



FCC RADIO TEST REPORT

FCC ID : 2AEUPBHAFL031
Equipment : Floodlight Cam Wired Pro
Brand Name : Ring
Model Name : 5B28S4
Applicant : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250 USA
Manufacturer : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250 USA
Standard : FCC Part 15 Subpart C §15.247

The product was received on Feb. 09, 2021 and testing was started from May 22, 2022 to Aug. 21, 2022. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)



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Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(1)	Number of Channels	Pass	-
3.2	15.247(a)(1)	Hopping Channel Separation	Pass	-
3.3	15.247(a)(1)	Dwell Time of Each Channel	Pass	-
3.4	15.247(a)(1)	20dB Bandwidth	Pass	-
3.4	2.1049	99% Occupied Bandwidth	Reporting only	-
3.5	15.247(b)(2)	Output Power	Pass	-
3.6	15.247(d)	Conducted Band Edges	Pass	-
3.7	15.247(d)	Conducted Spurious Emission	Pass	-
3.8	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	4.68 dB under the limit at 41.640 MHz for Quasi-Peak
3.9	15.207	AC Conducted Emission	Pass	3.30 dB under the limit at 0.499 MHz
3.10	15.203 & 15.247(b)	Antenna Requirement	Pass	-

Remark: This report is prepared for FCC class II permissive change. Difference compared with the original equipment is adding Spreading Factor 8/9/10/11 by software.

Declaration of Conformity:

- The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers. It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.
- The measurement uncertainty please refer to this report "Uncertainty of Evaluation".

Comments and Explanations:

The product specifications of the EUT presented in the report are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Keven Cheng

Report Producer: Clio Lo



1 General Description

1.1 Product Feature of Equipment Under Test

Bluetooth-LE, Wi-Fi 2.4GHz 802.11b/g/n, Wi-Fi 5GHz 802.11a/n/ac, LoRa, and 24G Radar.

Product Feature		
Antenna Type	WLAN:	
	<Ant. 1>: FPC Antenna <Ant. 2>: FPC Antenna Bluetooth-LE: FPC Antenna LoRa: PCB Antenna 24GHz Radar: Patch Antenna	
Antenna information		
902 MHz ~ 928 MHz	Peak Gain (dBi)	-0.83

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.2 Modification of EUT

No modifications are made to the EUT during all test items.

1.3 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No.
	TH02-HY, CO05-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	Sporton International Inc. Wensan Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No.
	03CH11-HY (TAF Code: 3786)
Remark	The Radiated Spurious Emission test item subcontracted to Sporton International Inc. Wensan Laboratory

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW1190 and TW3786



1.4 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. The TAF code is not including all the FCC KDB listed without accreditation.



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

LoRa 125KHz FHSS

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
902 – 928 MHz	1	902.2	28	907.6	55	913.0	82	918.4	109	923.8
	2	902.4	29	907.8	56	913.2	83	918.6	110	924.0
	3	902.6	30	908.0	57	913.4	84	918.8	111	924.2
	4	902.8	31	908.2	58	913.6	85	919.0	112	924.4
	5	903.0	32	908.4	59	913.8	86	919.2	113	924.6
	6	903.2	33	908.6	60	914.0	87	919.4	114	924.8
	7	903.4	34	908.8	61	914.2	88	919.6	115	925.0
	8	903.6	35	909.0	62	914.4	89	919.8	116	925.2
	9	903.8	36	909.2	63	914.6	90	920.0	117	925.4
	10	904.0	37	909.4	64	914.8	91	920.2	118	925.6
	11	904.2	38	909.6	65	915.0	92	920.4	119	925.8
	12	904.4	39	909.8	66	915.2	93	920.6	120	926.0
	13	904.6	40	910.0	67	915.4	94	920.8	121	926.2
	14	904.8	41	910.2	68	915.6	95	921.0	122	926.4
	15	905.0	42	910.4	69	915.8	96	921.2	123	926.6
	16	905.2	43	910.6	70	916.0	97	921.4	124	926.8
	17	905.4	44	910.8	71	916.2	98	921.6	125	927.0
	18	905.6	45	911.0	72	916.4	99	921.8	126	927.2
	19	905.8	46	911.2	73	916.6	100	922.0	127	927.4
	20	906.0	47	911.4	74	916.8	101	922.2	128	927.6
	21	906.2	48	911.6	75	917.0	102	922.4	129	927.8
	22	906.4	49	911.8	76	917.2	103	922.6	-	-
	23	906.6	50	912.0	77	917.4	104	922.8	-	-
	24	906.8	51	912.2	78	917.6	105	923.0	-	-
	25	907.0	52	912.4	79	917.8	106	923.2	-	-
	26	907.2	53	912.6	80	918.0	107	923.4	-	-
	27	907.4	54	912.8	81	918.2	108	923.6	-	-



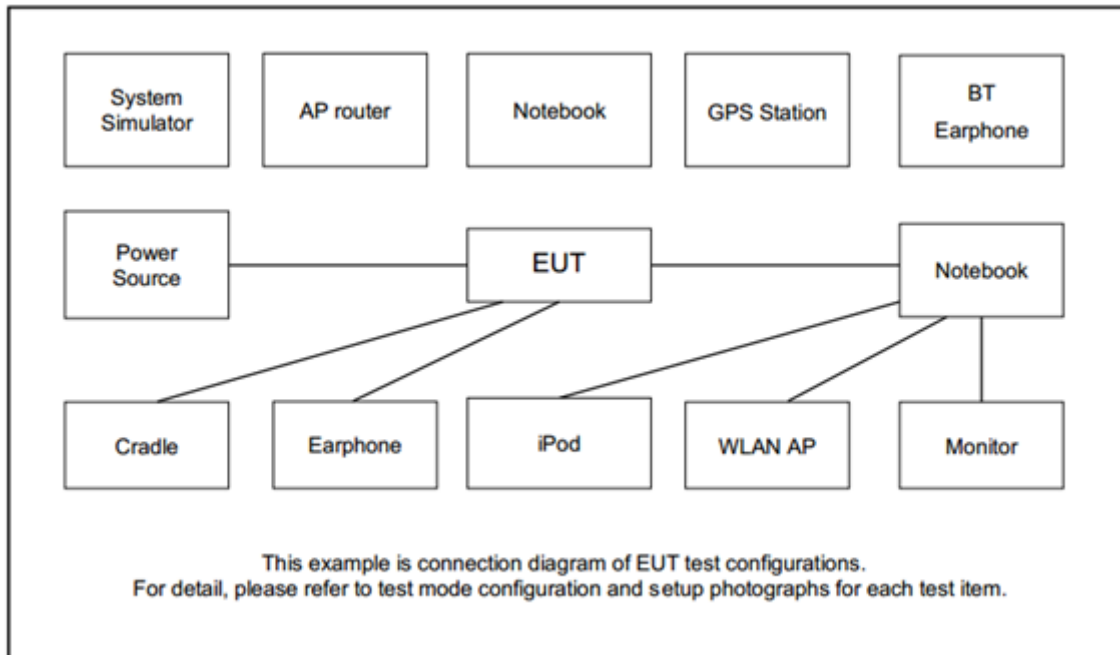
2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases		
Test Item	Feature	LoRa/FSK
Conducted Test Cases	LoRa 125 KHz FHSS_SF8	Mode 1: CH01 Tx_902.20 MHz Mode 2: CH65 Tx_915.00 MHz Mode 3: CH129 Tx_927.80 MHz
	LoRa 125 KHz FHSS_SF9	Mode 4: CH01 Tx_902.20 MHz Mode 5: CH65 Tx_915.00 MHz Mode 6: CH129 Tx_927.80 MHz
Radiated Test Cases	LoRa 125 KHz FHSS_SF8	Mode 1: CH01 Tx_902.20 MHz Mode 2: CH65 Tx_915.00 MHz Mode 3: CH129 Tx_927.80 MHz
AC Conducted Emission	Mode 1: LoRa Tx	

2.3 Connection Diagram of Test System



2.4 EUT Operation Test Setup

The RF test items, utility “Tera Term Version 4.89 (SVN 6182)” was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.5 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$

3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

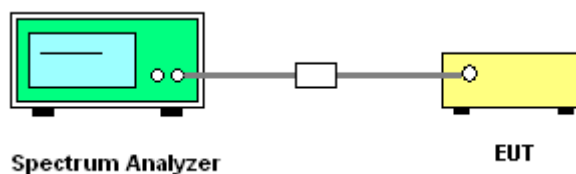
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW = 50kHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold for LoRa 125kHz FHSS.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

3.1.4 Test Setup



3.1.5 Test Result of Number of Hopping Frequency

Please refer to Appendix A.

3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

Frequency hopping systems operating in the 902 – 928 MHz band 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.

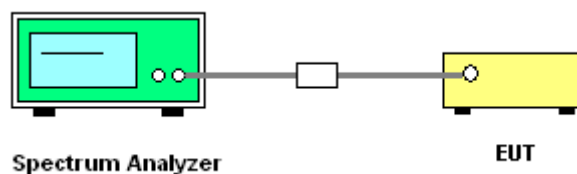
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels;
RBW = 50kHz for; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold for LoRa 125KHz FHSS.
6. Measure and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Hopping Channel Separation

Please refer to Appendix A.

3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

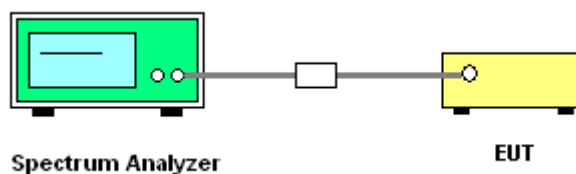
3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 20 kHz; VBW \geq RBW; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.3.4 Test Setup



3.3.5 Test Result of Dwell Time

Please refer to Appendix A.

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

99% Bandwidth is reporting only.

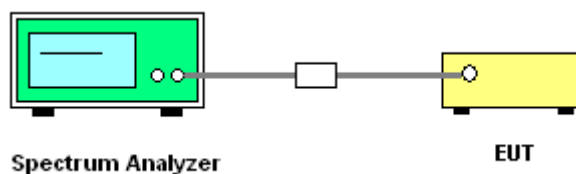
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.9.2 and 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.
Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel;
RBW \geq 1% of the 20 dB bandwidth; VBW \geq RBW; Sweep = auto; Detector function = peak;
Trace = max hold.
5. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.
Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
RBW \geq 1-5% of the 99% bandwidth; VBW \geq 3 * RBW; Sweep = auto; Detector function = peak;
Trace = max hold.
6. Measure and record the results in the test report.

