RF TEST REPORT

Report No.:	20230817G11099X-W2
Product Name:	Temperature Sensor
Main Model No.:	TS302-915M
Series Model No.:	NK302-915M, TS302-9M, NK302-9M, TS301-915M, NK301-915M, TS301-9M, NK301-9M, TS302, NK302, TS301, NK301
FCC ID:	2AYHY-TS30X
Applicant:	Xiamen Milesight IoT Co., Ltd.
Address:	Building C09, Software Park Phase III, Xiamen 361024, Fujian, China
Dates of Testing:	09/01/2023 - 09/18/2023
Issued by:	CCIC Southern Testing Co., Ltd.
Lab Location:	Electronic Testing Building, No. 43 Shahe Road, Xili Street, Nanshan District, Shenzhen, Guangdong, China.
	Tel: 86 755 26627338 **Fax:** 86 755 26627238

Test Report

Product .....:	Temperature Sensor
Trade Name .....:	Milesight
Brand Name .....:	Milesight
Applicant.....:	Xiamen Milesight IoT Co., Ltd.
Applicant Address .....:	Building C09, Software Park Phase III, Xiamen 361024, Fujian, China
Manufacturer .....:	Xiamen Milesight IoT Co., Ltd.
Manufacturer Address .....:	Building C09, Software Park Phase III, Xiamen 361024, Fujian, China
Test Standards.....:	47 CFR Part 15 Subpart C 15.247 ANSI C63.10-2013
Test Result.....:	Pass

Tested by .....:	kim Li	2023.09.20
	Kim Li, Test Engineer	
Reviewed by .....:	Chris You	2023.09.20
	Chris You, Senior Engineer	
Approved by .....:	Yang Fan	2023.09.20
	Yang Fan, Manager	

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Change History		
Issue	Date	Reason for change
1.0	2023.09.20	First edition

1. General Information

1.1. EUT Description

Product Name	Temperature Sensor
Frequency Range	LoRaWAN: 902MHz~928MHz
Channel Number	903.0~914.2MHz: 8 923.3~926.9MHz: 7
Data Rate	980bit/s
Modulation Type	LoRa
Antenna Type	PCB Antenna
Antenna Gain	2.11dBi
Power supply	2*3.6V Lithium Battery

Note 1: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

Note 2: The antenna gain, RF Cable loss and all the information provided by manufacturer and our lab not responsible for the accuracy of the antenna gain/cable loss information.

Note 3: Series models: TS302-915M, NK302-915M, TS302-9M, NK302-9M, TS301-915M, NK301-915M, TS301-9M, NK301-9M, TS302, NK302, TS301, NK301, and tested models: TS302-915M, have the same electromagnetic emission and electromagnetic compatibility characteristics.

Their differences are as follows:

Model No.	Difference
TS302-915M,NK302-915M,TS302-9M, NK302-9M,TS302,NK302	Dual channel version. Same hardware motherboard, and the child board has two M12 connectors.
TS301-915M,NK301-915M,TS301-9M, NK301-9M,TS301,NK301	Single channel version. Same hardware motherboard, and the child board has only one M12 interface.

1.2. Test Standards and Results

The purpose of the report is to conduct testing according to the following FCC certification standards:

No.	Identity	Document Title
1	47 CFR Part 15 Subpart C	Radio Frequency Devices
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3	KDB 558074 D01 15.247 Meas Guidance v05r02	Cuidance for Compliance Measurement on Digital Transmission Systems, Frequency Hopping Spread Spectrum Systems, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules

Test detailed items/section required by FCC rules and results are as below:

No.	Section in CFR 47	Description	Result
1	15.203 15.247(b)(4)	Antenna Requirement	PASS
2	15.247(b)(3)	Peak Conducted Output Power	PASS
3	15.247(a)(2)	6dB and 99% Bandwidth	PASS
4	15.247(d)	Conducted Band Edges and Spurious Emission	PASS
5	15.247(e)	Power spectral density (PSD)	PASS
6	15.207	AC Power Line Conducted Emission	PASS
7	15.209 15.205 15.247(d)	Radiated Band Edges and Spurious Emission	PASS

Note 1: The tests of Conducted Emission and Radiated Emission were performed according to the method of measurements prescribed in ANSI C63.10-2013.

Note 2: These RF tests were performed according to the method of measurements prescribed in KDB 558074 D01 15.247 Meas Guidance v05r02.

1.3. Carrier Frequency and channel List

LoRaWAN_903.0~914.2MHz					
Channel	Frequency(MHz)	Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	**903.0**	**3**	**907.8**	6	912.6
1	904.6	4	909.4	**7**	**914.2**
2	906.2	5	911.0	/	/
Note 1: F(MHz) = 903.0 + 1.6*n (0 ≤ n ≤ 7).					
Note 2: Channel 0, 3 and 7 selected for LoRaWAN as Lowest, Middle and Highest channel.					

LoRaWAN_923.3~926.9MHz					
Channel	Frequency(MHz)	Channel	Frequency(MHz)	Channel	Frequency(MHz)
0	**923.3**	**3**	**925.1**	**6**	**926.9**
1	923.9	4	925.7	/	/
2	924.5	5	926.3	/	/
Note 1: F(MHz) = 923.3 + 0.6*n (0 ≤ n ≤ 6).					
Note 2: Channel 0, 3 and 6 selected for LoRaWAN as Lowest, Middle and Highest channel.					

1.4. Test environment and mode

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

Operating Environment	
Temperature	15°C - 35°C
Humidity	30% -60%
Atmospheric Pressure	86kPa-106kPa
Test mode:	
Continuously transmitting mode	Keep the EUT in continuous transmitting with modulation

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate shown in the table below is the worst-case rate with respect to the specific test item. Investigation has been done on all the possible configurations for searching the worst cases. The following table is a list of the test modes shown in this test report.

Test Items	Modulation Type	Channel
Peak Conducted Output Power Power Spectral Density 6dB and 99% Bandwidth Conducted and Spurious Emission Radiated and Spurious Emission	LoRa	L, M, H
Conducted Band Edge	LoRa	L, H

1.5. Table for Supporting Units

No.	Equipment	Brand Name	Model Name	Manufacturer	Serial No.	Note
1	Laptop	HP	TPN-Q221	HP	5CD14347QB	FCC DOC

1.6. EUT Operation Test Setup

For RF test items, an engineering test program was provided and enable to make EUT transmitting.

1.7. Facilities and Accreditations

FCC-Registration No.: 406086

CCIC Southern Testing 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. Designation Number: CN1283, valid time is until June 30, 2025.

ISED Registration: 11185A-1

CCIC Southern Testing Co., Ltd. EMC Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 11185A-1 on Aug. 04, 2016, valid time is until June 30, 2025.

A2LA Code: 5721.01

CCIC-SET is a third party testing organization accredited by A2LA according to ISO/IEC 17025. The accreditation certificate number is 5721.01.

2. Test Requirements

2.1. Antenna requirement

2.1.1. Applicable Standard

And according to FCC 47 CFR Section 15.203: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the 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 §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. 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 § 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 FCC 47 CFR Section 15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2.1.2. Antenna Information

Antenna Category: PCB Antenna.

1. The PCB Antenna is permanently connected to the EUT, can't be removed.

Antenna General Information:

No.	EUT	Operating frequency range	Ant. Type	Ant. Gain
1	Temperature Sensor	902-928MHz	PCB Antenna	2.11dBi

2.1.3. Result: Comply

Please refer to the EUT photos.

2.2. Maximum Conducted Output Power

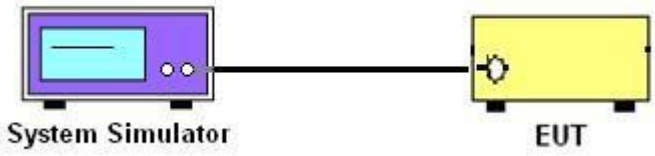
2.2.1. Limit of Peak Output Power

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.

2.2.2. Measuring Instruments

The measuring equipment is listed in the section 3 of this test report.

2.2.3. Test Setup



2.2.4. Test Procedures

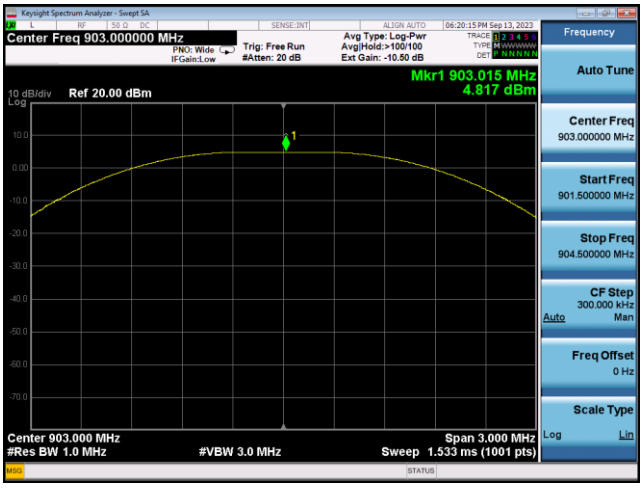
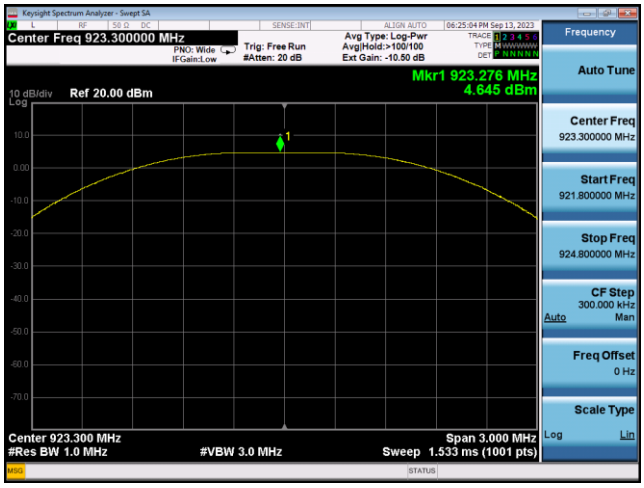
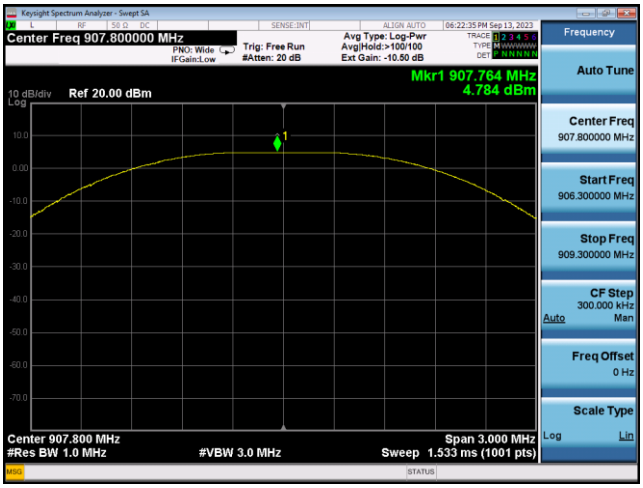
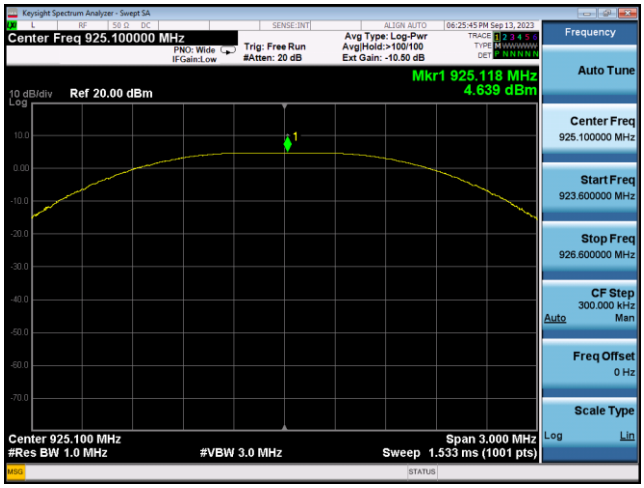
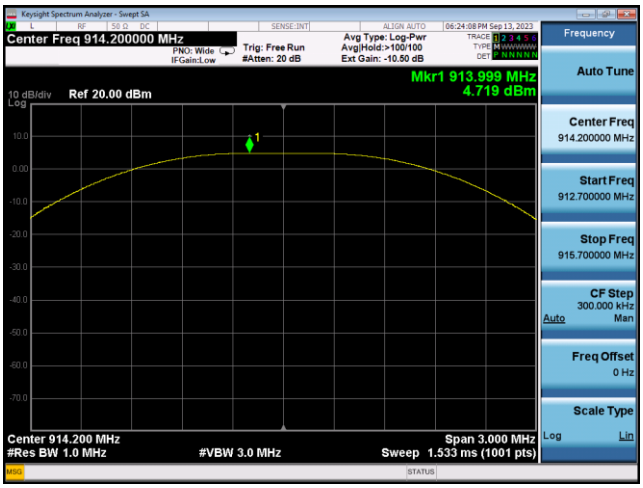
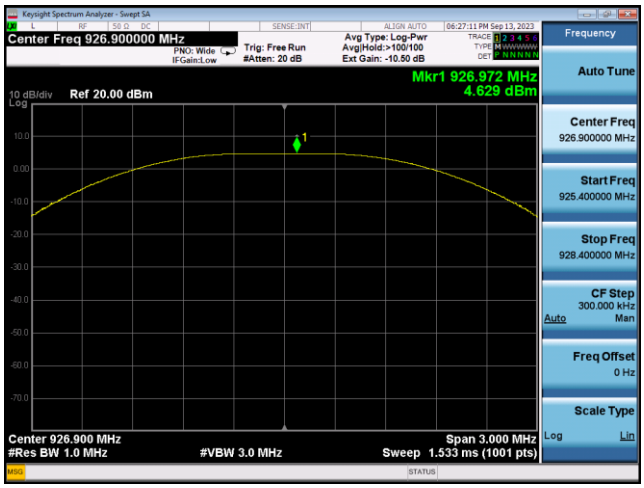
1. The testing follows the Measurement Procedure of ANSI C63.10-2013 Section 11.9.1.1.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings:

