

FCC 15B Test Report

Equipment : 802.11 ac/a/b/g/n + Bluetooth 4.2 module
(please refer to section 1.1.1 for more details.)

Model No. : ST60-2230C
(please refer to section 1.1.1 for more details.)

Brand Name : Laird Technologies

Applicant : Laird Technologies

Address : W66N220 Commerce Court, Cedarburg,
Wisconsin 53012, USA

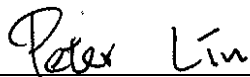
Standard : FCC Part 15, Subpart B, Class B
ICES-003 Issue 6
ANSI C63.4:2014

Received Date : Apr. 07, 2017

Tested Date : May 13 ~ May 16, 2017

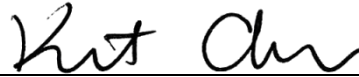
We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the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

Reviewed by:



Peter Lin / Supervisor

Approved by:



Kent Chen / Assistant Manager



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Release Record

Report No.	Version	Description	Issued Date
FD740701	Rev. 01	Initial issue	Jun. 14, 2017
FD740701	Rev. 02	Revised model name	Jul. 24, 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	-11.06dB QP@ 0.160MHz.	Pass
15.109	FCC Part 15, Subpart B, Class B	Radiated Emissions	-3.52dB PK@ 44.55MHz.	Pass

1 General Description

1.1 Information

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description	
Laird Technologies	ST60-SIPT	802.11 ac/a/b/g/n + Bluetooth 4.2 module	SIPT only	For marketing purpose
	SU60-SIPT			
	ST60-2230C	802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module	with carrier board	
	SU60-2230C			
† The above models, model ST60-2230C was selected as a representative one for the final test and only its data was recorded in this report.				

1.1.2 Feature of Equipment under Test (EUT)

Power Supply Type	DC 2.97V & DC 3.3V from host
Highest Frequency of the Internal Sources	5.8GHz

1.1.3 Accessories

N/A

1.2 Test Equipment and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	May 18, 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 18, 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 18, 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
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Oct. 25, 2016	Oct. 24, 2017
Preamplifier	Agilent	83017A	MY39501309	Sep. 29, 2016	Sep. 28, 2017
Preamplifier	EMC	EMC184045B	980192	Aug. 24, 2016	Aug. 23, 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

ISO/IEC 17025 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	±3.87dB
	Above 1GHz	±5.60 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	22°C/58%	Alex Tsai
Radiated Emissions	03CH02-WS	22°C/61%	Alex Tsai

➤ FCC site registration No.: 03CH02-WS: 933633

➤ IC site registration No.: 03CH02-WS: 10807A-2

2.2 The Worst Case Measurement Configuration

Radiation Pretest Mode	
Pretest Mode	Operating Description
1	Antenna: LSR/001-0009 / WiFi 5G TX, EUT: Y-axis
2	Antenna: NanoBlade-IP04 / WiFi 2.4G TX, EUT: Y-axis
3	Antenna: MAF95310 Mini NanoBlade Flex / WiFi 5G TX, EUT: Y-axis
4	Antenna: LSR/FlexPIFA 001-0016/ WiFi 2.4G TX, EUT: Y-axis
5	Antenna: Ethertronics WLAN_1000146/ WiFi 5G TX, EUT: Y-axis
6	Antenna: LSR/001-0009, BT TX, EUT: Y-axis

NOTE: For **Pretest Mode 6** is the worst case and only its data was record in this test report.

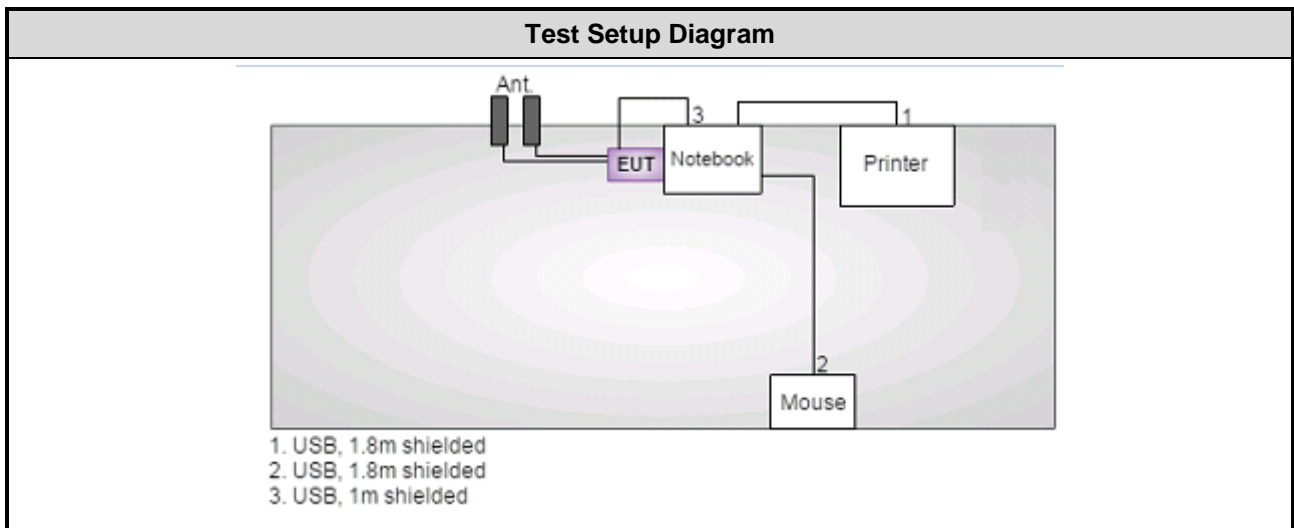
The Determined Worst Case Configurations	
Conducted Emissions	
Test Mode	Operating Description
1	Antenna: LSR/001-0009, BT TX, EUT: Y-axis
Radiated Emissions	
Test Mode ≤ 1GHz	Operating Description
1	Antenna: LSR/001-0009, BT TX, EUT: Y-axis
Test Mode > 1GHz	Operating Description
1	Antenna: LSR/001-0009, BT TX, EUT: Y-axis

2.3 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	S/N	Signal cable / Length (m)
1	Notebook	Lenovo	1706-BW8	LV-AF745 07/04	---
2	Printer	EPSON	XP-30	QSDK002410	USB, 1.8m shielded.
3	Mouse	DELL	MS111-L	2C3-00MM	USB, 1.8m shielded.

