Shenzhen CTL Testing Technology Co., Ltd.
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# TEST REPORT

## FCC PART 15 SUBPART C 15.247 & RSS 247

**Report Reference No.** .....: **CTL1705256072-WF**

| | | |
|---|---|---|
| Compiled by:<br>( position+printed name+signature) | Allen Wang<br>(File administrators) | Allen Wang |
| Tested by:<br>( position+printed name+signature) | Nice Nong<br>(Test Engineer) | Nice Nong |
| Approved by:<br>( position+printed name+signature) | Ivan Xie<br>(Manager) | Ivan Xie |

**Product Name**.....: LoRaWAN NSL76-S1 Module

**Model/Type reference** .....: NSL76-S1

**List Model(s)**.....: N/A

**Trade Mark** .....: nextan

**FCC ID** .....: 2AMUN-NSL76-S1

**Applicant's name** .....: **Nextan Pte Ltd**

**Address of applicant** .....: Blk 47 #06-15, Ayer Rajah Crescent, Singapore 139947

**Test Firm** .....: **Shenzhen CTL Testing Technology Co., Ltd.**

**Address of Test Firm** .....: Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055

**Test specification**.....:

Standard.....: **47 CFR FCC Part 15 Subpart C 15.247 & RSS 247 Issue 2, February 2017**

TRF Originator .....: Shenzhen CTL Testing Technology Co., Ltd.

Master TRF .....: Dated 2011-01

**Date of Receipt**.....: Jun. 05, 2017

**Date of Test Date**.....: Jun. 06, 2017–Jul. 10, 2017

**Data of Issue**.....: Jul. 11, 2017

**Result**.....: Pass

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# TEST REPORT

| Test Report No. : | CTL1705256072-WF | Jul. 11, 2017<br>Date of issue |
|---|---|---|

| | | |
|---|---|---|
| Equipment under Test | : | LoRaWAN NSL76-S1 Module |
| Model /Type | : | NSL76-S1 |
| Listed Models | : | N/A |
| **Applicant** | : | **Nextan Pte Ltd** |
| Address | : | Blk 47 #06-15, Ayer Rajah Crescent, Singapore 139947 |
| **Manufacturer** | : | **Nextan Pte Ltd** |
| Address | : | Blk 47 #06-15, Ayer Rajah Crescent, Singapore 139947 |

| Test result | Pass * |
|---|---|

＊ In the configuration tested, the EUT complied with the standards specified page 5.

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

# ** Modified History **

| Revisions | Description | Issued Data | Report No. | Remark |
|---|---|---|---|---|
| Version 1.0 | Initial Test Report Release | 2017-07-11 | CTL1705256072-WF | Tracy Qi |
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Shenzhen CTL Testing Technology Co., Ltd.

# 1. SUMMARY

## 1.1. TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

RSS-247-Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

RSS-Gen Issue 4: — General Requirements for Compliance of Radio Apparatus

ANSI C63.10:2013 : American National Standard for Testing Unlicensed Wireless Devices

ANSI C63.4: 2014: –American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40GHz

## 1.2. Test Description

| FCC PART 15.247 & RSS 247 | | |
|---|---|---|
| FCC Part 15.207<br>RSS-Gen 8.8 | AC Power Conducted Emission | PASS |
| FCC Part 15.247(a)(1)(i)<br>RSS 247 5.1 (a)<br>RSS-Gen 4.6 | 20dB Bandwidth & 99% Bandwidth | PASS |
| FCC Part 15.247(d)<br>RSS 247 5.5 | Spurious RF Conducted Emission | PASS |
| FCC Part 15.247(b)(2)<br>RSS 247 5.4 (a) | Maximum Peak Output Power | PASS |
| FCC Part 15.247(b)<br>RSS 247 5.1 (a)(1) | Pseudorandom Frequency Hopping Sequence | PASS |
| FCC Part 15.247(a)(1)(i)<br>RSS 247 5.1 (c) | Number of hopping frequency& Time of Occupancy | PASS |
| FCC Part 15.247(a)(1)<br>RSS 247 5.1 (b) | Frequency Separation | PASS |
| FCC Part 15.205/15.209<br>RSS-Gen 8.9 | Radiated Emissions | PASS |
| FCC Part 15.247(d)<br>RSS-Gen 8.10 | Band Edge Compliance of RF Emission | PASS |

## 1.3. Test Facility

### 1.3.1 Address of the test laboratory

Shenzhen CTL Testing Technology Co., Ltd.
Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 32/EN 55032 requirements.

### 1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

**IC Registration No.: 9618B**

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration No.: 9618B on November 13, 2013.

**FCC-Registration No.: 970318**

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 970318, December 19, 2013.

## 1.4. Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the Shenzhen CTL Testing Technology Co., Ltd. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CTL laboratory is reported:

| Test | Measurement Uncertainty | Notes |
|---|---|---|
| Transmitter power conducted | ±0.57 dB | (1) |
| Transmitter power Radiated | ±2.20 dB | (1) |
| Conducted spurious emission 9KHz-40 GHz | ±2.20 dB | (1) |
| Occupied Bandwidth | ±0.01ppm | (1) |
| Radiated Emission 30~1000MHz | ±4.10dB | (1) |
| Radiated Emission Above 1GHz | ±4.32dB | (1) |
| Conducted Disturbance0.15~30MHz | ±3.20dB | (1) |

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

# 2. GENERAL INFORMATION

## 2.1. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

| | |
|---|---|
| Normal Temperature: | 25°C |
| Relative Humidity: | 55 % |
| Air Pressure: | 101 kPa |

## 2.2. General Description of EUT

| | |
|---|---|
| Product Name: | LoRaWAN NSL76-S1 Module |
| Model/Type reference: | NSL76-S1 |
| Power supply: | DC 3.3V from host |
| **900MHz ISM Band wireless** | |
| Operation frequency: | 902.5MHz~927.5MHz |
| Modulation: | GFSK |
| Channel number: | 51 |
| Channel separation: | 0.5MHz |

Antenna type:

| Type | Antenna type | Gain | Remark |
|---|---|---|---|
| ILA.01 | SMT antenna | 1.00dBi | Integrated |
| HPD215T-B-915 | Spring antenna | 2.15dBi | Integrated |

Note: The 2 antenna all have been tested; only worse case Spring antenna is reported

## 2.3. Description of Test Modes and Test Frequency

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing.

**Operation Frequency：**

| Channel | Frequency (MHz) |
|---|---|
| **01** | **902.5** |
| 02 | 903.0 |
| ⋮ | ⋮ |
| 25 | 914.5 |
| **26** | **915.0** |
| 27 | 915.5 |
| ⋮ | ⋮ |
| 50 | 927.0 |
| **51** | **927.5** |

Note: The line display in grey were the channel selected for testing

## 2.4. Equipments Used during the Test

| Test Equipment | Manufacturer | Model No. | Serial No. | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| LISN | R&S | ENV216 | 3560.6550.12 | 2017/06/02 | 2018/06/01 |
| LISN | R&S | ESH2-Z5 | 860014/010 | 2017/06/02 | 2018/06/01 |
| Bilog Antenna | Sunol Sciences Corp. | JB1 | A061713 | 2017/06/02 | 2018/06/01 |
| EMI Test Receiver | R&S | ESCI | 103710 | 2017/06/02 | 2018/06/01 |
| Spectrum Analyzer | Agilent | E4407B | MY41440676 | 2017/05/21 | 2018/05/20 |
| Spectrum Analyzer | Agilent | N9020 | US46220290 | 2017/01/16 | 2018/01/15 |
| Power Meter | Anritsu | ML2487B | 110553 | 2017/06/02 | 2018/06/01 |
| Power Sensor | Anritsu | MA2411B | 100345 | 2017/05/21 | 2018/05/20 |
| Controller | EM Electronics | Controller EM 1000 | N/A | 2017/05/21 | 2018/05/20 |
| Horn Antenna | Sunol Sciences Corp. | DRH-118 | A062013 | 2017/05/19 | 2018/05/18 |
| Active Loop Antenna | SCHWARZBECK | FMZB1519 | 1519-037 | 2017/05/19 | 2018/05/18 |
| Amplifier | Agilent | 8349B | 3008A02306 | 2017/05/19 | 2018/05/18 |
| Amplifier | Agilent | 8447D | 2944A10176 | 2017/05/19 | 2018/05/18 |
| Temperature/Humidity Meter | Gangxing | CTH-608 | 02 | 2017/05/20 | 2018/05/19 |
| High-Pass Filter | K&L | 9SH10-2700/X12750-O/O | N/A | 2017/05/20 | 2018/05/19 |
| High-Pass Filter | K&L | 41H10-1375/U12750-O/O | N/A | 2017/05/20 | 2018/05/19 |
| Coaxial Cables | HUBER+SUHNER | SUCOFLEX 104PEA-10M | 10m | 2017/06/02 | 2018/06/01 |
| Coaxial Cables | HUBER+SUHNER | SUCOFLEX 104PEA-3M | 3m | 2017/06/02 | 2018/06/01 |
| Coaxial Cables | HUBER+SUHNER | SUCOFLEX 104PEA-3M | 3m | 2017/06/02 | 2018/06/01 |
| RF Cable | Megalon | RF-A303 | N/A | 2017/06/02 | 2018/06/01 |

The calibration interval was one year

## 2.5. Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with Section 15.247 of the FCC Part 15 Subpart C Rules.

## 2.6. Modifications

No modifications were implemented to meet testing criteria.

