FCC 15B Test Report

Equipment	:	**Bluetooth 4.2 module (BLE only)**
Model No.	:	**BL652-SA, BL652-SC** **(Refer to item 1.1.1 for more details)**
Brand Name	:	**Laird**
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	:	**May 14, 2018**
Tested Date	:	**Jun. 04 ~ Jun. 05, 2018**

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: **Approved by:**

Peter Lin / Supervisor **Kent Chen / Assistant Manager**

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
FD662202-06	Rev. 01	Initial issue	Jun. 11, 2018

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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	-24.28dB AV@ 0.276MHz.	Pass
15.109	FCC Part 15, Subpart B, Class B	Radiated Emissions	-3.04dB PK@ 62.98MHz.	Pass

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1 General Description

1.1 Information

This report is issued as a supplementary report to original ICC report no. FD662202. The modification is concerned with adding 4 antennas and 2 Mbps data rate by software setting. In this report, all tests had been re-tested and presented in the following sections.

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
Laird	BL652-SA	Bluetooth 4.2 module (BLE only)	with chip antenna
	BL652-SC		with MHF4 & IPEX connector type antenna
✦ The above models, model **BL652-SC** 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	3.3Vdc from host
Highest Frequency of the Internal Sources	2.4GHz

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1.1.3 Antenna Details

For NFC

Ant. No.	Brand	Model	Type	Connector	Gain (dBi)	Remarks
1	---	---	Flexi PCB	N/A	---	---

For Bluetooth (The new additions are marked in boldface.)

Ant. No.	Brand	Model	Type	Connector	Gain (dBi)	Remarks
1	ACX	AT3216-B2R7HAA	Chip	N/A	0.5	For BL652-SA
2	LSR	FlexPIFA 001-0022	FlexPIFA	MHF4	2	For BL652-SC
3	LSR	FlexNotch 001-0023	Flexible Notch	MHF4	2	
4	MAG. LAYERS	EDA-8709-2G4C1-B27	Dipole	MHF4	2	
5	Walsin	RFDPA870910EMAB302	Dipole	MHF4	2	
6	**Walsin**	**RFDPA870900SBAB8G1**	**Dipole**	**MHF4**	**2**	
7	**YAMAMOTO METAL**	**YAN-02-C-MHF4P-050**	**Chip**	**MHF4**	**1.76**	
8	**Laird**	**PCA-4606-2G4C1-A33-CY 0600-00056**	**PCB Dipole**	**IPEX**	**2.21**	
9	**Laird**	**EFA2400A3S-10MH4L 001-003**	**mFlexPIFA**	**MHF4**	**2**	

1.1.4 Accessories

N/A

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1.2 Test Equipment and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Test Date	Jun. 05, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101657	Jan. 05, 2018	Jan. 04, 2019
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 13, 2017	Nov. 12, 2018
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Nov. 24, 2017	Nov. 23, 2018
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 18, 2017	Dec. 17, 2018
50 ohm terminal (Support Unit)	NA	50	04	May 22, 2018	May 21, 2019
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)				
Test Date	Jun. 04, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	Agilent	N9038A	MY53290044	Sep. 26, 2017	Sep. 25, 2018
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-523	Nov. 10, 2017	Nov. 09, 2018
Preamplifier	EMC	EMC02325	980194	Sep. 25, 2017	Sep. 24, 2018
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	160501	Dec. 06, 2017	Dec. 05, 2018
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-003	Dec. 06, 2017	Dec. 05, 2018
LF cable 10M	EMCC	CFD400-E	CFD400-001	Dec. 06, 2017	Dec. 05, 2018
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)				
Test Date	Jun. 04, 2018				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Agilent	N9010A	MY53400091	Nov. 15, 2017	Nov. 14, 2018
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1095	Sep. 22, 2017	Sep. 21, 2018
Preamplifier	Agilent	83017A	MY39501309	Sep. 25, 2017	Sep. 24, 2018
RF Cable	EMC	EMC105-SM-SM-8000	180512	May 08, 2018	May 07, 2019
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16018/4	Dec. 06, 2017	Dec. 05, 2018
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

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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

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2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C/57%	Alex Tsai
Radiated Emissions	03CH02-WS	24°C/57%	Alex Tsai

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

2.2 The Worst Case Measurement Configuration

Radiation Pretest Mode	
Pretest Mode	**Operating Description**
1	Model: BL652-SC, BT Link, EUT: X-axis, Ant: EDA-8709-2G4C1-B27
2	Model: BL652-SC, BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27
3	Model: BL652-SC, BT Link, EUT: Z-axis, Ant: EDA-8709-2G4C1-B27
4	Model: BL652-SC, BT Link, EUT: X-axis, Ant: FlexPIFA 001-0022
5	Model: BL652-SC, BT Link, EUT: X-axis, Ant: FlexNotch 001-0023
6	Model: BL652-SA, BT Link, EUT: X-axis, Ant: AT3216-B2R7HAA
7	Model: BL652-SC, NFC Link, EUT: X-axis, Ant: Flexi PCB
8	Model: BL652-SC, BT Link, EUT: X-axis, Ant: YAN-02-C-MHF4P-050
9	Model: BL652-SC, BT Link, EUT: X-axis, Ant: PCA-4606-2G4C1-A33-CY
10	Model: BL652-SC, BT Link, EUT: X-axis, Ant: EFA2400A3S-10MH4L
For **Pretest Mode 9** 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	Model: BL652-SC, BT Link, EUT: X-axis, Ant: PCA-4606-2G4C1-A33-CY
Radiated Emissions	
Test Mode ≤ 1GHz	**Operating Description**
1	Model: BL652-SC, BT Link, EUT: X-axis, Ant: PCA-4606-2G4C1-A33-CY
Test Mode > 1GHz	**Operating Description**
1	Model: BL652-SC, BT Link, EUT: X-axis, Ant: PCA-4606-2G4C1-A33-CY

