FCC Test Report

Report No.:	2405X62415EB
Applicant:	Dragino Technology Co., Limited.
Address:	Room 202,BaoChengTai industrial park,No.8 CaiYun LongCheng Street,LongGang District,Shenzhen China
Product Name:	LoRaWAN Lidar Distance Sensor
Product Model:	DS20L
Multiple Models:	N/A
Trade Mark:	DRAGINO
FCC ID:	ZHZDS20L
Standards:	FCC CFR Title 47 Part 15C (§15.247)
Test Date:	2024-09-13 to 2024-11-25
Test Result:	Complied
Report Date:	2024-11-25

Reviewed by: Abel Chen — Abel Chen, Project Engineer

Approved by: Jacob Kong — Jacob Kong, Manager

Prepared by:

World Alliance Testing and Certification (Shenzhen) Co., Ltd

No. 1002, East Block, Laobing Building, Xingye Road 3012, Xixiang street, Bao'an District, Shenzhen, Guangdong, People's Republic of China

NVLAP TESTING NVLAP LAB CODE 600335-0

ilac-MRA

This report may contain data that are not covered by the NVLAP accreditation and shall be marked with an asterisk "★"

Announcement

1. This test report shall not be reproduced in full, without the written approval of World Alliance Testing and Certification (Shenzhen) Co., Ltd

2. The results in this report apply only to the sample tested.

3. This sample tested is in compliance with the limits of the above regulation.

4. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

5. The information marked "#" is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report. Customer model name, addresses, names, trademarks etc. are included.

Revision History

Version No.	Issued Date	Description
00	*2024-11-25*	*Original*

Contents

1 General Information

1.1Client Information

Applicant:	Dragino Technology Co., Limited.
Address:	Room 202,BaoChengTai industrial park,No.8 CaiYun LongCheng Street,LongGang District,Shenzhen China
Manufacturer:	Dragino Technology Co., Limited.
Address:	Room 202,BaoChengTai industrial park,No.8 CaiYun LongCheng Street,LongGang District,Shenzhen China

1.2Product Description of EUT

The EUT is LoRaWAN Lidar Distance Sensor that contains LoRa radio, this report covers the full testing of the LoRa radio FHSS mode.

Sample Serial Number	2R1Z-1 for CE test, 2R1Z-2 for RE test, 2R1Z-3 for RF conducted test (assigned by WATC)
Sample Received Date	2024-09-05
Sample Status	Good Condition
Frequency Range	902.3 MHz -914.9MHz
Maximum Conducted Peak Output Power	10.14dBm
Modulation Technology	CSS
Spatial Streams	SISO (1TX, 1RX)
Antenna Gain#	-7.98 dBi
Power Supply	DC 3.0~3.6V(typical DC 3.0V battery or DC 3.3V by External power)
Adapter Information	N/A
Modification	Sample No Modification by the test lab

1.3Antenna information

15.203 requirement:

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, 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.

Device Antenna information:	

The Lora antenna is an internal antenna which cannot replace by end-user, please see product internal photos for details.

1.4Related Submittal(s)/Grant(s)

FCC Part 15, Subpart C, Equipment Class: DTS, FCC ID: ZHZDS20L

1.5Measurement Uncertainty

Parameter		Expanded Uncertainty (Confidence of 95%(U = 2Uc(y)))
AC Power Lines Conducted Emissions		±3.14dB
Emissions, Radiated	Below 30MHz	±2.78dB
	Below 1GHz	±4.84dB
	Above 1GHz	±5.44dB
Emissions, Conducted		1.75dB
Conducted Power		0.74dB
Frequency Error		150Hz
Bandwidth		0.34%
Power Spectral Density		0.74dB

Note: *The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.*

1.6Laboratory Location

World Alliance Testing and Certification (Shenzhen) Co., Ltd

No. 1002, East Block, Laobing Building, Xingye Road 3012, Xixiang street, Bao'an District, Shenzhen, Guangdong, People's Republic of China

Tel: +86-755-29691511, Email: qa@watc.com.cn

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 463912, the FCC Designation No. : CN5040.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0160.

1.7Test Methodology

FCC CFR 47 Part 2

FCC CFR 47 Part 15

KDB 558074 D01 15.247 Meas Guidance v05r02

ANSI C63.10-2020

2 Description of Measurement

2.1Test Configuration

Operating channels: (902.3MHz-914.9MHz)							
Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	902.3	17	905.5	33	908.7	49	911.9
2	902.5	18	905.7	34	908.9	50	912.1
…	…	…	…	…	…	…	…
15	905.1	31	908.3	47	911.5	63	914.7
16	905.3	32	908.5	48	911.7	64	914.9

According to ANSI C63.10-2020 chapter 5.6.1 Table 11 requirement, select lowest channel, middle channel, and highest channel in the frequency range in which device operates for testing. The detailed frequency points are as follows:

Lowest channel		Middle channel		Highest channel	
Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	902.3	33	908.7	64	914.9

Test Mode:				
Transmitting mode:	The system was configured for testing in Engineering Mode, which was provided by the manufacturer.			
Exercise software#:	Serial Port Utility			
Mode	**Data rate**	**Powel Level Setting#**		
		Low Channel	**Middle Channel**	**High Channel**
Lora-FHSS	/	10	10	10
The exercise software and the maximum power setting that provided by manufacturer.				
Worst-Case Configuration:				
For radiated emissions, EUT was investigated in three orthogonal orientation, the worst-case orientation was recorded in report For AC power line conducted emission and radiated emission 9kHz-1GHz was performed with the EUT transmits at the channel with highest output power as worst-case scenario. The EUT has two input power type: battery and external power, the two power type switched by a switch on the device, the battery power mode was full test, the external power mode was checked AC power line conducted emission and radiated emission 9kHz-1GHz.				

2.2Test Auxiliary Equipment

Manufacturer	Description	Model	Serial Number
UNI-T	DC power supply	UTP1310S	BC-EL-204

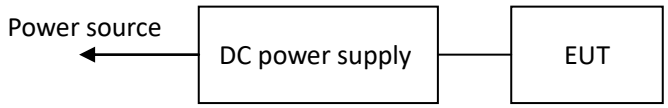
2.3Interconnecting Cables

Manufacturer	Description	Length(m)	From	To
Unknown	DC Power Cable	1.0	DC power supply	EUT

2.4Block Diagram of Connection between EUT and AE

Battery:

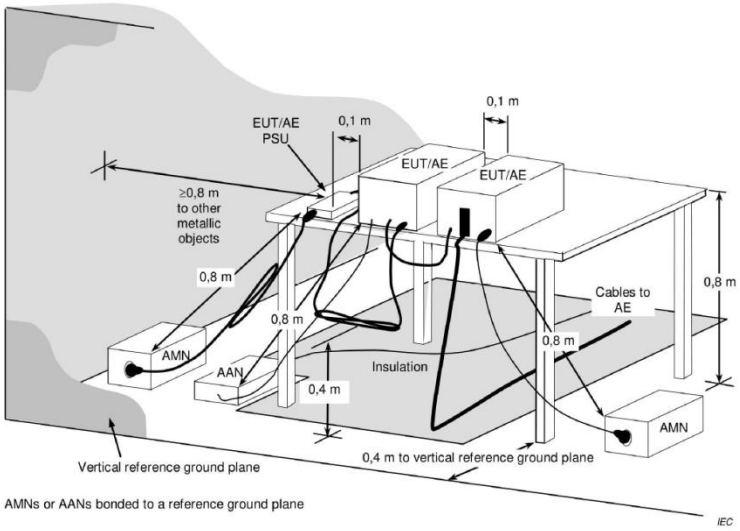
External Power:



Note: for reference only, the actual connection setup used for testing please refer to the test photos.

2.5Test Setup

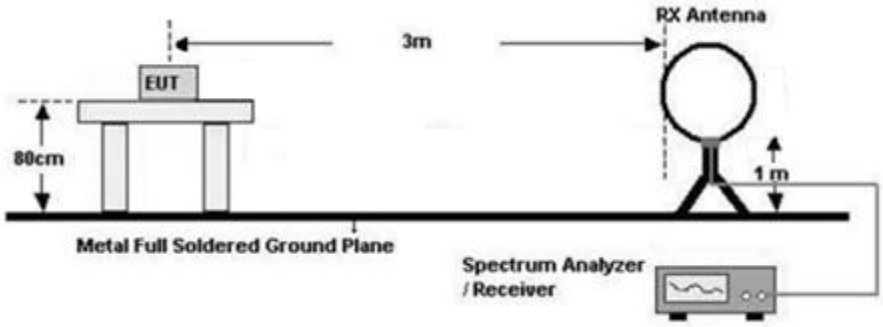
1) Conducted emission measurement:



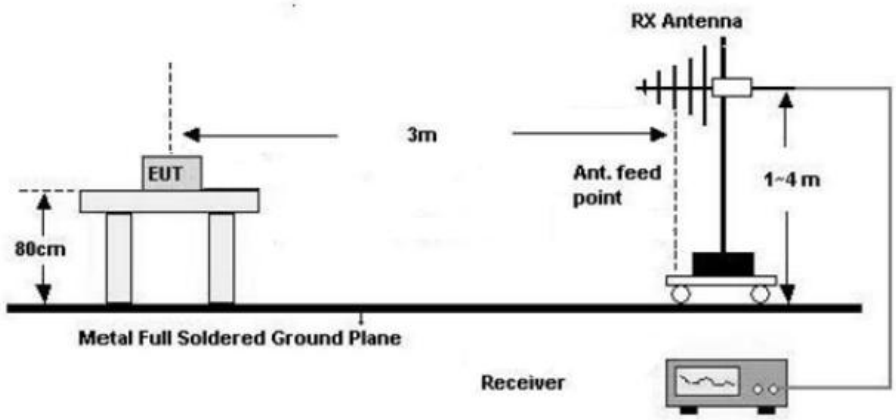
Note: The 0.8 m distance specified between EUT/AE/PSU and AMN/AAN, is applicable only to the EUT being measured. If the device is AE then it shall be >0.8 m.

