

FCC Test Report

FCC ID : 2AAS9-TBMH110
Equipment : MiniHub Pro
Model No. : TBMH110
Applicant : Browan Communications Inc.
Address : No. 15-1 Zhonghua Road, Hsinchu Industrial
Park, Hukou, Hsinchu, Taiwan (R.O.C.), 30352.
Standard : 47 CFR FCC Part 15.247
Received Date : Jul. 07, 2020
Tested Date : Jul. 13 ~ Jul. 17, 2020

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

Reviewed by:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Local Support Equipment List	7
1.3	Test Setup Chart	7
1.4	The Equipment List	8
1.5	Test Standards	9
1.6	Reference Guidance	9
1.7	Deviation from Test Standard and Measurement Procedure.....	9
1.8	Measurement Uncertainty	9
2	TEST CONFIGURATION	10
2.1	Testing Condition	10
2.2	The Worst Test Modes and Channel Details	10
3	TRANSMITTER TEST RESULTS.....	11
3.1	Conducted Emissions.....	11
3.2	6dB and Occupied Bandwidth	16
3.3	RF Output Power	19
3.4	Power Spectral Density	21
3.5	Unwanted Emissions into Restricted Frequency Bands	23
3.6	Emissions in Non-Restricted Frequency Bands	33
4	TEST LABORATORY INFORMATION	35

Release Record

Report No.	Version	Description	Issued Date
FR070702	Rev. 01	Initial issue	Aug. 03, 2020

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.690MHz 54.86 (Margin -1.14dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 46.32MHz 34.39 (Margin -5.61dB) - PK	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 26.25	Pass
15.247(a)(2)	6dB Bandwidth	Meet the requirement of limit	Pass
15.247(e)	Power Spectral Density	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information					
Frequency Range (MHz)	Ch. Freq. (MHz)	Channel Number	Data Rate (bit/sec)	Spread Factor	Channel Bandwidth (kHz)
902 ~ 928	923.3 ~ 927.5	1 ~ 8 [8]	980 ~ 21900	12 ~ 7	500
Note 1: RF output power specifies that Maximum Conducted (Average) Output Power.					
Note 2: The device uses Lora modulation.					

1.1.2 Antenna Details

Ant. No.	Type	Connector	Gain (dBi)
1	PIFA	IPEX	0

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	100-240Vac
-------------------	------------

1.1.4 Accessories

N/A

1.1.5 Channel List

Channel	Frequency(MHz)
1	923.3
2	923.9
3	924.5
4	925.1
5	925.7
6	926.3
7	926.9
8	927.5

1.1.6 Test Tool and Duty Cycle

Test Tool	Putty, version: 0.60.0.0	
Duty Cycle and Duty Factor	Duty Cycle (%)	Duty Factor (dB)
	100%	0

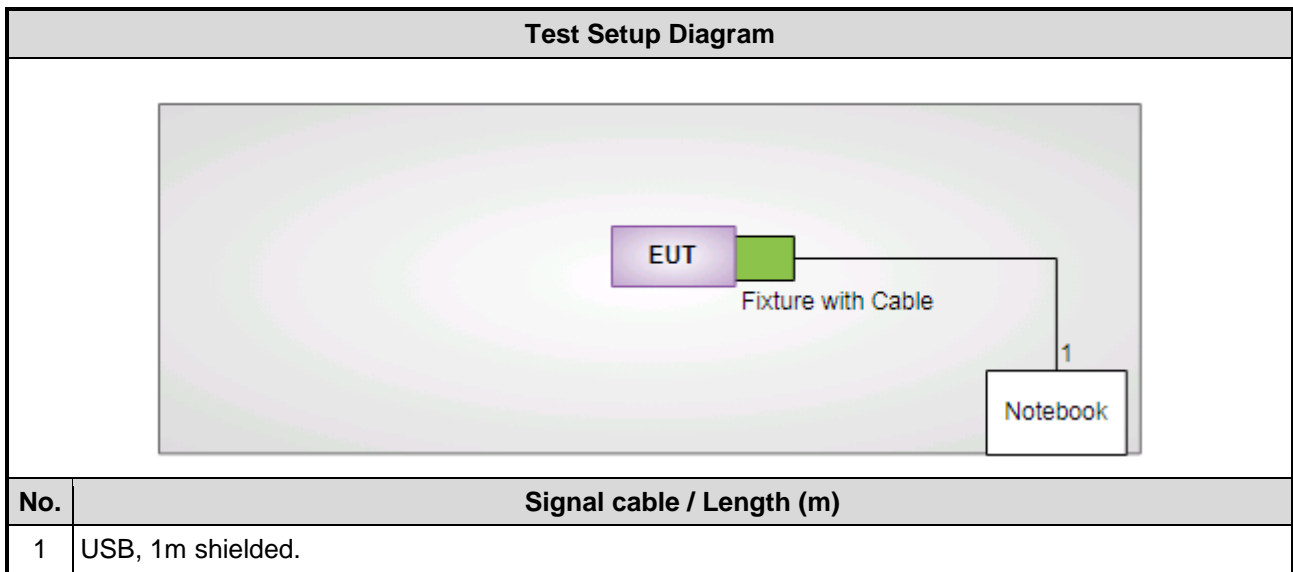
1.1.7 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)	
	923.3	927.5
Lora	26	26

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Notebook	DELL	Latitude E5470	3J5JVF2	---
2	Fixture with Cable	---	---	---	Provided by applicant.

1.3 Test Setup Chart



1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Jul. 17, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Dec. 12, 2019	Dec. 11, 2020
LISN	R&S	ENV216	101579	Mar. 12, 2020	Mar. 11, 2021
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Dec. 20, 2019	Dec. 19, 2020
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 22, 2019	Oct. 21, 2020
50 ohm terminal (Support Unit)	NA	50	04	Jun. 05, 2020	Jun. 04, 2021
Measurement Software	AUDIX	e3	6.120210k	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Jul. 13, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Dec. 17, 2019	Dec. 16, 2020
Receiver	R&S	ESR3	101657	Feb. 14, 2020	Feb. 13, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 10, 2020	Jul. 09, 2021
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 12, 2019	Dec. 11, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2019	Nov. 14, 2020
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2019	Nov. 12, 2020
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 07, 2019	Oct. 06, 2020
Preamplifier	EMC	EMC02325	980225	Jul. 03, 2020	Jul. 02, 2021
Preamplifier	Agilent	83017A	MY39501308	Oct. 08, 2019	Oct. 07, 2020
Preamplifier	EMC	EMC184045B	980192	Aug. 01, 2019	Jul. 31, 2020
RF Cable	EMC	EMC104-SM-SM-8000	181106	Oct. 07, 2019	Oct. 06, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Oct. 07, 2019	Oct. 06, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Oct. 07, 2019	Oct. 06, 2020
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	160502	Oct. 07, 2019	Oct. 06, 2020
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 07, 2019	Oct. 06, 2020
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Oct. 07, 2019	Oct. 06, 2020
Measurement Software	AUDIX	e3	6.120210g	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Jul. 16, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Apr. 30, 2020	Apr. 29, 2021
Spectrum Analyzer	R&S	FSV40	101499	Jan. 09, 2020	Jan. 08, 2021
Power Meter	Anritsu	ML2495A	1241002	Oct. 23, 2019	Oct. 22, 2020
Power Sensor	Anritsu	MA2411B	1207366	Oct. 23, 2019	Oct. 22, 2020
DC POWER SOURCE	GW INSTRON	GPC-6030D	GES855395	Oct. 29, 2019	Oct. 28, 2020
AC POWER SOURCE	APC	AFC-500W	F312060012	Dec. 02, 2019	Dec. 01, 2020
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.247
ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2))

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	±34.130 Hz
Conducted power	±0.808 dB
Power density	±0.583 dB
Conducted emission	±2.715 dB
AC conducted emission	±2.92 dB
Radiated emission ≤ 1GHz	±3.41 dB
Radiated emission > 1GHz	±4.59 dB

2 Test Configuration

2.1 Testing Condition

Test Laboratory	International Certification Corp.
Test Site	CO01-WS, 03CH01-WS, TH01-WS
Address of Test Site	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- ISED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Test Frequency (MHz)	Channel Bandwidth (kHz)	Modulation / SF
Conducted Emissions Radiated Emissions ≤1GHz Radiated Emissions >1GHz Maximum Output Power 6dB Bandwidth Power Spectral Density	923.3 / 927.5	500	LORA / 12
NOTE: The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The Z-plane results were found as the worst case and were shown in this report.			

