



# RF TEST REPORT

**Applicant**      Quectel Wireless Solutions Co., Ltd.  
**FCC ID**          XMR201707BG96  
**Product**        Quectel BG96  
**Brand**           Quectel  
**Model**           BG96  
**Report No.**      RXA1706-0199RF07  
**Issue Date**     August 29, 2017

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 2 (2017)/ FCC CFR47 Part 27C (2017)**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

*Jiang peng Lan*

*Performed by: Jiangpeng Lan*

*Kai Xu*

*Approved by: Kai Xu*

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## Summary of Measurement Results

| Number                                                                                                                                                          | Test Case                               | Clause in FCC rules         | Verdict |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-----------------------------|---------|
| 1                                                                                                                                                               | RF power output                         | 2.1046                      | PASS    |
| 2                                                                                                                                                               | Effective Isotropic Radiated power      | 27.50(b)(10) /27.50(c)(10)  | PASS    |
| 3                                                                                                                                                               | Occupied Bandwidth                      | 2.1049                      | PASS    |
| 4                                                                                                                                                               | Band Edge Compliance                    | 27.53(g)                    | PASS    |
| 5                                                                                                                                                               | Peak-to-Average Power Ratio             | 27.50(d)/KDB971168 D01(5.7) | PASS    |
| 6                                                                                                                                                               | Frequency Stability                     | 2.1055 / 27.54              | PASS    |
| 7                                                                                                                                                               | Spurious Emissions at Antenna Terminals | 2.1051 /27.53(g) /27.53(f)  | PASS    |
| 8                                                                                                                                                               | Radiates Spurious Emission              | 2.1053 /27.53(g) /27.53(f)  | PASS    |
| Date of Testing: August 4, 2017 ~ August 18, 2017                                                                                                               |                                         |                             |         |
| Note: PASS: The EUT complies with the essential requirements in the standard.<br>FAIL: The EUT does not comply with the essential requirements in the standard. |                                         |                             |         |

# **1 Test Laboratory**

## **1.1 Notes of the Test Report**

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above. This report must not be used by the client to claim product certification, approval, or endorsement by any government agencies.

## **1.2 Test facility**

### **CNAS (accreditation number: L2264)**

TA Technology (Shanghai) Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

### **FCC (Designation number: CN1179, Test Firm Registration Number: 446626)**

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

### **IC (recognition number is 8510A)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Canada to perform electromagnetic emission measurement.

### **VCCI (recognition number is C-4595, T-2154, R-4113, G-10766)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Japan to perform electromagnetic emission measurement.

### **A2LA (Certificate Number: 3857.01)**

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

### 1.3 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.  
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## 2 General Description of Equipment under Test

### Client Information

|                             |                                                                                    |
|-----------------------------|------------------------------------------------------------------------------------|
| <b>Applicant</b>            | Quectel Wireless Solutions Co., Ltd.                                               |
| <b>Applicant address</b>    | 7th Floor, Hongye Building, No. 1801 Hongmei Road, Xuhui District, Shanghai, China |
| <b>Manufacturer</b>         | Quectel Wireless Solutions Co., Ltd.                                               |
| <b>Manufacturer address</b> | 7th Floor, Hongye Building, No. 1801 Hongmei Road, Xuhui District, Shanghai, China |

### General information

General Information

| EUT Description                                                      |                                                                                                                                 |           |           |
|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|
| Model:                                                               | BG96                                                                                                                            |           |           |
| Hardware Version:                                                    | R1.0                                                                                                                            |           |           |
| Software Version:                                                    | BG96MAR02A02M1G                                                                                                                 |           |           |
| Power Supply:                                                        | External power supply                                                                                                           |           |           |
| Antenna Type:                                                        | The EUT don't have standard Antenna, The Antenna used for testing in this report is the after-market accessory (Dipole Antenna) |           |           |
| Test Mode(s):                                                        | NB-IOT Band 12; NB-IOT Band 13;                                                                                                 |           |           |
| Test Modulation                                                      | BPSK, QPSK                                                                                                                      |           |           |
| NB-IOT Category                                                      | NB1                                                                                                                             |           |           |
| Maximum E.R.P.                                                       | NB-IOT Band 12:                                                                                                                 | 27.21 dBm |           |
|                                                                      | NB-IOT Band 13:                                                                                                                 | 26.40 dBm |           |
| Rated Power Supply Voltage:                                          | 3.8V                                                                                                                            |           |           |
| Extreme Voltage:                                                     | Minimum: 3.3V      Maximum: 4.3V                                                                                                |           |           |
| Extreme Temperature:                                                 | Lowest: -40°C      Highest: +85°C                                                                                               |           |           |
| Operating Frequency Range(s)                                         | Mode                                                                                                                            | Tx (MHz)  | Rx (MHz)  |
|                                                                      | NB-IOT Band 12                                                                                                                  | 699 ~ 716 | 729 ~ 746 |
|                                                                      | NB-IOT Band 13                                                                                                                  | 777 ~ 787 | 746 ~ 756 |
| Note: 1. The information of the EUT is declared by the manufacturer. |                                                                                                                                 |           |           |

| Accessory equipment |                         |
|---------------------|-------------------------|
| Evaluation Board    | RF Cable                |
| RS232-to-USB Cable  | Antenna: Dipole Antenna |
| Headset             | USB Cable               |

### **3 Applied Standards**

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

**FCC CFR47 Part 2 (2017)**

**FCC CFR47 Part 27C (2017)**

**ANSI/TIA-603-D (2010)**

**KDB 971168 D01 Power Meas License Digital Systems v02r02**

## 4 Test Configuration

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes. EUT lie-down stand-up position (X, Y axis), lie-down position (Z axis),. Receiver antenna polarization (horizontal and vertical), the worst emission was found in position (Z axis, vertical polarization) and the worst case was recorded.

All mode and data rates and positions and RB size and modulations were investigated.

Subsequently, only the worst case emissions are reported.

The following testing in NB-IOT is set based on the maximum RF Output Power.

The following testing in different Bandwidth is set to detail in the following table:

Test modes are chosen to be reported as the worst case configuration below for NB-IOT Band 12/13:

| Test items                                                                                                                                           | Modes      | Deployment mode | Subcarrier Spacing (kHz) |    | Modulation |      | Test Channel |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------|--------------------------|----|------------|------|--------------|---|---|
|                                                                                                                                                      |            | Stand-alone     | 3                        | 15 | BPSK       | QPSK | L            | M | H |
| RF power output                                                                                                                                      | NB-IOT B12 | O               | O                        | O  | O          | O    | O            | O | O |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | O            | O | O |
| Effective Isotropic Radiated power                                                                                                                   | NB-IOT B12 | O               | O                        | O  | O          | O    | O            | O | O |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | O            | O | O |
| Occupied Bandwidth                                                                                                                                   | NB-IOT B12 | O               | O                        | O  | O          | O    | O            | O | O |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | O            | O | O |
| Band Edge Compliance                                                                                                                                 | NB-IOT B12 | O               | O                        | O  | O          | O    | O            | - | O |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | O            | - | O |
| Peak-to-Average Power Ratio                                                                                                                          | NB-IOT B12 | O               | O                        | O  | O          | O    | -            | O | - |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | -            | O | - |
| Frequency Stability                                                                                                                                  | NB-IOT B12 | O               | O                        | O  | O          | O    | -            | O | - |
|                                                                                                                                                      | NB-IOT B13 | O               | O                        | O  | O          | O    | -            | O | - |
| Spurious Emissions at Antenna Terminals                                                                                                              | NB-IOT B12 | O               | -                        | O  | -          | O    | O            | O | O |
|                                                                                                                                                      | NB-IOT B13 | O               | -                        | O  | -          | O    | O            | O | O |
| Radiates Spurious Emission                                                                                                                           | NB-IOT B12 | O               | -                        | O  | -          | O    | O            | O | O |
|                                                                                                                                                      | NB-IOT B13 | O               | -                        | O  | -          | O    | O            | O | O |
| <b>Note</b><br>1. The mark "O" means that this configuration is chosen for testing.<br>2. The mark "-" means that this configuration is not testing. |            |                 |                          |    |            |      |              |   |   |

## 5 Test Case Results

### 5.1 RF Power Output

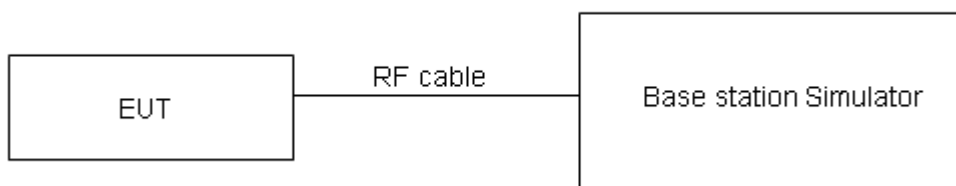
#### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

#### Methods of Measurement

During the process of the testing, The EUT is controlled by the Base Station Simulator to ensure max power transmission and proper modulation.

#### Test Setup



The loss between RF output port of the EUT and the input port of the tester has been taken into consideration.

#### Limits

No specific RF power output requirements in part 2.1046.

#### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 2$ ,  $U=0.4$  dB.

**Test Results**

| NB-IOT Band 12  |                           |            |        | Conducted Power(dBm)   |             |             |
|-----------------|---------------------------|------------|--------|------------------------|-------------|-------------|
| Deployment mode | Sub-carrier spacing (kHz) | Modulation | Ntones | Channel/Frequency(MHz) |             |             |
|                 |                           |            |        | 23011/699.1            | 23095/707.5 | 23179/715.9 |
| Stand-alone     | 3.75                      | BPSK       | 1@0    | 22.47                  | 22.85       | 23.17       |
|                 |                           | BPSK       | 1@47   | 22.45                  | 22.95       | 23.16       |
|                 | 15                        | BPSK       | 1@0    | 23.05                  | 22.92       | 23.71       |
|                 |                           | BPSK       | 1@11   | 23.08                  | 23.14       | 23.70       |
|                 | 3.75                      | QPSK       | 1@0    | 22.48                  | 22.89       | 23.15       |
|                 |                           | QPSK       | 1@47   | 22.46                  | 22.98       | 23.18       |
|                 | 15                        | QPSK       | 1@0    | 23.02                  | 23.33       | 23.69       |
|                 |                           | QPSK       | 1@11   | 23.09                  | 23.14       | 23.74       |
|                 |                           | QPSK       | 12@0   | 23.26                  | 23.62       | 23.78       |

| NB-IOT Band 13  |                           |            |        | Conducted Power(dBm)   |           |             |
|-----------------|---------------------------|------------|--------|------------------------|-----------|-------------|
| Deployment mode | Sub-carrier spacing (kHz) | Modulation | Ntones | Channel/Frequency(MHz) |           |             |
|                 |                           |            |        | 23181/777.1            | 23230/782 | 23279/786.9 |
| Stand-alone     | 3.75                      | BPSK       | 1@0    | 22.36                  | 22.53     | 22.53       |
|                 |                           | BPSK       | 1@47   | 22.34                  | 22.34     | 22.51       |
|                 | 15                        | BPSK       | 1@0    | 22.68                  | 22.69     | 22.90       |
|                 |                           | BPSK       | 1@11   | 22.67                  | 22.67     | 22.94       |
|                 | 3.75                      | QPSK       | 1@0    | 22.32                  | 22.51     | 22.54       |
|                 |                           | QPSK       | 1@47   | 22.35                  | 22.36     | 22.52       |
|                 | 15                        | QPSK       | 1@0    | 22.60                  | 22.69     | 22.87       |
|                 |                           | QPSK       | 1@11   | 22.66                  | 22.71     | 22.91       |
|                 |                           | QPSK       | 12@0   | 22.81                  | 23.02     | 23.13       |

## 5.2 Effective Isotropic Radiated Power

### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

### Methods of Measurement

1. The testing follows FCC KDB 971168 v02r02 Section 5.8 and ANSI / TIA-603-D-2010 Section 2.2.12.
2. Above 30MHz: The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H). Above 1GHz: (Note: the FCC's permission to use 1.5m as an aNB-LoTrnative per TCBC Conf call of Dec. 2, 2014.) The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).
3. A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted in place of the EUT. The log-periodic antenna will be driven by a signal generator and the level will be adjusted till the same power value on the spectrum analyzer or receiver. The level of the spurious emissions can be calculated through the level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.
4. The EUT is then put into continuously transmitting mode at its maximum power level during the test. Set Test Receiver or Spectrum RBW=1MHz, VBW=3MHz, And the maximum value of the receiver should be recorded as (Pr).
5. The EUT shall be replaced by a substitution antenna. In the chamber, an substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (PMea) is applied to the input of the substitution antenna, and adjust the level of the signal generator output until the value of the receiver reach the previously recorded (Pr). The power of signal source (PMea) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.
6. A amplifier should be connected to the Signal Source output port. And the cable should be connect between the Amplifier and the Substitution Antenna. The cable loss (Pcl) ,the Substitution Antenna Gain (Ga) and the Amplifier Gain (PAg) should be recorded after test.
7. The measurement results are obtained as described below:  

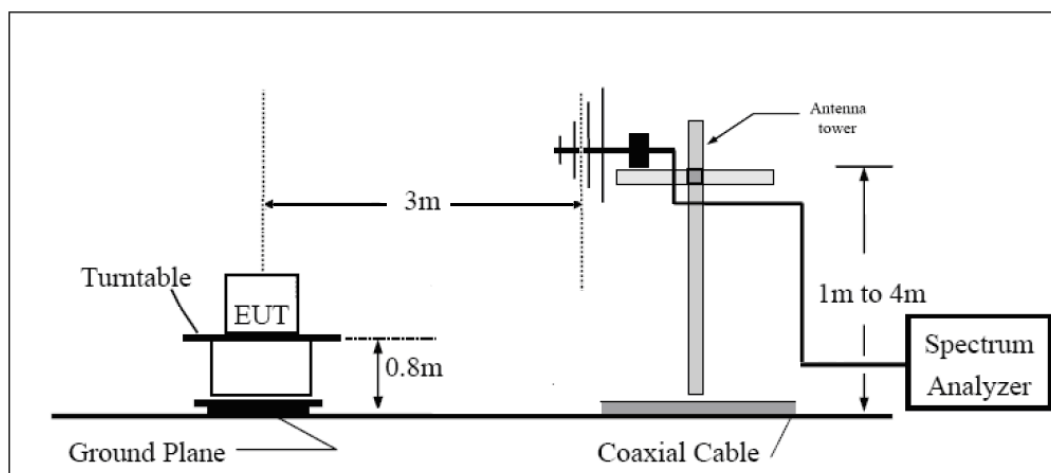
$$\text{Power(EIRP)} = \text{PMea} - \text{PAg} - \text{Pcl} + \text{Ga}$$
The measurement results are amend as described below:  

$$\text{Power(EIRP)} = \text{PMea} - \text{Pcl} + \text{Ga}$$
8. This value is EIRP since the measurement is calibrated using an antenna of known gain (2.15 dBi) and known input power. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP

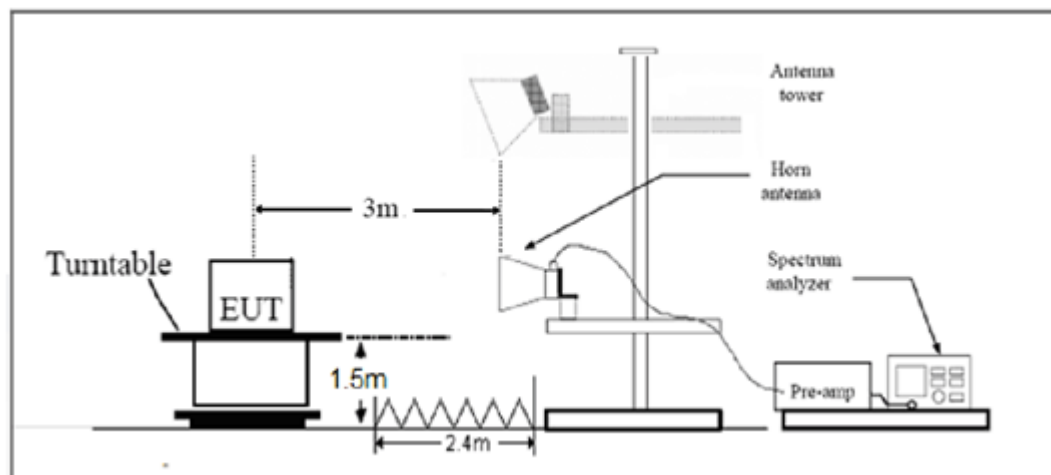
= EIRP-2.15dBi.

