# AS/NZS Test Report

| | | |
|---|---|---|
| **Equipment** | : | **Bluetooth 5.0 BLE Data Module** |
| **Model No.** | : | **BL654** |
| **Brand Name** | : | **Laird** |
| **Applicant** | : | **Laird Technologies** |
| **Address** | : | **W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA** |
| **Standard** | : | **AS/NZS 4268:2017** |
| **Received Date** | : | **Jan. 30, 2018** |
| **Tested Date** | : | **May 02 ~ May 08, 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. 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 |
|---|---|---|---|
| AR813002 | Rev. 01 | Initial issue | Jun. 25, 2018 |

# 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.

# 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 | BL654 | Bluetooth 5.0 BLE Data Module | With Printed PCB Antenna |
| | | | With Connector Type 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. | Brand | Model | Type | Connector | Gain (dBi) | Remark |
|---|---|---|---|---|---|---|
| 1 | Laird | NanoBlue | PCB Dipole | IPEX MHF4 | 2 | Connector Type Antenna |
| 2 | Laird | FlexPIFA | PCB Dipole | IPEX MHF4 | 2 | Connector Type Antenna |
| 3 | Laird | FlexNotch | PCB Dipole | IPEX MHF4 | 2 | Connector Type Antenna |
| 4 | Mag.Layers | EDA-8709-2G4C1-B27-CY | Dipole | IPEX MHF4 | 2 | Connector Type Antenna |
| 5 | Laird | mFlexPIFA | PIFA | IPEX MHF4 | 2 | Connector Type Antenna |
| 6 | Laird | Laird NFC | NFC | N/A | N/A | Printed PCB Antenna & Connector Type Antenna |
| 7 | Laird | BL654-SA PCB printed antenna | Printed PCB | N/A | 0 | Printed PCB Antenna |
| 8 | Walsin | RFDPA870900SBAB8G1 | Dipole | SMA | 2 | Connector Type Antenna |

### 1.1.4 EUT Operational Condition

| | | | |
|---|---|---|---|
| **Power Supply Type** | 1.8Vdc & 3.3Vdc from host | | |
| **Operational Voltage** | ☒ Vnom (3.3 V) | ☒ Vmax (3.6 V) | ☒ Vmin (1.7 V) |
| **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). |

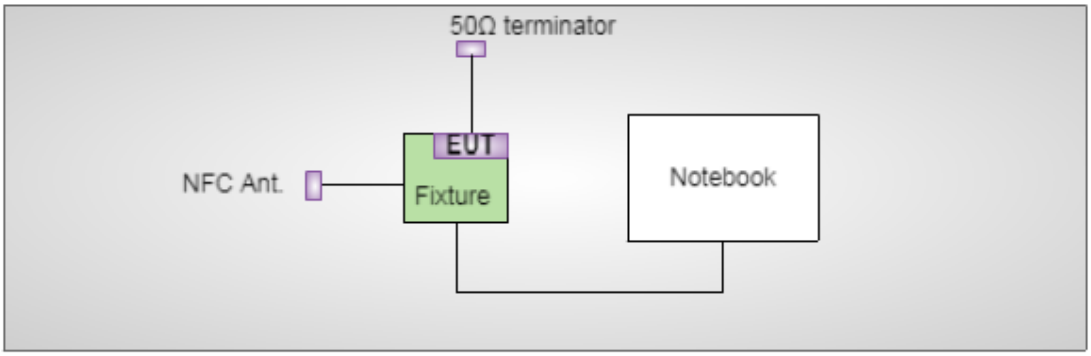
## 1.2 Local Support Equipment List

| Support Equipment List | | | | | |
|---|---|---|---|---|---|
| **No.** | **Equipment** | **Brand** | **Model** | **S/N** | **Signal cable / Length (m)** |
| 1 | Notebook | DELL | Latitude E6440 | 7MW3Z52 | USB, 1m shielded. |
| 2 | 50Ω terminator | --- | --- | --- | --- |
| 4 | Fixture | --- | --- | --- | --- |

Note: Fixture is provided by applicant.

## 1.3 Test Setup Chart

**Test Setup Diagram**




1. USB cable, 1m shielded.

## 1.4 Test Equipment and Calibration Data

| Test Item | Radiated Emissions | | | | |
|---|---|---|---|---|---|
| **Test Site** | Fully-anechoic chamber 1 / (05CH01-WS) | | | | |
| **Tested Date** | May 02, 2018 | | | | |
| **Instrument** | **Manufacturer** | **Model No.** | **Serial No.** | **Calibration Date** | **Calibration Until** |
| Spectrum Analyzer | Agilent | N9010A | MY54200247 | Sep. 28, 2017 | Sep. 27, 2018 |
| Bilog Antenna | SCHWARZBECK | VULB9168 | VULB9168-524 | Oct. 27, 2017 | Oct. 26, 2018 |
| Horn Antenna 1G-18G | SCHWARZBECK | BBHA 9120 D | BBHA 9120 D 1094 | Nov. 10, 2017 | Nov. 09, 2018 |
| Horn Antenna 18G-40G | SCHWARZBECK | BBHA 9170 | BBHA 9170508 | Dec. 19, 2017 | Dec. 18, 2018 |
| Preamplifier | Agilent | 83017A | MY39501310 | Nov. 28, 2017 | Nov. 27, 2018 |
| Preamplifier | EMC | EMC02325 | 980146 | Oct. 13, 2017 | Oct. 12, 2018 |
| Preamplifier | EMC | EMC184045B | 980192 | Aug. 22, 2017 | Aug. 21, 2018 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY22626/4 | Nov. 24, 2017 | Nov. 23, 2018 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY16608/4 | Nov. 24, 2017 | Nov. 23, 2018 |
| RF Cable | HUBER+SUHNER | SUCOFLEX104 | MY16617/4 | Nov. 24, 2017 | Nov. 23, 2018 |
| LF cable 3M | Woken | CFD400NL-LW | CFD400NL-005 | Nov. 24, 2017 | Nov. 23, 2018 |
| LF cable 10M | Woken | CFD400NL-LW | CFD400NL-006 | Nov. 24, 2017 | Nov. 23, 2018 |
| Measurement Software | AUDIX | e3 | 6.120210g | NA | NA |
| Note: Calibration Interval of instruments listed above is one year. | | | | | |

| Test Item | Radiated Emissions | | | | |
|---|---|---|---|---|---|
| **Test Site** | (10CH02-HY) | | | | |
| **Tested Date** | May 08, 2018 | | | | |
| **Instrument** | **Manufacturer** | **Model No.** | **Serial No.** | **Calibration Date** | **Calibration Until** |
| Receiver | R&S | ESI | 838496/008 | Sep. 01, 2017 | Sep. 01, 2018 |
| Preamplifier | EMC | EMC02325 | 980225 | Jul. 28, 2017 | Jul. 27, 2018 |
| RF Cable-R03m | Jye Bao | RG142 | CB031 | Dec. 29, 2017 | Dec. 28, 2018 |
| RF Cable-10m | MTJ | RG223/U+RG8/U | CB026-DOOR | Dec. 29, 2017 | Dec. 28, 2018 |
| Loop Antenna | R&S | HFH2-Z2 | 100330 | Nov. 13, 2017 | Nov. 12, 2018 |
| Software | Audix | E3 | 4.03260c | N/A | N/A |
| Note: Calibration Interval of instruments listed above is one year. | | | | | |

## 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 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 | $\pm 1.4 \times 10^{-9}$ |
| 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 % |

# 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 | 05CH01-WS | 25°C / 65% | Mars Lai |
| Radiated Emission ≤ 30 MHz | 10CH02-HY* | 22.1°C / 61% | 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 | NFC | 13.56 | 1, 2, 3 |

**NOTE:**

1) The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** results were found as the worst case and were shown in this report.
2) The EUT supports two DC voltage options, DC 1.8V & 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.
3) Test configurations are listed as below:
   1) Configuration 1: Antenna: Laird NFC + EDA-8709-2G4C1-B27-CY
   2) Configuration 2: Antenna: Laird NFC + mFlexPIFA
   3) Configuration 3: Antenna: Laird NFC + BL654-SA PCB printed antenna