Note: No. 1 was supplied by applicant.

2.4 Test Setup Chart



2.5 Test Software and Operating Condition

- a. To enable all functions of test system.
- b. The support notebook was set in Linux OS.
- c. The support notebook communicated with EUT by executing "Terminal.exe" to transmitting continuously by BT or WiFi.

3 Emission Tests Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

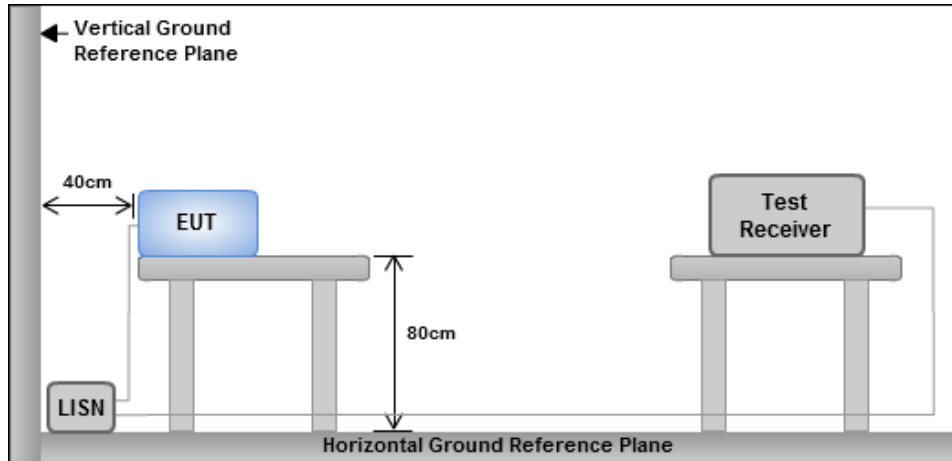
Applicable Standard: FCC Part 15, Subpart B §15.107, ICES-003 §6.1				
Frequency Range (MHz)	Class A (dB μ V)		Class B (dB μ V)	
	Limits			
	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.50	79	66	66 to 56	56 to 46
0.50 to 5	73	60	56	46
5 to 30	73	60	60	50

Note 1: The lower limit shall apply at the transition frequencies.
 Note 2: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

3.1.2 Test Procedures

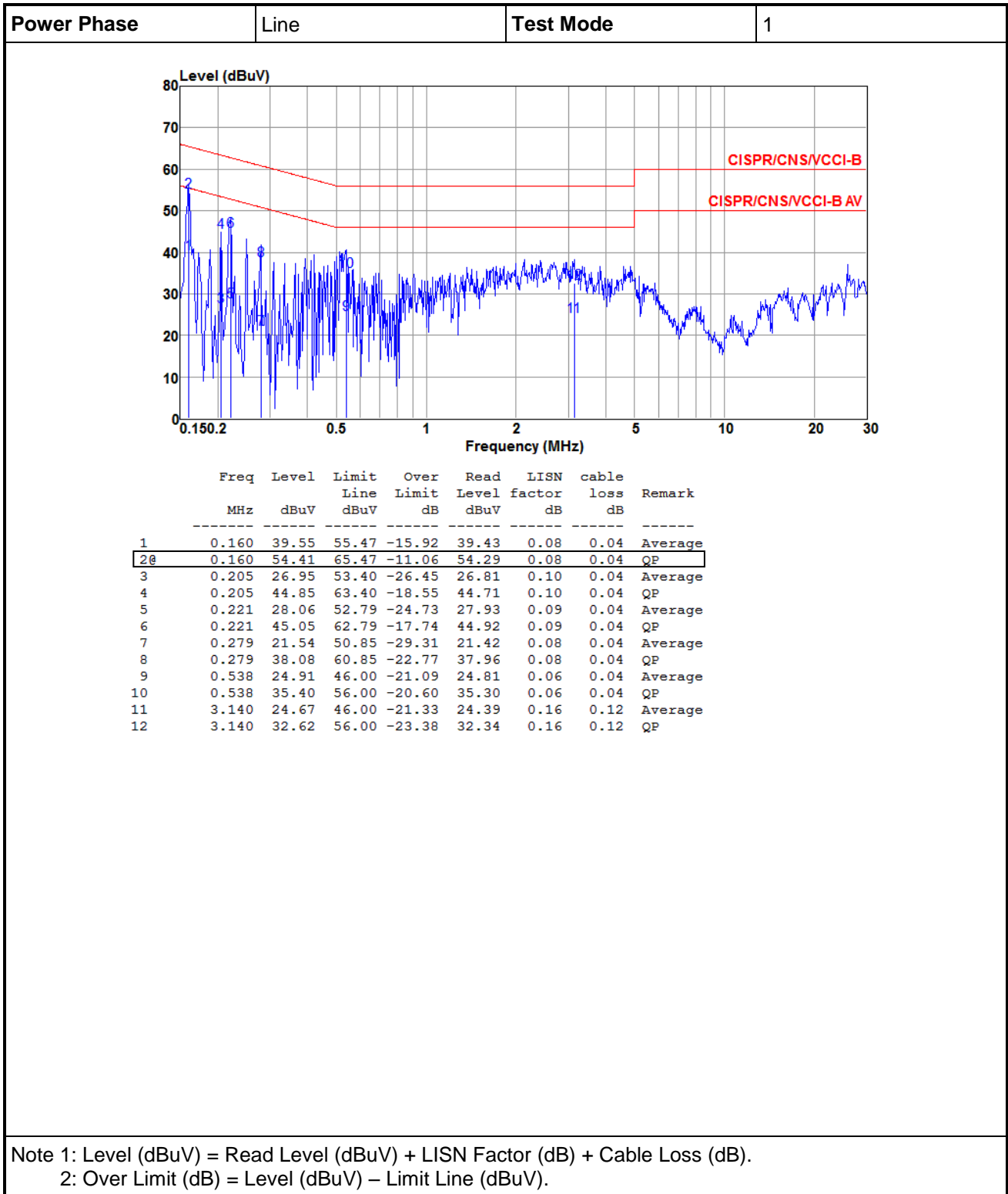
- a. The EUT was placed on a table with a height of 0.8 meters from the metal ground plane and 0.4 meters from the conducting wall of the shielding room and it was kept at least 0.8 meters from any other grounded conducting surface.
- b. The test equipment EUT installed received DC power through a Line Impedance Stabilization Network (LISN), which supplied power source and was grounded to the ground plane.
- c. All the support units were connected to the other LISN.
- d. The LISN provides 50 ohm coupling impedance for the measuring instrument.
- e. The CISPR states that a 50 ohm, 50 microhenry LISN should be used.
- f. Both sides of AC line were checked for maximum conducted interference.
- g. The measurement frequency range extends from 150 kHz to 30 MHz.
- h. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