3.4.4 Test Setup



3.4.5 Test Result of 20dB Bandwidth

Please refer to Appendix A.

3.4.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

3.5 Output Power Measurement

3.5.1 Limit of Output Power

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

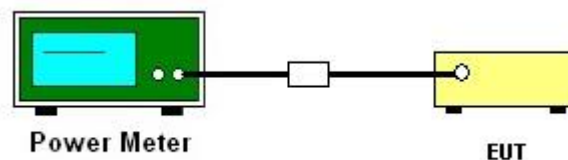
3.5.2 Measuring Instruments

See list of measuring equipment of this test report.

3.5.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

3.5.4 Test Setup



3.5.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.5.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

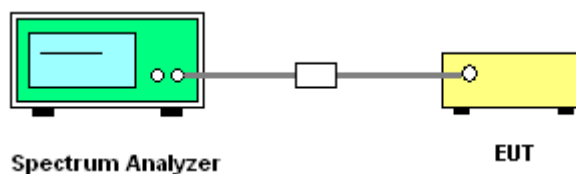
3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100kHz, VBW = 300kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 2. and 3.
5. Measure and record the results in the test report.

3.6.4 Test Setup



3.6.5 Test Result of Conducted Band Edges

Please refer to Appendix A.

3.6.6 Test Result of Conducted Hopping Mode Band Edges

Please refer to Appendix A.

3.7 Conducted Spurious Emission Measurement

3.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

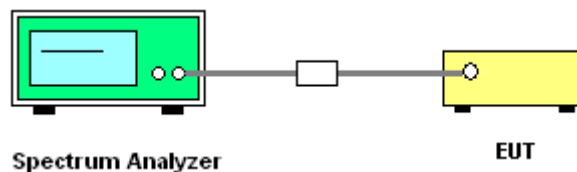
3.7.2 Measuring Instruments

See list of measuring equipment of this test report.

3.7.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.7.4 Test Setup



3.7.5 Test Result of Conducted Spurious Emission

Please refer to Appendix A.



3.8 Radiated Band Edges and Spurious Emission Measurement

3.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.8.2 Measuring Instruments

See list of measuring equipment of this test report.

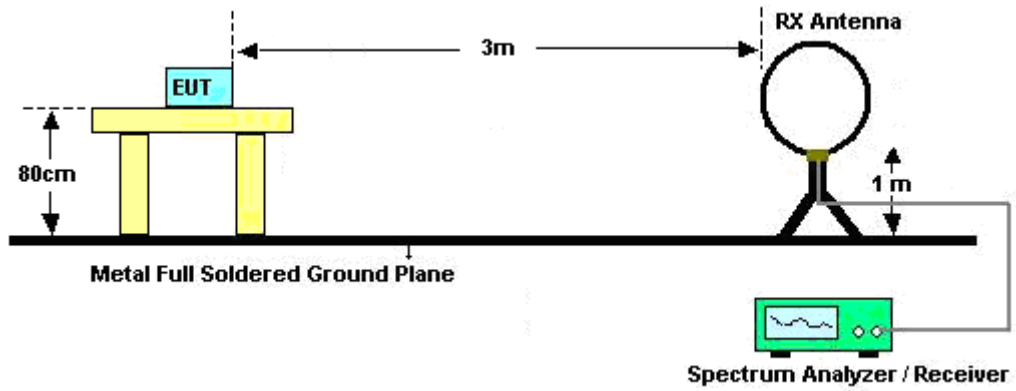


3.8.3 Test Procedures

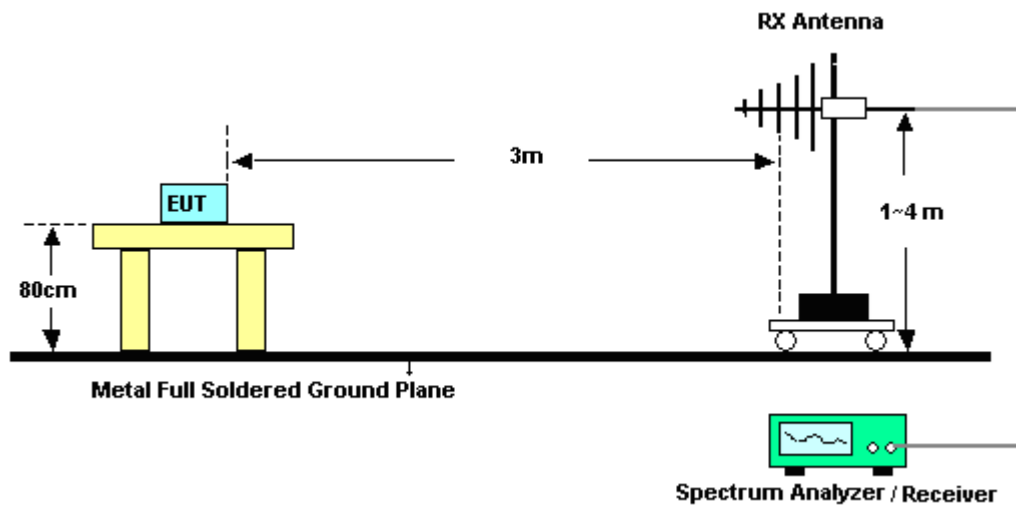
1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. Use the following spectrum analyzer settings:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz for $f < 1$ GHz, RBW=1MHz for $f > 1$ GHz ; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
 - (3) For average measurement: use duty cycle correction factor method per 15.35(c).
Duty cycle = On time/100 milliseconds
On time = $N_1 * L_1 + N_2 * L_2 + \dots + N_{n-1} * L_{n-1} + N_n * L_n$
Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 * \log(\text{Duty cycle})$
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. Radiated testing below 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as “-”.
8. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-”.

3.8.4 Test Setup

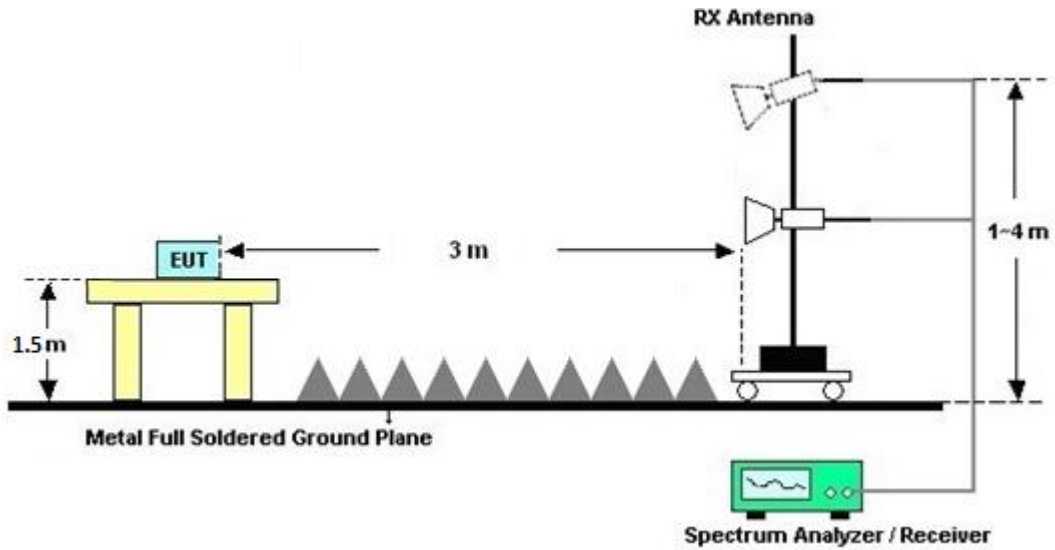
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.8.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

3.8.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.8.7 Duty Cycle

Please refer to Appendix E.

3.8.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C and D.



3.9 AC Conducted Emission Measurement

3.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

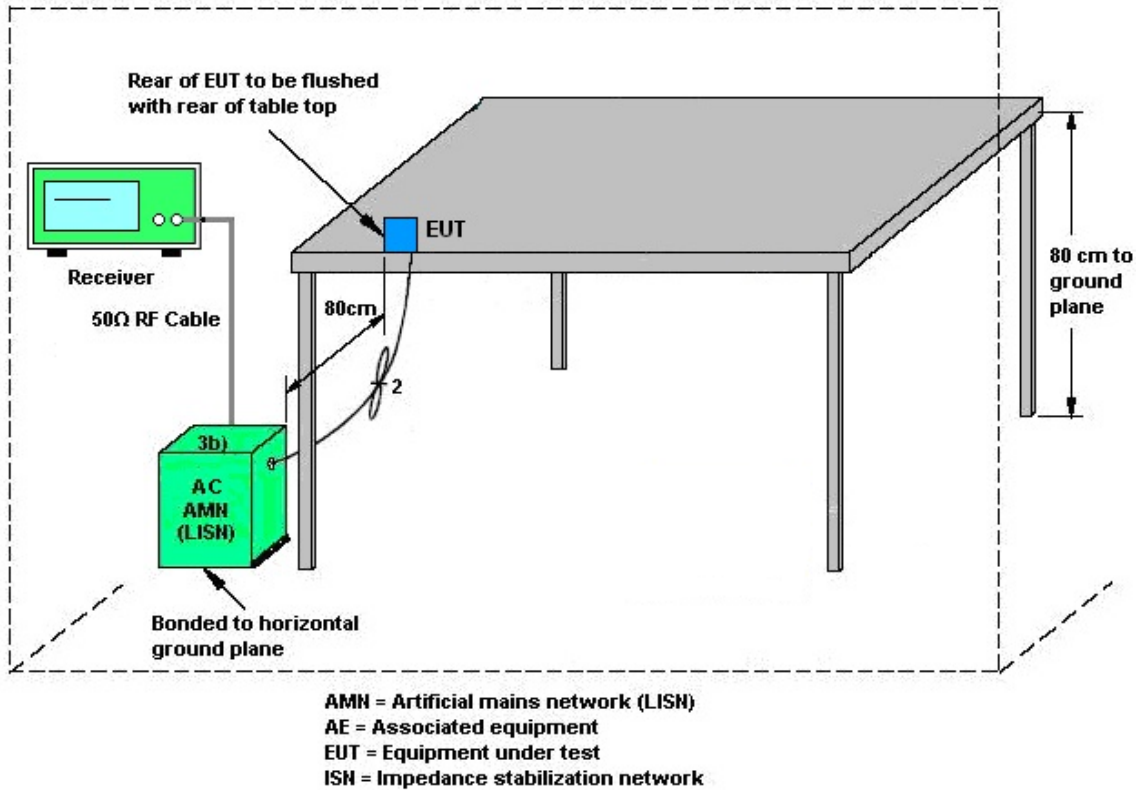
3.9.2 Measuring Instruments

See list of measuring equipment of this test report.