# 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).

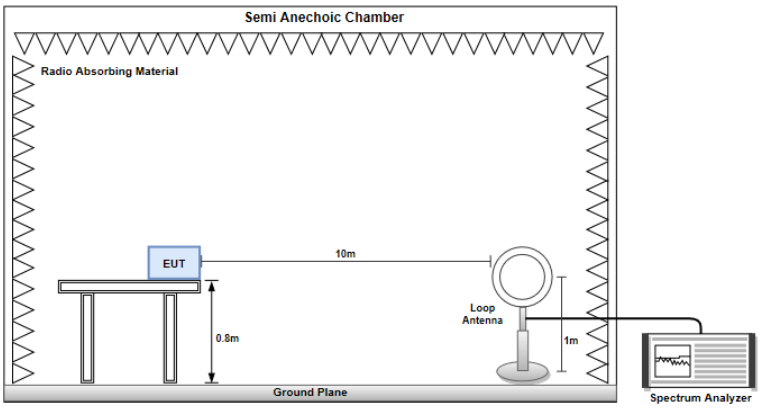
| Spurious Emissions Limit (Peak Power) | Frequency Range | Measurement Bandwidth |
|---|---|---|
| -56 dBW (2.5μW) e.i.r.p (59 dBμV/m at 10 metres) | < 150 kHz | 1 kHz |
| | 150 kHz – 30 MHz | 10 kHz |

### 3.1.2 Test Procedures

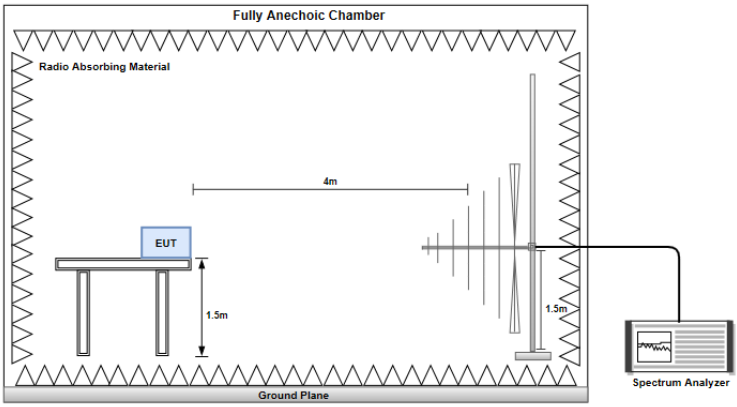
Reference to clause 4.3.5.3 of EN 300 330 V2.1.1 (2017-02).

