AS/NZS Test Report

Equipment	:	**Bluetooth v5 Power Amplified Module**
Model No.	:	**BL654PA**
Brand Name	:	**Laird**
Applicant	:	**Laird Connectivity**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**AS/NZS 4268:2017**
Received Date	:	**Apr. 01, 2019**
Tested Date	:	**May 16 ~ May 24, 2019**

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. The test results contained in this report refer exclusively to the product. 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:**

James Fan / Assistant Manager **Gary Chang / Manager**

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
AR940104	Rev. 01	Initial issue	Aug. 05, 2019

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Summary of Test Results

Ref. Std. Clause	Test Items	Measured	Result
6.3	Maximum EIRP	Note	Note
6.4	Transmitter Spurious Emissions	Note	Note
6.5	Emission Bandwidth	Note	Note
6.6	Operating Frequencies	Note	Note
7.2	Receiver Spurious Emissions	Meet the requirement of limit.	Pass

Note: This test item is not required since the NFC function is passive only.

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

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1 General Description

1.1 Information

1.1.1 Product Details

The device supports integrated and external antenna.

Brand Name	Model Name	Product Name	Description
Laird	BL654PA	Bluetooth v5 Power Amplified Module	Integrated antenna
			External antenna

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information			
Frequency Range (MHz)	Modulation	Ch. Frequency (MHz)	Channel Number
13.553 – 13.567	ASK	13.56	1

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1-10MH4L	PCB Dipole	IPEX MHF4	2	Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	Connector Type Antenna
3	Laird	2.4GHz Dipole Antenna	001-0001	Dipole	RP-SMA Male	2	Connector Type Antenna
4	Mag.Layers	EDA-8709-2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	Connector Type Antenna
5	Laird	mFlexPIFA	EFA2400A3S-10MH4L	PIFA	IPEX MHF4	2	Connector Type Antenna
6	Laird	Laird NFC	0600-00061	NFC	N/A	---	Printed PCB Antenna & Connector Type Antenna
7	Laird	BL654-SA PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

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1.1.4 EUT Operational Condition

Power Supply Type	DC 3.3V & DC 5V from host		
Operational Voltage	☒ Vnom (5 Vdc)	☒ Vmax (5.5 Vdc)	☒ Vmin (4.5 Vdc)
	☒ Vnom (3.3 Vdc)	☒ Vmax (3.6 Vdc)	☒ Vmin (3 Vdc)
Test Voltage	☒ Vnom (3.3 Vdc)		
Operational Climatic	☒ Tnom (20°C)	☒ Tmax (85°C)	☒ Tmin (-40°C)

1.1.5 Accessories

N/A

1.1.6 Receiver Category

	Receiver Category
☐	1 Highly reliable SRD communication media; e.g. serving human life inherent systems (may result in a physical risk to a person).
☐	2 Medium reliable SRD communication media e.g. causing Inconvenience to persons, which cannot simply be overcome by other means.
☒	3 Standard reliable SRD communication media e.g. Inconvenience to persons, which can simply be overcome by other means (e.g. manual).

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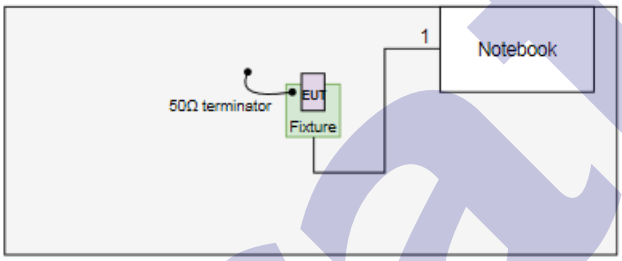
1.2 Local Support Equipment List

Support Equipment List					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Remarks**
1	Notebook	DELL	Latitude E5420	B6FT9T1	---
2	50Ω terminator	---	---	---	---
3	Fixture	Laird	DVK-BL654	---	Provided by applicant.

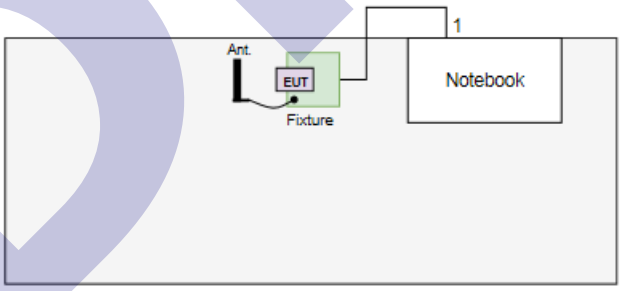
1.3 Test Setup Chart

Test Setup Diagram (Radiated >30 MHz)



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

Test Setup Diagram (Radiated ≤ 30 MHz)



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

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1.4 Test Equipment and Calibration Data

Test Item	Radiated Emission				
Test Site	966 chamber 3 / (03CH03-WS)				
Tested Date	May 16, 2019				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101499	Jan. 07, 2019	Jan. 06, 2020
Receiver	R&S	ESR3	101658	Dec. 11, 2018	Dec. 10, 2019
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Apr. 17, 2019	Apr. 16, 2020
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Jan. 07, 2019	Jan. 06, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2018	Nov. 14, 2019
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 09, 2018	Nov. 08, 2019
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 08, 2018	Oct. 07, 2019
Preamplifier	EMC	EMC02325	980187	Aug. 24, 2018	Aug. 23, 2019
Preamplifier	Agilent	83017A	MY53270014	Aug. 09, 2018	Aug. 08, 2019
Preamplifier	EMC	EMC184045B	980192	Aug. 09, 2018	Aug. 08, 2019
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/**4**	Oct. 01, 2018	Sep. 30, 2019
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Oct. 01, 2018	Sep. 30, 2019
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Oct. 01, 2018	Sep. 30, 2019
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Oct. 01, 2018	Sep. 30, 2019
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Oct. 01, 2018	Sep. 30, 2019
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Oct. 01, 2018	Sep. 30, 2019
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emissions				
Test Site	(10CH01-HY)				
Tested Date	May 21, 2019				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	Keysight	N9038A	MY54130031	Nov. 06, 2018	Nov. 05, 2019
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 09, 2018	Nov. 08, 2019
RF Cable-R10m	Suhner Switzerland + Rosenberger	RG223/U + UAA220A-0	CB022-DOOR	Nov. 11, 2018	Nov. 10, 2019
Turn Table	HD	DT 60 RPS	1513/004/00	NCR	---
Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

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1.5 Testing Applied Standards

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

AS/NZS 4268:2017
EN 300 330 V2.1.1 (2017-02)

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 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	
Parameters	**Uncertainty**
Radio Frequency	±1.4 x 10^{-9}
RF power conducted	±0.808 dB
RF power radiated	±3.401 dB
Spurious emission, conducted	±2.994 dB
Spurious emission, radiated	±3.401 dB
Humidity	±0.6 ^{o}C
Temperature	±0.29 %
Time	±0.1 %

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2 Test Configuration

2.1 Testing Condition

Testing Location					
☒	ICC Lab	ADD : No.3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan (R.O.C.) TEL : 886-3-271-8666 FAX : 886-3-318-0155			
☒	Sporton Lab	ADD : No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL : 886-3-327-3456 FAX : 886-3-327-0973			
Test Item		**Test Site**	**Ambient Condition**	**Tested By**	
Radiated Emission > 30 MHz		03CH03-WS	24°C / 63%	Roger Lu	
Radiated Emission ≤ 30 MHz		10CH01-HY*	25°C / 65%	Jack Li	

Note: * ICC lab subcontracts this test item to Sporton Lab (TAF:1190).
Sporton Lab is a TAF accreditation test firm and also is an approved provider of ICC lab.

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test channel (MHz)	Test Configuration
Receiver Spurious Emissions ≤ 30 MHz	NFC	13.56	1 ~ 6
Receiver Spurious Emissions > 30 MHz	NFC	13.56	7

1. The EUT supports two DC voltage options, DC 5V & DC 3.3V. Both options were assessed and **DC 3.3V** was found to be the worst case and was selected for the final test.
2. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.
3. Test configurations are listed as below:
   1) Configuration 1: Antenna:Laird NFC + EDA-8709-2G4C1-B27-CY
   2) Configuration 2: Antenna: Laird NFC + 2.4GHz Dipole Antenna
   3) Configuration 3: Antenna:Laird NFC + FlexPIFA
   4) Configuration 4: Antenna:Laird NFC + mFlexPIFA
   5) Configuration 5: Antenna:Laird NFC + NanoBlue
   6) Configuration 6: Antenna:BL654-SA PCB printed antenna
   7) Configuration 7: Antenna:Laird NFC+ 50Ω terminator

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3 Receiver Test Results

3.1 Receiver Spurious Emissions

3.1.1 Receiver Spurious Emissions Limits

Measurement below 30 MHz

Frequency 9 kHz ≤ f < 10 MHz	Frequency 10 MHz ≤ f < 30 MHz
5,5 dBµA/m at 9 kHz descending 3 dB/oct	-25 dBµA/m

Measurement above 30 MHz

The measured values shall not exceed 2 nW e.r.p. (-57 dBm).

Spurious Emissions Limit (Peak Power)	Frequency Range	Measurement Bandwidth
-56 dBW (2.5µW) e.i.r.p (59 dBµV/m at 10 metres)	< 150 kHz	1 kHz
	150 kHz – 30 MHz	10 kHz

3.1.2 Test Procedures

Reference to clause 4.3.5.3 of EN 300 330 V2.1.1 (2017-02).

