# Radio Spectrum

## TEST REPORT

| | |
|---|---|
| **Report No.** | **: 170800032TWN-001** |
| **Model No.** | **: UMC-LORA** |
| **Issued Date** | **: Sep. 08, 2017** |

**Applicant:** **Wistron Neweb Corporation**
**20 Park Avenue II (or Yuanchiu 2nd Rd), Hsinchu Science Park, Hsinchu 308, Taiwan**

**Test Method/ Standard:** **47 CFR FCC Part 15.247 & ANSI C63.10 2013**
**KDB 558074 D01 v04**
**KDB 662911 D01 v02r01**

**Test Site:** **960839**

**Test By:** **Intertek Testing Services Taiwan Ltd.**
**No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li, Shiang-Shan District, Hsinchu City, Taiwan**



Testing Laboratory
0597

**The test report was prepared by:**

Candy Liu/ Assistant

**These measurements were taken by:**

Durant Wei/ Engineer

**The test report was reviewed by:**

**Name** Jimmy Yang
**Title** Group Leader

# Revision History

| Report No. | Issue Date | Revision Summary |
|---|---|---|
| 170800032TWN-001 | Sep. 08, 2017 | Original report |

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## Summary of Test Data

| Test Requirement | Applicable Rule (Section 15.247) | Result |
|---|---|---|
| Minimum 6 dB Bandwidth | 15.247(a)(2) | Pass |
| Maximum Peak Conducted Output Power | 15.247(b)(3) | Pass |
| Power Spectral Density | 15.247(e) | Pass |
| Emissions In Non-Restricted Frequency Bands | 15.247(d) | Pass |
| Emissions In Restricted Frequency Bands (Radiated emission measurements) | 15.247(d), 15.205, 15.209 | Pass |
| Emission On The Band Edge | 15.247(d), 15.205 | Pass |
| AC Power Line Conducted Emission | 15.207 | Pass |
| Antenna Requirement | 15.203 | Pass |

# 1. General information

## 1.1. Identification of the EUT

| | |
|---|---|
| Product: | UMC-LORA |
| Model No.: | UMC-LORA |
| Operating Frequency: | 902.7 MHz ~ 927.2 MHz |
| Channel Number: | 50 channels |
| Frequency of Each Channel | 902.7MHz + 0.5k, k = 0~49 |
| Modulation | FSK |
| Rated Power: | DC 5 V From adapter |
| Power Cord: | N/A |
| Sample receiving date: | Aug. 2, 2017 |
| Sample condition: | Workable |
| Test Date(s): | Aug. 3, 2017 ~ Sep. 1, 2017 |

Note 1: The test report only allows to be revised within three years from its original issued date unless further standard or the requirement was noticed.
Note 2: When determining the test conclusion, the Measurement Uncertainty of test has been considered.
Note 3: *Except where explicitly agreed in writing, all work and services performed by Intertek is subject to our standard Terms and Conditions which can be obtained at our website:* http://www.intertek-twn.com/terms/ *. Intertek's responsibility and liability are limited to the terms and conditions of the agreement.*

## 1.2. Description of the EUT

| Modulation mode | Transmit path | |
|---|---|---|
| | Chain 0 / Main | Chain 1 / AUX |
| LoRa | V | X |

The UMC-LORA module is a daughter card that can be assembled/applied in the WNC's SMCCs (Smart Metering Communication Cards) including UMC-A21LG, UMC-I210C , UMC-A21LG-C and UMC-A21LG2-R models. The differences among these 4 models are using different HW platforms and they are for different meters and usages. The different between these four models doesn't affect the measurement results so we used UMC-I210C for final testing.

| Model/Meter | Aclara I210+c (Residential meter) | L+G RXRe-SD (Residential meter) | L+G S4X (C&I meter) |
|---|---|---|---|
| UMC-I210C/ HW platform | V/GCT solution | | |
| UMC-A21LG/ HW platform | | V/GCT solution | |
| UMC-A21LG-C/ HW platform | | | V/Qualcomm solution |
| UMC-A21LG2-R/ HW platform | | V/ Qualcomm solution | |

## 1.3. Antenna description

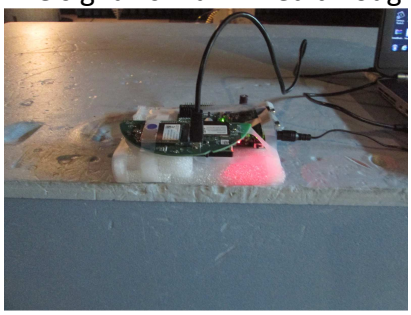
The EUT uses a permanently connected antenna.

Antenna Gain : 1.03 dBi
Antenna Type : Patch Antenna
Connector Type : Fixed

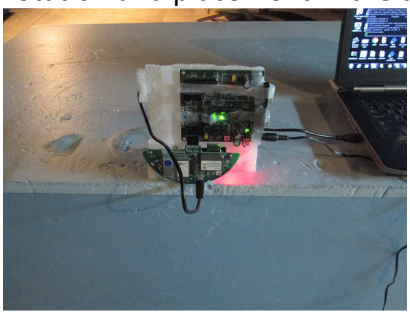
### 1.4. Operation mode

TX-MODE is based on a telnet command, and the program can select different frequency.

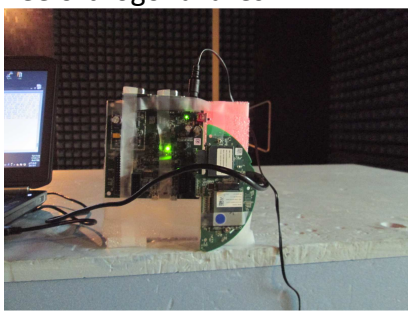
The signal is maximized through rotation and placement in the three orthogonal axes.



**X axis**



**Y axis**



**Z axis**

After verifying three axes, we found the maximum electromagnetic field was occurred at X axis. The final test data was executed under this configuration.

With individual verifying, the maximum output power were found out LoRa mod the final tests were executed under these conditions recorded in this report individually.

### 1.5. Applied test modes and channels

| Test items | Mode | Channel | Antenna |
|---|---|---|---|
| Maximum Conducted Output Power | LoRa | 0,25,49 | Chain0 |
| Power Spectrum Density | LoRa | 0,25,49 | Chain0 |
| Emission BW | LoRa | 0,25,49 | Chain0 |
| Radiated spurious Emission 9kHz~1GHz | Worst case | | |
| Emissions In Restricted Frequency Bands (Radiated emission measurements) | LoRa | 0,25,49 | Chain0 |
| Emission on The Band Edge | LoRa | 0,25,49 | Chain0 |
| AC Line Conducted Emission | Normal Link | | |

### 1.6. Power setting of test software

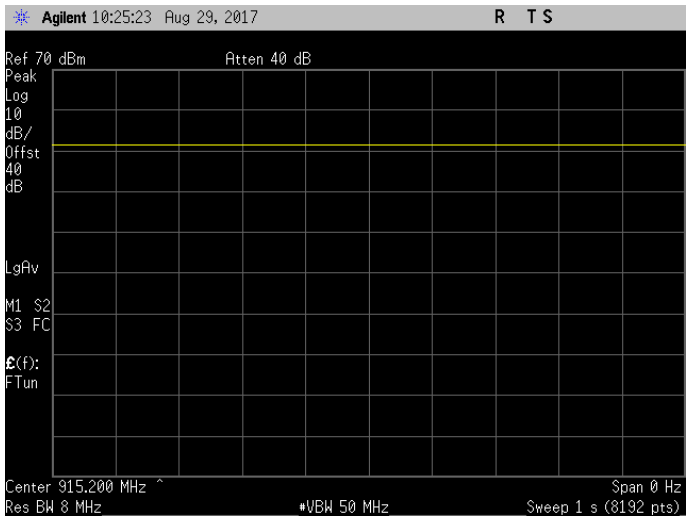
Channels & power setting software provided by the client was used to change the operating channels as well as the output power level and is going to be installed in the final end product.

| Mode | Channel | Frequency | Power setting |
|---|---|---|---|
| LoRa | 0 | 902.7 | 20 |
| | 25 | 915.2 | 20 |
| | 49 | 927.2 | 20 |

Note: The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

| Mode | Channel | Frequency (MHz) | Signal on time(s) | Total signal transmit time(s) | Duty cycle | Duty Cycle factor |
|---|---|---|---|---|---|---|
| LoRa | 25 | 915.2 | 1.00 | 1.00 | 1.00 | 0.00 |

**Channel 25 : Ducty Cycle @ LoRa 915.2MHz**



## 1.7. Peripherals equipment

| Peripherals | Brand | Model No. | Serial No. | Data cable |
|---|---|---|---|---|
| Notebook PC | DELL | Latitude E5420 | HXYJBT1 | Micro USB × 1 meter |
| Adapter | N/A | WA8078 | N/A | N/A |
| SMCC | N/A | N/A | N/A | N/A |
| Interface Board | N/A | N/A | N/A | N/A |

## 2. Minimum 6 dB Bandwidth

### 2.1. Instrument Setting

| Spectrum Parameter | Setting |
|---|---|
| Detector | Peak |
| RBW | 100kHz |
| VBW | ≧3 x RBW |
| Sweep | Auto couple |
| Trace | Allow the trace to stabilize. |
| Span | Between two times and five times the occupied bandwidth |
| Attenuation | Auto |

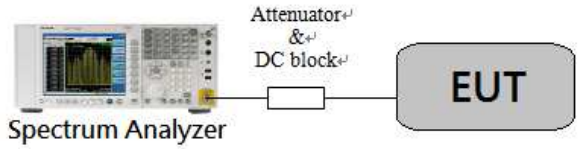
### 2.2. Test Procedure

Step 1 The transmitter output was connected to the spectrum analyzer.