# 3. TEST CONDITIONS AND RESULTS

## 3.1. Conducted Emissions Test

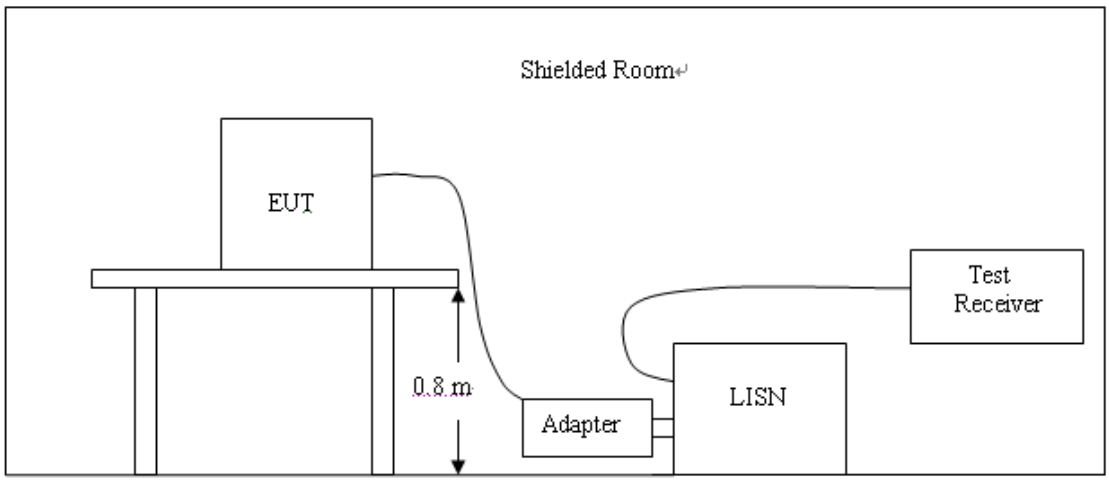
**LIMIT**

According to FCC CFR Title 47 Part 15 Subpart C Section 15.207 and RSS Gen 8.8, AC Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus as below:

| Frequency range (MHz) | Limit (dBuV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

**TEST CONFIGURATION**




**TEST PROCEDURE**

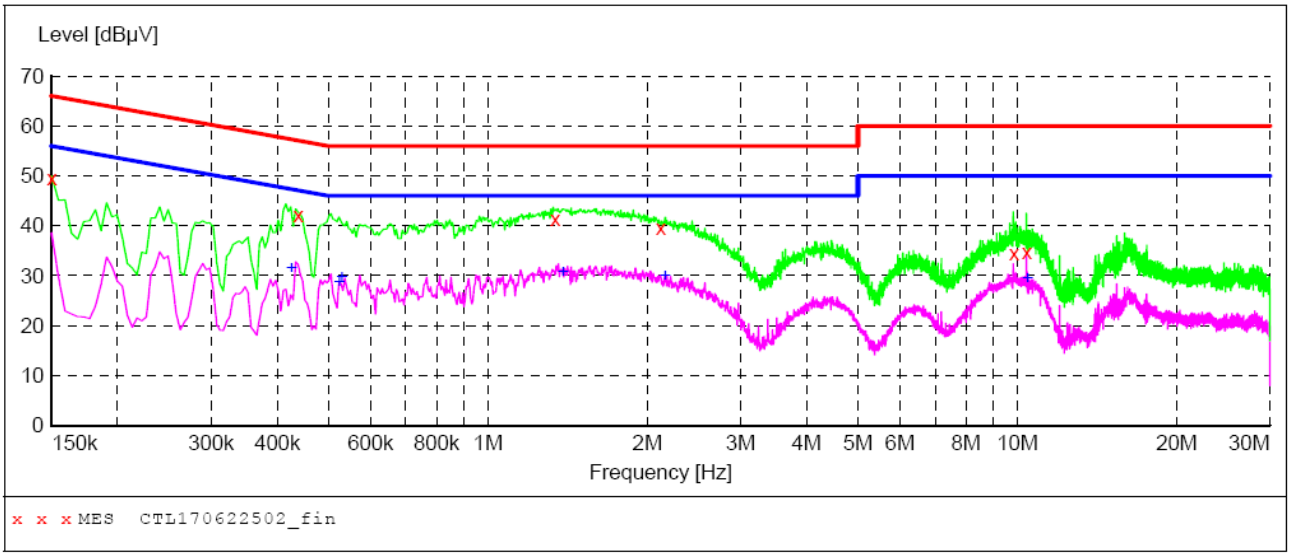
1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10:2013.
2. Support equipment, if needed, was placed as per ANSI C63.10:2013
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10:2013.
4. The adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

## TEST RESULTS

Remark: Tests were conducted at Low, Middle, and High channel; only the worst result of High Channel was reported as below:

| Line: | L |
|---|---|

*SCAN TABLE: "Voltage (9K-30M)FIN"*
Short Description: 150K-30M Voltage




*MEASUREMENT RESULT: "CTL170622502_fin"*

6/22/2017 9:47AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.150000 | 49.60 | 10.2 | 66 | 16.4 | QP | L1 | GND |
| 0.438000 | 42.20 | 10.2 | 57 | 14.9 | QP | L1 | GND |
| 1.340000 | 41.40 | 10.3 | 56 | 14.6 | QP | L1 | GND |
| 2.120000 | 39.50 | 10.4 | 56 | 16.5 | QP | L1 | GND |
| 9.848000 | 34.60 | 10.6 | 60 | 25.4 | QP | L1 | GND |
| 10.406000 | 34.80 | 10.6 | 60 | 25.2 | QP | L1 | GND |

*MEASUREMENT RESULT: "CTL170622502_fin2"*

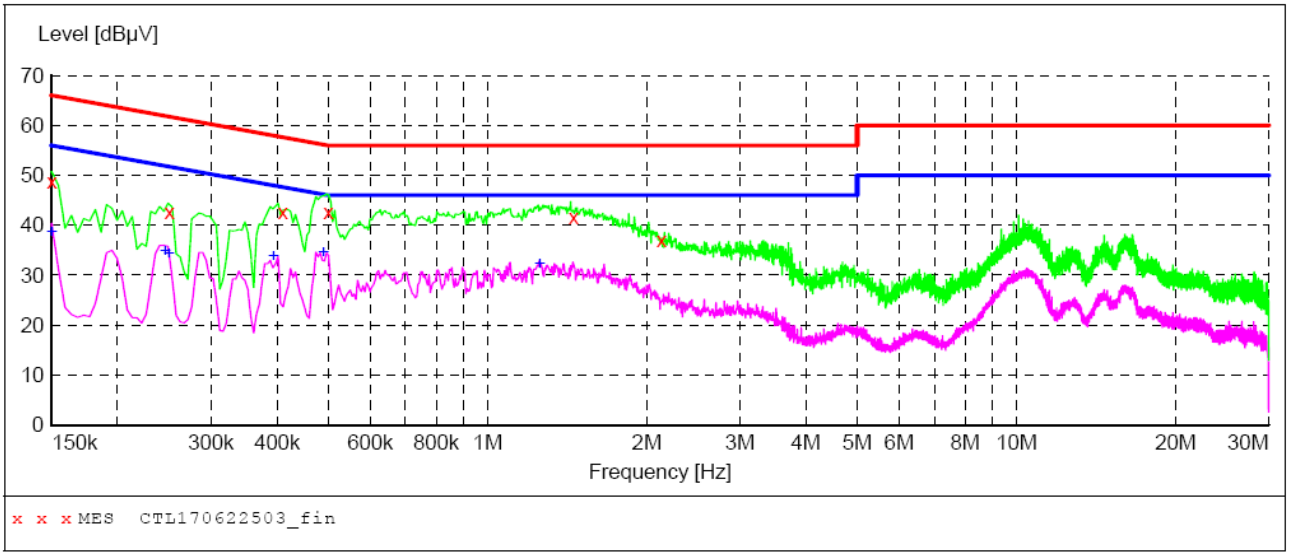
6/22/2017 9:47AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.426000 | 31.50 | 10.2 | 47 | 15.8 | AV | L1 | GND |
| 0.524000 | 28.70 | 10.2 | 46 | 17.3 | AV | L1 | GND |
| 0.530000 | 29.70 | 10.2 | 46 | 16.3 | AV | L1 | GND |
| 1.388000 | 30.70 | 10.3 | 46 | 15.3 | AV | L1 | GND |
| 2.162000 | 30.00 | 10.4 | 46 | 16.0 | AV | L1 | GND |
| 10.454000 | 29.40 | 10.6 | 50 | 20.6 | AV | L1 | GND |