2) Radiated emission measurement:

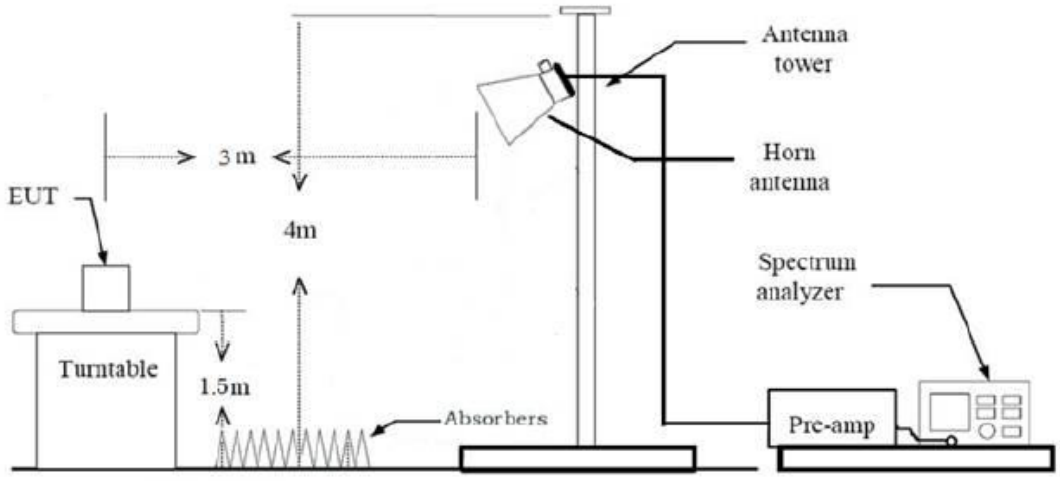
Below 30MHz (3m SAC)



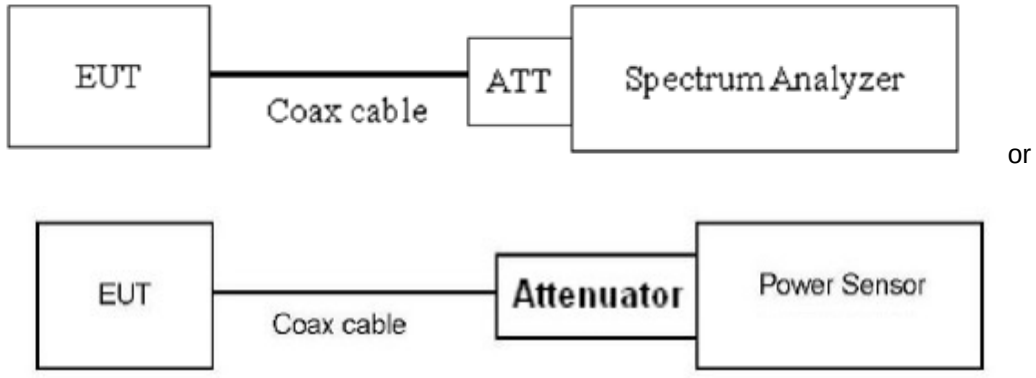
30MHz-1GHz (3m SAC)



1GHz-10GHz(3m FAC)



3) RF Conducted Test



2.6Test Procedure

Conducted emission:

1. The E.U.T is placed on a non-conducting table 40cm from the vertical ground plane and 80cm above the horizontal ground plane (Please refer to the block diagram of the test setup and photographs).
2. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.
3. Line conducted data is recorded for both Line and Neutral

Radiated Emission Procedure:

a) For below 30MHz

1. All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz- 30 MHz) to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were 40*Log (test distance / specification distance).
2. Loop antenna use, investigation was done on the three antenna orientations (parallel, perpendicular, gound-parallel)

b) For 30MHz-1GHz:

1. The EUT was placed on the tabletop of a rotating table 0.8 m the ground at a 3 m semi anechoic chamber. The measurement distance from the EUT to the receiving antenna is 3 m.
2. EUT works in each mode of operation that needs to be tested. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.

c) For above 1GHz:

1. The EUT was placed on the tabletop of a rotating table 1.5 m the ground at a 3 m fully anechoic room. The measurement distance from the EUT to the receiving antenna is 3 m.

2. EUT works in each mode of operation that needs to be tested，and having the EUT continuously working. The highest signal levels relative to the limit shall be determined by rotating the EUT from 0° to 360° and with varying the measurement antenna height between 1 m and 4 m in vertical and horizontal polarizations.
3. Open the test software to control the test antenna and test turntable. Perform the test, save the test results, and export the test data.
4. Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

RF Conducted Test:

1. The antenna port of EUT was connected to the RF port of the test equipment (Power Meter or Spectrum analyzer) through Attenuator and RF cable.
2. The cable assembly insertion loss of 6.5dB (including 6 dB Attenuator and 0.5dB cable) was entered as an offset in the Spectrum analyzer. Note: Actual cable loss was unavailable at the time of testing, therefore a loss of 0.5dB was assumed as worst case. This was later verified to be true by laboratory. (if the RF cable provided by client, the cable loss declared by client)
3. The EUT is keeping in continuous transmission mode and tested in all modulation modes.

2.7Measurement Method

Description of Test	Measurement Method
AC Line Conducted Emissions	ANSI C63.10-2020 Section 6.2
Maximum Conducted Output Power	ANSI C63.10-2020 Section 7.8.5
20 dB Emission Bandwidth	ANSI C63.10-2020 Section 6.9.2
99% Occupied Bandwidth	ANSI C63.10-2020 Section 6.9.3
Channel separation	ANSI C63.10-2020 Section 7.8.2
Number of hopping Frequency	ANSI C63.10-2020 Section 7.8.3
Time of occupancy (dwell time)	ANSI C63.10-2020 Section 7.8.4
100kHz Bandwidth of Frequency Band Edge	ANSI C63.10-2020 Section 7.8.7.2&6.10
Radiated emission	ANSI C63.10-2020 Section 7.8.8&6.3&6.4&6.5&6.6

2.8 Measurement Equipment

Manufacturer	Description	Model	Management No.	Calibration Date	Calibration Due Date
Conducted Emission Test					
ROHDE& SCHWARZ	EMI TEST RECEIVER	ESR	101817	2024/6/4	2025/6/3
R&S	LISN	ENV216	101748	2024/6/4	2025/6/3
N/A	Coaxial Cable	NO.12	N/A	2024/6/4	2025/6/3
Farad	Test Software	EZ-EMC	Ver. EMEC-3A1	/	/
Radiated Emission Test					
R&S	EMI test receiver	ESR3	102758	2024/6/4	2025/6/3
ROHDE& SCHWARZ	SPECTRUM ANALYZER	FSV40-N	101608	2024/6/4	2025/6/3
SONOMA INSTRUMENT	Low frequency amplifier	310	186014	2024/6/4	2025/6/3
A.H. Systems	PREAMPLIFIER	PAM-0118P	531	2024/6/4	2025/6/3
BACL	Loop Antenna	1313-1A	4010611	2024/2/7	2027/2/6
SCHWARZBECK	Log - periodic wideband antenna	VULB 9163	9163-872	2023/7/7	2026/7/6
Astro Antenna Ltd	Horn antenna	AHA-118S	3015	2023/7/6	2026/7/5
Unknown	6.7G High Pass Filter	Unknown	6.7G	2024/6/4	2025/6/3
Oulitong	Band Reject Filter	OBSF-902-928-40S	OE02104362	2024/6/4	2025/6/3
N/A	Coaxial Cable	NO.9	N/A	2024/6/4	2025/6/3
N/A	Coaxial Cable	NO.15	N/A	2024/6/4	2025/6/3
N/A	Coaxial Cable	NO.16	N/A	2024/6/4	2025/6/3
N/A	Coaxial Cable	NO.17	N/A	2024/6/4	2025/6/3
Audix	Test Software	E3	191218 V9	/	/
RF Conducted Test					
ROHDE& SCHWARZ	SPECTRUM ANALYZER	FSV40	101419	2024/6/4	2025/6/3
ROHDE& SCHWARZ	SPECTRUM ANALYZER	FSU-26	200680/026	2024/6/4	2025/6/3
ANRITSU	USB Power Sensor	MA24418A	12620	2024/6/4	2025/6/3
MEEA	6dB attenuator	603-06-1	N/A	2024/6/4	2025/6/3

Note: All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or International standards.

3 Test Results

3.1Test Summary

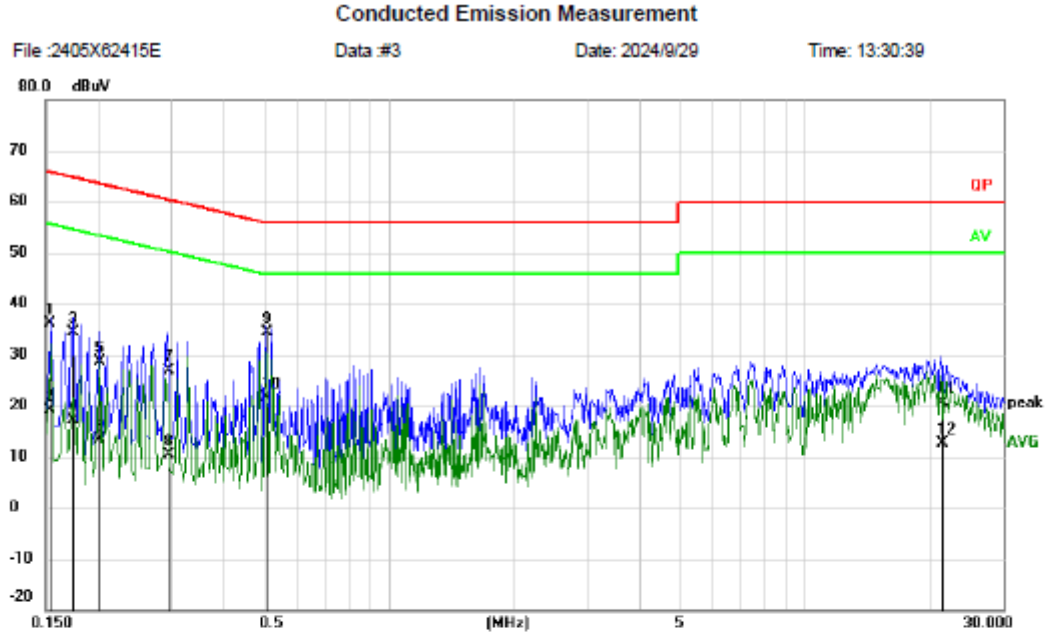
FCC Rules	Description of Test	Result
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.247 (a)(1)(i)	20dB Emission Bandwidth	Compliance
-	99% Occupied Bandwidth	Report only
§15.247 (a)(1)(i)	Channel separation	Compliance
§15.247 (a)(1)(i)	Number of hopping Frequency	Compliance
§15.247 (a)(1)(i)	Time of occupancy (dwell time)	Compliance
§15.247(b)(2)	Maximum Conducted Output Power	Compliance
§15.247(d)	100kHz Bandwidth of Frequency Band Edge	Compliance
§15.205, §15.209, §15.247(d)	Radiated emission	Compliance