3.1.3 Test Setup

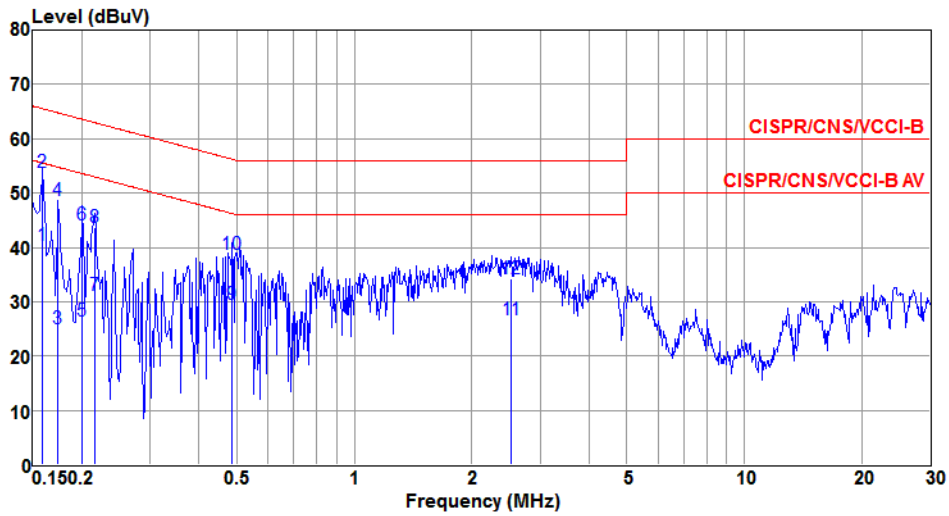


- Note: 1. Support units were connected to second LISN.**
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions



Power Phase	Neutral	Test Mode	1
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	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.159	40.32	55.52	-15.20	40.18	0.10	0.04	Average
2	0.159	53.72	65.52	-11.80	53.58	0.10	0.04	QP
3	0.174	25.01	54.77	-29.76	24.88	0.09	0.04	Average
4	0.174	48.70	64.77	-16.07	48.57	0.09	0.04	QP
5	0.201	26.38	53.58	-27.20	26.25	0.09	0.04	Average
6	0.201	44.09	63.58	-19.49	43.96	0.09	0.04	QP
7	0.216	31.25	52.96	-21.71	31.12	0.09	0.04	Average
8	0.216	43.70	62.96	-19.26	43.57	0.09	0.04	QP
9	0.486	29.40	46.23	-16.83	29.24	0.12	0.04	Average
10	0.486	38.72	56.23	-17.51	38.56	0.12	0.04	QP
11	2.527	26.64	46.00	-19.36	26.41	0.15	0.08	Average
12	2.527	34.12	56.00	-21.88	33.89	0.15	0.08	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

Applicable Standard: FCC Part 15, Subpart B §15.109, ICES-003 §6.2		
Frequency Range (MHz)	Class A (10 m)	Class B (10 m)
	Quasi-peak limits (dB μ V/m)	
30 to 230	40	30
230 to 1000	47	37

Note 1: The lower limit shall apply at the transition frequency.
Note 2: Additional provisions may be required for cases where interference occurs.

Note:

- 1) According to FCC Part 15, Subpart B §15.109(g): As an alternative to the radiated emission limits shown in paragraphs (a) and (b) of this section, digital devices may be shown to comply with the standards contained in Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, "Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement."
- 2) The CISPR 22 §6 standard limits are applied to the test data hereinafter.

Frequency range (MHz)	Class A (3 m)		Class B (3 m)	
	Average limit (dB μ V/m)	Peak limit (dB μ V/m)	Average limit (dB μ V/m)	Peak limit (dB μ V/m)
Above 1000	60	80	54	74

Note 1: The lower limit shall apply at the transition frequency.
Note 2: Additional provisions may be required for cases where interference occurs.

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:

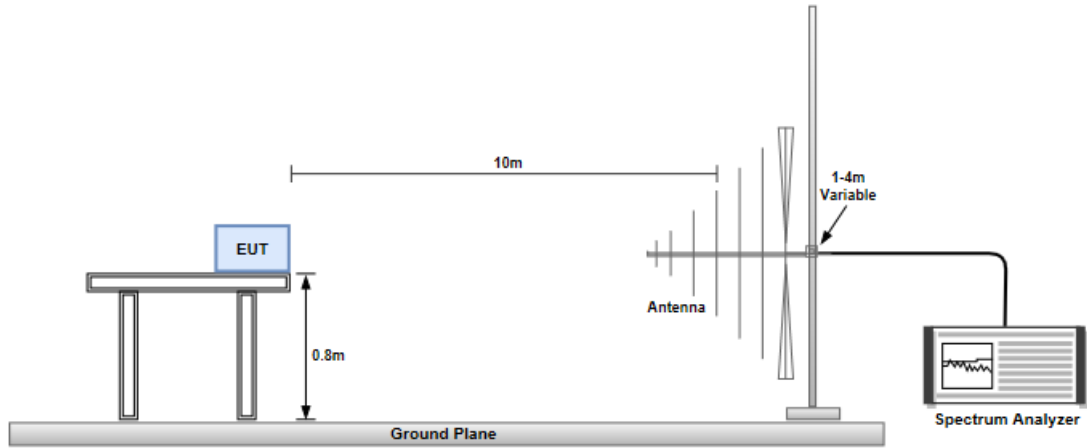
- a. The EUT was placed on a rotatable table top with a height of 0.8 meters which is placed on the ground plane.
- b. The EUT received DC power source from the outlet socket under the turntable. All support equipment power received from another socket under the turntable.
- c. The EUT was set 10 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
- d. The table was rotated 360 degrees to determine the position of the highest radiation.
- e. The antenna is a half wave dipole and its height is varied between one meter and four meters above ground to find the maximum value of the field strength both horizontal polarization and vertical polarization of the antenna are set to make the measurement.
- f. For each suspected emission the EUT was arranged to its worst case and then tune the antenna tower (from 1 to 4 meters) and turn table (from 0 to 360 degrees) to find the maximum reading.
- g. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.
- h. If the emission level of the EUT in peak mode was 2 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 2 dB margin will be repeated one by one using the quasi-peak method and reported.

Measuring above 1 GHz:

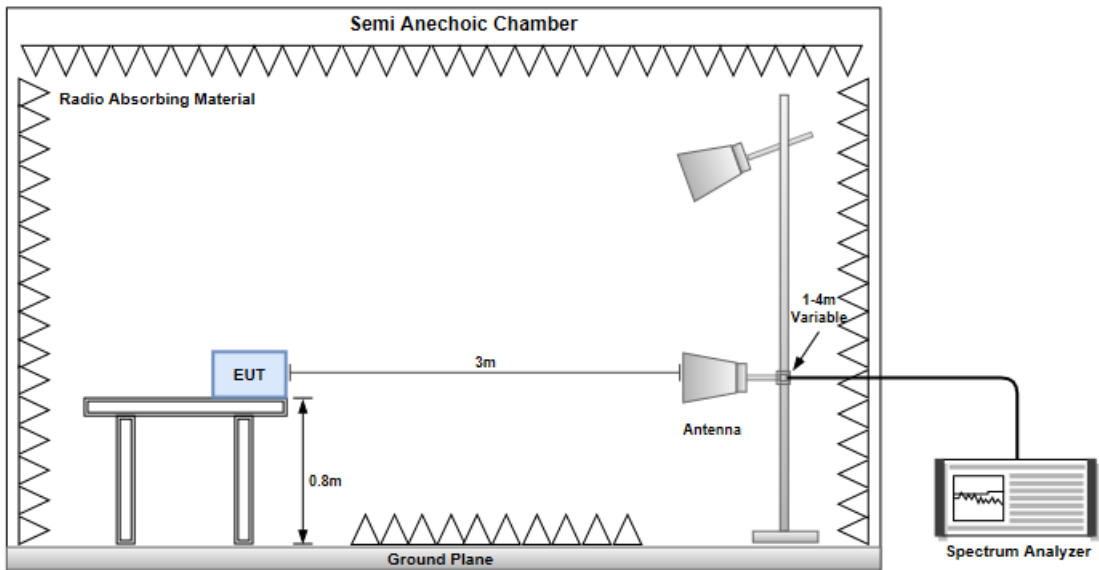
- a. Same test set up as below 1GHz radiated testing.
- b. The EUT was set 3 meters from the interference-receiving antenna which was mounted on the top of a variable height antenna tower.
- c. There should be absorber placed between the EUT and Antenna and its located size should let the test site meet 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

