



FCC TEST REPORT

**Test report
On Behalf of
Hangzhou Roombanker Technology Co., Ltd.
For
Smart Linux Gateway
Model No: DSGW-091
FCC ID: 2AUXBDSGW-091**

Prepared for : Hangzhou Roombanker Technology Co., Ltd.
A#801 Wantong center, Hangzhou, China

Prepared By : Shenzhen Tongzhou Testing Co., Ltd
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Date of Test: 2022/10/8 ~ 2022/10/25
Date of Report: 2022/10/25
Report Number: TZ220903661-E4

The test report apply only to the specific sample(s) tested under stated test conditions
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TEST RESULT CERTIFICATION

Applicant's name : **Hangzhou Roombanker Technology Co., Ltd.**

Address..... : A#801 Wantong center, Hangzhou, China

Manufacture's Name : **Hangzhou Roombanker Technology Co., Ltd.**

Address..... : A#801 Wantong center, Hangzhou, China

Product description

Trade Mark..... : Dusun

Product name : Smart Linux Gateway

Model No..... : DSGW-091

Standards : FCC Rules and Regulations Part 15 Subpart C Section 15.247
ANSI C63.10: 2013

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Date of Test :

Date (s) of performance of tests..... : **2022/10/8 ~ 2022/10/25**

Date of Issue..... : **2022/10/25**

Test Result..... : **PASS**

Testing Engineer : Anna Hu

(Anna Hu)

Technical Manager : Hugo Chen

(Hugo Chen)

Authorized Signatory : Andy Zhang

(Andy Zhang)



Revision History

| Revision | Issue Date | Revisions | Revised By |
|----------|------------|---------------|------------|
| 00 | 2022/10/25 | Initial Issue | Andy Zhang |
| | | | |
| | | | |



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1. GENERAL INFORMATION

1.1. Description of Device (EUT)

| | |
|------------------------------|---------------------------------|
| Product Name | : Smart Linux Gateway |
| Model Number | : DSGW-091 |
| Model Difference Declaration | : N/A |
| Test Model | : DSGW-091 |
| Power Supply | : Input: DC 5V,2A |
| Hardware version | : 5-1-9-009760 |
| Software version | : V1.0 |
| Sample ID | : TZ220903661-1#&TZ220903661-2# |

LoRa

LoRa-Hybrid Mode

| | |
|-----------------------|---------------------|
| Frequency Range | : 902.3 – 914.9 MHz |
| Channel Number | : 64 Channels |
| Modulation Technology | : LORA |

LoRa-DTS Mode

| | |
|-----------------------|------------------------------------|
| Frequency Range | : 923.3 – 927.5 MHz |
| Channel Number | : 8 Channels |
| Modulation Technology | : LORA |
| Antenna Type And Gain | : External Antenna / 2.44 dBi(Max) |

Bluetooth

| | |
|-----------------------|-----------------------------|
| Bluetooth Version | : V5.2 |
| Frequency Range | : 2402 – 2480 MHz |
| Channel Number | : 40 Channels for BLE (DTS) |
| Modulation Technology | : GFSK for BLE (DTS) |
| Data Rates | : BLE (DTS): 1Mbps |
| Antenna Type And Gain | FPC Antenna / -0.09dBi(Max) |

Zigbee

| | |
|-----------------------|-----------------------------|
| Frequency Range | : 2415 – 2480 MHz |
| Channel Number | : 14 Channels |
| Modulation Technology | : O-QPSK |
| Data Rates | : 250 kbps |
| Antenna Type And Gain | : PCB Antenna / 0.0dBi(Max) |

Z-Wave

| | |
|-----------------------|-------------------------------------------|
| Frequency Range | : 908.4 – 916 MHz |
| Channel Number | : Channel 1: 908.4MHz / Channel 2: 916MHz |
| Modulation Technology | : FSK |
| Antenna Type And Gain | : FPC Antenna / -1.8dBi(Max) |

Note 1: Antenna position refer to EUT Photos.

Note 2: the above information was supplied by the applicant.

Note3: LoRa supports Hybrid and DTS Mode, This Report is for DTS Mode.



1.2 EUT configuration

The following peripheral devices and interface cables were connected during the measurement:

- - supplied by the manufacturer
- - supplied by the lab

| | | | |
|---|---------|------------|------------------------------------------------------------------|
| ○ | Adapter | Model: | MDY-10-EH |
| | | Input: | 100-240VAC 50/60Hz 0.7A |
| | | Output: | DC 5.0V,3.0A; DC 9.0V,3.0A; DC 12.0V,2.25A; DC 20.0V,1.35A |
| | | Lab. Code: | SZTZ-ZB-EMC-010 |

1.3 External I/O Cable

| I/O Port Description | Quantity | Cable |
|----------------------|----------|-------|
| DC port | 1 | N/A |
| RJ45 port | 1 | N/A |

1.4. Description of Test Facility

FCC

Designation Number: CN1275

Test Firm Registration Number: 167722

Shenzhen Tongzhou Testing Co.,Ltd has been listed on the US Federal Communications Commission

list of test facilities recognized to perform electromagnetic emissions measurements.

A2LA

Certificate Number: 5463.01

Shenzhen Tongzhou Testing Co.,Ltd has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

IC

ISED#: 22033

CAB identifier: CN0099

Shenzhen Tongzhou Testing Co.,Ltd has been listed by Innovation, Science and Economic Development Canada to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010



1.5. 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 Tongzhou Testing 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.

1.6. Measurement Uncertainty

| Test Item | Frequency Range | Uncertainty | Note |
|------------------------|-----------------|-------------|------|
| Radiation Uncertainty | 9KHz~30MHz | ±3.08dB | (1) |
| | 30MHz~1000MHz | ±4.42dB | (1) |
| | 1GHz~40GHz | ±4.06dB | (1) |
| Conduction Uncertainty | 150kHz~30MHz | ±2.23dB | (1) |

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

1.7. Description of Test Modes

LoRa operates in the unlicensed Band at 902 – 928 MHz. All test modes were tested, only the result of the worst case was recorded in the report.

| Mode of Operations | Test Frequency (MHz) |
|-----------------------|----------------------|
| Hybrid | 923.3(LCH) |
| | 925.7(MCH) |
| | 927.5(HCH) |
| For Radiated Emission | |
| Test Mode | TX Mode |

Note: LCH means Low Channel; MCH means Middle Channel; HCH means High Channel

Worst-case mode and channel used for 9kHz-1000 MHz radiated emissions was the mode and channel with the highest output power, that was determined to be TX(LCH).