3.2Limit

Test items	Limit
AC Line Conducted Emissions	See details §15.207 (a)
Conducted Output Power	For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
20dB Emission Bandwidth Channel separation Number of hopping Frequency Time of occupancy (dwell time)	For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
Spurious Emissions, 100kHz Bandwidth of Frequency Band Edge	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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

3.3AC Line Conducted Emissions Test Data

Test Date:	2024-09-29	Test By:	Lirou Li
Environment condition:	Temperature: 23.5°C; Relative Humidity:64%; ATM Pressure: 100.8kPa		



Limit: QP
Mode:transmitting
Note: Lora 125kHz H channle

Phase: L1
Power: AC 120V/60Hz

Temperature: 23.5 ℃
Humidity: 64 %
Air Pressure: 1008 hpa

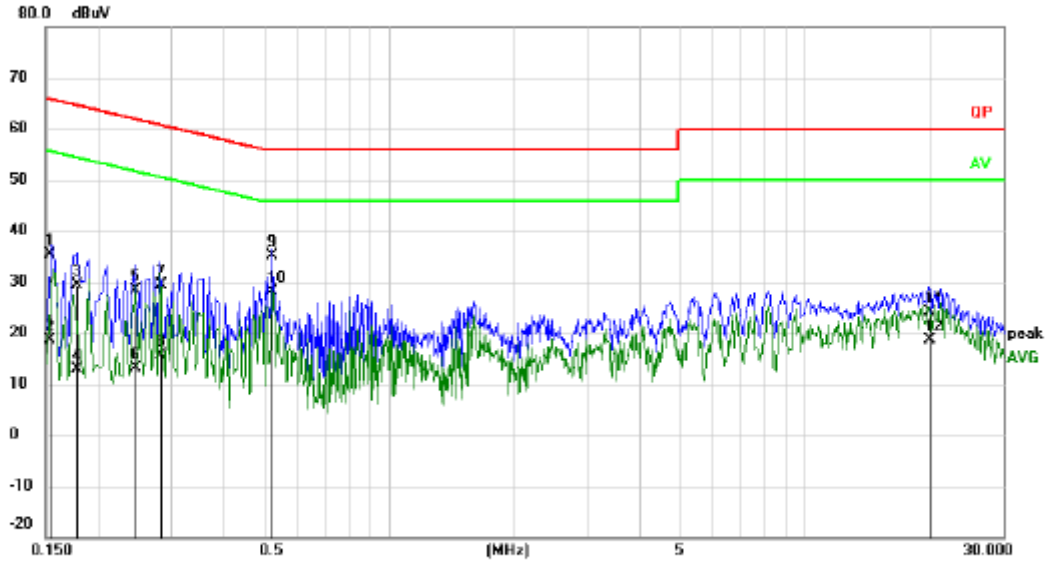
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over Limit		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1539	25.79	10.40	36.19	65.79	-29.60	QP	
2		0.1539	8.66	10.40	19.06	55.79	-36.73	AVG	
3		0.1740	24.02	10.36	34.38	64.77	-30.39	QP	
4		0.1740	6.81	10.36	17.17	54.77	-37.60	AVG	
5		0.2020	18.41	10.31	28.72	63.53	-34.81	QP	
6		0.2020	3.09	10.31	13.40	53.53	-40.13	AVG	
7		0.2940	16.56	10.40	26.96	60.41	-33.45	QP	
8		0.2940	-0.05	10.40	10.35	50.41	-40.06	AVG	
9	*	0.5100	23.93	10.51	34.44	56.00	-21.56	QP	
10		0.5100	11.19	10.51	21.70	46.00	-24.30	AVG	
11		21.3580	10.34	10.34	20.68	60.00	-39.32	QP	
12		21.3580	2.25	10.34	12.59	50.00	-37.41	AVG	

*:Maximum data x:Over limit !:over margin

Engineer Signature: Lirou

Conducted Emission Measurement

File :2405X62415E Data :#4 Date: 2024/9/29 Time: 13:43:03



Limit: QP
Mode:transmitting
Note: Lora 125kHz H channle

Phase: N
Power: AC 120V/60Hz

Temperature: 23.5 ℃
Humidity: 64 %
Air Pressure: 1008 hpa

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over Limit		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1539	25.20	10.22	35.42	65.79	-30.37	QP	
2		0.1539	8.50	10.22	18.72	55.79	-37.07	AVG	
3		0.1780	19.05	10.27	29.32	64.58	-35.26	QP	
4		0.1780	2.73	10.27	13.00	54.58	-41.58	AVG	
5		0.2460	18.00	10.35	28.35	61.89	-33.54	QP	
6		0.2460	2.77	10.35	13.12	51.89	-38.77	AVG	
7		0.2819	18.92	10.38	29.30	60.76	-31.46	QP	
8		0.2819	5.33	10.38	15.71	50.76	-35.05	AVG	
9		0.5260	24.58	10.51	35.09	56.00	-20.91	QP	
10	*	0.5260	17.60	10.51	28.11	46.00	-17.89	AVG	
11		19.8620	13.97	10.25	24.22	60.00	-35.78	QP	
12		19.8620	8.34	10.25	18.59	50.00	-31.41	AVG	

*:Maximum data x:Over limit !:over margin

Engineer Signature: Lirou

Remark:

Measurement (dBuV)= Reading Level (dBuV) + Correct Factor(dB)

Correct Factor(dB)= LISN Voltage Division Factor (dB)+ Cable loss(dB)

Over Limit = Measurement – Limit

3.4Radiated emission Test Data

9 kHz-30MHz:

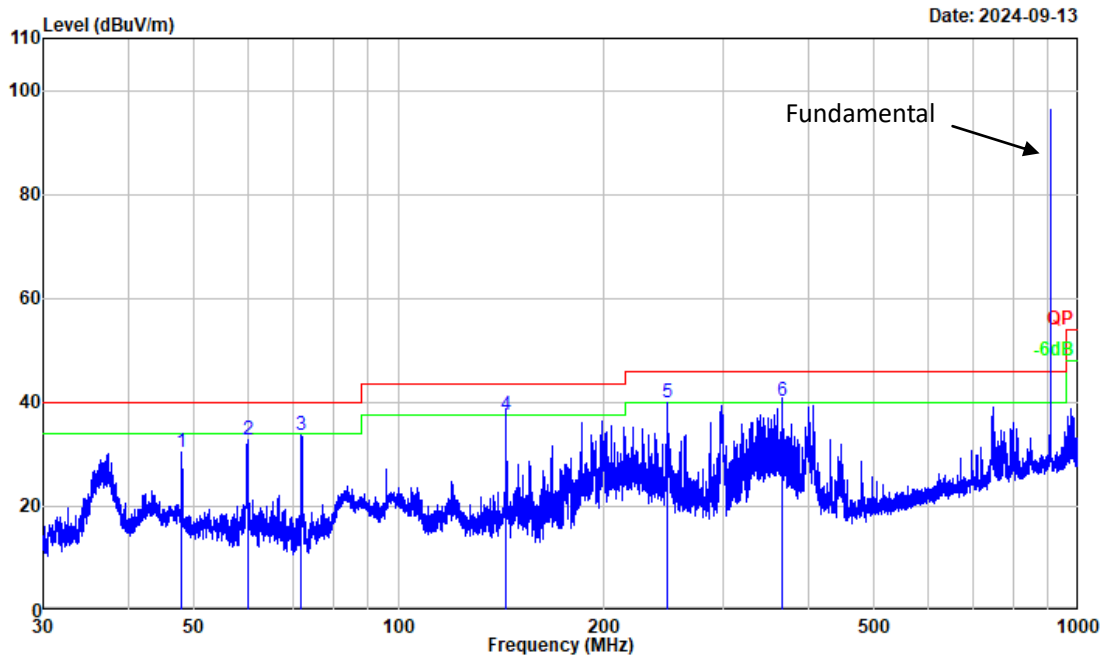
Test Date:	2024-09-13	**Test By:**	Bard Huang
Environment condition:	Temperature: 22.5°C; Relative Humidity:67%; ATM Pressure: 100.0kPa		

For radiated emissions below 30MHz, there were no emissions found within 20dB of limit.

