FCC 15B Test Report

Equipment	:	**2.4 GHz Bluetooth Low Energy Module**
Model No.	:	**SaBLE-x-R2**
Brand Name	:	**Laird Technologies**
Applicant	:	**Laird Technologies**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**FCC Part 15, Subpart B, Class B ICES-003 Issue 6 ANSI C63.4:2014**
Received Date	:	**Apr. 25, 2017**
Tested Date	:	**May 09 ~ May 10, 2017**

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:

Peter Lin / Supervisor

Approved by:

Kent Chen / Assistant Manager

Testing Laboratory 2732

Table of Contents

1 GENERAL DESCRIPTION 5

1.1 Information 5
1.2 The Equipment List 6
1.3 Testing Applied Standards 7
1.4 Measurement Uncertainty 7

2 TEST CONFIGURATION 8

2.1 Testing Condition 8
2.2 The Worst Case Measurement Configuration 8
2.3 Local Support Equipment List 9
2.4 Test Setup Chart 9
2.5 Test Software and Operating Condition 10

3 EMISSION TESTS RESULTS 11

3.1 Conducted Emissions 11
3.2 Radiated Emissions 16

4 PHOTOGRAPHS OF THE TEST CONFIGURATION 23

5 TEST LABORATORY INFORMATION 27

Release Record

Report No.	Version	Description	Issued Date
FD742502	Rev. 01	Initial issue	Jun. 02, 2017

Summary of Test Results

FCC Part 15, Subpart B Emission Tests				
Ref. Std. Clause	**Test Standard**	**Test Items**	**Measured**	**Result**
15.107	FCC Part 15, Subpart B, Class B	Conducted Emissions	-10.46dB AV@ 0.150MHz.	Pass
15.109	FCC Part 15, Subpart B, Class B	Radiated Emissions	-7.58dB PK@ 166.77MHz.	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

Operating Frequency	2402 MHz ~ 2480 MHz
Modulation Type	Bluetooth LE: GFSK

1.1.2 Antenna Details

Ant. No.	Model	Type	Gain (dBi)	Connector
1	LSR 001-0001 center-fed 2.4 GHz dipole antenna	Dipole	SMA	2
2	LSR 001-0014 2.4 GHz FlexPIFA antenna	PIFA	U.FL	2
3	LSR 001-0015 2.4 GHz FlexNotch antenna	Notch	U.FL	2
4	On module PCB trace antenna	On-Board Trace antenna	N/A	0

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 1.8V & DC 3.3V from host

1.1.4 Accessories

N/A

1.2 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	May 10, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Dec. 21, 2016	Dec. 20, 2017
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 08, 2016	Nov. 07, 2017
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Nov. 25, 2016	Nov. 24, 2017
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 20, 2016	Dec. 19, 2017
50 ohm terminal (Support Unit)	NA	50	02	Apr. 07, 2017	Apr. 06, 2018
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission below 1GHz				
Test Site	966 chamber 2 / (03CH02-WS)				
Tested Date	May 09, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Dec. 21, 2016	Dec. 20, 2017
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 10, 2016	Nov. 09, 2017
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-523	Nov. 07, 2016	Nov. 06, 2017
Preamplifier	EMC	EMC02325	980194	Sep. 26, 2016	Sep. 25, 2017
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	16051	Dec. 09, 2016	Dec. 08, 2017
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-003	Dec. 09, 2016	Dec. 08, 2017
LF cable 10M	EMCC	CFD400-E	CFD400-001	Dec. 09, 2016	Dec. 08, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission above 1GHz				
Test Site	966 chamber 2 / (03CH02-WS)				
Tested Date	May 09, 2017				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Dec. 16, 2016	Dec. 15, 2017
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1095	Sep. 21, 2016	Sep. 20, 2017
Preamplifier	Agilent	83017A	MY39501309	Sep. 29, 2016	Sep. 28, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16018/4	Dec. 09, 2016	Dec. 08, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.3 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

FCC Part 15, Subpart B, Class B
ICES-003 Issue 6
ANSI C63.4:2014

1.4 Measurement Uncertainty

CISPR 16-4-2 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty		
Test Item	**Frequency**	**Uncertainty**
Conducted Emissions	150kHz ~ 30MHz	±2.90 dB
Radiated Emissions	30MHz ~ 1GHz	±3.87 dB
	Above 1GHz	±5.60 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	21°C / 56%	Alex Tsai
Radiated Emissions	03CH02-WS	21°C / 61%	Alex Tsai

- FCC site registration No.: 933633
- IC site registration No.: 10807A-2

2.2 The Worst Case Measurement Configuration

The determined worst case configurations are listed as follows:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z- axis. The Y-axis results were found as the worst case and were shown in this report.

Radiation Pretest Mode	
Pretest Mode	**Operating Description**
1	On-Board Trace Ant, BT Link, DC 3.3V, EUT orientation: Y-axis
2	Dipole Ant, BT Link, DC 3.3V, EUT orientation: Y-axis
3	PIFA Ant, BT Link, DC 3.3V, EUT orientation: Y-axis
4	Notch Ant, BT Link, DC 3.3V, EUT orientation: Y-axis
For **Pretest Mode 2** is the worst case and only its data was record in this test report.	

The Determined Worst Case Configurations	
Conducted Emissions	
Test Mode	**Operating Description**
1	Dipole Ant, BT Link, DC 3.3V, with Notebook, EUT orientation: Y-axis
2	Dipole Ant, BT Link, DC 1.8V, with Power supply, EUT orientation: Y-axis
Radiated Emissions	
Test Mode ≤ 1GHz	**Operating Description**
1	Dipole Ant, BT Link, DC 3.3V, EUT orientation: Y-axis
Test Mode > 1GHz	**Operating Description**
1	Dipole Ant, BT Link, DC 3.3V, EUT orientation: Y-axis