1.8. Frequency of Channels

LoRa-DTS

| Channel | Frequency(MHz) |
|---------|----------------|
| 0 | 923.3 |
| 1 | 923.9 |
| 2 | 924.5 |
| 3 | 925.1 |
| 4 | 925.7 |
| 5 | 926.3 |
| 6 | 926.9 |
| 7 | 927.5 |



2. TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

The radiated testing was performed at an antenna-to-EUT distance of 3 meters. All radiated and conducted emissions measurement was performed at Shenzhen Tongzhou Testing Co.,Ltd

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to FCC's request, Test Procedure KDB558074 D01 DTS Meas. Guidance v04 and KDB 662911 are required to be used for this kind of FCC 15.247 digital modulation device.

According to its specifications, the EUT must comply with the requirements of the Section 15.203, 15.205, 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3. General Test Procedures

2.3.1 Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2.1 of ANSI C63.10-2013 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using Quasi-peak and average detector modes.

2.3.2 Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 6.3 of ANSI C63.10-2013

2.4. Test Sample

The application provides 1sample to meet requirement;

| Sample ID | Description |
|----------------|---------------------------------------|
| TZ220903661-1# | Engineer sample – continuous transmit |
| TZ220903661-2# | Normal sample – Intermittent transmit |



3. SYSTEM TEST CONFIGURATION

3.1. Justification

The system was configured for testing in a continuous transmits condition.

3.2. EUT Exercise Software

The system was configured for Bluetooth testing in a continuous transmits condition and change test channels by software(PuTTY 0.73) provided by application.

3.3. Special Accessories

| No. | Equipment | Manufacturer | Model No. | Serial No. | Length | shielded/ unshielded | Notes |
|-----|-----------|--------------|-----------|--------------------|--------|-------------------------|-------|
| 1 | PC | ASUS | X454L | 15105- 0038A100 | / | / | / |

3.4. Block Diagram/Schematics

Please refer to the related document

3.5. Equipment Modifications

Shenzhen Tongzhou Testing Co.,Ltd has not done any modification on the EUT.

3.6. Test Setup

Please refer to the test setup photo.



4. SUMMARY OF TEST RESULTS

| Applied Standard: FCC Part 15 Subpart C | | | |
|-----------------------------------------|-------------------------------------------|----------------------------------|-----------|
| FCC Rules | Description of Test | Test Sample(s) | Result |
| §15.247(b) | Maximum Conducted Output Power | TZ220903661-1# | Compliant |
| §15.247(e) | Power Spectral Density | TZ220903661-1# | Compliant |
| §15.247(a)(2) | 6dB Bandwidth | TZ220903661-1# | Compliant |
| §15.247(a) | Occupied Bandwidth | TZ220903661-1# | Compliant |
| §15.209, §15.247(d) | Radiated and Conducted Spurious Emissions | TZ220903661-1# | Compliant |
| §15.205 | Emissions at Restricted Band | TZ220903661-1# | Compliant |
| §15.207(a) | Conducted Emissions | TZ220903661-1# TZ220903661-2# | Compliant |
| §15.203 | Antenna Requirements | TZ220903661-1# | Compliant |
| §15.247(i)§2.1093 | RF Exposure | TZ220903661-1# | Compliant |

Remark: The measurement uncertainty is not included in the test result.



5. TEST RESULT

5.1. On Time and Duty Cycle

5.1.1. Standard Applicable

None; for reporting purpose only.

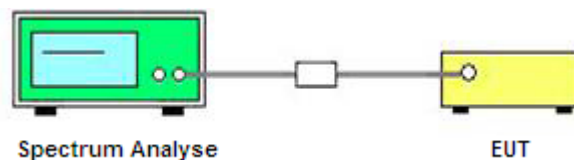
5.1.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of the spectrum analyzer.

5.1.3. Test Procedures

1. Set the center frequency of the spectrum analyzer to the transmitting frequency;
2. Set the span=0MHz, RBW=3MHz, VBW=3MHz, Sweep time=5ms;
3. Detector = peak;
4. Trace mode = Single hold.

5.1.4. Test Setup Layout



5.1.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.1.6. Test result

Pass

Remark:

1. Please refer to Appendix G of Appendix Test Data for LoRa-DTS for test data.

5.2. Maximum Peak Conducted Output Power Measurement

5.2.1. Standard Applicable

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

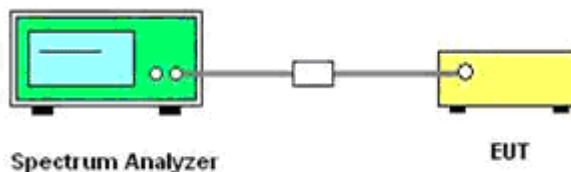
5.2.2. Test Procedures

The transmitter output (antenna port) was connected to the spectrum analyzer. According to KDB558074 D01 DTS Measurement Guidance Section 9.1 Maximum peak conducted output power 9.1.1.

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- a) Set the RBW \geq DTS bandwidth.
- b) Set VBW $\geq 3 \times$ RBW.
- c) Set span $\geq 3 \times$ RBW
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

5.2.3. Test Setup Layout



5.2.4. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.2.5. Test Result of Maximum Conducted Output Power

Pass

Remark:

1. Test results including cable loss;
2. Please refer to Appendix C of Appendix Test Data for LoRa-DTS for test data.

5.3. Maximum peak Power Spectral Density Measurement

5.3.1. Standard Applicable

According to §15.247(e): 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.

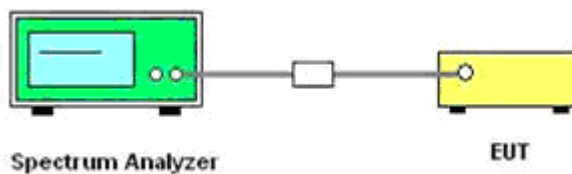
5.3.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.3.3. Test Procedures

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. The power was monitored at the coupler port with a Spectrum Analyzer. The power level was set to the maximum level.
3. Set the RBW = 3kHz.
4. Set the VBW $\geq 3 \times$ RBW
5. Set the span to 1.5 times the DTS channel bandwidth.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Use the peak marker function to determine the maximum power level.
11. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
12. The resulting peak PSD level must be 8dBm.

5.3.4. Test Setup Layout



5.3.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.



5.3.6. Test Result of Power Spectral Density

Pass

Remark:

1. *Test results including cable loss;*
2. *Please refer to Appendix D of Appendix Test Data for LoRa-DTS for test data.*

5.4. 6 dB Spectrum Bandwidth Measurement

5.4.1. Standard Applicable

According to §15.247(a) (2): For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz.