### Test setup

30MHz~~~ 1GHz



Above 1GHz



Note: Area side:2.4mX3.6m

### Limits

Rule Part 27.50(b) (10) specifies that “Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP”

Rule Part 27.50(c) (10) specifies that “Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP”

|                              |                                |
|------------------------------|--------------------------------|
| Part 27.50(b)(10)Limit (ERP) | $\leq 3 \text{ W}$ (34.77 dBm) |
| Part 27.50(c)(10)Limit (ERP) | $\leq 3 \text{ W}$ (34.77 dBm) |

### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 2$ ,  $U = 1.19 \text{ dB}$

**Test Results**

| NB-IOT Band 12 Standalone |            |                           |          |          |          |          |           |             |            |
|---------------------------|------------|---------------------------|----------|----------|----------|----------|-----------|-------------|------------|
| Frequency (MHz)           | Modulation | Sub-carrier spacing (kHz) | Rt (dBm) | Rs (dBm) | Ps (dBm) | Gs (dBd) | ERP (dBm) | Limit (dBm) | Conclusion |
| 699.1                     | BPSK       | 3.75                      | -49.98   | -47.92   | 0.00     | 2.06     | 25.97     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -49.98   | -47.92   | 0.00     | 2.06     | 25.98     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -49.91   | -47.85   | 0.00     | 2.06     | 26.55     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -49.91   | -47.85   | 0.00     | 2.06     | 26.52     | 34.77       | Pass       |
| 707.5                     | BPSK       | 3.75                      | -50.29   | -48.27   | 0.00     | 2.03     | 26.35     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -50.29   | -48.27   | 0.00     | 2.03     | 26.39     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -50.29   | -48.26   | 0.00     | 2.03     | 26.42     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -50.29   | -48.26   | 0.00     | 2.03     | 26.83     | 34.77       | Pass       |
| 715.9                     | BPSK       | 3.75                      | -50.64   | -48.68   | 0.00     | 1.96     | 26.67     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -50.64   | -48.68   | 0.00     | 1.96     | 26.65     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -50.62   | -48.66   | 0.00     | 1.96     | 27.21     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -50.62   | -48.66   | 0.00     | 1.96     | 27.19     | 34.77       | Pass       |

| NB-IOT Band 13 Standalone |            |                           |          |          |          |          |           |             |            |
|---------------------------|------------|---------------------------|----------|----------|----------|----------|-----------|-------------|------------|
| Frequency (MHz)           | Modulation | Sub-carrier spacing (kHz) | Rt (dBm) | Rs (dBm) | Ps (dBm) | Gs (dBd) | ERP (dBm) | Limit (dBm) | Conclusion |
| 777.1                     | BPSK       | 3.75                      | -52.25   | -50.88   | 0.00     | 1.37     | 25.86     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -52.25   | -50.88   | 0.00     | 1.37     | 25.82     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -52.59   | -51.22   | 0.00     | 1.37     | 26.18     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -52.59   | -51.22   | 0.00     | 1.37     | 26.10     | 34.77       | Pass       |
| 782                       | BPSK       | 3.75                      | -52.01   | -50.66   | 0.00     | 1.34     | 26.03     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -52.01   | -50.66   | 0.00     | 1.34     | 26.01     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -52.24   | -50.89   | 0.00     | 1.34     | 26.19     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -52.24   | -50.89   | 0.00     | 1.34     | 25.92     | 34.77       | Pass       |
| 786.9                     | BPSK       | 3.75                      | -51.58   | -50.27   | 0.00     | 1.31     | 26.03     | 34.77       | Pass       |
|                           | QPSK       | 3.75                      | -51.58   | -50.27   | 0.00     | 1.31     | 26.04     | 34.77       | Pass       |
|                           | BPSK       | 15                        | -51.76   | -50.45   | 0.00     | 1.31     | 26.40     | 34.77       | Pass       |
|                           | QPSK       | 15                        | -51.76   | -50.45   | 0.00     | 1.31     | 26.37     | 34.77       | Pass       |

Note: 1. EIRP= E.R.P+2.15

### 5.3 Occupied Bandwidth

#### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

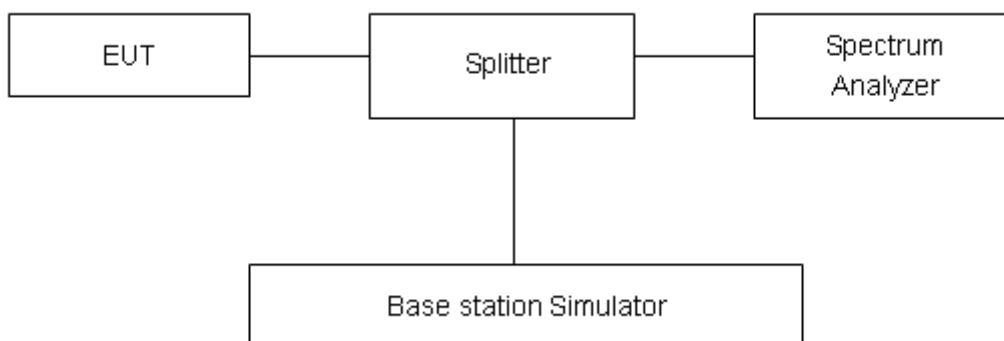
#### Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The occupied bandwidth is measured using spectrum analyzer.

RBW is set to 2kHz, VBW is set to 6.2kHz for NB-IOT Band 12/13.

99% power and -26dBc occupied bandwidths are recorded. Spectrum analyzer plots are included on the following pages.

#### Test Setup



#### Limits

No specific occupied bandwidth requirements in part 2.1049.

#### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 2$ ,  $U=624\text{Hz}$ .

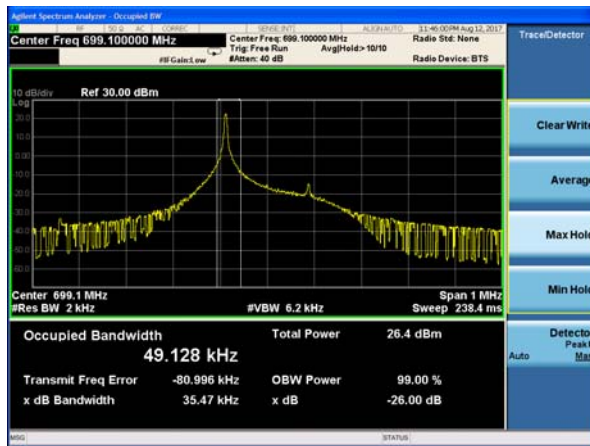
**Test Result**

| NB-IOT Band 12 Standalone      |            |                                 |        |                             |                          |
|--------------------------------|------------|---------------------------------|--------|-----------------------------|--------------------------|
| Channel/<br>Frequency<br>(MHz) | Modulation | Sub-carrier<br>spacing<br>(kHz) | Ntones | 99% Power<br>Bandwidth(kHz) | -26dBc<br>Bandwidth(kHz) |
| 23011/<br>699.1                | BPSK       | 3.75                            | 1@0    | 49.128                      | 35.470                   |
|                                | QPSK       | 3.75                            | 1@0    | 162.730                     | 134.100                  |
|                                | BPSK       | 15                              | 1@0    | 59.688                      | 39.570                   |
|                                | QPSK       | 15                              | 1@0    | 132.830                     | 129.800                  |
|                                | QPSK       | 15                              | 12@0   | 199.470                     | 304.700                  |
| 23095/<br>707.5                | BPSK       | 3.75                            | 1@0    | 51.215                      | 38.060                   |
|                                | QPSK       | 3.75                            | 1@0    | 148.180                     | 107.500                  |
|                                | BPSK       | 15                              | 1@0    | 56.256                      | 39.580                   |
|                                | QPSK       | 15                              | 1@0    | 141.800                     | 130.400                  |
|                                | QPSK       | 15                              | 12@0   | 197.860                     | 276.100                  |
| 23179/<br>715.9                | BPSK       | 3.75                            | 1@0    | 47.805                      | 36.310                   |
|                                | QPSK       | 3.75                            | 1@0    | 162.520                     | 132.600                  |
|                                | BPSK       | 15                              | 1@0    | 61.578                      | 41.580                   |
|                                | QPSK       | 15                              | 1@0    | 141.860                     | 116.100                  |
|                                | QPSK       | 15                              | 12@0   | 199.830                     | 319.400                  |

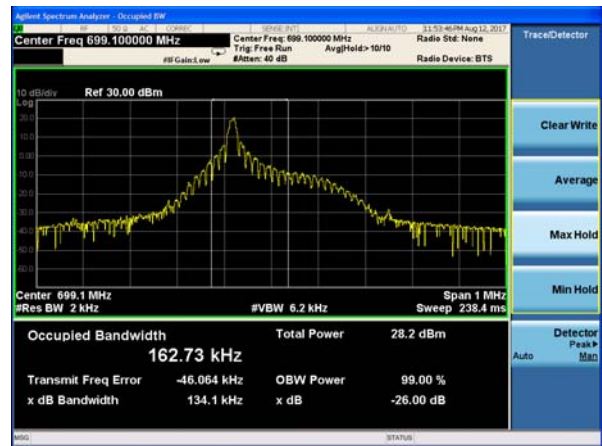
| NB-IOT Band 13 Standalone      |            |                                 |        |                             |                          |
|--------------------------------|------------|---------------------------------|--------|-----------------------------|--------------------------|
| Channel/<br>Frequency<br>(MHz) | Modulation | Sub-carrier<br>spacing<br>(kHz) | Ntones | 99% Power<br>Bandwidth(kHz) | -26dBc<br>Bandwidth(kHz) |
| 23181/<br>777.1                | BPSK       | 3.75                            | 1@0    | 54.004                      | 38.290                   |
|                                | QPSK       | 3.75                            | 1@0    | 150.670                     | 114.000                  |
|                                | BPSK       | 15                              | 1@0    | 61.886                      | 43.310                   |
|                                | QPSK       | 15                              | 1@0    | 146.580                     | 117.600                  |
|                                | QPSK       | 15                              | 12@0   | 195.410                     | 279.900                  |
| 23230/<br>782                  | BPSK       | 3.75                            | 1@0    | 53.659                      | 38.370                   |
|                                | QPSK       | 3.75                            | 1@0    | 157.480                     | 119.600                  |
|                                | BPSK       | 15                              | 1@0    | 63.697                      | 42.090                   |
|                                | QPSK       | 15                              | 1@0    | 140.750                     | 130.700                  |
|                                | QPSK       | 15                              | 12@0   | 198.660                     | 279.800                  |
| 23279/<br>786.9                | BPSK       | 3.75                            | 1@0    | 53.451                      | 38.540                   |
|                                | QPSK       | 3.75                            | 1@0    | 149.430                     | 117.400                  |
|                                | BPSK       | 15                              | 1@0    | 62.282                      | 40.380                   |
|                                | QPSK       | 15                              | 1@0    | 146.250                     | 142.000                  |
|                                | QPSK       | 15                              | 12@0   | 194.960                     | 275.700                  |



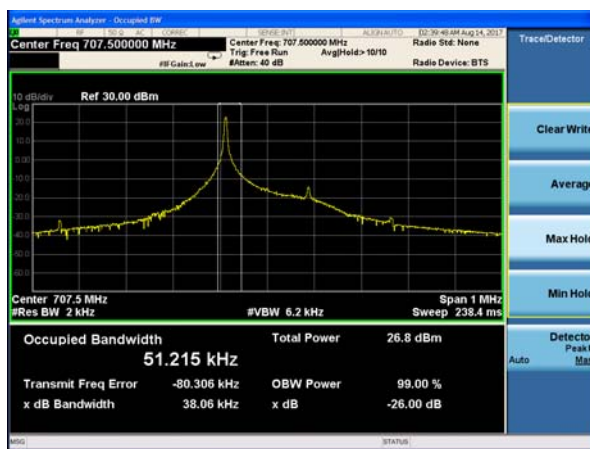
## NB-IOT Band 12 BPSK 3.75kHz 1@0 CH-Low



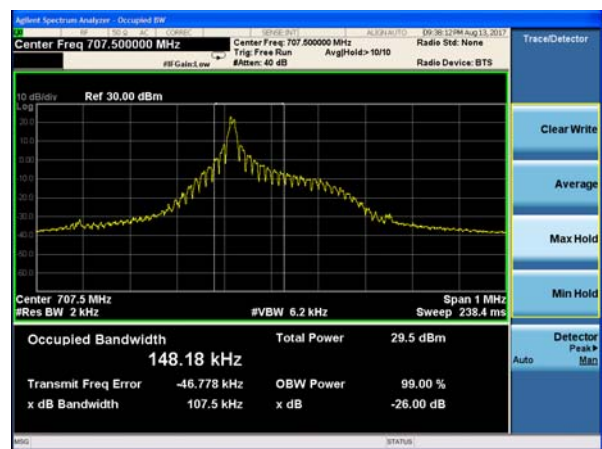
## NB-IOT Band 12 BPSK 15kHz 1@0 CH-Low



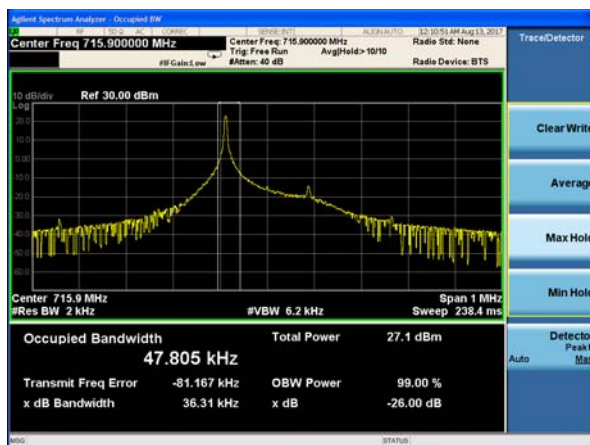
## NB-IOT Band 12 BPSK 3.75kHz 1@0 CH-Middle



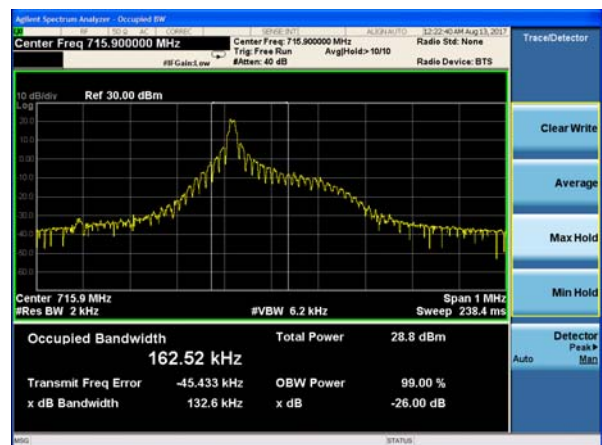
## NB-IOT Band 12 BPSK 15kHz 1@0 CH-Middle