### 3.1.3 Test Setup

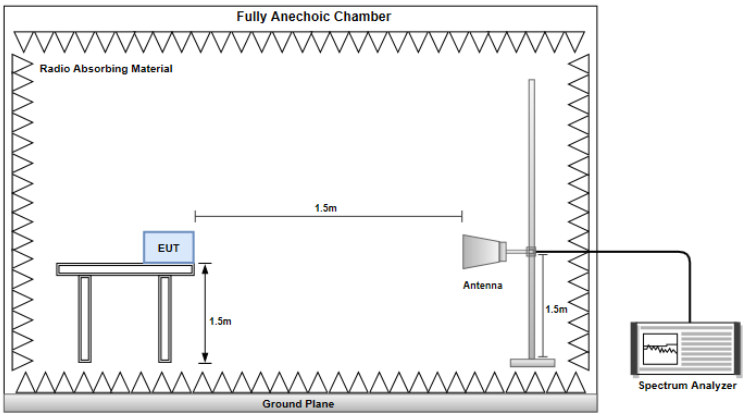
**Below 30MHz**




**Below 1GHz**



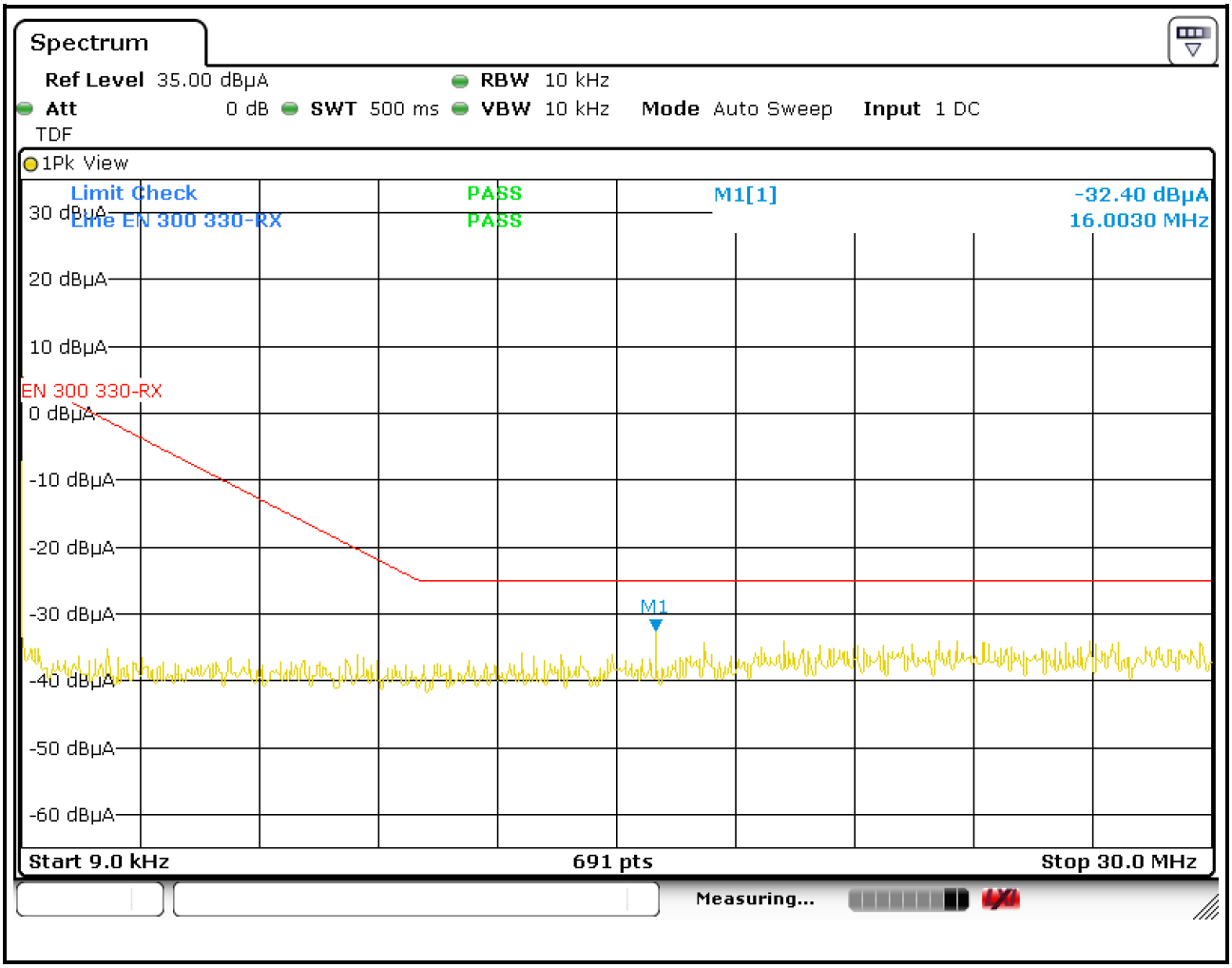

**Above 1 GHz**



### 3.1.4 Receiver Spurious Emissions (Below 30MHz)

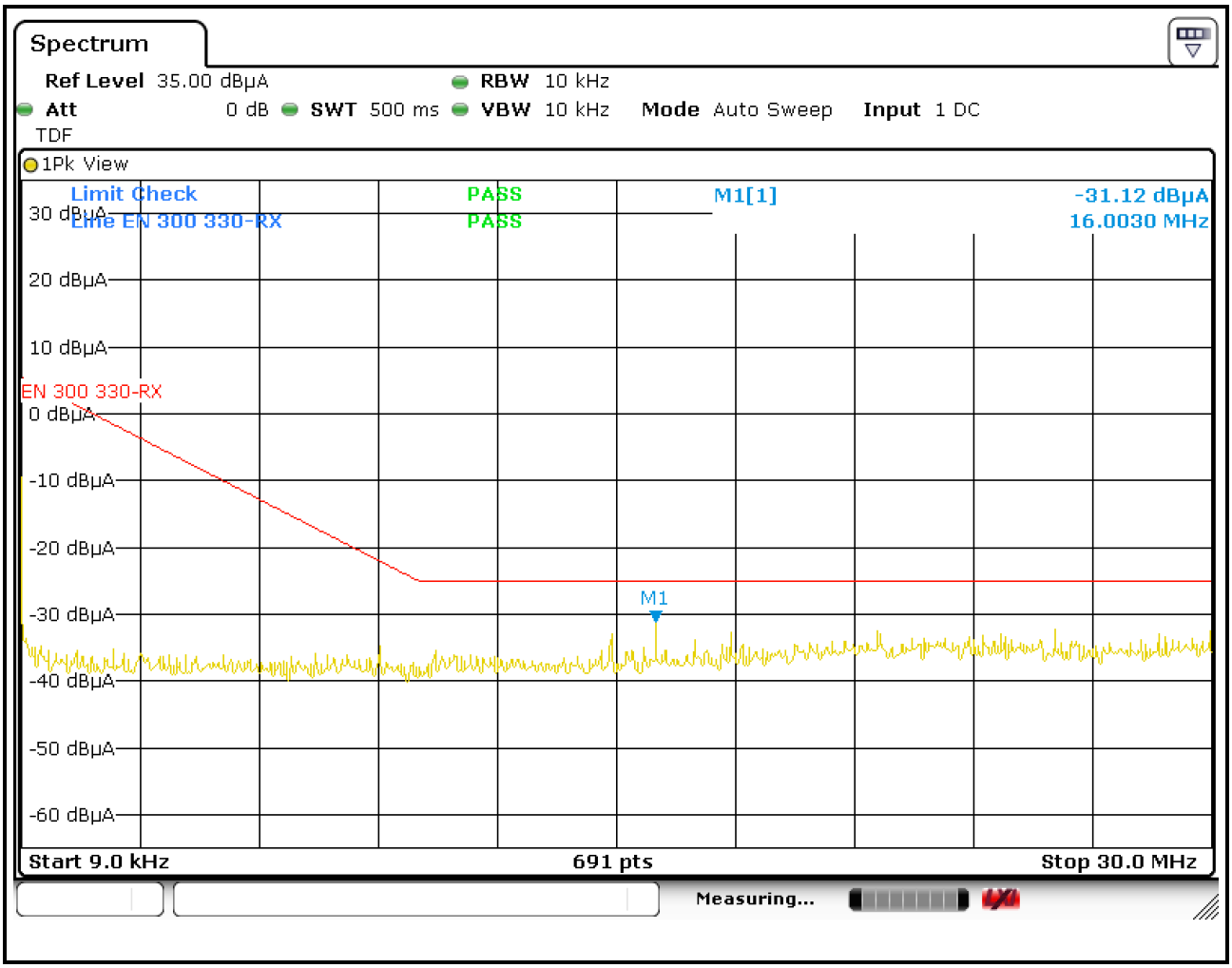
***Configuration 1: Antenna: Laird NFC + EDA-8709-2G4C1-B27-CY***

| Receiver Emissions in the Range from 9kHz~30MHz Result | | | | |
|---|---|---|---|---|
| **Emission Freq.** (MHz) | **H-field (dBuA/m at 10m)** | **H-field Limit** (dBuA/m at 10m) | **Level Type** | **Margin** (dB) |
| 16.003 | -32.40 | -25.00 | PK | 7.40 |



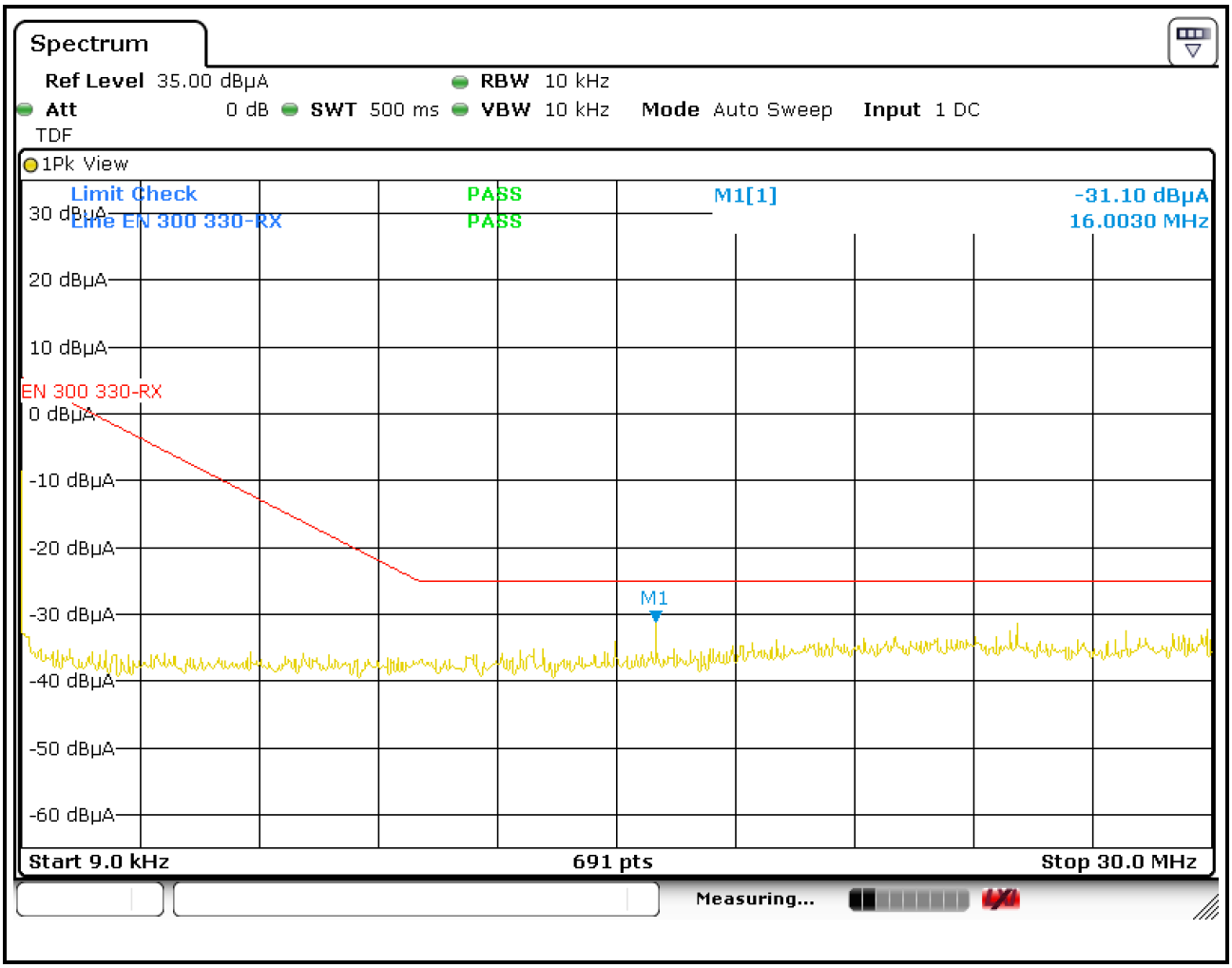
## *Configuration 2: Antenna: Laird NFC + mFlexPIFA*

| Receiver Emissions in the Range from 9kHz~30MHz Result | | | | |
|---|---|---|---|---|
| **Emission Freq.** (MHz) | **H-field (dBuA/m at 10m)** | **H-field Limit** (dBuA/m at 10m) | **Level Type** | **Margin** (dB) |
| 16.003 | -31.12 | -25.00 | PK | 6.12 |



