FCC EMC Test Report

Subject to

Supplier's Declaration of Conformity

Procedure

Product :	Wi-Fi & BT Module
Trade Mark :	B&T, Ai-Thinker
Model Number :	ESP-C3-12F, ESP-C3-32S, ESP-C3-13, ESP-C3-01M, ESP-C3-13U, ESP-C3-M1, ESP-C3-M1-I

Prepared for

Shenzhen Ai-Thinker Technology Co., Ltd.

410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China

Prepared by

Shenzhen NTEK Testing Technology Co., Ltd.

1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street, Bao'an District, Shenzhen 518126 P.R.China.

Tel.: 400-800-6106, 0755-2320 0050 / 2320 0090 Website: http://www.ntek.org.cn

TEST RESULT CERTIFICATION

Applicant's Name	Shenzhen Ai-Thinker Technology Co., Ltd.
Address	410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China
Manufacturer's Name	Shenzhen Ai-Thinker Technology Co., Ltd.
Address	410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China

Product description

Product name	Wi-Fi & BT Module
Model and/or type reference	ESP-C3-12F, ESP-C3-32S, ESP-C3-13, ESP-C3-01M, ESP-C3-13U, ESP-C3-M1, ESP-C3-M1-I
Standards	47 CFR FCC part 15 subpart B, 10-1-2021 ANSI C63.4:2014

This device described above has been tested by NTEK, and the test results show that the equipment under test (EUT) is in compliance with Part 15 of FCC Rules. And it is applicable only to the tested sample identified in the report.

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Date of Test	
Date (s) of performance of tests	20 May 2021 ~ 28 May 2021
Date of Issue	04 Nov. 2021
Test Result	**Pass**

Note: All test data of this report are based on the original report test data S21051101102001, dated by 2021-05-28.

Testing Engineer : Korka Lin
(Korka Lin)

Technical Manager : Sky Zhang
(Sky Zhang)

Authorized Signatory : Alex
(Alex)

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1. TEST SUMMARY

Test procedures according to the technical standards:

EMC Emission				
Standard	Test Item	Limit	Judgment	Remark
47 CFR FCC part 15 subpart B, 10-1-2021 ANSI C63.4:2014	Conducted Emission	Class B	PASS	
	Radiated Emission	Class B	PASS	

NOTE:

(1) 'N/A' denotes test is not applicable in this Test Report

(2) For client's request and manual description, the test will not be executed.

1.1 TEST FACILITY

Shenzhen NTEK Testing Technology Co., Ltd.

Add. : 1/F, Building E, Fenda Science Park, Sanwei Community, Xixiang Street Bao'an District, Shenzhen 518126 P.R. China

CNAS-Lab. : The Laboratory has been assessed and proved to be in compliance with CNAS-CL01:2018 (identical to ISO/IEC 17025:2017)
The Certificate Registration Number is L5516

IC-Registration : The Certificate Registration Number is CN0074

FCC- Accredited : Test Firm Registration Number: 463705
Designation Number: CN1184

A2LA-Lab. : The Certificate Registration Number is 4298.01
This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y** ± **U**, where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**, providing a level of confidence of approximately **95** %.

Test Item	Measurement Frequency Range	K	U(dB)
AC Mains Conducted Emission	0.009kHz ~ 0.15MHz	2	2.66
AC Mains Conducted Emission	0.15MHz ~ 30MHz	2	2.80
Telecom Conducted Emission (Cat 3)	0.15MHz ~ 30MHz	2	2.40
Telecom Conducted Emission (Cat 5)	0.15MHz ~ 30MHz	2	2.58
Radiated Emission	30MHz ~ 1000MHz	2	2.64
Radiated Emission	1000MHz ~ 6000MHz	2	5.10
Radiated Emission	6000MHz ~ 18000MHz	2	2.52
Power Clamp	30MHz ~ 300MHz	2	2.20

Revision History

Report No.	Version	Description	Issued Date
S21051101102001	Rev.01	Initial issue of report	May 28, 2021
S21102201102001	Rev.02	Added the additional model and photo.	Nov. 04, 2021

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	Wi-Fi & BT Module
Model Name	ESP-C3-12F
Additional Model Number(s)	ESP-C3-32S, ESP-C3-13, ESP-C3-01M, ESP-C3-13U, ESP-C3-M1, ESP-C3-M1-I
Model Difference	All models are identical except model's name.
Product Description	The EUT is a Wi-Fi & BT Module. Operating frequency: 2483.5 MHz(Declaration by factory) Connecting I/O port: N/A Based on the application, features, or specification exhibited in User's Manual. More details of EUT technical specification, please refer to the User's Manual.
Power Source	DC Voltage
Power Rating	DC 3.3V

2.2 DESCRIPTION OF TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

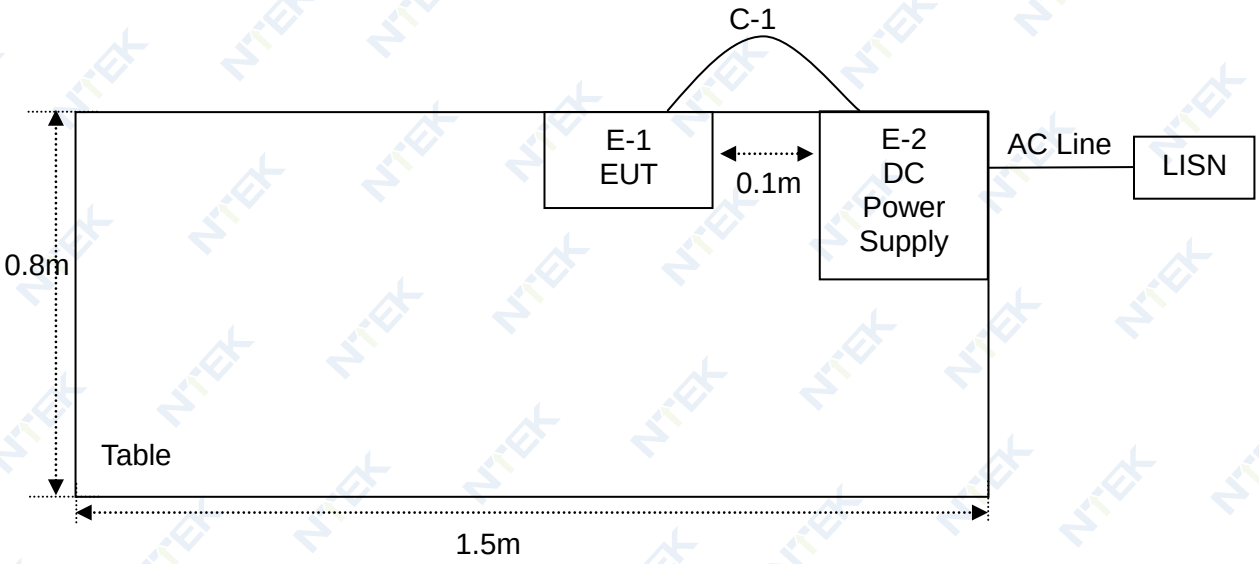
Pretest Mode	Description
Mode 1	On

For Conducted Test	
Final Test Mode	Description
Mode 1	On

For Radiated Test	
Final Test Mode	Description
Mode 1	On

2.3 DESCRIPTION OF TEST SETUP

Mode CE: On



2.4 DESCRIPTION TEST PERIPHERAL AND EUT PERIPHERAL

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	Brand	Model/Type No.	Series No.	Note
E-1	Wi-Fi & BT Module	B&T, Ai-Thinker	ESP-C3-12F	N/A	EUT
E-2	DC Power Supply	Zhaoxin	PS-6005D	20170400781	

Item	Shielded Type	Ferrite Core	Length	Note
C-1	NO	NO	80cm	

Note:

(1) The support equipment was authorized by Declaration of Confirmation.