## NB-IOT Band 12 BPSK 3.75kHz 1@0 CH-High

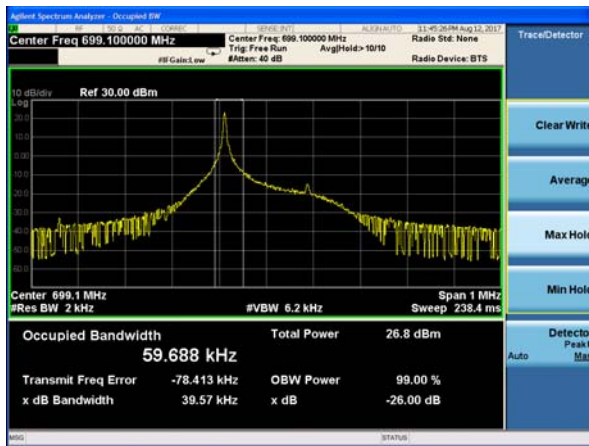


## NB-IOT Band 12 BPSK 15kHz 1@0 CH-High

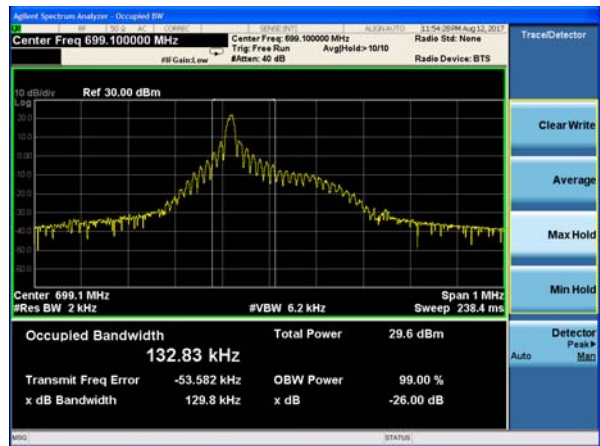




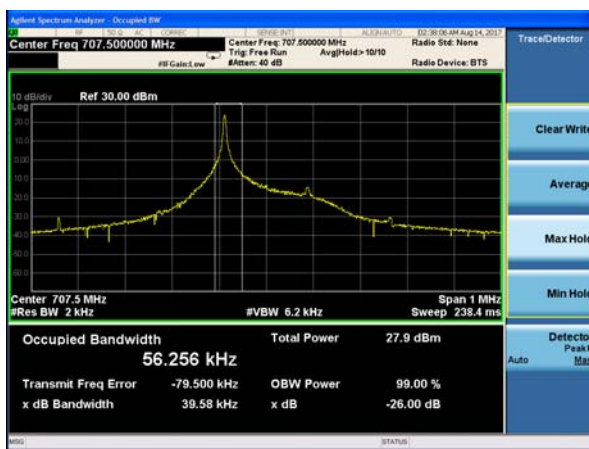
## NB-IOT Band 12 QPSK 3.75kHz 1@0 CH-Low



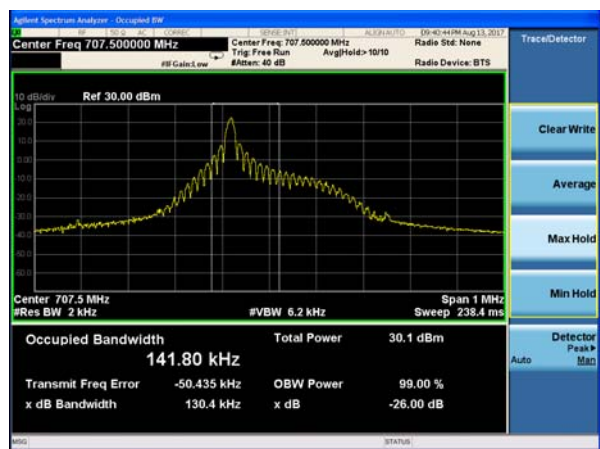
## NB-IOT Band 12 QPSK 15kHz 1@0 CH-Low



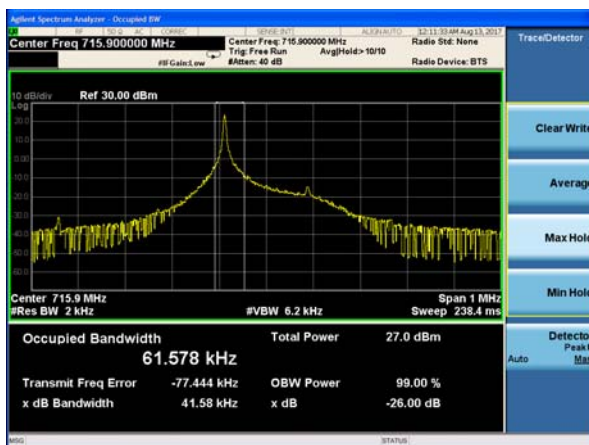
## NB-IOT Band 12 QPSK 3.75kHz 1@0 CH-Middle



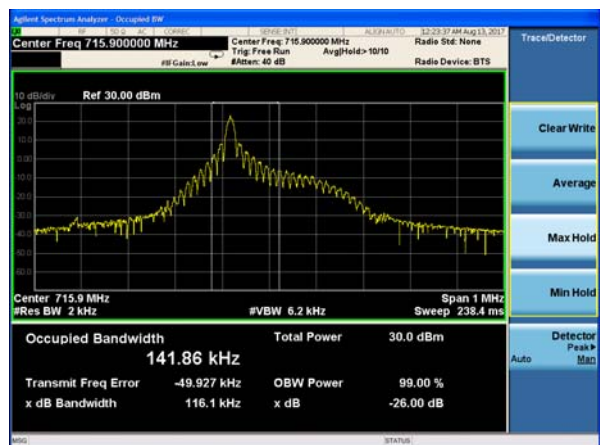
## NB-IOT Band 12 QPSK 15kHz 1@0 CH-Middle



## NB-IOT Band 12 QPSK 3.75kHz 1@0 CH-High

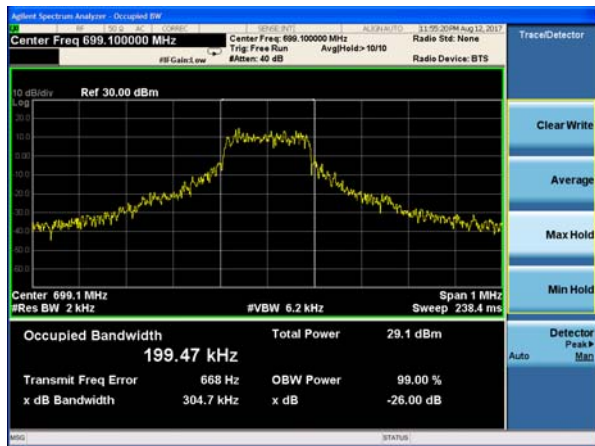


## NB-IOT Band 12 QPSK 15kHz 1@0 CH-High

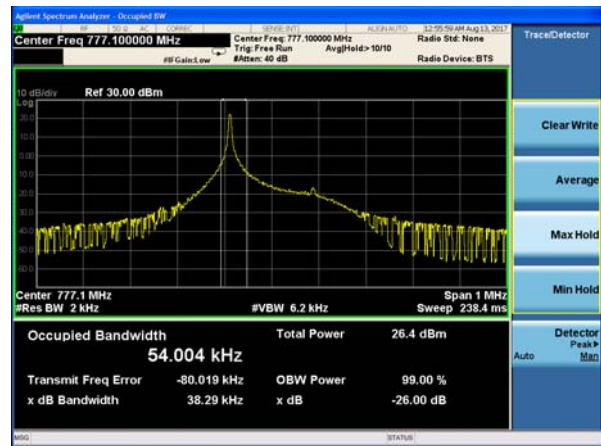




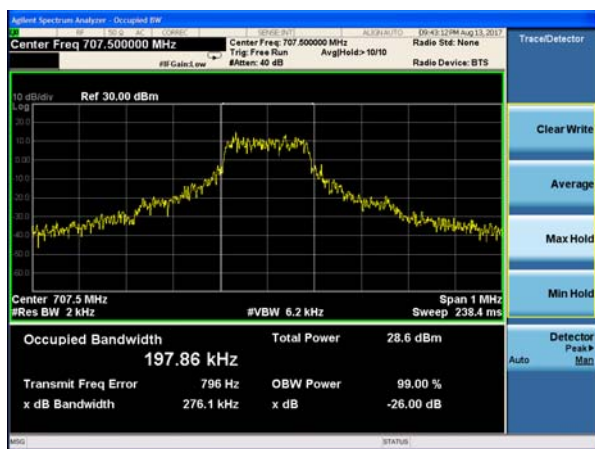
## NB-IOT Band 12 QPSK 15kHz 12@0 CH-Low



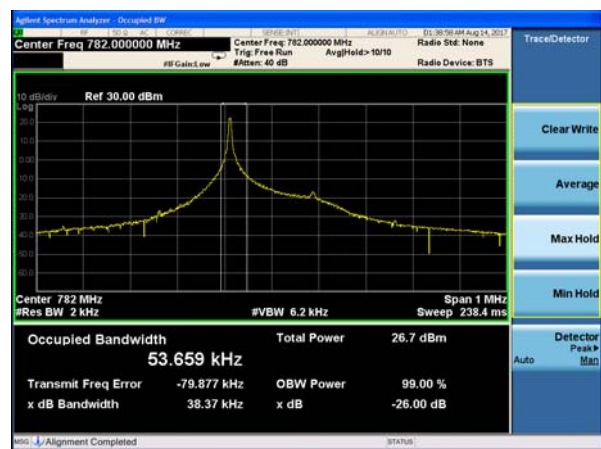
## NB-IOT Band 13 BPSK 3.75kHz 1@0 CH-Low



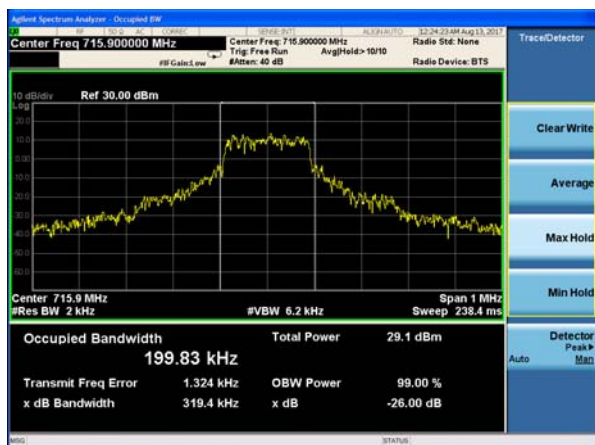
## NB-IOT Band 12 QPSK 15kHz 12@0 CH-Middle



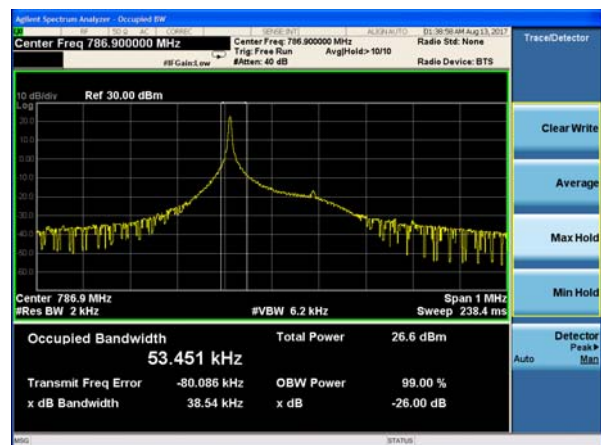
## NB-IOT Band 13 BPSK 3.75kHz 1@0 CH-Middle



## NB-IOT Band 12 QPSK 15kHz 12@0 CH-High

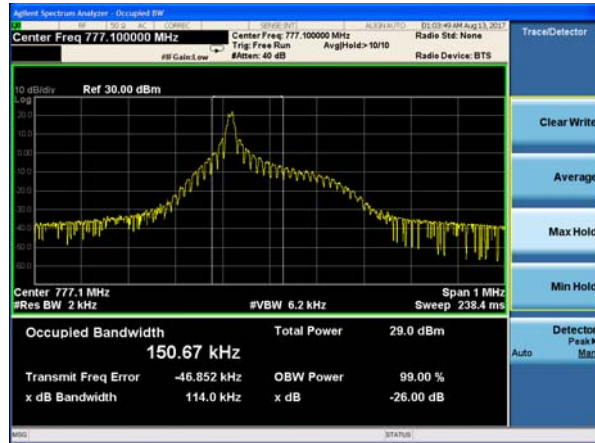


## NB-IOT Band 13 BPSK 3.75kHz 1@0 CH-High

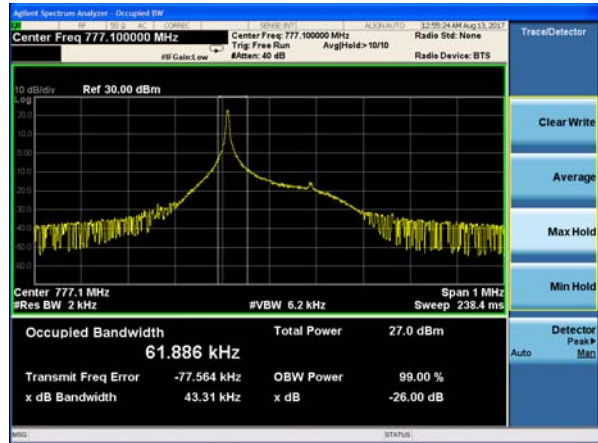




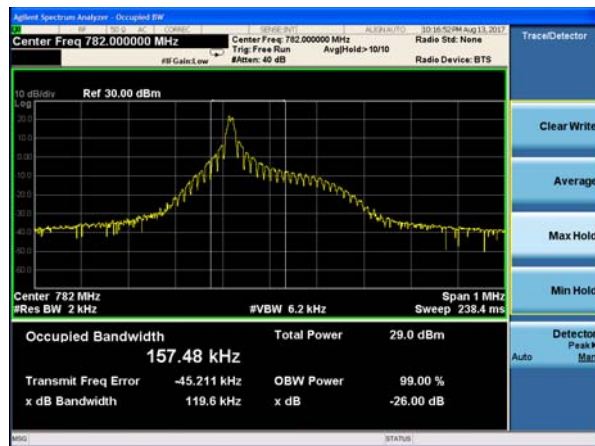
## NB-IOT Band 13 BPSK 15kHz 1@0 CH-Low



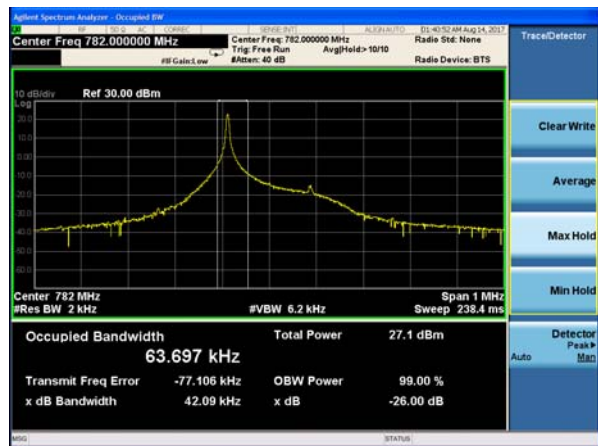
## NB-IOT Band 13 QPSK 3.75kHz 1@0 CH-Low



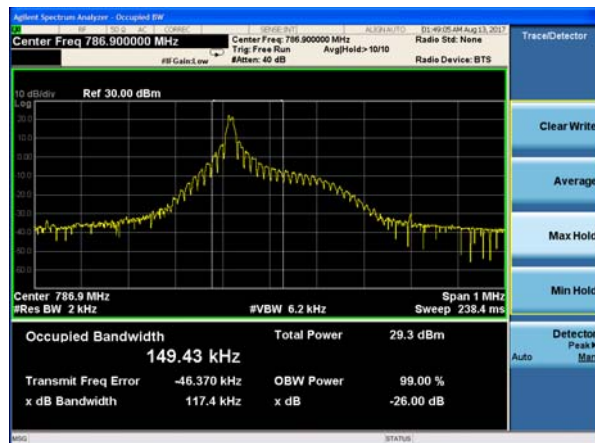
## NB-IOT Band 13 BPSK 15kHz 1@0 CH-Middle



