

LoRa-FHSS-Spreading Factor 7

Test Engineer:	Smile Wang	Temperature:	20~26	°C
Test Date:	2024/3/31~2024/5/30	Relative Humidity:	40~51	%

TEST RESULTS DATA									
20dB and 99% Occupied Bandwidth and Hopping Channel Separation									
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
SF7		1	1	902.2	0.147	0.128	0.222	0.147	Pass
SF7		1	65	915	0.147	0.128	0.214	0.147	Pass
SF7		1	128	927.6	0.146	0.129	0.163	0.146	Pass

TEST RESULTS DATA						
Dwell Time						
Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
SF7	hopping	50	3.00	0.15	0.4	Pass

TEST RESULTS DATA						
Peak Power Table						
mode	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result	Power Setting
SF7	902.2	1	20.72	30.00	Pass	20
	915	1	20.82	30.00	Pass	20
	927.6	1	20.54	30.00	Pass	20

TEST RESULTS DATA		
Number of Hopping Frequency		
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
128	> 50	Pass

LoRa-FHSS-Spreading Factor 8

Test Engineer:	Smile Wang	Temperature:	20~26	°C
Test Date:	2024/3/31~2024/5/30	Relative Humidity:	40~51	%

TEST RESULTS DATA									
20dB and 99% Occupied Bandwidth and Hopping Channel Separation									
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
SF8		1	1	902.2	0.150	0.129	0.224	0.150	Pass
SF8		1	65	915	0.151	0.129	0.201	0.151	Pass
SF8		1	128	927.6	0.149	0.129	0.193	0.149	Pass

TEST RESULTS DATA						
Dwell Time						
Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
SF8	hopping	90.01	2.00	0.18	0.4	Pass

TEST RESULTS DATA						
Peak Power Table						
mode	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result	Power Setting
SF8	902.2	1	20.74	30.00	Pass	20
	915	1	20.79	30.00	Pass	20
	927.6	1	20.53	30.00	Pass	20

TEST RESULTS DATA		
Number of Hopping Frequency		
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
128	> 50	Pass

LoRa-FHSS-Spreading Factor 9

Test Engineer:	Smile Wang	Temperature:	20~26	°C
Test Date:	2024/3/31~2024/5/30	Relative Humidity:	40~51	%

TEST RESULTS DATA									
20dB and 99% Occupied Bandwidth and Hopping Channel Separation									
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
SF9		1	1	902.2	0.149	0.131	0.205	0.149	Pass
SF9		1	65	915	0.147	0.130	0.212	0.147	Pass
SF9		1	128	927.6	0.149	0.130	0.193	0.149	Pass

TEST RESULTS DATA						
Dwell Time						
Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
SF9	hopping	152.02	1.00	0.15	0.4	Pass

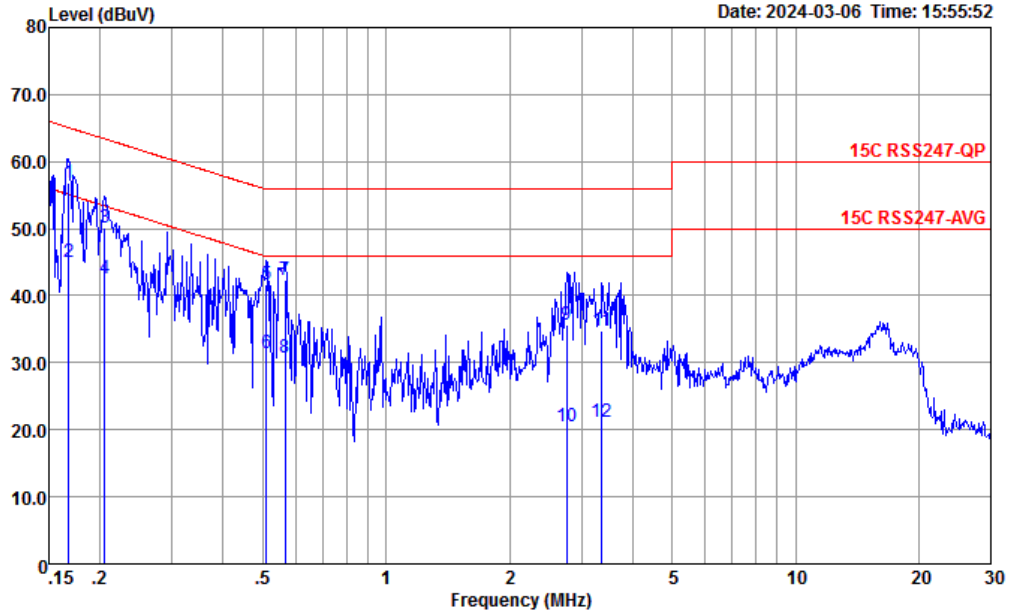
TEST RESULTS DATA						
Peak Power Table						
DH	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result	Power Setting
SF9	902.2	1	20.75	30.00	Pass	20
	915	1	20.78	30.00	Pass	20
	927.6	1	20.53	30.00	Pass	20

