

FCC TEST REPORT

Client Name : Seeed Technology Co., Ltd.
Address : 9F, G3 Building, TCL International E City,
Zhongshanyuan Road, Nanshan District, Shenzhen,
China 518055
Product Name : WM1302 LoRaWAN Gateway Module(SPI) - US915
Date : Dec. 07, 2021

Shenzhen Anbotech Compliance Laboratory Limited



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TEST REPORT

Applicant : Seeed Technology Co., Ltd.
Manufacturer : Seeed Technology Co., Ltd.
Product Name : WM1302 LoRaWAN Gateway Module(SPI) - US915
Model No. : WM1302-SPI-US915
Trade Mark : Seeed Studio
Rating(s) : Input: DC 3.3V/420mA

Test Standard(s) : FCC Part15 Subpart C, Section 15.247

Test Method(s) : ANSI C63.10: 2020

The device described above is tested by Shenzhen Anbotech 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 Anbotech 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 the FCC Part 15 Subpart C requirements.

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

Date of receipt

Nov. 24, 2021

Date of Test

Nov. 24~Dec. 03, 2021

Prepared by



(Ella Liang)

Approved & Authorized Signer



(Kingkong Jin)

1. General Information

1.1. Client Information

Applicant	:	Seeed Technology Co., Ltd.
Address	:	9F, G3 Building, TCL International E City, Zhongshanyuan Road, Nanshan District, Shenzhen, China 518055
Manufacturer	:	Seeed Technology Co., Ltd.
Address	:	9F, G3 Building, TCL International E City, Zhongshanyuan Road, Nanshan District, Shenzhen, China 518055
Factory	:	Shenzhen Xinxian Technology Co; Limited
Address	:	F5, Building B17, Hengfeng Industrial City, No. 739 Zhoushi Rd, Baoan District, Shenzhen, Guangdong, P.R.C.

1.2. Description of Device (EUT)

Product Name	:	WM1302 LoRaWAN Gateway Module(SPI) - US915	
Model No.	:	WM1302-SPI-US915	
Trade Mark	:	Seed Studio	
Test Power Supply	:	DC 3.3V by Debug board	
Test Sample No.	:	1-2-1(Normal Sample), 1-2-2(Engineering Sample)	
Product Description	:	Operation Frequency:	902~928MHz
	:	Number of Channel:	DTS: 16 Channels FHSS: 64 Channels
	:	Modulation Type:	LoRa Chirp Spread Spectrum
	:	Antenna Type:	Cylindrical antenna
	:	Antenna Gain(Peak):	3 dBi
Remark: 1) For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual. 2) This report for FHSS only.			

1.3. Auxiliary Equipment Used During Test

Adapter	:	M/N: SAW12-050-2100UB Input: 100-240V~ 50/60Hz, 0.3A Output: DC 5V, 2100mA
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1.4. Description of Test Modes

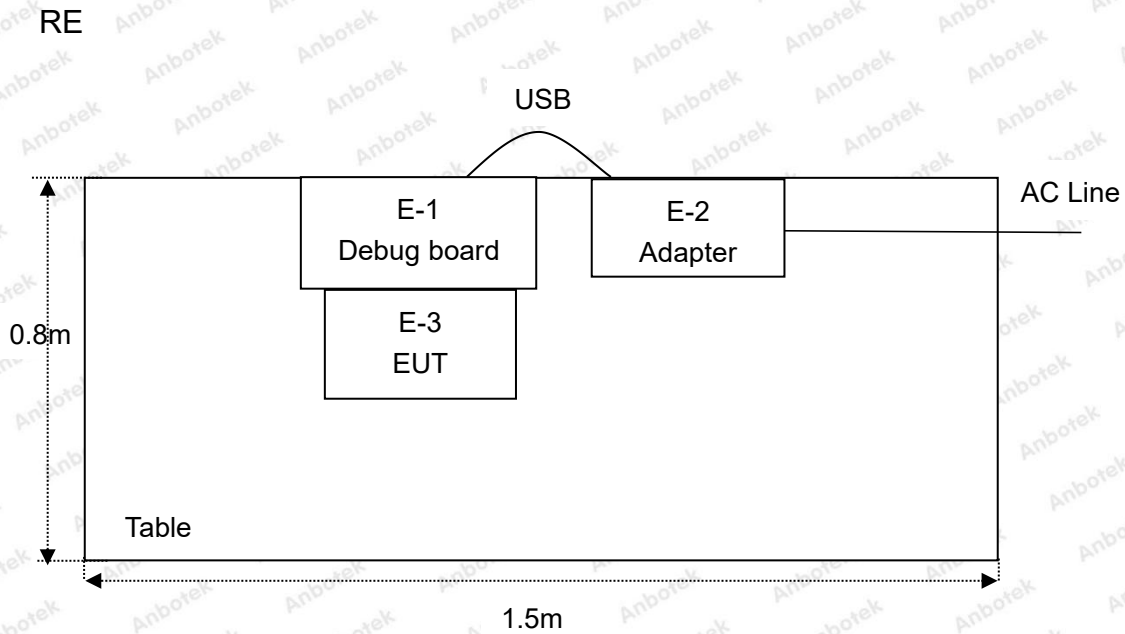
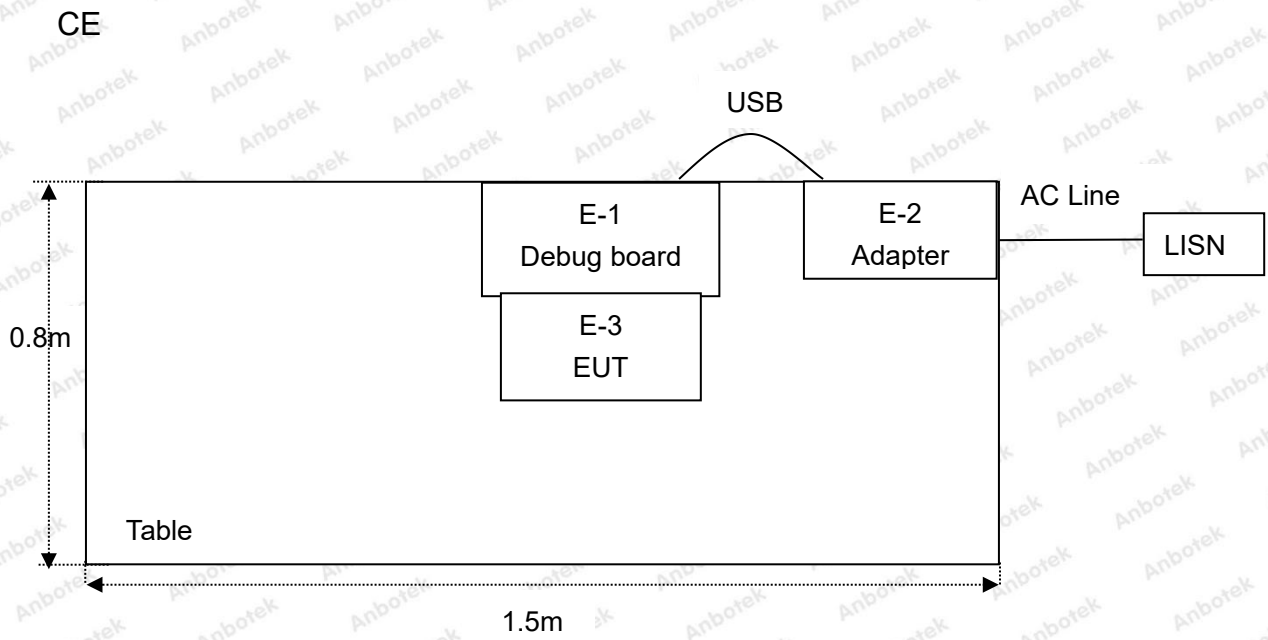
The system was configured for testing in testing mode, which was provided by manufacturer.