Step 2 Test was performed in accordance with clause 8.1 option1 of KDB 558074 D01.

Step 3 Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

### 2.3. Test Diagram




### 2.4. Limit

The minimum 6 dB bandwidth shall be at least 500 kHz.

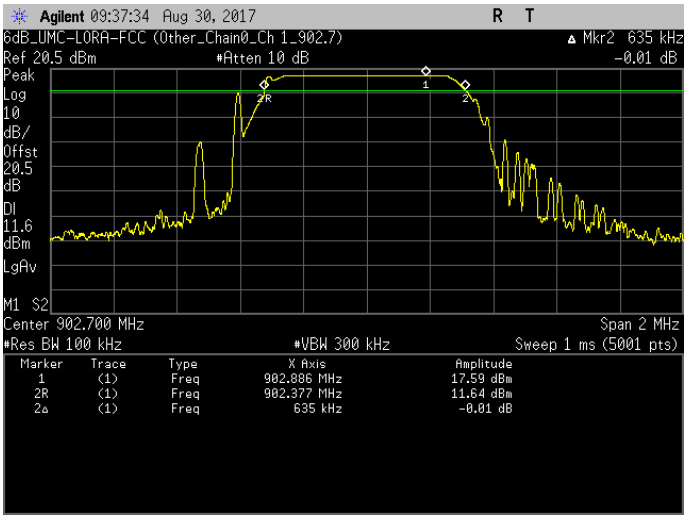
### 2.5. Operating Environment Condition

Temperature (℃) : 25
Relative Humidity (%) : 50
Atmospheric Pressure (hPa) : 1008
Test Date : 2017/8/30

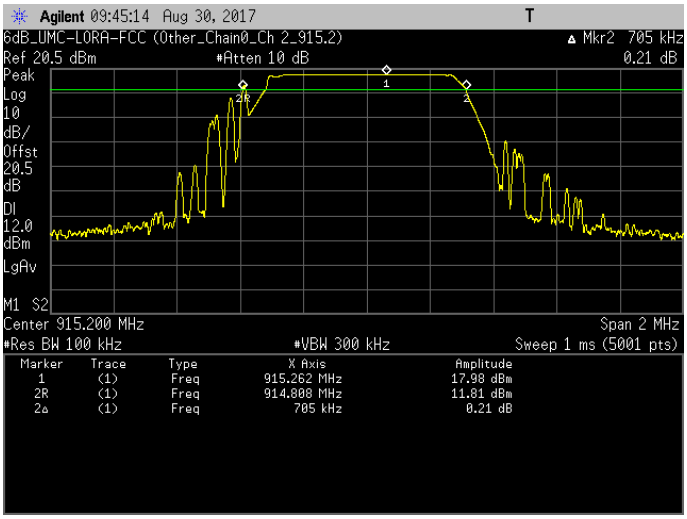
## 2.6. Test Results

| Mode | Channel | Frequency (MHz) | 6dB BW (MHz) | Limit (MHz) |
|---|---|---|---|---|
| LoRa | 0 | 902.7 | 0.635 | >0.5 |
| LoRa | 25 | 915.2 | 0.705 | >0.5 |
| LoRa | 49 | 927.2 | 0.702 | >0.5 |

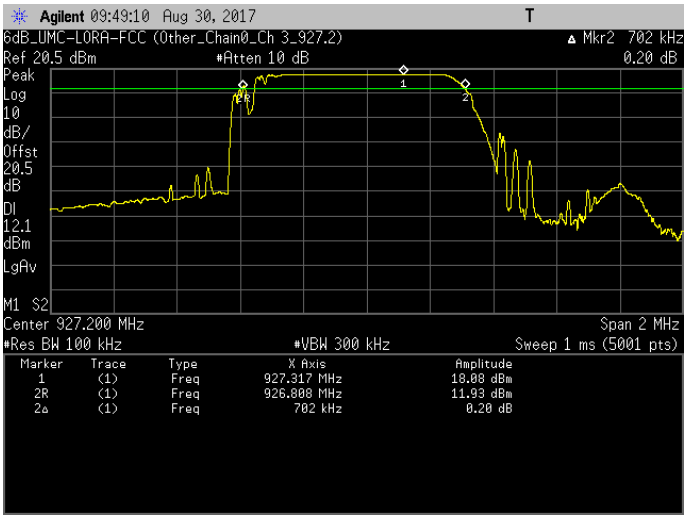
Chain0 : 6dB Bandwidth @ LoRa Ch 0




Chain0 : 6dB Bandwidth @ LoRa Ch 25




Chain0 : 6dB Bandwidth @ LoRa Ch 49



## 3. Maximum Peak Conducted Output Power

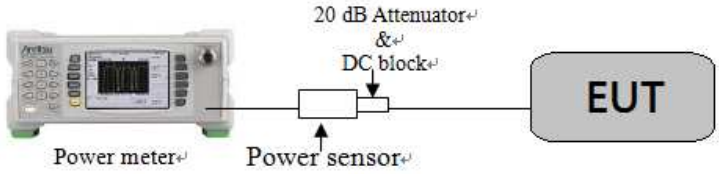
### 3.1. Instrument Setting

| Power Meter Parameter | Setting |
|---|---|
| Bandwidth | 65MHz bandwidth is greater than the EUT emission bandwidth |
| Detector | Peak & Average |

### 3.2. Test Procedure

Test procedures refer to clause 9.1.3 peak power meter method and clause 9.2.3.2 measurement using a gated RF average power meter of KDB 558074 D01.

### 3.3. Test Diagram




### 3.4. Limit

For systems using digital modulation in the 902-928 MHz: 1 Watt (30dBm)

### 3.5. Operating Environment Condition

Temperature (℃) : 25
Relative Humidity (%) : 50
Atmospheric Pressure (hPa) : 1008
Test Date : 2017/8/29

### 3.6. Test Results

| Mode | Channel | Pk Output Power (dBm) | Pk Output Power (mW) | Av Output Power (dBm) | Av Output Power (mW) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| LoRa | 0 | 17.19 | 52.36 | 17.04 | 50.58 | 30.00 | -12.81 |
| LoRa | 25 | 17.55 | 56.89 | 17.50 | 56.23 | 30.00 | -12.45 |
| LoRa | 49 | 17.7 | 58.88 | 17.65 | 58.21 | 30.00 | -12.30 |

## 4. Power Spectral Density

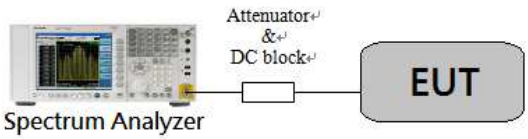
### 4.1. Instrument Setting

| Spectrum Function | Setting |
|---|---|
| Detector | Peak |
| RBW | ≧3 kHz |
| VBW | ≧3 x RBW |
| Sweep | Auto couple |
| Trace | Max hold |
| Span | 1.5 times x 6dB bandwidth |
| Attenuation | Auto |

### 4.2. Test Procedure

Step 1 Test procedure refer to clause 10.2 method PKPSD (peak PSD) of KDB 558074 D01.
Step 2 Using the maximum conducted output power in the fundamental emission demonstrates compliance. The EUT must be configured to transmit continuously at full power over the measurement duration.
Step 3 Use the peak marker function to determine the maximum amplitude level within the RBW.

