TEST REPORT

Product Name:	LoRa Module
FCC ID:	2ATPO-03SCH
Trademark:	B&T 博安通 / Ai-Thinker 安信可科技
Model Number:	Ra-03SCH
Prepared For:	Shenzhen Ai-Thinker Technology Co., Ltd
Address:	410, Block C, Huafeng Smart Innovation Port. Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China
Manufacturer:	Shenzhen Ai-Thinker Technology Co., Ltd
Address:	410, Block C, Huafeng Smart Innovation Port. Gushu 2nd Road, Gushu Community, Xixiang Street, Baoan District, Shenzhen, China
Prepared By:	Shenzhen CTB Testing Technology Co., Ltd.
Address:	1&2/F., Building A, No.26, Xinhe Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China
Sample Received Date:	Jun. 19, 2023
Sample tested Date:	Jun. 19, 2023 to Jul. 12, 2023
Issue Date:	Jul. 12, 2023
Report No.:	CTB230707004RFX
Test Standards	FCC Part15.247 ANSI C63.10:2013
Test Results	PASS
Remark:	This is LoRa radio test report.

Compiled by:	Reviewed by:	Approved by:
Chen Zheng	Arron Liu	Bin Mei / Director

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

TABLE OF CONTENT

(Note: N/A means not applicable)

1. VERSION

Report No.	Issue Date	Description	Approved
CTB230707004RFX	Jul. 12, 2023	Original	Valid

2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Band edge and RF Conducted Spurious Emissions	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013	PASS
Bandwidth	47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013	PASS
Power Spectral Density	47 CFR Part 15Subpart C Section 15.247 (e)	ANSI C63.10-2013/ KDB 558074 D01v05r02	PASS
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	/	PASS

Remark:
Test according to ANSI C63.10-2013.

3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Item	Uncertainty
Occupancy bandwidth	54.3kHz
Conducted output power Above 1G	0.9dB
Conducted output power below 1G	0.9dB
Power Spectral Density , Conduction	0.9dB
Conduction spurious emissions	2.0dB
Out of band emission	2.0dB
3m camber Radiated spurious emission(9K-30MHz)	4.8dB
3m camber Radiated spurious emission(30MHz-1GHz)	4.6dB
3m chamber Radiated spurious emission(1GHz-18GHz)	5.1dB
3m chamber Radiated spurious emission(18GHz-40GHz)	3.4dB
humidity uncertainty	5.5%
Temperature uncertainty	0.63℃
frequency	1×10-7
Conducted Emission (150KHz-30MHz)	3.2 dB
Radiated Emission(30MHz ~ 1000MHz)	4.8 dB
Radiated Emission(1GHz ~6GHz)	4.9 dB

4. PRODUCT INFORMATION AND TEST SETUP

4.1 Product Information

Model(s):	Ra-03SCH
Model Description:	N/A
Hardware Version:	V1.1
Software Version:	V1.0
Operation Frequency:	902.3-914.9MHz 923.3-927.5MHz
Max. RF output power:	16.063dBm
Type of Modulation:	LoRa
Antenna installation:	External antenna
Antenna Gain:	902.3-914.9MHz: 0.94dBi 923.3-927.5MHz: 0.67dBi
Ratings:	DC 3.3V by notebook

4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1.	Laptop	DELL	Vostro 5490	N/A	N/A

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

4.4 Channel List

902.3-914.9MHz

CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)
0	902.3	16	905.50	32	908.70	48	911.90
1	902.50	17	905.70	33	908.90	49	912.10
2	902.70	18	905.90	34	909.10	50	912.30
3	902.90	19	906.10	35	909.30	51	912.50
4	903.10	20	906.30	36	909.50	52	912.70
5	903.30	21	906.50	37	909.70	53	912.90
6	903.50	22	906.70	38	909.90	54	913.10
7	903.70	23	906.90	39	910.10	55	913.30
8	903.90	24	907.10	40	910.30	56	913.50
9	904.10	25	907.30	41	910.50	57	913.70
10	904.30	26	907.50	42	910.70	58	913.90
11	904.50	27	907.70	43	910.90	59	914.10
12	904.70	28	907.90	44	911.10	60	914.30
13	904.90	29	908.10	45	911.30	61	914.50
14	905.10	30	908.30	46	911.50	62	914.70
15	905.30	31	908.50	47	911.70	63	914.90

923.3-927.5MHz:

CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)	CH No.	Frequency (MHz)
1	923.30	3	924.50	5	925.70	7	926.90
2	923.90	4	925.10	6	926.30	8	927.50

4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

902.3-914.9MHz:

Test mode	Low channel	Middle channel	High channel
Transmitting (LoRa)	902.3MHz	908.7MHz	914.9MHz
Receiving (LoRa)	902.3MHz	908.7MHz	914.9MHz

923.3-927.5MHz:

Test mode	Low channel	Middle channel	High channel
Transmitting (LoRa)	923.3MHz	925.1MHz	927.5MHz
Receiving (LoRa)	923.3MHz	925.1MHz	927.5MHz

4.6 Test Environment

Humidity(%):	54
Atmospheric Pressure(kPa):	101
Normal Voltage(DC):	3.3V
Normal Temperature(℃)	23
Low Temperature(℃)	0
High Temperature(℃)	40

5. TEST FACILITY AND TEST INSTRUMENT USED

5.1 Test Facility

All measurement facilities used to collect the measurement data are located at Floor 1&2, Building A, No. 26 of Xinhe Road, Xinqiao Street, Baoan District, Shenzhen China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

5.2 Test Instrument Used

Item	Equipment	Manufacturer	Type No.	Serial No.	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	2023.07.19
2	Power Sensor	Agilent	U2021XA	MY56120032	2023.07.19
3	Power Sensor	Agilent	U2021XA	MY56120034	2023.07.19
4	Communication test set	R&S	CMW500	108058	2023.07.19
5	Spectrum Analyzer	KEYSIGHT	N9020A	MY51289897	2023.07.19
6	Signal Generator	Agilent	N5181A	MY50140365	2023.07.19
7	Vector signal generator	Agilent	N5182A	MY47420195	2023.07.19
8	Communication test set	Agilent	E5515C	MY50102567	2023.07.19
9	2.4 GHz Filter	Shenxiang	MSF2400-2483.5MS-1154	20181015001	2023.07.19
10	5 GHz Filter	Shenxiang	MSF5150-5850 MS-1155	20181015001	2023.07.19
11	Filter	Xingbo	XBLBQ-DZA120	190821-1-1	2023.07.19
12	BT&WI-FI Automatic test software	Micowave	MTS8000	Ver. 2.0.0.0	/
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	2023.10.30
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	2023.07.19
15	234G Automatic test software	Micowave	MTS8200	Ver. 2.0.0.0	/
16	966 chamber	C.R.T.	966	/	2024.08.11
17	Receiver	R&S	ESPI	100362	2023.07.19
18	Amplifier	HP	8447E	2945A02747	2023.07.19
19	Amplifier	Agilent	8449B	3008A01838	2023.07.19
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2023.07.22

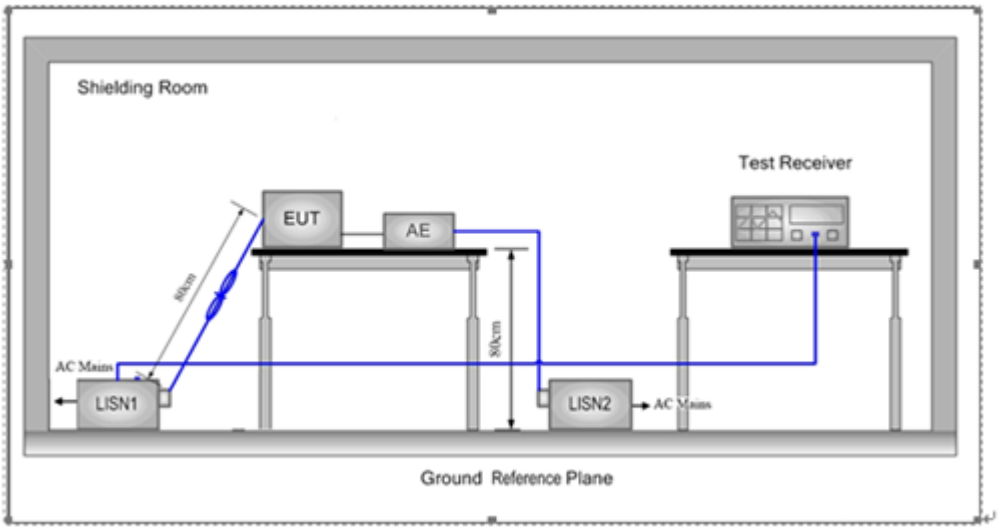
21	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA9120D	01911	2023.07.22
22	EMI test software	Fala	EZ-EMC	FA-03A2 RE	/
23	Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-224	2023.07.23
24	loop antenna	ZHINAN	ZN30900A	GTS534	/
25	40G Horn antenna	A/H/System	SAS-574	588	2024.10.30
26	Amplifier	AEROFLEX	Aeroflex	097	2024.10.30