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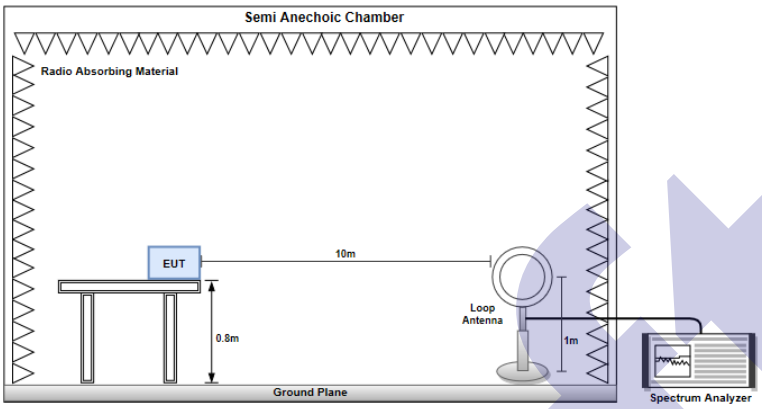
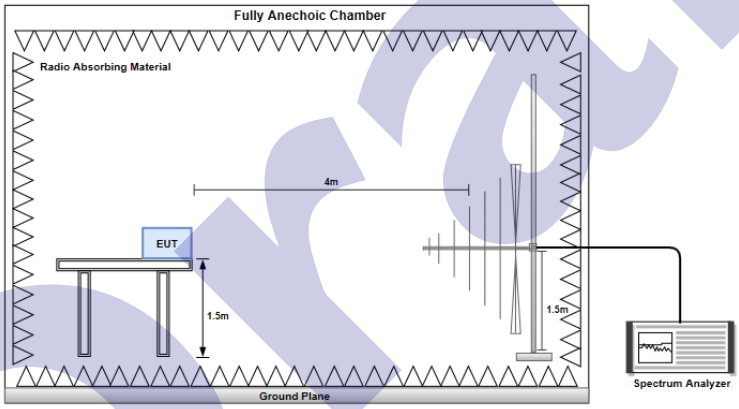
3.1.3 Test Setup

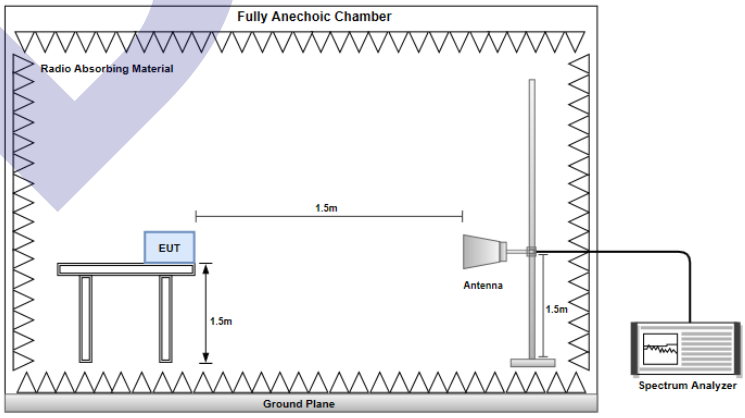
Below 30MHz



Below 1GHz



Above 1 GHz



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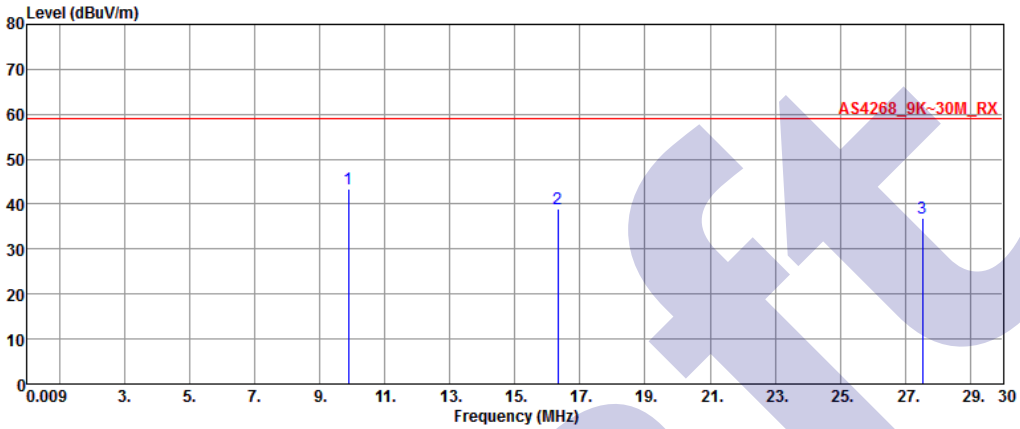
3.1.4 Receiver Spurious Emissions (Below 30MHz)

Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	1		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.87	43.42	59.00	-15.58	20.31	23.11
2	16.33	38.85	59.00	-20.15	21.37	17.48
3	27.54	36.91	59.00	-22.09	22.17	14.74

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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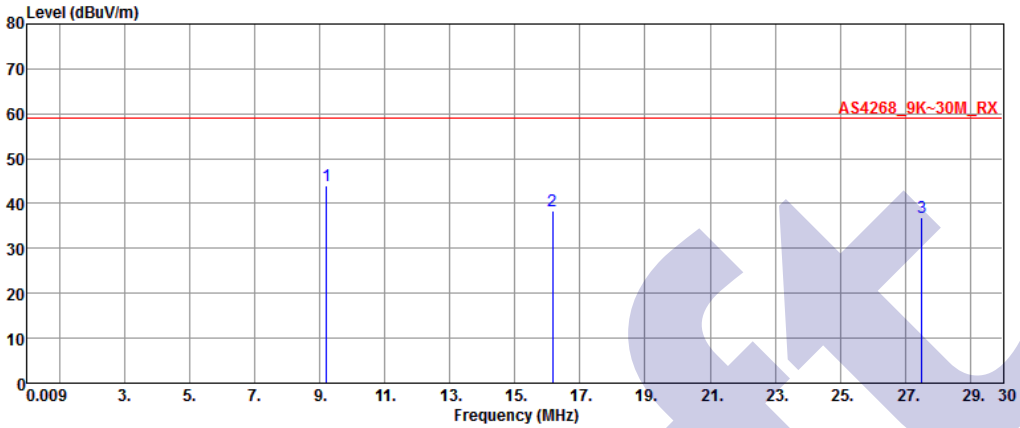
Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	2		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.21	43.87	59.00	-15.13	20.25	23.62
2	16.17	38.36	59.00	-20.64	21.35	17.01
3	27.51	36.87	59.00	-22.13	22.16	14.71

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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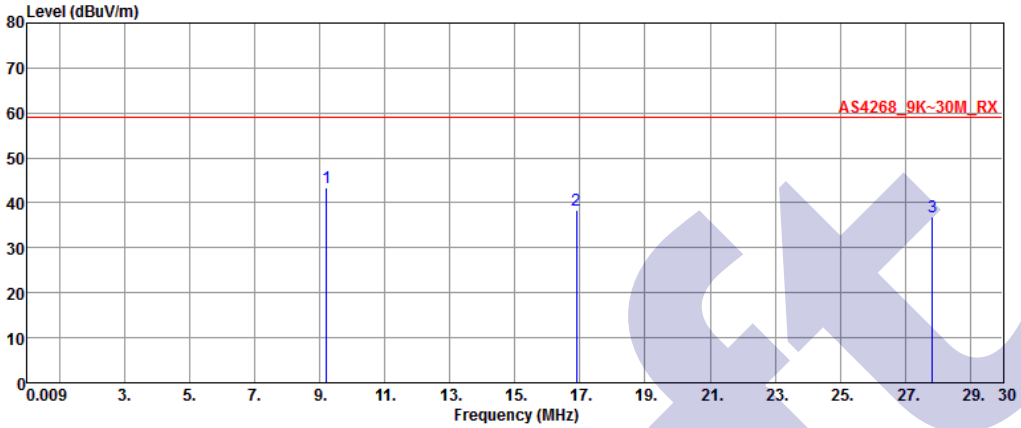
Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	3		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.20	43.36	59.00	-15.64	20.25	23.11
2	16.89	38.30	59.00	-20.70	21.45	16.85
3	27.84	36.96	59.00	-22.04	22.19	14.77

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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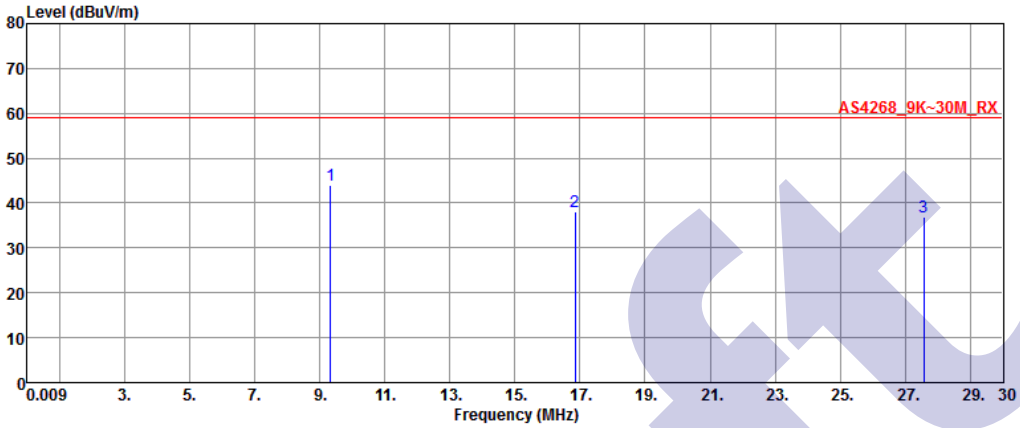
Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	4		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.32	43.85	59.00	-15.15	20.26	23.59
2	16.84	38.17	59.00	-20.83	21.44	16.73
3	27.57	36.85	59.00	-22.15	22.17	14.68