(2) For detachable type I/O cable should be specified the length in cm in 『Length』 column.

(3) "YES" means "shielded" "with core"; "NO" means "unshielded" "without core".

2.5 MEASUREMENT INSTRUMENTS LIST

2.5.1 CONDUCTED TEST

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	Single Phase LISN	R&S	ENV216	101490	Jul. 13, 2020	Jul. 12, 2021	1 year
2	Single Phase LISN	R&S	ENV216	101313	Apr. 27, 2021	Apr. 26, 2022	1 year
3	Three-Phase LISN	SCHWARZBECK	NNLK 8129	8129245	Apr. 27, 2021	Apr. 26, 2022	1 year
4	Low frequency cable	N/A	C-01	N/A	May 11, 2020	May 10, 2023	3 years
5	50Ω Coaxial Switch	Anritsu	MP59B	6200983704	May 11, 2020	May 10, 2023	3 years
6	EMI Test Receiver	R&S	ESCI	101160	Apr. 27, 2021	Apr. 26, 2022	1 year

2.5.2 RADIATED TEST

Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until	Calibration period
1	EMI Test Receiver	R&S	ESPI7	101318	Apr. 27, 2021	Apr. 26, 2022	1 year
2	Bilog Antenna	TESEQ	CBL6111D	31216	Mar. 29, 2021	Mar. 28, 2022	1 year
3	System Controller	SKET	N/A	N/A	N/A	N/A	N/A
4	Antenna Mast	SKET	N/A	N/A	N/A	N/A	N/A
5	System Controller	ADT	SC100	N/A	N/A	N/A	N/A
6	Antnna Mast	ADT	N/A	N/A	N/A	N/A	N/A
7	50Ω Coaxial Switch	Anritsu	MP59B	6200983705	May 11, 2020	May 10, 2023	3 years
8	Low Frequency Cable	N/A	R-03	N/A	Jun. 28, 2019	Jun. 27, 2022	3 years
9	RF Cable	Pasternack	PE332-1000CM	N/A	Nov. 10, 2019	Nov. 09, 2022	3 years
10	Broadband Horn Antenna	EM	EM-AH-10180	2011071402	Mar. 29, 2021	Mar. 28, 2022	1 year
11	Spectrum Analyzer	Agilent	E4407B	MY45108040	Apr. 27, 2021	Apr. 26, 2022	1 year
12	Low Noise Amplifier	B&Z	BZ-P540-550850-452727	16476-11729	Apr. 01, 2021	Mar. 31, 2022	1 year
13	Cable	Keysight	A40-2.92M2.92M-2M	1808041	Nov. 18, 2019	Nov. 17, 2022	3 years

3. EMC EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 POWER LINE CONDUCTED EMISSION (Frequency Range 150kHz-30MHz)

FREQUENCY (MHz)	☐Class A (dBμV)		☒Class B (dBμV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 - 0.5	79.00	66.00	66 - 56 *	56 - 46 *
0.50 - 5.0	73.00	60.00	56.00	46.00
5.0 - 30.0	73.00	60.00	60.00	50.00

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

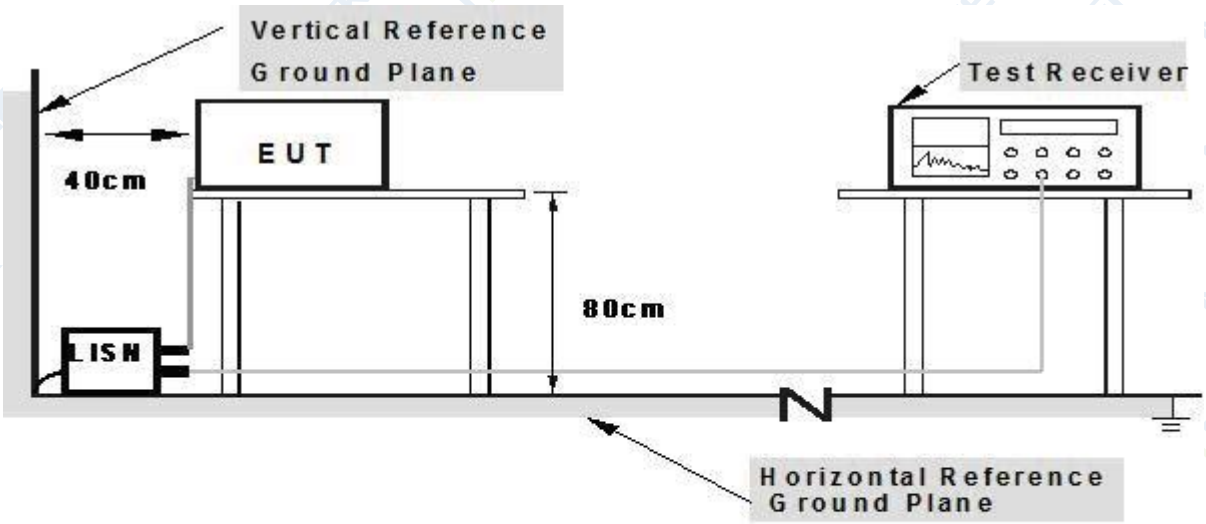
The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

3.1.2 TEST PROCEDURE

a. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of The cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN at least 80 cm from nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.1.3 TEST SETUP



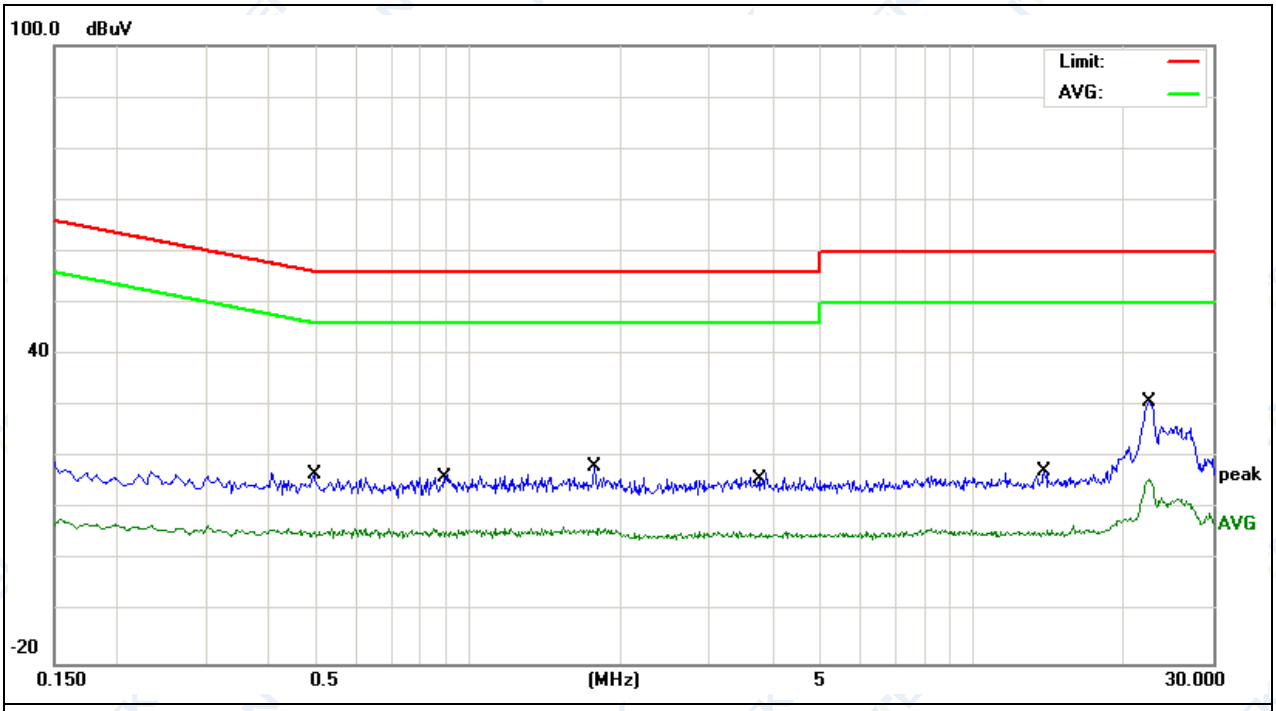
Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