### 4.3. Test Diagram




### 4.4. Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission

### 4.5. Operating Environment Condition

| | |
|---|---|
| Temperature (℃) : | 25 |
| Relative Humidity (%) : | 50 |
| Atmospheric Pressure (hPa) : | 1008 |
| Test Date : | 2017/8/30 |

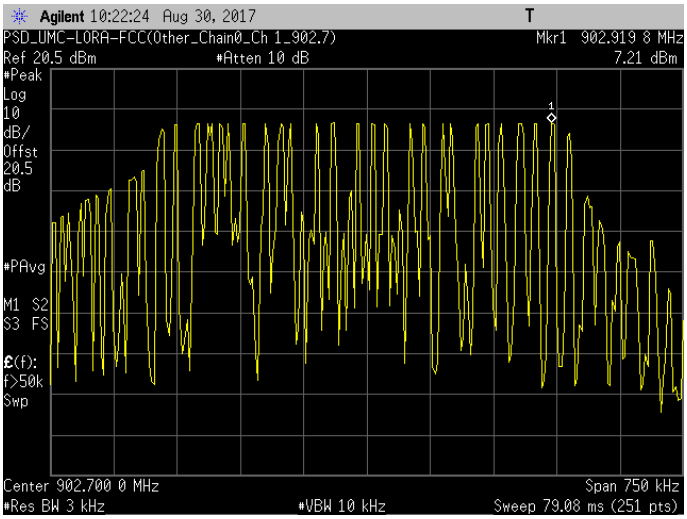
## 4.6. Test Results

| Mode | Channel | Frequency (MHz) | PSD(dBm)@10kHz | Correction Factor(dB) | PSD(dBm)@3kHz | Limit(dBm) | Margin(dB) |
|---|---|---|---|---|---|---|---|
| LoRa | 0 | 902.7 | 7.21 | 5.23 | 1.98 | 8 | -6.02 |
| LoRa | 25 | 915.2 | 8.74 | 5.23 | 3.51 | 8 | -4.49 |
| LoRa | 49 | 927.2 | 8.06 | 5.23 | 2.83 | 8 | -5.17 |

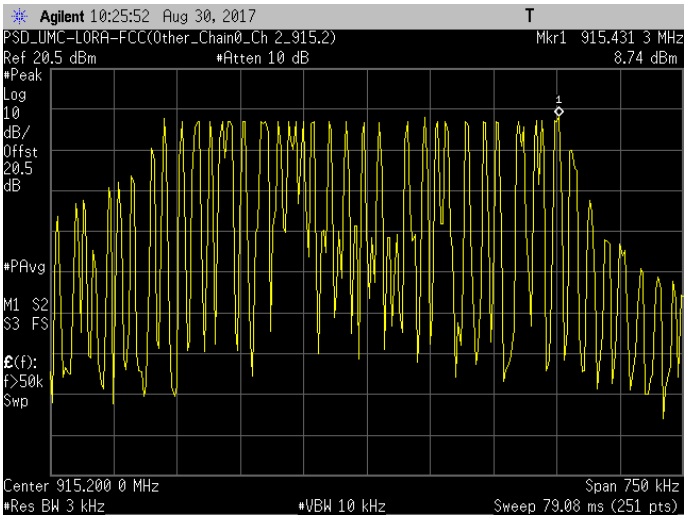
Note1: RBW Correction = 10*log(10kHz/3kHz) = 5.229

Note2: PSD in 3kHz = PSD in 10kHz – RBW Correction

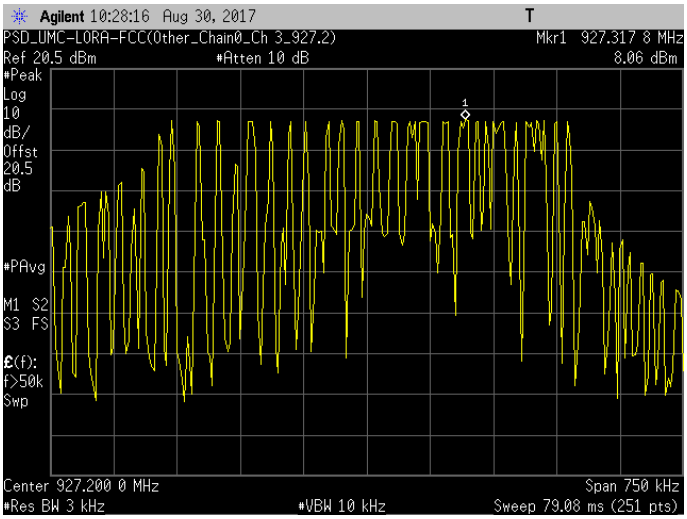
Chain0 : Power Spectral Density @ LoRa Ch 0




Chain0 : Power Spectral Density @ LoRa Ch 25




Chain0 : Power Spectral Density @ LoRa Ch 49



## 5. Emissions in Non-Restricted Frequency Bands

### 5.1. Instruments Setting

| Spectrum Function | Setting (Reference Level) | Setting (Emission Level) |
|---|---|---|
| Detector | Peak | Peak |
| RBW | ≧100 kHz | ≧100 kHz |
| VBW | ≧3 x RBW | ≧3 x RBW |
| Sweep | Auto couple | Auto couple |
| Trace | Max hold | Max hold |
| Span | ≧1.5 time 6dB bandwidth | |
| Attenuation | Auto | Auto |

### 5.2. Test Procedure

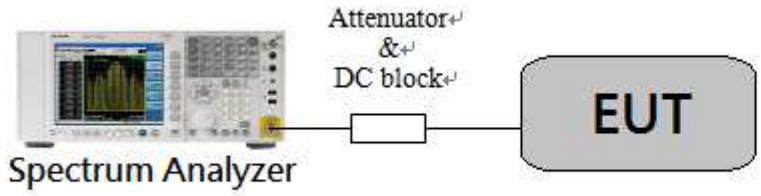
Step 1 The procedure was used in antenna-port conducted and connected to the spectrum analyzer.

Step 2 Set instrument center frequency to center frequency.

Step 3 Use the parameter configured in clause 5.1 to measure.

Step 4 Use the peak marker function to determine the maximum amplitude level.

### 5.3. Test Diagram




### 5.4. Limit

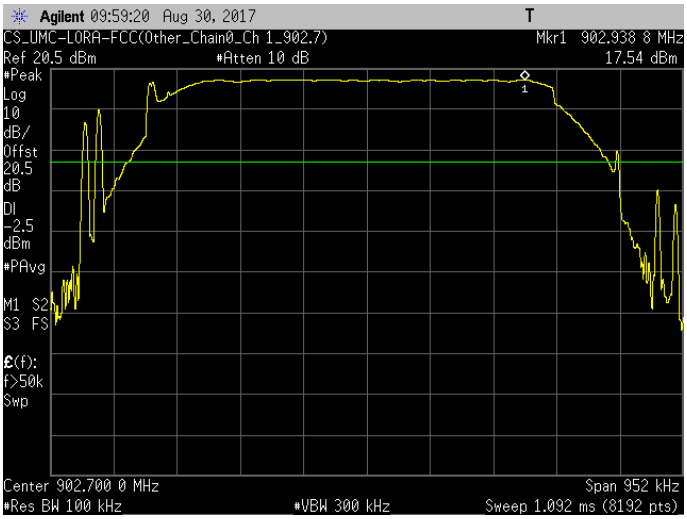
The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz

## 5.5. Operating Environment Condition

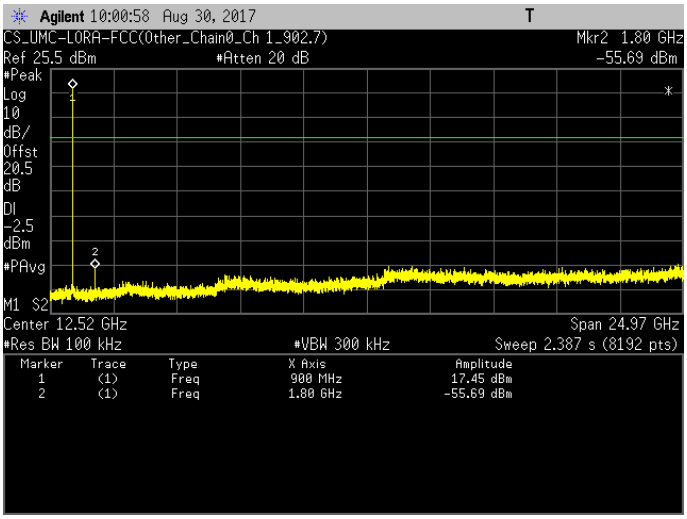
| | |
|---|---|
| Temperature (℃) : | 25 |
| Relative Humidity (%) : | 50 |
| Atmospheric Pressure (hPa) : | 1008 |
| Test Date : | 2017/8/30 |