3.9.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.9.4 Test Setup



3.9.5 Test Result of AC Conducted Emission

Please refer to Appendix B.



3.10 Antenna Requirements

3.10.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.10.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.10.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 07, 2022	May 30, 2022~ Aug. 17, 2022	Jan. 06, 2023	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D & N-6-06	35414 & AT-N0602	30MHz~1GHz	Oct. 09, 2021	May 30, 2022~ Aug. 17, 2022	Oct. 08, 2022	Radiation (03CH11-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1212	1GHz ~ 18GHz	Mar. 10, 2022	May 30, 2022~ Aug. 17, 2022	Mar. 09, 2023	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 10, 2021	May 30, 2022~ Aug. 17, 2022	Dec. 09, 2022	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 10, 2021	May 30, 2022~ Aug. 17, 2022	Nov. 09, 2022	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55- 303	171000180005 5007	1GHz~18GHz	Jun. 16, 2021	May 30, 2022~ May 31, 2022	Jun. 15, 2022	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55- 303	171000180005 5007	1GHz~18GHz	Jun. 15, 2022	Aug. 16, 2022~ Aug. 17, 2022	Jun. 14, 2023	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 15, 2021	May 30, 2022~ Aug. 17, 2022	Oct. 14, 2022	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MX E)	MY55420170	20MHz~8.4GHz	Jul. 15, 2021	May 30, 2022~ May 31, 2022	Jul. 14, 2022	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MX E)	MY54130085	20MHz~8.4GHz	Oct. 21, 2021	Aug. 16, 2022~ Aug. 17, 2022	Oct. 20, 2022	Radiation (03CH11-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	May 30, 2022~ Aug. 17, 2022	N/A	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500 -B	N/A	1~4m	N/A	May 30, 2022~ Aug. 17, 2022	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	May 30, 2022~ Aug. 17, 2022	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	May 30, 2022~ Aug. 17, 2022	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz-40GHz	Mar. 10, 2022	May 30, 2022~ Aug. 17, 2022	Mar. 09, 2023	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	9kHz-30MHz	Mar. 10, 2022	May 30, 2022~ Aug. 17, 2022	Mar. 09, 2023	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	30MHz-18GHz	Mar. 10, 2022	May 30, 2022~ Aug. 17, 2022	Mar. 09, 2023	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	811852/4	30MHz-18GHz	Mar. 10, 2022	May 30, 2022~ Aug. 17, 2022	Mar. 09, 2023	Radiation (03CH11-HY)
Filter	Wainwright	WLK4-1000- 1530-8000-4 0SS	SN11	1.53G Low Pass	Sep. 13, 2021	May 30, 2022~ Aug. 17, 2022	Sep. 12, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-27 00-3000-180 00-60SS	SN3	3GHz High Pass Filter	Sep. 13, 2021	May 30, 2022~ Aug. 17, 2022	Sep. 12, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-90 0-1000-1500 0-60SS	SN12	1GHz High Pass Filter	Nov. 04, 2021	May 30, 2022~ Aug. 17, 2022	Nov. 03, 2022	Radiation (03CH11-HY)
Hygrometer	TECEPEL	DTM-303B	TP140325	N/A	Nov. 26, 2021	May 30, 2022~ Aug. 17, 2022	Nov. 25, 2022	Radiation (03CH11-HY)
Hygrometer	TECEPEL	DTM-303B	TP200880	N/A	Sep. 30, 2021	May 30, 2022~ Aug. 17, 2022	Sep. 29, 2022	Radiation (03CH11-HY)



Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Jul. 14, 2022	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102388	9kHz~3.6GHz	Dec. 01, 2021	Jul. 14, 2022	Nov. 30, 2022	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Nov. 17, 2021	Jul. 14, 2022	Nov. 16, 2022	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100080	9kHz~30MHz	Dec. 03, 2021	Jul. 14, 2022	Dec. 02, 2022	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32	N/A	N/A	N/A	Jul. 14, 2022	N/A	Conduction (CO05-HY)
Pulse Limiter	SCHWARZBECK	VTSD 9561-F N	00691	N/A	Jul. 28, 2021	Jul. 14, 2022	Jul. 27, 2022	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	Dec. 30, 2021	Jul. 14, 2022	Dec. 29, 2022	Conduction (CO05-HY)
Hygrometer	TECPEL	TR-32	HE17XB2468	N/A	Mar. 18, 2022	May 22, 2022~ Aug. 21, 2022	Mar. 17, 2023	Conducted (TH02-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101564	10Hz~40GHz	Aug. 30, 2021	May 22, 2022~ Aug. 21, 2022	Aug. 29, 2022	Conducted (TH02-HY)
Power Meter	Anritsu	ML2495A	932001	N/A	Sep. 30, 2021	May 22, 2022~ Aug. 21, 2022	Sep. 29, 2022	Conducted (TH02-HY)
Power Sensor	Anritsu	MA2411B	846202	300MHz~40GHz	Sep. 30, 2021	May 22, 2022~ Aug. 21, 2022	Sep. 29, 2022	Conducted (TH02-HY)



5 Uncertainty of Evaluation

Uncertainty of Conducted Emission Measurement (150 kHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	3.1 dB
-------------------------------------------------------------------------	--------

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.8 dB
-------------------------------------------------------------------------	--------

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.4 dB
-------------------------------------------------------------------------	--------

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.9 dB
-------------------------------------------------------------------------	--------

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Tommy Lee	Temperature:	20-25	°C
Test Date:	2022/5/22~2022/8/21	Relative Humidity:	49-56	%

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
Lora 125KHz	SF8	1	1	902.2	0.156	0.133	0.208	0.1563	Pass
Lora 125KHz	SF8	1	65	915	0.152	0.132	0.234	0.1524	Pass
Lora 125KHz	SF8	1	129	927.8	0.152	0.131	0.210	0.1524	Pass

TEST RESULTS DATA						
Dwell Time						
Mod.	Hopping Channel Number Rate	Hops Over Occupancy Time(hops)	Package Transfer Time (msec)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Lora 125KHz	129	1	392.68	0.39	0.4	Pass

TEST RESULTS DATA					
Peak Power Table					
Mod.	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
Lora 125KHz	1	1	24.87	30.00	Pass
	65	1	24.69	30.00	Pass
	129	1	24.34	30.00	Pass

TEST RESULTS DATA				
Average Power Table				
(Reporting Only)				
Mod.	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
Lora 125KHz	1	1	24.83	0.00
	65	1	24.65	0.00
	129	1	24.29	0.00

TEST RESULTS DATA		
Number of Hopping Frequency		
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
129	> 50	Pass

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
Lora 125KHz	SF9	1	1	902.2	0.153	0.132	0.201	0.1534	Pass
Lora 125KHz	SF9	1	65	915	0.153	0.132	0.261	0.1529	Pass
Lora 125KHz	SF9	1	129	927.8	0.155	0.132	0.234	0.1549	Pass

TEST RESULTS DATA						
Dwell Time						
Mod.	Hopping Channel Number Rate	Hops Over Occupancy Time(hops)	Package Transfer Time (msec)	Dwell Time (sec)	Limits (sec)	Pass/Fail
Lora 125KHz	129	1	375.35	0.38	0.4	Pass

TEST RESULTS DATA					
Peak Power Table					
Mod.	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
Lora 125KHz	1	1	24.86	30.00	Pass
	65	1	24.68	30.00	Pass
	129	1	24.32	30.00	Pass

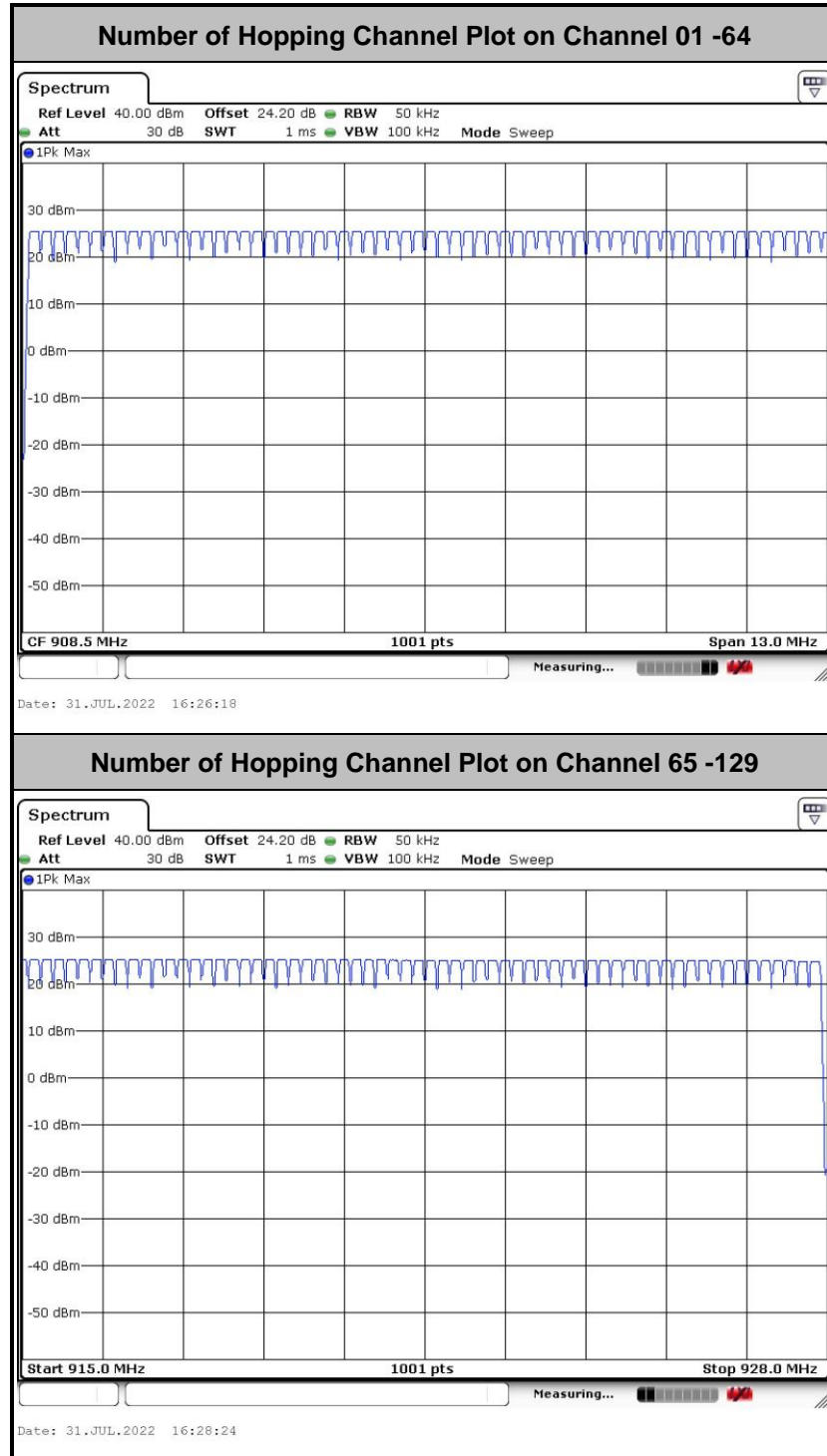
TEST RESULTS DATA				
Average Power Table				
(Reporting Only)				
Mod.	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
Lora 125KHz	1	1	24.82	0.00
	65	1	24.63	0.00
	129	1	24.27	0.00