3.1.4 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

3.1.5 TEST RESULTS

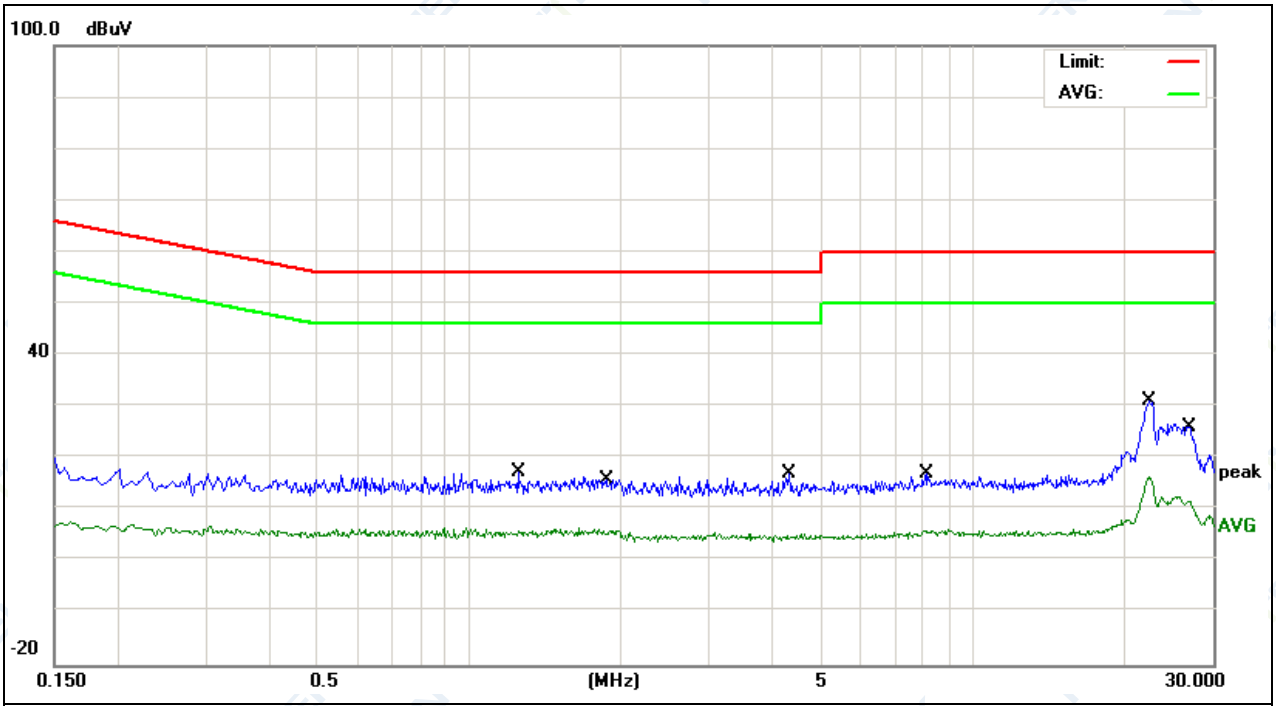
EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	21.3℃	Relative Humidity:	54%
Pressure:	1010hPa	Test Date:	2021-05-24
Test Mode:	On	Phase:	L
Test Voltage:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.4940	7.06	9.55	16.61	56.10	-39.49	QP	
2		0.4940	-3.40	9.55	6.15	46.10	-39.95	AVG	
3		0.8860	7.11	9.55	16.66	56.00	-39.34	QP	
4		0.8860	-3.77	9.55	5.78	46.00	-40.22	AVG	
5		1.7780	8.75	9.58	18.33	56.00	-37.67	QP	
6		1.7780	-3.34	9.58	6.24	46.00	-39.76	AVG	
7		3.8020	7.52	9.60	17.12	56.00	-38.88	QP	
8		3.8020	-4.39	9.60	5.21	46.00	-40.79	AVG	
9		13.8859	7.60	9.76	17.36	60.00	-42.64	QP	
10		13.8859	-3.70	9.76	6.06	50.00	-43.94	AVG	
11	*	22.4580	20.82	9.94	30.76	60.00	-29.24	QP	
12		22.4580	5.94	9.94	15.88	50.00	-34.12	AVG	

Remark:
Correct Factor = Insertion Loss + Cable Loss
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	21.3℃	Relative Humidity:	54%
Pressure:	1010hPa	Test Date:	2021-05-24
Test Mode:	On	Phase:	N
Test Voltage:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		1.2540	7.71	9.55	17.26	56.00	-38.74	QP	
2		1.2540	-3.51	9.55	6.04	46.00	-39.96	AVG	
3		1.8580	6.41	9.57	15.98	56.00	-40.02	QP	
4		1.8580	-3.54	9.57	6.03	46.00	-39.97	AVG	
5		4.3299	7.32	9.61	16.93	56.00	-39.07	QP	
6		4.3299	-4.20	9.61	5.41	46.00	-40.59	AVG	
7		8.0899	7.43	9.66	17.09	60.00	-42.91	QP	
8		8.0899	-3.71	9.66	5.95	50.00	-44.05	AVG	
9	*	22.3500	21.25	9.92	31.17	60.00	-28.83	QP	
10		22.3500	6.38	9.92	16.30	50.00	-33.70	AVG	
11		26.9260	16.22	9.91	26.13	60.00	-33.87	QP	
12		26.9260	1.88	9.91	11.79	50.00	-38.21	AVG	

Remark:
Correct Factor = Insertion Loss + Cable Loss
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

3.2 RADIATED EMISSION MEASUREMENT

3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

FREQUENCY (MHz)	☐Class A (at 3m)	☒Class B (at 3m)
	dBμV/m	dBμV/m
30 ~ 88	49.5	40.0
88 ~ 216	53.9	43.5
216 ~ 960	56.9	46.0
Above 960	60.0	54.0

Notes:

(1) The limit for radiated test was performed according to as following: FCC PART 15B.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBμV/m)=20log Emission level (uV/m).

3.2.2 TEST PROCEDURE

a. The measuring distance of at 3m shall be used for measurements at frequency up to 1GHz. For frequencies above 1GHz, any suitable measuring distance may be used.

b. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The height of the equipment or of the substitution antenna shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

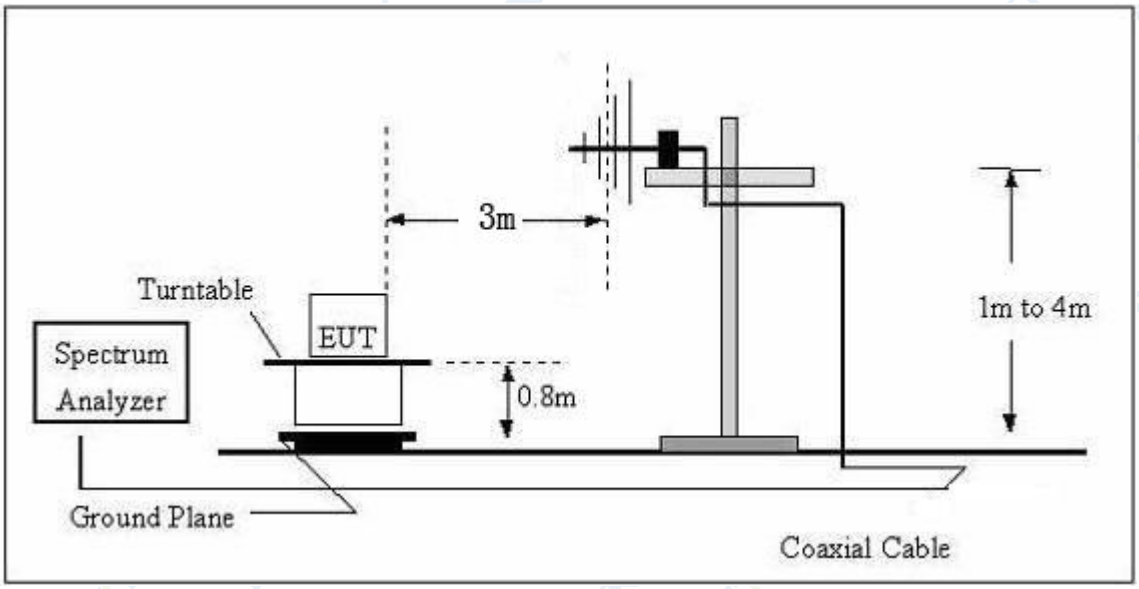
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked And then Quasi Peak detector mode re-measured, above 1G Average detector mode will be instead.

