

# TEST REPORT

of

## Australian/New Zealand Standard AS/NZS 4268:2017

Product: **ESP32 WROOM-32 module**  
Brand: **Fanstel**  
Model: **ESP32M4; ESP32E4; ESP32F4;  
ESP32M16; ESP32E16; ESP32F16**  
Model Difference: **Different in memory and antenna. Please  
see page 5 for detail**  
Applicant: **Fanstel Corporation, Taipei**  
Address **10F-10, No. 79, Sec. 1, Hsin Tai Wu  
Rd., Hsi-Chih, New Taipei City 221 Taiwan**

Test Performed by:



**International Standards Laboratory Corp. LT Lab.**

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Taiwan

Report No.: **ISL-20LR045ANZ**

Issue Date : **August 24, 2021**



Test results given in this report apply only to the specific sample(s) tested and are traceable to national or international standard through calibration of the equipment and evaluating measurement uncertainty herein.

The uncertainty of the measurement does not include in consideration of the test result unless the customer required the determination of uncertainty via the agreement, regulation or standard document specification. This test report shall not be reproduced except in full, without the written approval of International Standards Laboratory Corp.

## VERIFICATION OF COMPLIANCE

**Applicant:** Fanstel Corporation, Taipei  
**Equipment Under Test:** ESP32 WROOM-32 module  
**Brand:** Fanstel  
**Model Number:** ESP32M4; ESP32E4; ESP32F4; ESP32M16; ESP32E16; ESP32F16  
**Model Difference:** Different in memory and antenna. Please see page 5 for detail  
**Date of Test:** August 3, 2021 ~ August 24, 2021  
**Date of EUT Received:** August 3, 2021

| APPLICABLE STANDARDS        |             |
|-----------------------------|-------------|
| STANDARD                    | TEST RESULT |
| AS/NZS 4268:2017,<br>Row 59 | Complied    |

### We hereby certify that:

All the tests in this report have been performed and recorded in accordance with the standards described above and performed by an independent electromagnetic compatibility consultant, International Standards Laboratory Corp.

The test results contained in this report accurately represent the measurements of the characteristics and the energy generated by sample equipment under test at the time of the test. The sample equipment tested as described in this report is in compliance with the limits of above standards.

**Test By:**

*Weitin Chen*

**Date:**

August 24, 2021

*Weitin Chen / Senior Engineer*

**Prepared By:**

*Elisa Chen*

**Date:**

August 24, 2021

*Elisa Chen / Senior Engineer*

**Approved By:**

*Jerry Liu*

**Date:**

August 24, 2021

*Jerry Liu / Assistant Manager*

## Version

| Version No. | Date            | Description                  |
|-------------|-----------------|------------------------------|
| 00          | August 24, 2021 | Initial creation of document |
|             |                 |                              |

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## 1 Description of Equipment under Test (EUT)

General:

|                   |   |
|-------------------|---|
| Product Name:     | ESP32 WROOM-32 module   |
| Brand Name:       | Fanstel   |
| Model Name:       | ESP32M4; ESP32E4; ESP32M16; ESP32E16; ESP32F16; ESP32F4             |
| Model Difference: | Different in memory and antenna. Please see table below for detail. |
| Power Supply:     | 5Vdc from USB port  |

Model Summaries:

| module          | ESP32M4             | ESP32F4.            | ESP32E4.            | ESP32M16             | ESP32F16             | ESP32E16.            |
|-----------------|---------------------|---------------------|---------------------|----------------------|----------------------|----------------------|
| SoC             | ESP32-D0WD          | ESP32-D0WD          | ESP32-D0WD          | ESP32-D0WD           | ESP-D0WD             | ESP32-D0WD           |
| Flash memory    | 4MB, IS25LP032-JBLE | 4MB, IS25LP032-JBLE | 4MB, IS25LP032-JBLE | 16MB, IS25LP128-JBLE | 16MB, IS25LP128-JBLE | 16MB, IS25LP128-JBLE |
| Size            | 18x25.5             | 18x25.5             | 18x25.5             | 18x25.5              | 20x29.5              | 18x25.5              |
| WIFI            | PCB trace           | PCB trace           | u.FL                | PCB trace            | PCB trace            | u.FL                 |
| Operating temp. | -40°C to +105°C     | -40°C to +105°C     | -40°C to +105°C     | -40°C to +105°C      | -40°C to +105°C      | -40°C to +105°C      |

## 2.4GHz WLAN: 1TX/1RX

|                             |   |
|-----------------------------|---|
| Frequency Range:            | 2412MHz–2472MHz   |
| Channel number:             | 802.11b/g: 13channels<br>802.11n_HT20: 13 channels<br>802.11n_HT40: 9 channels            |
| Transmit Power (EIRP):      | 802.11b:17.92dBm<br>802.11g:19.82 dBm<br>802.11n_HT20:19.92 dBm<br>802.11n_HT40:19.92 dBm |
| Modulation Technology:      | DSSS, OFDM  |
| Antenna Designation:        | PCB Antenna<br>ESP32M : 2.22 dBi<br>ESP32F: 1.70 dBi<br>Dipole Antenna<br>ESP32E : 0dBi   |
| Modulation type:            | CCK, DQPSK, DBPSK for DSSS<br>256QAM.64QAM. 16QAM, QPSK, BPSK for OFDM                    |
| TPC feature:                | No  |
| DFS operation mode:         | N/A   |
| Ad-hoc mode:                | No.   |
| Occupied Channel Bandwidth: | Within 2400-2483.5MHz,  |
| Duty Cycle:                 | N/A   |
| Adaptive/ Non-Adaptive:     | Adaptive  |
| LBT based Detect and Avoid: | Load Based Equipment  |
| Antenna Beamforming:        | No  |

The EUT is compliance with IEEE 802.11 b/g/n Standard.

This test report applies for WLAN 802.11b/g/n.

**Remark:** The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

## 2 Description of Test Modes and Test Condition

The EUT has been tested under Operating and standby condition. And used to control the EUT for staying in continuous transmitting and receiving mode is programmed. Channel lower, mid and higher were chosen for testing.

### **Normal test conditions:**

Temperature : -20°C to 70°C

Relative humidity: 20 % to 75 %

5Vdc Voltage

### **Extreme Temperatures**

For test at extreme temperatures, measurements shall be in accordance with the procedures specified in section 5.3 of AS/NZS 4268 at upper value of +105 degree and at a lower value of -40 degree.

### **Extreme Test Source Voltages**

Low voltage is 4.5Vdc and 5.5Vdc for high voltage nominal voltage 5Vdc

### **3 General Description of Apply Standards**

The EUT According to the Specifications, it must comply with the requirements of the following standards:

AS/NZS 4268:2017, – Radio equipment and systems – Short range devices – Limits and methods of measurement.