TEST RESULTS DATA		
Number of Hopping Frequency		
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
129	> 50	Pass



<Data Rate: SF8>

Number of Hopping Frequency

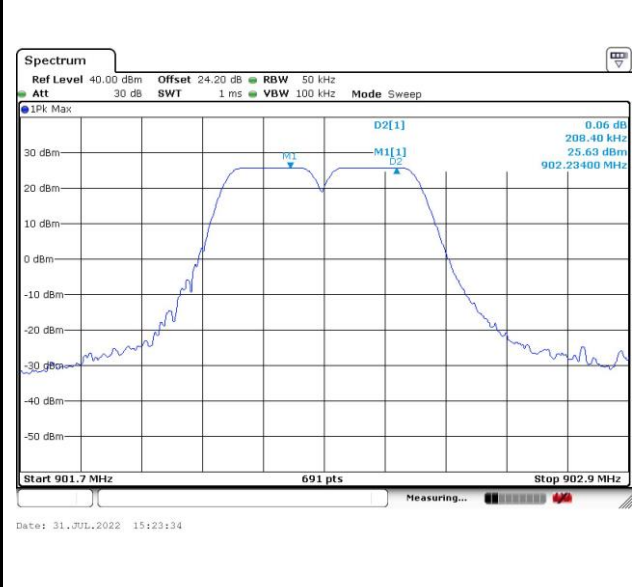




Hopping Channel Separation

< Lora 125kHz FHSS(SF8) >

Channel Separation Plot on Channel 01 - 02



Channel Separation Plot on Channel 64 - 65

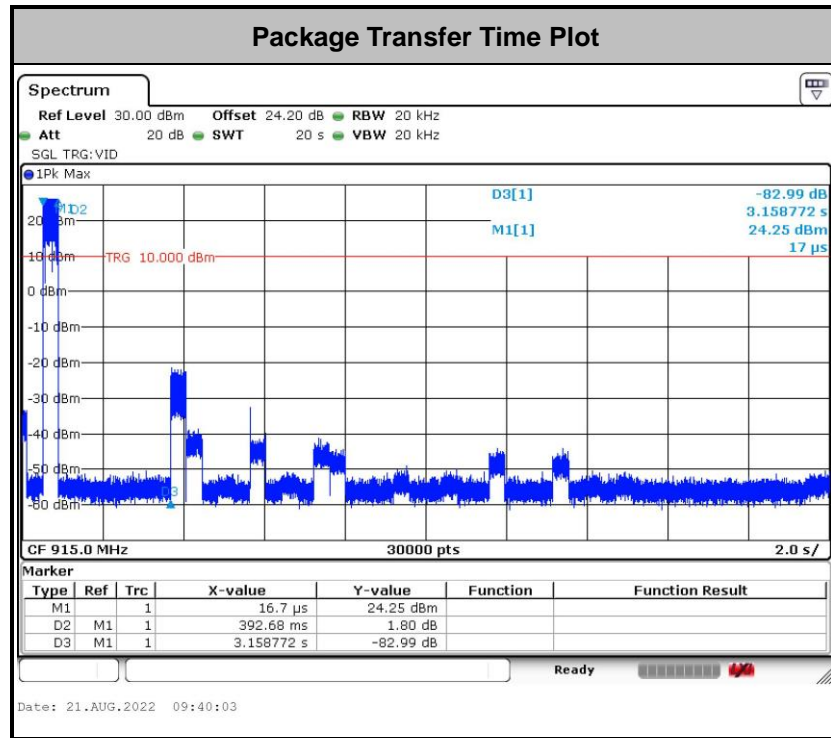


Channel Separation Plot on Channel 128 - 129





Dwell Time



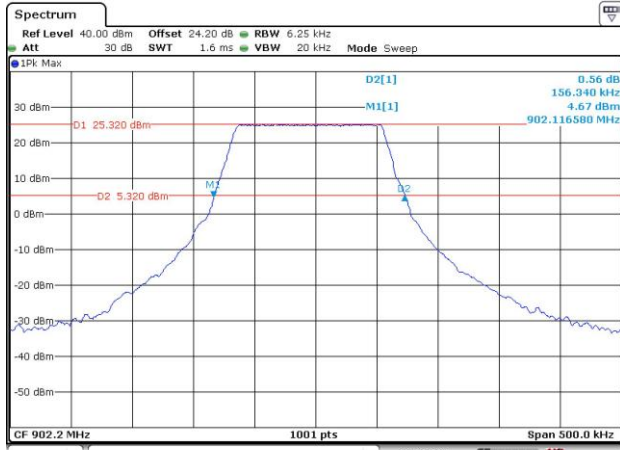
Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time