   RBW ≥ DTS bandwidth / VBW ≥ 3*RBW / Sweep time: Auto couple / Detector mode: Peak / Trace mode: Max hold / Allow trace to fully stabilize / Use peak marker function to determine the peak amplitude level.
5. Record the measurement results in the test report.

2.2.5. Test Result of Peak Output Power

LoRaWAN_903.0~914.2MHz			
Test Frequency	Conducted Power(dBm)	Limit(dBm)	Result
903.0	4.817	30	Pass
907.8	4.784		Pass
914.2	4.719		Pass

LoRaWAN_923.3~926.9MHz			
Test Frequency	Conducted Power(dBm)	Limit(dBm)	Result
923.3	4.645	30	Pass
925.1	4.639		Pass
926.9	4.629		Pass

Output Power: 903.0MHz	Output Power: 923.3MHz
	
Output Power: 907.8MHz	**Output Power: 925.1MHz**
	
Output Power: 914.2MHz	**Output Power: 926.9MHz**
	

2.3. 6dB and 99% Bandwidth

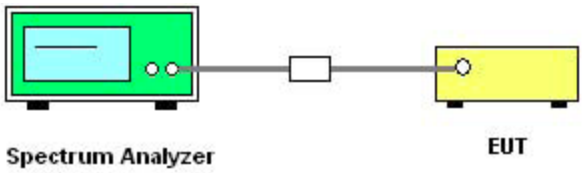
2.3.1. Limit of 6dB and 99% Bandwidth

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

2.3.2. Measuring Instruments

The measuring equipment is listed in the section 3 of this test report.

2.3.3. Test Setup



2.3.4. Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 Section 11.8.1 and 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the spectrum analyzer “Channel Bandwidth” function to easurement the 6dB EBW and 99% OBW.
5. For 6dB EBW Use the following spectrum analyzer settings:
   RBW: 100kHz / VBW: 300kHz / Detector: Peak / Trace mode: Max hold / Sweep time: Auto couple / Allow trace to fully stabilize.
6. For 99% OBW Use the following spectrum analyzer settings:
   Set RBW = 1% to 5% of the OBW, VBW ≥ 3 × RBW, Span = 1.5 times to 5.0 times the OBW.
7. Record the measurement results in the test report.

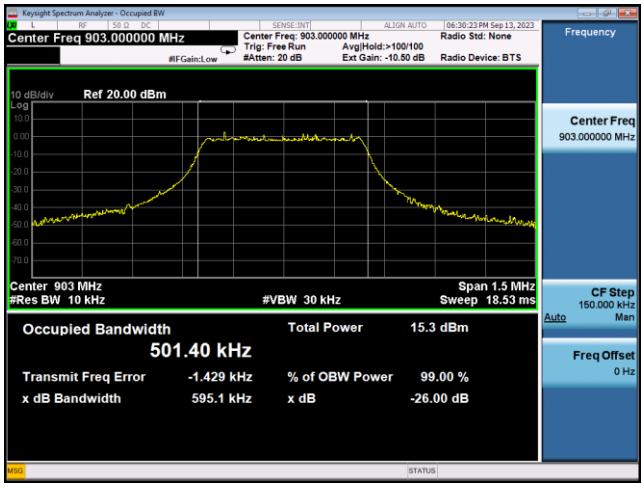
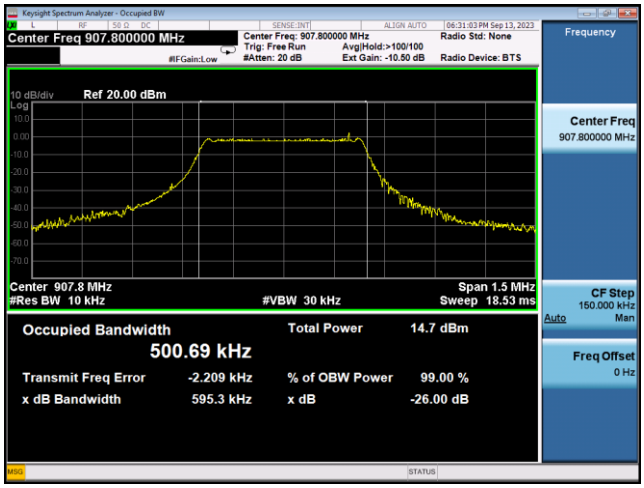
2.3.5. Test Results of 6dB and 99% Bandwidth

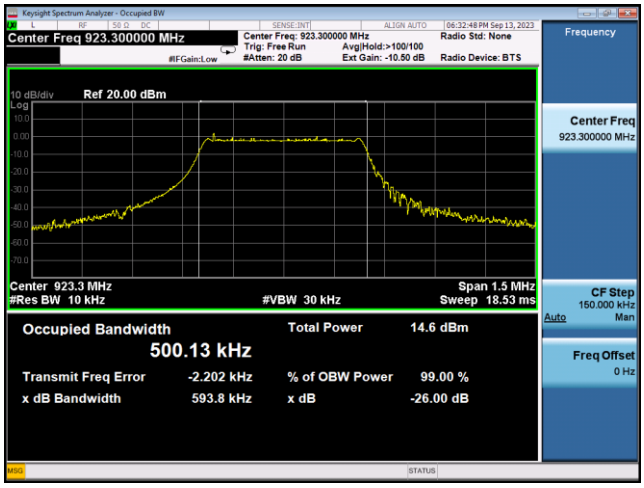
LoRaWAN_903.0~914.2MHz			
Test Frequency	6dB EBW(kHz)	Limit(dBm)	Result
903.0	629.4	≥ 500	Pass
907.8	631.9		Pass
914.2	627.5		Pass

LoRaWAN_903.0~914.2MHz			
Test Frequency	99% OBW(kHz)	Limit(dBm)	Result
903.0	501.40	N/A	Pass
907.8	500.69		Pass
914.2	501.35		Pass

LoRaWAN_923.3~926.9MHz			
Test Frequency	6dB EBW(kHz)	Limit(dBm)	Result
923.3	632.2	≥ 500	Pass
925.1	630.7		Pass
926.9	632.4		Pass

LoRaWAN_923.3~926.9MHz			
Test Frequency	99% OBW(kHz)	Limit(dBm)	Result
923.3	500.13	N/A	Pass
925.1	500.50		Pass
926.9	500.74		Pass

6dB EBW: 903.0MHz	99% OBW: 903.0MHz
	
6dB EBW: 907.8MHz	99% Bandwidth: 907.8MHz
	
6dB EBW: 914.2MHz	99% OBW: 914.2MHz
	

6dB EBW: 923.3MHz	99% OBW: 923.3MHz
	
6dB EBW: 925.1MHz	99% OBW: 925.1MHz
	
6dB EBW: 926.9MHz	99% OBW: 926.9MHz
	

2.4. Power spectral density (PSD)

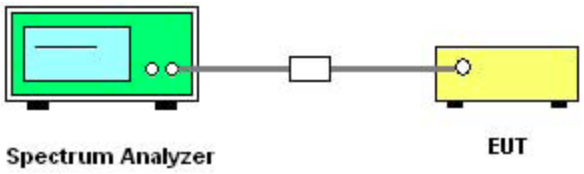
2.4.1. Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

2.4.2. Measuring Instruments

The measuring equipment is listed in the section 3 of this test report.