Row 59: Digital modulation transmitters

### **4 Test Facility**

International Standards Laboratory Corp.

<LT Lab.>

No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan

A fully anechoic chamber was used for the radiated spurious emissions test.



## 5 Support Equipment

Fig. 5-1 Configuration of Tested System

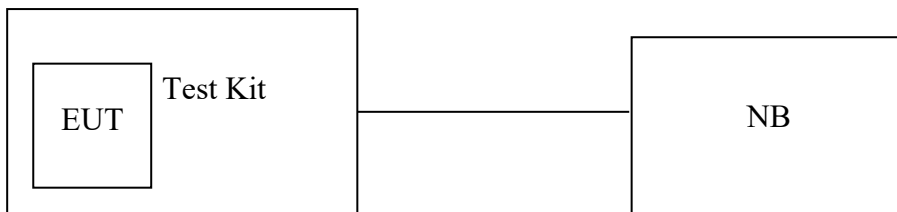


Table 5-1 Equipment Used in Tested System

| Item | Equipment | Mrf/Brand | Model name | Series No | Data Cable | Power Cable  |
|------|-----------|-----------|------------|-----------|------------|--------------|
| 1    | Notebook  | Lenovo    | X220i      | N/A       | N/A        | Non-shielded |

## 6 Maximum EIRP Measurement

### 6.1. Limit:

4W(36dBm) for Row 59

10W(20dBm) for Row 21

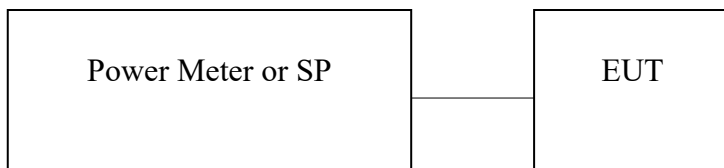
According to AS/NZS 4268:2017, Table 1, row 59: Digital modulation transmitters

According to AS/NZS 4268:2017, Table 1, row 21: All transmitters

### 6.2. Measurement Equipment Used:

| Location Conducted | Equipment Name                               | Brand       | Model                   | S/N                  | Last Cal. Date | Next Cal. Date |
|--------------------|--|-------------|-------------------------|----------------------|----------------|----------------|
| Conducted          | Power Meter                                  | Anritsu     | ML2495A                 | 1116010              | 09/25/2020     | 09/25/2021     |
| Conducted          | Power Sensor                                 | Anritsu     | MA2411B                 | 34NKF50              | 09/25/2020     | 09/25/2021     |
| Conducted          | Power Sensor                                 | DARE        | RPR3006W                | 13I00030SNO33        | 01/04/2021     | 01/04/2022     |
| Conducted          | Power Sensor                                 | DARE        | RPR3006W                | 13I00030SNO34        | 01/04/2021     | 01/04/2022     |
| Conducted          | Power Sensor                                 | DARE        | RPR3006W                | 14I00889SNO35        | 06/23/2021     | 06/23/2022     |
| Conducted          | Power Sensor                                 | DARE        | RPR3006W                | 14I00889SNO36        | 06/23/2021     | 06/23/2022     |
| Conducted          | Temperature Chamber                          | KSON        | THS-B4H100              | 2287                 | 04/26/2021     | 04/26/2022     |
| Conducted          | DC Power supply                              | ABM         | 8185D                   | N/A                  | 01/05/2021     | 01/05/2022     |
| Conducted          | AC Power supply                              | EXTECH      | CFC105W                 | NA                   | N/A            | N/A            |
| Conducted          | Spectrum analyzer                            | Keysight    | N9010A                  | MY56070257           | 09/23/2020     | 09/23/2021     |
| Conducted          | Test Software                                | DARE        | Radiation Ver:2013.1.23 | NA                   | NA             | NA             |
| Conducted          | Test Software                                | R&S         | CMUGO Ver:2.0.0         | N/A                  | N/A            | N/A            |
| Conducted          | Universal Digital Radio Communication Tester | R&S         | CMU200                  | 111968               | 11/29/2020     | 11/29/2021     |
| Conducted          | Wideband Radio Communication Tester          | R&S         | CMW500                  | 1201.002K50108793-JG | 10/28/2020     | 10/28/2021     |
| Conducted          | BT Simulator                                 | Agilent     | N4010A                  | MY48100200           | NA             | NA             |
| Conducted          | GPS Simulator                                | Welnavigate | GS-50                   | 701523               | NA             | NA             |
| Conducted (TS8997) | Wideband Radio Communication Tester          | R&S         | CMW500                  | 168811               | 07/19/2021     | 07/19/2022     |
| Conducted (TS8997) | Signal Generator                             | R&S         | SMB100B                 | 101085               | 10/28/2020     | 10/28/2021     |
| Conducted (TS8997) | Vector Signal Generator                      | R&S         | SMBV100A                | 263246               | 10/28/2020     | 10/28/2021     |
| Conducted (TS8997) | Signal analyzer 40GHz                        | R&S         | FSV40                   | 101884               | 10/20/2020     | 10/20/2021     |
| Conducted (TS8997) | OSP150 extension unit CAM-BUS                | R&S         | OSP150                  | 101107               | 04/06/2021     | 04/06/2022     |
| Conducted (TS8997) | Test Software                                | R&S         | EMC32                   | NA                   | NA             | NA             |

### 6.3. Test Setup:



### 6.4. Test Procedure:

Refer to ETSI EN 300 440-1 V1.6.1, clause 7.1.

Refer to ETSI EN 300 328 V2.1.1,

See Sub-Clause 5.3.2.1 of ETSI EN 300 328 for the test conditions

See Sub-Clause 5.3.2.2.1.1 of ETSI EN 300 328 for conducted method.

