# RF TEST REPORT

**Report No.: 16020932-FCC-R1**
**Supersede Report No.: N/A**

| | |
|---|---|
| **Applicant** | Kohler Co. |
| **Product Name** | Kohler VAB Amplifier |
| **Main Model** | 1263840 |
| **Serial Model** | N/A |
| **Test Standard** | FCC Part 15.247: 2015, ANSI C63.10: 2013 |
| **Test Date** | July 20 to July 25, 2016 |
| **Issue Date** | July 26, 2016 |
| **Test Result** | ☑ **Pass** ☐ **Fail** |
| **Equipment complied with the specification** | ☑ |
| **Equipment did not comply with the specification** | ☐ |

| | | |
|---|---|---|
| Louise Tu | Miro Bao | |
| **Louise Tu**<br>**Test Engineer** | **Miro Bao**<br>**Checked By** | |

**This test report may be reproduced in full only**
**Test result presented in this test report is applicable to the tested sample only**


**Issued by:**
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# Laboratories Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.


In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

## Accreditations for Conformity Assessment

| Country/Region | Scope |
|---|---|
| USA | EMC, RF/Wireless, SAR, Telecom |
| Canada | EMC, RF/Wireless, SAR, Telecom |
| Taiwan | EMC, RF, Telecom, SAR, Safety |
| Hong Kong | RF/Wireless, SAR, Telecom |
| Australia | EMC, RF, Telecom, SAR, Safety |
| Korea | EMI, EMS, RF, SAR, Telecom, Safety |
| Japan | EMI, RF/Wireless, SAR, Telecom |
| Singapore | EMC, RF, SAR, Telecom |
| Europe | EMC, RF, SAR, Telecom, Safety |

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# CONTENTS

# 1. Report Revision History

| Report No. | Report Version | Description | Issue Date |
|---|---|---|---|
| 16020932-FCC-R1 | NONE | Original | July 26, 2016 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 2. Customer information

| | |
|---|---|
| Applicant Name | Kohler Co. |
| Applicant Add | 444 Highland Drive Kohler, Wisconsin USA 53044 |
| Manufacturer 1 | Dayton Audio |
| Manufacturer Add 1 | 705 Pleasant Valley Drive Springboro, Ohio 45066 |
| Manufacturer 2 | Sure Electronics Co., Ltd. |
| Manufacturer Add 2 | 3F, Building F6,No.9, Weidi Road, Xianlin, Qixia Dist.,Nanjing, China |

# 3. Test site information

| | |
|---|---|
| Lab performing tests | SIEMIC (Nanjing-China) Laboratories |
| Lab Address | 2-1 Longcang Avenue Yuhua Economic and Technology Development Park, Nanjing, China |
| FCC Test Site No. | 986914 |
| IC Test Site No. | 4842B-1 |
| Test Software | Labview of SIEMIC version 1.0 |

# 4. Equipment under Test (EUT) Information

| | |
|---|---|
| Description of EUT: | Kohler VAB Amplifier |
| Main Model: | 1263840 |
| Serial Model: | N/A |
| Date EUT received: | July 07, 2016 |
| Test Date(s): | July 20 to July 25, 2016 |
| Equipment Category : | DSS |
| Antenna Gain: | Bluetooth: 4dBi |
| Type of Modulation: | Bluetooth: GFSK, π/4DQPSK, 8DPSK |
| RF Operating Frequency (ies): | Bluetooth: 2402-2480 MHz |
| Max. Output Power: | -3.145dBm |
| Number of Channels: | Bluetooth: 79CH |
| Port: | Power Port, RS485 Port |
| Power: | Adapter:<br>INPUT: 100-240VAC 1.1A 50/60Hz<br>OUTPUT: +24VDC 3.75A |
| Trade Name : | Kohler |
| FCC ID: | N82KOHLER017 |

## 5. Test Summary

The product was tested in accordance with the following specifications.
All testing has been performed according to below product classification:

| FCC Rules | Description of Test | Result |
|---|---|---|
| §15.203 | Antenna Requirement | Compliance |
| §15.247(a)(1) | Channel Separation | Compliance |
| §15.247(a)(1) | 20 dB Bandwidth | Compliance |
| §15.247(b)(1) | Peak Output Power | Compliance |
| §15.247(a)(1)(iii) | Number of Hopping Channel | Compliance |
| §15.247(a)(1)(iii) | Time of Occupancy (Dwell Time) | Compliance |
| §15.247(d) | Band Edge& Restricted Band | Compliance |
| §15.207(a) | AC Line Conducted Emissions | Compliance |
| §15.205, §15.209, §15.247(d) | Radiated Emissions& Restricted Band | Compliance |

**Measurement Uncertainty**

| Emissions | | |
|---|---|---|
| **Test Item** | **Description** | **Uncertainty** |
| Conducted Emissions &Radiated Spurious Emissions | Confidence level of approximately 95% (in the case where distributions are normal), with a coverage factor of 2 (for EUTs < 0.5m X 0.5m X 0.5m) | 1.634dB / 3.952dB |

# 6. Measurements, Examination And Derived Results

## 6.1 Antenna Requirement

### Applicable Standard

According to § 15.203, 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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit. And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### Antenna Connector Construction

The EUT has 1 antenna:
A permanently attached PIFA antenna for Bluetooth, the gain is 4dBi for Bluetooth.

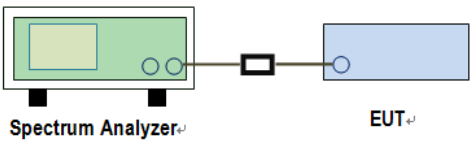
### The antenna meets up with the ANTENNA REQUIREMENT.

**Result:** Compliance.

## 6.2 Channel Separation

| Temperature | 25℃ |
|---|---|
| Relative Humidity | 53% |
| Atmospheric Pressure | 1001mbar |
| Test date : | July 25, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| § 15.247(a)(1) | a) | Channel Separation < 20dB BW and 20dB BW < 25KHz ;<br>Channel Separation Limit=25KHz<br>Chanel Separation < 20dB BW and 20dB BW > 25kHz ;<br>Channel Separation Limit=2/3 20dB BW | ☑ |
| Test Setup |  | | |
| Test Procedure | The test follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>Use the following spectrum analyzer settings:<br>- The EUT must have its hopping function enabled<br>- Span = wide enough to capture the peaks of two adjacent channels<br>- Resolution (or IF) Bandwidth (RBW) ≥1% of the span<br>- Video (or Average) Bandwidth (VBW) ≥RBW<br>- Sweep = auto<br>- Detector function = peak<br>- Trace = max hold<br>- Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot. | | |
| Remark | | | |
| Result | ☑ Pass ☐ Fail | | |

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☑ Yes (See below) ☐ N/A

**Channel Separation measurement result**

| Type/ Modulation | CH | CH Frequency (MHz) | CH Separation (MHz) | Limit (MHz) | Result |
|---|---|---|---|---|---|
| CH Separation GFSK | Low Channel | 2402 | 1.002 | 0.928 | Pass |
| | Adjacency Channel | 2403 | | | |
| | Mid Channel | 2441 | 0.996 | 0.922 | Pass |
| | Adjacency Channel | 2440 | | | |
| | High Channel | 2480 | 0.993 | 0.863 | Pass |
| | Adjacency Channel | 2479 | | | |
| CH Separation π/4 DQPSK | Low Channel | 2402 | 0.987 | 0.806 | Pass |
| | Adjacency Channel | 2403 | | | |
| | Mid Channel | 2441 | 0.999 | 0.851 | Pass |
| | Adjacency Channel | 2440 | | | |
| | High Channel | 2480 | 1.005 | 0.819 | Pass |
| | Adjacency Channel | 2479 | | | |
| CH Separation 8DPSK | Low Channel | 2402 | 1.005 | 0.812 | Pass |
| | Adjacency Channel | 2403 | | | |
| | Mid Channel | 2441 | 1.008 | 0.853 | Pass |
| | Adjacency Channel | 2440 | | | |
| | High Channel | 2480 | 1.011 | 0.839 | Pass |
| | Adjacency Channel | 2479 | | | |

## Test Plots

## Channel Separation measurement result


GFSK - Low Channel


GFSK - Middle Channel


GFSK - High Channel


π/4 DQPSK - Low Channel


π/4 DQPSK - Middle Channel


π/4 DQPSK - High Channel


8DPSK - Low Channel

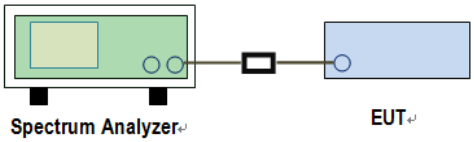

8DPSK - Middle Channel


8DPSK - High Channel

## 6.3 20dB Bandwidth

| | |
|---|---|
| Temperature | 24℃ |
| Relative Humidity | 53% |
| Atmospheric Pressure | 1001mbar |
| Test date : | July 25, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| §15.247(a) (1) | a) | Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. | ☑ |
| Test Setup |  | | |
| Test Procedure | The test follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>Use the following spectrum analyzer settings:<br>- Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel<br>- RBW ≥1% of the 20 dB bandwidth<br>- VBW ≥RBW<br>- Sweep = auto<br>- Detector function = peak<br>- Trace = max hold.<br>- The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). | | |
| Remark | | | |
| Result | ☑ Pass ☐ Fail | | |

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☑ Yes (See below) ☐ N/A

**Measurement result**

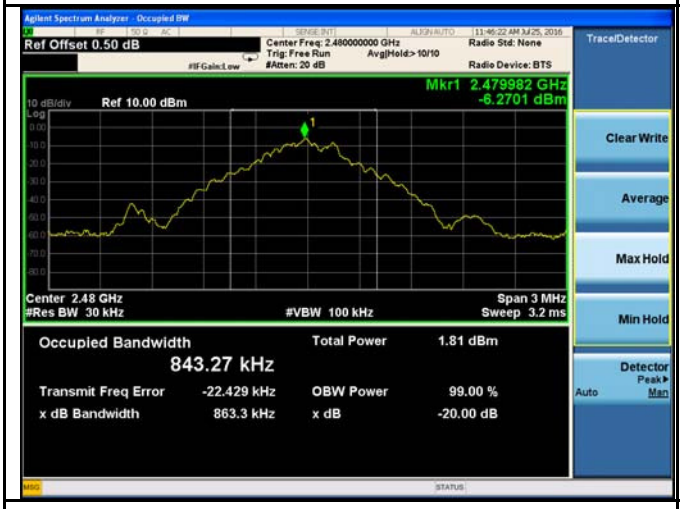
| Modulation | CH | CH Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Occupied Bandwidth (MHz) |
|---|---|---|---|---|
| GFSK | Low | 2402 | 0.9280 | 0.8569 |
| | Mid | 2441 | 0.9218 | 0.8468 |
| | High | 2480 | 0.8633 | 0.8433 |
| π/4 DQPSK | Low | 2402 | 1.209 | 1.1701 |
| | Mid | 2441 | 1.276 | 1.1731 |
| | High | 2480 | 1.229 | 1.1716 |
| 8DPSK | Low | 2402 | 1.218 | 1.1638 |
| | Mid | 2441 | 1.280 | 1.1627 |
| | High | 2480 | 1.258 | 1.1565 |