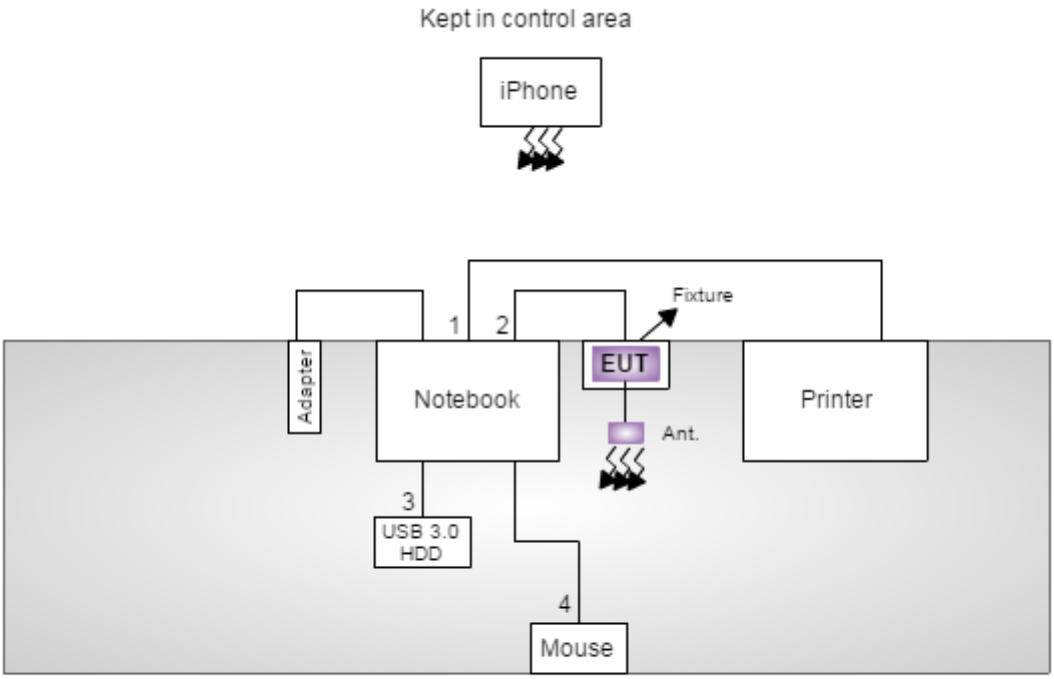
2.3 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Signal cable / Length (m)**
1	Notebook	DELL	Latitude E6440	8VXMD12	---
2	Printer	EPSON	XP-30	QSDK002410	USB, 1.8m shielded.
3	USB 3.0 HDD	WD	WDBKXH5000ABK	WX31AB210213	USB, 0.5m shielded.
4	Mouse	DELL	MS111-L	2C3-00MM	USB, 1.8m shielded.
5	DC Power Supply	GWINSTEK	GPC-60300	EM884797	---
6	iPhone	Apple	A1530	6FRC6	---
7	Fixture	----	---	---	USB, 1m shielded.

Note: No.7 was provided by applicant

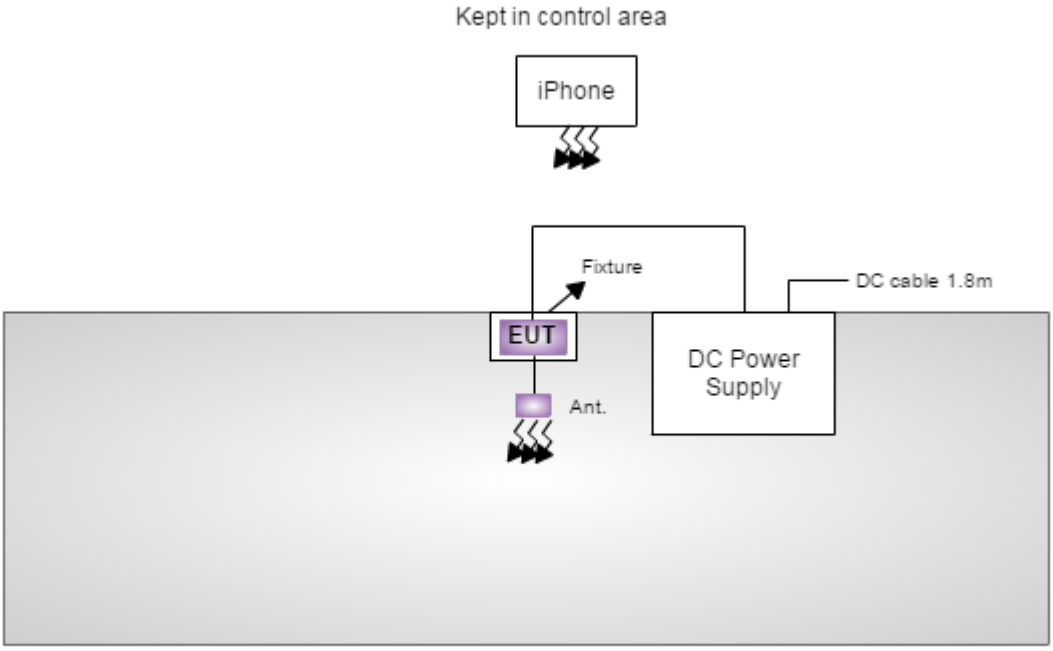
2.4 Test Setup Chart

Test Setup Diagram (Test Mode 1)



1. USB, 1.8m shielded.
2. USB, 1m shielded.
3. USB, 0.5m shielded.
4. USB, 1.8m shielded.

Test Setup Diagram (Test Mode 2)



1. USB, 1m shielded.

2.5 Test Software and Operating Condition

For Test Mode 1

a. To enable all function of test system.
b. The support notebook executed “WinEMC.exe” to send “H” patterns to its monitor and the monitor displayed them.
c. The support notebook executed “WinEMC.exe” to send “H” patterns to the printer.
d. The support notebook executed “WinEMC.exe” to read and wrote data from USB 3.0 HDD.
e. The support iPhone links to the EUT by bluetooth.
f. The support iPhone executed "LSR ModuleLink for BLE" app and monitor the status of BT connection between support iPhone and EUT.

For Test Mode 2

a. The support iPhone links to the EUT by bluetooth.
b. The support iPhone executed "LSR ModuleLink for BLE" app and monitor the status of BT connection between support iPhone and EUT.

3 Emission Tests Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

Conducted Emissions Limit		
Frequency Emission (MHz)	**Quasi-Peak**	**Average**
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50
Note 1: * Decreases with the logarithm of the frequency.		

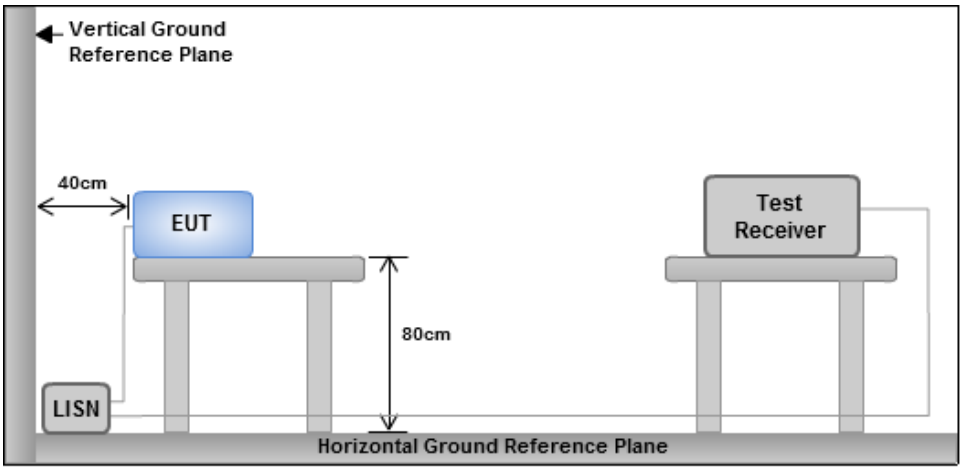
3.1.2 Test Procedures

a. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.

b. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.

c. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.

