

Hangzhou Tuya Information Technology Co.,Ltd

RF TEST REPORT

Report Type:

FCC Part 15.247 RF report

Model:

CBU-IPEX

REPORT NUMBER:

221101130SHA-001

ISSUE DATE:

August 18, 2023

DOCUMENT CONTROL NUMBER:

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Applicant: Hangzhou Tuya Information Technology Co.,Ltd
Room701, Building 3, More Center, No.87 GuDun Road, Hangzhou,
Zhejiang, China

Manufacturer: Hangzhou Tuya Information Technology Co.,Ltd
Room701, Building 3, More Center, No.87 GuDun Road, Hangzhou,
Zhejiang, China

FCC ID: 2ANDL-CBU-IPEX

SUMMARY:

The equipment complies with the requirements according to the following standard(s) or Specification:

47CFR Part 15 (2021): Radio Frequency Devices (Subpart C)

ANSI C63.10 (2020): American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

PREPARED BY:



Project Engineer
Erick Liu

REVIEWED BY:



Reviewer
Wakeyou Wang

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Revision History

| Report No. | Version | Description | Issued Date |
|------------------|---------|-------------------------|-----------------|
| 221101130SHA-001 | Rev. 01 | Initial issue of report | August 18, 2023 |
| | | | |
| | | | |

Measurement result summary

| TEST ITEM | FCC REFERANCE | IC REFERANCE | RESULT |
|--|-----------------------------|------------------------------------|--------|
| Minimum 6dB Bandwidth | 15.247(a)(2) | RSS-247 Issue 2 Clause 5.2 | NT |
| Maximum conducted output power and e.i.r.p. | 15.247(b)(3) | RSS-247 Issue 2 Clause 5.4 | NT |
| Power spectrum density | 15.247(e) | RSS-247 Issue 2 Clause 5.2 | NT |
| Emission outside the frequency band | 15.247(d) | RSS-247 Issue 2 Clause 5.5 | NT |
| Radiated Emissions in restricted frequency bands | 15.247(d), 15.205&15.209 | RSS-Gen Issue 5 Clause 8.9&8.10 | Pass |
| Power line conducted emission | 15.207(a) | RSS-Gen Issue 5 Clause 8.8 | NT |
| Occupied bandwidth | - | RSS-Gen Issue 5 Clause 6.6 | NT |
| Antenna requirement | 15.203 | - | Pass |

Notes: 1: NA =Not Applicable

2: Determination of the test conclusion is based on IEC Guide 115 in consideration of measurement uncertainty.

3: Additions, Deviations and Exclusions from Standards: None.

1 GENERAL INFORMATION

1.1 Description of Equipment Under Test (EUT)

| | |
|-----------------------|---|
| Product name: | Wi-Fi and Bluetooth module |
| Type/Model: | CBU-IPEX |
| Description of EUT: | The product covered by this report is a wireless module which has WiFi and BLE function, it has only one model. This is C2PC report, only an external antenna model has been added, after evaluation, we performed Radiated Emissions test for the EUT. |
| Rating: | DC 3.0-3.6V |
| EUT type: | <input checked="" type="checkbox"/> Table top <input type="checkbox"/> Floor standing |
| Software Version: | / |
| Hardware Version: | / |
| Sample received date: | December 1, 2022 |
| Date of test: | December 1, 2022 ~ December 29, 2022 |

1.2 Technical Specification

| | |
|---------------------|---|
| Frequency Range: | 2400MHz ~ 2483.5MHz |
| Support Standards: | IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40 |
| Type of Modulation: | IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK) IEEE 802.11g: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT20: OFDM (64-QAM, 16-QAM, QPSK, BPSK) IEEE 802.11n-HT40: OFDM (64-QAM, 16-QAM, QPSK, BPSK) |
| Channel Number: | 11 Channels for 802.11b, 802.11g and 802.11n(HT20) 9 Channels for 802.11n(HT40) |
| Data Rate: | IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n-HT20: Up to MCS7 IEEE 802.11n-HT40: Up to MCS7 |
| Channel Separation: | 5 MHz |

| | |
|---------------------|---------------------|
| Frequency Band: | 2400MHz ~ 2483.5MHz |
| Bluetooth Version: | Bluetooth LE |
| Type of Modulation: | GFSK |
| Channel Number: | 40 |
| Data Rate: | 1 Mbps |
| Channel Separation: | 2 MHz |