20dB Bandwidth

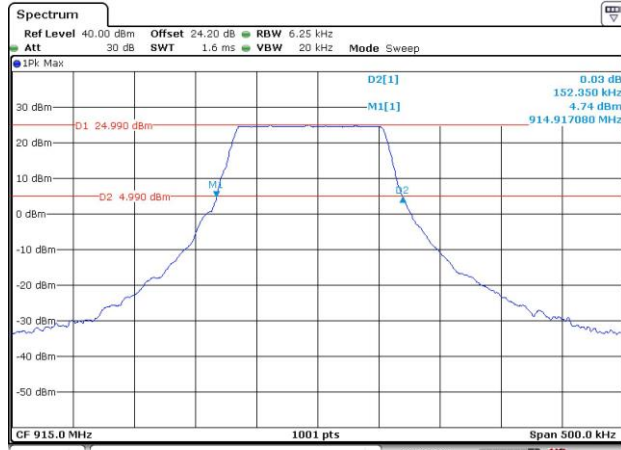
< Lora 125kHz FHSS(SF8) >

20 dB Bandwidth Plot on Channel 00



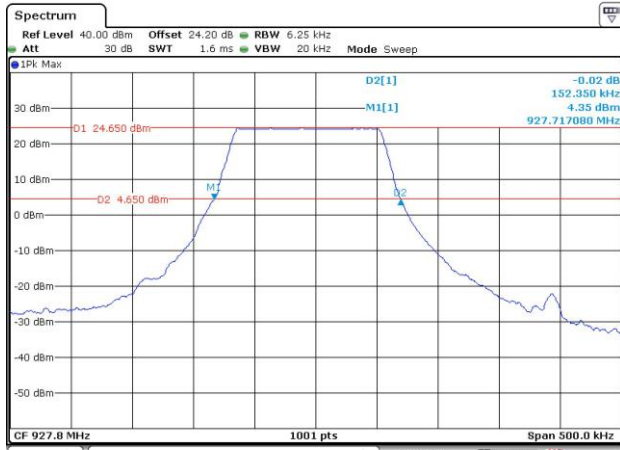
Date: 31.JUL.2022 15:01:20

20 dB Bandwidth Plot on Channel 65



Date: 31.JUL.2022 15:05:14

20 dB Bandwidth Plot on Channel 129



Date: 31.JUL.2022 16:07:30



99% Occupied Bandwidth

< Lora 125kHz FHSS(SF8) >

99% Occupied Bandwidth on Channel 01



99% Occupied Bandwidth on Channel 65



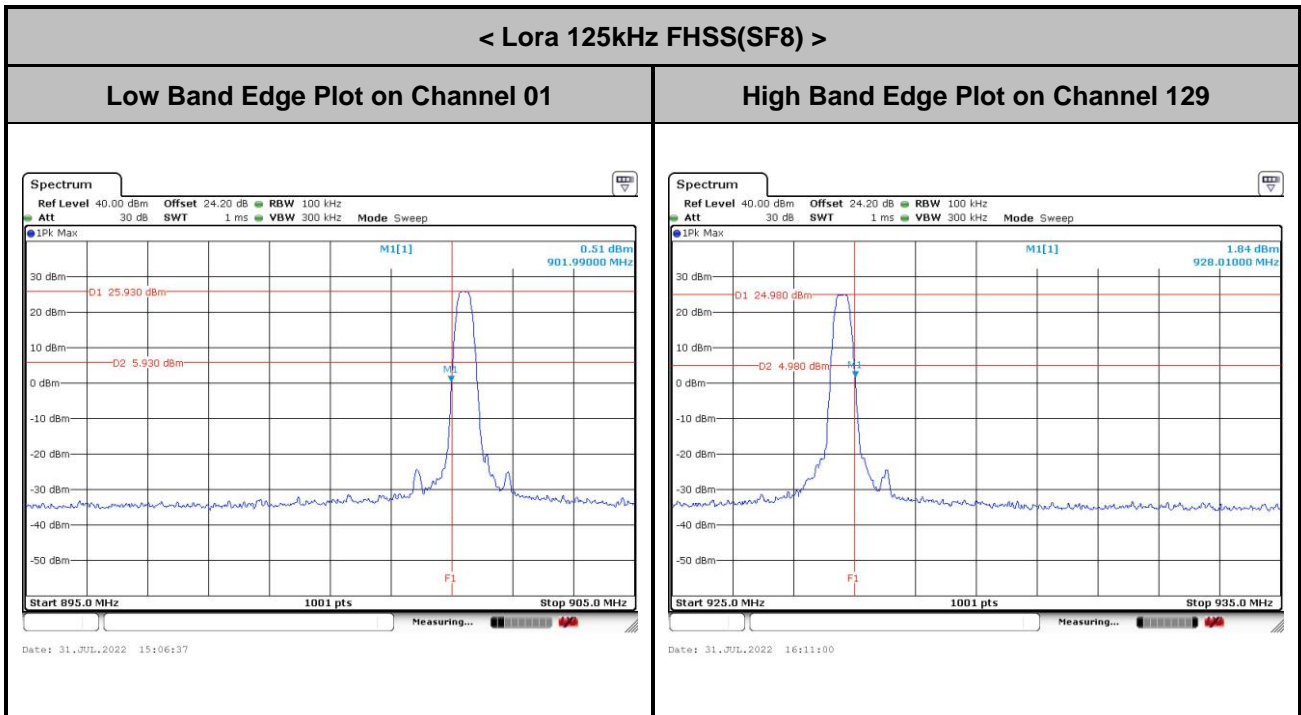
99% Occupied Bandwidth on Channel 129



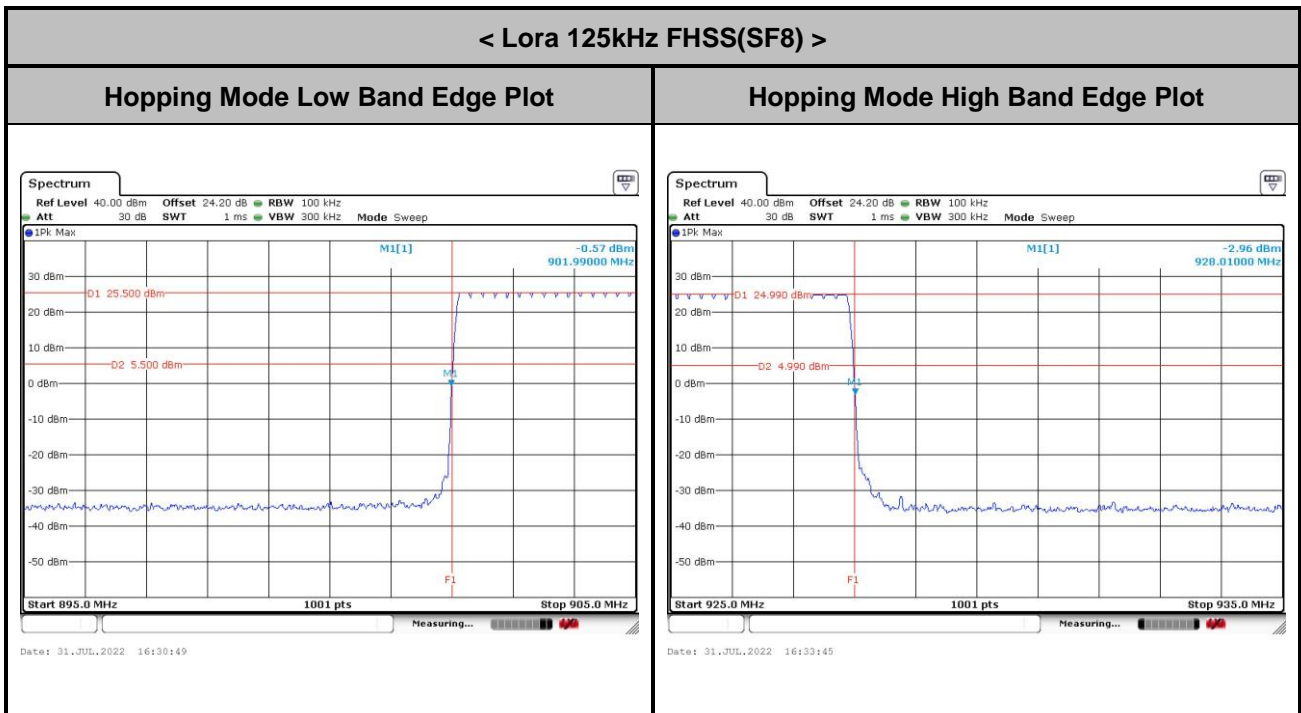
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.



Band Edges



Hopping Mode Band Edges

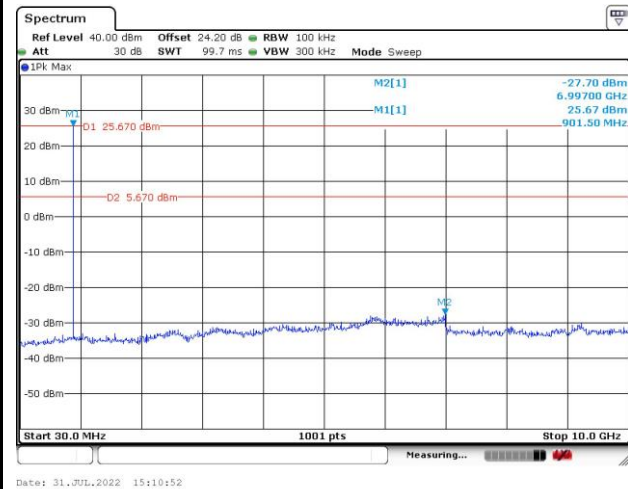




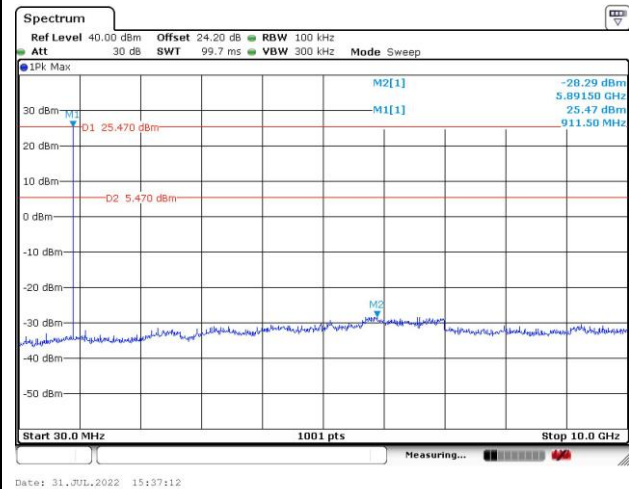
Spurious Emission

< Lora 125kHz FHSS(SF8) >

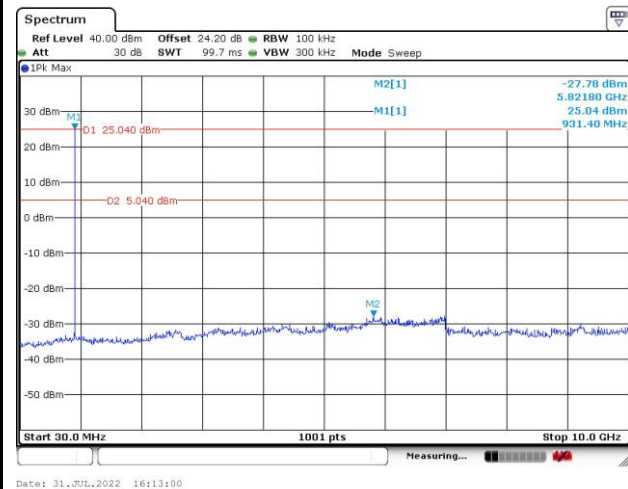
CSE Plot on Ch 01 between 30MHz ~ 10 GHz



CSE Plot on Ch 65 between 30MHz ~ 10 GHz



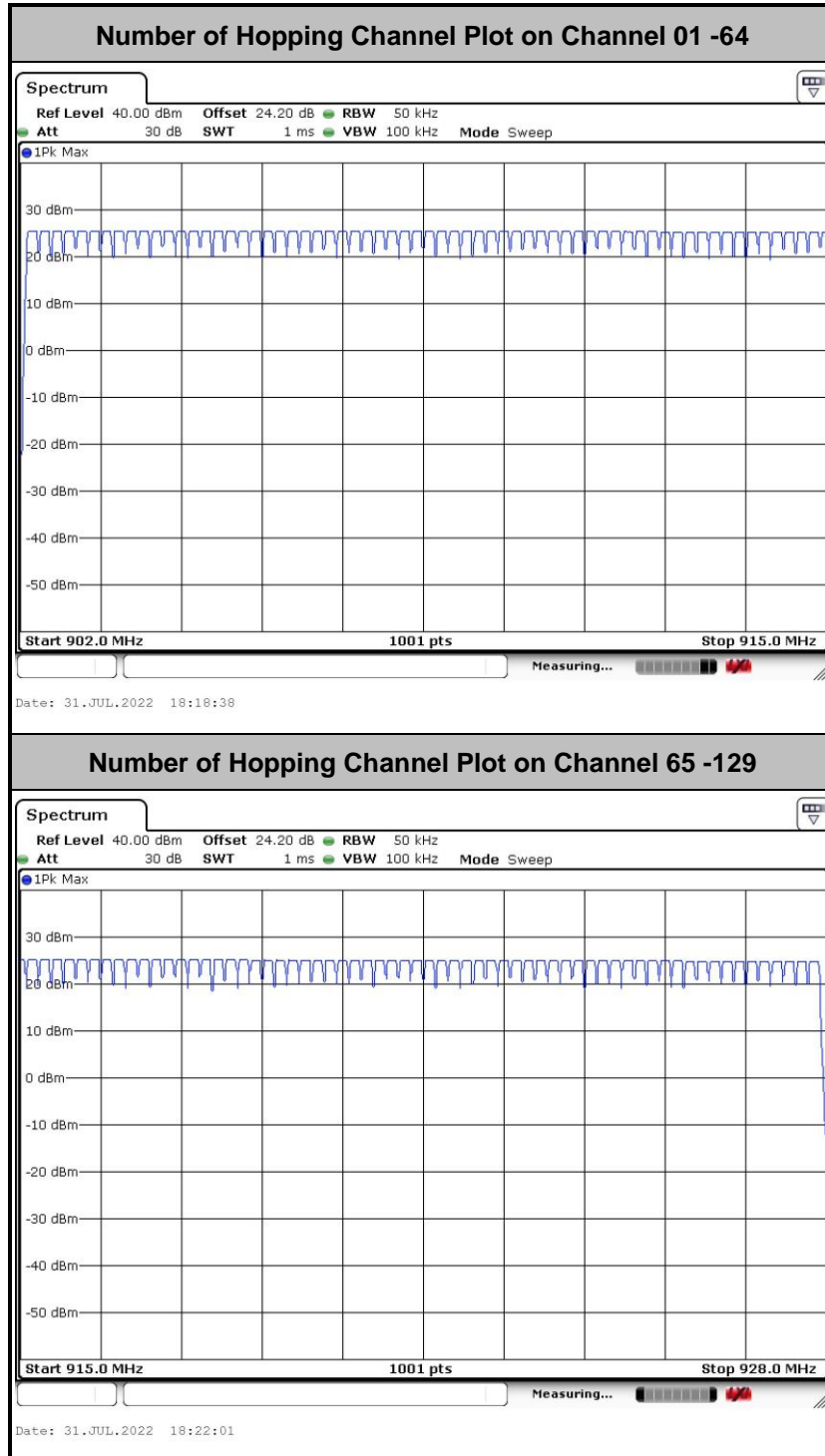
CSE Plot on Ch 129 between 30MHz ~ 10 GHz