### 6.5. Measurement Result: Refer to next page for the details.

### 6.5.1. Test Results:

Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

| Mode         | Frequency (MHz) | Temp.  | Output Power e.i.r.p. (dBm) | Limit (dBm) | Results |
|--------------|-----------------|--------|-----------------------------|-------------|---------|
| 802.11b      | 2412            | Normal | -4.17                       | 20          | Pass    |
|              |                 | Low    | -0.07                       | 20          | Pass    |
|              |                 | High   | -4.17                       | 20          | Pass    |
|              | 2437            | Normal | -3.97                       | 20          | Pass    |
|              |                 | Low    | -0.17                       | 20          | Pass    |
|              |                 | High   | -3.97                       | 20          | Pass    |
|              | 2472            | Normal | -4.37                       | 20          | Pass    |
|              |                 | Low    | -0.37                       | 20          | Pass    |
|              |                 | High   | -4.37                       | 20          | Pass    |
| 802.11g      | 2412            | Normal | -4.05                       | 20          | Pass    |
|              |                 | Low    | 0.05                        | 20          | Pass    |
|              |                 | High   | -4.05                       | 20          | Pass    |
|              | 2437            | Normal | -3.85                       | 20          | Pass    |
|              |                 | Low    | -0.05                       | 20          | Pass    |
|              |                 | High   | -3.85                       | 20          | Pass    |
|              | 2472            | Normal | -4.25                       | 20          | Pass    |
|              |                 | Low    | -0.25                       | 20          | Pass    |
|              |                 | High   | -4.25                       | 20          | Pass    |
| 802.11n HT20 | 2412            | Normal | -4.33                       | 20          | Pass    |
|              |                 | Low    | -0.13                       | 20          | Pass    |
|              |                 | High   | -4.33                       | 20          | Pass    |
|              | 2437            | Normal | -4.13                       | 20          | Pass    |
|              |                 | Low    | 0.07                        | 20          | Pass    |
|              |                 | High   | -4.13                       | 20          | Pass    |
|              | 2472            | Normal | -4.53                       | 20          | Pass    |
|              |                 | Low    | -0.43                       | 20          | Pass    |
|              |                 | High   | -4.53                       | 20          | Pass    |
| 802.11n HT40 | 2422            | Normal | -3.66                       | 20          | Pass    |
|              |                 | Low    | 0.14                        | 20          | Pass    |
|              |                 | High   | -3.66                       | 20          | Pass    |
|              | 2437            | Normal | -3.86                       | 20          | Pass    |
|              |                 | Low    | 0.24                        | 20          | Pass    |
|              |                 | High   | -3.86                       | 20          | Pass    |
|              | 2462            | Normal | -4.06                       | 20          | Pass    |
|              |                 | Low    | -0.06                       | 20          | Pass    |
|              |                 | High   | -4.06                       | 20          | Pass    |

## **7 Transmitter Spurious Emissions Measurement**

### **7.1. Limit:**

According to AS/NZS 4268:2017, Section 6.2.2

### **7.2. Measurement Equipment Used:**

Refer to section 6.2 of present report.

### **7.3. Test Setup:**

Refer to section 6.3 of present report.

### **7.4. Test Procedure:**

Refer to ETSI EN 300 440-1 V1.6.1, clause 7.3.

### **7.5. Measurement Result:**

Refer to next page for the details.

### 7.5.1. Test Results: (Radiated)

**Model: ESP32M (PCB Ant.)**

**Ambient temperature: 25°C**

**Relative humidity: 65%**

**Test Date: 2021/08/16**

**Test Mode: 802.11b mode (worst case), TX CH Low**

| No | Freq<br>MHz | Reading<br>dBm | Aux<br>dB | Level<br>dBm | Limit<br>dBm | Margin<br>dB | Pol<br>V/H |
|----|-------------|----------------|-----------|--------------|--------------|--------------|------------|
| 1  | 90.14       | -72.53         | 0.59      | -71.94       | -54.00       | -17.94       | VERTICAL   |
| 2  | 251.16      | -75.91         | 4.86      | -71.05       | -54.00       | -17.05       | VERTICAL   |
| 3  | 514.03      | -80.05         | 8.94      | -71.11       | -54.00       | -17.11       | VERTICAL   |
| 4  | 612.00      | -80.61         | 10.62     | -69.99       | -54.00       | -15.99       | VERTICAL   |
| 5  | 766.23      | -81.13         | 13.62     | -67.51       | -54.00       | -13.51       | VERTICAL   |
| 6  | 883.60      | -83.10         | 16.16     | -66.94       | -54.00       | -12.94       | VERTICAL   |
| 7  | 4804.00     | -75.28         | 15.71     | -59.57       | -30.00       | -29.57       | VERTICAL   |
| 8  | 7013.00     | -79.40         | 21.94     | -57.46       | -30.00       | -27.46       | VERTICAL   |
|    |             |                |           |              |              |              |            |
| 1  | 90.14       | -66.00         | 0.70      | -65.30       | -54.00       | -11.30       | HORIZONTAL |
| 2  | 573.20      | -81.13         | 10.61     | -70.52       | -54.00       | -16.52       | HORIZONTAL |
| 3  | 657.59      | -81.39         | 11.79     | -69.60       | -54.00       | -15.60       | HORIZONTAL |
| 4  | 773.02      | -81.36         | 14.22     | -67.14       | -54.00       | -13.14       | HORIZONTAL |
| 5  | 893.30      | -82.38         | 15.64     | -66.74       | -54.00       | -12.74       | HORIZONTAL |
| 6  | 944.71      | -81.68         | 16.91     | -64.77       | -54.00       | -10.77       | HORIZONTAL |
| 7  | 4804.00     | -70.08         | 15.71     | -54.37       | -30.00       | -24.37       | HORIZONTAL |
| 8  | 6278.00     | -78.09         | 19.15     | -58.94       | -30.00       | -28.94       | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

Test Mode: 802.11b mode (worst case), TX CH High

| No | Freq MHz | Reading dBm | Aux dB | Level dBm | Limit dBm | Margin dB | Pol V/H    |
|----|----------|-------------|--------|-----------|-----------|-----------|------------|
| 1  | 96.93    | -65.62      | -0.23  | -65.85    | -54.00    | -11.85    | VERTICAL   |
| 2  | 478.14   | -78.78      | 8.99   | -69.79    | -54.00    | -15.79    | VERTICAL   |
| 3  | 572.23   | -81.79      | 9.47   | -72.32    | -54.00    | -18.32    | VERTICAL   |
| 4  | 653.71   | -80.93      | 12.22  | -68.71    | -54.00    | -14.71    | VERTICAL   |
| 5  | 811.82   | -82.03      | 13.78  | -68.25    | -54.00    | -14.25    | VERTICAL   |
| 6  | 911.73   | -81.76      | 17.00  | -64.76    | -54.00    | -10.76    | VERTICAL   |
| 7  | 2001.00  | -64.13      | 4.63   | -59.50    | -30.00    | -29.50    | VERTICAL   |
| 8  | 4960.00  | -77.57      | 16.40  | -61.17    | -30.00    | -31.17    | VERTICAL   |
|    |          |             |        |           |           |           |            |
| 1  | 106.63   | -73.31      | 1.11   | -72.20    | -54.00    | -18.20    | HORIZONTAL |
| 2  | 282.20   | -74.45      | 3.99   | -70.46    | -54.00    | -16.46    | HORIZONTAL |
| 3  | 399.57   | -78.71      | 6.86   | -71.85    | -54.00    | -17.85    | HORIZONTAL |
| 4  | 577.08   | -82.02      | 10.70  | -71.32    | -54.00    | -17.32    | HORIZONTAL |
| 5  | 677.96   | -82.08      | 12.15  | -69.93    | -54.00    | -15.93    | HORIZONTAL |
| 6  | 796.30   | -82.34      | 14.17  | -68.17    | -54.00    | -14.17    | HORIZONTAL |
| 7  | 4960.00  | -74.05      | 16.40  | -57.65    | -30.00    | -27.65    | HORIZONTAL |
| 8  | 7664.00  | -79.43      | 23.76  | -55.67    | -30.00    | -25.67    | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

