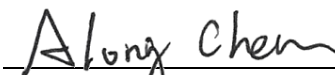


FCC Test Report

FCC ID : 2AAS9TBSP100
Equipment : LoRaWAN Sensor
Model No. : TBAM100, TBSL100, TBWL100
(refer to item 1.1.1 for more details)
Brand Name : BROWAN
Applicant : BROWAN COMMUNICATIONS
INCORPORATION
Address : No.15-1 Zhonghua Rd., Hsinchu Industrial
Park, Hukou, Hsinchu, Taiwan (R.O.C.), 30352
Standard : 47 CFR FCC Part 15.247
Received Date : Aug. 18, 2020
Tested Date : Aug. 25 ~ Oct. 05, 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.

Reviewed by:


Along Chen / Assistant Manager

Approved by:

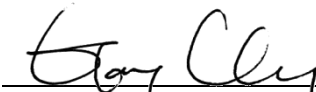

Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
FR081801-1AH	Rev. 01	Initial issue	Oct. 27, 2020

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	Note	N/A
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 9149.00MHz 49.16 (Margin -4.84dB) - AV	Pass
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(2)(3)	Conducted Output Power	Power [dBm]: 19.12	Pass
15.247(a)(1)(i)	Number of Hopping Channels	Meet the requirement of limit	Pass
15.247(a)(1)	Hopping Channel Separation	Meet the requirement of limit	Pass
15.247(f)	Dwell Time	Meet the requirement of limit	Pass
15.247(f)	Power spectral density	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass
Note: The EUT consumes power from battery, so the test is not required.			

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 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
BROWAN	TBAM100	Ambient Light Sensor	With Sensor Board: Ambient Light Sensor
	TBSL100	Sound Level Sensor	With Sensor Board: Sound Level Sensor
	TBWL100	Water Leak Sensor	With Sensor Board: Water Leak Sensor

1.1.2 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	902.3 ~ 914.9	1-64 [64]	980 ~ 5470	10 ~ 7	125
Note 1: RF output power specifies that Maximum Conducted (Average) Output Power. Note 2: The device uses CSS modulation. Note 3: The device supports hybrid mode.					

1.1.3 Antenna Details

Ant. No.	Type	Connector	Gain (dBi)
1	monopole	N/A	-1.7

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.6Vdc from battery
-------------------	---------------------

1.1.5 Accessories

Accessories		
No.	Equipment	Description
1	RAMWAY Battery	Model: ER14250 Rating: 3.6Vdc
2	FANSO Battery	Model: ER14250H Rating: 3.6Vdc
3	Detachable probe (For Water Leak Sensor)	1m non-shielded without core

1.1.6 Channel List

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.3	17	905.5	33	908.7	49	911.9
2	902.5	18	905.7	34	908.9	50	912.1
3	902.7	19	905.9	35	909.1	51	912.3
4	902.9	20	906.1	36	909.3	52	912.5
5	903.1	21	906.3	37	909.5	53	912.7
6	903.3	22	906.5	38	909.7	54	912.9
7	903.5	23	906.7	39	909.9	55	913.1
8	903.7	24	906.9	40	910.1	56	913.3
9	903.9	25	907.1	41	910.3	57	913.5
10	904.1	26	907.3	42	910.5	58	913.7
11	904.3	27	907.5	43	910.7	59	913.9
12	904.5	28	907.7	44	910.9	60	914.1
13	904.7	29	907.9	45	911.1	61	914.3
14	904.9	30	908.1	46	911.3	62	914.5
15	905.1	31	908.3	47	911.5	63	914.7
16	905.3	32	908.5	48	911.7	64	914.9

1.1.7 Test Tool and Duty Cycle

Test Tool	Python, version: 3.8.5
Duty cycle	100 %

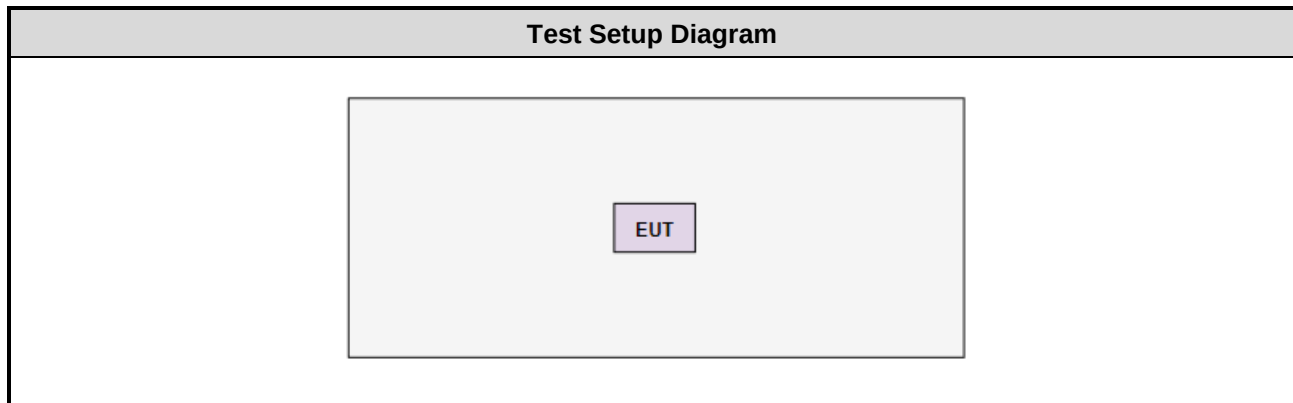
1.1.8 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
	902.3	908.5	914.9
CSS	20	20	20

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Signal cable / Length (m)
1	Notebook	DELL	Latitude E5470	DoC	---

1.3 Test Setup Chart



Note: The support notebook is disconnected from EUT and removed from test table after sending command from notebook to control EUT to transmit continuously.

1.4 The Equipment List

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Aug. 25 ~ Oct. 05, 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	Jul. 21, 2020	Jul. 20, 2021
RF Cable	EMC	EMC104-SM-SM-80 00	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-N M-1000	160502	Oct. 07, 2019	Oct. 06, 2020
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 07, 2019	Oct. 06, 2020
LF cable 11M	EMC	EMCCFD400-NW-N W-11000	200801	Aug. 13, 2020	Aug. 12, 2021
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	Sep. 07, 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
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Dec. 12, 2019	Dec. 11, 2020
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
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
Radiated emission ≤ 1 GHz	± 3.41 dB
Radiated emission > 1 GHz	± 4.59 dB

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	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
- ISSED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Test Frequency (MHz)	Channel Bandwidth (kHz)	Modulation / SF	Test Configuration
Conducted Emissions Radiated Emissions > 1GHz Conducted Output Power Hopping Channel Separation 20dB and Occupied bandwidth Power Spectral Density	902.3 / 908.5 / 914.9	125	CSS / 10	1
Radiated Emissions ≤ 1GHz	902.3 / 908.5 / 914.9	125	CSS / 10	1, 2, 3
Number of Hopping Channels	902.3 ~ 914.9	125	CSS / 10	1
Dwell Time	902.3	125	CSS: 10 / 9 / 8 / 7	1

NOTE:

1. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **X-plane** result was found as the worst case and was shown in this report.
2. Test configurations for radiated emission below 1GHz test are listed as follows:
 - 1) Test configuration 1: model TBAM100
 - 2) Test configuration 2: model TBSL100
 - 3) Test configuration 3: model TBWL100

3 Transmitter Test Results

3.1 Unwanted Emissions into Restricted Frequency Bands

3.1.1 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:
Qusai-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.

3.1.2 Test Procedures

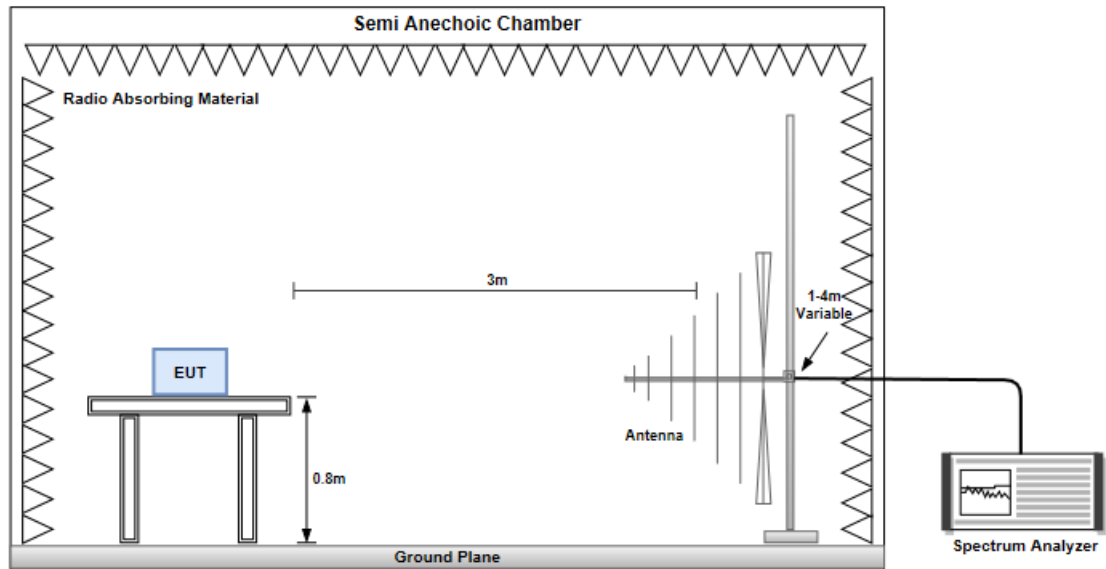
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