2.4.3. Test Setup



2.4.4. Test Procedures

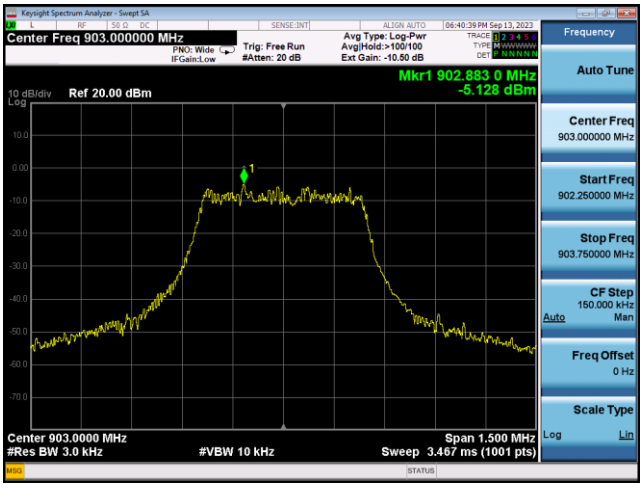
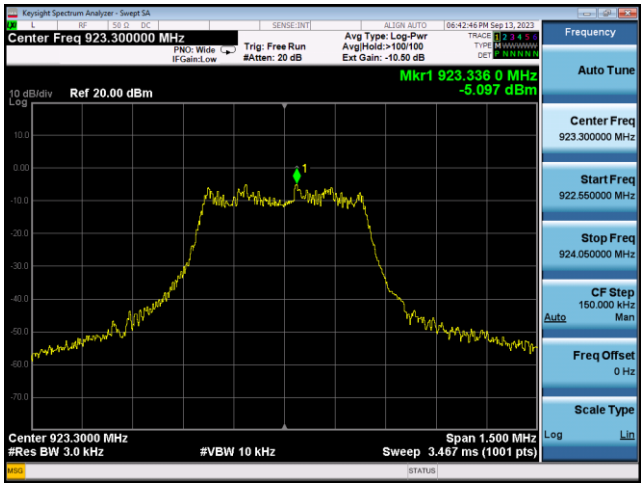
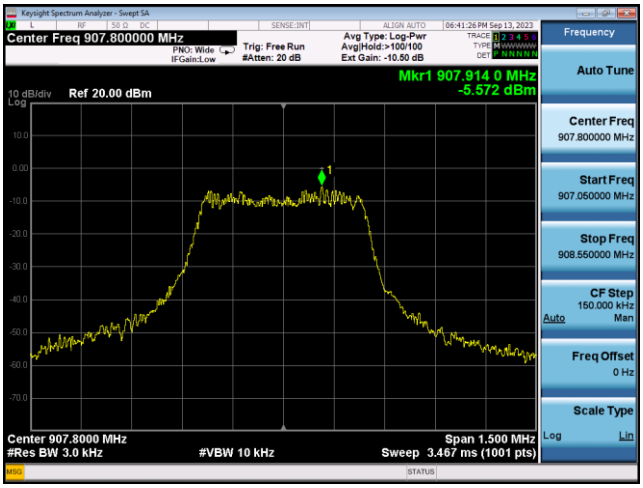
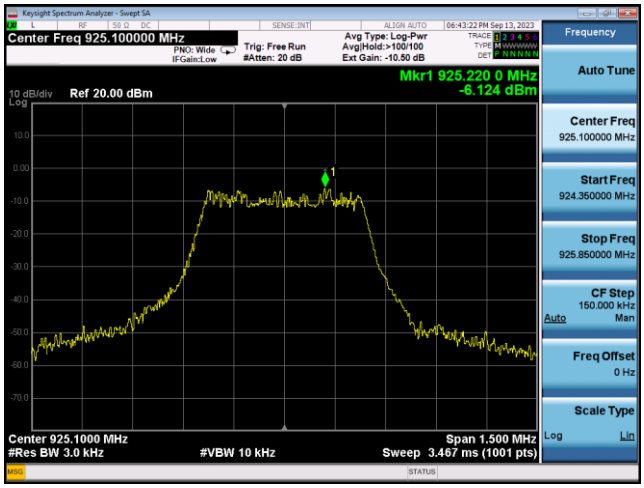
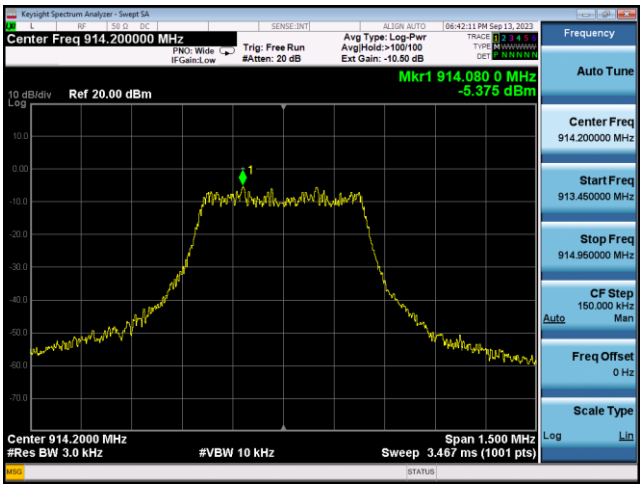
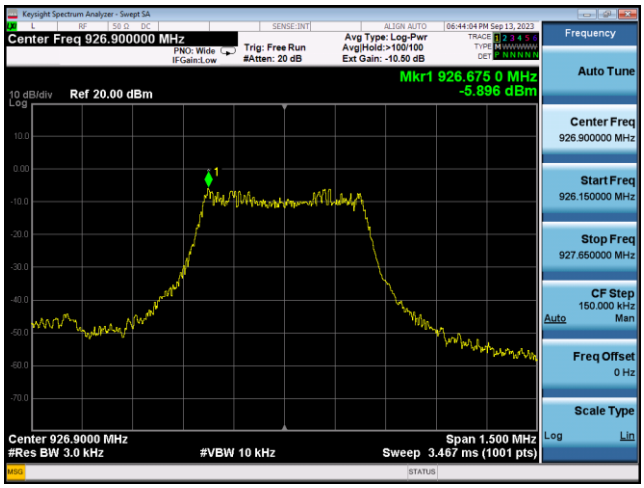
1. The testing follows the Measurement Procedure of ANSI C63.10-2013 Section 11.10.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings:

   Set instrument center frequency to DTS channel center frequency / Set the span to 1.5 times the DTS bandwidth / RBW: 3kHz / VBW: 10kHz / Detector: Peak / Sweep time: Auto couple / Trace mode: Max hold / Allow trace to fully stabilize / Use the peak marker function to determine the maximum power level.
5. Record the measurement results in the test report.

2.4.5. Test Results of Power spectral density

LoRaWAN_903.0~914.2MHz			
Test Frequency	PSD(dBm/3kHz)	Limit(dBm/3kHz)	Result
903.0	-5.128	8	Pass
907.8	-5.572		Pass
914.2	-5.375		Pass

LoRaWAN_923.3~926.9MHz			
Test Frequency	PSD(dBm/3kHz)	Limit(dBm/3kHz)	Result
923.3	-5.097	8	Pass
925.1	-6.124		Pass
926.9	-5.896		Pass

Power spectral density: 903.0MHz	Power spectral density: 923.3MHz
	
Power spectral density: 907.8MHz	**Power spectral density: 925.1MHz**
	
Power spectral density: 914.2MHz	**Power spectral density: 926.9MHz**
	

2.5. Conducted Band Edges and Spurious Emissions

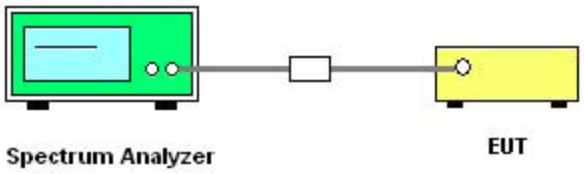
2.5.1. Limit of Conducted Band Edges and Spurious Emissions

In any 100 kHz bandwidth outside the frequency band in which the intentional radiator is perating, 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.

2.5.2. Measuring Instruments

The measuring equipment is listed in the section 3 of this test report.

2.5.3. Test Setup



2.5.4. Test Procedure

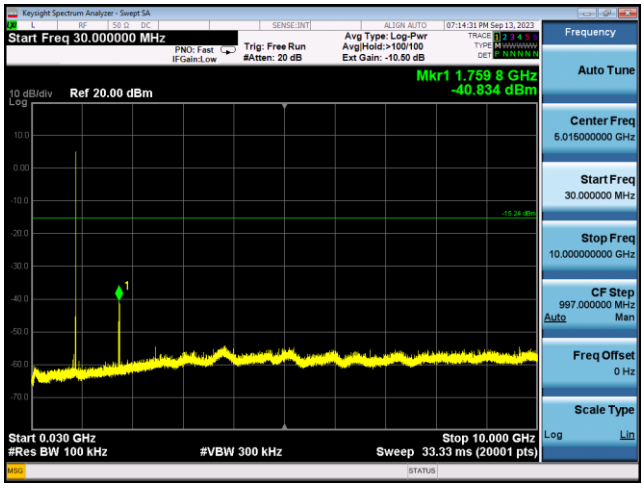
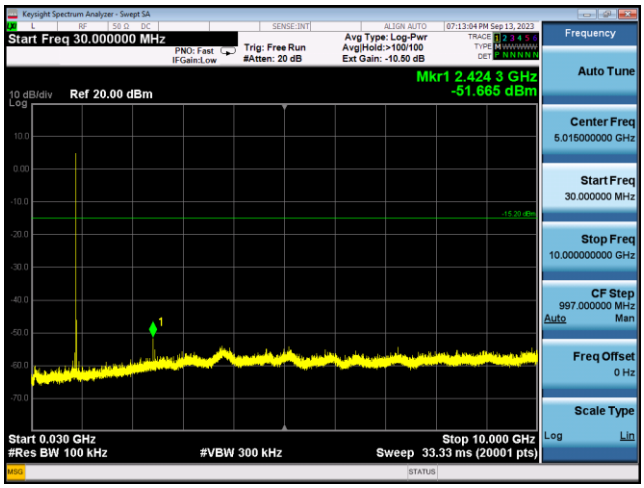
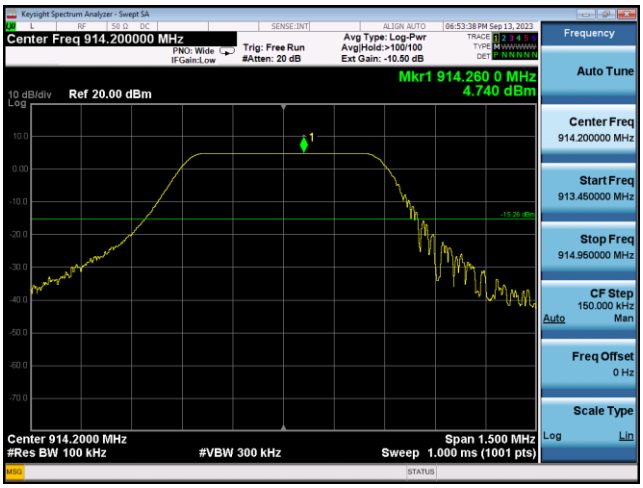
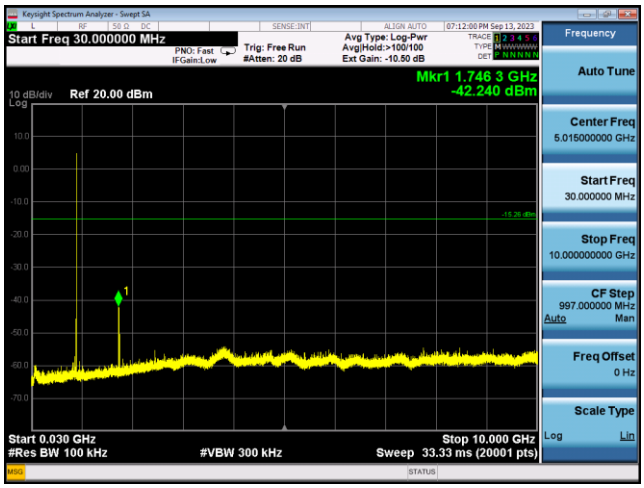
1. The testing follows the Measurement Procedure of ANSI C63.10-2013 Section 11.11 and 11.13.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings:

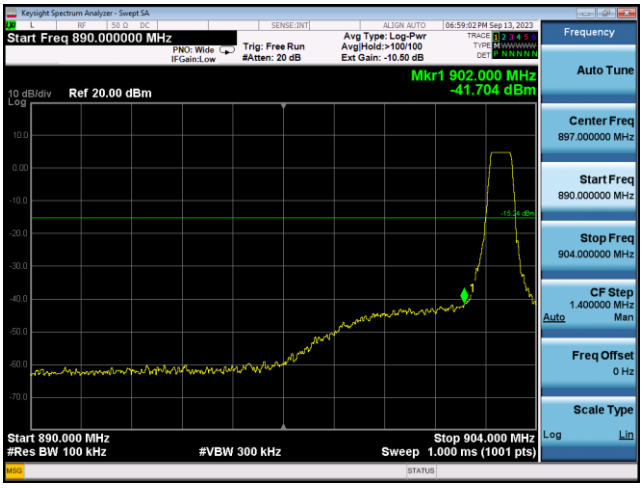
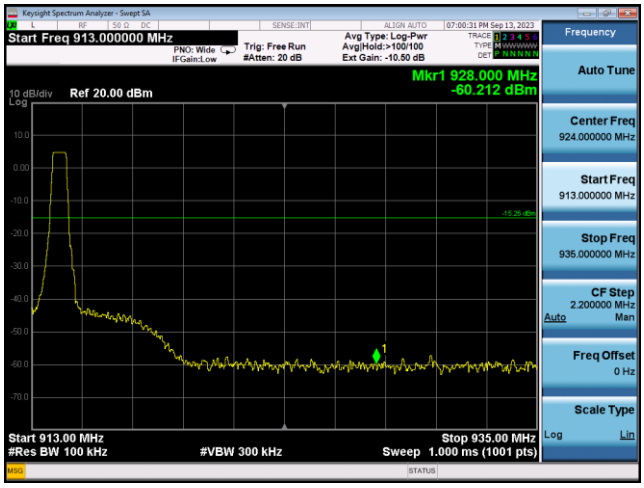
   Reference level measurement: Set spectrum analyzer center frequency to DTS channel center frequency / Set the span to ≥1.5 times the DTS bandwidth / RBW: 100kHz / VBW: 300kHz / Detector: Peak / Sweep time: Auto couple / Trace mode: Max hold / Allow trace to fully stabilize / Use the peak marker function to determine the maximum PSD level and attenuate it by 20dB.