For LoRa mode, Detailed Frequency as below:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.3	23	906.7	45	911.1
2	902.5	24	906.9	46	911.3
3	902.7	25	907.1	47	911.5
4	902.9	26	907.3	48	911.7
5	903.1	27	907.5	49	911.9
6	903.3	28	907.7	50	912.1
7	903.5	29	907.9	51	912.3
8	903.7	30	908.1	52	912.5
9	903.9	31	908.3	53	912.7
10	904.1	32	908.5	54	912.9
11	904.3	33	908.7	55	913.1
12	904.5	34	908.9	56	913.3
13	904.7	35	909.1	57	913.5
14	904.9	36	909.3	58	913.7
15	905.1	37	909.5	59	913.9
16	905.3	38	909.7	60	914.1
17	905.5	39	909.9	61	914.3
18	905.7	40	910.1	62	914.5
19	905.9	41	910.3	63	914.7
20	906.1	42	910.5	64	914.9
21	906.3	43	910.7	-	-
22	906.5	44	910.9	-	-

Note: 1. Note: EUT was tested with Channel 1, 32 and 64.

1.6. Description Of Test Setup



1.7. Test Equipment List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Three Phase V-type Artificial Power Network	CYBERTEK	EM5040DT	E215040DT001	Jul 05, 2021	1 Year
2.	EMI Test Receiver	Rohde & Schwarz	ESCI	100627	Oct. 22, 2021	1 Year
3.	EMI Test Receiver	Rohde & Schwarz	ESR26	101481	Oct. 22, 2021	1 Year
4.	RF Switching Unit	Compliance Direction	RSU-M2	38303	Oct. 22, 2021	1 Year
5.	MAX Spectrum Analysis	Agilent	N9020A	MY51170037	Oct. 22, 2021	1 Year
6.	Preamplifier	SKET Electronic	BK1G18G30 D	KD17503	Oct. 22, 2021	1 Year
7.	Double Ridged Horn Antenna	Instruments corporation	GTH-0118	351600	Oct. 22, 2021	2 Year
8.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	VULB 9163-289	Oct. 22, 2021	2 Year
9.	Loop Antenna	Schwarzbeck	FMZB1519B	00053	Oct. 22, 2021	2 Year
10.	Horn Antenna	A-INFO	LB-180400-K F	J211060628	Oct. 22, 2021	2 Year
11.	Pre-amplifier	SONOMA	310N	186860	Oct. 22, 2021	1 Year
12.	EMI Test Software EZ-EMC	SHURPLE	N/A	N/A	N/A	N/A
13.	RF Test Control System	YIHENG	YH3000	2017430	Oct. 22, 2021	1 Year
14.	Power Sensor	DAER	RPR3006W	15I00041SN045	Oct. 22, 2021	1 Year
15.	Power Sensor	DAER	RPR3006W	15I00041SN046	Oct. 22, 2021	1 Year
16.	MXA Spectrum Analysis	KEYSIGHT	N9020A	MY53280032	Oct. 22, 2021	1 Year
17.	MXG RF Vector Signal Generator	Agilent	N5182A	MY48180656	Oct. 22, 2021	1 Year
18.	Signal Generator	Agilent	E4421B	MY41000743	Oct. 22, 2021	1 Year
19.	DC Power Supply	IVYTECH	IV3605	1804D360510	Oct. 22, 2021	1 Year
20.	Constant Temperature Humidity Chamber	ZHONGJIAN	ZJ-KHWS80 B	N/A	Oct. 22, 2021	1 Year

1.8. Measurement Uncertainty

Radiation Uncertainty	:	Ur = 3.9 dB (Horizontal)
		Ur = 3.8 dB (Vertical)
Conduction Uncertainty	:	Uc = 3.4 dB

1.9. Description of Test Facility

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

FCC-Registration No.: 184111

Shenzhen Anbotech 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 Anbotech 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 Anbotech Compliance Laboratory Limited.