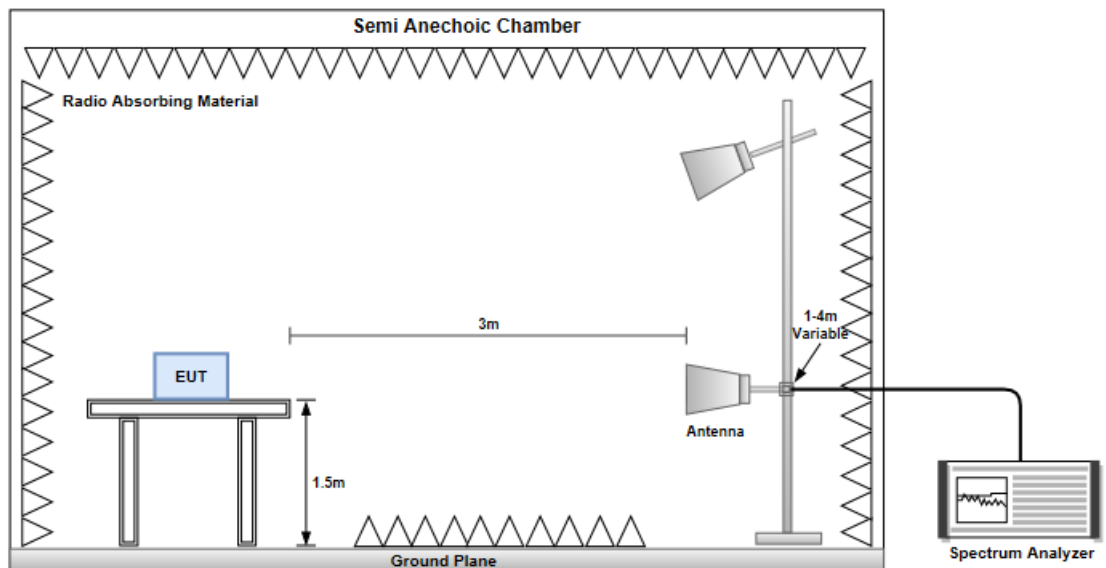
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.1.3 Test Setup

Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



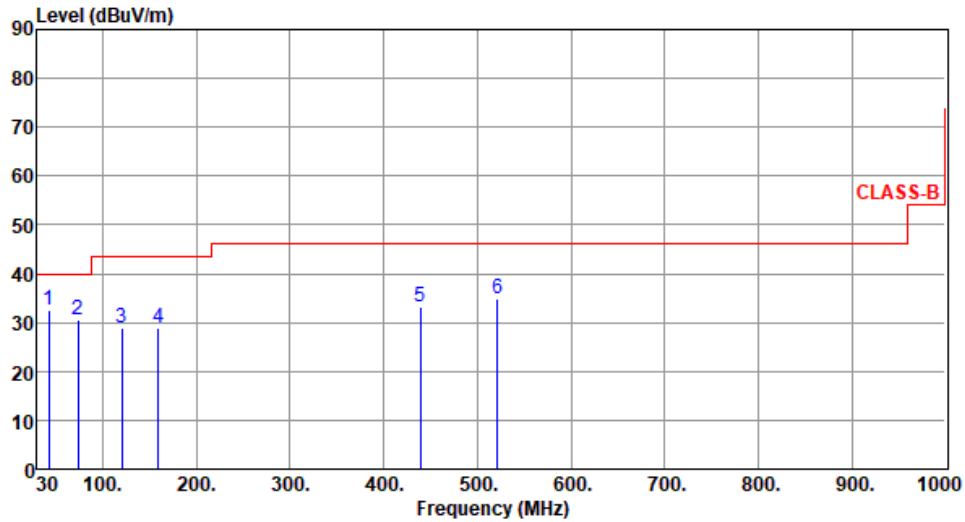
Test configuration 1: model TBAM100

3.1.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):24 Humidity(%):61			
Level (dBuV/m) </			

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Vertical		

Test By :Roger Lu Temperature(°C):24 Humidity(%):61



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	42.61	32.67	40.00	-7.33	40.87	-8.20	Peak	---	---
2	73.65	30.68	40.00	-9.32	42.44	-11.76	Peak	---	---
3	120.21	28.77	43.50	-14.73	39.42	-10.65	Peak	---	---
4	159.01	28.83	43.50	-14.67	37.70	-8.87	Peak	---	---
5	439.34	33.35	46.00	-12.65	38.05	-4.70	Peak	---	---
6	521.79	34.89	46.00	-11.11	37.83	-2.94	Peak	---	---

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

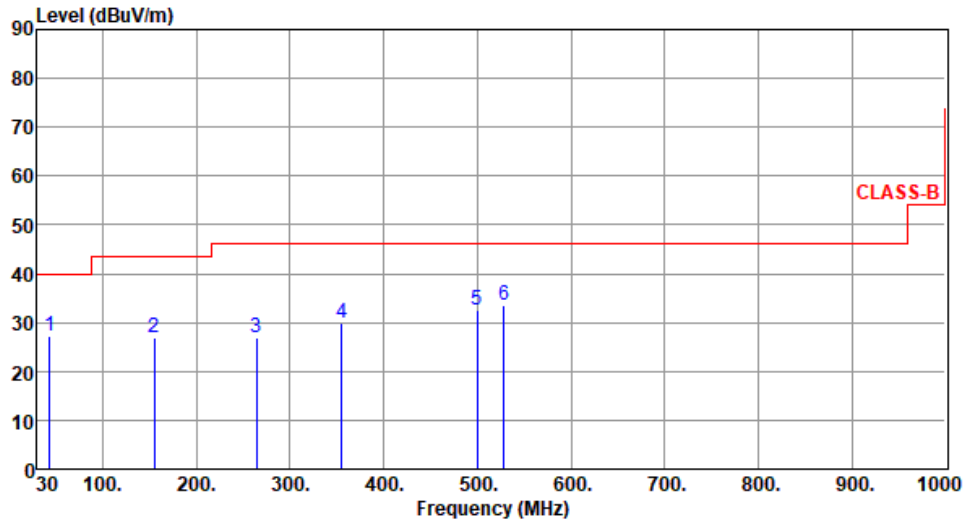
*Factor includes antenna factor , cable loss and amplifier gain

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	CSS / 10	Test Freq. (MHz)	908.5
Polarization	Horizontal		

Test By :Roger Lu Temperature(°C):24 Humidity(%):61



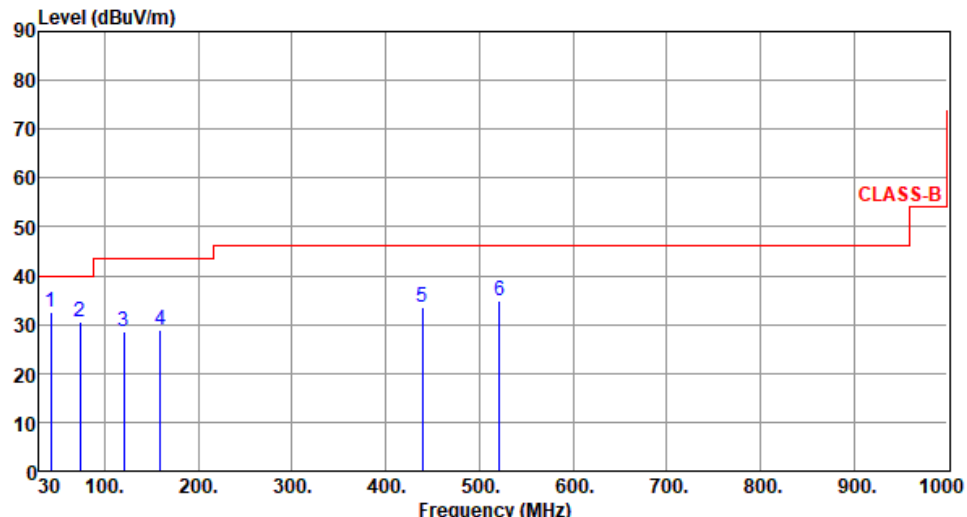
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	43.62	27.36	40.00	-12.64	35.71	-8.35	Peak	---	---
2	155.22	26.75	43.50	-16.75	35.55	-8.80	Peak	---	---
3	264.61	26.84	46.00	-19.16	36.44	-9.60	Peak	---	---
4	354.88	29.75	46.00	-16.25	36.43	-6.68	Peak	---	---
5	499.52	32.64	46.00	-13.36	35.97	-3.33	Peak	---	---
6	528.42	33.49	46.00	-12.51	36.42	-2.93	Peak	---	---

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

*Factor includes antenna factor , cable loss and amplifier gain

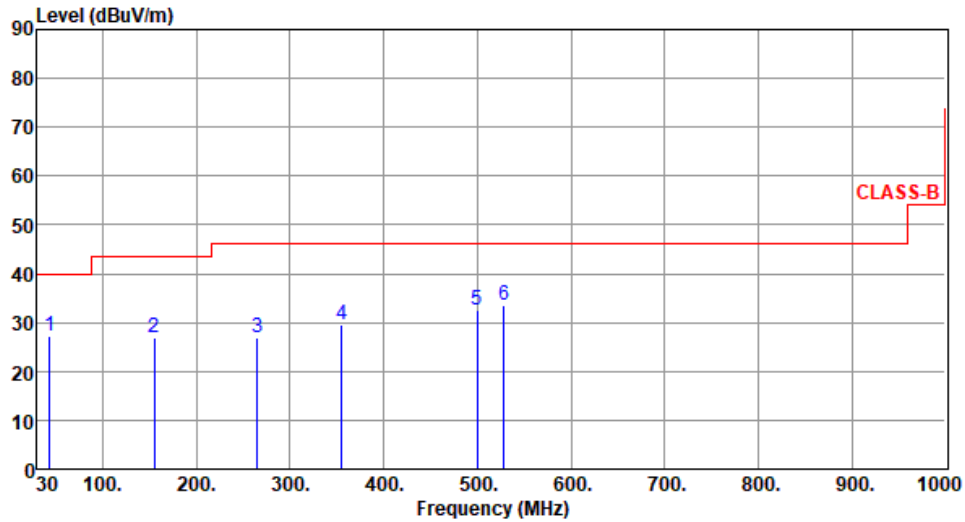
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

