FCC TEST REPORT

Client Name	:	Michel Normanha Bardauil Eletrônicos ME
Address	:	R. Dr. Jose Antonio Poletto, 351 Campinas, Sao Paulo, Brazil
Product Name	:	FastChecker FC01
Date	:	May 10, 2020

Shenzhen Anbotek Compliance Laboratory Limited

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TEST REPORT

Applicant	:	Michel Normanha Bardauil Eletrônicos ME
Manufacturer	:	Winnix Technologies Co.,Ltd
Product Name	:	FastChecker FC01
Model No.	:	FC01
Trade Mark	:	Fasttag
Rating(s)	:	Input: DC 5V, 50mA
Test Standard(s)	**:**	**FCC Part15 Subpart C 2019, Section 15.247**
Test Method(s)	**:**	**ANSI C63.10: 2013**

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 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 Anbotek Compliance Laboratory Limited.

Date of receipt	Jan. 15, 2020
Date of Test	Jan. 15~Apr. 03, 2020
Prepared by	(Engineer / Dolly Mo)
Reviewer	(Supervisor / Bibo Zhang)
Approved & Authorized Signer	(Manager / Tom Chen)

1. General Information

1.1. Client Information

Applicant	:	Michel Normanha Bardauil Eletrônicos ME
Address	:	R. Dr. Jose Antonio Poletto, 351 Campinas, Sao Paulo, Brazil
Manufacturer	:	Winnix Technologies Co.,Ltd
Address	:	Room635, MingYou Industrial products exhibition center B, No.168, Baoyuan Road, XixiangStreet, Bao'an District, Shenzhen, 518101, China
Factory	:	Winnix Technologies Co.,Ltd
Address	:	Room635, MingYou Industrial products exhibition center B, No.168, Baoyuan Road, XixiangStreet, Bao'an District, Shenzhen, 518101, China

1.2. Description of Device (EUT)

Product Name	:	FastChecker FC01	
Model No.	:	FC01	
Trade Mark	:	Fasttag	
Test Power Supply	:	AC 120V, 60Hz for MacBook Air	
Test Sample No.	:	1-2-1(Normal Sample), 1-2-2(Engineering Sample)	
Product Description	:	Operation Frequency:	902.75MHz~927.25MHz
		Number of Channel:	50 Channels
		Modulation Type:	ASK
		Antenna Type:	PCB Antenna
		Antenna Gain(Peak):	2 dBi
Remark: 1) 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

MacBook Air	:	Model: A1466 Input: 14.85V/3.05A CMIIT ID:C02HXB48DRVC
		Adapter:
		Input: AC 100-240V, 1A, 50-60Hz Output: 14.85V/3.05A

1.4. 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.

TEST MODE:

Mode 1	ASK	CH01	TX Only
Mode 2		CH26	
Mode 3		CH50	

Note:

(1) The measurements are performed at the highest, middle, lowest available channels.

(2)The data rate was set in 1Mbps for radiated emission due to the highest RF output power.

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1.5. List of channels

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
01	902.75	11	907.75	21	912.75	31	917.75	41	922.75
02	903.25	12	908.25	22	913.25	32	918.25	42	923.25
03	903.75	13	908.75	23	913.75	33	918.75	43	923.75
04	904.25	14	909.25	24	914.25	54	919.25	44	924.25
05	904.75	15	909.75	25	914.75	35	919.75	45	924.75
05	905.25	16	910.25	26	915.25	36	920.25	46	925.25
07	905.75	17	910.75	27	915.75	37	920.75	47	925.75
08	906.25	18	911.25	28	916.25	38	921.25	48	926.25
09	906.75	19	911.75	29	916.75	39	921.75	49	926.75
10	907.25	20	912.25	30	917.25	40	922.25	50	927.25

Note:

1. The engineering test program was provided and the EUT was programmed to be in continuously transmitting mode.

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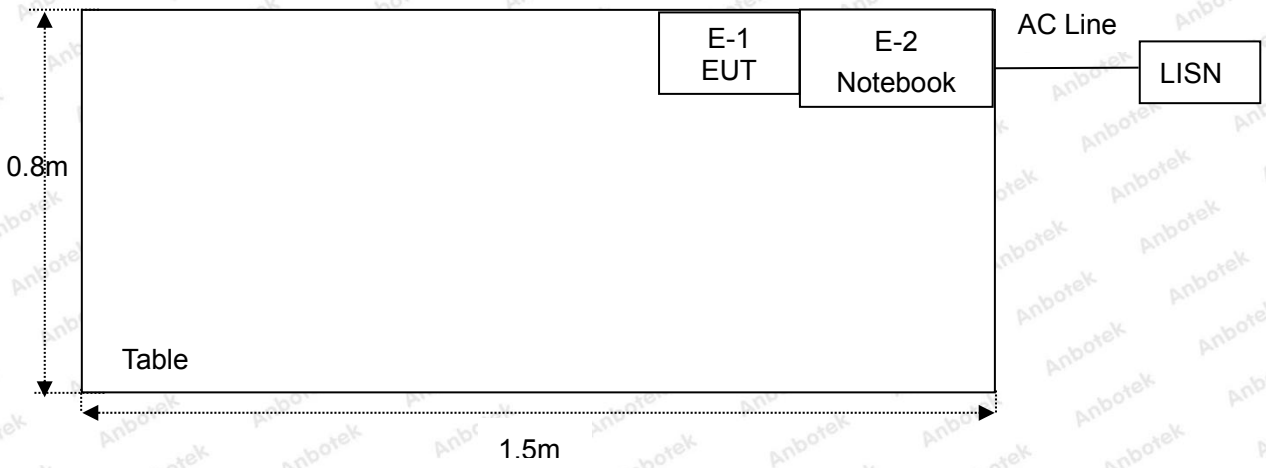
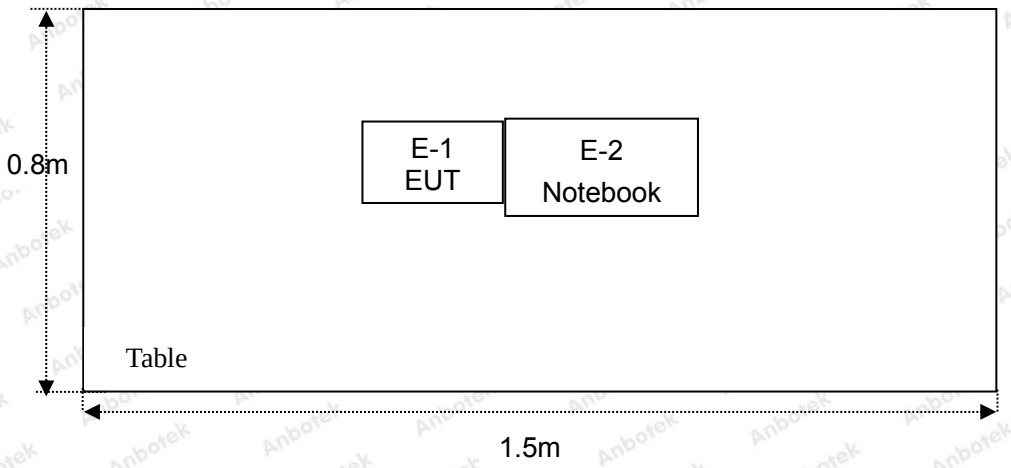
1.6. Description Of Test Setup

CE



RE



1.7. Test Equipment List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	L.I.S.N. Artificial Mains Network	Rohde & Schwarz	ENV216	100055	Nov. 04, 2019	1 Year
2.	EMI Test Receiver	Rohde & Schwarz	ESPI3	101604	Nov. 04, 2019	1 Year
3.	RF Switching Unit	Compliance Direction	RSU-M2	38303	Nov. 04, 2019	1 Year
4.	MAX Spectrum Analysis	Agilent	N9020A	MY51170037	Nov. 04, 2019	1 Year
5.	Preamplifier	SKET Electronic	BK1G18G30D	KD17503	Nov. 04, 2019	1 Year
6.	Double Ridged Horn Antenna	Instruments corporation	GTH-0118	351600	Nov. 01, 2019	1 Year
7.	Bilog Broadband Antenna	Schwarzbeck	VULB9163	VULB 9163-289	Nov. 01, 2019	1 Year
8.	Loop Antenna	Schwarzbeck	FMZB1519B	00053	Nov. 01, 2019	1 Year
9.	Horn Antenna	A-INFO	LB-180400-KF	J211060628	Nov. 01, 2019	1 Year
10.	Pre-amplifier	SONOMA	310N	186860	Nov. 04, 2019	1 Year
11.	EMI Test Software EZ-EMC	SHURPLE	N/A	N/A	N/A	N/A
12.	RF Test Control System	YIHENG	YH3000	2017430	Nov. 04, 2019	1 Year
13.	Power Sensor	DAER	RPR3006W	15I00041SN045	Nov. 04, 2019	1 Year
14.	Power Sensor	DAER	RPR3006W	15I00041SN046	Nov. 04, 2019	1 Year
15.	MXA Spectrum Analysis	Agilent	N9020A	MY51170037	Nov. 04, 2019	1 Year
16.	MXG RF Vector Signal Generator	Agilent	N5182A	MY48180656	Nov. 04, 2019	1 Year
17.	Signal Generator	Agilent	E4421B	MY41000743	Nov. 04, 2019	1 Year
18.	DC Power Supply	LW	TPR-6420D	374470	Nov. 04, 2019	1 Year
19.	Constant Temperature Humidity Chamber	ZHONGJIAN	ZJ-KHWS80B	N/A	Nov. 04, 2019	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 Anbotek Compliance Laboratory Limited, EMC Laboratory has been registed 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, September 27, 2019.

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, March 07, 2019.

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.518102

2. Summary of Test Results

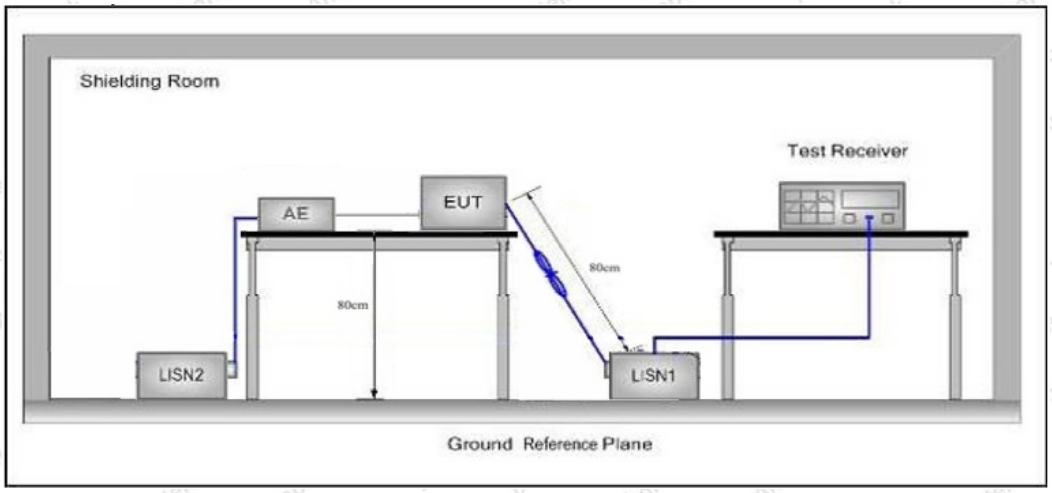
Standard Section	Test Item	Result
15.203/15.247(c)	Antenna Requirement	PASS
15.207	Conducted Emission	PASS
15.205/15.209	Spurious Emission	PASS
15.247(b)(1)	Conducted Peak Output Power	PASS
15.247(a)(1)	20dB Occupied Bandwidth	PASS
15.247(a)(1)	Carrier Frequencies Separation	PASS
15.247(a)(1)	Hopping Channel Number	PASS
15.247(a)(1)	Dwell Time	PASS
15.247(d)	Band Edge	PASS
Remark: “N/A” is an abbreviation for Not Applicable.		

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 C63.10-2013 on Conducted Emission Measurement.

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

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

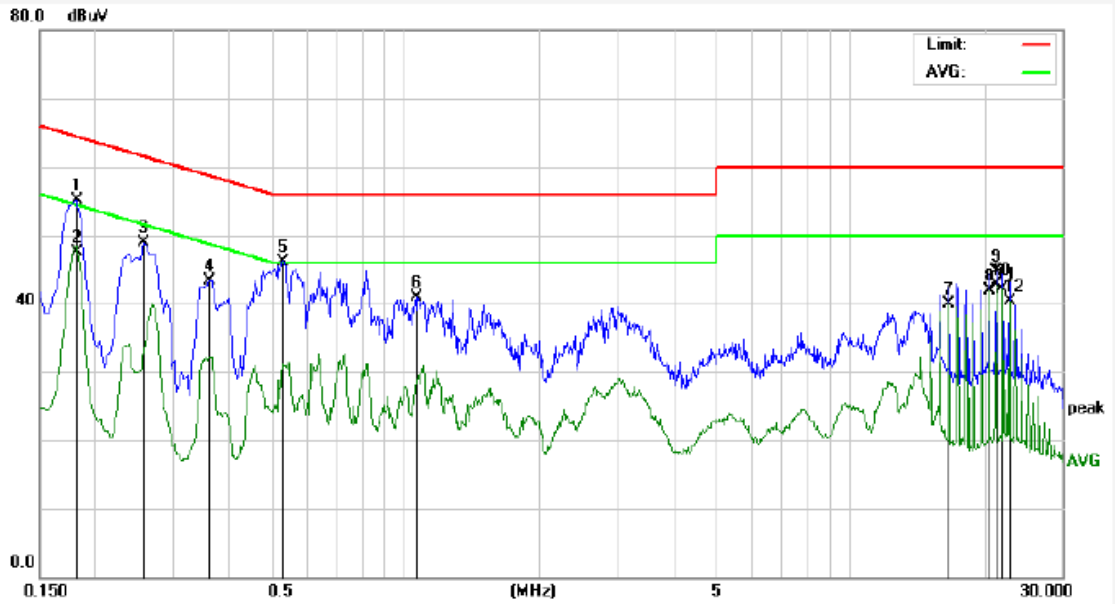
3.4. Test Data

PASS

During the test, pre-scan all the modes, and found the Low channel which is the worst case, only the worst case is recorded in the report.

Conducted Emission Test Data

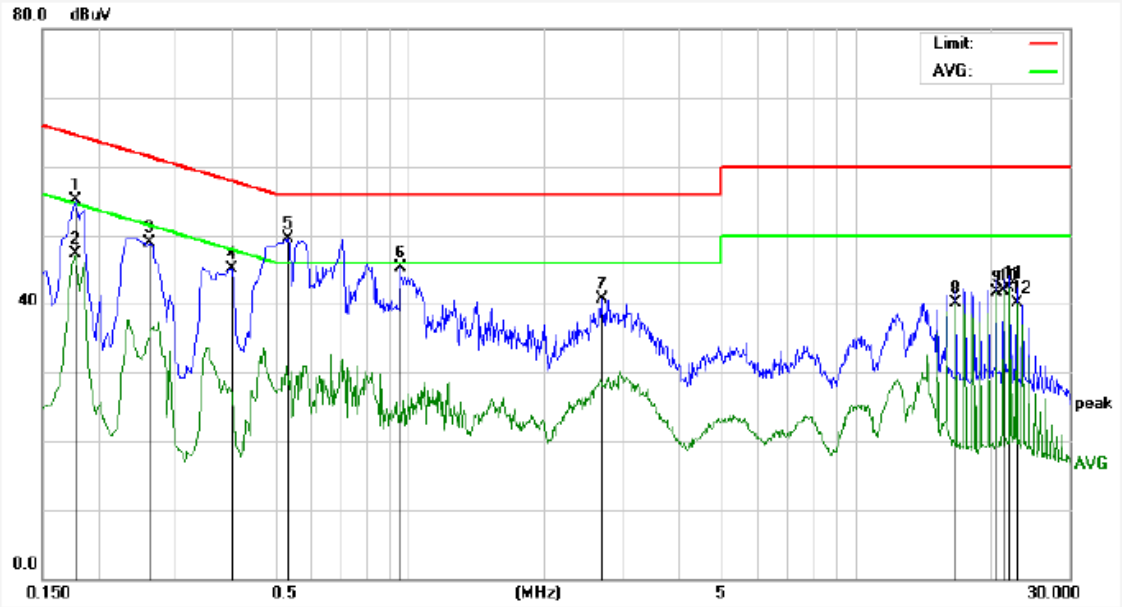
Test Site: 1# Shielded Room
Operating Condition: Mode 1
Test Specification: AC 120V, 60Hz for MacBook Air
Comment: Live Line
Tem.: 22℃ Hum.: 53%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.1819	35.21	19.90	55.11	64.39	-9.28	QP	
2	0.1819	27.58	19.90	47.48	54.39	-6.91	AVG	
3	0.2580	29.05	19.89	48.94	61.49	-12.55	QP	
4	0.3620	23.44	19.92	43.36	58.68	-15.32	QP	
5	0.5299	26.21	19.99	46.20	56.00	-9.80	QP	
6	1.0620	20.86	20.12	40.98	56.00	-15.02	QP	
7	16.7180	19.58	20.29	39.87	50.00	-10.13	AVG	
8	20.5140	21.60	20.33	41.93	50.00	-8.07	AVG	
9	21.2740	24.39	20.32	44.71	60.00	-15.29	QP	
10	21.2740	22.34	20.32	42.66	50.00	-7.34	AVG	
11	22.0340	21.76	20.32	42.08	50.00	-7.92	AVG	
12	22.7939	20.00	20.31	40.31	50.00	-9.69	AVG	

Conducted Emission Test Data

Test Site: 1# Shielded Room
Operating Condition: Mode 1
Test Specification: AC 120V, 60Hz for MacBook Air
Comment: Neutral Line
Tem.: 22℃ Hum.: 53%



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit (dBuV)	Over Limit (dB)	Detector	Remark
1	0.1780	35.28	19.90	55.18	64.57	-9.39	QP	
2	0.1780	27.42	19.90	47.32	54.57	-7.25	AVG	
3	0.2620	28.98	19.89	48.87	61.36	-12.49	QP	
4	0.3980	25.25	19.93	45.18	57.89	-12.71	QP	
5	0.5340	29.51	19.99	49.50	56.00	-6.50	QP	
6	0.9500	25.12	20.11	45.23	56.00	-10.77	QP	
7	2.6860	20.58	20.15	40.73	56.00	-15.27	QP	
8	16.7139	19.86	20.29	40.15	50.00	-9.85	AVG	
9	20.5140	21.34	20.33	41.67	50.00	-8.33	AVG	
10	21.2740	21.49	20.32	41.81	50.00	-8.19	AVG	
11	22.0340	21.99	20.32	42.31	50.00	-7.69	AVG	
12	22.7939	19.74	20.31	40.05	50.00	-9.95	AVG	