## Test Plots

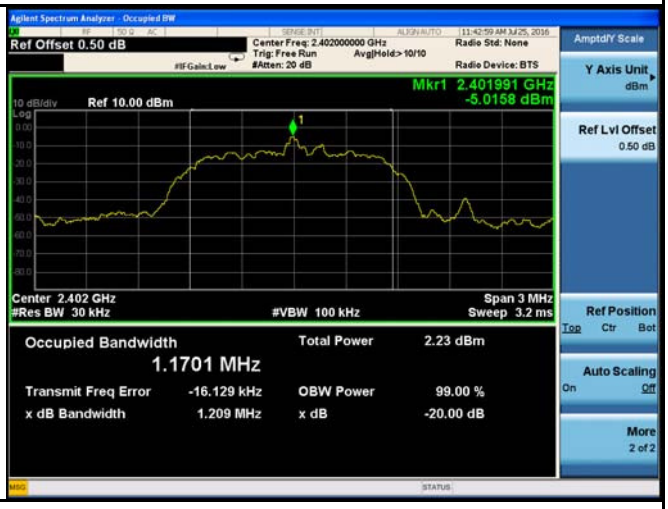
### 20dB Bandwidth measurement result


GFSK - Low Channel

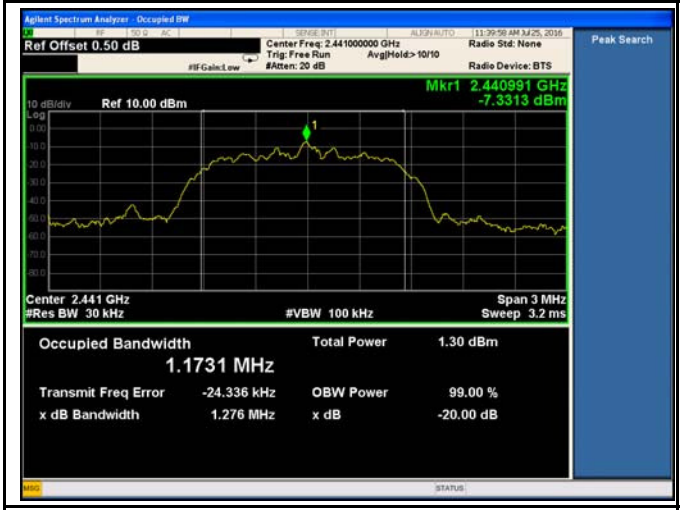

GFSK - Middle Channel




GFSK - High Channel

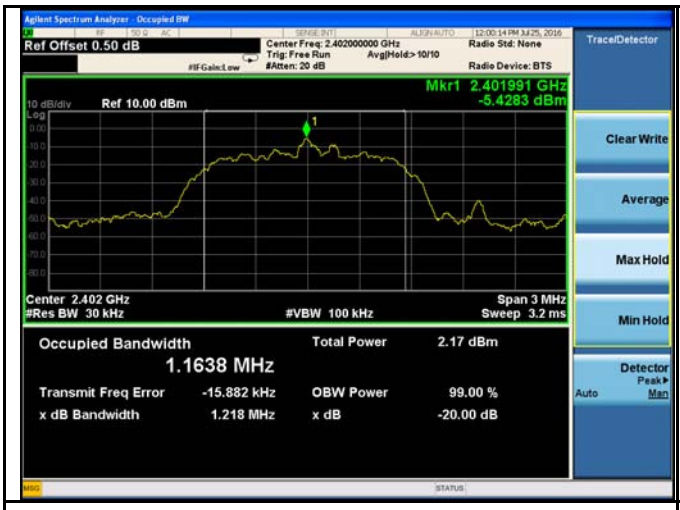



π/4 DQPSK - Low Channel

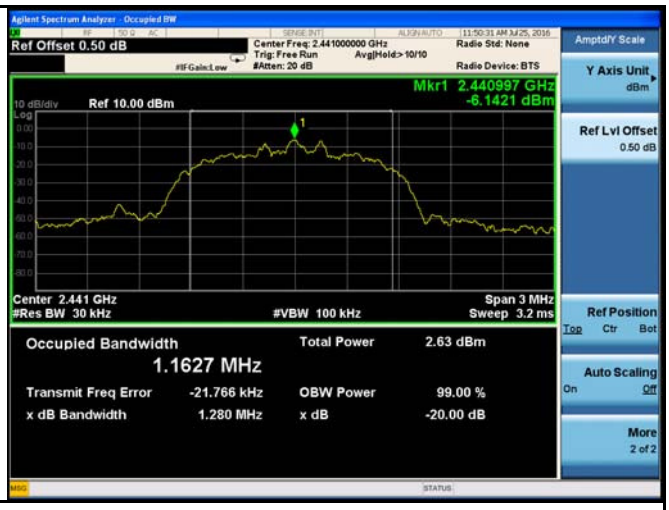



π/4 DQPSK - Middle Channel


π/4 DQPSK - High Channel




8DPSK - Low Channel



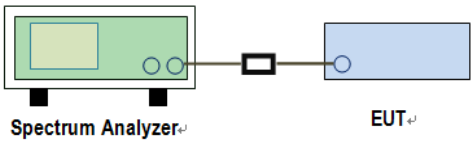

8DPSK - Middle Channel


8DPSK - High Channel

## 6.4 Peak Output Power

| | |
|---|---|
| Temperature | 24℃ |
| Relative Humidity | 53% |
| Atmospheric Pressure | 1001mbar |
| Test date : | July 21, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| §15.247(b) (3) | a) | FHSS in 2400-2483.5MHz with ≥ 75 channels: ≤1 Watt | ☑ |
| | b) | FHSS in 5725-5850MHz: ≤1 Watt | ☐ |
| | c) | For all other FHSS in the 2400-2483.5MHz band: ≤0.125 Watt. | ☑ |
| | d) | FHSS in 902-928MHz with ≥ 50 channels: ≤1 Watt | ☐ |
| | e) | FHSS in 902-928MHz with ≥ 25 & <50 channels: ≤0.25 Watt | ☐ |
| | f) | DTS in 902-928MHz, 2400-2483.5MHz: ≤1 Watt | ☐ |
| Test Setup | |   | |
| Test Procedure | | The test follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>Use the following spectrum analyzer settings:<br>- Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel<br>- RBW > the 20 dB bandwidth of the emission being measured<br>- VBW ≥RBW<br>- Sweep = auto<br>- Detector function = peak<br>- Trace = max hold<br>- Allow the trace to stabilize.<br>- Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the note above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot. A peak responding power meter may be used instead of a spectrum analyzer. | |
| Remark | | | |
| Result | | ☑ Pass ☐ Fail | |

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☑ Yes (See below) ☐ N/A

**Peak Output Power measurement result**

| Type | Modulation | CH | Frequency (MHz) | Conducted Power (dBm) | Conducted Power (mW) | Limit (mW) | Result |
|---|---|---|---|---|---|---|---|
| Output power | GFSK | Low | 2402 | -3.350 | 0.462 | 1000 | Pass |
| | | Mid | 2441 | -3.635 | 0.433 | 1000 | Pass |
| | | High | 2480 | **-3.145** | **0.485** | 1000 | Pass |
| | π/4 DQPSK | Low | 2402 | -4.417 | 0.362 | 125 | Pass |
| | | Mid | 2441 | -5.377 | 0.290 | 125 | Pass |
| | | High | 2480 | -5.047 | 0.313 | 125 | Pass |
| | 8DPSK | Low | 2402 | -4.260 | 0.375 | 125 | Pass |
| | | Mid | 2441 | -4.824 | 0.329 | 125 | Pass |
| | | High | 2480 | -5.180 | 0.303 | 125 | Pass |

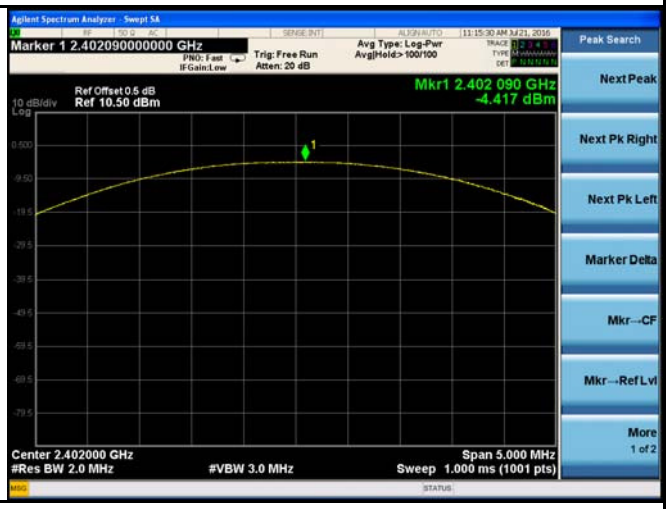
## Test Plots

## Output Power measurement result

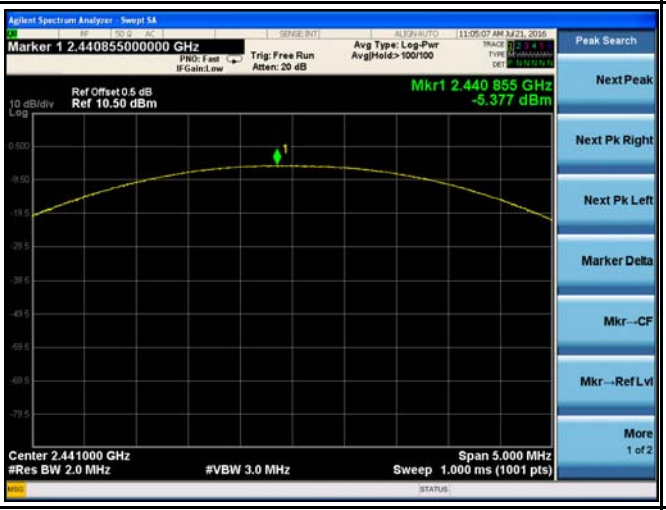

GFSK Output power - Low CH 2402


GFSK Output power - Mid CH 2441


GFSK Output power - High CH 2480



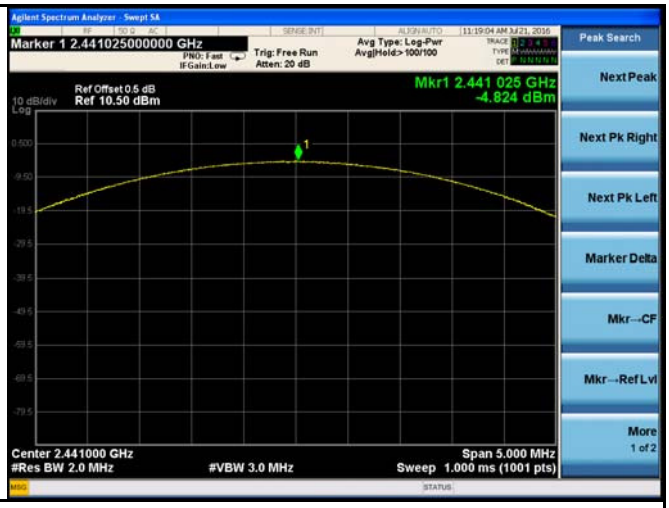

π/4 DQPSK Output power - Low CH 2402




π/4 DQPSK Output power - Mid CH 2441


π/4 DQPSK Output power - High CH 2480


8DPSK Output power - Low CH 2402



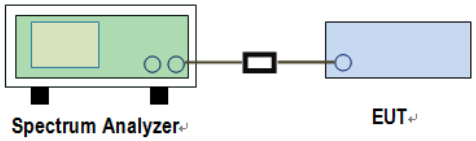

8DPSK Output power - Mid CH 2441


8DPSK Output power - High CH 2480

## 6.5 Number of Hopping Channel

| | |
|---|---|
| Temperature | 24℃ |
| Relative Humidity | 53% |
| Atmospheric Pressure | 1001mbar |
| Test date : | July 25, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| §15.247(a)(1)(iii) | a) | FHSS in 2400-2483.5MHz ≥ 15 channels | ☑ |
| Test Setup |  | | |
| Test Procedure | The test follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>Use the following spectrum analyzer settings:<br>The EUT must have its hopping function enabled.<br>- Span = the frequency band of operation<br>- RBW ≥1% of the span<br>- VBW ≥RBW<br>- Sweep = auto<br>- Detector function = peak<br>- Trace = max hold<br>- Allow trace to fully stabilize.<br>- It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). | | |
| Remark | | | |
| Result | ☑ Pass ☐ Fail | | |

**Test Data** ☑ Yes ☐ N/A

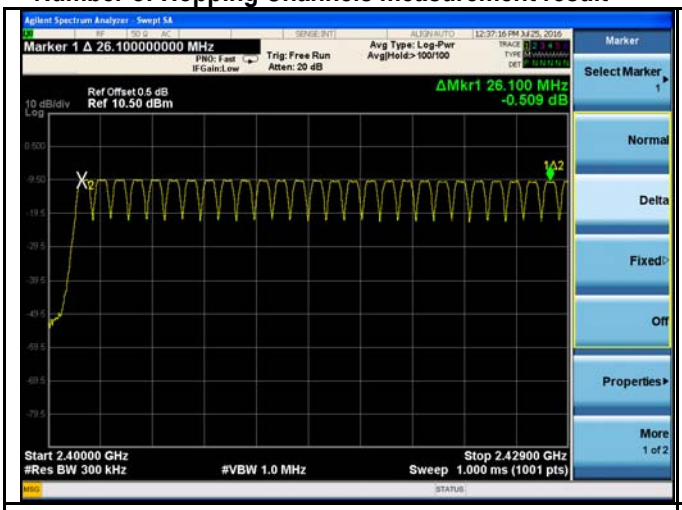
**Test Plot** ☑ Yes (See below) ☐ N/A

**Number of Hopping Channel measurement result**

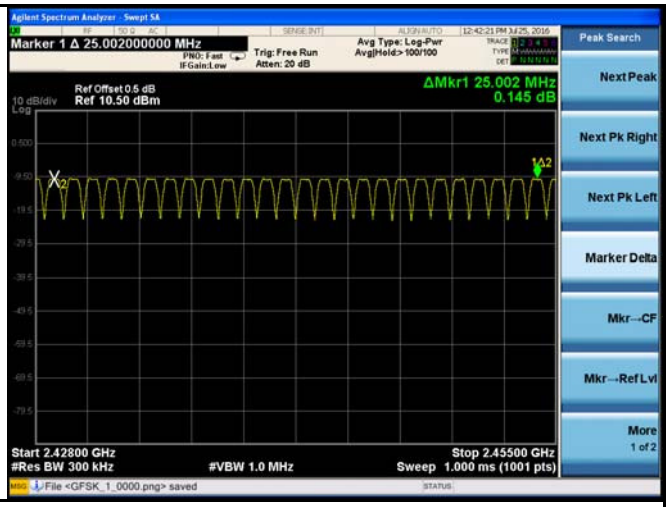
| Type | Modulation | Frequency Range | Number of Hopping Channel | Limit |
|---|---|---|---|---|
| Number of Hopping Channel | GFSK | 2400-2483.5 | 79 | 15 |
| | π/4 DQPSK | 2400-2483.5 | 79 | 15 |
| | 8-DPSK | 2400-2483.5 | 79 | 15 |

## Test Plots

### Number of Hopping Channels measurement result

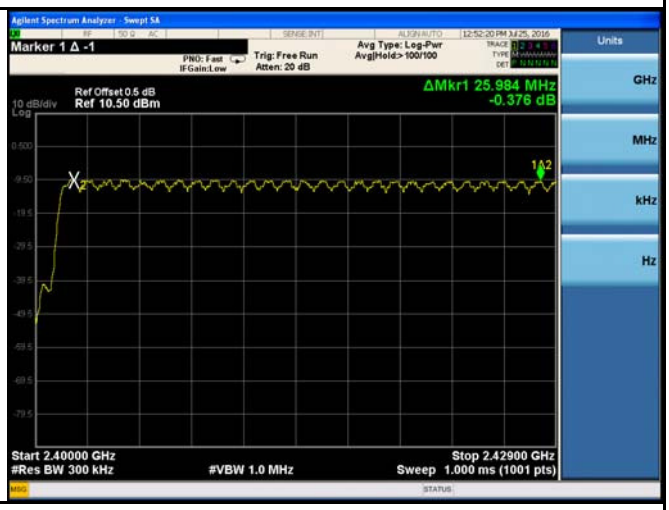



GFSK

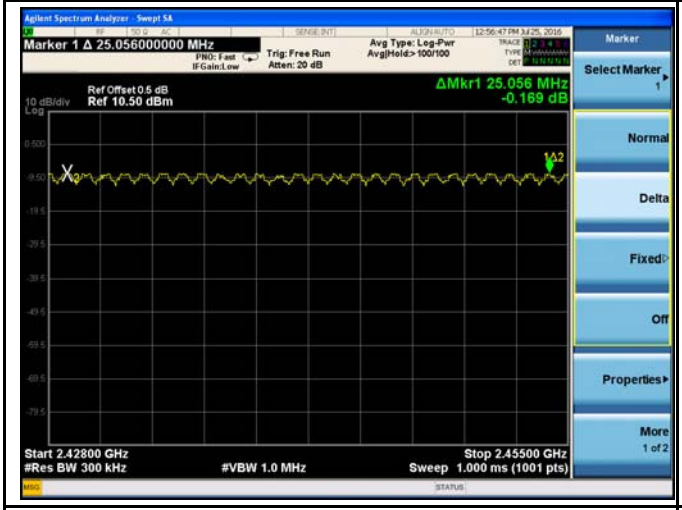



GFSK


GFSK

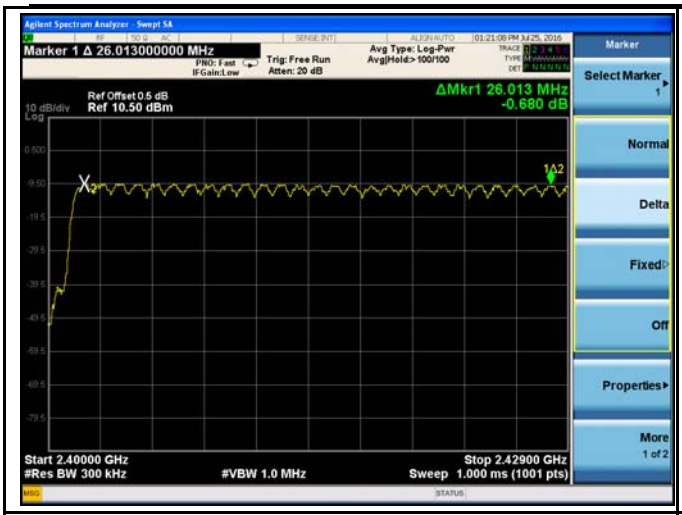



π/4DQPSK

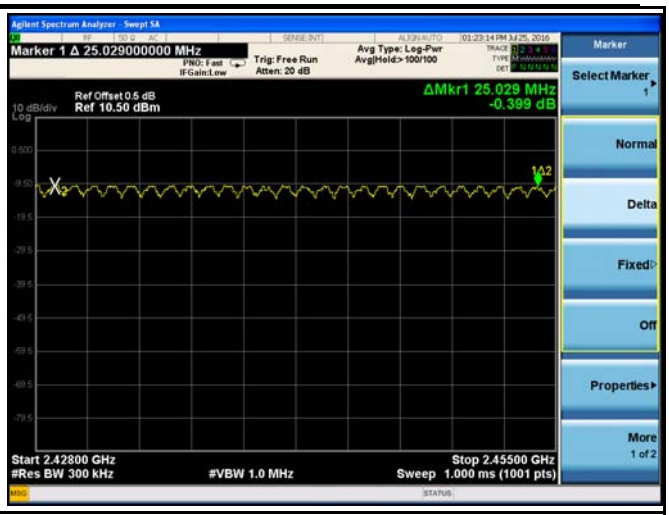



π/4DQPSK


π/4DQPSK




8DPSK



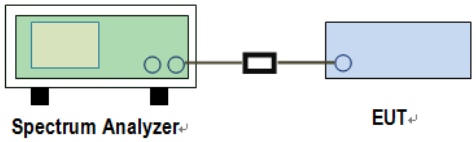

8DPSK


8DPSK

## 6.6 Time of Occupancy (Dwell Time)

| | |
|---|---|
| Temperature | 24℃ |
| Relative Humidity | 53% |
| Atmospheric Pressure | 1001mbar |
| Test date : | July 25, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| §15.247(a)(1)(iii) | a) | Dwell Time < 0.4s | ☑ |
| Test Setup |  | | |
| Test Procedure | The test follows FCC Public Notice DA 00-705 Measurement Guidelines.<br>Use the following spectrum analyzer<br>- Span = zero span, centered on a hopping channel<br>- RBW = 1 MHz<br>- VBW ≥RBW<br>- Sweep = as necessary to capture the entire dwell time per hopping channel<br>- Detector function = peak<br>- Trace = max hold<br>- use the marker-delta function to determine the dwell time | | |
| Remark | | | |
| Result | ☑ Pass ☐ Fail | | |