e. If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP(AV) Limits and then no additional QP Mode measurement performed.

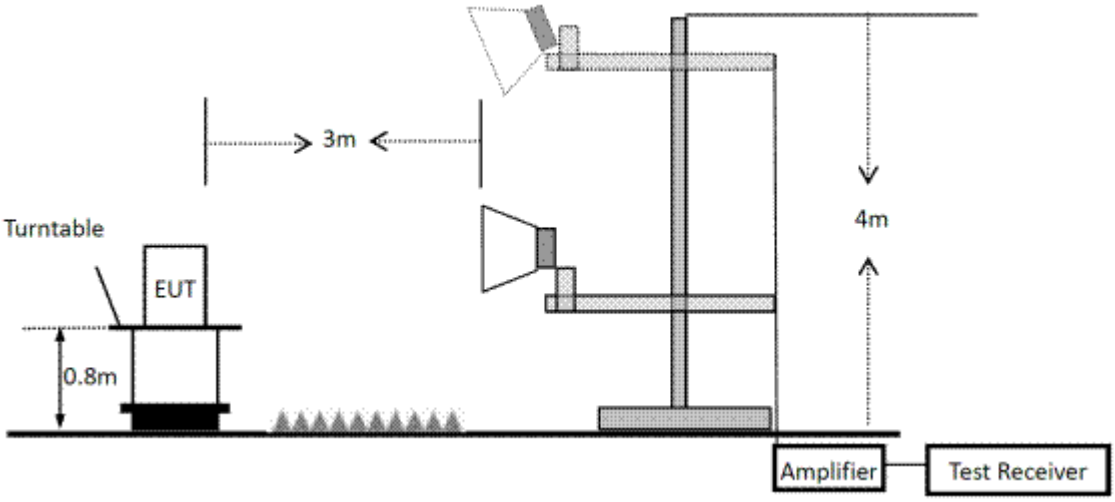
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.2.3 TEST SETUP

(A) Radiated Emission Test Set-Up Frequency Below 1 GHz



(B) Radiated Emission Test Set-Up Frequency Above 1GHz

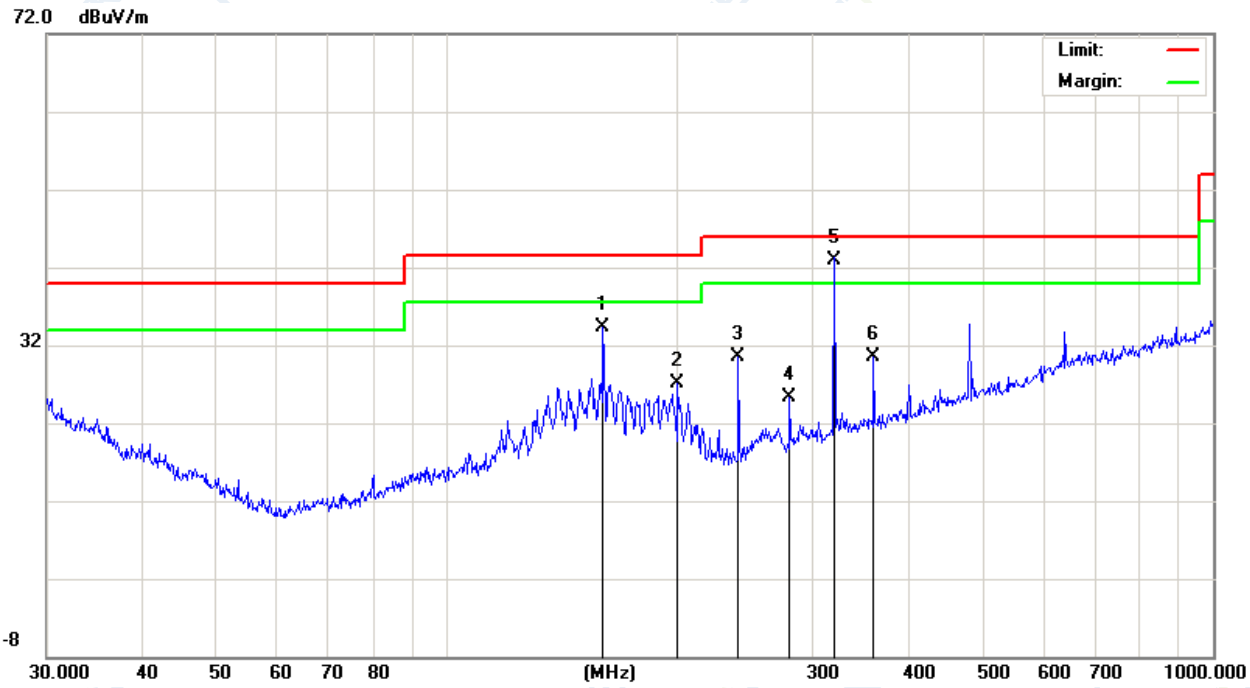


3.2.4 EUT OPERATING CONDITIONS

The EUT tested system was configured as the statements of **2.3** Unless otherwise a special operating condition is specified in the follows during the testing.