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

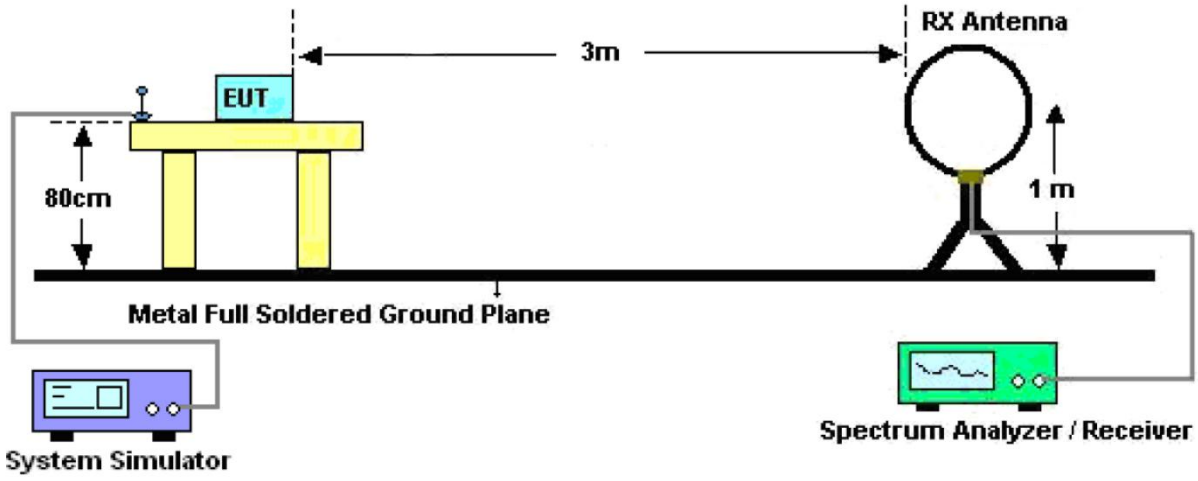


Figure 1. Below 30MHz

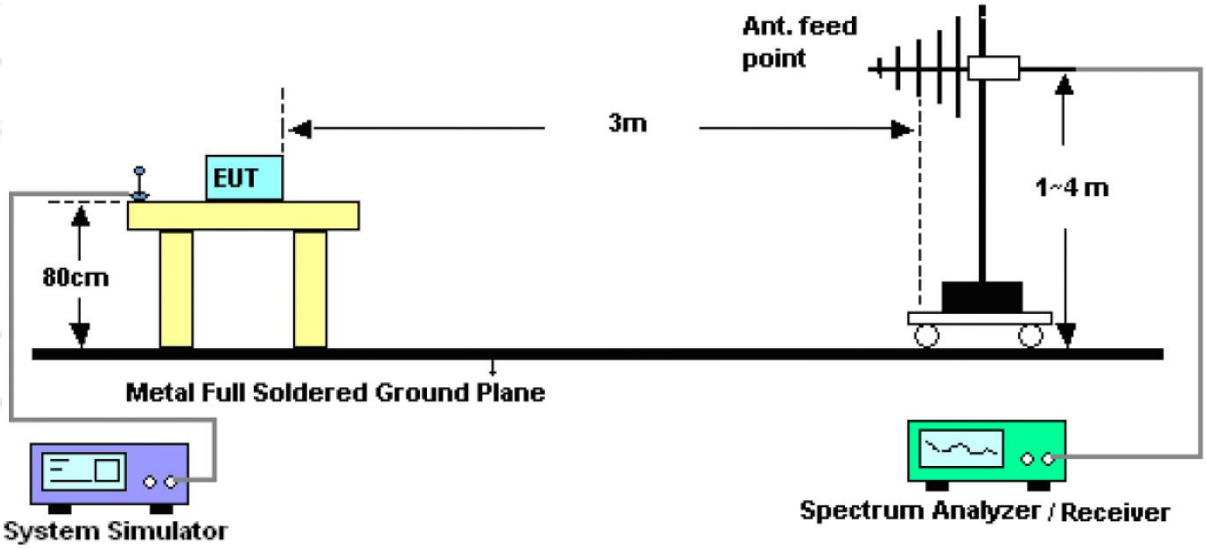


Figure 2. 30MHz to 1GHz

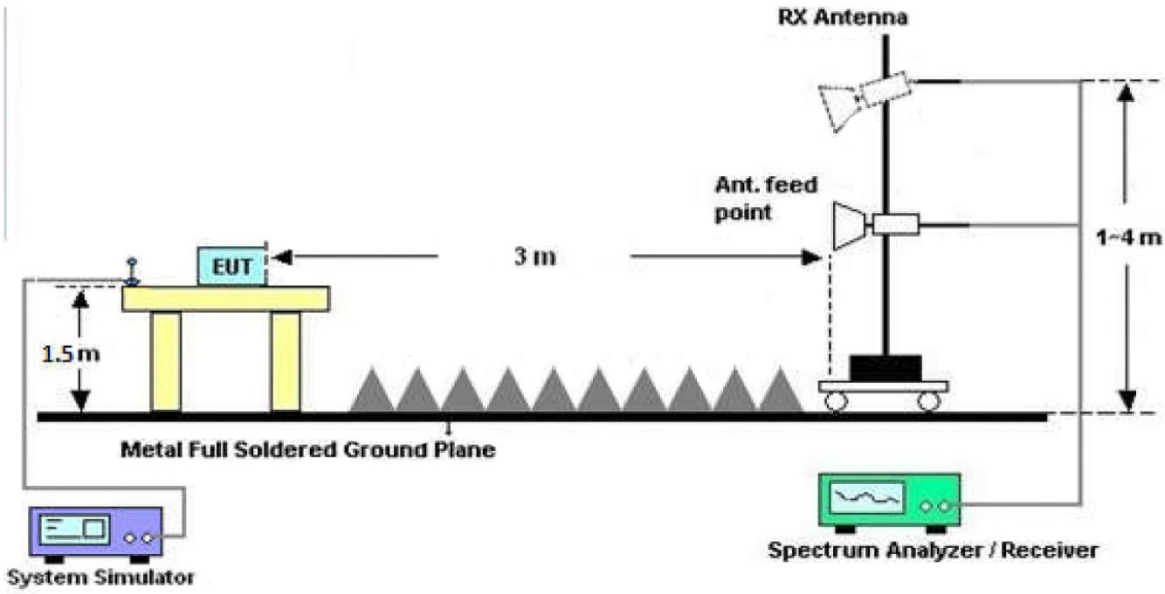


Figure 3. Above 1 GHz

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.

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

During the test, pre-scan all the modes, and found the middle channel which is the worst case, only the worst case is recorded in the report.

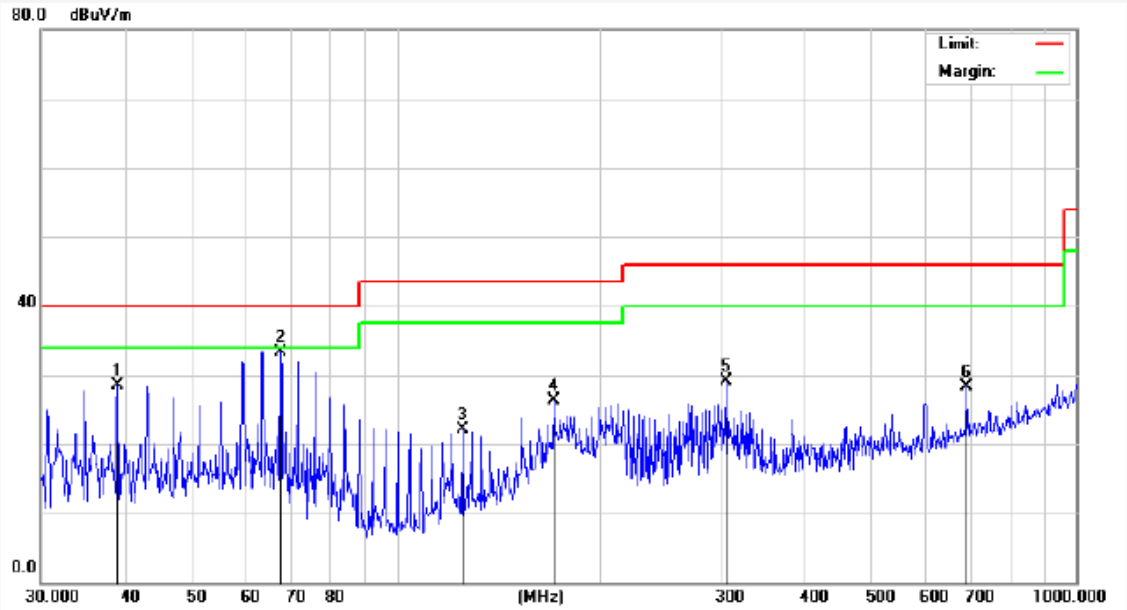
Test Results (30~1000MHz)

Test Mode: Mode 2

Power Source: AC 120V, 60Hz for MacBook Air

Polarization: Vertical

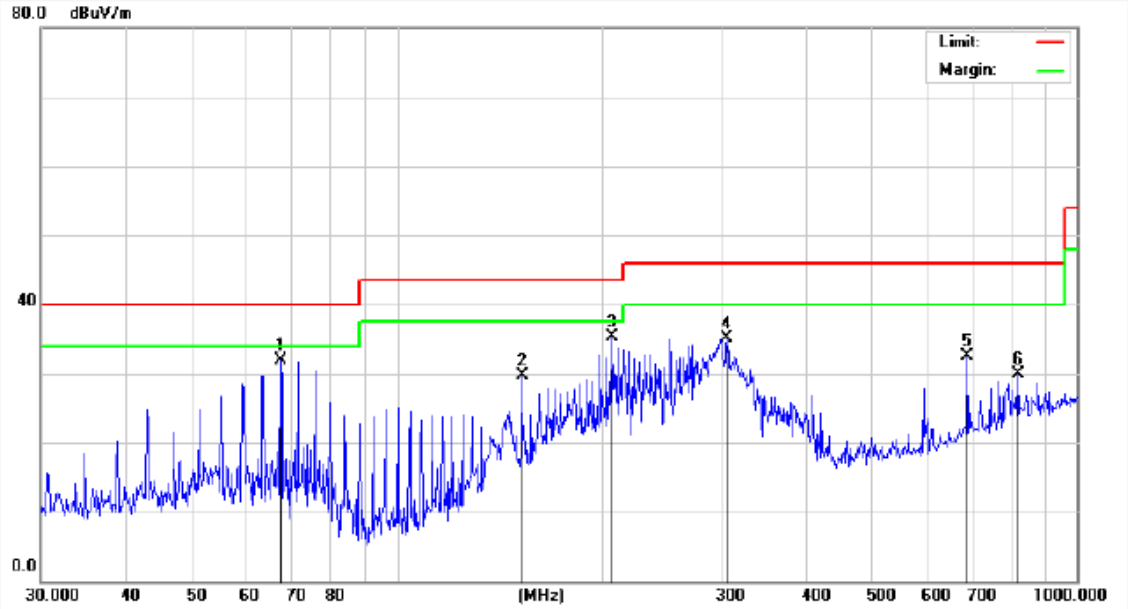
Temp.(℃)/Hum.(%RH): 22.1℃/49%RH



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Over Limit (dB)	Detector	Height (cm)	degree (deg)	Remark
1	38.8878	45.54	-17.08	28.46	40.00	-11.54	QP	100	0	
2	67.4382	53.78	-20.38	33.40	40.00	-6.60	QP	100	360	
3	125.0066	41.86	-19.72	22.14	43.50	-21.36	QP	100	0	
4	170.1948	46.23	-19.96	26.27	43.50	-17.23	QP	100	360	
5	305.6800	45.77	-16.59	29.18	46.00	-16.82	QP	100	0	
6	689.5644	38.54	-10.28	28.26	46.00	-17.74	QP	100	360	

Test Results (30~1000MHz)

Test Mode: Mode 2
Power Source: AC 120V, 60Hz for MacBook Air
Polarization: Horizontal
Temp.(℃)/Hum.(%RH): 22.1℃/49%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	67.4382	53.34	-21.38	31.96	40.00	-8.04	QP	100	0	
2	152.6641	54.46	-24.76	29.70	43.50	-13.80	QP	100	360	
3	207.1226	57.51	-22.13	35.38	43.50	-8.12	QP	100	0	
4	305.6800	54.21	-19.03	35.18	46.00	-10.82	QP	100	360	
5	689.5644	43.07	-10.49	32.58	46.00	-13.42	QP	100	0	
6	818.8341	38.09	-8.14	29.95	46.00	-16.05	QP	100	360	

Test Results (1GHz-25GHz)

Low Channel

Frequency	Antenna	Reading	Cable Loss	Ant Factor	Amplifier	Level	Limits	Margin	Det.
(MHz)	Pol.	(dBuV/m)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	Mode
1805.5000	H	46.17	7.39	28.73	26.31	55.98	74	-18.02	PK
1805.5000	H	36.4	7.39	28.73	26.31	46.21	54	-7.79	AV
2708.2500	H	44.18	8.10	29.71	27.01	54.98	74	-19.02	PK
2708.2500	H	35.42	8.10	29.71	27.01	46.22	54	-7.78	AV
3611.0000	H	--	--	--	--	--	--	--	PK
3611.0000	H	--	--	--	--	--	--	--	AV
1805.5000	V	46.4	7.39	28.73	26.31	56.21	74	-17.79	PK
1805.5000	V	36.17	7.39	28.73	26.31	45.98	54	-8.02	AV
2708.2500	V	44.21	8.10	29.71	27.01	55.01	74	-18.99	PK
2708.2500	V	34.53	8.10	29.71	27.01	45.33	54	-8.67	AV
3611.0000	V	--	--	--	--	--	--	--	PK
3611.0000	V	--	--	--	--	--	--	--	AV

Address: 1/F., Building D, Sogood Science and Technology Park, Sanwei Community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.
Tel:(86) 755-26066440 Fax: (86) 755-26014772 Email: service@anbotek.com
Hotline 400-003-0500
www.anbotek.com

Middle Channel

Frequency	Antenna	Reading	Cable Loss	Ant Factor	Amplifier	Level	Limits	Margin	Det.
(MHz)	Pol.	(dBuV/m)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	Mode
1830.5000	H	48.57	7.41	28.72	26.31	58.39	74	-15.61	PK
1830.5000	H	38.06	7.41	28.72	26.31	47.88	54	-6.12	AV
2745.7500	H	45.44	8.11	29.71	27.01	56.25	74	-17.75	PK
2745.7500	H	34.17	8.11	29.71	27.01	44.98	54	-9.02	AV
3661.0000	H	--	--	--	--	--	--	--	PK
3661.0000	H	--	--	--	--	--	--	--	AV
1830.5000	V	49.39	7.41	28.72	26.31	59.21	74	-14.79	PK
1830.5000	V	36.05	7.41	28.72	26.31	45.87	54	-8.13	AV
2745.7500	V	46.07	8.11	29.71	27.01	56.88	74	-17.12	PK
2745.7500	V	35.93	8.11	29.71	27.01	46.74	54	-7.26	AV
3661.0000	V	--	--	--	--	--	--	--	PK
3661.0000	V	--	--	--	--	--	--	--	AV

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High Channel

Frequency	Antenna	Reading	Cable Loss	Ant Factor	Amplifier	Level	Limits	Margin	Det.
(MHz)	Pol.	(dBuV/m)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	(dB)	Mode
1854.5000	H	48.51	7.43	28.69	26.31	58.32	74	-15.68	PK
1854.5000	H	36.17	7.43	28.69	26.31	45.98	54	-8.02	AV
2781.7500	H	46.01	8.15	29.84	27.01	56.99	74	-17.01	PK
2781.7500	H	35.23	8.15	29.84	27.01	46.21	54	-7.79	AV
3709.0000	H	--	--	--	--	--	--	--	PK
3709.0000	H	--	--	--	--	--	--	--	AV
1854.5000	V	45.98	7.43	28.69	26.31	55.79	74	-18.21	PK
1854.5000	V	37.06	7.43	28.69	26.31	46.87	54	-7.13	AV
2781.7500	V	46	8.15	29.84	27.01	56.98	74	-17.02	PK
2781.7500	V	35.89	8.15	29.84	27.01	46.87	54	-7.13	AV
3709.0000	V	--	--	--	--	--	--	--	PK
3709.0000	V	--	--	--	--	--	--	--	AV

Remark:

1. Level = Reading + Cable Loss+Ant Factor-Amplifier
2. " -- " Mark indicated Background Noise Level

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	42.63	22.45	4.48	31.33	38.23	46.00	-7.77	H	QP
928.0000	40.44	22.59	4.54	31.35	36.22	46.00	-9.78	H	QP
902.0000	41.94	22.45	4.48	31.33	37.54	46.00	-8.46	V	QP
928.0000	40.44	22.59	4.54	31.35	36.22	46.00	-9.78	V	QP

Address: 1/F., Building D, Sogood Science and Technology Park, Sanwei Community, Hangcheng Street, Bao'an District, Shenzhen, Guangdong, China.
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Hotline 400-003-0500
www.anbotek.com

5. Maximum Peak Output Power Test

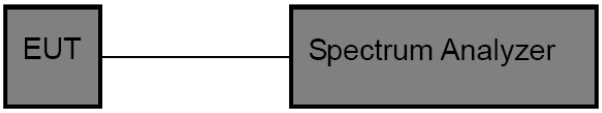
5.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (b)(2)& (b)(4)

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

5.2. Test Setup



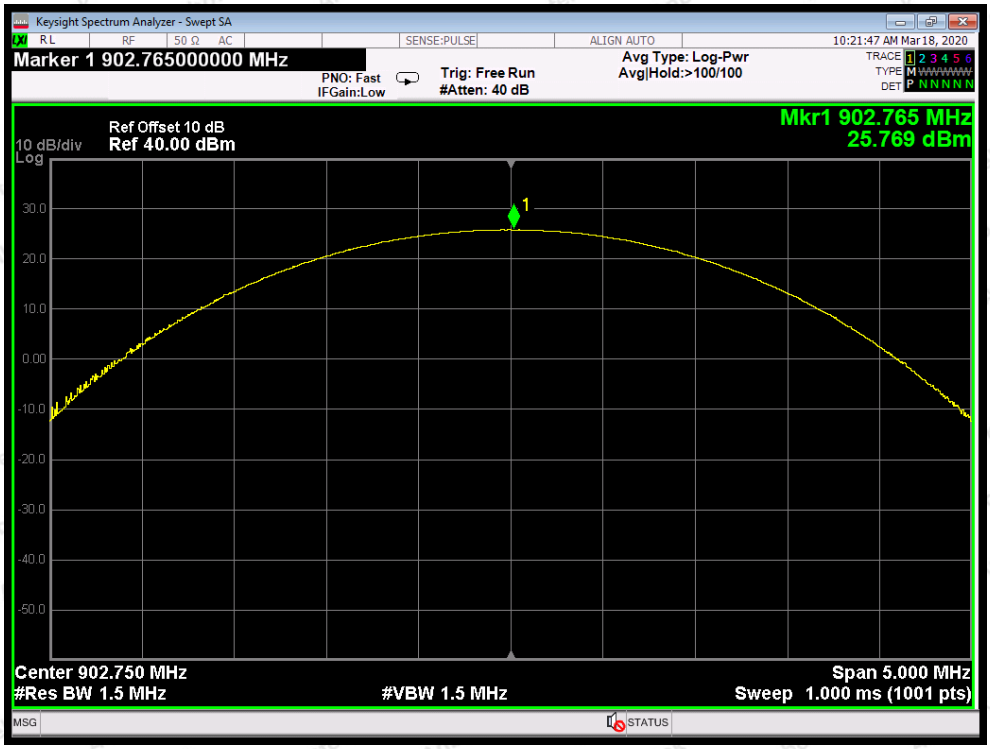
5.3. Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above,
2. Spectrum Setting:
   RBW > the 20 dB bandwidth of the emission being measured
   Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold