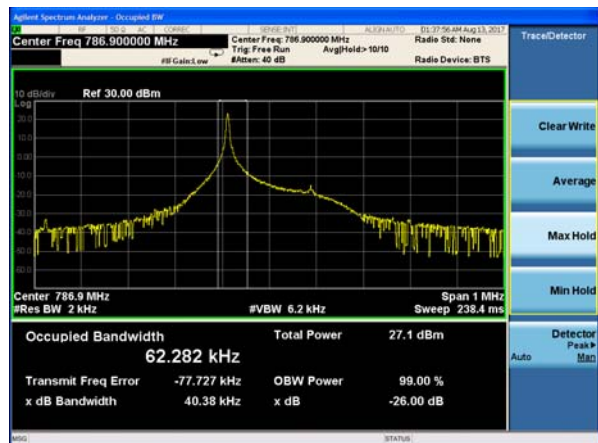
## NB-IOT Band 13 QPSK 3.75kHz 1@0 CH-Middle



## NB-IOT Band 13 BPSK 15kHz 1@0 CH-High

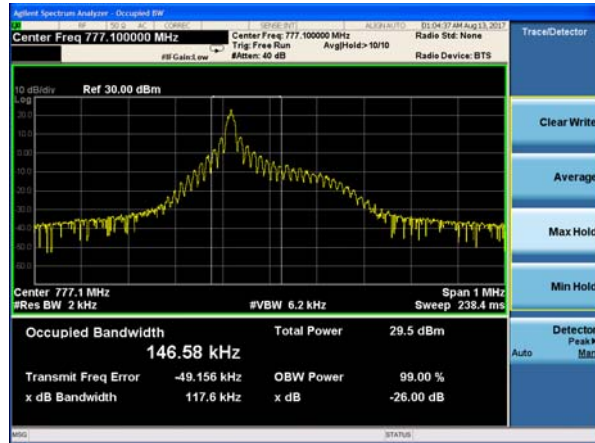


## NB-IOT Band 13 QPSK 3.75kHz 1@0 CH-High

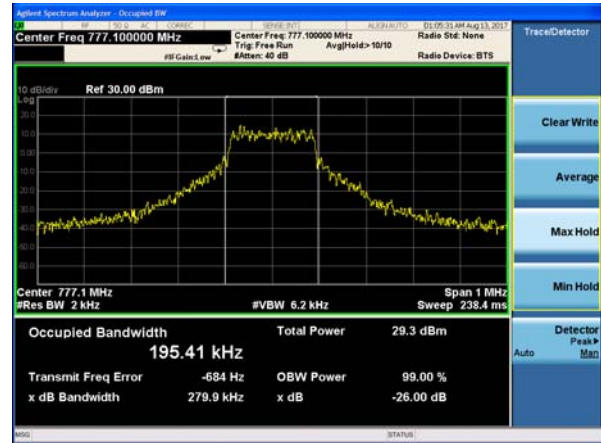




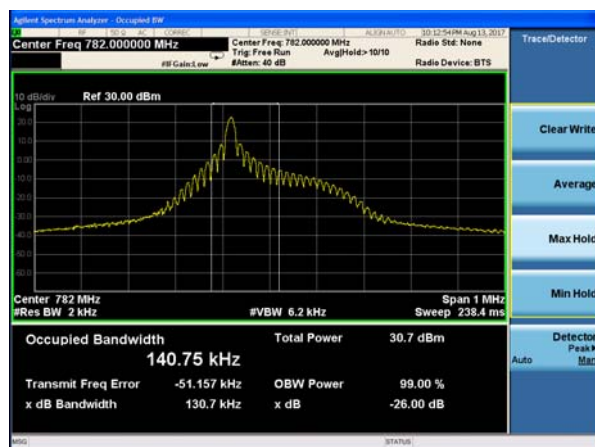
## NB-IOT Band 13 QPSK 15kHz 1@0 CH-Low



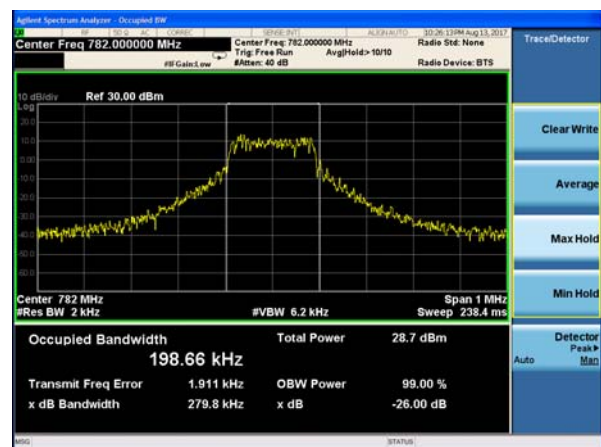
## NB-IOT Band 13 QPSK 15kHz 12@0 CH-Low



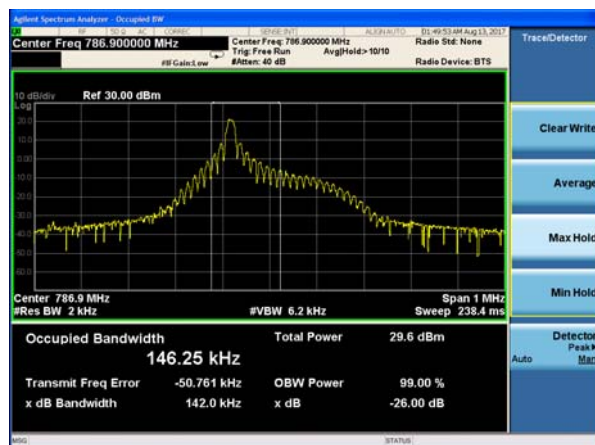
## NB-IOT Band 13 QPSK 15kHz 1@0 CH-Middle



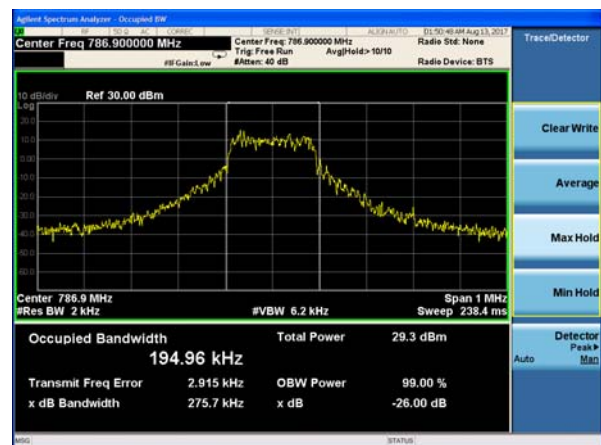
## NB-IOT Band 13 QPSK 15kHz 12@0 CH-Middle



## NB-IOT Band 13 QPSK 15kHz 1@0 CH-High



## NB-IOT Band 13 QPSK 15kHz 12@0 CH-High



## 5.4 Band Edge Compliance

### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

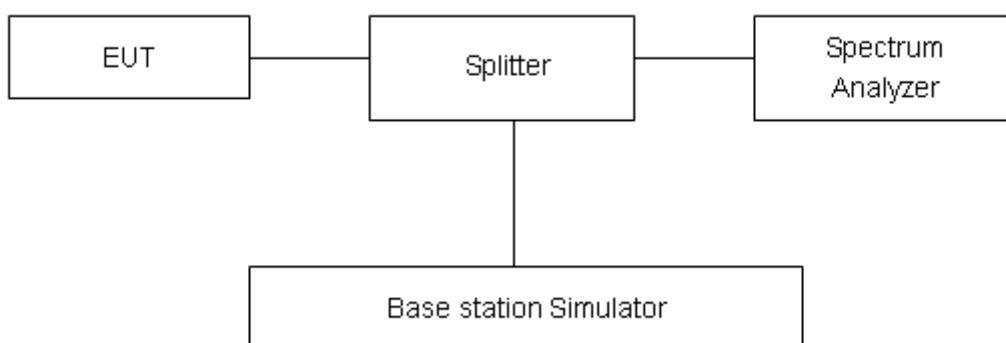
### Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The band edge of the lowest and highest channels were measured.

The testing follows KDB 971168 v02r02 Section 6.0

1. The EUT was connected to spectrum analyzer and system simulator via a power divider.
2. The band edges of low and high channels for the highest RF powers were measured.
3. RBW is set to 51Hz, VBW is set to 160Hz for 3.75KHz single carrier,  
RBW is set to 200Hz, VBW is set to 620Hz for 15KHz single carrier,  
RBW is set to 2kHz, VBW is set to 6.2KHz for 15KHz full carrier on spectrum analyzer.
4. Set spectrum analyzer with RMS detector.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.
6. Checked that all the results comply with the emission limit line.

### Test Setup





## Limits

Part 27.53(g) specifies that “ For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log_{10} (P)$  dB.”

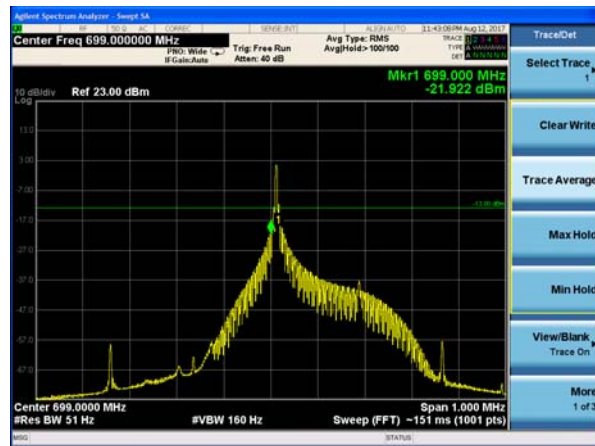
## Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 1.96$ ,  $U=0.684\text{dB}$ .

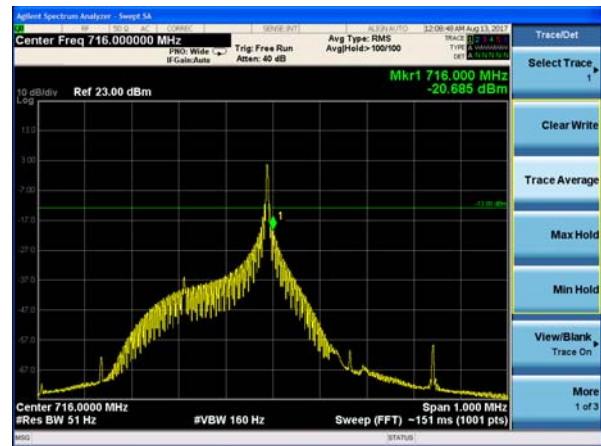


## Test Result

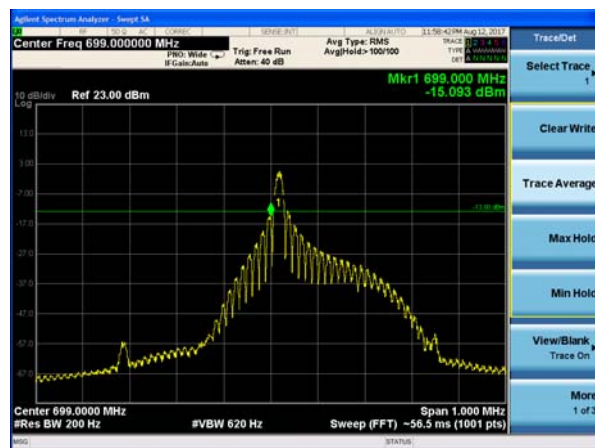
NB-IOT Band 12 BPSK 3.75kHz 1@0 CH-Low



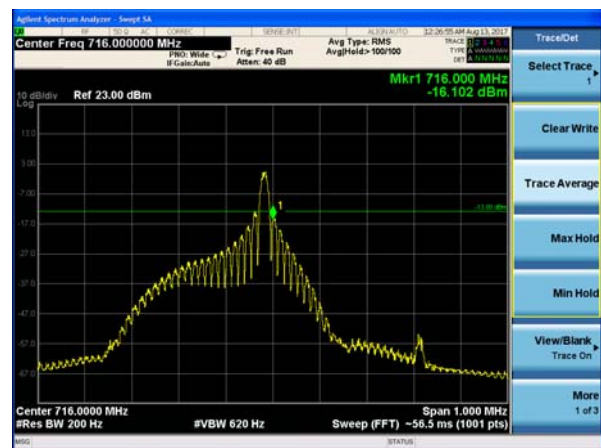
NB-IOT Band 12 BPSK 3.75kHz 1@47 CH-High