1/F, Building D, Sogood Science and Technology Park, Sanwei community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.518102

2. Summary of Test Results

Standard Section	Test Item	Result
15.203/15.247(c)	Antenna Requirement	PASS
15.207	Conducted Emission	PASS
15.205/15.209	Spurious Emission	PASS
Remark: "N/A" is an abbreviation for Not Applicable.		

Remark: This is a Class II application of the device, the difference between the original device and current one described as following:

(1) Change the Antenna of the product.

(2) Change the antenna gain to 3dBi.

Based on the change made to the device, the spurious emission test items were performed.

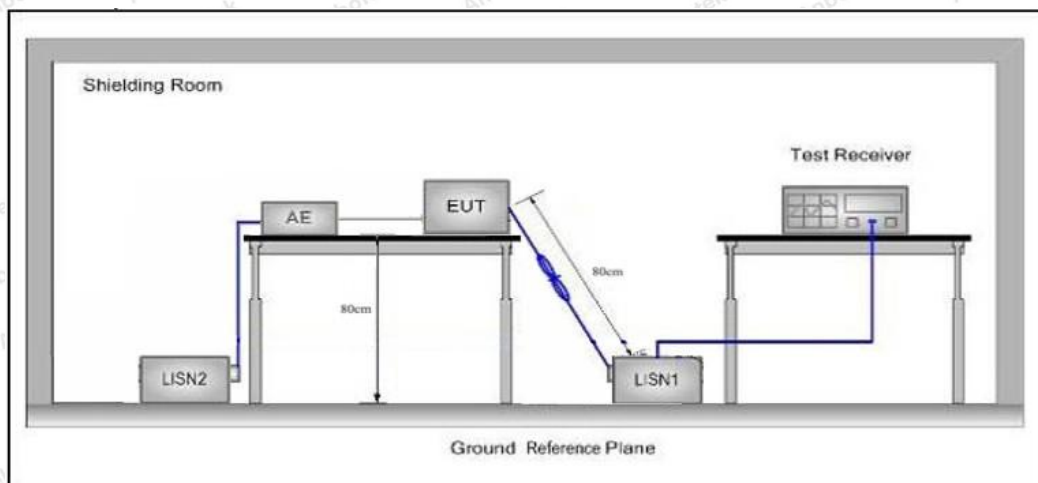


3. Conducted Emission Test

3.1. Test Standard and Limit

Test Standard	FCC Part15 Section 15.207		
Test Limit	Frequency	Maximum RF Line Voltage (dBuV)	
		Quasi-peak Level	Average Level
	150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
	500kHz~5MHz	56	46
	5MHz~30MHz	60	50
Remark: (1) *Decreasing linearly with logarithm of the frequency. (2) The lower limit shall apply at the transition frequency.			

3.2. Test Setup



3.3. Test Procedure

The EUT system is connected to the power mains through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm coupling impedance for the EUT system. Please refer the block diagram of the test setup and photographs. Both sides of AC line are checked to find out the maximum conducted emission. In order to find the maximum emission levels, the relative positions of equipment and all of the interface cables shall be changed according to FCC ANSI C63.10: 2020 on Conducted Emission Measurement.

The bandwidth of test receiver (ESCI) set at 9kHz.

The frequency range from 150kHz to 30MHz is checked.