TEST RESULTS DATA		
Number of Hopping Frequency		
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
128	> 50	Pass



Appendix B. AC Conducted Emission Test Results

Test Engineer :	Amos Zhang	Temperature :	25.3~26.2°C
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	Phase :	Line

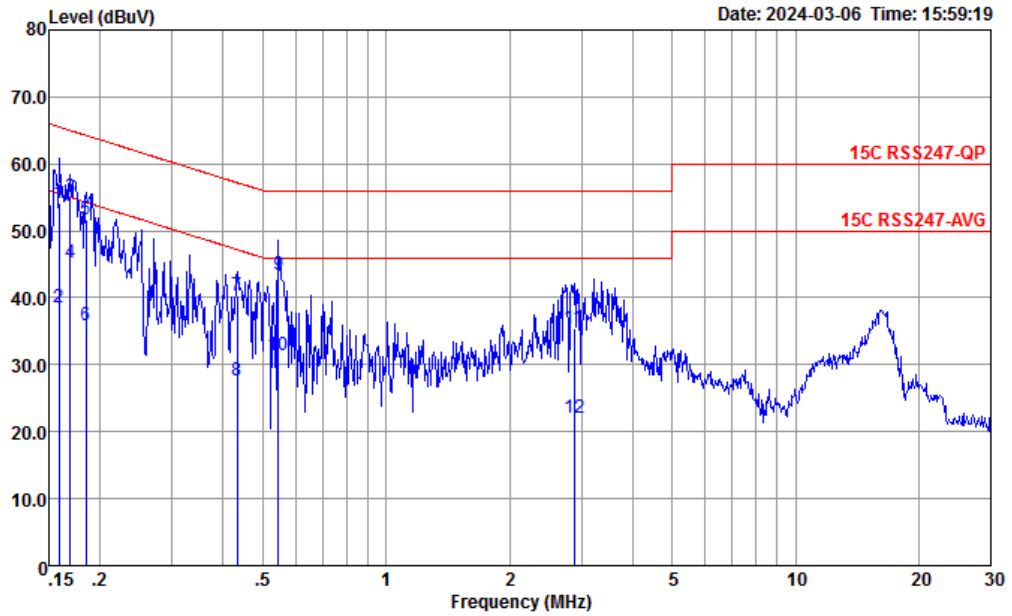


Site : CO01-KS
 Condition : 15C RSS247-QP LISN-060105-L 2023 LINE

	Freq	Level	Over	Limit	Read	LISN	Cable	Remark
	MHz	dBuV	Limit	Line	Level	Factor	Loss	
			dB	dBuV	dBuV	dB	dB	
1 *	0.168	56.76	-8.32	65.08	46.30	0.04	10.42	QP
2	0.168	45.06	-10.02	55.08	34.60	0.04	10.42	Average
3	0.205	50.04	-13.36	63.40	39.60	0.03	10.41	QP
4	0.205	42.64	-10.76	53.40	32.20	0.03	10.41	Average
5	0.510	41.68	-14.32	56.00	31.49	-0.03	10.22	QP
6	0.510	31.38	-14.62	46.00	21.19	-0.03	10.22	Average
7	0.567	42.35	-13.65	56.00	32.21	-0.05	10.19	QP
8	0.567	30.65	-15.35	46.00	20.51	-0.05	10.19	Average
9	2.765	35.58	-20.42	56.00	25.60	-0.09	10.07	QP
10	2.765	20.48	-25.52	46.00	10.50	-0.09	10.07	Average
11	3.364	34.77	-21.23	56.00	24.79	-0.09	10.07	QP
12	3.364	21.27	-24.73	46.00	11.29	-0.09	10.07	Average



