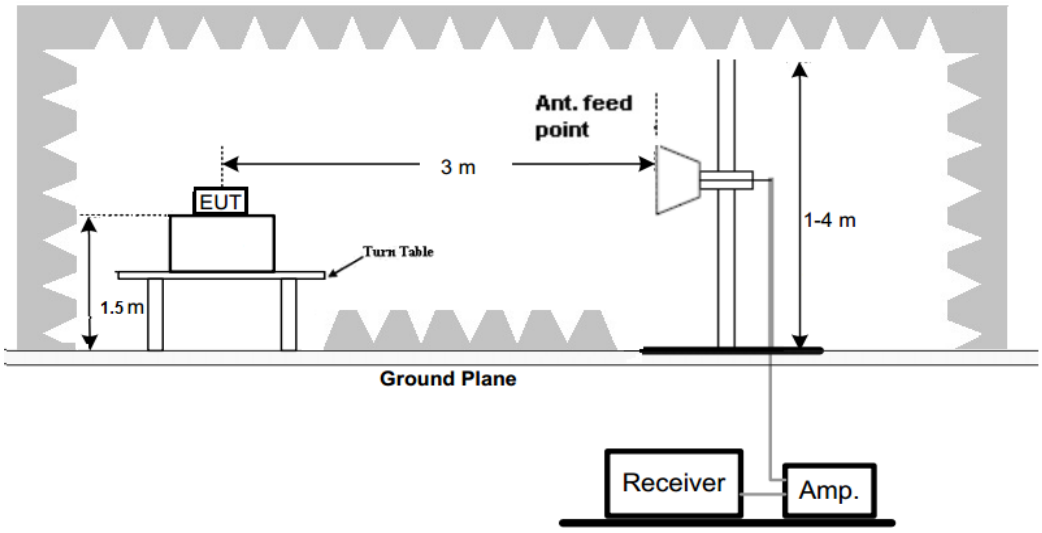
Compliance with the provisions of §15.205 shall be demonstrated using the measurement instrumentation specified in that section.

4.2. Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.231(b) and FCC Part 15.209 Limit.


Loop Antenna
EUT
3m
Amplifier
Spectrum Analyzer
0.8m
1 m


Antenna Tower
Search Antenna
EUT
3m
4m
RF Test Receiver
Turn Table
0.8m
1m
Ground Plane


Ant. feed point
3 m
EUT
Turn Table
1-4 m
1.5 m
Ground Plane
Receiver
Amp.

4.3. Corrected Amplitude & Margin Calculation

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

Corr. Ampl. = Indicated Reading +Ant.Loss +Cab. Loss – Ampl.Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dBμV means the emission is 6dBμV below the maximum limit. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – FCC Part15C Limit

4.4. Environmental Conditions

Temperature:	21℃
Relative Humidity:	50%
ATM Pressure:	1011 mbar

4.5. Test Data

According to the data below, the FCC Part 15.205, 15.209 and 15.231 standards, and had the worst margin of:

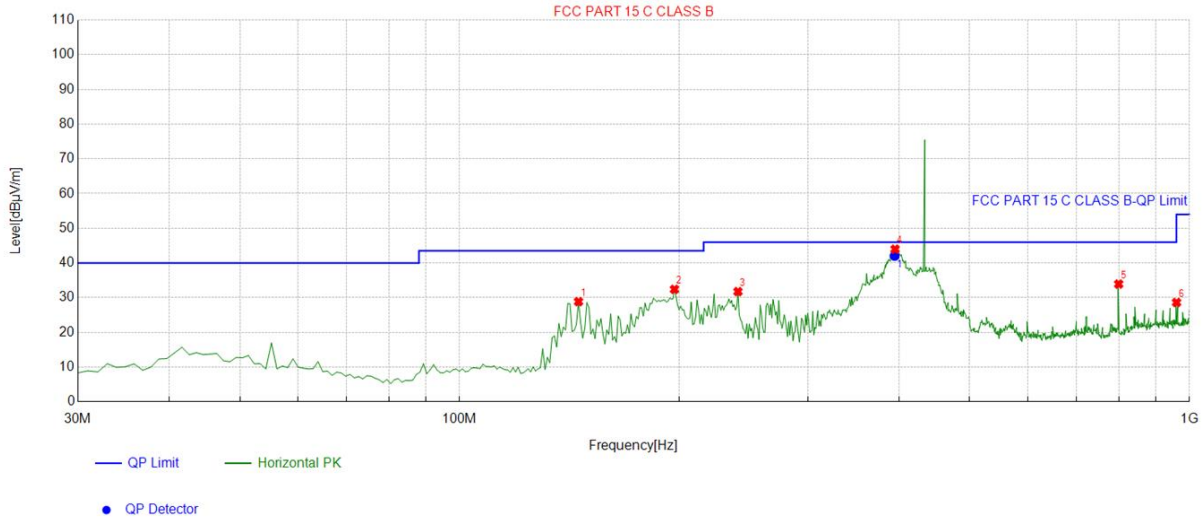
Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.

(Fundamental 433.917MHz)

No.	Frequency	Reading	Corr.	Result	Limit	Margin	Deg.	Height	Polarity	Remark
	MHz	dBuV/m	Factor (dB)	dBuV/m	dBuV/m	dB	(°)	(cm)		
1	433.9170	64.19	12.33	76.52	100.8	-24.28	177	100	H	Peak
2	433.9170	N/A	N/A	76.52	80.83	-4.31	177	100	H	AV
3	433.9170	56.35	12.33	68.68	100.8	-32.12	177	100	V	Peak
4	433.9170	N/A	N/A	68.68	80.83	-12.15	117	100	V	AV

Radiated Emission

Antenna polarity: H



Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	145.54554	-18.27	47.13	28.86	43.50	14.64	100	167	Horizontal
2	197.00700	-14.97	47.37	32.40	43.50	11.10	100	195	Horizontal
3	240.70070	-13.63	45.38	31.75	46.00	14.25	100	178	Horizontal
4	395.08508	-9.10	53.07	43.97	46.00	2.03	100	42	Horizontal
5	799.97998	-3.01	36.93	33.92	46.00	12.08	100	339	Horizontal
6	960.19019	-0.54	29.15	28.61	54.00	25.39	100	355	Horizontal

Final Data List									
NO.	Freq. [MHz]	Factor [dB]	QP Reading [dBµV/m]	QP Value [dBµV/m]	QP Limit [dBµV/m]	QP Margin [dB]	Height [cm]	Angle [°]	Polarity
1	394.5698	-9.10	51.16	42.06	46.00	3.94	100	42	Horizontal

Remark: Factor = Cable loss + Antenna factor + Attenuator – Preamplifier; Level = Reading + Factor; Margin = Level-Limit.

Antenna polarity: V

Suspected List									
NO.	Freq. [MHz]	Factor [dB]	Reading [dBµV/m]	Level [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	41.651652	-13.41	39.03	25.62	40.00	14.38	100	132	Vertical
2	59.129129	-13.54	36.28	22.74	40.00	17.26	100	279	Vertical
3	149.42942	-18.08	46.27	28.19	43.50	15.31	100	97	Vertical
4	180.50050	-16.33	40.88	24.55	43.50	18.95	100	108	Vertical
5	233.90390	-13.88	37.81	23.93	46.00	22.07	100	279	Vertical
6	395.08508	-9.10	46.49	37.39	46.00	8.61	100	257	Vertical

Remark: Factor = Cable loss + Antenna factor + Attenuator – Preamplifier; Level = Reading + Factor; Margin = Level-Limit.