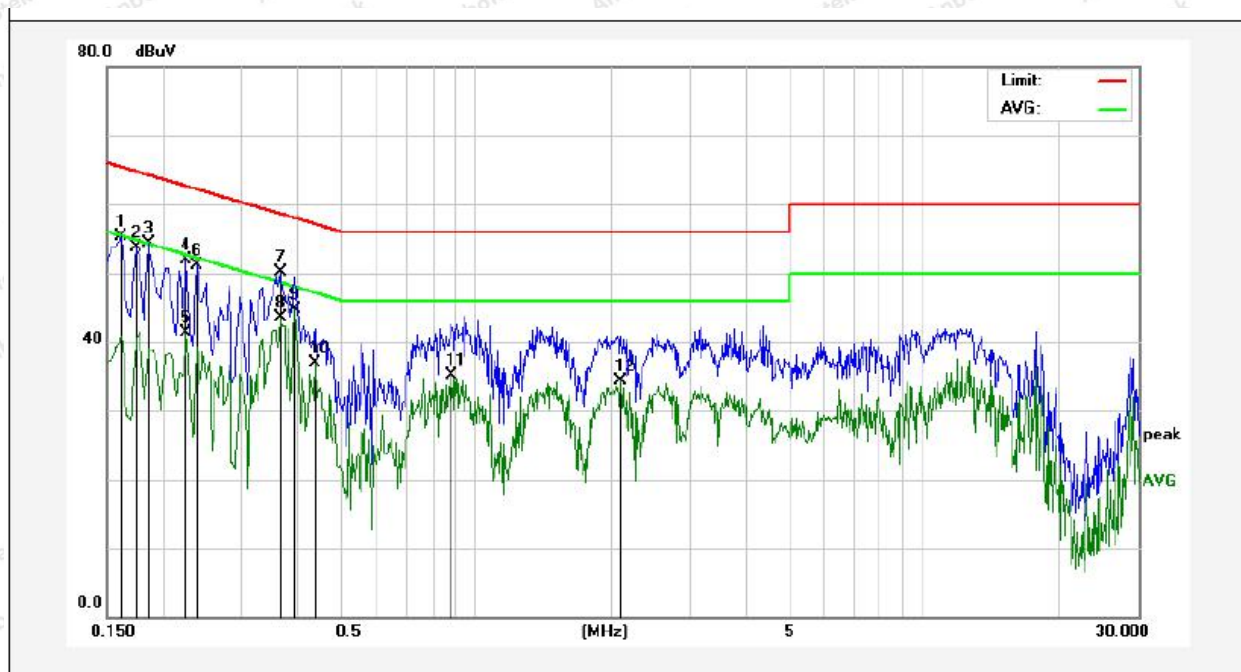
3.4. Test Data

During the test, pre-scan all the modes, and found CH01 (TX) which is the worst case, only the worst case is recorded in the report.

Please to see the following pages.

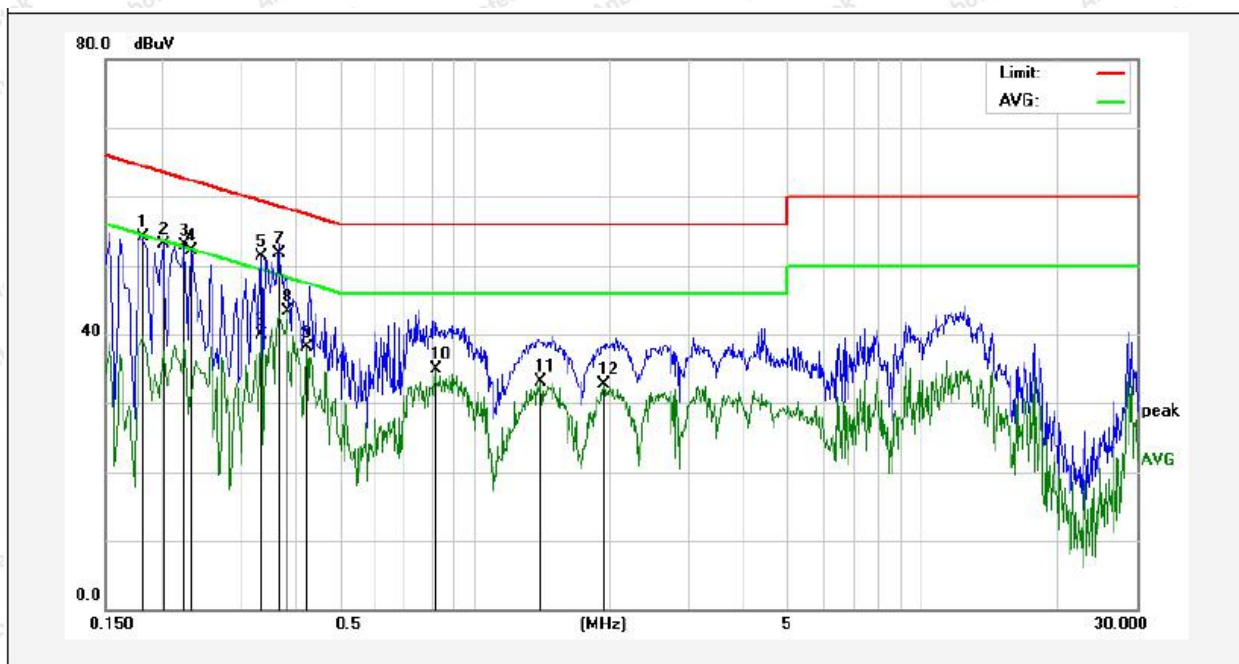
Conducted Emission Test Data

Test Site: 1# Shielded Room
 Operating Condition: CH01
 Test Specification: AC 120V, 60Hz
 Comment: Live Line
 Tem.: 22.4°C Hum.: 53%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.1620	55.14	0.12	55.26	65.36	-10.10	QP	
2	0.1740	53.66	0.12	53.78	64.76	-10.98	QP	
3	0.1860	54.11	0.12	54.23	64.21	-9.98	QP	
4	0.2260	51.81	0.12	51.93	62.59	-10.66	QP	
5	0.2260	41.25	0.12	41.37	52.59	-11.22	AVG	
6	0.2380	51.08	0.12	51.20	62.16	-10.96	QP	
7	0.3660	50.01	0.12	50.13	58.59	-8.46	QP	
8	0.3660	43.32	0.12	43.44	48.59	-5.15	AVG	
9	0.3940	44.50	0.11	44.61	47.98	-3.37	AVG	
10	0.4380	36.68	0.13	36.81	47.10	-10.29	AVG	
11	0.8820	34.87	0.15	35.02	46.00	-10.98	AVG	
12	2.1020	34.17	0.12	34.29	46.00	-11.71	AVG	