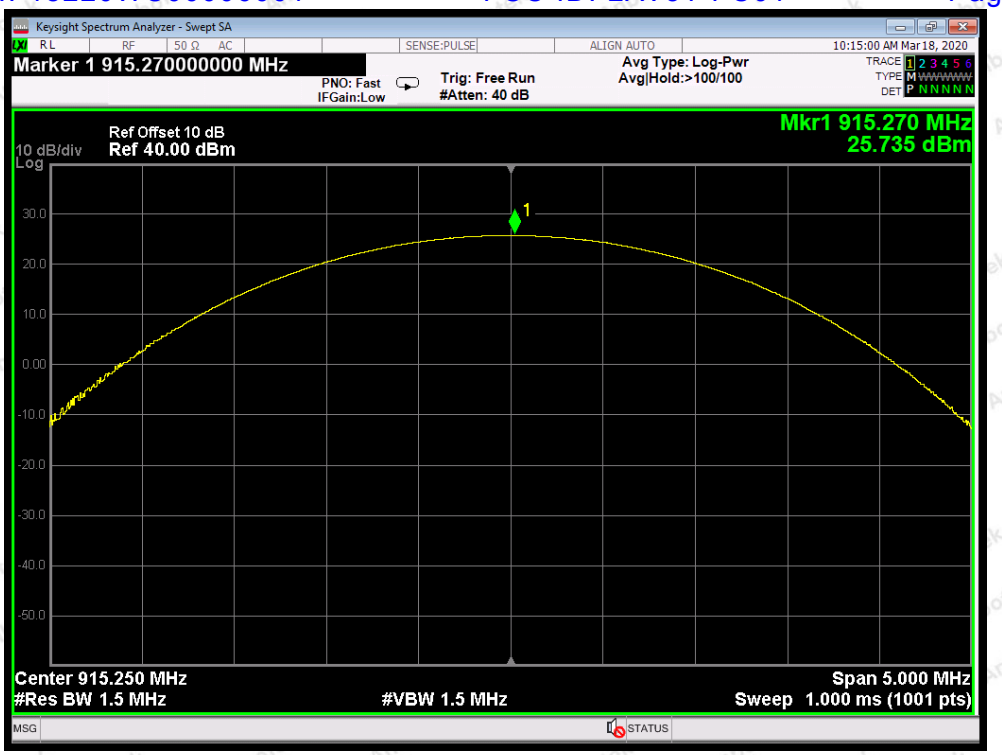
5.4. Test Data

Test Item	:	Max. peak output power	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

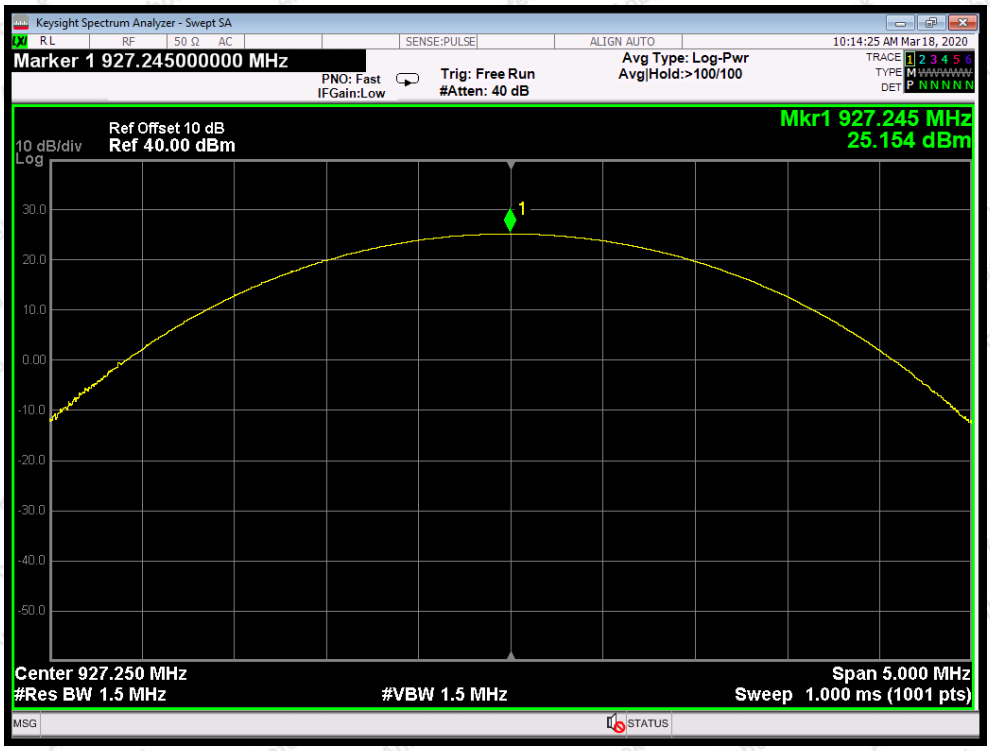
Channel Frequency (MHz)	Peak Power output (dBm)	Limit (dBm)	Results
902.75	25.769	30	PASS
915.25	25.735	30	PASS
927.25	25.154	30	PASS



Low Channel



Middle Channel



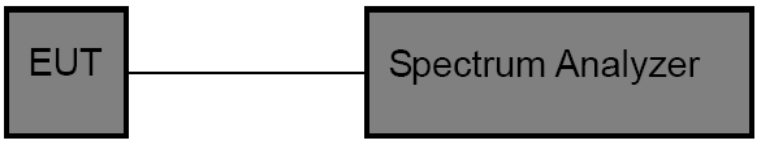
High Channel

6. 20DB Occupy Bandwidth Test

6.1. Test Standard

Test Standard	FCC Part15 C Section 15.247 (a)(1)

6.2. Test Setup



6.3. Test Procedure

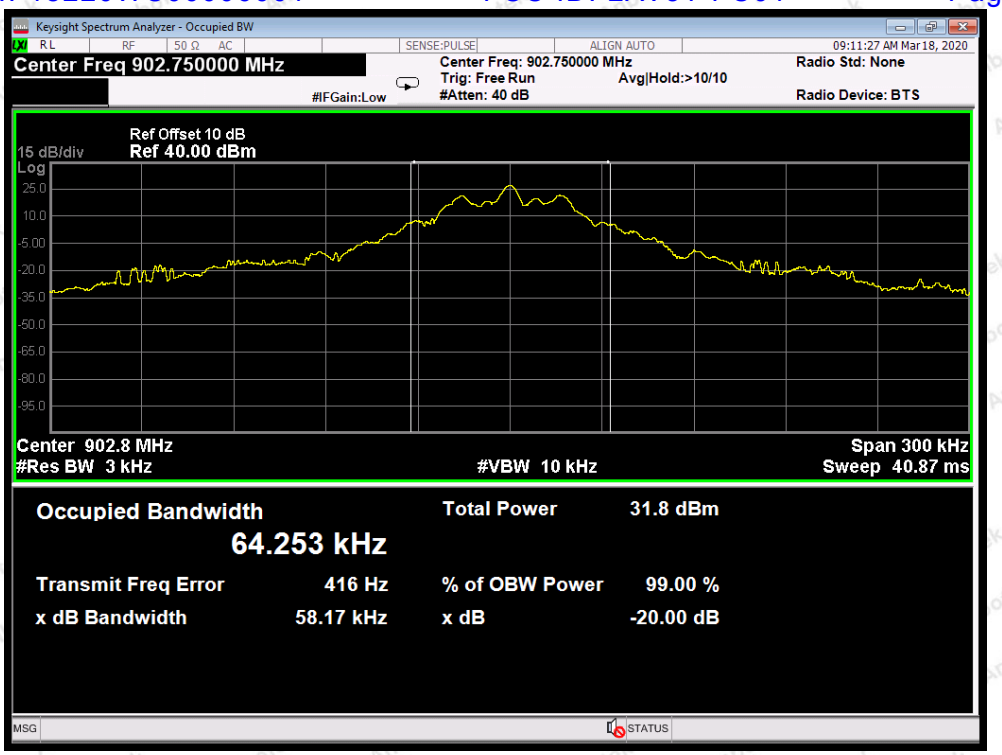
Using the following spectrum analyzer settings:

1. Span= approximately 2 to 3 times the 20dB bandwidth, centered on a hopping channel.
2. Set the RBW = 30 kHz.
3. Set the VBW = 100 kHz.
4. Sweep time = auto couple.
5. Detector function = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.

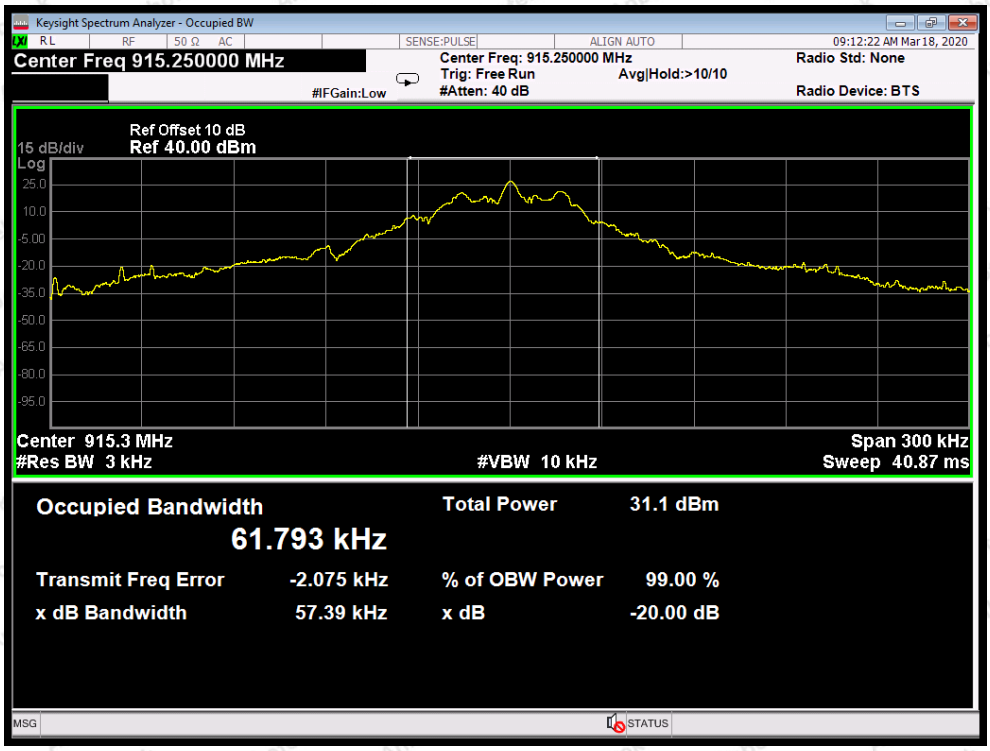
6.4. Test Data

Test Item	:	20dB BW	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

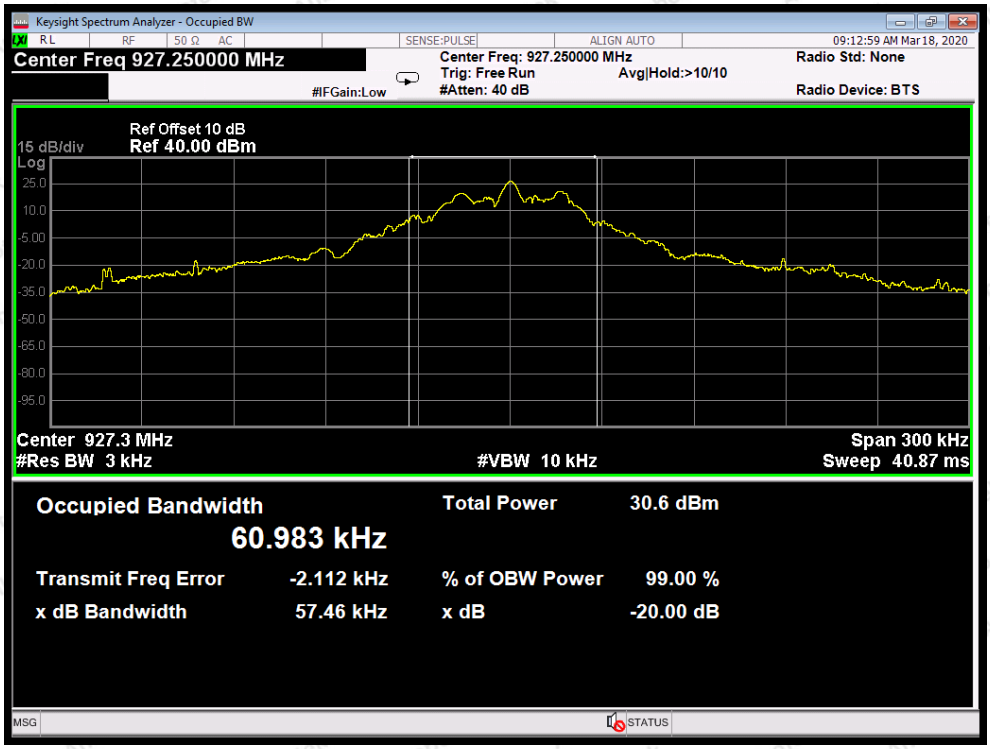
Channel	Frequency(MHz)	20dB Down BW(kHz)	Limit(MHz)	Verdict
Low	902.75	58.17	0.250	PASS
Middle	915.25	57.39	0.250	PASS
High	927.25	57.46	0.250	PASS


Keysight Spectrum Analyzer - Occupied BW
RL RF 50 Ω AC SENSE:PULSE ALIGN AUTO 09:11:27 AM Mar 18, 2020
Center Freq 902.750000 MHz
Center Freq: 902.750000 MHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 40 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
Ref Offset 10 dB
15 dB/div
Ref 40.00 dBm
Log
25.0
10.0
-5.00
-20.0
-35.0
-50.0
-65.0
-80.0
-95.0
Center 902.8 MHz
#Res BW 3 kHz
#VBW 10 kHz
Span 300 kHz
Sweep 40.87 ms
Occupied Bandwidth
64.253 kHz
Total Power 31.8 dBm
Transmit Freq Error 416 Hz
% of OBW Power 99.00 %
x dB Bandwidth 58.17 kHz
x dB -20.00 dB
MSG
STATUS

Low


Keysight Spectrum Analyzer - Occupied BW
RL RF 50 Ω AC SENSE:PULSE ALIGN AUTO 09:12:22 AM Mar 18, 2020
Center Freq 915.250000 MHz
Center Freq: 915.250000 MHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 40 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
Ref Offset 10 dB
15 dB/div
Ref 40.00 dBm
Log
25.0
10.0
-5.00
-20.0
-35.0
-50.0
-65.0
-80.0
-95.0
Center 915.3 MHz
#Res BW 3 kHz
#VBW 10 kHz
Span 300 kHz
Sweep 40.87 ms
Occupied Bandwidth
61.793 kHz
Total Power 31.1 dBm
Transmit Freq Error -2.075 kHz
% of OBW Power 99.00 %
x dB Bandwidth 57.39 kHz
x dB -20.00 dB
MSG
STATUS

Middle


Keysight Spectrum Analyzer - Occupied BW
RL
RF
50 Ω AC
SENSE:PULSE
ALIGN AUTO
09:12:59 AM Mar 18, 2020
Center Freq 927.250000 MHz
Center Freq: 927.250000 MHz
Trig: Free Run
Avg|Hold:>10/10
#Atten: 40 dB
#IFGain:Low
Radio Std: None
Radio Device: BTS
Ref Offset 10 dB
15 dB/div
Ref 40.00 dBm
Log
25.0
10.0
-5.00
-20.0
-35.0
-50.0
-65.0
-80.0
-95.0
Center 927.3 MHz
#Res BW 3 kHz
#VBW 10 kHz
Span 300 kHz
Sweep 40.87 ms
Occupied Bandwidth
60.983 kHz
Total Power 30.6 dBm
Transmit Freq Error -2.112 kHz
% of OBW Power 99.00 %
x dB Bandwidth 57.46 kHz
x dB -20.00 dB
MSG
STATUS

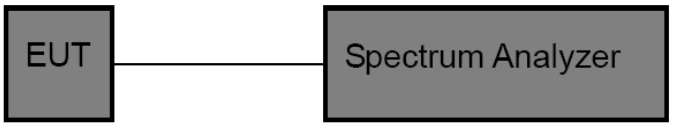
High

7. Carrier Frequency Separation Test

7.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (a)(1)
Test Limit	a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater

7.2. Test Setup



7.3. Test Procedure

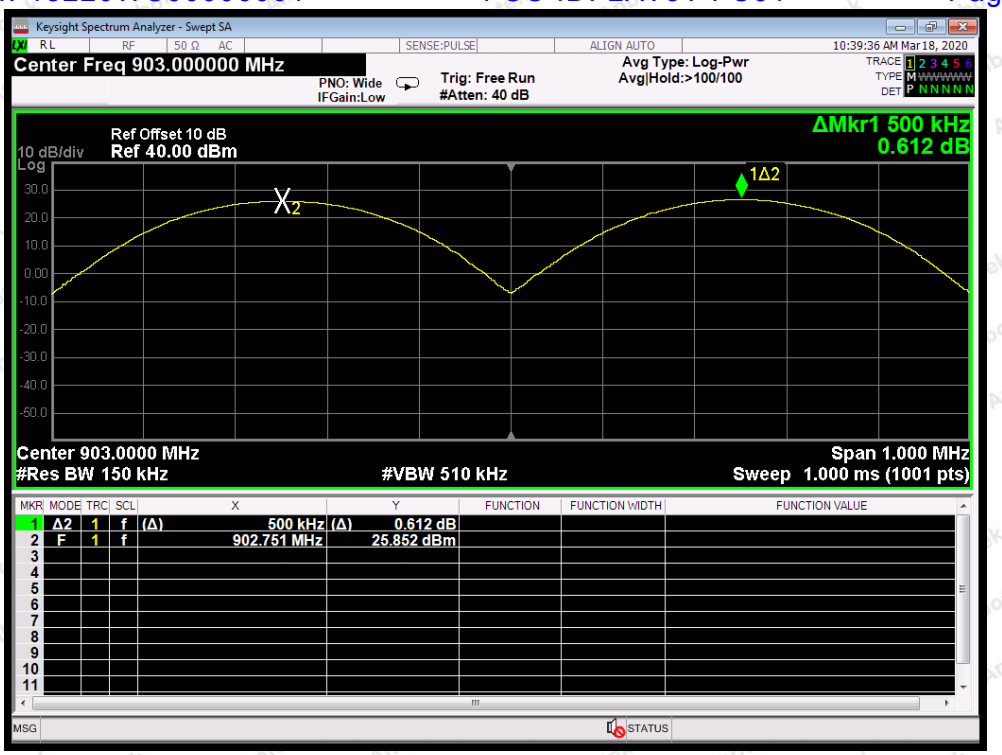
The EUT must have its hopping function enabled. Using the following spectrum analyzer settings:

1. Span= Wide enough to capture the peaks of two adjacent channels
2. Set the RBW = 30 kHz.
3. Set the VBW = 100 kHz.
4. Sweep time = auto couple.
5. Detector function = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.