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1.3 Antenna information

| Antenna information: | | | |
|----------------------|------------------|---------|------|
| No. | Antenna Type | Gain | Note |
| 1 | External antenna | 1.87dBi | - |

| Mode | Tx/Rx Function | Beamforming function | CDD function |
|---------------|----------------|----------------------|--------------|
| 802.11b | 1Tx/1Rx | NO | NO |
| 802.11g | 1Tx/1Rx | NO | NO |
| 802.11n(HT20) | 1Tx/1Rx | NO | NO |
| 802.11n(HT40) | 1Tx/1Rx | NO | NO |

1.4 Description of Test Facility

| | |
|------------|---|
| Name: | Intertek Testing Services Shanghai |
| Address: | Building 86, No. 1198 Qinzhou Road (North), Shanghai 200233, P.R. China |
| Telephone: | 86 21 61278200 |
| Telefax: | 86 21 54262353 |

| | |
|---|---|
| The test facility is recognized, certified, or accredited by these organizations: | CNAS Accreditation Lab Registration No. CNAS L0139 |
| | FCC Accredited Lab Designation Number: CN0175 |
| | IC Registration Lab CAB identifier.: CN0014 |
| | VCCI Registration Lab Registration No.: R-14243, G-10845, C-14723, T-12252 |
| | A2LA Accreditation Lab Certificate Number: 3309.02 |

TEST REPORT

2 TEST SPECIFICATIONS

2.1 Standards or specification

47CFR Part 15 (2021)
ANSI C63.10 (2020)
KDB 558074(v05r02)

2.2 Mode of operation during the test

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

| Software name | Manufacturer | Version | Supplied by |
|-----------------------|--------------|---------|-------------|
| Beken Wi-Fi Test Tool | / | V1.6.0 | Applicant |

The lowest, middle and highest channel were tested as representatives.

| Frequency Band (MHz) | Mode | Lowest (MHz) | Middle (MHz) | Highest (MHz) | Power Setting |
|----------------------|---------------|--------------|--------------|---------------|---------------|
| 2400-2483.5 | 802.11b | 2412 | 2437 | 2462 | Auto |
| | 802.11g | 2412 | 2437 | 2462 | Auto |
| | 802.11n(HT20) | 2412 | 2437 | 2462 | Auto |
| | 802.11n(HT40) | 2422 | 2437 | 2452 | Auto |
| | BLE | 2402 | 2440 | 2480 | Auto |

Data rate VS Power:

The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases. After this pre-scan, we choose the following table of the data rate as the worst case.

| Frequency Band (MHz) | Mode | Worst case data rate |
|----------------------|---------------|----------------------|
| 2400-2483.5 | 802.11b | 1Mbps |
| | 802.11g | 6Mbps |
| | 802.11n(HT20) | MCS0 |
| | 802.11n(HT40) | MCS0 |

The EUT will use two types antenna, and there have the following test mode:

Radiated test mode:

Mode 1: EUT transmitted signal with internal antenna;

Conducted test mode:

Mode 2: EUT transmitted signal from PCBA RF port connected to SPA directly;

We have verified all test modes, and choose the worst mode 1 for radiated test and mode 2 for conducted test as representatively to list the results in this report.

TEST REPORT

2.3 Test software list

| Test Items | Software | Manufacturer | Version |
|--------------------|----------|--------------|-------------|
| Conducted emission | e3 | Audix | 9 20151119i |
| Radiated emission | e3 | Audix | 9.160323 |

2.4 Test peripherals list

| Item No. | Name | Band and Model | Description |
|----------|-----------------|----------------|-------------------------|
| 1 | Laptop computer | DELL 5480 | - |
| 2 | RF cable | / | 0.2m length; 0.5dB loss |

2.5 Test environment condition:

| Test items | Temperature | Humidity |
|--|-------------|----------|
| Radiated Emissions in restricted frequency bands | 24.7°C | 52%RH |