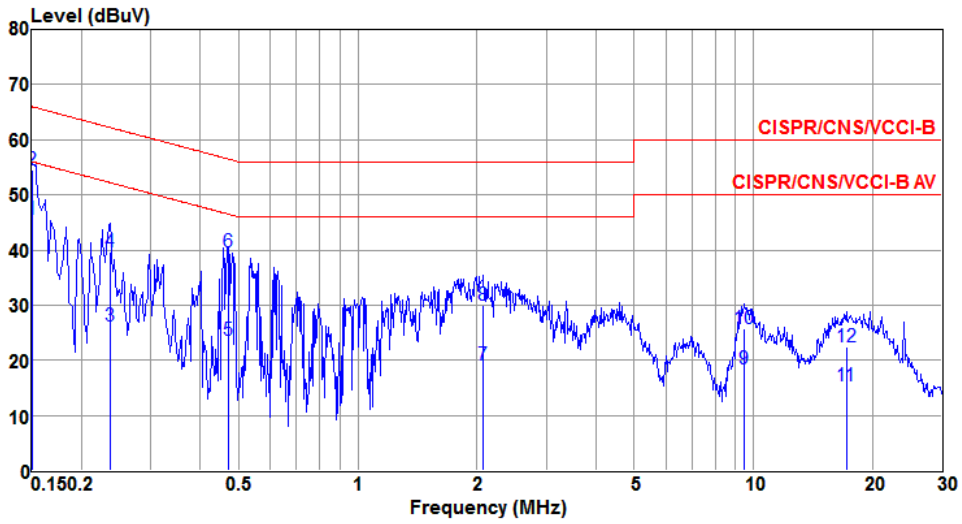
3.1.3 Test Setup



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

3.1.4 Test Result of Conducted Emissions

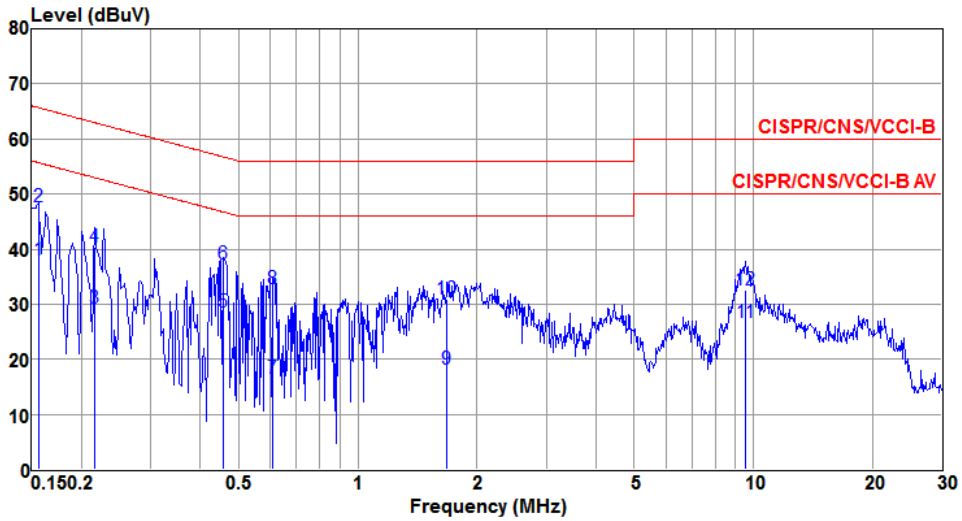
Power Phase	Line	Test Mode	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1@	0.150	45.54	56.00	-10.46	45.43	0.07	0.04	Average
2	0.150	54.61	66.00	-11.39	54.50	0.07	0.04	QP
3	0.237	26.21	52.22	-26.01	26.08	0.09	0.04	Average
4	0.237	39.64	62.22	-22.58	39.51	0.09	0.04	QP
5	0.471	23.59	46.49	-22.90	23.49	0.06	0.04	Average
6	0.471	39.72	56.49	-16.77	39.62	0.06	0.04	QP
7	2.077	19.16	46.00	-26.84	18.98	0.13	0.05	Average
8	2.077	30.06	56.00	-25.94	29.88	0.13	0.05	QP
9	9.451	18.42	50.00	-31.58	18.00	0.20	0.22	Average
10	9.451	25.79	60.00	-34.21	25.37	0.20	0.22	QP
11	17.199	15.27	50.00	-34.73	14.67	0.36	0.24	Average
12	17.199	22.44	60.00	-37.56	21.84	0.36	0.24	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

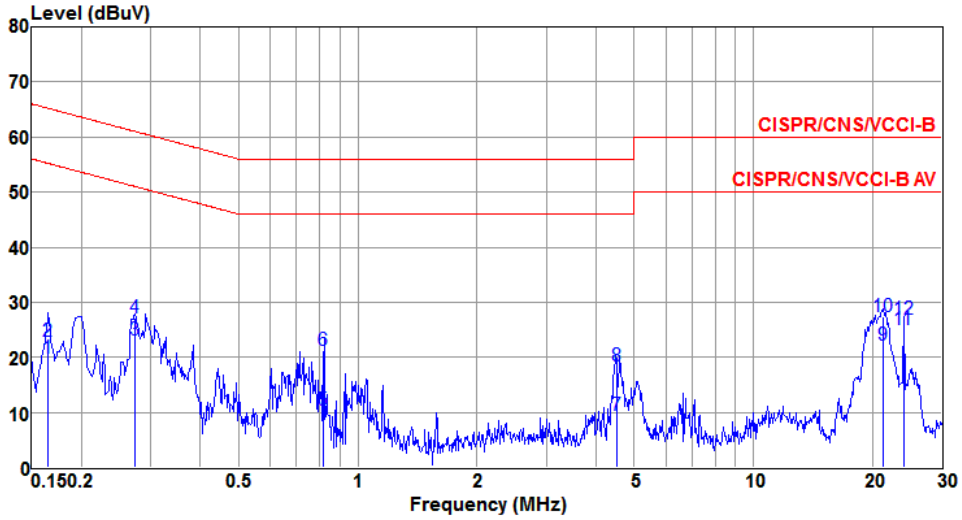
Power Phase	Neutral	Test Mode	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1@	0.156	37.89	55.69	-17.80	37.75	0.10	0.04	Average
2	0.156	47.56	65.69	-18.13	47.42	0.10	0.04	QP
3	0.216	29.37	52.96	-23.59	29.24	0.09	0.04	Average
4	0.216	40.48	62.96	-22.48	40.35	0.09	0.04	QP
5	0.456	28.52	46.76	-18.24	28.36	0.12	0.04	Average
6	0.456	37.37	56.76	-19.39	37.21	0.12	0.04	QP
7	0.608	16.56	46.00	-29.44	16.41	0.11	0.04	Average
8	0.608	32.78	56.00	-23.22	32.63	0.11	0.04	QP
9	1.680	18.26	46.00	-27.74	18.08	0.14	0.04	Average
10	1.680	30.82	56.00	-25.18	30.64	0.14	0.04	QP
11	9.552	26.56	50.00	-23.44	26.04	0.30	0.22	Average
12	9.552	32.65	60.00	-27.35	32.13	0.30	0.22	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

