FCC 15B Test Report

Equipment	:	**802.11abgn Molex 60-pin board-to-board module w/SDIO interface**
Model No.	:	**MSD50NBT**
Brand Name	:	**Laird Technologies**
Applicant	:	**Laird Technologies**
Address	:	**11160 Thompson Ave., Lenexa, Kansas 66219, USA**
Standard	:	**FCC Part 15, Subpart B, Class B ICES-003 Issue 6 ANSI C63.4:2014**
Received Date	:	**Sep. 11, 2015**
Tested Date	:	**Feb. 16 ~ Feb. 22, 2016**

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.

Approved & Reviewed by:

Kent Chen / Assistant Manager

Testing Laboratory
2732

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Release Record

Report No.	Version	Description	Issued Date
FD591103	Rev. 01	Initial issue	Mar. 03, 2016

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	-6.02dB AV@ 21.931MHz.	Pass
15.109	FCC Part 15, Subpart B, Class B	Radiated Emissions	-3.67dB QP@ 49.40MHz.	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

WLAN	
Operating Frequency	802.11b/g/n: 2412 MHz ~ 2462 MHz 802.11a/n: 5180 MHz ~ 5240 MHz; 5260 MHz ~ 5320 MHz; 5500 MHz ~ 5700 MHz, 5745 MHz ~ 5825 MHz
Modulaton Type	802.11b: DSSS (DBPSK / DQPSK / CCK) 802.11a/g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM)
Bluetooth	
Operating Frequency	2402 MHz ~ 2480 MHz
Modulaton Type	Bluetooth 4.0 LE: GFSK Bluetooth BR(1Mbps): GFSK Bluetooth EDR (2Mbps): π/4-DQPSK Bluetooth EDR (3Mbps): 8-DPSK

1.1.2 Antenna Details

Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)				
				2400~2483.5	5150~5250	5250~5350	5470~5725	5725~5850
1	Laird MAF94051	Dipole	RP-SMA	2.1	2.4	2.6	3.4	3.4
2	Laird NanoBlade-IP04	PCB Dipole	IPEX MHF	2	3.9	3.9	4	4
3	Laird MAF95310 Mini NanoBlade Flex	PCB Dipole	IPEX MHF	2.79	3.38	3.38	3.38	3.38
4	Laird NanoBlue-IP04	PCB Dipole	IPEX MHF	2	---	---	---	---
5	Ethertronics WLAN_1000146	Isolated Magnetic Dipole	IPEX MHF	2.5	3.5	3.5	3.5	3.5

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3Vdc from host

1.1.4 Accessories

N/A

1.2 Test Equipment and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Feb. 16, 2016				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
EMC Receiver	R&S	ESCS 30	100169	Oct. 21, 2015	Oct. 20, 2016
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 13, 2015	Nov. 12, 2016
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 21, 2015	Dec. 20, 2016
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	Feb. 18, 2016				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Jan. 12, 2016	Jan. 11, 2017
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-523	Nov. 09, 2015	Nov. 08, 2016
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 10, 2015	Dec. 09, 2016
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16015/4	Dec. 10, 2015	Dec. 09, 2016
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-003	Dec. 10, 2015	Dec. 09, 2016
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	Feb. 22, 2016				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Dec. 17, 2015	Dec. 16, 2016
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1095	Oct. 07, 2015	Oct. 06, 2016
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 04, 2015	Nov. 03, 2016
Preamplifier	Burgeon	BPA-530	100218	Nov. 03, 2015	Nov. 02, 2016
Preamplifier	Agilent	83017A	MY39501309	Sep. 22, 2015	Sep. 21, 2016
Preamplifier	EMC	EMC184045B	980192	Sep. 01, 2015	Aug. 31, 2016
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	Dec. 10, 2015	Dec. 09, 2016
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16018/4	Dec. 10, 2015	Dec. 09, 2016
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	±3.87 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	22°C / 55%	Sky Huang
Radiated Emissions ≤1GHz	03CH02-WS	20°C / 63%	Alex Tsai
Radiated Emissions >1GHz	03CH02-WS	19°C / 62%	Alex Tsai

2.2 The Worst Case Measurement Configuration

Radiation below 1GHz Pretest Mode	
Pretest Mode	**Operating Description**
1	Wifi 5G link, Dipole Ant. MAF94051, Y-axis
2	Wifi 5G link, Isolated Magnetic Dipole Ant. WLAN_1000146, Y-axis
3	Wifi 5G link, PCB Dipole Ant. NanoBlade-IP04, Y-axis
4	Wifi 5G link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex, Y-axis
5	Wifi 2.4G link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex, Y-axis
6	BT link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex, Y-axis

NOTE:
1) For **Pretest Mode 4** is the worst case and only its data was record in this test report.
2) The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-axis. The Y-axis result was found as the worst case and was shown in this report.

Radiation above 1GHz Pretest Mode	
Pretest Mode	**Operating Description**
1	Wifi 5G link, Dipole Ant. MAF94051, Y-axis
2	Wifi 5G link, Isolated Magnetic Dipole Ant. WLAN_1000146, Y-axis
3	Wifi 5G link, PCB Dipole Ant. NanoBlade-IP04, Y-axis
4	Wifi 5G link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex, Y-axis

NOTE:
1) For **Pretest Mode 2** is the worst case and only its data was record in this test report.
2) The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-axis. The Y-axis result was found as the worst case and was shown in this report.