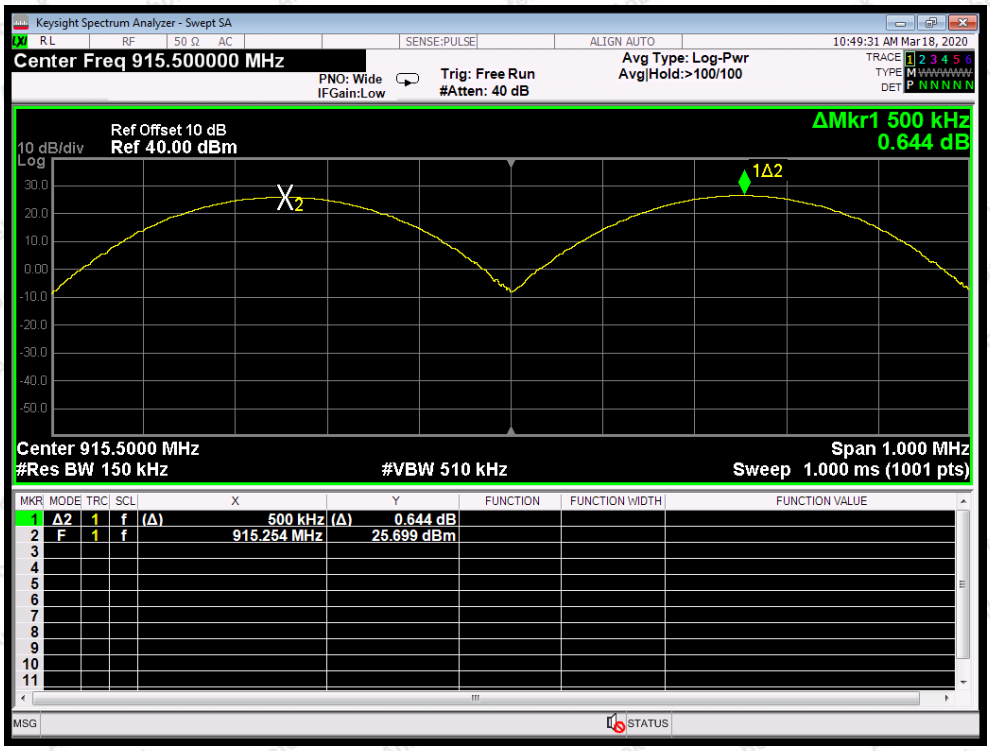
7.4. Test Data

Test Item	:	Frequency Separation	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

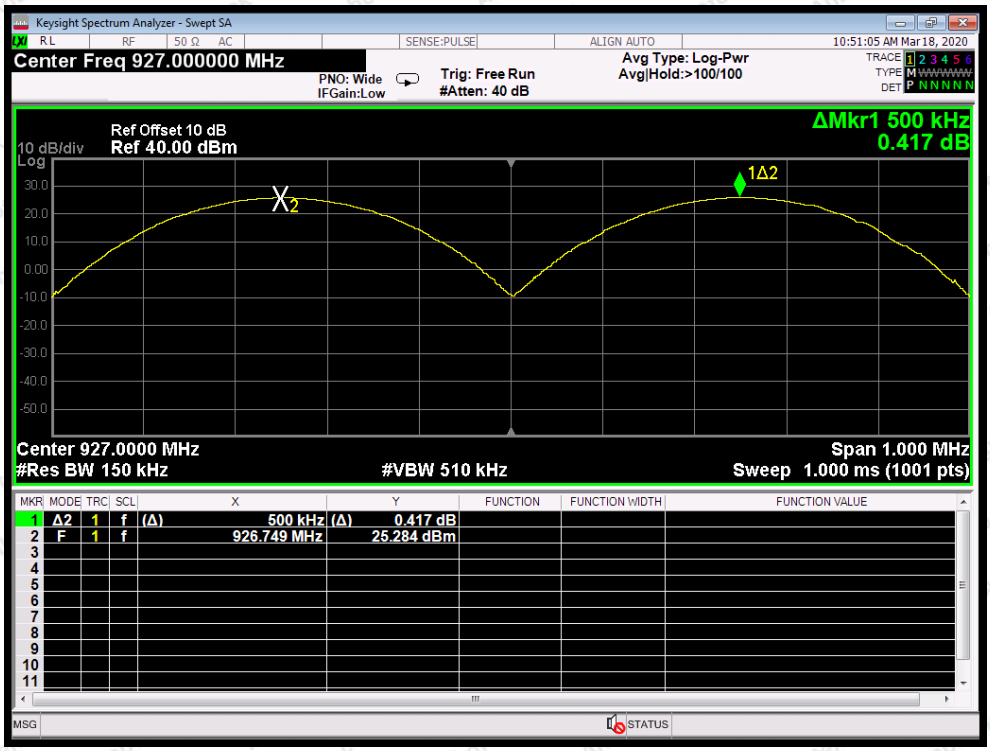
Channel	Frequency (MHz)	Separation Read Value (kHz)	Limit (kHz)	Verdict
Low Channel	902.75	500	58.17	PASS
Adjacency Channel	903.25			
Middle Channel	914.75	500	57.39	PASS
Adjacency Channel	915.25			
High Channel	927.25	500	57.46	PASS
Adjacency Channel	926.75			


Keysight Spectrum Analyzer - Swept SA
Center Freq 903.000000 MHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
10:39:36 AM Mar 18, 2020
Ref Offset 10 dB
10 dB/div
Ref 40.00 dBm
ΔMkr1 500 kHz
0.612 dB
Center 903.0000 MHz
#Res BW 150 kHz
#VBW 510 kHz
Span 1.000 MHz
Sweep 1.000 ms (1001 pts)
1 Δ2 1 f (Δ) 500 kHz (Δ) 0.612 dB
2 F 1 f 902.751 MHz 25.852 dBm

Low


Keysight Spectrum Analyzer - Swept SA
Center Freq 915.500000 MHz
PNO: Wide
IFGain:Low
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
10:49:31 AM Mar 18, 2020
Ref Offset 10 dB
10 dB/div
Ref 40.00 dBm
ΔMkr1 500 kHz
0.644 dB
Center 915.5000 MHz
#Res BW 150 kHz
#VBW 510 kHz
Span 1.000 MHz
Sweep 1.000 ms (1001 pts)
1 Δ2 1 f (Δ) 500 kHz (Δ) 0.644 dB
2 F 1 f 915.254 MHz 25.699 dBm

Middle


Keysight Spectrum Analyzer - Swept SA
Center Freq 927.000000 MHz
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
10:51:05 AM Mar 18, 2020
Ref Offset 10 dB
10 dB/div
Ref 40.00 dBm
ΔMkr1 500 kHz
0.417 dB
Center 927.0000 MHz
#Res BW 150 kHz
#VBW 510 kHz
Span 1.000 MHz
Sweep 1.000 ms (1001 pts)
1 Δ2 1 f (Δ) 500 kHz (Δ) 0.417 dB
2 F 1 f 926.749 MHz 25.284 dBm

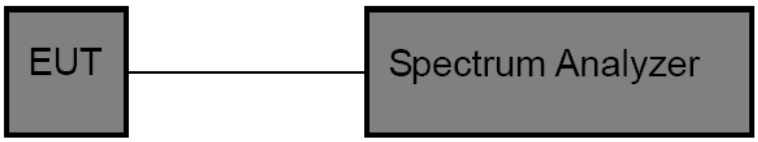
High

8. Number of Hopping Channel Test

8.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (a)(1)
Test Limit	≥50 channels

8.2. Test Setup



8.3. Test Procedure

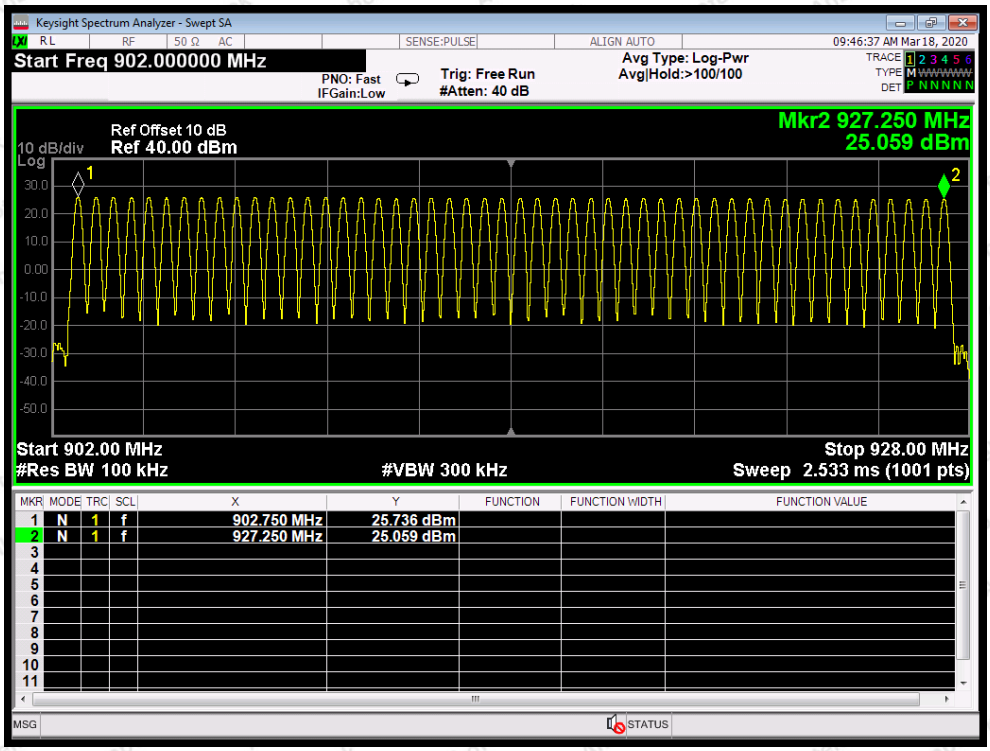
The EUT must have its hopping function enabled. Using the following spectrum analyzer setting:

1. Span= the frequency band of operation
2. Set the RBW = 100kHz.
3. Set the VBW = 300kHz.
4. Sweep time = auto couple.
5. Detector function = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.

8.4. Test Data

Test Item	:	Number of Hopping Frequency	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

Hopping Channel Frequency Range(MHz)	Quantity of Hopping Channel	Limit	Verdict
902.75-927.25	50	≥50	PASS

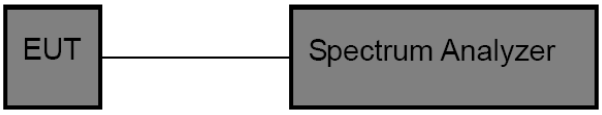

Keysight Spectrum Analyzer - Swept SA
Start Freq 902.000000 MHz
Trig: Free Run
#Atten: 40 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
09:46:37 AM Mar 18, 2020
Ref Offset 10 dB
10 dB/div
Ref 40.00 dBm
Mkr2 927.250 MHz
25.059 dBm
Start 902.00 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 928.00 MHz
Sweep 2.533 ms (1001 pts)
1 N 1 f 902.750 MHz 25.736 dBm
2 N 1 f 927.250 MHz 25.059 dBm

9. Dwell Time Test

9.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (a)(1)
Test Limit	0.4 sec

9.2. Test Setup



9.3. Test Procedure

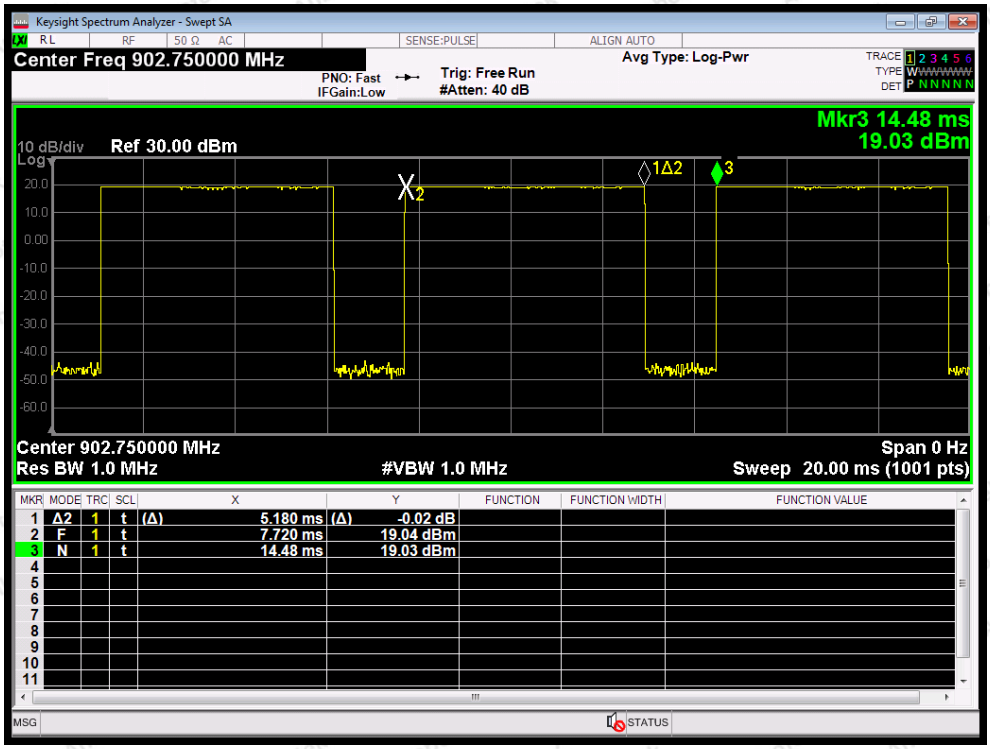
The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span= zero span, centered on a hopping channel
2. Set the RBW = 1 MHz.
3. Set the VBW = 1 MHz.
4. Sweep time = as necessary to capture the entire dwell time per hopping channel.
5. Detector function = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.

9.4. Test Data

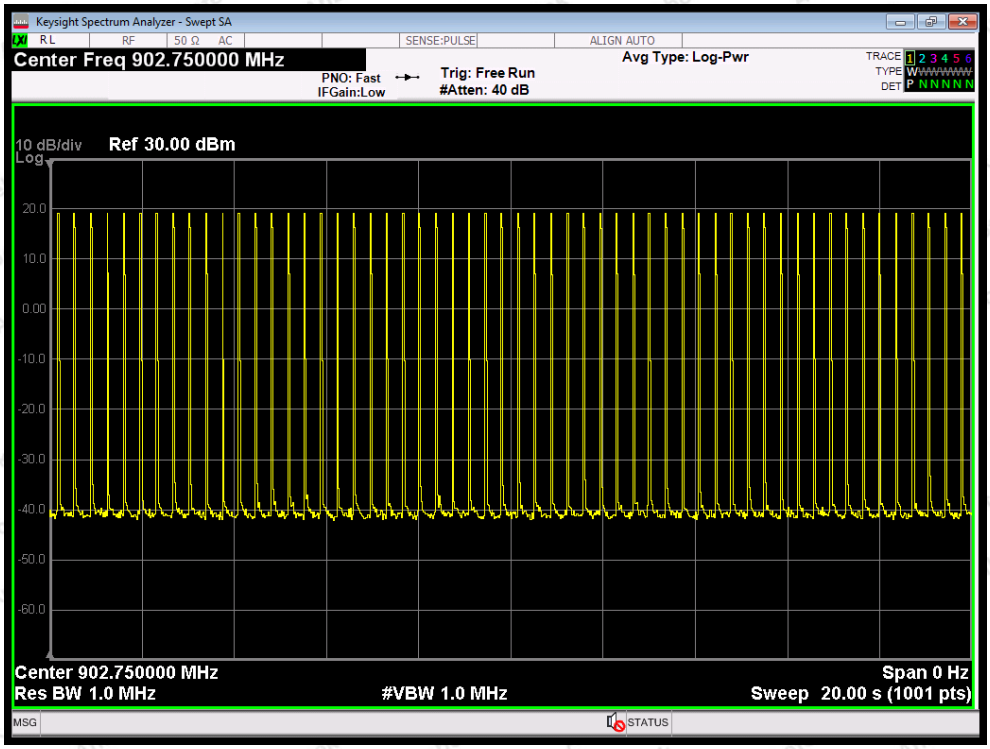
Test Item	:	Time of Occupancy	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

Frequency (MHz)	Test period (s)	Number of Bursts per Hopping Period	Burst Duration (ms)	Dwell time (s)	Limit (s)
902.75	20	56	5.180	0.29	0.4
915.25	20	56	5.040	0.28	0.4
927.25	20	56	5.020	0.28	0.4