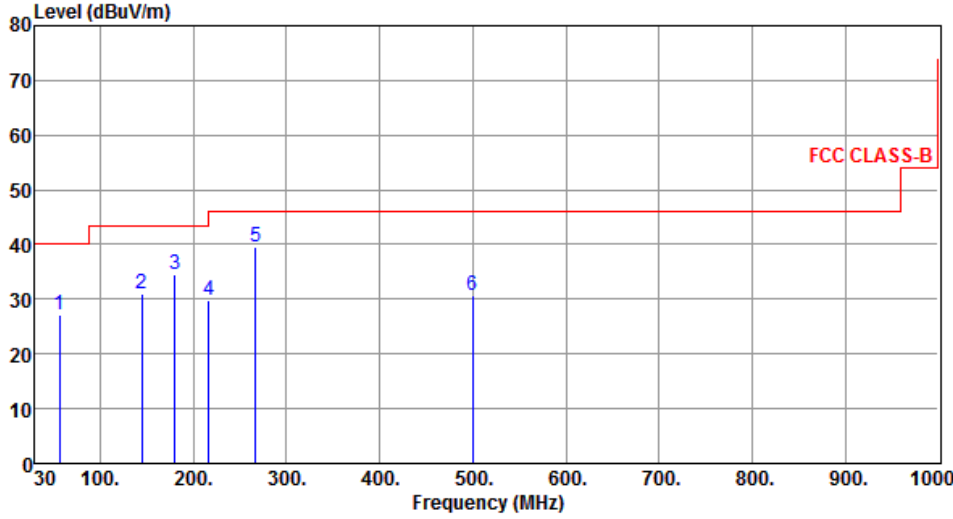
Radiated Emissions below 1 GHz

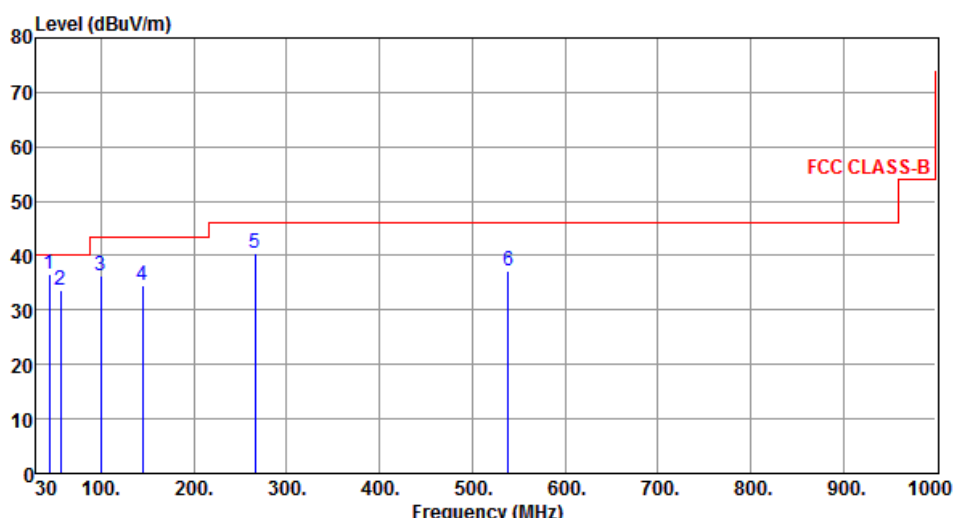


Radiated Emissions above 1 GHz

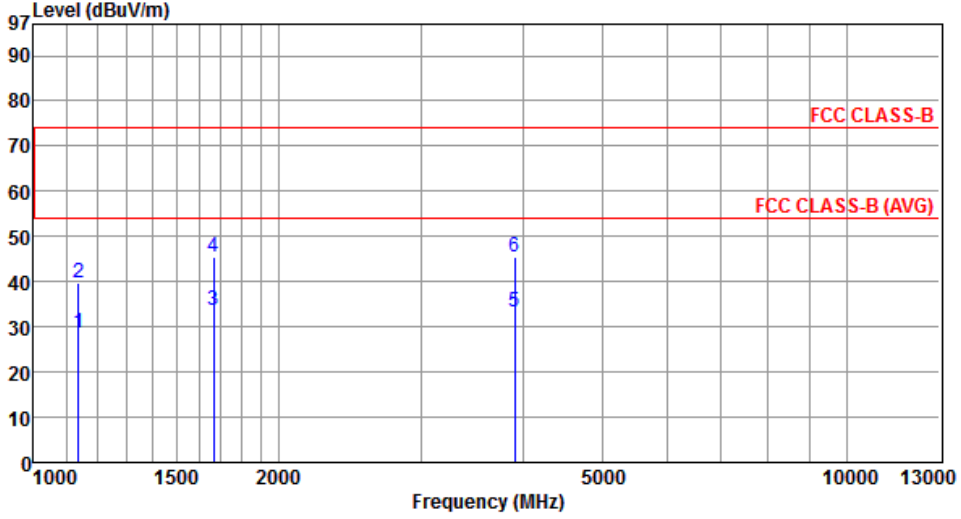


3.2.4 Radiated Emissions (Below 1GHz)

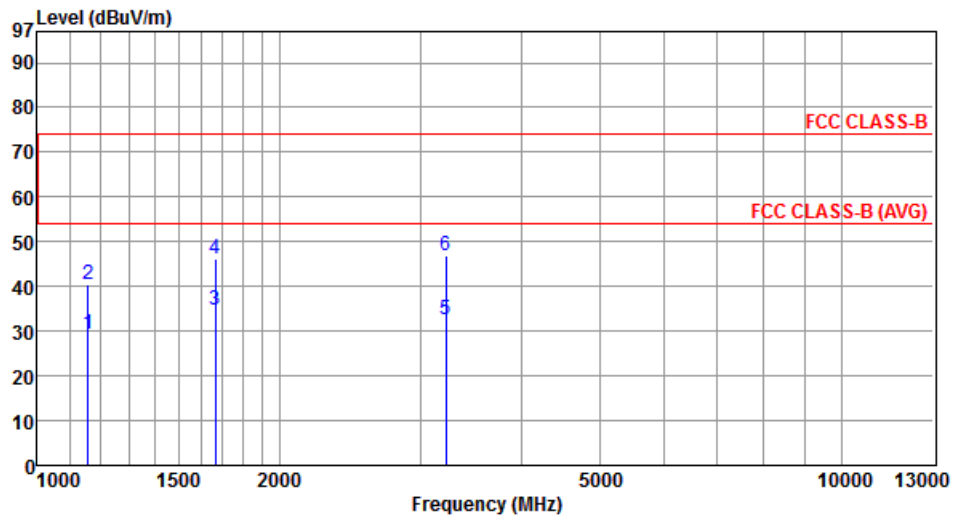
Polarization	Horizontal		Test Mode	1					
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	56.19	27.02	40.00	-12.98	35.87	-8.85	Peak	---	---
2	144.46	30.99	43.50	-12.51	39.41	-8.42	Peak	---	---
3	180.35	34.52	43.50	-8.98	44.53	-10.01	Peak	---	---
4	216.24	29.88	46.00	-16.12	41.01	-11.13	Peak	---	---
5	266.68	39.57	46.00	-6.43	48.46	-8.89	Peak	---	---
6	499.48	30.79	46.00	-15.21	33.47	-2.68	Peak	---	---
<p>Note 1: Emission level (dBUV/m) = SA reading (dBUV) + Factor (dB) 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m)</p>									

Polarization	Vertical	Test Mode	1						
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	44.55	36.48	40.00	-3.52	44.61	-8.13	Peak	---	---
2	56.19	33.77	40.00	-6.23	42.62	-8.85	Peak	---	---
3	99.84	36.18	43.50	-7.32	49.41	-13.23	Peak	---	---
4	144.46	34.52	43.50	-8.98	42.94	-8.42	Peak	---	---
5	265.71	40.34	46.00	-5.66	49.29	-8.95	Peak	---	---
6	539.25	37.23	46.00	-8.77	39.04	-1.81	Peak	---	---
<p>Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB) 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)</p>									