Test Engineer :	Amos Zhang	Temperature :	25.3~26.2°C
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral



Site : CO01-KS
 Condition : 15C RSS247-QP LISN-060105-N 2023 NEUTRAL

	Freq	Level	Over	Limit	Read	LISN	Cable	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.159	54.06	-11.46	65.52	43.60	0.04	10.42	QP
2	0.159	38.66	-16.86	55.52	28.20	0.04	10.42	Average
3	0.169	55.06	-9.93	64.99	44.60	0.04	10.42	QP
4 *	0.169	45.16	-9.83	54.99	34.70	0.04	10.42	Average
5	0.184	51.66	-12.62	64.28	41.20	0.05	10.41	QP
6	0.184	35.96	-18.32	54.28	25.50	0.05	10.41	Average
7	0.433	40.40	-16.80	57.20	30.20	-0.06	10.26	QP
8	0.433	27.70	-19.50	47.20	17.50	-0.06	10.26	Average
9	0.546	43.43	-12.57	56.00	33.30	-0.07	10.20	QP
10	0.546	31.33	-14.67	46.00	21.20	-0.07	10.20	Average
11	2.884	35.44	-20.56	56.00	25.50	-0.13	10.07	QP
12	2.884	22.14	-23.86	46.00	12.20	-0.13	10.07	Average

Note:

1. Level(dBμV) = Read Level(dBμV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBμV) – Limit Line(dBμV)



Appendix C. Radiated Spurious Emission

Remark: For RSE different Spread Factor, only the test data of SF9 is shown in the report according to the maximum power.

902.2~927.6MHz

LORA FHSS SF=9 (Band Edge @ 3m)

	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.2MHz		393.75	37.15	-8.85	46	44.85	21.51	2.9	32.11	-	-	P	H
		902.03	106.9	-	-	104.63	29.18	4.37	31.28	-	-	P	H
		410.24	34.35	-11.65	46	40.96	22.54	2.96	32.11	-	-	P	V
		902.03	116.51	-	-	114.24	29.18	4.37	31.28	-	-	P	V
915MHz		399.57	37.71	-8.29	46	45.16	21.74	2.92	32.11	-	-	P	H
		914.64	108.2	-	-	105.44	29.55	4.4	31.19	-	-	P	H
		395.69	35.53	-10.47	46	43.15	21.58	2.91	32.11	-	-	P	V
		914.64	115.3	-	-	112.54	29.55	4.4	31.19	-	-	P	V
927.6MHz		391.81	34.6	-11.40	46	42.95	21.48	3.02	32.85	-	-	P	H
		927.60	110.72	-	-	110.63	27.16	4.66	31.73	-	-	P	H
		463.59	34.51	-11.49	46	41.42	22.82	3.29	33.02	-	-	P	V
		927.60	116.26	-	-	116.17	27.16	4.66	31.73	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



LORA FHSS SF=9 125KHZ (Harmonic @ 3m)