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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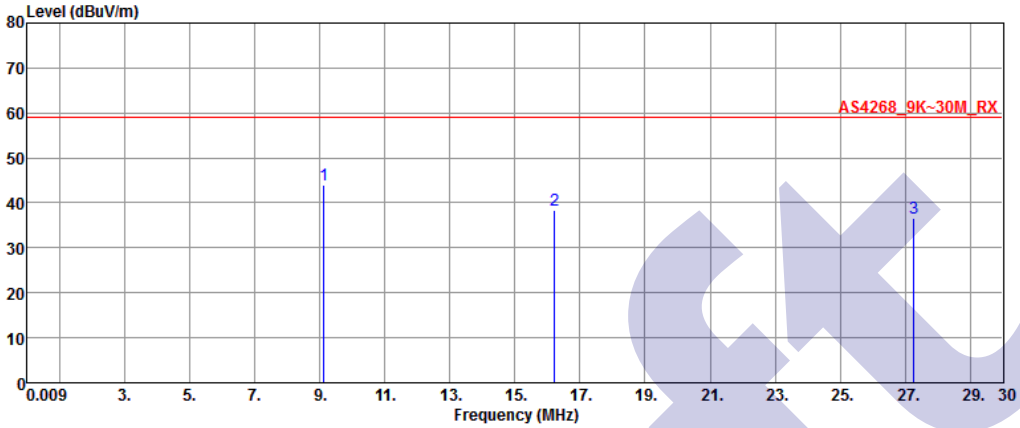
Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	5		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.12	43.85	59.00	-15.15	20.24	23.61
2	16.21	38.35	59.00	-20.65	21.36	16.99
3	27.27	36.51	59.00	-22.49	22.16	14.35

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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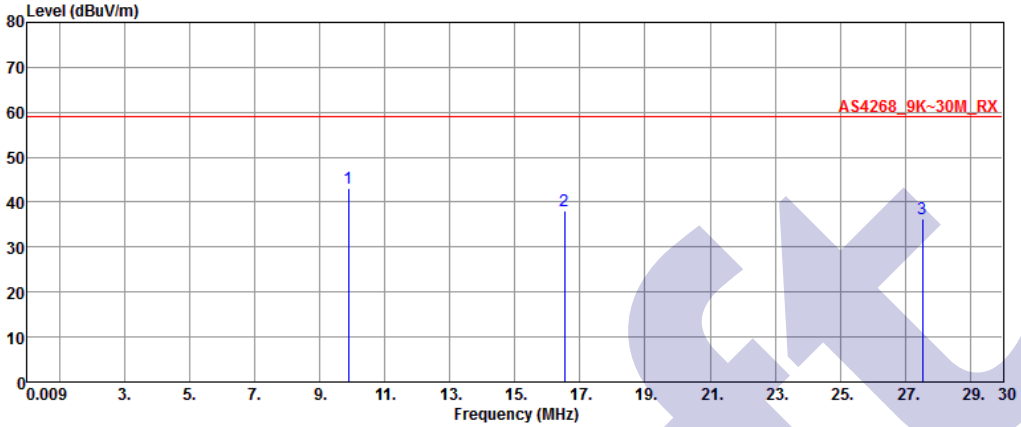
Mode	NFC	**Test Freq. (MHz)**	13.56
Test Configuration	6		



	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	9.87	43.21	59.00	-15.79	20.31	22.90
2	16.51	38.22	59.00	-20.78	21.39	16.83
3	27.54	36.24	59.00	-22.76	22.17	14.07

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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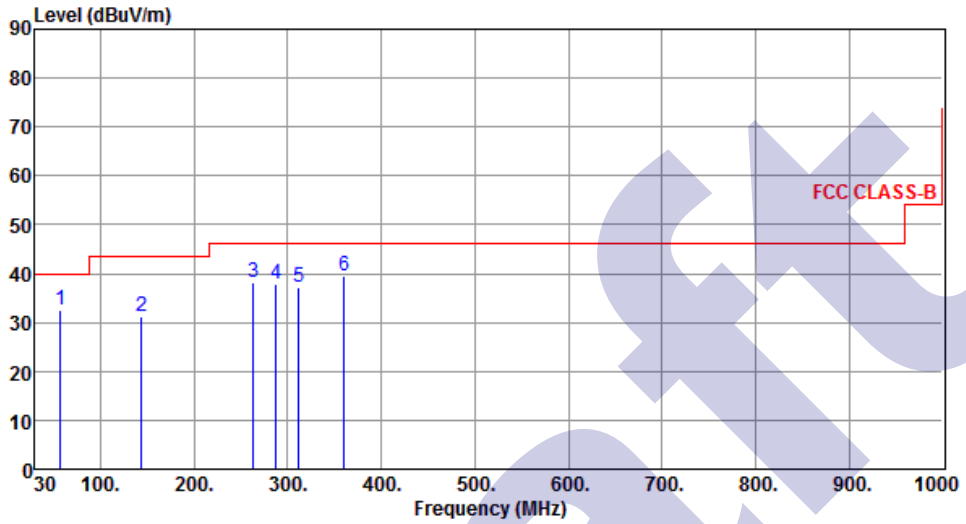
3.1.5 Receiver Radiated Unwanted Emissions (Above 30MHz)

Polarization	Horizontal	**Test Freq. (MHz)**	13.56
Test Configuration	7		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	57.31	32.55	40.00	-7.45	41.63	-9.08	Peak	---	---
2	143.51	31.26	43.50	-12.24	40.25	-8.99	Peak	---	---
3	263.73	38.05	46.00	-7.95	47.82	-9.77	Peak	---	---
4	287.32	37.77	46.00	-8.23	46.54	-8.77	Peak	---	---
5	311.44	37.24	46.00	-8.76	45.29	-8.05	Peak	---	---
6	360.69	39.47	46.00	-6.53	46.42	-6.95	Peak	---	---

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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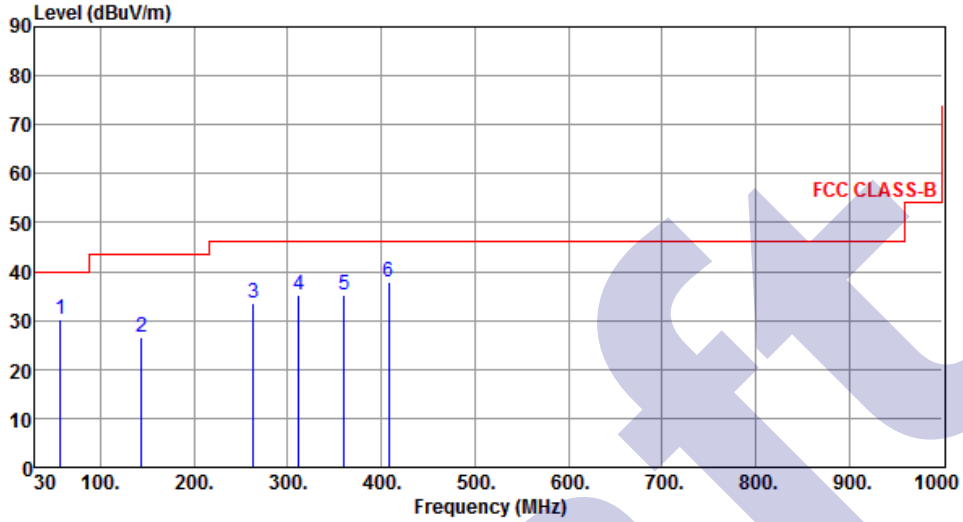
Polarization	Vertical	Test Freq. (MHz)	13.56
Test Configuration	7		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	57.34	30.11	40.00	-9.89	39.20	-9.09	Peak	---	---
2	143.64	26.59	43.50	-16.91	35.57	-8.98	Peak	---	---
3	263.51	33.58	46.00	-12.42	43.36	-9.78	Peak	---	---
4	311.47	35.35	46.00	-10.65	43.40	-8.05	Peak	---	---
5	360.74	35.28	46.00	-10.72	42.23	-6.95	Peak	---	---
6	408.34	37.94	46.00	-8.06	43.56	-5.62	Peak	---	---

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB).
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm).