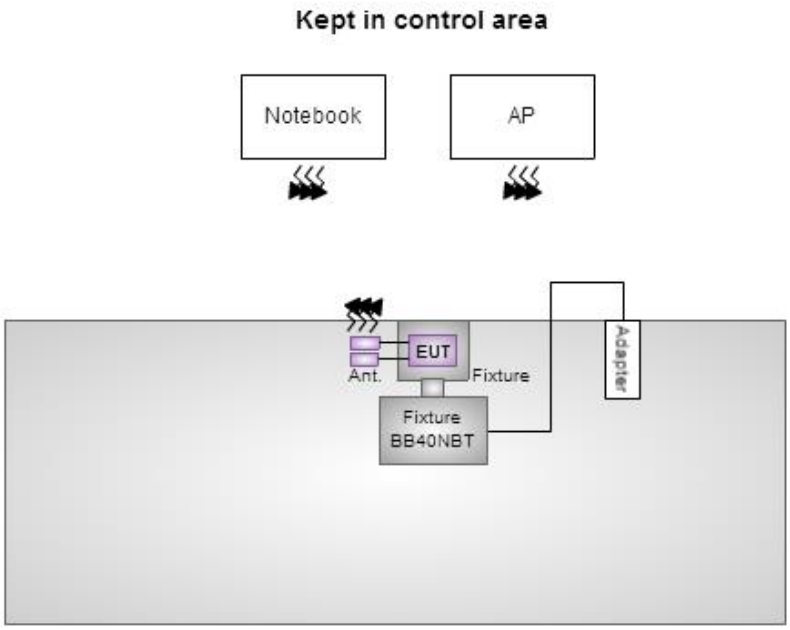
The Determined Worst Case Configurations	
Conducted Emissions	
Test Mode	**Operating Description**
1	Wifi 5G link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex
Radiated Emissions	
Test Mode ≤ 1GHz	**Operating Description**
1	Wifi 5G link, PCB Dipole Ant. MAF95310 Mini NanoBlade Flex, Y-axis
Test Mode > 1GHz	**Operating Description**
1	Wifi 5G link, Isolated Magnetic Dipole Ant. WLAN_1000146, Y-axis

2.3 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Signal cable / Length (m)**
1	Wireless AP	D-LINK	DIR-818LW	2000849	---
2	Notebook	DELL	Latitude E6440	FNXMD12	---
3	Fixture	---	---	---	---
4	Fixture	Laird	BB40NBT	---	---
5	Adapter for fixture BB40NBT	OEM	ADS0128-W 120100	---	Remarks: Input:100-240V~ 50-60Hz, 0.5A Output:12V~1.0A

Note: Item 3-5 were provided by applicant.

2.4 Test Setup Chart

Test Setup Diagram


2.5 Test Software and Operating Condition

a. The support notebook communicated with the EUT by using ping command through AP to receive and transmit data by WLAN.

3 Emission Tests Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

Applicable Standard: FCC Part 15, Subpart B §15.107				
Frequency Range (MHz)	Class A (dBµV)		Class B (dBµV)	
	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.

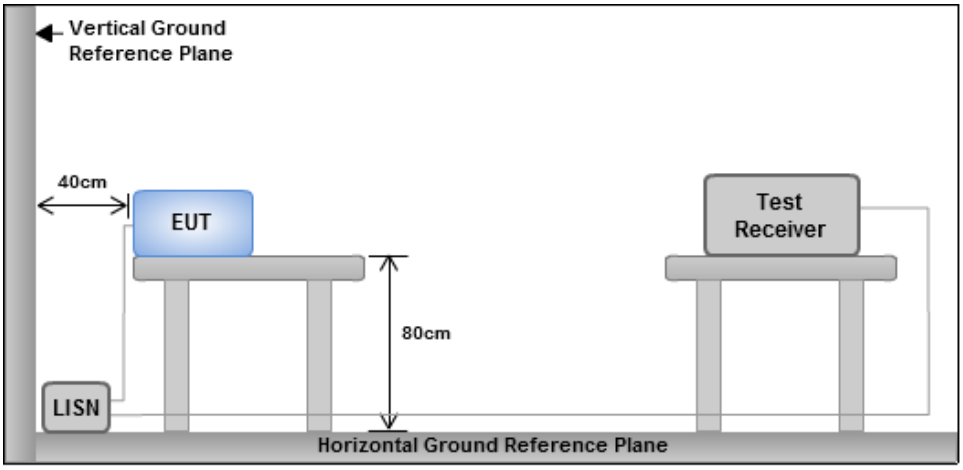
e. The CISPR states that a 50 ohm, 50 microhenry LISN should be used.

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

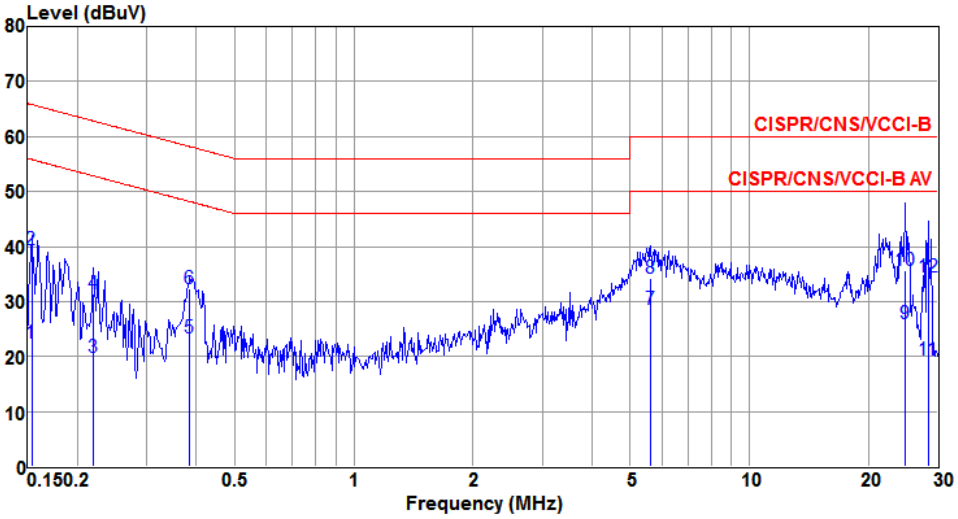


Note: 1. Support units were connected to second LISN.