Above 1GHz

Horizontal

No.	Frequency	Reading	Corr.	Result	Limit	Margin	Deg.	Height	Remark
	MHz	dBuV/m	Factor (dB)	dBuV/m	dBuV/m	dB	(°)	(cm)	
1	1301.7	24.35	23.21	47.56	74	-26.44	41	100	Peak
	1301.7	/	/	47.56	54	-6.44	306	100	Ave
2	1735.6	25.32	22.02	47.34	74	-26.66	204	100	Peak
	1735.6	/	/	47.34	54	-6.66	87	100	Ave

Vertical

No.	Frequency	Reading	Corr.	Result	Limit	Margin	Deg.	Height	Remark
	MHz	dBuV/m	Factor (dB)	dBuV/m	dBuV/m	dB	(°)	(cm)	
1	1301.7	26.88	25.83	52.71	74	-21.29	151	100	Peak
	1301.7	/	/	52.71	54	-1.29	74	100	Ave
2	1735.6	27.16	27.25	54.41	74	-19.59	332	100	Peak
	1735.6	/	/	54.41	54	0.41	51	100	Ave

Note: Testing is carried out with frequency rang 30MHz to the tenth harmonics, which above 5th Harmonics are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

The fundamental frequency is 433.917MHz, so the fundamental and spurious emissions radiated limit base on the the operating frequency 433.917MHz.

Frequency Range (9 kHz-30MHz)

Frequency (MHz)	Level@3m (dBμV/m		Limit@3m (dBμV/m)	
--	--	--	--	--
--	--	--	--	--
--	--	--	--	--

Note: 1. Emission Level=Reading+ Cable loss-Antenna factor-Amp factor

2. The emission levels are 20 dB below the limit value, which are not reported. It is deemed to comply with the requirement.

5. 20dB Occupy Bandwidth Test

5.1. Standard Applicable

According to FCC Part 15.231(c), The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

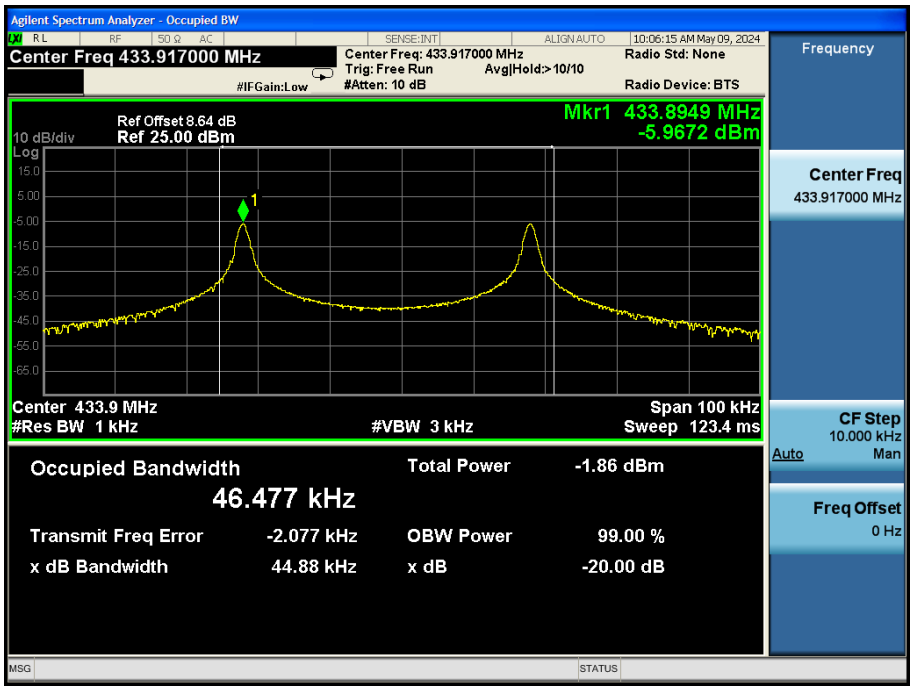
5.2. Test Procedure

With the EUT's antenna attached, the EUT's 20dB Bandwidth power was received by the test antenna, which was connected to the spectrum analyzer with the START, and STOP frequencies set to the EUT's operation band.