Test Site: 1# Shielded Room
Operating Condition: CH01
Test Specification: AC 120V, 60Hz
Comment: Neutral Line
Tem.: 22.4℃ Hum.: 53%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.1819	53.93	0.12	54.05	64.39	-10.34	QP	
2	0.2020	53.08	0.12	53.20	63.52	-10.32	QP	
3	0.2260	52.75	0.12	52.87	62.59	-9.72	QP	
4	0.2340	52.08	0.12	52.20	62.30	-10.10	QP	
5	0.3339	51.26	0.12	51.38	59.35	-7.97	QP	
6	0.3339	39.80	0.12	39.92	49.35	-9.43	AVG	
7	0.3660	51.57	0.12	51.69	58.59	-6.90	QP	
8	0.3820	43.13	0.11	43.24	48.23	-4.99	AVG	
9	0.4220	38.06	0.12	38.18	47.41	-9.23	AVG	
10	0.8180	34.79	0.15	34.94	46.00	-11.06	AVG	
11	1.4060	32.96	0.14	33.10	46.00	-12.90	AVG	
12	1.9460	32.50	0.12	32.62	46.00	-13.38	AVG	

Note: The EUT received input Voltage DC 3.3V from Debug board, and the Debug board received AC 120V/60Hz from Adapter.

4. Radiation Spurious Emission and Band Edge

4.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.209 and 15.205				
Test Limit	Frequency (MHz)	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz~0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz~88MHz	100	40.0	Quasi-peak	3
	88MHz~216MHz	150	43.5	Quasi-peak	3
	216MHz~960MHz	200	46.0	Quasi-peak	3
	960MHz~1000MHz	500	54.0	Quasi-peak	3
	Above 1000MHz	500	54.0	Average	3
		-	74.0	Peak	3

Remark:

(1)The lower limit shall apply at the transition frequency.