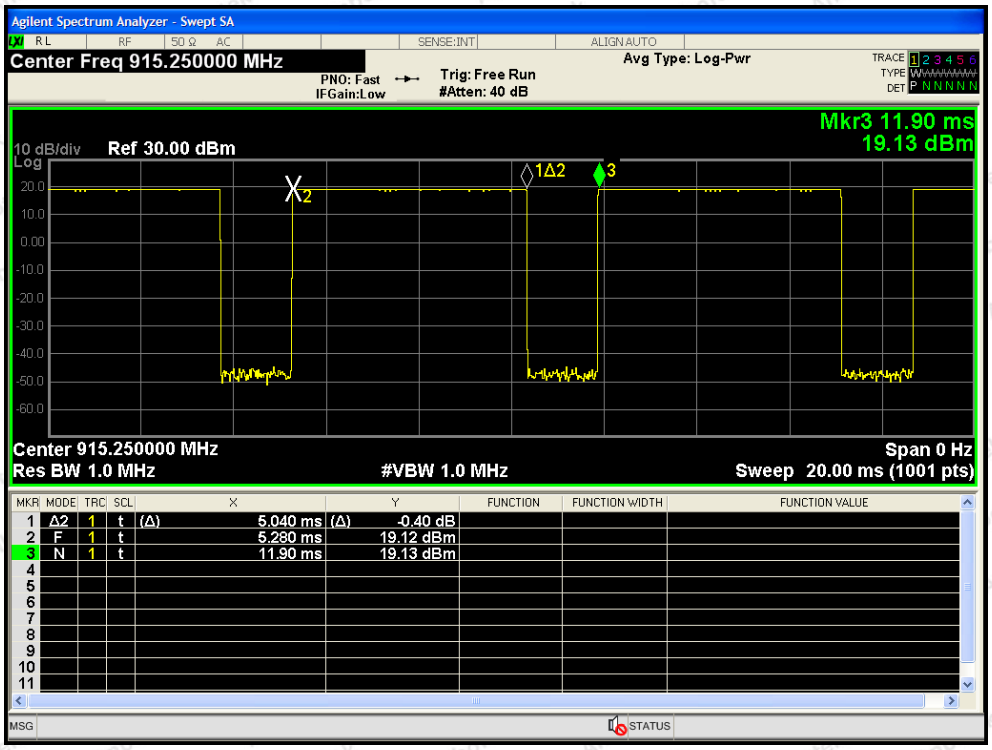
Low channel

Burst Durration



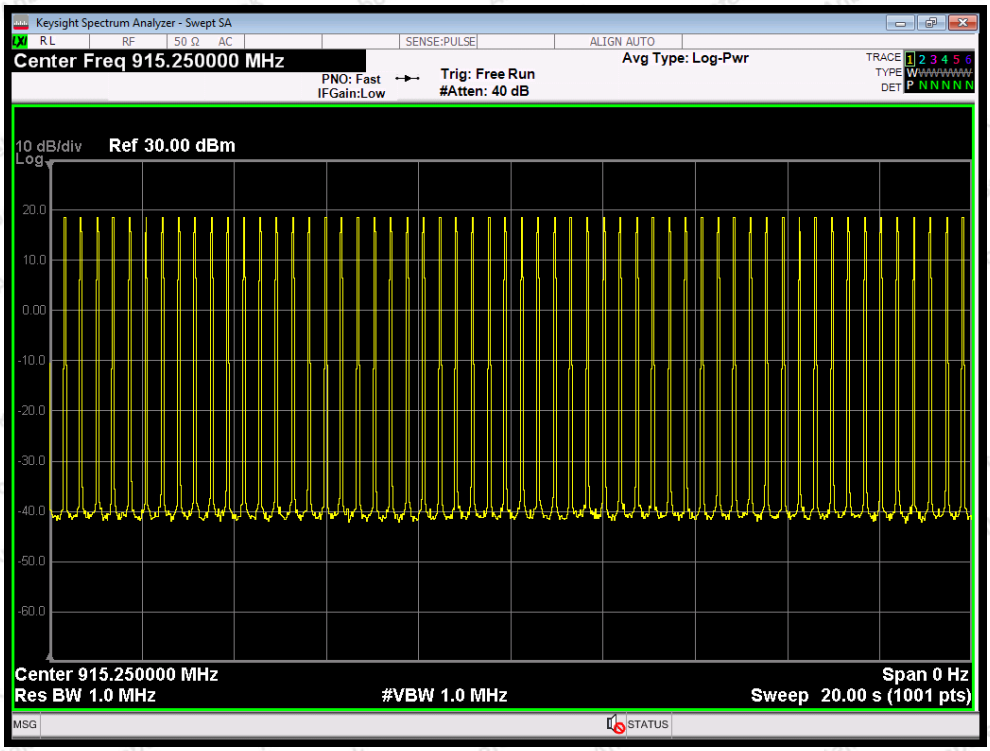
Low channel

Number of Bursts



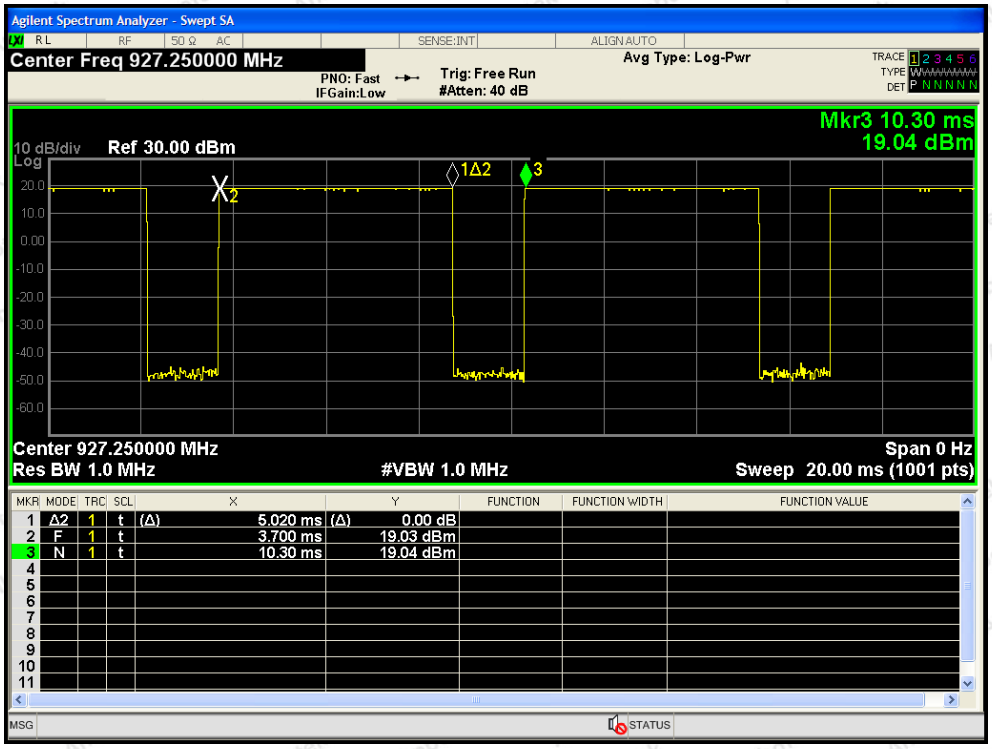
Middle channel

Burst Durration



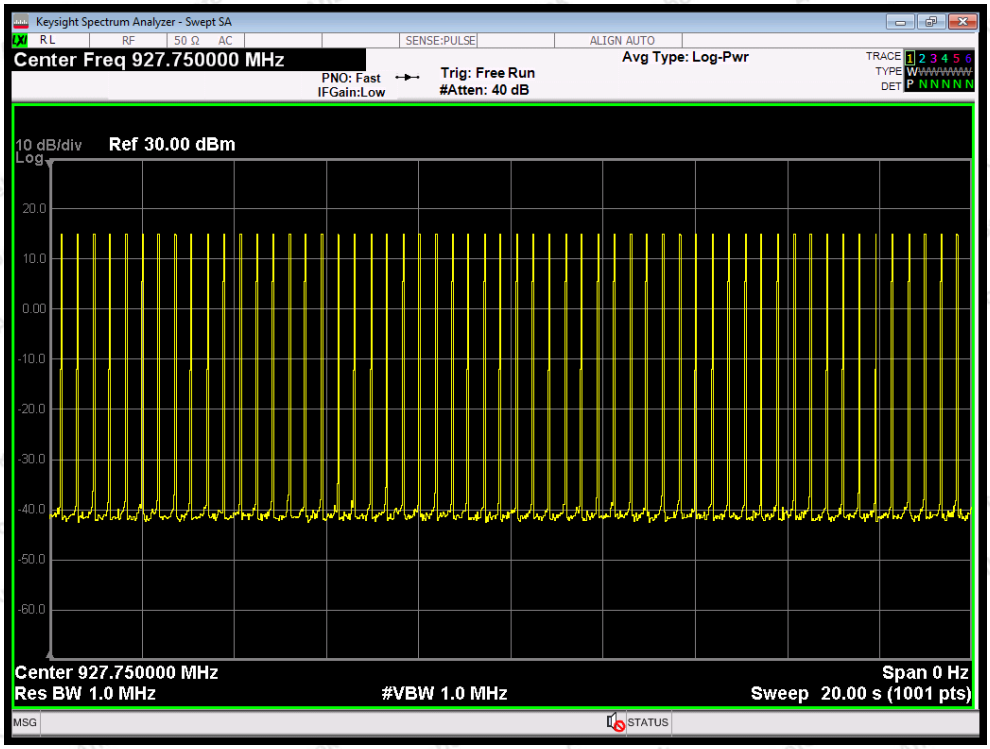
Middle channel

Number of Bursts



High channel

Burst Durration



High channel

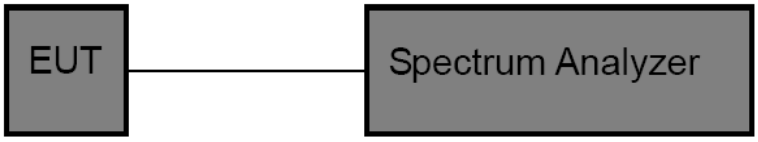
Number of Bursts

10. 100kHz Bandwidth of Frequency Band Edge Requirement

10.1. Test Standard and Limit

Test Standard	FCC Part15 C Section 15.247 (d)
Test Limit	in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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).

10.2. Test Setup



10.3. Test Procedure

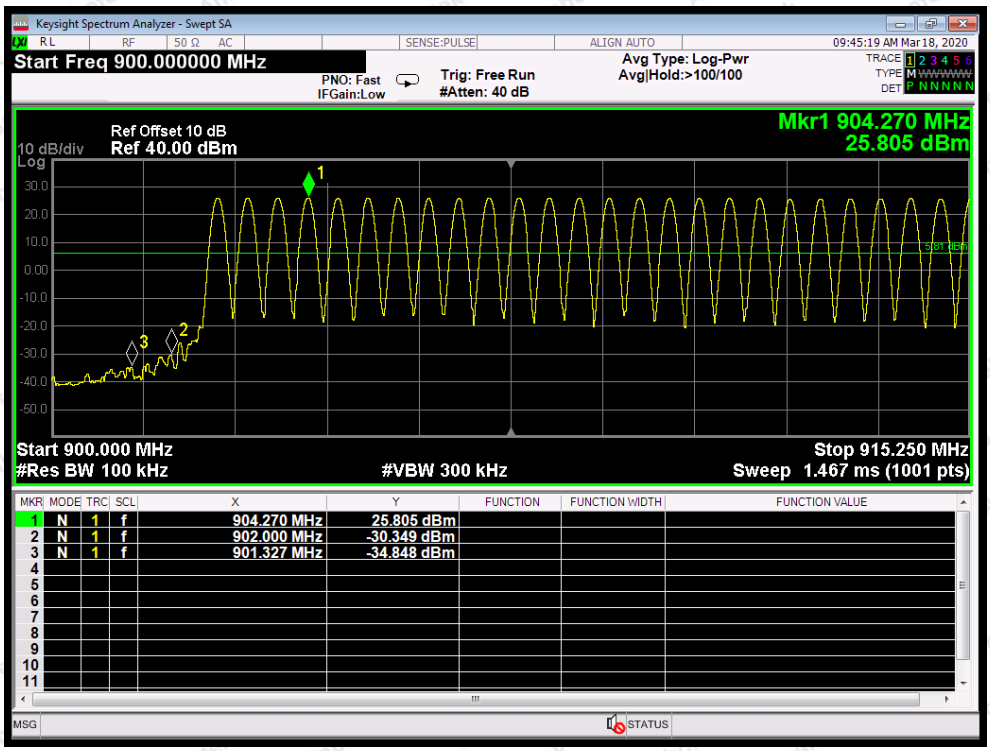
The EUT must have its hopping/Non-hopping function enabled. Using the following spectrum analyzer setting:

1. Set the RBW = 100kHz.
2. Set the VBW = 300kHz.
3. Sweep time = auto couple.
4. Detector function = peak.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.

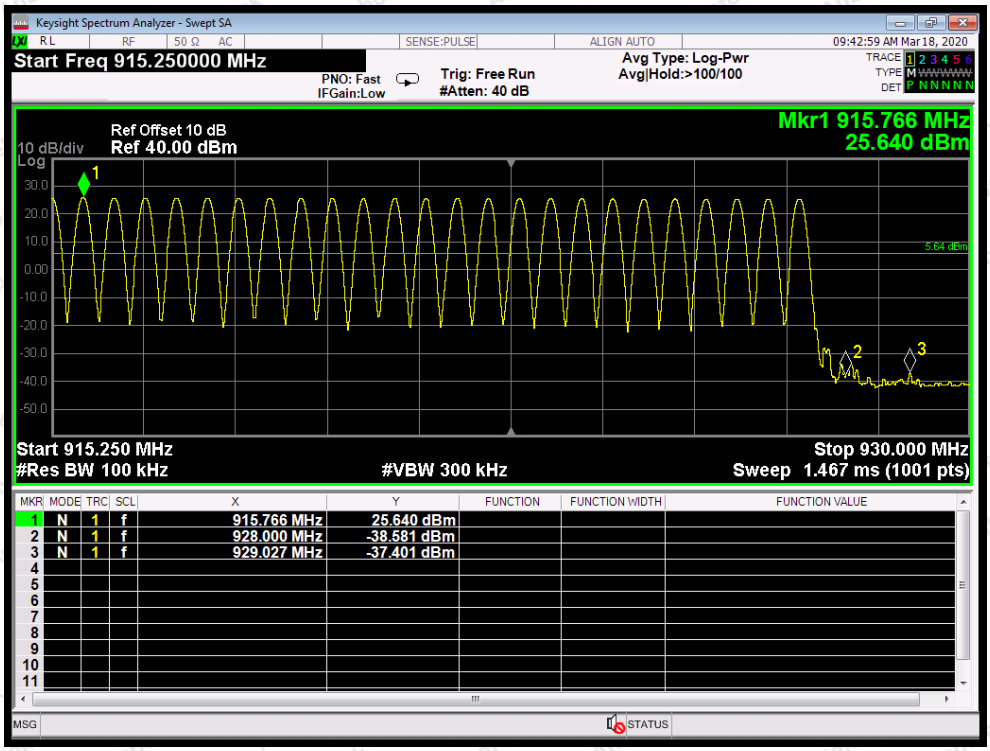
10.4. Test Data

Test Item	:	Band edge	Test Mode	:	CH Low ~ CH High
Test Voltage	:	AC 120V, 60Hz for MacBook Air	Temperature	:	23.1℃
Test Result	:	PASS	Humidity	:	52%RH