   Emission level measurement: Set the center frequency and span to encompass frequency range to be measured / RBW: 100kHz / VBW: 300kHz / Detector: Peak / Sweep time: Auto couple / Trace mode: Max hold / Allow trace to fully stabilize / Use the peak marker function to determine the maximum amplitude level.
5. Record the measurement results in the test report.

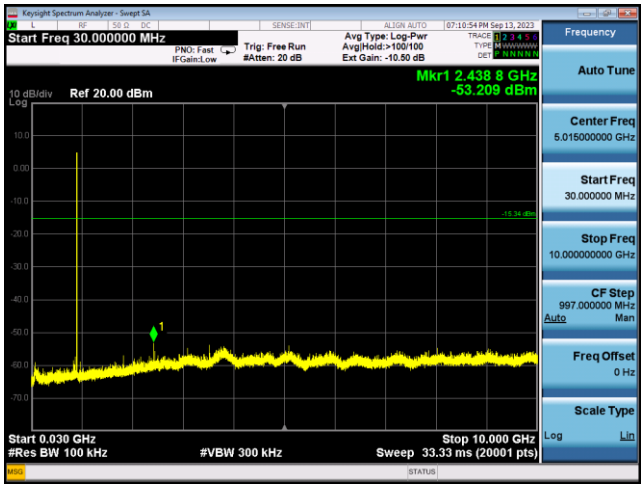
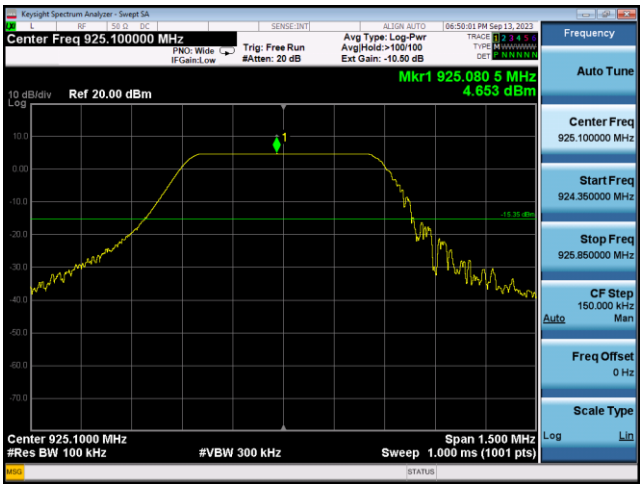
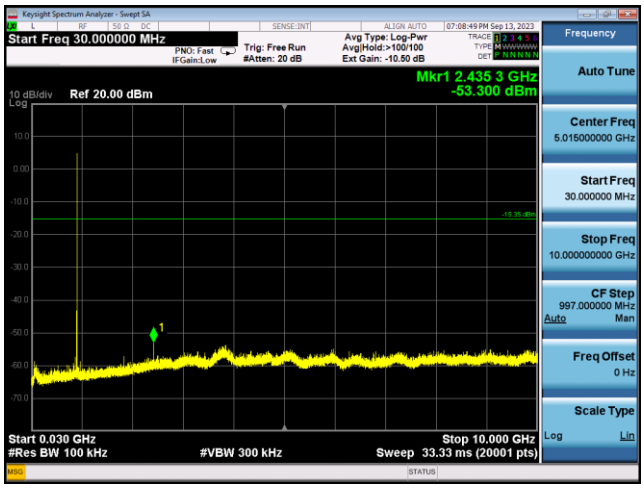
2.5.5. Test Results of Conducted Band Edges and Spurious Emissions

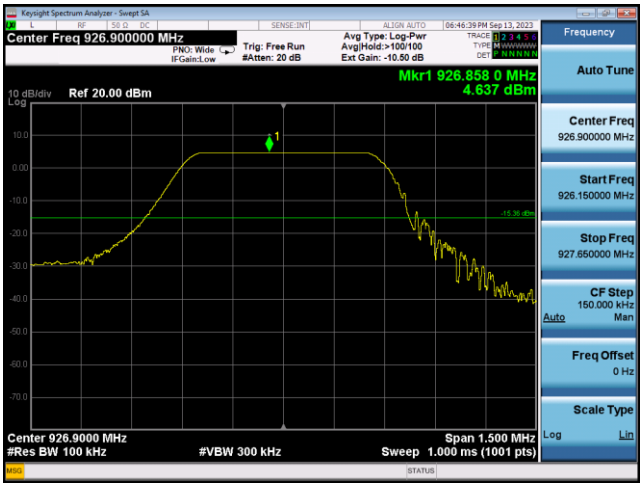
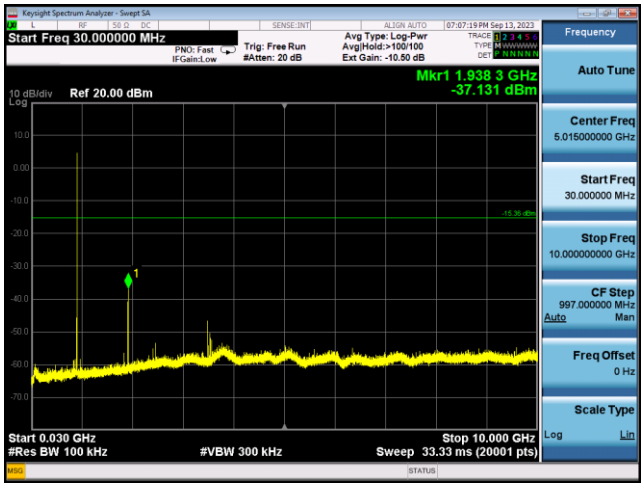
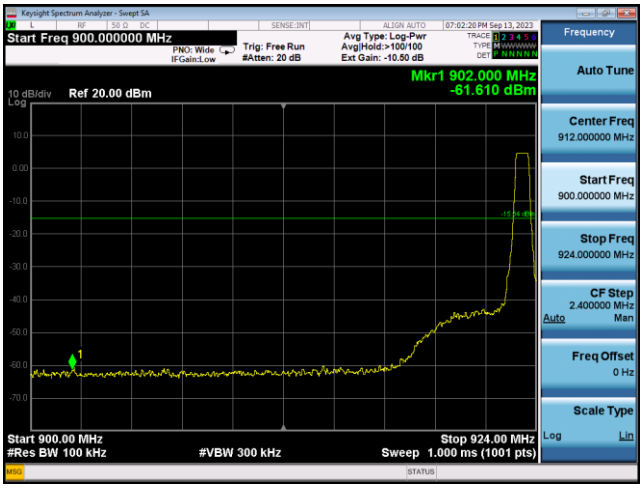
LoRaWAN_903.0~914.2MHz:

Referecy Level: 903.0MHz	Conducted Spurious Emission: 903.0MHz
	
Referecy Level: 907.8MHz	Conducted Spurious Emission: 907.8MHz
	
Referecy Level: 914.2MHz	Conducted Spurious Emission: 914.2MHz
	

Conducted Band Edge: 903.0MHz	Conducted Band Edge: 914.2MHz
	

LoRaWAN_923.3~926.9MHz:

Referecy Level: 923.3MHz	Conducted Spurious Emission: 923.3MHz
	
Referecy Level: 925.1MHz	**Conducted Spurious Emission: 925.1MHz**
	

Referecy Level: 926.9MHz	Conducted Spurious Emission: 926.9MHz
	
Conducted Band Edge: 923.3MHz	**Conducted Band Edge: 926.9MHz**
	

2.6. Radiated Band Edge and Spurious Emission

2.6.1. Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the frequency band in which the 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. If the transmitter uses an RMS average conducted power limit, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the estricted bands, as defi ned in §15.205(a), must also comply with the radiated emission limits specifi ed in §15.209(a).

§15.209(a) Radiated emission limits:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)
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

Restricted bands of operation refer to §15.205 (a):

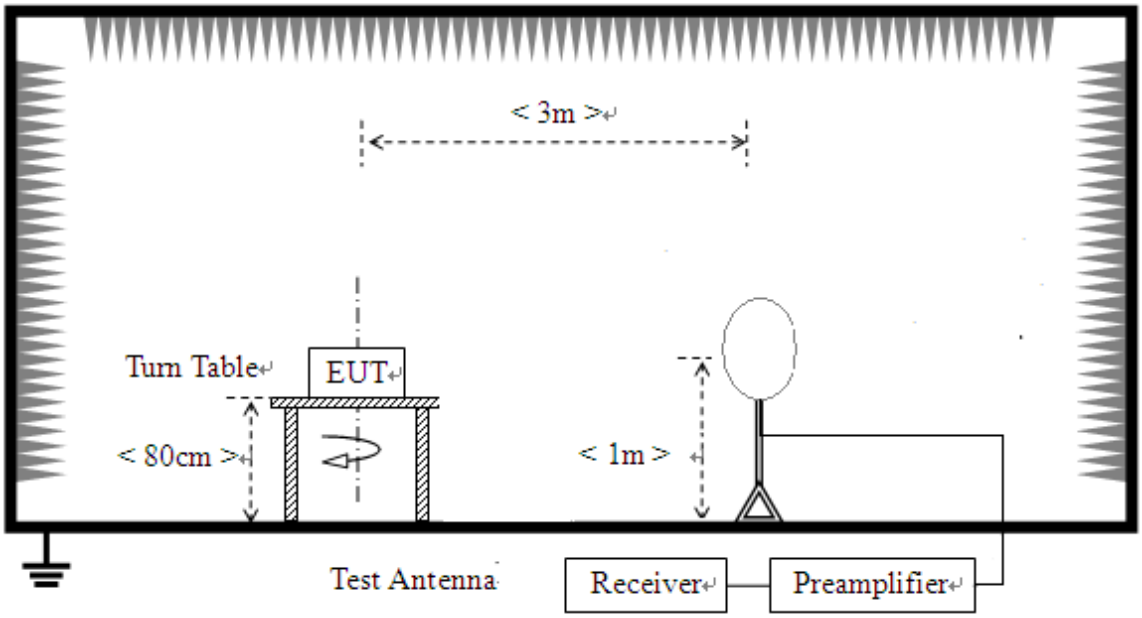
MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	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	/	/	/
Note: [1]Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz. [2]Above 38.6.			