**Test Data** ☑ Yes ☐ N/A

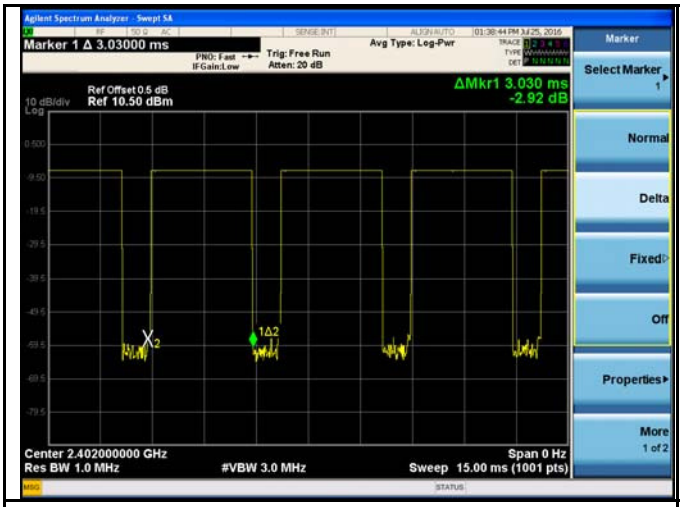
**Test Plot** ☑ Yes (See below) ☐ N/A

**Dwell Time measurement result**

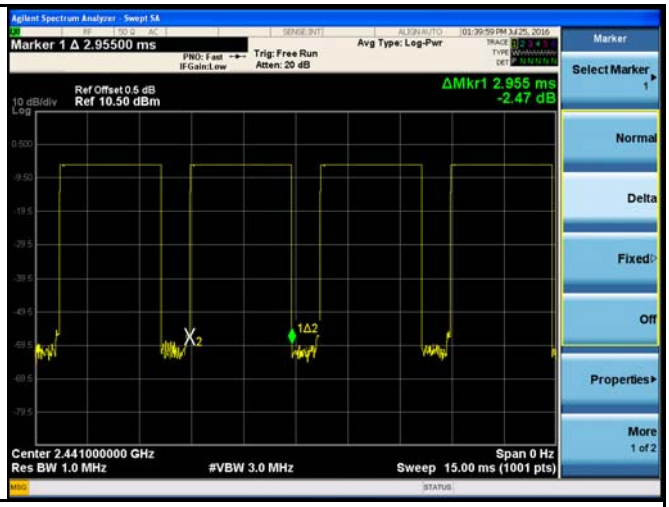
| Type | Modulation | CH | Pulse Width (ms) | Dwell Time (ms) | Limit (ms) | Result |
|---|---|---|---|---|---|---|
| Dwell Time (DH5) | GFSK | Low | 3.030 | 323.200 | 400 | Pass |
| | | Mid | 2.955 | 315.200 | 400 | Pass |
| | | High | 3.000 | 320.000 | 400 | Pass |
| | π/4 DQPSK | Low | 3.015 | 321.600 | 400 | Pass |
| | | Mid | 3.000 | 320.000 | 400 | Pass |
| | | High | 3.015 | 321.600 | 400 | Pass |
| | 8-DPSK | Low | 3.000 | 320.000 | 400 | Pass |
| | | Mid | 2.970 | 316.800 | 400 | Pass |
| | | High | 3.030 | 323.200 | 400 | Pass |
| Note: Dwell time (DH5)=Pulse Time (ms) × (1600 ÷ 6 ÷ 79) ×31.6 | | | | | | |

Note: We tested the Dwell time all the modes: DH1, DH3, DH5; but we only show the worst case DH5 in this report.

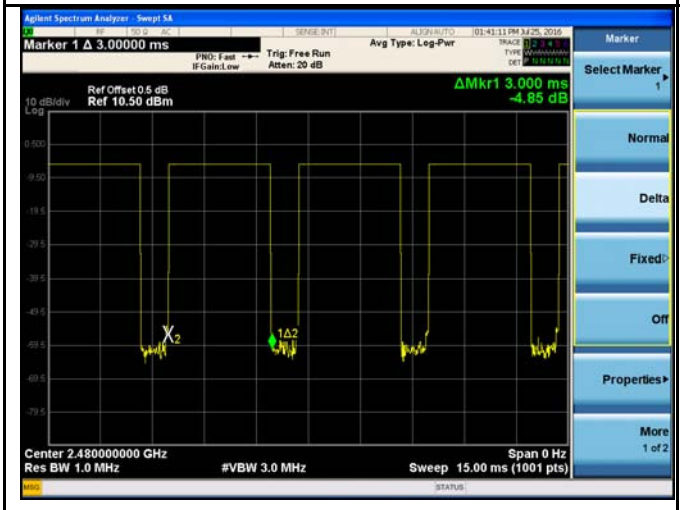
## Test Plots
## Dwell Time measurement result



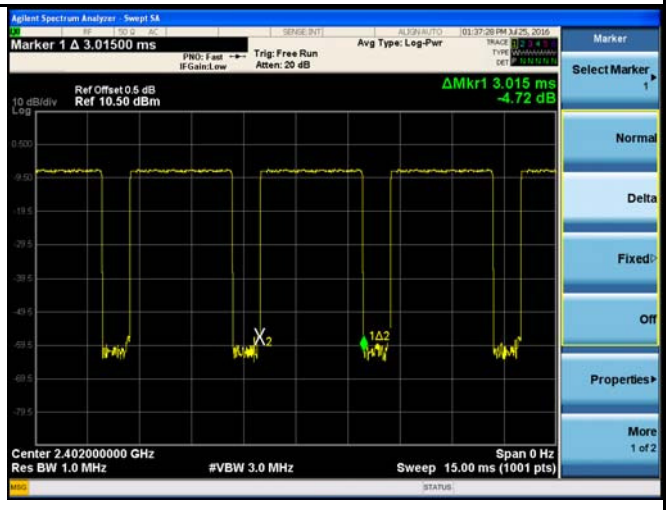

GFSK - Low CH 2402-DH5



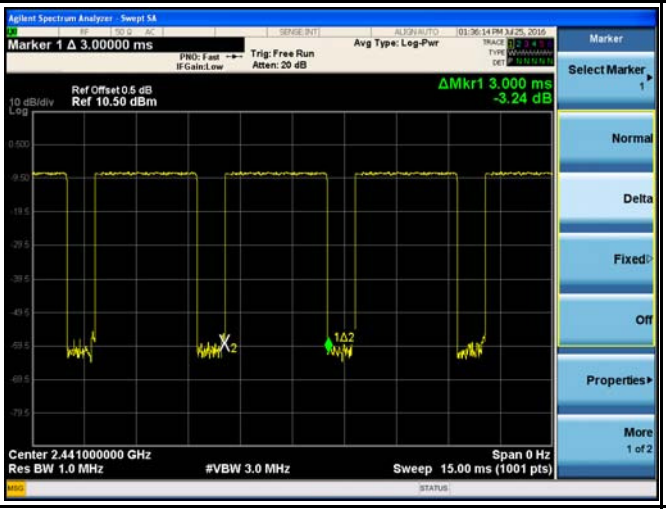

GFSK - Mid CH 2441-DH5



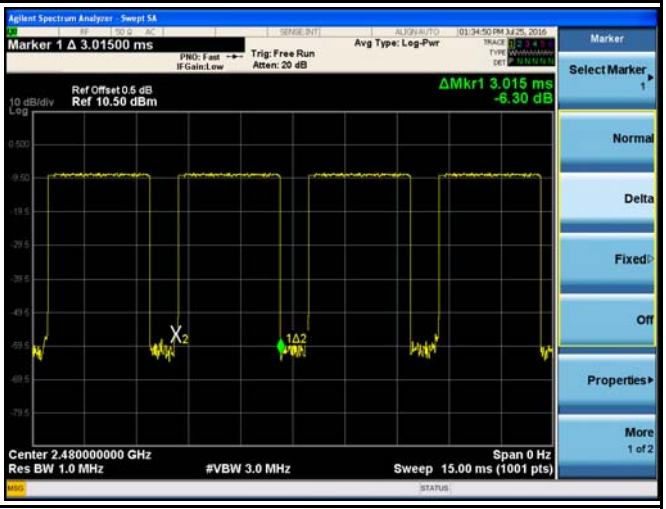

GFSK - High CH 2480-DH5



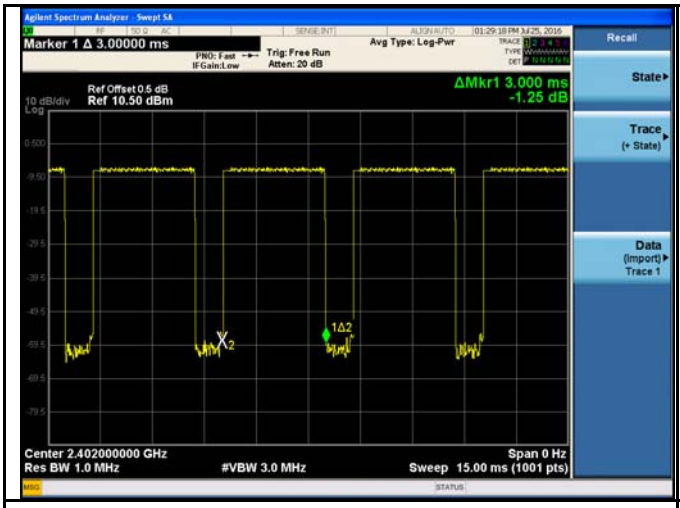

π/4 DQPSK - Low CH 2402-DH5



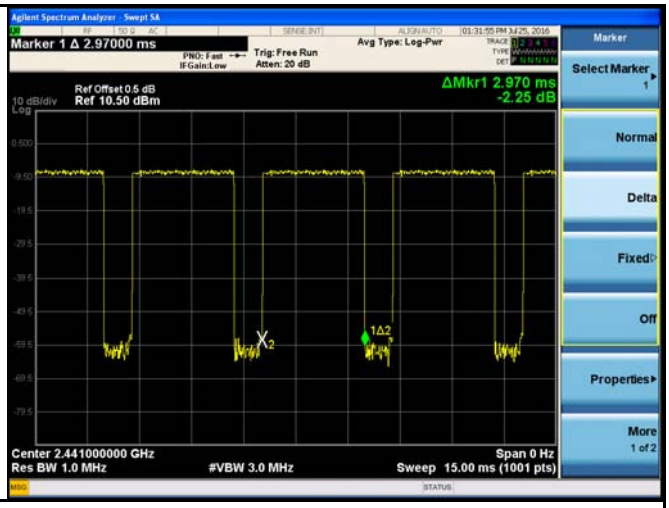

π/4 DQPSK - Mid CH 2441-DH5



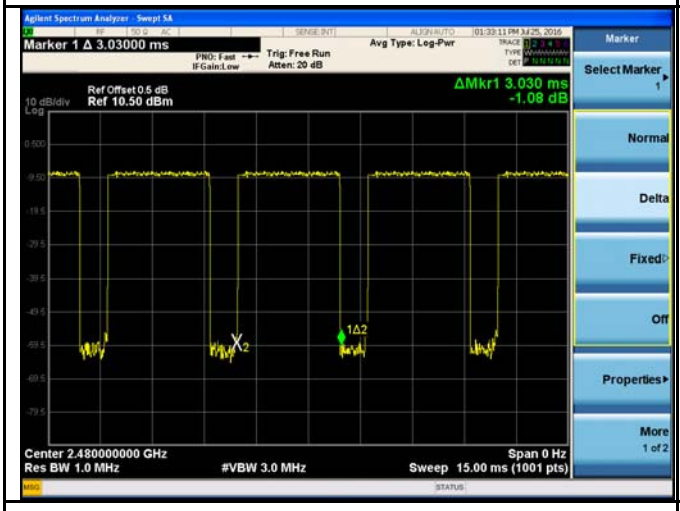

π/4 DQPSK - High CH 2480-DH5




8DPSK - Low CH 2402-DH5




8DPSK - Mid CH 2441-DH5




8DPSK - High CH 2480-DH5

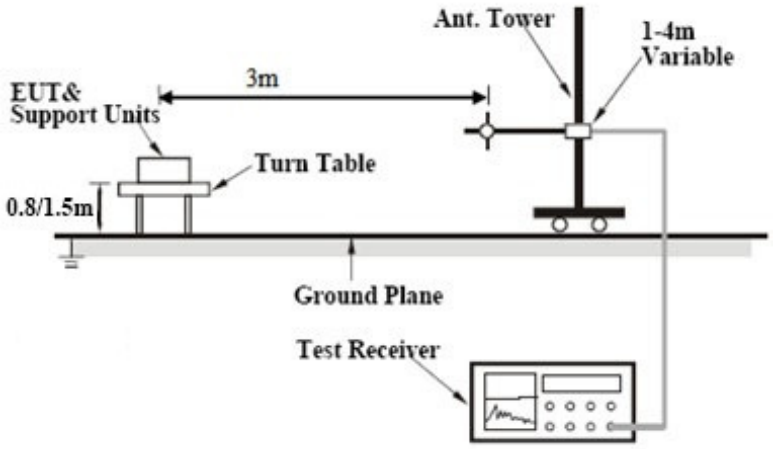
## 6.7 Band Edge & Restricted Band

| | |
|---|---|
| Temperature | 22℃ |
| Relative Humidity | 55% |
| Atmospheric Pressure | 1013mbar |
| Test date : | July 25, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

| Spec | Item | Requirement | Applicable |
|---|---|---|---|
| §15.247(a)(1)(iii) | a) | In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. | ☑ |

**Test Setup**




**Test Procedure**

The test follows FCC Public Notice DA 00-705 Measurement Guidelines.

