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EMC TEST REPORT

Product name.....:	Sense-U Dongle
Trademark .....:	Sense-U
Model no.....:	SU12014
Test Standards.....:	**FCC Part 15.249: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz and 24.0 - 24.25 GHz**
Applicant .....:	LEDO Network Inc.
Address of applicant.....:	560 S. Winchester Blvd, Suite 500, San Jose, CA, 95128
Date of Receipt .....:	April 02, 2014
Date of Test Date .....:	April 15, 2014 to April 23, 2014
Data of issue. .....:	April 25, 2014

Test result .....:	Pass

Testing Engineer : Mart Xiong
(Mart Xiong)

Reviewed By: : Tony Wang
(Tony Wang)

Approved Signatory : Walter Chen
(Walter Chen)

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1. TEST SUMMARY

The tests were performed according to following standards:

47 CFR FCC Rules Part 15.249: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz and 24.0 - 24.25 GHz.
ANSI C63.10: 2009 – American National Standard for Teating Unlicensed Wireless Devices

FCC Part 15 15.249 Requirement		
FCC Rules	Description of Test	Result
§15.109, §15.205(a), §15.209(a),15.249(a), §15.249(c), §15.35	Radiated Emissions	PASS
§15.207(a)	Conduction Emissions	PASS
§15.249(d)	Out of Band Emissions	PASS
§15.215(c)	20 dB Bandwidth	PASS
§15.203	Antenna Requirement	PASS

Remark: The measurement uncertainty is not included in the test result.

1.1TEST FACILITY

1.1.1 Address of the test laboratory
Shenzhen GTI Technology Co., Ltd
1F, 2 Block, Jiaquan Building, Guanlan High-tech Park Baoan District, Shenzhen, Guangdong, China

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

IC Registration No.: 9783A

The 3m alternate test site of Shenzhen GTI Technology Co., Ltd.EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration NO.: 9783A on Aug, 2011.

FCC-Registration No.: 214666

Shenzhen GTI Technology Co., Ltd. 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 214666, Sep 19, 2011

1.1.3 Environmental conditions
During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 ° C
Humidity:	30-60 %
Atmospheric pressure:	950-1050mbar

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 Items	Measurement Uncertainty	Notes
Transmitter power conducted	0.57 dB	(1)
Conducted spurious emission 9KHz-40 GHz	1.60 dB	(1)
Radiated Emission 9KHz~30MHz	3.85 dB	(1)
Conducted Emission 9KHz-30MHz	3.39 dB	(1)
Radiated Emission 30~1000MHz	4.24 dB	(1)
Radiated Emissio 1~25GHz	5.16 dB	(1)
Occupied Bandwidth	---------	(1)

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Name of EUT	**Sense-U Dongle**
Model Number	SU12014
Adding Model(s):	/
Model Difference:	/
Antenna Type	PCB antenna
2.4GHz Operation frequency	2402MHz-2480MHz with five fix channels
2.4GHz Modulation Type	GFSK(other protocal)

Note:

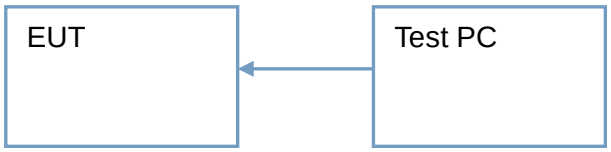
1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.2 DESCRIPTION OF TEST MODES

Following transmitting channels are provided to the EUT. Channel00/19/39 were selected for test.

Channel	Frequency(MHz)
1	**2402**
2	2420
3	**2440**
4	2460
5	**2480**

2.3 DESCRIPTION OF TEST SETUP



2.4 DESCRIPTION TEST PERIPHERAL AND EUT PERIPHERAL

Description	Equipment	Manufacturer	Model No.
Test PC	Notebook	IBM	T43

2.5 MEASUREMENT INSTRUMENTS LIST

20dB Bandwidth					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Rohde&Schwarz	FSP	1164.4391.40	Oct 25,2014
2	Climate Chamber	ESPEC	EL-10KA	05107008	Oct 25,2014

Radiated Emissions / Band Edge Measurement					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	EMI Test Receiver	R&S	ESCI	100658	Dec 26, 2014
2	High pass filter	Compliance Direction systems	BSU-6	34202	Oct 25,2014
3	Log-Bicon Antenna	Schwarzbeck	CBL6141A	4180	Dec 27, 2014
4	Ultra-Broadband Antenna	ShwarzBeck	BBHA9170	25841	Dec 27, 2014
5	Loop Antenna	LAPLAC INSTRUMENTS LTD	RF300	9138	Nov 15,2014
6	Spectrum Analyzer	HP	8563E	02052	Dec 27, 2014
7	Horn Antenna	Schwarzbeck	BBHA 9120D	648	Dec 27, 2014
8	Pre-Amplifier	HP	8447D	1937A03050	Dec 26, 2014
9	Pre-Amplifier	EMCI	EMC051835	980075	Dec 27, 2014
10	Antenna Mast	UC	UC3000	N/A	N/A
11	Turn Table	UC	UC3000	N/A	N/A

3. TEST CONDITIONS AND RESULTS

3.1 Radiated Emission

3.1.1 Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.

The frequency spectrum above 1 GHz for Transmitter was investigated. All emission not reported are much lower than the prescribed limits. Set the RBW=1MHz,VBW=3MHz for Peak Detector while the RBW=1MHz,VBW=10Hz for Average Detector,Readings are both peak and average values. The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

3.1.2 Test Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL – AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