5.4.2. Measuring Instruments and Setting

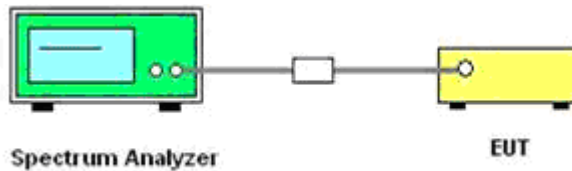
Please refer to section 6 of equipment list in this report. The following table is the setting of the Spectrum Analyzer.

| Spectrum Parameter | Setting |
|--------------------|----------|
| Attenuation | Auto |
| Span Frequency | > RBW |
| Detector | Peak |
| Trace | Max Hold |
| Sweep Time | 100ms |

5.4.3. Test Procedures

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. The resolution bandwidth and the video bandwidth were set according to KDB558074.
3. Measured the spectrum width with power higher than 6dB below carrier.

5.4.4. Test Setup Layout



5.4.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.4.6. Test Result of 6dB Spectrum Bandwidth

Pass

Remark:

1. *Test results including cable loss;*
2. *please refer to following plots;*
3. *Please refer to Appendix A of Appendix Test Data for LoRa-DTS for test data.*



5.5. Radiated Emissions and Restricted Band Emission Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|-------------------|---------------------|---------------|-------------|
| 0.090-0.110 | 16.42-16.423 | 399.9-410 | 4.5-5.15 |
| \1\ 0.495-0.505 | 16.69475-16.69525 | 608-614 | 5.35-5.46 |
| 2.1735-2.1905 | 16.80425-16.80475 | 960-1240 | 7.25-7.75 |
| 4.125-4.128 | 25.5-25.67 | 1300-1427 | 8.025-8.5 |
| 4.17725-4.17775 | 37.5-38.25 | 1435-1626.5 | 9.0-9.2 |
| 4.20725-4.20775 | 73-74.6 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 74.8-75.2 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 108-121.94 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 123-138 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 149.9-150.05 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 156.52475-156.52525 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.7-156.9 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 162.0125-167.17 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 167.72-173.2 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 240-285 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 322-335.4 | 3600-4400 | (\2\) |
| 13.36-13.41 | | | |

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510MHz.

\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

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

5.5.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of spectrum analyzer and receiver.

| Spectrum Parameter | Setting |
|-------------------------------------------|---------------------------------------------------|
| Attenuation | Auto |
| Start Frequency | 1000 MHz |
| Stop Frequency | 10 th carrier harmonic |
| RB / VB (Emission in restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average |
| RB / VB (Emission in non-restricted band) | 1MHz / 1MHz for Peak, 1 MHz / 1/B kHz for Average |

| Receiver Parameter | Setting |
|------------------------|--------------------------------------------|
| Attenuation | Auto |
| Start ~ Stop Frequency | 9kHz~150kHz / RB/VB 200Hz/1KHz for QP/AVG |
| Start ~ Stop Frequency | 150kHz~30MHz / RB/VB 9kHz/30KHz for QP/AVG |
| Start ~ Stop Frequency | 30MHz~1000MHz / RB/VB 120kHz/1MHz for QP |

5.5.3. Test Procedures



1) Sequence of testing 9 kHz to 30 MHz

Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.
- If the EUT is a floor standing device, it is placed on the ground.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

Premeasurement:

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1.3 meter.
- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).
- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.
- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.



2) Sequence of testing 30 MHz to 1 GHz

Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

Premeasurement:

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 to 3 meter.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

- The final measurement will be performed with minimum the six highest peaks.
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ($\pm 45^\circ$) and antenna movement between 1 and 4 meter.
- The final measurement will be done with QP detector with an EMI receiver.
- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.



3) Sequence of testing 1 GHz to 18 GHz

Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 3 meter.
- The EUT was set into operation.

Premeasurement:

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height scan range is 1 meter to 2.5 meter.
- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

- The final measurement will be performed with minimum the six highest peaks.
- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position ($\pm 45^\circ$) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.
- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.
- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.



4) Sequence of testing above 18 GHz

Setup:

- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.
- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables were positioned to simulate normal operation conditions
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- The measurement distance is 1 meter.
- The EUT was set into operation.

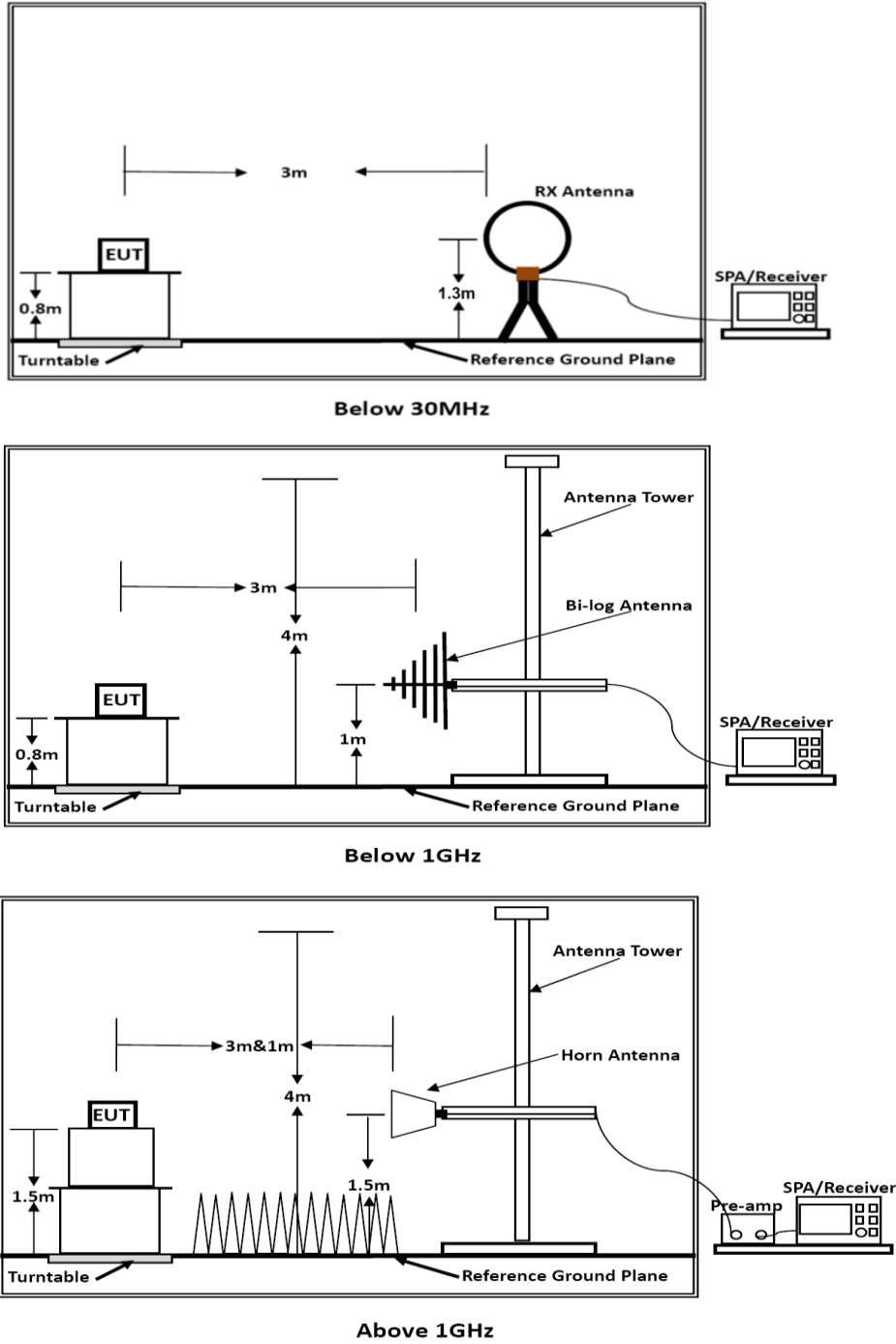
Premeasurement:

- The antenna is moved spherical over the EUT in different polarizations of the antenna.

Final measurement:

- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.
- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

5.5.4. Test Setup Layout



Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade from 3m to 1.5m.

Distance extrapolation factor = $20 \log (\text{specific distance [3m]} / \text{test distance [1.5m]})$ (dB);
 Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].



5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9 kHz~30MHz)

| | | | |
|---------------|---------|----------------|----------|
| Temperature | 24.3°C | Humidity | 55% |
| Test Engineer | Anna Hu | Configurations | LoRa-DTS |

| Freq. (MHz) | Level (dBuV) | Over Limit (dB) | Over Limit (dBuV) | Remark |
|-------------|--------------|-----------------|-------------------|----------|
| - | - | - | - | See Note |

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log(\text{specific distance} / \text{test distance})$ (dB);

Limit line = specific limits (dBuV) + distance extrapolation factor.

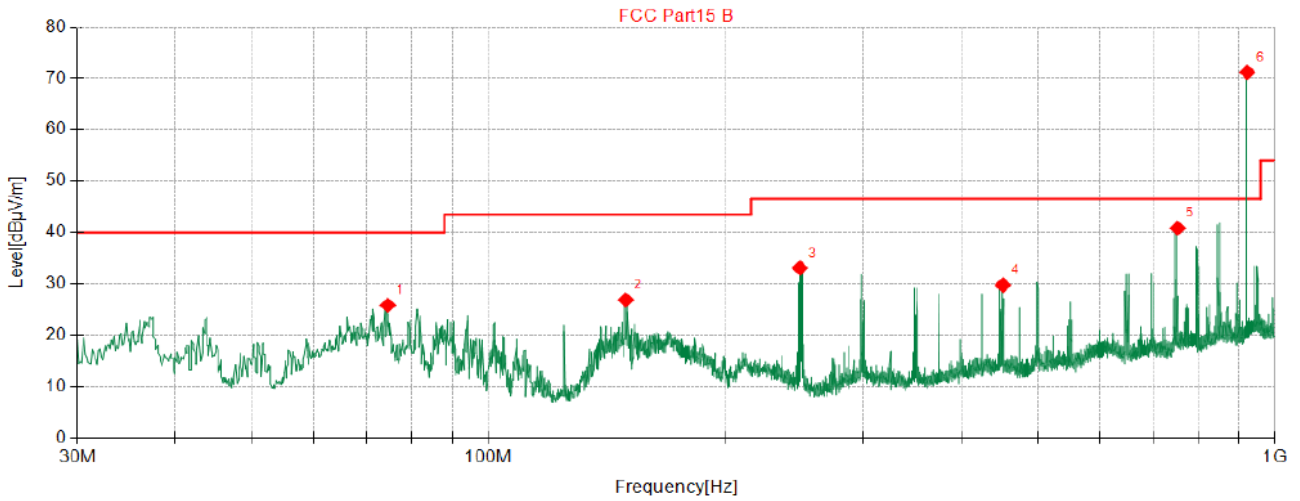
5.5.7. Results of Radiated Emissions (30MHz~1GHz)

| | | | |
|---------------|---------|----------------|----------|
| Temperature | 24.3°C | Humidity | 55% |
| Test Engineer | Anna Hu | Configurations | LoRa-DTS |



Results of Radiated Emissions (30MHz~1GHz)
Low Channel

Vertical



◆ QP Detector

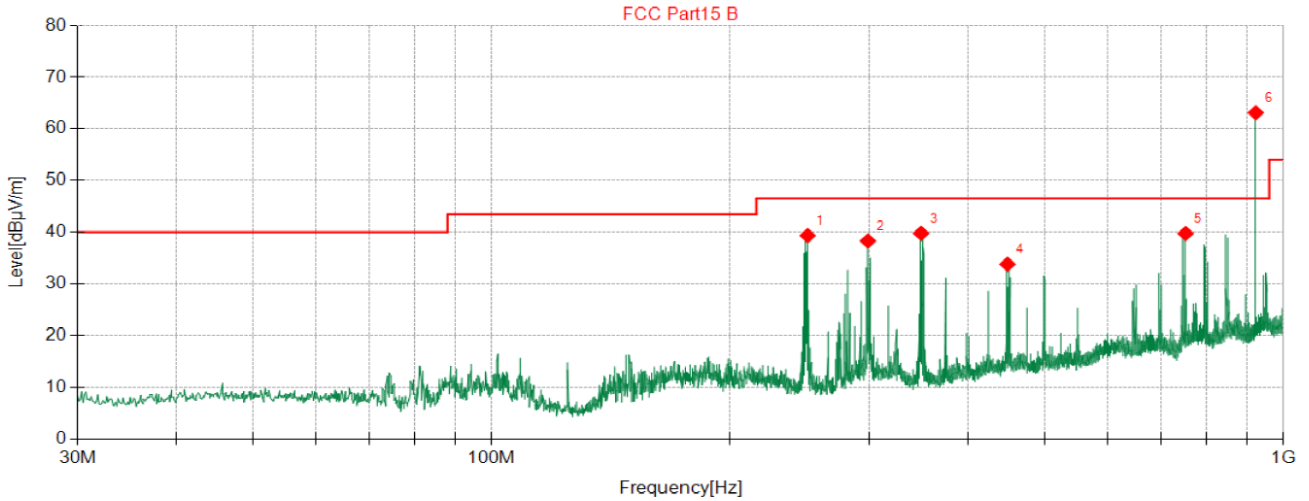
| Suspected Data List | | | | | | | | | |
|---------------------|-------------|----------------|---------------|----------------|----------------|-------------|-------------|-----------|----------|
| NO. | Freq. [MHz] | Reading [dBµV] | Factor [dB/m] | Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity |
| 1 | 74.49 | 44.10 | -18.24 | 25.86 | 40.00 | 14.14 | 100 | 269 | Vertical |
| 2 | 149.5 | 44.57 | -17.67 | 26.90 | 43.50 | 16.60 | 100 | 187 | Vertical |
| 3 | 249.2 | 46.88 | -13.80 | 33.08 | 46.50 | 13.42 | 100 | 162 | Vertical |
| 4 | 451.5 | 39.23 | -9.45 | 29.78 | 46.50 | 16.72 | 100 | 285 | Vertical |
| 5 | 752.8 | 44.95 | -4.12 | 40.83 | 46.50 | 5.67 | 100 | 336 | Vertical |
| 6 | 923.2 | 72.02 | -0.82 | 71.20 | 46.50 | -24.70 | 100 | 309 | Vertical |