3.2.5 Radiated Emissions (Above 1GHz)

Polarization	Horizontal		Test Mode	1					
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	1135.00	28.63	54.00	-25.37	37.56	-8.93	Average	125	111
2	1135.00	39.63	74.00	-34.37	48.56	-8.93	Peak	125	111
3	1664.00	33.54	54.00	-20.46	38.88	-5.34	Average	130	33
4	1664.00	45.32	74.00	-28.68	50.66	-5.34	Peak	130	33
5	3900.00	33.42	54.00	-20.58	31.04	2.38	Average	115	277
6	3900.00	45.31	74.00	-28.69	42.93	2.38	Peak	115	277
<p>Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB) 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)</p>									

Polarization	Vertical	Test Mode	1
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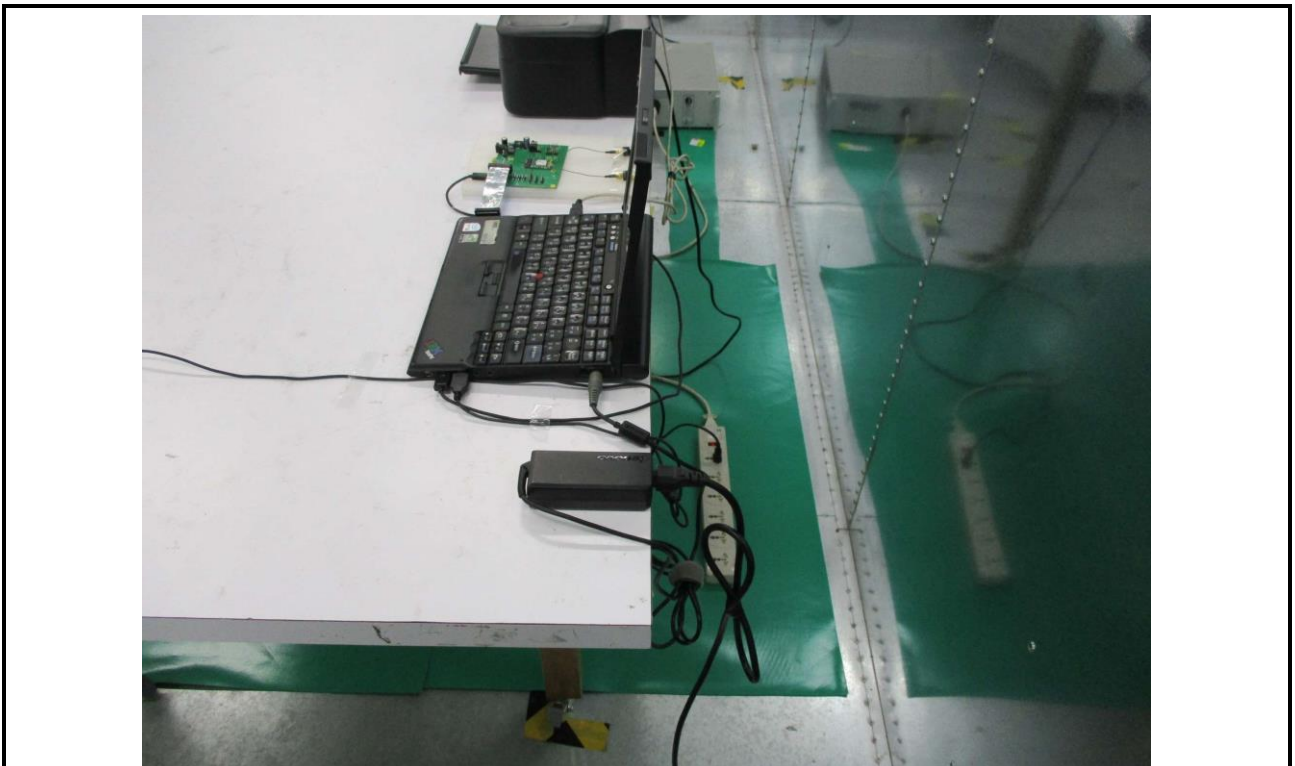


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1155.00	29.33	54.00	-24.67	38.11	-8.78	Average	100	166
2	1155.00	40.37	74.00	-33.63	49.15	-8.78	Peak	100	166
3	1665.00	34.82	54.00	-19.18	40.15	-5.33	Average	100	280
4	1665.00	46.10	74.00	-27.90	51.43	-5.33	Peak	100	280
5	3220.00	32.48	54.00	-21.52	32.11	0.37	Average	100	211
6	3220.00	46.92	74.00	-27.08	46.55	0.37	Peak	100	211