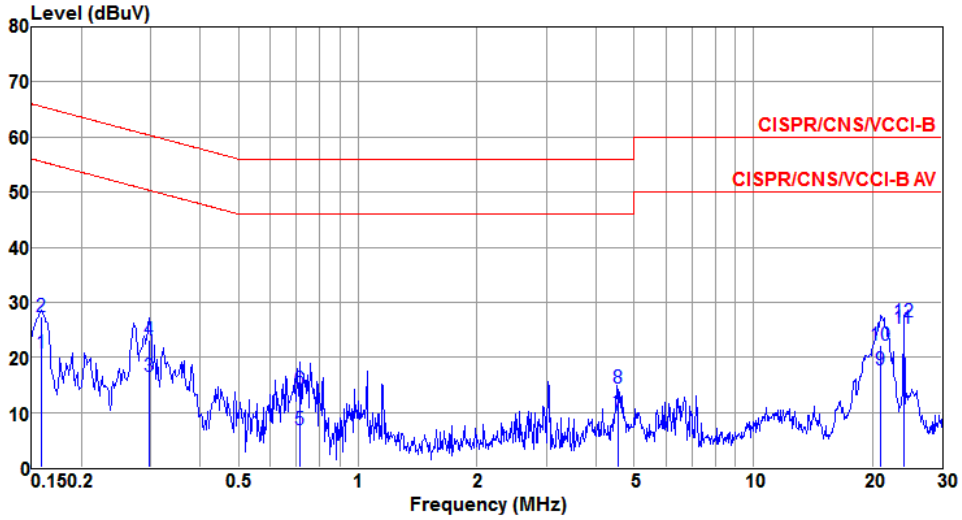
Power Phase	Line	Test Mode	2



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.165	19.84	55.21	-35.37	19.72	0.08	0.04	Average
2	0.165	22.92	65.21	-42.29	22.80	0.08	0.04	QP
3	0.273	23.08	51.03	-27.95	22.96	0.08	0.04	Average
4	0.273	27.17	61.03	-33.86	27.05	0.08	0.04	QP
5	0.816	10.39	46.00	-35.61	10.28	0.07	0.04	Average
6	0.816	21.21	56.00	-34.79	21.10	0.07	0.04	QP
7	4.517	9.52	46.00	-36.48	9.18	0.17	0.17	Average
8	4.517	18.33	56.00	-37.67	17.99	0.17	0.17	QP
9	21.358	22.17	50.00	-27.83	21.49	0.41	0.27	Average
10	21.358	27.42	60.00	-32.58	26.74	0.41	0.27	QP
11@	24.001	25.01	50.00	-24.99	24.31	0.42	0.28	Average
12	24.001	26.81	60.00	-33.19	26.11	0.42	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Power Phase	Neutral	Test Mode	2



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.159	20.73	55.52	-34.79	20.59	0.10	0.04	Average
2	0.159	27.36	65.52	-38.16	27.22	0.10	0.04	QP
3	0.297	16.43	50.32	-33.89	16.28	0.11	0.04	Average
4	0.297	23.09	60.32	-37.23	22.94	0.11	0.04	QP
5	0.716	6.86	46.00	-39.14	6.72	0.10	0.04	Average
6	0.716	14.18	56.00	-41.82	14.04	0.10	0.04	QP
7	4.538	9.40	46.00	-36.60	9.07	0.16	0.17	Average
8	4.538	14.51	56.00	-41.49	14.18	0.16	0.17	QP
9	21.035	17.81	50.00	-32.19	17.12	0.42	0.27	Average
10	21.035	22.28	60.00	-37.72	21.59	0.42	0.27	QP
11@	24.001	25.36	50.00	-24.64	24.63	0.45	0.28	Average
12	24.001	26.39	60.00	-33.61	25.66	0.45	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 Radiated Emissions

3.2.1 Limit of Radiated Emissions

According to FCC Part 15, Subpart B §15.109, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

Note: According to FCC Part 15, Subpart B §15.33: For an unintentional radiator is shown in the table above.

3.2.2 Test Procedures

Measuring below 1 GHz:

a. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at a height of 0.8 m test table above the ground plane.

b. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.

c. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Measuring above 1 GHz:

a. Same test set up as below 1GHz radiated testing.

b. The EUT was set 3 meters from the interference-receiving antenna which was mounted on the top of a variable height antenna tower.

c. There should be absorber placed between the EUT and Antenna and its located size should let the test site meet CISPR16-1-4 requirement.

d. The table was rotated 360 degrees to determine the position of the highest radiation.

e. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.

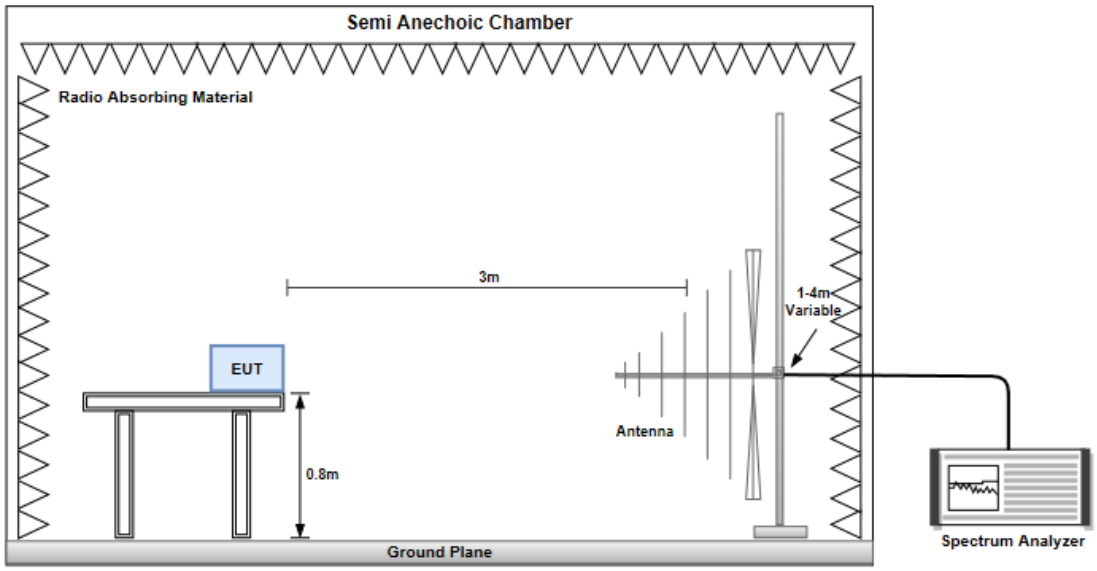
f. Set the Horn Antenna at 1m height, then run the turn table to get the maximum noise reading from Horizontal and Vertical polarity separately.

g. When EUT locating on the turn-table, the Horn Antenna must be raised up and descended down, then turning around the turn-table to get the maximum noise reading of the Horizontal and Vertical polarity separately. Note the maximum raise up height is same as the top of EUT.