30MHz-1GHz:

Test Date:	2024-09-13	**Test By:**	Bard Huang
Environment condition:	Temperature: 22.5°C; Relative Humidity:67%; ATM Pressure: 100.0kPa		

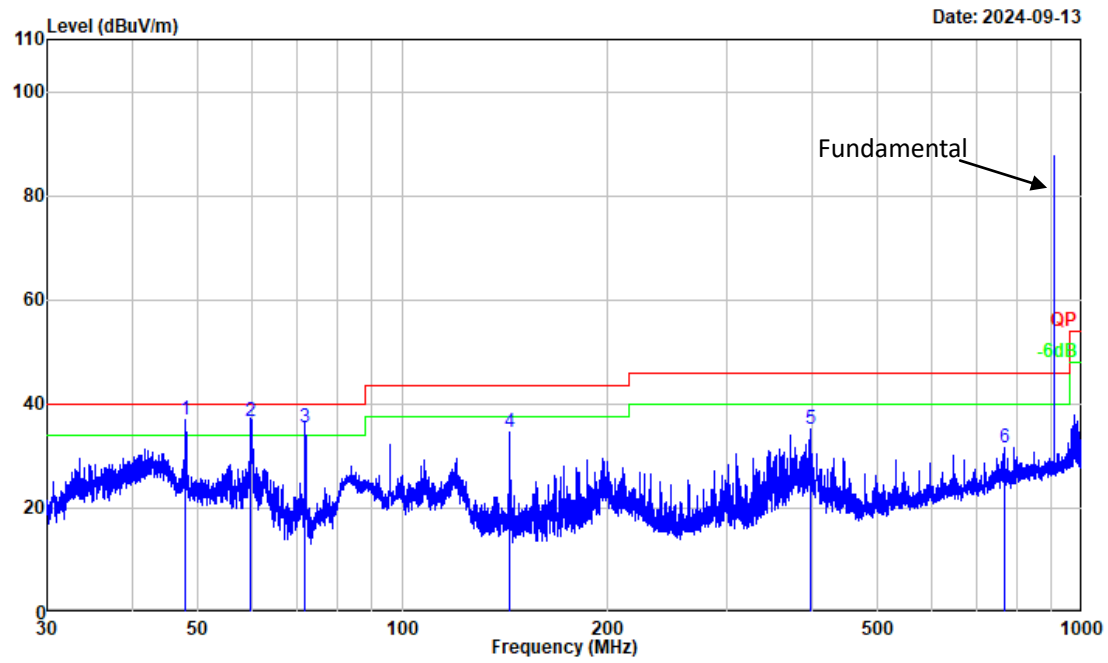
Power by battery:



Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 22.5℃/67%R.H./100.0kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : Lora 125K high channel

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	47.913	42.70	-12.15	30.55	40.00	-9.45	Peak
2	59.943	46.23	-13.59	32.64	40.00	-7.36	Peak
3	71.934	50.51	-16.72	33.79	40.00	-6.21	Peak
4	143.858	54.69	-17.13	37.56	43.50	-5.94	QP
5	248.291	51.67	-11.69	39.98	46.00	-6.02	Peak
6	366.616	48.61	-8.29	40.32	46.00	-5.68	QP

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

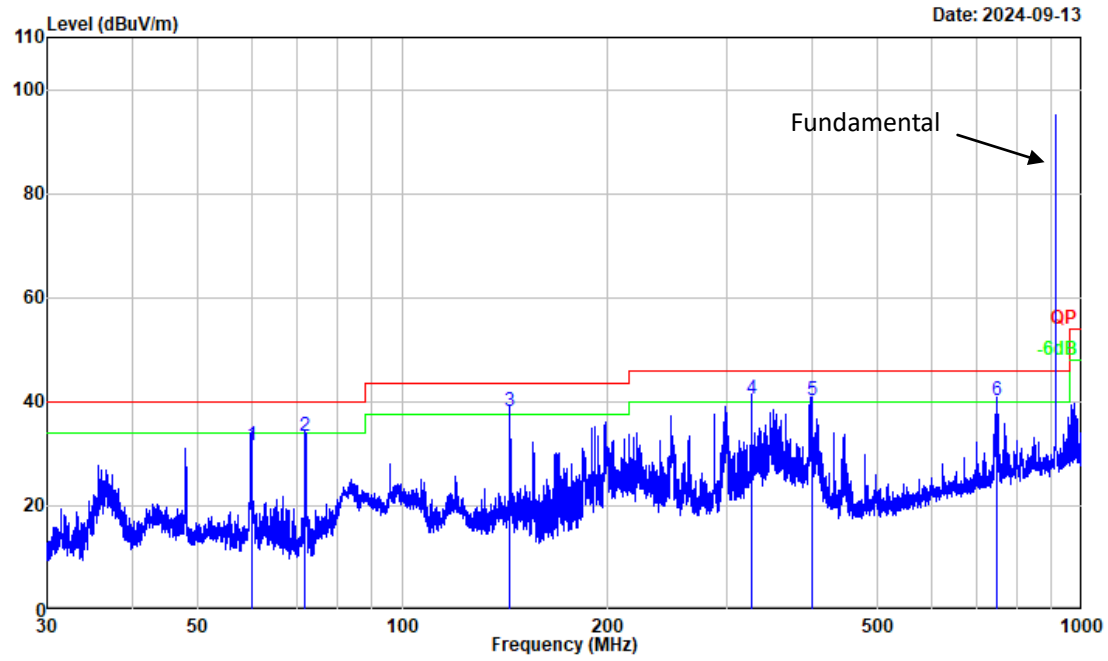


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 22.5℃/67%R.H./100.0kPa
Tested by : Bard Huang
Polarization : vertical
Remark : Lora 125K high channel

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	47.934	49.00	-12.15	36.85	40.00	-3.15	QP
2	59.759	50.10	-13.58	36.52	40.00	-3.48	QP
3	71.903	52.20	-16.71	35.49	40.00	-4.51	QP
4	143.921	51.67	-17.13	34.54	43.50	-8.96	Peak
5	398.460	42.50	-7.44	35.06	46.00	-10.94	Peak
6	767.040	32.09	-0.35	31.74	46.00	-14.26	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

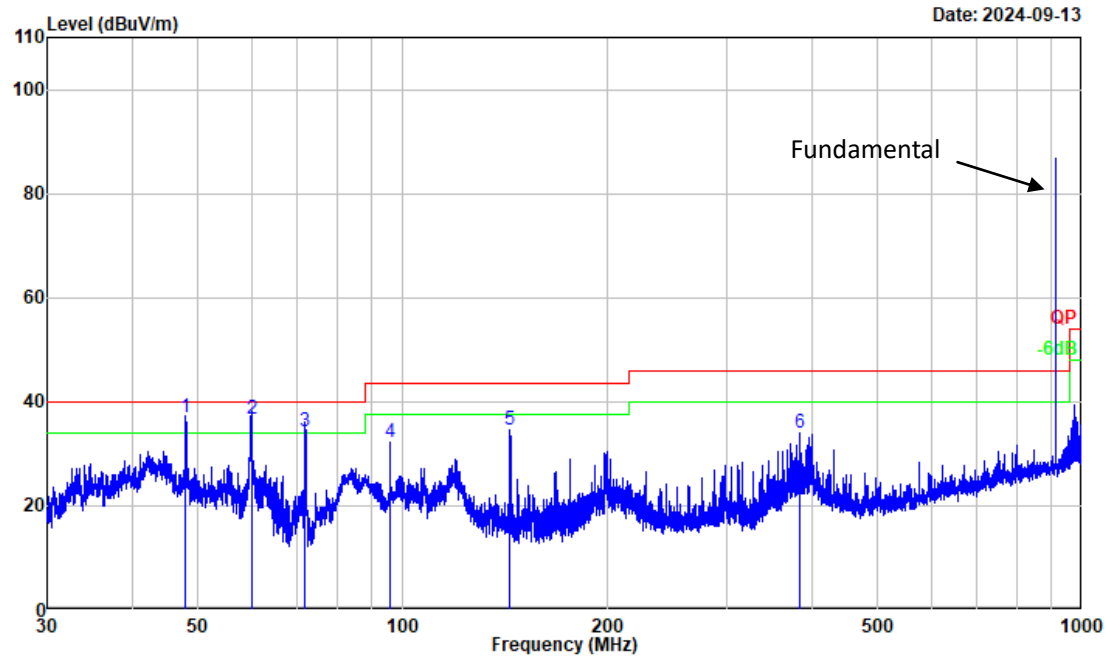
Power by External power:



Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : DC 3.3V
Environment : 22.5℃/67%R.H./100.0kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : Lora 125K high channel

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	59.943	45.10	-13.59	31.51	40.00	-8.49	QP
2	71.966	50.21	-16.74	33.47	40.00	-6.53	QP
3	143.795	55.19	-17.13	38.06	43.50	-5.44	QP
4	326.265	50.20	-9.56	40.64	46.00	-5.36	QP
5	400.562	47.61	-7.36	40.25	46.00	-5.75	QP
6	750.739	40.71	-0.56	40.15	46.00	-5.85	QP

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit



Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : DC 3.3V
Environment : 22.5℃/67%R.H./100.0kPa
Tested by : Bard Huang
Polarization : vertical
Remark : Lora 125K high channel

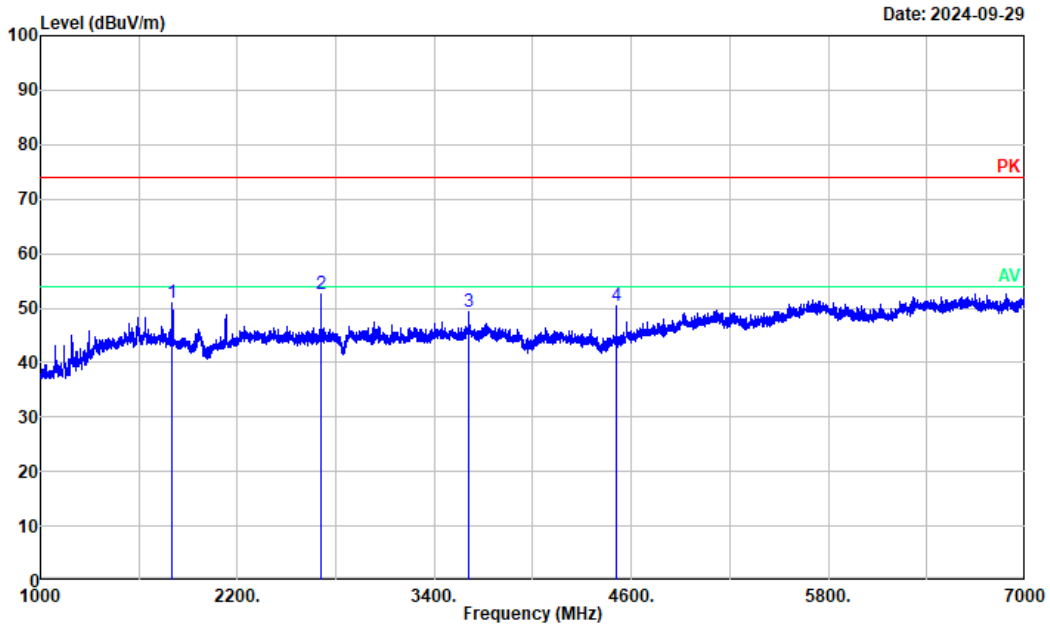
--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	47.955	49.00	-12.15	36.85	40.00	-3.15	QP
2	59.917	50.40	-13.59	36.81	40.00	-3.19	QP
3	71.903	50.90	-16.71	34.19	40.00	-5.81	QP
4	95.902	46.50	-14.36	32.14	43.50	-11.36	Peak
5	143.858	51.56	-17.13	34.43	43.50	-9.07	Peak
6	384.054	42.08	-7.95	34.13	46.00	-11.87	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Above 1GHz:

Test Date:	2024-09-29	Test By:	Bard Huang
Environment condition:	Temperature: 23.3°C; Relative Humidity:61%; ATM Pressure: 100.3kPa		

Mode:	LoRa	Channel:	902.3MHz

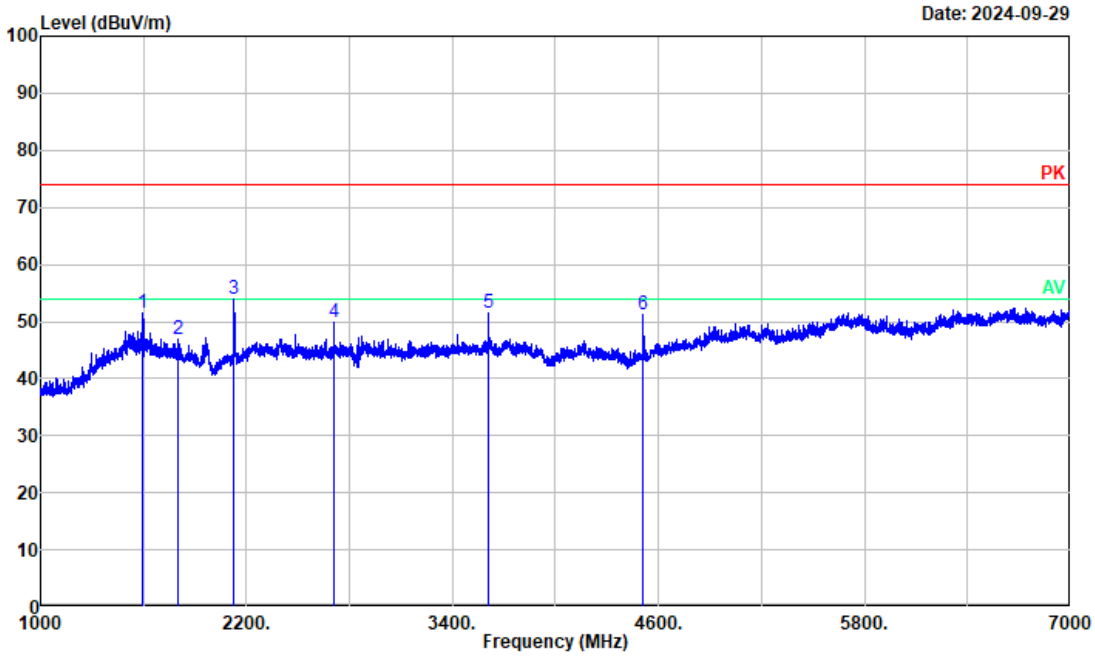


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K low channel 902.3Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	1804.600	53.72	-2.74	50.98	74.00	-23.02	Peak
2	2706.900	54.52	-1.87	52.65	74.00	-21.35	Peak
3	3609.200	51.33	-2.08	49.25	74.00	-24.75	Peak
4	4511.500	54.34	-3.88	50.46	74.00	-23.54	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	902.3MHz

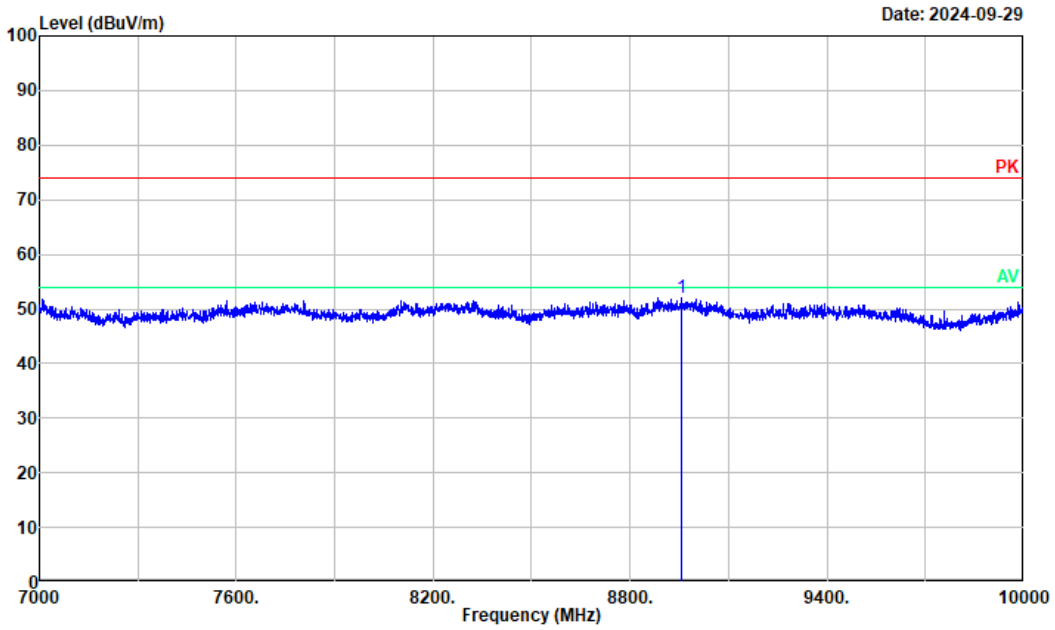


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K low channel 902.3Mhz

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	1595.099	54.48	-3.09	51.39	74.00	-22.61	Peak
2	1804.600	49.64	-2.74	46.90	74.00	-27.10	Peak
3	2125.188	56.94	-3.13	53.81	74.00	-20.19	Peak
4	2706.900	51.69	-1.87	49.82	74.00	-24.18	Peak
5	3609.200	53.47	-2.08	51.39	74.00	-22.61	Peak
6	4511.500	55.01	-3.88	51.13	74.00	-22.87	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	902.3MHz

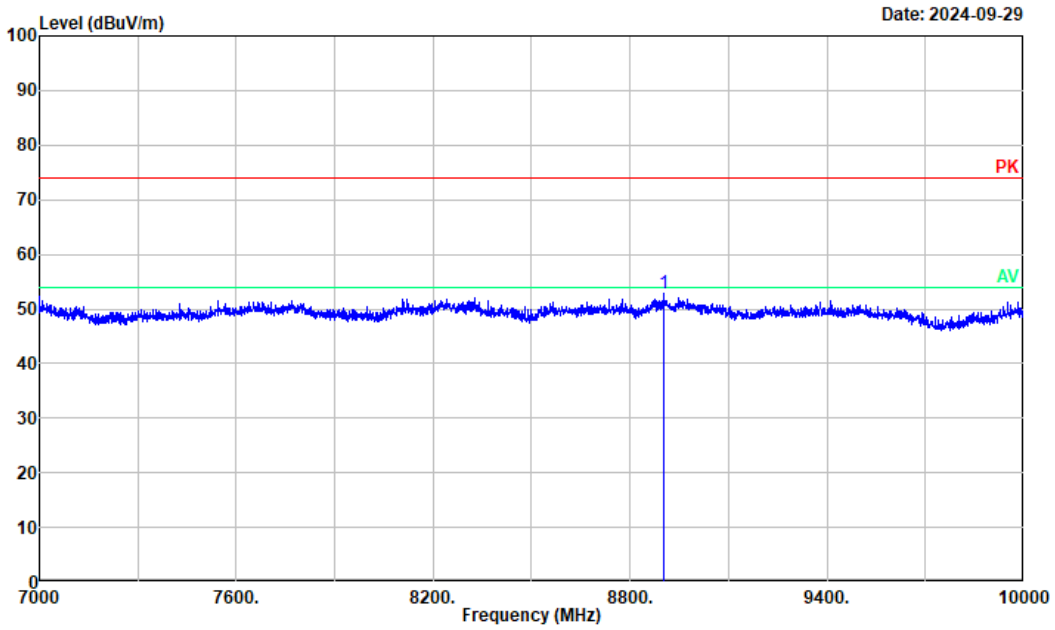


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K low channel 902.3Mhz

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	8956.652	51.09	1.00	52.09	74.00	-21.91	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	902.3MHz

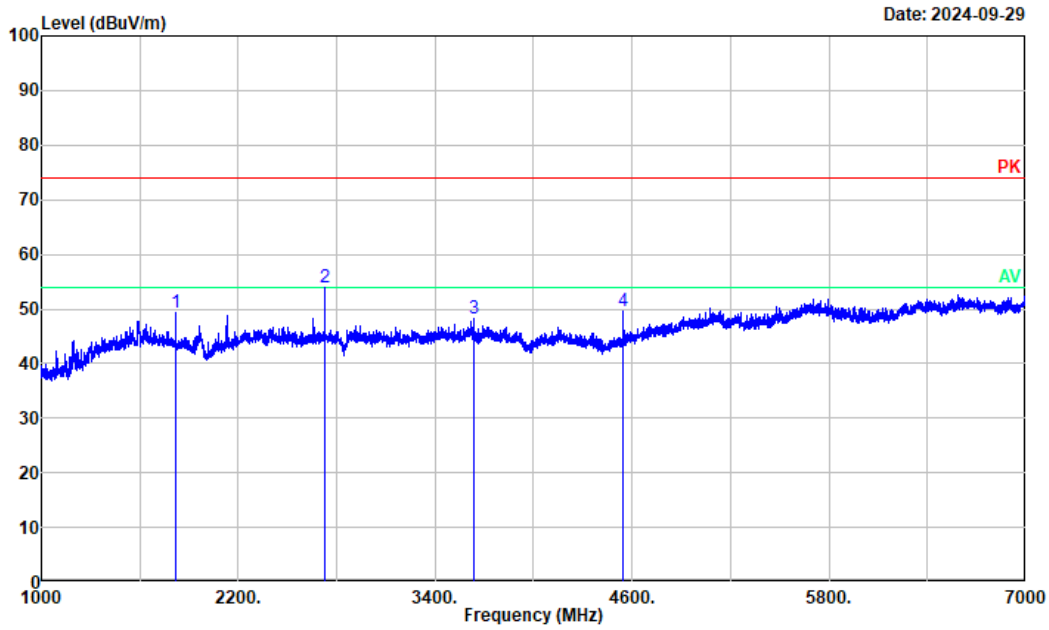


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K low channel 902.3Mhz

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	8900.634	51.74	1.01	52.75	74.00	-21.25	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	908.7MHz