3.2.5 TEST RESULTS(30-1000MHz)

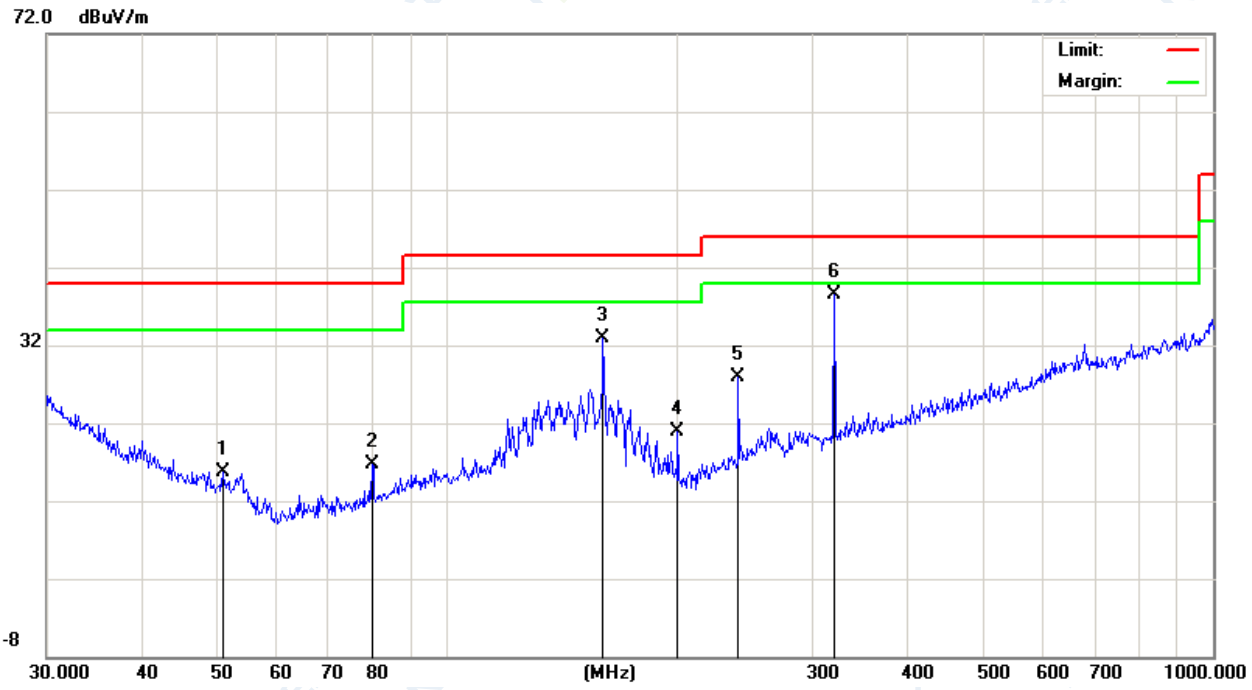
EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	24.9℃	Relative Humidity:	52%
Pressure:	1010hPa	Test Date:	2021-05-21
Test Mode:	On	Polarization:	Horizontal
Test Power:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		159.7844	22.11	12.29	34.40	43.50	-9.10	QP			
2		199.9856	17.57	9.50	27.07	43.50	-16.43	QP			
3		239.9874	17.90	12.63	30.53	46.00	-15.47	QP			
4		280.0237	11.35	14.01	25.36	46.00	-20.64	QP			
5	*	319.9370	27.04	15.86	42.90	46.00	-3.10	QP			
6		360.4476	13.49	16.94	30.43	46.00	-15.57	QP			

Remark:
Correct Factor = Antenna Factor + Cable Loss – Pre-Amplifier gain
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	24.9℃	Relative Humidity:	52%
Pressure:	1010hPa	Test Date:	2021-05-21
Test Mode:	On	Polarization:	Vertical
Test Power:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		

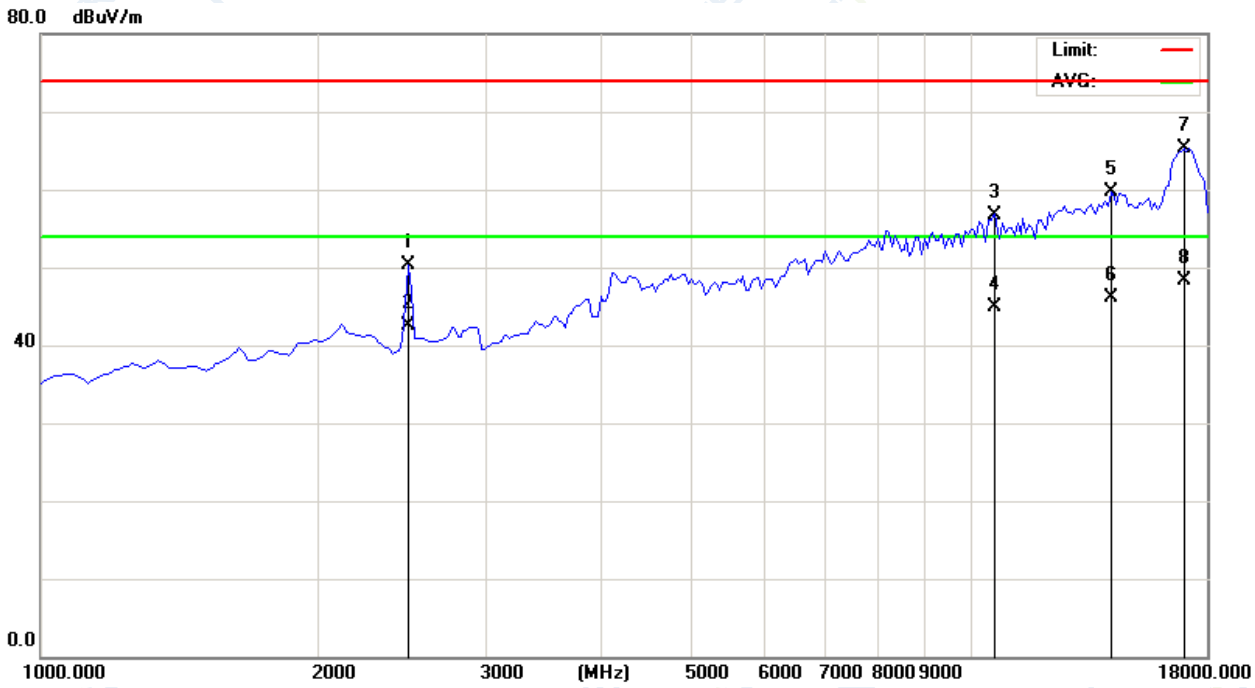


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		50.9420	7.15	8.47	15.62	40.00	-24.38	QP			
2		79.8002	8.62	8.04	16.66	40.00	-23.34	QP			
3		159.7844	20.59	12.29	32.88	43.50	-10.62	QP			
4		199.9856	11.43	9.50	20.93	43.50	-22.57	QP			
5		239.9874	15.20	12.63	27.83	46.00	-18.17	QP			
6	*	319.9370	22.56	15.86	38.42	46.00	-7.58	QP			

Remark:
Correct Factor = Antenna Factor + Cable Loss – Pre-Amplifier gain
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

3.2.6 TEST RESULTS(Above 1000MHz)

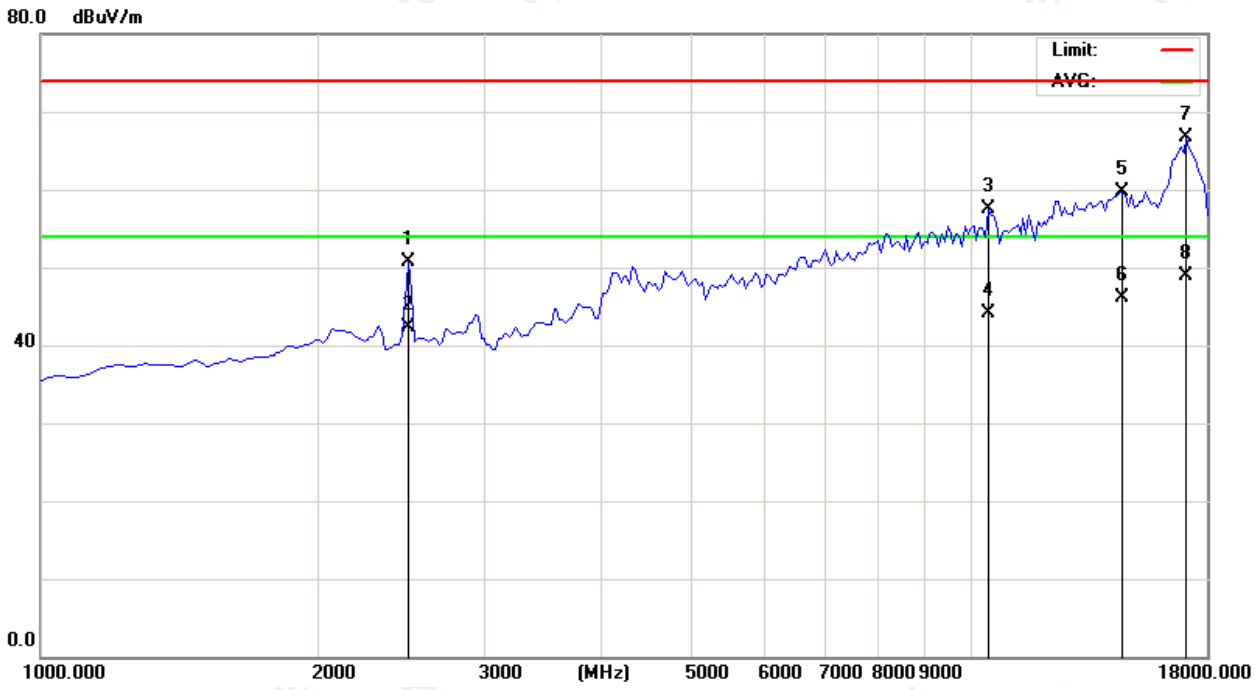
EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	24.5℃	Relative Humidity:	48%
Pressure:	1010hPa	Test Date:	2021-05-22
Test Mode:	On	Polarization:	Horizontal
Test Power:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2487.500	73.67	-23.29	50.38	74.00	-23.62	peak			
2		2487.500	65.81	-23.29	42.52	54.00	-11.48	AVG			
3		10690.00	62.80	-6.00	56.80	74.00	-17.20	peak			
4		10690.00	50.82	-6.00	44.82	54.00	-9.18	AVG			
5		14217.50	63.44	-3.77	59.67	74.00	-14.33	peak			
6		14217.50	49.78	-3.77	46.01	54.00	-7.99	AVG			
7		17107.50	60.93	4.42	65.35	74.00	-8.65	peak			
8	*	17107.50	43.90	4.42	48.32	54.00	-5.68	AVG			