## *Configuration 3: Antenna: Laird NFC + BL654-SA PCB printed antenna*

| Receiver Emissions in the Range from 9kHz~30MHz Result | | | | |
|---|---|---|---|---|
| **Emission Freq.** (MHz) | **H-field (dBuA/m at 10m)** | **H-field Limit** (dBuA/m at 10m) | **Level Type** | **Margin** (dB) |
| 16.003 | -31.10 | -25.00 | PK | 6.10 |



### *Configuration 1: Antenna: Laird NFC + EDA-8709-2G4C1-B27-CY*

| Freq. (MHz) | Freq. (MHz) | Value (dBuA/m) | Factor | Value (dBuV/m) | Margin (dBuV/m) | Limit (dBuV/m) | Result |
|---|---|---|---|---|---|---|---|
| 13.56 | 16.003 | -32.4 | 51.5 | 19.1 | -39.9 | 59 | Pass |

### *Configuration 2: Antenna: Laird NFC + mFlexPIFA*

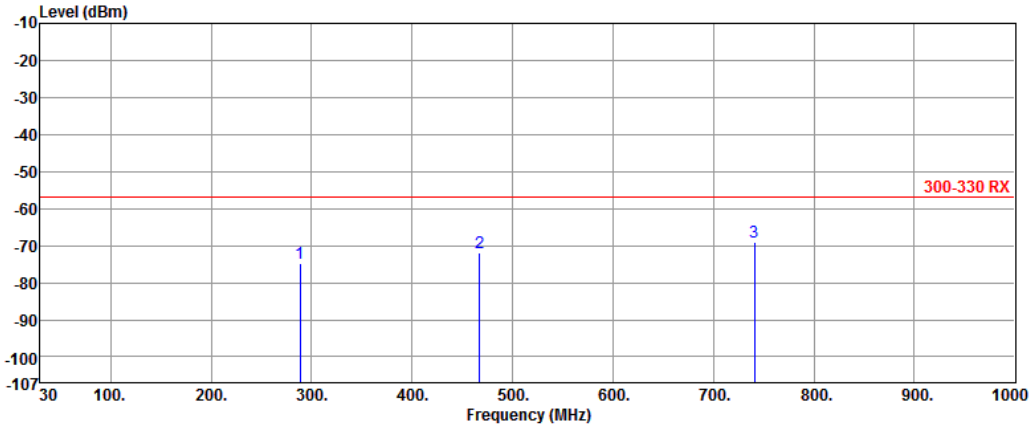
| Freq. (MHz) | Freq. (MHz) | Value (dBuA/m) | Factor | Value (dBuV/m) | Margin (dBuV/m) | Limit (dBuV/m) | Result |
|---|---|---|---|---|---|---|---|
| 13.56 | 16.003 | -31.2 | 51.5 | 20.3 | -38.7 | 59 | Pass |

### *Configuration 3: Antenna: Laird NFC + BL654-SA PCB printed antenna*

| Freq. (MHz) | Freq. (MHz) | Value (dBuA/m) | Factor | Value (dBuV/m) | Margin (dBuV/m) | Limit (dBuV/m) | Result |
|---|---|---|---|---|---|---|---|
| 13.56 | 16.003 | -31.1 | 51.5 | 20.4 | -38.6 | 59 | Pass |

### 3.1.5 Receiver Radiated Unwanted Emissions (Above 30MHz)

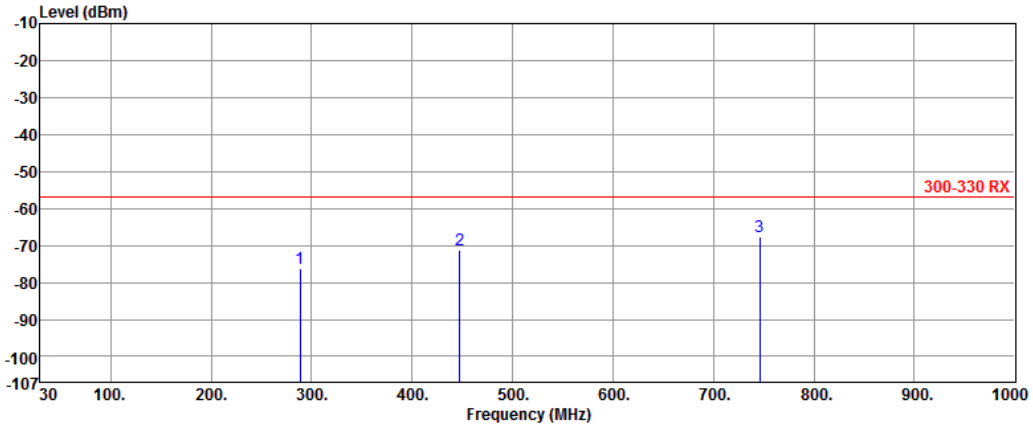
| **Polarization** | Horizontal | **Test Configuration** | 1 |
|---|---|---|---|




| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.73 | -74.72 | -57.00 | -17.72 | -1.36 | -73.36 |
| 2 | 467.31 | -72.10 | -57.00 | -15.10 | 2.24 | -74.34 |
| 3 | 740.72 | -69.15 | -57.00 | -12.15 | 7.67 | -76.82 |

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

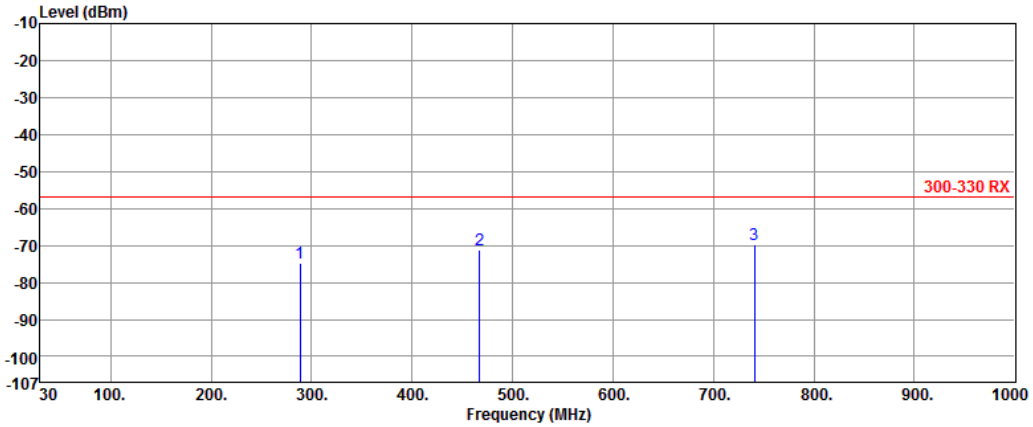
| Polarization | Vertical | Test Configuration | 1 |
|---|---|---|---|




| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.37 | -76.19 | -57.00 | -19.19 | -1.91 | -74.28 |
| 2 | 447.32 | -71.05 | -57.00 | -14.05 | 1.90 | -72.95 |
| 3 | 746.35 | -67.56 | -57.00 | -10.56 | 7.81 | -75.37 |