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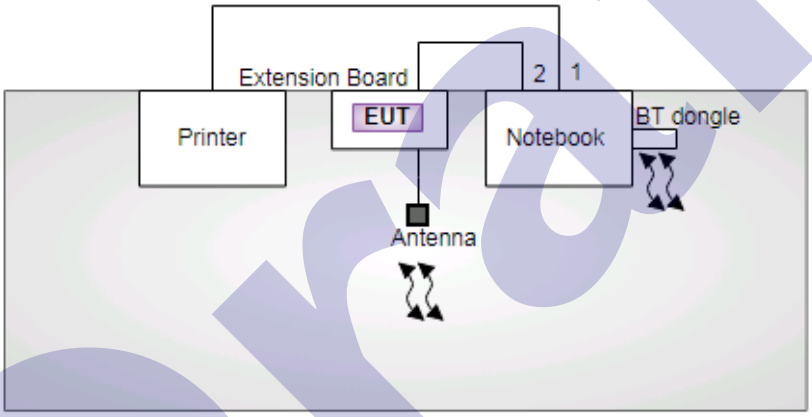
2.3 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Remarks**
1	Notebook	DELL	Latitude 3470	GC1JZD2	---
2	Printer	EPSON	XP-30	QSDK002410	---
3	BT dongle	nordic semiconductor	N/A	---	Provided by applicant.
4	Extension Board	Laird	DVK-BL652-A1	---	Provided by applicant.

2.4 Test Setup Chart

Test Setup Diagram



No.	Signal cable / Length (m)
1	USB, 1.8m shielded.
2	USB, 1m shielded.

2.5 Test Software and Operating Condition

a. To enable all function of test system.
b. The support notebook executed “EMCTest.exe” to send “H” patterns to its monitor and the monitor displayed them.
c. The support notebook executed “EMCTest.exe” to send “H” patterns to the printer.
d. The support notebook executed “Uwterminal.exe” and “Master Control Panel” for BT link to BT dongle.

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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 (dBµV)		Class B (dBµV)	
	Limits			
	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,5	79	66	66 to 56	56 to 46
0,5 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.

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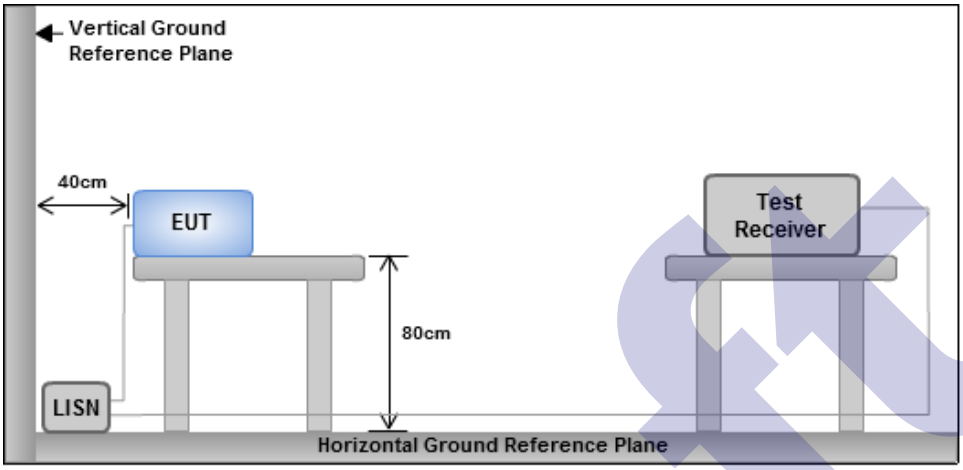
3.1.3 Test Setup



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

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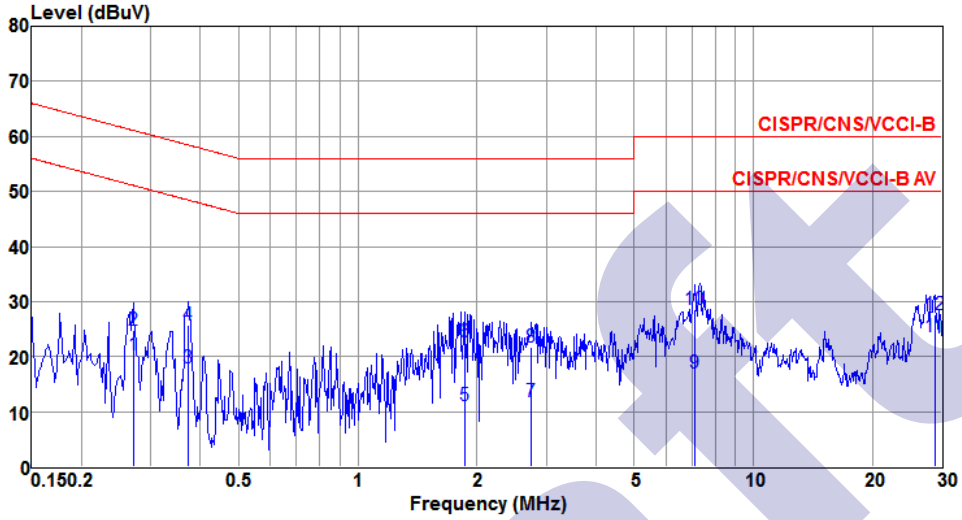
3.1.4 Test Result of Conducted Emissions