Temperature:	21℃
Relative Humidity:	52%
ATM Pressure:	1011 mbar

5.3. Test Data

Freq. (MHz)	Modulation Type	Bandwidth (kHz)	Limit (kHz)	Results
433.917	ASK	44.88	<1084.8	PASS



6. Transmission Time

6.1. Standard Applicable

According to FCC Part 15.231(a), the transmitter shall be complied the following requirements:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

6.2. Test Procedure

With the EUT's antenna attached, the EUT's output signal was received by the test antenna, which was connected to the spectrum analyzer. Set the center frequency to 433.917MHz, than set the spectrum analyzer to Zero Span for the release time reading. During the testing, the switch was released then the EUT automatically deactivated.

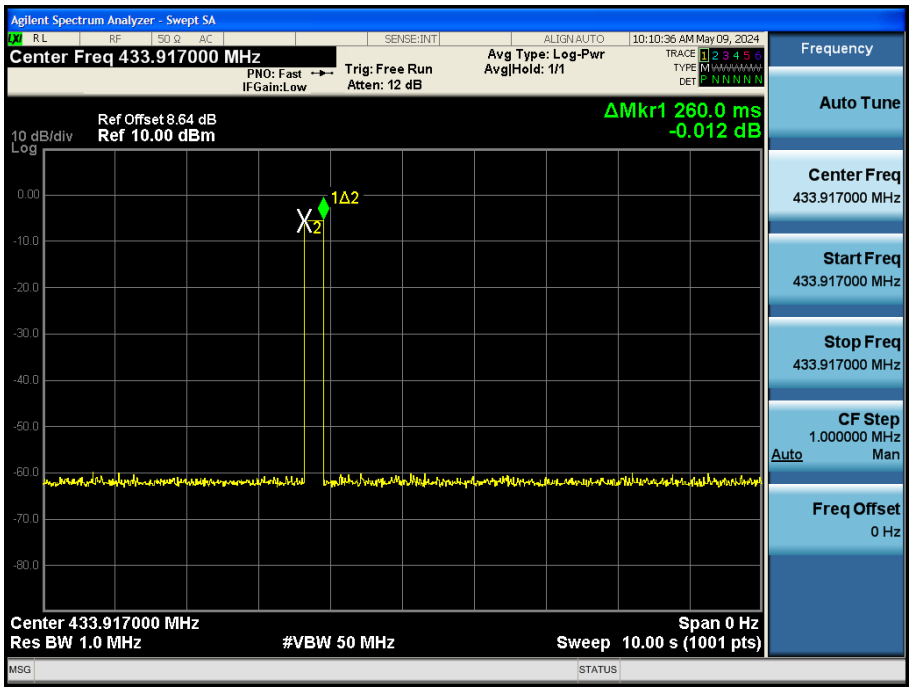
6.3. Environmental Conditions

Temperature:	20℃
Relative Humidity:	52%
ATM Pressure:	1011 mbar

6.4. Test Data

Transmission Type	Test Frequency MHz	Transmission Time seconds	Limit s	Result
Manually	433.917	0.26	5	PASS

Please refer the following plot.



7. Duty Cycle

7.1. Standard Applicable

According to FCC Part 15.231(b)(2) and 15.35 (c),For pulse operation transmitter, the averaging pulsed emissions are calculated by peak value of measured emission plus duty cycle factor.

7.2. Test Procedure

1) The EUT was placed on a turntable which is 0.8m above ground plane.

2) Set EUT operating in continuous transmitting mode

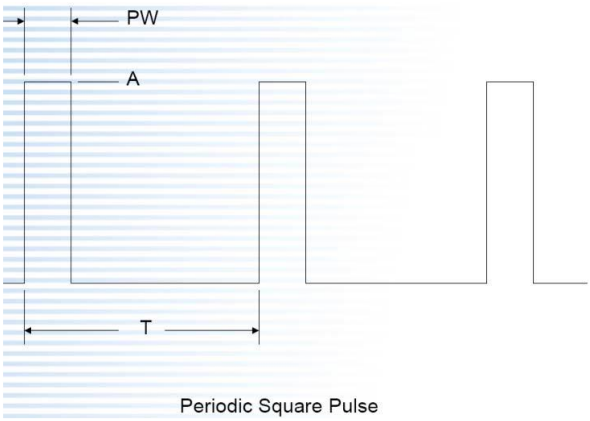
3) Set Test Receiver into spectrum analyzer mode, Tune the spectrum analyzer to the transmitter carrier frequency, and set the spectrum analyzer resolution bandwidth(RBW) to 1000kHz and video bandwidth(VBW) to 1000kHz, Span was set to 0Hz.