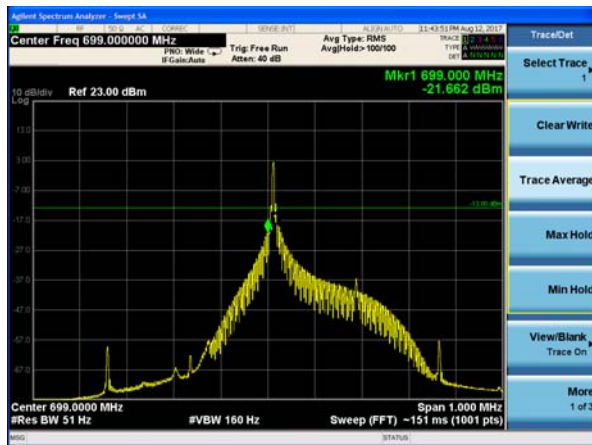
NB-IOT Band 12 BPSK 15kHz 1@0 CH-Low



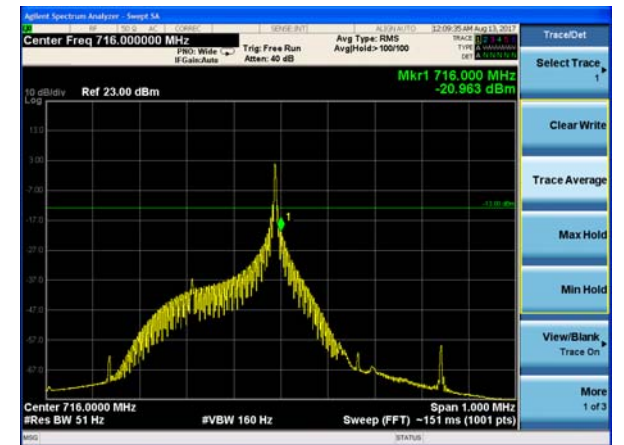
NB-IOT Band 12 BPSK 15kHz 1@11 CH-High



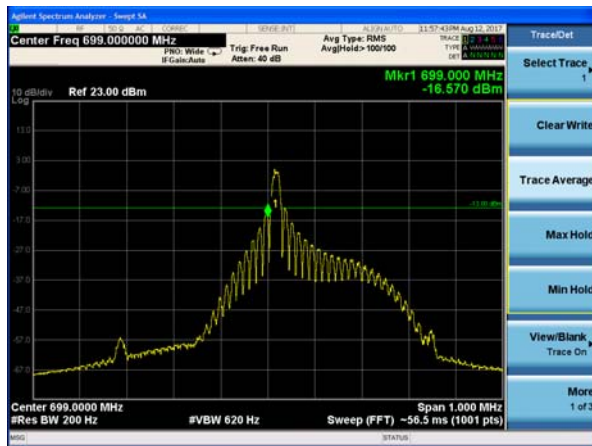
NB-IOT Band 12 QPSK 3.75kHz 1@0 CH-Low



NB-IOT Band 12 QPSK 3.75kHz 1@47 CH-High



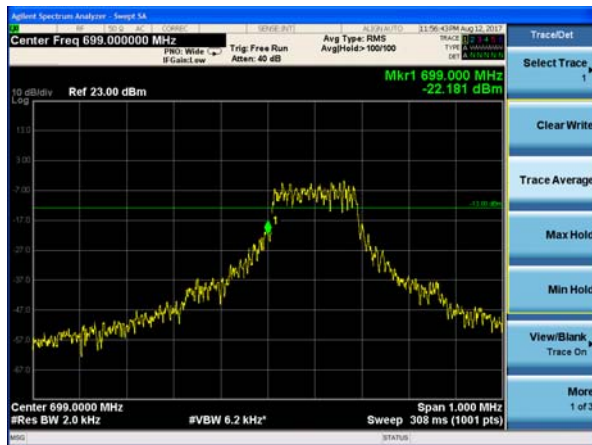
NB-IOT Band 12 QPSK 15kHz 1@0 CH-Low



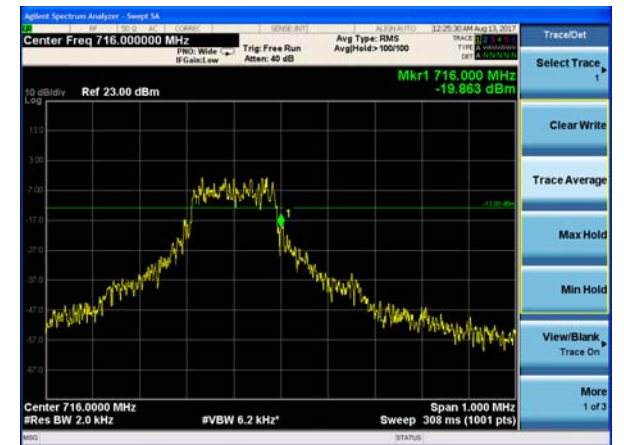
NB-IOT Band 12 QPSK 15kHz 1@11 CH-High



NB-IOT Band 12 QPSK 15kHz 12@0 CH-Low

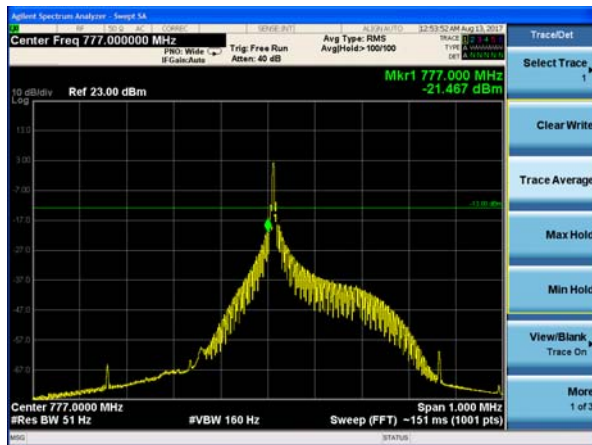


NB-IOT Band 12 QPSK 15kHz 12@0 CH-High

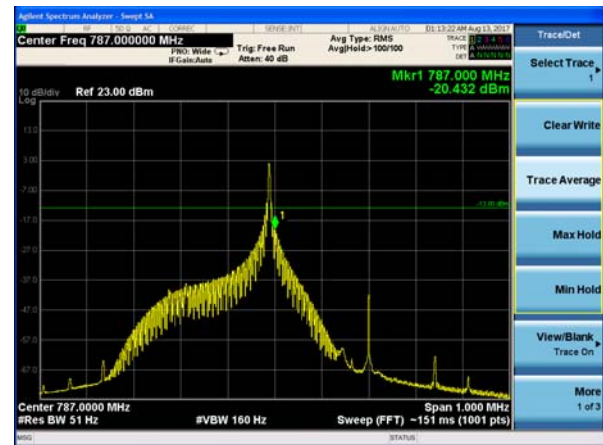




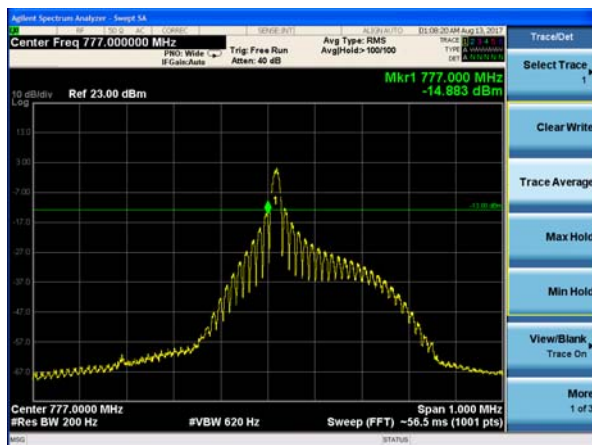
## NB-IOT Band 13 BPSK 3.75kHz 1@0 CH-Low



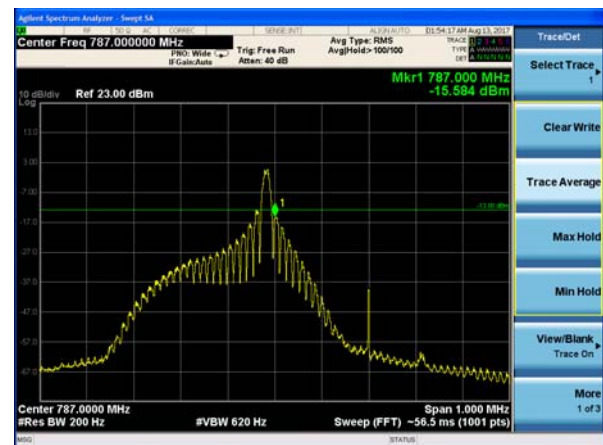
## NB-IOT Band 13 BPSK 3.75kHz 1@47 CH-High



## NB-IOT Band 13 BPSK 15kHz 1@0 CH-Low

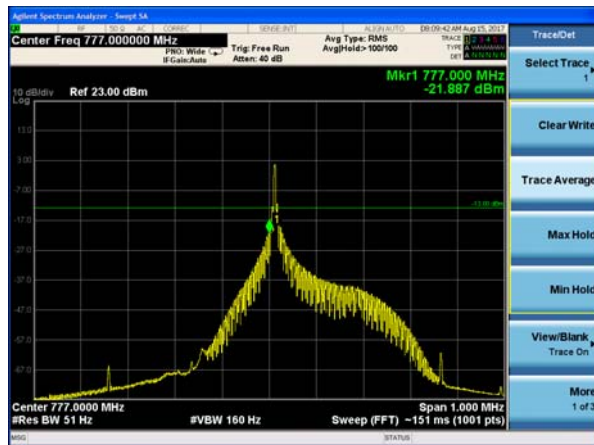


## NB-IOT Band 13 BPSK 15kHz 1@11 CH-High

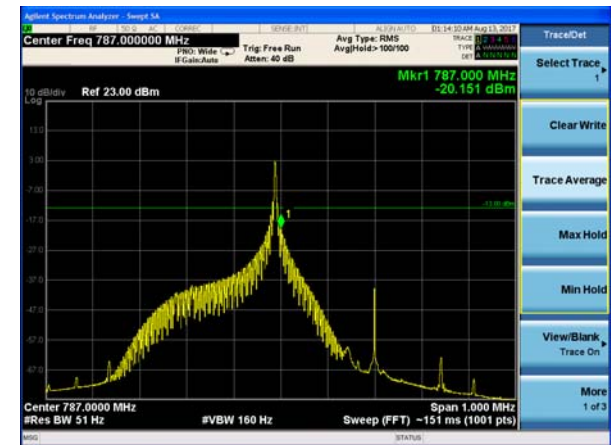




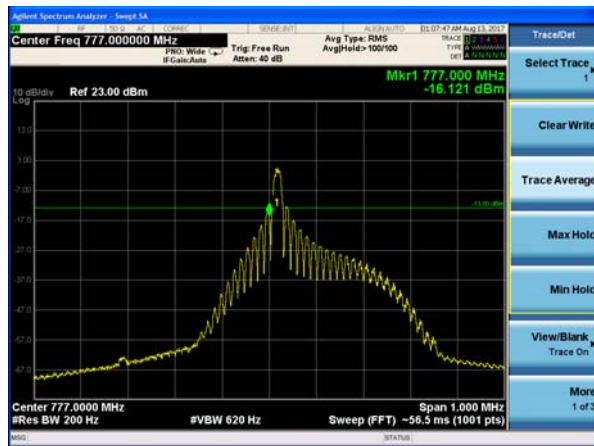
NB-IOT Band 13 QPSK 3.75kHz 1@0 CH-Low



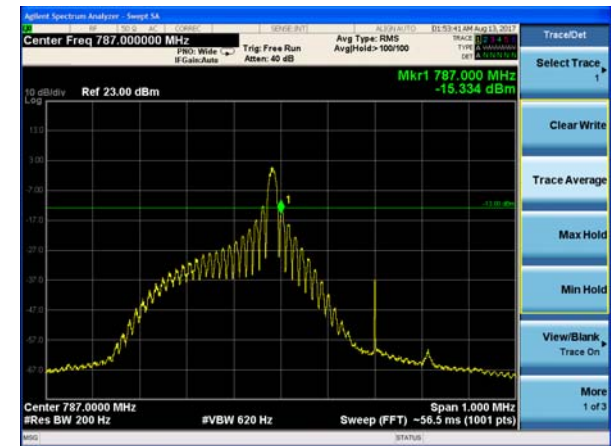
NB-IOT Band 13 QPSK 3.75kHz 1@47 CH-High



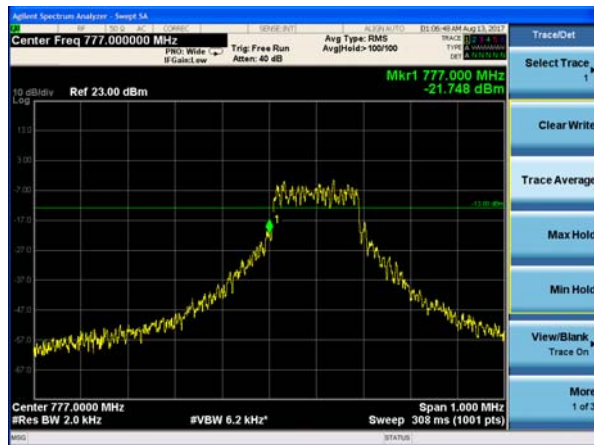
NB-IOT Band 13 QPSK 15kHz 1@0 CH-Low



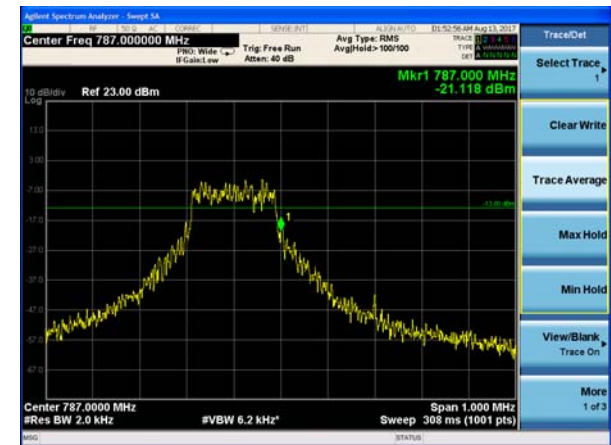
NB-IOT Band 13 QPSK 15kHz 1@11 CH-High



NB-IOT Band 13 QPSK 15kHz 12@0 CH-Low



NB-IOT Band 13 QPSK 15kHz 12@0 CH-High



## 5.5 Peak-to-Average Power Ratio (PAPR)

### Ambient condition

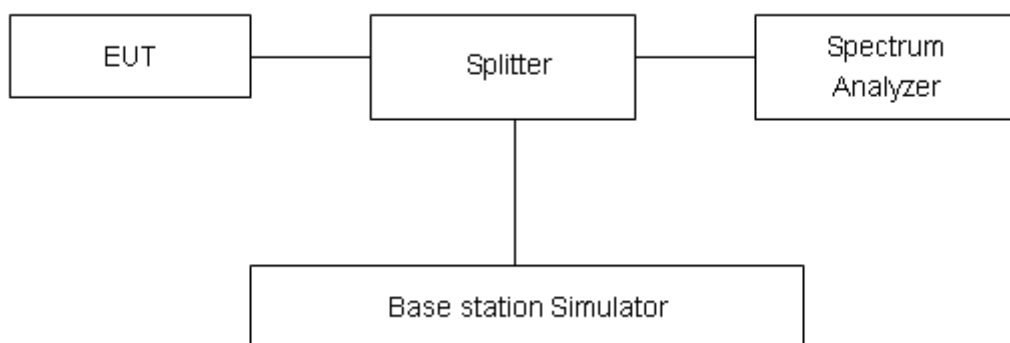
| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

### Methods of Measurement

Measure the total peak power and record as PPk. And measure the total average power and record as PAvg. Both the peak and average power levels must be expressed in the same logarithmic units (e.g., dBm). Determine the PAPR from:

$$\text{PAPR (dB)} = \text{PPk (dBm)} - \text{PAvg (dBm)}.$$

### Test Setup



### Limits

Rule Part 27.50(d)(5) Equipment employed must be authorized in accordance with the provisions of 24.51. Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (d)(6) of this section. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = 2$ ,  $U = 0.4$  dB.

## Test Results

| NB-IOT Band 12 Standalone |                           |                          |            |           |           |            |            |
|---------------------------|---------------------------|--------------------------|------------|-----------|-----------|------------|------------|
| Modulation                | Sub-carrier spacing (kHz) | Channel/ Frequency (MHz) | Peak (dBm) | Avg (dBm) | PAPR (dB) | Limit (dB) | Conclusion |
| BPSK                      | 3.75                      | 23095/707.5              | 26.39      | 22.85     | 3.54      | ≤13        | PASS       |
| QPSK                      | 3.75                      | 23095/707.5              | 29.56      | 22.92     | 6.64      | ≤13        | PASS       |
| BPSK                      | 15                        | 23095/707.5              | 26.48      | 22.89     | 3.59      | ≤13        | PASS       |
| QPSK                      | 15                        | 23095/707.5              | 29.99      | 23.33     | 6.66      | ≤13        | PASS       |

| NB-IOT Band 13 Standalone |                           |                          |            |           |           |            |            |
|---------------------------|---------------------------|--------------------------|------------|-----------|-----------|------------|------------|
| Modulation                | Sub-carrier spacing (kHz) | Channel/ Frequency (MHz) | Peak (dBm) | Avg (dBm) | PAPR (dB) | Limit (dB) | Conclusion |
| BPSK                      | 3.75                      | 23230/782                | 25.83      | 22.53     | 3.30      | ≤13        | PASS       |
| QPSK                      | 3.75                      | 23230/782                | 28.76      | 22.69     | 6.07      | ≤13        | PASS       |
| BPSK                      | 15                        | 23230/782                | 25.72      | 22.51     | 3.21      | ≤13        | PASS       |
| QPSK                      | 15                        | 23230/782                | 28.84      | 22.69     | 6.15      | ≤13        | PASS       |

## 5.6 Frequency Stability

### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

### Method of Measurement

#### 1. Frequency Stability (Temperature Variation)

The temperature inside the climate chamber is varied from -40°C to +85°C in 10°C step size.

(1) With all power removed, the temperature was decreased to -10°C and permitted to stabilize for three hours.

(2) Measure the carrier frequency with the test equipment in a “call mode”. These measurements should be made within 1 minute of powering up the mobile station, to prevent significant self warming.

(3) Repeat the above measurements at 10°C increments from -40°C to +85°C. Allow at least 1.5 hours at each temperature, un-powered, before making measurements.

#### 2. Frequency Stability (Voltage Variation)

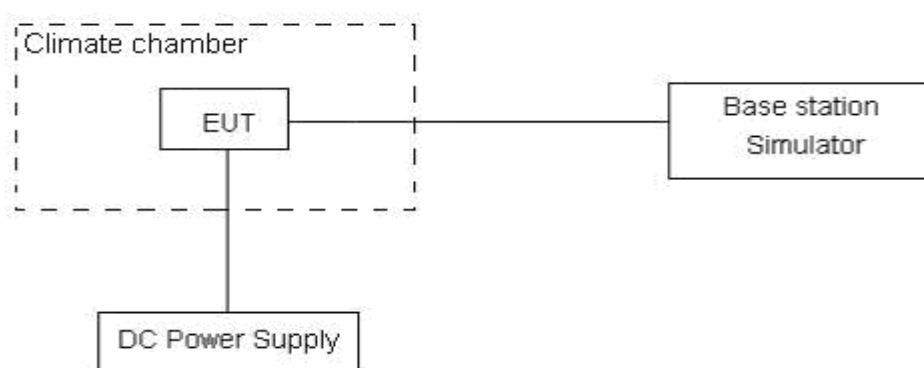
The frequency stability shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery-operating end point which shall be specified by the manufacturer.