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

Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5																																																																						
Polarization	Vertical																																																																								
Test By :Roger Lu Temperature(°C):24 Humidity(%):61																																																																									
Level (dBuV/m)  Frequency (MHz) <table><thead><tr><th></th><th>Freq. MHz</th><th>Emission level dBuV/m</th><th>Limit dBuV/m</th><th>Margin dB</th><th>SA reading dBuV</th><th>Factor dB</th><th>Remark</th><th>ANT High cm</th><th>Turn Table deg</th></tr></thead><tbody><tr><td>1</td><td>42.55</td><td>32.56</td><td>40.00</td><td>-7.44</td><td>40.76</td><td>-8.20</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>2</td><td>73.59</td><td>30.45</td><td>40.00</td><td>-9.55</td><td>42.19</td><td>-11.74</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>3</td><td>120.33</td><td>28.66</td><td>43.50</td><td>-14.84</td><td>39.32</td><td>-10.66</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>4</td><td>159.19</td><td>28.74</td><td>43.50</td><td>-14.76</td><td>37.61</td><td>-8.87</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>5</td><td>439.46</td><td>33.46</td><td>46.00</td><td>-12.54</td><td>38.16</td><td>-4.70</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>6</td><td>521.69</td><td>34.76</td><td>46.00</td><td>-11.24</td><td>37.69</td><td>-2.93</td><td>Peak</td><td>---</td><td>---</td></tr></tbody></table>					Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg	1	42.55	32.56	40.00	-7.44	40.76	-8.20	Peak	---	---	2	73.59	30.45	40.00	-9.55	42.19	-11.74	Peak	---	---	3	120.33	28.66	43.50	-14.84	39.32	-10.66	Peak	---	---	4	159.19	28.74	43.50	-14.76	37.61	-8.87	Peak	---	---	5	439.46	33.46	46.00	-12.54	38.16	-4.70	Peak	---	---	6	521.69	34.76	46.00	-11.24	37.69	-2.93	Peak	---	---
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg																																																																
1	42.55	32.56	40.00	-7.44	40.76	-8.20	Peak	---	---																																																																
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5	439.46	33.46	46.00	-12.54	38.16	-4.70	Peak	---	---																																																																
6	521.69	34.76	46.00	-11.24	37.69	-2.93	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	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Horizontal		

Test By :Roger Lu Temperature(°C):24 Humidity(%):61



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	43.46	27.31	40.00	-12.69	35.61	-8.30	Peak	---	---
2	155.22	26.79	43.50	-16.71	35.59	-8.80	Peak	---	---
3	264.66	26.87	46.00	-19.13	36.47	-9.60	Peak	---	---
4	354.88	29.64	46.00	-16.36	36.32	-6.68	Peak	---	---
5	499.52	32.67	46.00	-13.33	36.00	-3.33	Peak	---	---
6	528.46	33.48	46.00	-12.52	36.41	-2.93	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	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):24 Humidity(%):61			
Level (dBuV/m)			

3.1.5 Transmitter Radiated Unwanted Emissions (Above 1GHz)

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBuV/m)			

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBUV/m) <			

Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBUV/m) <			

Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBUV/m)			

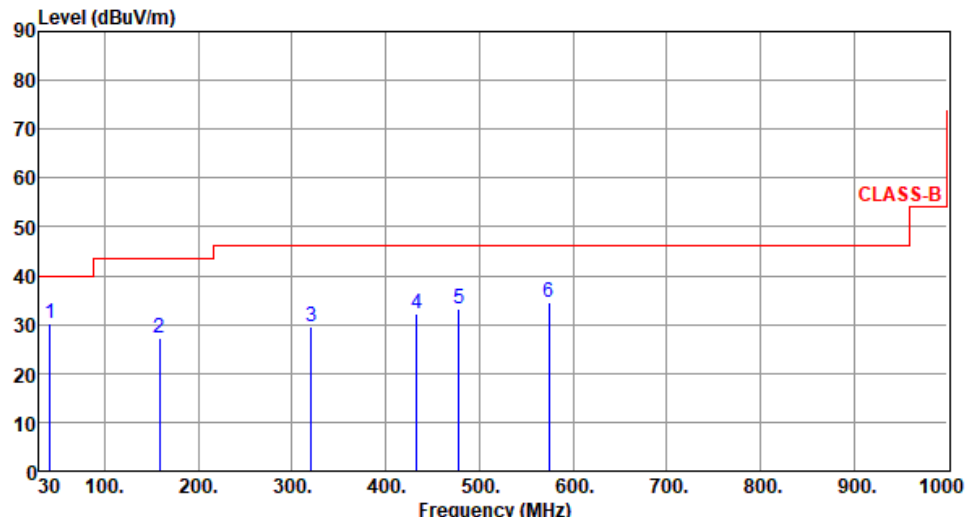
Modulation / SF	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBuV/m) </			

Modulation / SF	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):25 Humidity(%):63			
Level (dBuV/m)			

Test configuration 2: model TBSL100

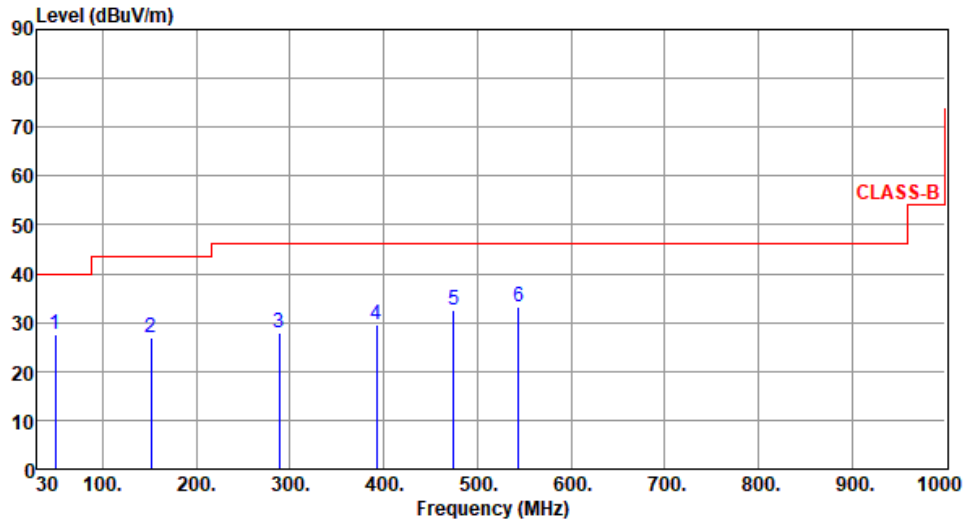
3.1.6 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):23 Humidity(%):63			
Level (dBUV/m)			

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3																																																																						
Polarization	Vertical																																																																								
Test By :Roger Lu Temperature(°C):23 Humidity(%):63																																																																									
Level (dBuV/m)  Frequency (MHz) <table><thead><tr><th></th><th>Freq. MHz</th><th>Emission level dBuV/m</th><th>Limit dBuV/m</th><th>Margin dB</th><th>SA reading dBuV</th><th>Factor dB</th><th>Remark</th><th>ANT High cm</th><th>Turn Table deg</th></tr></thead><tbody><tr><td>1</td><td>41.49</td><td>30.21</td><td>40.00</td><td>-9.79</td><td>38.66</td><td>-8.45</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>2</td><td>158.23</td><td>27.28</td><td>43.50</td><td>-16.22</td><td>36.23</td><td>-8.95</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>3</td><td>320.33</td><td>29.41</td><td>46.00</td><td>-16.59</td><td>36.92</td><td>-7.51</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>4</td><td>432.98</td><td>32.35</td><td>46.00</td><td>-13.65</td><td>37.19</td><td>-4.84</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>5</td><td>478.35</td><td>33.37</td><td>46.00</td><td>-12.63</td><td>37.18</td><td>-3.81</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>6</td><td>574.36</td><td>34.55</td><td>46.00</td><td>-11.45</td><td>36.43</td><td>-1.88</td><td>Peak</td><td>---</td><td>---</td></tr></tbody></table>					Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg	1	41.49	30.21	40.00	-9.79	38.66	-8.45	Peak	---	---	2	158.23	27.28	43.50	-16.22	36.23	-8.95	Peak	---	---	3	320.33	29.41	46.00	-16.59	36.92	-7.51	Peak	---	---	4	432.98	32.35	46.00	-13.65	37.19	-4.84	Peak	---	---	5	478.35	33.37	46.00	-12.63	37.18	-3.81	Peak	---	---	6	574.36	34.55	46.00	-11.45	36.43	-1.88	Peak	---	---
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg																																																																
1	41.49	30.21	40.00	-9.79	38.66	-8.45	Peak	---	---																																																																
2	158.23	27.28	43.50	-16.22	36.23	-8.95	Peak	---	---																																																																
3	320.33	29.41	46.00	-16.59	36.92	-7.51	Peak	---	---																																																																
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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	CSS / 10	Test Freq. (MHz)	908.5
Polarization	Horizontal		

Test By :Roger Lu Temperature(°C):23 Humidity(%):63



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	49.52	27.63	40.00	-12.37	36.00	-8.37	Peak	---	---
2	151.33	26.97	43.50	-16.53	35.92	-8.95	Peak	---	---
3	288.75	27.75	46.00	-18.25	36.30	-8.55	Peak	---	---
4	392.73	29.53	46.00	-16.47	35.50	-5.97	Peak	---	---
5	474.33	32.52	46.00	-13.48	36.42	-3.90	Peak	---	---
6	544.23	33.36	46.00	-12.64	35.98	-2.62	Peak	---	---

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

*Factor includes antenna factor , cable loss and amplifier gain

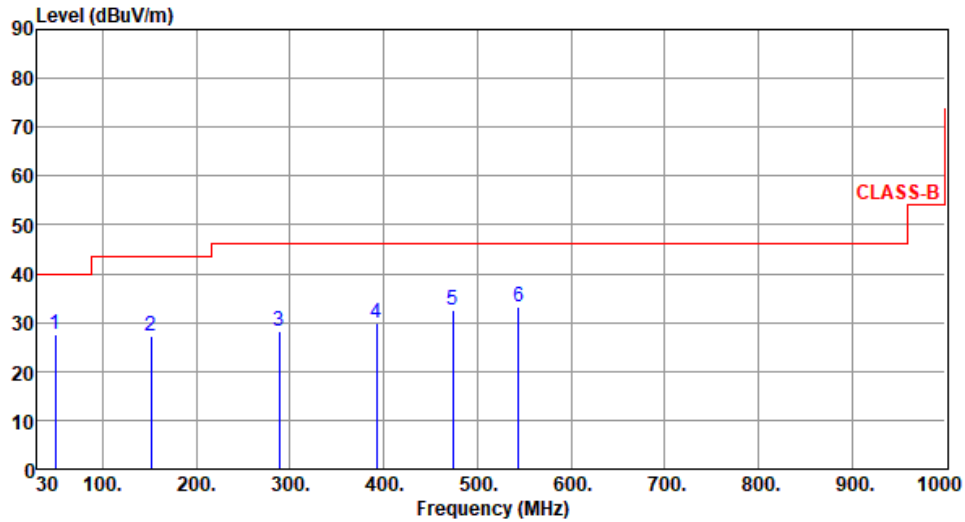
Note 2: Margin (dB) = Emission level (dBUV/m) – Limit (dBUV/m).