Continuous disturbance					
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	LISN	ROHDE&SCHWARZ	ESH3-Z5	100318	2023.07.19
2	Pulse limiter	ROHDE&SCHWARZ	ESH3Z2	357881052	2023.07.19
3	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428/003	2023.07.19
4	Coaxial cable	ZDECL	Z302S-NJ-SMAJ-12M	18091905	2023.07.19
5	ISN	Schwarzbeck	NTFM8158	183	2023.07.19
6	Communication test set	Agilent	E5515C	MY50102567	2023.07.19
7	Communication test set	R&S	CMW500	108058	2023.07.19
8	EZ-EMC	Frad	EMC-con3A1.1	/	/

Radiated emission					
No.	Equipment	Manufacturer	Model No.	Serial No.	Calibrated until
1	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	01911	2023.07.22
2	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	2023.07.22
3	Amplifier	Agilent	8449B	3008A01838	2023.07.19
4	Amplifier	HP	8447E	2945A02747	2023.07.19
5	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428/003	2023.07.19
6	Coaxial cable	ETS	RFC-SNS-100-NMS-80 NI	/	2023.07.19
7	Coaxial cable	ETS	RFC-SNS-100-NMS-20 NI	/	2023.07.19
8	Coaxial cable	ETS	RFC-SNS-100-SMS-20 NI	/	2023.07.19
9	Coaxial cable	ETS	RFC-NNS-100 -NMS-300 NI	/	2023.07.19
10	Communication test set	Agilent	E5515C	MY50102567	2023.07.19
11	Communication test set	R&S	CMW500	108058	2023.07.19
12	EZ-EMC	Frad	EMC-con3A1.1	/	/

6. AC POWER LINE CONDUCTED EMISSION

6.1 Block Diagram Of Test Setup



6.2 Limit

Table 4 – AC power-line conducted emissions limits

Frequency (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56[Note 1]	56 to 46[Note 1]
0.5 – 5	56	46
5 – 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

* Decreasing linearly with the logarithm of the frequency

6.3 Test procedure

1) The mains terminal disturbance voltage test was conducted in a shielded room.

2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50µH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.

3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,

4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0,4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0,8 m from the boundary of the unit under

test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0,8 m from the LISN 2.

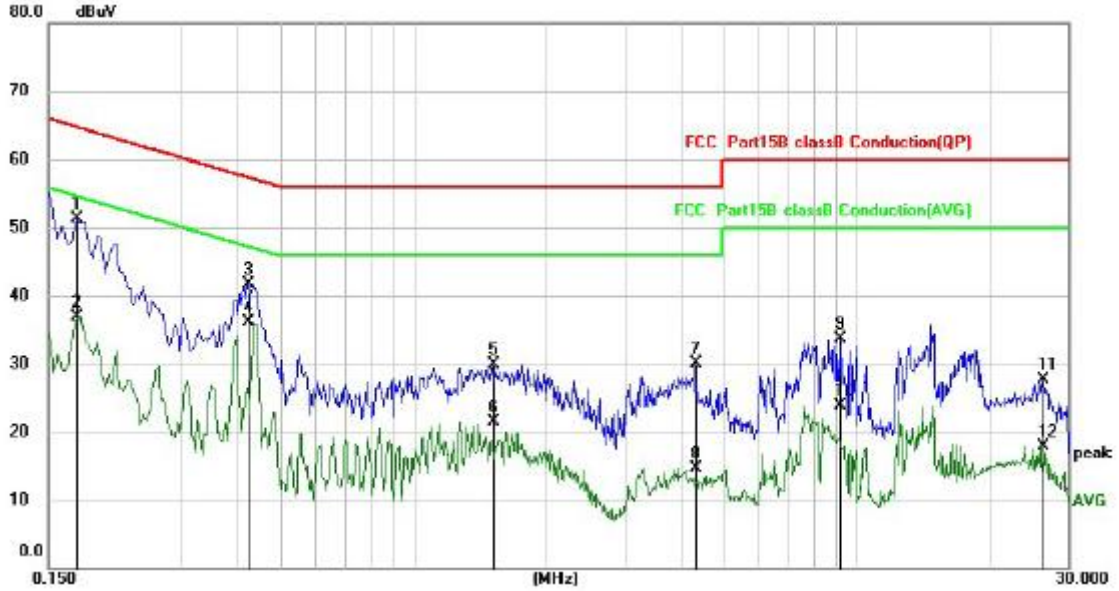
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement**.**

6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.

7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

6.4 Test Result

Worst case- LoRa (low channel)
L:



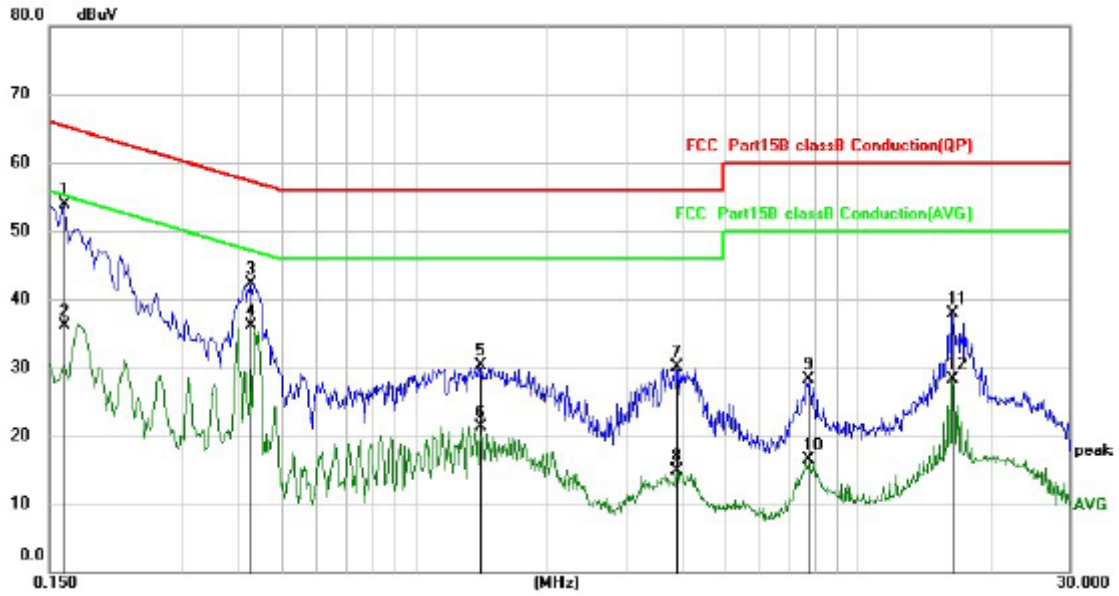
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1740	41.25	10.01	51.26	64.77	-13.51	QP
2		0.1740	26.93	10.01	36.94	54.77	-17.83	AVG
3		0.4220	31.80	9.98	41.78	57.41	-15.63	QP
4	*	0.4220	26.21	9.98	36.19	47.41	-11.22	AVG
5		1.5100	19.97	10.00	29.97	56.00	-26.03	QP
6		1.5100	11.43	10.00	21.43	46.00	-24.57	AVG
7		4.3340	19.90	10.14	30.04	56.00	-25.96	QP
8		4.3340	4.58	10.14	14.72	46.00	-31.28	AVG
9		9.1620	23.36	10.32	33.68	60.00	-26.32	QP
10		9.1620	13.64	10.32	23.96	50.00	-26.04	AVG
11		26.1740	17.06	10.62	27.68	60.00	-32.32	QP
12		26.1740	7.28	10.62	17.90	50.00	-32.10	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

Worst case- LoRa (low channel)

N:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1620	43.96	10.01	53.97	65.36	-11.39	QP
2		0.1620	26.19	10.01	36.20	55.36	-19.16	AVG
3		0.4260	32.27	9.98	42.25	57.33	-15.08	QP
4	*	0.4260	26.05	9.98	36.03	47.33	-11.30	AVG
5		1.4100	20.24	10.00	30.24	56.00	-25.76	QP
6		1.4100	11.23	10.00	21.23	46.00	-24.77	AVG
7		3.8940	19.89	10.12	30.01	56.00	-25.99	QP
8		3.8940	4.73	10.12	14.85	46.00	-31.15	AVG
9		7.7580	17.99	10.27	28.26	60.00	-31.74	QP
10		7.7580	6.16	10.27	16.43	50.00	-33.57	AVG
11		16.3740	27.50	10.49	37.99	60.00	-22.01	QP
12		16.3740	17.84	10.49	28.33	50.00	-21.67	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