Radiated Method Only

- 1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 2. Position the EUT without connection to measurement instrument. Put it on the Rotated table and turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
- 3. First, set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, check the emission of EUT, if pass then set Spectrum Analyzer as below:
  a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasiy Peak detection at frequency below 1GHz.
  b. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak measurement at frequency above 1GHz.
  c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz with Peak detection for Average Measurement as below at frequency above 1GHz.
- 4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
- 5. Repeat above procedures until all measured frequencies were complete.

**Remark**

| Result | ☑ Pass | ☐ Fail |
|---|---|---|

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☐ Yes (See below) ☑ N/A

**Results for Band edge Testing (Radiated)**

**Low Channel: GFSK Mode (Worst Case) (2402 MHz)-Non-hopping**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 2375.26 | 46.02 | PK | H | 30.23 | 5.8 | 35.2 | 46.85 | 74 | -27.15 |
| 2375.26 | 33.43 | AV | H | 30.23 | 5.8 | 35.2 | 34.26 | 54 | -19.74 |
| 2389.47 | 47.48 | PK | H | 30.23 | 5.81 | 35.2 | 48.32 | 74 | -25.68 |
| 2389.47 | 34.89 | AV | H | 30.23 | 5.81 | 35.2 | 35.73 | 54 | -18.27 |
| 2376.98 | 45.62 | PK | V | 30.23 | 5.8 | 35.2 | 46.45 | 74 | -27.55 |
| 2376.98 | 33.59 | AV | V | 30.23 | 5.8 | 35.2 | 34.42 | 54 | -19.58 |
| 2389.23 | 49.33 | PK | V | 30.23 | 5.81 | 35.2 | 50.17 | 74 | -23.83 |
| 2389.23 | 38.17 | AV | V | 30.23 | 5.81 | 35.2 | 39.01 | 54 | -14.99 |

**High Channel: GFSK Mode (Worst Case) (2480 MHz) -Non-hopping**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 2483.72 | 49.41 | PK | H | 30.35 | 5.8 | 35 | 50.36 | 74 | -23.64 |
| 2483.72 | 35.06 | AV | H | 30.35 | 5.8 | 35 | 36.01 | 54 | -17.99 |
| 2487.76 | 45.31 | PK | H | 30.35 | 5.81 | 35 | 47.47 | 74 | -26.53 |
| 2487.76 | 32.66 | AV | H | 30.35 | 5.81 | 35 | 34.82 | 54 | -19.18 |
| 2484.49 | 50.55 | PK | V | 30.35 | 5.8 | 35 | 50.7 | 74 | -23.3 |
| 2484.49 | 36.37 | AV | V | 30.35 | 5.8 | 35 | 36.52 | 54 | -17.48 |
| 2488.54 | 47.48 | PK | V | 30.35 | 5.81 | 35 | 49.14 | 74 | -24.86 |
| 2488.54 | 34.12 | AV | V | 30.35 | 5.81 | 35 | 35.78 | 54 | -18.22 |

**Low Channel: GFSK Mode (Worst Case) (2402 MHz)-Hopping**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 2376.5 | 45.96 | PK | H | 30.23 | 5.8 | 35.2 | 46.79 | 74 | -27.21 |
| 2376.5 | 32.21 | AV | H | 30.23 | 5.8 | 35.2 | 33.04 | 54 | -20.96 |
| 2390.22 | 48.32 | PK | H | 30.23 | 5.81 | 35.2 | 49.16 | 74 | -24.84 |
| 2390.22 | 35.44 | AV | H | 30.23 | 5.81 | 35.2 | 36.28 | 54 | -17.72 |
| 2376.97 | 46.29 | PK | V | 30.23 | 5.8 | 35.2 | 47.12 | 74 | -26.88 |
| 2376.97 | 33.28 | AV | V | 30.23 | 5.8 | 35.2 | 34.11 | 54 | -19.89 |
| 2392.06 | 52.26 | PK | V | 30.23 | 5.81 | 35.2 | 53.1 | 74 | -20.9 |
| 2392.06 | 40.76 | AV | V | 30.23 | 5.81 | 35.2 | 41.6 | 54 | -12.4 |

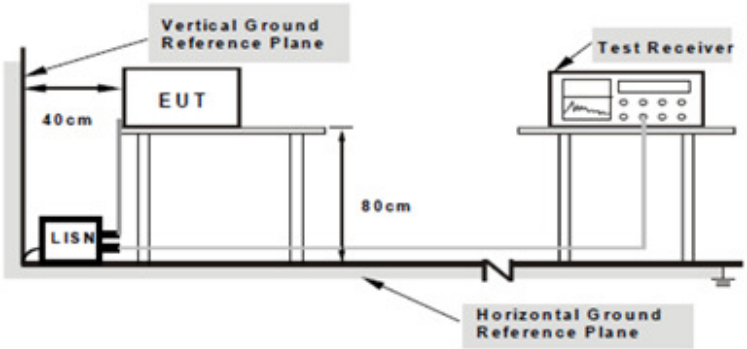
**High Channel: GFSK Mode (Worst Case) (2480 MHz) - Hopping**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 2483.89 | 38.42 | PK | H | 30.35 | 5.8 | 35 | 39.57 | 74 | -34.43 |
| 2483.89 | 35.07 | AV | H | 30.35 | 5.8 | 35 | 36.22 | 54 | -17.78 |
| 2484.31 | 46.09 | PK | H | 30.35 | 5.81 | 35 | 47.25 | 74 | -26.75 |
| 2484.31 | 34.87 | AV | H | 30.35 | 5.81 | 35 | 36.03 | 54 | -17.97 |
| 2485.51 | 48.76 | PK | V | 30.35 | 5.8 | 35 | 49.91 | 74 | -24.09 |
| 2485.51 | 35.89 | AV | V | 30.35 | 5.8 | 35 | 37.04 | 54 | -16.96 |
| 2487.71 | 46.65 | PK | V | 30.35 | 5.81 | 35 | 47.81 | 74 | -26.19 |
| 2487.71 | 38.57 | AV | V | 30.35 | 5.81 | 35 | 39.73 | 54 | -14.27 |

## 6.8 AC Power Line Conducted Emissions

| | |
|---|---|
| Temperature | 25℃ |
| Relative Humidity | 55% |
| Atmospheric Pressure | 1013mbar |
| Test date : | July 21, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

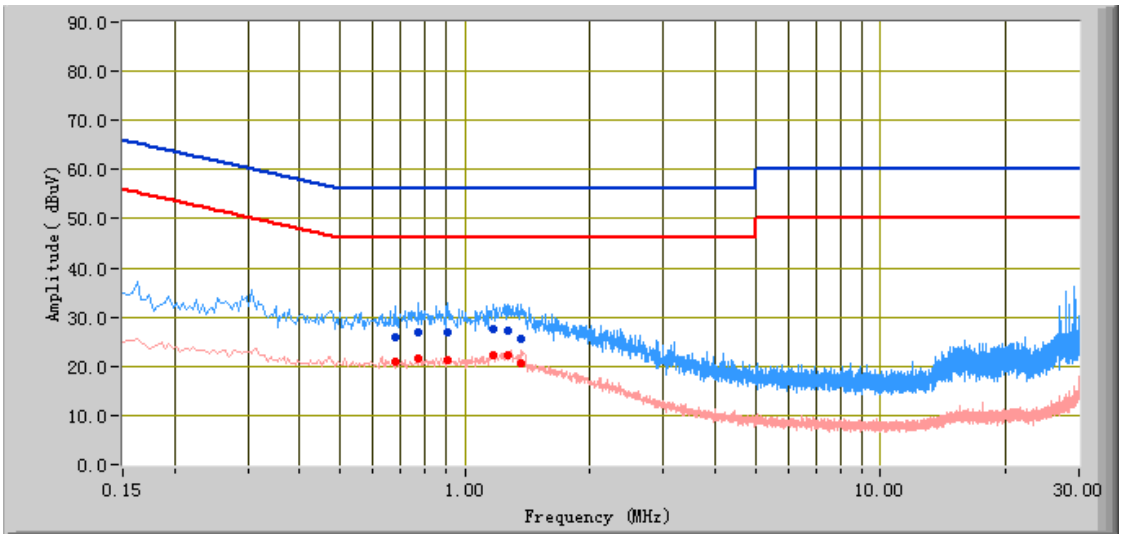
<table>
<tr><th>Spec</th><th>Item</th><th>Requirement</th><th>Applicable</th></tr>
<tr><td>47CFR§15.207, RSS210 (A8.1)</td><td>a)</td><td>For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 [mu]H/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequencies ranges.
<table>
<tr><th rowspan="2">Frequency ranges (MHz)</th><th colspan="2">Limit (dBμV)</th></tr>
<tr><th>QP</th><th>Average</th></tr>
<tr><td>0.15 ~ 0.5</td><td>66 – 56</td><td>56 – 46</td></tr>
<tr><td>0.5 ~ 5</td><td>56</td><td>46</td></tr>
<tr><td>5 ~ 30</td><td>60</td><td>50</td></tr>
</table></td><td>☑</td></tr>
<tr><td>Test Setup</td><td colspan="3"> 

Note: 1.Support units were connected to second LISN.<br>2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.</td></tr>
<tr><td>Procedure</td><td colspan="3">1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.<br>2. The power supply for the EUT was fed through a 50W/50mH EUT LISN, connected to filtered mains.<br>3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.<br>4. All other supporting equipment were powered separately from another main supply.<br>5. The EUT was switched on and allowed to warm up to its normal operating condition.<br>6. A scan was made on the NEUTRAL line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.<br>7. High peaks, relative to the limit line, The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz.<br>8. Step 7 was then repeated for the LIVE line (for AC mains) or DC line (for DC power).</td></tr>
<tr><td>Remark</td><td colspan="3"></td></tr>
<tr><td>Result</td><td colspan="3">☑ Pass ☐ Fail</td></tr>
</table>

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☑ Yes (See below) ☐ N/A

| Test Mode: | Transmitting Mode |
|---|---|

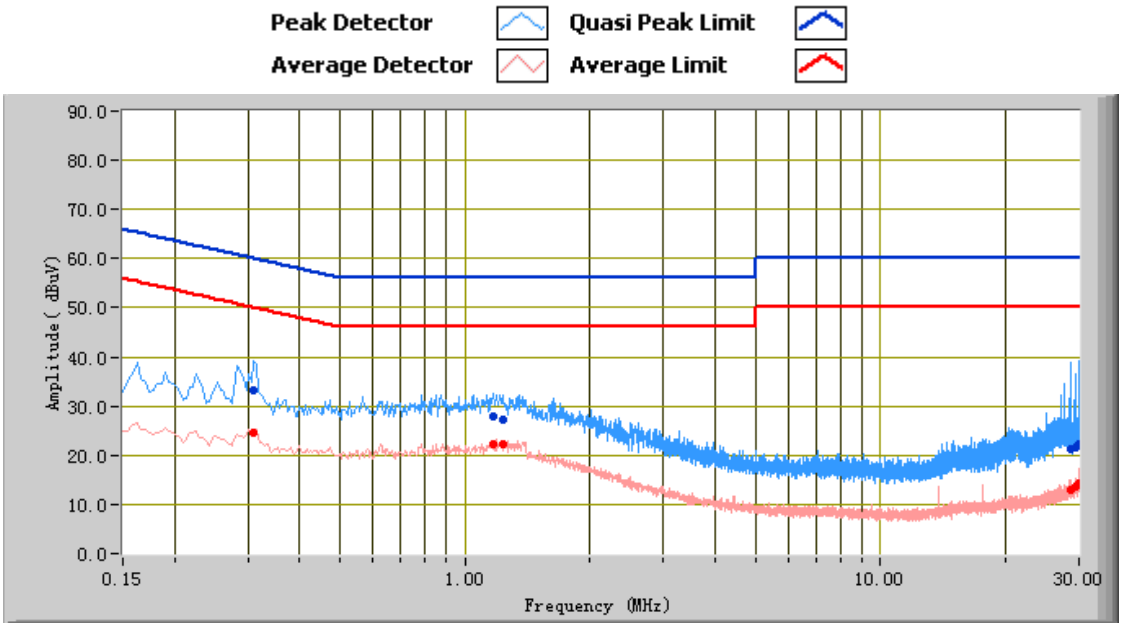



***Test Data***

**Phase Line Plot at AC 120V 60Hz**

| Frequency (MHz) | Quasi Peak (dBµV) | Limit (dBµV) | Margin (dB) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Factors (dB) |
|---|---|---|---|---|---|---|---|
| 0.91 | 27.02 | 56.00 | -28.98 | 21.34 | 46.00 | -24.66 | 10.76 |
| 0.77 | 26.83 | 56.00 | -29.17 | 21.56 | 46.00 | -24.44 | 10.87 |
| 1.26 | 27.36 | 56.00 | -28.64 | 22.17 | 46.00 | -23.83 | 10.73 |
| 1.36 | 25.72 | 56.00 | -30.28 | 20.68 | 46.00 | -25.32 | 10.75 |
| 1.17 | 27.69 | 56.00 | -28.31 | 22.17 | 46.00 | -23.83 | 10.71 |
| 0.68 | 26.05 | 56.00 | -29.95 | 20.90 | 46.00 | -25.10 | 10.94 |