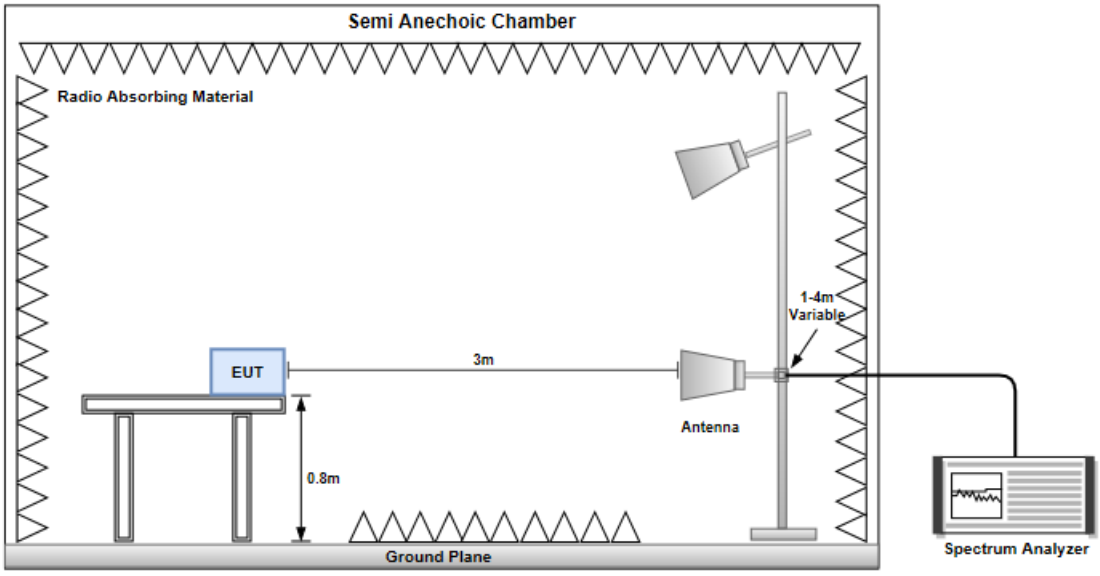
h. If emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

3.2.3 Test Setup

Radiated Emissions below 1 GHz

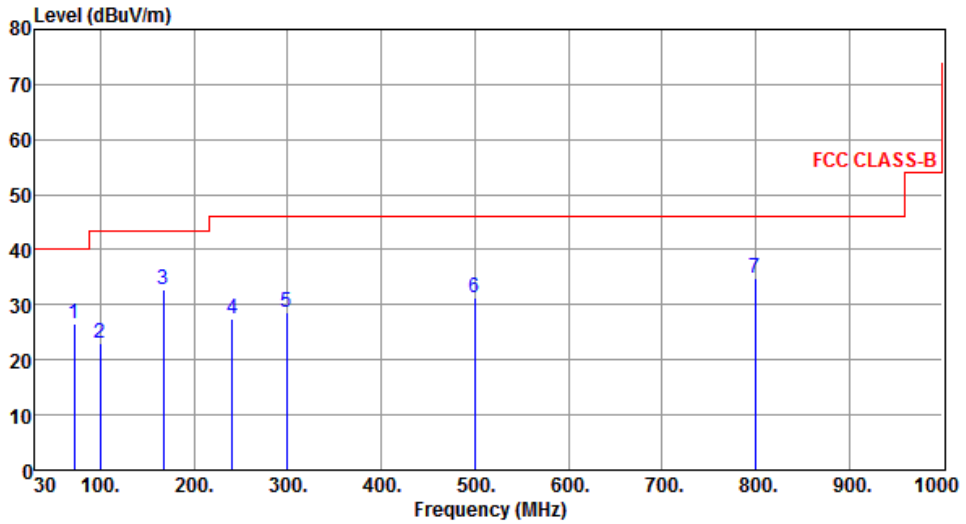


Radiated Emissions above 1 GHz



3.2.4 Radiated Emissions (Below 1GHz)

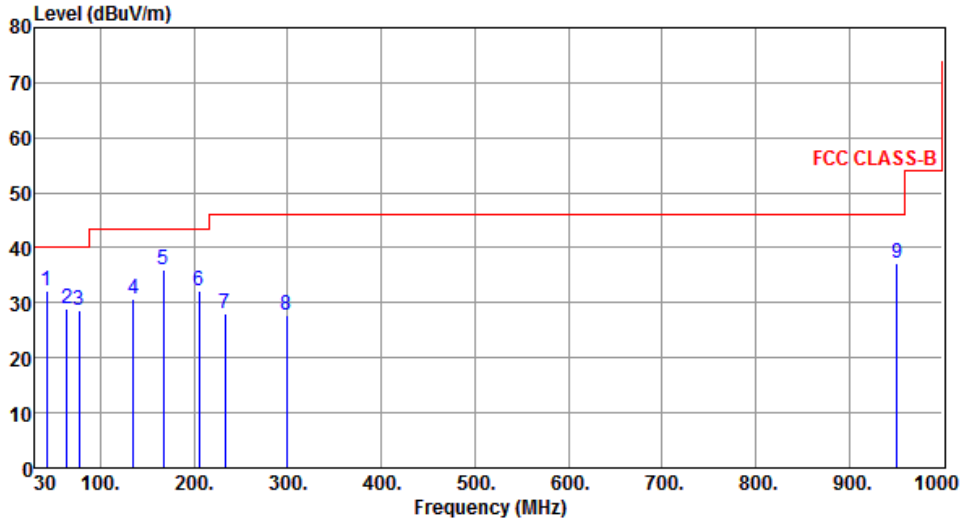
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	71.71	26.67	40.00	-13.33	37.94	-11.27	Peak	---	---
2	99.84	22.89	43.50	-20.61	36.12	-13.23	Peak	---	---
3	166.77	32.85	43.50	-10.65	41.31	-8.46	Peak	---	---
4	240.49	27.53	46.00	-18.47	37.22	-9.69	Peak	---	---
5	298.69	28.55	46.00	-17.45	36.21	-7.66	Peak	---	---
6	499.48	31.25	46.00	-14.75	33.93	-2.68	Peak	---	---
7	799.21	34.75	46.00	-11.25	32.20	2.55	Peak	---	---

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

Polarization	Vertical	Test Mode	1

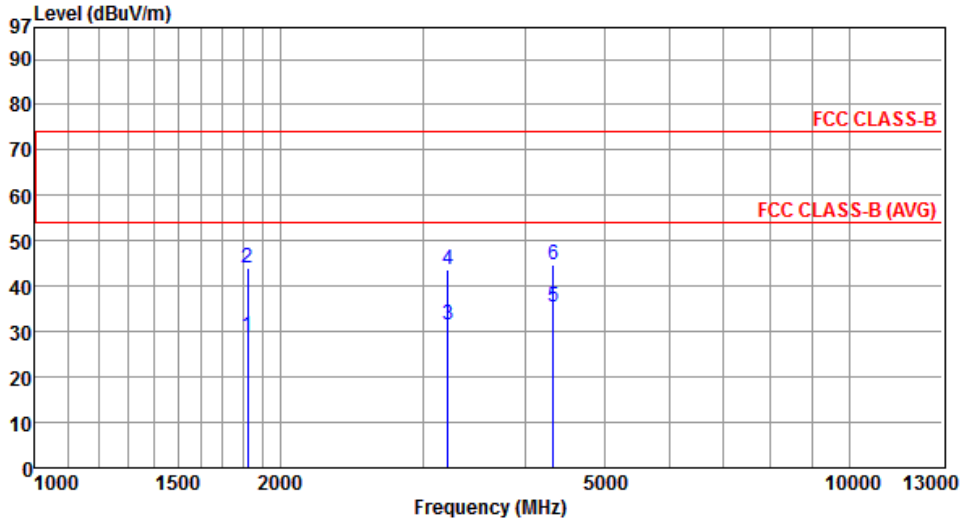


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	42.61	32.03	40.00	-7.97	40.25	-8.22	Peak	---	---
2	63.95	28.80	40.00	-11.20	38.72	-9.92	Peak	---	---
3	77.53	28.78	40.00	-11.22	41.00	-12.22	Peak	---	---
4	134.76	30.64	43.50	-12.86	39.46	-8.82	Peak	---	---
5	166.77	35.92	43.50	-7.58	44.38	-8.46	Peak	---	---
6	205.57	32.18	43.50	-11.32	43.45	-11.27	Peak	---	---
7	232.73	28.02	46.00	-17.98	38.10	-10.08	Peak	---	---
8	298.69	27.67	46.00	-18.33	35.33	-7.66	Peak	---	---
9	951.50	37.30	46.00	-8.70	32.12	5.18	Peak	---	---