2.6 Instrument list

| Radiated Emission | | | | | |
|-------------------------------------|--------------------------|-------------------|------------------------|--------------|------------|
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| <input checked="" type="checkbox"/> | Test Receiver | R&S | ESIB 26 | EC 3045 | 2024-07-18 |
| <input checked="" type="checkbox"/> | Test Receiver | R&S | ESR | EC6501 | 2023-09-05 |
| <input checked="" type="checkbox"/> | Bilog Antenna | TESEQ | CBL 6112B | EC 6411 | 2024-08-23 |
| <input type="checkbox"/> | TRILOG broadband Antenna | Schwarzbeck | VULB9168 | EC 6402 | 2024-01-16 |
| <input checked="" type="checkbox"/> | Pre-amplifier | R&S | AFS42-00101800-25-S-42 | EC 5262 | 2024-06-04 |
| <input type="checkbox"/> | Pre-amplifier | Tonscend | tap01018050 | EC 6432-1 | 2023-12-07 |
| <input type="checkbox"/> | Horn antenna | Tonscend | bha9120d | EC 6432-2 | 2024-01-08 |
| <input checked="" type="checkbox"/> | Horn antenna | ETS | 3117 | EC 4792-1 | 2024-08-28 |
| <input type="checkbox"/> | Horn antenna | TOYO | HAP18-26W | EC 4792-3 | 2024-07-29 |
| <input checked="" type="checkbox"/> | Active loop antenna | Schwarzbeck | FMZB1519 | EC 5345 | 2024-06-15 |
| <input type="checkbox"/> | Horn antenna | ETS | 3116c | EC 5955 | 2024-06-17 |
| Tet Site | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| <input checked="" type="checkbox"/> | Semi-anechoic chamber | Albatross project | - | EC 3048 | 2024-07-08 |
| Additional instrument | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| <input checked="" type="checkbox"/> | Thermo-Hygrograph | ZJ1-2A | S.M.I.F. | EC 3442 | 2024-01-02 |
| Test software | | | | | |
| Used | Test project | Software name | | Version | |
| <input checked="" type="checkbox"/> | RE | EMC-I | | V1.3.0.2 | |

TEST REPORT**2.7 Measurement uncertainty**

The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Test item | Measurement uncertainty |
|---|--------------------------------|
| Radiated Emissions in restricted frequency bands below 1GHz | $\pm 4.90\text{dB}$ |
| Radiated Emissions in restricted frequency bands above 1GHz | $\pm 5.02\text{dB}$ |

3 Radiated Emissions in restricted frequency bands

Test result: Pass

3.1 Limit

The radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified showed as below:

| Frequencies (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|-------------------|-----------------------------------|-------------------------------|
| 0.009 ~ 0.490 | 2400/F(kHz) | 300 |
| 0.490 ~ 1.705 | 24000/F(kHz) | 30 |
| 1.705 ~ 30.0 | 30 | 30 |
| 30 ~ 88 | 100 | 3 |
| 88 ~ 216 | 150 | 3 |
| 216 ~ 960 | 200 | 3 |
| Above 960 | 500 | 3 |

3.2 Measurement Procedure

For Radiated emission below 30MHz:

- a) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c) Both X and Y axes of the antenna are set to make the measurement.
- d) For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e) The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

TEST REPORT**For Radiated emission above 30MHz:**

- a) The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c) The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e) The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f) The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