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

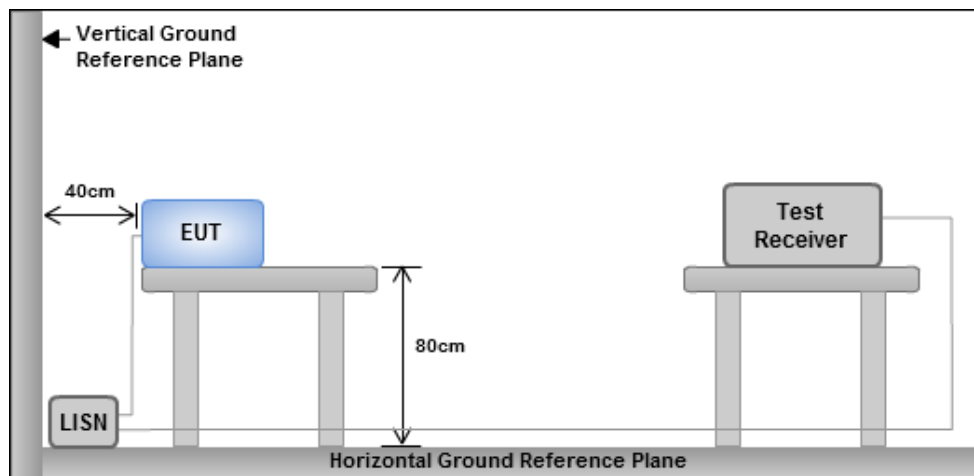
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 Test Procedures

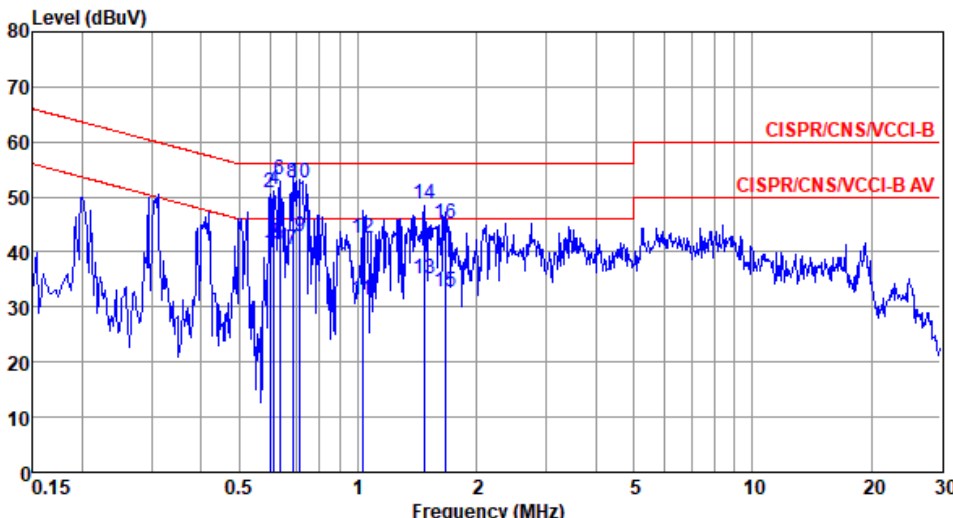
1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V / 60Hz.

3.1.3 Test Setup



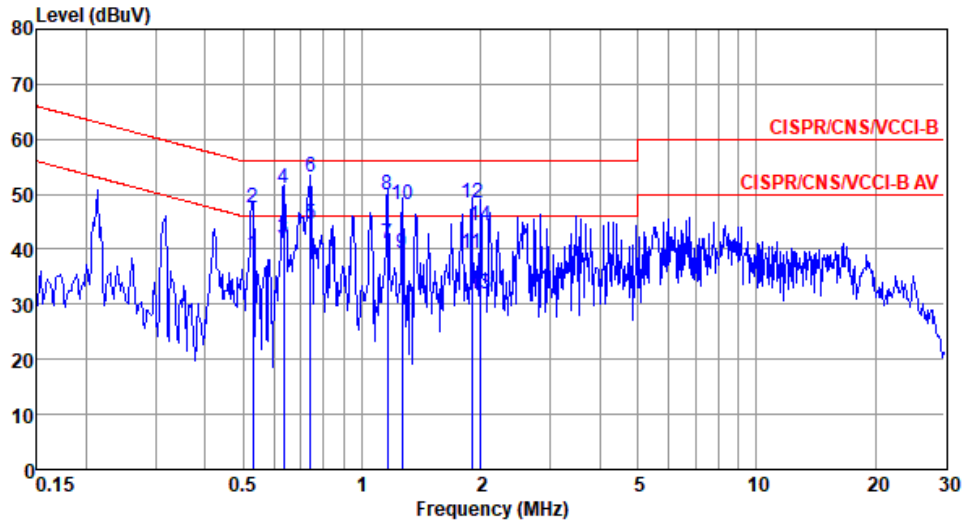
- Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3																																																																																																																																																									
Power Phase	Line																																																																																																																																																											
Test by : Alex Tsai Temperature: 25°C Humidity: 67%																																																																																																																																																												
																																																																																																																																																												