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

Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):23 Humidity(%):63			
Level (dBuV/m) </			

Modulation / SF	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Horizontal		

Test By :Roger Lu Temperature(°C):23 Humidity(%):63



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	49.77	27.57	40.00	-12.43	35.89	-8.32	Peak	---	---
2	151.52	27.23	43.50	-16.27	36.16	-8.93	Peak	---	---
3	288.75	28.33	46.00	-17.67	36.88	-8.55	Peak	---	---
4	392.68	29.78	46.00	-16.22	35.75	-5.97	Peak	---	---
5	474.25	32.59	46.00	-13.41	36.49	-3.90	Peak	---	---
6	544.28	33.36	46.00	-12.64	35.98	-2.62	Peak	---	---

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

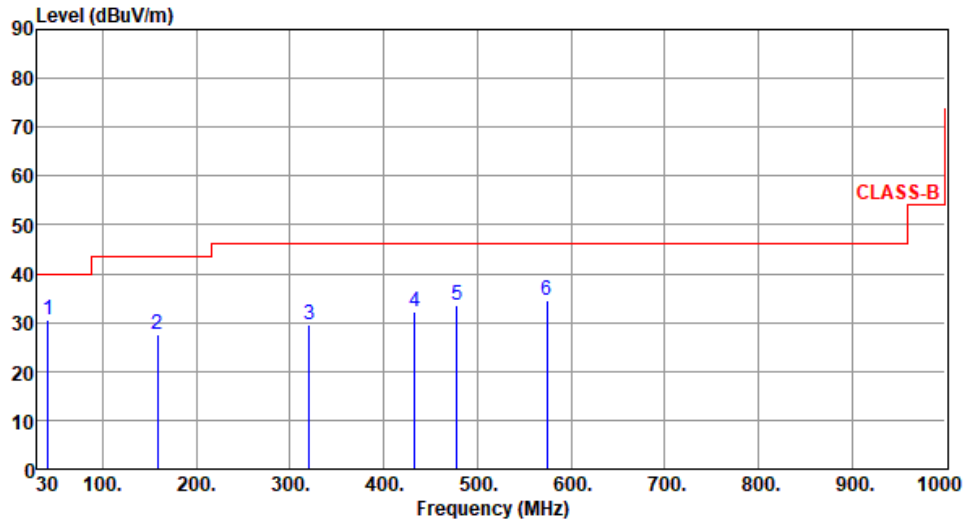
*Factor includes antenna factor , cable loss and amplifier gain

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	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Vertical		

Test By :Roger Lu Temperature(°C):23 Humidity(%):63



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	41.63	30.52	40.00	-9.48	38.92	-8.40	Peak	---	---
2	158.33	27.45	43.50	-16.05	36.39	-8.94	Peak	---	---
3	320.34	29.53	46.00	-16.47	37.04	-7.51	Peak	---	---
4	433.52	32.28	46.00	-13.72	37.11	-4.83	Peak	---	---
5	478.28	33.56	46.00	-12.44	37.37	-3.81	Peak	---	---
6	574.34	34.39	46.00	-11.61	36.27	-1.88	Peak	---	---

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

*Factor includes antenna factor , cable loss and amplifier gain

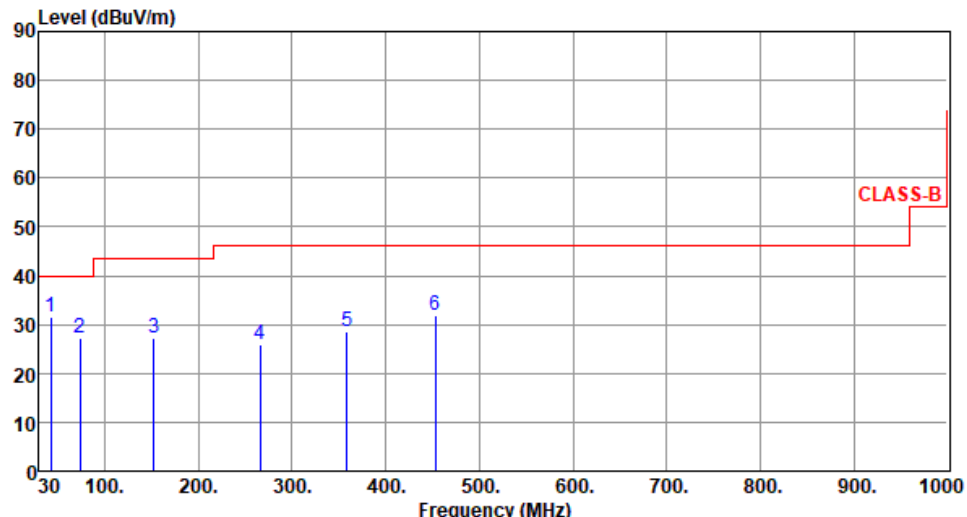
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

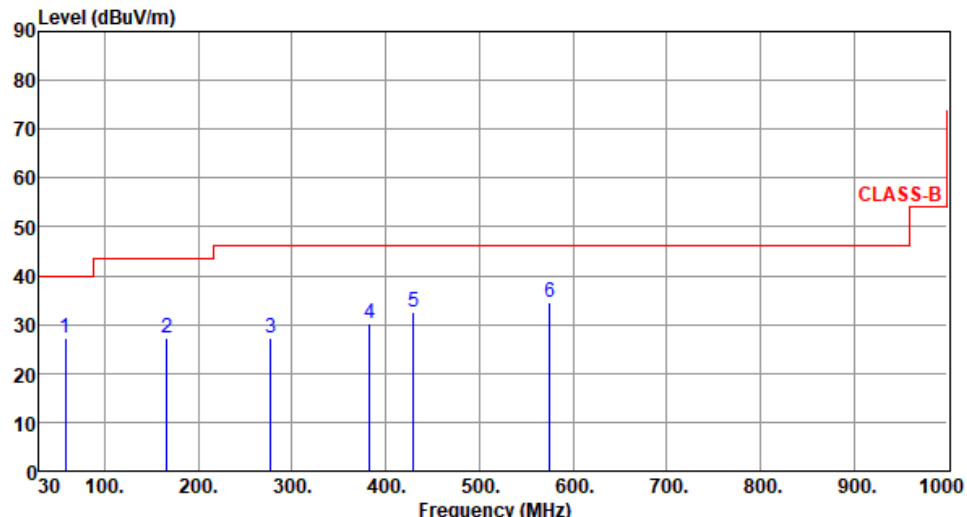
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

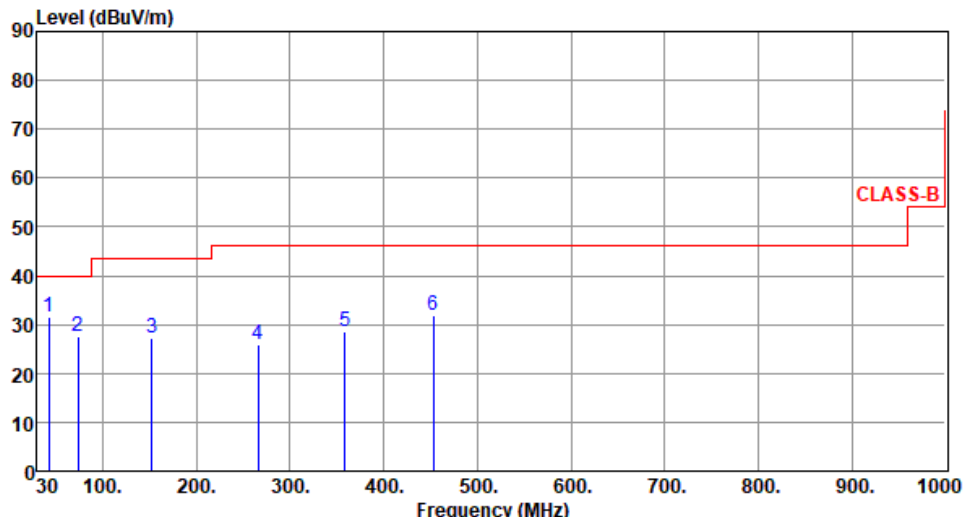
Test configuration 3: model TBWL100

3.1.7 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):24 Humidity(%):61			
Level (dBuV/m) </			