## 5.6. Test Results

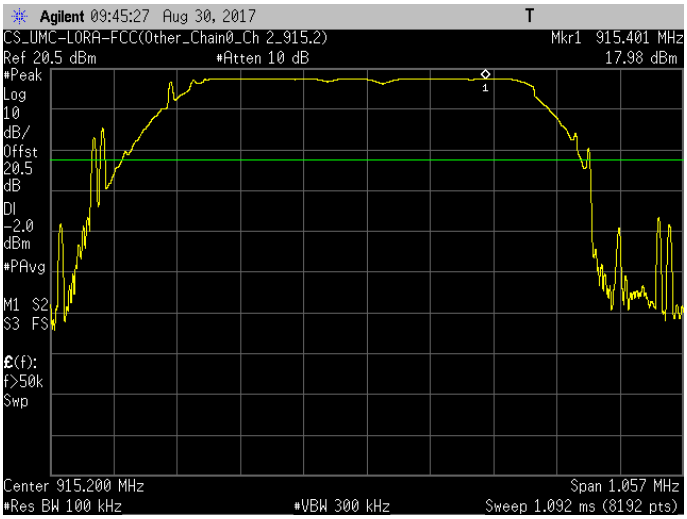
Chain0 : Conducted Spurious @ LoRa Ch 0



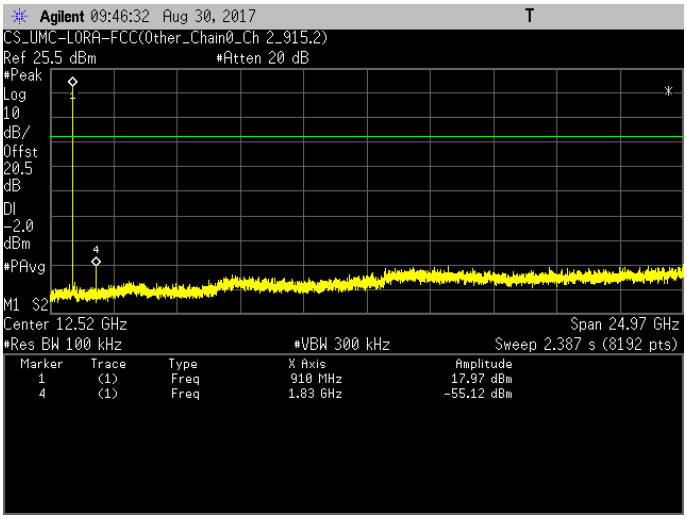

Chain0 : Conducted Spurious @ LoRa Ch 0



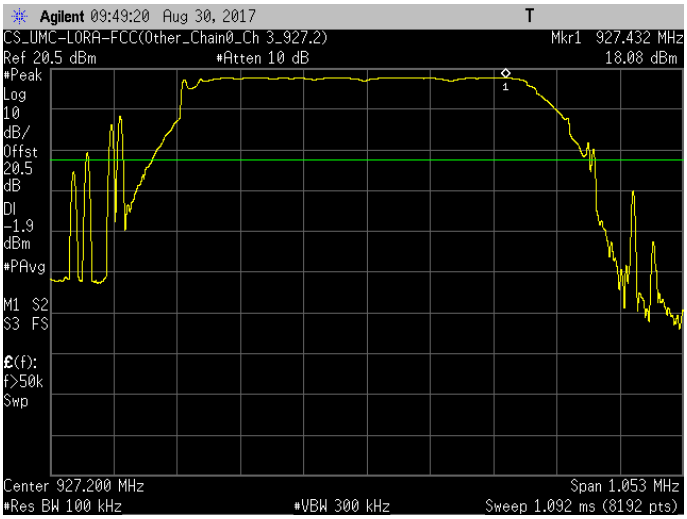

Chain0 : Conducted Spurious @ LoRa Ch 25



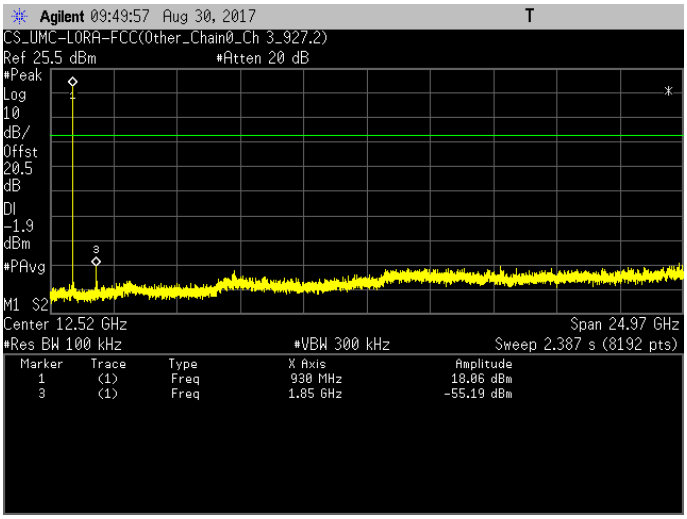
Chain0 : Conducted Spurious @ LoRa Ch 25




Chain0 : Conducted Spurious @ LoRa Ch 49




Chain0 : Conducted Spurious @ LoRa Ch 49



## 6. Emissions in Restricted Frequency Bands (Radiated emission measurements)

### 6.1. Instrument Setting

| Receiver Function | Setting (Below 1GHz) | Setting (Above 1GHz) |
|---|---|---|
| Detector | QP | Peak and Average |
| RBW | 9-150 kHz ; 200-300 Hz<br>0.15-30 MHz; 9-10 kHz<br>30-1000 MHz; 100-120 kHz | 1MHz |
| VBW | ≧3 x RBW | 3MHz |
| Sweep | Auto couple | Auto couple |
| Start Frequency | 9 kHz | 1GHz |
| Stop Frequency | 1 GHz | Tenth harmonic |
| Attenuation | Auto | Auto |

### 6.2. Test Procedure

Step 1 Configure the EUT according to ANSI C63.10:2013. The EUT was placed on the top of the turntable 0.8 meter (below 1GHz) and 1.5 meter (above 1GHz) above ground. The center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.

Step 2 Power on the EUT and all the companion devices. The turntable was rotated by 360 degree to find the position of the maximum emission level.

Step 3 The height of the receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of the both horizontal and vertical polarization.

Step 4 If find the frequencies above the limit or below within 3dB, the antenna tower was scan (from 1m to 4m) and then the turntable was rotated to find the maximum reading.

Step 5 Set the test-receiver system to peak or CISPR quasi-peak detector with specified bandwidth under maximum hold mode.

Step 6 For emissions above 1GHz, use 1MHz VBW and 3MHz RBW for reading in spectrum analyzer.
Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.

Step 7 If the emissions level of the EUT in peak mode was 3dB lower than the average limit

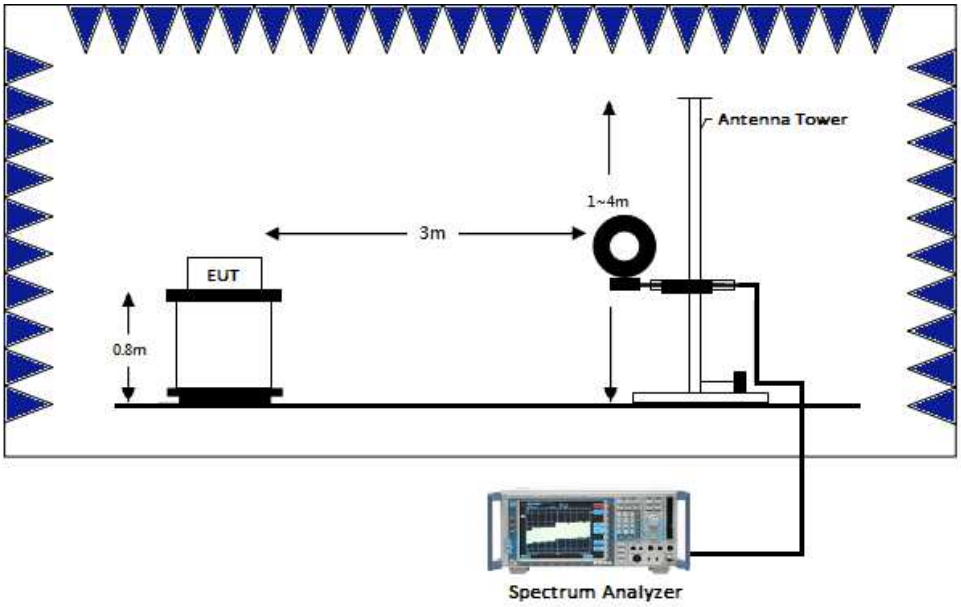
specified then testing will be stopped and peak values of the EUT will be reported. LoRawise, the emissions which do not have 3dB margin will be measured using the quasi-peak method for below 1GHz.