(2) 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

4.2. Test Setup

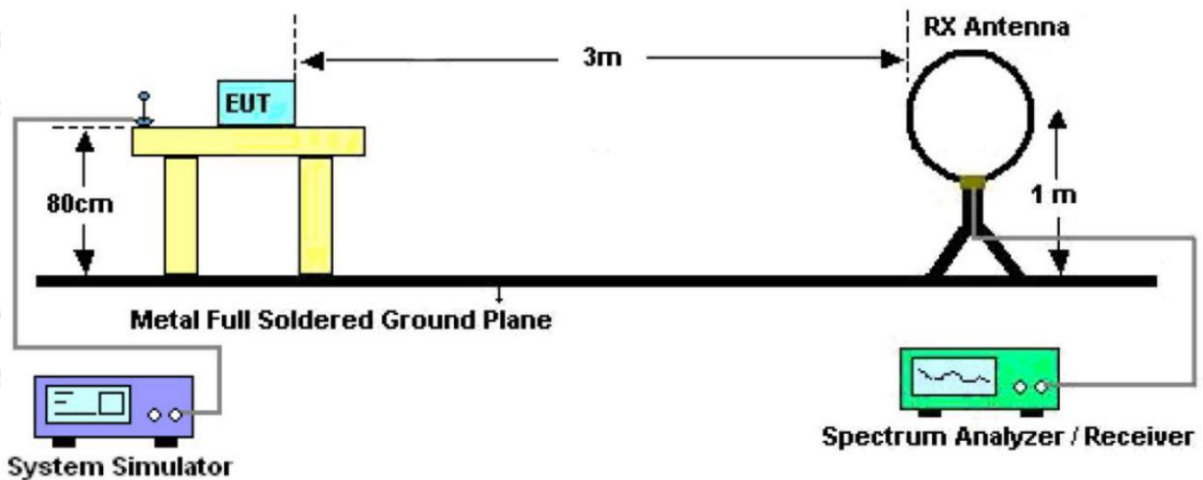


Figure 1. Below 30MHz

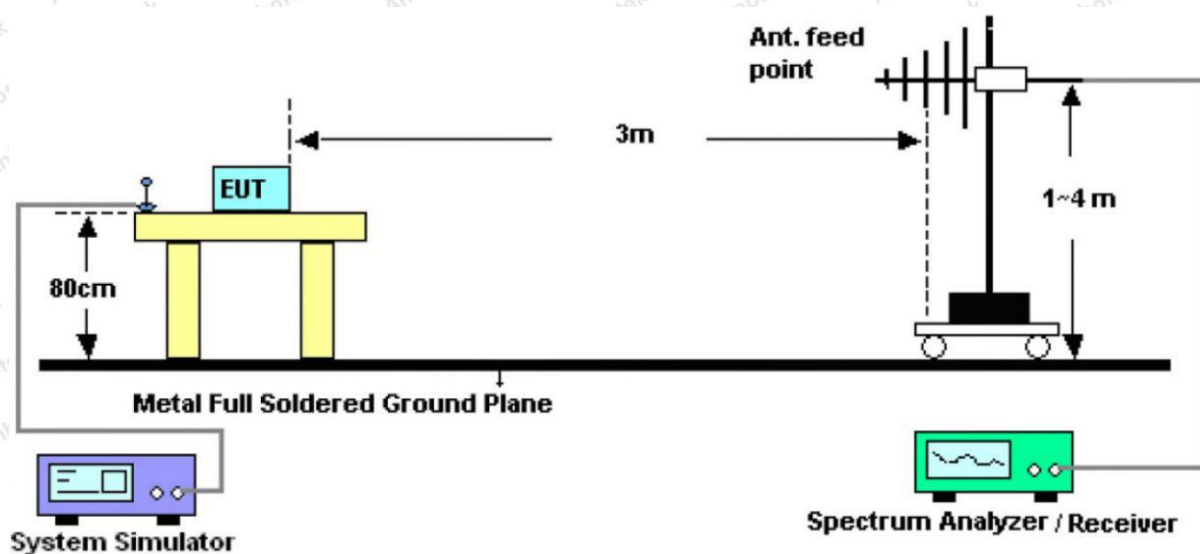


Figure 2. 30MHz to 1GHz

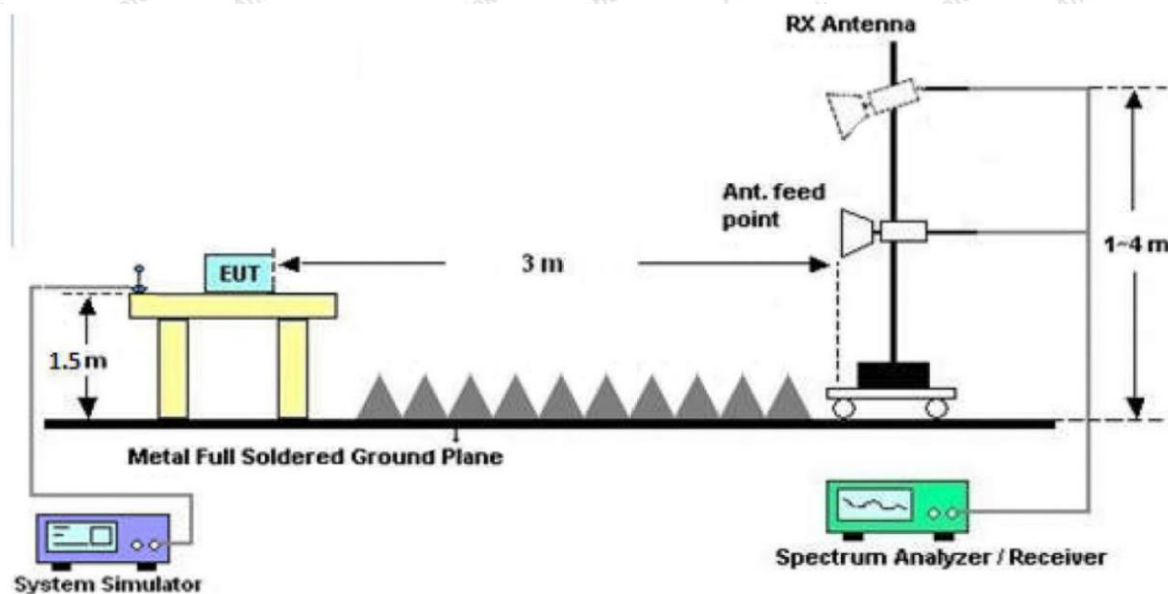


Figure 3. Above 1 GHz

4.3. Test Procedure

For below 1GHz: The EUT is placed on a turntable, which is 0.8m above the ground plane.

For above 1GHz: The EUT is placed on a turntable, which is 1.5m above the ground plane.

The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT is set 3 meters away from the receiving antenna which is mounted on a antenna tower. The antenna can be moved up and down from 1 to 4 meters to find out the maximum emission level. Rotated the EUT through three orthogonal axes to determine the maximum emissions, both horizontal and vertical polarization of the antenna are set on test. The EUT is tested in 9*6*6 Chamber. The device is evaluated in xyz orientation.

For the radiated emission test above 1GHz:

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

For 9kHz to 150kHz, Set the spectrum analyzer as:

RBW = 200Hz, VBW = 1kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 150kHz to 30MHz, Set the spectrum analyzer as:

RBW = 9KHz, VBW = 30kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For 30MHz to 1000MHz, Set the spectrum analyzer as:

RBW = 100kHz, VBW = 300kHz, Detector= Quasi-Peak, Trace mode= Max hold, Sweep- auto couple.

For above 1GHz, Set the spectrum analyzer as:

RBW = 1MHz, VBW = 1MHz, Detector= Peak, Trace mode= Max hold, Sweep- auto couple.

RBW = 1MHz, VBW = 10Hz, Detector= Average, Trace mode= Max hold, Sweep- auto couple.

4.4. Test Data

PASS

During the test, Pre-scan all kind of the place mode (X-axis, Y-axis, Z-axis), and found the X-axis is the worst case.

During the test, pre-scan all the modes, and found the CH01 (TX) which is the worst case, only the worst case is recorded in the report.

The test results of 9kHz-30MHz was attenuated more than 20dB below the permissible limits, so the results don't record in the report.



Test Results (30~1000MHz)