7. RADIATED SPURIOUS EMISSION

7.1 Block Diagram Of Test Setup

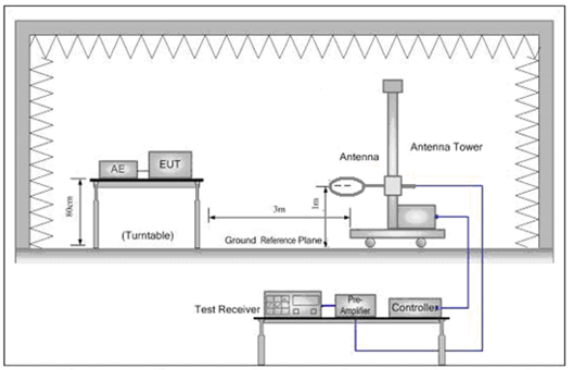


Figure 1. Below 30MHz

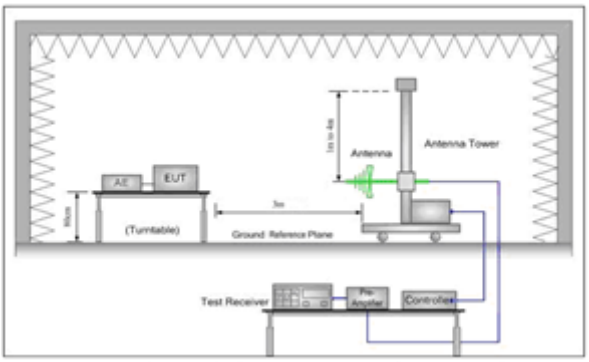
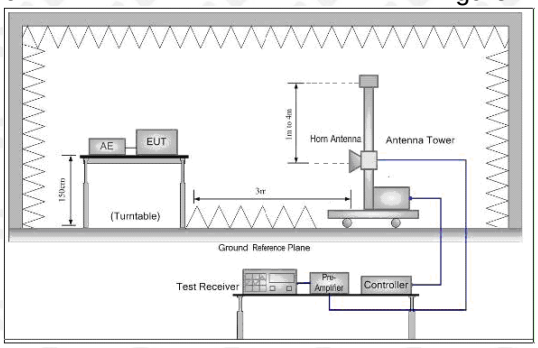


Figure 2. 30MHz to 1GHz



7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

Below 1GHz test procedure as below:

a.The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b.The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c.The antenna height 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.

d.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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.

e.The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f.If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

g.Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).

h.Test the EUT in the lowest channel ,the middle channel ,the Highest channel

i.Repeat above procedures until all frequencies measured was complete.

j. Full battery is usedduring test

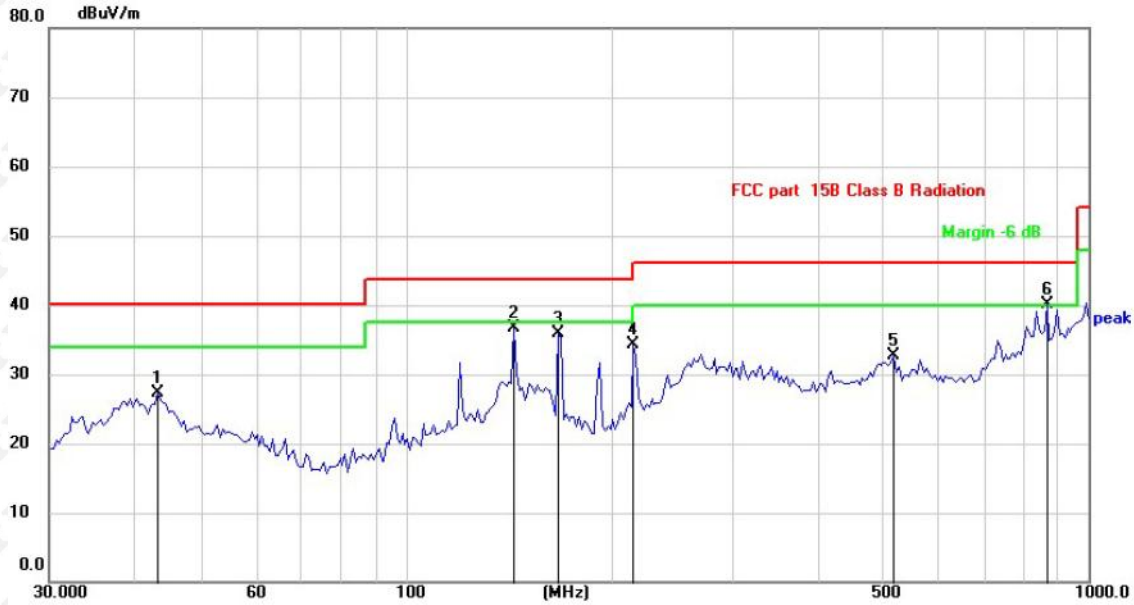
Receiver set:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30KHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30KHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30KHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30KHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

7.4 Test Result

Worst case- LoRa (low channel)

Below 1GHz Test Results:
Antenna polarity: H

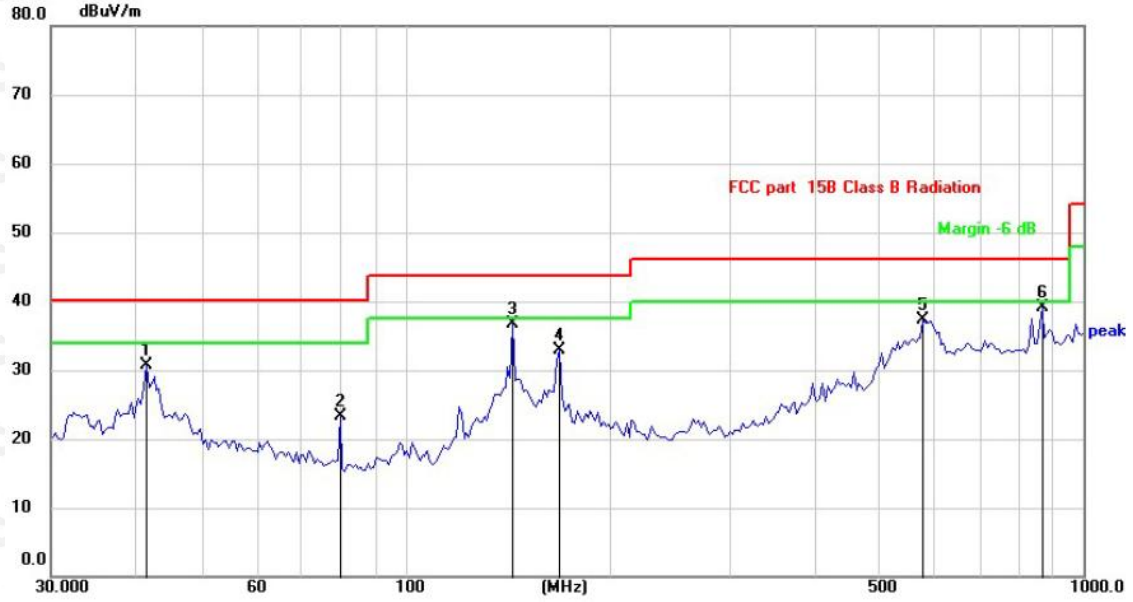


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		43.3534	33.90	-6.52	27.38	40.00	-12.62	QP
2		144.0817	42.20	-5.49	36.71	43.50	-6.79	QP
3		167.2366	42.33	-6.34	35.99	43.50	-7.51	QP
4		215.6452	43.36	-9.07	34.29	43.50	-9.21	QP
5		518.1556	32.19	0.47	32.66	46.00	-13.34	QP
6	*	869.1300	33.49	6.66	40.15	46.00	-5.85	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Worst case- LoRa (low channel)

Antenna polarity: V



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dB/m	dB	Detector
1		41.4941	37.25	-6.49	30.76	40.00	-9.24	QP
2		80.0805	33.72	-10.50	23.22	40.00	-16.78	QP
3	*	144.0817	42.25	-5.49	36.76	43.50	-6.74	QP
4		168.7093	39.48	-6.52	32.96	43.50	-10.54	QP
5		580.7024	35.23	1.98	37.21	46.00	-8.79	QP
6		869.1300	32.52	6.66	39.18	46.00	-6.82	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

902.3-914.9MHz:

Above 1 GHz Test Results:

CH Low

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1804.6	108.47	-5.84	52.69	74	-21.31	peak
1804.6	95.53	-5.84	43.65	54	-10.35	AVG
2706.9	56.41	-3.64	52.77	74	-21.23	peak
2706.9	47.14	-3.64	43.50	54	-10.50	AVG
3609.2	58.13	-0.95	57.18	74	-16.82	peak
3609.2	48.15	-0.95	47.20	54	-6.80	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1804.6	108.40	-5.84	52.69	74	-21.31	peak
1804.6	95.55	-5.84	43.65	54	-10.35	AVG
2706.9	56.31	-3.64	52.67	74	-21.33	peak
2706.9	47.03	-3.64	43.39	54	-10.61	AVG
3609.2	58.10	-0.95	57.15	74	-16.85	peak
3609.2	48.18	-0.95	47.23	54	-6.77	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH Middle

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1817.4	108.27	-5.71	52.67	74	-21.33	peak
1817.4	95.06	-5.71	45.61	54	-8.39	AVG
2726.1	56.01	-3.51	52.50	74	-21.50	peak
2726.1	46.87	-3.51	43.36	54	-10.64	AVG
3634.8	58.11	-0.82	57.29	74	-16.71	peak
3634.8	47.84	-0.82	47.02	54	-6.98	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1817.4	108.40	-5.71	52.67	74	-21.33	peak
1817.4	95.11	-5.71	45.61	54	-8.39	AVG
2726.1	56.05	-3.51	52.54	74	-21.46	peak
2726.1	46.88	-3.51	43.37	54	-10.63	AVG
3634.8	58.10	-0.82	57.28	74	-16.72	peak
3634.8	47.94	-0.82	47.12	54	-6.88	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH High

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1829.8	56.40	-5.65	52.36	74	-21.64	peak
1829.8	47.28	-5.65	46.89	54	-7.11	AVG
2744.7	56.10	-3.43	52.67	74	-21.33	peak
2744.7	47.40	-3.43	43.97	54	-10.03	AVG
3659.6	57.28	-0.75	56.53	74	-17.47	peak
3659.6	47.67	-0.75	46.92	54	-7.08	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1829.8	56.30	-5.65	52.36	74	-21.64	peak
1829.8	47.21	-5.65	46.89	54	-7.11	AVG
2744.7	56.25	-3.43	52.82	74	-21.18	peak
2744.7	47.38	-3.43	43.95	54	-10.05	AVG
3659.6	57.35	-0.75	56.60	74	-17.40	peak
3659.6	47.66	-0.75	46.91	54	-7.09	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

..