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	0.270	20.27	51.12	-30.85	20.16	0.08	0.03	Average
2	0.270	24.83	61.12	-36.29	24.72	0.08	0.03	QP
3	0.371	17.87	48.47	-30.60	17.77	0.08	0.02	Average
4	0.371	25.69	58.47	-32.78	25.59	0.08	0.02	QP
5	1.858	11.11	46.00	-34.89	10.91	0.11	0.09	Average
6	1.858	22.70	56.00	-33.30	22.50	0.11	0.09	QP
7	2.750	11.76	46.00	-34.24	11.49	0.12	0.15	Average
8	2.750	21.69	56.00	-34.31	21.42	0.12	0.15	QP
9	7.137	16.91	50.00	-33.09	16.46	0.17	0.28	Average
10	7.137	28.65	60.00	-31.35	28.20	0.17	0.28	QP
11@	28.755	23.54	50.00	-26.46	22.85	0.29	0.40	Average
12	28.755	27.64	60.00	-32.36	26.95	0.29	0.40	QP

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

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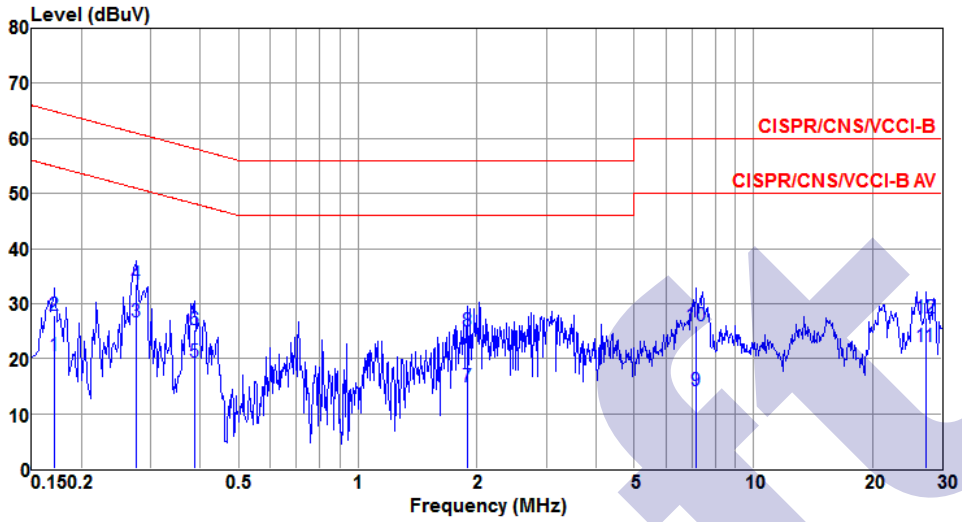
Power Phase	Neutral	Test Mode	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.171	20.59	54.90	-34.31	20.53	0.04	0.02	Average
2	0.171	27.80	64.90	-37.10	27.74	0.04	0.02	QP
3@	0.276	26.66	50.94	-24.28	26.59	0.04	0.03	Average
4	0.276	33.48	60.94	-27.46	33.41	0.04	0.03	QP
5	0.387	19.39	48.12	-28.73	19.33	0.04	0.02	Average
6	0.387	25.32	58.12	-32.80	25.26	0.04	0.02	QP
7	1.898	14.81	46.00	-31.19	14.64	0.07	0.10	Average
8	1.898	25.02	56.00	-30.98	24.85	0.07	0.10	QP
9	7.175	14.21	50.00	-35.79	13.79	0.14	0.28	Average
10	7.175	25.86	60.00	-34.14	25.44	0.14	0.28	QP
11	27.271	22.30	50.00	-27.70	21.61	0.30	0.39	Average
12	27.271	27.31	60.00	-32.69	26.62	0.30	0.39	QP

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

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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.

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3.2.2 Test Procedures

Measuring below 1 GHz:

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.

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.

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:

Same test set up as below 1GHz radiated testing.

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

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

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

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

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

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.

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.