<Data Rate: SF9>

Number of Hopping Frequency





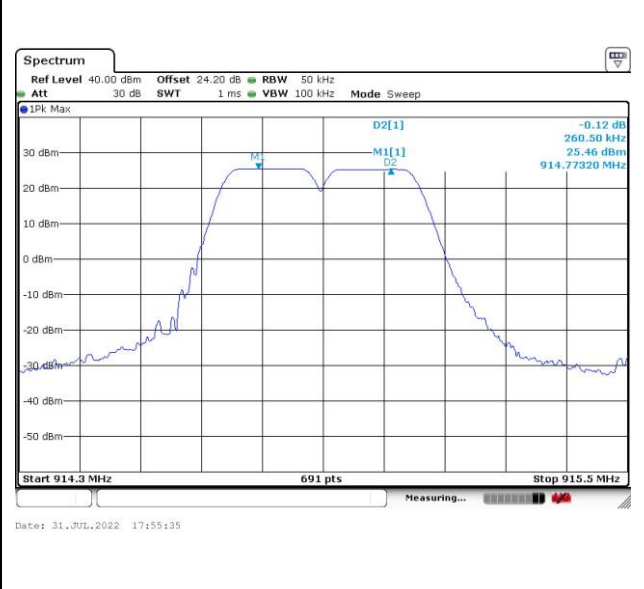
Hopping Channel Separation

< Lora 125kHz FHSS(SF9) >

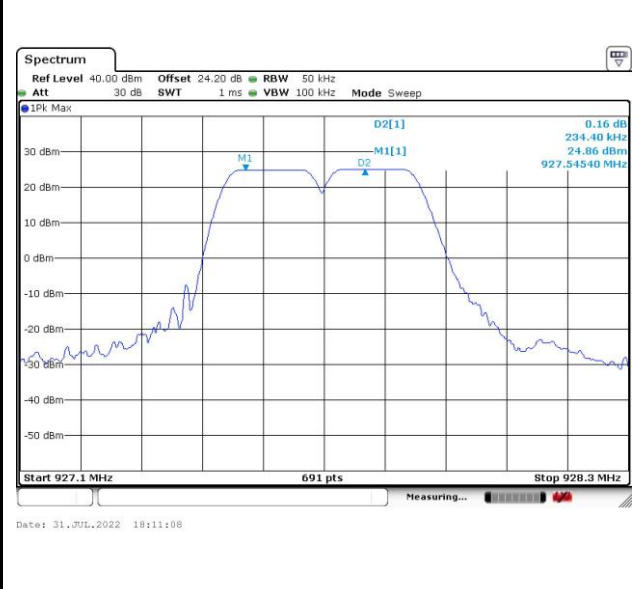
Channel Separation Plot on Channel 01 - 02



Channel Separation Plot on Channel 64 - 65

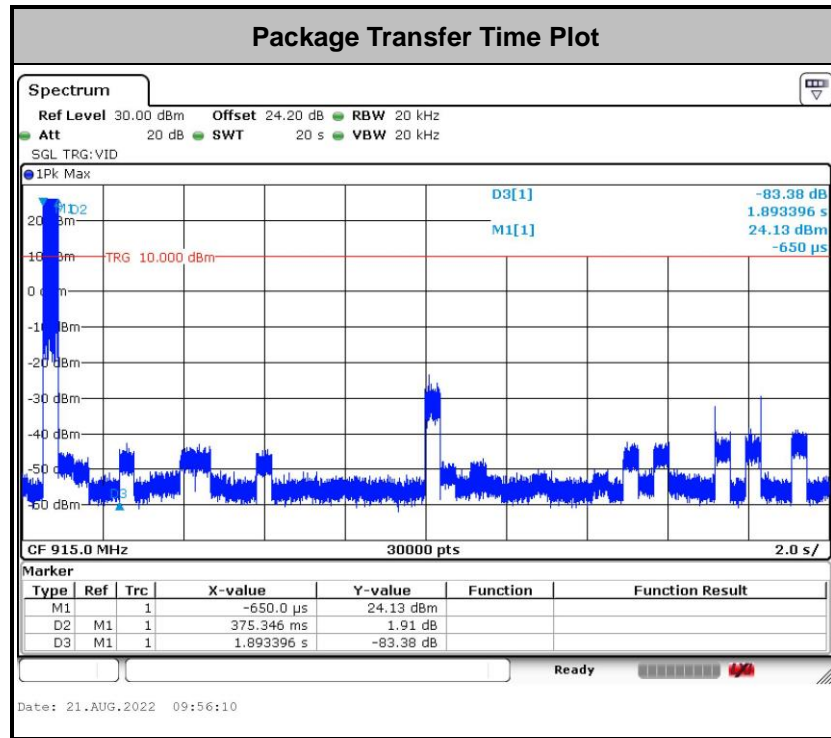


Channel Separation Plot on Channel 128 - 129





Dwell Time



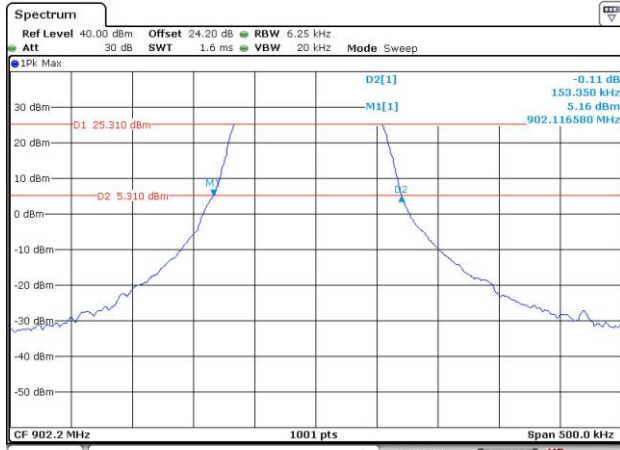
Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time.