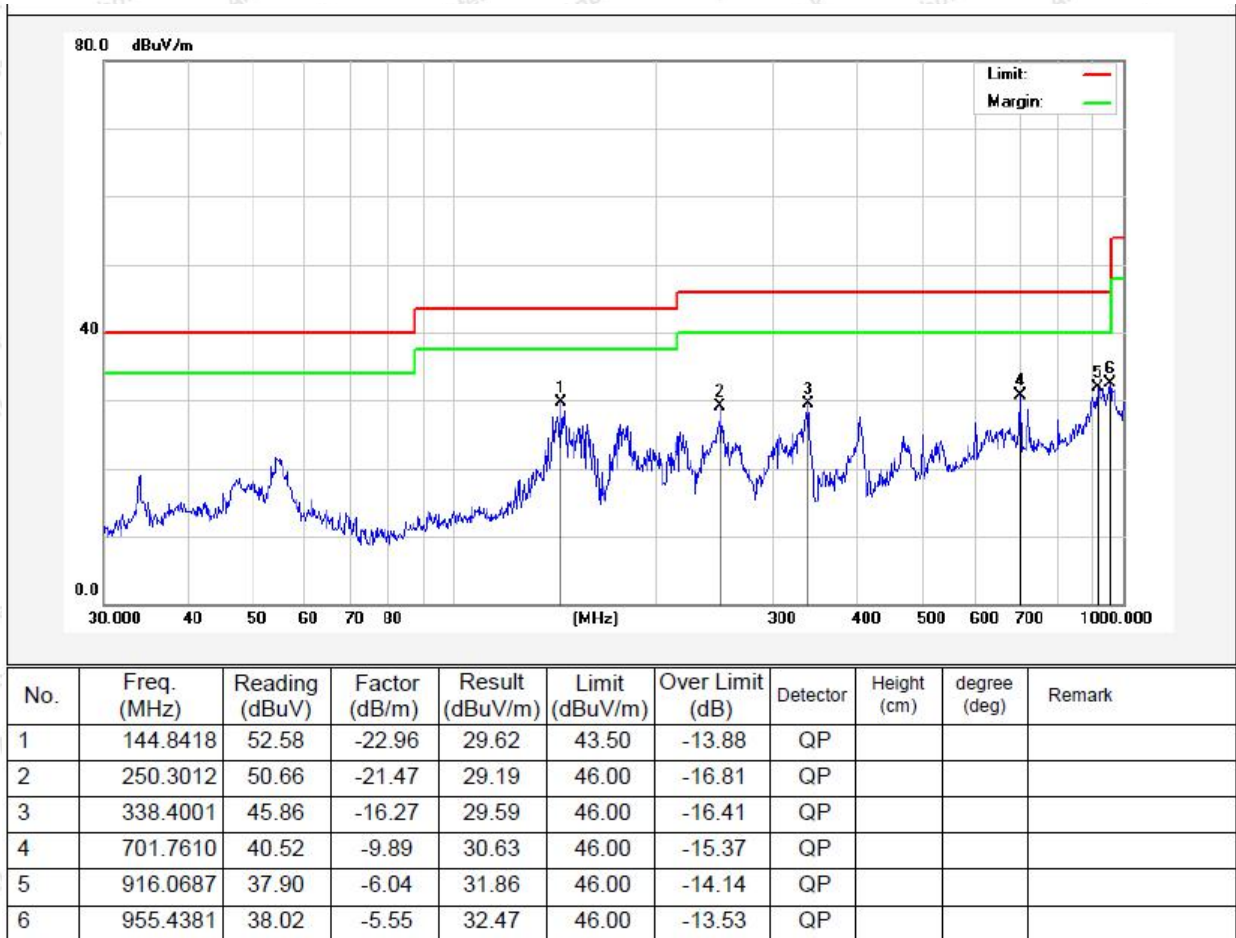
Test Mode: CH01
Power Source: AC 120V, 60Hz
Polarization: Vertical
Temp.(°C)/Hum.(%RH): 22°C/52%RH



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Height (cm)	degree (deg)	Remark
1	50.2324	45.13	-15.86	29.27	40.00	-10.73	QP			
2	144.8418	52.93	-22.14	30.79	43.50	-12.71	QP			
3	155.9101	47.63	-21.83	25.80	43.50	-17.70	QP			
4	601.4265	40.16	-10.53	29.63	46.00	-16.37	QP			
5	929.0082	35.28	-5.88	29.40	46.00	-16.60	QP			
6	952.0937	36.27	-5.61	30.66	46.00	-15.34	QP			



Test Mode: CH01
Power Source: AC 120V, 60Hz
Polarization: Horizontal
Temp.(°C)/Hum.(%RH): 22°C/52%RH



Note: The EUT received input Voltage DC 3.3V from Debug board, and the Debug board received AC 120V/60Hz from Adapter.

Test Results (1GHz-25GHz)

Test Mode: CH01					Test channel: Lowest				
Frequency (MHz)	Antenna Pol.	Reading (dBuV/m)	Cable Loss (dB)	Ant Factor (dB)	Amplifier (dB)	Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Det. Mode
1804.6000	H	43.76	7.39	28.73	26.31	53.57	74	-20.43	PK
1804.6000	H	34.65	7.39	28.73	26.31	44.46	54	-9.54	AV
2706.9000	H	41.83	8.10	29.71	27.01	52.63	74	-21.37	PK
2706.9000	H	33.92	8.10	29.71	27.01	44.72	54	-9.28	AV
3609.2000	H	--	--	--	--	--	--	--	PK
3609.2000	H	--	--	--	--	--	--	--	AV
1804.6000	V	43.01	7.39	28.73	26.31	52.82	74	-21.18	PK
1804.6000	V	34.82	7.39	28.73	26.31	44.63	54	-9.37	AV
2706.9000	V	41.87	8.10	29.71	27.01	52.67	74	-21.33	PK
2706.9000	V	34.34	8.10	29.71	27.01	45.14	54	-8.86	AV
3609.2000	V	--	--	--	--	--	--	--	PK
3609.2000	V	--	--	--	--	--	--	--	AV



Test Mode: CH32					Test channel: Middle				
Frequency (MHz)	Antenna Pol.	Reading (dBuV/m)	Cable Loss (dB)	Ant Factor (dB)	Amplifier (dB)	Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Det. Mode
1817.0000	H	46.88	7.41	28.72	26.31	56.70	74	-17.30	PK
1817.0000	H	37.14	7.41	28.72	26.31	46.96	54	-7.04	AV
2725.5000	H	46.22	8.11	29.71	27.01	57.03	74	-16.97	PK
2725.5000	H	34.83	8.11	29.71	27.01	45.64	54	-8.36	AV
3634.0000	H	--	--	--	--	--	--	--	PK
3634.0000	H	--	--	--	--	--	--	--	AV
1817.0000	V	47.68	7.41	28.72	26.31	57.50	74	-16.50	PK
1817.0000	V	35.91	7.41	28.72	26.31	45.73	54	-8.27	AV
2725.5000	V	47.08	8.11	29.71	27.01	57.89	74	-16.11	PK
2725.5000	V	34.77	8.11	29.71	27.01	45.58	54	-8.42	AV
3634.0000	V	--	--	--	--	--	--	--	PK
3634.0000	V	--	--	--	--	--	--	--	AV