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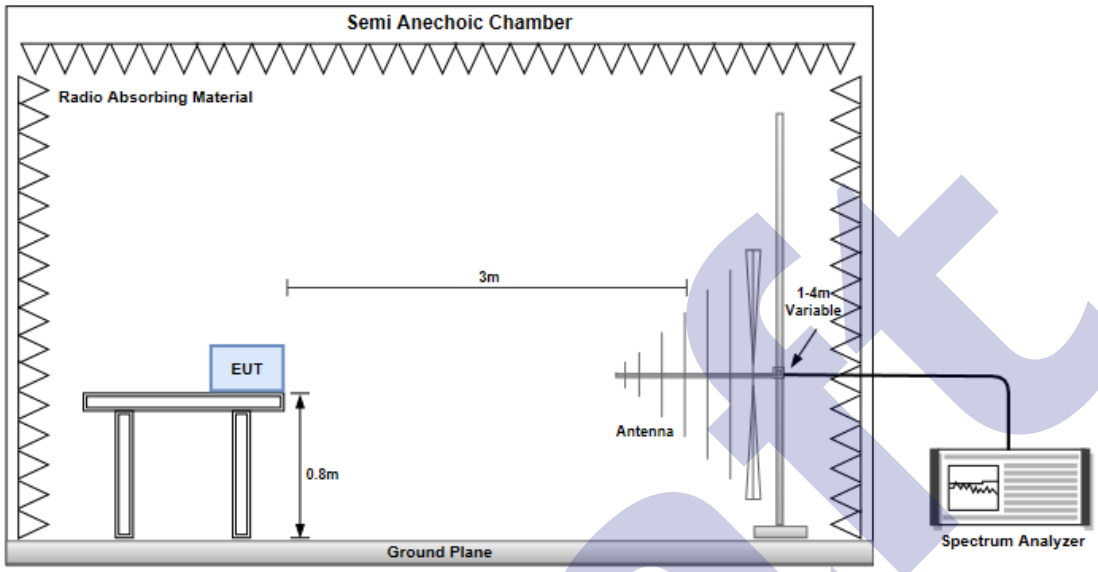
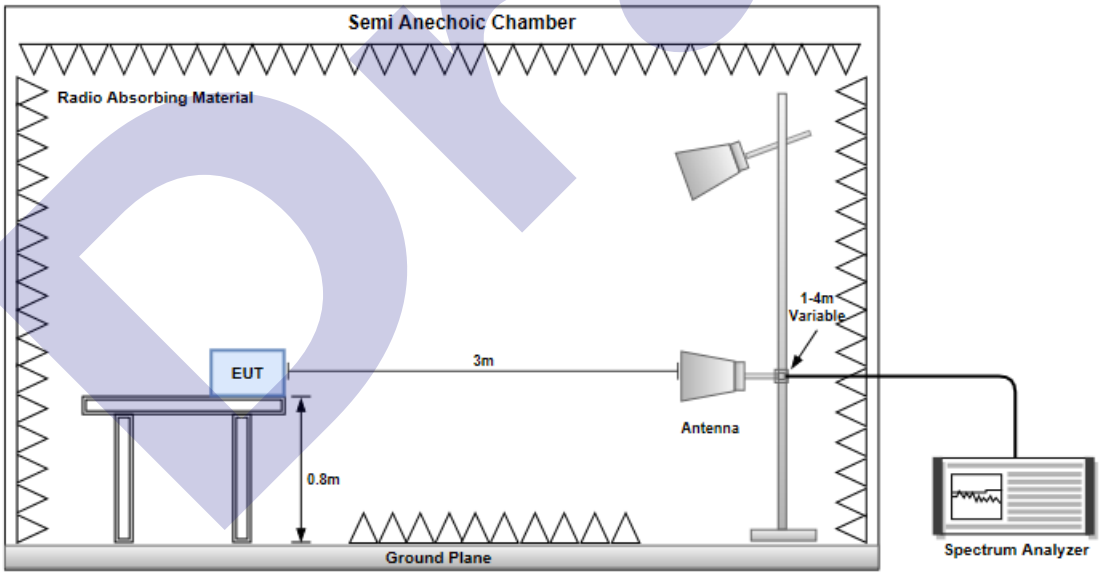
3.2.3 Test Setup

Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



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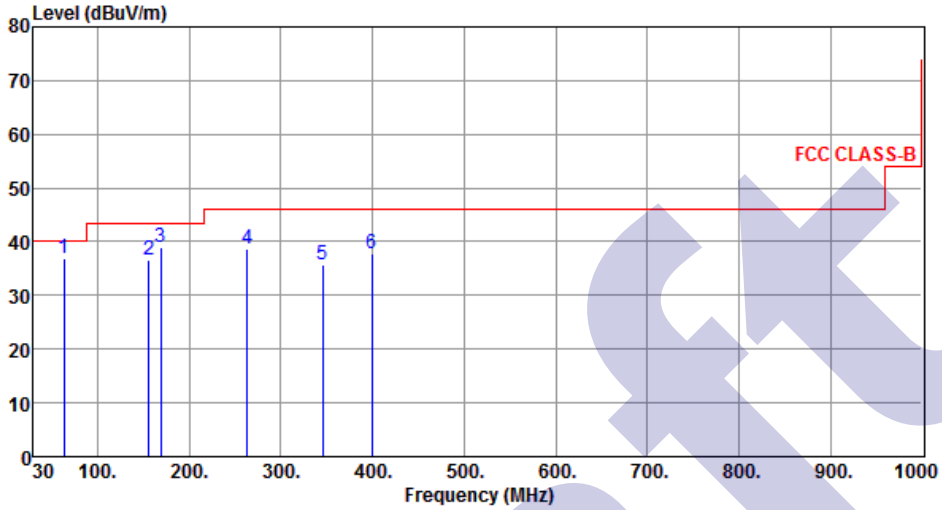
3.2.4 Radiated Emissions (Below 1GHz)