This transceiver is specified to operate with an input voltage of between 3.3 V and 4.3 V, with a nominal voltage of 3.8V.

### Test setup



### Limits

No specific frequency stability requirements in part 27.54

### Measurement Uncertainty

The assessed measurement uncertainty to ensure 99.75% confidence level for the normal distribution is with the coverage factor  $k = 3, U = 0.01\text{ppm}$ .

**Test Result**

| NB-IOT Band 12 Standalone CH23095<br>Test Results (ppm) |                      |          |          |
|---------------------------------------------------------|----------------------|----------|----------|
| Sub-carrier<br>spacing (kHz)                            | Test status          | BPSK     | QPSK     |
| 3.75                                                    | -40°C/Normal Voltage | -0.00459 | -0.00035 |
|                                                         | -30°C/Normal Voltage | -0.00274 | -0.00177 |
|                                                         | -20°C/Normal Voltage | -0.00568 | -0.00220 |
|                                                         | -10°C/Normal Voltage | -0.00356 | -0.00117 |
|                                                         | 0°C/Normal Voltage   | -0.00168 | -0.00353 |
|                                                         | 10°C/Normal Voltage  | -0.00243 | -0.00076 |
|                                                         | 20°C/Normal Voltage  | -0.00308 | -0.00045 |
|                                                         | 30°C/Normal Voltage  | -0.00095 | 0.00010  |
|                                                         | 40°C/Normal Voltage  | -0.00112 | -0.00103 |
|                                                         | 50°C/Normal Voltage  | 0.00734  | -0.00201 |
|                                                         | 60°C/Normal Voltage  | -0.00461 | -0.00041 |
|                                                         | 70°C/Normal Voltage  | -0.00083 | -0.00175 |
|                                                         | 80°C/Normal Voltage  | -0.00284 | -0.00414 |
|                                                         | 85°C/Normal Voltage  | -0.00216 | -0.00078 |
|                                                         | 20°C/Minimum Voltage | -0.00220 | -0.00211 |
|                                                         | 20°C/Maximum Voltage | -0.00372 | -0.00124 |
| 15                                                      | -40°C/Normal Voltage | -0.00331 | -0.00095 |
|                                                         | -30°C/Normal Voltage | 0.00027  | -0.00082 |
|                                                         | -20°C/Normal Voltage | -0.00148 | 0.00109  |
|                                                         | -10°C/Normal Voltage | -0.00064 | 0.00110  |
|                                                         | 0°C/Normal Voltage   | 0.00167  | -0.00247 |
|                                                         | 10°C/Normal Voltage  | -0.00171 | 0.00147  |
|                                                         | 20°C/Normal Voltage  | 0.00038  | 0.00073  |
|                                                         | 30°C/Normal Voltage  | -0.00163 | -0.00034 |
|                                                         | 40°C/Normal Voltage  | -0.00189 | -0.00131 |
|                                                         | 50°C/Normal Voltage  | -0.00348 | 0.00150  |
|                                                         | 60°C/Normal Voltage  | -0.00180 | -0.00041 |
|                                                         | 70°C/Normal Voltage  | -0.00076 | -0.00192 |
|                                                         | 80°C/Normal Voltage  | -0.00425 | -0.00284 |
|                                                         | 85°C/Normal Voltage  | -0.00506 | -0.00327 |
|                                                         | 20°C/Minimum Voltage | -0.00129 | -0.00161 |
|                                                         | 20°C/Maximum Voltage | -0.00250 | -0.00100 |

| NB-IOT Band 13 Standalone Channel 23230 |                      |          |          |
|-----------------------------------------|----------------------|----------|----------|
| Test Results (ppm)                      |                      |          |          |
| Sub-carrier spacing (kHz)               | Test status          | BPSK     | QPSK     |
| 3.75                                    | -40°C/Normal Voltage | 0.00306  | -0.00334 |
|                                         | -30°C/Normal Voltage | 0.00425  | -0.00230 |
|                                         | -20°C/Normal Voltage | 0.00095  | 0.00084  |
|                                         | -10°C/Normal Voltage | -0.00104 | 0.00162  |
|                                         | 0°C/Normal Voltage   | -0.00050 | 0.00040  |
|                                         | 10°C/Normal Voltage  | -0.00338 | 0.00015  |
|                                         | 20°C/Normal Voltage  | -0.00313 | -0.00215 |
|                                         | 30°C/Normal Voltage  | -0.00191 | -0.00165 |
|                                         | 40°C/Normal Voltage  | -0.00193 | -0.00059 |
|                                         | 50°C/Normal Voltage  | -0.00274 | 0.00074  |
|                                         | 60°C/Normal Voltage  | -0.00032 | -0.00162 |
|                                         | 70°C/Normal Voltage  | -0.00176 | -0.00302 |
|                                         | 80°C/Normal Voltage  | -0.00301 | -0.00248 |
|                                         | 85°C/Normal Voltage  | -0.00098 | -0.00225 |
|                                         | 20°C/Minimum Voltage | 0.00302  | 0.00175  |
|                                         | 20°C/Maximum Voltage | 0.00367  | 0.00191  |
| 15                                      | -40°C/Normal Voltage | -0.00169 | -0.00107 |
|                                         | -30°C/Normal Voltage | -0.00339 | -0.00215 |
|                                         | -20°C/Normal Voltage | -0.00120 | -0.00312 |
|                                         | -10°C/Normal Voltage | -0.00191 | -0.00133 |
|                                         | 0°C/Normal Voltage   | -0.00155 | 0.00022  |
|                                         | 10°C/Normal Voltage  | -0.00202 | -0.00137 |
|                                         | 20°C/Normal Voltage  | -0.00157 | -0.00088 |
|                                         | 30°C/Normal Voltage  | -0.00267 | -0.00159 |
|                                         | 40°C/Normal Voltage  | -0.00262 | 0.00026  |
|                                         | 50°C/Normal Voltage  | 0.00024  | -0.00275 |
|                                         | 60°C/Normal Voltage  | 0.00074  | -0.00249 |
|                                         | 70°C/Normal Voltage  | -0.00161 | -0.00175 |
|                                         | 80°C/Normal Voltage  | -0.00075 | -0.00082 |
|                                         | 85°C/Normal Voltage  | -0.00086 | -0.00097 |
|                                         | 20°C/Minimum Voltage | 0.00139  | -0.00142 |
|                                         | 20°C/Maximum Voltage | -0.00156 | -0.00060 |

## 5.7 Spurious Emissions at Antenna Terminals

### Ambient condition

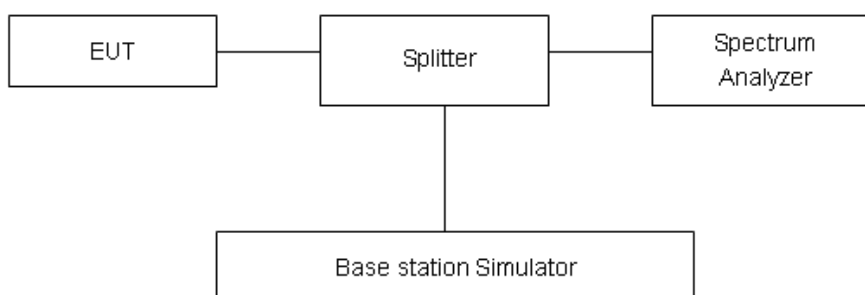
| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

### Method of Measurement

The EUT was connected to Spectrum Analyzer and Base Station Simulator via power Splitter. The measurement is carried out using a spectrum analyzer. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. Set RBW 1MHz and VBW3MHz, Sweep is set to ATUO.

Of those disturbances below (limit – 20 dB), the mark is not required for the EUT.

### Test setup



### Limits

Rule Part 27.53 (g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

Rule Part 27.53(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to –70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and –80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

**NB-IOT B12 Limit**

|       |         |
|-------|---------|
| Limit | -13 dBm |
|-------|---------|

**NB-IOT B13 Limit**

|                                     |         |
|-------------------------------------|---------|
| Limit out of the band 1559-1610 MHz | -13 dBm |
| Limit in the band 1559-1610 MHz     | -40 dBm |

**Measurement Uncertainty**

The assessed measurement uncertainty to ensure 99.75% confidence level for the normal distribution is with the coverage factor  $k = 1.96$ .

| Frequency     | Uncertainty |
|---------------|-------------|
| 100kHz-2GHz   | 0.684 dB    |
| 2GHz-12.75GHz | 1.407 dB    |

## Test Result

Sweep from 9 kHz to 30MHz, and the emissions more than 20 dB below the permissible value are not reported.

If disturbances were found more than 20dB below limit line, the mark is not required for the EUT.

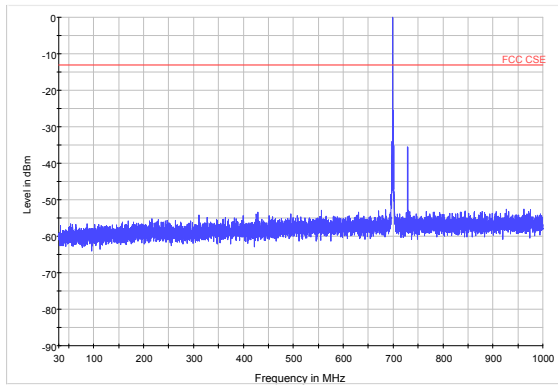
The signal beyond the limit is carrier.

**Standalone deployment with 15 KHz subcarrier spacing and QPSK mode for CAT NB1:**

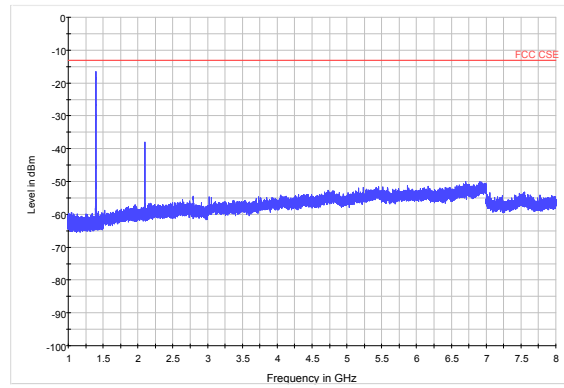
| Test Data File Name           | Frequency (MHz) | Peak (dBm) | Limit (dBm) | Margin (dB) |
|-------------------------------|-----------------|------------|-------------|-------------|
| CSE_ NB-IOT B12_CHLOW_1-8GHz  | 1398.1          | -16.24     | -13.00      | 3.24        |
| CSE_ NB-IOT B12_CHMID_1-8GHz  | 1417.8          | -17.30     | -13.00      | 4.30        |
| CSE_ NB-IOT B12_CHHIGH_1-8GHz | 1431.6          | -17.48     | -13.00      | 4.48        |