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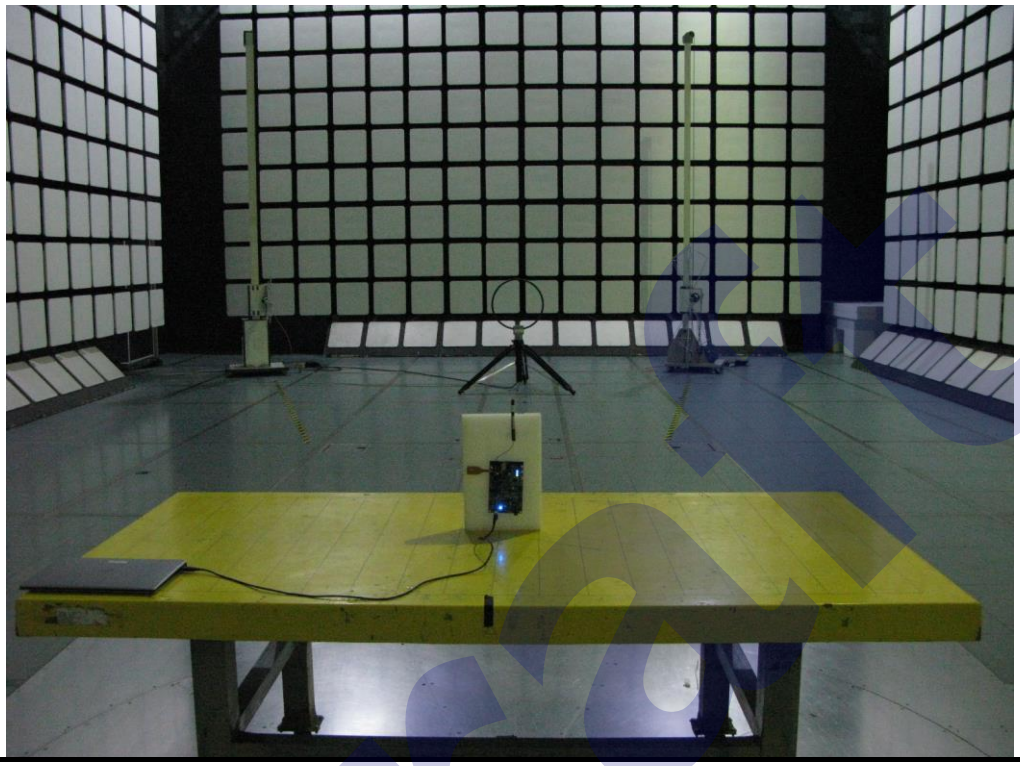
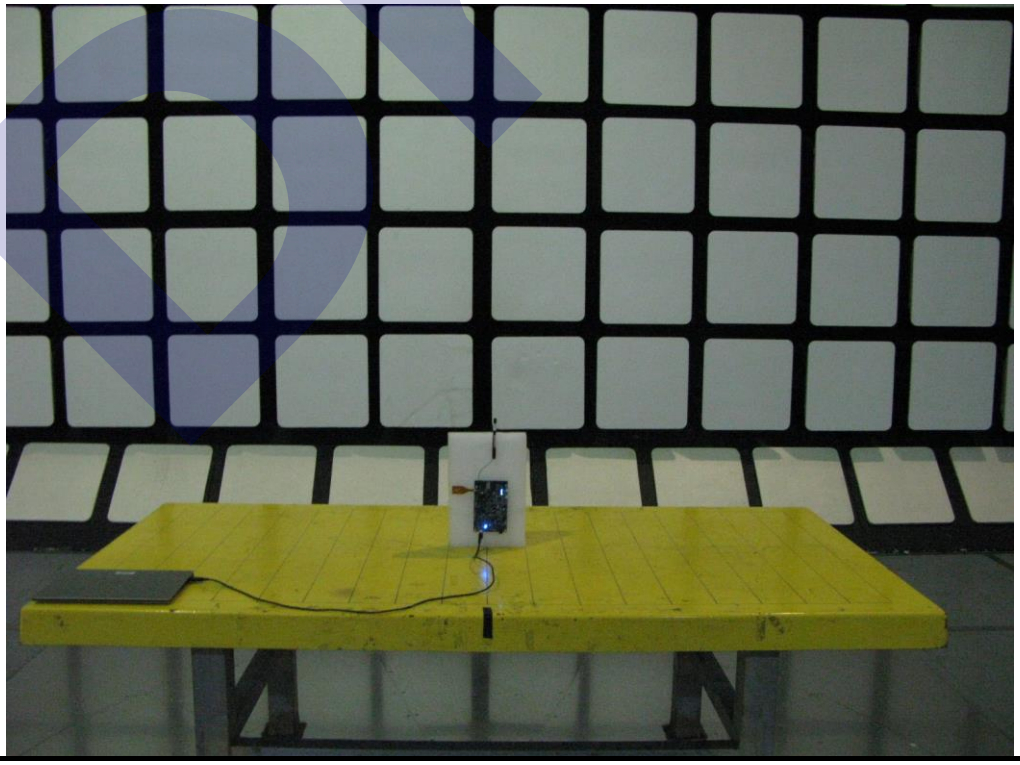
4 Photographs of the Test Configuration

Spurious Emission Test below 30MHz (EDA-8709-2G4C1-B27-CY)





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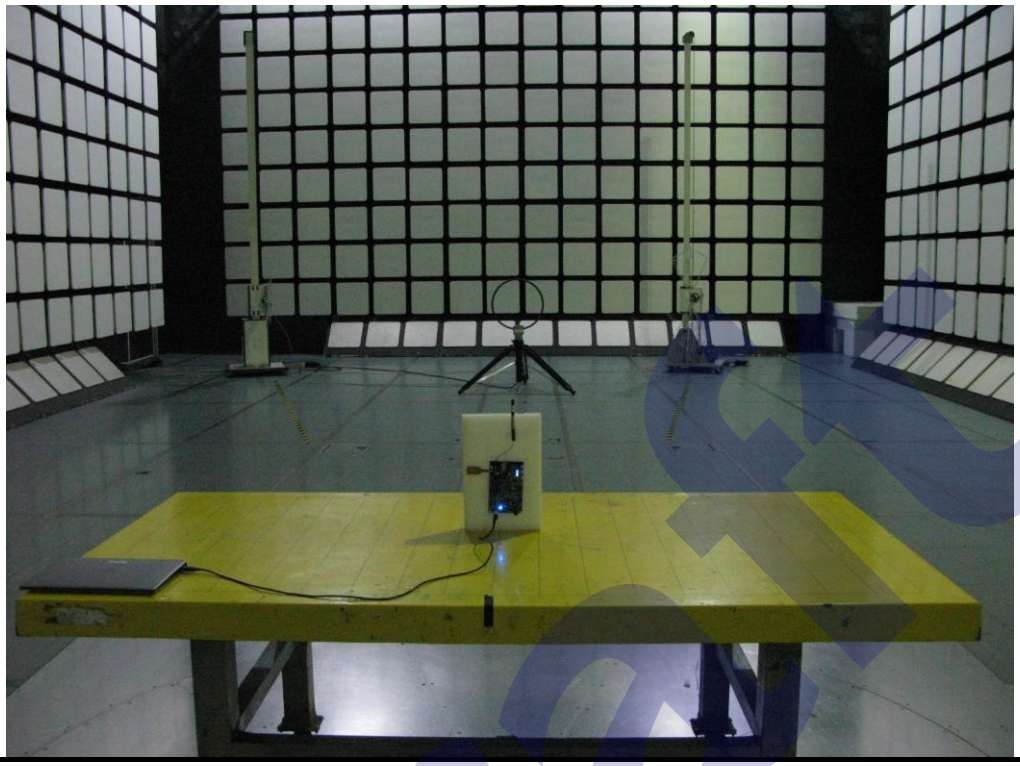
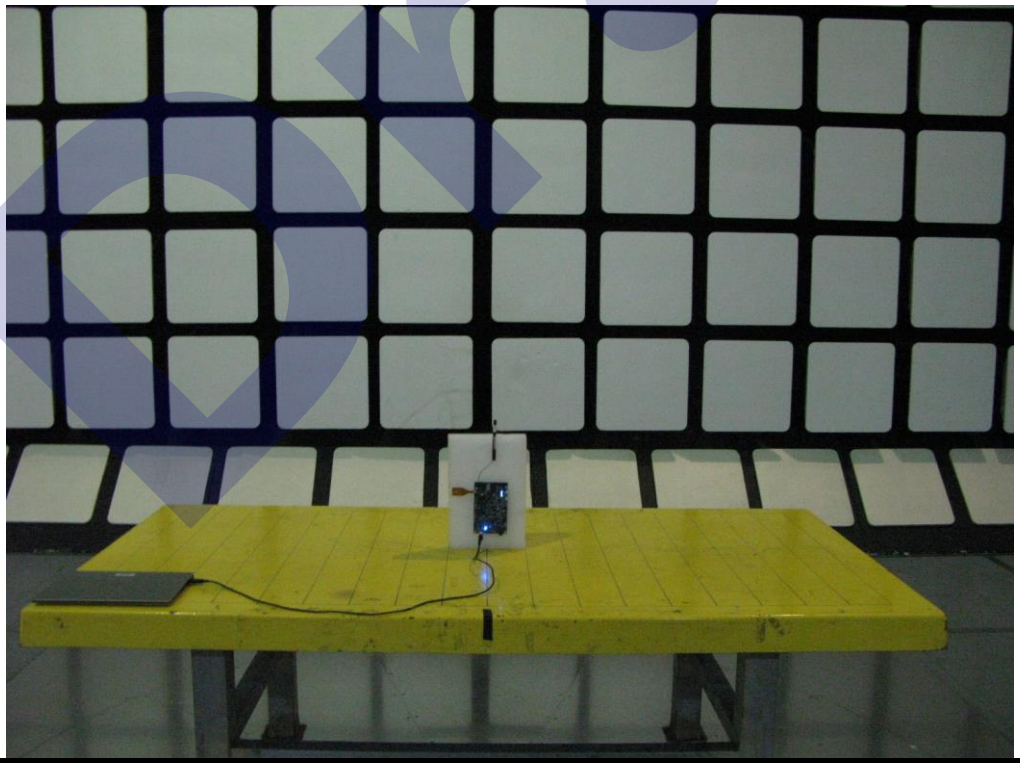
Spurious Emission Test below 30MHz (2.4GHz Dipole Antenna)