<table border="1"> <thead> <tr> <th></th> <th>Freq MHz</th> <th>Level dBuV</th> <th>Limit Line dBuV</th> <th>Over Limit dB</th> <th>Read Level dBuV</th> <th>LISN factor dB</th> <th>cable loss dB</th> <th>Remark</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.598</td><td>39.84</td><td>46.00</td><td>-6.16</td><td>29.83</td><td>9.63</td><td>0.10</td><td>Average</td></tr> <tr><td>2</td><td>0.598</td><td>50.83</td><td>56.00</td><td>-5.17</td><td>40.82</td><td>9.63</td><td>0.10</td><td>QP</td></tr> <tr><td>3</td><td>0.614</td><td>41.58</td><td>46.00</td><td>-4.42</td><td>31.57</td><td>9.63</td><td>0.10</td><td>Average</td></tr> <tr><td>4</td><td>0.614</td><td>51.43</td><td>56.00</td><td>-4.57</td><td>41.42</td><td>9.63</td><td>0.10</td><td>QP</td></tr> <tr><td>5</td><td>0.634</td><td>41.46</td><td>46.00</td><td>-4.54</td><td>31.44</td><td>9.63</td><td>0.10</td><td>Average</td></tr> <tr><td>6*</td><td>0.634</td><td>53.02</td><td>56.00</td><td>-2.98</td><td>43.00</td><td>9.63</td><td>0.10</td><td>QP</td></tr> <tr><td>7</td><td>0.683</td><td>40.32</td><td>46.00</td><td>-5.68</td><td>30.30</td><td>9.63</td><td>0.10</td><td>Average</td></tr> <tr><td>8</td><td>0.683</td><td>52.48</td><td>56.00</td><td>-3.52</td><td>42.46</td><td>9.63</td><td>0.10</td><td>QP</td></tr> <tr><td>9</td><td>0.712</td><td>42.66</td><td>46.00</td><td>-3.34</td><td>32.63</td><td>9.63</td><td>0.11</td><td>Average</td></tr> <tr><td>10</td><td>0.712</td><td>52.69</td><td>56.00</td><td>-3.31</td><td>42.66</td><td>9.63</td><td>0.11</td><td>QP</td></tr> <tr><td>11</td><td>1.027</td><td>31.41</td><td>46.00</td><td>-14.59</td><td>21.34</td><td>9.63</td><td>0.12</td><td>Average</td></tr> <tr><td>12</td><td>1.027</td><td>42.36</td><td>56.00</td><td>-13.64</td><td>32.29</td><td>9.63</td><td>0.12</td><td>QP</td></tr> <tr><td>13</td><td>1.472</td><td>35.26</td><td>46.00</td><td>-10.74</td><td>25.14</td><td>9.64</td><td>0.15</td><td>Average</td></tr> <tr><td>14</td><td>1.472</td><td>48.65</td><td>56.00</td><td>-7.35</td><td>38.53</td><td>9.64</td><td>0.15</td><td>QP</td></tr> <tr><td>15</td><td>1.671</td><td>32.84</td><td>46.00</td><td>-13.16</td><td>22.71</td><td>9.64</td><td>0.16</td><td>Average</td></tr> <tr><td>16</td><td>1.671</td><td>45.16</td><td>56.00</td><td>-10.84</td><td>35.03</td><td>9.64</td><td>0.16</td><td>QP</td></tr> </tbody> </table>					Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark	1	0.598	39.84	46.00	-6.16	29.83	9.63	0.10	Average	2	0.598	50.83	56.00	-5.17	40.82	9.63	0.10	QP	3	0.614	41.58	46.00	-4.42	31.57	9.63	0.10	Average	4	0.614	51.43	56.00	-4.57	41.42	9.63	0.10	QP	5	0.634	41.46	46.00	-4.54	31.44	9.63	0.10	Average	6*	0.634	53.02	56.00	-2.98	43.00	9.63	0.10	QP	7	0.683	40.32	46.00	-5.68	30.30	9.63	0.10	Average	8	0.683	52.48	56.00	-3.52	42.46	9.63	0.10	QP	9	0.712	42.66	46.00	-3.34	32.63	9.63	0.11	Average	10	0.712	52.69	56.00	-3.31	42.66	9.63	0.11	QP	11	1.027	31.41	46.00	-14.59	21.34	9.63	0.12	Average	12	1.027	42.36	56.00	-13.64	32.29	9.63	0.12	QP	13	1.472	35.26	46.00	-10.74	25.14	9.64	0.15	Average	14	1.472	48.65	56.00	-7.35	38.53	9.64	0.15	QP	15	1.671	32.84	46.00	-13.16	22.71	9.64	0.16	Average	16	1.671	45.16	56.00	-10.84	35.03	9.64	0.16	QP
	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark																																																																																																																																																				
1	0.598	39.84	46.00	-6.16	29.83	9.63	0.10	Average																																																																																																																																																				
2	0.598	50.83	56.00	-5.17	40.82	9.63	0.10	QP																																																																																																																																																				
3	0.614	41.58	46.00	-4.42	31.57	9.63	0.10	Average																																																																																																																																																				
4	0.614	51.43	56.00	-4.57	41.42	9.63	0.10	QP																																																																																																																																																				
5	0.634	41.46	46.00	-4.54	31.44	9.63	0.10	Average																																																																																																																																																				
6*	0.634	53.02	56.00	-2.98	43.00	9.63	0.10	QP																																																																																																																																																				
7	0.683	40.32	46.00	-5.68	30.30	9.63	0.10	Average																																																																																																																																																				
8	0.683	52.48	56.00	-3.52	42.46	9.63	0.10	QP																																																																																																																																																				
9	0.712	42.66	46.00	-3.34	32.63	9.63	0.11	Average																																																																																																																																																				
10	0.712	52.69	56.00	-3.31	42.66	9.63	0.11	QP																																																																																																																																																				
11	1.027	31.41	46.00	-14.59	21.34	9.63	0.12	Average																																																																																																																																																				
12	1.027	42.36	56.00	-13.64	32.29	9.63	0.12	QP																																																																																																																																																				
13	1.472	35.26	46.00	-10.74	25.14	9.64	0.15	Average																																																																																																																																																				
14	1.472	48.65	56.00	-7.35	38.53	9.64	0.15	QP																																																																																																																																																				
15	1.671	32.84	46.00	-13.16	22.71	9.64	0.16	Average																																																																																																																																																				
16	1.671	45.16	56.00	-10.84	35.03	9.64	0.16	QP																																																																																																																																																				
Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB). Note 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).																																																																																																																																																												

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3
Power Phase	Neutral		

Test by : Alex Tsai Temperature: 25°C Humidity: 67%



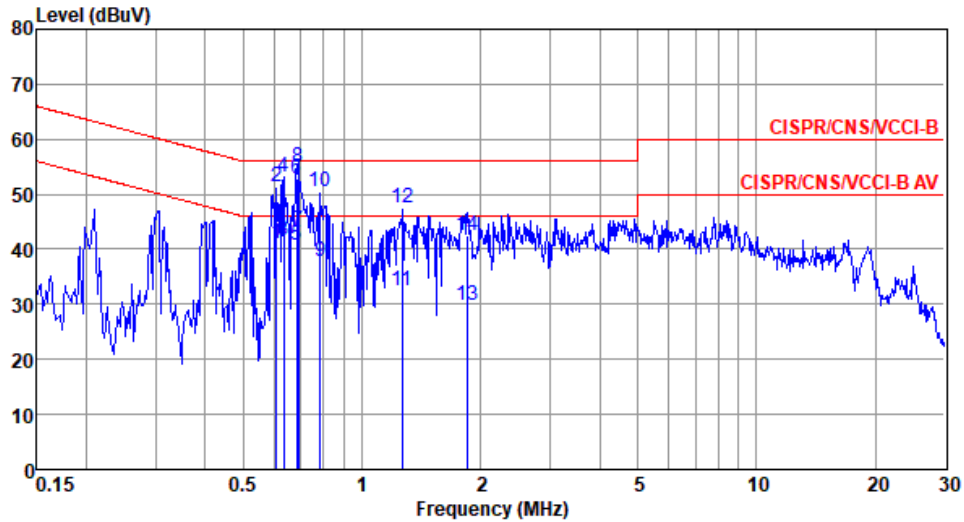
	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.529	39.07	46.00	-6.93	29.15	9.65	0.09	Average
2	0.529	47.52	56.00	-8.48	37.60	9.65	0.09	QP
3	0.634	41.94	46.00	-4.06	32.00	9.65	0.10	Average
4	0.634	51.00	56.00	-5.00	41.06	9.65	0.10	QP
5*	0.739	44.63	46.00	-1.37	34.68	9.65	0.11	Average
6	0.739	53.22	56.00	-2.78	43.27	9.65	0.11	QP
7	1.160	40.99	46.00	-5.01	31.00	9.65	0.13	Average
8	1.160	50.00	56.00	-6.00	40.01	9.65	0.13	QP
9	1.262	39.16	46.00	-6.84	29.15	9.65	0.14	Average
10	1.262	48.12	56.00	-7.88	38.11	9.65	0.14	QP
11	1.898	39.38	46.00	-6.62	29.28	9.66	0.18	Average
12	1.898	48.38	56.00	-7.62	38.28	9.66	0.18	QP
13	2.001	31.81	46.00	-14.19	21.71	9.66	0.18	Average
14	2.001	44.14	56.00	-11.86	34.04	9.66	0.18	QP

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

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
------------------------	-----------	-------------------------	-------

Power Phase	Line
--------------------	------

Test by : Alex Tsai Temperature: 25°C Humidity: 67%

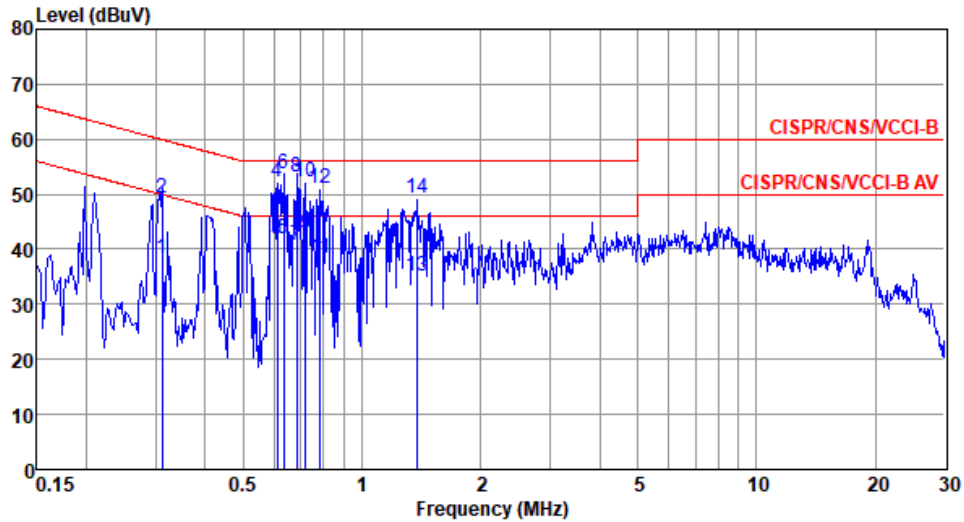


	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.608	41.18	46.00	-4.82	31.17	9.63	0.10	Average
2	0.608	51.37	56.00	-4.63	41.36	9.63	0.10	QP
3	0.634	41.56	46.00	-4.44	31.54	9.63	0.10	Average
4	0.634	53.23	56.00	-2.77	43.21	9.63	0.10	QP
5	0.683	40.74	46.00	-5.26	30.72	9.63	0.10	Average
6	0.683	52.81	56.00	-3.19	42.79	9.63	0.10	QP
7	0.690	43.28	46.00	-2.72	33.26	9.63	0.10	Average
8*	0.690	54.86	56.00	-1.14	44.84	9.63	0.10	QP
9	0.783	37.83	46.00	-8.17	27.79	9.63	0.11	Average
10	0.783	50.60	56.00	-5.40	40.56	9.63	0.11	QP
11	1.262	32.38	46.00	-13.62	22.28	9.63	0.14	Average
12	1.262	47.49	56.00	-8.51	37.39	9.63	0.14	QP
13	1.848	29.82	46.00	-16.18	19.67	9.64	0.17	Average
14	1.848	42.63	56.00	-13.37	32.48	9.64	0.17	QP