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

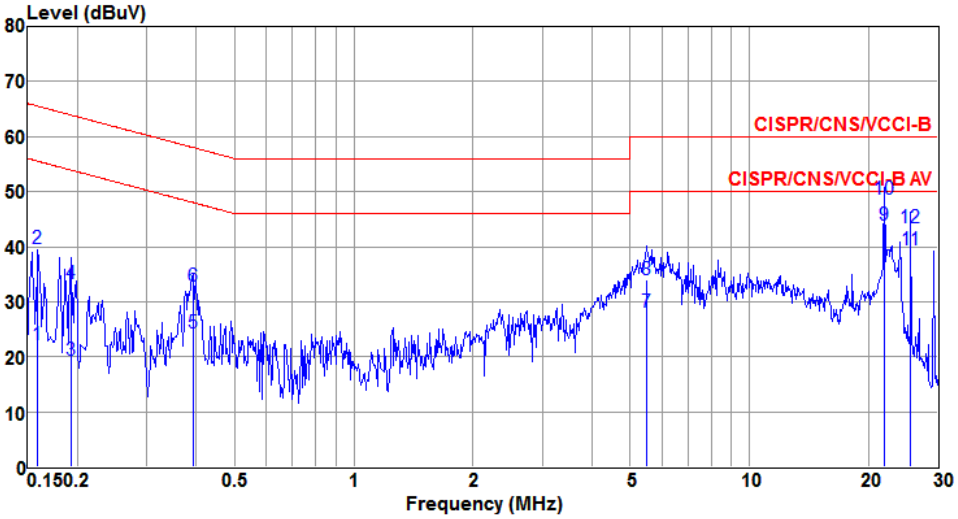
Power Phase	Line	Test Mode	1



	Freq	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.153	22.40	55.82	-33.42	21.50	0.88	0.02	Average
2	0.153	39.48	65.82	-26.34	38.58	0.88	0.02	QP
3	0.220	19.74	52.83	-33.09	19.48	0.24	0.02	Average
4	0.220	31.32	62.83	-31.51	31.06	0.24	0.02	QP
5	0.385	23.46	48.17	-24.71	23.25	0.18	0.03	Average
6	0.385	32.37	58.17	-25.80	32.16	0.18	0.03	QP
7@	5.623	28.46	50.00	-21.54	27.92	0.41	0.13	Average
8	5.623	34.33	60.00	-25.67	33.79	0.41	0.13	QP
9	24.790	25.99	50.00	-24.01	24.80	0.95	0.24	Average
10	24.790	35.64	60.00	-24.36	34.45	0.95	0.24	QP
11	28.302	19.30	50.00	-30.70	17.99	1.07	0.24	Average
12	28.302	34.45	60.00	-25.55	33.14	1.07	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	Level	Limit Line	Over Limit	Read Level	LISN factor	cable loss	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.159	22.09	55.52	-33.43	21.34	0.73	0.02	Average
2	0.159	39.56	65.52	-25.96	38.81	0.73	0.02	QP
3	0.192	19.43	53.93	-34.50	19.10	0.31	0.02	Average
4	0.192	33.37	63.93	-30.56	33.04	0.31	0.02	QP
5	0.391	24.21	48.03	-23.82	24.05	0.13	0.03	Average
6	0.391	32.78	58.03	-25.25	32.62	0.13	0.03	QP
7	5.505	28.01	50.00	-21.99	27.22	0.66	0.13	Average
8	5.505	33.88	60.00	-26.12	33.09	0.66	0.13	QP
9@	21.931	43.98	50.00	-6.02	42.92	0.86	0.20	Average
10	21.931	48.66	60.00	-11.34	47.60	0.86	0.20	QP
11	25.591	39.51	50.00	-10.49	38.20	1.06	0.25	Average
12	25.591	43.37	60.00	-16.63	42.06	1.06	0.25	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.

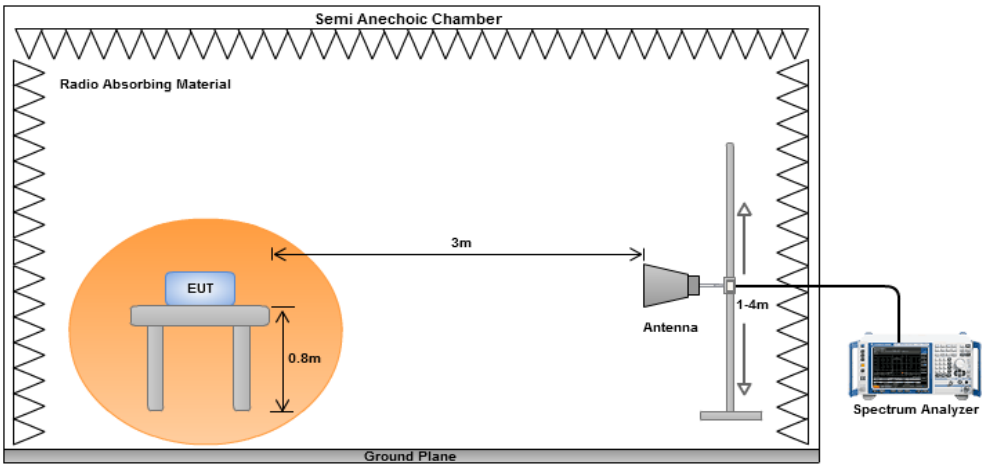
f. Set the Horn Antenna at 1m height, then run the turn table to get the maximum noise reading from Horizontal and Vertical polarity separately.