20dB Bandwidth

< Lora 125kHz FHSS(SF9) >

20 dB Bandwidth Plot on Channel 00



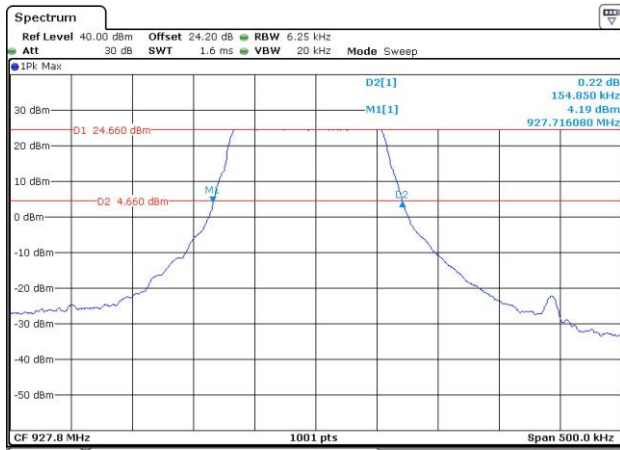
Date: 31.JUL.2022 17:13:29

20 dB Bandwidth Plot on Channel 65



Date: 31.JUL.2022 17:49:23

20 dB Bandwidth Plot on Channel 129



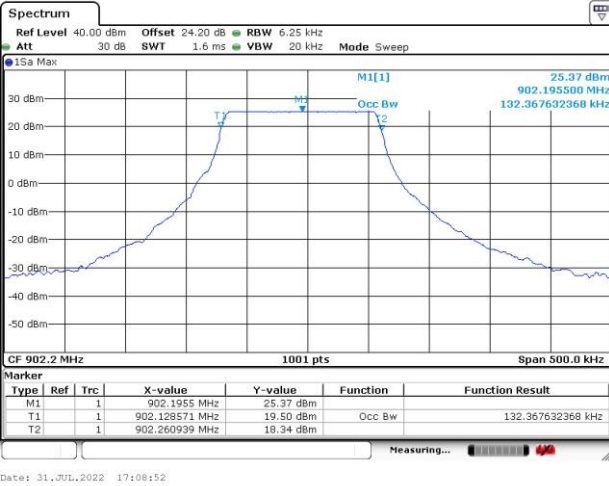
Date: 31.JUL.2022 18:34:08



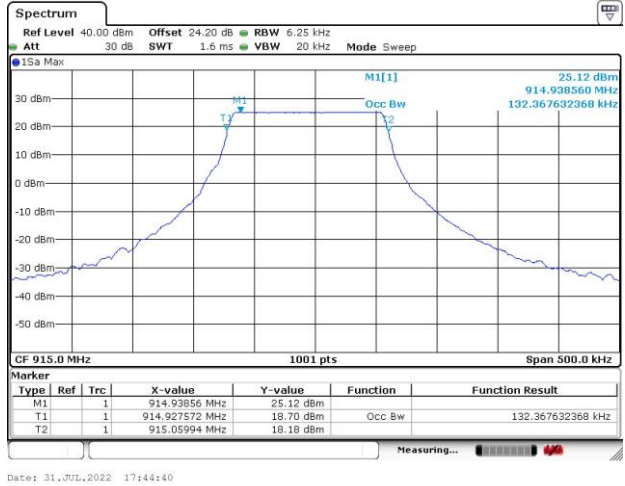
99% Occupied Bandwidth

< Lora 125kHz FHSS(SF9) >

99% Occupied Bandwidth on Channel 01



99% Occupied Bandwidth on Channel 65



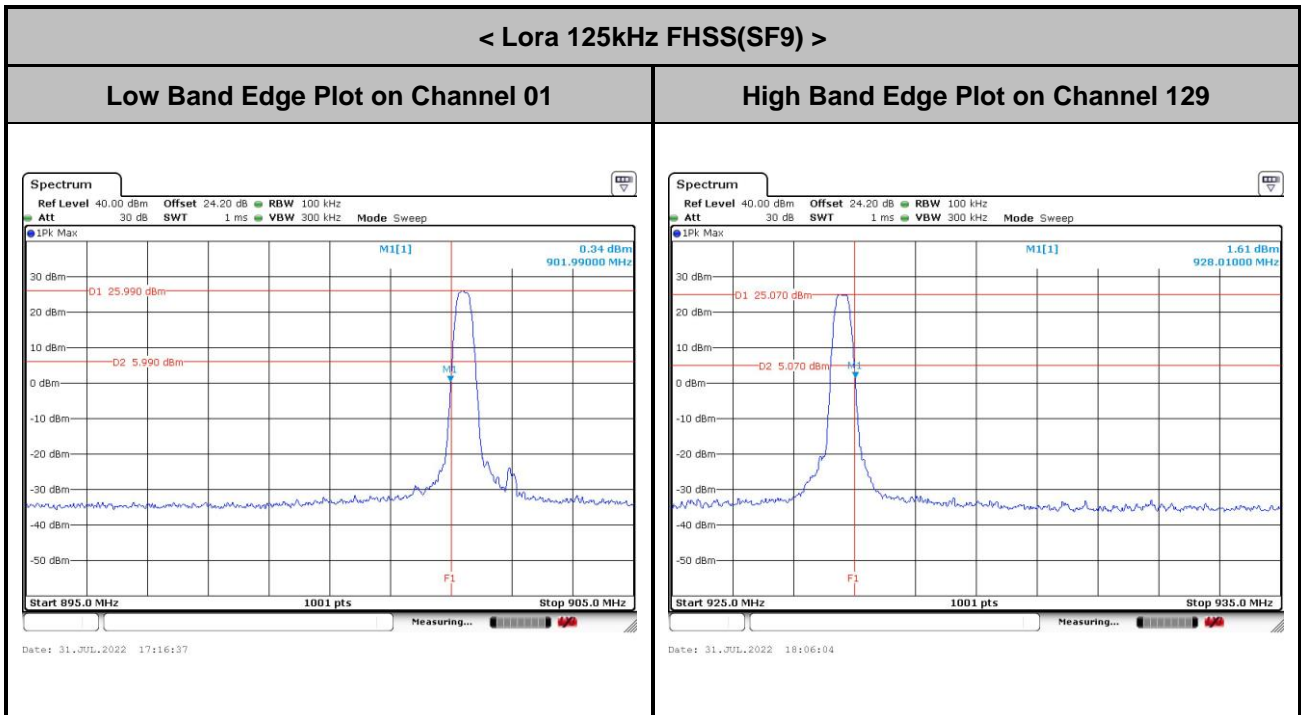
99% Occupied Bandwidth on Channel 129



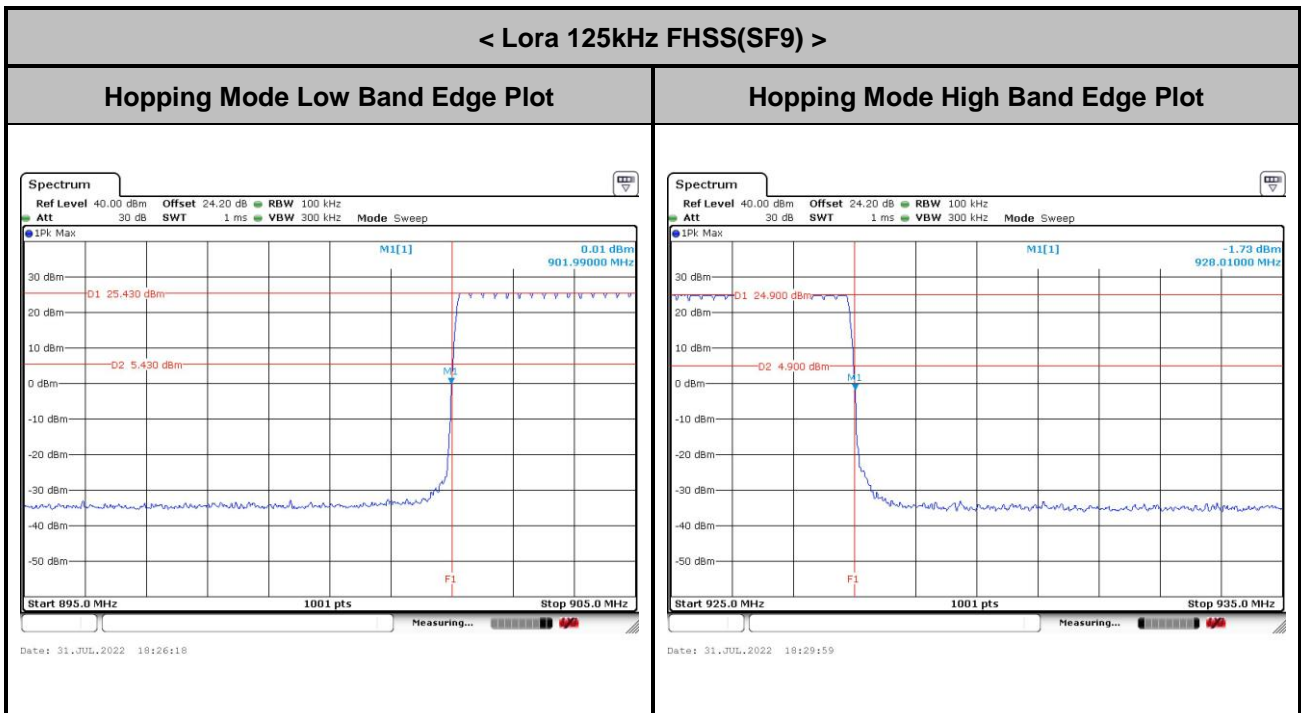
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.



Band Edges



Hopping Mode Band Edges

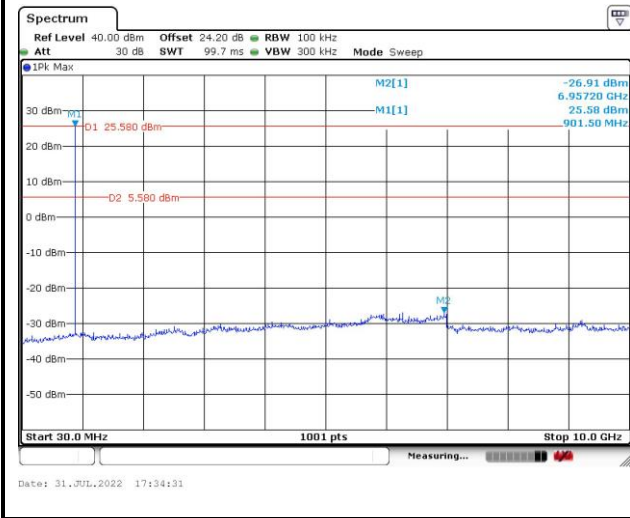




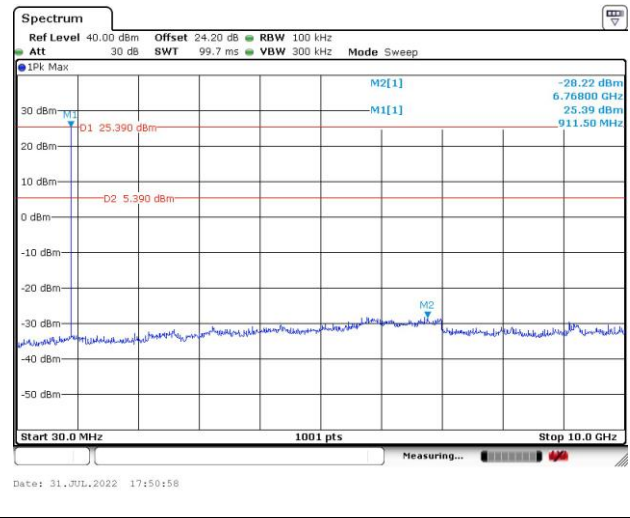
Spurious Emission

< Lora 125kHz FHSS(SF9) >

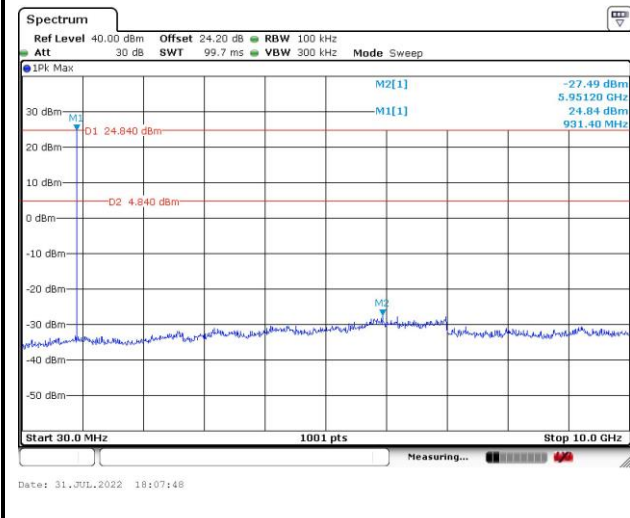
CSE Plot on Ch 01 between 30MHz ~ 10 GHz