| Line: | N |
|---|---|

***SCAN TABLE: "Voltage (9K-30M)FIN"***

Short Description: 150K-30M Voltage




***MEASUREMENT RESULT: "CTL170622503_fin"***

6/22/2017 9:51AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.150000 | 48.90 | 10.2 | 66 | 17.1 | QP | N | GND |
| 0.250000 | 42.70 | 10.2 | 62 | 19.1 | QP | N | GND |
| 0.410000 | 42.70 | 10.2 | 58 | 14.9 | QP | N | GND |
| 0.500000 | 42.70 | 10.2 | 56 | 13.3 | QP | N | GND |
| 1.454000 | 41.60 | 10.3 | 56 | 14.4 | QP | N | GND |
| 2.132000 | 37.00 | 10.4 | 56 | 19.0 | QP | N | GND |

***MEASUREMENT RESULT: "CTL170622503_fin2"***

6/22/2017 9:51AM

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|---|---|---|---|---|---|---|---|
| 0.150000 | 38.50 | 10.2 | 56 | 17.5 | AV | N | GND |
| 0.246000 | 34.70 | 10.2 | 52 | 17.2 | AV | N | GND |
| 0.250000 | 34.30 | 10.2 | 52 | 17.5 | AV | N | GND |
| 0.394000 | 33.70 | 10.2 | 48 | 14.3 | AV | N | GND |
| 0.490000 | 34.50 | 10.2 | 46 | 11.7 | AV | N | GND |
| 1.256000 | 32.10 | 10.3 | 46 | 13.9 | AV | N | GND |

## 3.2. Radiated Emissions and Band Edge

**Limit**

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a)

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission

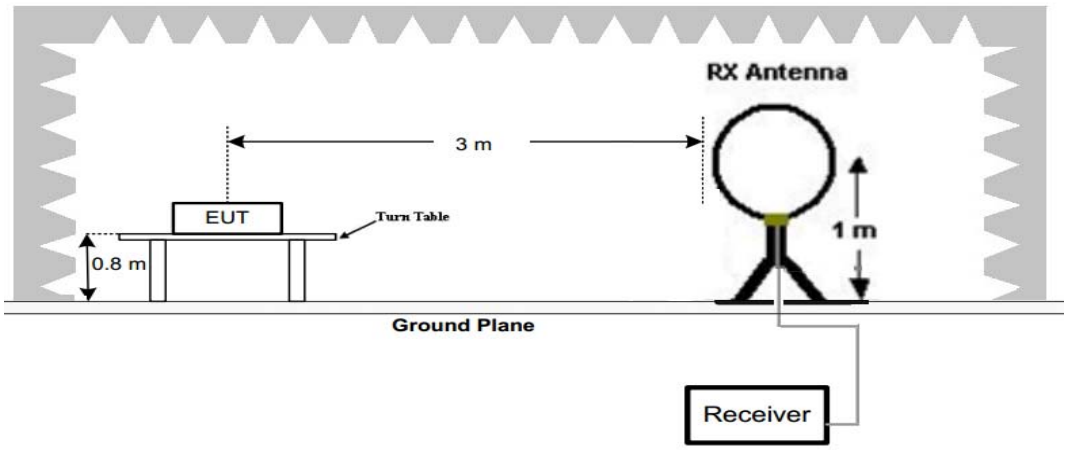
Unwanted emissions that fall into restricted bands shall comply with the limits specified in RSS-Gen; and Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Radiated emission limits

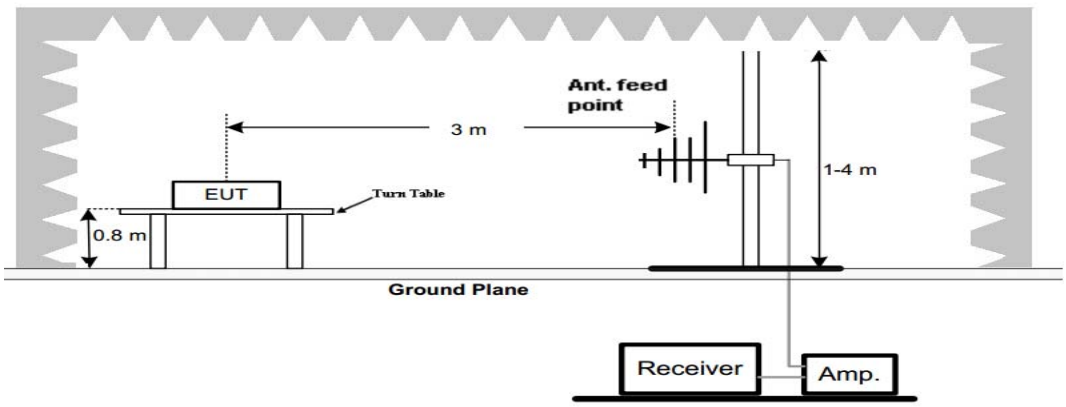
| Frequency (MHz) | Distance (Meters) | Radiated (dBμV/m) | Radiated (μV/m) |
|---|---|---|---|
| 0.009-0.49 | 3 | 20log(2400/F(KHz))+40log(300/3) | 2400/F(KHz) |
| 0.49-1.705 | 3 | 20log(24000/F(KHz))+ 40log(30/3) | 24000/F(KHz) |
| 1.705-30 | 3 | 20log(30)+ 40log(30/3) | 30 |
| 30-88 | 3 | 40.0 | 100 |
| 88-216 | 3 | 43.5 | 150 |
| 216-960 | 3 | 46.0 | 200 |
| Above 960 | 3 | 54.0 | 500 |

**TEST CONFIGURATION**

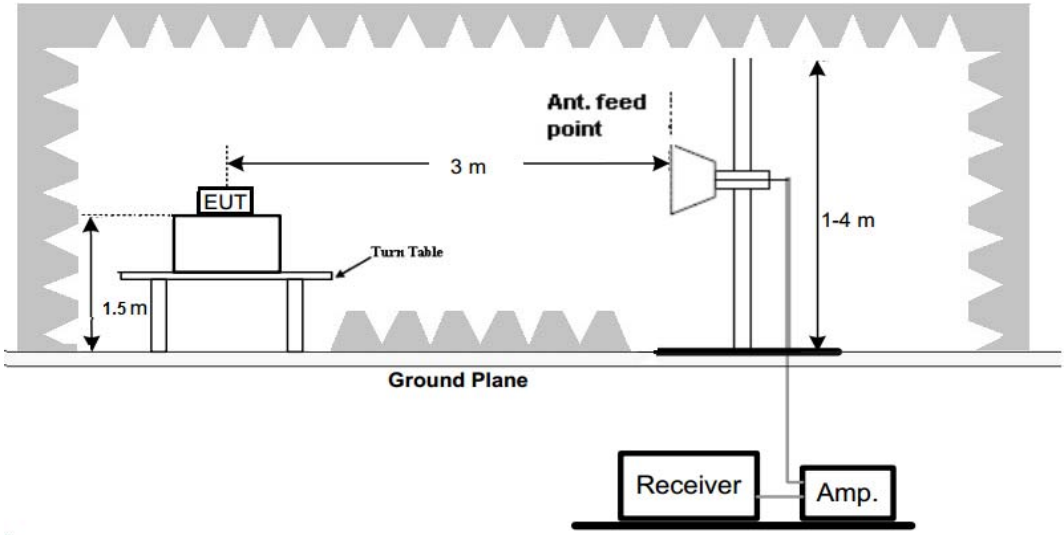
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz




(B) Radiated Emission Test Set-Up, Frequency below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz




**Test Procedure**

1. The EUT was placed on turn table which is 0.8m above ground plane for below 1GHz test, and on a low permittivity and low loss tangent turn table which is 1.5m above ground plane for above 1GHz test.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.