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.

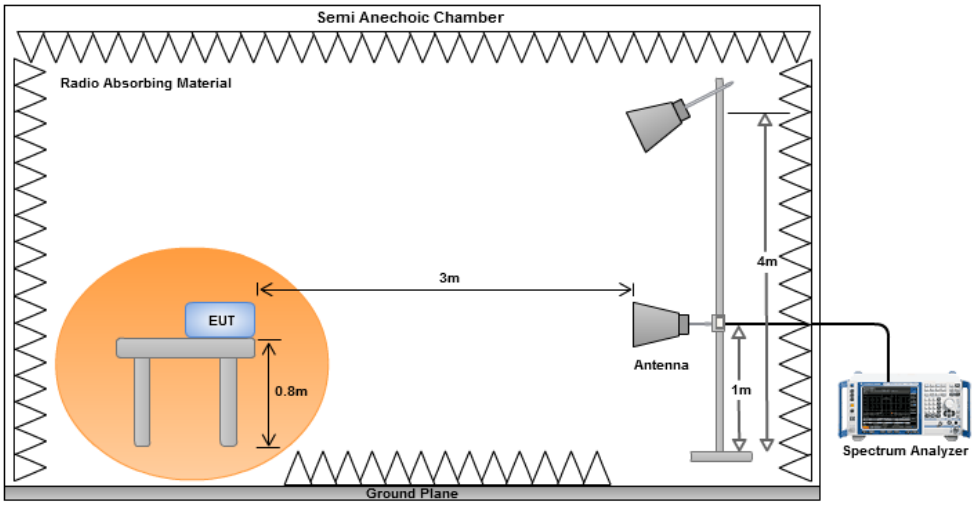
h. If emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again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

3.2.3 Test Setup

Radiated Emissions below 1 GHz

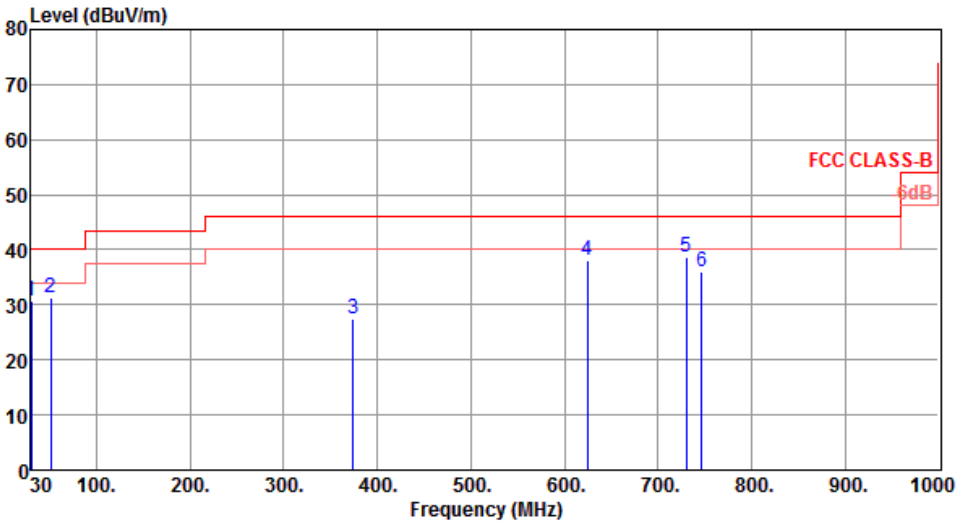


Radiated Emissions above 1 GHz



3.2.4 Radiated Emissions (Below 1GHz)

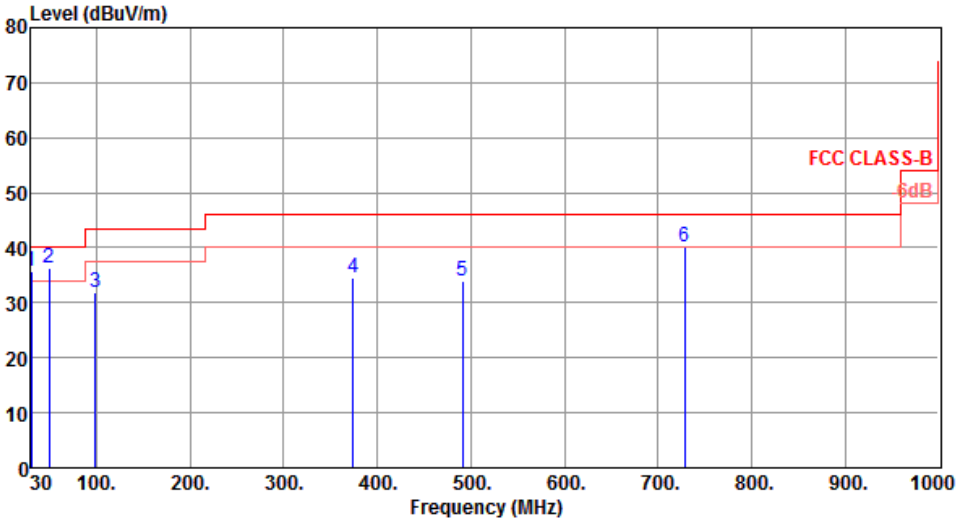
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	30.00	30.81	40.00	-9.19	43.63	-12.82	Peak	---	---
2	51.34	31.31	40.00	-8.69	43.14	-11.83	Peak	---	---
3	374.35	27.47	46.00	-18.53	36.83	-9.36	Peak	---	---
4	624.61	38.06	46.00	-7.94	42.35	-4.29	Peak	---	---
5	730.34	38.76	46.00	-7.24	41.46	-2.70	Peak	---	---
6	746.83	36.13	46.00	-9.87	38.55	-2.42	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