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

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
Power Phase	Neutral		

Test by : Alex Tsai Temperature: 25°C Humidity: 67%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.312	38.42	49.93	-11.51	28.54	9.65	0.07	Average
2	0.312	49.38	59.93	-10.55	39.50	9.65	0.07	QP
3	0.611	41.79	46.00	-4.21	31.86	9.65	0.10	Average
4	0.611	52.14	56.00	-3.86	42.21	9.65	0.10	QP
5	0.634	41.86	46.00	-4.14	31.92	9.65	0.10	Average
6*	0.634	53.76	56.00	-2.24	43.82	9.65	0.10	QP
7	0.683	40.82	46.00	-5.18	30.88	9.65	0.10	Average
8	0.683	53.23	56.00	-2.77	43.29	9.65	0.10	QP
9	0.720	42.81	46.00	-3.19	32.86	9.65	0.11	Average
10	0.720	52.28	56.00	-3.72	42.33	9.65	0.11	QP
11	0.783	38.37	46.00	-7.63	28.42	9.65	0.11	Average
12	0.783	50.96	56.00	-5.04	41.01	9.65	0.11	QP
13	1.374	35.15	46.00	-10.85	25.12	9.65	0.15	Average
14	1.374	49.22	56.00	-6.78	39.19	9.65	0.15	QP

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

3.2 6dB and Occupied Bandwidth

3.2.1 Limit of 6dB Bandwidth

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

3.2.2 Test Procedures

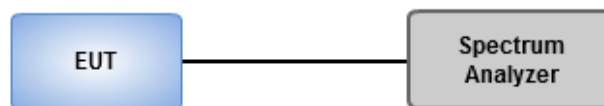
6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set resolution bandwidth (RBW) = 10kHz, Video bandwidth = 30kHz.
2. Detector = Sample, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

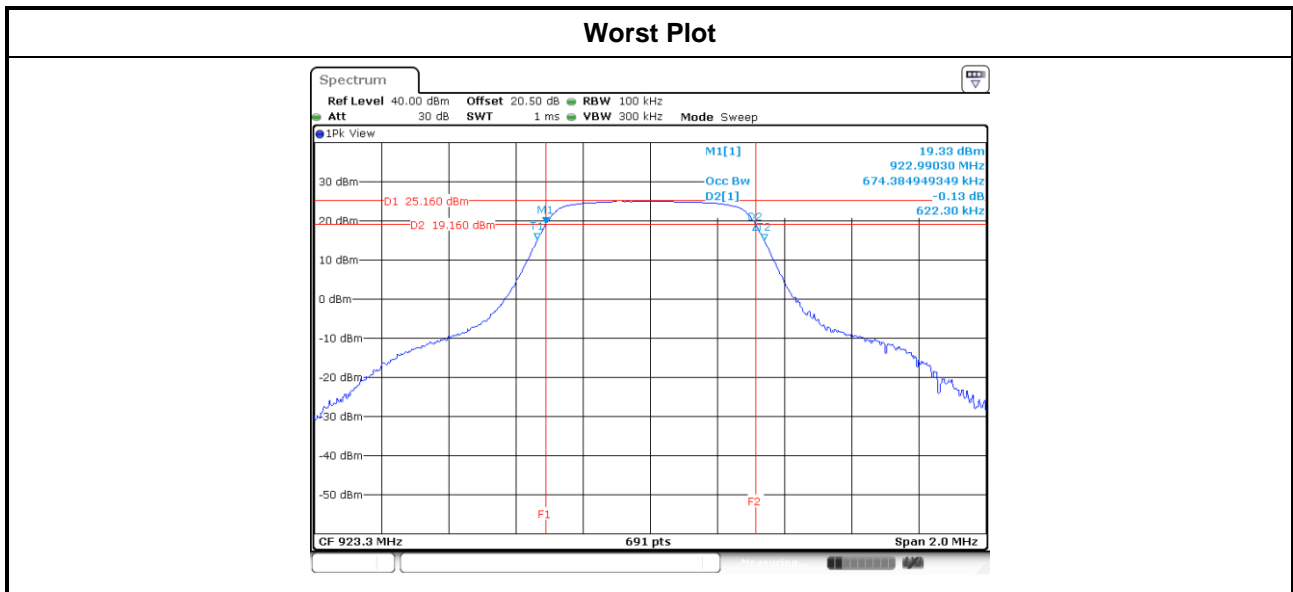
3.2.3 Test Setup



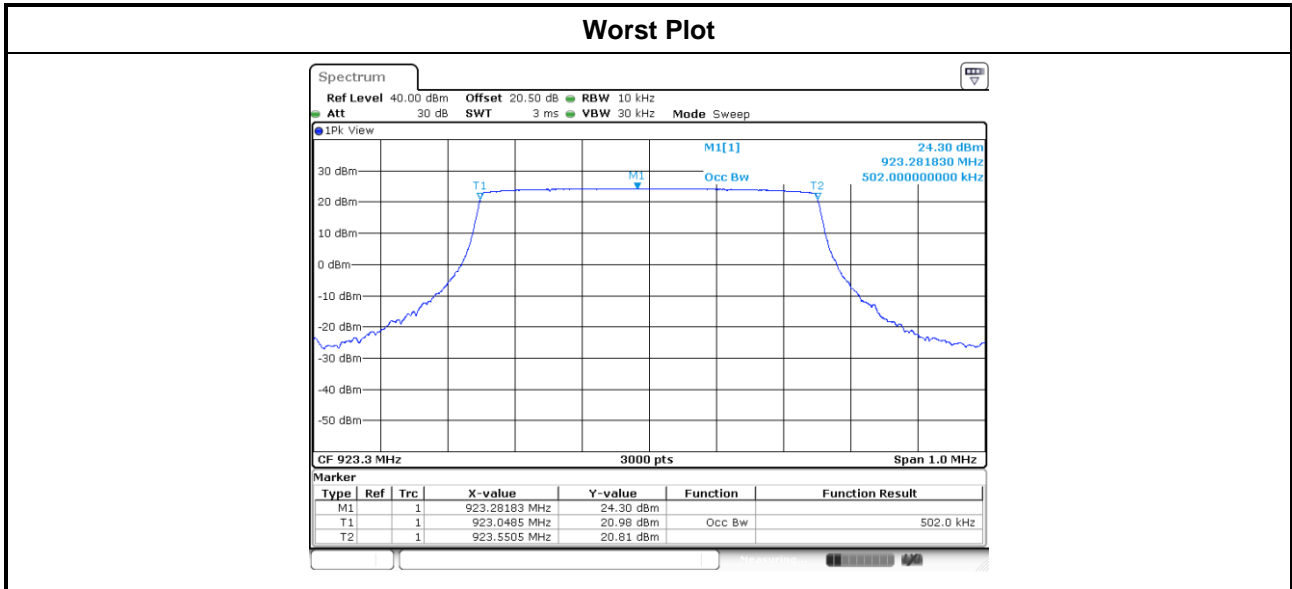
3.2.4 Test Result of 6dB and Occupied Bandwidth

Ambient Condition	23°C / 63%	Tested By	Brad Wu
--------------------------	------------	------------------	---------

Modulation / SF	Freq. (MHz)	6dB Bandwidth (MHz)	Limit (MHz)
Lora / 12	923.3	0.622	0.5
Lora / 12	927.5	0.619	0.5



Modulation / SF	Freq. (MHz)	99% Occupied Bandwidth (MHz)
Lora / 12	923.3	0.502
Lora / 12	927.5	0.501



3.3 RF Output Power

3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

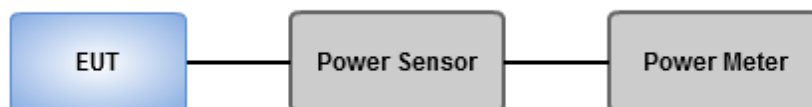
- Antenna gain \leq 6dBi, no any corresponding reduction is in output power limit.
- Antenna gain $>$ 6dBi

Transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi

3.3.2 Test Procedures

- Maximum Peak Conducted Output Power
 - Spectrum analyzer**
 1. Set RBW = 1MHz, VBW = 3MHz, Detector = Peak.
 2. Sweep time = auto, Trace mode = max hold, Allow trace to fully stabilize.
 3. Use the spectrum analyzer channel power measurement function with the band limits set equal to the DTS bandwidth edges.
 - Power meter**
 1. A broadband Peak RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.
- Maximum Conducted Output Power
 - Power meter**
 1. A broadband Average RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.