**Model: ESP32E (Dipole Ant.)**

**Ambient temperature: 25°C**

**Relative humidity: 65%**

**Test Date: 2021/08/16**

**Test Mode: 802.11b mode (worst case), TX CH Low**

| No | Freq<br>MHz | Reading<br>dBm | Aux<br>dB | Level<br>dBm | Limit<br>dBm | Margin<br>dB | Pol<br>V/H |
|----|-------------|----------------|-----------|--------------|--------------|--------------|------------|
| 1  | 30.00       | -72.01         | 8.27      | -63.74       | -54.00       | -9.74        | VERTICAL   |
| 2  | 96.93       | -66.49         | -0.23     | -66.72       | -54.00       | -12.72       | VERTICAL   |
| 3  | 571.26      | -81.51         | 9.45      | -72.06       | -54.00       | -18.06       | VERTICAL   |
| 4  | 739.07      | -82.47         | 13.75     | -68.72       | -54.00       | -14.72       | VERTICAL   |
| 5  | 809.88      | -82.69         | 13.72     | -68.97       | -54.00       | -14.97       | VERTICAL   |
| 6  | 933.07      | -82.42         | 17.39     | -65.03       | -54.00       | -11.03       | VERTICAL   |
| 7  | 4804.00     | -79.43         | 15.71     | -63.72       | -30.00       | -33.72       | VERTICAL   |
| 8  | 6299.00     | -77.19         | 19.19     | -58.00       | -30.00       | -28.00       | VERTICAL   |
|    |             |                |           |              |              |              |            |
| 1  | 30.97       | -77.33         | 10.48     | -66.85       | -54.00       | -12.85       | HORIZONTAL |
| 2  | 106.63      | -73.57         | 1.11      | -72.46       | -54.00       | -18.46       | HORIZONTAL |
| 3  | 476.20      | -81.68         | 8.39      | -73.29       | -54.00       | -19.29       | HORIZONTAL |
| 4  | 595.51      | -82.70         | 11.13     | -71.57       | -54.00       | -17.57       | HORIZONTAL |
| 5  | 671.17      | -81.68         | 12.03     | -69.65       | -54.00       | -15.65       | HORIZONTAL |
| 6  | 741.98      | -82.65         | 14.01     | -68.64       | -54.00       | -14.64       | HORIZONTAL |
| 7  | 4804.00     | -79.18         | 15.63     | -63.55       | -30.00       | -33.55       | HORIZONTAL |
| 8  | 6481.00     | -78.67         | 23.69     | -54.98       | -30.00       | -24.98       | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.



Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

Test Mode: 802.11b mode (worst case), TX CH High

| No | Freq MHz | Reading dBm | Aux dB | Level dBm | Limit dBm | Margin dB | Pol V/H    |
|----|----------|-------------|--------|-----------|-----------|-----------|------------|
| 1  | 90.14    | -66.05      | 0.59   | -65.46    | -54.00    | -11.46    | VERTICAL   |
| 2  | 205.57   | -73.07      | 1.98   | -71.09    | -54.00    | -17.09    | VERTICAL   |
| 3  | 528.58   | -81.98      | 8.93   | -73.05    | -54.00    | -19.05    | VERTICAL   |
| 4  | 640.13   | -82.24      | 11.71  | -70.53    | -54.00    | -16.53    | VERTICAL   |
| 5  | 718.70   | -82.14      | 13.82  | -68.32    | -54.00    | -14.32    | VERTICAL   |
| 6  | 833.16   | -81.10      | 14.39  | -66.71    | -54.00    | -12.71    | VERTICAL   |
| 7  | 4960.00  | -76.22      | 16.40  | -59.82    | -30.00    | -29.82    | VERTICAL   |
| 8  | 7545.00  | -79.24      | 23.35  | -55.89    | -30.00    | -25.89    | VERTICAL   |
|    |          |             |        |           |           |           |            |
| 1  | 70.74    | -75.08      | 4.38   | -70.70    | -54.00    | -16.70    | HORIZONTAL |
| 2  | 200.72   | -72.47      | 1.28   | -71.19    | -54.00    | -17.19    | HORIZONTAL |
| 3  | 480.08   | -80.38      | 8.39   | -71.99    | -54.00    | -17.99    | HORIZONTAL |
| 4  | 583.87   | -82.05      | 10.86  | -71.19    | -54.00    | -17.19    | HORIZONTAL |
| 5  | 679.90   | -81.56      | 12.18  | -69.38    | -54.00    | -15.38    | HORIZONTAL |
| 6  | 784.66   | -81.78      | 14.20  | -67.58    | -54.00    | -13.58    | HORIZONTAL |
| 7  | 4960.00  | -78.64      | 16.15  | -62.49    | -30.00    | -32.49    | HORIZONTAL |
| 8  | 6404.00  | -77.97      | 22.98  | -54.99    | -30.00    | -24.99    | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

## **8 Emission Bandwidth Measurement**

### **8.1. Limit:**

99% power emission bandwidth shall within 2400MHz and 2483.5MHz.  
According to AS/NZS 4268:2017, section 6.5.

### **8.2. Measurement Equipment Used:**

Refer to section 6.2 of present report.

### **8.3. Test Setup:**

Refer to section 6.3 of present report.

### **8.4. Test Procedure:**

Refer to section 6.5 of AS/NZS 4268 for the details.

## 8.5. Measurement Result:

Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

802.11b

| Channel      | Measured Frequency (MHz) | Limit (MHz) |
|--------------|--------------------------|-------------|
| Channel Low  | 2405.45                  | >2400       |
| Channel High | 2468.74                  | <2483.5     |

802.11g

| Channel      | Measured Frequency (MHz) | Limit (MHz) |
|--------------|--------------------------|-------------|
| Channel Low  | 2403.42                  | >2400       |
| Channel High | 2470.48                  | <2483.5     |

802.11n 20M

| Channel      | Measured Frequency (MHz) | Limit (MHz) |
|--------------|--------------------------|-------------|
| Channel Low  | 2403.232                 | >2400       |
| Channel High | 2480.711                 | <2483.5     |

802.11n 40M

| Channel      | Measured Frequency (MHz) | Limit (MHz) |
|--------------|--------------------------|-------------|
| Channel Low  | 2404.406                 | >2400       |
| Channel High | 2480.075                 | <2483.5     |

## **9 Operating Frequencies Measurement**

### **9.1. Limit:**

2400MHz and 2483.5MHz.

According to AS/NZS 4268:2017 section 6.6.

### **9.2. Measurement Equipment Used:**

Refer to section 6.2 of present report.