| Test Mode: | Transmitting Mode |
| --- | --- |

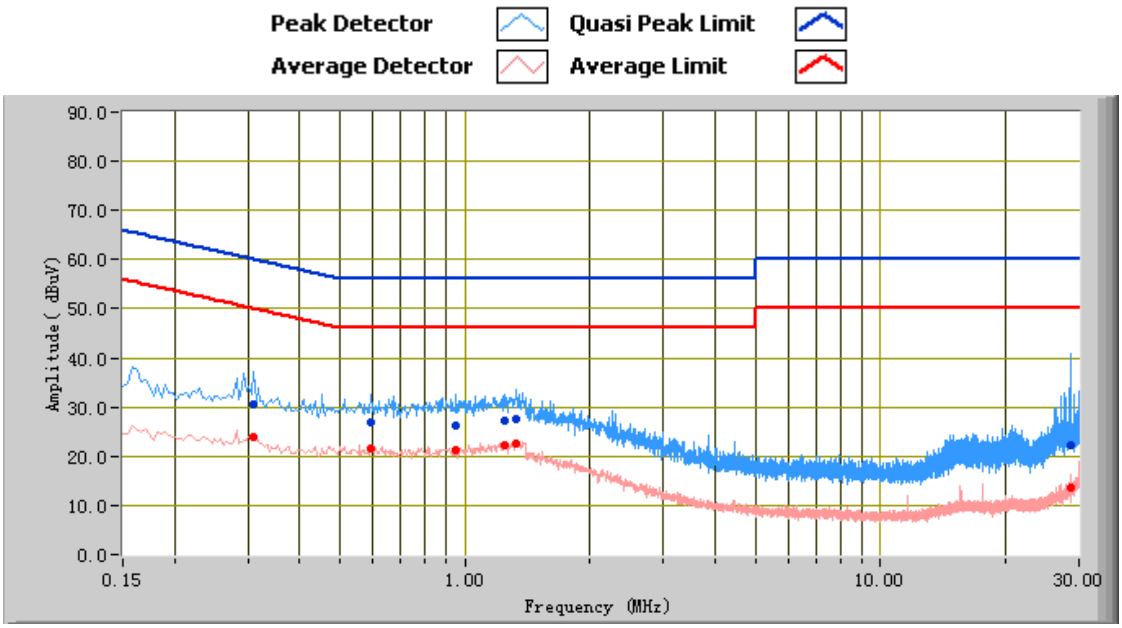



***Test Data***

**Phase Neutral Plot at AC 120V 60Hz**

| Frequency (MHz) | Quasi Peak (dBµV) | Limit (dBµV) | Margin (dB) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Factors (dB) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0.31 | 33.31 | 59.97 | -26.66 | 24.65 | 49.97 | -25.32 | 11.36 |
| 29.94 | 22.33 | 60.00 | -37.67 | 14.29 | 50.00 | -35.71 | 11.89 |
| 28.80 | 21.35 | 60.00 | -38.65 | 13.01 | 50.00 | -36.99 | 11.85 |
| 29.56 | 21.45 | 60.00 | -38.55 | 13.62 | 50.00 | -36.38 | 11.88 |
| 1.17 | 27.75 | 56.00 | -28.25 | 22.30 | 46.00 | -23.70 | 10.74 |
| 1.23 | 27.17 | 56.00 | -28.83 | 22.09 | 46.00 | -23.91 | 10.75 |

| Test Mode: | Transmitting Mode |
| --- | --- |

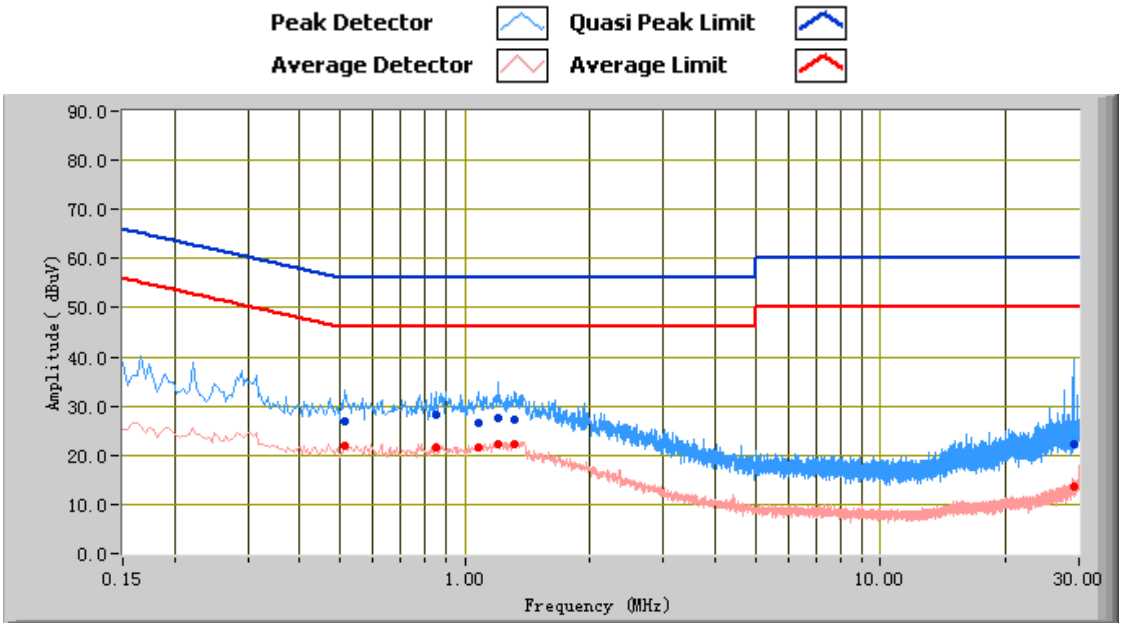



***Test Data***

**Phase Line Plot at AC 240V 60Hz**

| Frequency (MHz) | Quasi Peak (dBµV) | Limit (dBµV) | Margin (dB) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Factors (dB) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 28.79 | 22.19 | 60.00 | -37.81 | 13.76 | 50.00 | -36.24 | 11.83 |
| 1.33 | 27.67 | 56.00 | -28.33 | 22.46 | 46.00 | -23.54 | 10.75 |
| 0.31 | 30.52 | 59.97 | -29.45 | 24.02 | 49.97 | -25.95 | 11.37 |
| 0.95 | 26.26 | 56.00 | -29.74 | 21.19 | 46.00 | -24.81 | 10.72 |
| 1.25 | 27.33 | 56.00 | -28.67 | 22.30 | 46.00 | -23.70 | 10.73 |
| 0.59 | 26.76 | 56.00 | -29.24 | 21.58 | 46.00 | -24.42 | 11.01 |

| Test Mode: | Transmitting Mode |
| --- | --- |




***Test Data***

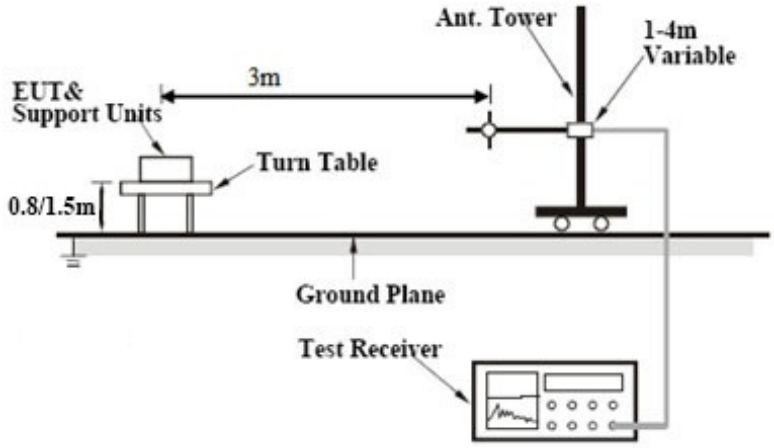
**Phase Neutral Plot at AC 240V 60Hz**

| Frequency (MHz) | Quasi Peak (dBµV) | Limit (dBµV) | Margin (dB) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Factors (dB) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 29.25 | 22.17 | 60.00 | -37.83 | 13.65 | 50.00 | -36.35 | 11.87 |
| 1.20 | 27.48 | 56.00 | -28.52 | 22.27 | 46.00 | -23.73 | 10.74 |
| 0.51 | 26.99 | 56.00 | -29.01 | 22.00 | 46.00 | -24.00 | 11.05 |
| 0.85 | 28.16 | 56.00 | -27.84 | 21.73 | 46.00 | -24.27 | 10.81 |
| 1.07 | 26.64 | 56.00 | -29.36 | 21.60 | 46.00 | -24.40 | 10.72 |
| 1.31 | 27.28 | 56.00 | -28.72 | 22.39 | 46.00 | -23.61 | 10.77 |

## 6.9 Radiated Spurious Emissions & Restricted Band

| | |
|---|---|
| Temperature | 25℃ |
| Relative Humidity | 55% |
| Atmospheric Pressure | 1013mbar |
| Test date : | July 20, 2016 |
| Tested By : | Louise Tu |

**Requirement(s):**

<table>
<tr><th>Spec</th><th>Item</th><th>Requirement</th><th>Applicable</th></tr>
<tr><td>47CFR§15.205, §15.209, §15.247(d)</td><td>a)</td><td>Except higher limit as specified elsewhere in other section, the emissions from the low-power radio-frequency devices shall not exceed the field strength levels specified in the following table and the level of any unwanted emissions shall not exceed the level of the fundamental emission. The tighter limit applies at the band edges
<table>
<tr><th>Frequency range (MHz)</th><th>Field Strength (μV/m)</th></tr>
<tr><td>30 – 88</td><td>100</td></tr>
<tr><td>88 – 216</td><td>150</td></tr>
<tr><td>216 – 960</td><td>200</td></tr>
<tr><td>Above 960</td><td>500</td></tr>
</table></td><td>☑</td></tr>
<tr><td>Test Setup</td><td colspan="3"> 
</td></tr>
<tr><td>Procedure</td><td colspan="3">1. The EUT was switched on and allowed to warm up to its normal operating condition.<br>2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:<br>a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.<br>b. The EUT was then rotated to the direction that gave the maximum emission.<br>c. Finally, the antenna height was adjusted to the height that gave the maximum emission.<br>3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasiy Peak detection at frequency below 1GHz.<br>4. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak measurement at frequency above 1GHz.<br>The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz with Peak detection for Average Measurement as below at frequency above 1GHz.<br>5. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.</td></tr>
<tr><td>Remark</td><td colspan="3"></td></tr>
</table>

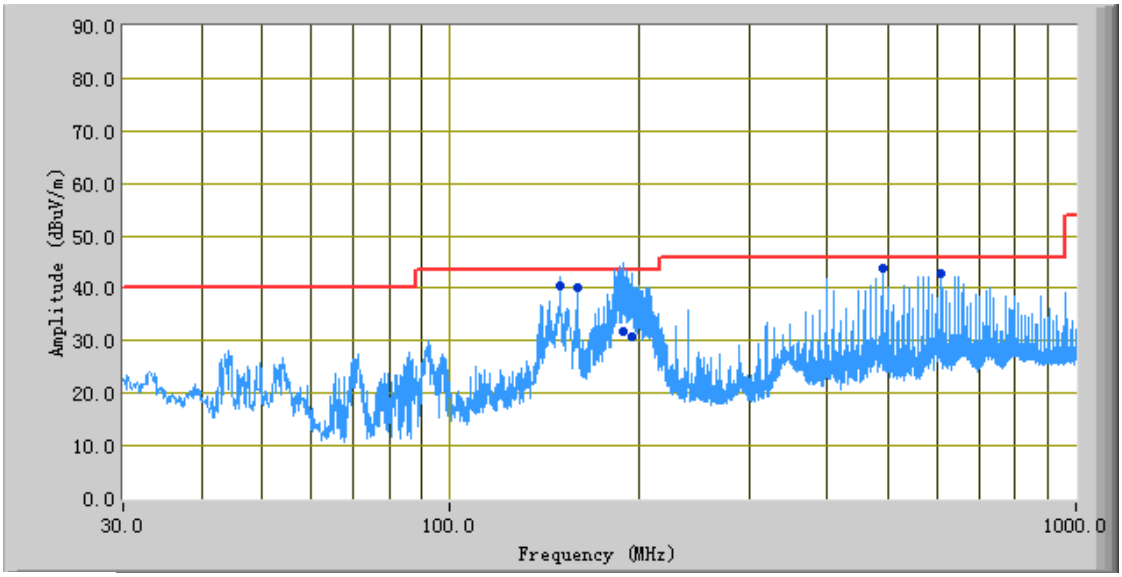
| Result | ☑ Pass | ☐ Fail |
|---|---|---|

**Test Data** ☑ Yes ☐ N/A

**Test Plot** ☑ Yes (See below) ☐ N/A

| **Test Mode:** | **Transmitting Mode** |
|---|---|

***Below 1GHz***



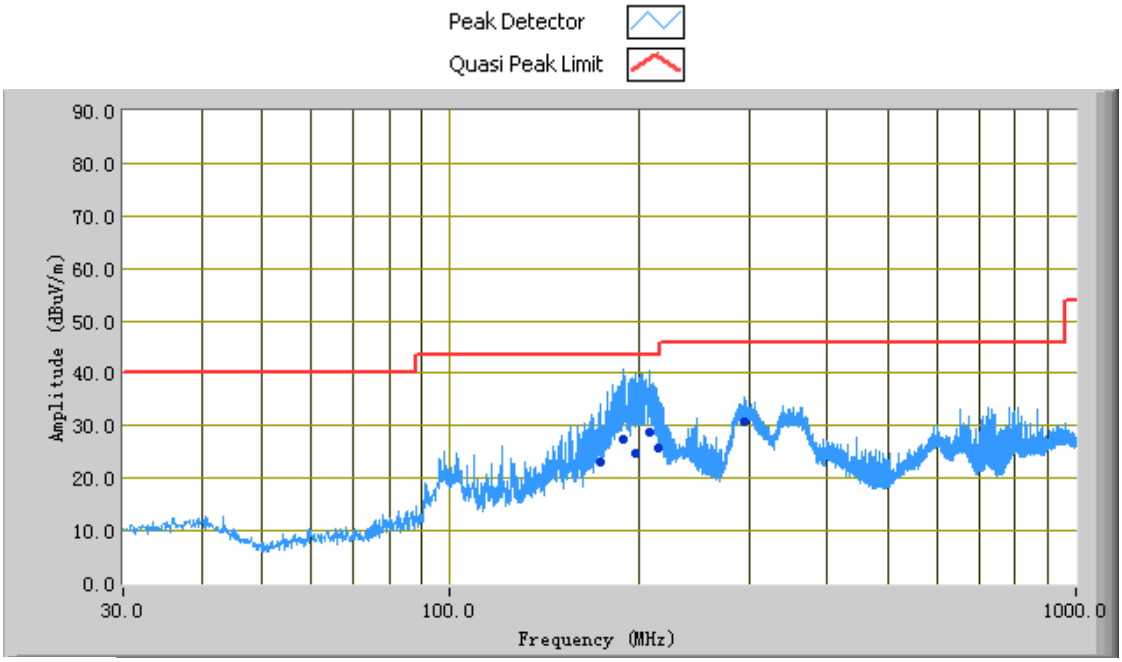

***Test Data***

**Vertical Polarity Plot @3m**

| Frequency (MHz) | Quasi Peak (dBµV/m) | Azimuth | Polarity (H/V) | Height (cm) | Limit (dBµV/m) | Margin (dB) | Factors (dB) |
|---|---|---|---|---|---|---|---|
| 188.94 | 31.62 | 280.00 | V | 135.00 | 43.50 | -11.88 | 31.86 |
| 195.01 | 30.64 | 278.00 | V | 122.00 | 43.50 | -12.86 | 31.96 |
| 149.99 | 40.63 | 282.00 | V | 118.00 | 43.50 | -2.87 | 31.21 |
| 489.96 | 43.86 | 290.00 | V | 120.00 | 46.00 | -2.14 | 28.64 |
| 609.97 | 42.71 | 342.00 | V | 108.00 | 46.00 | -3.29 | 22.69 |
| 159.99 | 40.09 | 301.00 | V | 103.00 | 43.50 | -3.41 | 31.37 |

| Test Mode: | Transmitting Mode |
|---|---|

***Below 1GHz***




***Test Data***

**Horizontal Polarity Plot @3m**

| Frequency (MHz) | Quasi Peak (dBµV/m) | Azimuth | Polarity (H/V) | Height (cm) | Limit (dBµV/m) | Margin (dB) | Factors (dB) |
|---|---|---|---|---|---|---|---|
| 189.21 | 27.28 | 220.00 | H | 242.00 | 43.50 | -16.22 | 31.52 |
| 208.72 | 28.73 | 234.00 | H | 227.00 | 43.50 | -14.77 | 30.87 |
| 198.12 | 24.89 | 186.00 | H | 239.00 | 43.50 | -18.61 | 31.54 |
| 215.29 | 25.76 | 212.00 | H | 143.00 | 43.50 | -17.74 | 30.37 |
| 173.67 | 22.93 | 217.00 | H | 156.00 | 43.50 | -20.57 | 31.50 |
| 294.71 | 30.70 | 95.00 | H | 100.00 | 46.00 | -15.30 | 29.08 |

| Test Mode: | Transmitting Mode (Above 1GHz) |
|---|---|

**Low Channel: GFSK Mode (Worst Case) (2402 MHz)**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 4803.5 | 34.97 | AV | V | 33.83 | 6.86 | 31.72 | 43.94 | 54 | -10.06 |
| 4803.5 | 33.47 | AV | H | 33.83 | 6.86 | 31.72 | 42.44 | 54 | -11.56 |
| 4803.5 | 46.7 | PK | V | 33.83 | 6.86 | 31.72 | 55.67 | 74 | -18.33 |
| 4803.5 | 45.36 | PK | H | 33.83 | 6.86 | 31.72 | 54.33 | 74 | -19.67 |