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	62.98	36.96	40.00	-3.04	46.10	-9.14	Peak	---	---
2	156.10	36.47	43.50	-7.03	44.66	-8.19	QP	127	178
3	168.71	39.08	43.50	-4.42	47.66	-8.58	Peak	---	---
4	263.77	38.63	46.00	-7.37	47.18	-8.55	Peak	---	---
5	345.25	35.82	46.00	-10.18	41.91	-6.09	Peak	---	---
6	399.57	37.74	46.00	-8.26	42.27	-4.53	Peak	---	---

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

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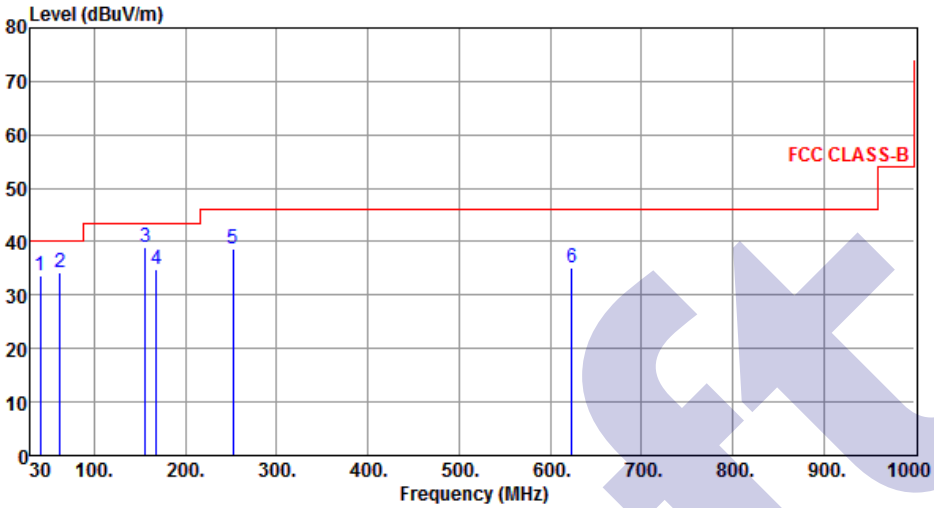
Polarization	Vertical	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	40.67	33.58	40.00	-6.42	41.82	-8.24	QP	100	135
2	62.01	34.23	40.00	-5.77	43.18	-8.95	QP	136	119
3	156.10	38.97	43.50	-4.53	47.16	-8.19	QP	105	182
4	167.74	34.84	43.50	-8.66	43.38	-8.54	QP	136	314
5	252.13	38.62	46.00	-7.38	47.55	-8.93	Peak	---	---
6	623.64	35.18	46.00	-10.82	34.89	0.29	Peak	---	---

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

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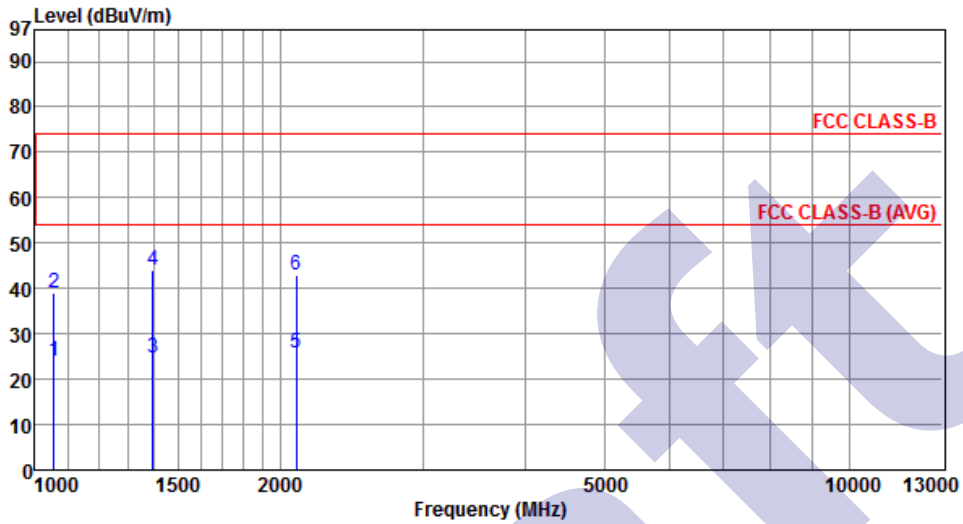
3.2.5 Radiated Emissions (Above 1GHz)

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	1056.00	23.92	54.00	-30.08	33.65	-9.73	Average	163	245
2	1056.00	38.88	74.00	-35.12	48.61	-9.73	Peak	163	245
3	1395.00	24.57	54.00	-29.43	31.70	-7.13	Average	124	347
4	1395.00	44.06	74.00	-29.94	51.19	-7.13	Peak	124	347
5	2095.00	25.83	54.00	-28.17	30.08	-4.25	Average	135	160
6	2095.00	42.89	74.00	-31.11	47.14	-4.25	Peak	135	160