### **9.3. Test Setup:**

Refer to section 6.3 of present report.

### **9.4. Test Procedure:**

Refer to ETSI EN 300 440-1 V1.6.1, clause 7.2.2 and 7.2.3.

Refer to ETSI EN 300 328 V2.1.1, clause 4.3.2.7

### 9.5. Measurement Result:

Ambient temperature: 20°C

Relative humidity: 66%

Test Date: 2021/08/16

#### Test Mode: 802.11b

|                                  |       |     |
|----------------------------------|-------|-----|
| antenna assembly gain "G" in dBi | 2.22  | dBi |
| beamforming gain "Y" in dB       | 0.00  | dB  |
| Cable Loss=                      | 21.00 | dB  |

| TEST CONDITIONS                           |                  |      |   | FREQUENCY (MHz)                 |                                 |
|---|------------------|------|---|---------------------------------|---------------------------------|
|   |                  |      |   | Lowest                          | Highest                         |
| Temp -40 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0000                      | 24720.0100                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0100                      | 24720.0300                      |
| Temp 25 °C                                | V <sub>nom</sub> | 5.00 | V | 24120.0000                      | 24720.0200                      |
| Temp 105 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0100                      | 24720.0200                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0000                      | 24720.0000                      |
| Measured frequencies (lowest and highest) |                  |      |   | f <sub>L</sub> = 24120.0000 MHz | f <sub>H</sub> = 24720.0300 MHz |
| Limit                                     |                  |      |   | 2400.0000 MHz                   | 2483.5000 MHz                   |
| Measurement Uncertainty                   |                  |      |   | +/- 120kHz                      |                                 |

#### Test Mode: 802.11g

|                                  |       |     |
|----------------------------------|-------|-----|
| antenna assembly gain "G" in dBi | 2.22  | dBi |
| beamforming gain "Y" in dB       | 0.00  | dB  |
| Cable Loss=                      | 21.00 | dB  |

| TEST CONDITIONS                           |                  |      |   | FREQUENCY (MHz)                 |                                 |
|---|------------------|------|---|---------------------------------|---------------------------------|
|   |                  |      |   | Lowest                          | Highest                         |
| Temp -40 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0000                      | 24720.0100                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0100                      | 24720.0000                      |
| Temp 25 °C                                | V <sub>nom</sub> | 5.00 | V | 24120.0200                      | 24720.0300                      |
| Temp 105 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0200                      | 24720.0000                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0200                      | 24720.0000                      |
| Measured frequencies (lowest and highest) |                  |      |   | f <sub>L</sub> = 24120.0000 MHz | f <sub>H</sub> = 24720.0300 MHz |
| Limit                                     |                  |      |   | 2400.0000 MHz                   | 2483.5000 MHz                   |
| Measurement Uncertainty                   |                  |      |   | +/- 120kHz                      |                                 |

**Test Mode: 802.11n HT20**

|                                  |       |     |
|----------------------------------|-------|-----|
| antenna assembly gain "G" in dBi | 2.22  | dBi |
| beamforming gain "Y" in dB       | 0.00  | dB  |
| Cable Loss=                      | 21.00 | dB  |

| TEST CONDITIONS                           |                  |      |   | FREQUENCY (MHz)                 |                                 |
|---|------------------|------|---|---------------------------------|---------------------------------|
|   |                  |      |   | Lowest                          | Highest                         |
| Temp -40 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0000                      | 24720.0300                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0200                      | 24720.0200                      |
| Temp 25 °C                                | V <sub>nom</sub> | 5.00 | V | 24120.0100                      | 24720.0200                      |
| Temp 105 °C                               | V <sub>min</sub> | 4.50 | V | 24120.0100                      | 24720.0000                      |
|   | V <sub>max</sub> | 5.50 | V | 24120.0000                      | 24720.0200                      |
| Measured frequencies (lowest and highest) |                  |      |   | f <sub>L</sub> = 24120.0000 MHz | f <sub>H</sub> = 24720.0300 MHz |
| Limit                                     |                  |      |   | 2400.0000 MHz                   | 2483.5000 MHz                   |
| Measurement Uncertainty                   |                  |      |   | +/- 120kHz                      |                                 |

**Test Mode: 802.11n HT40**

|                                  |       |     |
|----------------------------------|-------|-----|
| antenna assembly gain "G" in dBi | 2.22  | dBi |
| beamforming gain "Y" in dB       | 0.00  | dB  |
| Cable Loss=                      | 21.00 | dB  |

| TEST CONDITIONS                           |                  |      |   | FREQUENCY (MHz)                 |                                 |
|---|------------------|------|---|---------------------------------|---------------------------------|
|   |                  |      |   | Lowest                          | Highest                         |
| Temp -40 °C                               | V <sub>min</sub> | 4.50 | V | 24220.0000                      | 24620.0000                      |
|   | V <sub>max</sub> | 5.50 | V | 24220.0000                      | 24620.0300                      |
| Temp 25 °C                                | V <sub>nom</sub> | 5.00 | V | 24220.0300                      | 24620.0300                      |
| Temp 105 °C                               | V <sub>min</sub> | 4.50 | V | 24220.0100                      | 24620.0300                      |
|   | V <sub>max</sub> | 5.50 | V | 24220.0200                      | 24620.0000                      |
| Measured frequencies (lowest and highest) |                  |      |   | f <sub>L</sub> = 24120.0000 MHz | f <sub>H</sub> = 24720.0300 MHz |
| Limit                                     |                  |      |   | 2400.0000 MHz                   | 2483.5000 MHz                   |
| Measurement Uncertainty                   |                  |      |   | +/- 120kHz                      |                                 |

## **10 Receiver Emissions Measurement**

### **10.1. Limit:**

According to section 7.2 of AS/NZS 4268:2017  
25MHz to 1 GHz 2 nW ERP (-57 dBm).  
1GHz to 40 GHz 20 nW ERP (-47 dBm).

### **10.2. Measurement Equipment Used:**

Refer to section 6.2 of present report.

### **10.3. Test Setup:**

Refer to section 6.3 of present report.

### **10.4. Test Procedure:**

Refer to ETSI EN 300 440-1 V1.6.1, clause 8.4.