Remark:
(1) Measuring frequencies from 1 GHz to the 25 GHz。
(2). All modes of operation were investigated and the worst-case emissions are reported.
(3). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

923.3-927.5MHz

Above 1 GHz Test Results:

CH Low

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1846.6	108.49	-5.84	52.69	74	-21.31	peak
1846.6	95.47	-5.84	43.65	54	-10.35	AVG
2769.9	56.41	-3.64	52.77	74	-21.23	peak
2769.9	47.09	-3.64	43.45	54	-10.55	AVG
3693.2	58.25	-0.95	57.30	74	-16.70	peak
3693.2	48.07	-0.95	47.12	54	-6.88	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1846.6	108.47	-5.84	52.69	74	-21.31	peak
1846.6	95.52	-5.84	43.65	54	-10.35	AVG
2769.9	56.31	-3.64	52.67	74	-21.33	peak
2769.9	47.07	-3.64	43.43	54	-10.57	AVG
3693.2	58.15	-0.95	57.20	74	-16.80	peak
3693.2	48.13	-0.95	47.18	54	-6.82	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH Middle

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1850.2	108.31	-5.71	52.67	74	-21.33	peak
1850.2	95.08	-5.71	45.61	54	-8.39	AVG
2775.3	56.08	-3.51	52.57	74	-21.43	peak
2775.3	46.76	-3.51	43.25	54	-10.75	AVG
3700.4	58.02	-0.82	57.20	74	-16.80	peak
3700.4	47.97	-0.82	47.15	54	-6.85	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1850.2	108.43	-5.71	52.67	74	-21.33	peak
1850.2	95.05	-5.71	45.61	54	-8.39	AVG
2775.3	55.94	-3.51	52.43	74	-21.57	peak
2775.3	46.85	-3.51	43.34	54	-10.66	AVG
3700.4	58.01	-0.82	57.19	74	-16.81	peak
3700.4	47.83	-0.82	47.01	54	-6.99	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

CH High

Horizontal:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1855	56.32	-5.65	52.36	74	-21.64	peak
1855	47.32	-5.65	46.89	54	-7.11	AVG
2782.5	56.09	-3.43	52.66	74	-21.34	peak
2782.5	47.47	-3.43	44.04	54	-9.96	AVG
3710	57.24	-0.75	56.49	74	-17.51	peak
3710	47.62	-0.75	46.87	54	-7.13	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

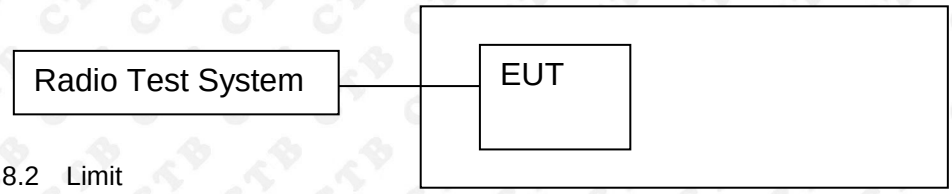
Vertical:

Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Margin (dB)	Detector Type
1855	56.41	-5.65	52.36	74	-21.64	peak
1855	47.28	-5.65	46.89	54	-7.11	AVG
2782.5	56.16	-3.43	52.73	74	-21.27	peak
2782.5	47.34	-3.43	43.91	54	-10.09	AVG
3710	57.35	-0.75	56.60	74	-17.40	peak
3710	47.67	-0.75	46.92	54	-7.08	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier.						

Remark:
(1) Measuring frequencies from 1 GHz to the 25 GHz。
(2). All modes of operation were investigated and the worst-case emissions are reported.
(3). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

8. BAND EDGE AND RF COUNDUCTED SPURIOUS EMISSIONS

8.1 Block Diagram Of Test Setup



8.2 Limit

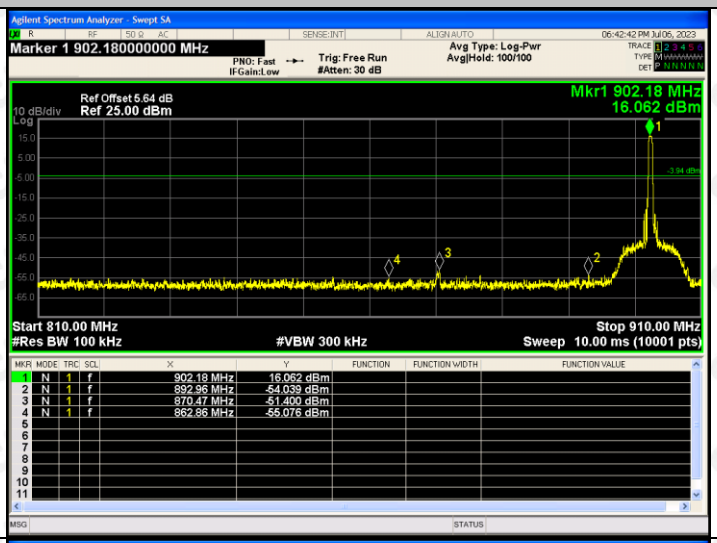
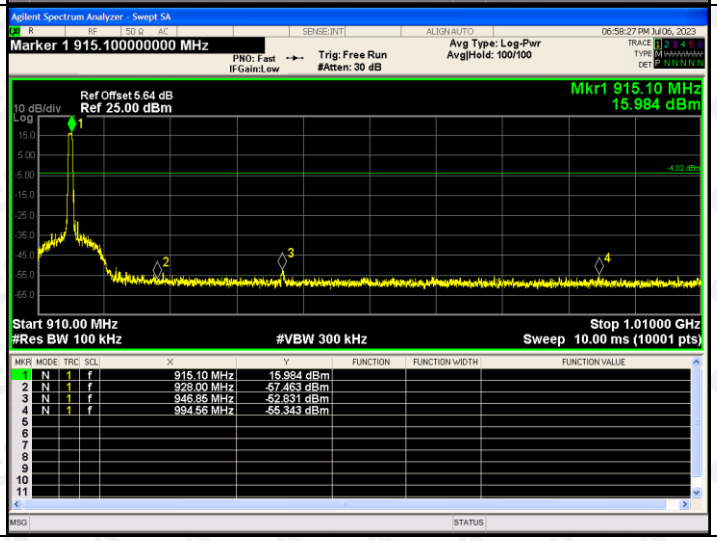
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF 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)).