	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	Limit	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.2MHz		1052.80	45.84	-28.16	74	77.80	28.50	4.70	65.16	-	-	P	H
		2706.40	54.18	-19.82	74	79.09	33.06	7.58	65.55	333	245	P	H
		2706.40	52.25	-1.75	54	77.16	33.06	7.58	65.55	333	245	A	H
		5413.60	52.03	-21.97	74	71.44	35.25	10.79	65.45	100	265	P	H
		5413.60	50.10	-3.90	54	69.51	35.25	10.79	65.45	100	265	A	H
		1031.20	49.30	-24.70	74	80.91	28.87	4.66	65.14	-	-	P	V
		2706.40	52.39	-21.61	74	77.30	33.06	7.58	65.55	100	306	P	V
		2706.40	50.46	-3.54	54	75.37	33.06	7.58	65.55	100	306	A	V
		5413.60	54.06	-19.94	74	73.47	35.25	10.79	65.45	300	327	P	V
		5413.60	52.13	-1.87	54	71.54	35.25	10.79	65.45	300	327	A	V
915MHz		1056.40	46.02	-27.98	74	78.03	28.44	4.71	65.16	-	-	P	H
		2744.80	53.70	-20.30	74	78.74	32.83	7.63	65.50	111	246	P	H
		2744.80	51.77	-2.23	54	76.81	32.83	7.63	65.50	111	246	A	H
		5489.80	52.13	-36.07	88.20	71.74	34.94	10.87	65.42	-	-	P	H
		1057.60	49.37	-24.63	74	81.40	28.42	4.71	65.16	-	-	P	V
		2744.80	52.24	-21.76	74	77.28	32.83	7.63	65.50	300	279	P	V
		2744.80	50.31	-3.69	54	75.35	32.83	7.63	65.50	300	279	A	V
		5489.80	55.72	-39.94	95.30	75.33	34.94	10.87	65.42	-	-	P	V
927.6MHz		1063.60	46.50	-27.50	74	79.74	27.20	4.72	65.16	-	-	P	H
		2782.60	51.72	-22.28	74	77.40	32.10	7.68	65.46	100	335	P	H
		2782.60	49.79	-4.21	54	75.47	32.10	7.68	65.46	100	335	A	H
		5565.40	54.33	-36.39	90.72	73.95	34.80	10.96	65.38	-	-	P	H
		1079.80	48.17	-25.83	74	81.75	26.84	4.76	65.18	-	-	P	V
		2782.60	53.02	-20.98	74	78.70	32.10	7.68	65.46	300	328	P	V
		2782.60	51.09	-2.91	54	76.77	32.10	7.68	65.46	300	328	A	V
		5565.40	55.77	-40.49	96.26	75.39	34.80	10.96	65.38	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	Peak or Average
H/V	Horizontal or Vertical



A calculation example for radiated spurious emission is shown as below:

Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
	(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.2MHz	2707.00	51.94	-22.06	74	76.85	33.06	7.58	65.55	333	245	P	H
	2707.00	50.01	-3.99	54	74.92	33.06	7.58	65.55	333	245	A	H

- Level(dBμV/m) = Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
- Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2707MHz:

- Level(dBμV/m)
 = Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
 = 33.06(dB/m) + 7.58(dB) + 76.85(dBμV) – 65.55 (dB)
 = 51.94 (dBμV/m)
- Over Limit(dB)
 = Level(dBμV/m) – Limit Line(dBμV/m)
 = 51.94(dBμV/m) – 74(dBμV/m)
 = -22.06(dB)

For Average Limit @ 2707MHz:

- AV Level(dBμV/m)
 = Peak Level(dBμV/m) +Duty cycle correction factor (dB)
 = 51.94 (dBμV/m) + (-1.93) (dB)
 = 50.01 (dBμV/m)
- Over Limit(dB)
 = Level(dBμV/m) – Limit Line(dBμV/m)
 = 50.01(dBμV/m) – 54(dBμV/m)
 = -3.99(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.



Appendix D. Radiated Spurious Emission Plots

Note symbol

-L	Low channel location
-R	High channel location



LoRa 125KHz FHSS SF=9 (Band Edge @ 3m)