## 10.5. Measurement Result:

**Model: ESP32M (PCB Ant.)**

**Ambient temperature: 25°C**

**Relative humidity: 65%**

**Test Date: 2021/08/16**

**Test Mode: 802.11b mode (worst case), RX CH Low**

| No | Freq<br>MHz | Reading<br>dBm | Aux<br>dB | Level<br>dBm | Limit<br>dBm | Margin<br>dB | Pol<br>V/H |
|----|-------------|----------------|-----------|--------------|--------------|--------------|------------|
| 1  | 30.97       | -72.10         | 7.94      | -64.16       | -57.00       | -7.16        | VERTICAL   |
| 2  | 90.14       | -67.38         | 0.59      | -66.79       | -57.00       | -9.79        | VERTICAL   |
| 3  | 201.69      | -72.77         | 1.69      | -71.08       | -57.00       | -14.08       | VERTICAL   |
| 4  | 469.41      | -78.90         | 9.01      | -69.89       | -57.00       | -12.89       | VERTICAL   |
| 5  | 673.11      | -82.81         | 12.93     | -69.88       | -57.00       | -12.88       | VERTICAL   |
| 6  | 772.05      | -82.05         | 13.58     | -68.47       | -57.00       | -11.47       | VERTICAL   |
| 7  | 4955.00     | -75.44         | 16.38     | -59.06       | -47.00       | -12.06       | VERTICAL   |
| 8  | 6999.00     | -78.71         | 21.91     | -56.80       | -47.00       | -9.80        | VERTICAL   |
|    |             |                |           |              |              |              |            |
| 1  | 31.94       | -76.39         | 7.61      | -68.78       | -57.00       | -11.78       | HORIZONTAL |
| 2  | 144.46      | -78.95         | 5.57      | -73.38       | -57.00       | -16.38       | HORIZONTAL |
| 3  | 246.31      | -73.81         | 4.66      | -69.15       | -57.00       | -12.15       | HORIZONTAL |
| 4  | 381.14      | -80.47         | 5.91      | -74.56       | -57.00       | -17.56       | HORIZONTAL |
| 5  | 547.01      | -81.51         | 8.91      | -72.60       | -57.00       | -15.60       | HORIZONTAL |
| 6  | 767.20      | -82.72         | 13.61     | -69.11       | -57.00       | -12.11       | HORIZONTAL |
| 7  | 2008.00     | -70.75         | 4.81      | -65.94       | -47.00       | -18.94       | HORIZONTAL |
| 8  | 4955.00     | -74.67         | 16.13     | -58.54       | -47.00       | -11.54       | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

### Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.



Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

Test Mode: 802.11b mode (worst case), RX CH High

| No | Freq MHz | Reading dBm | Aux dB | Level dBm | Limit dBm | Margin dB | Pol V/H    |
|----|----------|-------------|--------|-----------|-----------|-----------|------------|
| 1  | 30.97    | -71.68      | 7.94   | -63.74    | -57.00    | -6.74     | VERTICAL   |
| 2  | 90.14    | -67.18      | 0.59   | -66.59    | -57.00    | -9.59     | VERTICAL   |
| 3  | 184.23   | -73.82      | 2.89   | -70.93    | -57.00    | -13.93    | VERTICAL   |
| 4  | 316.15   | -78.01      | 4.68   | -73.33    | -57.00    | -16.33    | VERTICAL   |
| 5  | 422.85   | -77.07      | 7.52   | -69.55    | -57.00    | -12.55    | VERTICAL   |
| 6  | 630.43   | -82.06      | 11.34  | -70.72    | -57.00    | -13.72    | VERTICAL   |
| 7  | 1994.00  | -66.06      | 4.60   | -61.46    | -47.00    | -14.46    | VERTICAL   |
| 8  | 4955.00  | -77.51      | 16.38  | -61.13    | -47.00    | -14.13    | VERTICAL   |
|    |          |             |        |           |           |           |            |
| 1  | 30.00    | -76.68      | 10.91  | -65.77    | -57.00    | -8.77     | HORIZONTAL |
| 2  | 90.14    | -72.92      | 0.70   | -72.22    | -57.00    | -15.22    | HORIZONTAL |
| 3  | 167.74   | -75.58      | 3.25   | -72.33    | -57.00    | -15.33    | HORIZONTAL |
| 4  | 251.16   | -75.20      | 4.59   | -70.61    | -57.00    | -13.61    | HORIZONTAL |
| 5  | 516.94   | -81.06      | 8.99   | -72.07    | -57.00    | -15.07    | HORIZONTAL |
| 6  | 833.16   | -80.65      | 14.70  | -65.95    | -57.00    | -8.95     | HORIZONTAL |
| 7  | 1931.00  | -71.02      | 4.48   | -66.54    | -47.00    | -19.54    | HORIZONTAL |
| 8  | 4955.00  | -73.83      | 16.13  | -57.70    | -47.00    | -10.70    | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

**Model: ESP32E (Dipole Ant.)**

**Ambient temperature: 25°C**

**Relative humidity: 65%**

**Test Date: 2021/08/16**

**Test Mode: 802.11b mode (worst case), RX CH Low**

| No | Freq<br>MHz | Reading<br>dBm | Aux<br>dB | Level<br>dBm | Limit<br>dBm | Margin<br>dB | Pol<br>V/H |
|----|-------------|----------------|-----------|--------------|--------------|--------------|------------|
| 1  | 30.97       | -72.32         | 7.94      | -64.38       | -57.00       | -7.38        | VERTICAL   |
| 2  | 90.14       | -68.37         | 0.59      | -67.78       | -57.00       | -10.78       | VERTICAL   |
| 3  | 226.91      | -73.07         | 3.44      | -69.63       | -57.00       | -12.63       | VERTICAL   |
| 4  | 422.85      | -78.51         | 7.52      | -70.99       | -57.00       | -13.99       | VERTICAL   |
| 5  | 588.72      | -80.77         | 9.87      | -70.90       | -57.00       | -13.90       | VERTICAL   |
| 6  | 751.68      | -80.53         | 13.70     | -66.83       | -57.00       | -9.83        | VERTICAL   |
| 7  | 3268.00     | -72.77         | 8.41      | -64.36       | -47.00       | -17.36       | VERTICAL   |
| 8  | 7160.00     | -78.69         | 22.33     | -56.36       | -47.00       | -9.36        | VERTICAL   |
|    |             |                |           |              |              |              |            |
| 1  | 30.97       | -75.95         | 10.48     | -65.47       | -57.00       | -8.47        | HORIZONTAL |
| 2  | 106.63      | -73.37         | 1.11      | -72.26       | -57.00       | -15.26       | HORIZONTAL |
| 3  | 167.74      | -73.46         | 3.25      | -70.21       | -57.00       | -13.21       | HORIZONTAL |
| 4  | 372.41      | -79.52         | 5.98      | -73.54       | -57.00       | -16.54       | HORIZONTAL |
| 5  | 532.46      | -81.38         | 9.49      | -71.89       | -57.00       | -14.89       | HORIZONTAL |
| 6  | 705.12      | -81.71         | 12.71     | -69.00       | -57.00       | -12.00       | HORIZONTAL |
| 7  | 4955.00     | -74.29         | 16.13     | -58.16       | -47.00       | -11.16       | HORIZONTAL |
| 8  | 7034.00     | -79.44         | 23.55     | -55.89       | -47.00       | -8.89        | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