**Middle Channel: GFSK Mode (Worst Case) (2441 MHz)**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 4882.75 | 32.26 | AV | V | 33.86 | 6.82 | 31.82 | 41.12 | 54 | -12.88 |
| 4882.75 | 31.37 | AV | H | 33.86 | 6.82 | 31.82 | 40.23 | 54 | -13.77 |
| 4882.75 | 44.89 | PK | V | 33.86 | 6.82 | 31.82 | 53.75 | 74 | -20.25 |
| 4882.75 | 43.95 | PK | H | 33.86 | 6.82 | 31.82 | 52.81 | 74 | -21.19 |

**High Channel: GFSK Mode (Worst Case) (2480 MHz)**

| Frequency (MHz) | S.A. Reading (dBµV) | Detector (PK/AV) | Polarity (H/V) | Ant. Factor (dB/m) | Cable Loss (dB) | Pre-Amp. Gain (dB) | Cord. Amp. (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 4959.25 | 32.31 | AV | V | 33.9 | 6.76 | 31.92 | 41.05 | 54 | -12.95 |
| 4959.25 | 31.57 | AV | H | 33.9 | 6.76 | 31.92 | 40.31 | 54 | -13.69 |
| 4959.25 | 45.11 | PK | V | 33.9 | 6.76 | 31.92 | 53.85 | 74 | -20.15 |
| 4959.25 | 44.19 | PK | H | 33.9 | 6.76 | 31.92 | 52.93 | 74 | -21.07 |

**Note:**

*1, The testing has been conformed to 10*2480MHz=24,800MHz*

*2, All other emissions more than 30 dB below the limit*

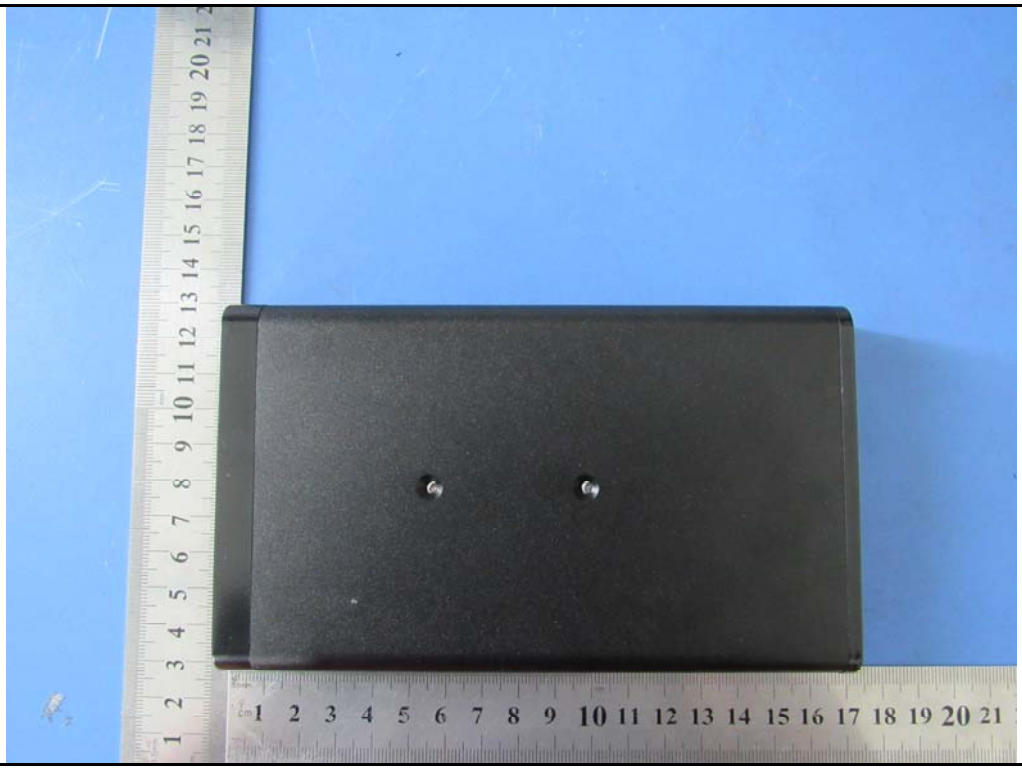
*3, X-Axis, Y-Axis and Z-Axis were investigated. The results above show only the worst case.*

# Annex A. TEST INSTRUMENT

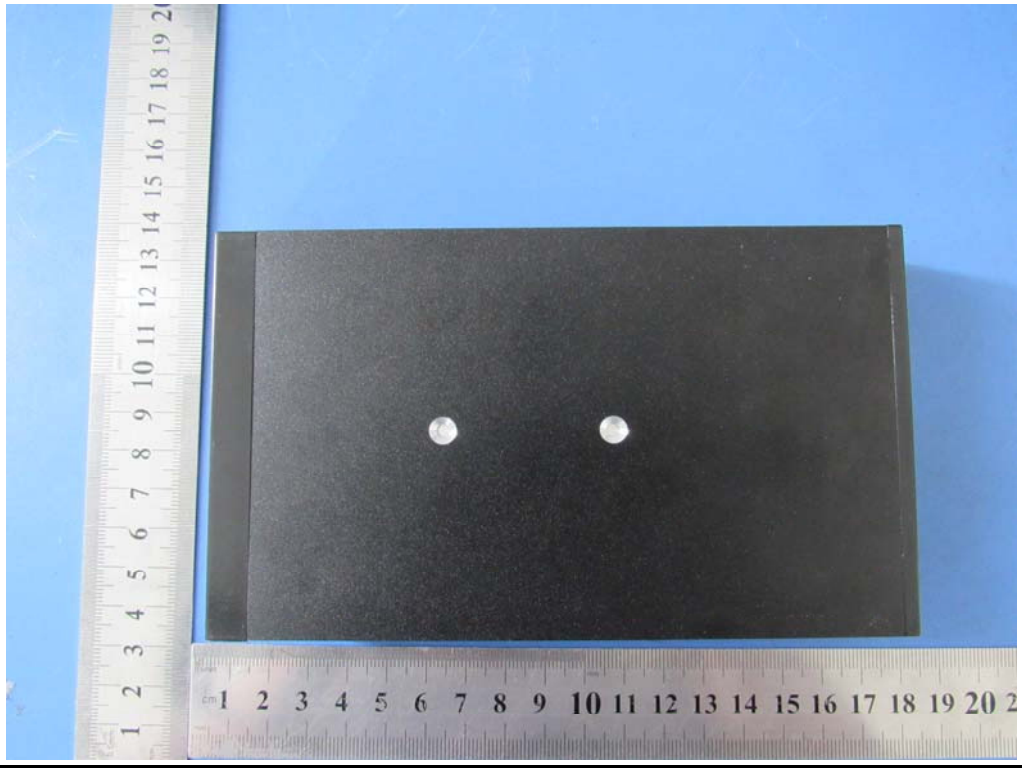
| Instrument | Model | Serial # | Cal Date | Cal Due | In use |
|---|---|---|---|---|---|
| **AC Line Conducted Emissions** | | | | | |
| R&S EMI Test Receiver | ESPI3 | 101216 | 03/31/2016 | 03/31/2017 | ☑ |
| V-LISN | ESH3-Z5 | 838979/005 | 03/31/2016 | 03/31/2017 | ☑ |
| SIEMIC Conducted Emissions software | V1.0 | N/A | N/A | N/A | ☑ |
| **RF conducted test** | | | | | |
| R&S EMI Receiver | ESPI3 | 101216 | 03/31/2016 | 03/31/2017 | ☑ |
| **Radiated Emissions** | | | | | |
| Agilent Technologies Spectrum Analyzer | N9010A | MY47191130 | 03/11/2016 | 03/10/2017 | ☑ |
| R&S EMI Receiver | ESPI3 | 101216 | 03/31/2016 | 03/31/2017 | ☑ |
| Antenna (30MHz~6GHz) | JB6 | A121411 | 10/31/2015 | 10/31/2016 | ☑ |
| EMCO Horn Antenna (1 ~18GHz) | 3115 | N/A | 10/09/2015 | 10/08/2016 | ☑ |
| INFOMW Antenna (1 ~18GHz) | JXTXLB-10180 | J2031081120092 | 10/31/2015 | 10/31/2016 | ☑ |
| Hp Agilent Pre-Amplifier | 8447F | 1937A01160 | 10/30/2015 | 10/30/2016 | ☑ |
| MITEQ Pre-Amplifier (0.1 ~ 18GHz) | AMF-7D-00101800-30-10P | 1451709 | 10/27/2015 | 10/26/2016 | ☑ |
| SIEMIC Radiated Emissions software | V1.0 | N/A | N/A | N/A | ☑ |