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

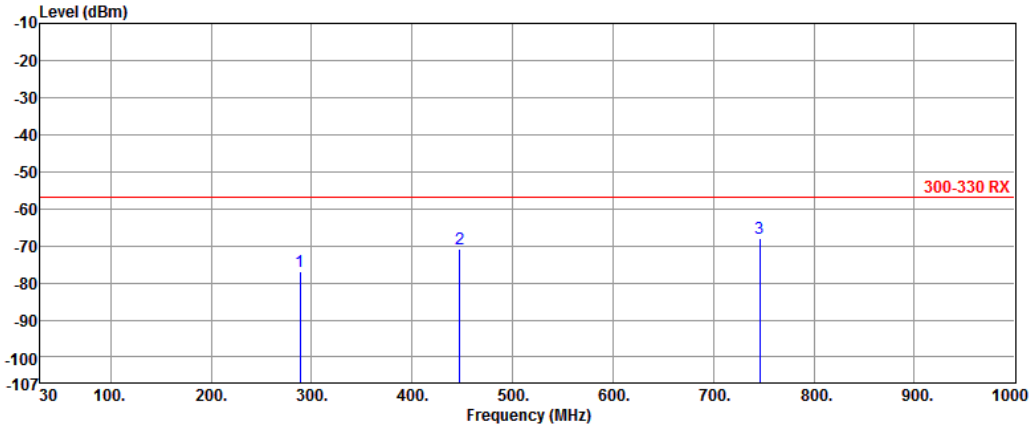
| Polarization | Horizontal | Test Configuration | 2 |
|---|---|---|---|




| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.61 | -74.73 | -57.00 | -17.73 | -1.36 | -73.37 |
| 2 | 467.39 | -71.31 | -57.00 | -14.31 | 2.24 | -73.55 |
| 3 | 740.56 | -69.86 | -57.00 | -12.86 | 7.68 | -77.54 |

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

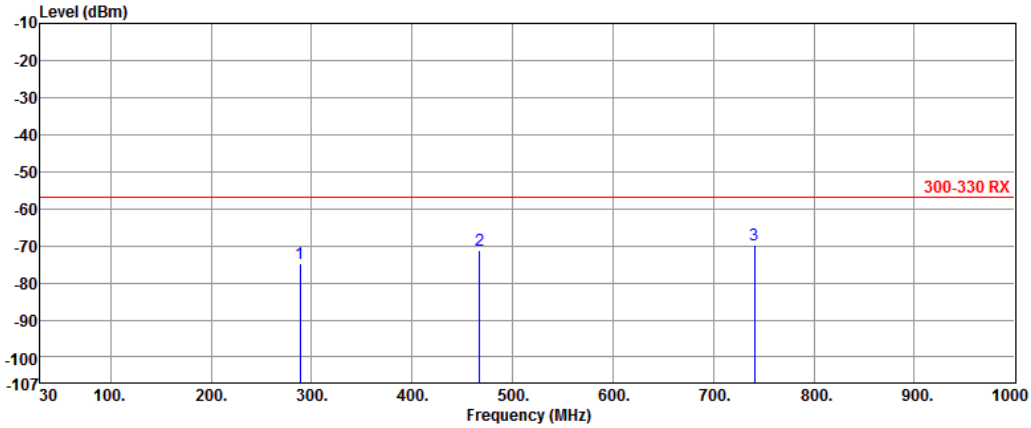
| Polarization | Vertical | Test Configuration | 2 |
|---|---|---|---|




| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.39 | -76.86 | -57.00 | -19.86 | -1.91 | -74.95 |
| 2 | 447.32 | -70.75 | -57.00 | -13.75 | 1.90 | -72.65 |
| 3 | 746.07 | -67.94 | -57.00 | -10.94 | 7.80 | -75.74 |

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

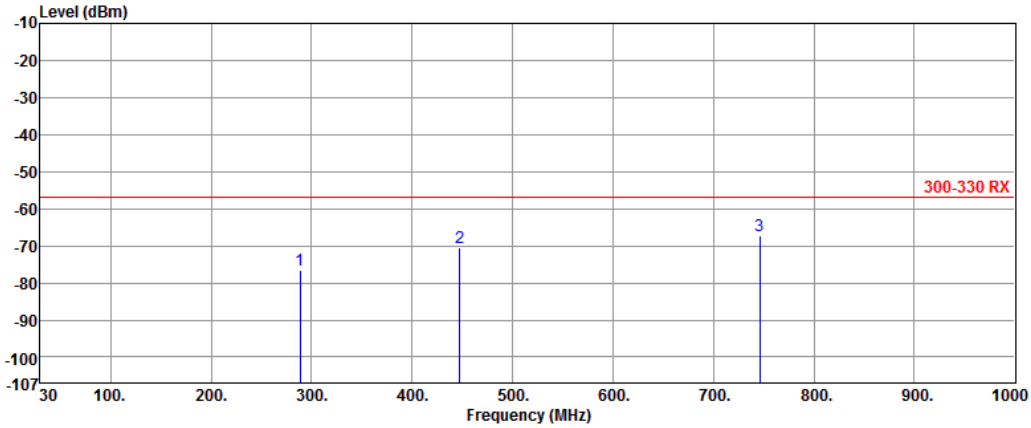
| Polarization | Horizontal | Test Configuration | 3 |
|---|---|---|---|




| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.82 | -74.86 | -57.00 | -17.86 | -1.37 | -73.49 |
| 2 | 467.50 | -71.23 | -57.00 | -14.23 | 2.24 | -73.47 |
| 3 | 740.74 | -69.66 | -57.00 | -12.66 | 7.67 | -77.33 |