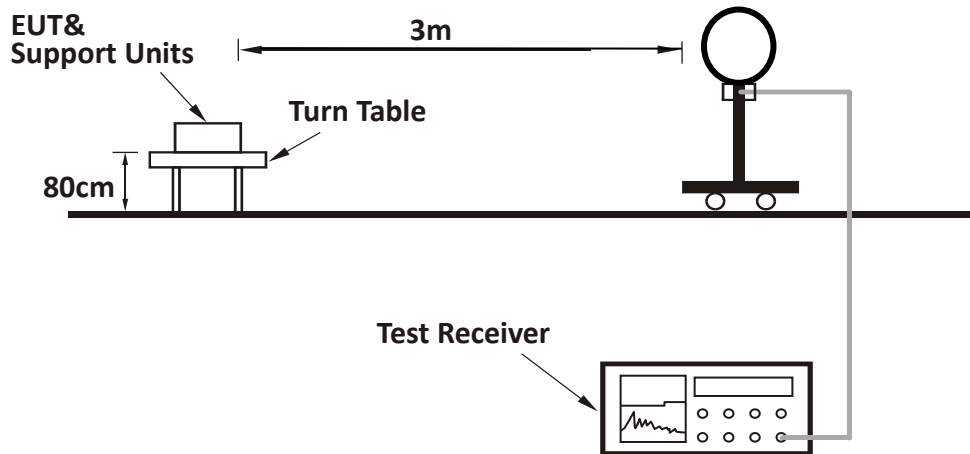
Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or $3 \times \text{RBW}$ (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported

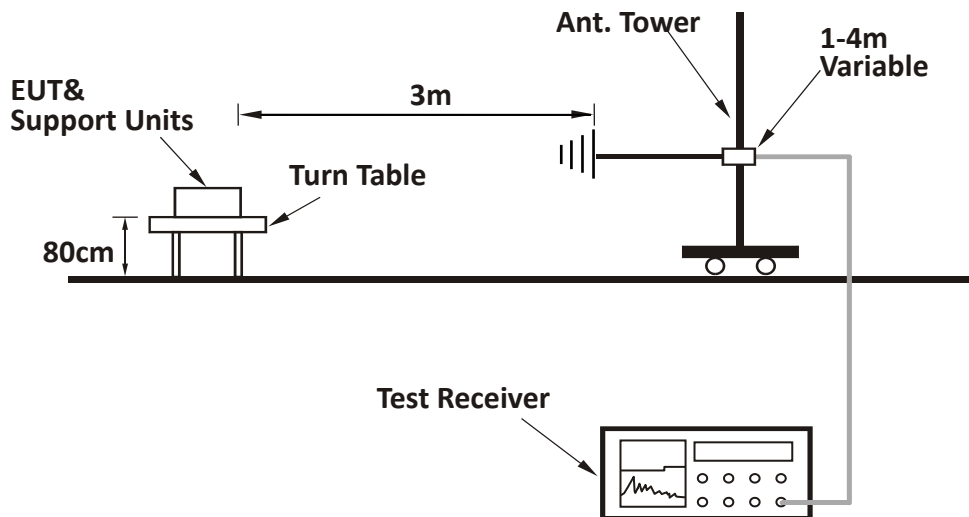
TEST REPORT

3.3 Test Configuration

For Radiated emission below 30MHz:

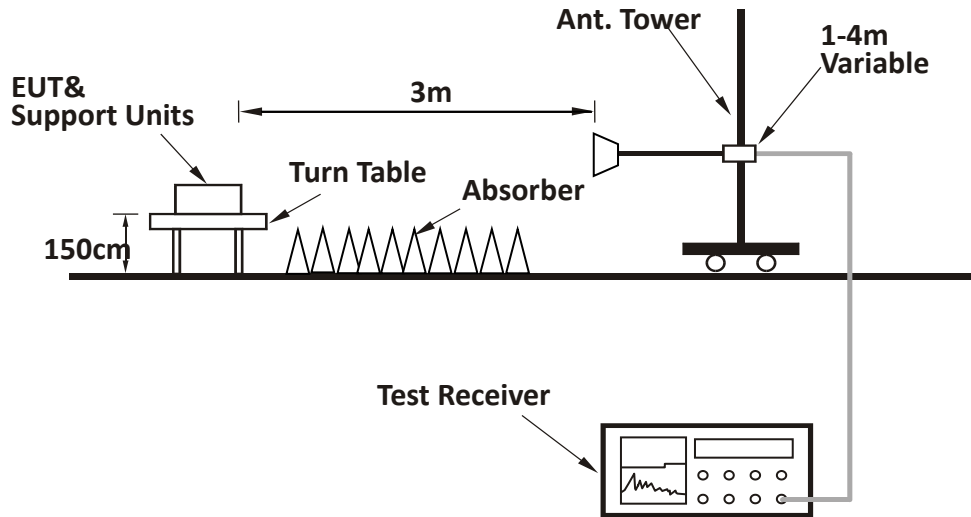


For Radiated emission 30MHz to 1GHz:



TEST REPORT

For Radiated emission above 1GHz:



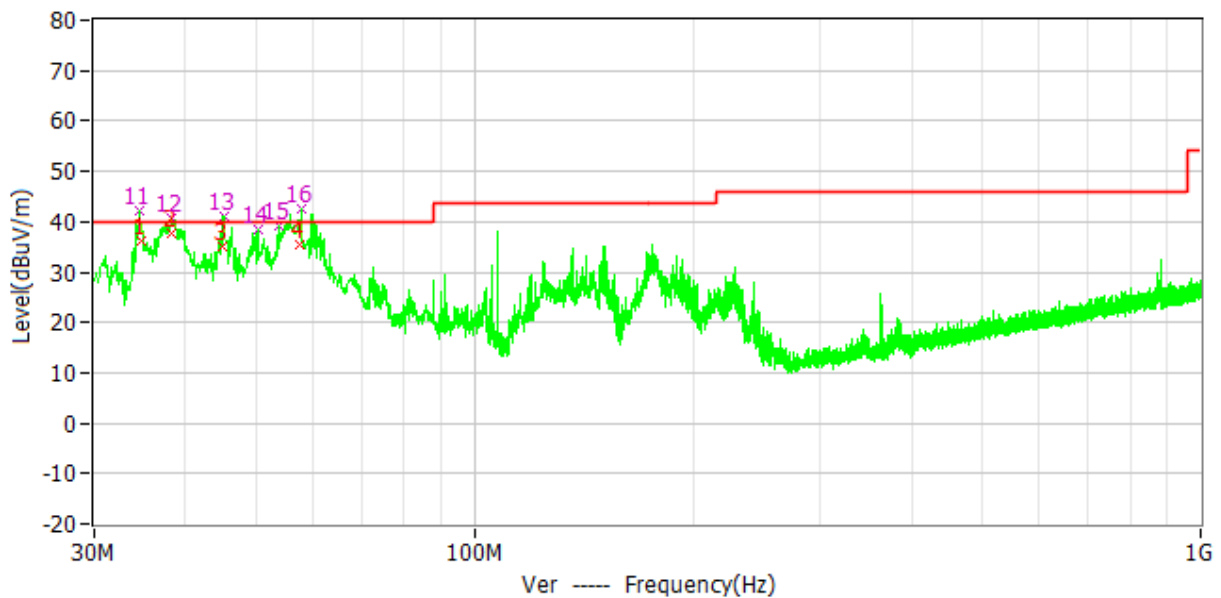
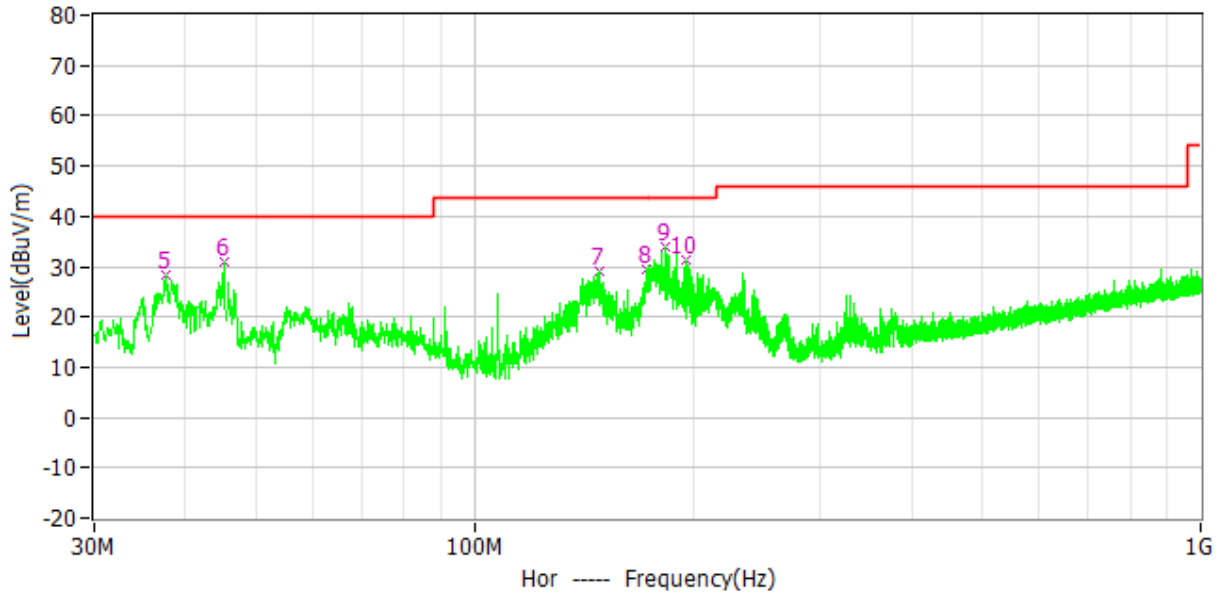
TEST REPORT