For Hopping Mode

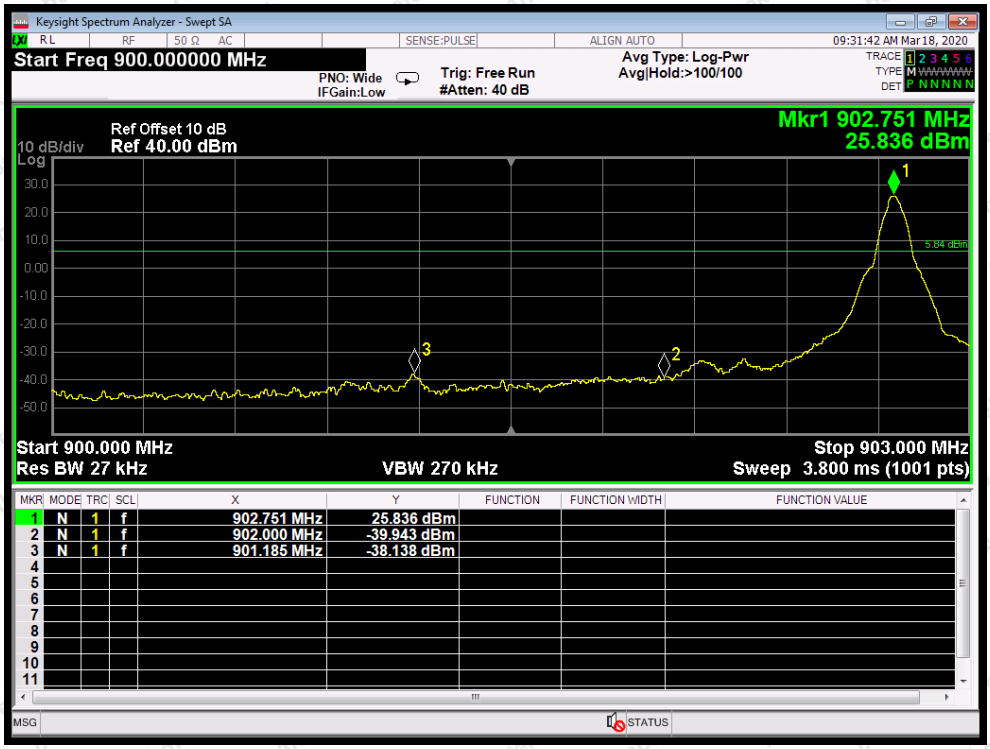


Lowest

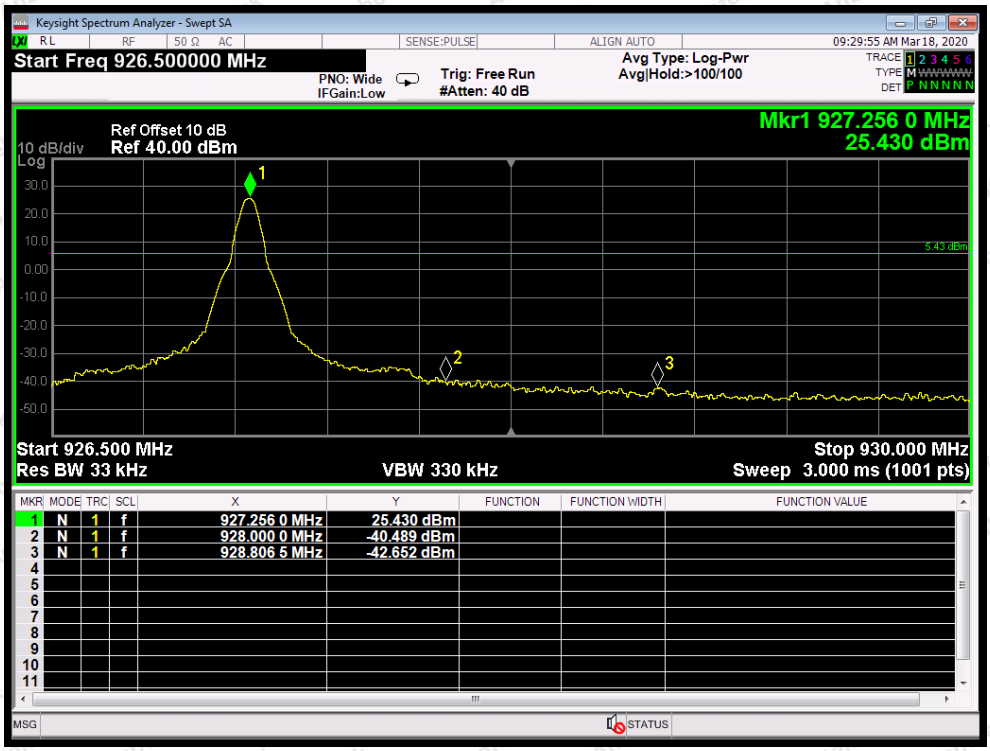


Highest

For Non-Hopping Mode

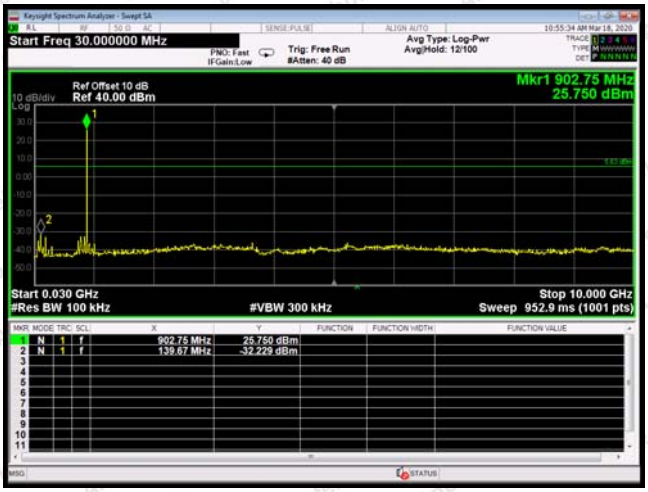


Lowest

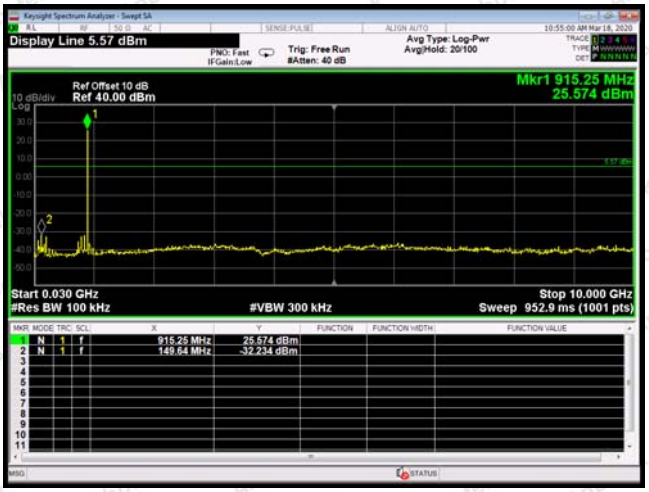


Highest

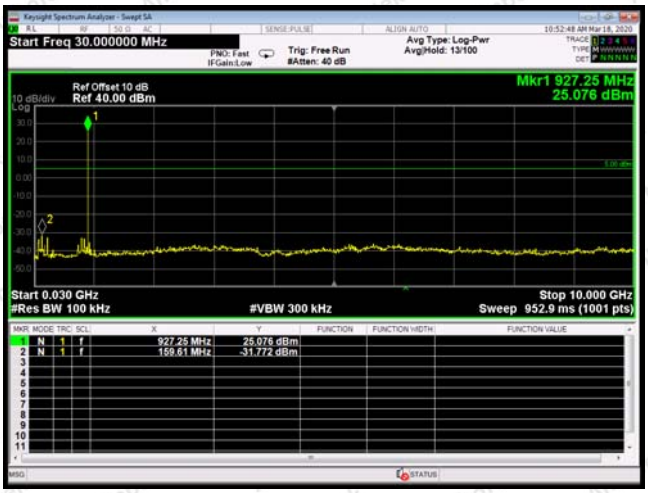
Conducted Emission Method



Low



Mid



High

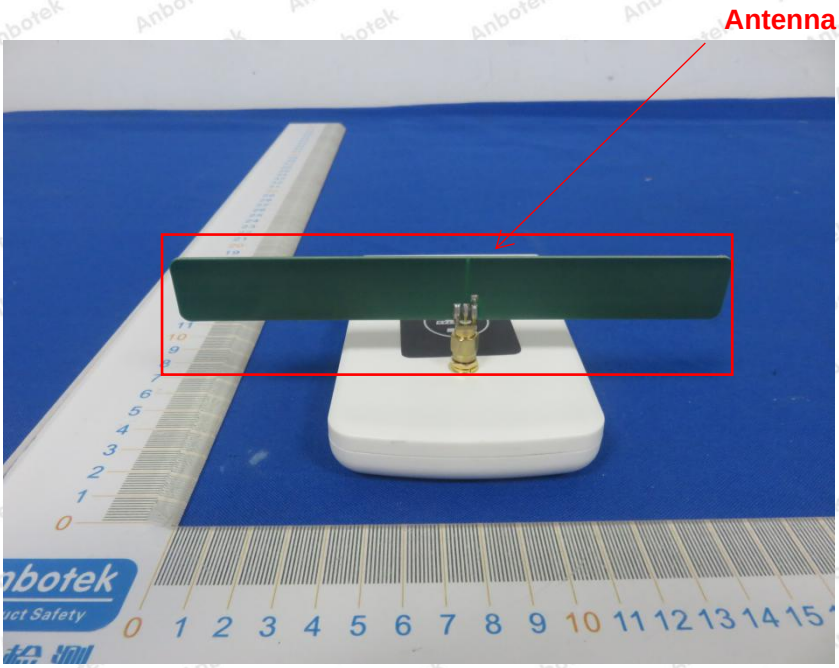
11. Antenna Requirement

11.1. 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

11.2. Antenna Connected Construction

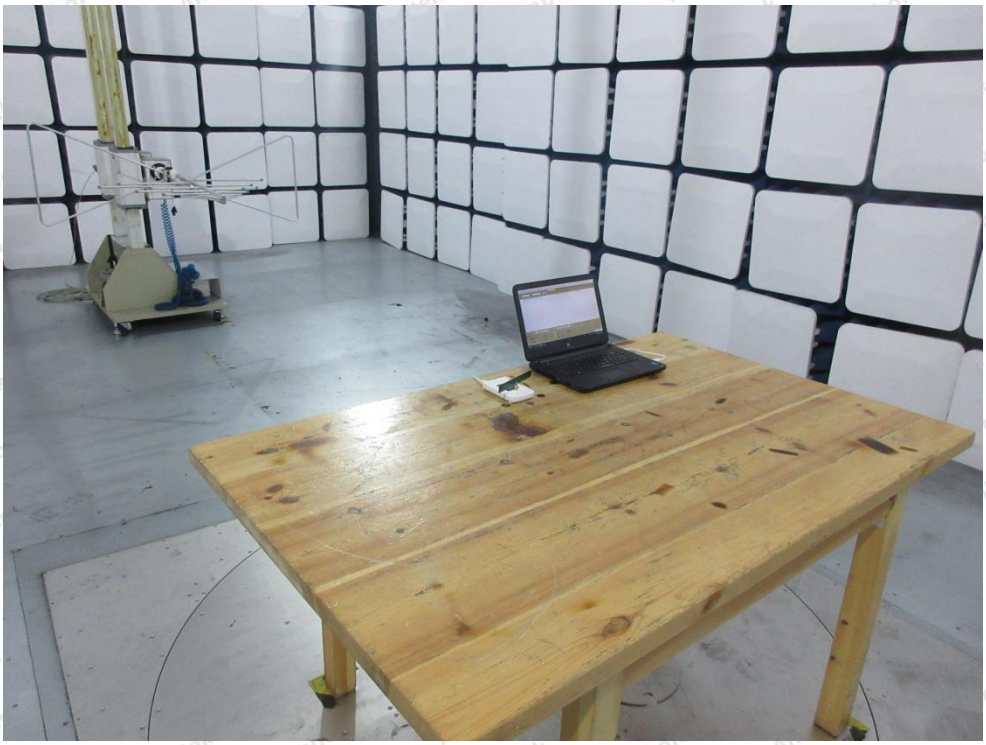
The antenna is PCB Antenna which permanently attached, and the best case gain of the antenna is 2 dBi. It complies with the standard requirement.

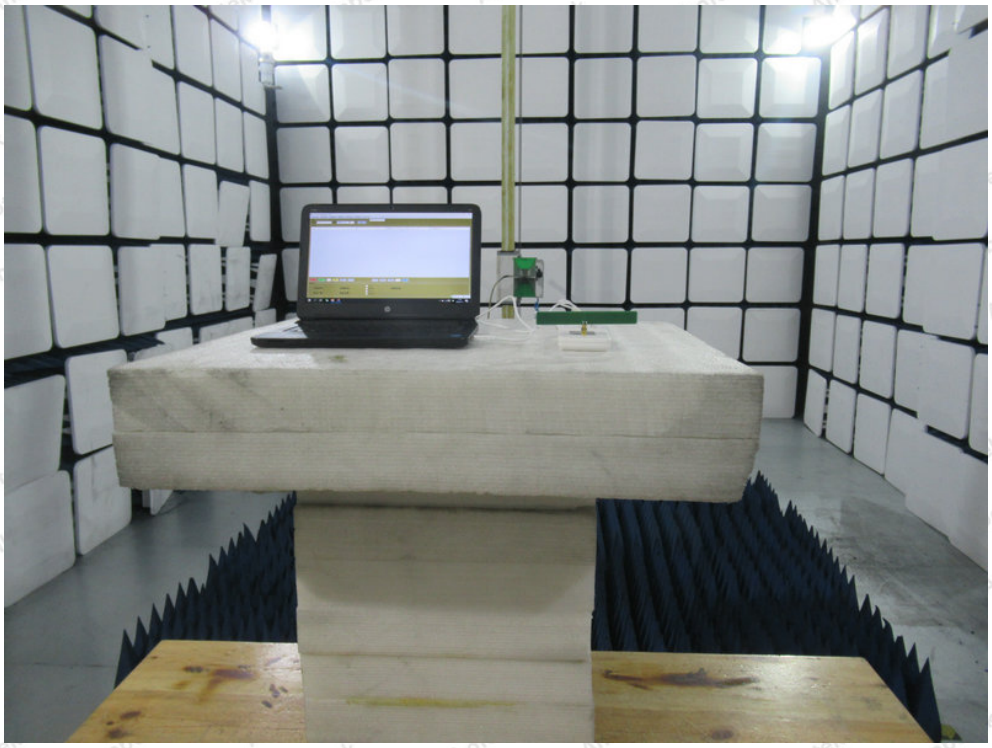


APPENDIX I -- TEST SETUP PHOTOGRAPH

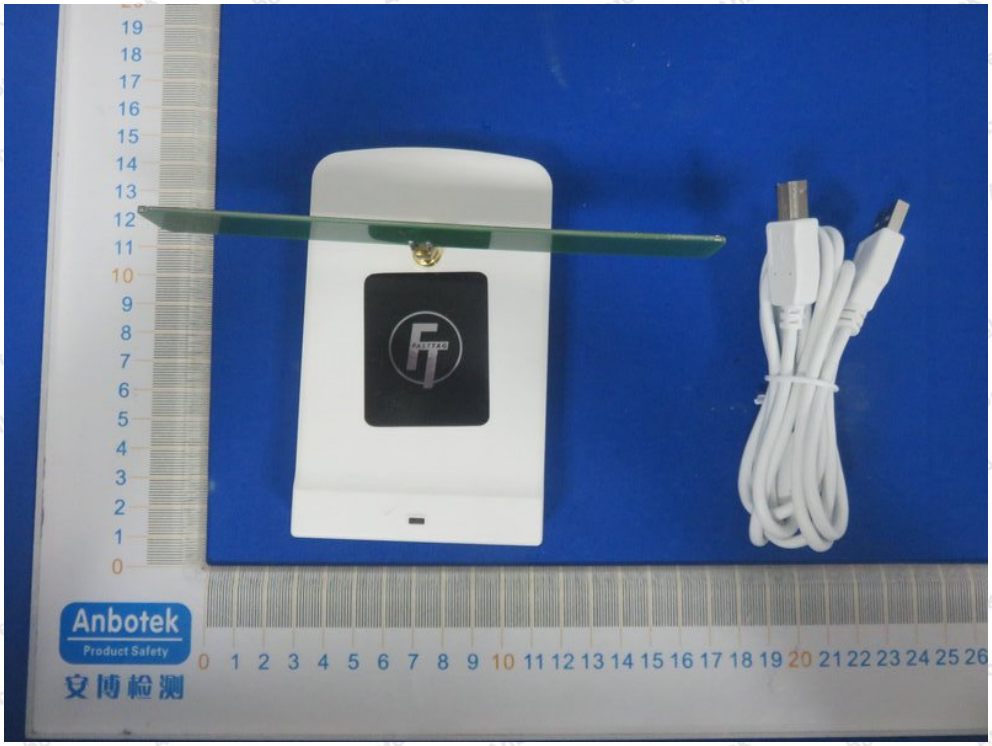
Photo of Conducted Emission Measurement

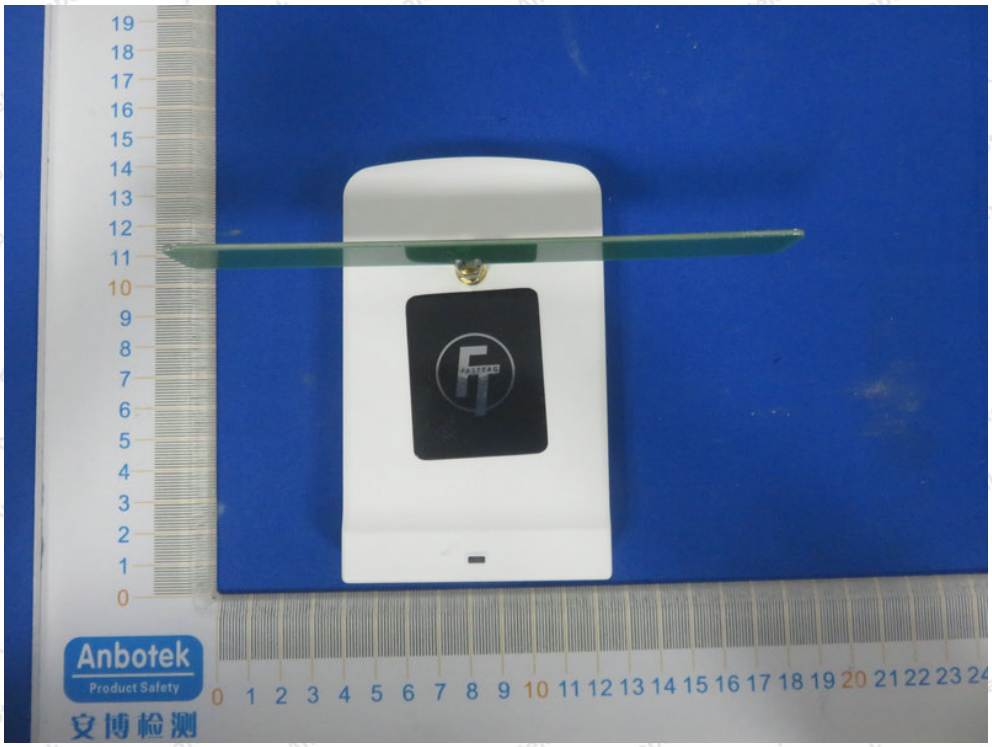
Photo of Radiation Emission Test





APPENDIX II -- EXTERNAL PHOTOGRAPH





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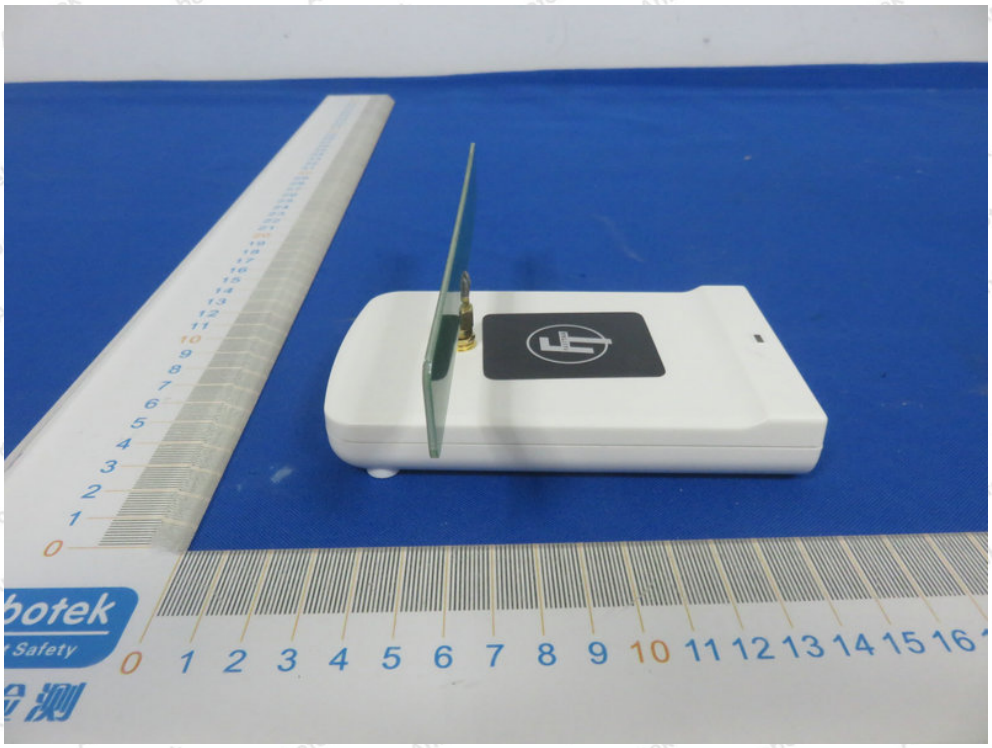
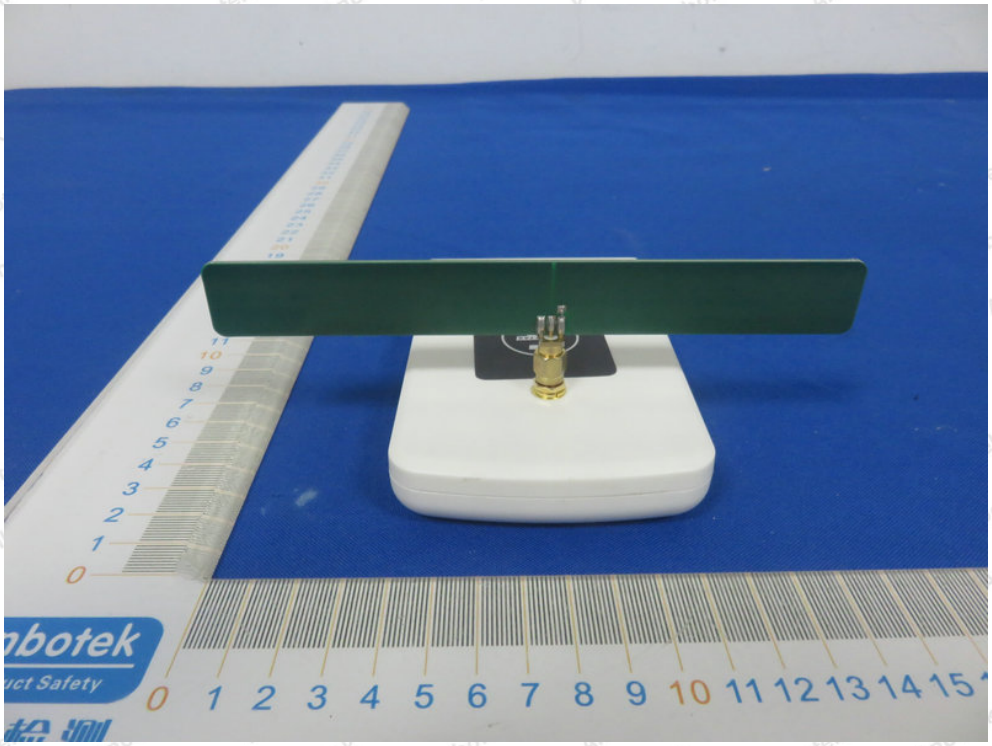
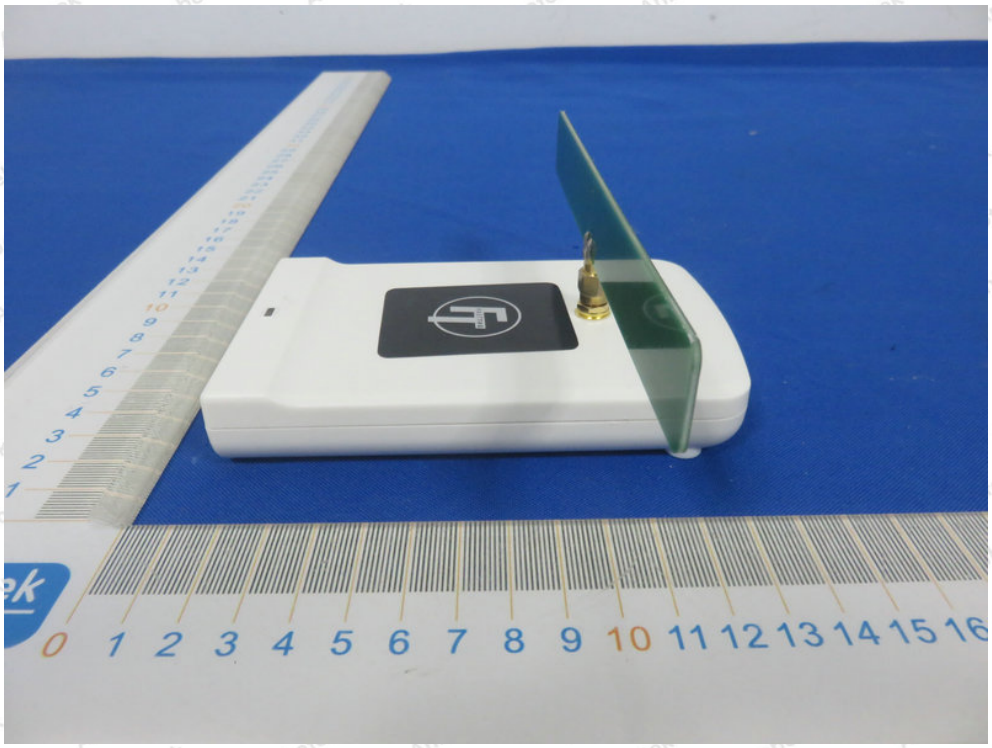
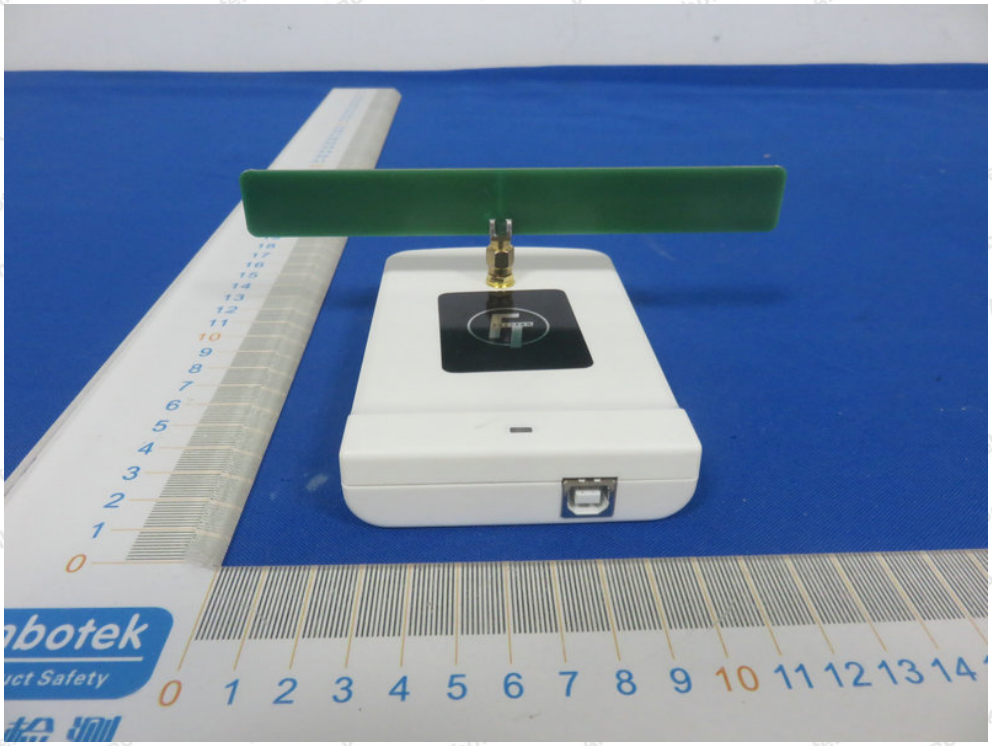
安博检测