Step 8 For testing above 1GHz, The emissions level of the EUT in peak mode was lower than average limit, then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported.

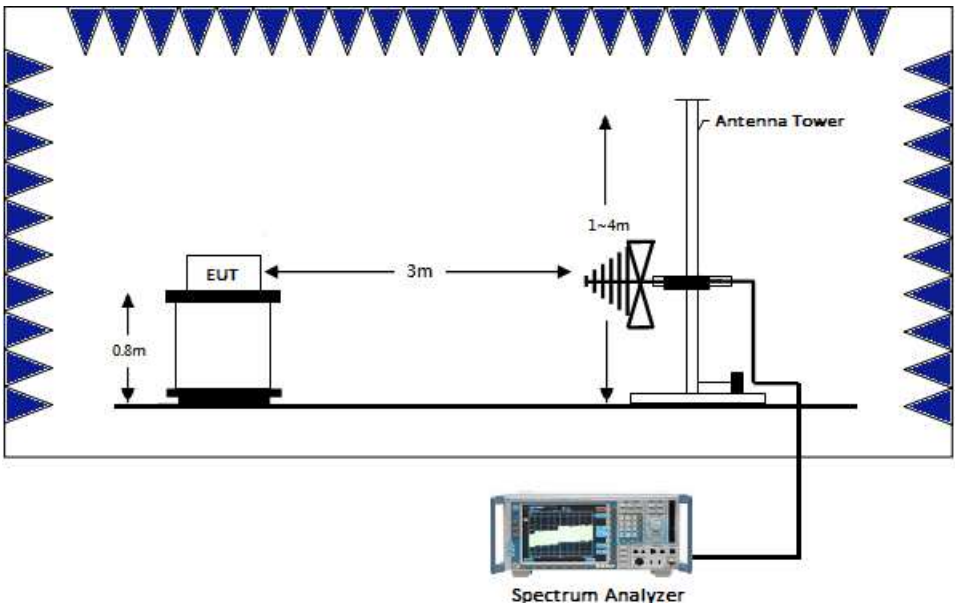
Step 9 In case the emission is lower than 30MHz, loop antenna has to be used for measurement and the recorded data should be quasi-peak measured by receiver.

## 6.3. Test Diagram

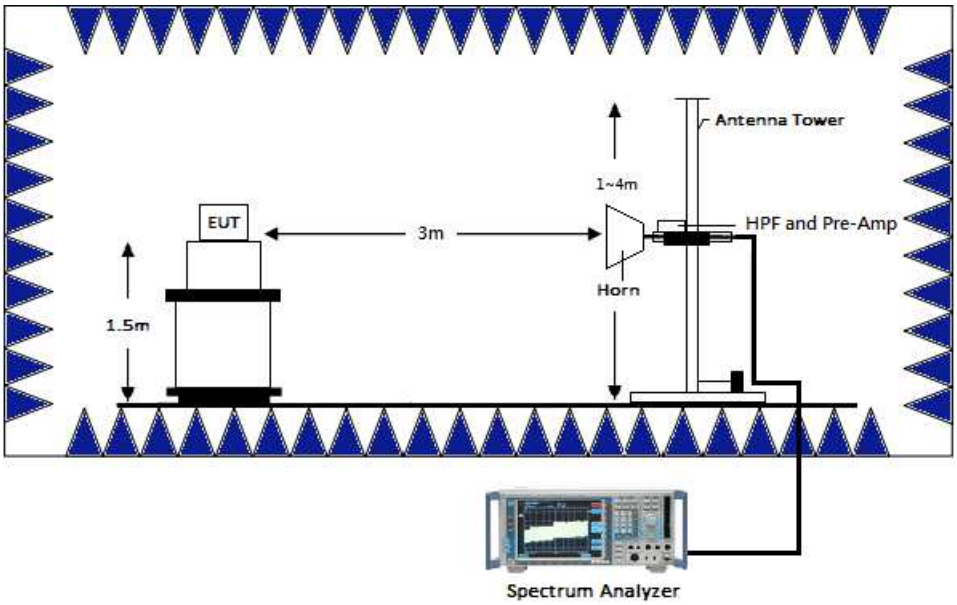
### 6.3.1. Radiated emission from 9kHz to 30MHz uses Loop Antenna:



### 6.3.2. Radiated emission below 1GHz using Bilog Antenna




### 6.3.3. Radiated emission above 1GHz using Horn Antenna



### 6.4. Limit

| Frequency(MHz) | Field Strength(uV/m) | Measurement distance(m) |
|---|---|---|
| 0.009~0.490 | 2400/F(kHz) | 300 |
| 0.490~1.705 | 24000/F(kHz) | 30 |
| 1.705~30 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

### 6.5. Operating Environment Condition

Temperature (℃) : 25
Relative Humidity (%) : 50
Atmospheric Pressure (hPa) : 1008
Test Date : 2017/8/25~2017/8/30

## 6.6. Test Result

### 6.6.1. Measurement results: frequencies 9kHz to 30MHz

The test was performed on EUT under LoRa continuously transmitting mode. The worst case occurred at LoRa ch0

| Mode | Channel | Detector | Frequency (MHz) | Factor (dB/m) | Reading (dBuV) | Corrected Reading (dBuV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|
| LoRa | 0 | QP | 0.02 | 20.21 | 41.63 | 61.84 | 121.58 | -59.74 |
| LoRa | 0 | QP | 0.03 | 20.36 | 42.81 | 63.17 | 118.06 | -54.89 |
| LoRa | 0 | QP | 0.07 | 19.47 | 33.01 | 52.48 | 110.7 | -58.22 |
| LoRa | 0 | QP | 0.10 | 19.06 | 38.97 | 58.03 | 107.6 | -49.57 |
| LoRa | 0 | QP | 0.11 | 19.06 | 33.81 | 52.86 | 106.78 | -53.92 |
| LoRa | 0 | QP | 0.21 | 19.03 | 41.6 | 60.62 | 101.16 | -40.54 |
| LoRa | 0 | QP | 0.45 | 19.01 | 40.28 | 59.29 | 94.54 | -35.25 |
| LoRa | 0 | QP | 0.75 | 19.13 | 30.06 | 49.19 | 70.1 | -20.91 |
| LoRa | 0 | QP | 0.99 | 19.23 | 33.01 | 52.25 | 67.69 | -15.44 |
| LoRa | 0 | QP | 1.52 | 19.15 | 27.49 | 46.64 | 63.97 | -17.33 |
| LoRa | 0 | QP | 2.06 | 19.04 | 23.1 | 42.14 | 69.54 | -27.4 |

Remark: Corr. Factor = Antenna Factor + Cable Loss

### 6.6.2. Measurement results: frequencies below 1 GHz

The test was performed on EUT under LoRa continuously transmitting mode. The worst case occurred at LoRa ch0

| Mode | Channel | Ant Polarity | Detector | Frequency (MHz) | Factor (dB/m) | Reading (dBuV) | Corrected Reading (dBuV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|
| LoRa | 0 | H | QP | 70.74 | 18.06 | 8.13 | 26.2 | 40 | -13.8 |
| LoRa | 0 | H | QP | 142.52 | 20.37 | 8.45 | 28.82 | 43.5 | -14.68 |
| LoRa | 0 | H | QP | 165.8 | 20.61 | 8.19 | 28.8 | 43.5 | -14.7 |
| LoRa | 0 | H | QP | 239.52 | 19.61 | 11.29 | 30.9 | 46 | -15.1 |
| LoRa | 0 | H | QP | 336.52 | 22.69 | 10.23 | 32.93 | 46 | -13.07 |
| LoRa | 0 | H | QP | 493.66 | 26.8 | 5.42 | 32.21 | 46 | -13.79 |
| LoRa | 0 | H | QP | 800.18 | 32.08 | 11.05 | 43.13 | 46 | -2.87 |
| LoRa | 0 | V | QP | 47.46 | 19.45 | 9.88 | 29.34 | 40 | -10.66 |
| LoRa | 0 | V | QP | 55.22 | 19.08 | 9.02 | 28.1 | 40 | -11.9 |
| LoRa | 0 | V | QP | 61.04 | 19.46 | 5.6 | 25.05 | 40 | -14.95 |
| LoRa | 0 | V | QP | 76.56 | 16.84 | 8.69 | 25.53 | 40 | -14.47 |
| LoRa | 0 | V | QP | 167.74 | 20.59 | 2.7 | 23.29 | 43.5 | -20.21 |
| LoRa | 0 | V | QP | 800.18 | 32.08 | 4.59 | 36.67 | 46 | -9.33 |