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

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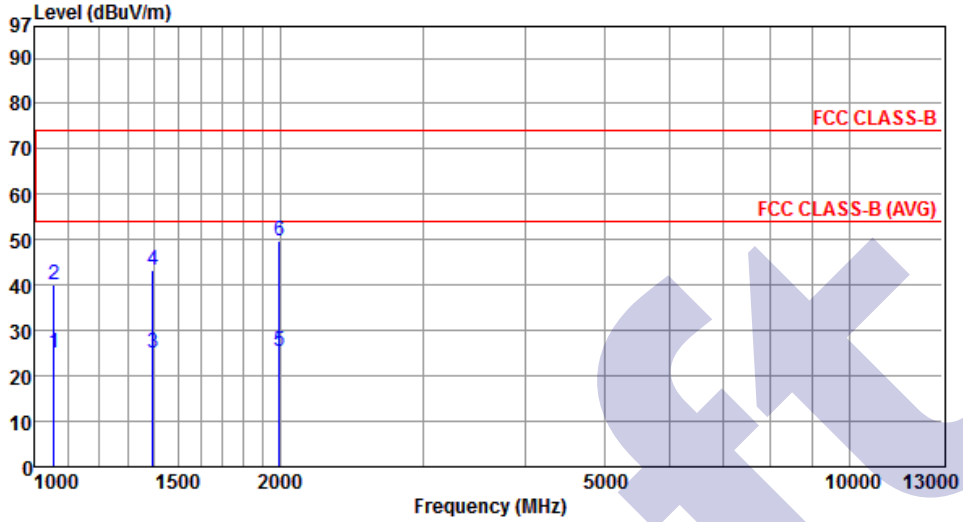
Polarization	Vertical	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1055.00	25.03	54.00	-28.97	34.78	-9.75	Average	161	311
2	1055.00	40.23	74.00	-33.77	49.98	-9.75	Peak	161	311
3	1395.00	24.88	54.00	-29.12	32.01	-7.13	Average	137	200
4	1395.00	43.19	74.00	-30.81	50.32	-7.13	Peak	137	200
5	1996.00	25.54	54.00	-28.46	30.23	-4.69	Average	120	152
6	1996.00	49.62	74.00	-24.38	54.31	-4.69	Peak	120	152

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

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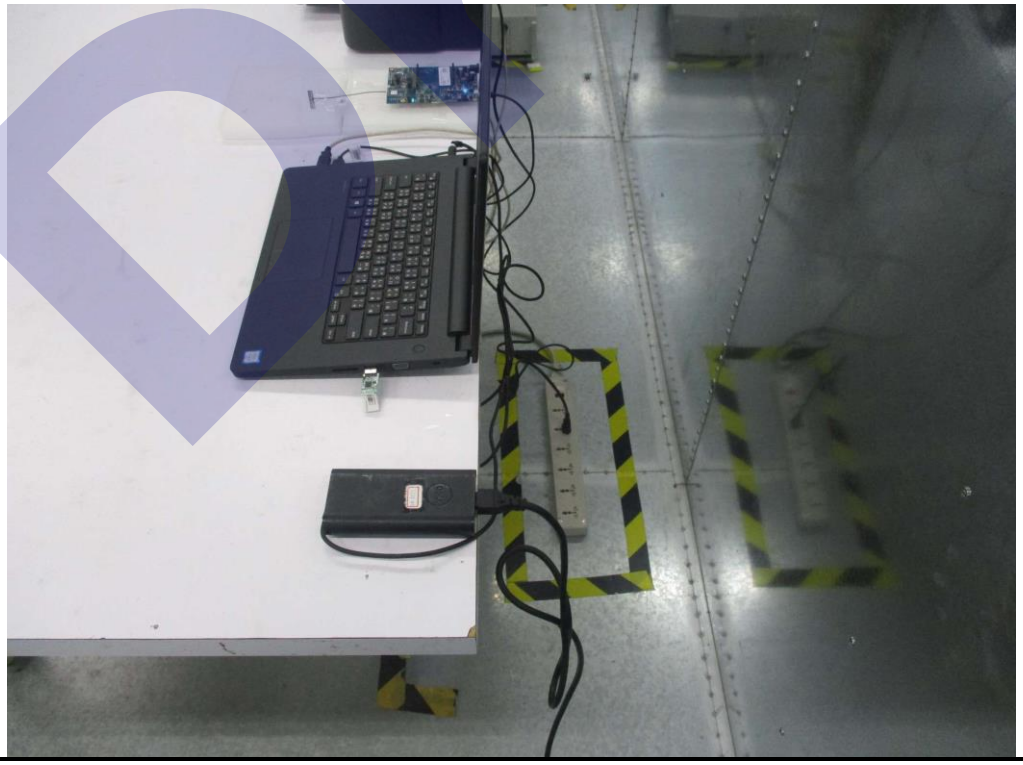
4 Photographs of the Test Configuration