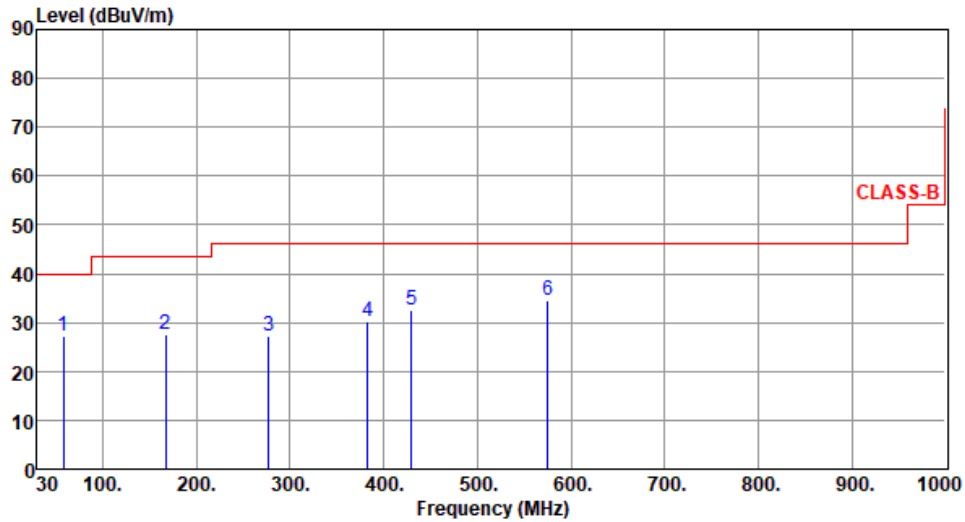
Modulation / SF	CSS / 10	Test Freq. (MHz)	902.3																																																																						
Polarization	Vertical																																																																								
Test By :Roger Lu Temperature(°C):24 Humidity(%):61																																																																									
Level (dBuV/m)  Frequency (MHz) <table><thead><tr><th></th><th>Freq. MHz</th><th>Emission level dBuV/m</th><th>Limit dBuV/m</th><th>Margin dB</th><th>SA reading dBuV</th><th>Factor dB</th><th>Remark</th><th>ANT High cm</th><th>Turn Table deg</th></tr></thead><tbody><tr><td>1</td><td>42.55</td><td>31.64</td><td>40.00</td><td>-8.36</td><td>39.84</td><td>-8.20</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>2</td><td>73.59</td><td>27.31</td><td>40.00</td><td>-12.69</td><td>39.05</td><td>-11.74</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>3</td><td>152.33</td><td>27.29</td><td>43.50</td><td>-16.21</td><td>36.20</td><td>-8.91</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>4</td><td>265.61</td><td>25.74</td><td>46.00</td><td>-20.26</td><td>35.28</td><td>-9.54</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>5</td><td>358.79</td><td>28.69</td><td>46.00</td><td>-17.31</td><td>35.27</td><td>-6.58</td><td>Peak</td><td>---</td><td>---</td></tr><tr><td>6</td><td>452.80</td><td>31.87</td><td>46.00</td><td>-14.13</td><td>36.15</td><td>-4.28</td><td>Peak</td><td>---</td><td>---</td></tr></tbody></table>					Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg	1	42.55	31.64	40.00	-8.36	39.84	-8.20	Peak	---	---	2	73.59	27.31	40.00	-12.69	39.05	-11.74	Peak	---	---	3	152.33	27.29	43.50	-16.21	36.20	-8.91	Peak	---	---	4	265.61	25.74	46.00	-20.26	35.28	-9.54	Peak	---	---	5	358.79	28.69	46.00	-17.31	35.27	-6.58	Peak	---	---	6	452.80	31.87	46.00	-14.13	36.15	-4.28	Peak	---	---
	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg																																																																
1	42.55	31.64	40.00	-8.36	39.84	-8.20	Peak	---	---																																																																
2	73.59	27.31	40.00	-12.69	39.05	-11.74	Peak	---	---																																																																
3	152.33	27.29	43.50	-16.21	36.20	-8.91	Peak	---	---																																																																
4	265.61	25.74	46.00	-20.26	35.28	-9.54	Peak	---	---																																																																
5	358.79	28.69	46.00	-17.31	35.27	-6.58	Peak	---	---																																																																
6	452.80	31.87	46.00	-14.13	36.15	-4.28	Peak	---	---																																																																
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Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5																																																																																										
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	Freq.	Emission	Limit	Margin	SA	Factor	Remark	ANT	Turn																																																																																				
	MHz	level	dBuV/m	dB	reading	dB		High	Table																																																																																				
		dBuV/m			dBuV			cm	deg																																																																																				
1	58.22	27.36	40.00	-12.64	36.30	-8.94	Peak	---	---																																																																																				
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3	277.49	27.29	46.00	-18.71	36.15	-8.86	Peak	---	---																																																																																				
4	383.12	30.24	46.00	-15.76	36.40	-6.16	Peak	---	---																																																																																				
5	429.59	32.47	46.00	-13.53	37.41	-4.94	Peak	---	---																																																																																				
6	575.12	34.43	46.00	-11.57	36.29	-1.86	Peak	---	---																																																																																				
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Modulation / SF	CSS / 10	Test Freq. (MHz)	908.5																																																																																										
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	Freq.	Emission	Limit	Margin	SA	Factor	Remark	ANT	Turn																																																																																				
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Modulation / SF	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Horizontal		

Test By :Roger Lu Temperature(°C):24 Humidity(%):61



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	58.13	27.29	40.00	-12.71	36.22	-8.93	Peak	---	---
2	166.77	27.42	43.50	-16.08	36.58	-9.16	Peak	---	---
3	277.35	27.18	46.00	-18.82	36.05	-8.87	Peak	---	---
4	383.08	30.33	46.00	-15.67	36.49	-6.16	Peak	---	---
5	429.64	32.59	46.00	-13.41	37.52	-4.93	Peak	---	---
6	575.14	34.53	46.00	-11.47	36.39	-1.86	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	CSS / 10	Test Freq. (MHz)	914.9
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):24 Humidity(%):61			
Level (dBuV/m) </			

3.2 Unwanted Emissions into Non-Restricted Frequency Bands

3.2.1 Limit of Unwanted Emissions into Non-Restricted Frequency Bands

The peak output power measured 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.

3.2.2 Test Procedures

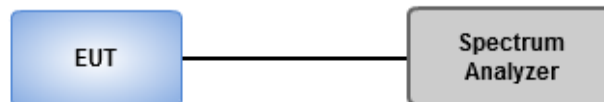
Reference Level Measurement

1. Set the RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Set Sweep time = auto couple, Trace mode = max hold.
3. Allow trace to fully stabilize.
4. Use the peak marker function to determine the maximum amplitude level.

Unwanted Emissions Level Measurement

1. Set RBW = 100 kHz, VBW = 300 kHz, Detector = peak.
2. Trace Mode = max hold, Sweep = auto couple.
3. Allow the trace to stabilize.
4. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

3.2.3 Test Setup

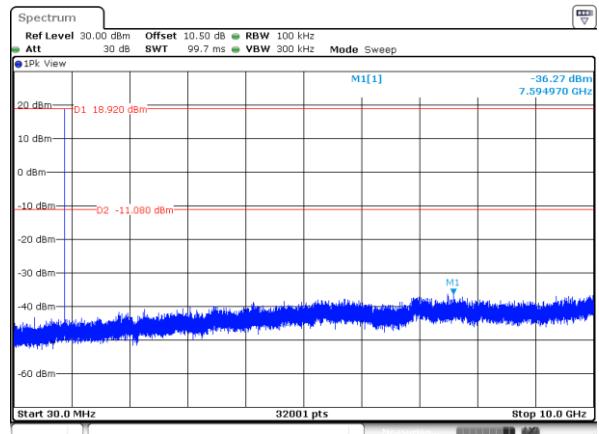
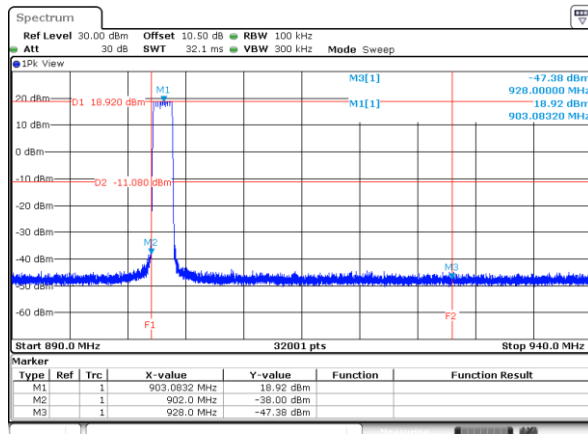


3.2.4 Unwanted Emissions into Non-Restricted Frequency Bands

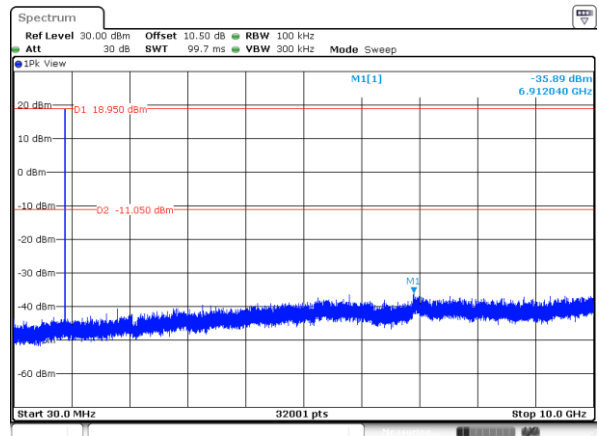
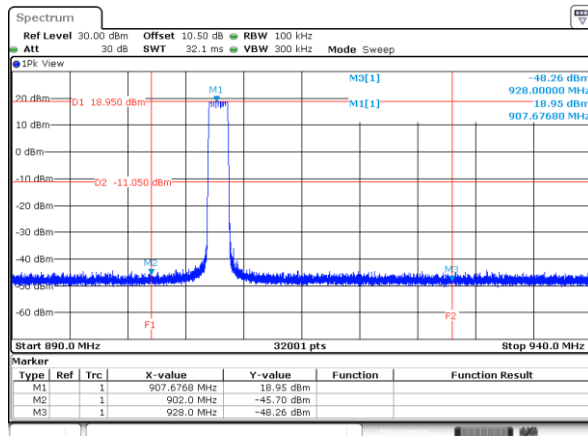
Ambient Condition	23°C / 63%	Tested By	Brad Wu
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Hopping on

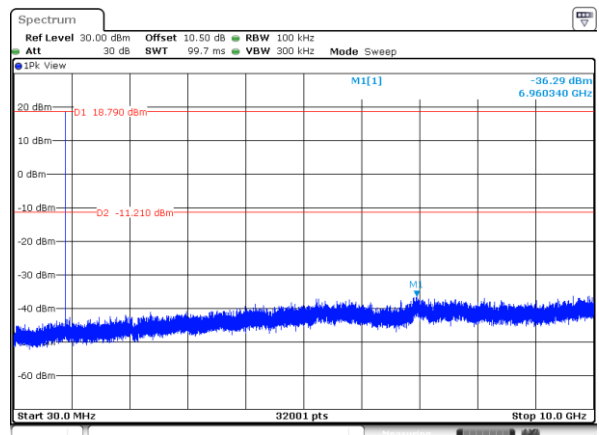
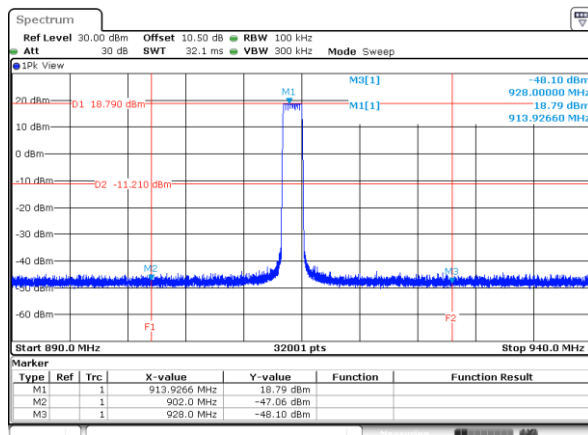
TX Frequency 902.3~903.7-MHz / 30MHz~10GHz (down 30dBc)