4) The Duty Cycle was measured and recorded.

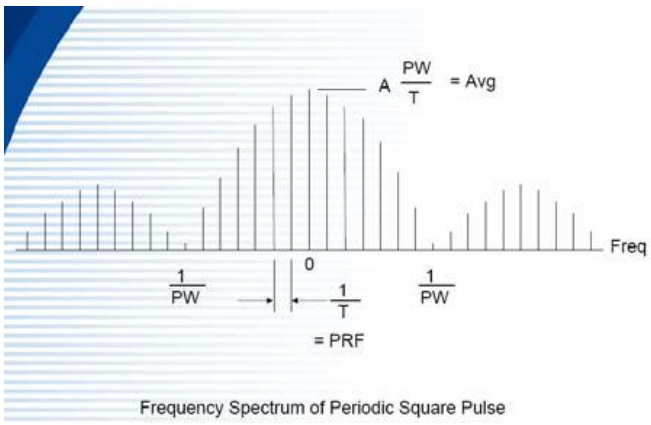
7.3. Introduction to PDCF Reference:

(§15.35 Measurement detector functions and bandwidths.)

1) Part 15 of the FCC Rules provides for the operation of low power communication devices without an individual license (e.g., intrusion detectors, pulsed water tank level gauges, etc.), subject to certain requirements. Some of these devices use extremely narrow pulses to generate wideband emissions, which are measured to determine compliance with the rules. These measurements are typically performed with a receiver or spectrum analyzer. Depending on a number of factors (e.g., resolution bandwidth, pulse width, etc.), the spectrum analyzer may not always display the true peak value of the measured emission. This effect, called “pulse desensitization,” relates to the capabilities of the measuring instrument. For the measurement and reporting of the true peak of pulsed emissions, it may be necessary to apply a “pulse desensitization correction factor” (PDCF) to the measured value, pursuant to 47 CFR 15.35(a).



Periodic Square Pulse



Frequency Spectrum of Periodic Square Pulse

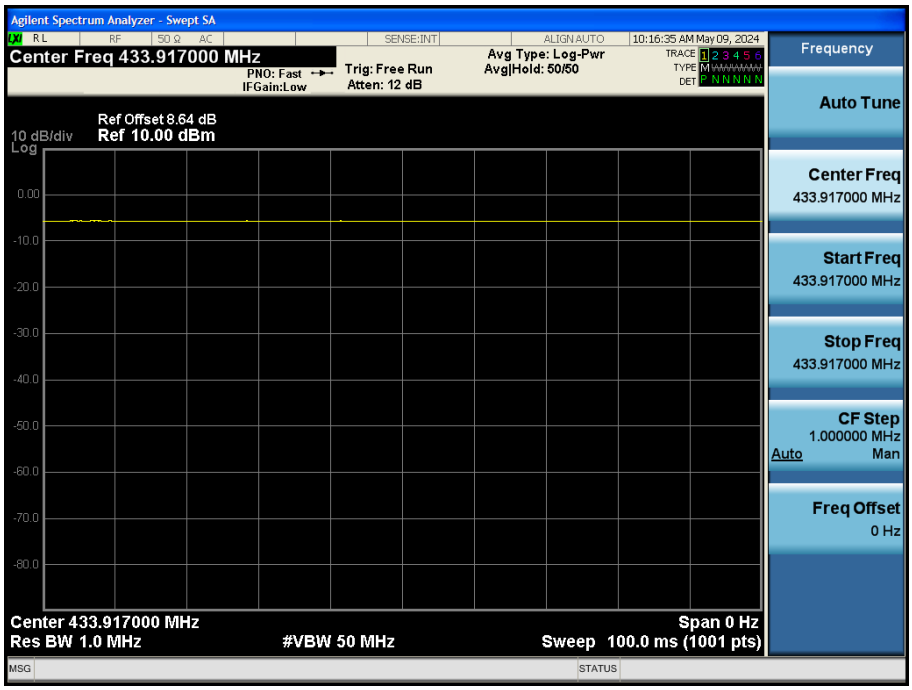
If using spectrum analyzer to measure pulse signal, it have to make sure the RBW use is at least 2/PW.
•When RBW is less than 2/PW, you are able to measure the true peak level of the pulse signal. If this is the case,
PDCF is required to compensate to determine true peak value.
Pulse desensitization:
PW =29250usec (0.6* 13+ 1.65*13), Period=67500usec, Level=A
RBW>2/PW=0.068K, 1/T=0.15K
NOTE: 2 / PW < RBW, first don't need