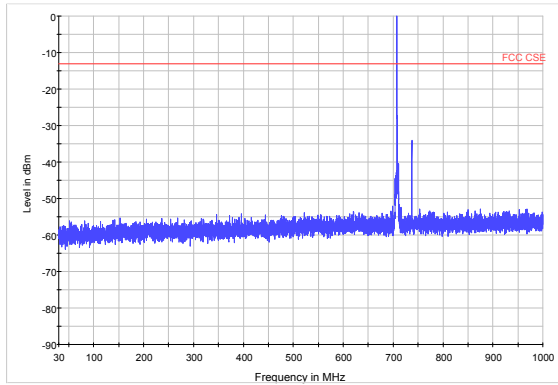
NB-IOT Band 12 CH-Low 30MHz~1GHz



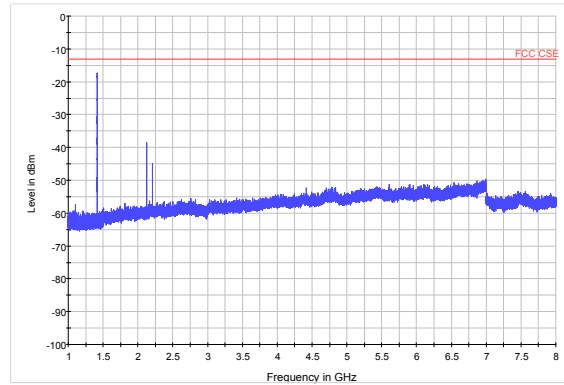
NB-IOT Band 12 CH-Low 1GHz~8GHz



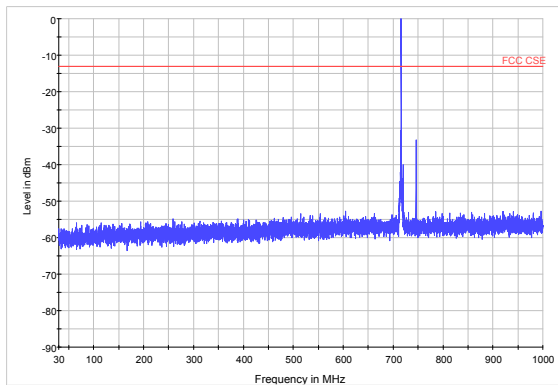
NB-IOT Band 12 CH-Middle 30MHz~1GHz



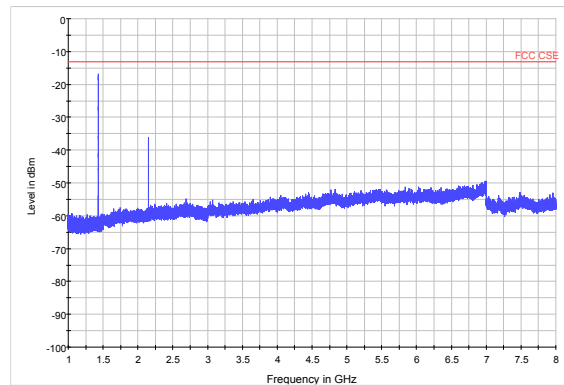
NB-IOT Band 12 CH-Middle 1GHz~8GHz



NB-IOT Band 12 CH-High 30MHz~1GHz

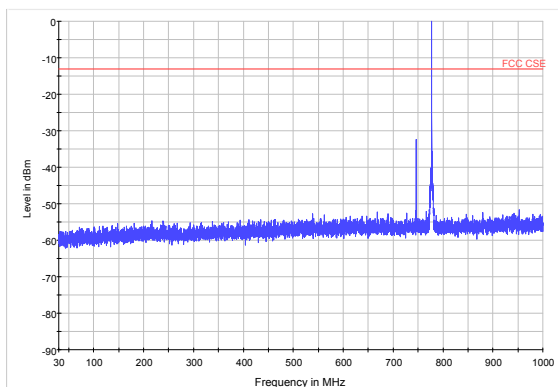


NB-IOT Band 12 CH-High 1GHz~8GHz

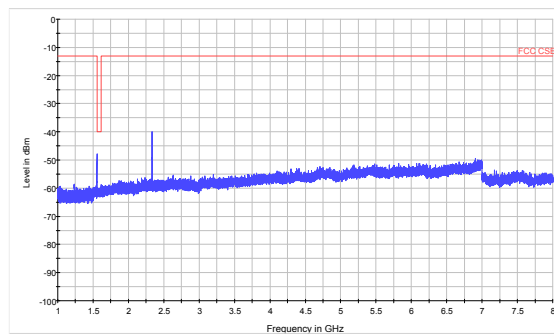




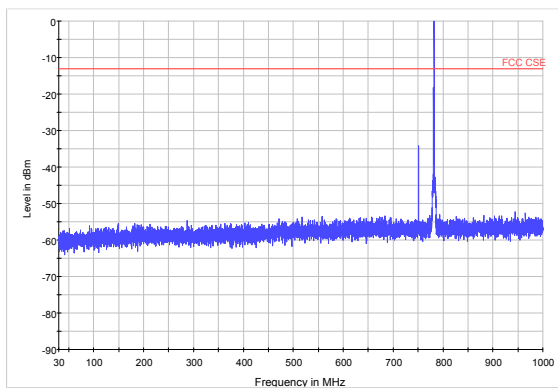
NB-IOT Band 13 CH-Low 30MHz~1GHz



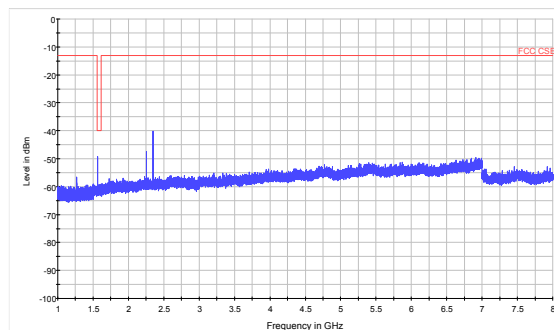
NB-IOT Band 13 CH-Low 1GHz~8GHz



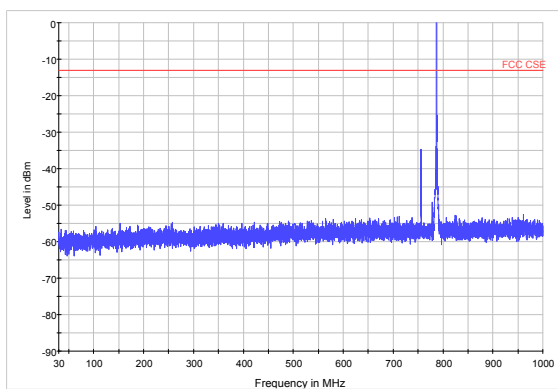
NB-IOT Band 13 CH-Middle 30MHz~1GHz



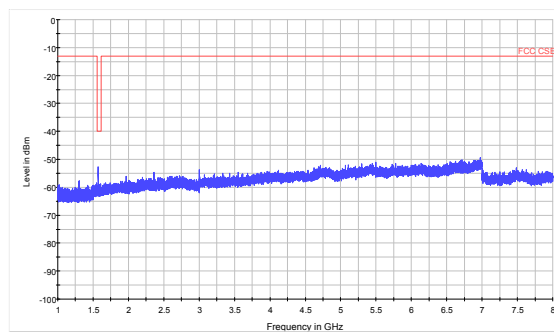
NB-IOT Band 13 CH-Middle 1GHz~8GHz



NB-IOT Band 13 CH-High 30MHz~1GHz



NB-IOT Band 13 CH-High 1GHz~8GHz



## 5.8 Radiates Spurious Emission

### Ambient condition

| Temperature | Relative humidity | Pressure |
|-------------|-------------------|----------|
| 23°C ~25°C  | 45%~50%           | 101.5kPa |

### Method of Measurement

1. The testing follows FCC KDB 971168 v02r02 Section 5.8 and ANSI / TIA-603-D-2010 Section 2.2.12.
2. Above 30MHz: The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H). Above 1GHz: (Note: the FCC's permission to use 1.5m as an aNB-IoT native per TCBC Conf call of Dec. 2, 2014.) The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).
3. A log-periodic antenna or double-ridged waveguide horn antenna shall be substituted in place of the EUT. The log-periodic antenna will be driven by a signal generator and the level will be adjusted till the same power value on the spectrum analyzer or receiver. The level of the spurious emissions can be calculated through the level of the signal generator, cable loss, the gain of the substitution antenna and the reading of the spectrum analyzer or receiver.
4. The EUT is then put into continuously transmitting mode at its maximum power level during the test. Set Test Receiver or Spectrum RBW=1MHz, VBW=3MHz, And the maximum value of the receiver should be recorded as (Pr).
5. The EUT shall be replaced by a substitution antenna. In the chamber, an substitution antenna for the frequency band of interest is placed at the reference point of the chamber. An RF Signal source for the frequency band of interest is connected to the substitution antenna with a cable that has been constructed to not interfere with the radiation pattern of the antenna. A power (PMea) is applied to the input of the substitution antenna, and adjust the level of the signal generator output until the value of the receiver reach the previously recorded (Pr). The power of signal source (PMea) is recorded. The test should be performed by rotating the test item and adjusting the receiving antenna polarization.
6. A amplifier should be connected to the Signal Source output port. And the cable should be connect between the Amplifier and the Substitution Antenna. The cable loss (Pcl), the Substitution Antenna Gain (Ga) and the Amplifier Gain (PAg) should be recorded after test.
7. The measurement results are obtained as described below:  

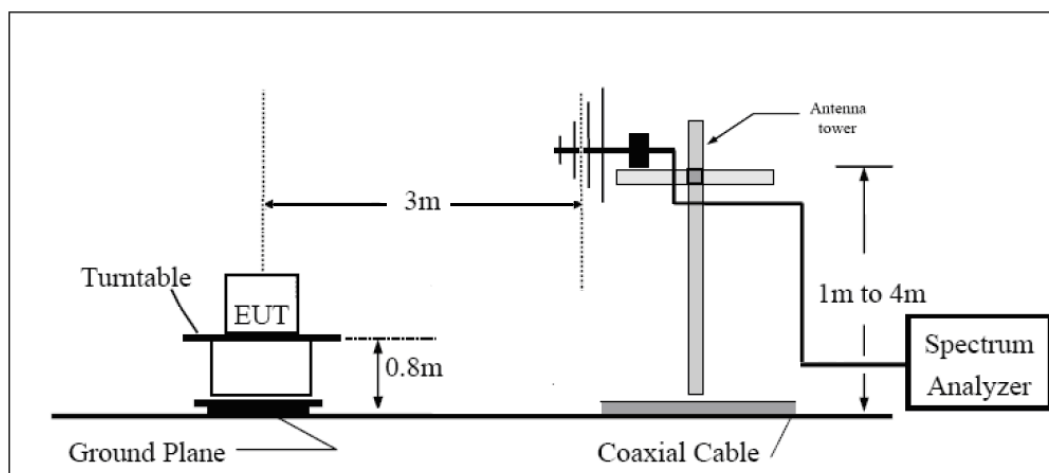
$$\text{Power(EIRP)} = \text{PMea} - \text{PAg} - \text{Pcl} + \text{Ga}$$
The measurement results are amend as described below:  

$$\text{Power(EIRP)} = \text{PMea} - \text{Pcl} + \text{Ga}$$
8. This value is EIRP since the measurement is calibrated using an antenna of known gain (2.15 dBi) and known input power. ERP can be calculated from EIRP by subtracting the gain of the dipole, ERP

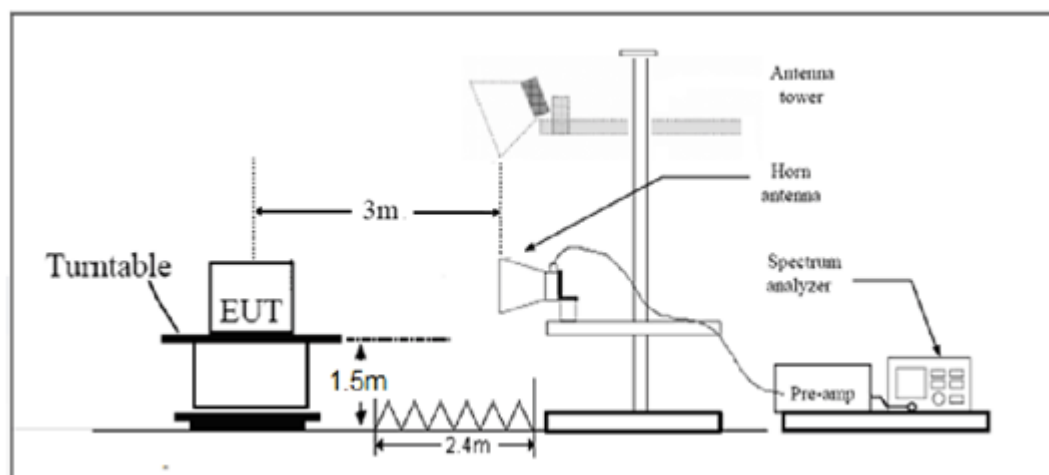
= EIRP-2.15dBi.

## Test setup

30MHz~~~ 1GHz



Above 1GHz



Note: Area side:2.4mX3.6m

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes. EUT lie-down stand-up position (X, Y axis), lie-down position (Z axis),. Receiver antenna polarization (horizontal and vertical), the worst emission was found in position (Z axis, vertical polarization) and the worst case was recorded.

## Limits

Rule Part 27.53 (g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

Rule Part 27.53(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

#### NB-IOT Band 12 Limit

|       |         |
|-------|---------|
| Limit | -13 dBm |
|-------|---------|

#### NB-IOT Band 13 Limit

|                                     |         |
|-------------------------------------|---------|
| Limit out of the band 1559-1610 MHz | -13 dBm |
| Limit in the band 1559-1610 MHz     | -40 dBm |

#### Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor  $k = \pm 1.96$ ,  $U = \pm 3.55$  dB.

**Test Result**

The other Spurious RF Radiated emissions level is no more than noise floor.

The worst emission was found in the antenna is vertical position.

**Standalone deployment with 15 KHz subcarrier spacing and QPSK mode for CAT NB1:**

NB-IOT Band 12 QPSK CH-Low, RB 1

| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1398.2          | -50.31   | 2.00            | 10.15      | Vertical             | -44.31          | -13.00      | 31.31       | 135           |
| 3        | 2097.3          | -56.51   | 2.50            | 11.35      | Vertical             | -49.81          | -13.00      | 36.81       | 225           |
| 4        | 2796.4          | -54.04   | 4.20            | 10.85      | Vertical             | -49.54          | -13.00      | 36.54       | 45            |
| 5        | 3495.5          | -53.92   | 5.20            | 11.35      | Vertical             | -49.92          | -13.00      | 36.92       | 180           |
| 6        | 4194.6          | -52.38   | 5.50            | 11.95      | Vertical             | -48.08          | -13.00      | 35.08       | 315           |
| 7        | 4893.7          | -50.84   | 5.70            | 13.55      | Vertical             | -45.14          | -13.00      | 32.14       | 45            |
| 8        | 5592.8          | -49.93   | 6.30            | 13.75      | Vertical             | -44.63          | -13.00      | 31.63       | 180           |
| 9        | 6291.9          | -48.37   | 6.80            | 13.85      | Vertical             | -43.47          | -13.00      | 30.47       | 315           |
| 10       | 6991.0          | -46.90   | 6.90            | 14.25      | Vertical             | -41.70          | -13.00      | 28.70       | 135           |

NB-IOT Band 12 QPSK CH-Middle, RB 1

| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1415.0          | -55.61   | 2.00            | 10.75      | Vertical             | -49.01          | -13.00      | 36.01       | 225           |
| 3        | 2122.5          | -56.87   | 2.51            | 11.05      | Vertical             | -50.48          | -13.00      | 37.48       | 90            |
| 4        | 2830.0          | -54.29   | 4.20            | 11.15      | Vertical             | -49.49          | -13.00      | 36.49       | 180           |
| 5        | 3537.5          | -54.30   | 5.20            | 11.15      | Vertical             | -50.50          | -13.00      | 37.50       | 45            |
| 6        | 4245.0          | -52.44   | 5.50            | 11.95      | Vertical             | -48.14          | -13.00      | 35.14       | 180           |
| 7        | 4952.5          | -49.98   | 5.70            | 13.55      | Vertical             | -44.28          | -13.00      | 31.28       | 45            |
| 8        | 5660.0          | -50.48   | 6.30            | 13.75      | Vertical             | -45.18          | -13.00      | 32.18       | 0             |
| 9        | 6367.5          | -48.06   | 6.80            | 13.85      | Vertical             | -43.16          | -13.00      | 30.16       | 135           |
| 10       | 7075.0          | -47.18   | 6.90            | 14.25      | Vertical             | -41.98          | -13.00      | 28.98       | 225           |



## NB-IOT Band 12 QPSK CH-High, RB 1

| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1431.8          | -58.45   | 2.00            | 10.15      | Vertical             | -52.45          | -13.00      | 39.45       | 90            |
| 3        | 2147.7          | -53.95   | 2.51            | 11.05      | Vertical             | -47.56          | -13.00      | 34.56       | 225           |
| 4        | 2863.6          | -55.13   | 4.20            | 11.15      | Vertical             | -50.33          | -13.00      | 37.33       | 180           |
| 5        | 3579.5          | -53.91   | 5.20            | 11.15      | Vertical             | -50.11          | -13.00      | 37.11       | 270           |
| 6        | 4295.4          | -52.74   | 5.50            | 11.95      | Vertical             | -48.44          | -13.00      | 35.44       | 135           |
| 7        | 5011.3          | -50.04   | 5.70            | 13.55      | Vertical             | -44.34          | -13.00      | 31.34       | 45            |
| 8        | 5727.2          | -50.21   | 6.30            | 13.75      | Vertical             | -44.91          | -13.00      | 31.91       | 180           |
| 9        | 6443.1          | -48.38   | 6.80            | 13.85      | Vertical             | -43.48          | -13.00      | 30.48       | 315           |
| 10       | 7159.0          | -47.32   | 6.90            | 14.25      | Vertical             | -42.12          | -13.00      | 29.12       | 135           |

## NB-IOT Band 13 QPSK CH-Low, RB 1

| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1554.2          | -59.12   | 2.00            | 10.15      | Vertical             | -53.12          | -40.00      | 13.12       | 225           |
| 3        | 2331.3          | -50.55   | 2.50            | 11.35      | Vertical             | -43.85          | -13.00      | 30.85       | 90            |
| 4        | 3108.4          | -55.25   | 4.20            | 10.85      | Vertical             | -50.75          | -13.00      | 37.75       | 180           |
| 5        | 3885.5          | -52.86   | 5.20            | 11.35      | Vertical             | -48.86          | -13.00      | 35.86       | 45            |
| 6        | 4662.6          | -51.24   | 5.50            | 11.95      | Vertical             | -46.94          | -13.00      | 33.94       | 180           |
| 7        | 5439.7          | -50.65   | 5.70            | 13.55      | Vertical             | -44.95          | -13.00      | 31.95       | 45            |
| 8        | 6216.8          | -50.18   | 6.30            | 13.75      | Vertical             | -44.88          | -13.00      | 31.88       | 0             |
| 9        | 6993.9          | -48.64   | 6.80            | 13.85      | Vertical             | -43.74          | -13.00      | 30.74       | 135           |
| 10       | 7771.0          | -46.08   | 6.90            | 14.25      | Vertical             | -40.88          | -13.00      | 27.88       | 225           |



## NB-IOT Band 13 QPSK CH-Middle, RB 1

| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1564.0          | -59.31   | 2.00            | 10.75      | Vertical             | -52.71          | -40.00      | 12.71       | 90            |
| 3        | 2346.0          | -50.01   | 2.51            | 11.05      | Vertical             | -43.62          | -13.00      | 30.62       | 225           |
| 4        | 3128.0          | -54.55   | 4.20            | 11.15      | Vertical             | -49.75          | -13.00      | 36.75       | 180           |
| 5        | 3910.0          | -52.16   | 5.20            | 11.15      | Vertical             | -48.36          | -13.00      | 35.36       | 270           |
| 6        | 4692.0          | -51.25   | 5.50            | 11.95      | Vertical             | -46.95          | -13.00      | 33.95       | 135           |
| 7        | 5474.0          | -50.56   | 5.70            | 13.55      | Vertical             | -44.86          | -13.00      | 31.86       | 45            |
| 8        | 6256.0          | -49.95   | 6.30            | 13.75      | Vertical             | -44.65          | -13.00      | 31.65       | 180           |
| 9        | 7038.0          | -48.28   | 6.80            | 13.85      | Vertical             | -43.38          | -13.00      | 30.38       | 315           |
| 10       | 7820.0          | -45.08   | 6.90            | 14.25      | Vertical             | -39.88          | -13.00      | 26.88       | 135           |