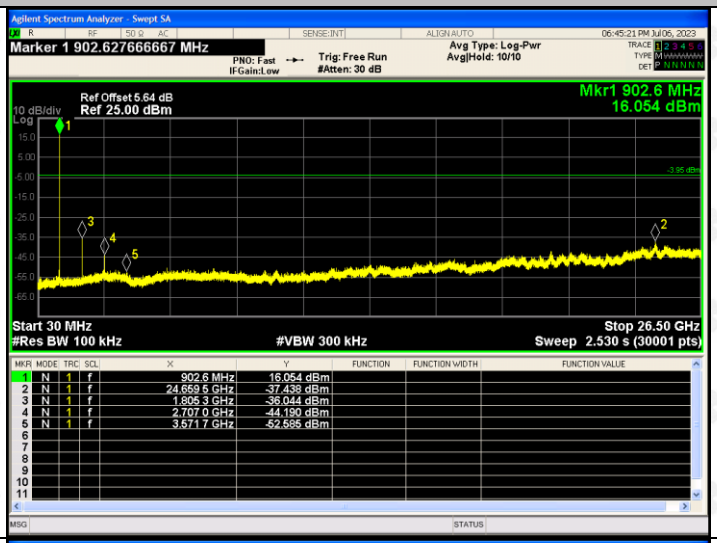
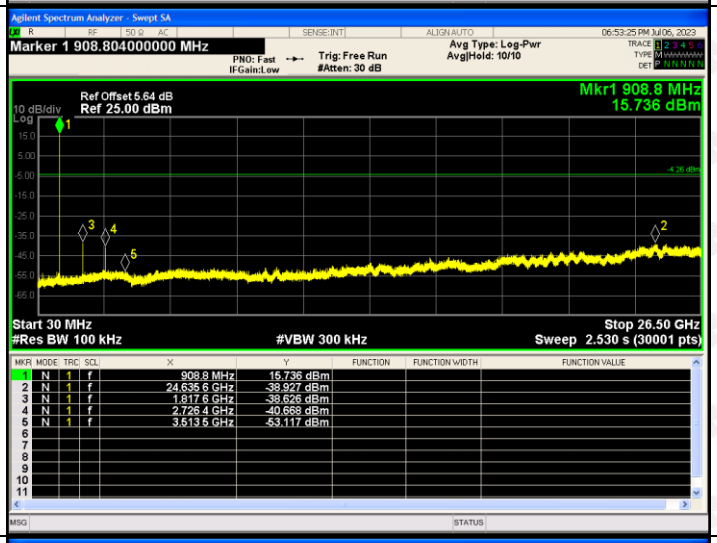
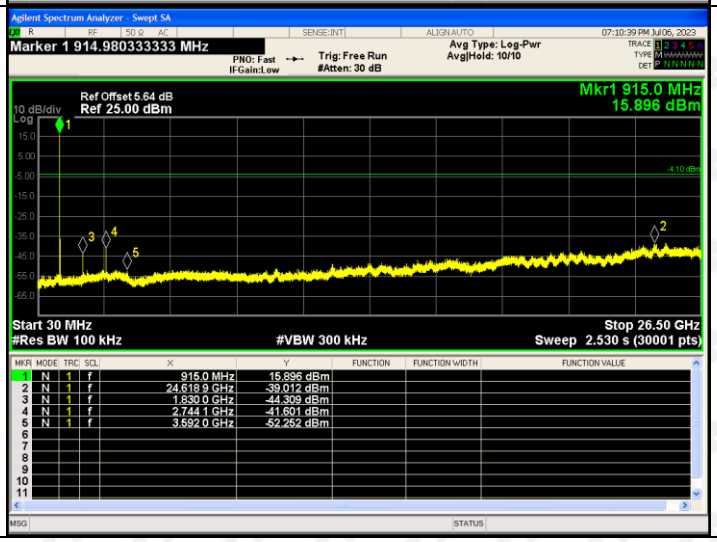
8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:
Blow 30MHz:
RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold
Above 30MHz:
RBW = 100KHz, VBW = 300KHz, Sweep = auto
Detector function = peak, Trace = max hold

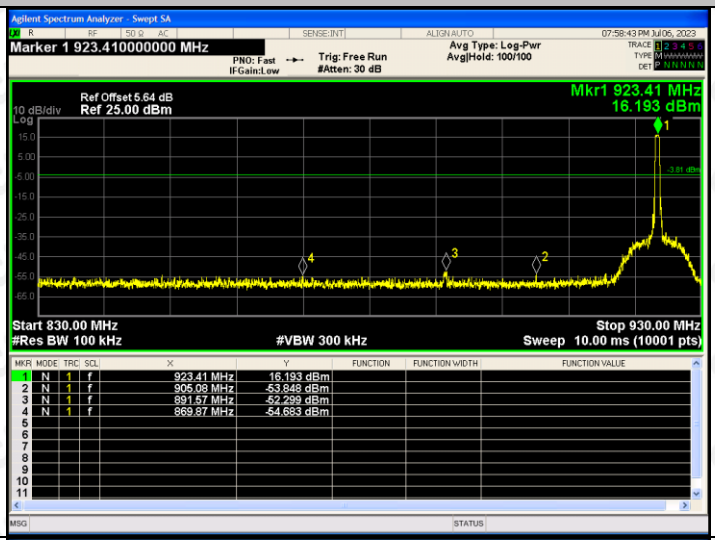
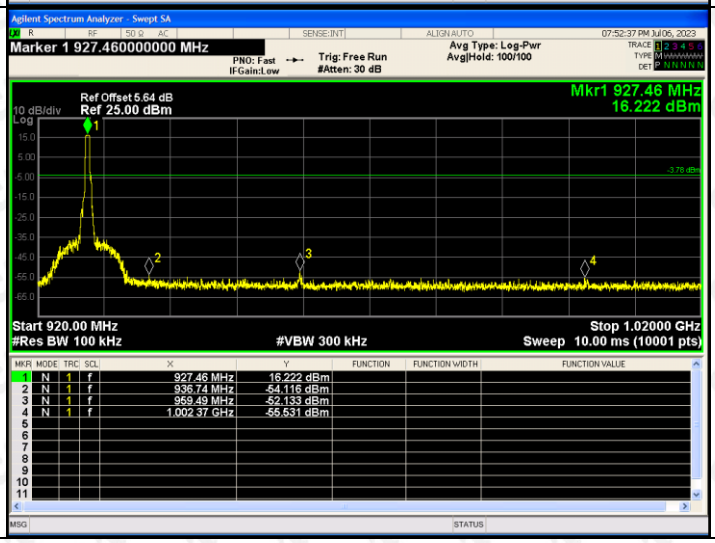
8.4 Test Result

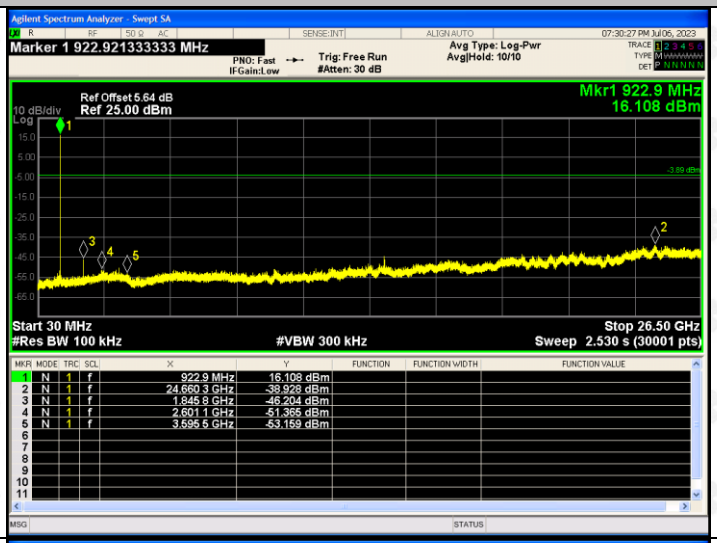
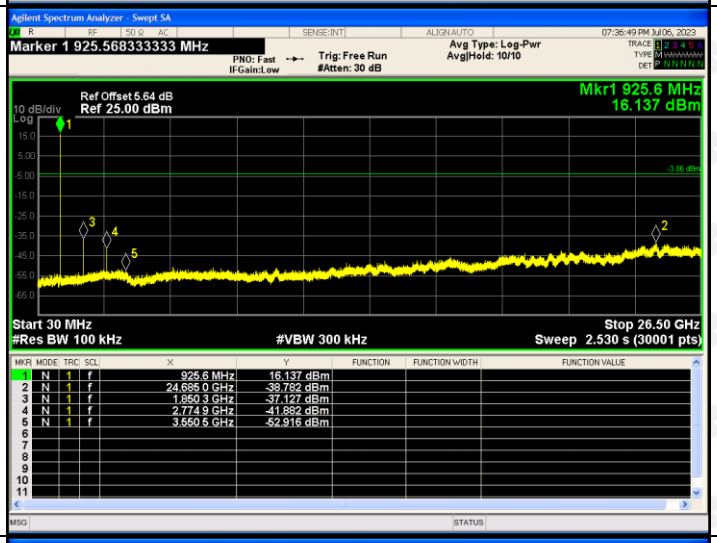
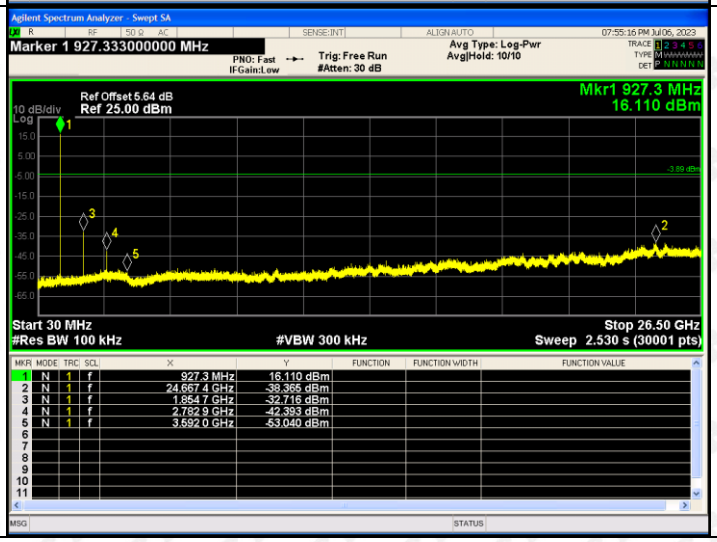
902.3-914.9MHz:

BAND EDGE Graphs			
LoRa/LCH			
LoRa/HCH			

RF Conducted Spurious Emissions Graphs		
LoRa/LCH		
LoRa/MCH		
LoRa/HCH		

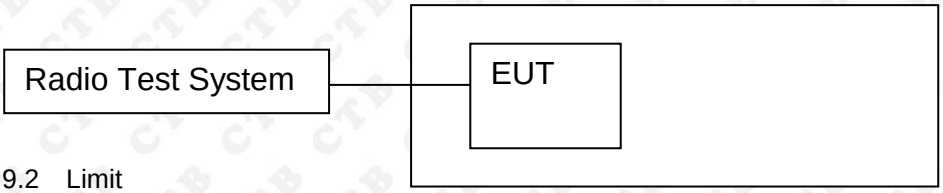
923.3-927.5MHz:

BAND EDGE Graphs			
LoRa/LCH			
LoRa/HCH			

RF Conducted Spurious Emissions Graphs		
LoRa/LCH		
LoRa/MCH		
LoRa/HCH		

9. COUDUCTED OUTPUT POWER

9.1 Block Diagram Of Test Setup



9.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3)	Output Power	1 watt or 30dBm	2400-2483.5	PASS

9.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Channel power measurement.
Sweep = auto; Detector Function = peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

9.4 Test Result

902.3-914.9MHz:

Mode	Channel.	Maximum Output Power [dBm]	Limit[dBm]	Verdict
LoRa	LCH	15.907	30	PASS
	MCH	15.751	30	PASS
	HCH	15.848	30	PASS

Duty Cycle

Mode	Channel.	Duty Cycle(%)	Correction Factor (dB)
LoRa	LCH	100	0
	MCH	100	0
	HCH	100	0

923.3-927.5MHz:

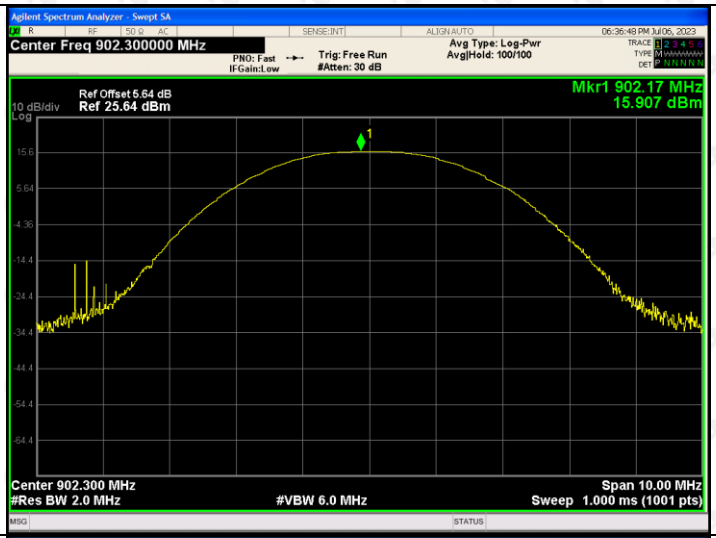
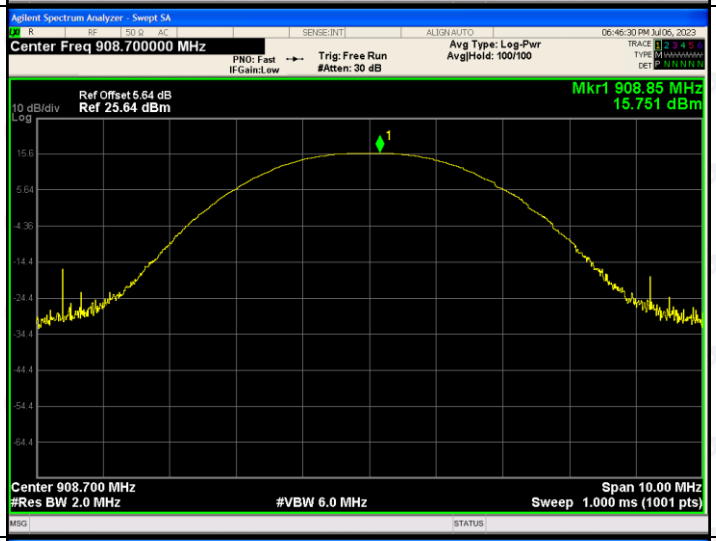
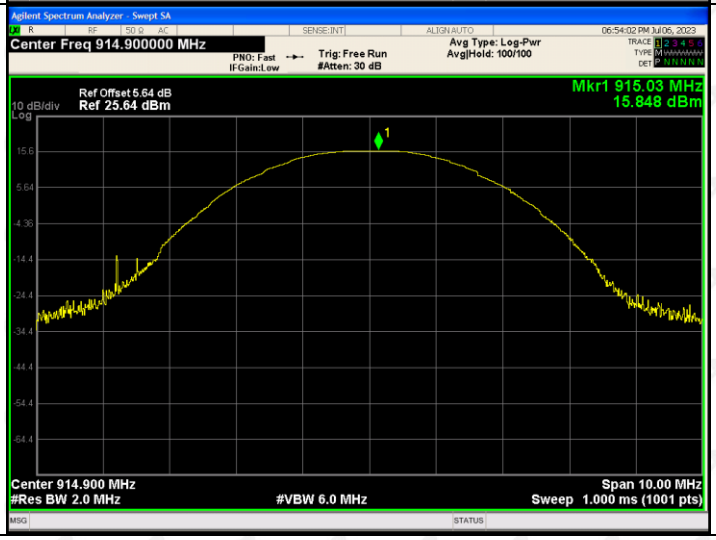
Mode	Channel.	Maximum Output Power [dBm]	Limit[dBm]	Verdict
LoRa	LCH	16.057	30	PASS
	MCH	16.063	30	PASS
	HCH	16.051	30	PASS

Duty Cycle

Mode	Channel.	Duty Cycle(%)	Correction Factor (dB)
LoRa	LCH	100	0
	MCH	100	0
	HCH	100	0

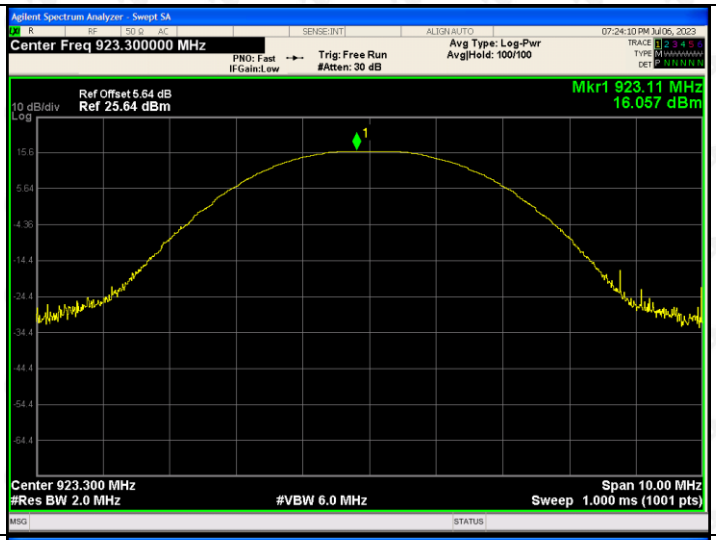
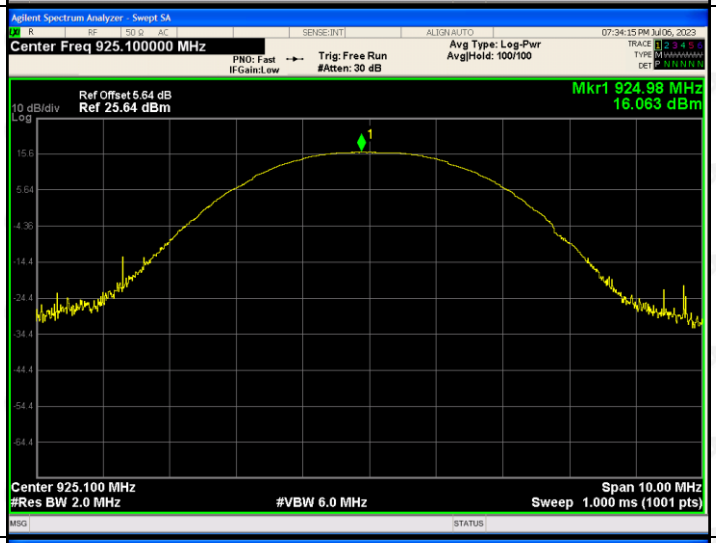
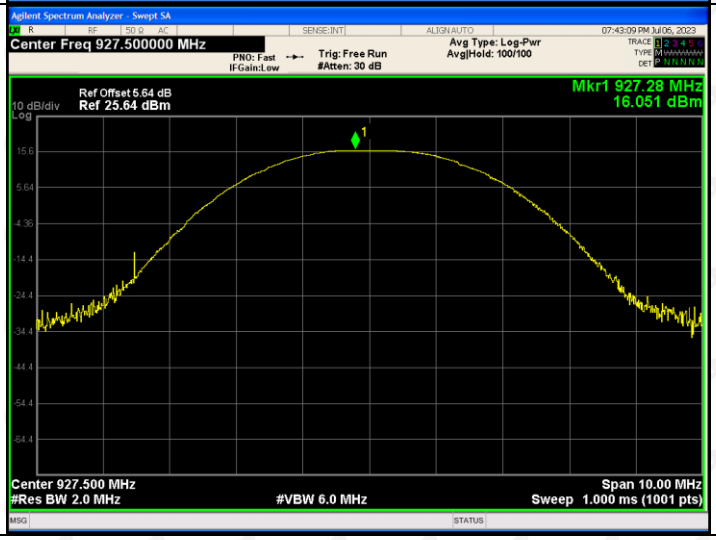
902.3-914.9MHz:

Test Graph:

LoRa Low channel		
LoRa Mid channel		
LoRa High channel		

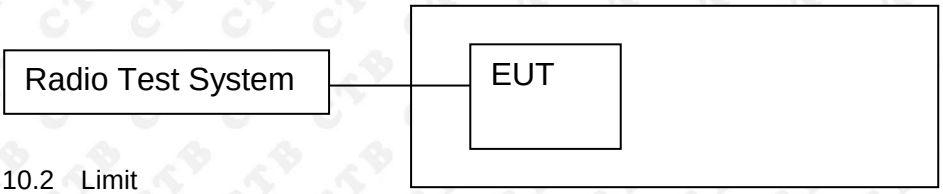
923.3-927.5MHz:

Test Graph:

LoRa Low channel		
LoRa Mid channel		
LoRa High channel		

10. 6DB OCCUPIED BANDWIDTH

10.1 Block Diagram Of Test Setup



10.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	>= 500KHz (6dB bandwidth)	902-928	PASS

10.3 Test procedure

1. Rem1. Set RBW = 100kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

10.4 Test Result

902.3-914.9MHz:

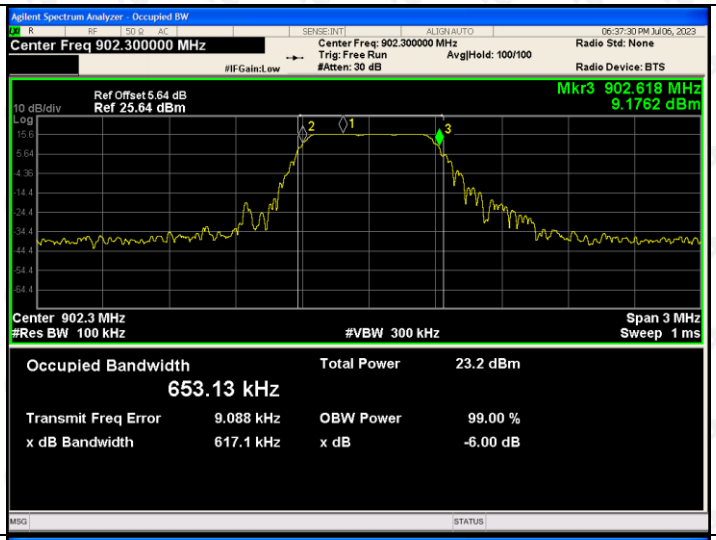
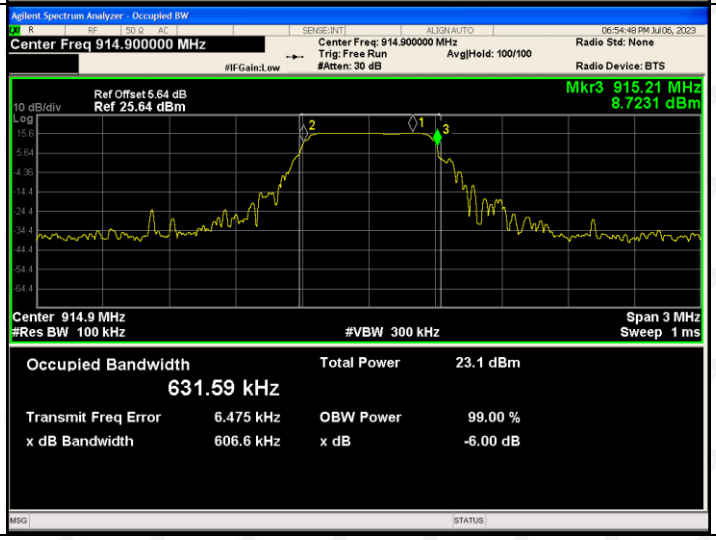
Test Mode	Frequency	6dB Bandwidth (MHz)	Result
LoRa	Low channel	0.617	PASS
	Mid channel	0.603	PASS
	High channel	0.607	PASS

923.3-927.5MHz:

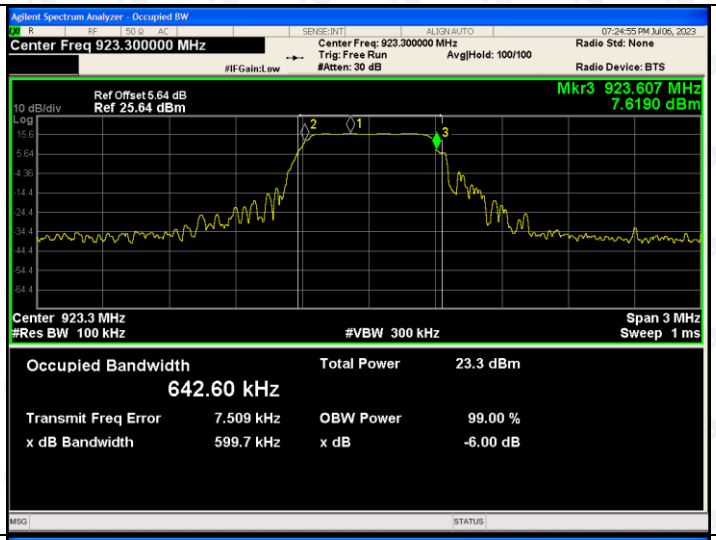
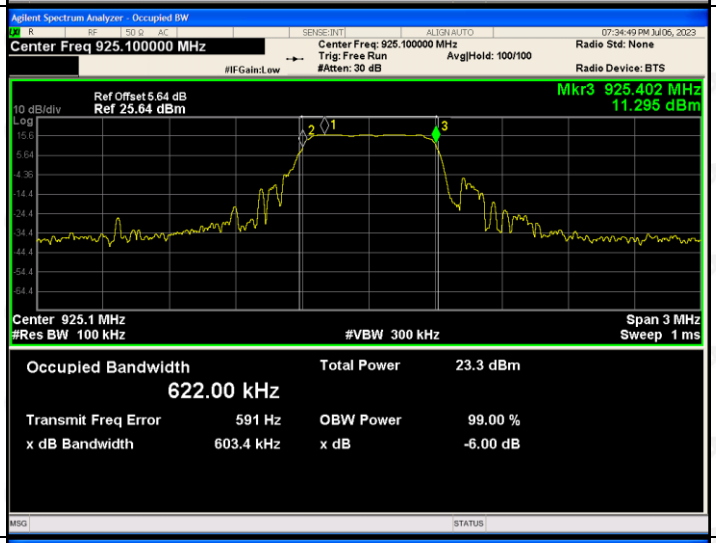
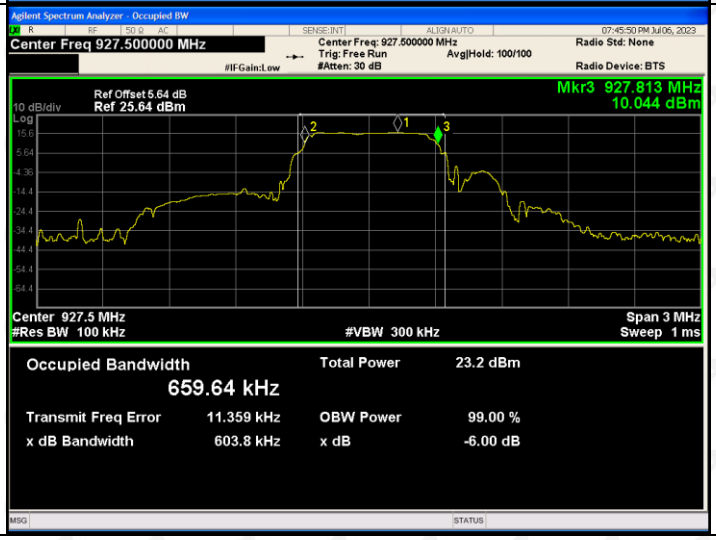
Test Mode	Frequency	6dB Bandwidth (MHz)	Result
LoRa	Low channel	0.6	PASS
	Mid channel	0.603	PASS
	High channel	0.604	PASS

Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

902.3-914.9MHz:
Test Graph:

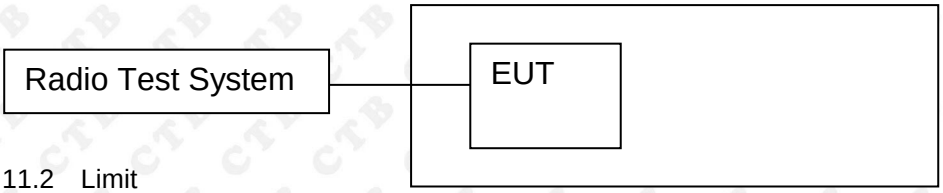
LoRa Low channel		
LoRa Mid channel		
LoRa High channel		