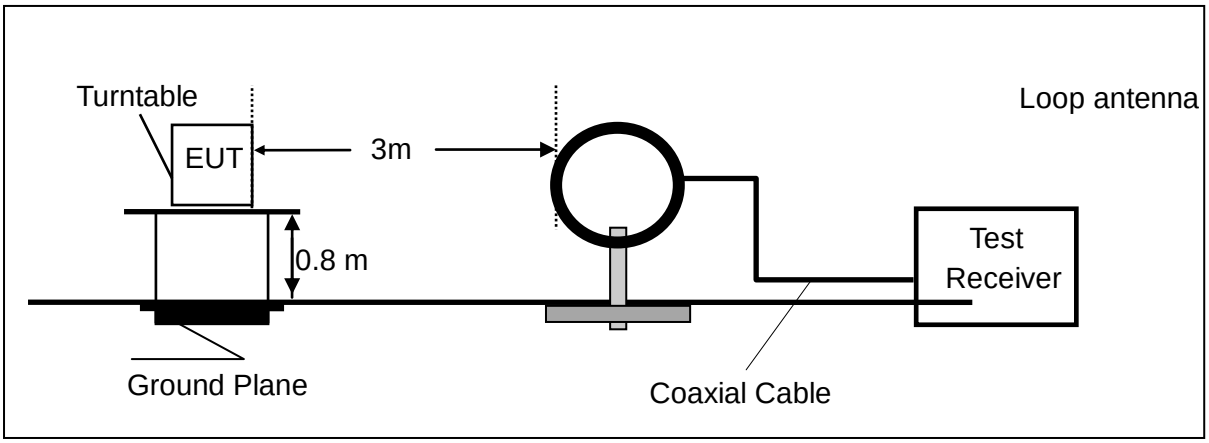
For example

Frequency (MHz)	FS (dBμV/m)	RA (dBμV/m)	AF (dB)	CL (dB)	AG (dB)	Transd (dB)
300.00	40	58.1	12.2	1.6	31.90	-18.1

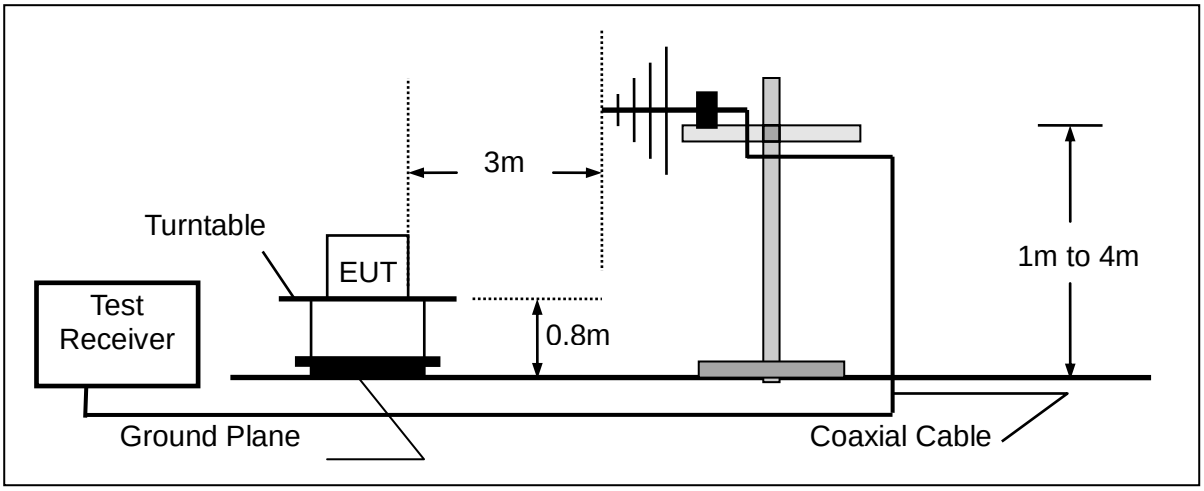
Transd=AF +CL-AG

3.1.3 Test Configuration

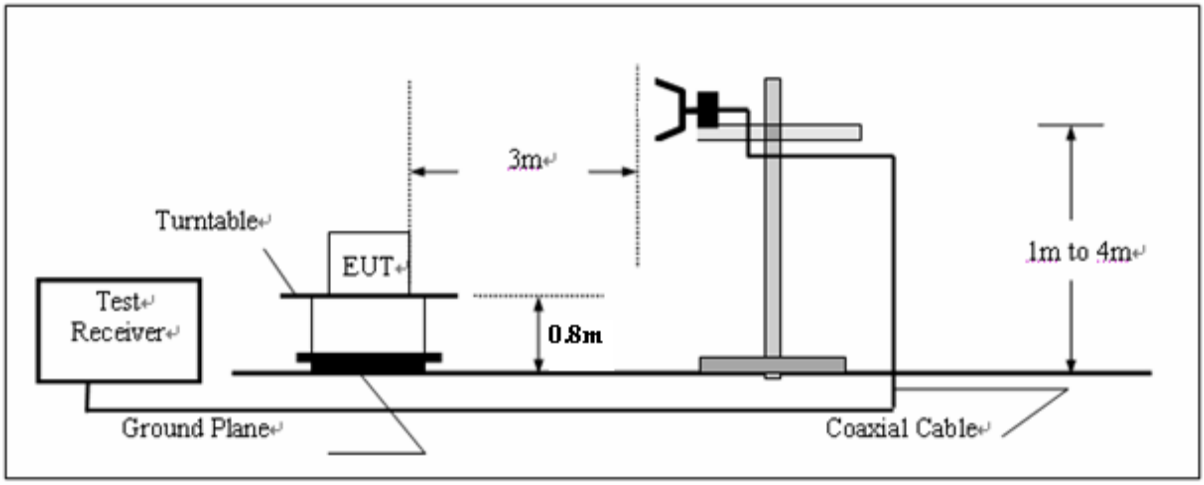
Frequency range 9KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz

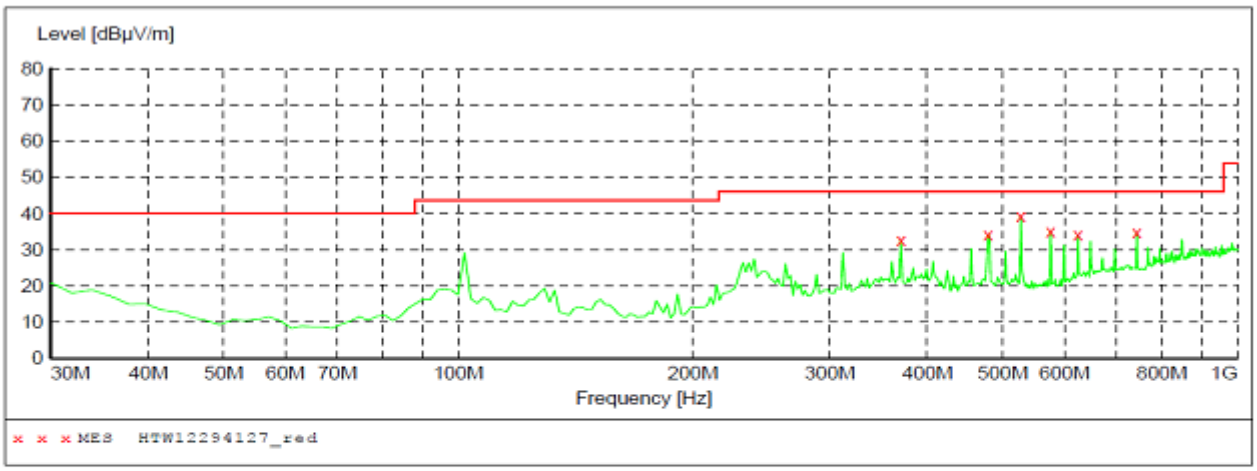


3.1.4 Test Results

Remark: 1. We tested three channels and recorded worst case.