**Remark:**

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

Ambient temperature: 25°C

Relative humidity: 65%

Test Date: 2021/08/16

Test Mode: 802.11b mode (worst case), RX CH High

| No | Freq MHz | Reading dBm | Aux dB | Level dBm | Limit dBm | Margin dB | Pol V/H    |
|----|----------|-------------|--------|-----------|-----------|-----------|------------|
| 1  | 30.97    | -73.45      | 7.94   | -65.51    | -57.00    | -8.51     | VERTICAL   |
| 2  | 90.14    | -66.31      | 0.59   | -65.72    | -57.00    | -8.72     | VERTICAL   |
| 3  | 154.16   | -79.06      | 5.76   | -73.30    | -57.00    | -16.30    | VERTICAL   |
| 4  | 399.57   | -79.08      | 6.14   | -72.94    | -57.00    | -15.94    | VERTICAL   |
| 5  | 512.09   | -81.36      | 8.94   | -72.42    | -57.00    | -15.42    | VERTICAL   |
| 6  | 741.98   | -82.48      | 13.74  | -68.74    | -57.00    | -11.74    | VERTICAL   |
| 7  | 4955.00  | -75.02      | 16.38  | -58.64    | -47.00    | -11.64    | VERTICAL   |
| 8  | 7503.00  | -80.15      | 23.20  | -56.95    | -47.00    | -9.95     | VERTICAL   |
|    |          |             |        |           |           |           |            |
| 1  | 30.00    | -76.53      | 10.91  | -65.62    | -57.00    | -8.62     | HORIZONTAL |
| 2  | 106.63   | -72.56      | 1.11   | -71.45    | -57.00    | -14.45    | HORIZONTAL |
| 3  | 246.31   | -75.14      | 4.38   | -70.76    | -57.00    | -13.76    | HORIZONTAL |
| 4  | 399.57   | -79.66      | 6.86   | -72.80    | -57.00    | -15.80    | HORIZONTAL |
| 5  | 567.38   | -81.50      | 10.47  | -71.03    | -57.00    | -14.03    | HORIZONTAL |
| 6  | 754.59   | -81.75      | 14.27  | -67.48    | -57.00    | -10.48    | HORIZONTAL |
| 7  | 4955.00  | -74.19      | 16.13  | -58.06    | -47.00    | -11.06    | HORIZONTAL |
| 8  | 6670.00  | -79.31      | 23.76  | -55.55    | -47.00    | -8.55     | HORIZONTAL |

|                         |                        |
|-------------------------|------------------------|
| Measurement uncertainty | 30MHz - 80MHz: 5.04dB  |
|                         | 80MHz -1000MHz: 3.76dB |
|                         | 1GHz - 26GHz: 4.45dB   |

Remark:

1. The emission behaviors belong to narrowband spurious emission.
2. Remark " --- " means that the emission level is too low to be measured
3. Aux: Field strength to EIRP correction factor
4. Level (dBm) = Reading (dBm) + Aux (dB)
5. Measurement Range upto 26GHz.

## **11 Radiated Peak Power Spectral Density Measurement**

### **11.1. Limit:**

According to AS/NZS 4268:2017, Table 1, Note 2.

The radiated peak power spectral density in any 3kHz is limited to 25mW per 3kHz.

### **11.2. Measurement Equipment Used:**

Refer to section 6.2.

### **11.3. Test Setup:**

Refer to section 6.3.

### **11.4. Test Procedure:**

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW = 3kHz, VBW = 10kHz, Span = 1.5MHz, Sweep=100s, Record the max. reading.
4. Repeat above procedures until all frequency measured were complete.

## 11.5. Measurement Result:

### 802.11b Mode

| Channel | Power Density Reading (dBm) | Maximum Limit (dBm) |
|---------|-----------------------------|---------------------|
| Low     | 7.72                        | 13.97               |
| Mid     | 7.41                        | 13.97               |
| High    | 7.26                        | 13.97               |

### 802.11g Mode

| Channel | Power Density Reading (dBm) | Maximum Limit (dBm) |
|---------|-----------------------------|---------------------|
| Low     | 7.73                        | 13.97               |
| Mid     | 7.21                        | 13.97               |
| High    | 5.46                        | 13.97               |

### 802.11n HT20 Mode

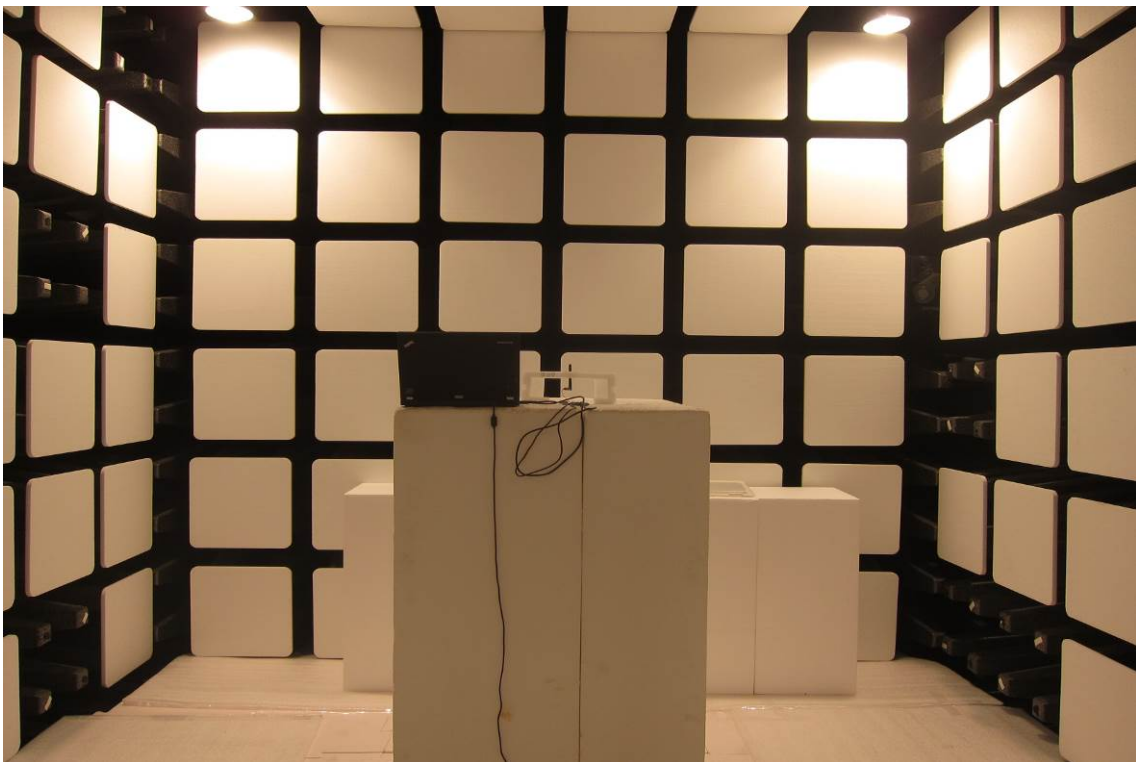
| Channel | Power Density Reading (dBm) | Maximum Limit (dBm) |
|---------|-----------------------------|---------------------|
| Low     | 7.74                        | 13.97               |
| Mid     | 7.19                        | 13.97               |
| High    | 5.51                        | 13.97               |