2). For the actual test, please refer to the ANSI C63.10, Annex C refer to section 5 for more detail

7.4. Test Data

The Duty Cycle is 100%

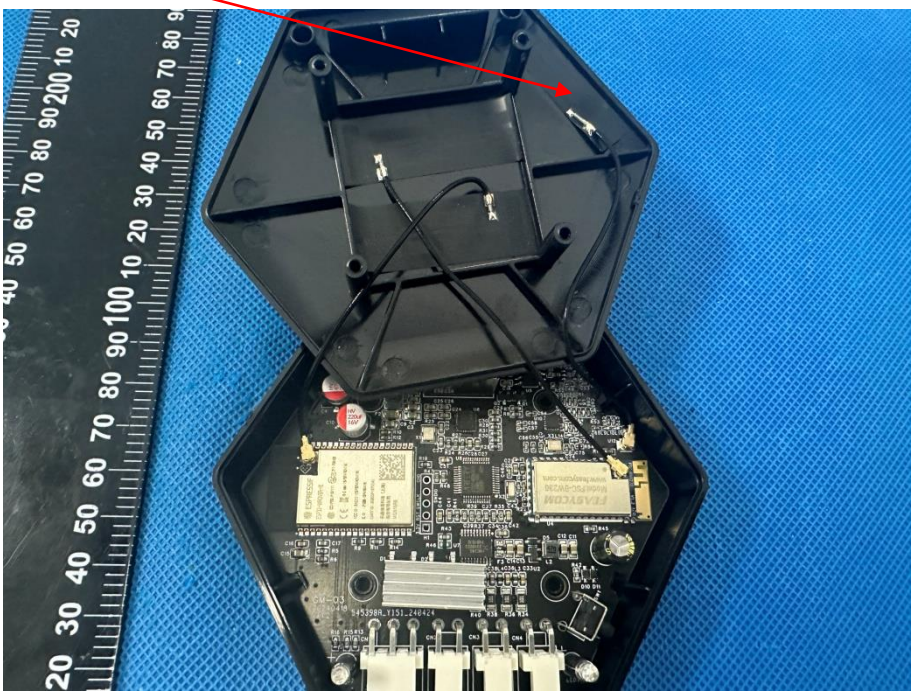
Please refer to the attached test plots



8. Antenna Connected Construction

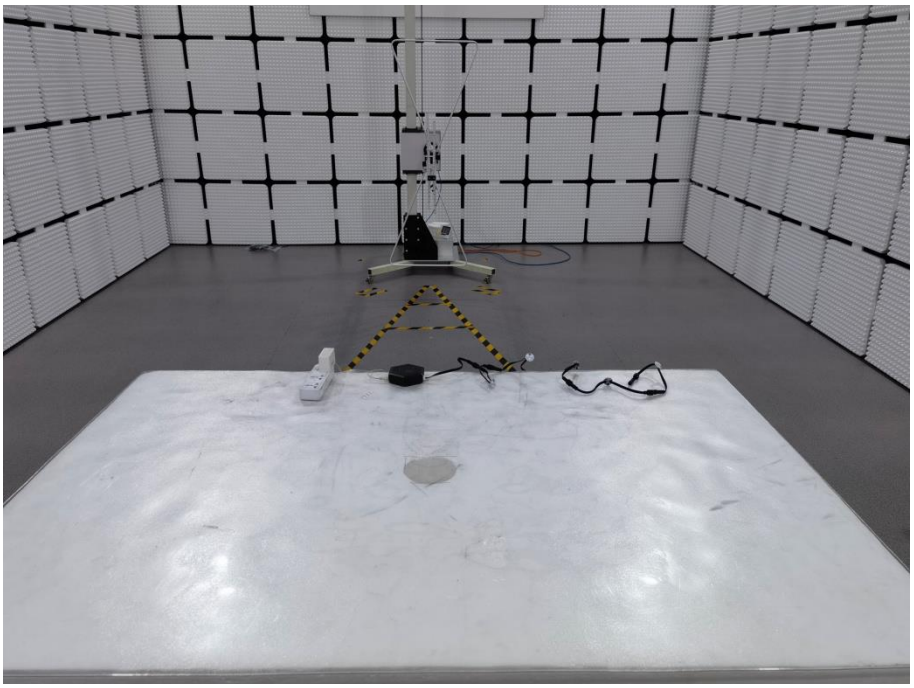
The antenna used in this product is a FPC antenna, need professional