For 30MHz to 1000MHz

SWEEP TABLE: "test (30M-1G)"
Short Description: Field Strength

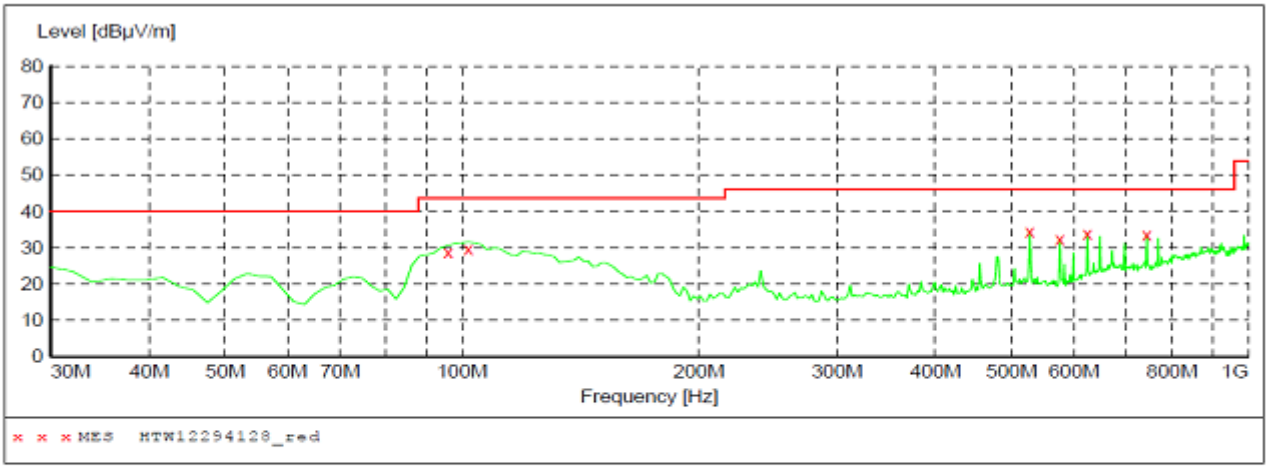


MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
370.180361	32.50	-14.9	46.0	13.5	Qp	100.0	326.00	HORIZONTAL
479.038076	34.10	-11.6	46.0	11.9	Qp	100.0	326.00	HORIZONTAL
527.635271	39.20	-11.0	46.0	6.8	Qp	100.0	331.00	HORIZONTAL
576.232465	35.10	-11.2	46.0	10.9	Qp	100.0	25.00	HORIZONTAL
624.829659	34.00	-9.0	46.0	12.0	Qp	100.0	25.00	HORIZONTAL
743.406814	34.70	-7.4	46.0	11.3	Qp	100.0	147.00	HORIZONTAL

SWEEP TABLE: "test (30M-1G)"

Short Description: Field Strength



MEASUREMENT RESULT:

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
96.092184	28.60	-18.5	43.5	14.9	QP	100.0	91.00	VERTICAL
101.923848	29.10	-18.4	43.5	14.4	QP	100.0	91.00	VERTICAL
527.635271	34.40	-11.0	46.0	11.6	QP	200.0	193.00	VERTICAL
576.232465	32.40	-11.2	46.0	13.6	QP	100.0	55.00	VERTICAL
624.829659	33.90	-9.0	46.0	12.1	QP	300.0	40.00	VERTICAL
743.406814	33.50	-7.4	46.0	12.5	QP	100.0	31.00	VERTICAL

For 1GHz to 25GHz

Low Channel @ Channel 00 @ 2402 MHz

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2402.00	85.57	PK	114.00	28.43	1.00 H	360	88.97	28.3	4.90	-36.6	-3.40
2	*2402.00	74.51	AV	94.00	19.49	1.00 H	360	77.91	28.3	4.90	-36.6	-3.40
3	4804.00	64.63	PK	74.00	9.37	1.00 H	216	62.55	31.58	7.00	36.5	2.08
4	4804.00	45.72	AV	54.00	8.28	1.00 H	216	43.64	31.58	7.00	36.5	2.08
5	7206.00	47.75	PK	74.00	26.25	1.00 H	273	37.09	37.06	8.90	35.3	10.66

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2402.00	84.12	PK	114.00	29.88	1.00 V	124	87.52	28.3	4.90	-36.6	-3.40
2	*2402.00	73.06	AV	94.00	20.94	1.00 V	124	76.46	28.3	4.90	-36.6	-3.40
3	4804.00	64.38	PK	74.00	9.62	1.00 V	35	62.30	31.58	7.00	36.5	2.08
4	4804.00	45.24	AV	54.00	8.76	1.00 V	35	43.16	31.58	7.00	36.5	2.08
5	7206.00	47.47	PK	74.00	26.53	1.00 V	114	36.81	37.06	8.90	35.3	10.66

Middle Channel @ Channel 39 @ 2440MHz

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2440.00	82.80	PK	114.00	31.20	1.00 V	224	86.20	28.3	4.90	-36.6	-3.40
2	*2440.00	77.17	AV	94.00	16.83	1.00 V	124	80.57	28.3	4.90	-36.6	-3.40
3	4880.00	63.66	PK	74.00	10.34	1.00 H	90	61.52	31.04	7.60	36.5	2.14
4	4880.00	45.45	AV	54.00	8.55	1.00 H	90	43.31	31.04	7.60	36.5	2.14
5	7323.00	49.80	PK	74.00	24.20	1.00 H	215	38.66	37.84	8.60	35.3	11.14