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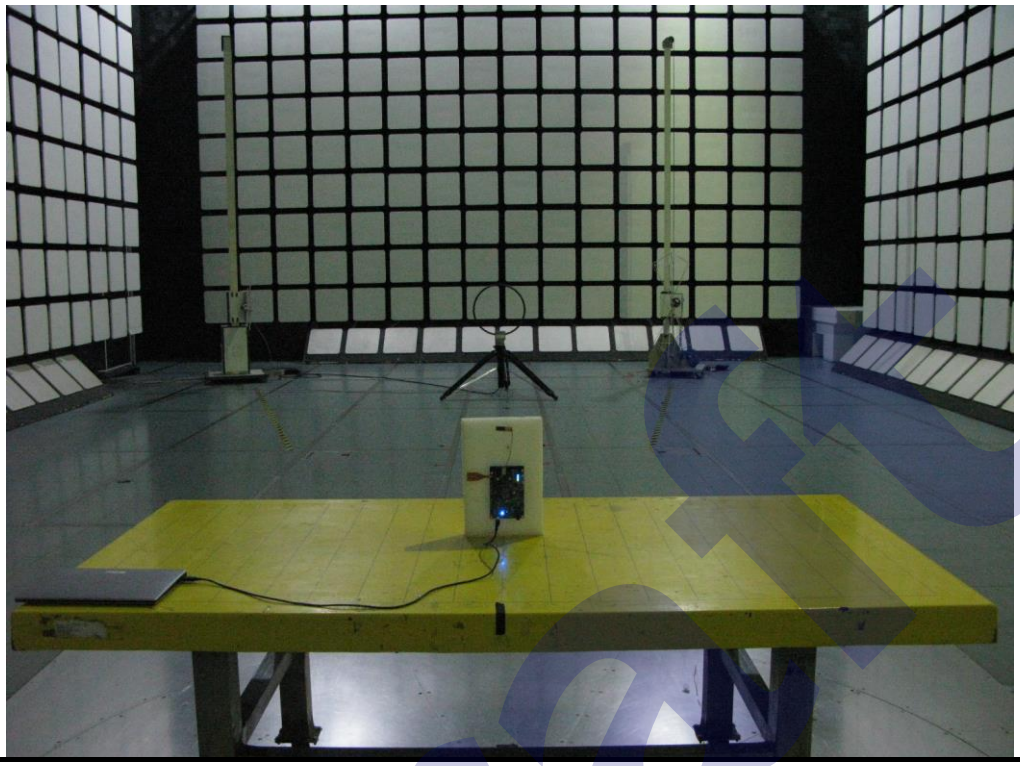
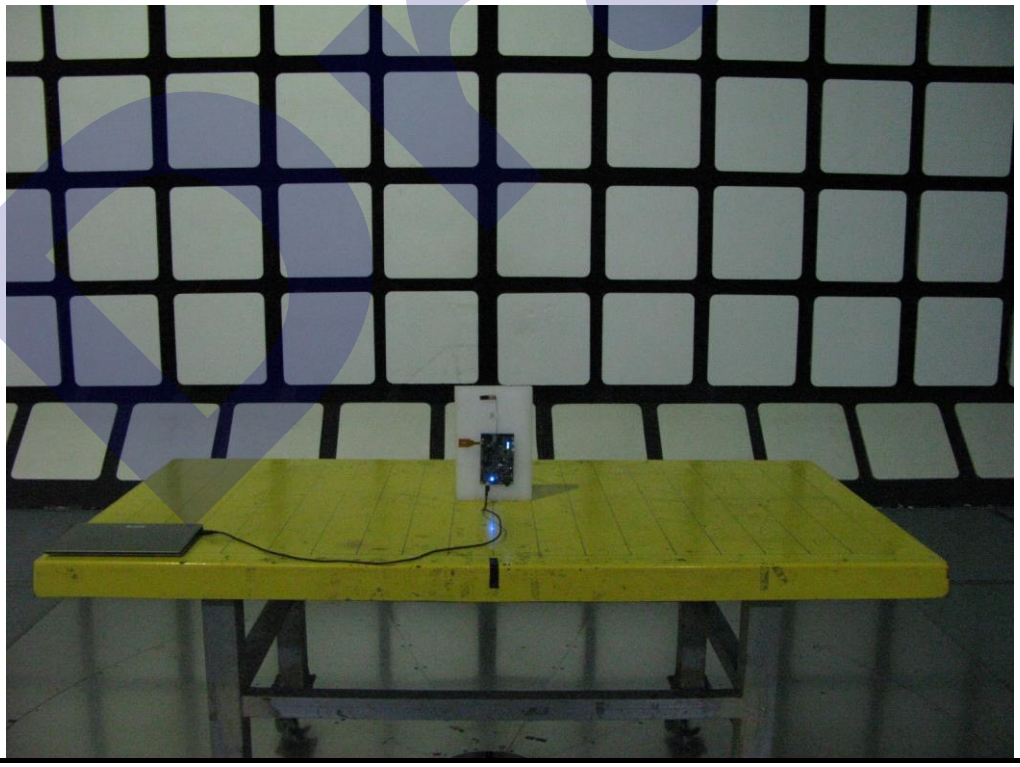
Spurious Emission Test below 30MHz (FlexPIFA)





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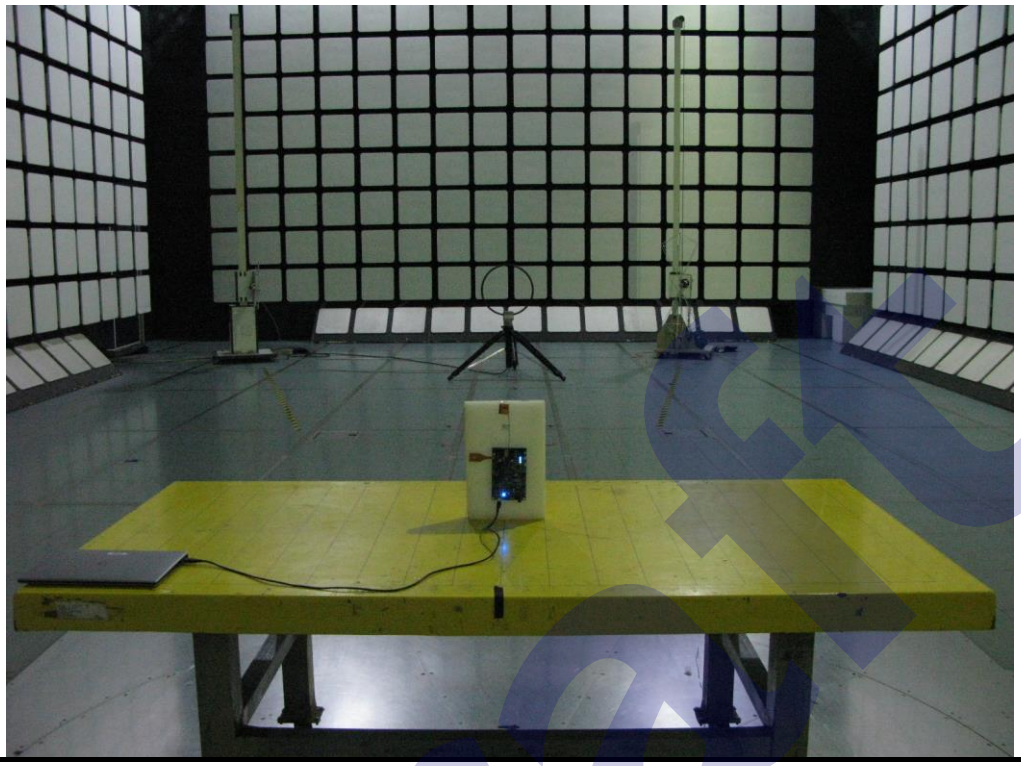
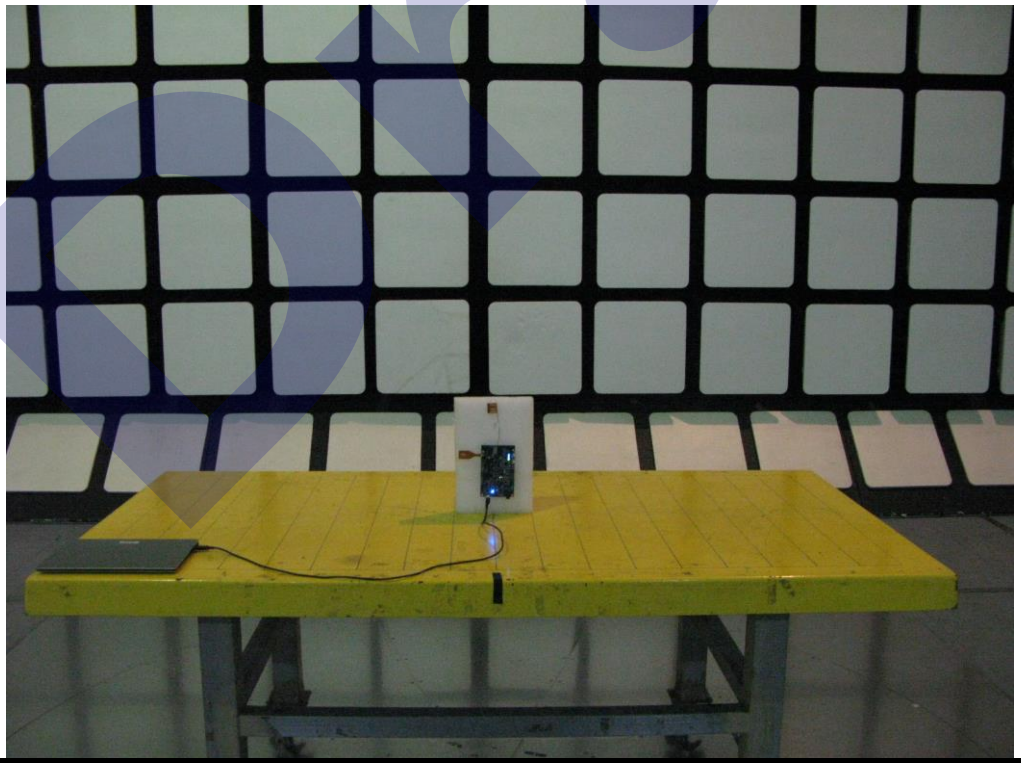
Spurious Emission Test below 30MHz (mFlexPIFA)