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

| Polarization | Vertical | Test Configuration | 3 |
|---|---|---|---|

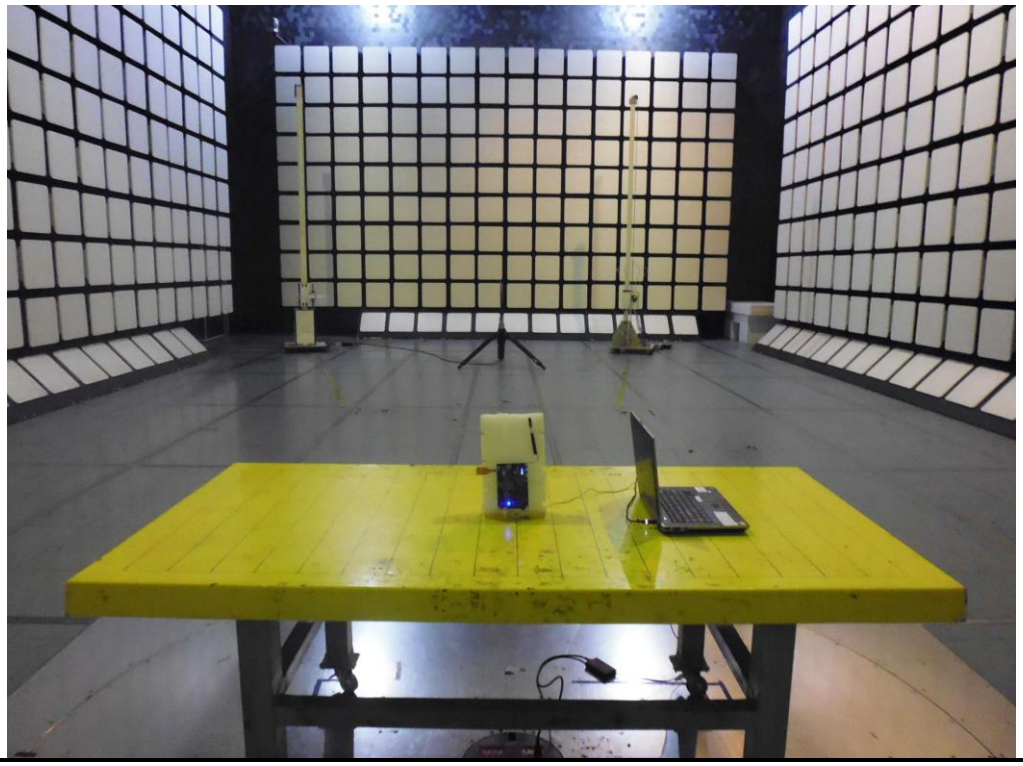


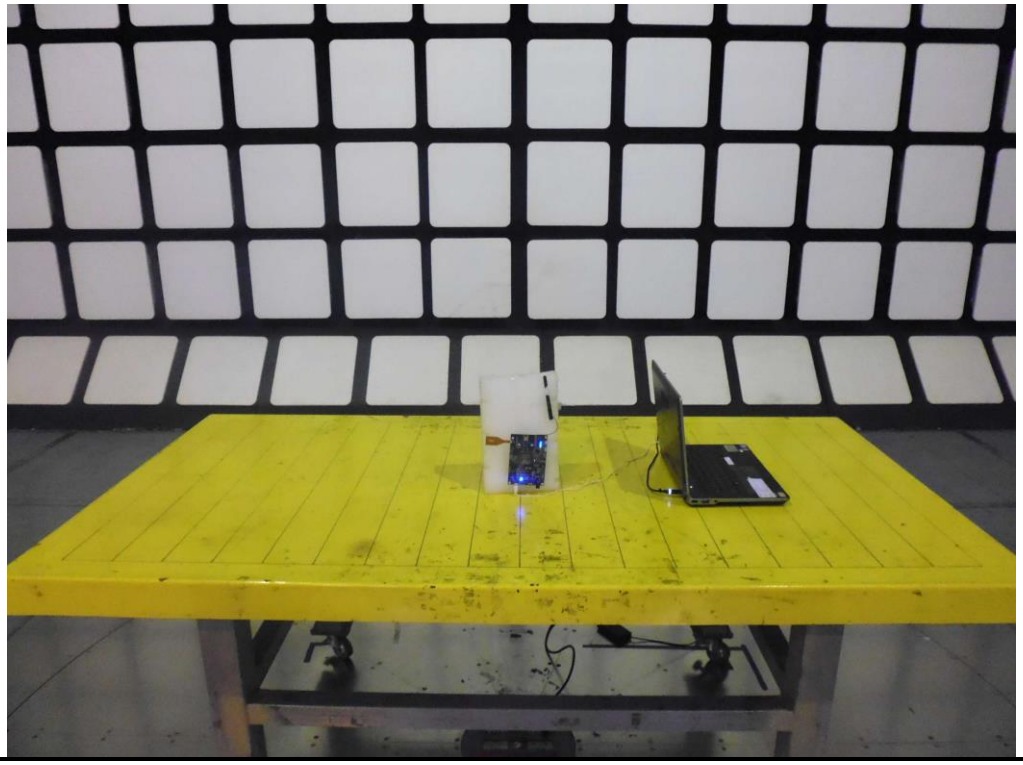

| | Freq. | Measured value | Limit | Margin | Factor | Reading |
|---|---|---|---|---|---|---|
| | MHz | dBm | dBm | dB | dB | dBm |
| 1 | 288.80 | -76.58 | -57.00 | -19.58 | -1.91 | -74.67 |
| 2 | 447.23 | -70.32 | -57.00 | -13.32 | 1.90 | -72.22 |
| 3 | 746.29 | -67.34 | -57.00 | -10.34 | 7.81 | -75.15 |

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

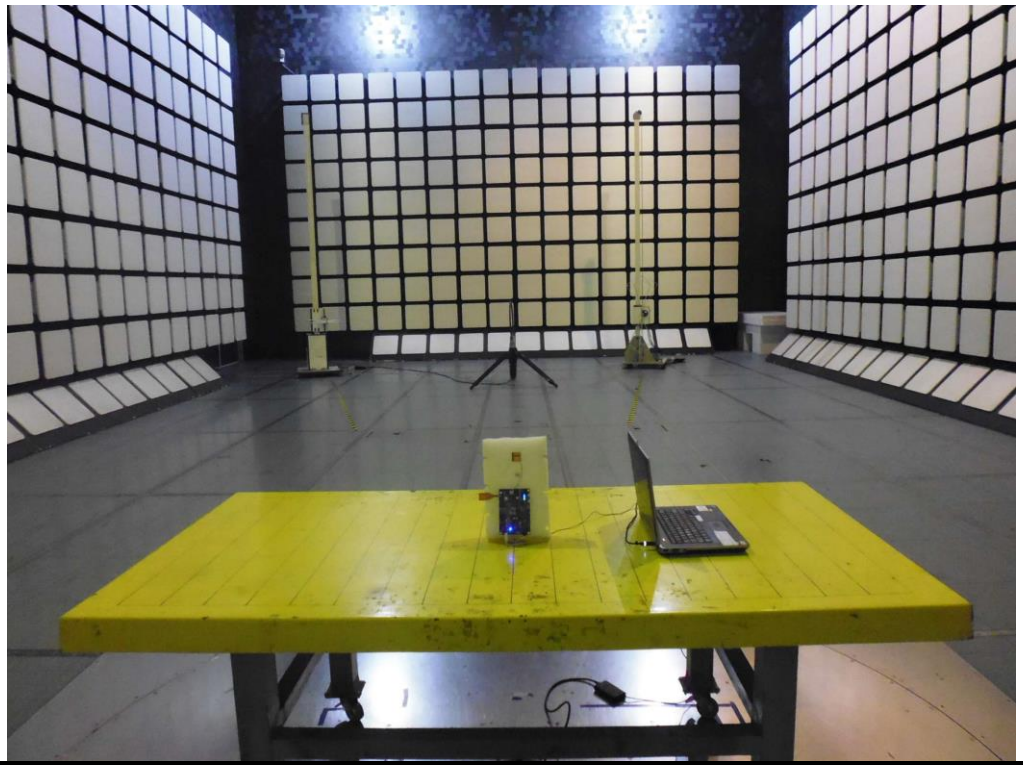
# 4 Photographs of the Test Configuration