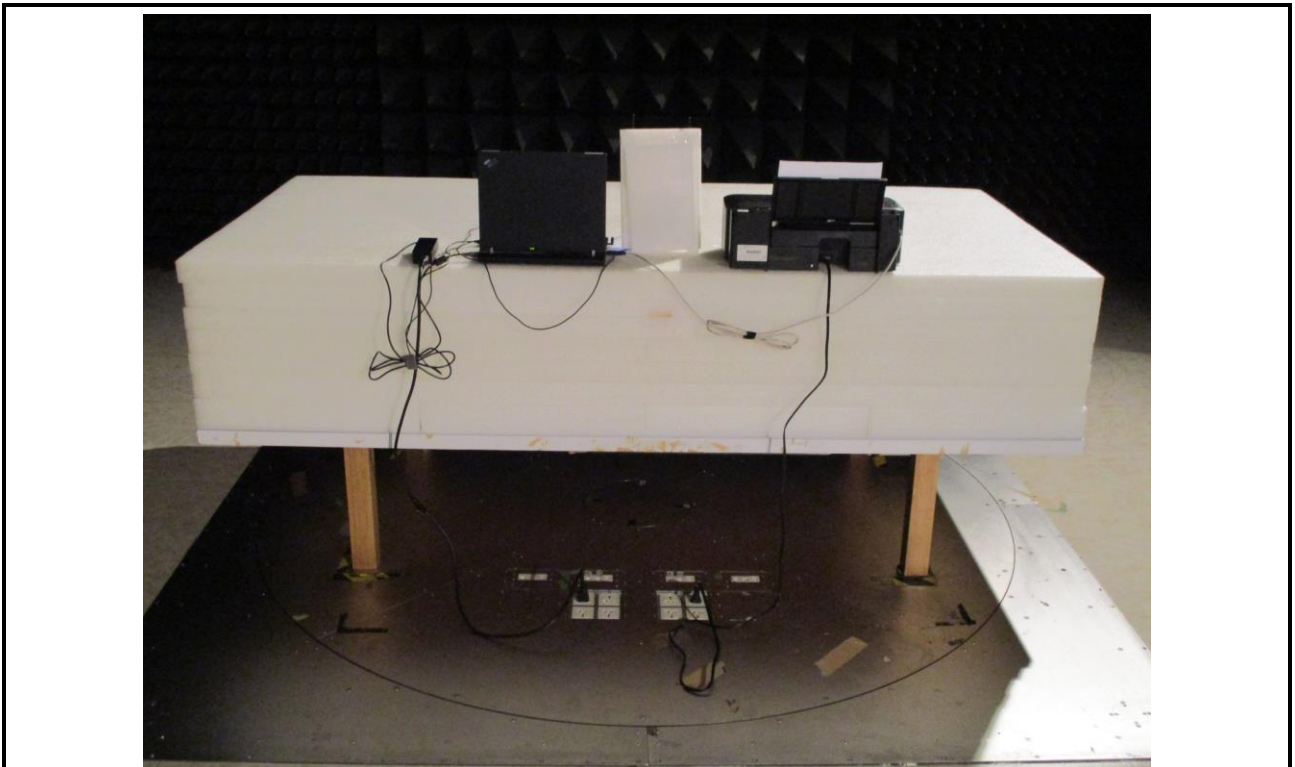
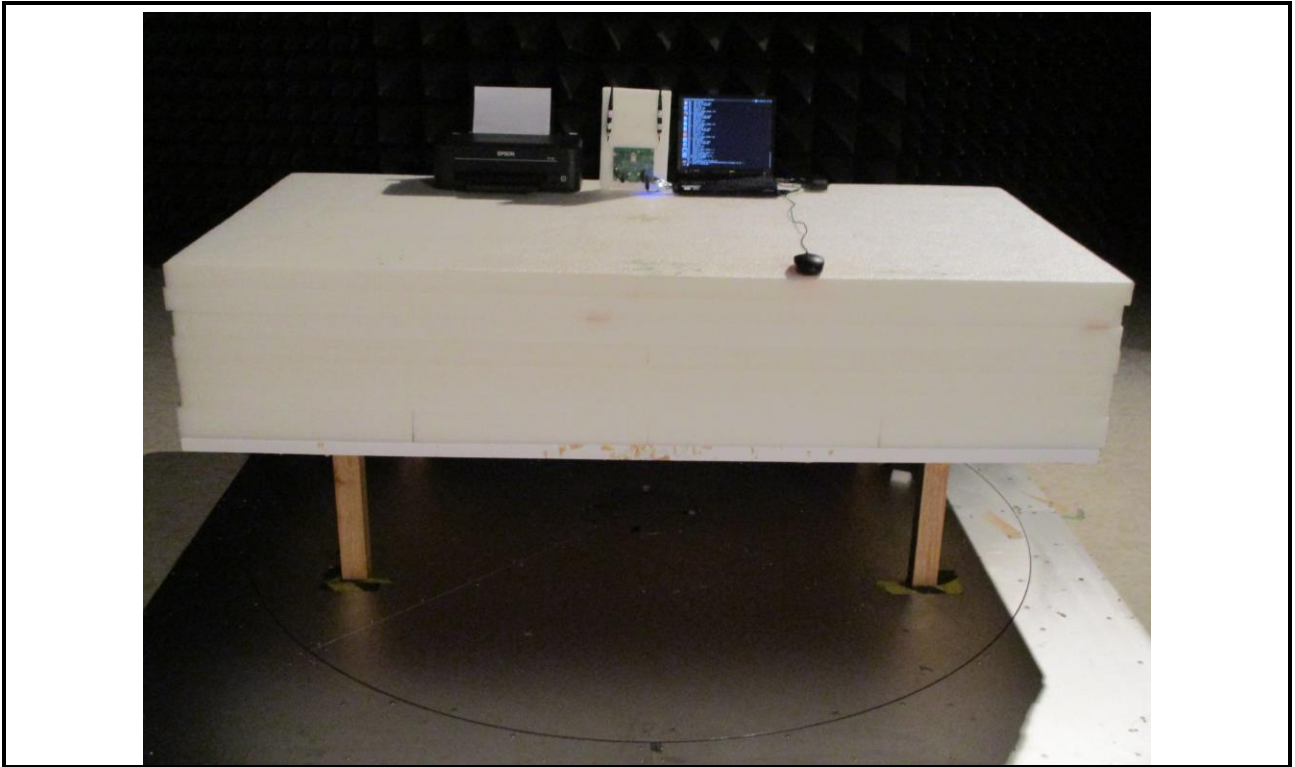
Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)
 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