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2440.00	80.51	PK	114.00	33.49	1.00 V	124	83.91	28.3	4.90	-36.6	-3.40
2	*2440.00	74.02	AV	94.00	19.98	1.00 V	124	77.42	28.3	4.90	-36.6	-3.40
3	4882.00	62.56	PK	74.00	11.44	1.00 V	225	60.42	31.04	7.60	36.5	2.14
4	4882.00	44.63	AV	54.00	9.37	1.00 V	225	42.49	31.04	7.60	36.5	2.14
5	7323.00	49.91	PK	74.00	24.09	1.00 V	114	38.77	37.84	8.60	35.3	11.14

High Channel @ Channel 78 @ 2480 MHz

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2480.00	80.61	PK	114.00	33.39	1.00 V	124	84.01	28.3	4.90	-36.6	-3.40
2	*2480.00	75.93	AV	94.00	18.07	1.00 V	124	79.33	28.3	4.90	-36.6	-3.40
3	4960.00	64.38	PK	74.00	9.62	1.00 H	256	61.95	31.63	7.00	36.2	2.43
4	4960.00	45.52	AV	54.00	8.48	1.00 H	256	43.09	31.63	7.00	36.2	2.43
5	7340.00	49.80	PK	74.00	24.20	1.00 H	104	38.20	38.40	8.50	35.3	11.60

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M												
No.	Frequency (MHz)	Emssion Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Antenna Factor	Cable Factor (dB)	Pre-amplifier	Correction Factor (dB/m)
1	*2480.00	79.47	PK	114.00	34.53	1.00 V	124	82.87	28.3	4.90	-36.6	-3.40
2	*2480.00	73.71	AV	94.00	20.29	1.00 V	124	77.11	28.3	4.90	-36.6	-3.40
3	4960.00	63.95	PK	74.00	10.05	1.00 V	216	61.52	31.63	7.00	-36.2	2.43
4	4960.00	44.63	AV	54.00	9.37	1.00 V	216	42.20	31.63	7.00	-36.2	2.43
5	7340.00	50.55	PK	74.00	23.45	1.00 V	105	38.95	38.40	8.50	-35.3	11.60

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV) + Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier
3. The other emission levels were very low against the limit.
4. Margin value = Limit value- Emission level.
5. The average measurement was not performed when the peak measured data under the limit of average detection.

3.2 Conducted Emissions Test

3.2.1 Limit

According to FCC Subpart 15 B §15.207 AC Conducted Emission Limits is as following：

Frequency fange (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.1~ 0.5	66 to 56*	56 to 46*
0.5 ~ 5	56	46
5 ~ 30	60	50
* Decreasing linearly with the logarithm of the frequency		

3.2.2 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 Weather station Transmitter; 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.

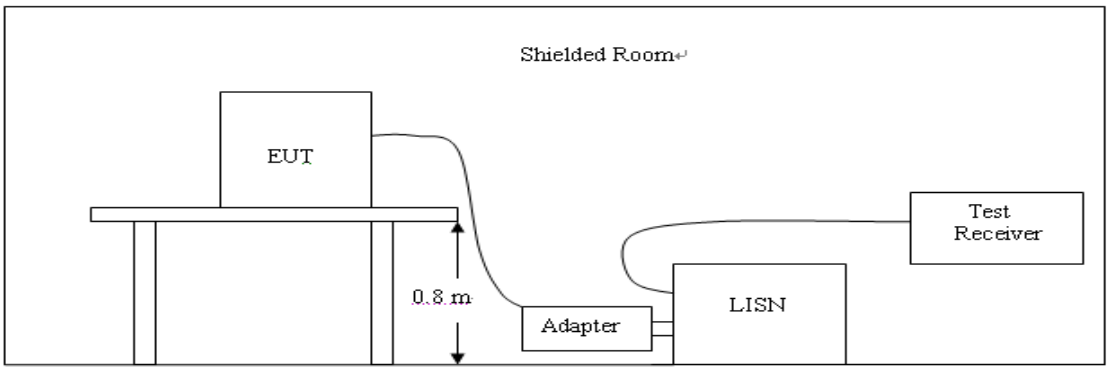
4 All support equipments received AC power from a second LISN, if any.

5 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.

6 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.

7 During the above scans, the emissions were maximized by cable manipulation.

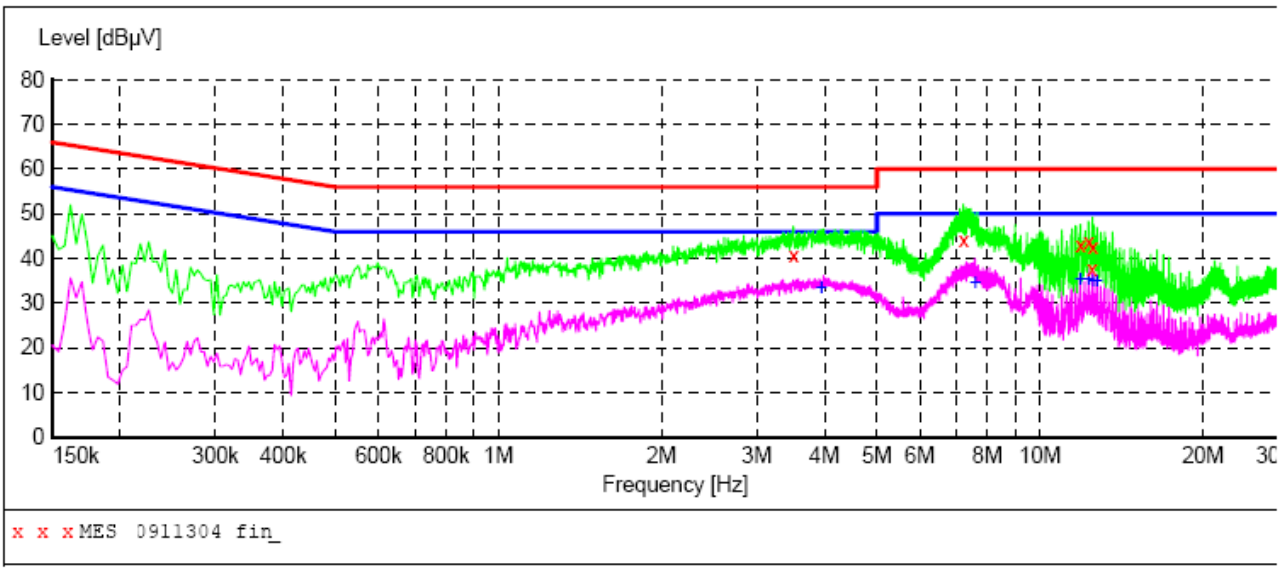
3.2.3 Test Configuration



3.2.4 Test Results

SCAN TABLE: "Voltage (9K-30M) FIN"