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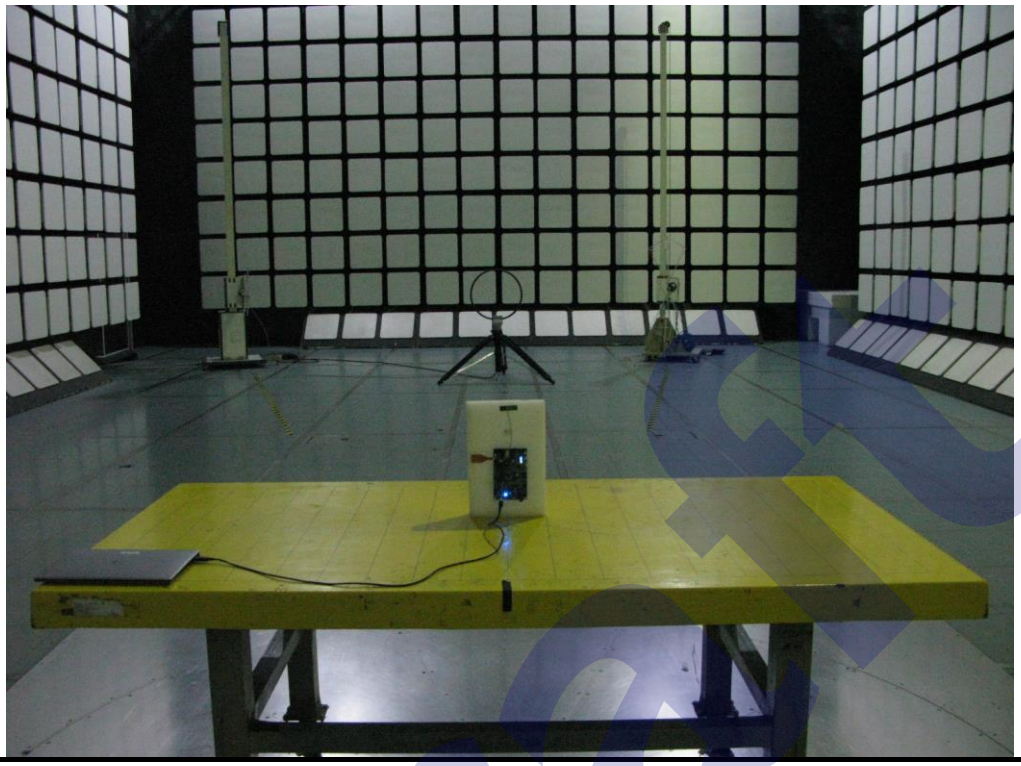
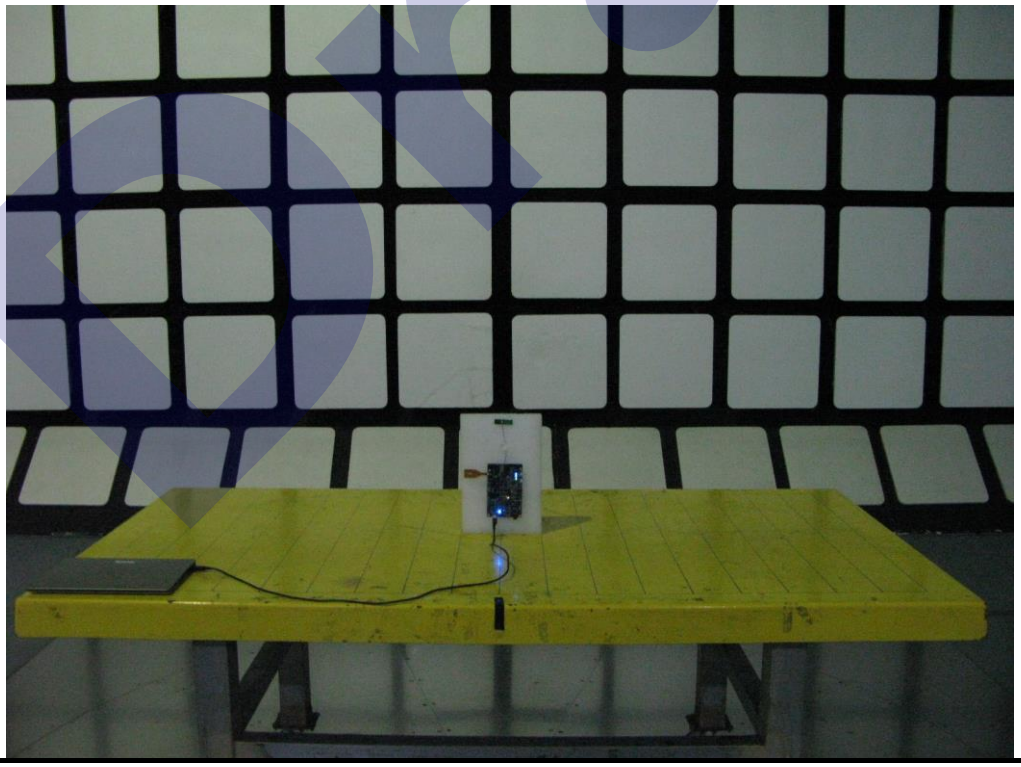
Spurious Emission Test below 30MHz (NanoBlue)