Remark:
Correct Factor = Antenna Factor + Cable Loss – Pre-Amplifier gain
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

EUT:	Wi-Fi & BT Module	Model Name:	ESP-C3-12F
Temperature:	24.5℃	Relative Humidity:	48%
Pressure:	1010hPa	Test Date:	2021-05-22
Test Mode:	On	Polarization:	Vertical
Test Power:	DC 3.3V powered by DC Power Supply AC 120V/60Hz		

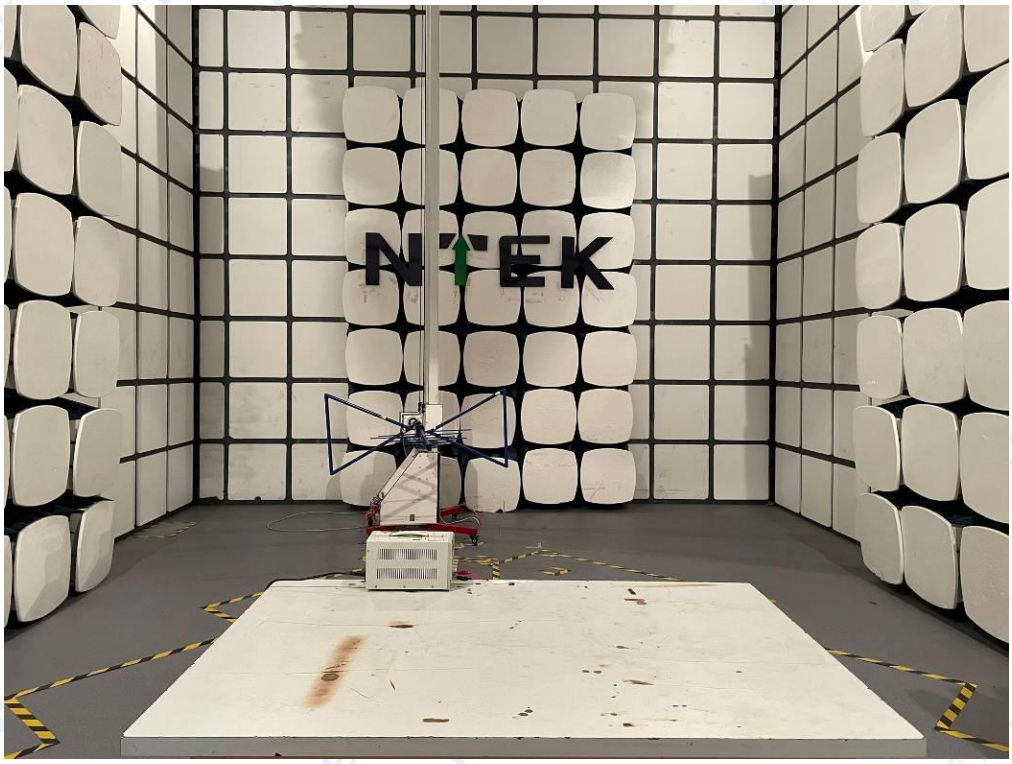


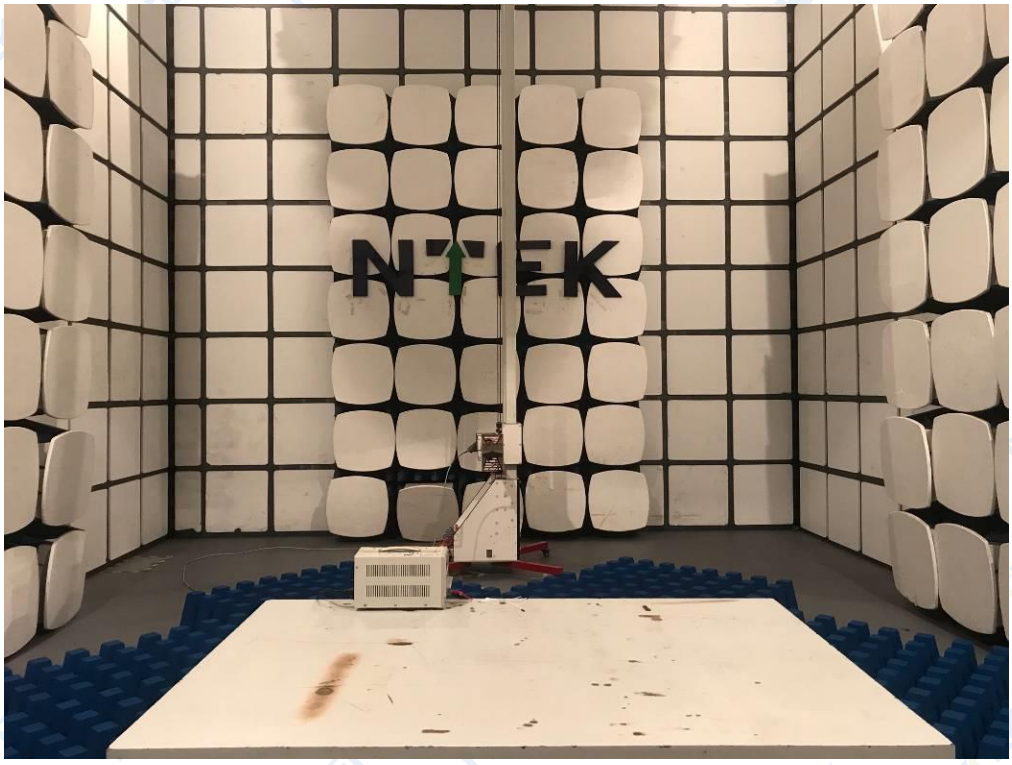
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		2487.500	74.03	-23.29	50.74	74.00	-23.26	peak			
2		2487.500	65.62	-23.29	42.33	54.00	-11.67	AVG			
3		10520.00	63.52	-6.07	57.45	74.00	-16.55	peak			
4		10520.00	50.08	-6.07	44.01	54.00	-9.99	AVG			
5		14600.00	62.16	-2.48	59.68	74.00	-14.32	peak			
6		14600.00	48.49	-2.48	46.01	54.00	-7.99	AVG			
7		17150.00	62.11	4.59	66.70	74.00	-7.30	peak			
8	*	17150.00	44.36	4.59	48.95	54.00	-5.05	AVG			

Remark:
Correct Factor = Antenna Factor + Cable Loss – Pre-Amplifier gain
Measurement Level = Reading Level + Correct Factor
Over Level = Measurement Level - Limit