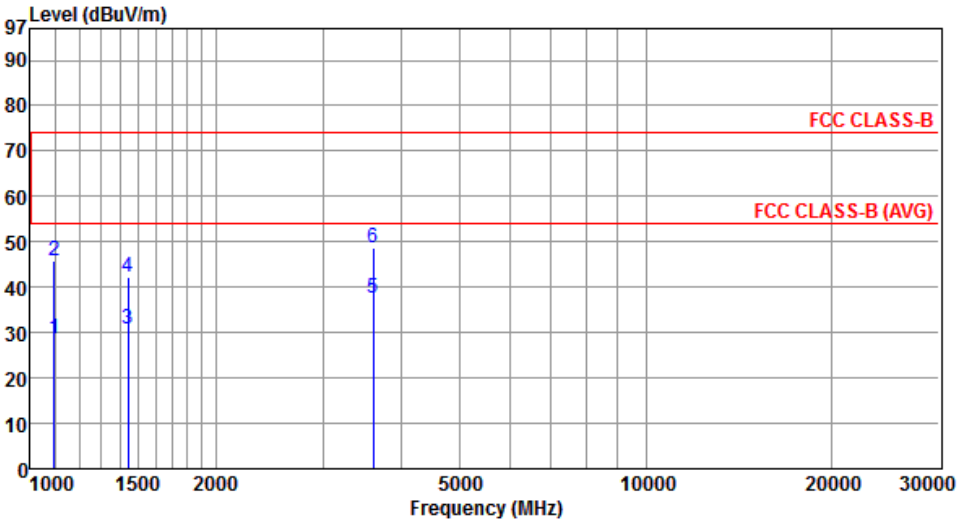


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	30.00	35.60	40.00	-4.40	48.42	-12.82	Peak	---	---
2	49.40	36.33	40.00	-3.67	48.00	-11.67	QP	100	300
3	98.87	31.83	43.50	-11.67	48.64	-16.81	Peak	---	---
4	374.35	34.42	46.00	-11.58	43.78	-9.36	Peak	---	---
5	490.75	33.82	46.00	-12.18	40.53	-6.71	Peak	---	---
6	728.40	40.18	46.00	-5.82	42.91	-2.73	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)

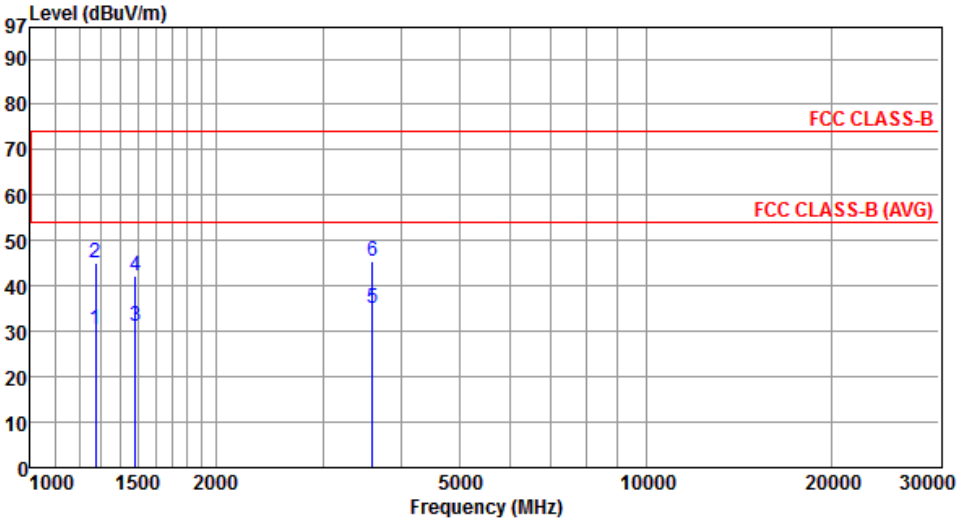
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1094.00	28.54	54.00	-25.46	38.09	-9.55	Average	100	258
2	1094.00	45.75	74.00	-28.25	55.30	-9.55	Peak	100	258
3	1441.00	30.85	54.00	-23.15	37.65	-6.80	Average	115	251
4	1441.00	42.34	74.00	-31.66	49.14	-6.80	Peak	115	251
5	3605.00	37.65	54.00	-16.35	37.15	0.50	Average	114	300
6	3605.00	48.72	74.00	-25.28	48.22	0.50	Peak	114	300