LoRa	902.2~927.6 Band Edge @ 3m																																																																													
ANT	LoRa 125KHz FHSS SF=9 CH01 902.2																																																																													
	Horizontal	Vertical																																																																												
Peak	<table border="1"> <thead> <tr> <th>Over</th> <th>L</th> <th>Read</th> <th>Cable/Antenna</th> <th>Preamp</th> <th>A/Pos</th> <th>T/Pos</th> <th>Remark</th> <th>Poi/Phas</th> </tr> <tr> <th>Freq</th> <th>Level</th> <th>Limit</th> <th>Loss</th> <th>Factor</th> <th>Factor</th> <th>cm</th> <th>deg</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>393.75</td> <td>37.15</td> <td>-8.85</td> <td>46.00</td> <td>44.85</td> <td>2.90</td> <td>21.51</td> <td>32.11</td> <td>--- Peak HORIZONTAL</td> </tr> <tr> <td>2</td> <td>902.83</td> <td>106.00</td> <td>-----</td> <td>104.63</td> <td>4.37</td> <td>29.18</td> <td>31.28</td> <td>---</td> <td>--- Peak HORIZONTAL</td> </tr> </tbody> </table>	Over	L	Read	Cable/Antenna	Preamp	A/Pos	T/Pos	Remark	Poi/Phas	Freq	Level	Limit	Loss	Factor	Factor	cm	deg		1	393.75	37.15	-8.85	46.00	44.85	2.90	21.51	32.11	--- Peak HORIZONTAL	2	902.83	106.00	-----	104.63	4.37	29.18	31.28	---	--- Peak HORIZONTAL	<table border="1"> <thead> <tr> <th>Over</th> <th>L</th> <th>Read</th> <th>Cable/Antenna</th> <th>Preamp</th> <th>A/Pos</th> <th>T/Pos</th> <th>Remark</th> <th>Poi/Phas</th> </tr> <tr> <th>Freq</th> <th>Level</th> <th>Limit</th> <th>Loss</th> <th>Factor</th> <th>Factor</th> <th>cm</th> <th>deg</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>439.24</td> <td>34.35</td> <td>-11.65</td> <td>46.00</td> <td>49.96</td> <td>2.96</td> <td>22.54</td> <td>32.11</td> <td>--- Peak VERTICAL</td> </tr> <tr> <td>2</td> <td>902.83</td> <td>116.31</td> <td>-----</td> <td>114.24</td> <td>4.37</td> <td>29.18</td> <td>31.28</td> <td>---</td> <td>--- Peak VERTICAL</td> </tr> </tbody> </table>	Over	L	Read	Cable/Antenna	Preamp	A/Pos	T/Pos	Remark	Poi/Phas	Freq	Level	Limit	Loss	Factor	Factor	cm	deg		1	439.24	34.35	-11.65	46.00	49.96	2.96	22.54	32.11	--- Peak VERTICAL	2	902.83	116.31	-----	114.24	4.37	29.18	31.28	---	--- Peak VERTICAL
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LoRa 125KHz FHSS SF=9 (Harmonic @ 3m)

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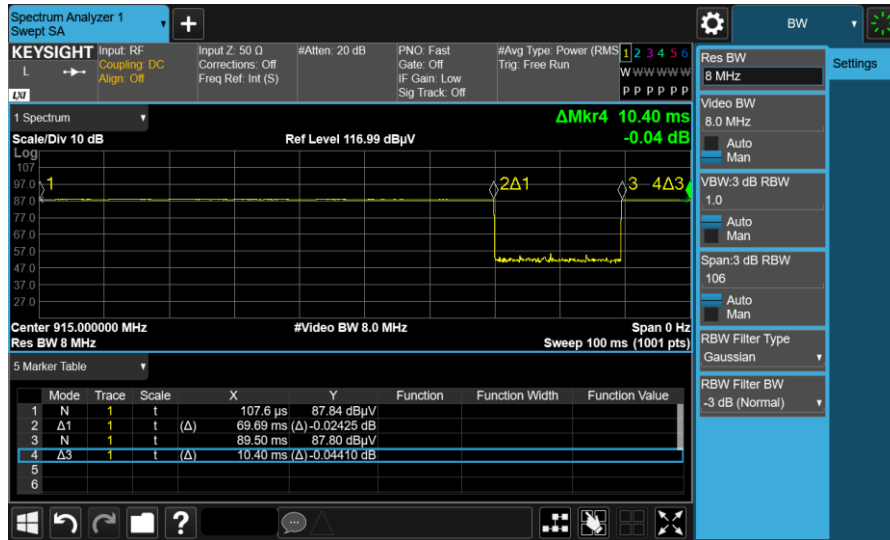
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Appendix E. Duty Cycle Plots

LORA FHSS SF=9 125KHZ on time Plot



Note:

1. Worst case Duty cycle = on time/100 milliseconds = 80.09 / 100 = 80.09 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -1.93 dB