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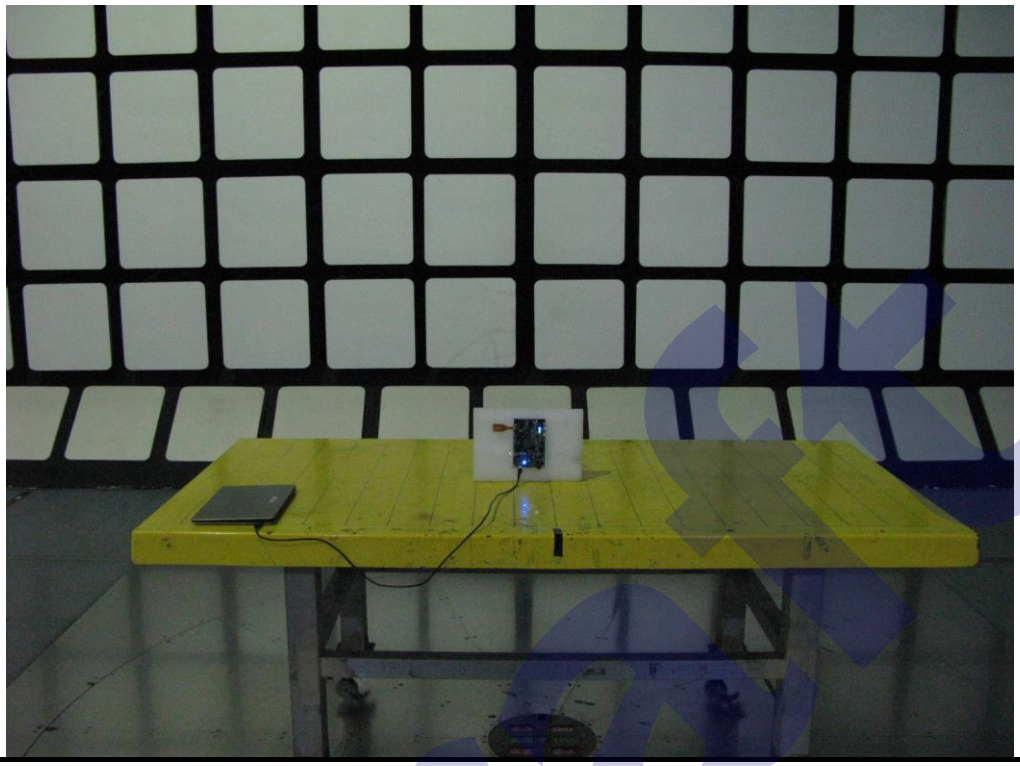
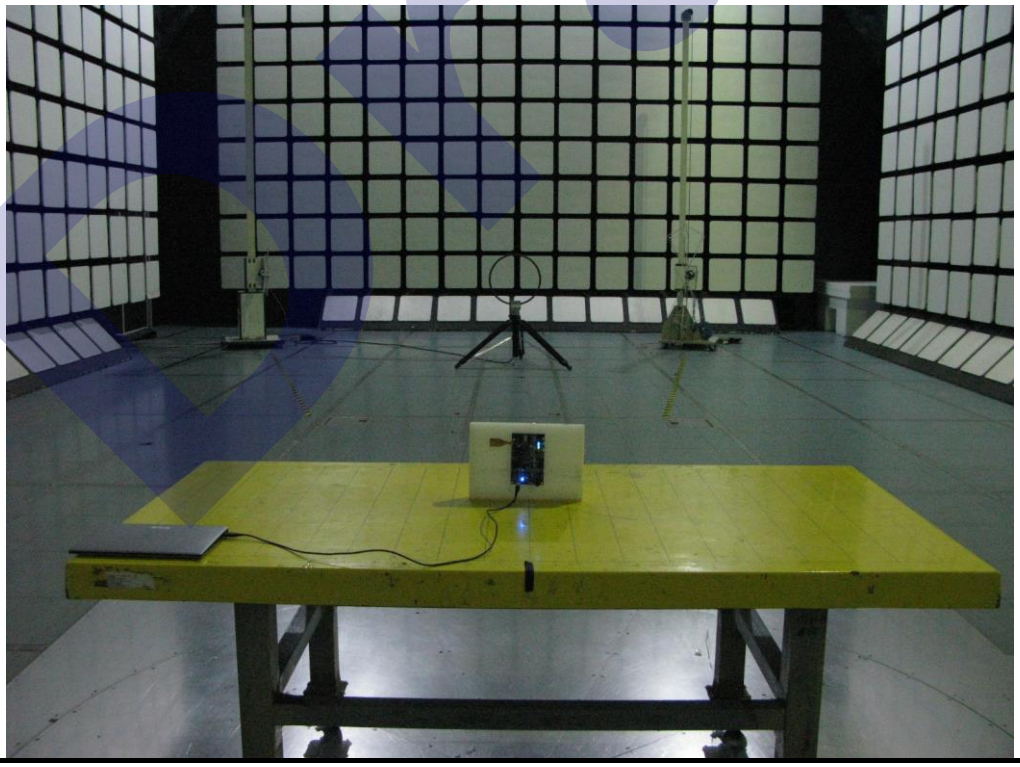
Spurious Emission Test below 30MHz (BL654-SA PCB printed antenna)





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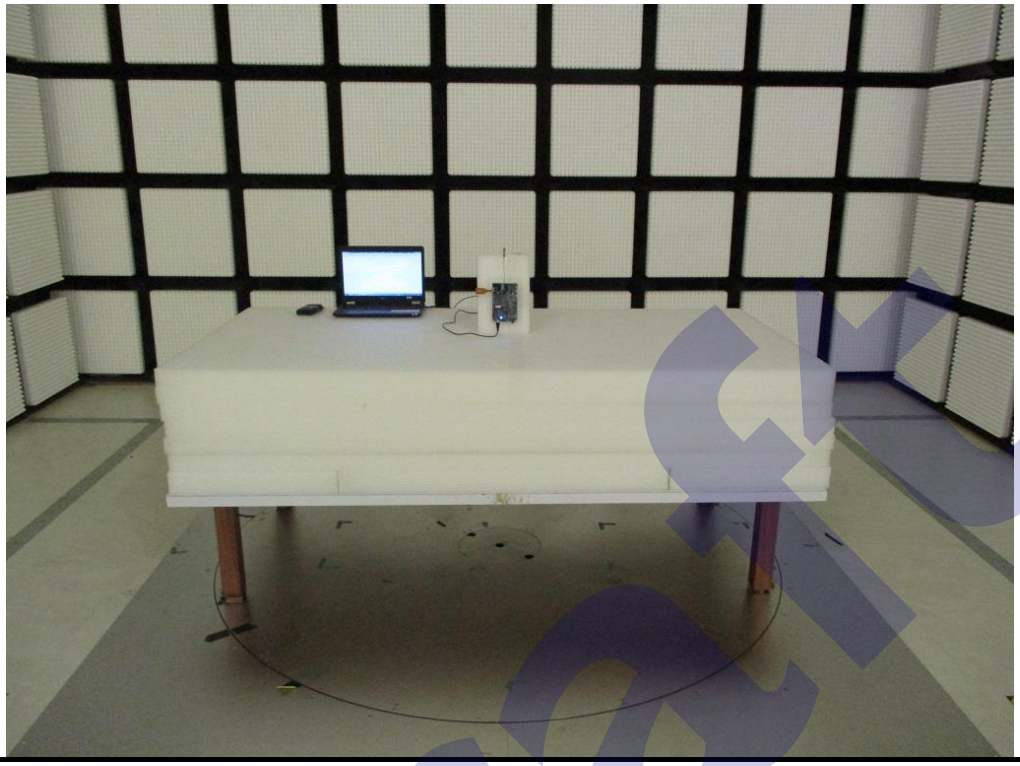
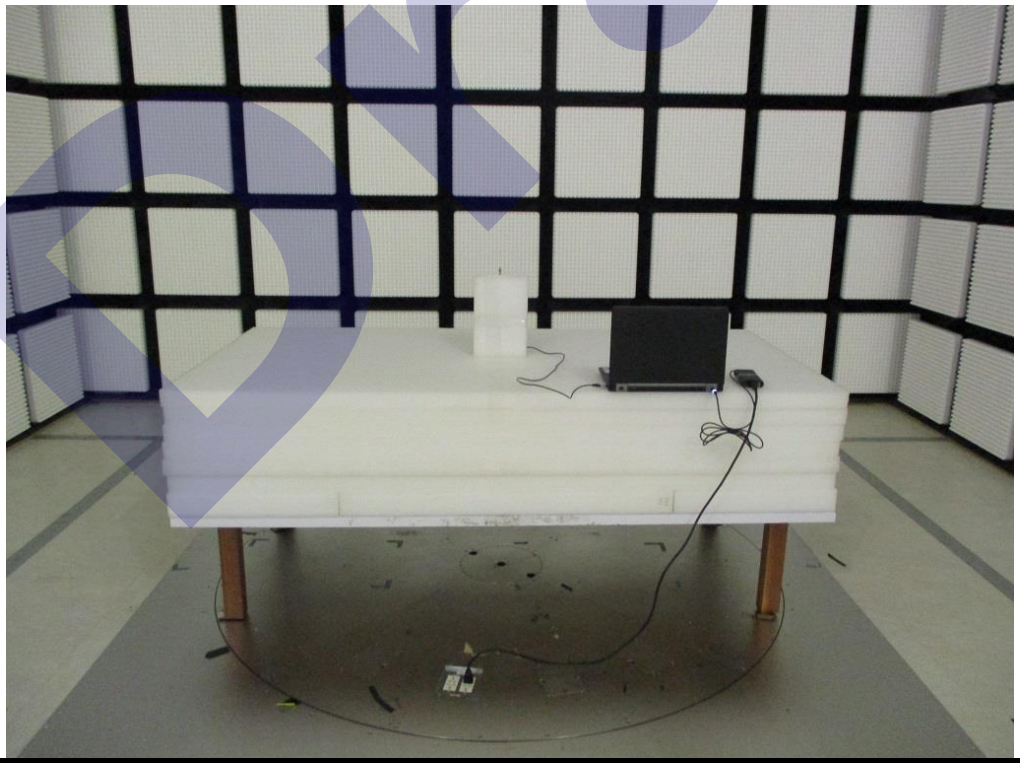
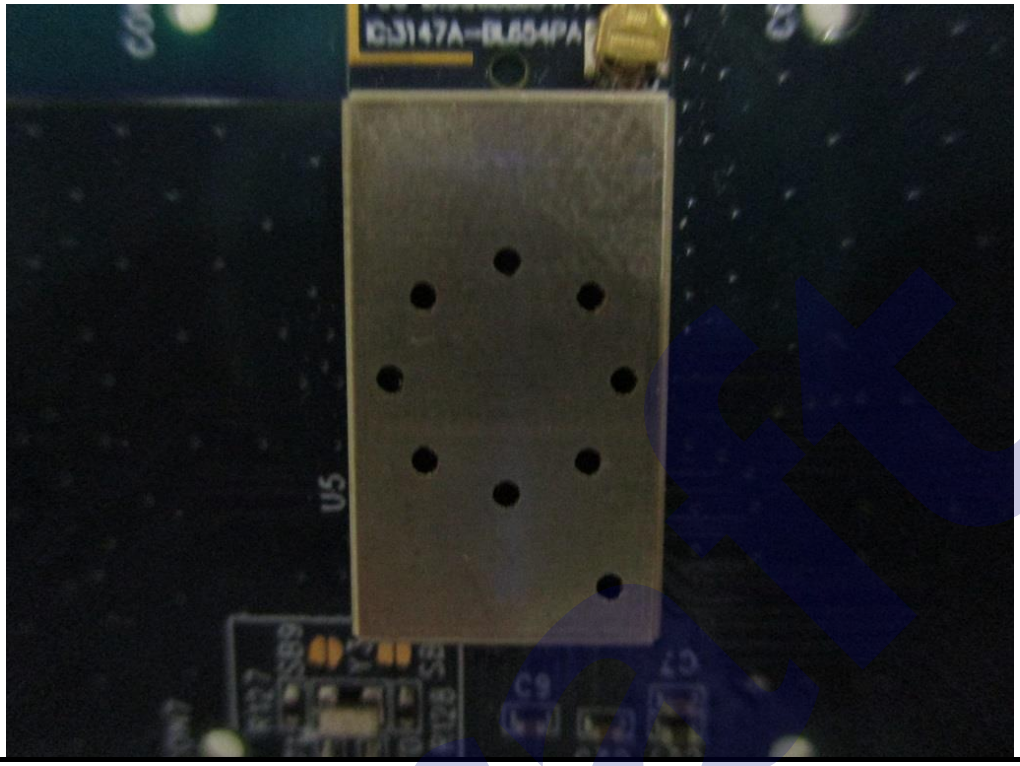
Spurious Emission Test above 30MHz (Test Configuration 7)