Remark: Corr. Factor = Antenna Factor + Cable Loss

### 6.6.3. Measurement results: frequency above 1GHz to 10GHz

| Mode | Ch | Ant Polarity | Detector | Freq. (MHz) | Preamp (dB) | Factor (dB/m) | Reading (dBμV) | Corrected Reading (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| LoRa | 0 | H | PK | 1805 | 38.55 | 32.87 | 20.9 | 53.77 | 74 | -20.23 |
| LoRa | 0 | H | PK | 2708 | 39.43 | 35.8 | 14.43 | 50.22 | 74 | -23.78 |
| LoRa | 0 | H | PK | 3611 | 40.1 | -0.92 | 35.78 | 34.86 | 74 | -39.14 |
| LoRa | 0 | H | PK | 4514 | 40.56 | 1.86 | 36.36 | 38.22 | 74 | -35.78 |
| LoRa | 0 | H | PK | 5416 | 38.44 | 4.36 | 32.92 | 37.28 | 74 | -36.72 |
| LoRa | 0 | H | PK | 6319 | 38.31 | 7.19 | 31.94 | 39.13 | 74 | -34.87 |
| LoRa | 0 | H | PK | 7222 | 38.17 | 9.93 | 30.88 | 40.81 | 74 | -33.19 |
| LoRa | 0 | H | PK | 8124 | 37.34 | 12.93 | 29.16 | 42.08 | 74 | -31.92 |
| LoRa | 0 | H | PK | 9027 | 37.54 | 13.56 | 29.5 | 43.06 | 74 | -30.94 |
| LoRa | 0 | H | PK | 9930 | 38.62 | 15.65 | 27.1 | 42.75 | 74 | -31.25 |
| LoRa | 0 | V | PK | 1805 | 38.55 | 32.87 | 13.54 | 46.42 | 74 | -27.58 |
| LoRa | 0 | V | PK | 2708 | 39.43 | 35.8 | 15.91 | 51.71 | 74 | -22.29 |
| LoRa | 0 | V | PK | 3611 | 40.1 | -0.92 | 36.52 | 35.6 | 74 | -38.4 |
| LoRa | 0 | V | PK | 4514 | 40.56 | 1.86 | 34.3 | 36.16 | 74 | -37.84 |
| LoRa | 0 | V | PK | 5416 | 38.44 | 4.36 | 33.08 | 37.44 | 74 | -36.56 |
| LoRa | 0 | V | PK | 6319 | 38.31 | 7.19 | 33.07 | 40.26 | 74 | -33.74 |
| LoRa | 0 | V | PK | 7222 | 38.17 | 9.93 | 32.01 | 41.94 | 74 | -32.06 |
| LoRa | 0 | V | PK | 8124 | 37.34 | 12.93 | 30.38 | 43.3 | 74 | -30.7 |
| LoRa | 0 | V | PK | 9027 | 37.54 | 13.56 | 28.9 | 42.46 | 74 | -31.54 |
| LoRa | 0 | V | PK | 9930 | 38.62 | 15.65 | 27.95 | 43.61 | 74 | -30.39 |
| LoRa | 25 | H | PK | 1830 | 38.53 | 33.13 | 20.54 | 53.67 | 74 | -20.33 |
| LoRa | 25 | H | PK | 2746 | 39.47 | 35.92 | 13.87 | 49.79 | 74 | -24.21 |
| LoRa | 25 | H | PK | 3661 | 40.13 | -0.68 | 36.14 | 35.45 | 74 | -38.55 |
| LoRa | 25 | H | PK | 4576 | 40.45 | 2.1 | 33.4 | 35.5 | 74 | -38.5 |
| LoRa | 25 | H | PK | 5491 | 38.21 | 4.47 | 32.68 | 37.15 | 74 | -36.85 |
| LoRa | 25 | H | PK | 6406 | 38.34 | 7.54 | 31.12 | 38.65 | 74 | -35.35 |
| LoRa | 25 | H | PK | 7322 | 38.06 | 10.34 | 30.43 | 40.77 | 74 | -33.23 |
| LoRa | 25 | H | PK | 8237 | 37.33 | 12.89 | 29.1 | 42 | 74 | -32 |
| LoRa | 25 | H | PK | 9152 | 37.67 | 13.81 | 27.39 | 41.2 | 74 | -32.8 |
| LoRa | 25 | H | PK | 10067 | 38.75 | 16.32 | 25.9 | 42.23 | 74 | -31.77 |
| LoRa | 25 | V | PK | 1830 | 38.53 | 33.13 | 19.53 | 52.65 | 74 | -21.35 |
| LoRa | 25 | V | PK | 2746 | 39.47 | 35.92 | 13.94 | 49.86 | 74 | -24.14 |
| LoRa | 25 | V | PK | 3661 | 40.13 | -0.68 | 35.93 | 35.25 | 74 | -38.75 |
| LoRa | 25 | V | PK | 4576 | 40.45 | 2.1 | 35.26 | 37.36 | 74 | -36.64 |
| LoRa | 25 | V | PK | 5491 | 38.21 | 4.47 | 34.58 | 39.05 | 74 | -34.95 |
| LoRa | 25 | V | PK | 6406 | 38.34 | 7.54 | 31.52 | 39.06 | 74 | -34.94 |

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

| Mode | Ch | Ant Polarity | Detector | Freq. (MHz) | Preamp (dB) | Factor (dB/m) | Reading (dBµV) | Corrected Reading (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| LoRa | 25 | V | PK | 7322 | 38.06 | 10.34 | 30.19 | 40.52 | 74 | -33.48 |
| LoRa | 25 | V | PK | 8237 | 37.33 | 12.89 | 29.29 | 42.18 | 74 | -31.82 |
| LoRa | 25 | V | PK | 9152 | 37.67 | 13.81 | 27.48 | 41.29 | 74 | -32.71 |
| LoRa | 25 | V | PK | 10067 | 38.75 | 16.32 | 26.33 | 42.65 | 74 | -31.35 |
| LoRa | 49 | H | PK | 1854 | 38.51 | 33.37 | 19.45 | 52.82 | 74 | -21.18 |
| LoRa | 49 | H | PK | 2782 | 39.5 | 36.04 | 16.74 | 52.78 | 74 | -21.22 |
| LoRa | 49 | H | PK | 3709 | 40.17 | -0.46 | 35.79 | 35.33 | 74 | -38.67 |
| LoRa | 49 | H | PK | 4636 | 40.35 | 2.34 | 34.04 | 36.38 | 74 | -37.62 |
| LoRa | 49 | H | PK | 5563 | 38.18 | 4.66 | 33.14 | 37.8 | 74 | -36.2 |
| LoRa | 49 | H | PK | 6490 | 38.38 | 7.87 | 31.03 | 38.9 | 74 | -35.1 |
| LoRa | 49 | H | PK | 7418 | 37.96 | 10.73 | 29.82 | 40.55 | 74 | -33.45 |
| LoRa | 49 | H | PK | 8345 | 37.32 | 12.86 | 28.7 | 41.57 | 74 | -32.43 |
| LoRa | 49 | H | PK | 9272 | 37.8 | 14.05 | 27.21 | 41.26 | 74 | -32.74 |
| LoRa | 49 | H | PK | 10199 | 38.84 | 17.27 | 26.51 | 43.77 | 74 | -30.23 |
| LoRa | 49 | V | PK | 1854 | 38.51 | 33.37 | 20.35 | 53.72 | 74 | -20.28 |
| LoRa | 49 | V | PK | 2782 | 39.5 | 36.04 | 17.28 | 53.32 | 74 | -20.68 |
| LoRa | 49 | V | PK | 3709 | 40.17 | -0.46 | 35.62 | 35.16 | 74 | -38.84 |
| LoRa | 49 | V | PK | 4636 | 40.35 | 2.34 | 35.57 | 37.91 | 74 | -36.09 |
| LoRa | 49 | V | PK | 5563 | 38.18 | 4.66 | 33.32 | 37.98 | 74 | -36.02 |
| LoRa | 49 | V | PK | 6490 | 38.38 | 7.87 | 35.78 | 43.65 | 74 | -30.35 |
| LoRa | 49 | V | PK | 7418 | 37.96 | 10.73 | 31.18 | 41.9 | 74 | -32.1 |
| LoRa | 49 | V | PK | 8345 | 37.32 | 12.86 | 32.57 | 45.43 | 74 | -28.57 |
| LoRa | 49 | V | PK | 9272 | 37.8 | 14.05 | 27.93 | 41.98 | 74 | -32.02 |
| LoRa | 49 | V | PK | 10199 | 38.84 | 17.27 | 26.61 | 43.88 | 74 | -30.12 |

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

## 7. Emission on Band Edge

### 7.1. Test Procedure

The test procedure is as same as section 5.2 of this report.