3.4 Test Results of Radiated Emissions

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

EUT was tested with all modes, and the worst data was listed in the report.

Test data below 1GHz



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| No. | Frequency | Limit dBuV/m | Level dBuV/m | Delta dB | Reading dBuV | Factor dB/m | Detector | Polar |
|-----|------------|--------------|--------------|----------|--------------|-------------|----------|-------|
| 1 | 34.784MHz | 40.0 | 36.1 | -3.9 | 22.8 | 13.3 | RMS | Ver |
| 2 | 38.345MHz | 40.0 | 37.8 | -2.2 | 24.2 | 13.6 | RMS | Ver |
| 3 | 44.909MHz | 40.0 | 35.0 | -5.0 | 20.8 | 14.2 | RMS | Ver |
| 4 | 57.592MHz | 40.0 | 35.5 | -4.5 | 21.3 | 14.2 | RMS | Ver |
| 5* | 37.566MHz | 40.0 | 28.2 | -11.8 | 14.7 | 13.5 | PK | Hor |
| 6* | 45.229MHz | 40.0 | 31.0 | -9.0 | 16.8 | 14.2 | PK | Hor |
| 7* | 148.825MHz | 43.5 | 28.9 | -14.6 | 14.5 | 14.4 | PK | Hor |
| 8* | 172.590MHz | 43.5 | 29.5 | -14.0 | 15.7 | 13.8 | PK | Hor |
| 9* | 183.745MHz | 43.5 | 34.0 | -9.5 | 21.2 | 12.8 | PK | Hor |
| 10* | 195.482MHz | 43.5 | 31.3 | -12.2 | 19.6 | 11.7 | PK | Hor |

Test result above 1GHz:

The emission was conducted from 1GHz to 25GHz

BLE

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|----|---------|-----------------|----------------------------|----------------|-------------|----------|
| L | H | 2390.00 | 51.60 | 74.00 | 22.40 | PK |
| | V | 2390.00 | 53.80 | 74.00 | 20.20 | PK |
| | H | 9608.00 | 48.40 | 74.00 | 25.60 | PK |
| | V | 9608.00 | 48.70 | 74.00 | 25.30 | PK |
| M | H | 9760.00 | 48.10 | 74.00 | 25.90 | PK |
| | V | 9760.00 | 48.60 | 74.00 | 25.40 | PK |
| H | H | 2483.50 | 50.90 | 74.00 | 23.10 | PK |
| | V | 2483.50 | 53.10 | 74.00 | 20.90 | PK |
| | H | 9920.00 | 48.30 | 74.00 | 25.70 | PK |
| | V | 9920.00 | 48.90 | 74.00 | 25.10 | PK |

TEST REPORT

802.11b

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|----|---------|-----------------|----------------------------|----------------|-------------|----------|
| L | H | 2390.00 | 49.10 | 74.00 | 24.90 | PK |
| | V | 2390.00 | 52.90 | 74.00 | 21.10 | PK |
| | H | 4824.00 | 44.40 | 74.00 | 29.60 | PK |
| | V | 4824.00 | 48.00 | 74.00 | 26.00 | PK |
| M | H | 4874.00 | 43.10 | 74.00 | 30.90 | PK |
| | V | 4874.00 | 48.80 | 74.00 | 25.20 | PK |
| H | H | 2483.50 | 49.20 | 74.00 | 24.80 | PK |
| | V | 2483.50 | 48.60 | 74.00 | 25.40 | PK |
| | H | 4924.00 | 43.10 | 74.00 | 30.90 | PK |
| | V | 4924.00 | 47.60 | 74.00 | 26.40 | PK |