installation, not easy to remove. It conforms to the standard requirements. The directional gains of antenna used for transmitting is 3dBi.

Antenna

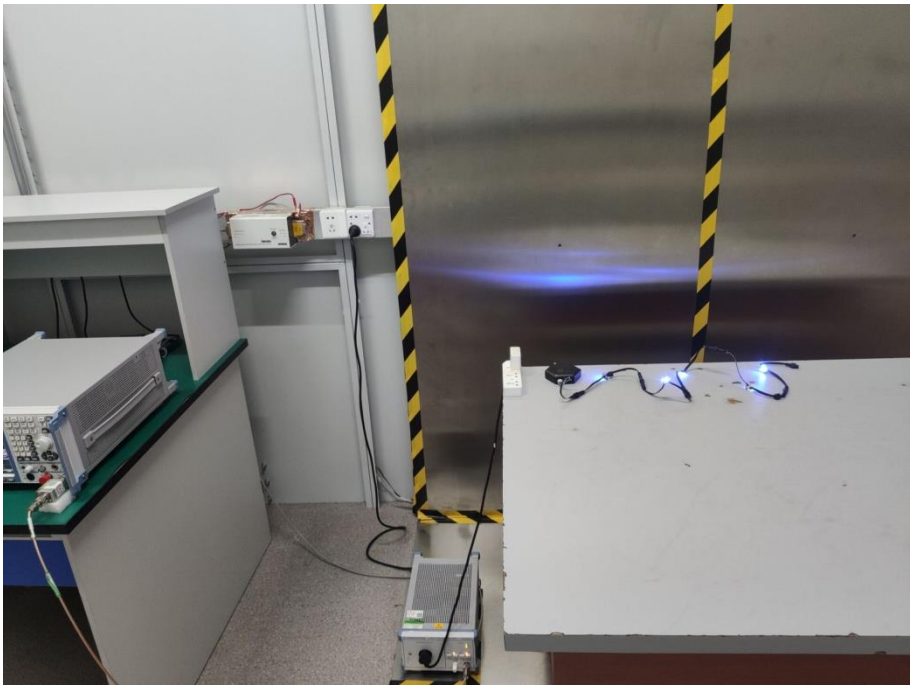


9. Photograph of Test

Radiated Emission



Conducted Emission



10. Photos of the EUT

Reference to the report: ANNEX A of External photos and ANNEX B of Internal photos

*****End of Report*****