# Annex B. EUT And Test Setup Photographs

## Annex B.i. Photograph: EUT External Photo

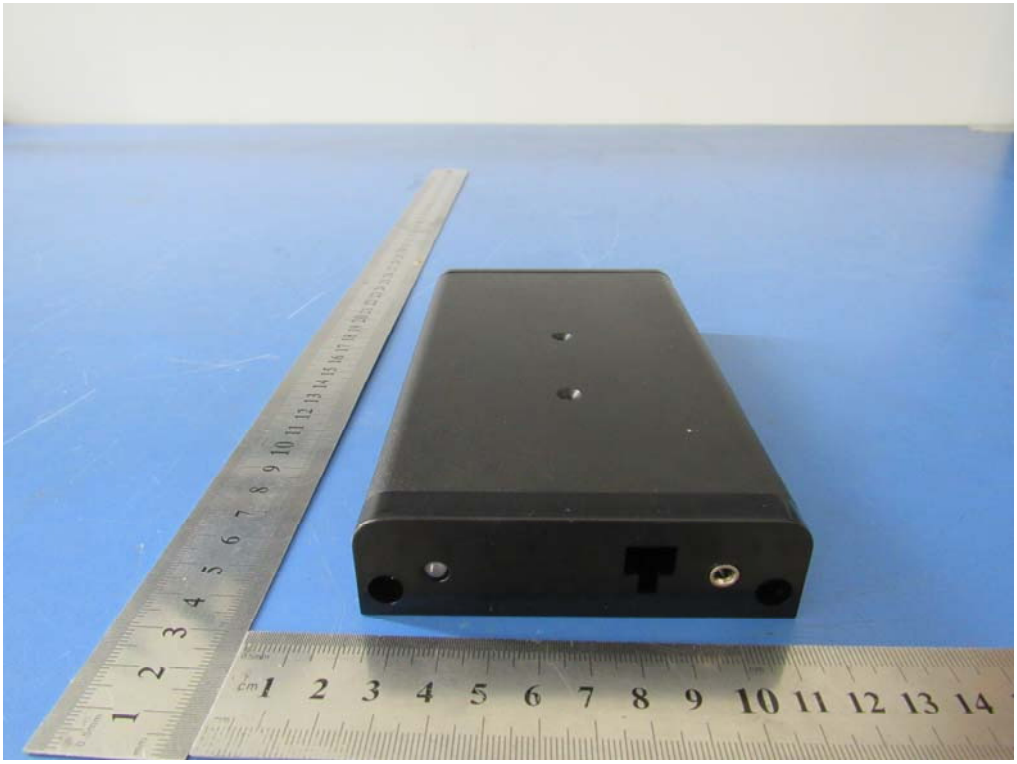


EUT- Front View

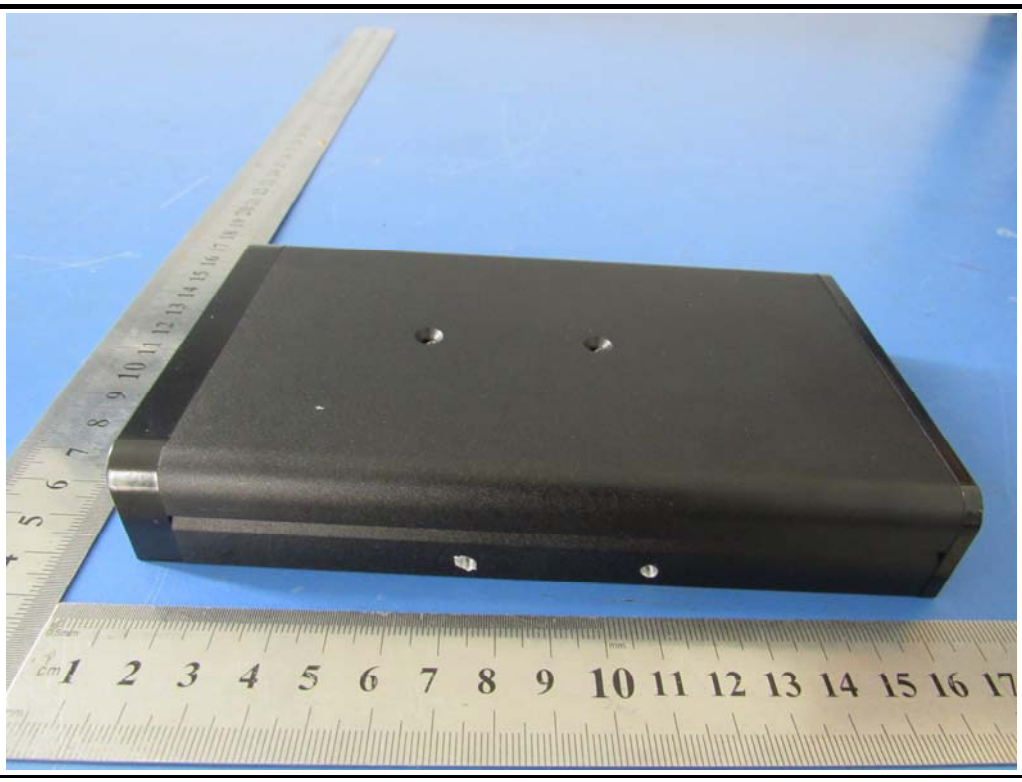


EUT- Rear View

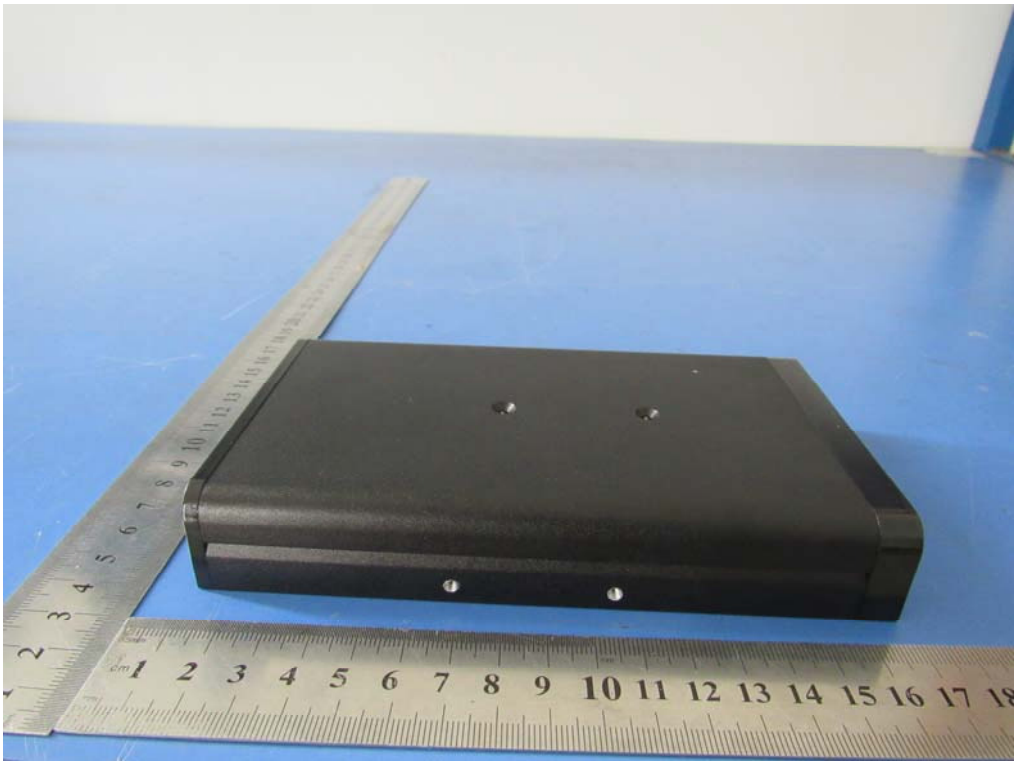
EUT- Top View



EUT- Bottom View

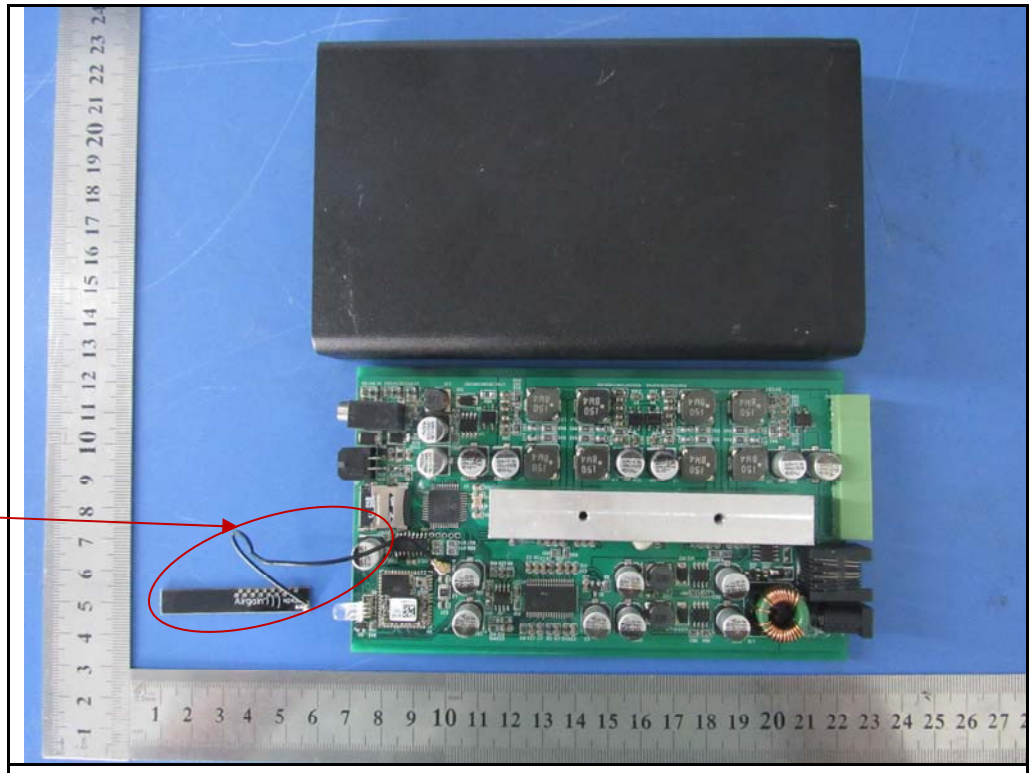


EUT- Left View

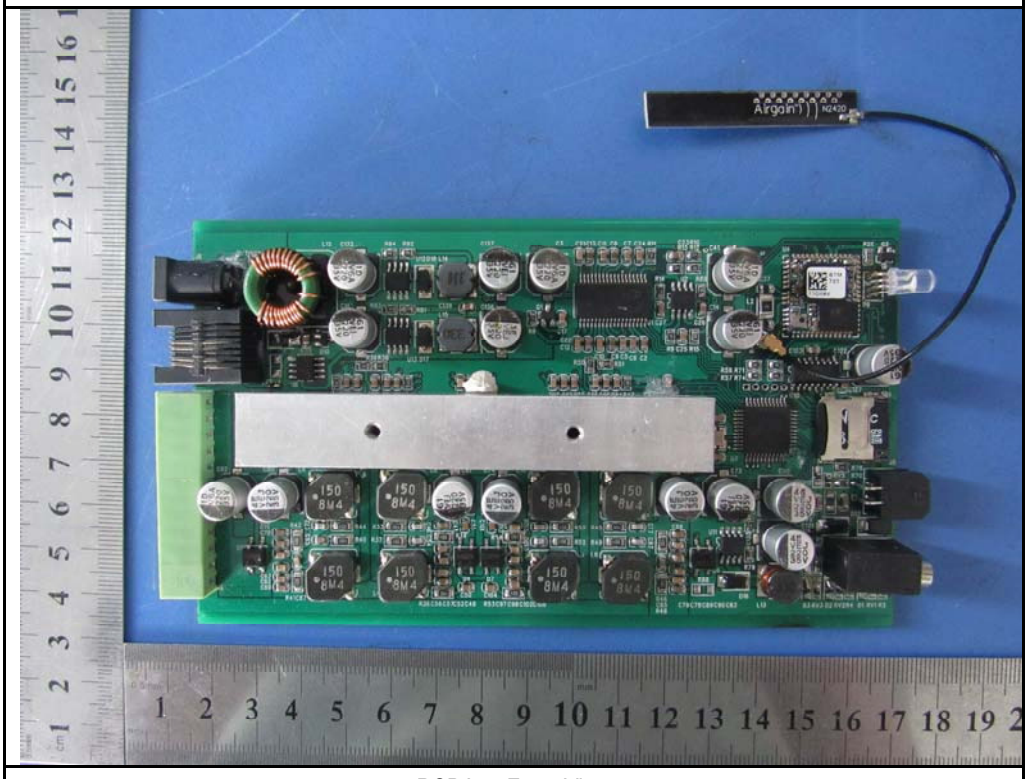


EUT- Right View

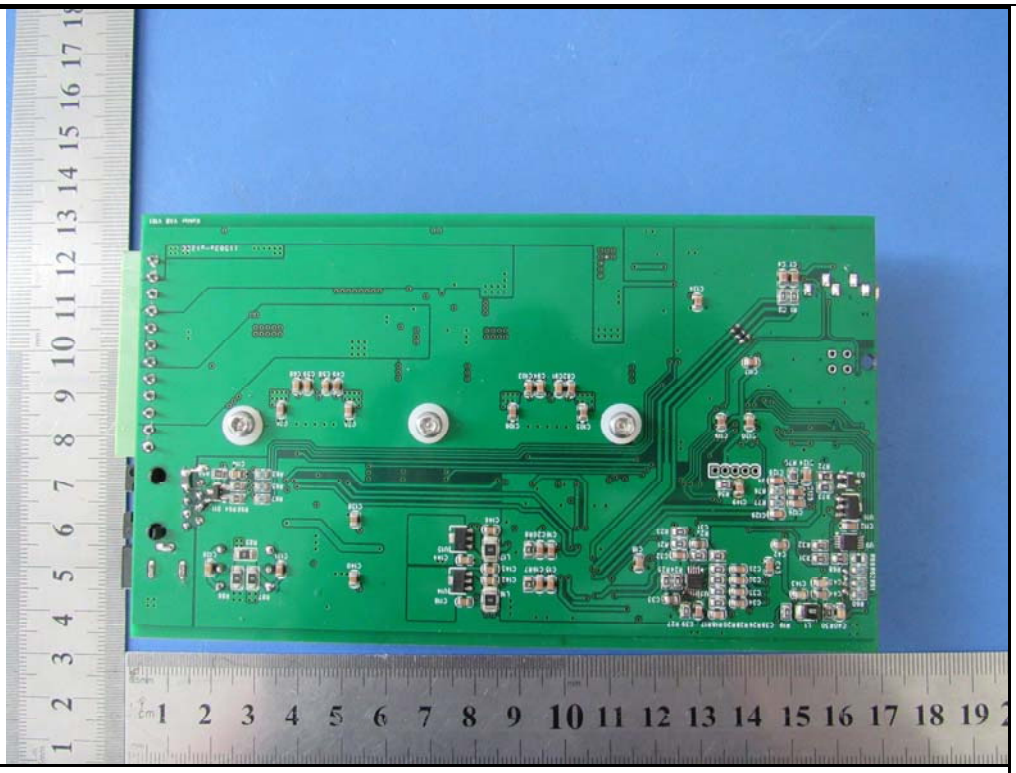
## Annex B.ii. Photograph: EUT Internal Photo