4 Photographs of the Test Configuration

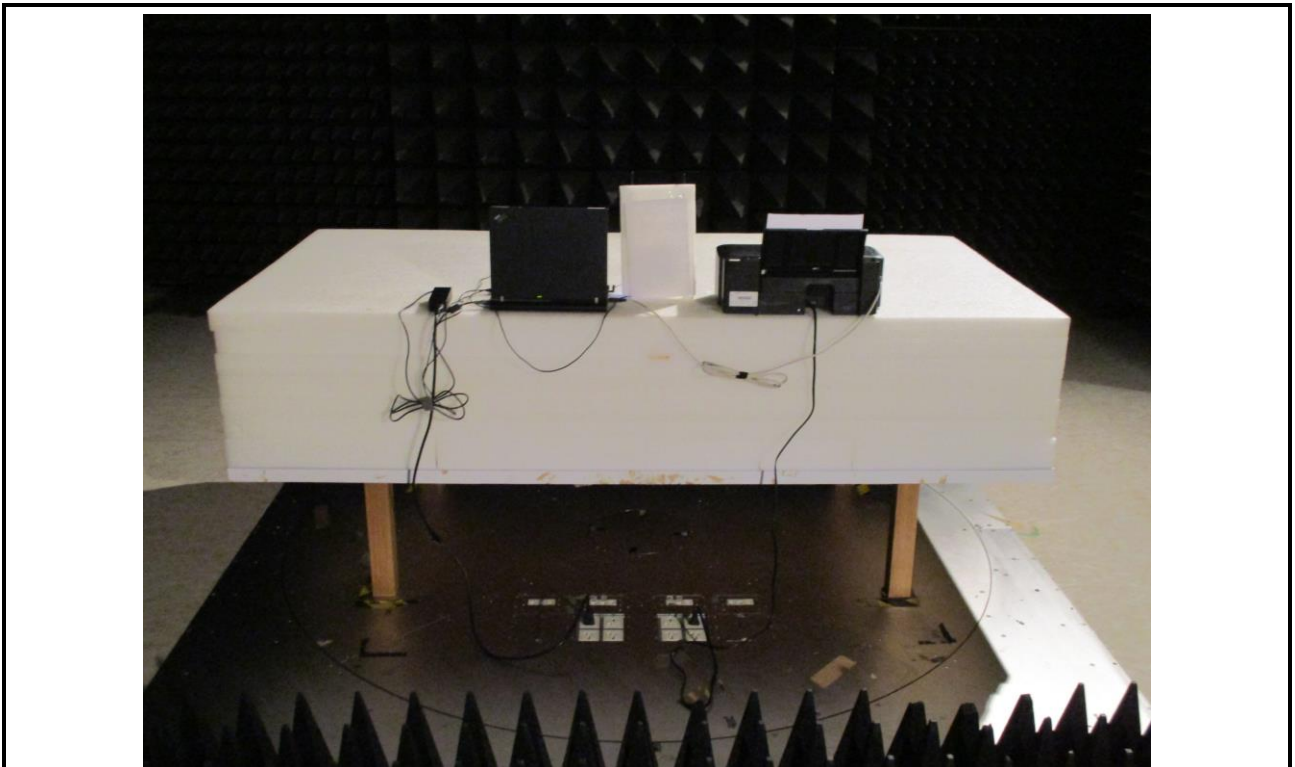
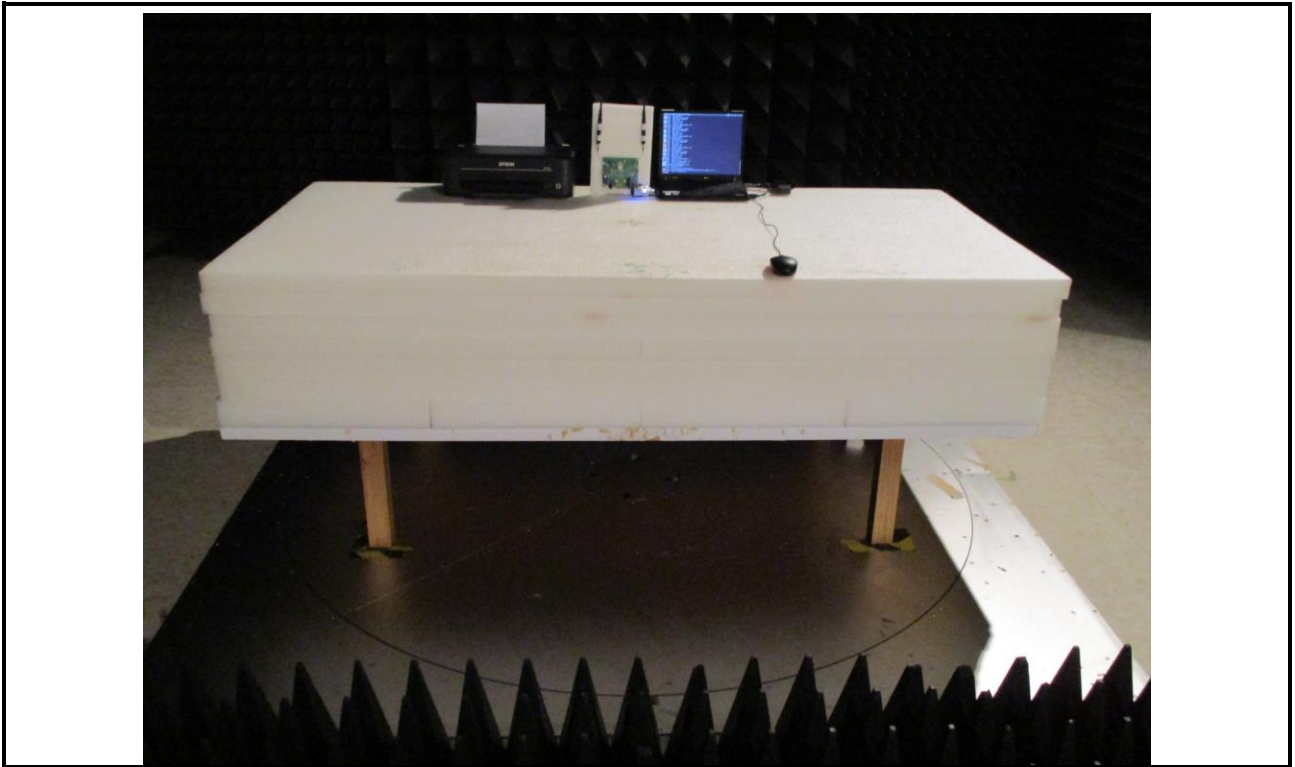
Conducted Emission Test



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

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin Kou
District, New Taipei City, Taiwan,
R.O.C.

Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

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

Tel: 886-3-271-8666

Fax: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

==END==