TX Frequency 907.1~908.5MHz / 30MHz~10GHz (down 30dBc)

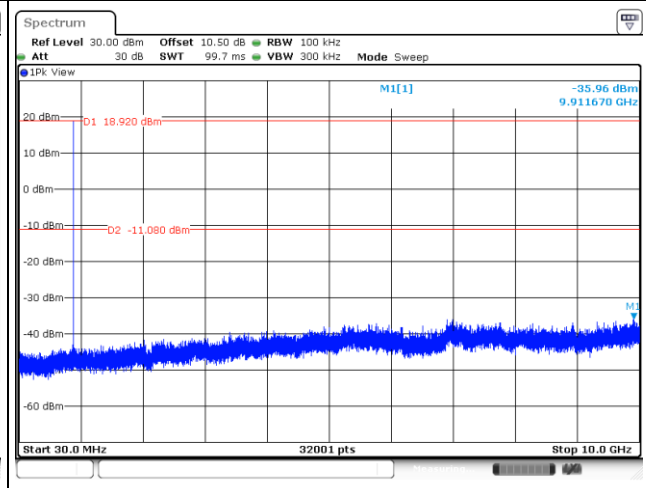
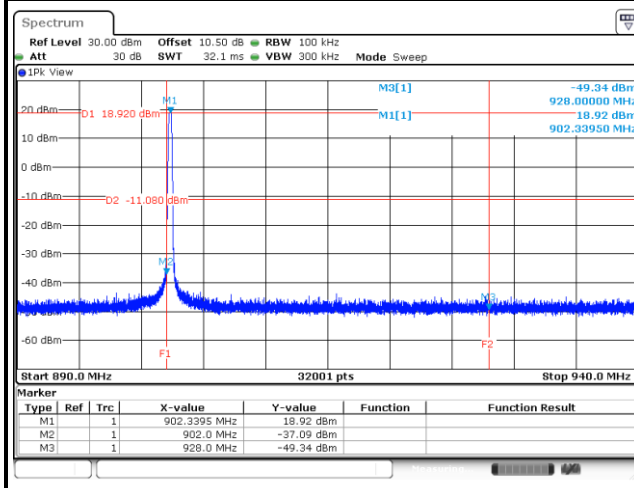


TX Frequency 913.5~914.9MHz / 30MHz~10GHz (down 30dBc)

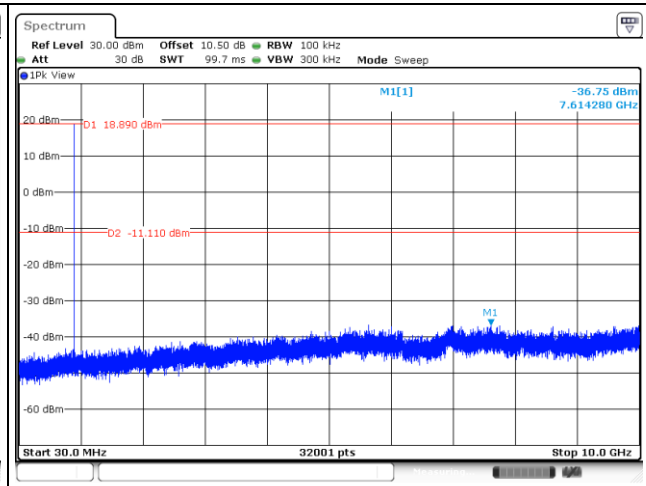
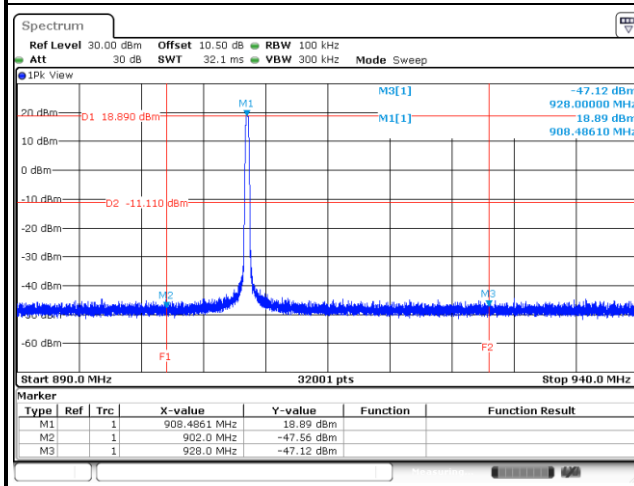


Hopping off

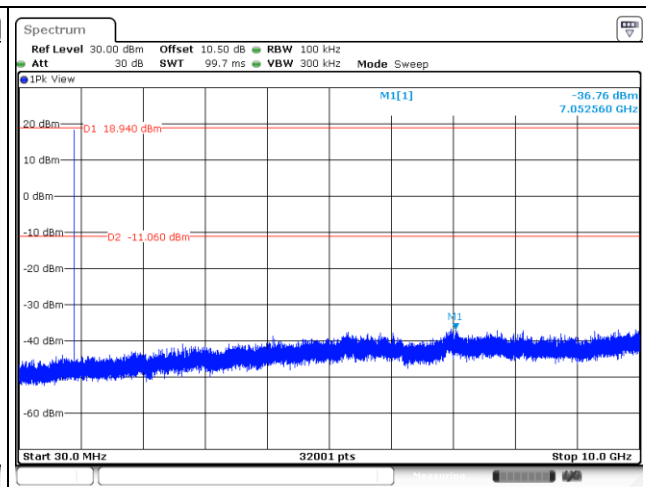
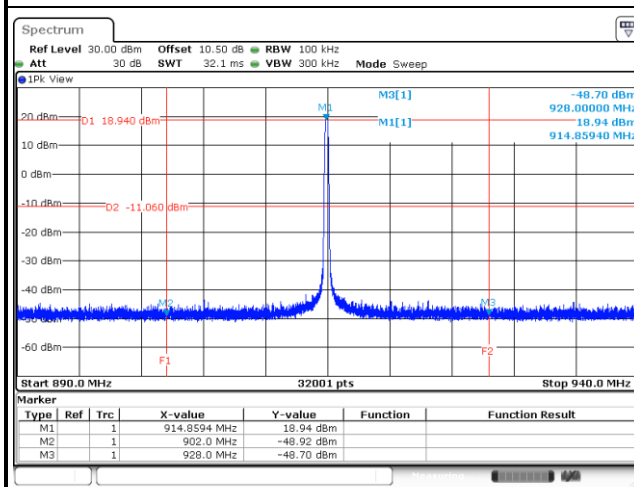
TX Frequency 902.3MHz / 30MHz~10GHz (down 30dBc)



TX Frequency 908.5MHz / 30MHz~10GHz (down 30dBc)



TX Frequency 914.9MHz / 30MHz~10GHz (down 30dBc)



3.3 Conducted Output Power

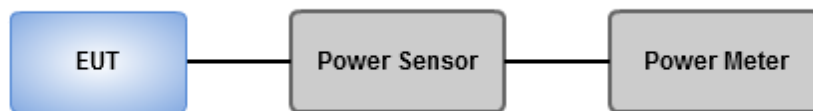
3.3.1 Limit of Conducted Output Power

- ☒ 1 Watt, systems employing at least 50 hopping channels;
- ☐ 0.25 Watt, for systems employing less than 50 hopping channels, but at least 25 hopping channels,

3.3.2 Test Procedures

1. A wideband power meter is used for power measurement. Bandwidth of power sensor and meter is 50MHz
2. 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 Conducted Output Power

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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Modulation / SF	Freq. (MHz)	Output Power (mW)	Output Power (dBm)	Limit (W)
CSS / 10	902.3	80.91	19.08	1
CSS / 10	908.5	81.47	19.11	1
CSS / 10	914.9	81.66	19.12	1

3.4 Number of Hopping Frequency

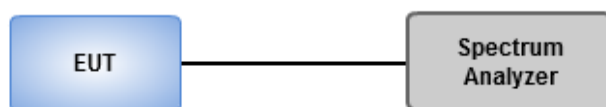
3.4.1 Limit of Number of Hopping Frequency

Number of Hopping Frequencies Limit for Frequency Hopping Systems	
☒	902-928 MHz Band:
☐	$N \geq 50$, 20 dB bandwidth of the hopping channel is less than 250 kHz
☐	$N \geq 25$, 20 dB bandwidth of the hopping channel is 250 kHz or greater
☒	Hybrid mode, No minimum number of hopping channels associated with hybrid system.
N: Number of Hopping Frequencies	

3.4.2 Test Procedures

1. Set RBW = 100kHz, VBW = 300kHz, Sweep time = Auto, Detector = Peak Trace max hold.
2. Allow trace to stabilize.

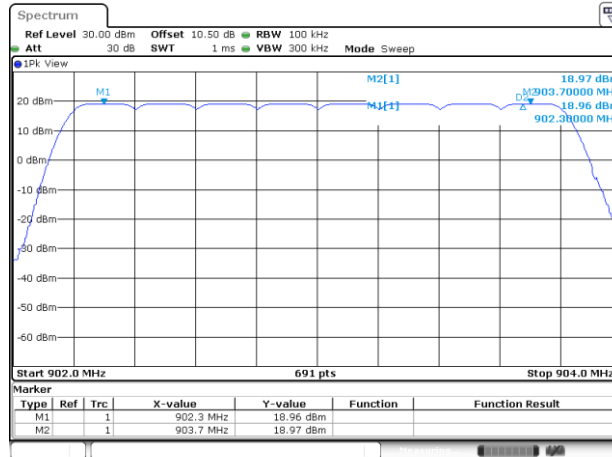
3.4.3 Test Setup



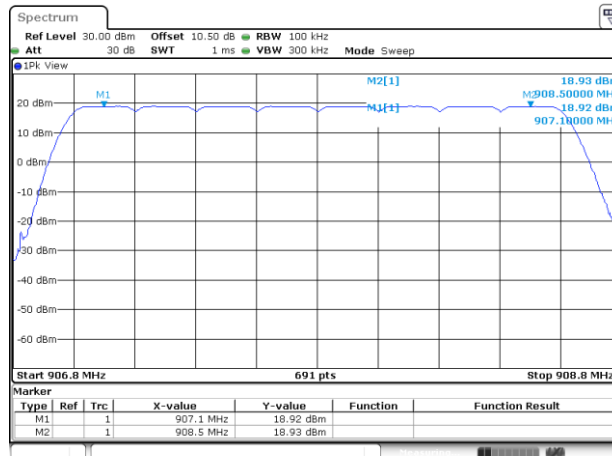
3.4.4 Test Result of Number of Hopping Frequency