Short Description: 150K-30M Voltage



MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
3.506000	40.70	10.5	56	15.3	QP	N	GND
7.226000	44.20	10.6	60	15.8	QP	N	GND
11.874000	43.20	10.7	60	16.8	QP	N	GND
12.298000	43.90	10.7	60	16.1	QP	N	GND
12.466000	37.80	10.7	60	22.2	QP	N	GND
12.526000	42.60	10.7	60	17.4	QP	N	GND

MEASUREMENT RESULT:

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
3.950000	33.60	10.5	46	12.4	AV	N	GND
7.602000	34.80	10.6	50	15.2	AV	N	GND
11.874000	35.40	10.7	50	14.6	AV	N	GND
12.318000	35.30	10.7	50	14.7	AV	N	GND
12.530000	34.90	10.7	50	15.1	AV	N	GND
12.754000	35.20	10.7	50	14.8	AV	N	GND

3.3 Out of band emissions

3.3.1 Limit

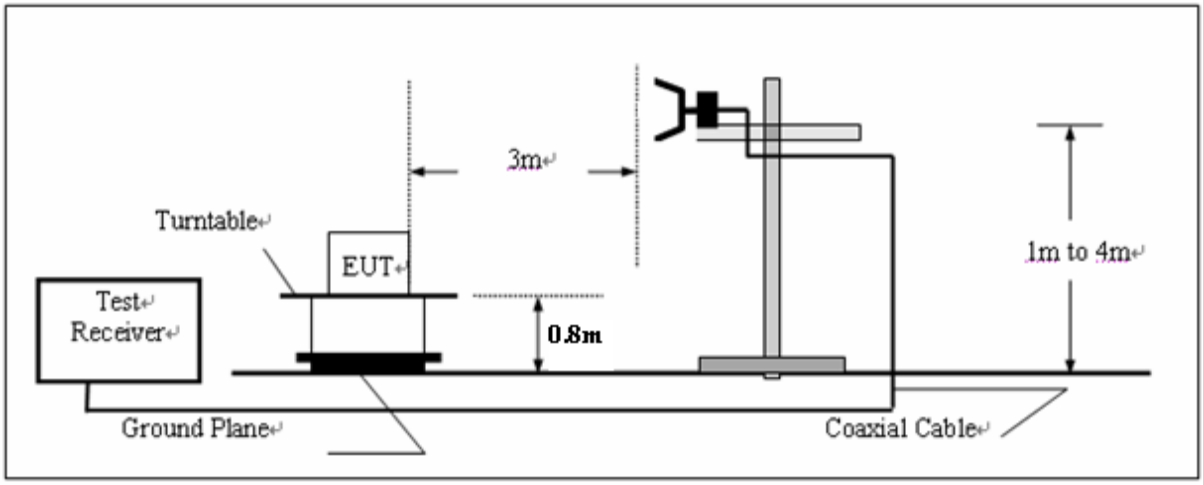
FCC PART 15.249(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

3.3.2 Test Procedure

The band edge compliance of RF radiated emission should be measured by following the guidance in ANSI C63.4 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW to 1MHz and VBM to 3MHz to measure the peak field strength and set RBW to 1MHz and VBW to 10Hz to measure the average radiated field strength.

The conducted RF band edge was measured by using a spectrum analyzer. Set span wide enough to capture the highest in-band emission and the emission at the band edge. Set RBW to 100 KHz and VBM to 300 KHz, to measure the conducted peak band edge.

3.3.3 Test Configuration



3.3.4 Test Results

Test Mode: Transmitting

Frequency (MHz)	Corrected Reading (dBμV/m)@3m	FCC Limit (dBμV/m) @3m	Margin (dB)	Detector	Polari-zation
Out of left side band					
2390.00	51.02	74	22.98	PK	Horizontal
2390.00	27.23	54	26.77	AV	Horizontal
2390.00	50.29	74	23.71	PK	Vertical
2390.00	26.34	54	27.66	AV	Vertical
Out of right side band					
2483.50	65.07	74	8.93	PK	Horizontal
2483.50	28.77	54	25.23	AV	Horizontal
2483.50	60.02	74	13.98	PK	Vertical
2483.50	29.02	54	24.98	AV	Vertical

Note: 1. The field strength of any emissions which appear outside of this band shall not exceed the general radiated emission limits in Section 15.209.

2. The average measurement was not performed when the peak measured data under the limit of average detection.

3. The test data is the worst case data in the restrict band.

3.4 .20dB Bandwidth Measurement

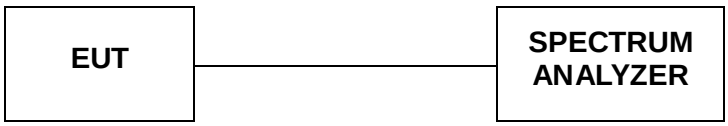
3.4.1 Limit

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

3.4.2 Test Procedure

The transmitter output is connected to the spectrum analyzer. The spectrum analyzer center frequency is set to the transmitter frequency. The RBW is set to 100 KHz and VBW is set 300 KHz.