***Note:

1. Level [dBµV/m] = Reading [dBµV] + Factor [dB/m]
2. Margin [dB] = Limit [dBµV/m] - Level [dBµV/m]



Horizontal



◆ QP Detector

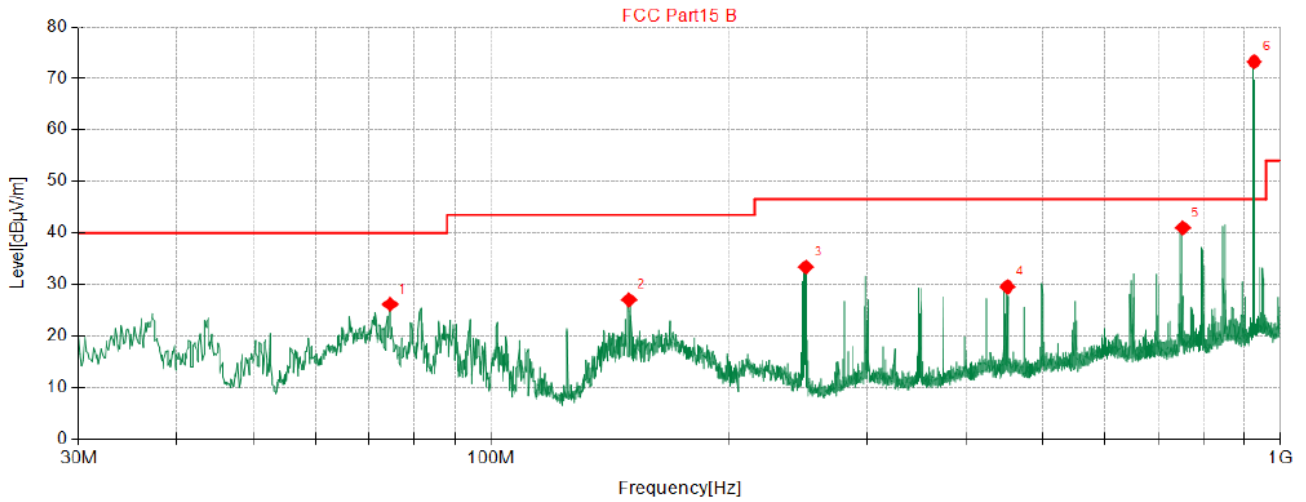
| Suspected Data List | | | | | | | | | |
|---------------------|-------------|----------------|---------------|----------------|----------------|-------------|-------------|-----------|------------|
| NO. | Freq. [MHz] | Reading [dBµV] | Factor [dB/m] | Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity |
| 1 | 250.7 | 53.18 | -13.85 | 39.33 | 46.50 | 7.17 | 100 | 61 | Horizontal |
| 2 | 298.81 | 51.13 | -12.83 | 38.30 | 46.50 | 8.20 | 100 | 252 | Horizontal |
| 3 | 348.7 | 51.22 | -11.45 | 39.77 | 46.50 | 6.73 | 100 | 249 | Horizontal |
| 4 | 448.4 | 42.88 | -9.08 | 33.80 | 46.50 | 12.70 | 100 | 246 | Horizontal |
| 5 | 752.8 | 43.32 | -3.58 | 39.74 | 46.50 | 6.76 | 100 | 113 | Horizontal |
| 6 | 923.2 | 63.88 | -0.76 | 63.12 | 46.50 | -16.62 | 100 | 268 | Horizontal |

***Note:

1. Level [dBµV/m] = Reading [dBµV] + Factor [dB/m]
2. Margin [dB] = Limit [dBµV/m] - Level [dBµV/m]



High Channel
Vertical



◆ QP Detector

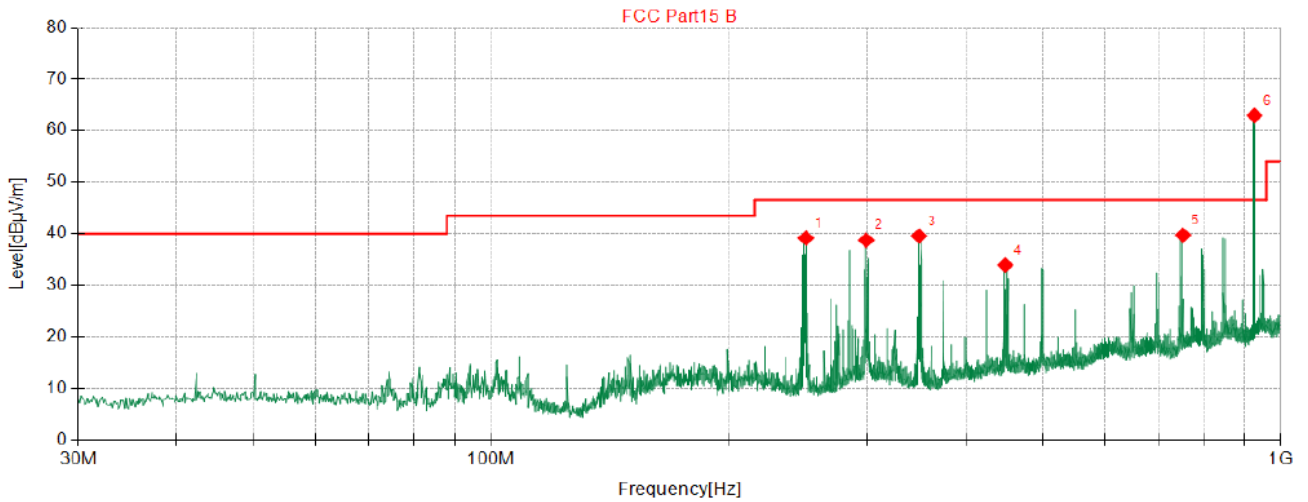
| Suspected Data List | | | | | | | | | |
|---------------------|-------------|----------------|---------------|----------------|----------------|-------------|-------------|-----------|----------|
| NO. | Freq. [MHz] | Reading [dBµV] | Factor [dB/m] | Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity |
| 1 | 74.49 | 44.42 | -18.24 | 26.18 | 40.00 | 13.82 | 100 | 344 | Vertical |
| 2 | 149.5 | 44.72 | -17.67 | 27.05 | 43.50 | 16.45 | 100 | 183 | Vertical |
| 3 | 250.7 | 47.14 | -13.76 | 33.38 | 46.50 | 13.12 | 100 | 158 | Vertical |
| 4 | 451.5 | 39.02 | -9.45 | 29.57 | 46.50 | 16.93 | 100 | 267 | Vertical |
| 5 | 752.8 | 45.11 | -4.12 | 40.99 | 46.50 | 5.51 | 100 | 332 | Vertical |
| 6 | 927.4 | 74.03 | -0.81 | 73.22 | 46.50 | -26.72 | 100 | 332 | Vertical |