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

3.2.5 Radiated Emissions (Above 1GHz)

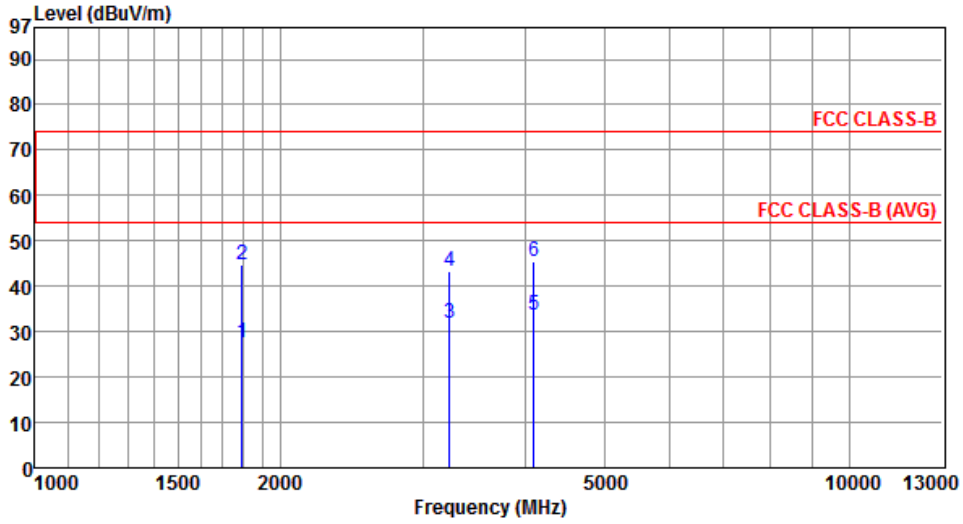
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1826.00	28.91	54.00	-25.09	33.63	-4.72	Average	115	118
2	1826.00	43.88	74.00	-30.12	48.60	-4.72	Peak	115	118
3	3213.00	31.47	54.00	-22.53	31.11	0.36	Average	121	233
4	3213.00	43.55	74.00	-30.45	43.19	0.36	Peak	121	233
5	4329.00	35.27	54.00	-18.73	31.45	3.82	Average	120	145
6	4329.00	44.64	74.00	-29.36	40.82	3.82	Peak	120	145

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

Polarization	Vertical	Test Mode	1

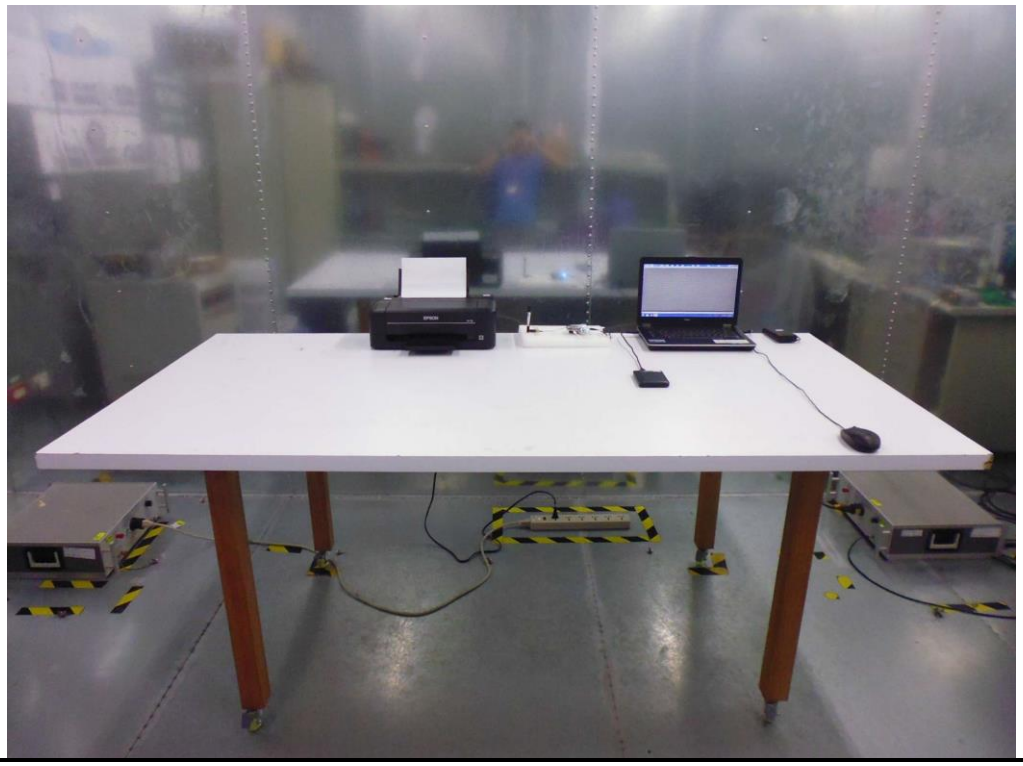


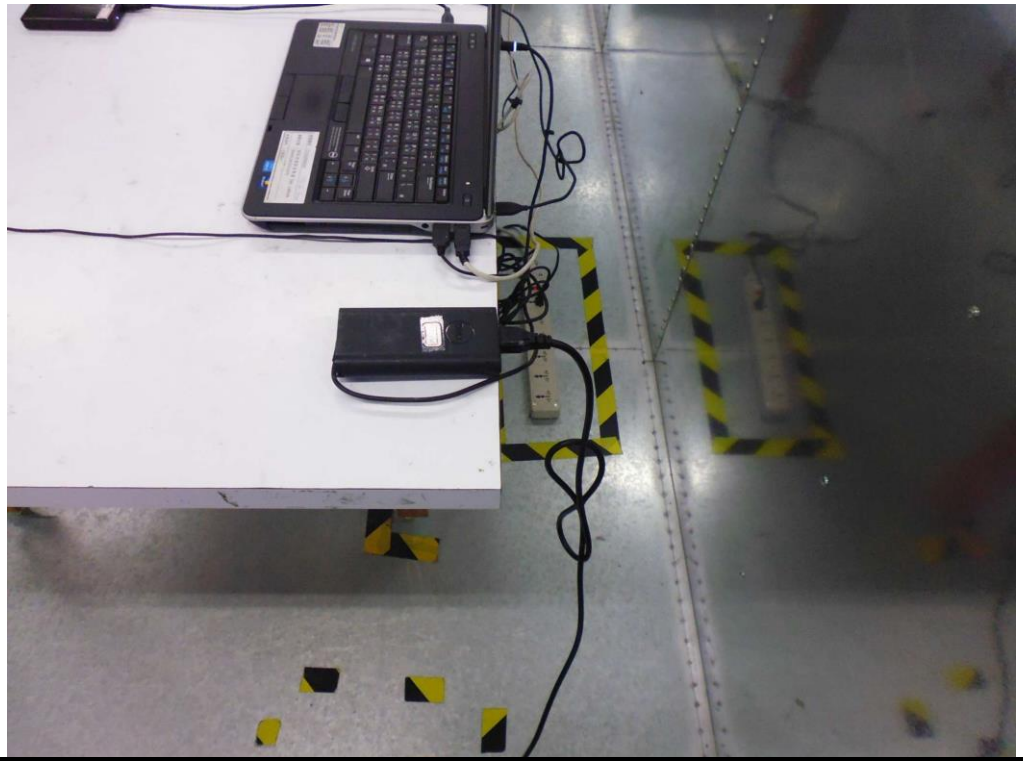
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1794.00	27.60	54.00	-26.40	32.44	-4.84	Average	100	140
2	1794.00	44.77	74.00	-29.23	49.61	-4.84	Peak	100	140
3	3225.00	31.95	54.00	-22.05	31.57	0.38	Average	100	226
4	3225.00	43.17	74.00	-30.83	42.79	0.38	Peak	100	226
5	4095.00	33.63	54.00	-20.37	30.53	3.10	Average	100	99
6	4095.00	45.39	74.00	-28.61	42.29	3.10	Peak	100	99