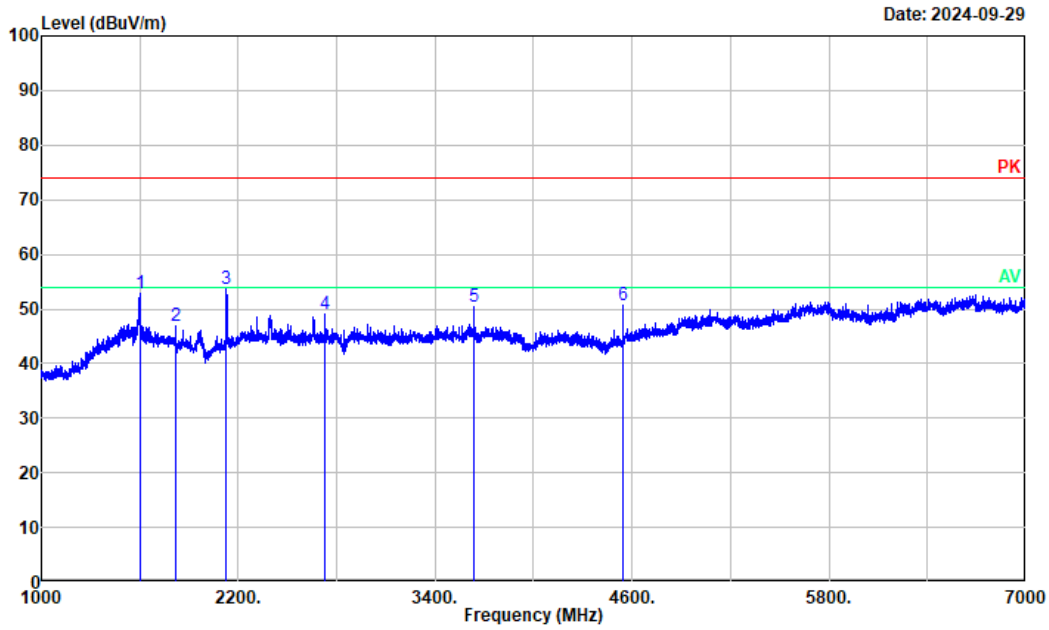


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K middle channel 908.7Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	1817.400	52.21	-2.79	49.42	74.00	-24.58	Peak
2	2726.100	55.84	-1.86	53.98	74.00	-20.02	Peak
3	3634.800	50.35	-2.15	48.20	74.00	-25.80	Peak
4	4543.500	52.87	-3.39	49.48	74.00	-24.52	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	908.7MHz

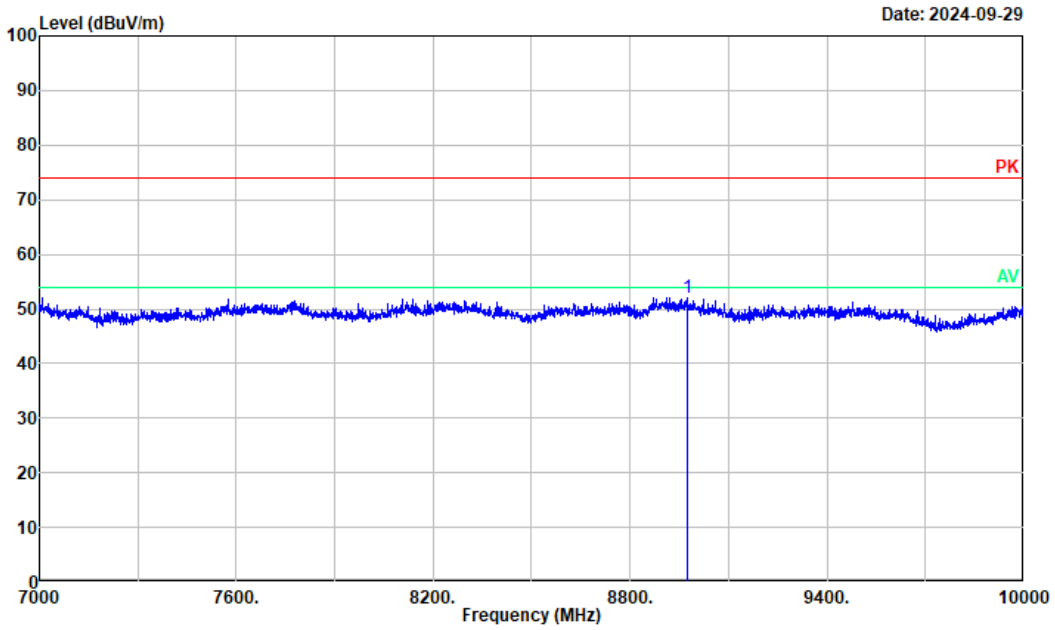


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K middle channel 908.7Mhz

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	1600.100	55.78	-3.06	52.72	74.00	-21.28	Peak
2	1817.400	49.64	-2.79	46.85	74.00	-27.15	Peak
3	2128.188	56.78	-3.12	53.66	74.00	-20.34	Peak
4	2726.100	50.89	-1.86	49.03	74.00	-24.97	Peak
5	3634.800	52.65	-2.15	50.50	74.00	-23.50	Peak
6	4543.500	54.05	-3.39	50.66	74.00	-23.34	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	908.7MHz

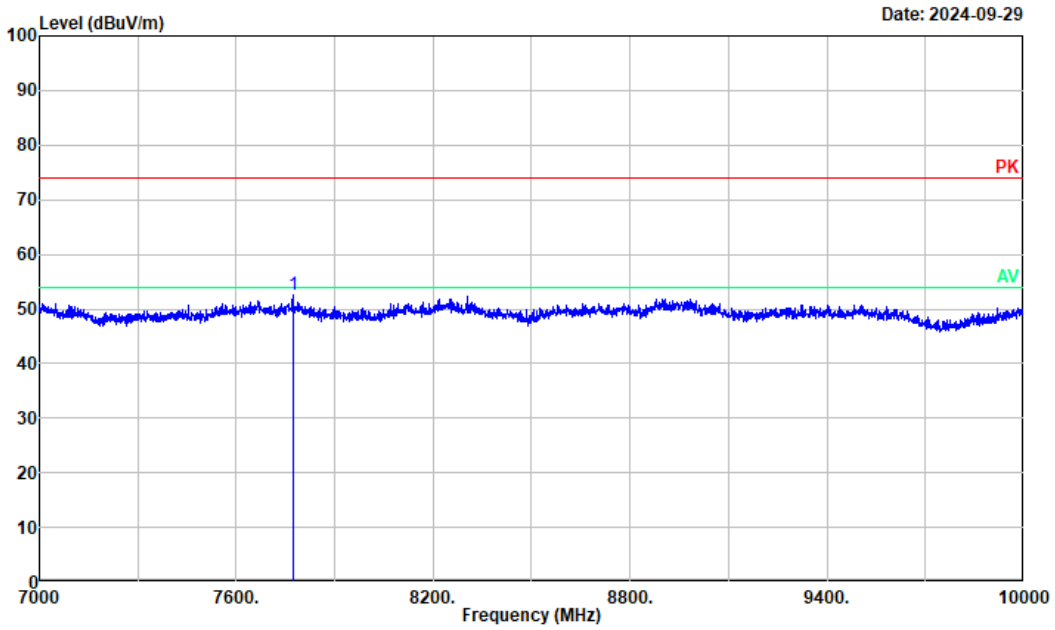


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K middle channel 908.7Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	8972.657	51.14	1.02	52.16	74.00	-21.84	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	908.7MHz

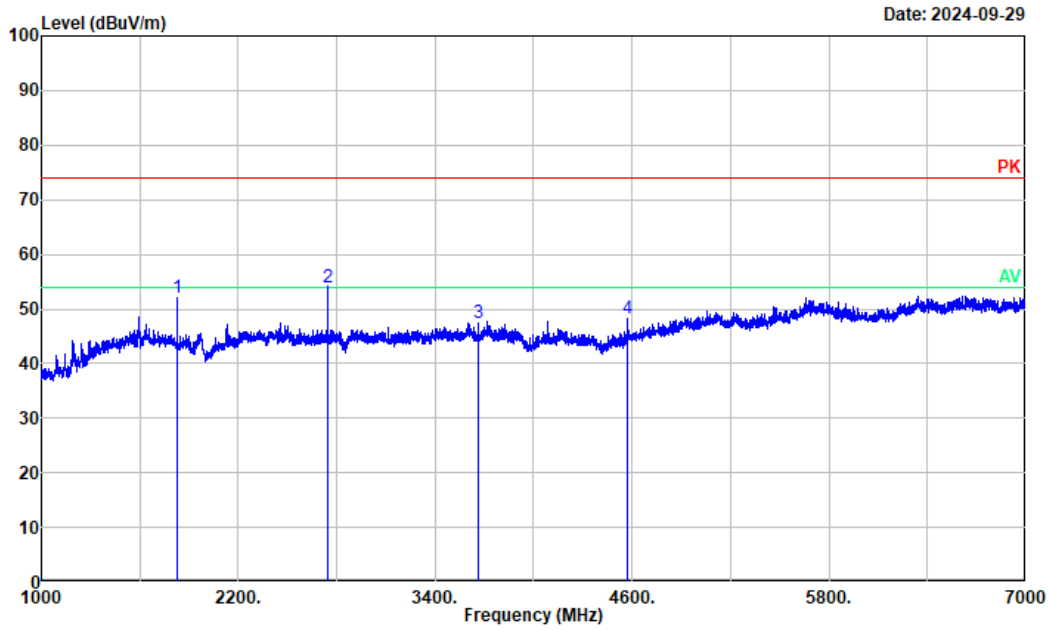


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K middle channel 908.7Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	7773.258	52.91	-0.44	52.47	74.00	-21.53	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	914.9MHz