2.6.2. Measuring Instruments

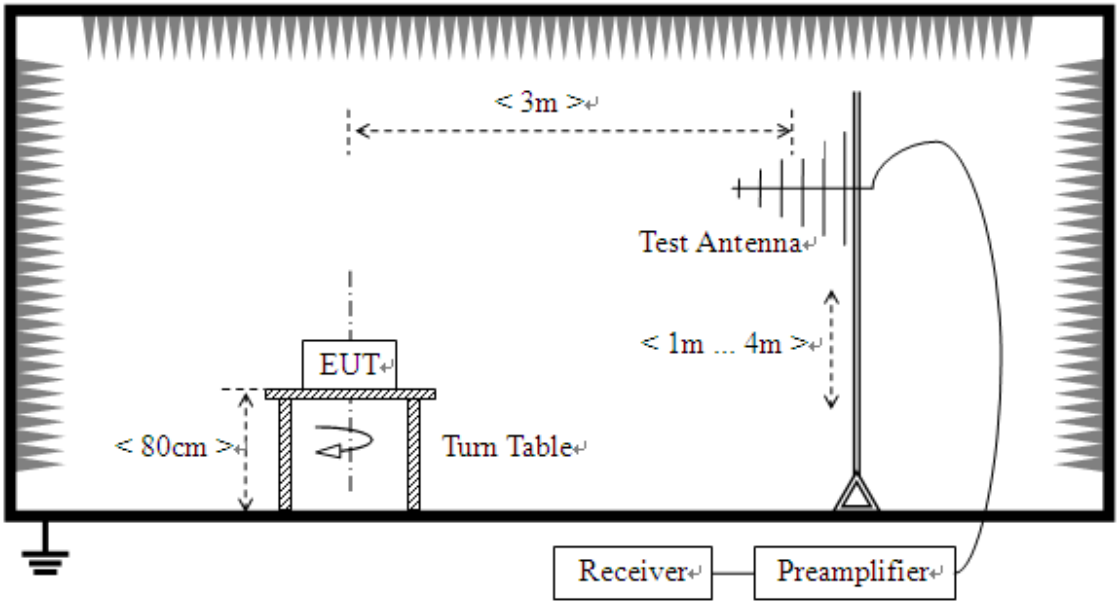
The measuring equipment is listed in the section 3 of this test report.

2.6.3. Test Setup

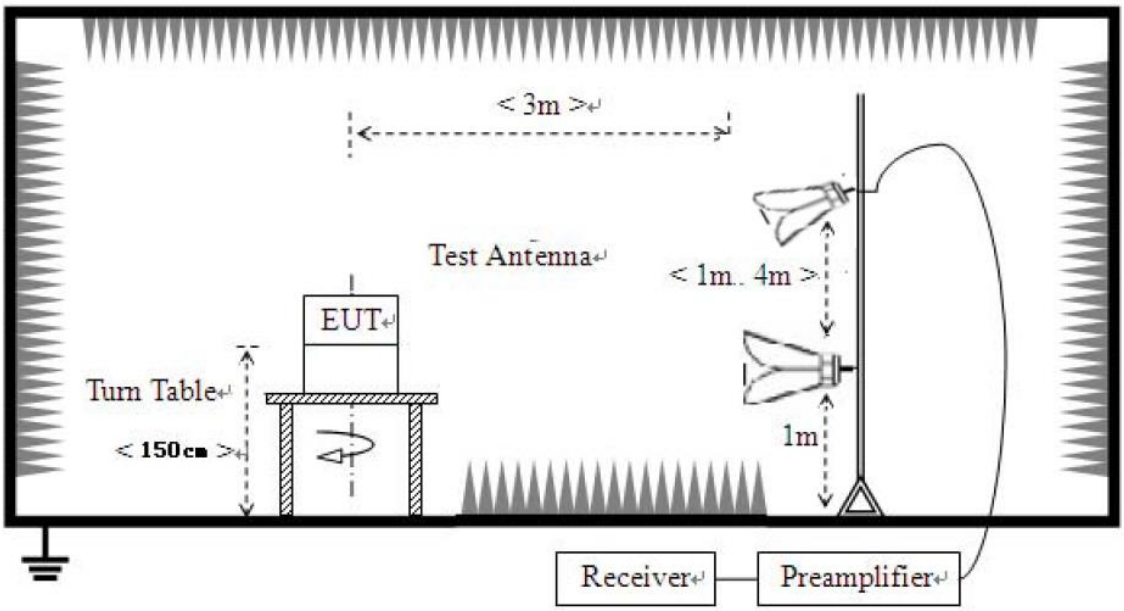
For radiated emissions from 9 kHz to 30 MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



2.6.4. Test Procedures

1. The EUT was placed on the top of a rotating table 0.8m for below 1GHz and 1.5m for above 1GHz above the ground at a 3 meters semi-anechoic chamber.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on thetop of a variable height antenna tower.
3. Height of receiving antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported.Otherwise the emissions would be re-tested one by one using peak, quasi-peak or average method as specified and then

reported in a data sheet.

7. For the radiated emission test above 1GHz:

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. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz for Peak detection at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T(Duty cycle < 98%) or 10Hz(Duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.
4. All radiated emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

2.6.5. Test Results of Radiated Band Edge and Spurious Emission

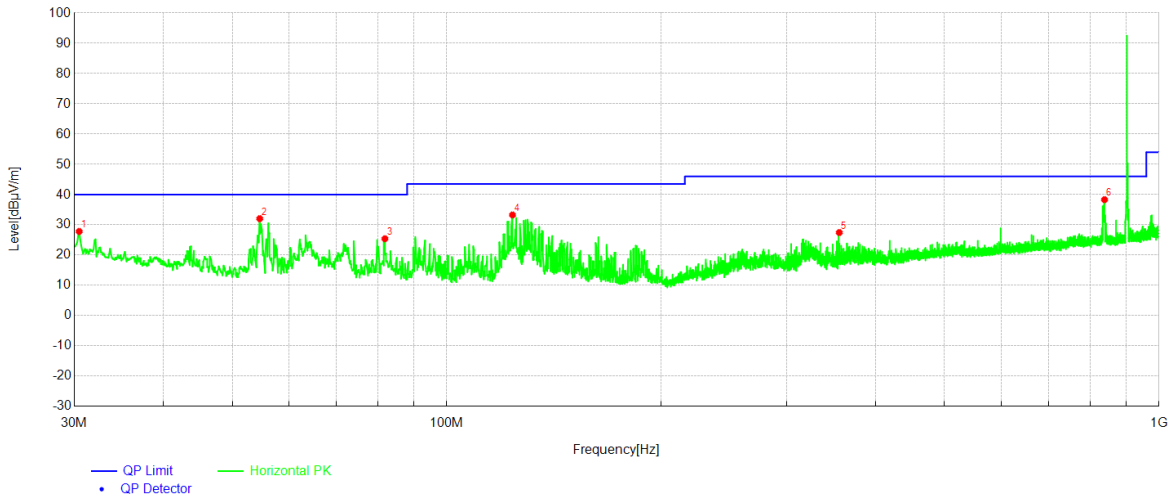
Note 1: For 9 kHz to 30MHz, The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Note 2: For 30MHz to 1GHz, All of the EUT Configure mode were tested and found 903.0MHz channel is the worst mode, the worst case is recorded in this report.

Note 3: For 1GHz to 10GHz, All of the EUT Configure mode were tested and found 903.0MHz and 926.9MHz channel is the worst mode, the worst case is recorded in this report.

Note 4: Antenna height and turntable angle are the worst positions, the worst case is recorded in this report.

For 30MHz to 1000MHz

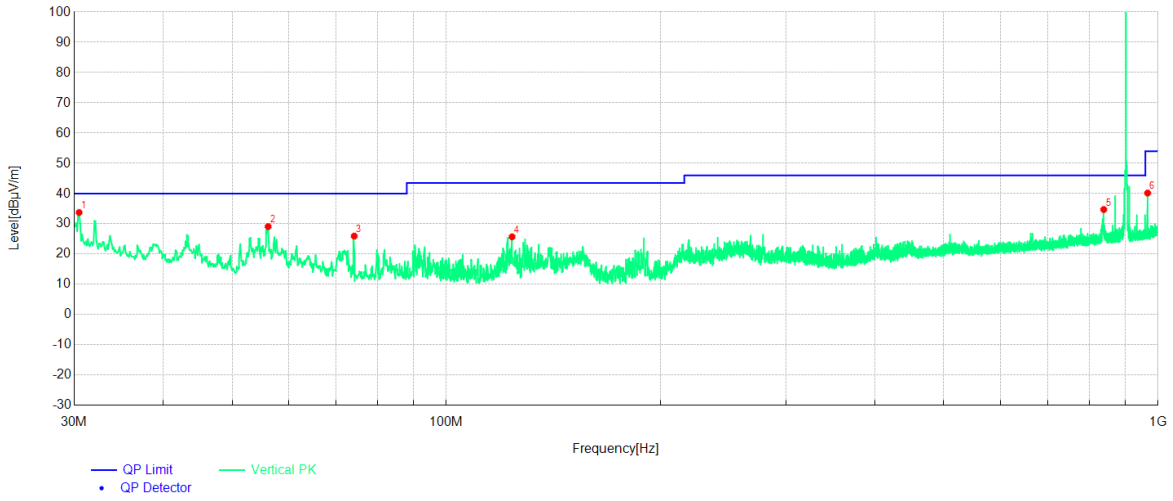


NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Height [cm]	Angle [°]	Polarity
1	30.49	27.83	19.04	40.00	12.17	120	65	Horizontal
2	54.64	32.06	8.42	40.00	7.94	120	250	Horizontal
3	81.90	25.43	9.99	40.00	14.57	120	28	Horizontal
4	123.71	33.29	10.98	43.50	10.21	120	356	Horizontal
5	355.76	27.47	15.03	46.00	18.53	120	266	Horizontal
6	838.58	38.33	24.05	46.00	7.67	120	273	Horizontal

Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Height [cm]	Angle [°]	Polarity
1	30.49	33.77	19.04	40.00	6.23	120	73	Vertical
2	56.19	29.11	7.75	40.00	10.89	120	306	Vertical
3	74.24	25.96	8.80	40.00	14.04	120	175	Vertical
4	123.71	25.73	10.98	43.50	17.77	120	149	Vertical
5	838.96	34.75	24.06	46.00	11.25	120	302	Vertical
6	966.82	40.21	25.45	54.00	13.79	120	257	Vertical

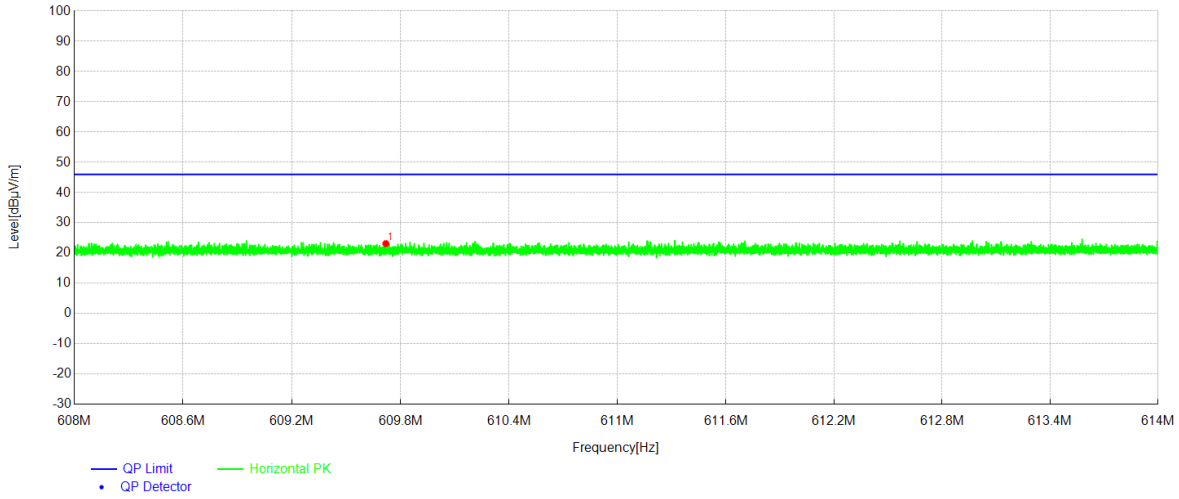
Test Result: Pass

Remark:

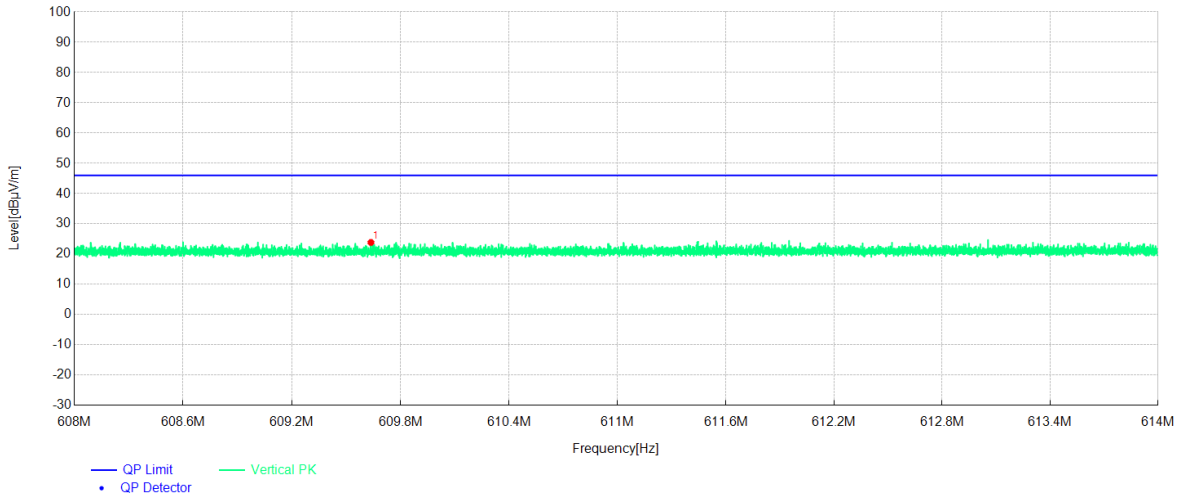
1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

Restricted-band band-edge: 608MHz~614MHz

LoRa_903.0MHz: Horizontal



LoRa_903.0MHz: Vertical



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Height [cm]	Angle [°]	Polarity
1	609.72	23.15	20.70	46.00	22.85	110	50	Horizontal
2	609.64	23.87	20.70	46.00	22.13	110	130	Vertical

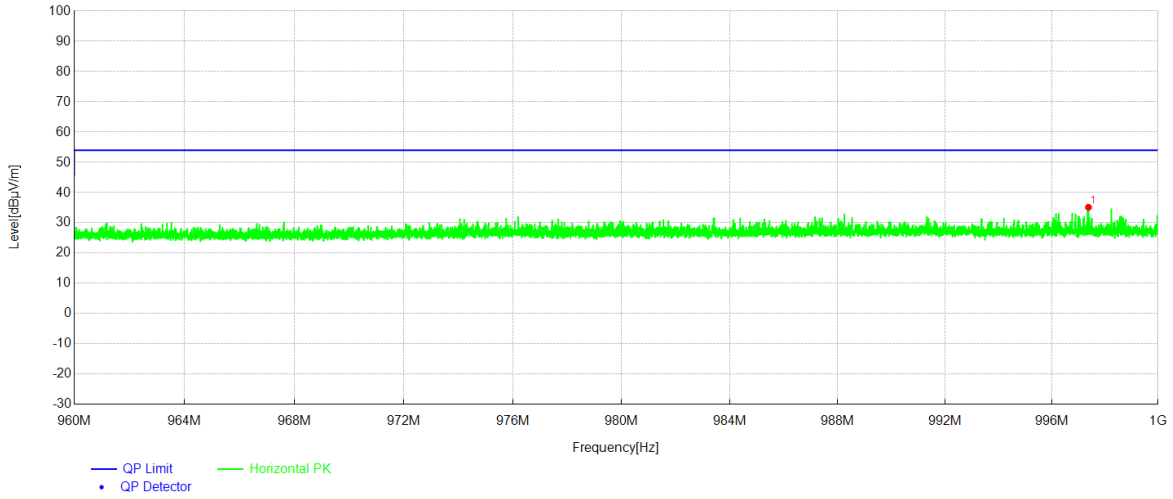
Test Result: Pass

Remark:

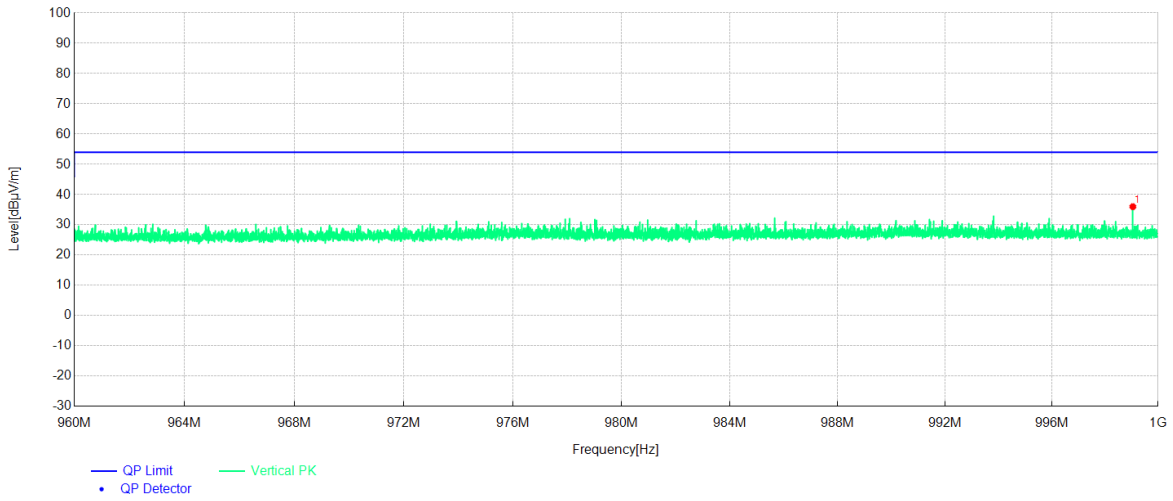
1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

Restricted-band band-edge: 960MHz~1000MHz

LoRa_926.9MHz: Horizontal



LoRa_926.9MHz: Vertical



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Height [cm]	Angle [°]	Polarity
1	997.38	35.16	25.71	54.00	18.84	100	240	Horizontal
2	999.05	36.02	25.69	54.00	17.98	100	30	Vertical

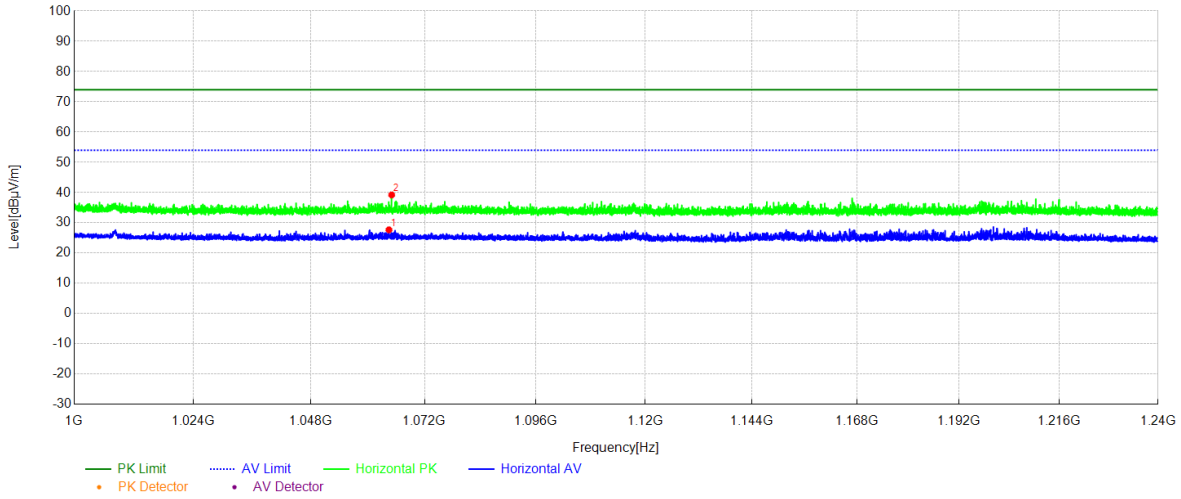
Test Result: Pass

Remark:

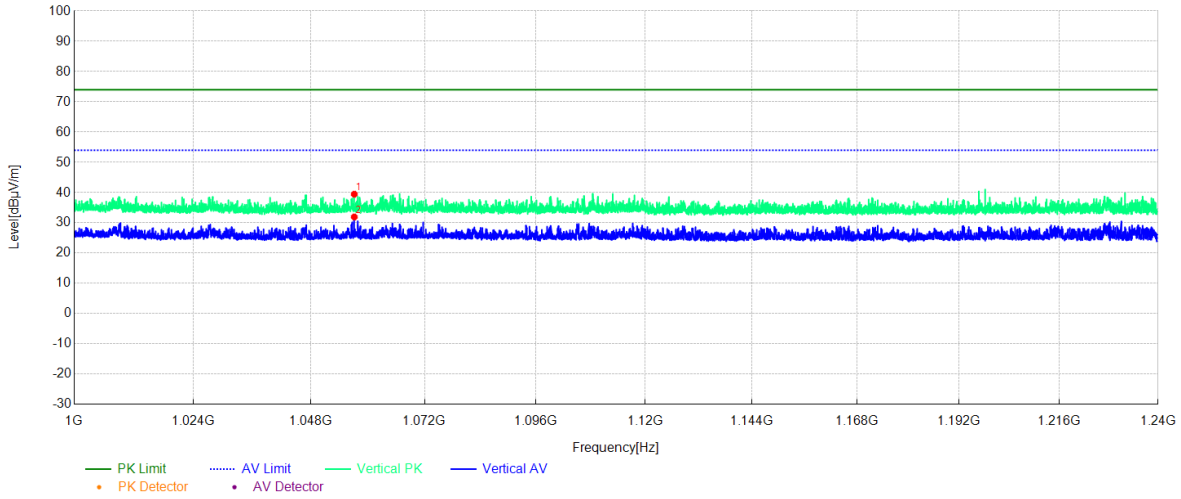
1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

Restricted-band band-edge: 1000MHz~1240MHz

LoRa_926.9MHz: Horizontal



LoRa_926.9MHz: Vertical



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Trace	Height [cm]	Angle [°]	Polarity
1	1064.47	27.71	-12.80	54.00	26.29	AV	150	250	Horizontal
2	1065.05	39.24	-12.81	74.00	34.76	PK	150	180	Horizontal
3	1057.17	39.49	-12.74	74.00	34.51	PK	140	173	Vertical
4	1057.17	31.96	-12.74	54.00	22.04	AV	140	181	Vertical