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

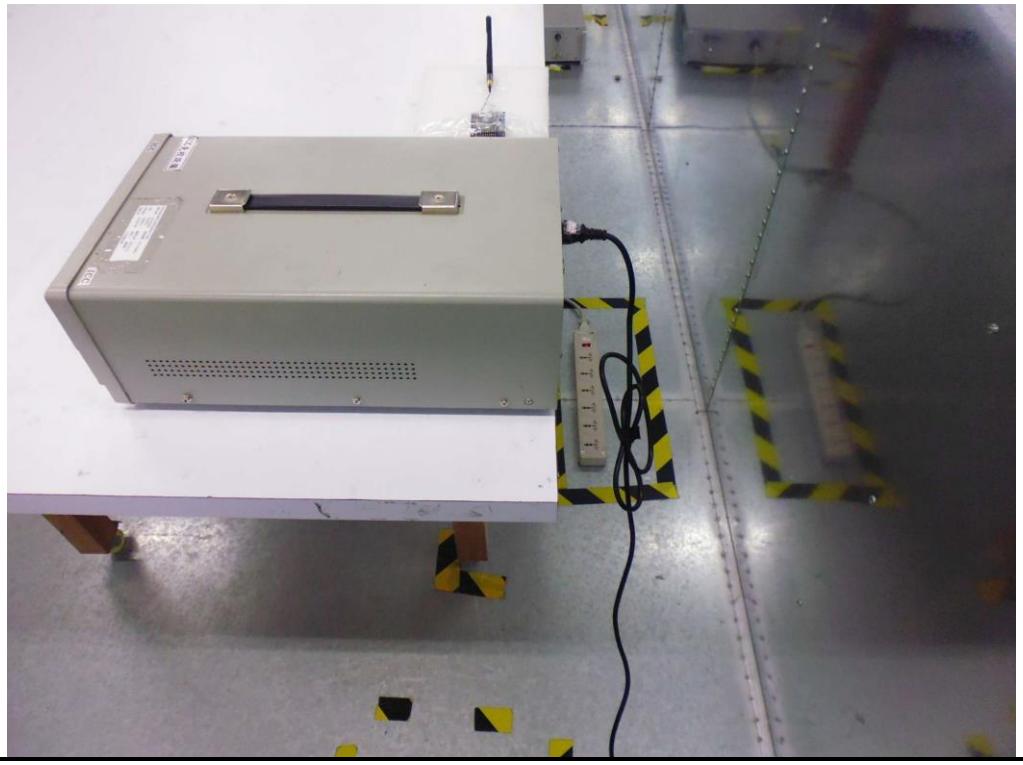
4 Photographs of the Test Configuration

Conducted Emission Test (Test Mode 1)