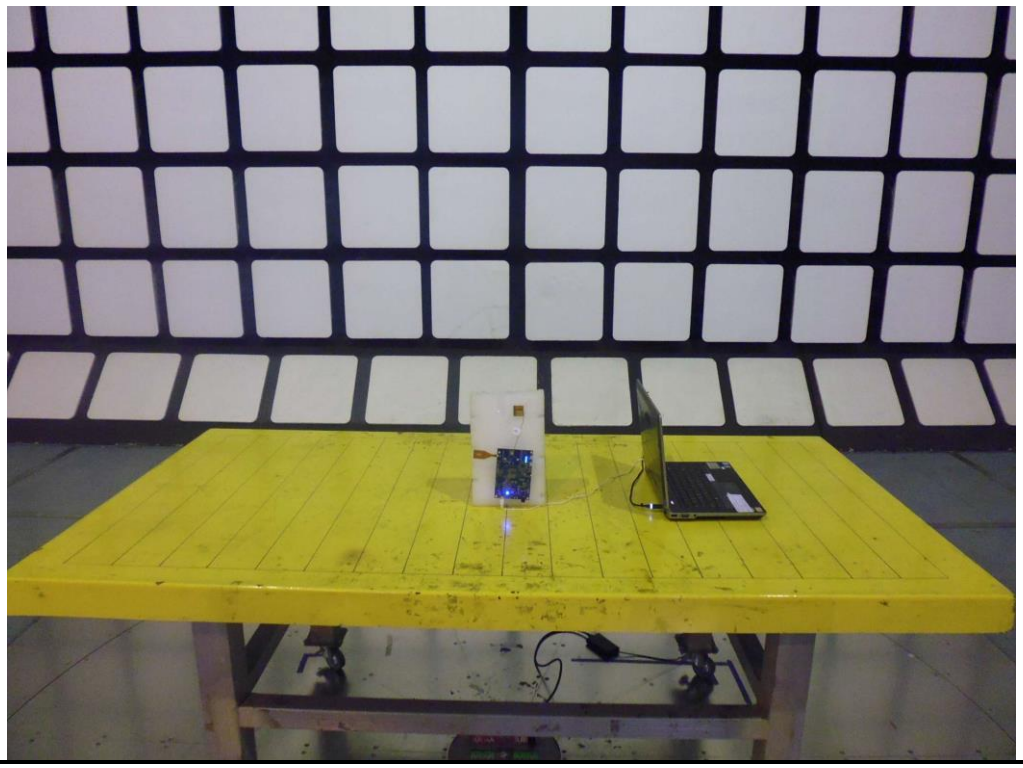
**Below 30MHz (Test Configuration 1)**



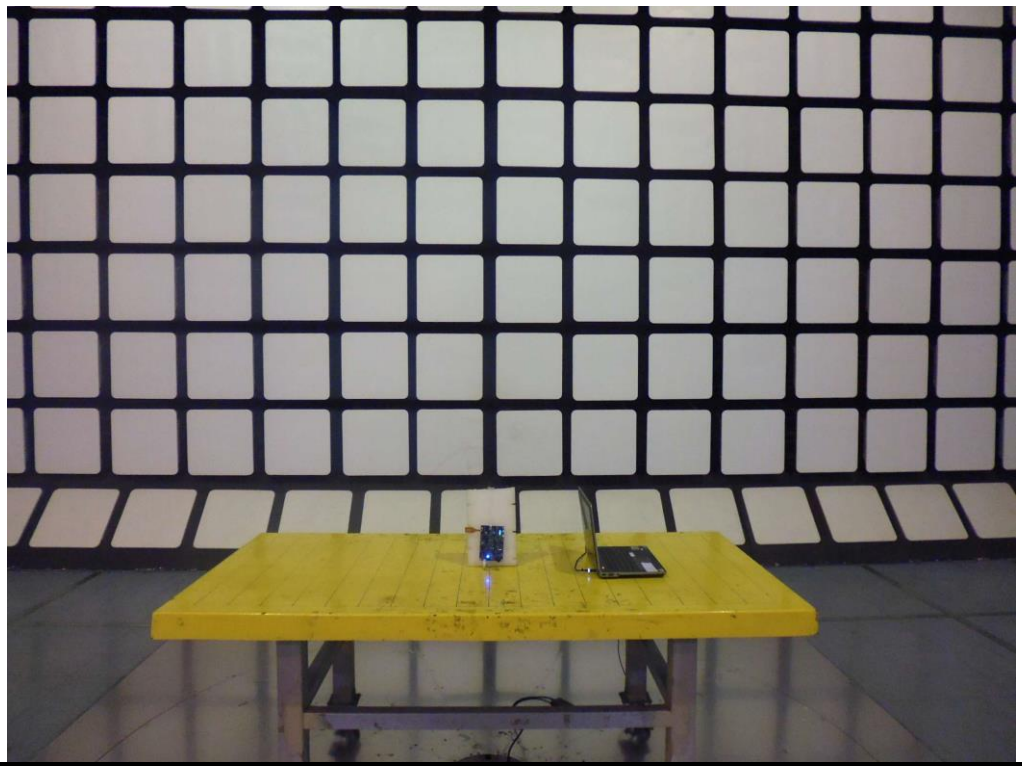


**Below 30MHz (Test Configuration 2)**

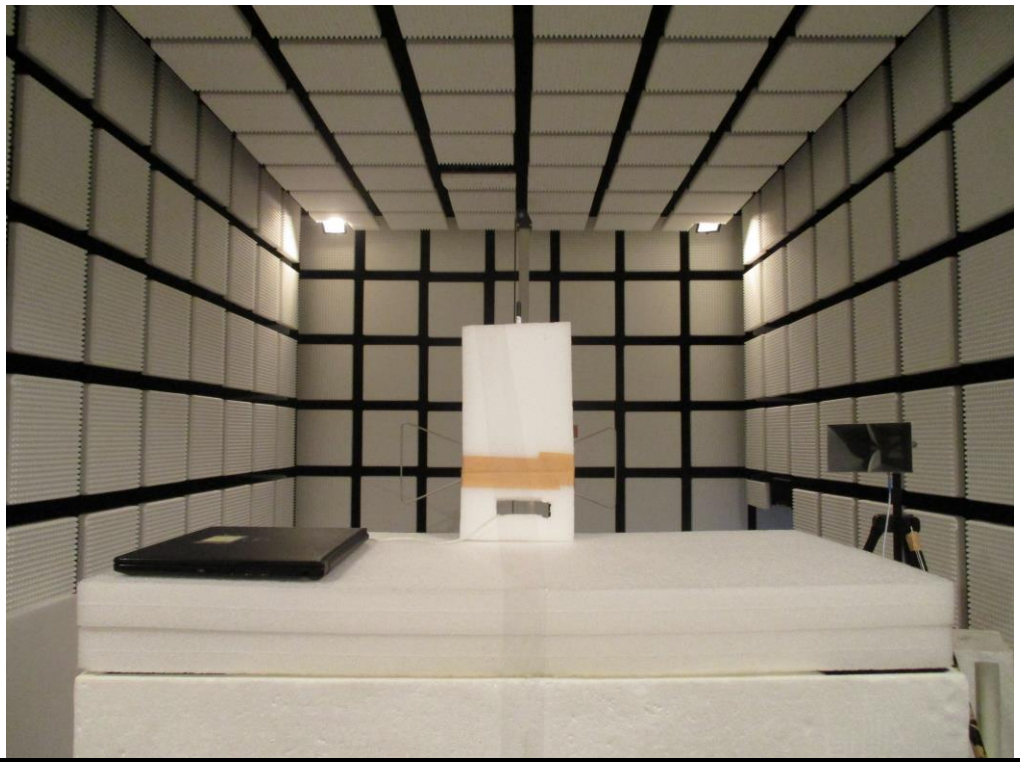




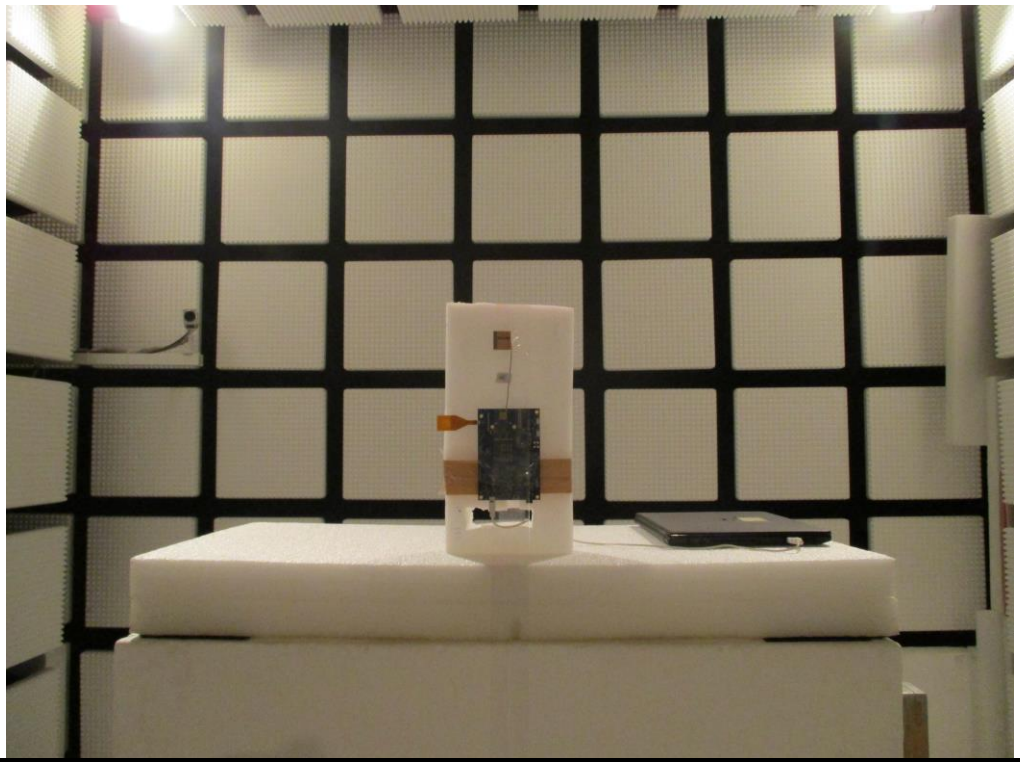
**Below 30MHz (Test Configuration 3)**

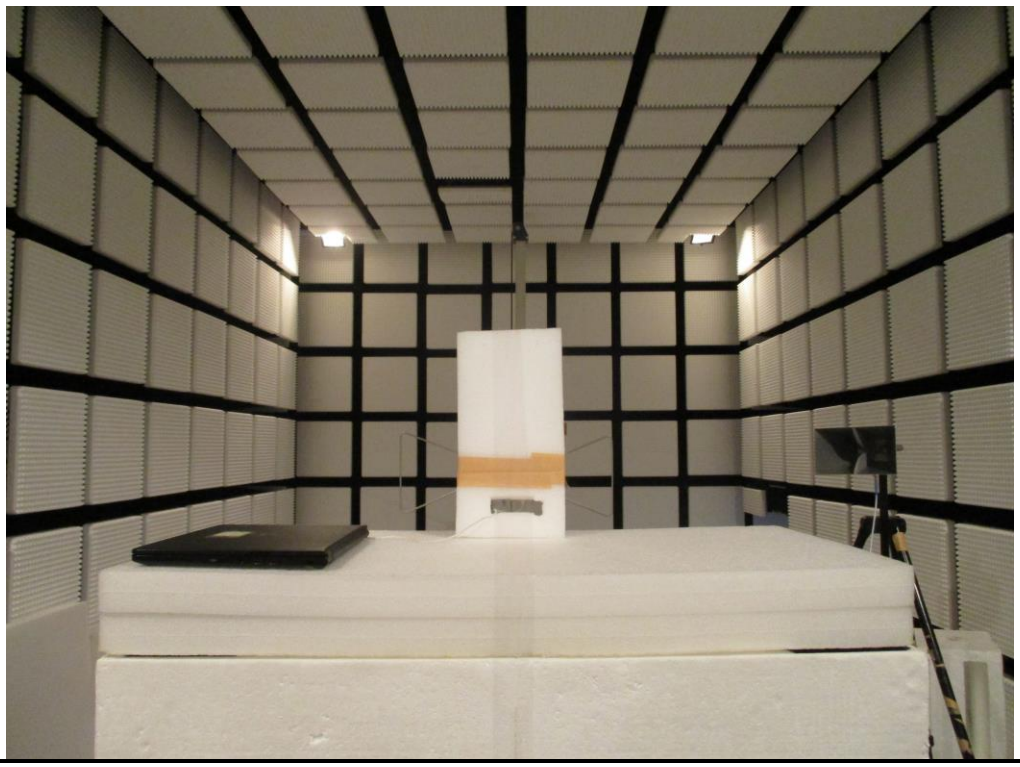