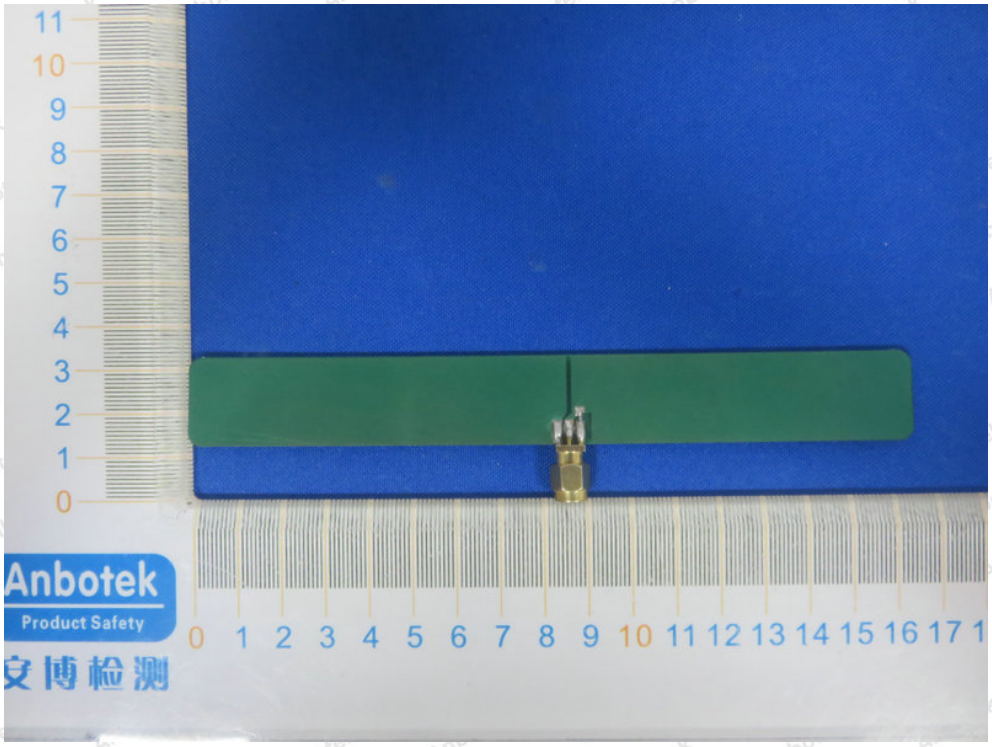


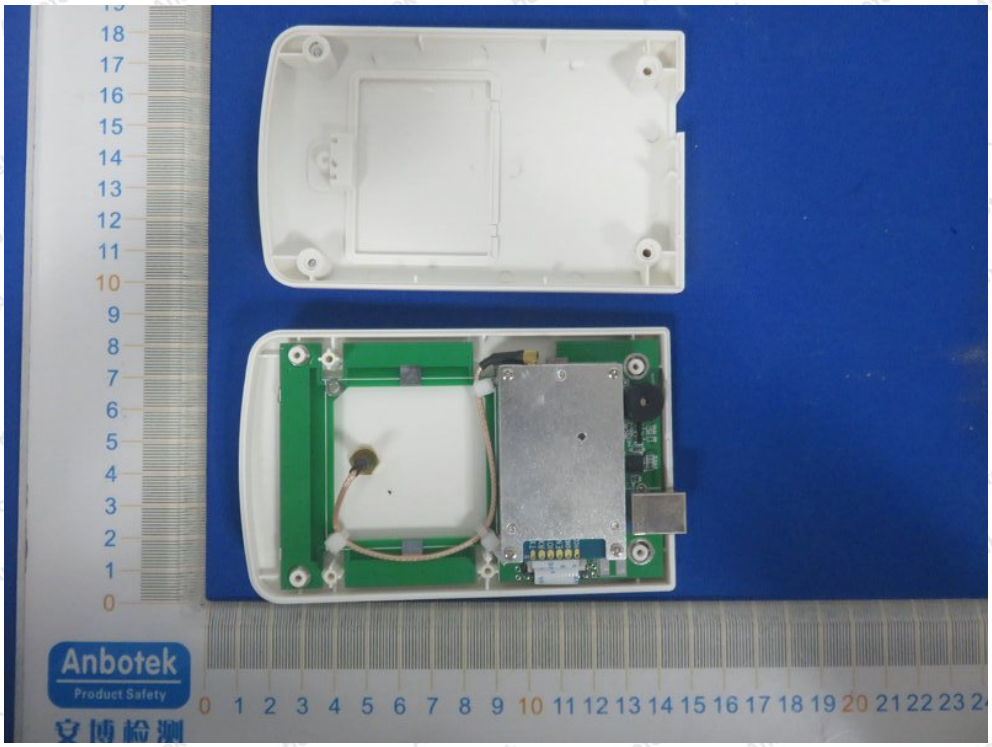


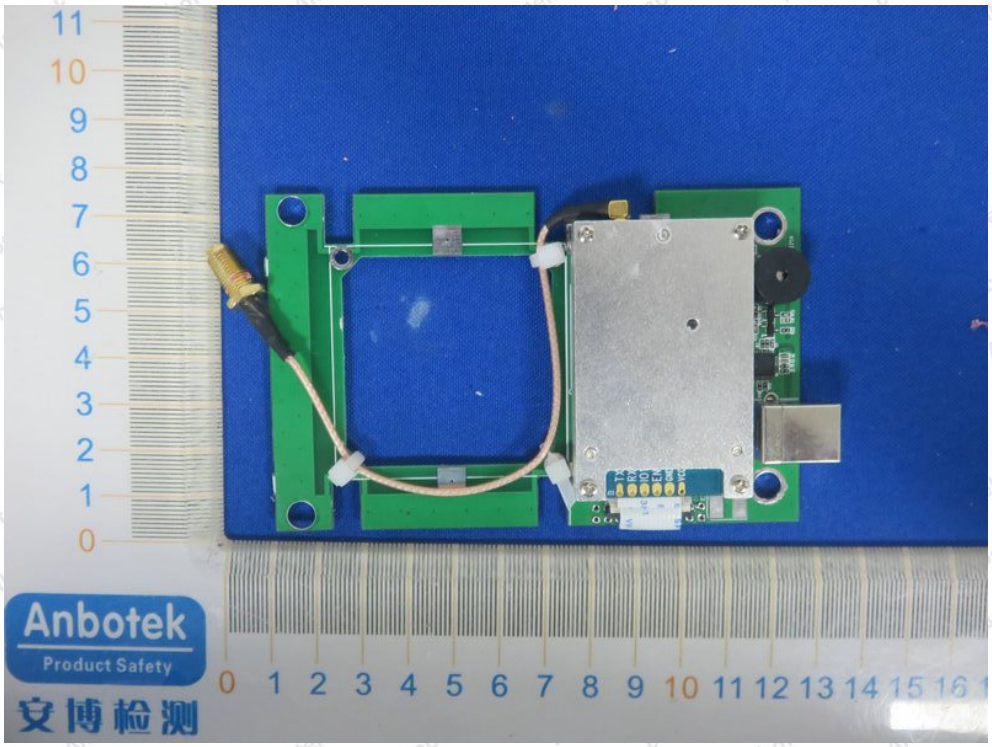




APPENDIX III -- INTERNAL PHOTOGRAPH



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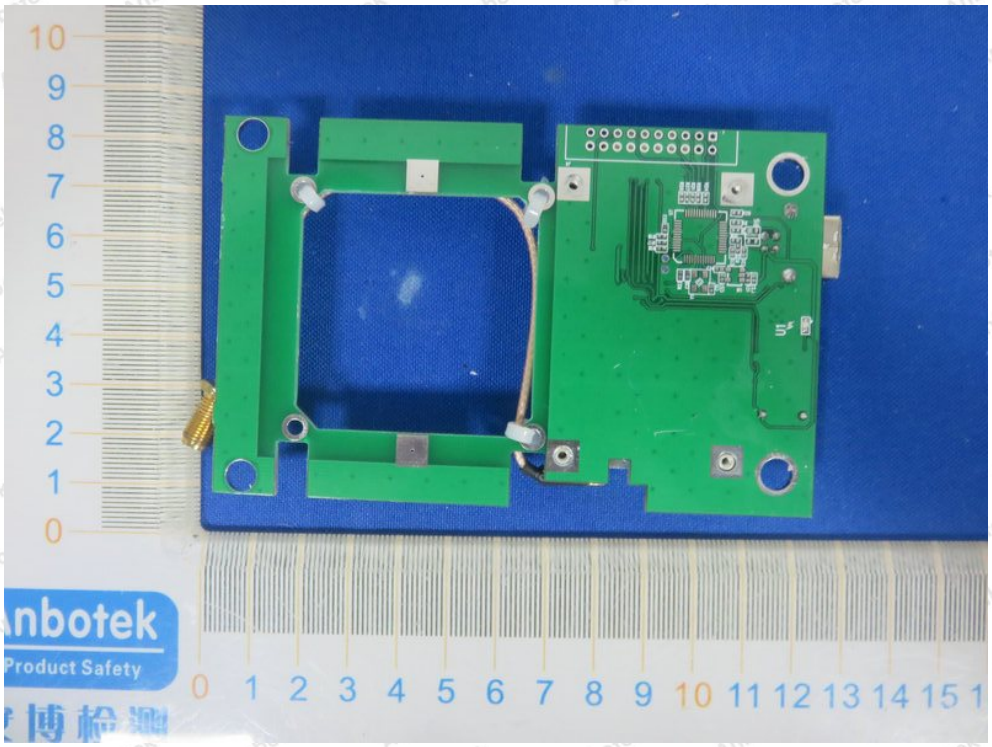
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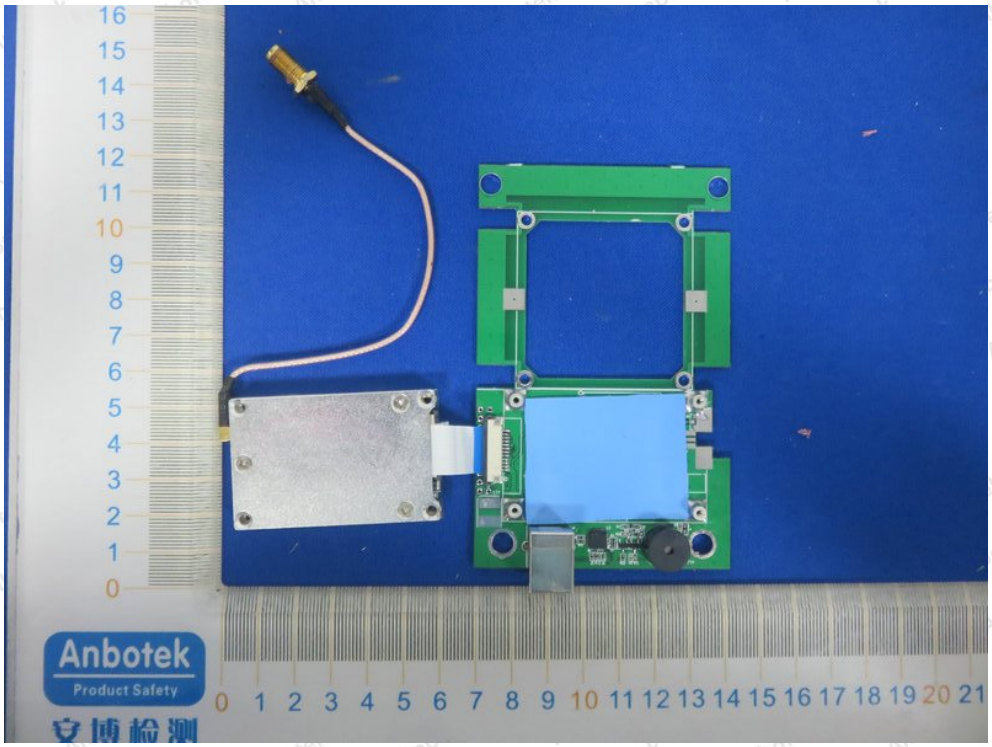
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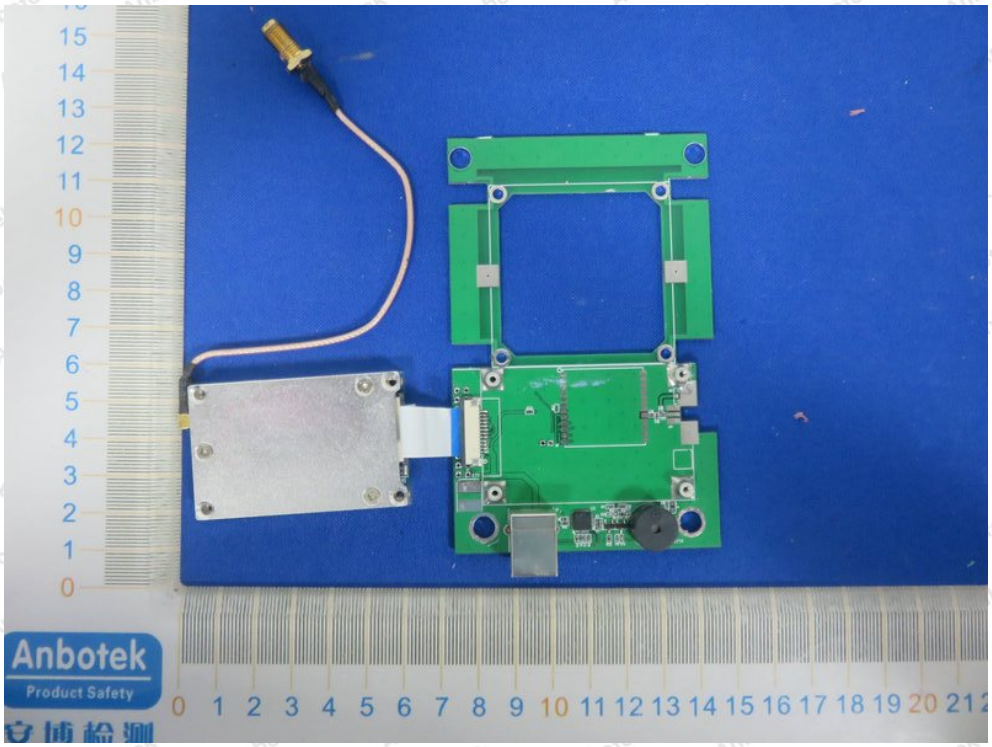
Product Safety
安博检测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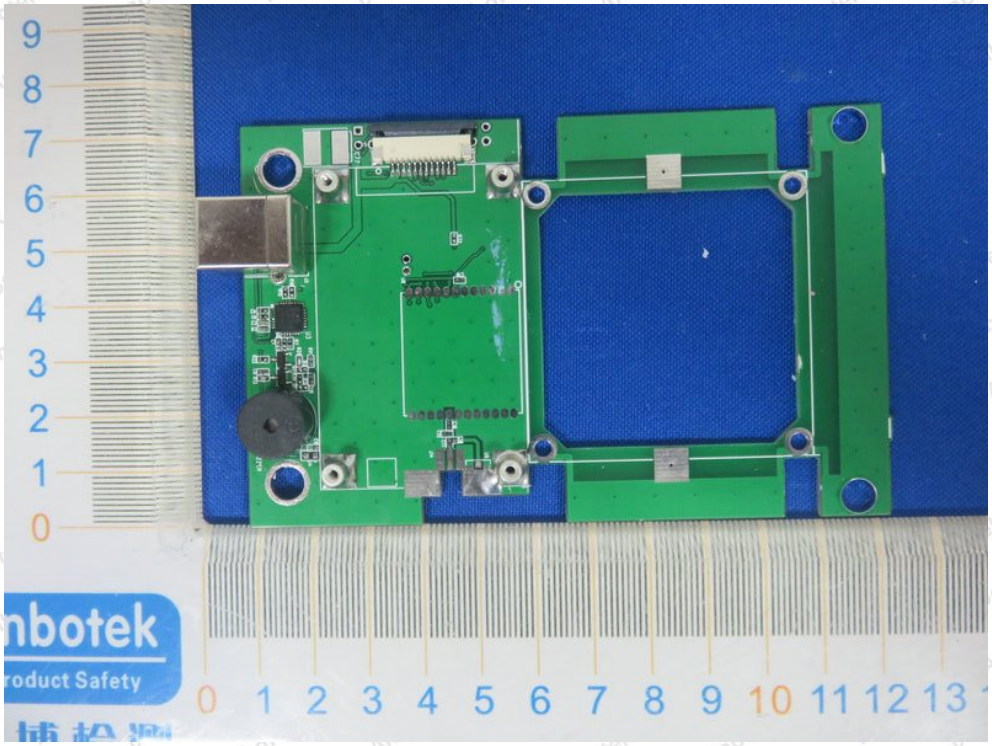