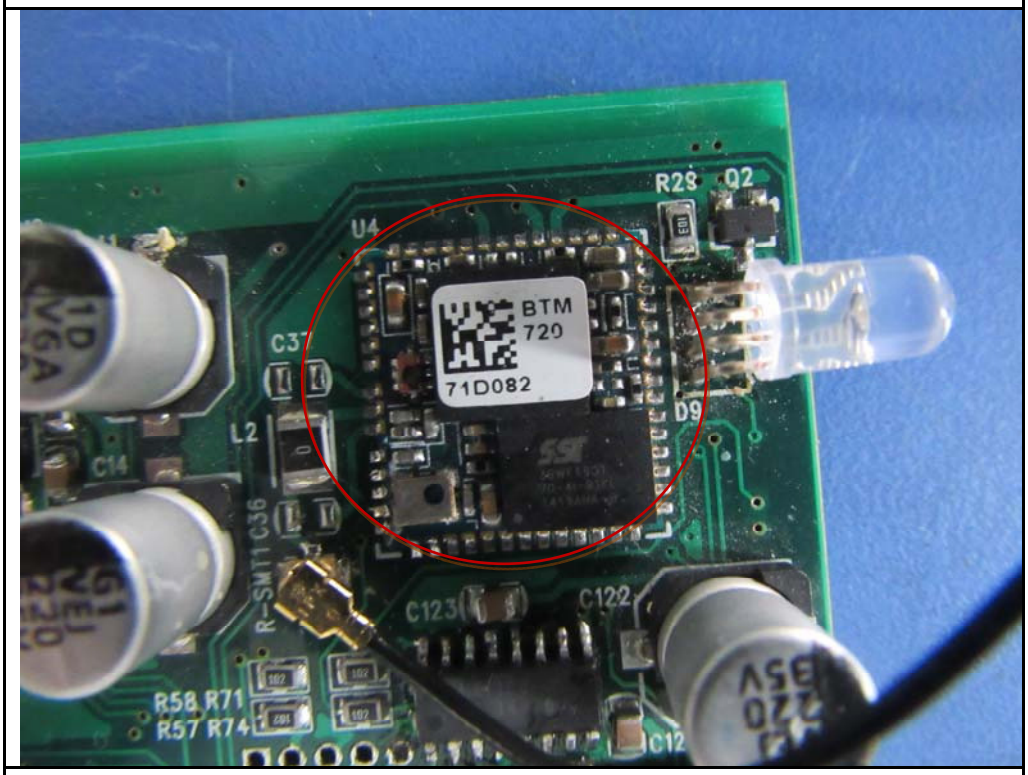

EUT Uncover - Front View



PCBA – Front View



PCBA – Rear View

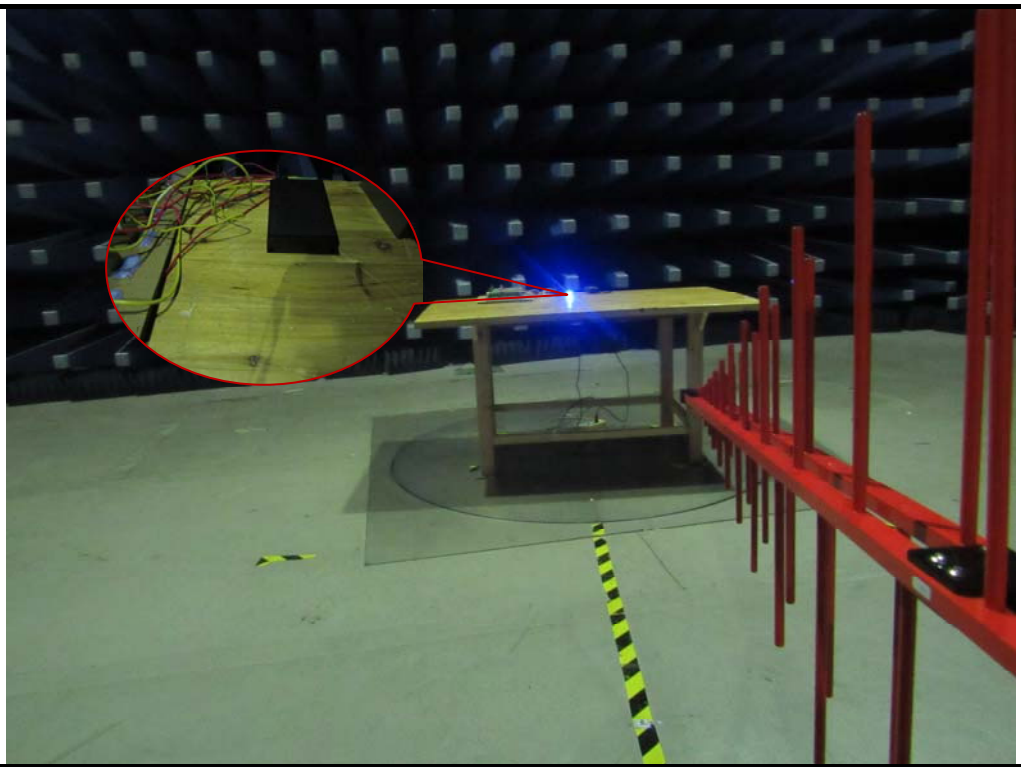



Antenna Module Front View

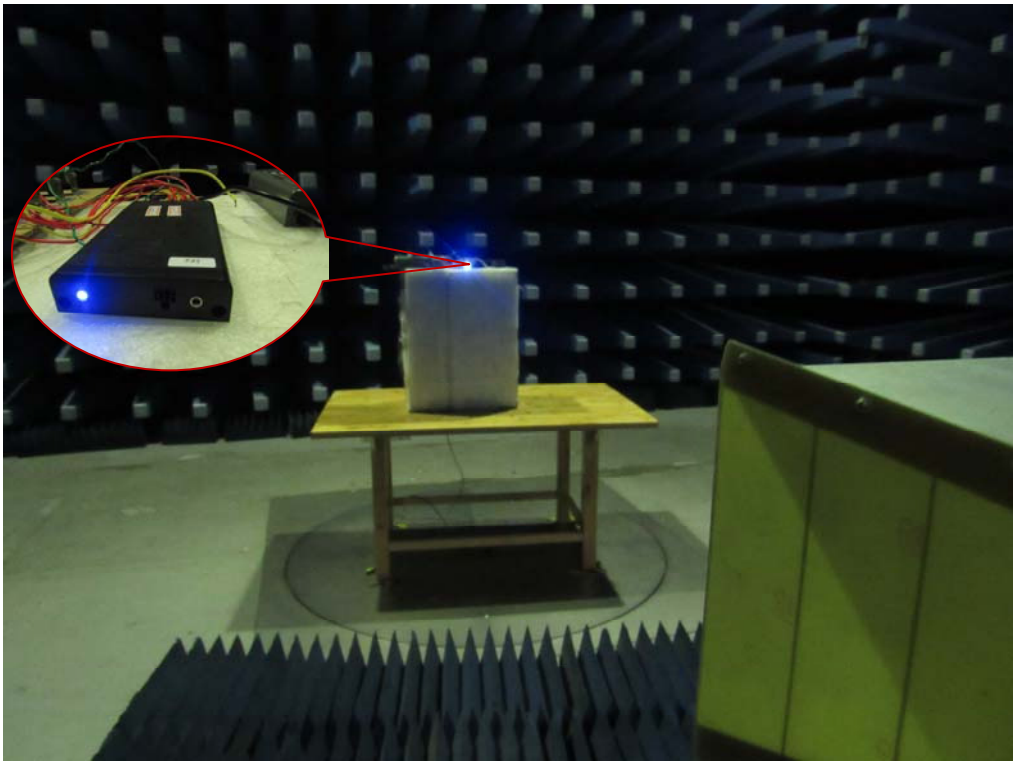
## Annex B.iii. Photograph: Test Setup Photo

Conducted Emissions Test Setup Front View

Conducted Emissions Test Setup Side View



Radiated Spurious Emissions Test Setup Below 1GHz

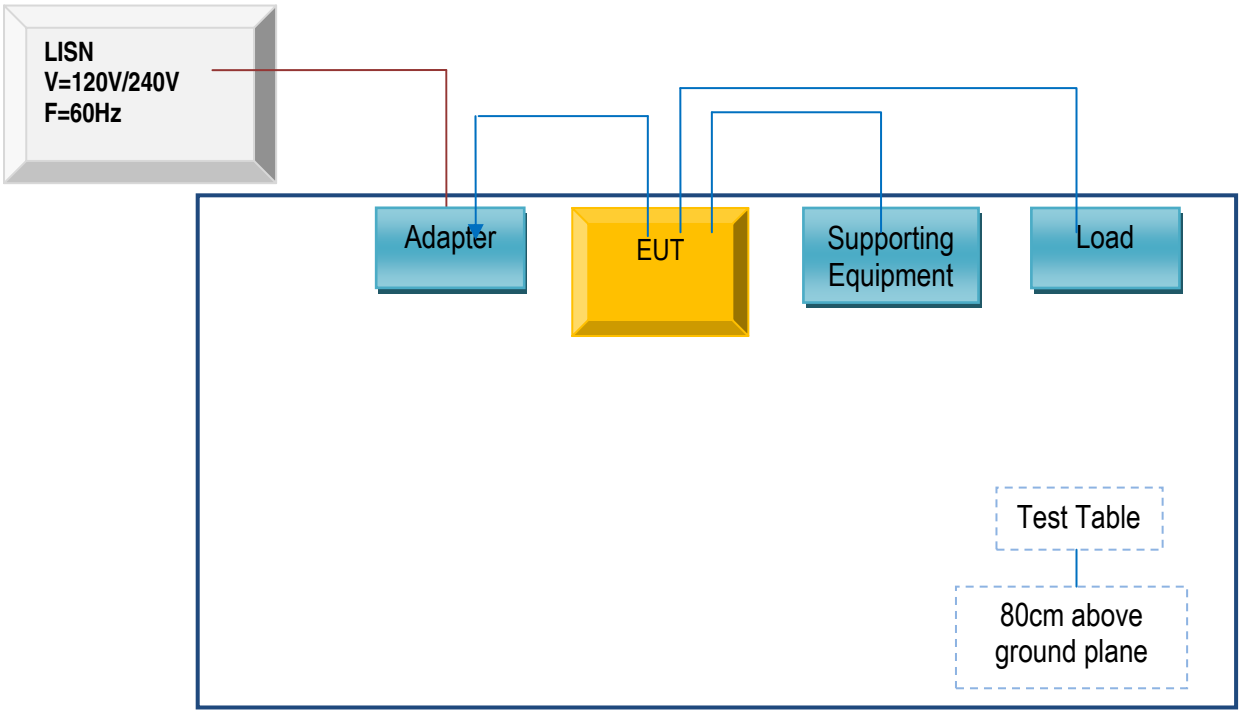


Radiated Spurious Emissions Test Setup Above 1GHz

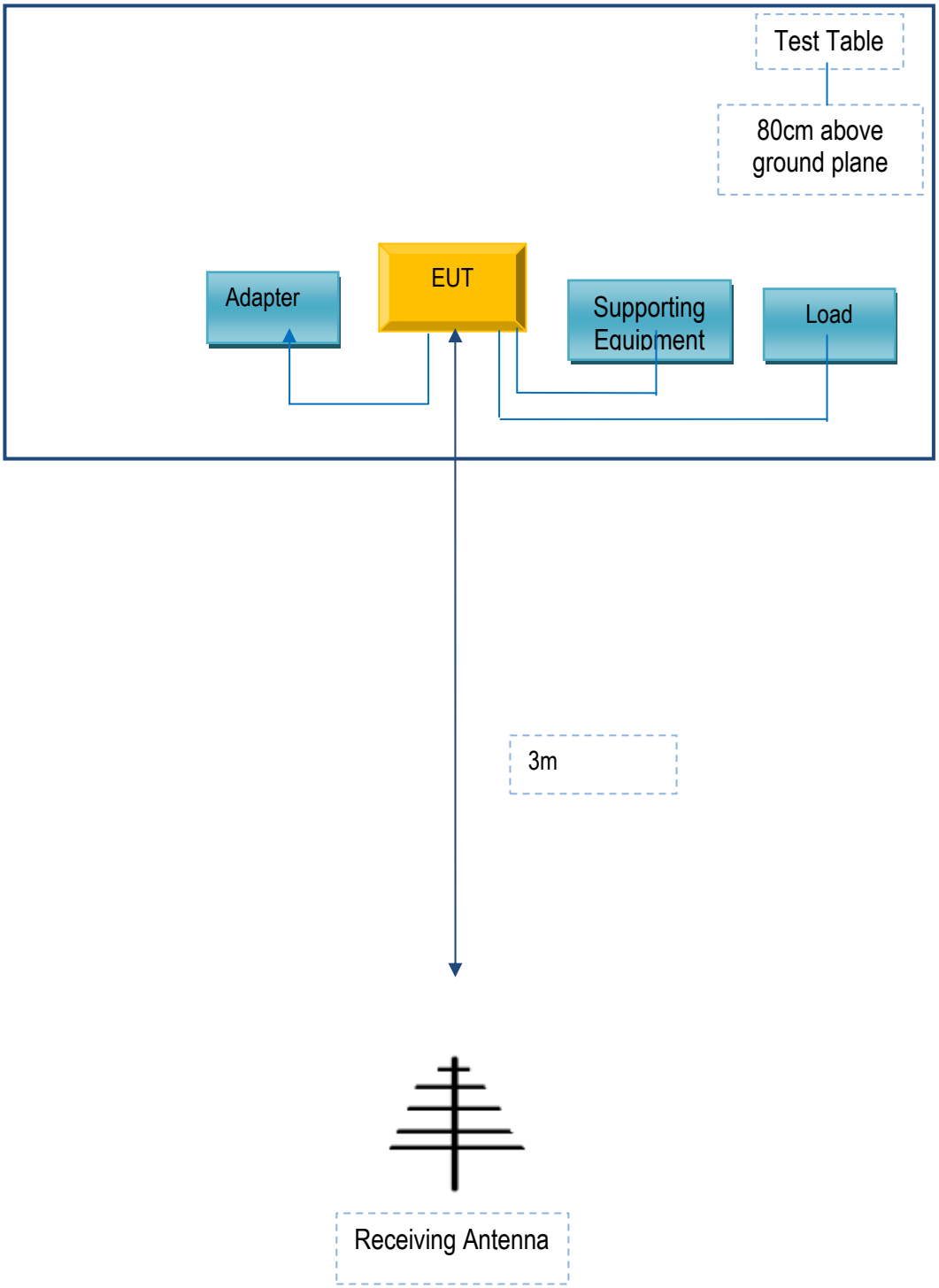
# Annex C. TEST SETUP AND SUPPORTING EQUIPMENT

## Annex C.i. TEST SET UP BLOCK

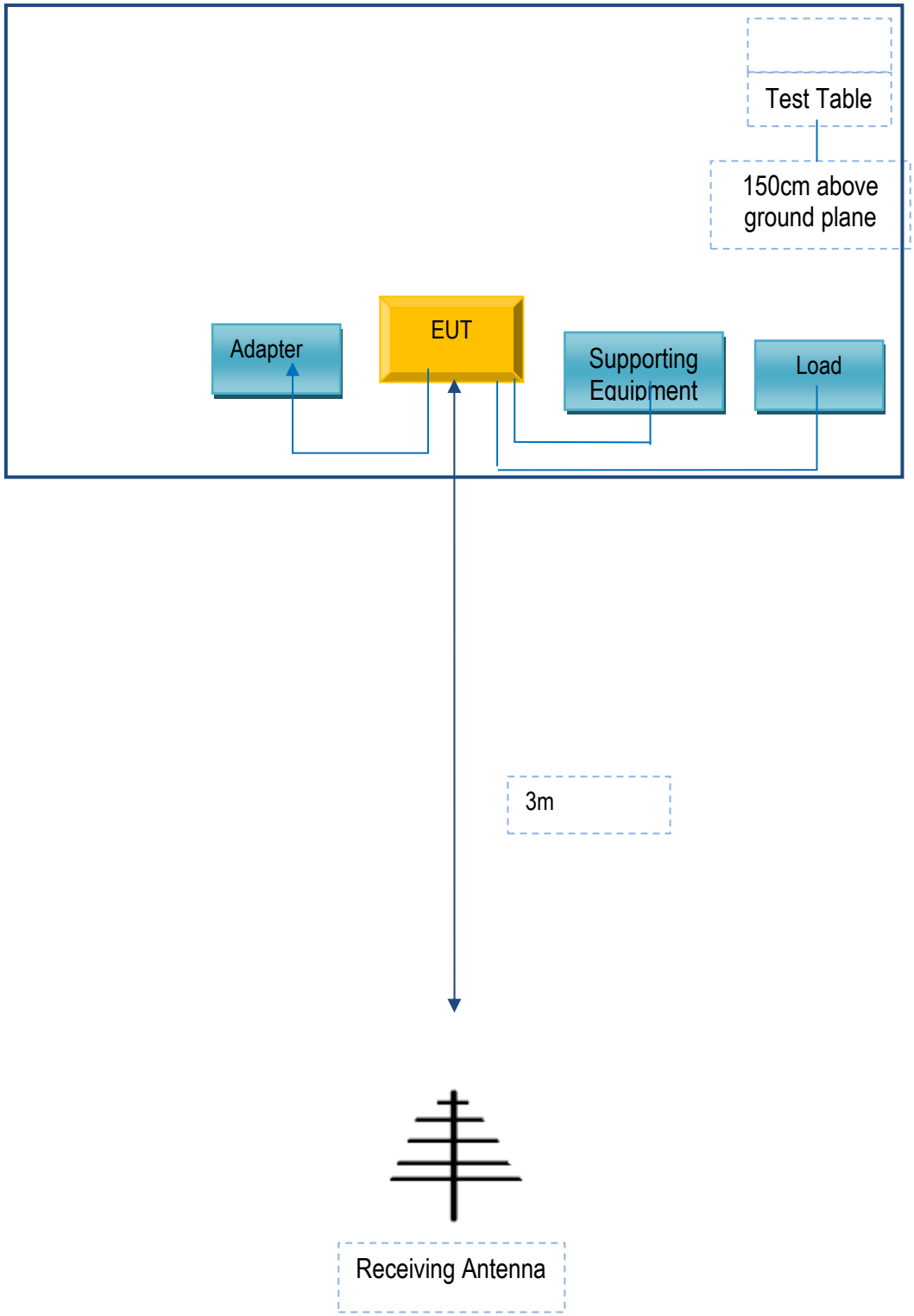
### Block Configuration Diagram for AC Line Conducted Emissions



**Block Configuration Diagram for Radiated Emissions ( Below 1GHz ) .**



**Block Configuration Diagram for Radiated Emissions ( Above 1GHz ) .**



## Annex C. ii. SUPPORTING EQUIPMENT DESCRIPTION

The following is a description of supporting equipment and details of cables used with the EUT.

**Supporting Equipment:**

| Manufacturer | Equipment Description | Model | Serial No |
|---|---|---|---|
| N/A | user interface for VAB system | UI | N/A |
| N/A | Load | N/A | N/A |

**Supporting Cable:**

| Cable type | Shield Type | Ferrite Core | Length | Serial No |
|---|---|---|---|---|
| Power Cable | Un-shielding | No | 1.8m | 42T441636200034 |

# Annex D. User Manual / Block Diagram / Schematics / Partlist

**Please see attachment**

# Annex E. DECLARATION OF SIMILARITY

**N/A**