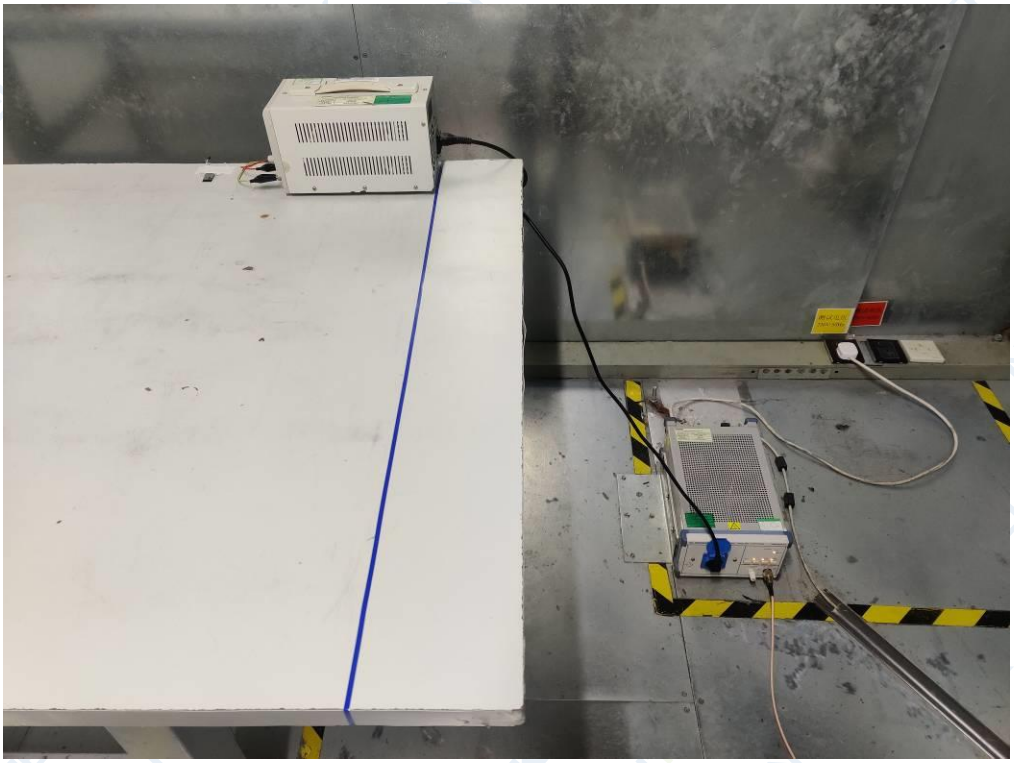
4. EUT TEST PHOTO

Radiated Measurement Photo





Conducted Measurement Photo



ATTACHMENT PHOTOGRAPHS OF EUT

Photo 1

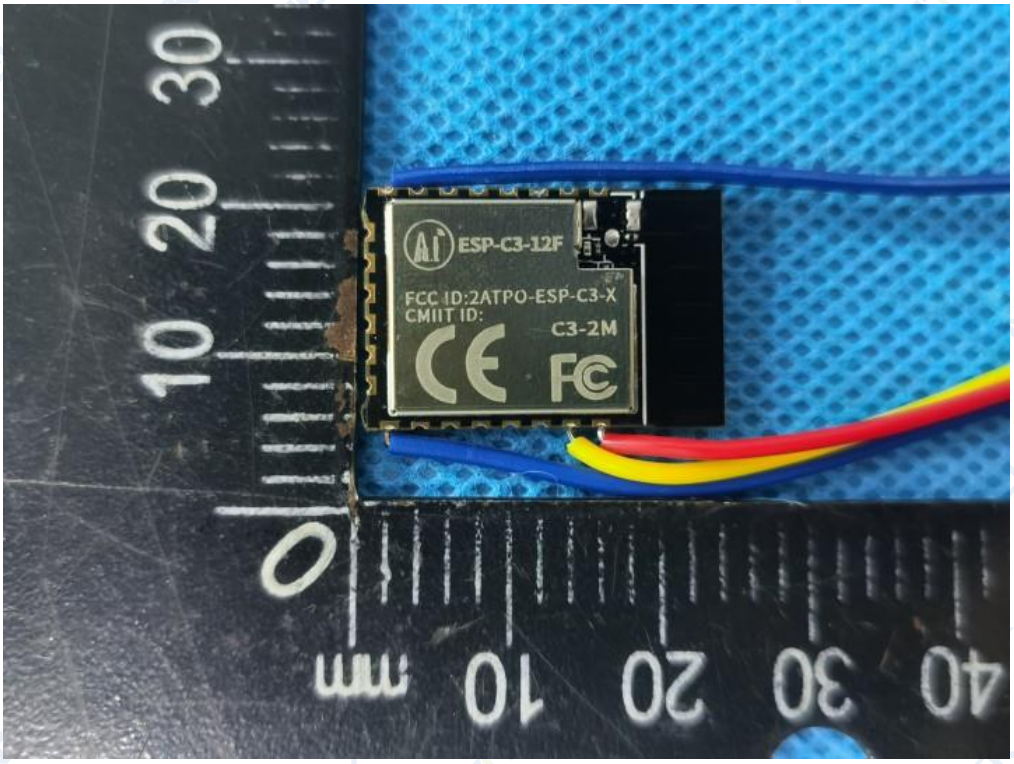


Photo 2

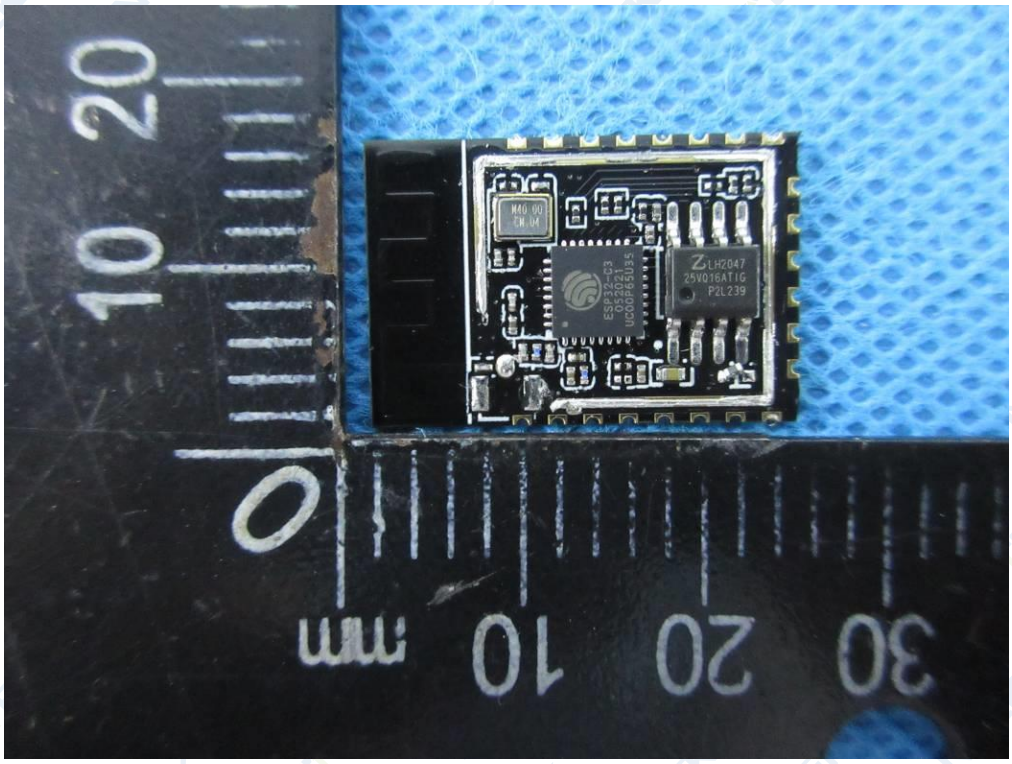