***Note:

1. Level [dBµV/m] = Reading [dBµV] + Factor [dB/m]
2. Margin [dB] = Limit [dBµV/m] - Level [dBµV/m]



Horizontal



◆ QP Detector

| Suspected Data List | | | | | | | | | |
|---------------------|-------------|----------------|---------------|----------------|----------------|-------------|-------------|-----------|------------|
| NO. | Freq. [MHz] | Reading [dBµV] | Factor [dB/m] | Level [dBµV/m] | Limit [dBµV/m] | Margin [dB] | Height [cm] | Angle [°] | Polarity |
| 1 | 250.7 | 52.99 | -13.85 | 39.14 | 46.50 | 7.36 | 100 | 56 | Horizontal |
| 2 | 298.81 | 51.57 | -12.83 | 38.74 | 46.50 | 7.76 | 100 | 52 | Horizontal |
| 3 | 348.7 | 51.01 | -11.45 | 39.56 | 46.50 | 6.94 | 100 | 257 | Horizontal |
| 4 | 448.4 | 42.99 | -9.08 | 33.91 | 46.50 | 12.59 | 100 | 250 | Horizontal |
| 5 | 752.8 | 43.28 | -3.58 | 39.70 | 46.50 | 6.80 | 100 | 105 | Horizontal |
| 6 | 927.6 | 63.65 | -0.72 | 62.93 | 46.50 | -16.43 | 100 | 297 | Horizontal |

***Note:

1. Level [dBµV/m] = Reading [dBµV] + Factor [dB/m]
2. Margin [dB] = Limit [dBµV/m] - Level [dBµV/m]



5.5.8. Results for Radiated Emissions (Above 1GHz)

Low Channel: 923.3MHz

| Freq. MHz | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|--------------|-----------------|---------------------|--------------------|--------------------|--------------------|-----------------|--------------|--------|------------|
| 1846.71 | 46.59 | 33.06 | 35.04 | 3.94 | 48.55 | 74.00 | 25.45 | Peak | Horizontal |
| 1847.06 | 48.32 | 33.06 | 35.04 | 3.94 | 50.28 | 74.00 | 23.72 | Peak | Vertical |
| 2770.22 | 49.82 | 33.06 | 35.04 | 3.94 | 51.78 | 74.00 | 22.22 | Peak | Horizontal |
| 2770.76 | 47.16 | 33.06 | 35.04 | 3.94 | 49.12 | 74.00 | 24.88 | Peak | Vertical |

Low Channel: 925.7MHz

| Freq. MHz | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|--------------|-----------------|---------------------|--------------------|--------------------|--------------------|-----------------|--------------|--------|------------|
| 1852.18 | 46.89 | 33.16 | 35.15 | 3.96 | 48.86 | 74.00 | 25.14 | Peak | Horizontal |
| 1852.39 | 44.28 | 33.16 | 35.15 | 3.96 | 46.25 | 74.00 | 27.75 | Peak | Vertical |
| 2777.31 | 47.17 | 33.16 | 35.15 | 3.96 | 49.14 | 74.00 | 24.86 | Peak | Horizontal |
| 2777.87 | 49.90 | 33.16 | 35.15 | 3.96 | 51.87 | 74.00 | 22.13 | Peak | Vertical |

Low Channel: 927.5MHz

| Freq. MHz | Reading dBuv | Ant. Fac dB/m | Pre. Fac. dB | Cab. Loss dB | Measured dBuv/m | Limit dBuv/m | Margin dB | Remark | Pol. |
|--------------|-----------------|---------------------|--------------------|--------------------|--------------------|-----------------|--------------|--------|------------|
| 1855.27 | 46.58 | 33.26 | 35.14 | 3.98 | 48.68 | 74.00 | 25.32 | Peak | Horizontal |
| 1855.74 | 46.70 | 33.26 | 35.14 | 3.98 | 48.80 | 74.00 | 25.20 | Peak | Vertical |
| 2782.69 | 47.04 | 33.26 | 35.14 | 3.98 | 49.14 | 74.00 | 24.86 | Peak | Horizontal |
| 2782.62 | 49.58 | 33.26 | 35.14 | 3.98 | 51.68 | 74.00 | 22.32 | Peak | Vertical |

Notes:

- 1). Measuring frequencies from 9k~10th harmonic (ex. 10GHz), No emission found between lowest internal used/generated frequency to 30 MHz.
- 2). Radiated emissions measured in frequency range from 9k~10th harmonic (ex. 10GHz) were made with an instrument using Peak detector mode.
- 3). Measured = Reading + Ant. Fac - Pre. Fac. + Cab. Loss; Margin = Limit - Measured



5.6. Conducted Spurious Emissions and Band Edges Test

5.6.1. Standard Applicable

According to §15.247 (d): In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

5.6.2. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of the spectrum analyzer.

| Spectrum Parameter | Setting |
|-------------------------------------------|---------------|
| Detector | Peak |
| Attenuation | Auto |
| RB / VB (Emission in restricted band) | 100KHz/300KHz |
| RB / VB (Emission in non-restricted band) | 100KHz/300KHz |

5.6.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9 kHz to 26.5GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

5.6.4. Test Setup Layout

This test setup layout is the same as that shown in section 5.4.4.