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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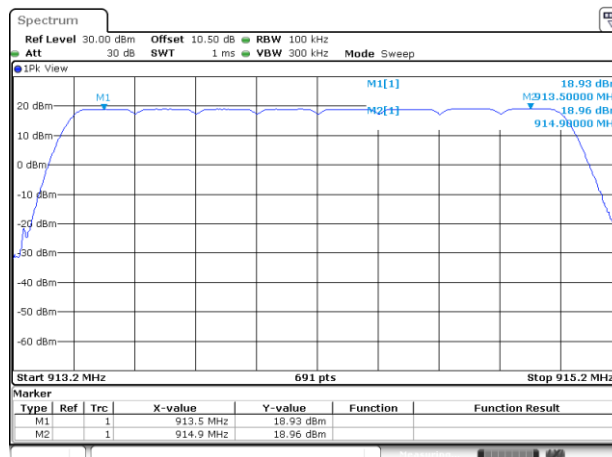
TX Frequency 902.3~903.7-1MHz



TX Frequency 907.1~908.5MHz



TX Frequency 913.5~914.9MHz



3.5 20dB and Occupied Bandwidth

3.5.1 Test Procedures

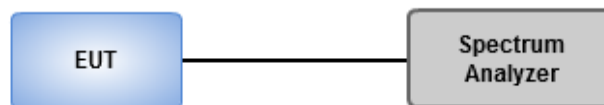
20dB Bandwidth

1. Set RBW=3kHz, VBW=10kHz, Sweep time=Auto, Detector=Peak Trace max hold.
2. Allow trace to stabilize.
3. 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 20 dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set RBW=3kHz, VBW=10kHz, Sweep time = Auto, Detector=Sample, Trace max hold
2. Allow trace to stabilize
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

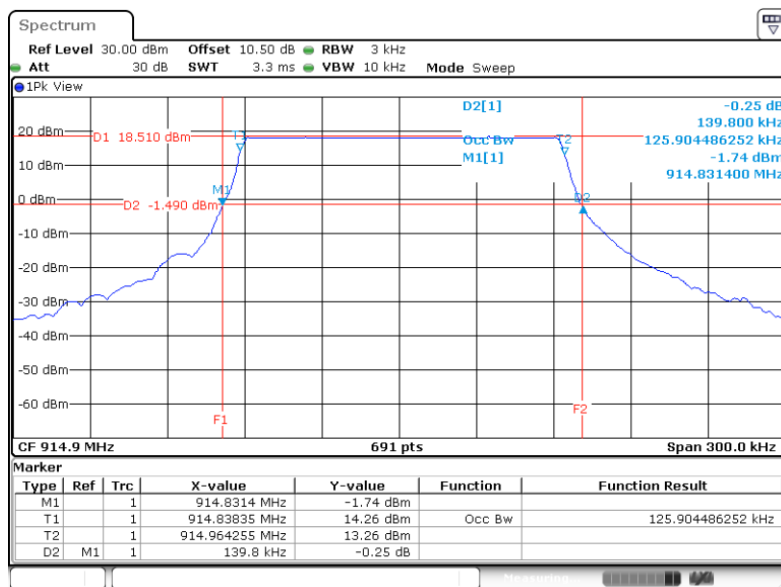
3.5.2 Test Setup



3.5.3 Test result of 20dB and Occupied Bandwidth

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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Modulation / SF	Freq. (MHz)	20dB Bandwidth (kHz)	Occupied Bandwidth (kHz)
CSS / 10	902.3	138.93	125.90
CSS / 10	908.5	138.93	125.90
CSS / 10	914.9	139.80	125.90



3.6 Channel Separation

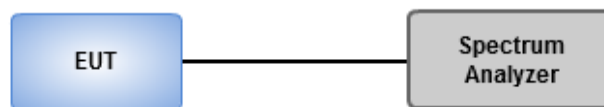
3.6.1 Limit of Channel Separation

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

3.6.2 Test Procedures

1. Set RBW=10kHz, VBW=30kHz, Sweep time=Auto, Detector=Peak Trace max hold.
2. Allow trace to stabilize.
3. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The EUT shall show compliance with the appropriate regulatory limit

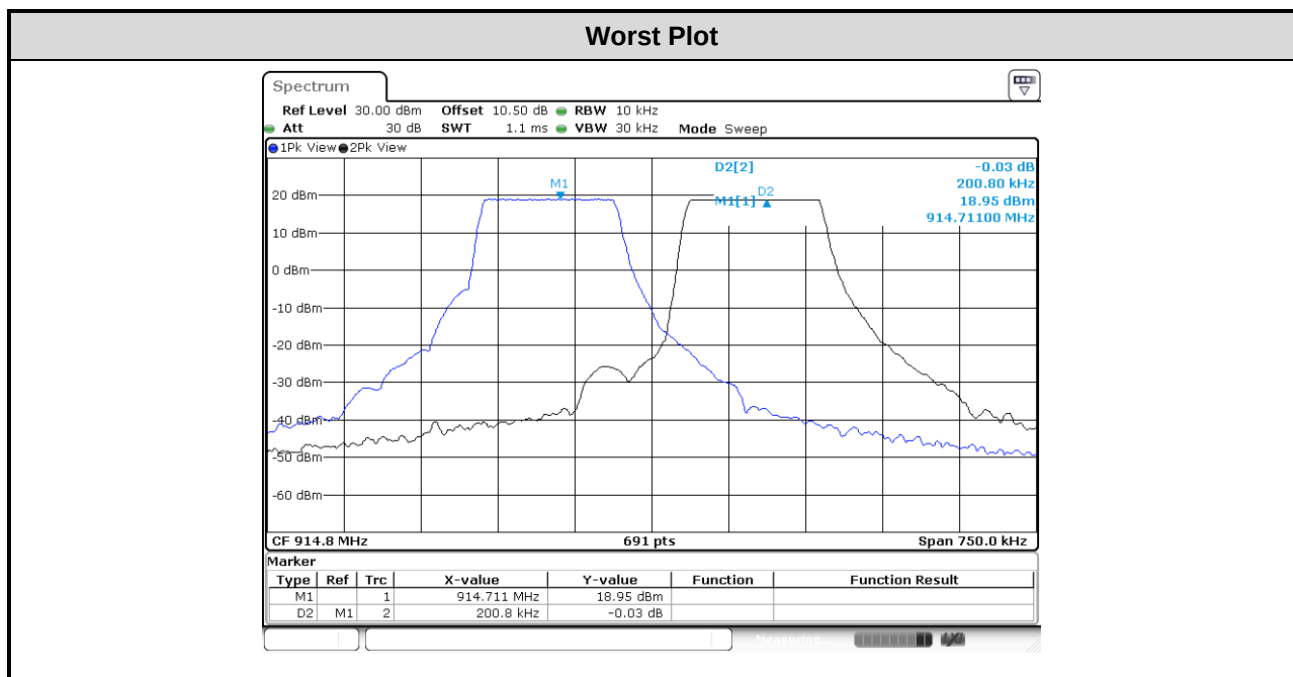
3.6.3 Test Setup



3.6.4 Test result of Channel Separation

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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Modulation / SF	Freq. (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Pass/Fail
CSS / 10	902.3	200.80	138.93	Pass
CSS / 10	908.5	200.80	138.93	Pass
CSS / 10	914.9	200.80	139.80	Pass



3.7 Number of Dwell Time

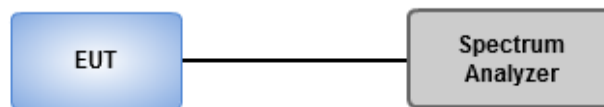
3.7.1 Limit of Dwell time

Time of Occupancy (Dwell Time) Limit for Frequency Hopping Systems	
☒	902-928 MHz Band:
☐	≤ 0.4 second within a 20 second period, 20 dB bandwidth of the hopping channel is less than 250 kHz
☐	≤ 0.4 second within a 10 second period, 20 dB bandwidth of the hopping channel is 250 kHz or greater
☒	Hybrid mode ,an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4

3.7.2 Test Procedures

1. Set RBW=100kHz, VBW=300kHz, Sweep time=6.4s / 500ms, Detector=Peak, Span=0Hz, Trace max hold.
2. Measure and record the burst on time.