3.3.3 Test Setup



3.3.4 Test Result of Maximum Output Power

Ambient Condition	23°C / 63%	Tested By	Brad Wu
--------------------------	------------	------------------	---------

Modulation / SF	Freq. (MHz)	Output Power (mW)	Output Power (dBm)	Limit (dBm)
Lora / 12	923.3	421.6965	26.25	30
Lora / 12	927.5	384.5918	25.85	30

3.4 Power Spectral Density

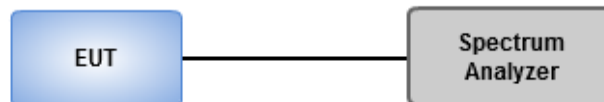
3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

3.4.2 Test Procedures

- Maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit.
 1. Set the RBW = 3kHz, VBW = 10kHz.
 2. Detector = Peak, Sweep time = auto couple.
 3. Trace mode = max hold, allow trace to fully stabilize.
 4. Use the peak marker function to determine the maximum amplitude level.
- Maximum (average) conducted output power was used to demonstrate compliance to the fundamental output power limit.
 1. Set the RBW = 3kHz, VBW = 10 kHz.
 2. Detector = RMS, Sweep time = auto couple.
 3. Employ trace averaging (RMS) mode over a minimum of 100 traces
 4. Use the peak marker function to determine the maximum amplitude level.

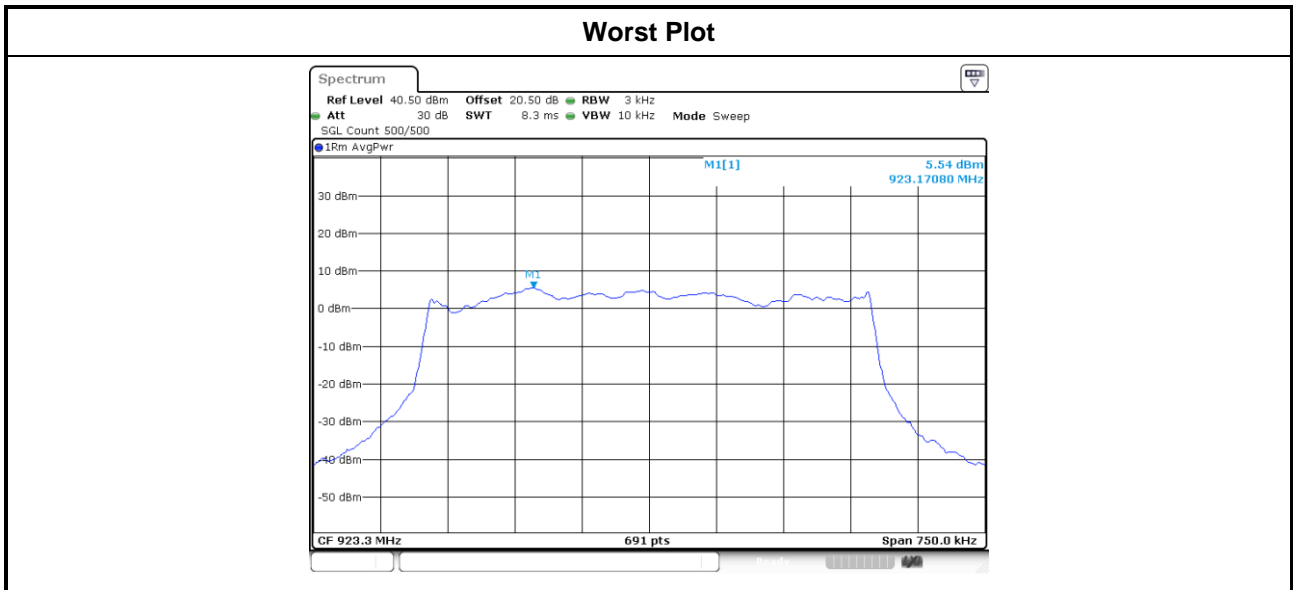
3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Ambient Condition	23°C / 63%	Tested By	Brad Wu
--------------------------	------------	------------------	---------

Modulation / SF	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
Lora / 12	923.3	5.54	8.00
Lora / 12	927.5	5.49	8.00



3.5 Unwanted Emissions into Restricted Frequency Bands

3.5.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Quasi-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.5.2 Test Procedures

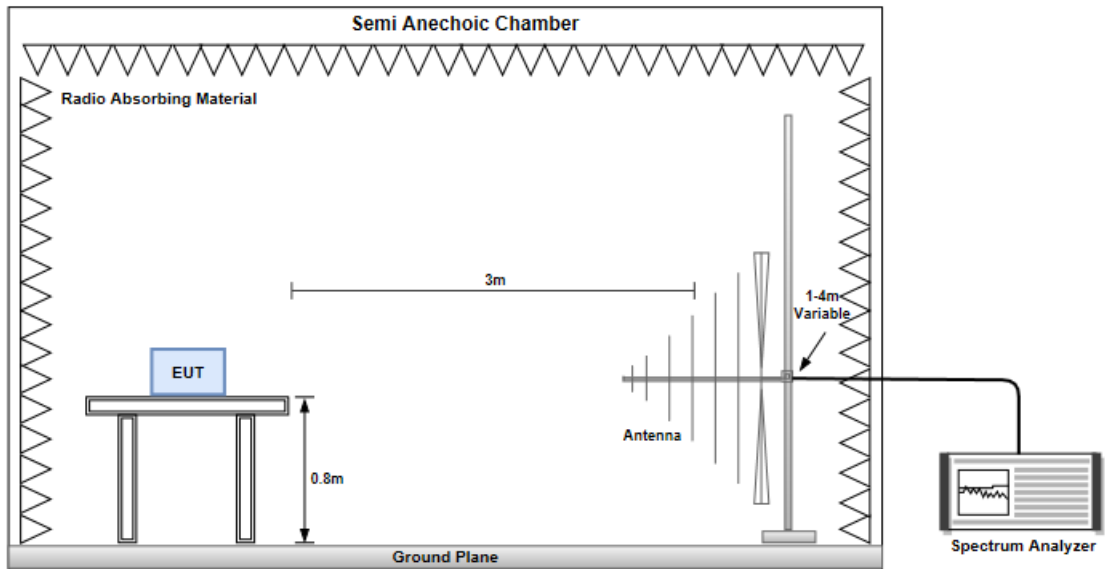
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