5.6.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.6.6. Test Results of Conducted Spurious Emissions

Pass

Remark:

1. *Test results including cable loss;*
2. *“---“means that the fundamental frequency not for 15.209 limits requirement.*
3. *Not recorded values as emission level lower than limit at least 20 dBc;*
4. *Please refer to Appendix F of Appendix Test Data for LoRa-DTS for Conducted Spurious Emissions test data.*
5. *Please refer to Appendix E of Appendix Test Data for LoRa-DTS for Conducted Band Edges test data.*

5.7. AC Power line conducted emissions

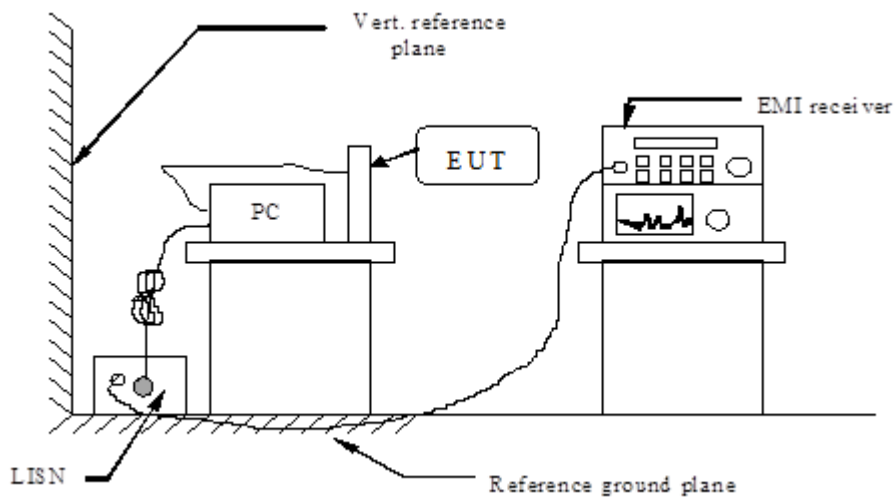
5.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

| Frequency Range (MHz) | Limits (dB μ V) | |
|-----------------------|---------------------|----------|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

* Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



5.7.3 Test Results

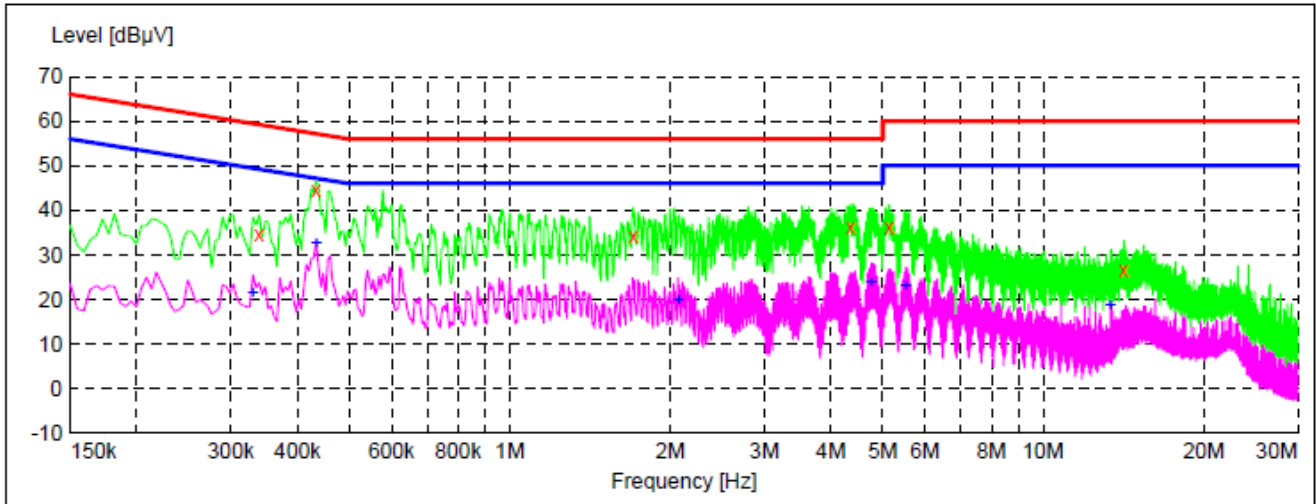
| | | | |
|----------------|----------|----------------|----------|
| 6. Temperature | 22.8°C | Humidity | 56% |
| Test Engineer | Nancy Li | Configurations | LoRa-DTS |

PASS.

The test data please refer to following page.



Neutral Line



| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|------------------|---------------|--------------|---------------|--------------|----------|------|-----|
| 0.339000 | 34.50 | 10.1 | 59 | 24.7 | QP | N | GND |
| 0.433500 | 44.50 | 10.0 | 57 | 12.7 | QP | N | GND |
| 1.702500 | 34.10 | 9.7 | 56 | 21.9 | QP | N | GND |
| 4.357500 | 36.10 | 9.7 | 56 | 19.9 | QP | N | GND |
| 5.136000 | 36.00 | 9.8 | 60 | 24.0 | QP | N | GND |
| 14.154000 | 26.80 | 9.8 | 60 | 33.2 | QP | N | GND |

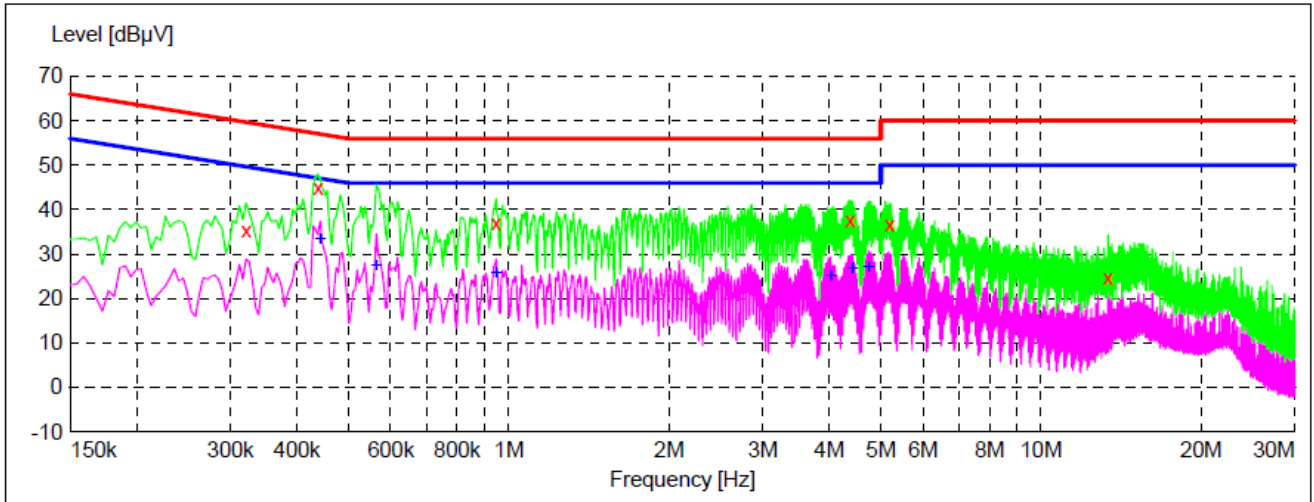
| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|------------------|---------------|--------------|---------------|--------------|----------|------|-----|
| 0.330000 | 21.50 | 10.1 | 50 | 28.0 | AV | N | GND |
| 0.433500 | 32.50 | 10.0 | 47 | 14.7 | AV | N | GND |
| 2.067000 | 19.70 | 9.7 | 46 | 26.3 | AV | N | GND |
| 4.758000 | 24.00 | 9.8 | 46 | 22.0 | AV | N | GND |
| 5.523000 | 23.20 | 9.8 | 50 | 26.8 | AV | N | GND |
| 13.357500 | 18.50 | 9.8 | 50 | 31.5 | AV | N | GND |