Test Mode: CH64					Test channel: High				
Frequency (MHz)	Antenna Pol.	Reading (dBuV/m)	Cable Loss (dB)	Ant Factor (dB)	Amplifier (dB)	Level (dBuV/m)	Limits (dBuV/m)	Margin (dB)	Det. Mode
1829.8000	H	46.20	7.43	28.69	26.31	56.01	74	-17.99	PK
1829.8000	H	36.79	7.43	28.69	26.31	46.60	54	-7.40	AV
2744.7000	H	46.13	8.15	29.84	27.01	57.11	74	-16.89	PK
2744.7000	H	34.39	8.15	29.84	27.01	45.37	54	-8.63	AV
3659.6000	H	--	--	--	--	--	--	--	PK
3659.6000	H	--	--	--	--	--	--	--	AV
1829.8000	V	47.65	7.43	28.69	26.31	57.46	74	-16.54	PK
1829.8000	V	36.16	7.43	28.69	26.31	45.97	54	-8.03	AV
2744.7000	V	46.84	8.15	29.84	27.01	57.82	74	-16.18	PK
2744.7000	V	34.39	8.15	29.84	27.01	45.37	54	-8.63	AV
3659.6000	V	--	--	--	--	--	--	--	PK
3659.6000	V	--	--	--	--	--	--	--	AV

Remark:

1. Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor
2. “--” means the test results were attenuated more than 20dB below the permissible limits, so the results don't record in the report.

Radiated Band Edge:

Frequency (MHz)	Read Level (dBuV/m)	Antenna Factor (dB)	Cable Loss (dB)	Preamp Factor (dB)	Level (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Pol.	Det.
902.0000	43.55	22.45	4.48	31.33	39.15	46.00	-6.85	H	QP
928.0000	40.77	22.59	4.54	31.35	36.55	46.00	-9.45	H	QP
902.0000	44.29	22.45	4.48	31.33	39.89	46.00	-6.11	V	QP
928.0000	40.09	22.59	4.54	31.35	35.87	46.00	-10.13	V	QP

Remark:

1. Level = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor

5. Antenna Requirement

5.1. Test Standard and Requirement

Test Standard	FCC Part15 Section 15.203 /247(c)
Requirement	1) 15.203 requirement: 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, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 2) 15.247(c) (1)(i) requirement: Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

5.2. Antenna Connected Construction

The antenna is Cylindrical antenna which permanently attached, and the best case gain of the antenna is 3dBi. It complies with the standard requirement.

APPENDIX I -- TEST SETUP PHOTOGRAPH

Photo of Conducted Emission Measurement

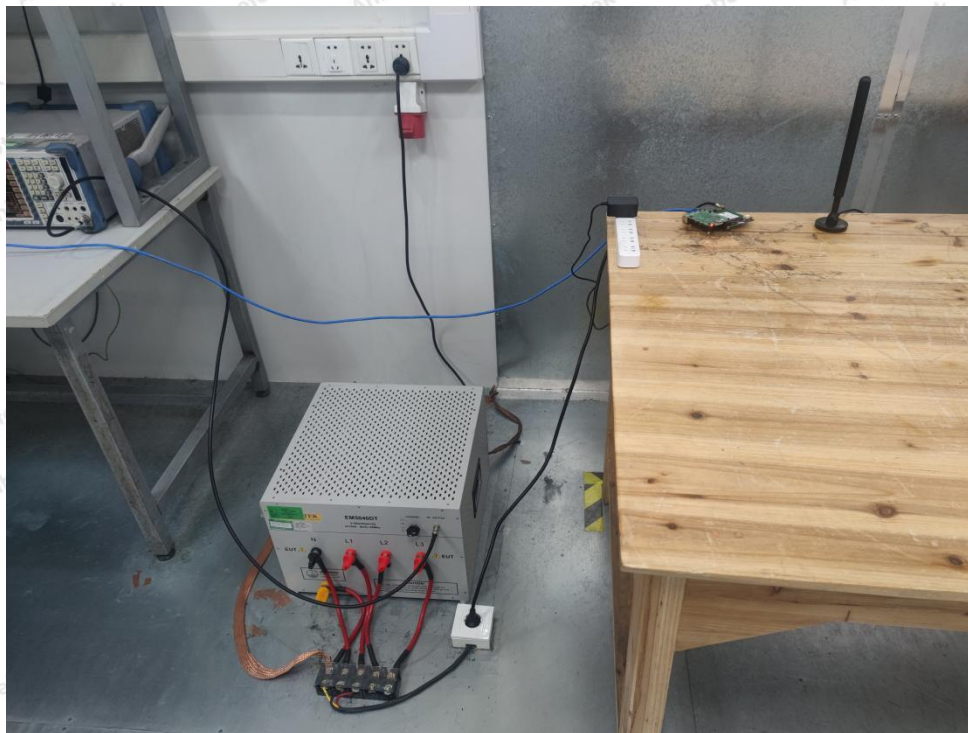


Photo of Radiation Emission Test





APPENDIX II -- EXTERNAL PHOTOGRAPH

Reference to the test report 18220WC10257601.

APPENDIX III -- INTERNAL PHOTOGRAPH

Reference to the test report 18220WC10257601

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