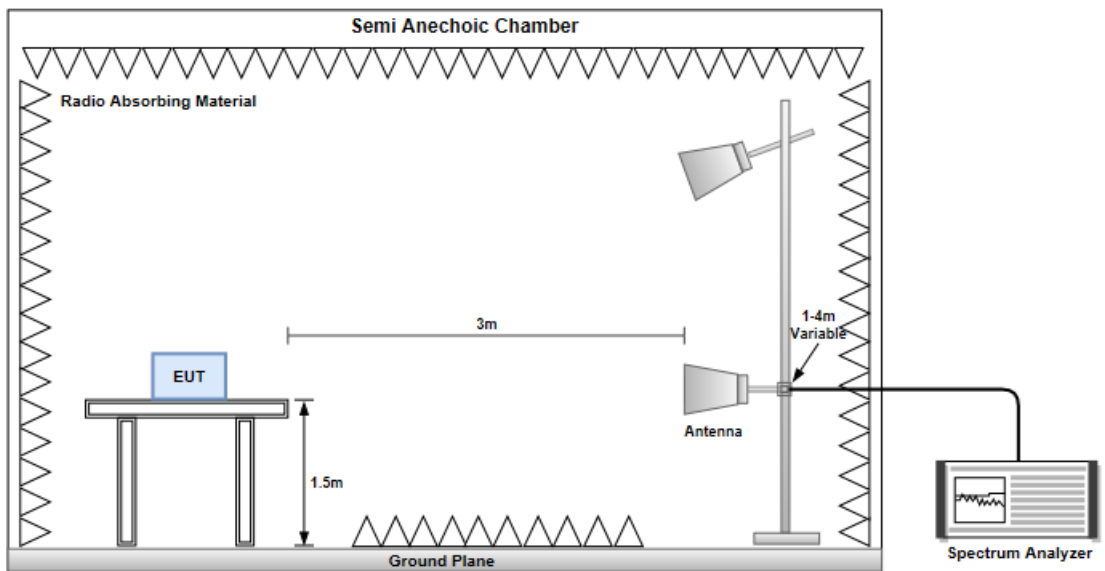
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

3.5.3 Test Setup

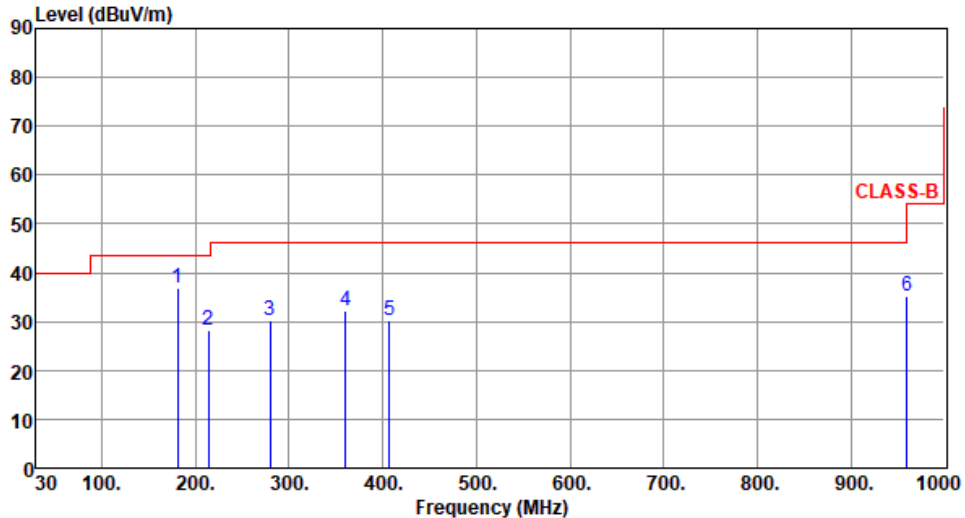
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz

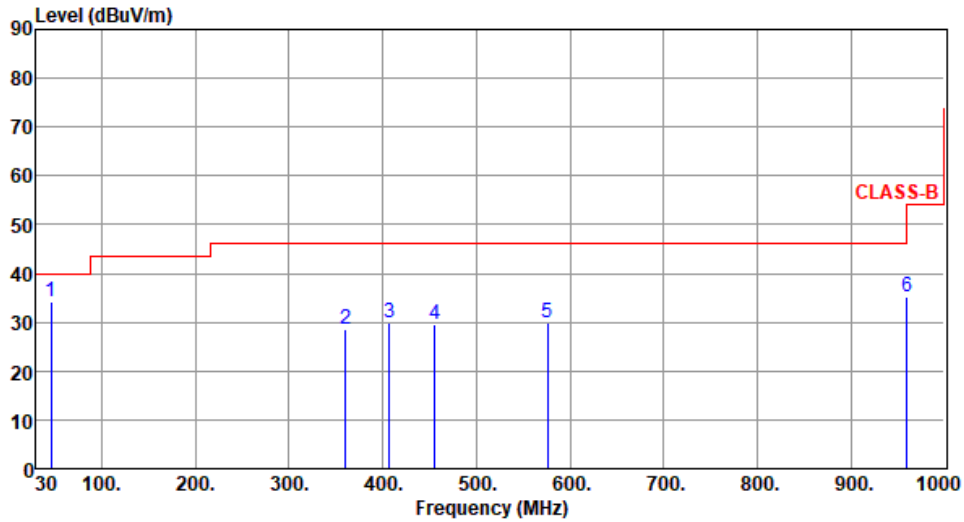


3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3						
Polarization	Horizontal								
Test By :Akun Chung Temperature(°C):24 Humidity(%):65									
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	181.11	36.88	43.50	-6.62	47.57	-10.69	Peak	---	---
2	213.60	28.08	43.50	-15.42	40.44	-12.36	Peak	---	---
3	280.00	30.08	46.00	-15.92	39.23	-9.15	Peak	---	---
4	360.00	32.09	46.00	-13.91	39.41	-7.32	Peak	---	---
5	407.20	30.14	46.00	-15.86	36.04	-5.90	Peak	---	---
6	960.18	35.11	54.00	-18.89	31.07	4.04	Peak	---	---
<p>Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB) *Factor includes antenna factor , cable loss and amplifier gain Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m). Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.</p>									

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3
Polarization	Vertical		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	45.98	34.22	40.00	-5.78	42.83	-8.61	Peak	---	---
2	360.00	28.54	46.00	-17.46	35.86	-7.32	Peak	---	---
3	407.20	30.01	46.00	-15.99	35.91	-5.90	Peak	---	---
4	456.00	29.50	46.00	-16.50	33.86	-4.36	Peak	---	---
5	576.00	30.02	46.00	-15.98	32.27	-2.25	Peak	---	---
6	960.20	35.22	54.00	-18.78	31.18	4.04	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

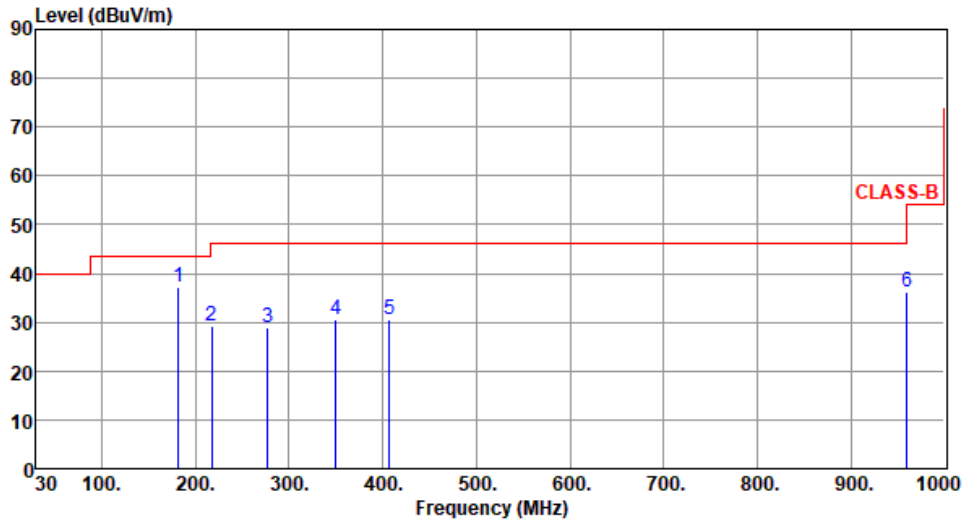
*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
Polarization	Horizontal		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	181.81	37.05	43.50	-6.45	19.47	17.58	Peak	---	---
2	217.60	29.27	46.00	-16.73	41.71	-12.44	Peak	---	---
3	276.80	28.97	46.00	-17.03	38.27	-9.30	Peak	---	---
4	349.60	30.47	46.00	-15.53	38.03	-7.56	Peak	---	---
5	407.20	30.39	46.00	-15.61	36.29	-5.90	Peak	---	---
6	960.00	36.36	46.00	-9.64	32.32	4.04	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