Note:

1. Margin(dB)= Limit(dBµV) - -Level(dBµV)
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: 9 kHz (150 kHz—30 MHz), Step size: 4 kHz, Scan time: auto.
4. Pre-scan all modes and recorded the worst case result in this report



Live Line



| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|------------------|---------------|--------------|---------------|--------------|----------|------|-----|
| 0.321000 | 35.20 | 10.2 | 60 | 24.5 | QP | L1 | GND |
| 0.438000 | 44.90 | 10.0 | 57 | 12.2 | QP | L1 | GND |
| 0.946500 | 37.00 | 9.8 | 56 | 19.0 | QP | L1 | GND |
| 4.380000 | 37.50 | 9.7 | 56 | 18.5 | QP | L1 | GND |
| 5.190000 | 36.80 | 9.8 | 60 | 23.2 | QP | L1 | GND |
| 13.353000 | 24.70 | 9.8 | 60 | 35.3 | QP | L1 | GND |

| Frequency MHz | Level dBµV | Transd dB | Limit dBµV | Margin dB | Detector | Line | PE |
|------------------|---------------|--------------|---------------|--------------|----------|------|-----|
| 0.442500 | 33.20 | 10.0 | 47 | 13.8 | AV | L1 | GND |
| 0.564000 | 27.30 | 9.9 | 46 | 18.7 | AV | L1 | GND |
| 0.946500 | 25.70 | 9.8 | 46 | 20.3 | AV | L1 | GND |
| 4.020000 | 25.10 | 9.7 | 46 | 20.9 | AV | L1 | GND |
| 4.416000 | 26.60 | 9.7 | 46 | 19.4 | AV | L1 | GND |
| 4.744500 | 26.90 | 9.8 | 46 | 19.1 | AV | L1 | GND |

Note:

1. Margin(dB)= Limit(dBµV) - Level(dBµV)
2. If QP Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: 9 kHz (150 kHz—30 MHz), Step size: 4 kHz, Scan time: auto.
4. Pre-scan all modes and recorded the worst case result in this report



5.8. Antenna Requirements

5.8.1 Standard Applicable

According to antenna requirement of §15.203.

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

5.8.2 Antenna Connected Construction

5.8.2.1. Standard Applicable

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

5.8.2.2. Antenna Connector Construction

The directional gains of antenna refer to section 1.1 of this report, and the antenna is an External antenna connect to EUT with Anti-SMA connector and no consideration of replacement. Please see EUT photo for details.

5.8.2.3. Results: Compliance.



6. LIST OF MEASURING EQUIPMENTS

| Item | Test Equipment | Manufacturer | Model No. | Serial No. | Calibration Date | Calibration Due Date |
|------|----------------------|-----------------|--------------|--------------|------------------|----------------------|
| 1 | MXA Signal Analyzer | Keysight | N9020A | MY52091623 | 2022/1/13 | 2023/1/12 |
| 2 | Power Sensor | Agilent | U2021XA | MY5365004 | 2022/1/13 | 2023/1/12 |
| 3 | Power Meter | Agilent | U2531A | TW53323507 | 2022/1/13 | 2023/1/12 |
| 4 | Loop Antenna | schwarzbeck | FMZB1519B | 00023 | 2019/11/16 | 2022/11/15 |
| 5 | Wideband Antenna | schwarzbeck | VULB 9163 | 958 | 2019/11/16 | 2022/11/15 |
| 6 | Horn Antenna | schwarzbeck | 9120D-1141 | 1574 | 2019/11/16 | 2022/11/15 |
| 7 | EMI Test Receiver | R&S | ESCI | 100849/003 | 2022/1/12 | 2023/1/11 |
| 8 | Controller | MF | MF7802 | N/A | N/A | N/A |
| 9 | Amplifier | schwarzbeck | BBV 9743 | 209 | 2022/1/12 | 2023/1/11 |
| 10 | Amplifier | Tonscend | TSAMP-0518SE | -- | 2022/1/12 | 2023/1/11 |
| 11 | RF Cable(below 1GHz) | HUBER+SUHNER | RG214 | N/A | 2022/1/12 | 2023/1/11 |
| 12 | RF Cable(above 1GHz) | HUBER+SUHNER | RG214 | N/A | 2022/1/14 | 2023/1/13 |
| 12 | Artificial Mains | ROHDE & SCHWARZ | ENV 216 | 101333-IP | 2022/1/13 | 2023/1/12 |
| 14 | EMI Test Software | ROHDE & SCHWARZ | ESK1 | V1.71 | N/A | N/A |
| 15 | RE test software | Tonscend | JS32-RE | V2.0.2.0 | N/A | N/A |
| 16 | Test Software | Tonscend | JS1120-3 | V2.5.77.0418 | N/A | N/A |
| 17 | Horn Antenna | A-INFO | LB-180400-KF | J211020657 | 2022/10/12 | 2024/10/11 |
| 18 | Amplifier | CDSA | PAP-1840 | 17021 | 2022/10/10 | 2023/10/09 |
| 19 | Spectrum Analyzer | R&S | FSP40 | 100550 | 2022/1/10 | 2023/1/9 |



7. TEST SETUP PHOTOGRAPHS

Please refer to separated files for Test Setup Photos of the EUT.

8.EXTERNAL PHOTOS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9.INTERIOR PHOTOS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

-----THE END OF REPORT-----