## NB-IOT Band 13 QPSK CH-High, RB 1

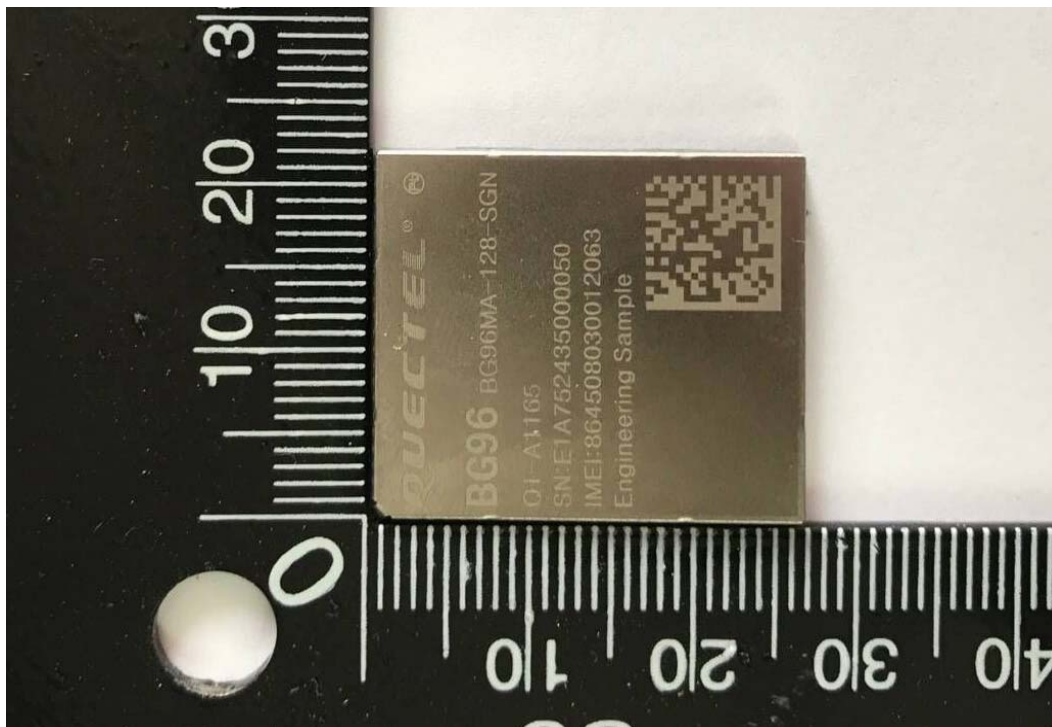
| Harmonic | Frequency (MHz) | SG (dBm) | Cable Loss (dB) | Gain (dBi) | Antenna Polarization | ERP Level (dBm) | Limit (dBm) | Margin (dB) | Azimuth (deg) |
|----------|-----------------|----------|-----------------|------------|----------------------|-----------------|-------------|-------------|---------------|
| 2        | 1573.8          | -60.27   | 2.00            | 10.15      | Vertical             | -54.27          | -40.00      | 14.27       | 225           |
| 3        | 2360.7          | -49.96   | 2.51            | 11.05      | Vertical             | -43.57          | -13.00      | 30.57       | 90            |
| 4        | 3147.6          | -54.03   | 4.20            | 11.15      | Vertical             | -49.23          | -13.00      | 36.23       | 180           |
| 5        | 3934.5          | -51.84   | 5.20            | 11.15      | Vertical             | -48.04          | -13.00      | 35.04       | 45            |
| 6        | 4721.4          | -51.17   | 5.50            | 11.95      | Vertical             | -46.87          | -13.00      | 33.87       | 180           |
| 7        | 5508.3          | -50.57   | 5.70            | 13.55      | Vertical             | -44.87          | -13.00      | 31.87       | 45            |
| 8        | 6295.2          | -49.67   | 6.30            | 13.75      | Vertical             | -44.37          | -13.00      | 31.37       | 0             |
| 9        | 7082.1          | -47.97   | 6.80            | 13.85      | Vertical             | -43.07          | -13.00      | 30.07       | 135           |
| 10       | 7869.0          | -44.89   | 6.90            | 14.25      | Vertical             | -39.69          | -13.00      | 26.69       | 225           |

## 6 Main Test Instruments

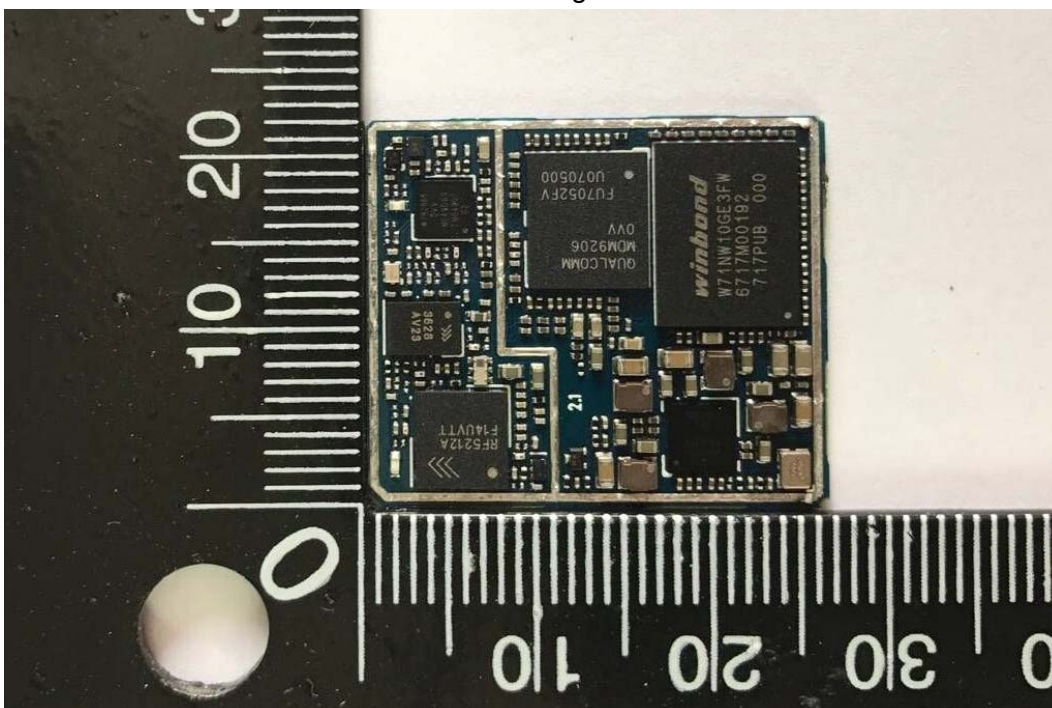
| Name                                 | Manufacturer | Type         | Serial Number | Calibration Date | Expiration Time |
|--------------------------------------|--------------|--------------|---------------|------------------|-----------------|
| Base Station Simulator               | R&S          | CMW500       | 150415        | 2017-05-14       | 2018-05-13      |
| Power Splitter                       | Hua Xiang    | SHX-GF2-2-13 | 10120101      | 2017-05-14       | 2018-05-13      |
| Universal Radio Communication Tester | Agilent      | E5515C       | MY48367192    | 2017-05-14       | 2018-05-13      |
| Spectrum Analyzer                    | Agilent      | N9010A       | MY47191109    | 2017-05-14       | 2018-05-13      |
| Signal Analyzer                      | R&S          | FSV30        | 100815        | 2016-12-16       | 2017-12-15      |
| Signal generator                     | R&S          | SMB 100A     | 102594        | 2017-05-14       | 2018-05-13      |
| EMI Test Receiver                    | R&S          | ESCI         | 100948        | 2017-05-20       | 2018-05-19      |
| Trilog Antenna                       | SCHWARZBECK  | VUBL 9163    | 9163-201      | 2014-12-06       | 2017-12-05      |
| Horn Antenna                         | R&S          | HF907        | 100126        | 2014-12-06       | 2017-12-05      |
| Horn Antenna                         | ETS-Lindgren | 3160-09      | 00102643      | 2015-01-30       | 2018-01-29      |
| Climatic Chamber                     | Re Ce        | PT-30B       | 20101891      | 2015-07-18       | 2018-07-17      |
| RF Cable                             | Agilent      | SMA 15cm     | 0001          | 2017-02-06       | 2017-08-05      |
| Preamplifier                         | R&S          | SCU18        | 102327        | 2017-06-18       | 2018-06-17      |

## ANNEX A: EUT Appearance and Test Setup

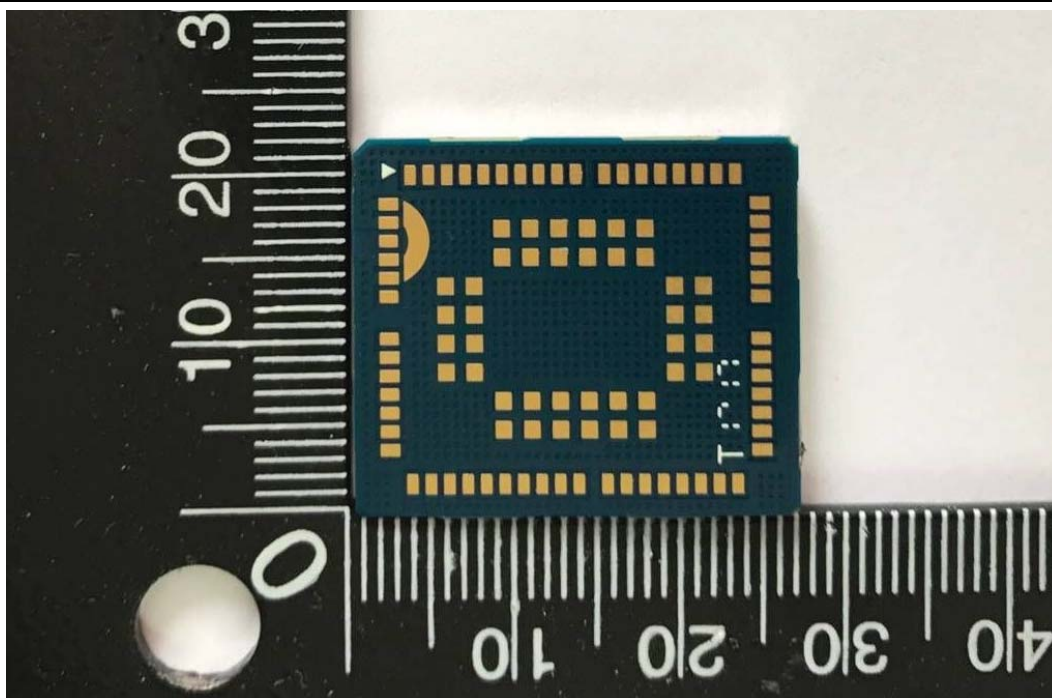
### A.1 EUT Appearance



shielding



No shielding  
Front Side

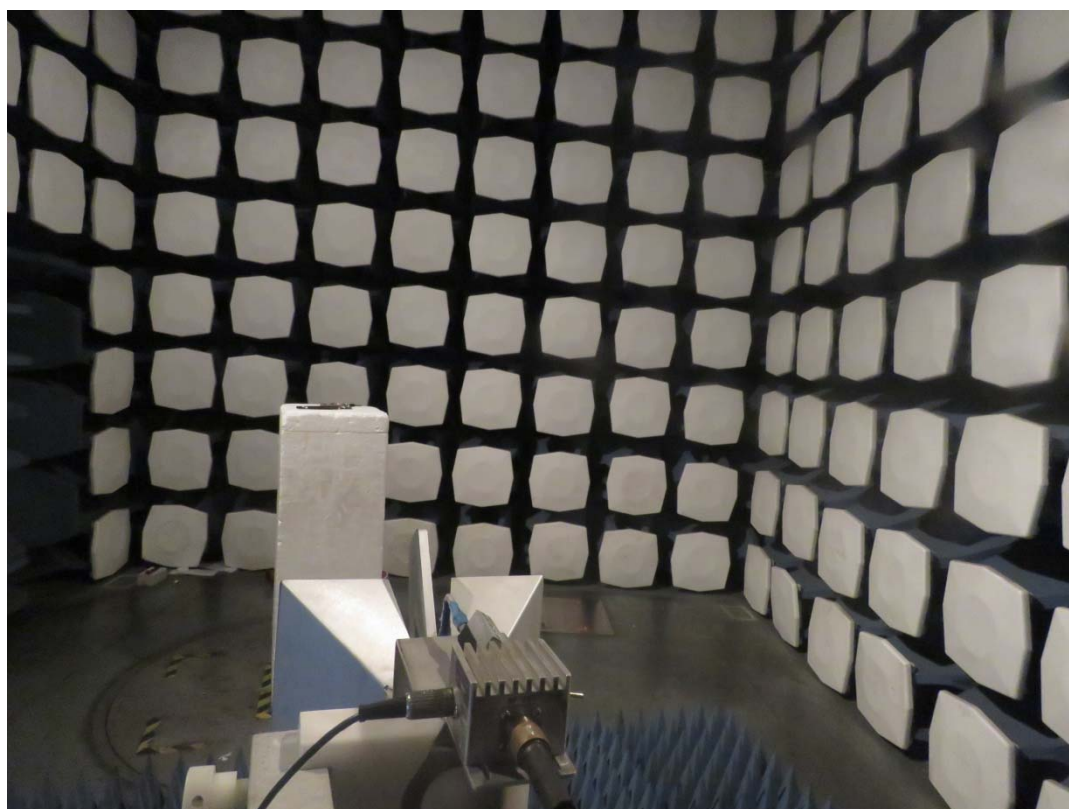
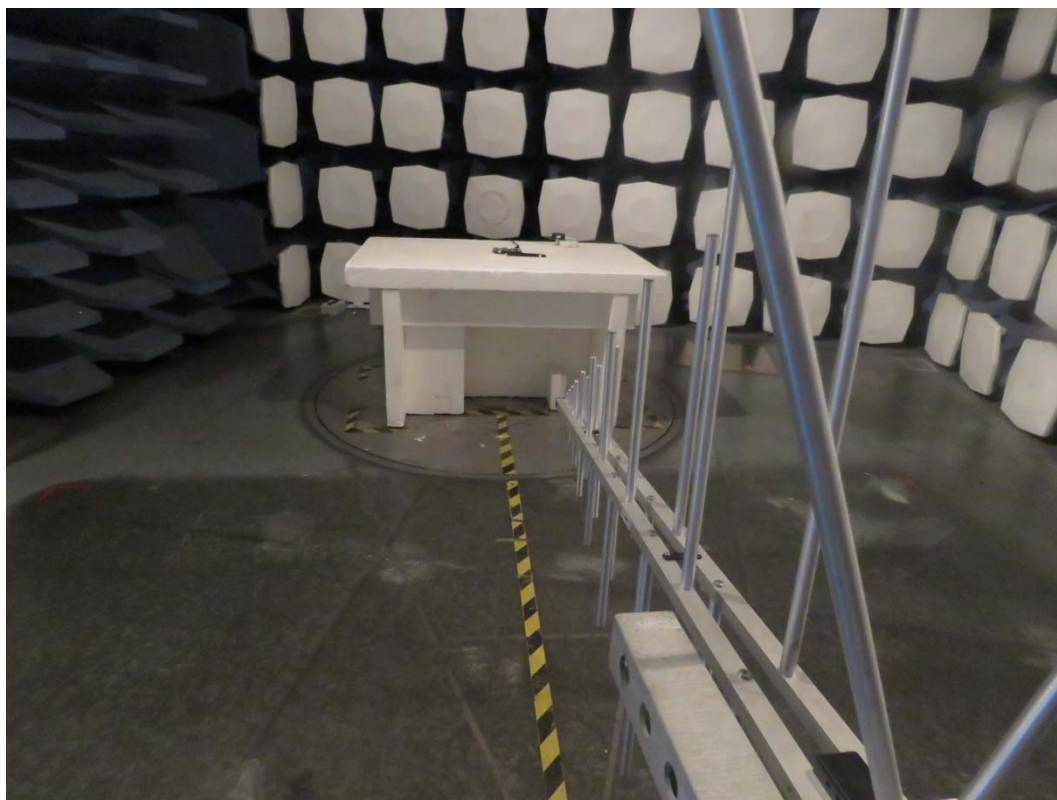


Back Side

a: EUT

**Picture 1 EUT and Accessory**

## A.2 Test Setup



Picture 2: Radiated Spurious Emissions Test setup