923.3-927.5MHz:
Test Graph:

LoRa Low channel		
LoRa Mid channel		
LoRa High channel		

11. POWER SPECTRAL DENSITY

11.1 Block Diagram Of Test Setup



11.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247	Power Spectral Density	8 dBm (in any 3KHz)	902-928	PASS

11.3 Test procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

11.4 Test Result

902.3-914.9MHz:

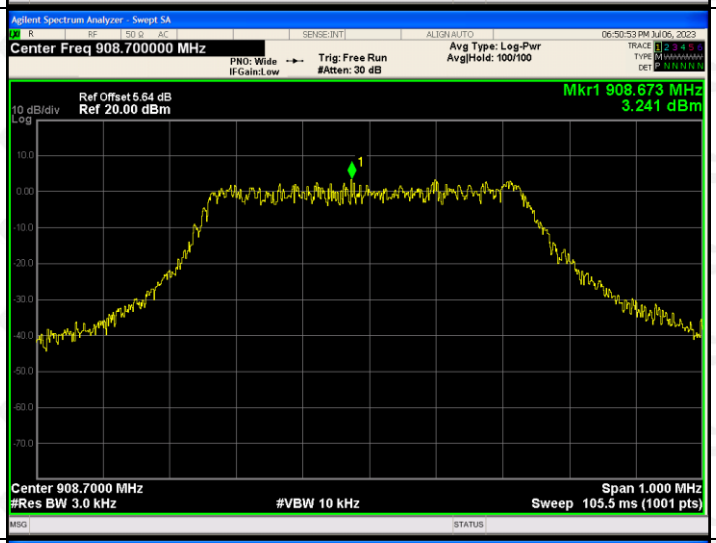
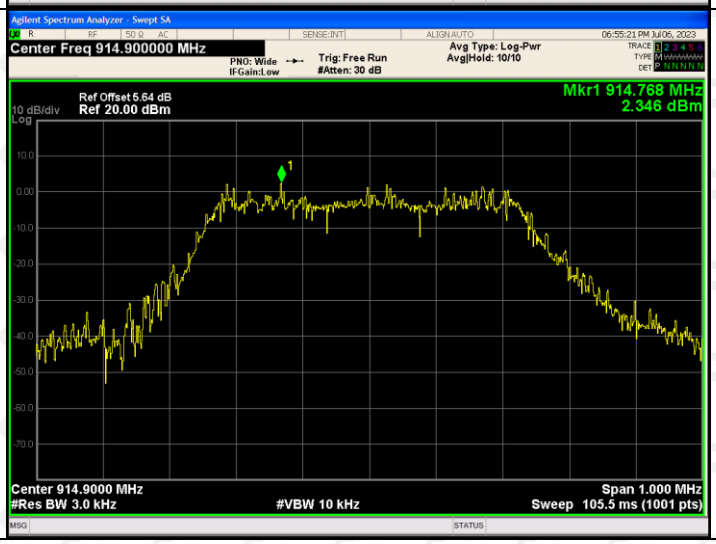
Mode	Channel.	Power Spectral Density (dBm/3KHz)	Limit(dBm/3KHz)	Verdict
LoRa	LCH	3.217	8	PASS
LoRa	MCH	3.241	8	PASS
LoRa	HCH	2.346	8	PASS

923.3-927.5MHz::

Mode	Channel.	Power Spectral Density (dBm/3KHz)	Limit(dBm/3KHz)	Verdict
LoRa	LCH	3.483	8	PASS
LoRa	MCH	2.526	8	PASS
LoRa	HCH	2.385	8	PASS

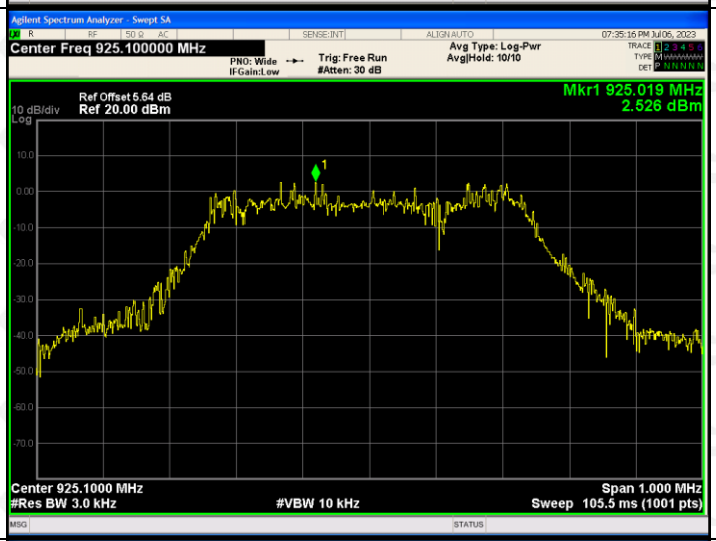
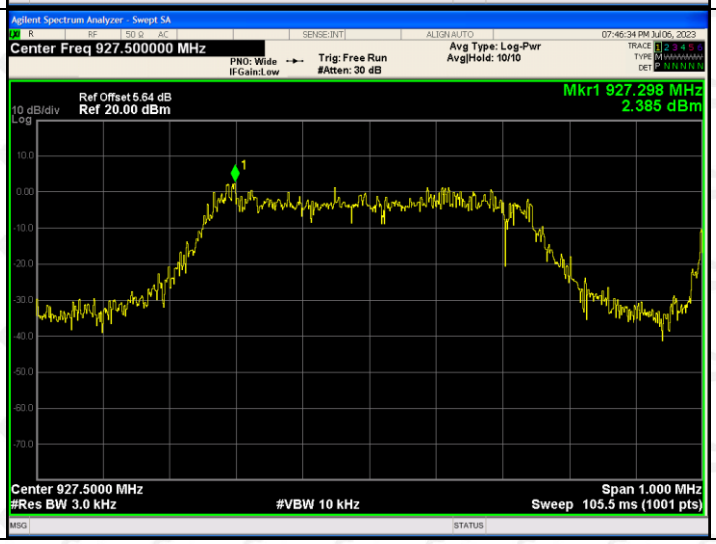
902.3-914.9MHz:

Test Graph

Graphs			
LoRa/LCH			
LoRa/MCH			
LoRa/HCH			

923.3-927.5MHz:

Test Graph

Graphs			
LoRa/LCH			
LoRa/MCH			
LoRa/HCH			

12. ANTENNA REQUIREMENT

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.
15.247(b) (4) requirement:
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.

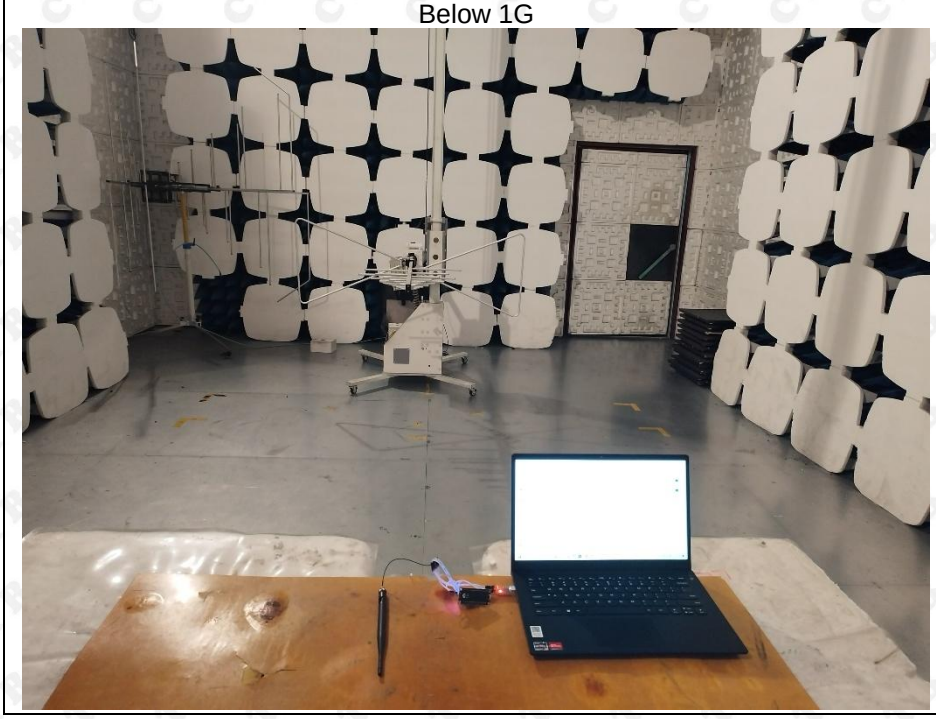
EUT Antenna:

The EUT antenna is External antenna. The best case gain of the antenna is 902.3-914.9MHz: 0.94dBi, 923.3-927.5MHz: 0.67dBi.

13. EUT TEST SETUP PHOTOGRAPHS

Radiated Emissions

Below 1G



Above 1G

Conducted emissions

※※※※※ **END OF REPORT** ※※※※※