**Above 30MHz (Test Configuration 1)**

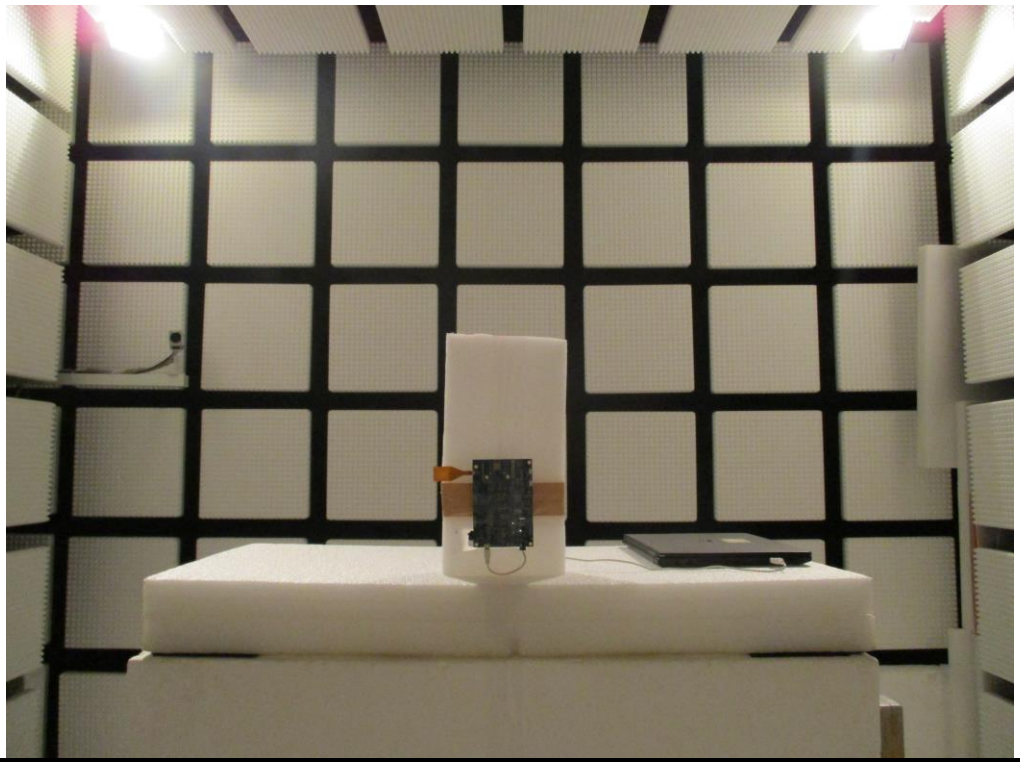


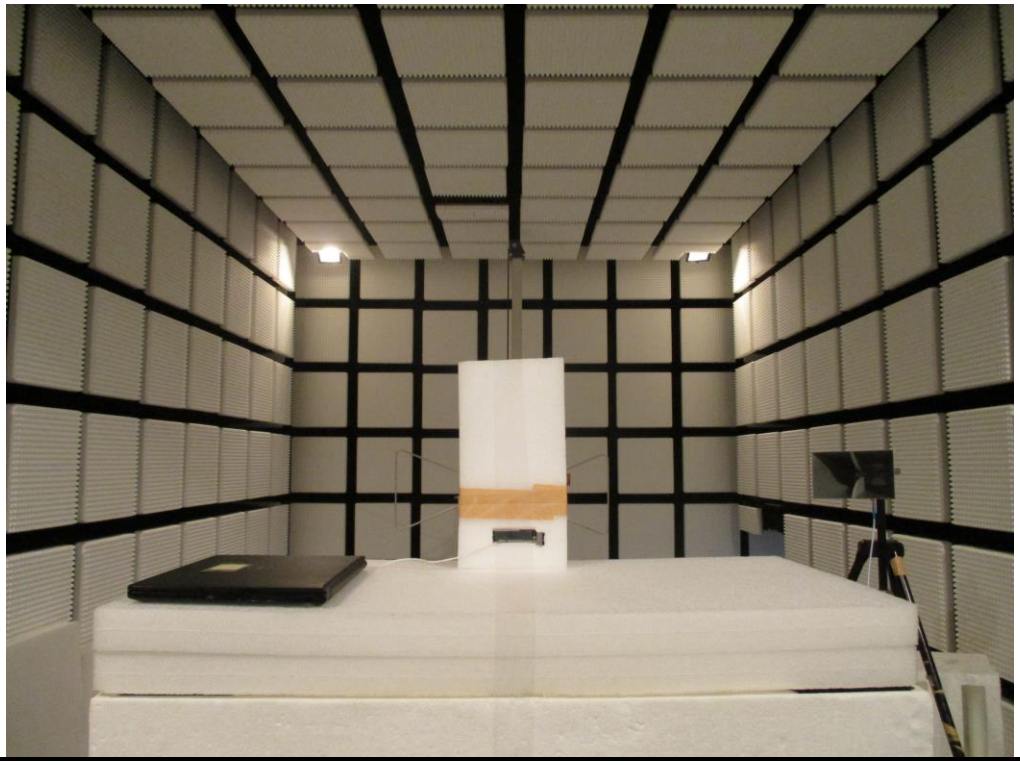
**Above 30MHz (Test Configuration 2)**





**Above 30MHz (Test Configuration 3)**





# 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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