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

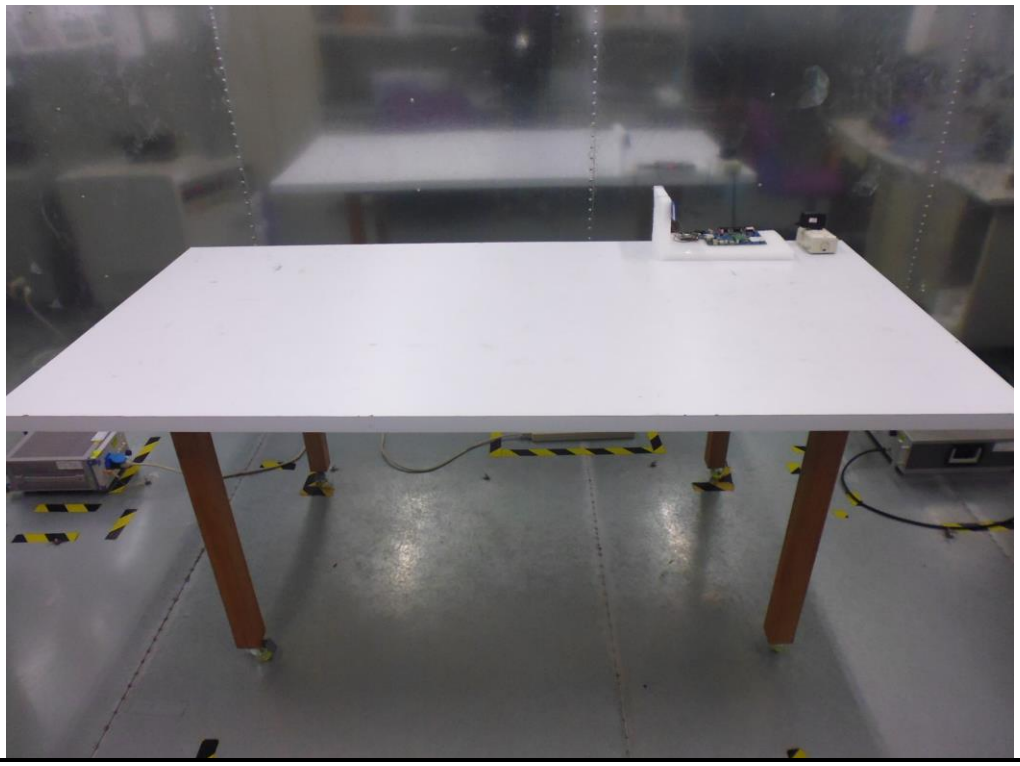


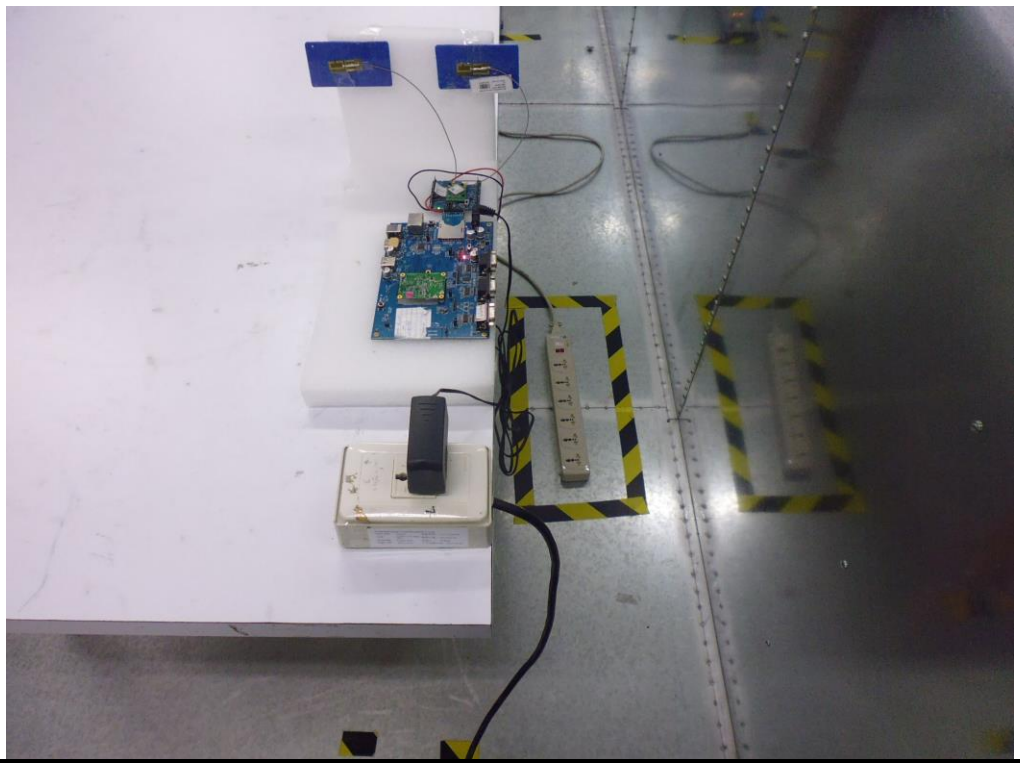
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1275.00	30.54	54.00	-23.46	38.65	-8.11	Average	100	215
2	1275.00	45.10	74.00	-28.90	53.21	-8.11	Peak	100	215
3	1483.00	31.07	54.00	-22.93	37.54	-6.47	Average	110	300
4	1483.00	42.13	74.00	-31.87	48.60	-6.47	Peak	110	300
5	3597.00	35.14	54.00	-18.86	34.66	0.48	Average	100	115
6	3597.00	45.45	74.00	-28.55	44.97	0.48	Peak	100	115