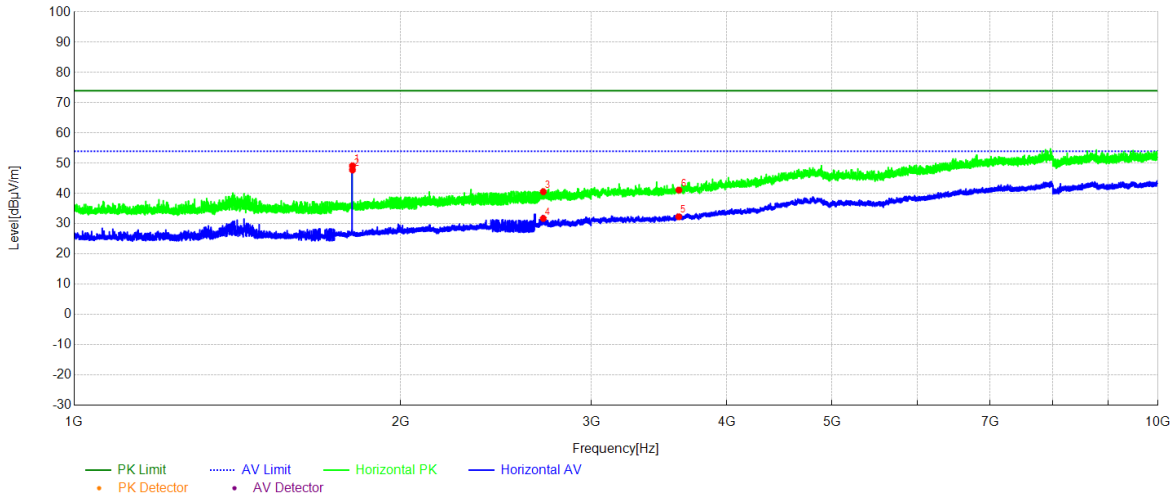
Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

For 1GHz to 10GHz:

LoRa_903.0MHz



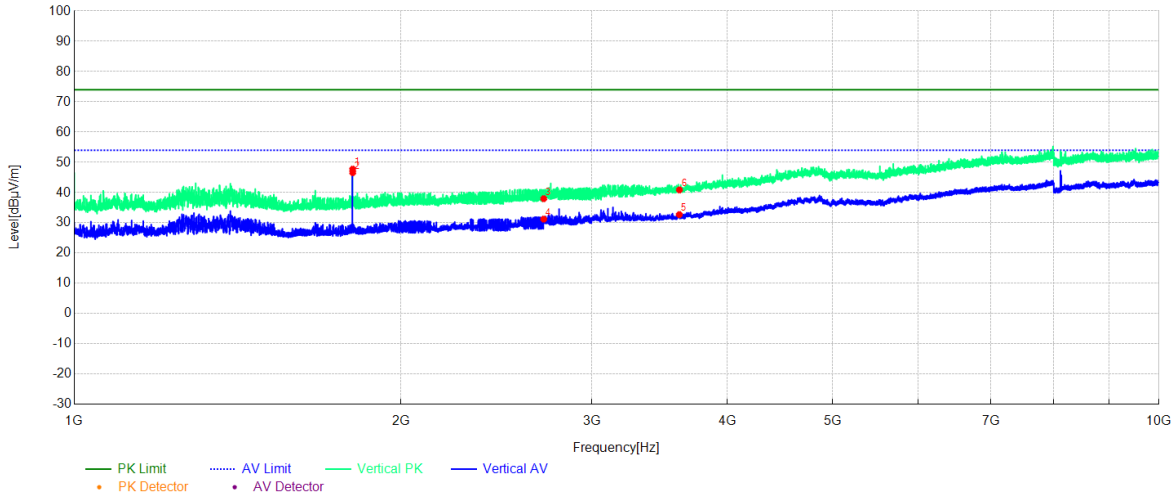
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Trace	Height [cm]	Angle [°]	Polarity
1	1806.2	49.19	-11.43	74.00	24.81	PK	160	108	Horizontal
2	1806.2	47.81	-11.43	54.00	6.19	AV	160	108	Horizontal
3	2709.1	40.63	-7.97	74.00	33.37	PK	160	92	Horizontal
4	2709.1	31.79	-7.97	54.00	22.21	AV	160	92	Horizontal
5	3612.5	32.35	-5.13	54.00	21.65	AV	160	277	Horizontal
6	3613.2	41.17	-5.13	74.00	32.83	PK	160	277	Horizontal

Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

LoRa_903.0MHz



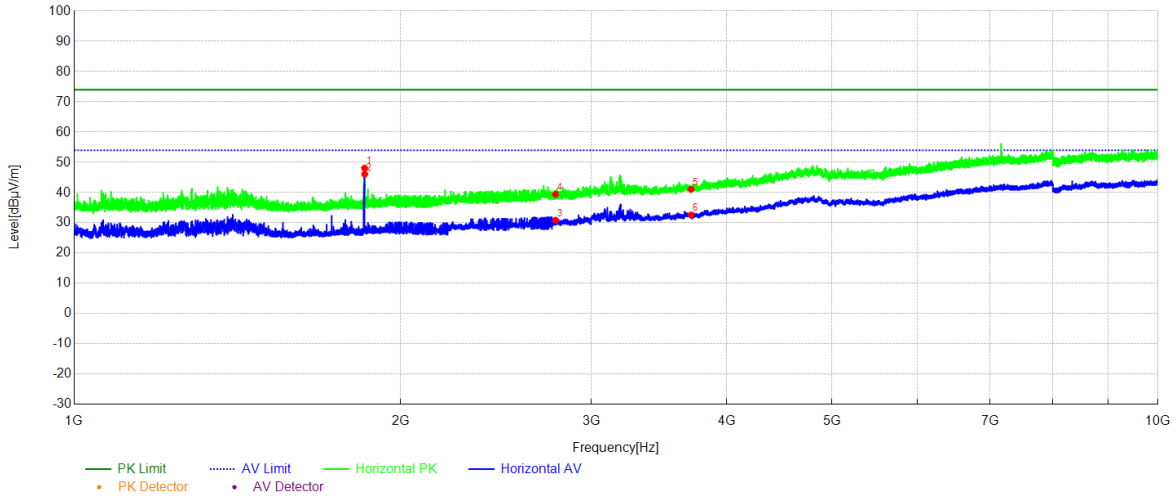
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Trace	Height [cm]	Angle [°]	Polarity
1	1805.8	47.76	-11.42	74.00	26.24	PK	150	5	Vertical
2	1806.0	46.59	-11.42	54.00	7.41	AV	150	5	Vertical
3	2709.1	38.00	-7.97	74.00	33.99	PK	150	242	Vertical
4	2709.1	31.25	-7.97	54.00	22.02	AV	150	265	Vertical
5	3612.5	32.75	-5.13	54.00	21.25	AV	150	94	Vertical
6	3613.2	40.91	-5.13	74.00	33.09	PK	150	306	Vertical

Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

LoRa_926.9MHz



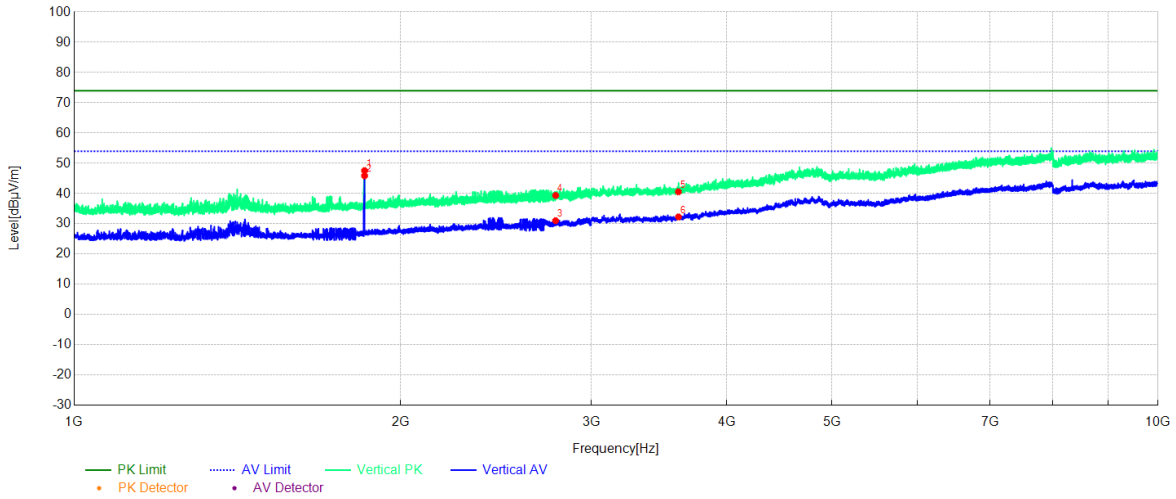
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Trace	Height [cm]	Angle [°]	Polarity
1	1853.2	48.08	-11.28	74.00	25.92	PK	160	0	Horizontal
2	1853.6	46.09	-11.28	54.00	7.91	AV	160	0	Horizontal
3	2780.7	30.84	-7.83	54.00	23.16	AV	160	276	Horizontal
4	2780.7	39.44	-7.83	74.00	34.56	PK	160	223	Horizontal
5	3707.7	41.09	-4.72	74.00	32.91	PK	160	50	Horizontal
6	3707.7	32.63	-4.72	54.00	21.37	AV	160	305	Horizontal

Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

LoRa_926.9MHz



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dBµV/m]	Trace	Height [cm]	Angle [°]	Polarity
1	1853.2	47.60	-11.28	74.00	26.40	PK	160	236	Vertical
2	1853.2	45.91	-11.28	54.00	8.09	AV	160	236	Vertical
3	2780.7	31.06	-7.83	54.00	22.94	AV	160	101	Vertical
4	2780.9	39.40	-7.83	74.00	34.60	PK	160	63	Vertical
5	3609.7	40.62	-5.15	74.00	33.38	PK	160	17	Vertical
6	3610.4	32.31	-5.15	54.00	21.69	AV	160	299	Vertical

Test Result: Pass

Remark:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m).
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB).
3. Margin value = Limit value – Emission Level.
4. The other emission levels were very low against the limit.

2.7. AC Power Line Conducted Emission

2.7.1. Limit of AC Power Line Conducted Emission

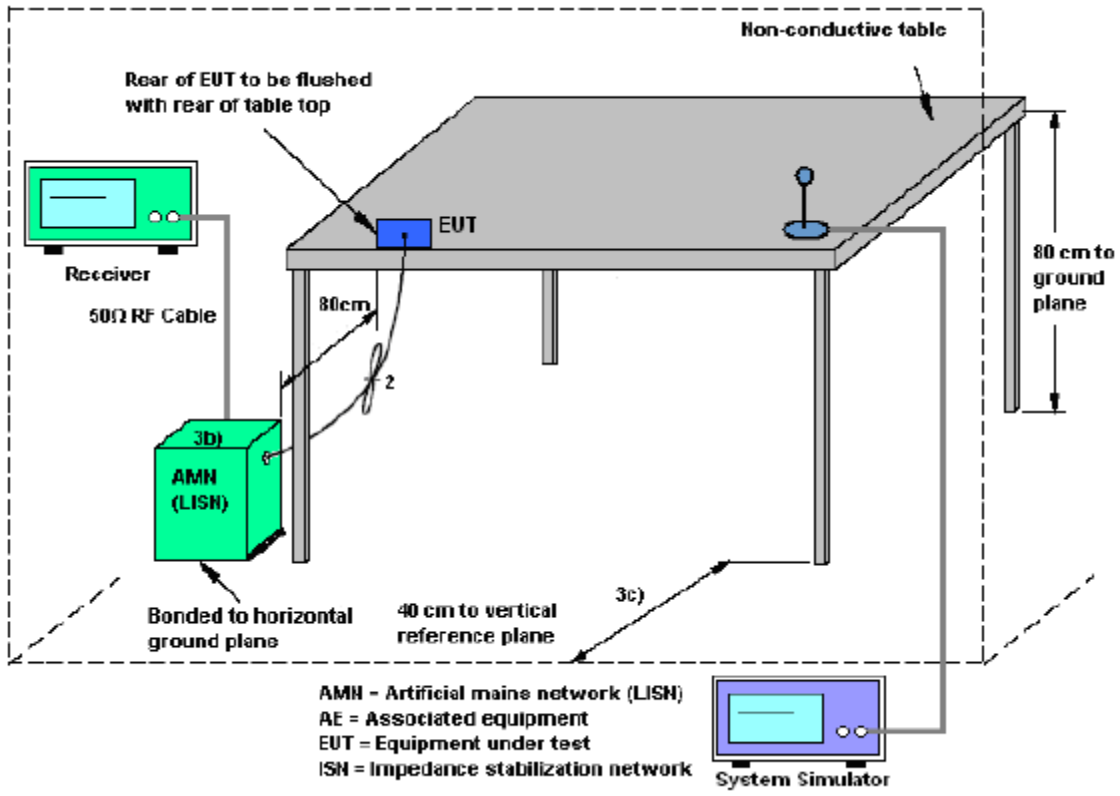
For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency range (MHz)	Conducted Limit (dBμV)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

2.7.2. Measuring Instruments

The measuring equipment is listed in the section 3 of this test report.