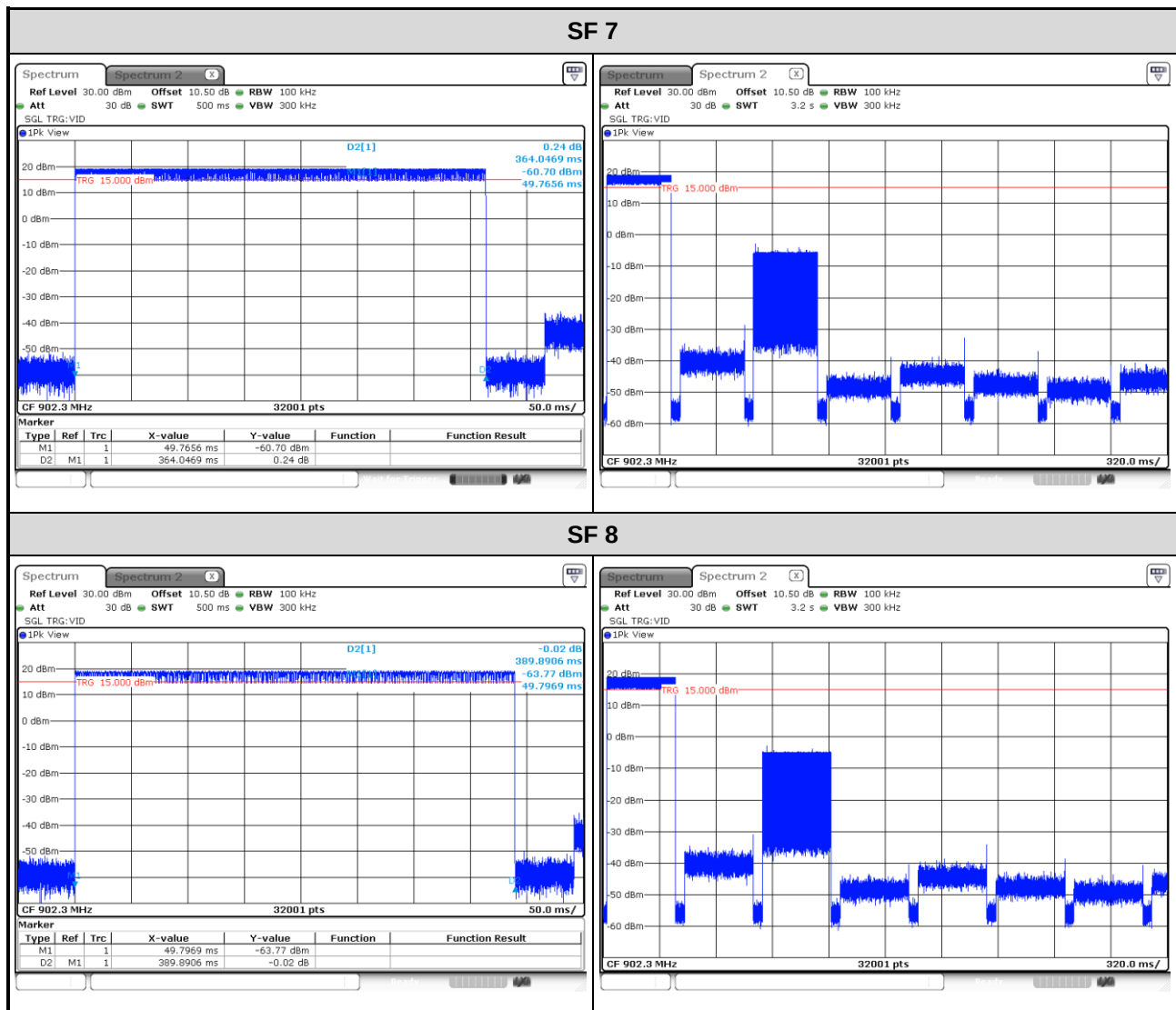
3.7.3 Test Setup



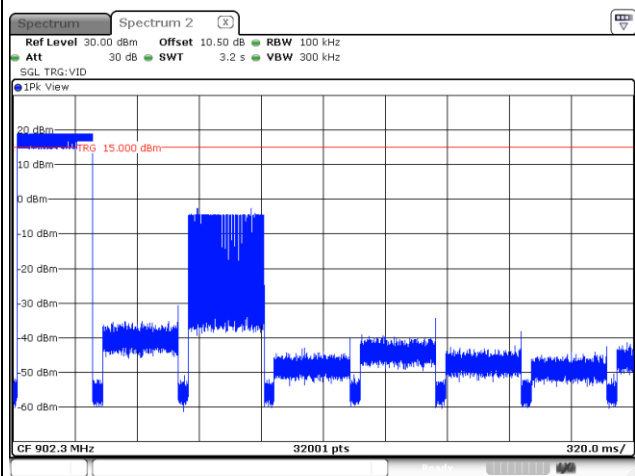
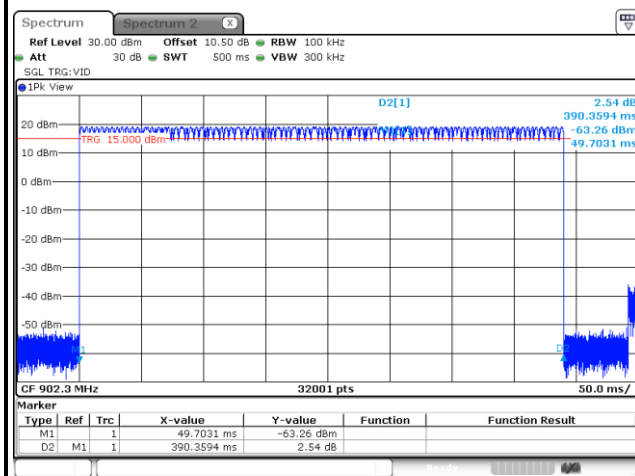
3.7.4 Test Result of Dwell Time

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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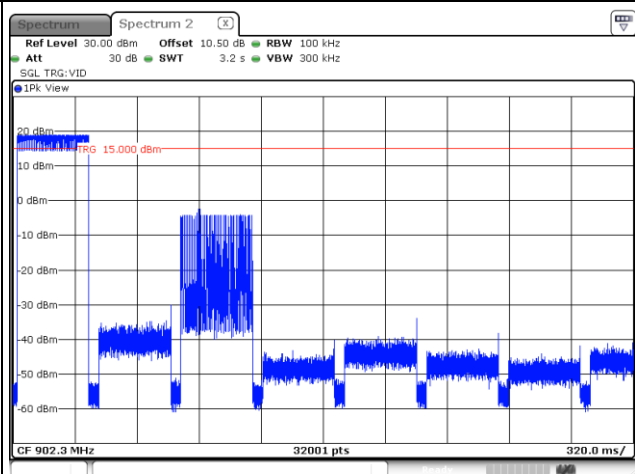
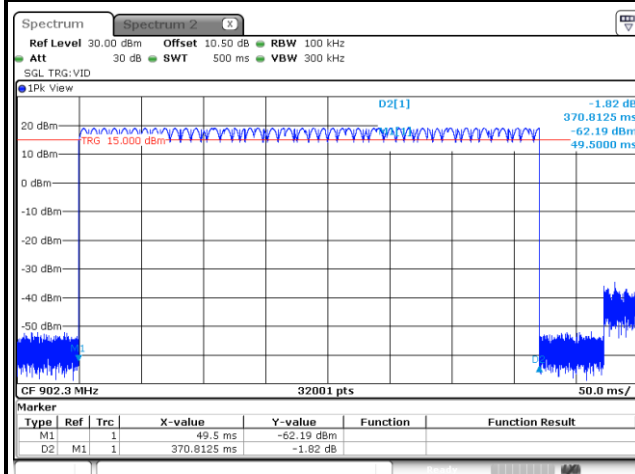
Modulation / SF	Freq. (MHz)	Length of Transmission Time (sec)	Number of Transmission in a 3.2 s (8 Hopping channels *0.4s)	Result (s)	Limit (s)
CSS / 7	902.3	0.364047	1	0.364047	0.4
CSS / 8	902.3	0.389891	1	0.389891	0.4
CSS / 9	902.3	0.390359	1	0.390359	0.4
CSS / 10	902.3	0.370813	1	0.370813	0.4



SF 9



SF 10



3.8 Power Spectral Density

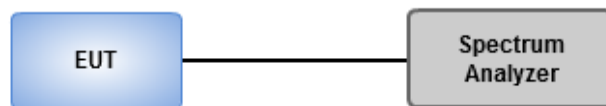
3.8.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band. This item is for Hybrid mode.

3.8.2 Test Procedures

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.

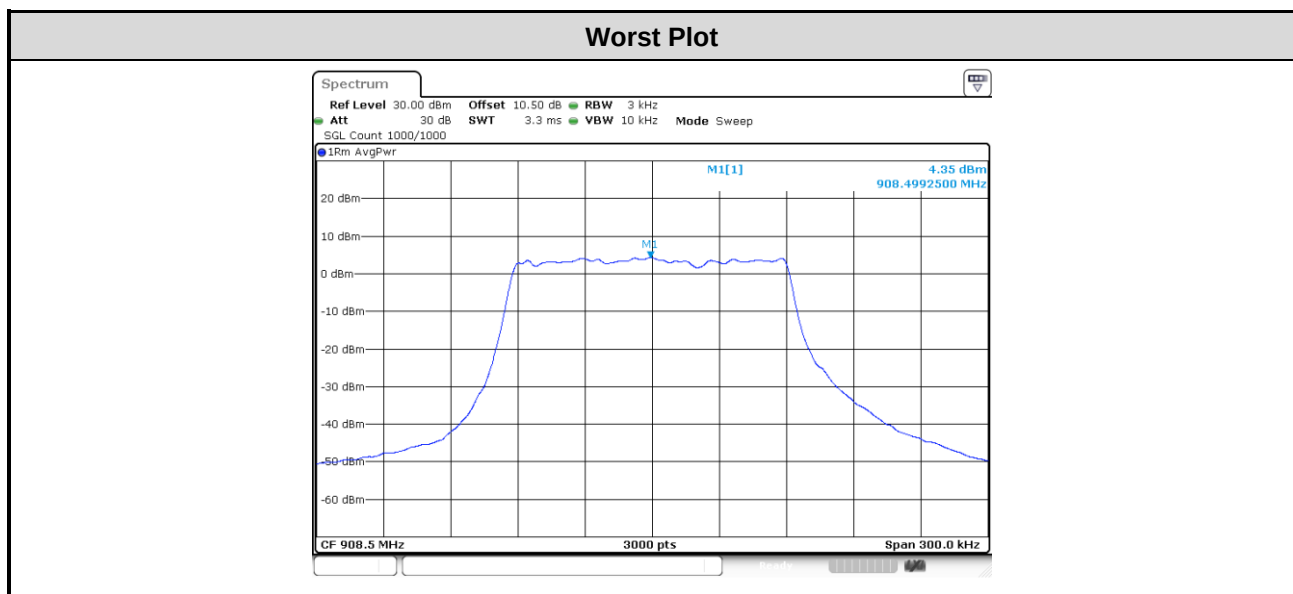
3.8.3 Test Setup



3.8.4 Test Result of Power Spectral Density

Ambient Condition	23°C / 63%	Tested By	Brad Wu
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Modulation / SF	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
CSS / 10	902.3	3.84	8.00
CSS / 10	908.5	4.35	8.00
CSS / 10	914.9	4.33	8.00



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==