**TEST RESULTS**

Remark:
1. Radiated Emission measured from 9 KHz to 10th harmonic of fundamental and only worst point recorded in this report.
2. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that “Z axis” position was the worst, and test data recorded in this report.

| Frequency(MHz): | | | | 902.5 | | Polarity: | | | Horizontal | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 311.50 | 38.76 | PK | 46.00 | 7.24 | 47.46 | 19.25 | 1.29 | 29.24 | -8.70 |
| 2 | 614.00 | 35.52 | PK | 46.00 | 10.48 | 42.29 | 21.45 | 1.89 | 30.11 | -6.77 |
| 3 | 1805.00 | 57.25 | PK | 74.00 | 16.75 | 61.52 | 27.17 | 4.01 | 35.45 | -4.27 |
| 3 | 1805.00 | 49.60 | AV | 54.00 | 4.4 | 53.87 | 27.17 | 4.01 | 35.45 | -4.27 |
| 4 | 2707.50 | 55.62 | PK | 74.00 | 18.38 | 55.96 | 29.34 | 4.94 | 34.61 | -0.34 |
| 4 | 2707.50 | 47.41 | AV | 54.00 | 6.59 | 47.75 | 29.34 | 4.94 | 34.61 | -0.34 |
| 5 | 3610.00 | 40.25 | PK | 74.00 | 33.75 | 37.84 | 32.08 | 5.95 | 35.62 | 2.41 |
| 5 | 3610.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4512.50 | 37.50 | PK | 74.00 | 36.5 | 32.40 | 32.88 | 6.73 | 34.51 | 5.10 |
| 6 | 4512.50 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

| Frequency(MHz): | | | | 902.5 | | Polarity: | | | Vertical | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 311.50 | 38.89 | PK | 46.00 | 7.11 | 47.59 | 19.25 | 1.29 | 29.24 | 1.18 |
| 2 | 614.00 | 35.66 | PK | 46.00 | 10.34 | 42.43 | 21.45 | 1.89 | 30.11 | 1.57 |
| 3 | 1805.00 | 57.74 | PK | 74.00 | 16.26 | 62.01 | 27.17 | 4.01 | 35.45 | -4.27 |
| 3 | 1805.00 | 49.85 | AV | 54.00 | 4.15 | 54.12 | 27.17 | 4.01 | 35.45 | -4.27 |
| 4 | 2707.50 | 55.79 | PK | 74.00 | 18.21 | 56.13 | 29.34 | 4.94 | 34.61 | -0.34 |
| 4 | 2707.50 | 47.82 | AV | 54.00 | 6.18 | 48.16 | 29.34 | 4.94 | 34.61 | -0.34 |
| 5 | 3610.00 | 40.33 | PK | 74.00 | 33.67 | 37.92 | 32.08 | 5.95 | 35.62 | 2.41 |
| 5 | 3610.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4512.50 | 37.87 | PK | 74.00 | 36.13 | 32.77 | 32.88 | 6.73 | 34.51 | 5.10 |
| 6 | 4512.50 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below QP/AV limit.
5. The other emission levels were very low against the limit.
6. RBW100KHz VBW300KHz for test at below 1GHz; RBW1MHz VBW3MHz Peak detector is for PK value, RBW 1MHz VBW10Hz Peak detector is for AV value for test at above 1GHz.

| Frequency(MHz): | | | | 915 | | Polarity: | | | Horizontal | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 314.25 | 37.24 | PK | 46.00 | 8.76 | 45.13 | 19.50 | 1.57 | 28.96 | -7.89 |
| 2 | 548.79 | 35.56 | PK | 46.00 | 10.44 | 40.11 | 22.91 | 1.96 | 29.42 | -4.55 |
| 3 | 1830.00 | 58.25 | PK | 74.00 | 15.75 | 62.34 | 27.31 | 4.04 | 35.43 | -4.09 |
| 3 | 1830.00 | 50.12 | AV | 54.00 | 3.88 | 54.21 | 27.31 | 4.04 | 35.43 | -4.09 |
| 4 | 2745.00 | 55.45 | PK | 74.00 | 18.55 | 55.58 | 29.47 | 4.98 | 34.58 | -0.13 |
| 4 | 2745.00 | 47.98 | AV | 54.00 | 6.02 | 48.11 | 29.47 | 4.98 | 34.58 | -0.13 |
| 5 | 3660.00 | 40.55 | PK | 74.00 | 33.45 | 37.78 | 32.39 | 6.01 | 35.64 | 2.77 |
| 5 | 3660.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4575.00 | 38.04 | PK | 74.00 | 35.96 | 32.77 | 32.97 | 6.77 | 34.47 | 5.27 |
| 6 | 4575.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

| Frequency(MHz): | | | | 915 | | Polarity: | | | Vertical | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 314.25 | 37.85 | PK | 43.50 | 8.15 | 45.74 | 19.50 | 1.57 | 28.96 | -7.89 |
| 2 | 548.79 | 35.63 | PK | 46.00 | 10.37 | 40.18 | 22.91 | 1.96 | 29.42 | -4.55 |
| 3 | 1830.00 | 58.47 | PK | 74.00 | 15.53 | 62.56 | 27.31 | 4.04 | 35.43 | -4.09 |
| 3 | 1830.00 | 50.55 | AV | 54.00 | 3.45 | 54.64 | 27.31 | 4.04 | 35.43 | -4.09 |
| 4 | 2745.00 | 55.29 | PK | 74.00 | 18.71 | 55.42 | 29.47 | 4.98 | 34.58 | -0.13 |
| 4 | 2745.00 | 47.74 | AV | 54.00 | 6.26 | 47.87 | 29.47 | 4.98 | 34.58 | -0.13 |
| 5 | 3660.00 | 40.62 | PK | 74.00 | 33.38 | 37.85 | 32.39 | 6.01 | 35.64 | 2.77 |
| 5 | 3660.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4575.00 | 38.49 | PK | 74.00 | 35.51 | 33.22 | 32.97 | 6.77 | 34.47 | 5.27 |
| 6 | 4575.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below QP/AV limit.
5. The other emission levels were very low against the limit.
6. RBW100KHz VBW300KHz for test at below 1GHz; RBW1MHz VBW3MHz Peak detector is for PK value, RBW 1MHz VBW10Hz Peak detector is for AV value for test at above 1GHz.

| Frequency(MHz): | | | | 927.5 | | Polarity: | | | Horizontal | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 311.30 | 37.32 | PK | 46.00 | 8.68 | 45.14 | 19.78 | 1.54 | 29.14 | -7.82 |
| 2 | 960.00 | 35.54 | PK | 46.00 | 10.46 | 41.67 | 22.63 | 1.29 | 30.05 | -6.13 |
| 3 | 1855.00 | 58.15 | PK | 74.00 | 15.85 | 62.05 | 27.44 | 4.06 | 35.40 | -3.90 |
| 3 | 1855.00 | 50.78 | AV | 54.00 | 3.22 | 54.68 | 27.44 | 4.06 | 35.40 | -3.90 |
| 4 | 2782.50 | 55.56 | PK | 74.00 | 18.44 | 55.47 | 29.61 | 5.02 | 34.54 | 0.09 |
| 4 | 2782.50 | 47.98 | AV | 54.00 | 6.02 | 47.89 | 29.61 | 5.02 | 34.54 | 0.09 |
| 5 | 3710.00 | 40.54 | PK | 74.00 | 33.46 | 37.41 | 32.70 | 6.07 | 35.65 | 3.13 |
| 5 | 3710.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4637.50 | 38.57 | PK | 74.00 | 35.43 | 33.10 | 33.10 | 6.81 | 34.44 | 5.47 |
| 6 | 4637.50 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

| Frequency(MHz): | | | | 927.5 | | Polarity: | | | Vertical | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Frequency (MHz) | Emission Level (dBuV/m) | | Limit (dBuV/m) | Margin (dB) | Raw Value (dBuV) | Antenna Factor (dB/m) | Cable Factor (dB) | Pre-amplifier (dB) | Correction Factor (dB/m) |
| 1 | 311.30 | 37.48 | PK | 46.00 | 8.52 | 45.30 | 19.78 | 1.54 | 29.14 | -7.82 |
| 2 | 960.00 | 35.26 | PK | 46.00 | 10.74 | 41.39 | 22.63 | 1.29 | 30.05 | -6.13 |
| 3 | 1855.00 | 58.50 | PK | 74.00 | 15.50 | 62.40 | 27.44 | 4.06 | 35.40 | -3.90 |
| 3 | 1855.00 | 50.41 | AV | 54.00 | 3.59 | 54.31 | 27.44 | 4.06 | 35.40 | -3.90 |
| 4 | 2782.50 | 55.58 | PK | 74.00 | 18.42 | 55.49 | 29.61 | 5.02 | 34.54 | 0.09 |
| 4 | 2782.50 | 47.90 | AV | 54.00 | 6.10 | 47.81 | 29.61 | 5.02 | 34.54 | 0.09 |
| 5 | 3710.00 | 40.63 | PK | 74.00 | 33.37 | 37.50 | 32.70 | 6.07 | 35.65 | 3.13 |
| 5 | 3710.00 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |
| 6 | 4637.50 | 38.48 | PK | 74.00 | 35.52 | 33.01 | 33.10 | 6.81 | 34.44 | 5.47 |
| 6 | 4637.50 | -- | AV | 54.00 | -- | -- | -- | -- | -- | -- |

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below QP/AV limit.
5. The other emission levels were very low against the limit.
6. RBW100KHz VBW300KHz for test at below 1GHz; RBW1MHz VBW3MHz Peak detector is for PK value, RBW 1MHz VBW10Hz Peak detector is for AV value for test at above 1GHz.