### 7.2. Limit

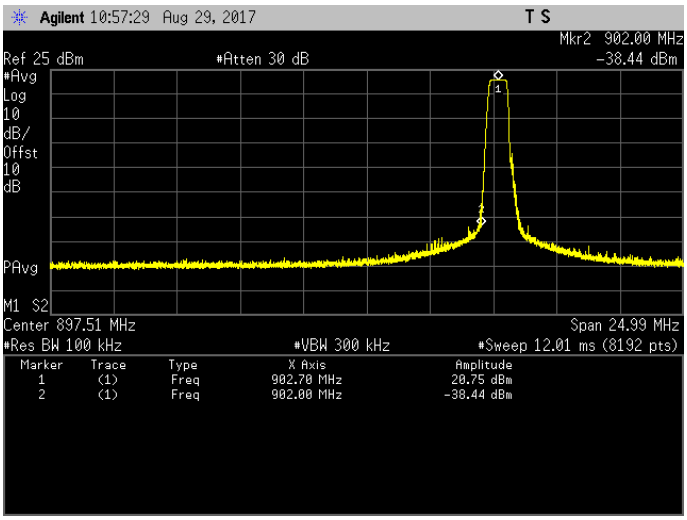
The peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

### 7.3. Operating Environment Condition

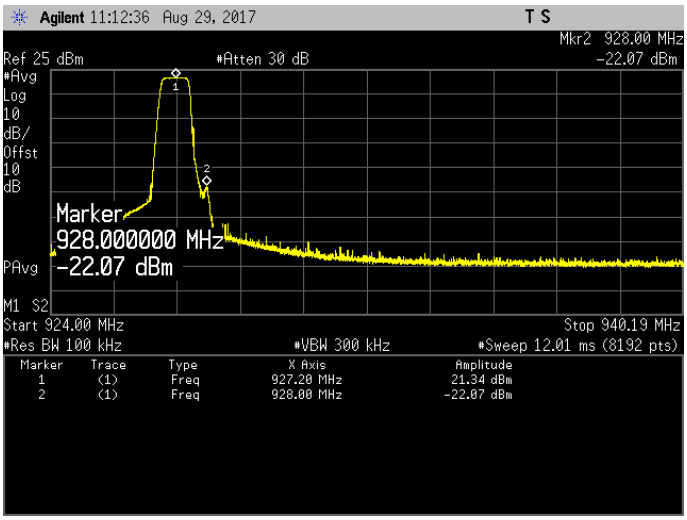
| | |
|---|---|
| Temperature (℃) : | 25 |
| Relative Humidity (%) : | 50 |
| Atmospheric Pressure (hPa) : | 1008 |
| Test Date : | 2017/8/29 |

## 7.4. Test Results

LoRa Channel 0 : Authorized Band Bandedge @ 902.7MHz




LoRa Channel 49 : Authorized Band Bandedge @ 927.2MHz



## 8. AC Power Line Conducted Emission

### 8.1. Measuring instrument setting

| Receiver Function | Setting |
|---|---|
| Detector | QP |
| Start frequency | 0.15MHz |
| Stop frequency | 30MHz |
| IF bandwidth | 9 kHz |
| Attenuation | 10dB |

### 8.2. Test Procedure

Step 1 Configure the EUT according to ANSI C63.10:2013. The EUT or host of EHT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.

Step 2 Connect EUT or host of EUT to the power mains through a line impedance stabilization network.

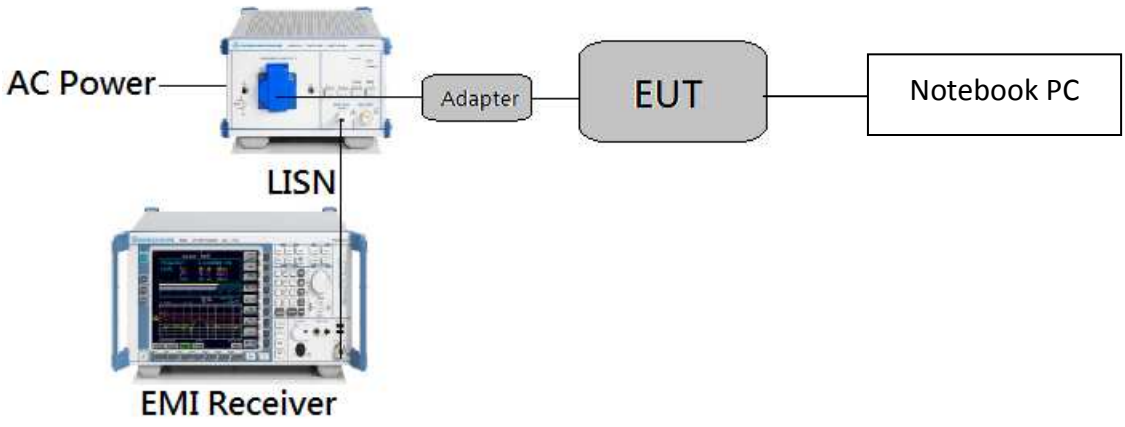
Step 3 All the companion devices are connected to the other LISN. The LISN should provide 50Uh/50ohms coupling impedance.

Step 4 The frequency range from 150 kHz to 30MHz was searched.

Step 5 Set the test-receiver system to peak detector and specified bandwidth with maximum hold mode.

Step 6 The measurement has to be done between each power line and ground at the power terminal.

### 8.3. Test Diagram



## 8.4. Limit

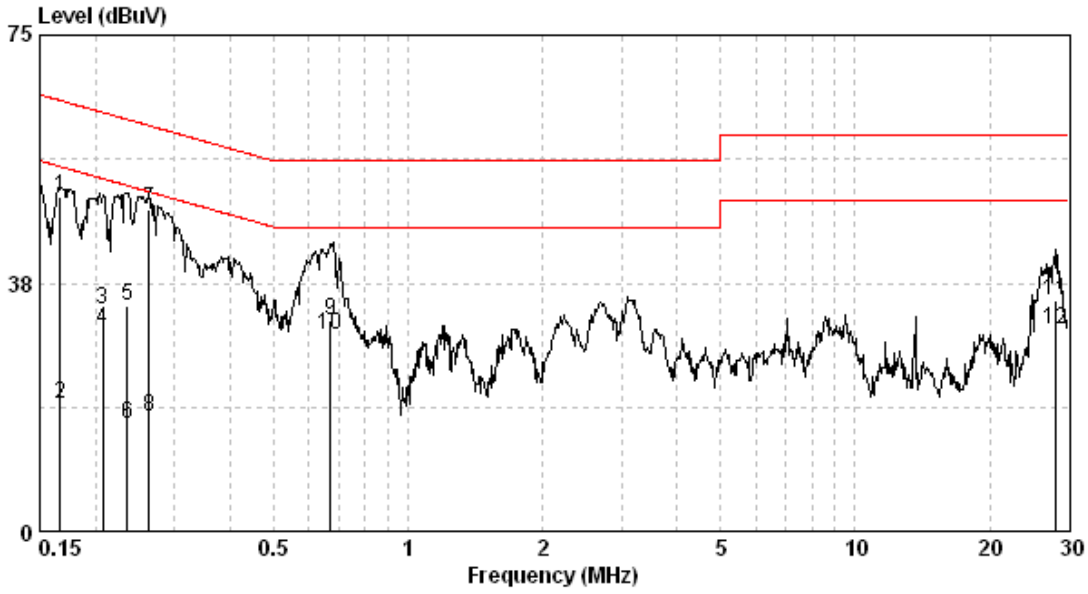
| Frequency (MHz) | Conducted Limit (dBuV) | |
|---|---|---|
| | Q.P. | Ave. |
| 0.15~0.50 | 66 – 56 | 56 – 46 |
| 0.50~5.00 | 56 | 46 |
| 5.00~30.0 | 60 | 50 |