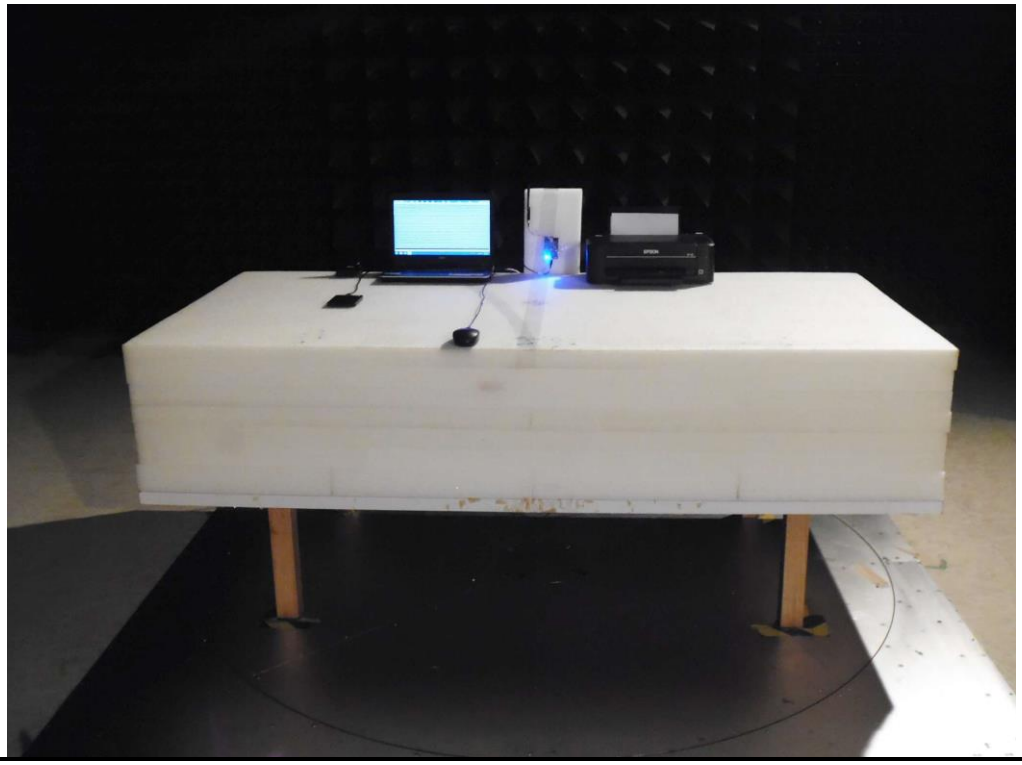


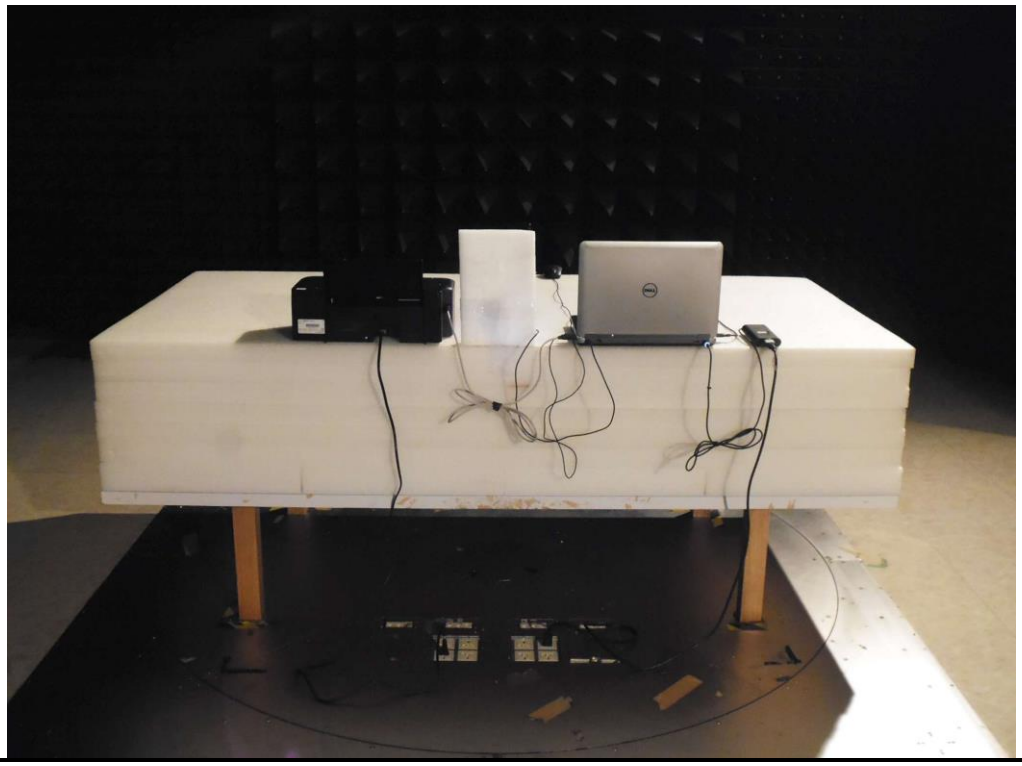


Conducted Emission Test (Test Mode 2)

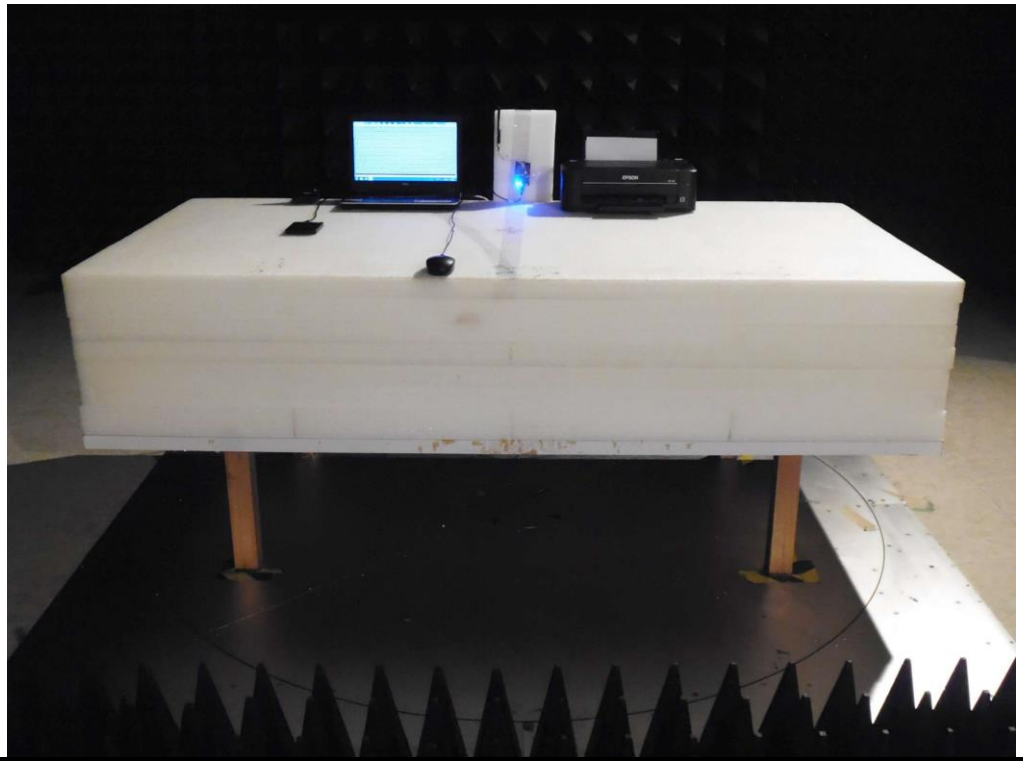


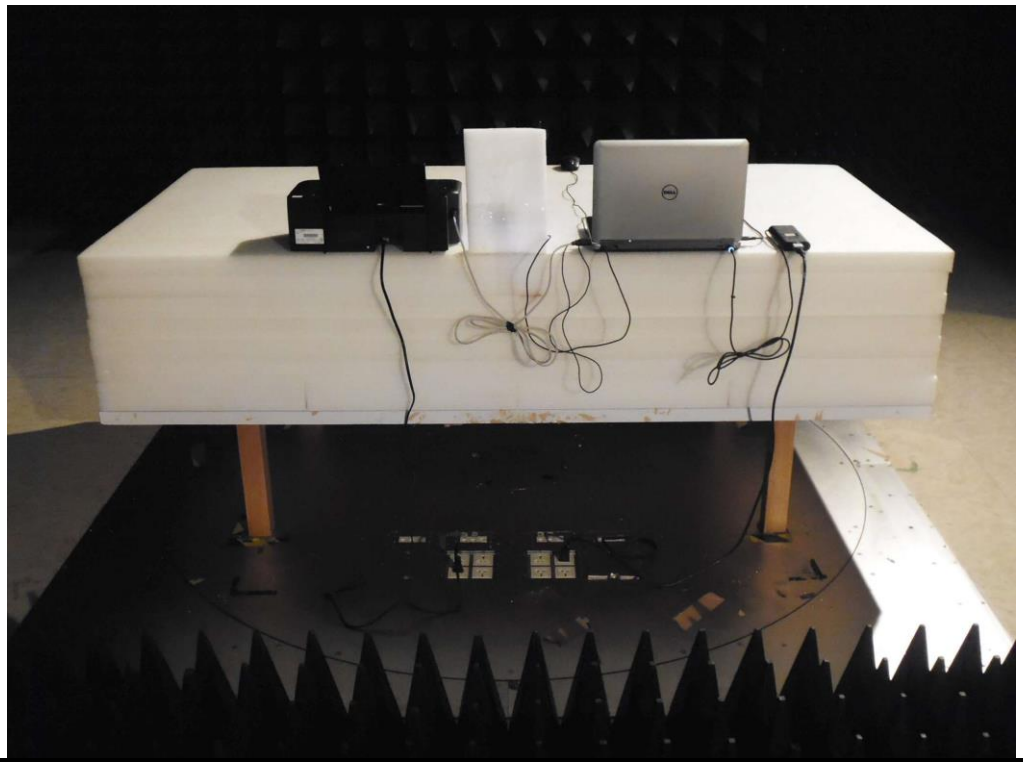
Radiated Emission Below 1GHz Test





Radiated Emission Above 1GHz Test





5 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

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