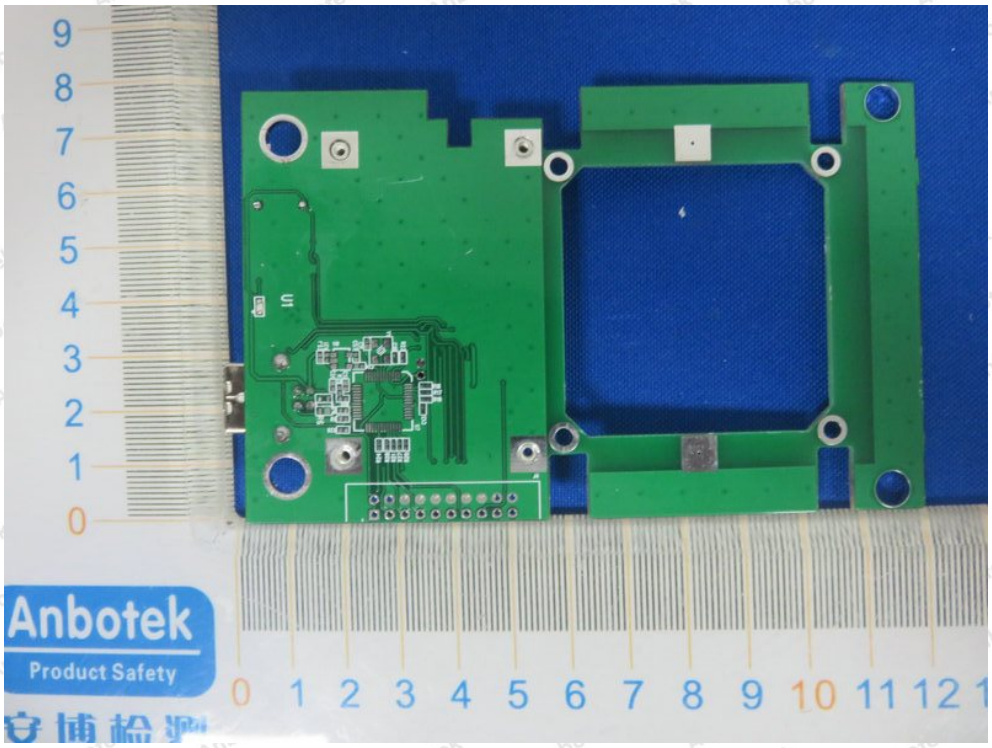

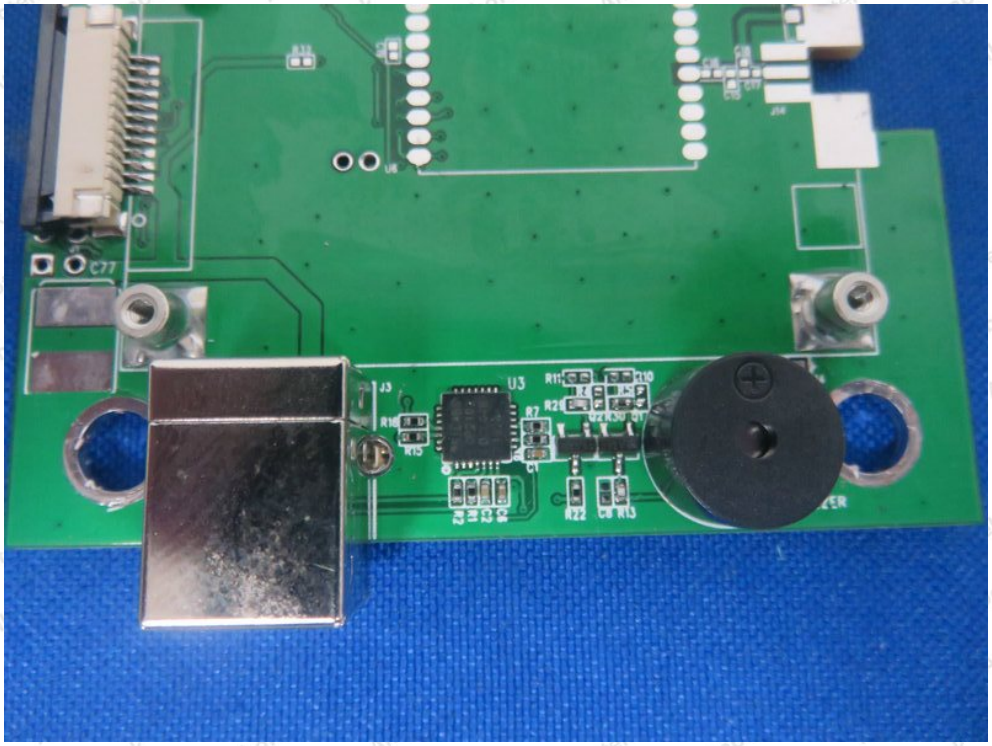

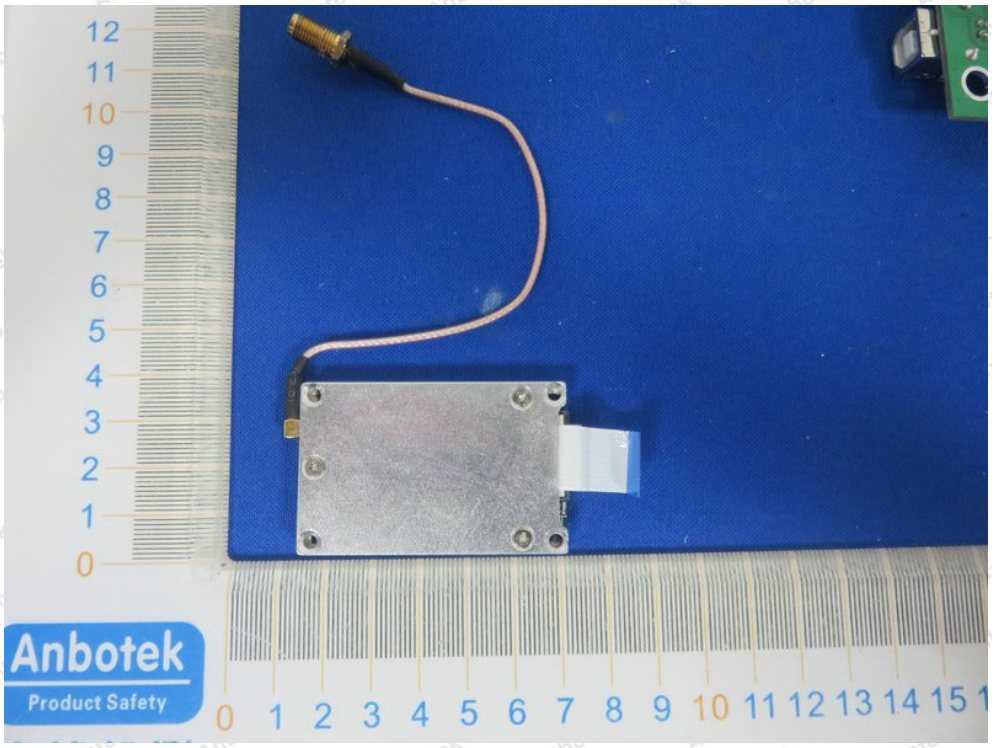

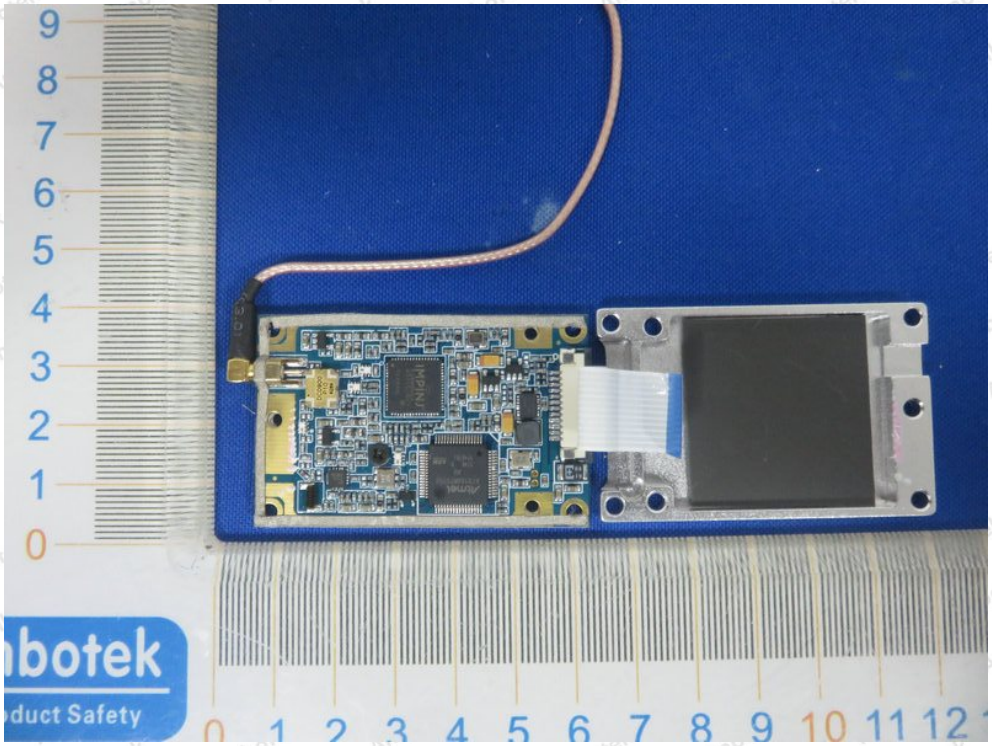

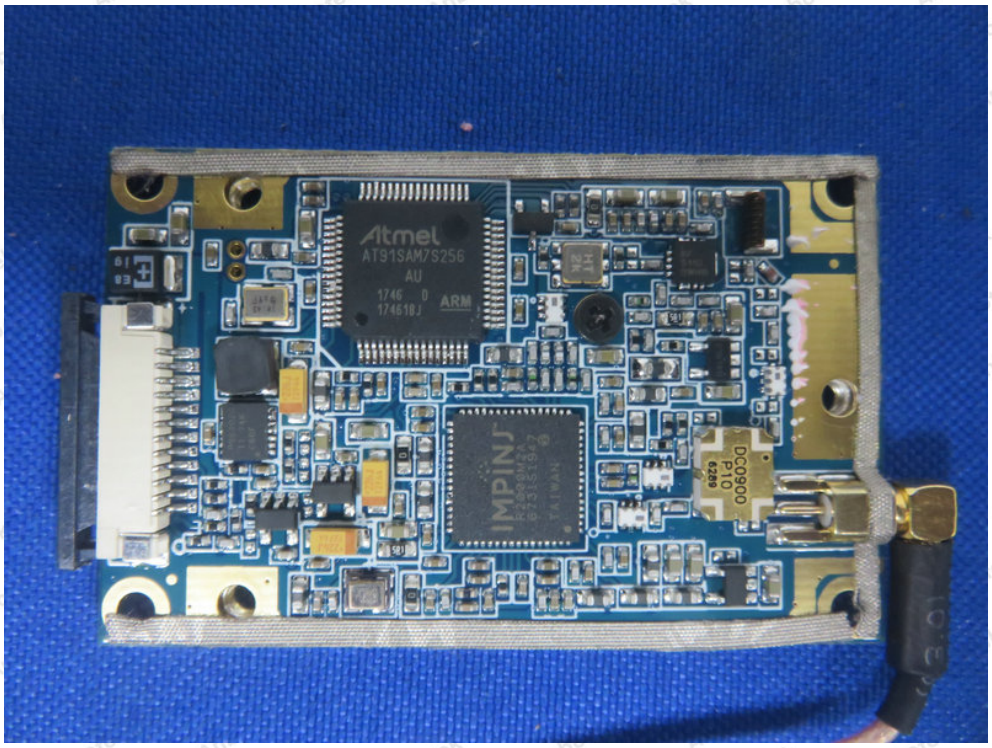
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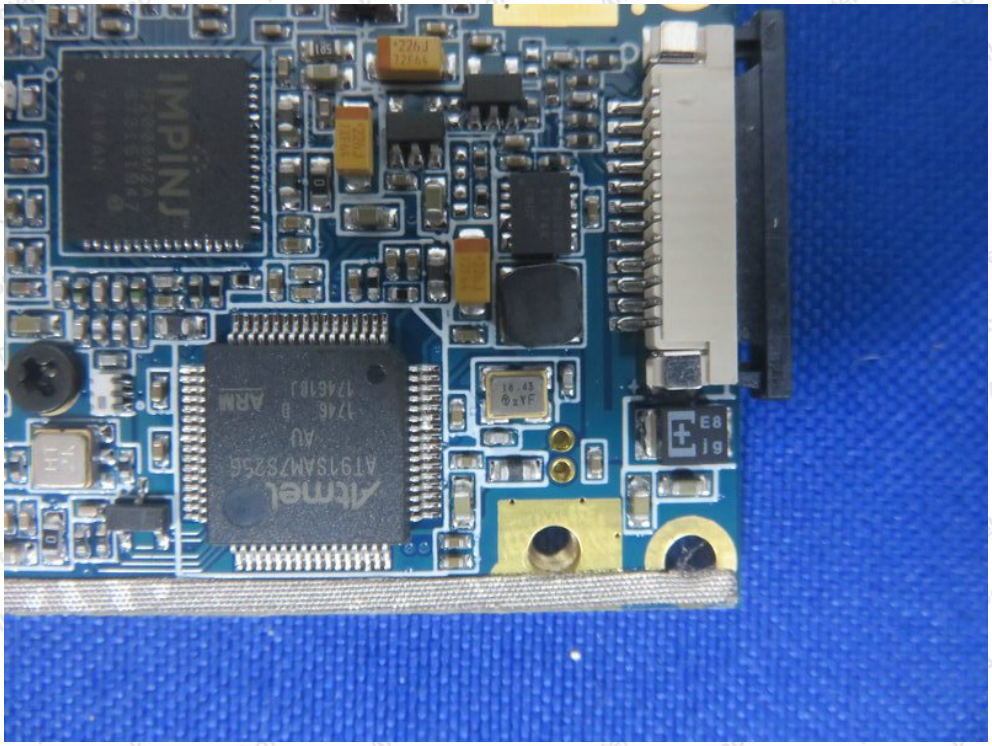
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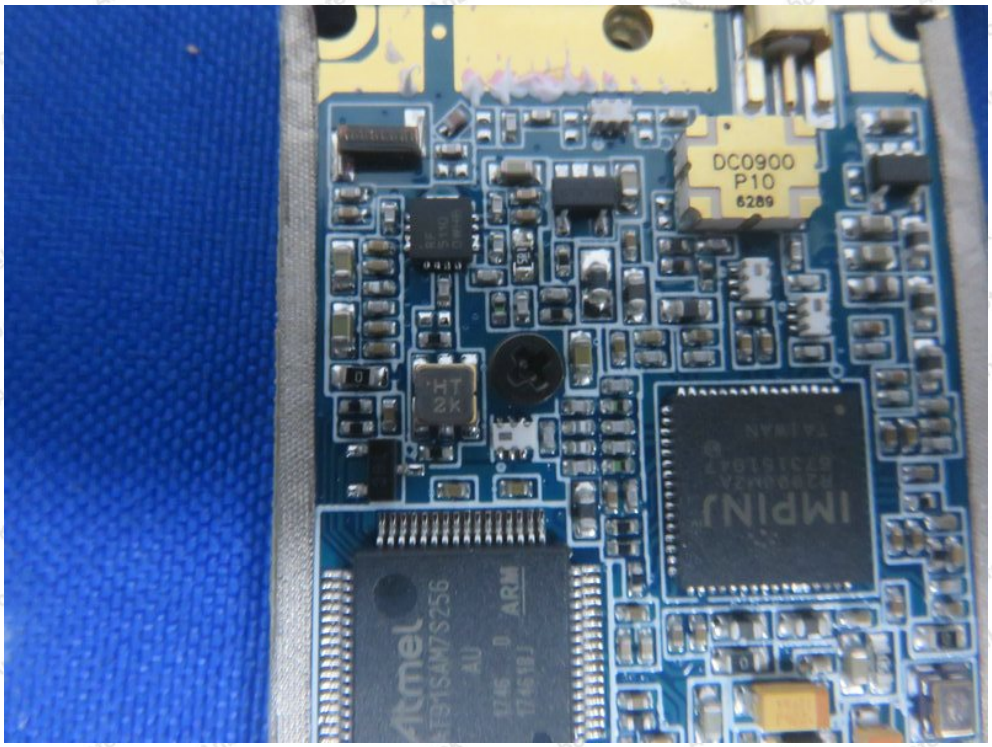
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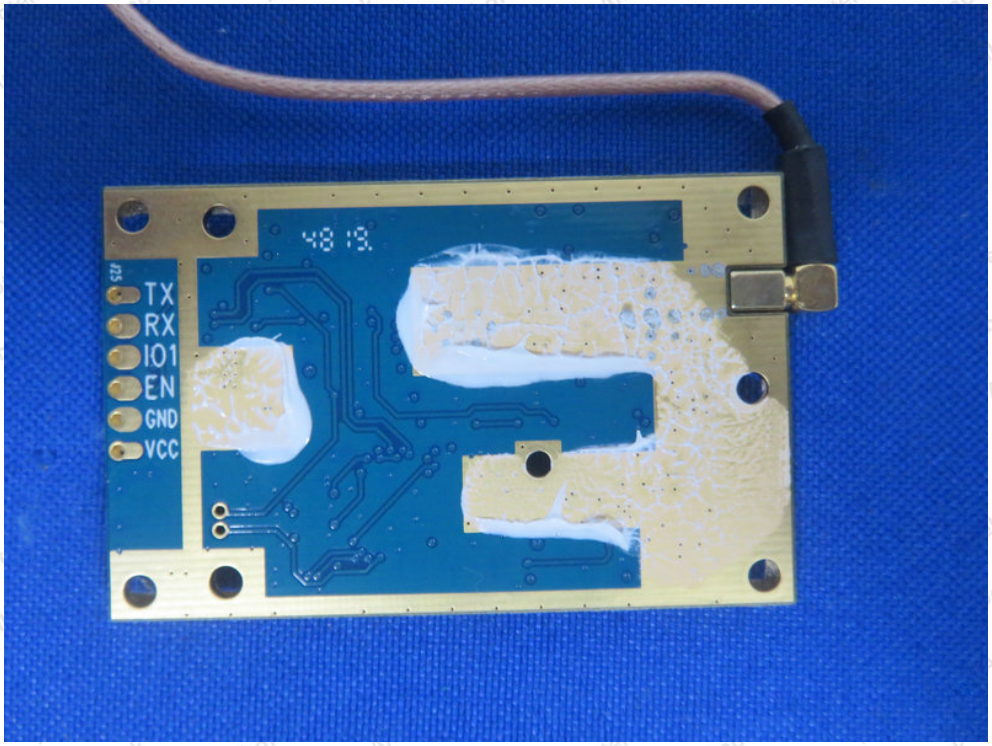

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