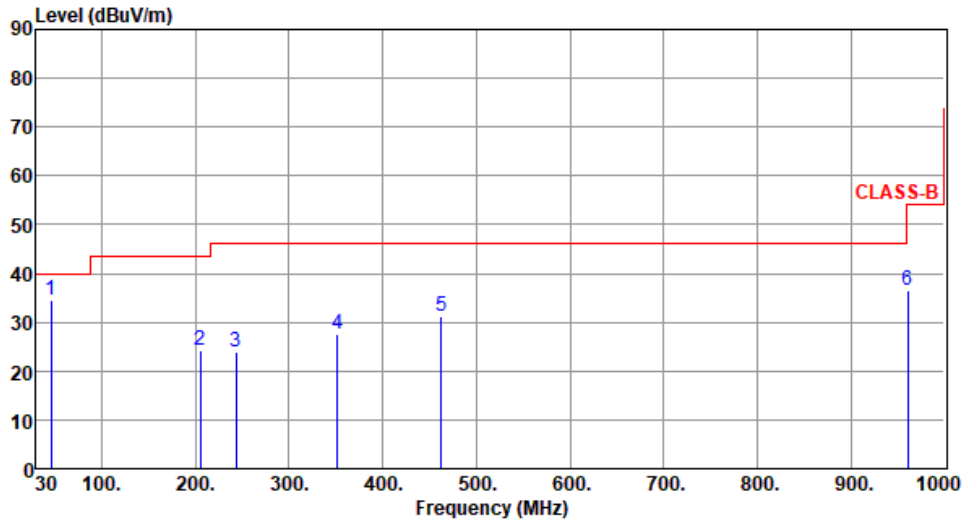
*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
Polarization	Vertical		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	46.32	34.39	40.00	-5.61	14.99	19.40	Peak	---	---
2	205.60	24.19	43.50	-19.31	36.56	-12.37	Peak	---	---
3	243.20	23.80	46.00	-22.20	34.44	-10.64	Peak	---	---
4	352.00	27.61	46.00	-18.39	35.13	-7.52	Peak	---	---
5	462.40	31.07	46.00	-14.93	35.28	-4.21	Peak	---	---
6	960.80	36.45	54.00	-17.55	32.39	4.06	Peak	---	---

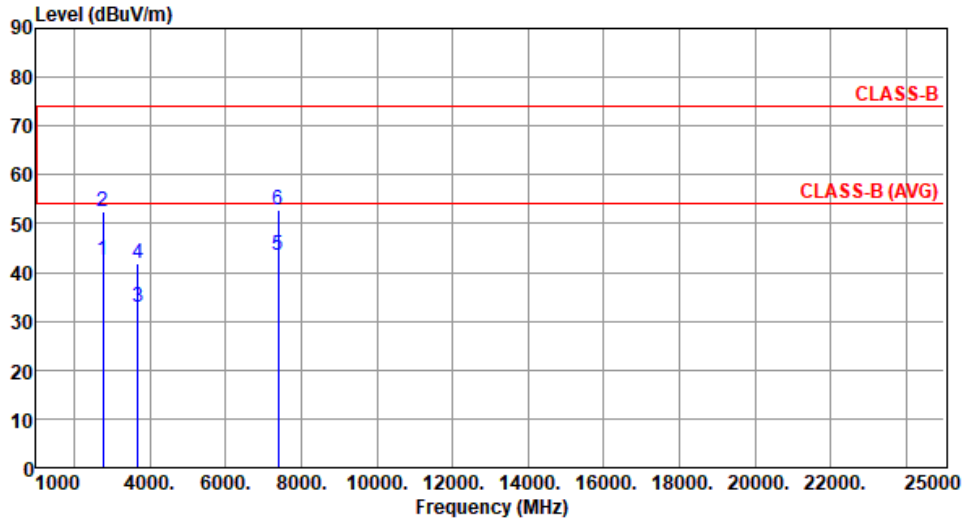
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

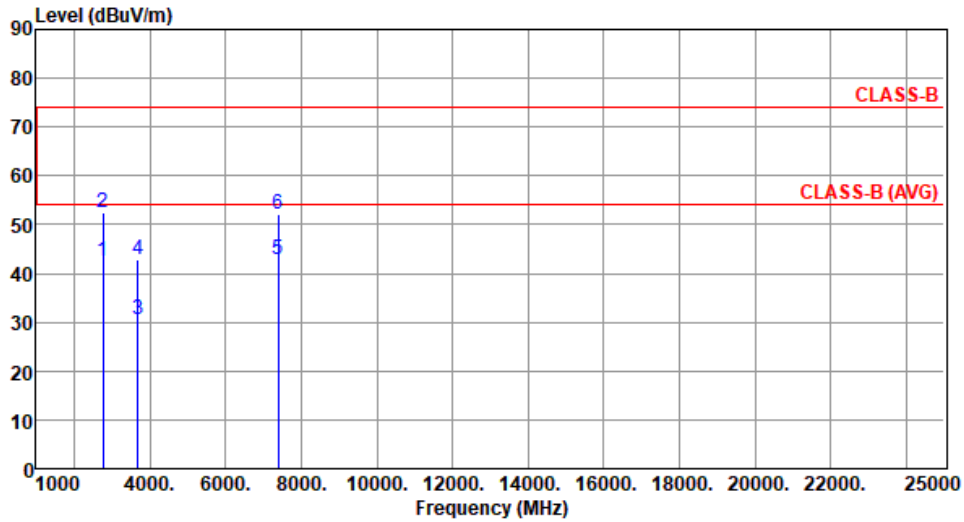
3.5.5 Transmitter Radiated Unwanted Emissions (Above 1GHz)

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3						
Polarization	Horizontal								
Test By : Akun Chung Temperature(°C): 24 Humidity(%): 65									
									
	Freq.	Emission level	Limit	Margin	SA reading	Factor	Remark	ANT High	Turn Table
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB		cm	deg
1	2769.90	42.50	54.00	-11.50	44.53	-2.03	Average	100	58
2	2769.90	52.50	74.00	-21.50	54.53	-2.03	Peak	100	58
3	3693.20	32.72	54.00	-21.28	32.45	0.27	Average	191	151
4	3693.20	42.01	74.00	-31.99	41.74	0.27	Peak	191	151
5	7386.40	43.61	54.00	-10.39	34.54	9.07	Average	235	107
6	7386.40	52.66	74.00	-21.34	43.59	9.07	Peak	235	107

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)
 *Factor includes antenna factor , cable loss and amplifier gain
 Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation / SF	Lora / 12	Test Freq. (MHz)	923.3
Polarization	Vertical		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2769.90	42.53	54.00	-11.47	44.56	-2.03	Average	100	20
2	2769.90	52.62	74.00	-21.38	54.65	-2.03	Peak	100	20
3	3693.20	30.54	54.00	-23.46	30.27	0.27	Average	100	86
4	3693.20	42.76	74.00	-31.24	42.49	0.27	Peak	100	86
5	7386.40	42.77	54.00	-11.23	33.70	9.07	Average	368	23
6	7386.40	51.98	74.00	-22.02	42.91	9.07	Peak	368	23

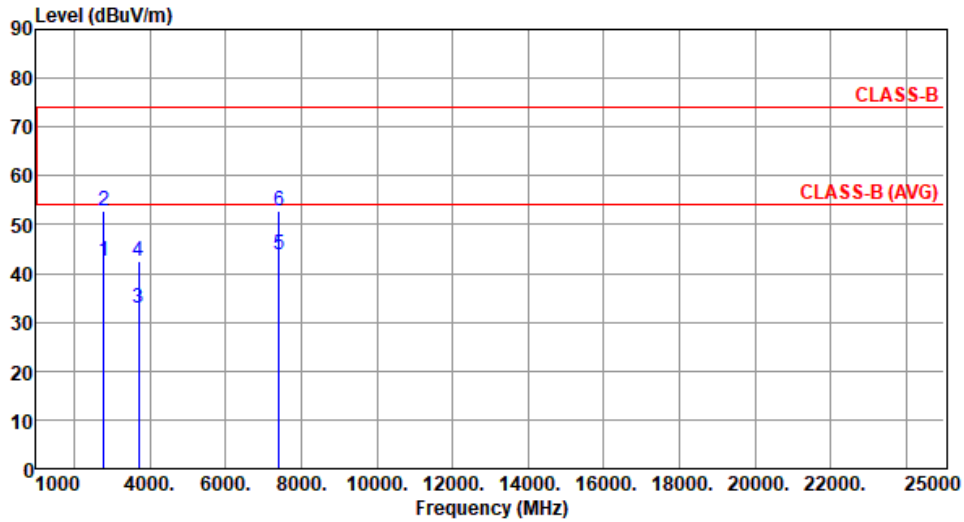
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
Polarization	Horizontal		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2782.50	42.67	54.00	-11.33	44.62	-1.95	Average	100	62
2	2782.50	52.67	74.00	-21.33	54.62	-1.95	Peak	100	63
3	3710.00	32.88	54.00	-21.12	32.57	0.31	Average	194	155
4	3710.00	42.57	74.00	-31.43	42.26	0.31	Peak	194	155
5	7420.00	43.91	54.00	-10.09	34.78	9.13	Average	240	102
6	7420.00	52.93	74.00	-21.07	43.80	9.13	Peak	240	102