## 3.3. Maximum Peak Conducted Output Power

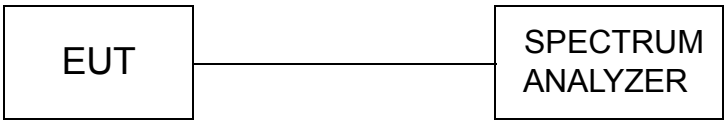
**Limit**

The Maximum Peak Output Power Measurement is 30dBm.

**Test Procedure**

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum. Spectrum set RBW 100KHz, VBW≥RBW, Peak Detector, Trace MaxHold.

**Test Configuration**




**Test Results**

| Channel | Output power (dBm) | Limit (dBm) | Result |
|---|---|---|---|
| 01 | 19.357 | 30.00 | Pass |
| 26 | 19.412 | | |
| 51 | 19.515 | | |

Note: 1.The test results including the cable lose.

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*Normal Modulation*

*CH01*

*CH26*

*CH51*

## 3.4. 20dB and 99% Bandwidth

**Limit**

For frequency hopping systems operating in the 902-928 MHz band. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

**Test Procedure**

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.

The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

RBW=1% to 5% of the OBW
VBW=approximately 3 X RBW
Detector=Peak
Trace Mode: Max Hold

Use the 99% power bandwidth function of the instrument to measure the Occupied Bandwidth and recoded.

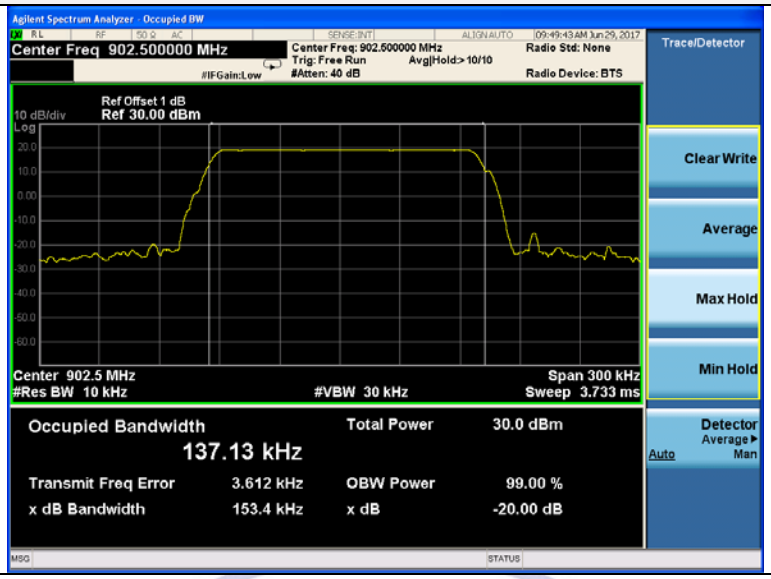
**Test Configuration**

**Test Results**

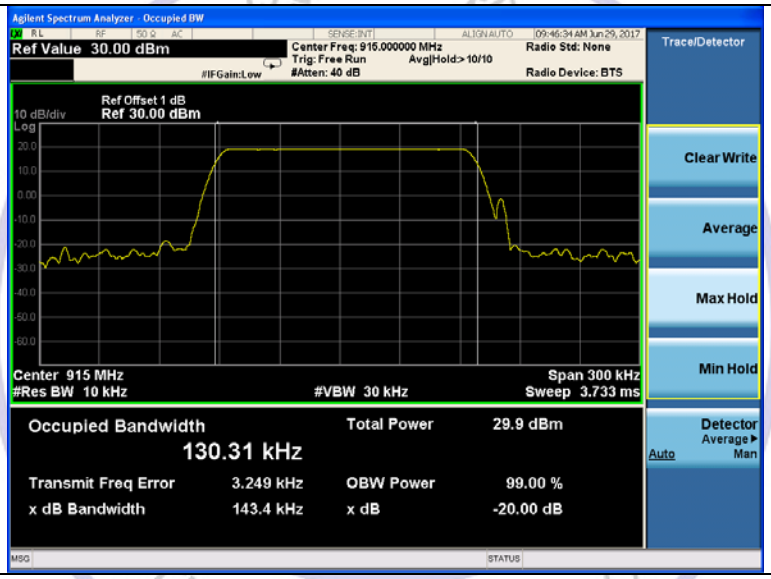
| Channel | 20dB bandwidth (KHz) | 99% OBW(KHz) | Result |
|---|---|---|---|
| CH01 | 153.40 | 137.13 | Pass |
| CH26 | 143.40 | 130.31 | |
| CH51 | 154.30 | 141.34 | |

**Test plot as follows:**

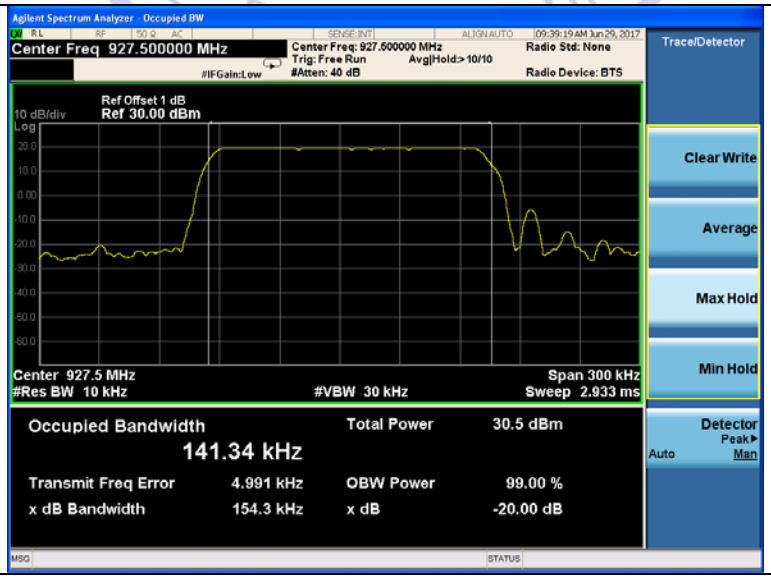
*Normal Modulation*




*CH01*




*CH26*




*CH51*

## 3.5. Frequency Separation

**LIMIT**

FHSs 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 PROCEDURE**

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with100 KHz RBW and 300 KHz VBW.

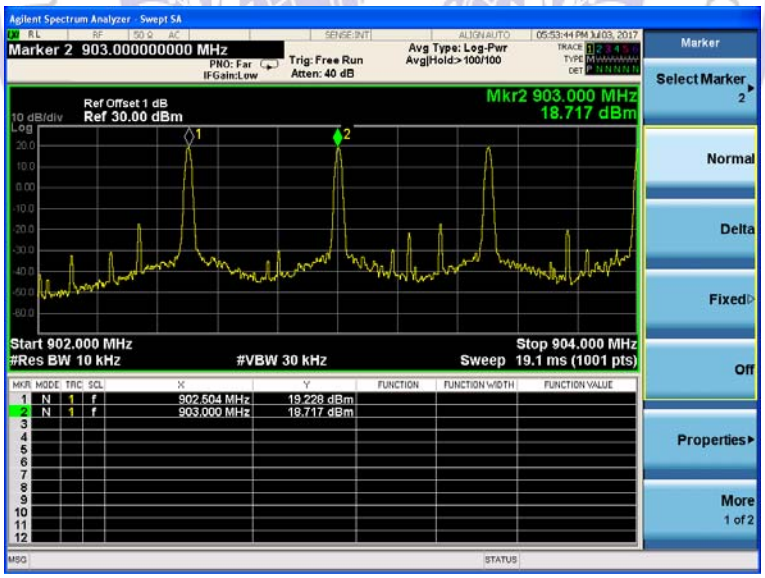
**TEST CONFIGURATION**

**TEST RESULTS**

| Channel | Channel Separation (MHz) | Limit | Result |
|---|---|---|---|
| CH01 | 0.496 | 25KHz or 20dB bandwidth | Pass |
| CH02 | | | |

Note: We have tested all mode at high, middle and low channel, and recorded worst case at low channel