3.4.2 Test Configuration



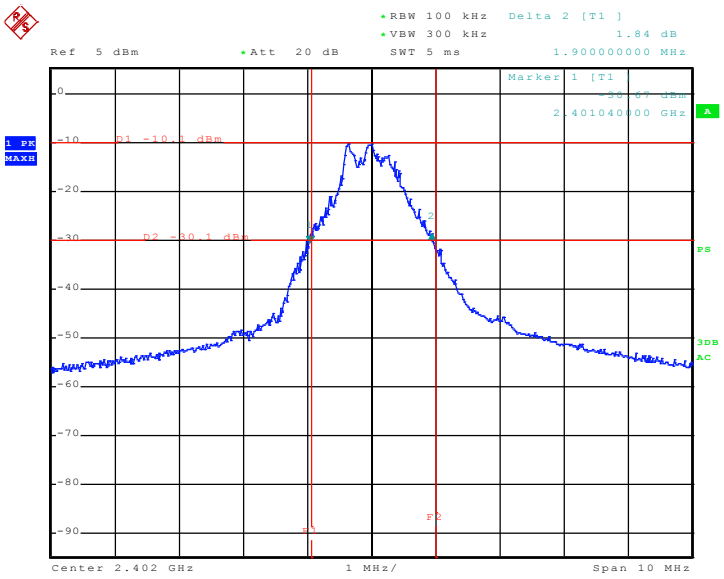
3.4.2 Test Results

A. Test Verdict

Operating Frequency (MHz)	Limits(MHz)		Result
	Lower Frequency (MHz)	Upper Frequency (MHz)	
2402	>2400	<2483.5	PASS
2440	>2400	<2483.5	PASS
2480	>2400	<2483.5	PASS

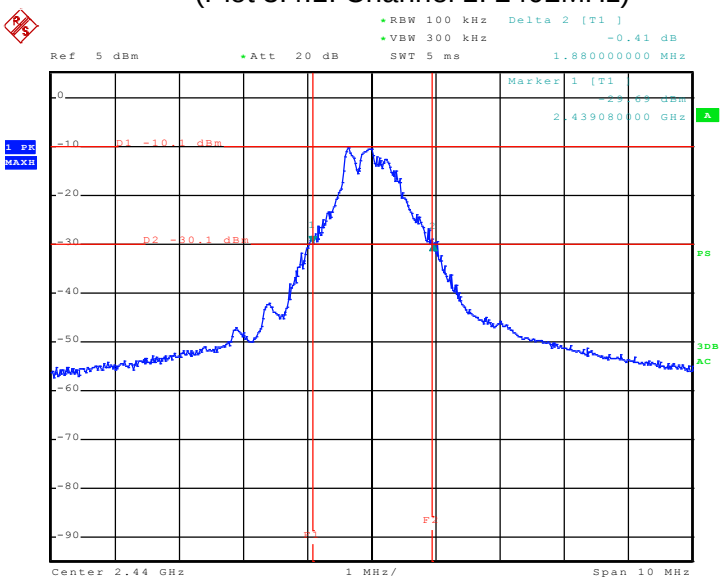
Note: 1.The test results including the cable lose.

B. Test Plots



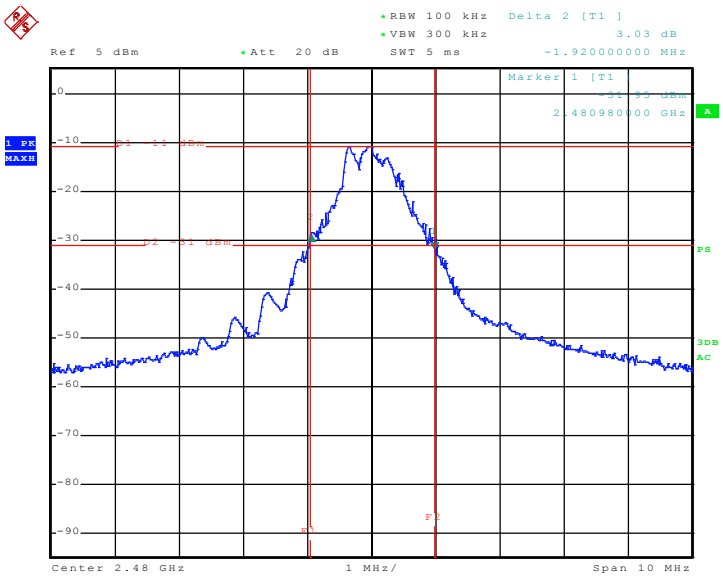
Date: 23.APR.2014 14:40:33

(Plot 3.4.1: Channel 1: 2402MHz)



Date: 23.APR.2014 14:42:21

(Plot 3.4.2: Channel 3: 2440MHz)



Date: 23.APR.2014 14:44:35

(Plot 3.4.3: Channel 5: 2480MHz)