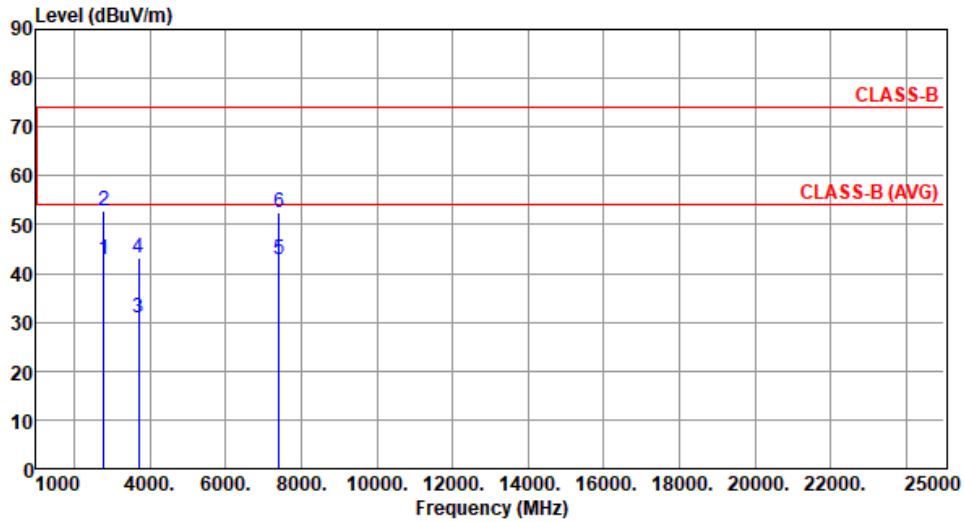
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation / SF	Lora / 12	Test Freq. (MHz)	927.5
Polarization	Vertical		

Test By :Akun Chung Temperature(°C):24 Humidity(%):65



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2782.50	42.88	54.00	-11.12	44.83	-1.95	Average	100	23
2	2782.50	52.90	74.00	-21.10	54.85	-1.95	Peak	100	23
3	3710.00	30.95	54.00	-23.05	30.64	0.31	Average	100	74
4	3710.00	43.09	74.00	-30.91	42.78	0.31	Peak	100	74
5	7420.00	42.88	54.00	-11.12	33.75	9.13	Average	370	20
6	7420.00	52.36	74.00	-21.64	43.23	9.13	Peak	370	20

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.6 Emissions in Non-Restricted Frequency Bands

3.6.1 Emissions in Non-Restricted Frequency Bands Limit

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz

3.6.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

3.6.3 Test Procedures

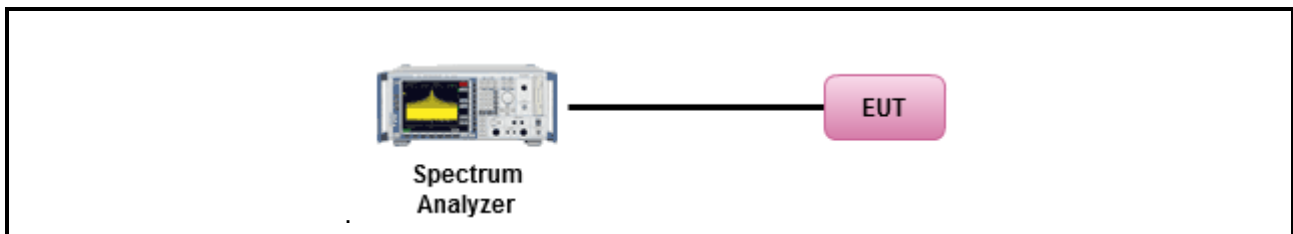
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

Emission level measurement

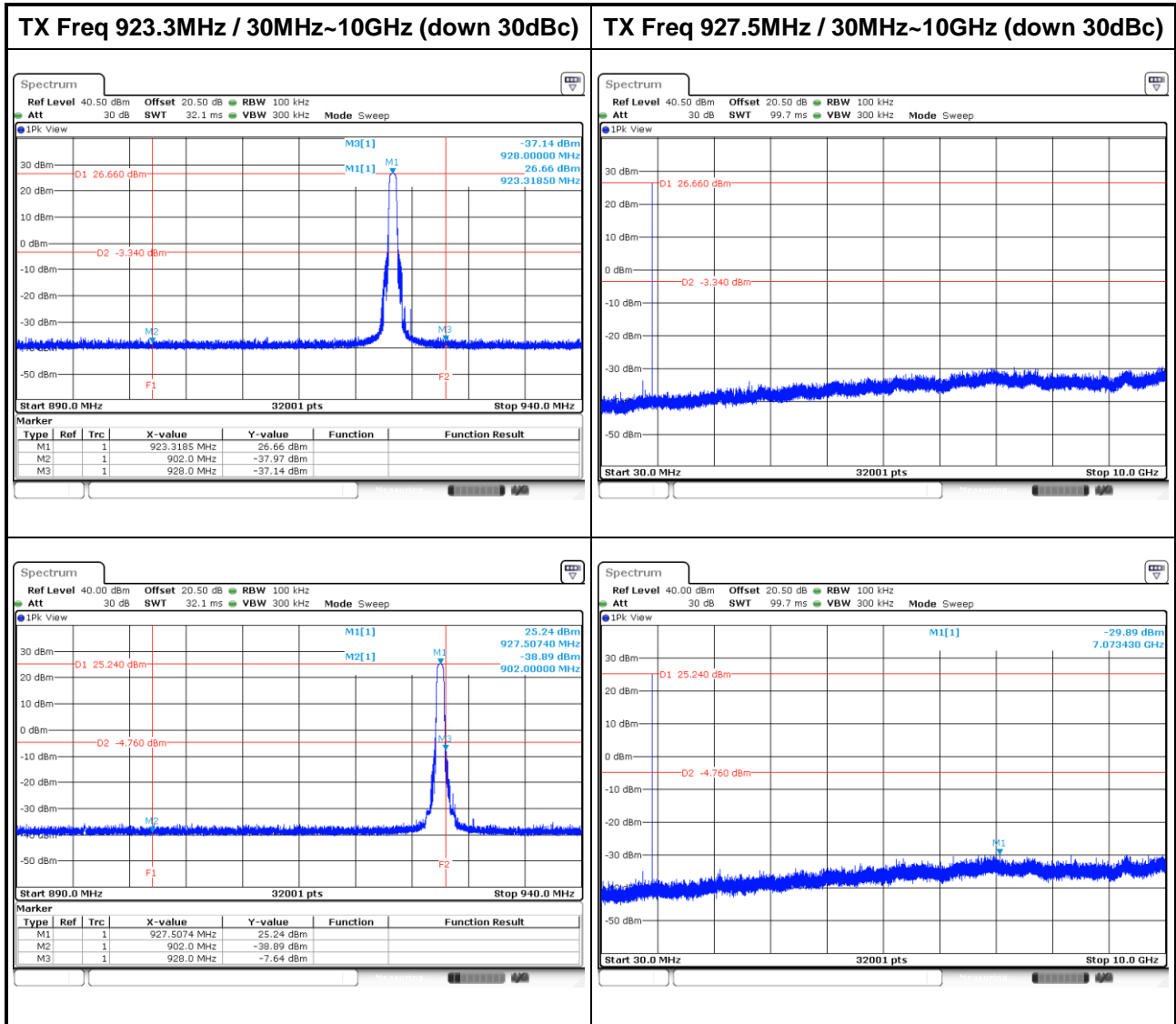
1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 10GHz
4. Use the peak marker function to determine the maximum amplitude level

3.6.4 Test Setup



3.6.5 Unwanted Emissions into Non-Restricted Frequency Bands

Ambient Condition	23°C / 63%	Tested By	Brad Wu
-------------------	------------	-----------	---------



4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin
Kou District, New Taipei City,
Taiwan, R.O.C.

Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd St.,
Kwei Shan District, Tao Yuan City
333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

==END==