**Test plot as follows:**



## 3.6. Number of hopping frequency

**Limit**

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

**Test Procedure**

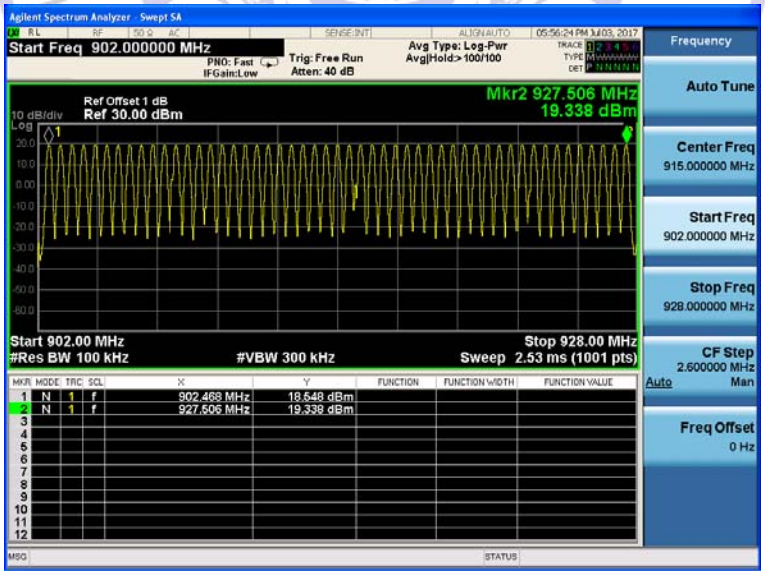
The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 902MHz to 928MHz.

**Test Configuration**

**Test Results**

| Modulation | Number of Hopping Channel | Limit | Result |
|---|---|---|---|
| FHSS | 51 | ≥50 | Pass |

**Test plot as follows:**



## 3.7. Time of Occupancy (Dwell Time)

**Limit**

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period.

**Test Procedure**

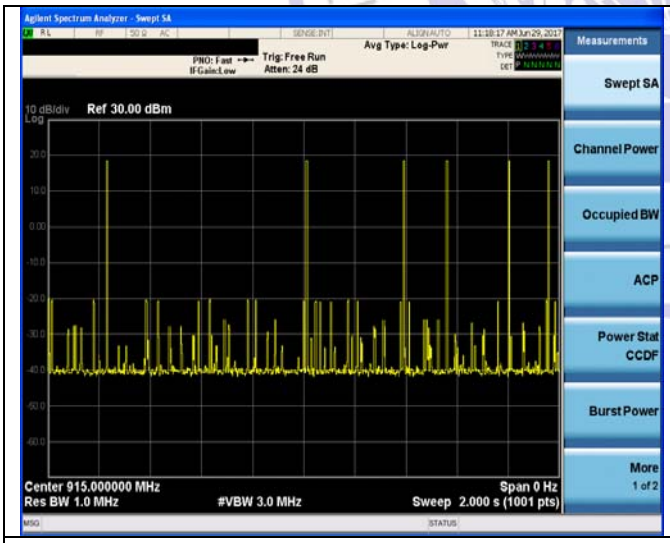
The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 1MHz VBW, Span 0Hz.

**Test Configuration**

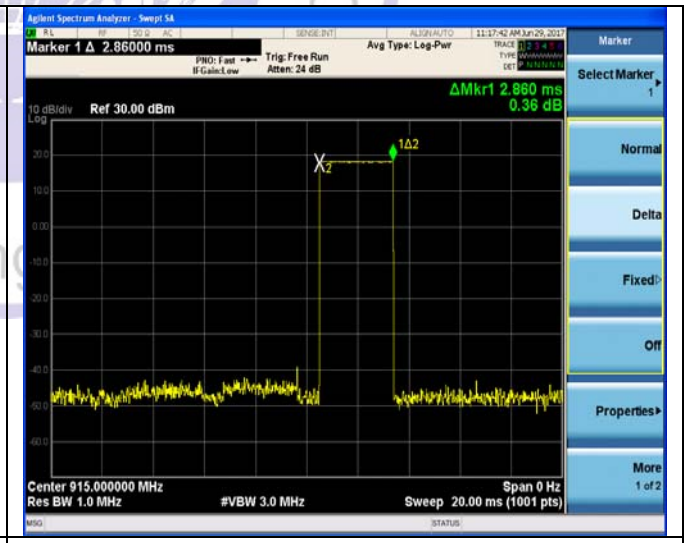
**Test Results**

In measurement time of 2s, total of 6 transmissions occurred. The duration of one transmission was 2.860ms.Based on these measurements the transmitter operated 10*6*2.860ms=0.1716s during the 20s period. The measurement result 0.1716s<0.4s,The test result is pass.

**Test plot as follows:**




Total Busts in 2.00s Observation time




Occupancy Time per burst

## 3.8. Out-of-band Emissions

**Limit**

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 con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**Test Procedure**

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

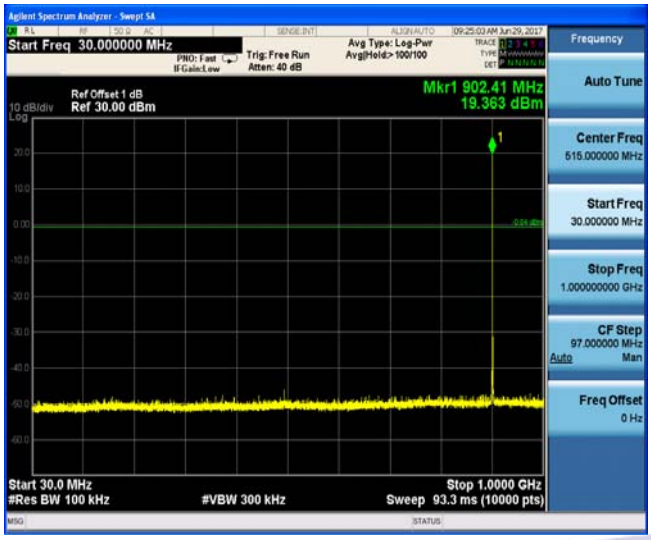
**Test Configuration**

**Test Results**

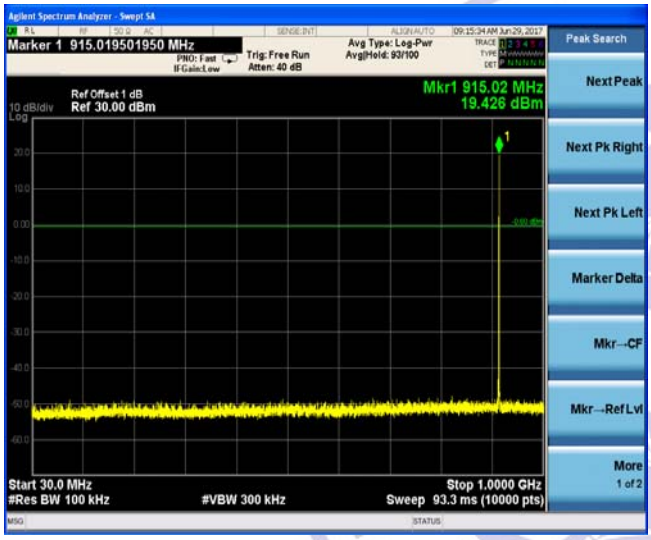
Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

Test plot as follows:

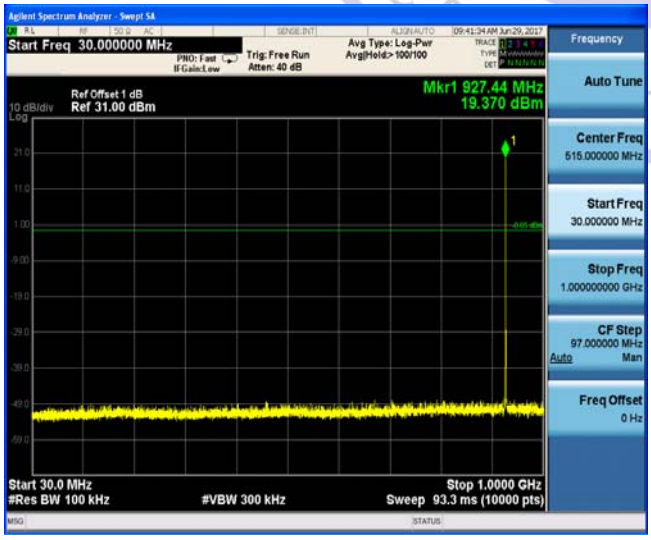
## Normal modulation

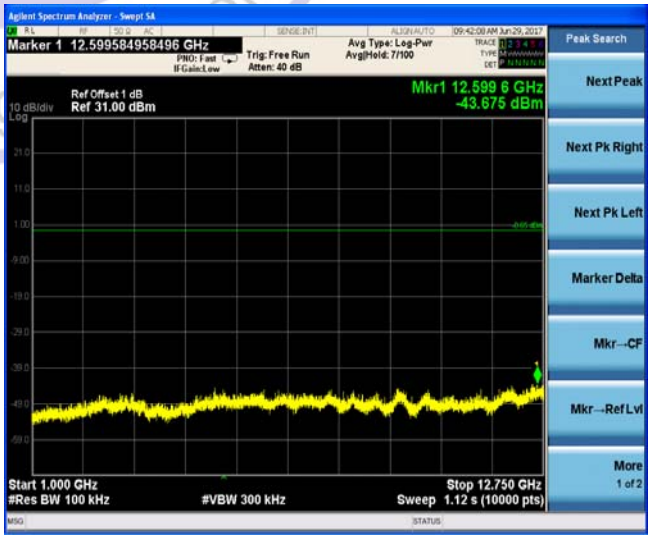


*CH01*

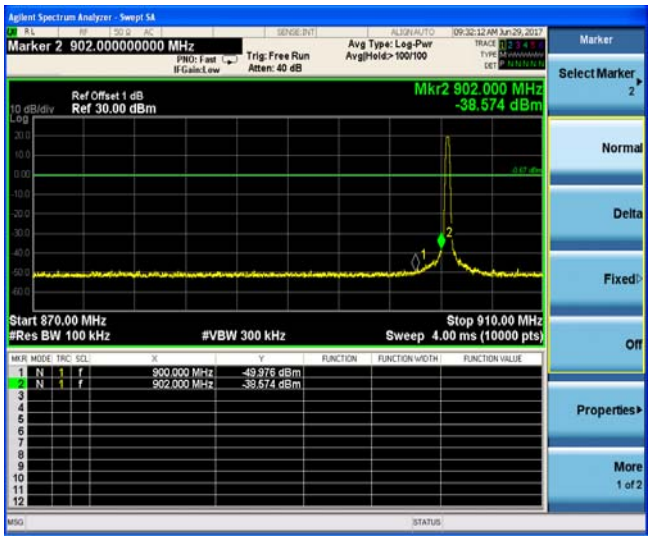


*CH26*

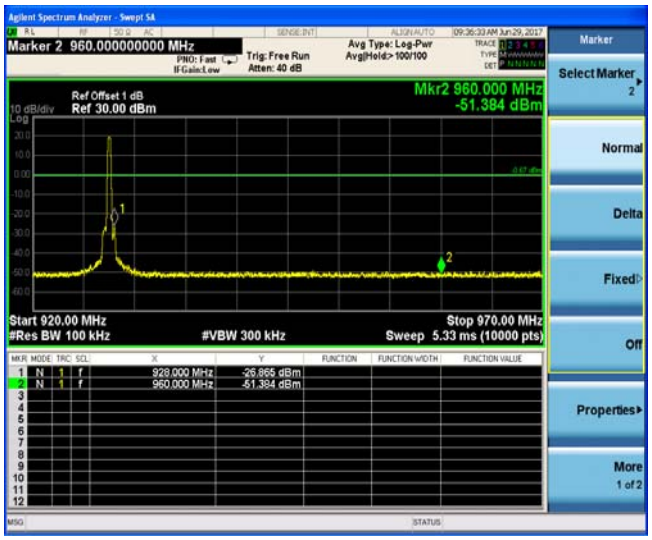


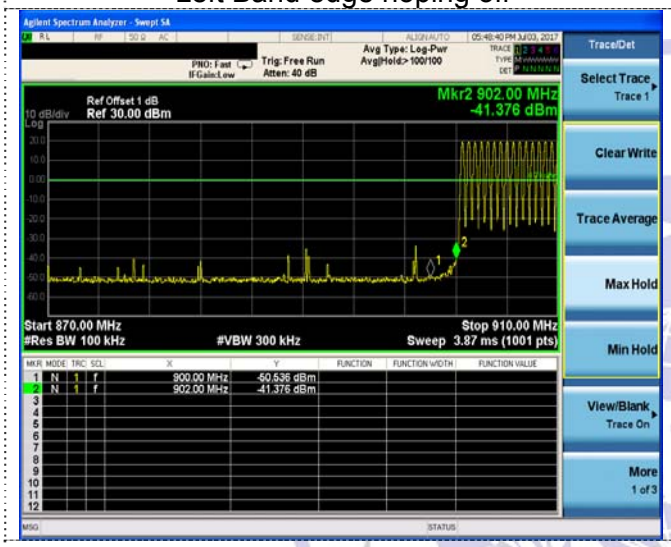

*CH50*



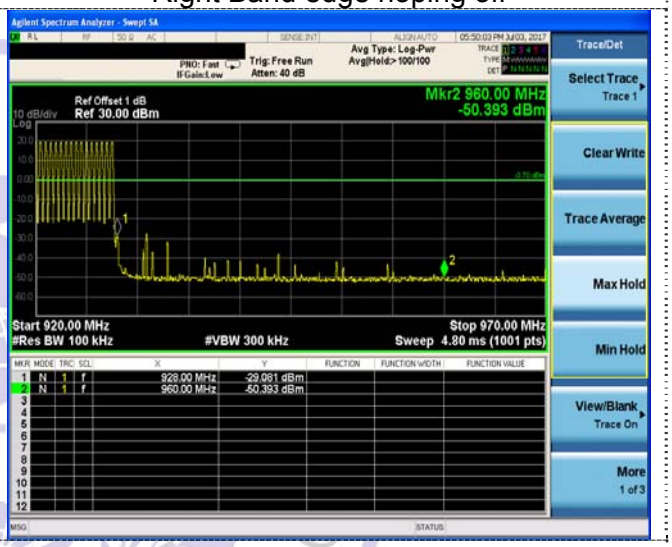

Left Band edge hoping off




Right Band edge hoping off




Left Band edge hoping on




Right Band edge hoping on

CTL Testing Technology

## 3.9. Pseudorandom Frequency Hopping Sequence

**TEST APPLICABLE**

**For 47 CFR Part 15C section 15.247 (a) (1) & RSS 247 requirement:**

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hop-ping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

**Test result**

Conforms

The device hops on 51 channel frequencies that are selected in a pseudo random order.
An example of the order is:
{48, 25, 17, 20, 41, 37, 36, 10, 15, 44, 30, 6, 42, 33, 5, 8, 28, 1, 23, 49, 16, 3, 19, 29, 21, 43, 31, 9, 18, 27, 22, 45, 13, 2, 32, 11, 14, 46, 12, 24, 4, 7, 38, 47, 35, 40, 50, 34, 39, 26, 51}

Where Channel 1 is 902.5 MHZ and Channel 51 is 927.50 MHZ.

The dwell time of the hopping is 180ms. Each channel is used equally on average.