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

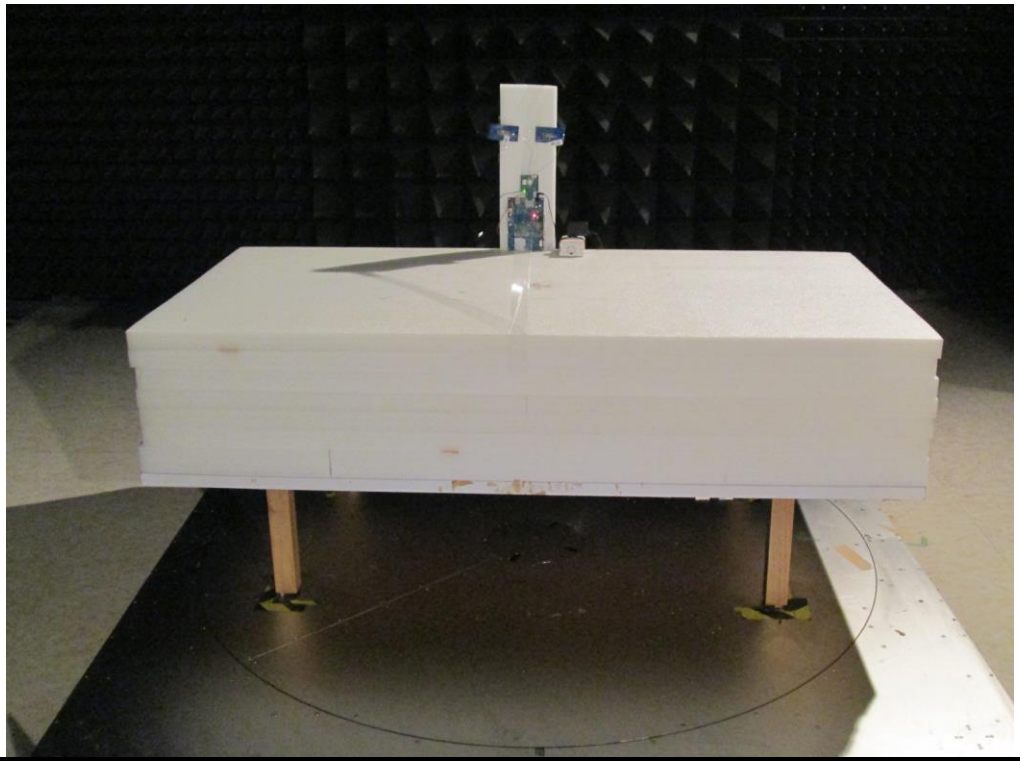
4 Photographs of the Test Configuration

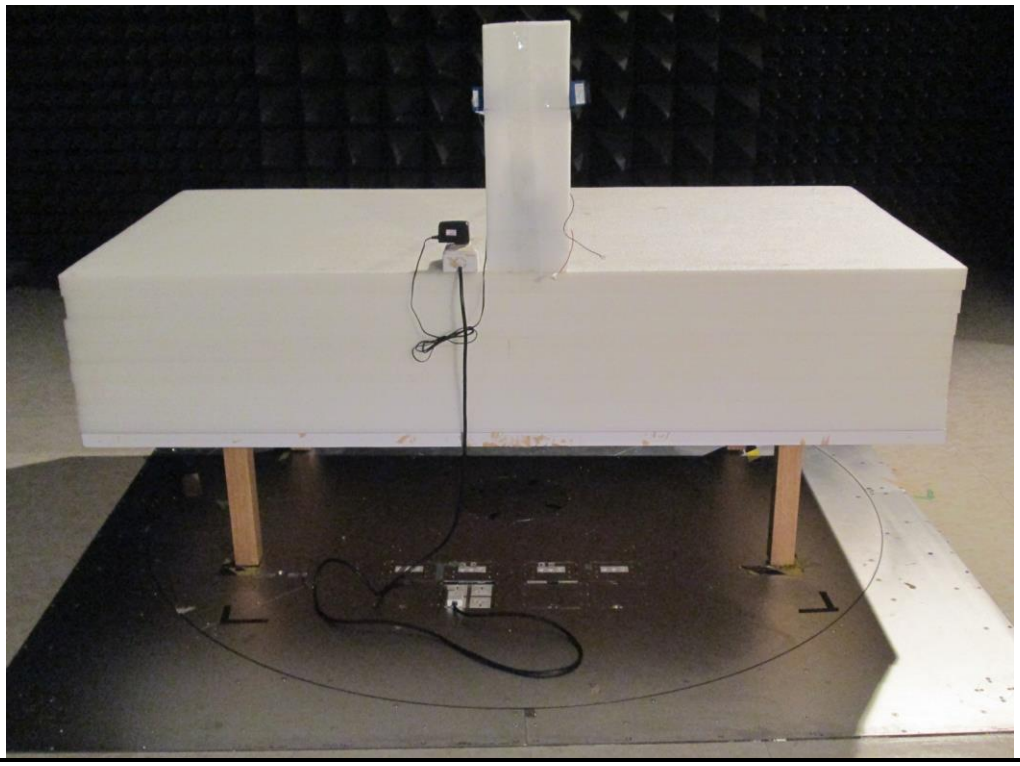
Conducted Emission Test



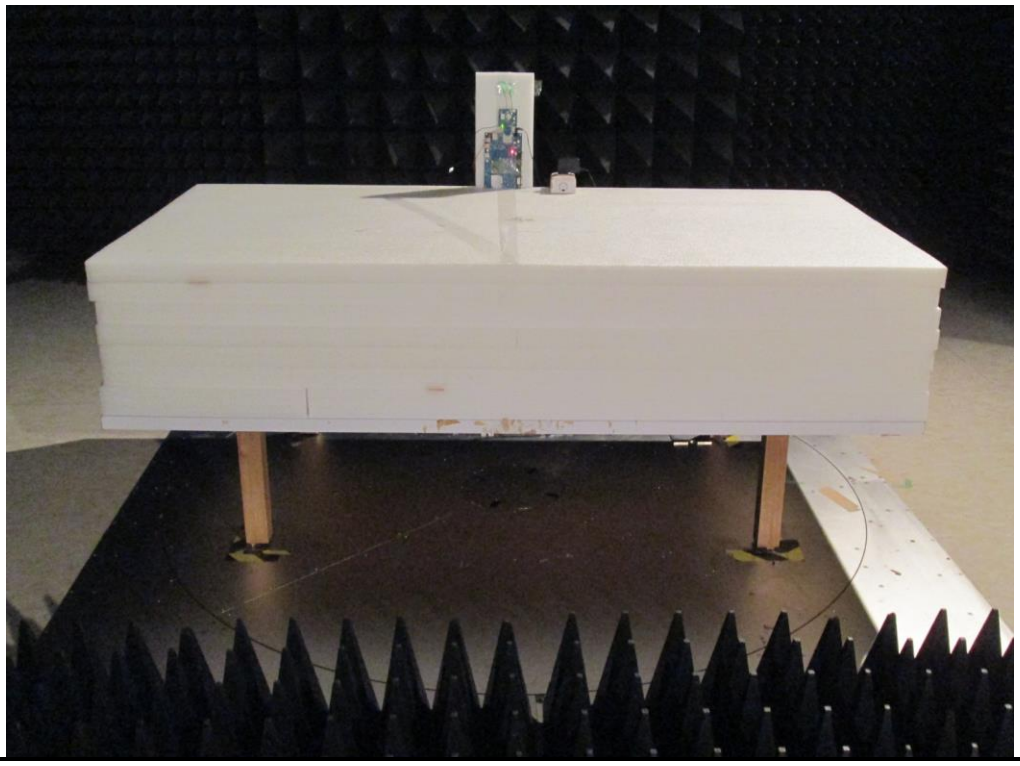


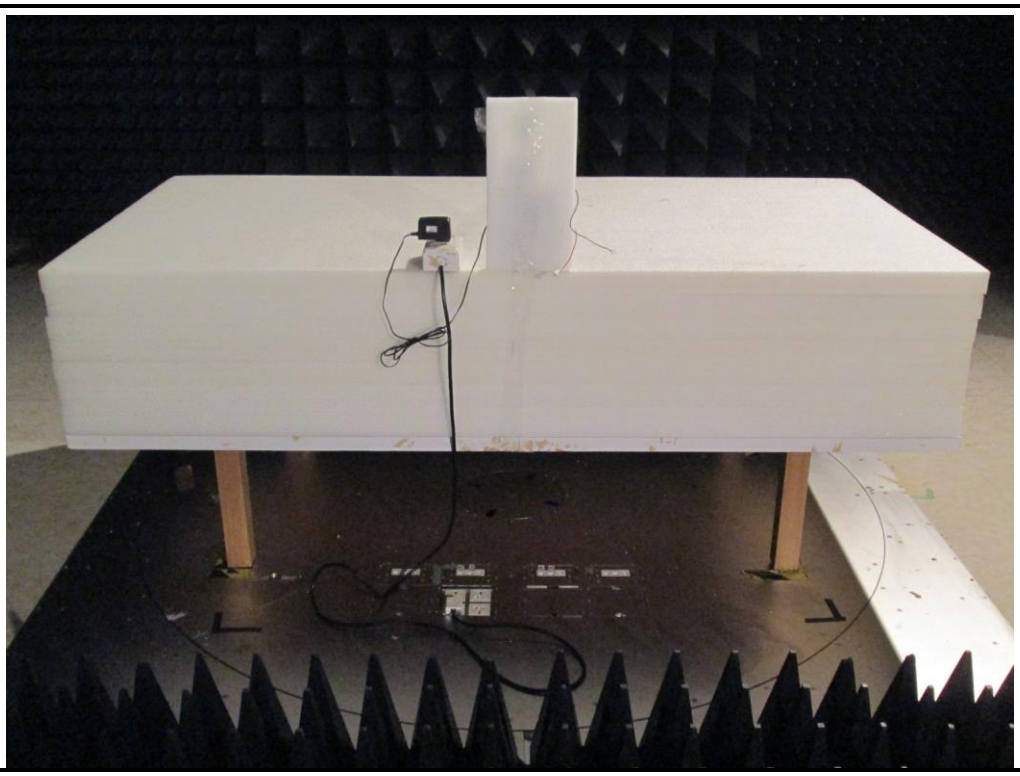
Radiated Emission Below 1GHz Test





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, 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 Hsiang. 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 Hsiang, Tao Yuan Hsien 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan Hsiang, Tao Yuan Hsien 333, Taiwan, R.O.C.

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

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Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

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