3.5 Antenna Requirement

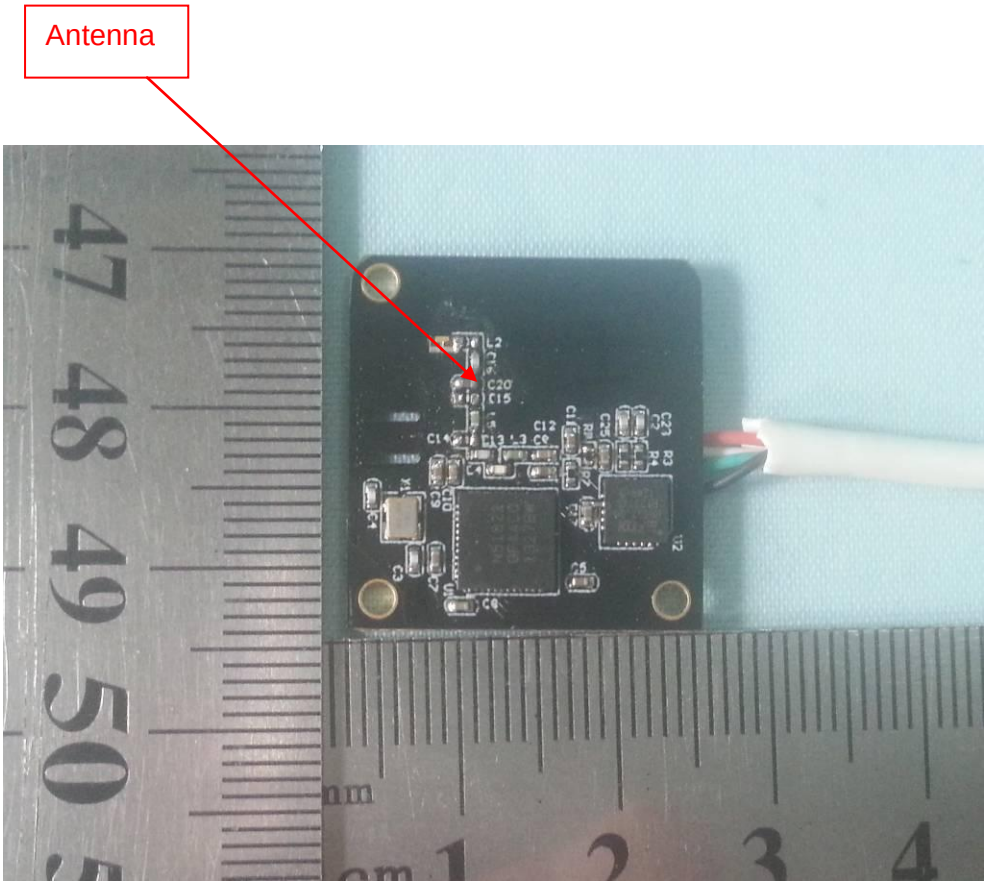
According to FCC Part 15C § 15.203,

a), An intentional radiator shall be de-signed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.
b), 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.

The EUT use of a PCB antenna，Please refer to the EUT Internal photos.

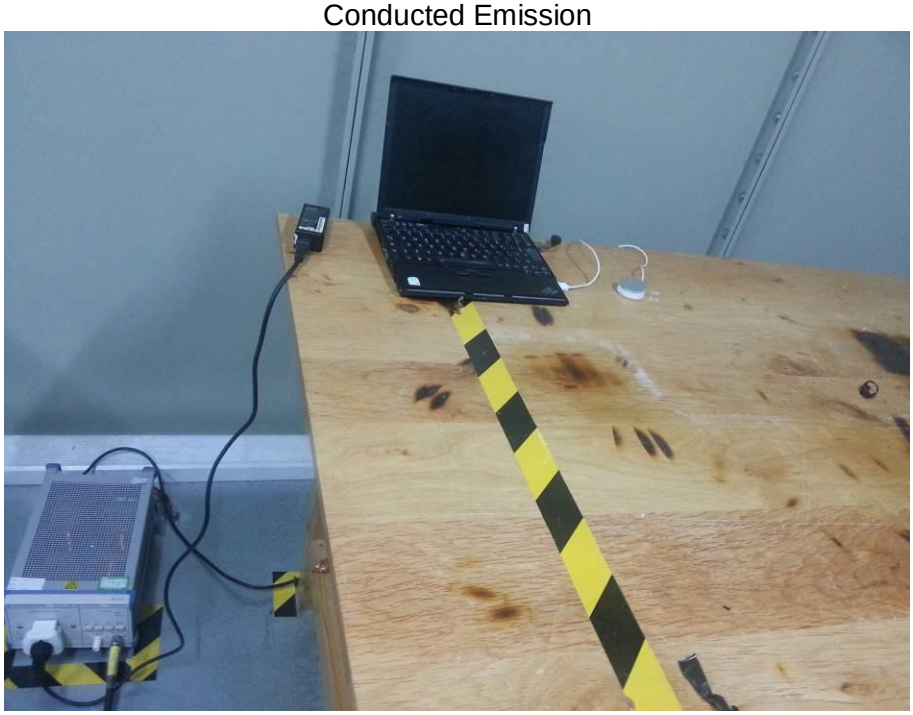
The EUT complied the antenna requirement. The maximum Gain of the antenna only 1dBi.please see the

photo as following:



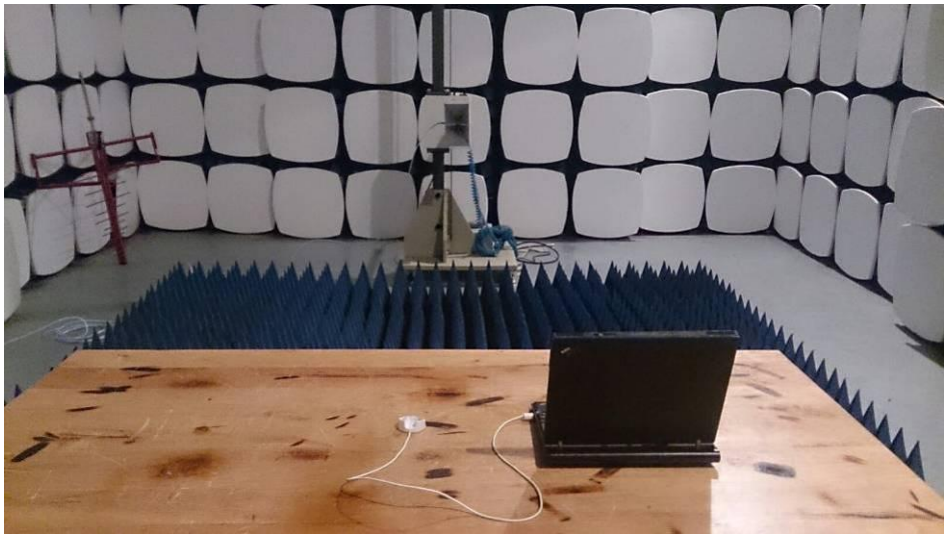
4. EUT TEST PHOTO

Conducted Emission



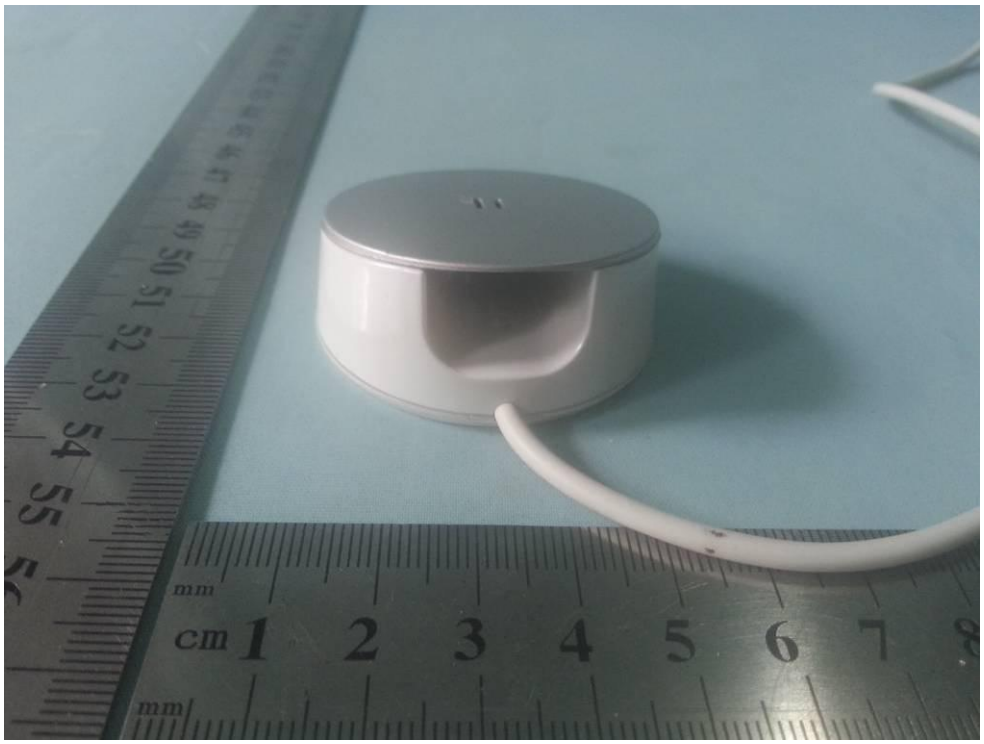
Radiated Emission(30MHz-1GHz)

Radiated Emission(1GHz-25GHz)

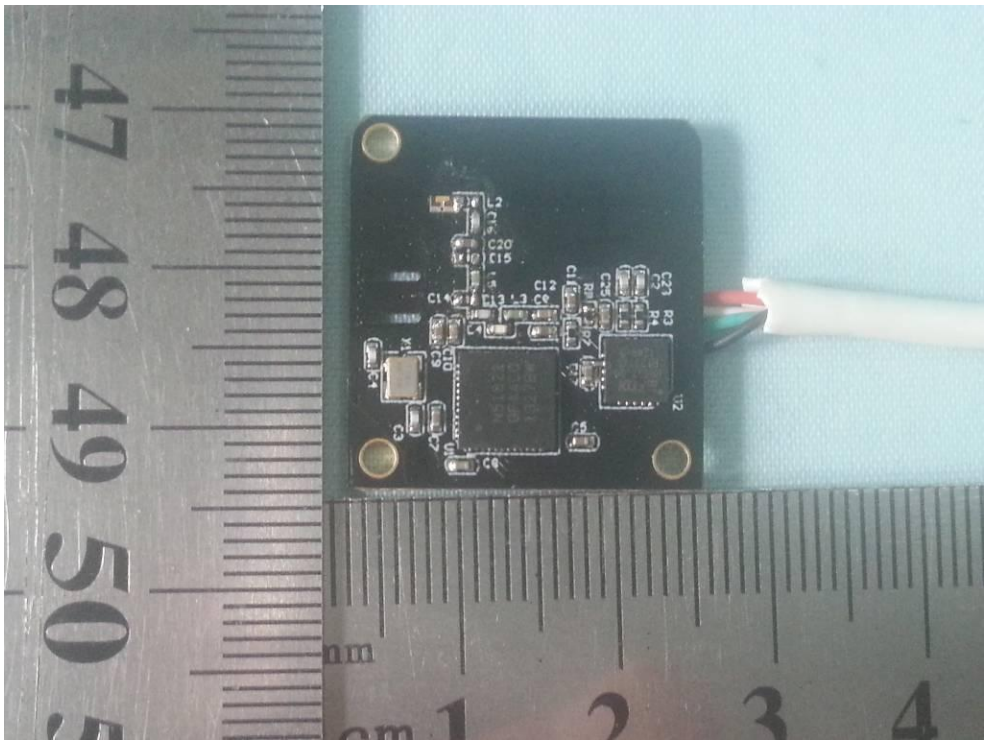


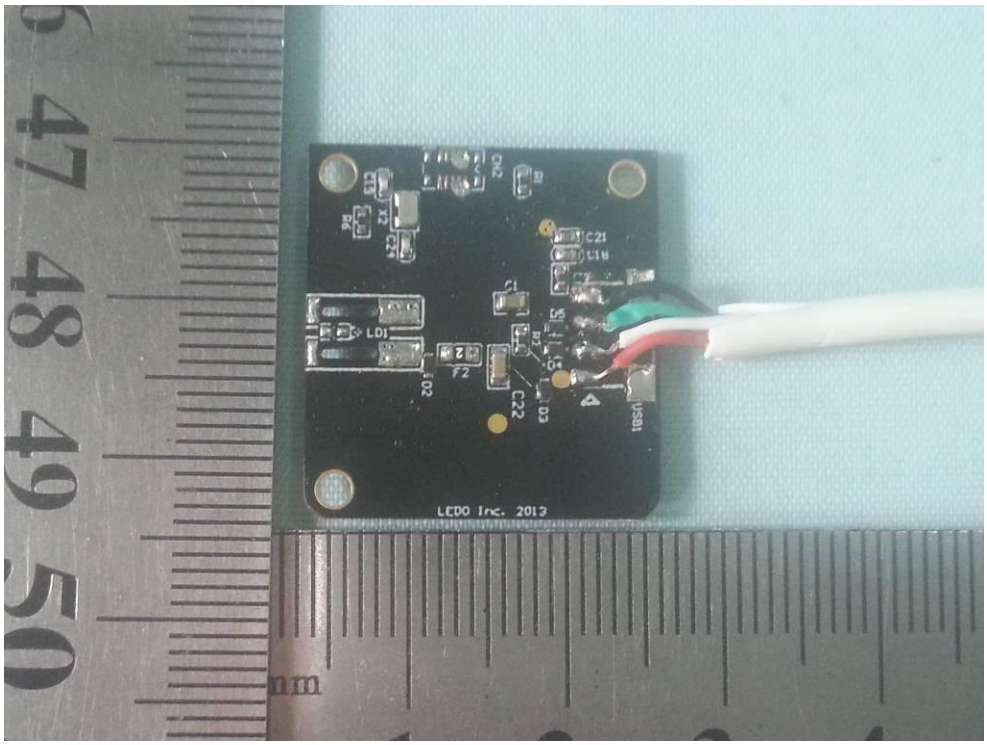
5 APPENDIX-PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS

External photos of EUT



Internal photos of EUT





**************************THE END**************************