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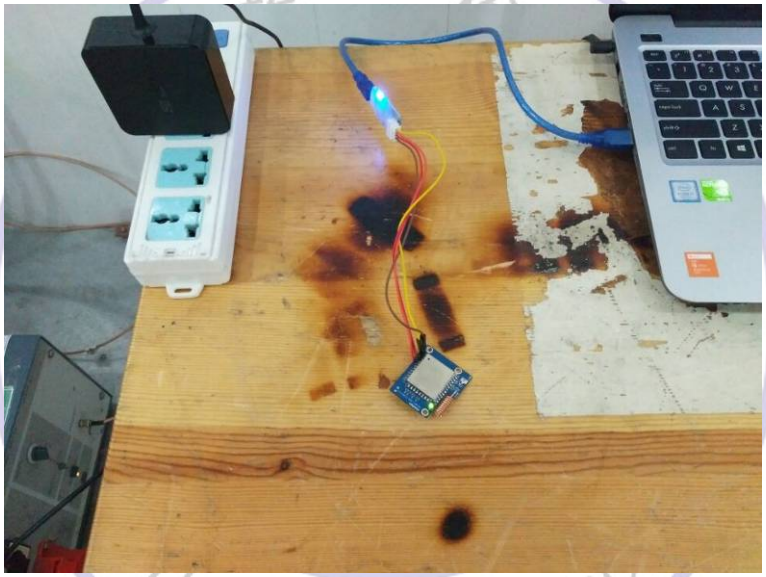
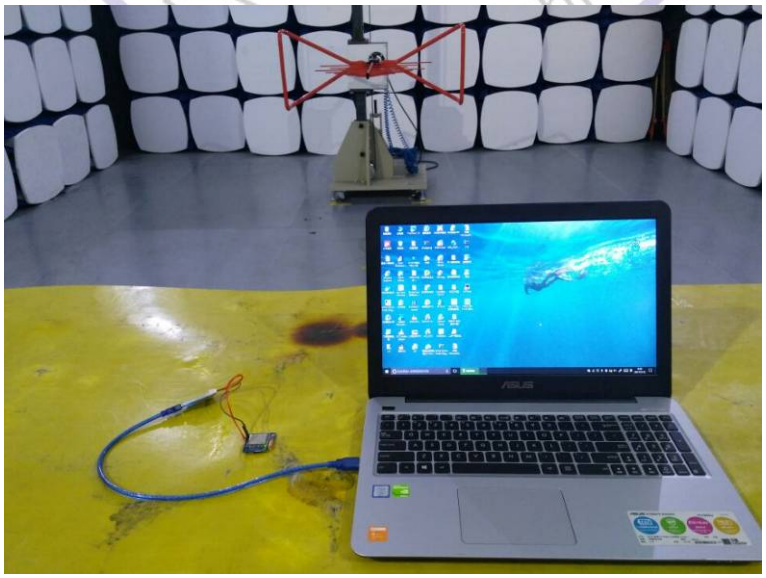
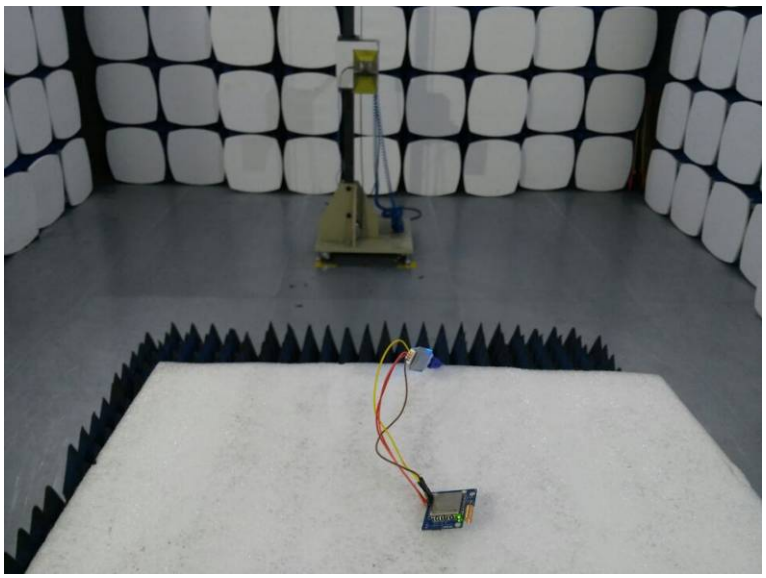
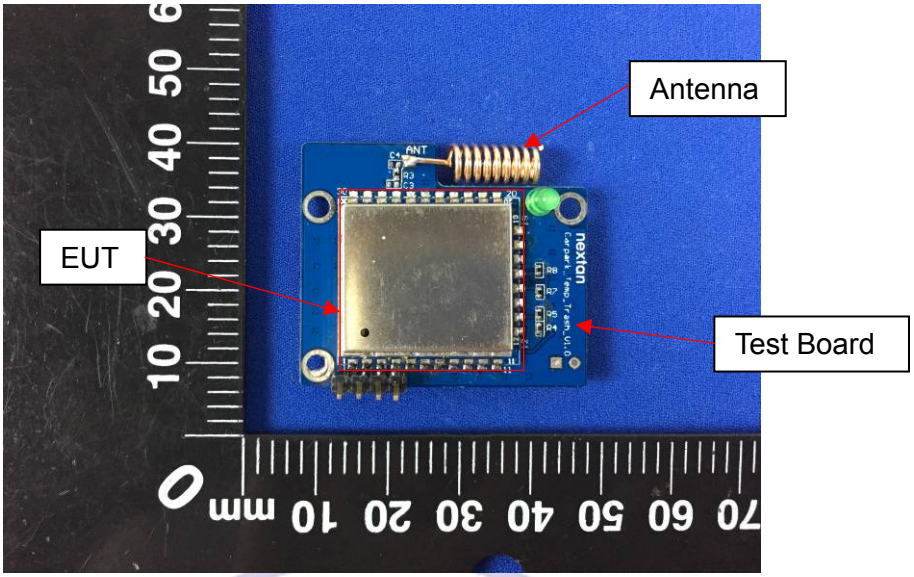
# 4. Test Setup Photos of the EUT

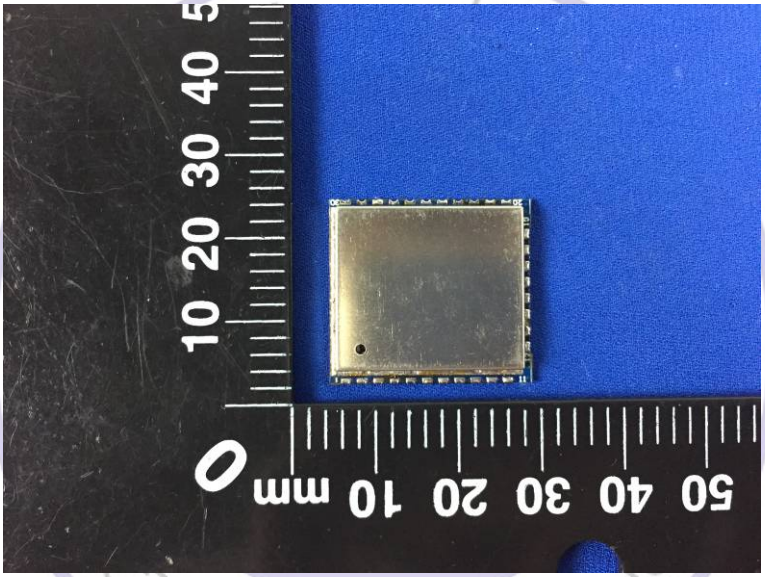


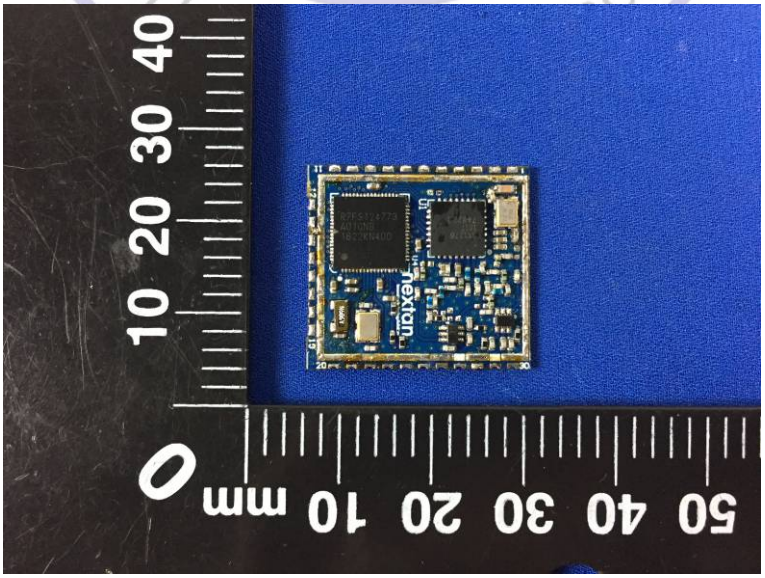


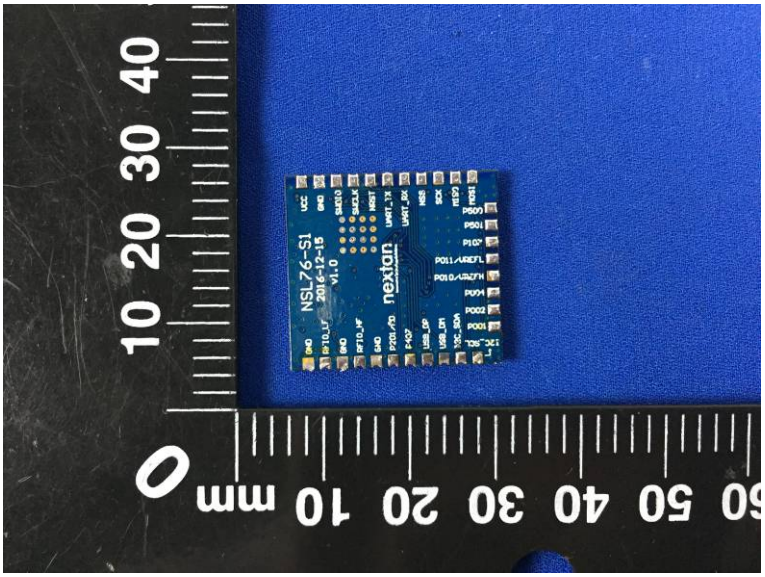


# 5. Photos of the EUT








********** End of Report **********

Shenzhen CTL Testing Technology Co.,Ltd.