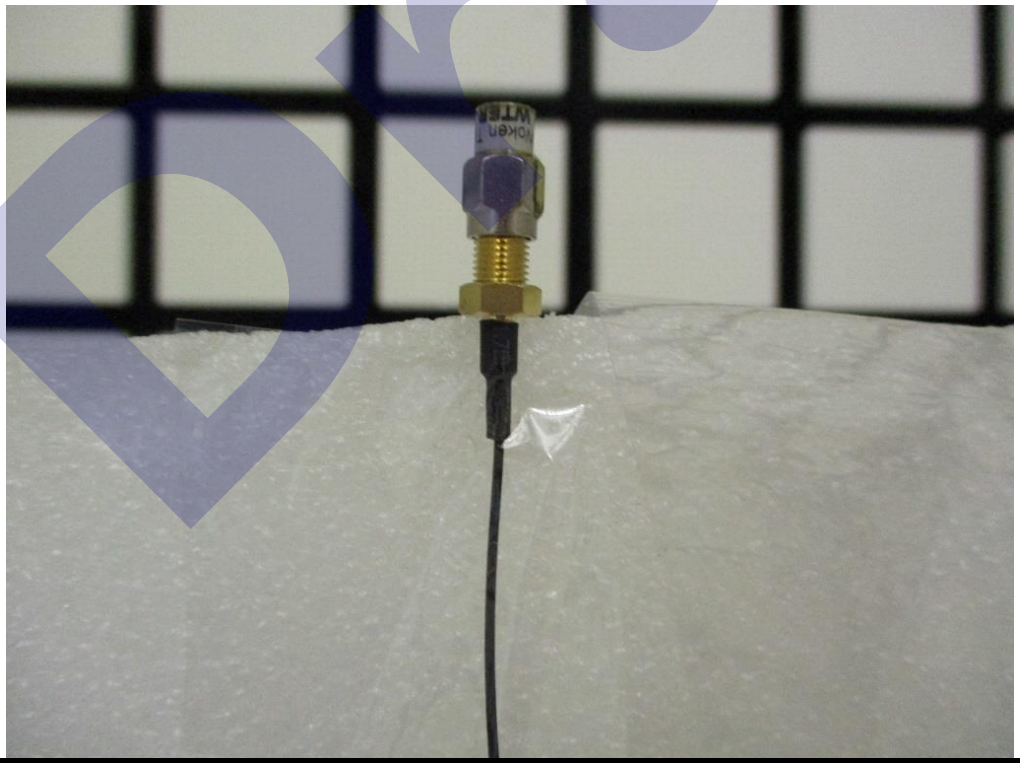




Draft

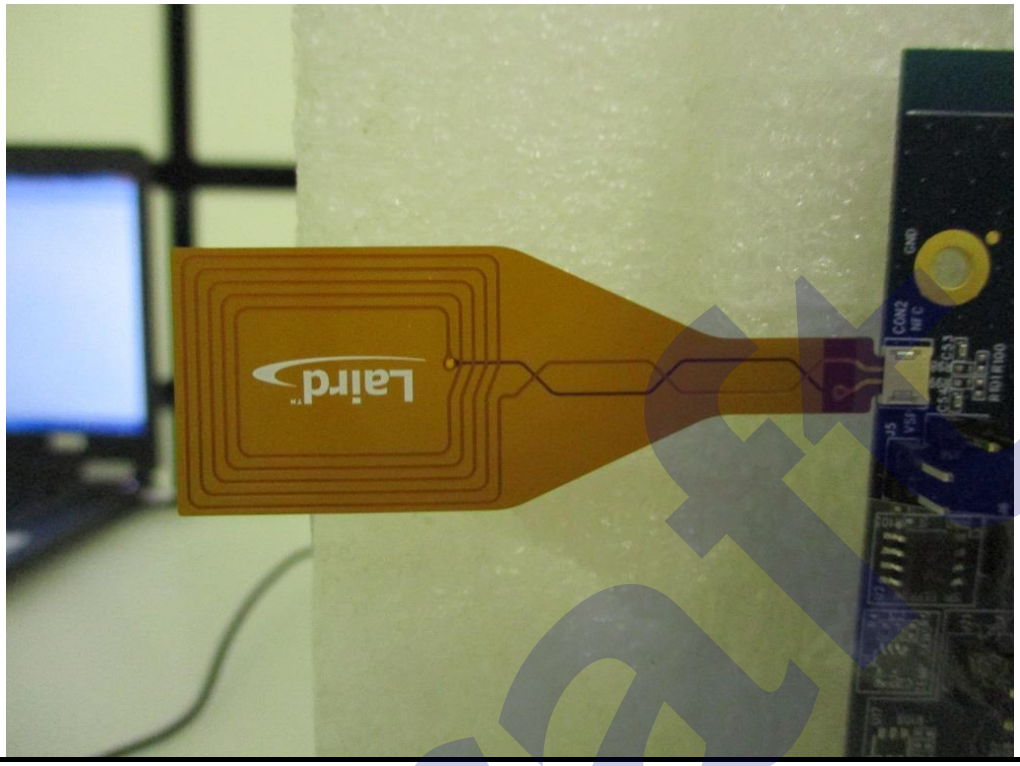
Spurious Emission Test above 30MHz (Test Configuration 7)

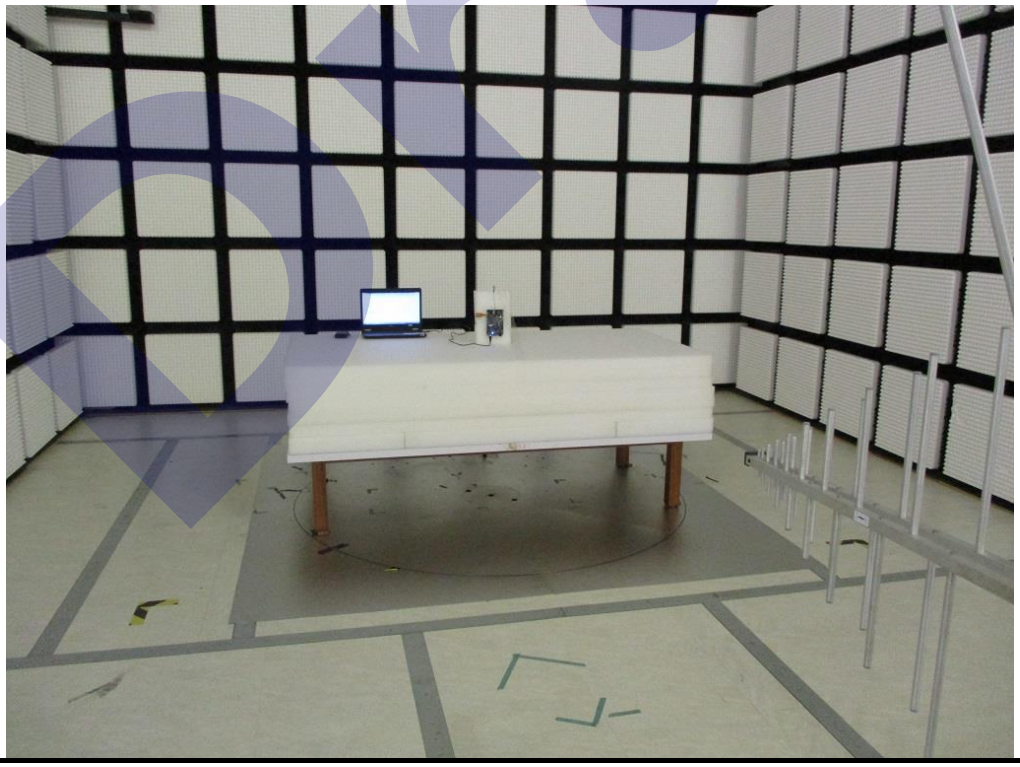




Draft

Spurious Emission Test above 30MHz (Test Configuration 7)





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

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