### 802.11n HT40 Mode

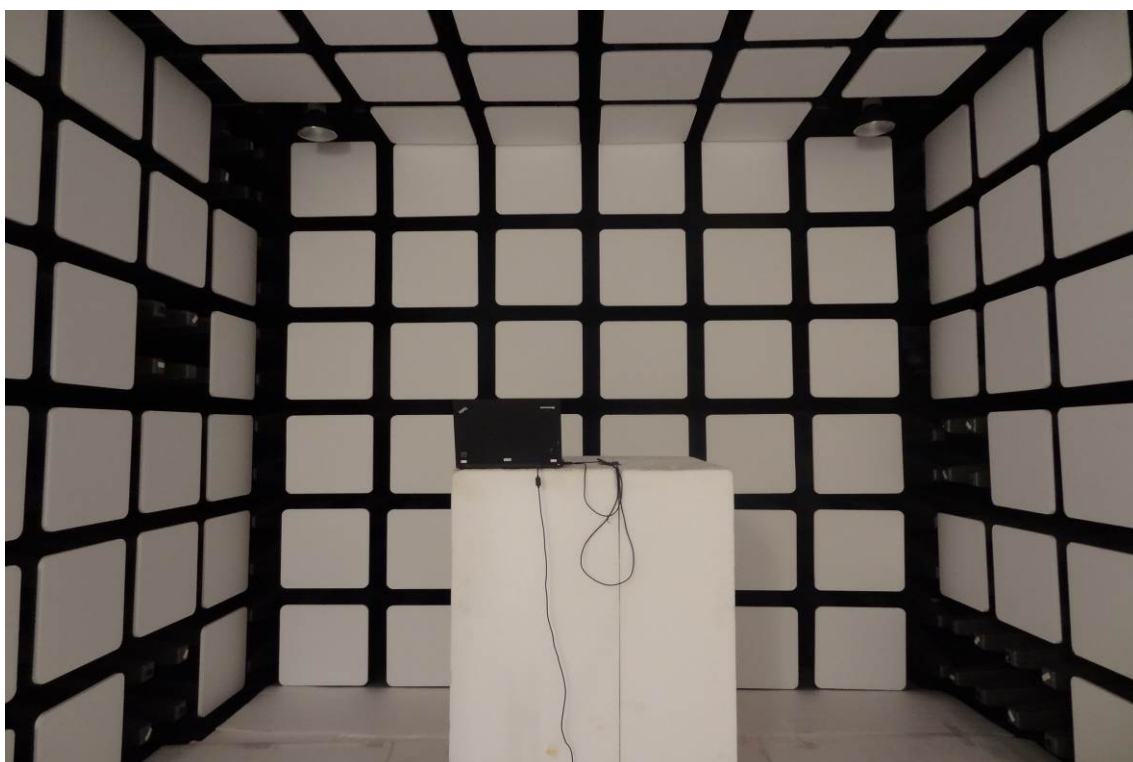
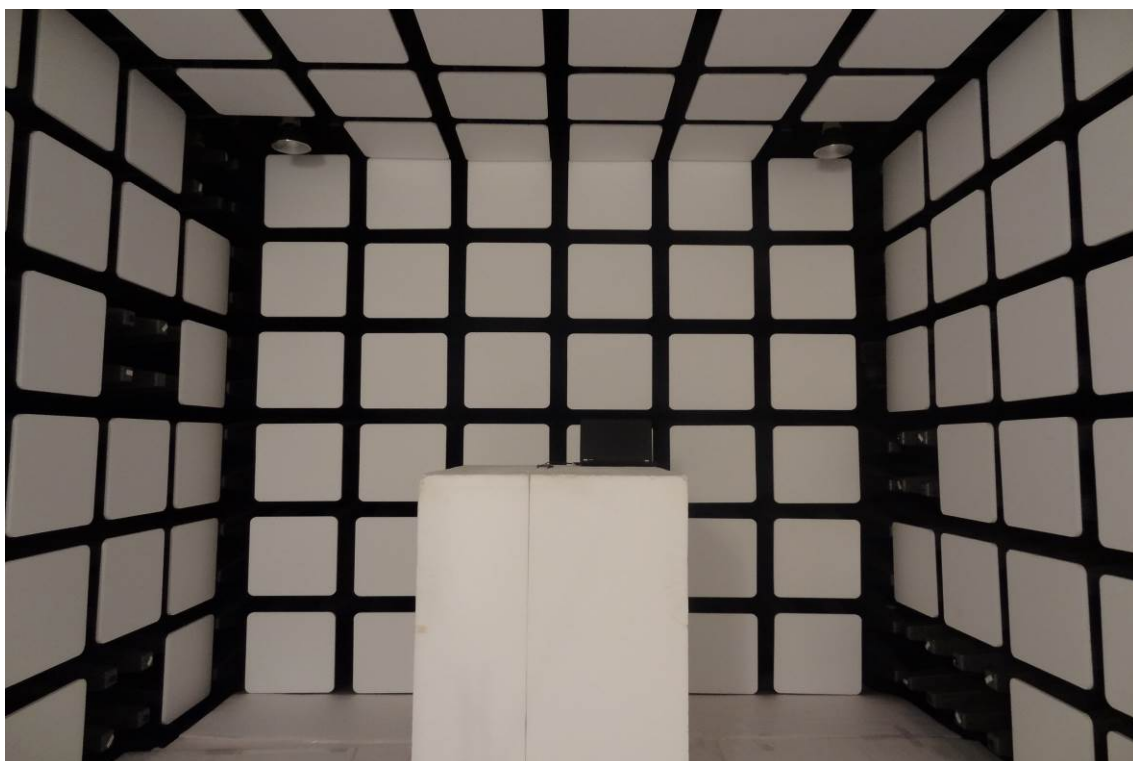
| Channel | Power Density Reading (dBm) | Maximum Limit (dBm) |
|---------|-----------------------------|---------------------|
| Low     | 5.51                        | 13.97               |
| Mid     | 5.15                        | 13.97               |
| High    | 3.98                        | 13.97               |

## 12 Appendix B: Photographs of Setup

**Dipole Ant**



**PCB Ant**



## **13 Appendix C: Photographs of EUT**

Please refer to the File of **ISL-20LR045P**

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