## 8.5. Test Results

| Phase: | Live Line | | | |
|---|---|---|---|---|
| Temperature: | 27 | ℃ | Model No.: | UMC-LORA |
| Relative Humidity: | 65 | % | Test Date: | Aug. 08, 2017 |
| Atmospheric Pressure: | 1003 | hPa | Remark: | N/A |

| Frequency (MHz) | Corr. Factor (dB) | Level Qp (dBuV) | Limit Qp (dBuV) | Level AV (dBuV) | Limit Av (dBuV) | Margin (dB) Qp | Av |
|---|---|---|---|---|---|---|---|
| 0.167 | 9.62 | 50.52 | 65.12 | 19.18 | 55.12 | -14.60 | -35.94 |
| 0.207 | 9.62 | 33.47 | 63.32 | 30.40 | 53.32 | -29.84 | -22.91 |
| 0.235 | 9.62 | 33.99 | 62.26 | 16.30 | 52.26 | -28.27 | -35.95 |
| 0.263 | 9.62 | 48.69 | 61.34 | 17.33 | 51.34 | -12.65 | -34.01 |
| 0.672 | 9.64 | 31.76 | 56.00 | 29.72 | 46.00 | -24.24 | -16.28 |
| 28.003 | 9.91 | 34.87 | 60.00 | 30.53 | 50.00 | -25.13 | -19.47 |

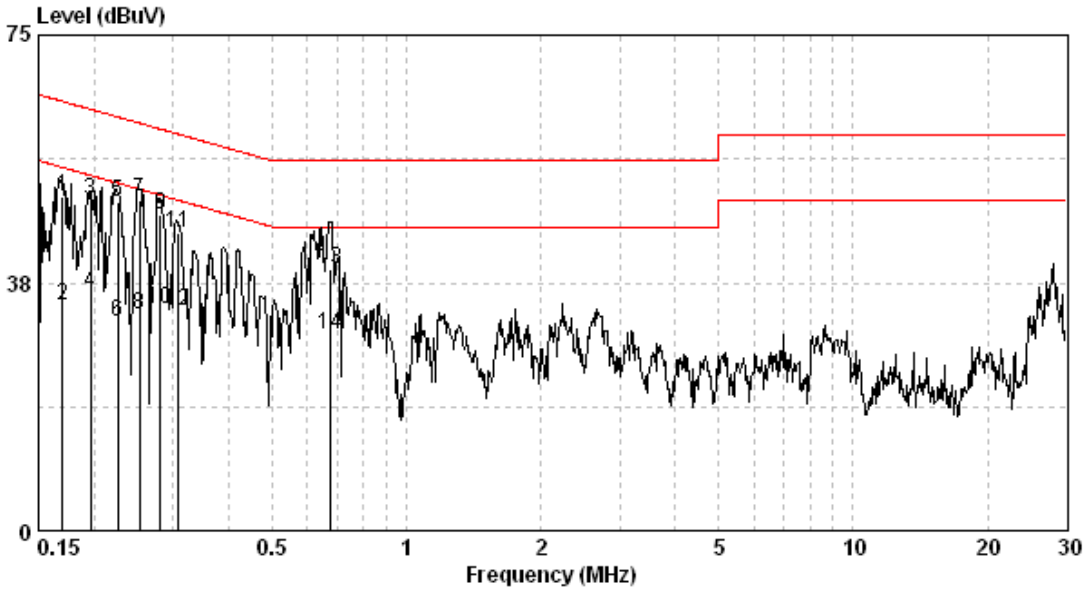
Remark:
1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



| Phase: | Neutral Line | | | |
|---|---|---|---|---|
| Temperature: | 27 | ℃ | Model No.: | UMC-LORA |
| Relative Humidity: | 65 | % | Test Date: | Aug. 08, 2017 |
| Atmospheric Pressure: | 1003 | hPa | Remark: | N/A |

| Frequency (MHz) | Corr. Factor (dB) | Level Qp (dBuV) | Limit Qp (dBuV) | Level AV (dBuV) | Limit Av (dBuV) | Margin (dB) Qp | Av |
|---|---|---|---|---|---|---|---|
| 0.169 | 9.62 | 50.55 | 64.99 | 34.05 | 54.99 | -14.44 | -20.93 |
| 0.197 | 9.62 | 50.00 | 63.76 | 35.91 | 53.76 | -13.75 | -17.85 |
| 0.226 | 9.62 | 49.63 | 62.61 | 31.69 | 52.61 | -12.98 | -20.92 |
| 0.252 | 9.62 | 50.04 | 61.69 | 32.56 | 51.69 | -11.64 | -19.13 |
| 0.282 | 9.62 | 47.90 | 60.76 | 33.54 | 50.76 | -12.86 | -17.23 |
| 0.307 | 9.62 | 45.11 | 60.06 | 33.38 | 50.06 | -14.95 | -16.68 |
| 0.675 | 9.64 | 39.62 | 56.00 | 29.55 | 46.00 | -16.38 | -16.45 |

Remark:
1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



## Appendix A: Test equipment list

| Test Equipment/ Test site | Brand | Model No. | Serial No. | Calibration Date | Next Calibration Date |
|---|---|---|---|---|---|
| ESCI EMI Test Receiver | Rohde & Schwarz | ESCI | 100018 | 2016/11/30 | 2017/11/29 |
| Spectrum Analyzer | Rohde & Schwarz | FSP30 | 100245 | 2017/02/15 | 2018/02/14 |
| Horn Antenna (1-18G) | SHWARZBECK | BBHA 9120 D | 9120D-456 | 2017/02/18 | 2018/02/17 |
| Horn Antenna (14-42G) | SHWARZBECK | BBHA 9170 | BBHA9170159 | 2014/09/16 | 2017/09/14 |
| Broadband Antenna | SHWARZBECK | VULB 9168 | 9168-172 | 2017/04/05 | 2018/04/04 |
| Pre-Amplifier | EMC Co. | EMC12635SE | 980205 | 2016/10/08 | 2017/10/07 |
| Pre-Amplifier | MITEQ | JS4-26004000--27-8A | 828825 | 2016/09/12 | 2017/09/11 |
| Power Meter | Anritsu | ML2495A | 0844001 | 2016/11/09 | 2017/11/08 |
| Power Sensor | Anritsu | MA2411B | 0738452 | 2016/11/09 | 2017/11/08 |
| Signal Analyzer | Agilent | N9030A | MY51380492 | 2017/08/29 | 2018/08/28 |
| 966-2(A) Cable 9kHz~26.5GHz | SUHNER | SMA / EX 100 | N/A | 2017/08/15 | 2018/08/14 |
| 966-2(B) Cable 9kHz~26.5GHz | SUHNER | SUCOFLEX 104P | CB0005 | 2017/08/15 | 2018/08/14 |
| RF Cable 9kHz~26.5GHz | SUHNER | SUCOFLEX 102 | CB0006 | 2017/05/04 | 2018/05/03 |
| 966-2_3m Semi-Anechoic Chamber | 966_2 | CEM-966_2 | N/A | 2017/03/29 | 2018/03/28 |
| High Pass Filter | Wainwright | WHKX3.0/ 18G-12SS | N/A | 2017/06/02 | 2018/06/01 |
| Active Loop Antenna | SCHWARZBECK MESS-ELEKTRONIC | FMZB1519 | 1519-067 | 2017/03/30 | 2018/03/29 |

Note: No Calibration Required (NCR).

| Test Equipment/ Test site | Brand | Model No. | Serial No. | Calibration Date | Next Calibration Date |
|---|---|---|---|---|---|
| EMI Receiver | R&S | ESCI | 100059 | 2016/11/21 | 2017/11/20 |
| Two-Line V-Network | R&S | ENV216 | 101159 | 2017/06/03 | 2018/06/02 |
| Artificial Mains Network (LISN) | SCHAFFNER | MN2050D | 1586 | 2017/05/31 | 2018/05/30 |
| CON-1 Shielded Room | N/A | N/A | N/A | NCR | NCR |
| CON-1 Cable | SUHNER | SUCOFLEX-104 | 26438414 | 2017/05/04 | 2018/05/03 |
| WiMAX PSA Spectrum Analyzer 3Hz-26.5GHz | Agilent | E4440A | MY46186191 | 2017/05/22 | 2018/05/21 |
| Test software | Audix | e3 | 4.20040112L | NCR | NCR |

Note: No Calibration Required (NCR).

**Appendix B: Measurement Uncertainty**

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

| Item | Uncertainty |
|---|---|
| Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m | 5.14 dB |
| Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m | 5.22 dB |
| Vertically polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m | 3.64 dB |
| Horizontally polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m | 3.64 dB |
| Vertically polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m | 2.68 dB |
| Horizontally polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m | 2.68 dB |
| Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m | 3.54 dB |
| Emission on the Band Edge Test | 3.64 dB |
| Minimum 6dB Bandwidth | 0.85 dB |
| Maximum Conducted Output Power | 0.42 dB |
| Power Spectral Density | 0.85 dB |
| Emissions In Non-Restricted Frequency Bands | 0.85 dB |
| AC Power Line Conducted Emission | 2.48 dB |