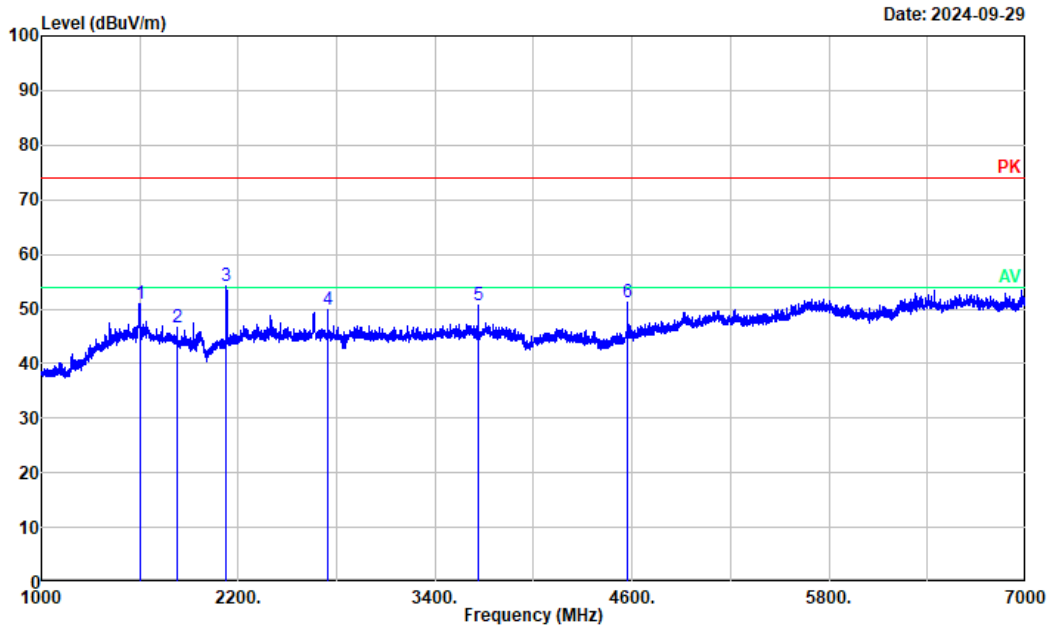


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K high channel 914.9Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	1829.800	54.88	-2.85	52.03	74.00	-21.97	Peak
2	2744.700	55.76	-1.86	53.90	74.00	-20.10	Peak
3	3659.600	49.69	-2.17	47.52	74.00	-26.48	Peak
4	4574.500	51.32	-2.99	48.33	74.00	-25.67	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	914.9MHz

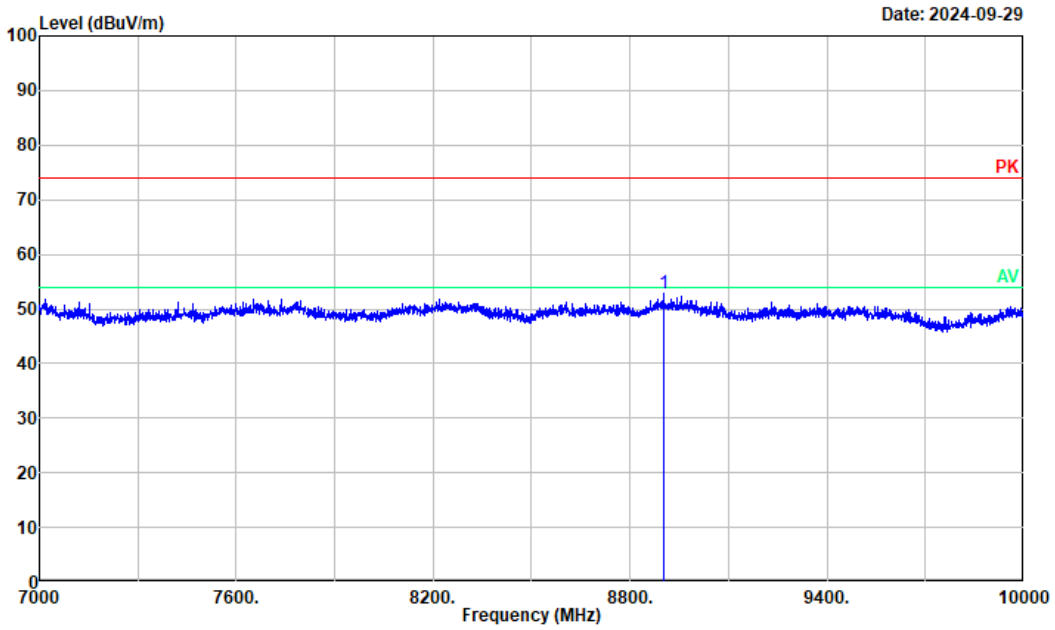


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K high channel 914.9Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	1599.100	54.01	-3.07	50.94	74.00	-23.06	Peak
2	1829.800	49.50	-2.85	46.65	74.00	-27.35	Peak
3	2125.188	57.43	-3.13	54.30	74.00	-19.70	Peak
4	2744.700	51.75	-1.86	49.89	74.00	-24.11	Peak
5	3659.600	52.81	-2.17	50.64	74.00	-23.36	Peak
6	4574.500	54.14	-2.99	51.15	74.00	-22.85	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	914.9MHz

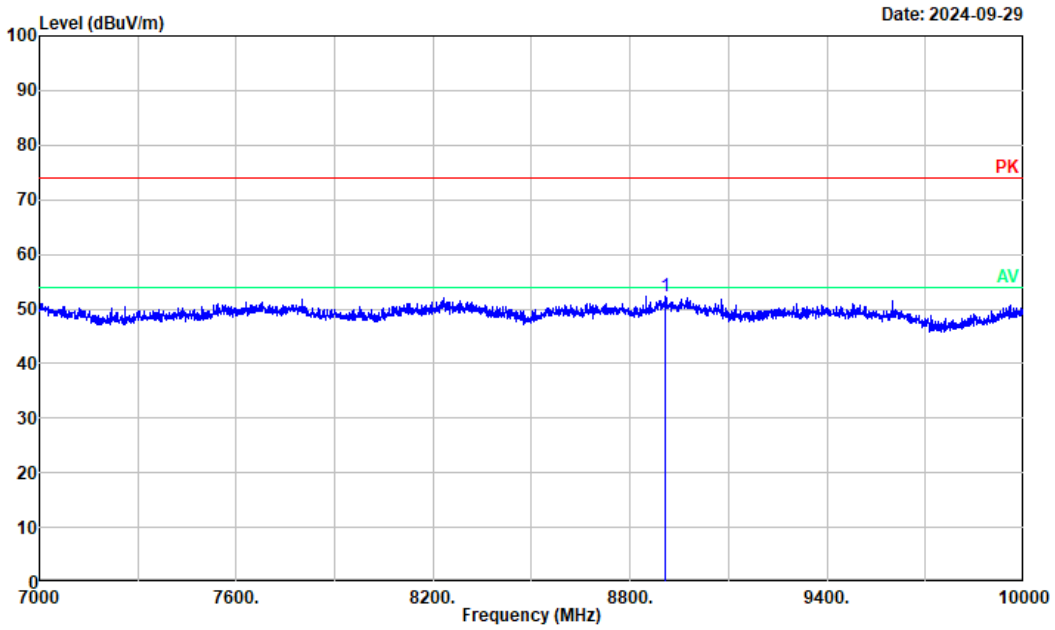


Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : horizontal
Remark : 125K high channel 914.9Mhz

--No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)	Detector
1	8900.634	51.79	1.01	52.80	74.00	-21.20	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

Mode:	LoRa	Channel:	914.9MHz



Project No. : 2405X62415E
Test Mode : Transmitting
Test Voltage : Power by battery
Environment : 23.3℃/61%R.H./100.3kPa
Tested by : Bard Huang
Polarization : vertical
Remark : 125K high channel 914.9Mhz

--No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)	Detector
1	8908.636	51.36	1.01	52.37	74.00	-21.63	Peak

Remarks: Factor = Antenna factor + Cable loss - Preamp gain
Result = Reading + Factor
Over Limit = Result - Limit

3.5 RF Conducted Test Data

Test Date:	2024-09-30~2024-11-25	Test By:	Ryan Zhang
Environment condition:	Temperature: 25.3~25.5°C; Relative Humidity:47~50%; ATM Pressure: 100.3~100.5kPa		

3.5.1 20 dB Emission Bandwidth and 99% Occupied Bandwidth

Test Mode	Channel [MHz]	20dB BW [MHz]	99% OBW [MHz]	20dB BW Limit [kHz]	Verdict
Lora-FHSS	902.3	0.139	0.126	250	Pass
	908.7	0.139	0.126	250	Pass
	914.9	0.139	0.126	250	Pass

3.5.2 Maximum Conducted Peak Output Power

Test Mode	Channel[MHz]	Conducted power [dBm]	Limit[dBm]	Verdict
Lora-FHSS	902.3	9.93	30	Pass
	908.7	10.05	30	Pass
	914.9	10.14	30	Pass

3.5.3 Channel separation

Test Mode	Channel[MHz]	Result[MHz]	Limit[MHz]	Verdict
Lora-FHSS	902.3	0.200	>0.139	Pass
	908.7	0.200	>0.138	Pass
	914.9	0.200	>0.139	Pass

Note： Limit≥20dB BW

3.5.4 Number of hopping Frequency

Test Mode	Channel	Result[Num]	Limit[Num]	Verdict
Lora-FHSS	Hop	64	>=50	Pass

3.5.5 Time of occupancy (dwell time)

Test Mode	Channel[MHz]	Pulse Time [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
Lora-FHSS	Hopping	375	1	0.375	<=0.4	Pass

Note:

Result = Total Hops* Pulse time

Observe period is 20s

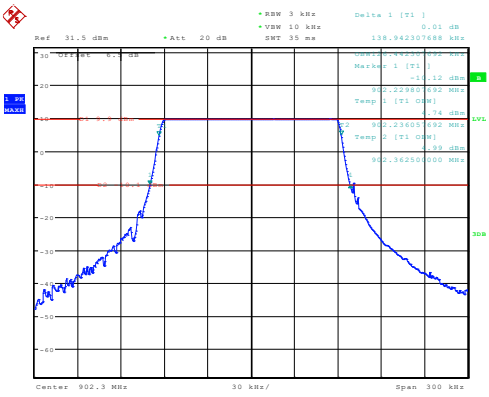
3.5.6 100 kHz Bandwidth of Frequency Band Edge

Mode	Value [dBc]	Limit [dBc]	Result
Low	45.46	20.00	Pass
High	52.71	20.00	Pass
Hopping_Lower	47.94	20.00	Pass
Hopping_Upper	52.97	20.00	Pass