Conducted Emission Test



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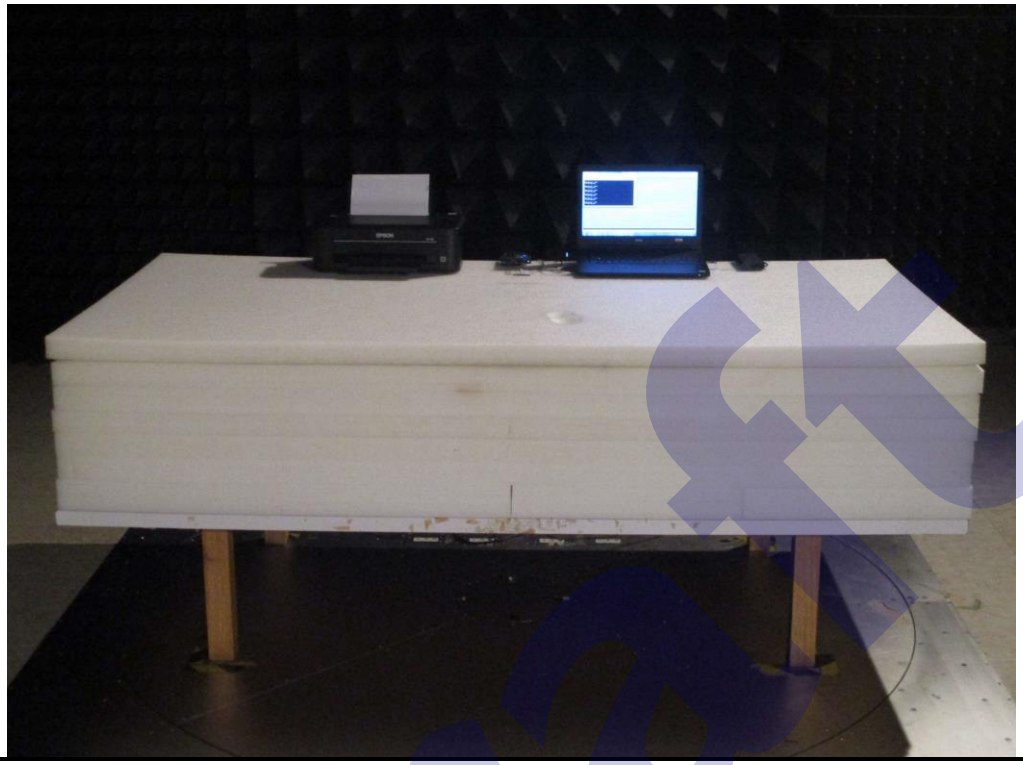
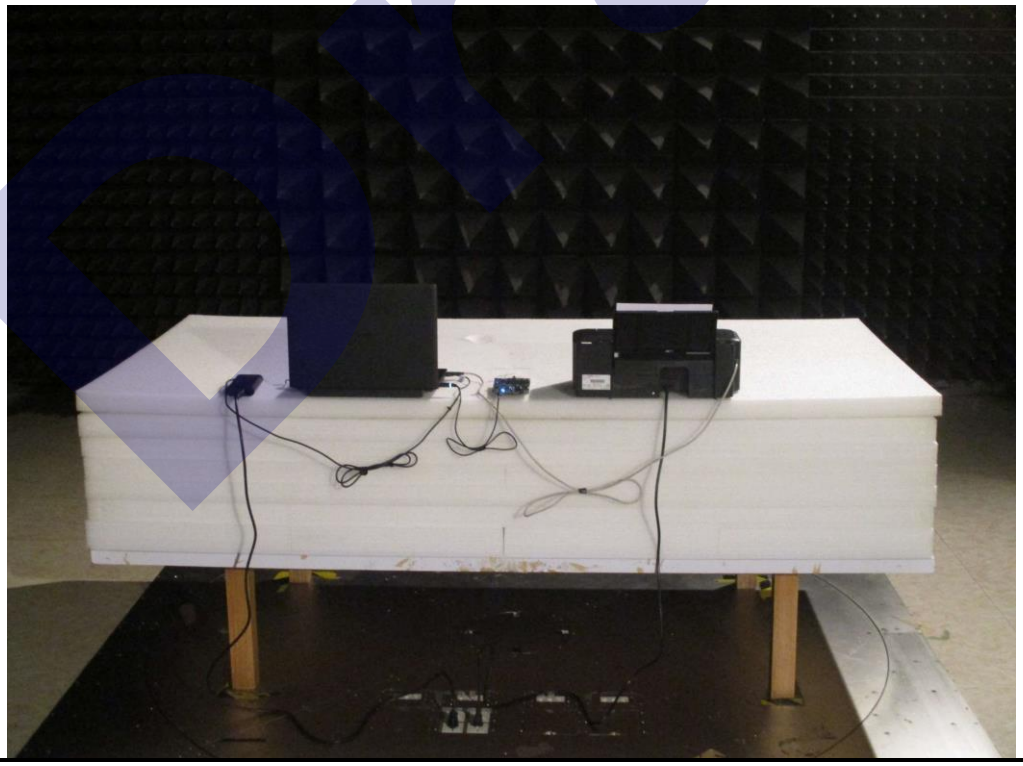
Radiated Emission Below 1GHz Test