802.11g

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|----|---------|-----------------|----------------------------|----------------|-------------|----------|
| L | H | 2390.00 | 50.60 | 74.00 | 23.40 | PK |
| | V | 2390.00 | 53.70 | 74.00 | 20.30 | PK |
| | H | 4824.00 | 44.60 | 74.00 | 29.40 | PK |
| | V | 4824.00 | 48.10 | 74.00 | 25.90 | PK |
| M | H | 4874.00 | 43.90 | 74.00 | 30.10 | PK |
| | V | 4874.00 | 48.30 | 74.00 | 25.70 | PK |
| H | H | 2483.50 | 51.60 | 74.00 | 22.40 | PK |
| | V | 2483.50 | 53.40 | 74.00 | 20.60 | PK |
| | H | 4924.00 | 43.10 | 74.00 | 30.90 | PK |
| | V | 4924.00 | 47.60 | 74.00 | 26.40 | PK |

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802.11n(HT20)

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|----|---------|-----------------|----------------------------|----------------|-------------|----------|
| L | H | 2390.00 | 49.60 | 74.00 | 24.40 | PK |
| | V | 2390.00 | 52.10 | 74.00 | 21.90 | PK |
| | H | 4824.00 | 43.60 | 74.00 | 30.40 | PK |
| | V | 4824.00 | 48.90 | 74.00 | 25.10 | PK |
| M | H | 4874.00 | 43.50 | 74.00 | 30.50 | PK |
| | V | 4874.00 | 48.50 | 74.00 | 25.50 | PK |
| H | H | 2483.50 | 50.60 | 74.00 | 23.40 | PK |
| | V | 2483.50 | 53.60 | 74.00 | 20.40 | PK |
| | H | 4924.00 | 44.10 | 74.00 | 29.90 | PK |
| | V | 4924.00 | 48.80 | 74.00 | 25.20 | PK |

802.11n(HT40)

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|----|---------|-----------------|----------------------------|----------------|-------------|----------|
| | H | 2390.00 | 49.10 | 74.00 | 24.90 | PK |
| | V | 2390.00 | 52.60 | 74.00 | 21.40 | PK |
| | H | 4844.00 | 43.90 | 74.00 | 30.10 | PK |
| | V | 4844.00 | 48.60 | 74.00 | 25.40 | PK |
| M | H | 4874.00 | 43.30 | 74.00 | 30.70 | PK |
| | V | 4874.00 | 48.50 | 74.00 | 25.50 | PK |
| H | H | 2483.50 | 50.20 | 74.00 | 23.80 | PK |
| | V | 2483.50 | 53.60 | 74.00 | 20.40 | PK |
| | H | 4904.00 | 43.50 | 74.00 | 30.50 | PK |
| | V | 4904.00 | 49.10 | 74.00 | 24.90 | PK |

- Remark: 1. Correct Factor = Antenna Factor + Cable Loss (- Amplifier, for higher than 1GHz), the value was added to Original Receiver Reading by the software automatically.
 2. Corrected Reading = Original Receiver Reading + Correct Factor
 3. Margin = Limit - Corrected Reading
 4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

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Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10.00dBuV,
Limit = 40.00dBuV/m.
Then Correct Factor = $30.20 + 2.00 - 32.00 = 0.20\text{dB/m}$;
Corrected Reading = $10\text{dBuV} + 0.20\text{dB/m} = 10.20\text{dBuV/m}$;
Margin = $40.00\text{dBuV/m} - 10.20\text{dBuV/m} = 29.80\text{dB}$.

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4 Antenna requirement

Requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Result:

EUT uses an unique coupling to the intentional radiator, so it can comply with the provisions of this section.

***** END *****