Test Plots:

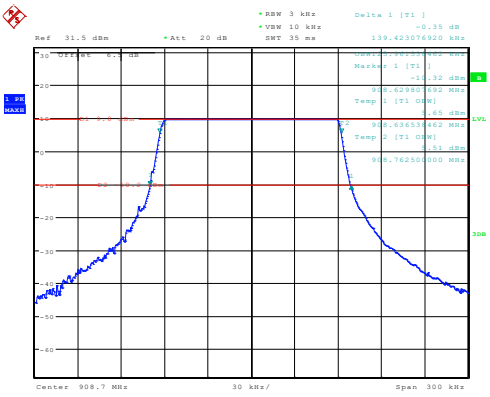
20 dB Emission Bandwidth&99% Occupied Bandwidth:

Low



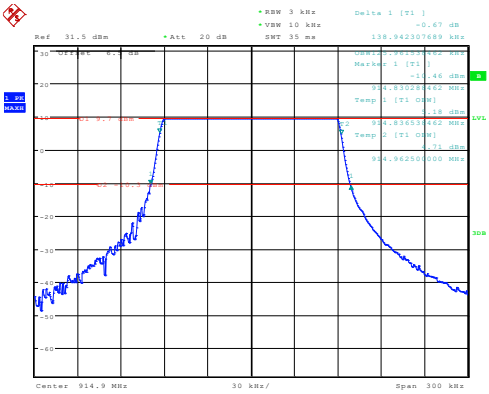
ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 25.NOV.2024 17:49:35

Middle



ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 25.NOV.2024 17:47:05

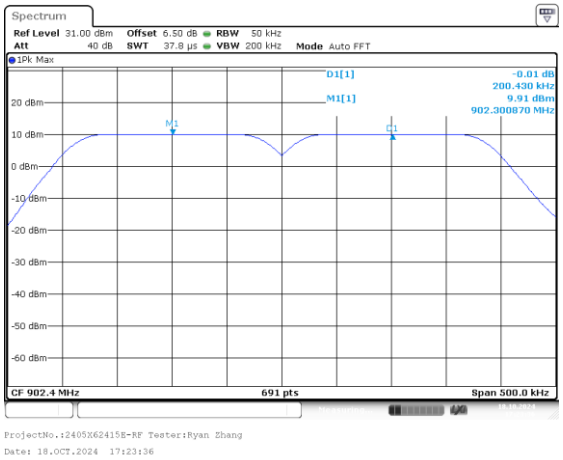
High



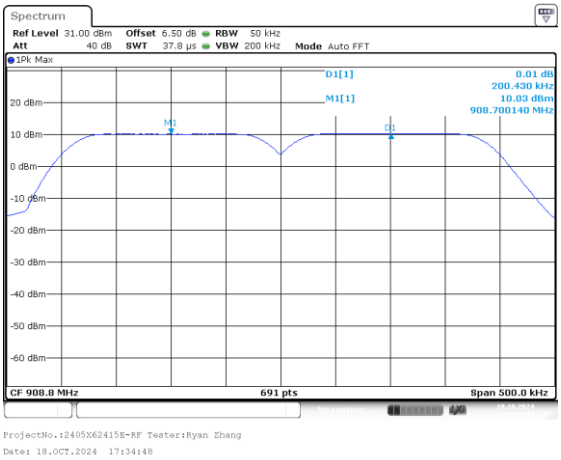
ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 25.NOV.2024 17:52:14

Channel separation:

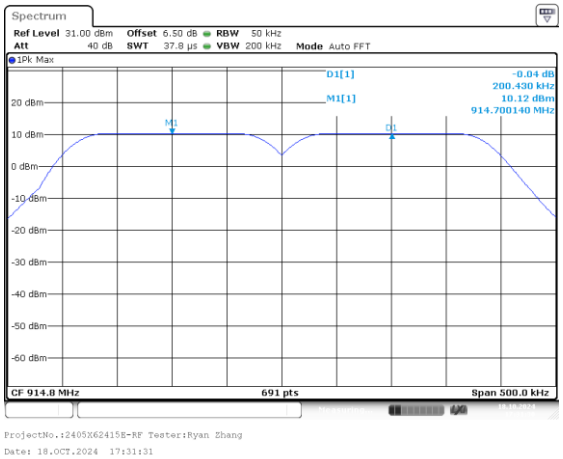
Low



Middle

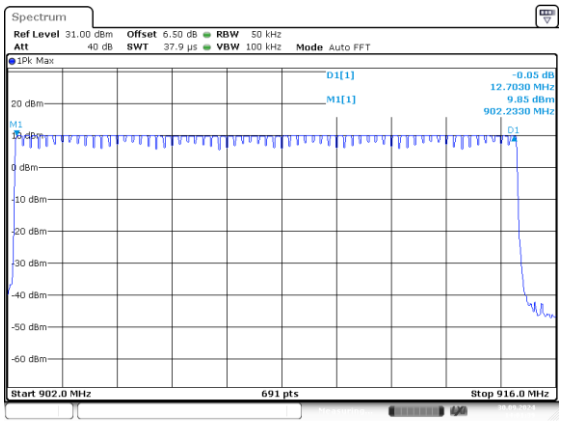


High



Number of hopping Frequency

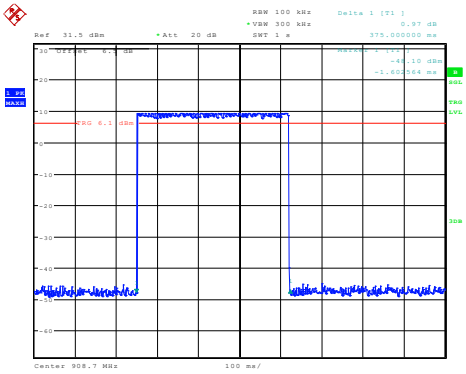
Hopping



ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 30.SEP.2024 14:01:40

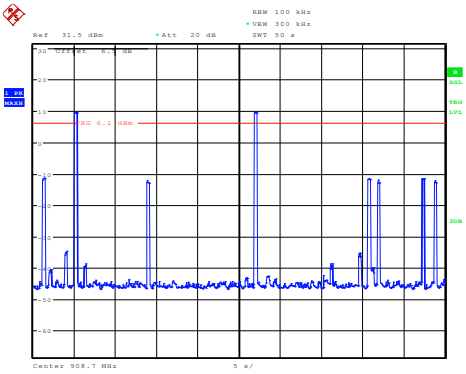
Time of occupancy (dwell time)

Pulse Time



ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 25.NOV.2024 18:03:23

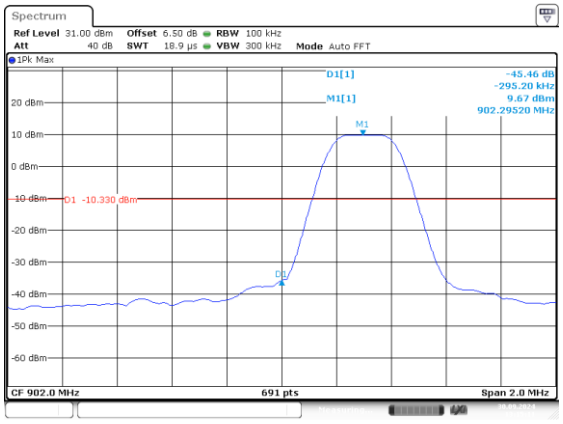
Hopping number



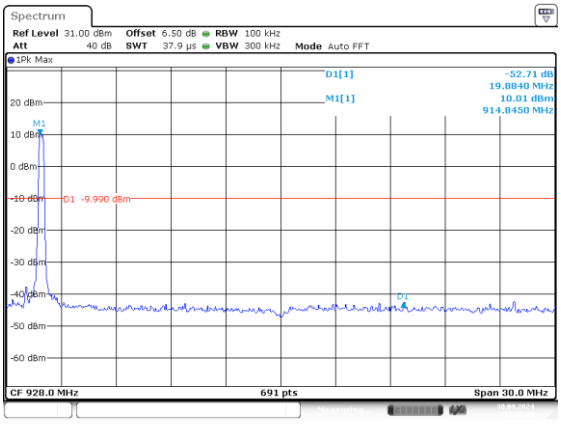
ProjectNo.:2405X62415E-RF Tester:Ryan Zhang
Date: 25.NOV.2024 18:02:07

100kHz Bandwidth of Frequency Band Edge:

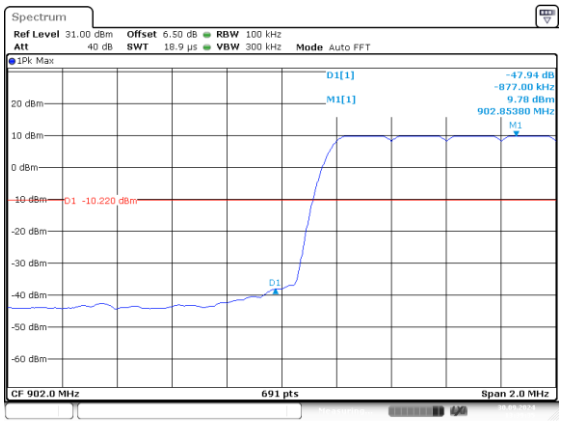
Low



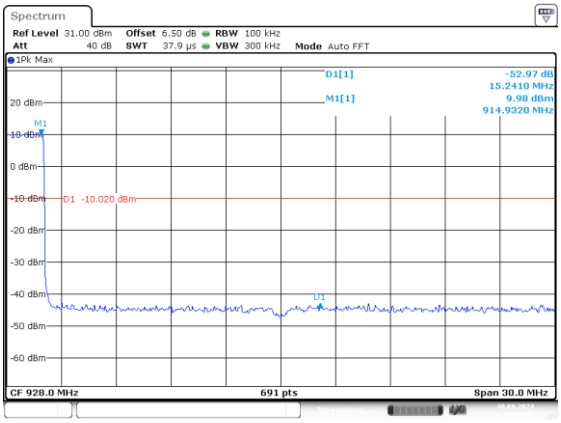
High



Hopping_Lower



Hopping_Upper



4 Test Setup Photo

Please refer to the attachment 2405X62415E Test Setup photo.

5 E.U.T Photo

Please refer to the attachment 2405X62415E External photo and 2405X62415E Internal photo.

---End of Report---