2.7.3. Test Setup



2.7.4. Test Procedures

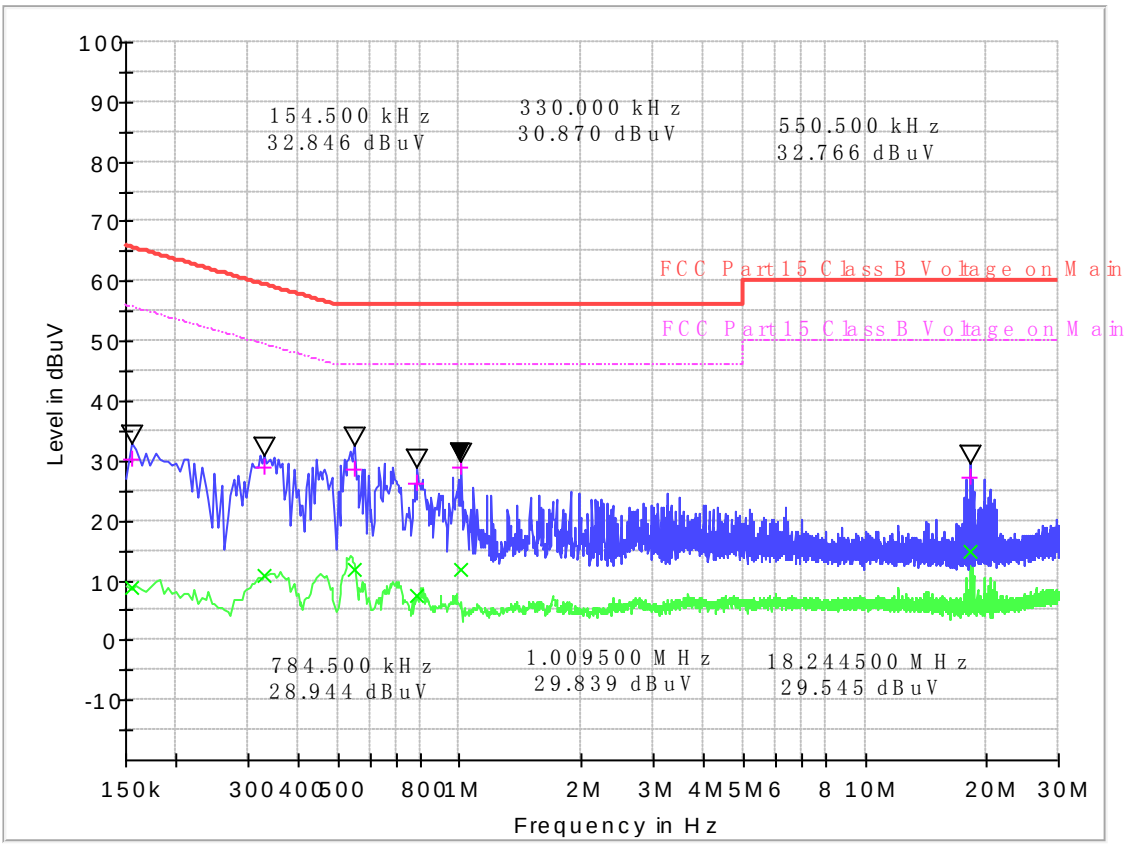
1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 micrometry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

2.7.5. Test Results of Conducted Emission

NOTE 1: The EUT configuration of the emission tests is LoRa Link + Charging from Adapter.

NOTE 2: All of the EUT Configure mode were tested and found LoRa 903MHz channel is the worst mode, the worst case is recorded in this report.

Line Phase

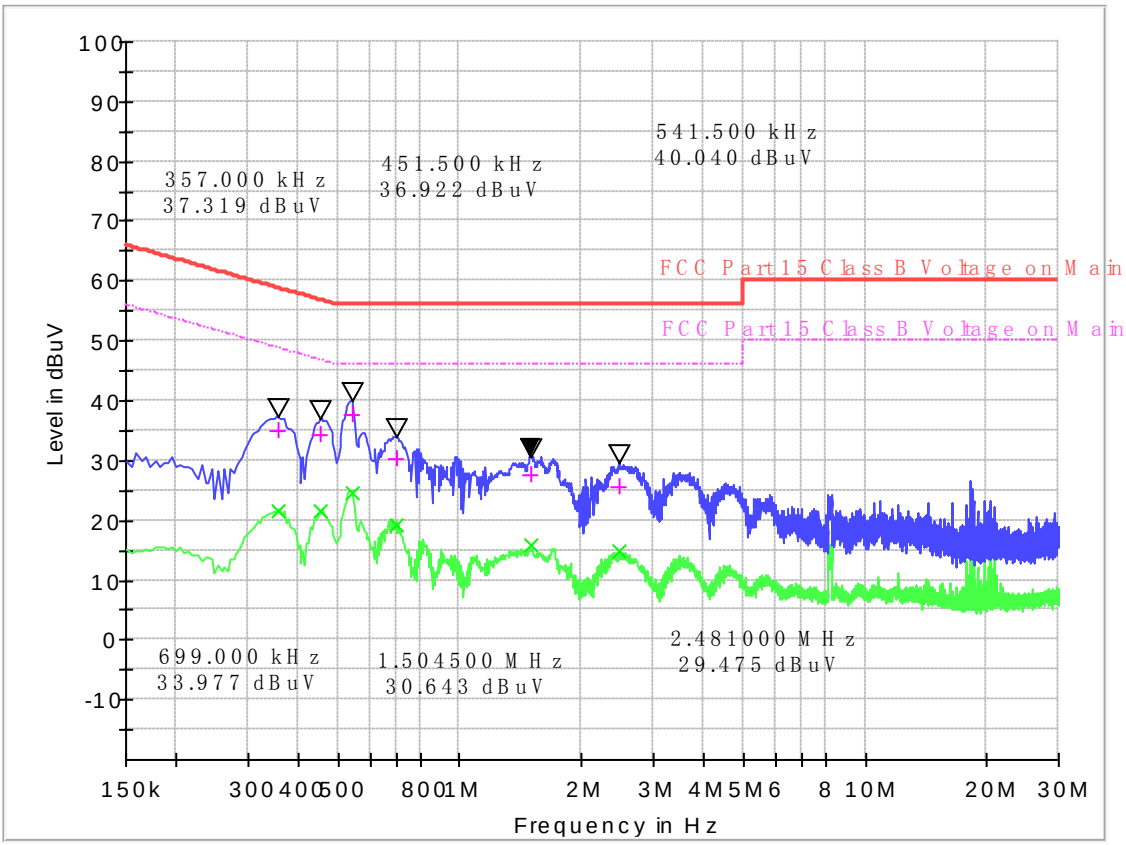


Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Corr.Factor (dB)	Margin - QPK	Limit - QPK (dB µ V)	Margin - AV (dB)	Limit - AV (dBµV)
0.154500	30.22	8.86	10.4	35.53	65.8	46.89	55.8
0.330000	29.10	10.72	10.5	30.35	59.5	38.73	49.5
0.550500	28.61	12.01	10.4	27.39	56.0	33.99	46.0
0.784500	26.10	7.37	10.4	29.90	56.0	38.63	46.0
1.009500	28.96	11.99	10.4	27.04	56.0	34.01	46.0
18.244500	27.32	14.76	11.1	32.68	60.0	35.24	50.0

Test Result : Pass

Note: Final Level = Receiver Read level + Correction factor.

Neutral Phase



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Corr.Factor (dB)	Margin - QPK	Limit - QPK (dB µ V)	Margin - AV (dB)	Limit - AV (dBµV)
0.357000	34.85	21.49	10.6	23.95	58.8	27.31	48.8
0.451500	34.32	21.40	10.5	22.53	56.8	25.45	46.8
0.541500	37.59	24.70	10.5	18.41	56.0	21.30	46.0
0.699000	30.38	19.09	10.6	25.62	56.0	26.91	46.0
1.504500	27.46	15.93	10.5	28.54	56.0	30.07	46.0
2.481000	25.66	14.93	10.5	30.34	56.0	31.07	46.0

Test Result : Pass

Note: Final Level = Receiver Read level + Correction factor.

3. List of measuring equipment

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	EMI Test Receiver	ROHDE&SCHWARZ	ESW26	A180502935	2023.06.08	2024.06.07
2	5M Anechoic Chamber	Albatross	SAC-5MAC 12.8x6.8x6.4m	A0304210	2023.08.01	2026.07.31
3	Loop Antenna	Schwarz beck	HFH2-Z2	A0304220	2022.05.02	2025.05.01
4	Broadband antenna (30MHz~1GHz)	R&S	HL562	A0304224	2023.06.08	2026.06.07
5	EMI Horn Ant. (1-18G)	ETC	1209	A150402241	2021.01.02	2024.01.01
6	Horn antenna (18GHz~26.5GHz)	AR	AT4510	A0804450	2023.06.01	2026.05.31
7	Amplifier 30M~1GHz	MILMEGA	80RF1000-10004	A140101634	2022.12.13	2023.12.12
8	Amplifier 1G~18GHz	MILMEGA	AS0104R-800/400	A160302517	2022.12.13	2023.12.12
9	Spectrum Analyzer	KEYSIGHT	N9030A	A160702554	2023.02.20	2024.02.19
10	Test Receiver	KEYSIGHT	N9038A	A141202036	2023.06.12	2024.06.11
11	LISN	ROHDE&SCHWARZ	ENV216	A140701847	2023.08.21	2024.08.20
12	Cable	MATCHING PAD	W7	/	2023.08.21	2024.08.20

4. Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence . The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of AC Power Line Conducted Emission Measurement (150KHz~30MHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	2.8dB

Uncertainty of Radiated Emission Measurement (9KHz~30MHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	3.5dB

Uncertainty of Radiated Emission Measurement (30MHz~1GHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	3.91dB

Uncertainty of Radiated Emission Measurement (1GHz~18GHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	4.5dB

Uncertainty of Radiated Emission Measurement (18GHz~40GHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	4.9dB

Uncertainty of RF Conducted Measurement (9KHz~40GHz)

Measuring Uncertainty for a level of confidence of 95%(U=2Uc(y))	1.3dB

END OF REPORT