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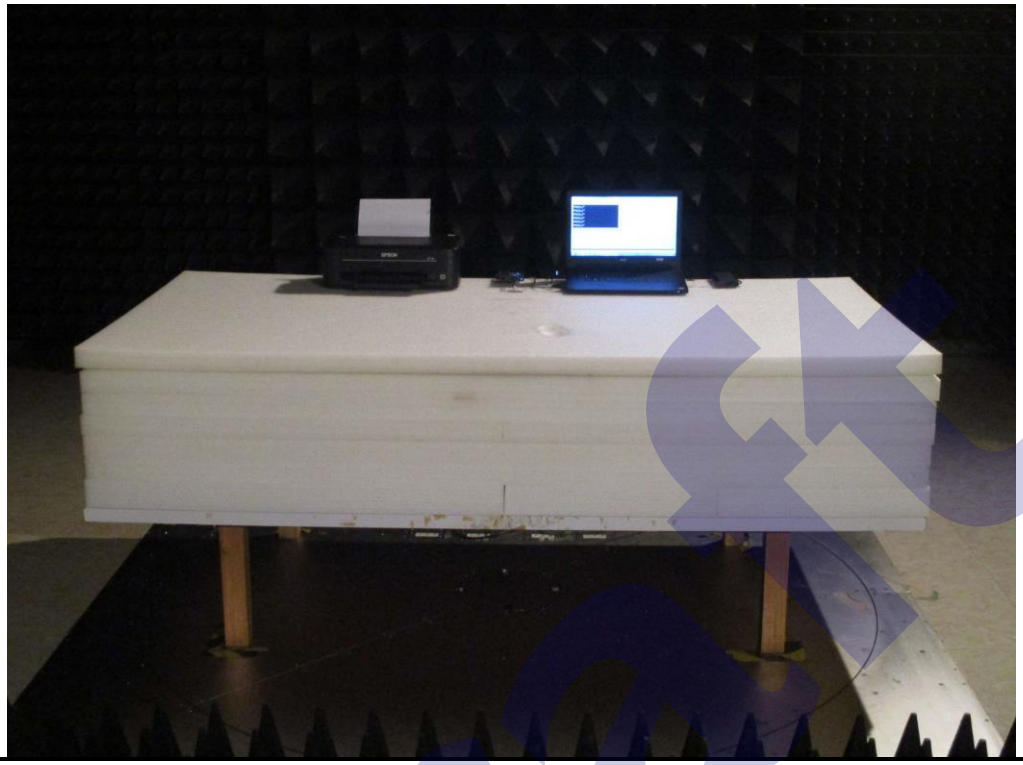
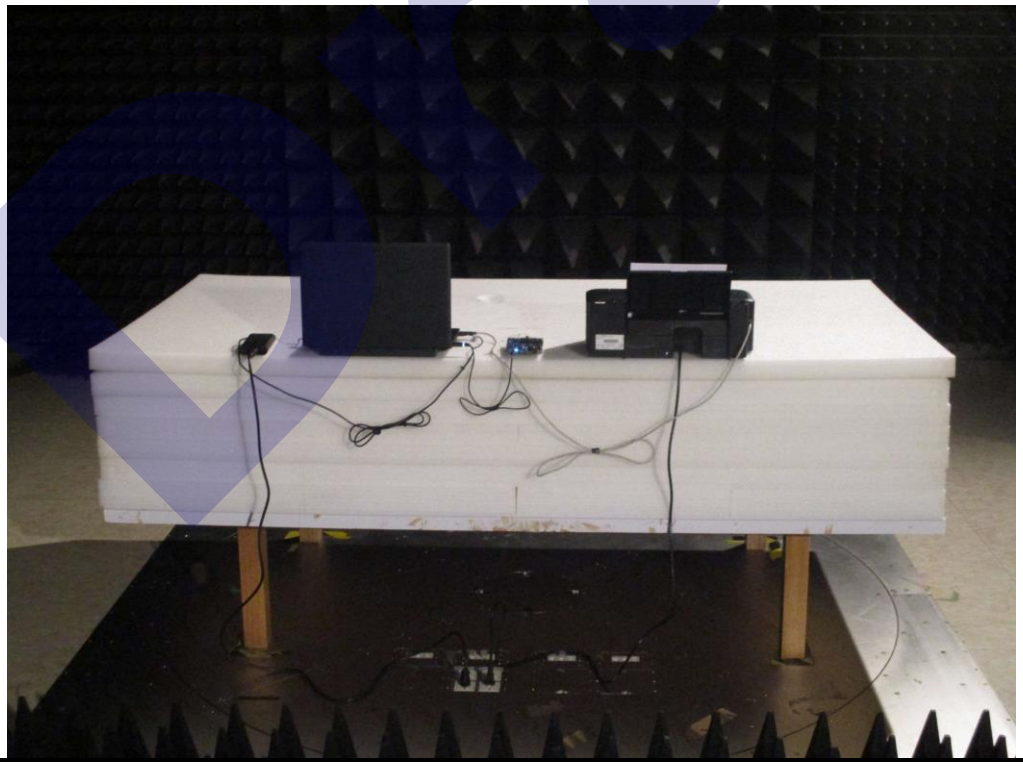
Radiated Emission Above 1GHz Test





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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

Tel: 886-3-271-8666
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Email: ICC_Service@icertifi.com.tw

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