Photo 3

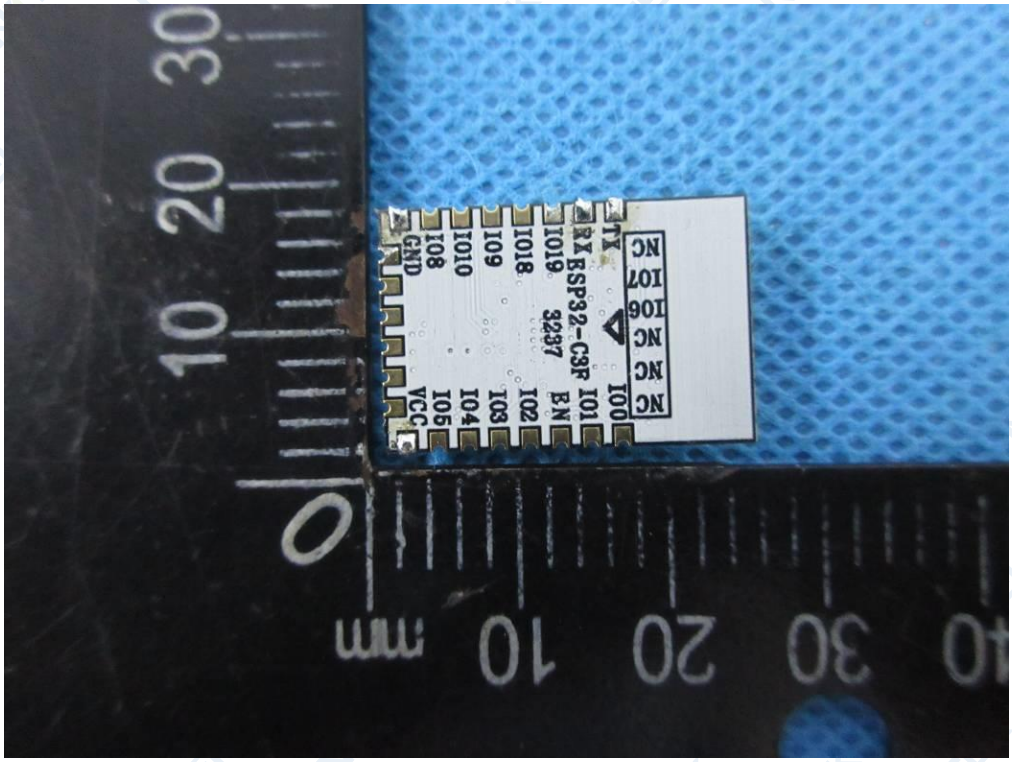


Photo 4

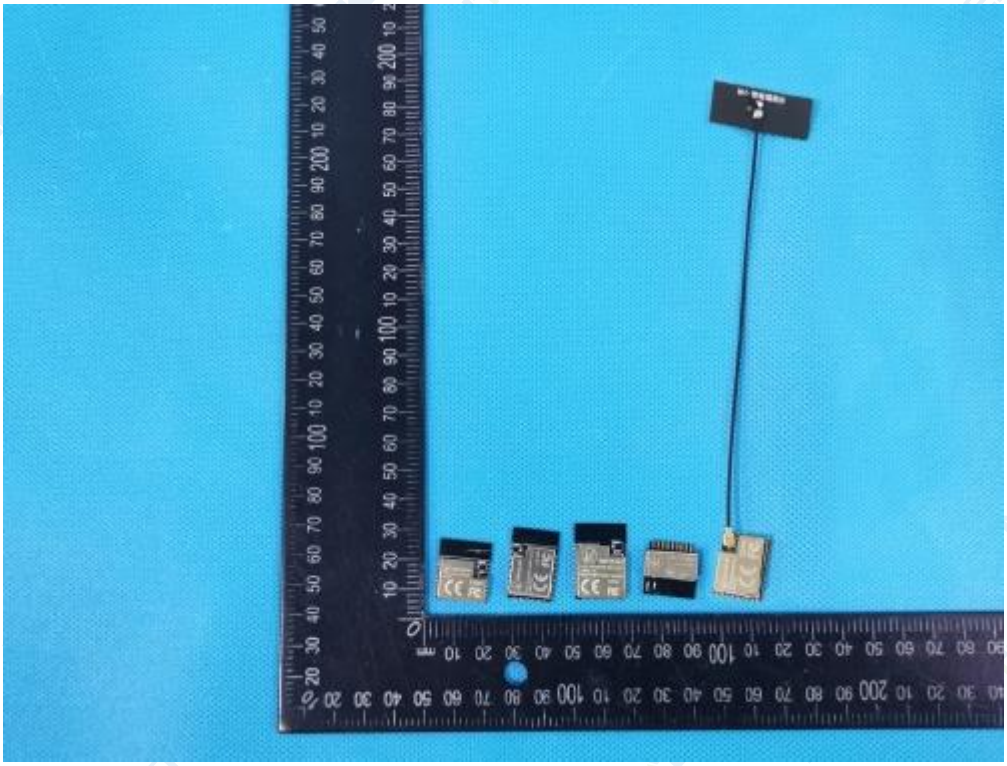
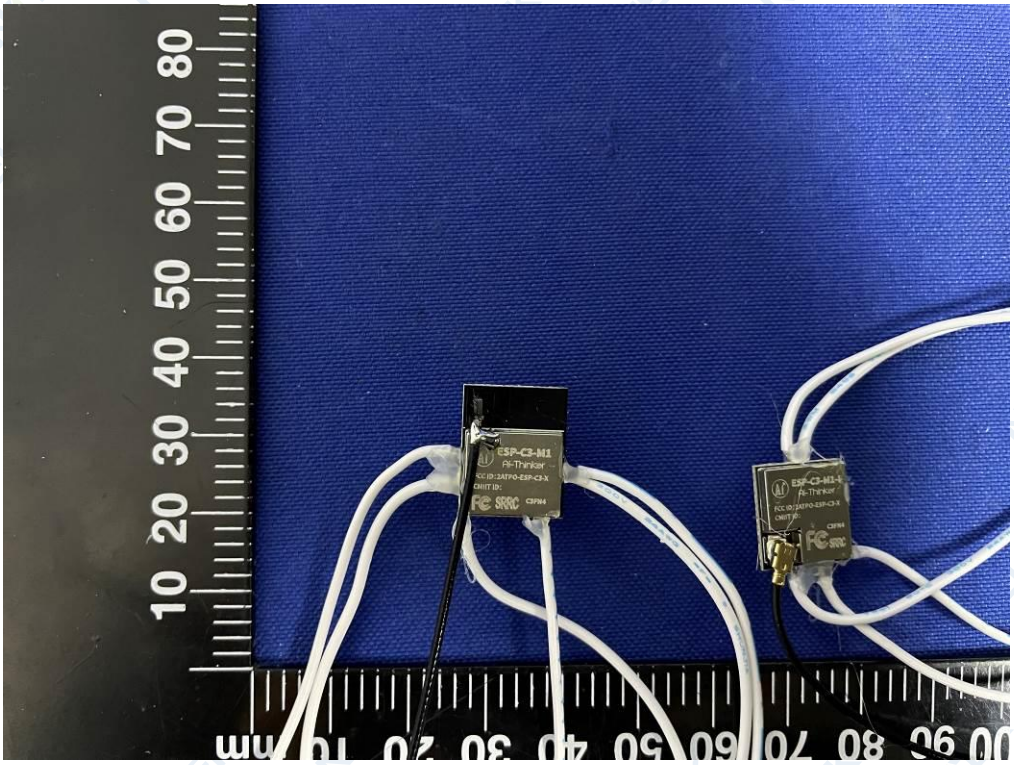


Photo 5 (2021-11)



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