CSE Plot on Ch 65 between 30MHz ~ 10 GHz



CSE Plot on Ch 129 between 30MHz ~ 10 GHz





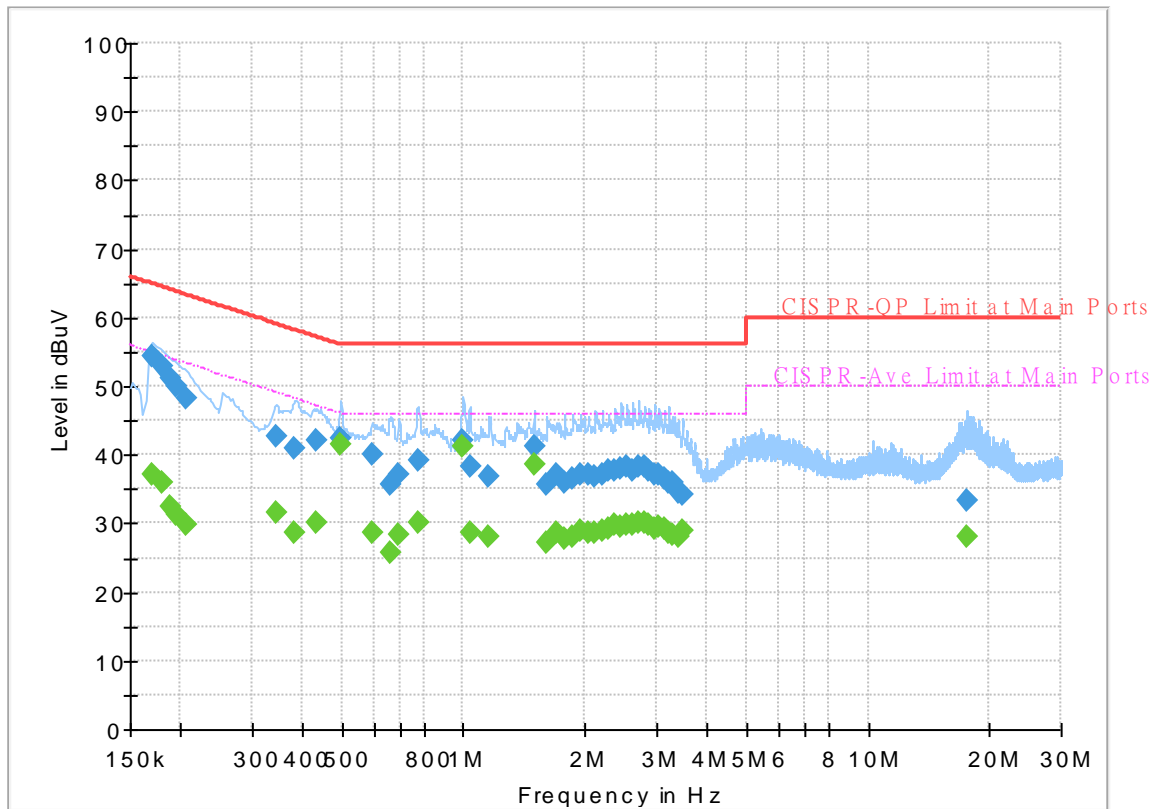
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Tom Lee	Temperature :	23~26°C
		Relative Humidity :	45~55%

EUT Information

Report NO : 120337-09
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Line

Full Spectrum



Final_Result

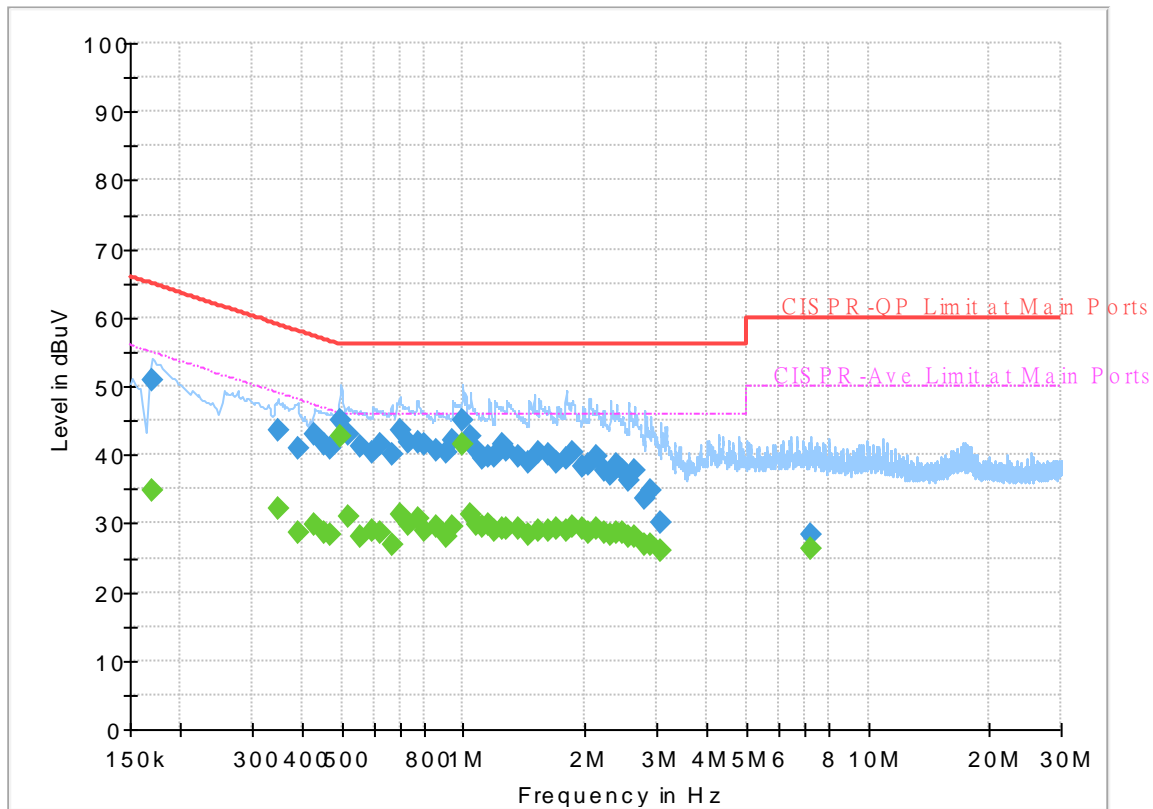
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.170250	---	37.13	54.95	17.82	L1	OFF	19.6
0.170250	54.50	---	64.95	10.45	L1	OFF	19.6
0.179250	---	35.93	54.52	18.59	L1	OFF	19.6
0.179250	52.78	---	64.52	11.74	L1	OFF	19.6
0.188250	---	32.56	54.11	21.55	L1	OFF	19.6
0.188250	51.08	---	64.11	13.03	L1	OFF	19.6
0.195000	---	31.25	53.82	22.57	L1	OFF	19.6
0.195000	50.01	---	63.82	13.81	L1	OFF	19.6
0.206250	---	29.75	53.36	23.61	L1	OFF	19.6
0.206250	48.23	---	63.36	15.13	L1	OFF	19.6
0.343500	---	31.44	49.12	17.68	L1	OFF	19.6
0.343500	42.71	---	59.12	16.41	L1	OFF	19.6
0.384000	---	28.55	48.19	19.64	L1	OFF	19.6
0.384000	41.04	---	58.19	17.15	L1	OFF	19.6
0.431250	---	30.24	47.23	16.99	L1	OFF	19.6
0.431250	42.14	---	57.23	15.09	L1	OFF	19.6
0.496500	---	41.62	46.06	4.44	L1	OFF	19.6
0.496500	42.35	---	56.06	13.71	L1	OFF	19.6
0.595500	---	28.66	46.00	17.34	L1	OFF	19.6
0.595500	40.17	---	56.00	15.83	L1	OFF	19.6
0.663000	---	25.82	46.00	20.18	L1	OFF	19.6

0.663000	35.73	---	56.00	20.27	L1	OFF	19.6
0.690000	---	28.29	46.00	17.71	L1	OFF	19.6
0.690000	37.21	---	56.00	18.79	L1	OFF	19.6
0.773250	---	30.09	46.00	15.91	L1	OFF	19.6
0.773250	39.29	---	56.00	16.71	L1	OFF	19.6
0.996000	---	41.15	46.00	4.85	L1	OFF	19.6
0.996000	42.17	---	56.00	13.83	L1	OFF	19.6
1.038750	---	28.56	46.00	17.44	L1	OFF	19.7
1.038750	38.32	---	56.00	17.68	L1	OFF	19.7
1.155750	---	27.96	46.00	18.04	L1	OFF	19.7
1.155750	36.74	---	56.00	19.26	L1	OFF	19.7
1.495500	---	38.71	46.00	7.29	L1	OFF	19.7
1.495500	41.20	---	56.00	14.80	L1	OFF	19.7
1.610250	---	27.23	46.00	18.77	L1	OFF	19.7
1.610250	35.67	---	56.00	20.33	L1	OFF	19.7
1.695750	---	28.53	46.00	17.47	L1	OFF	19.7
1.695750	37.17	---	56.00	18.83	L1	OFF	19.7
1.779000	---	27.89	46.00	18.11	L1	OFF	19.7
1.779000	36.07	---	56.00	19.93	L1	OFF	19.7
1.860000	---	28.20	46.00	17.80	L1	OFF	19.7
1.860000	36.53	---	56.00	19.47	L1	OFF	19.7
1.950000	---	28.87	46.00	17.13	L1	OFF	19.7
1.950000	37.24	---	56.00	18.76	L1	OFF	19.7
2.031000	---	28.65	46.00	17.35	L1	OFF	19.7
2.031000	37.16	---	56.00	18.84	L1	OFF	19.7
2.121000	---	28.62	46.00	17.38	L1	OFF	19.7
2.121000	36.88	---	56.00	19.12	L1	OFF	19.7
2.204250	---	29.09	46.00	16.91	L1	OFF	19.7
2.204250	37.24	---	56.00	18.76	L1	OFF	19.7
2.285250	---	29.34	46.00	16.66	L1	OFF	19.7
2.285250	37.59	---	56.00	18.41	L1	OFF	19.7
2.368500	---	29.91	46.00	16.09	L1	OFF	19.7
2.368500	37.60	---	56.00	18.40	L1	OFF	19.7
2.458500	---	29.51	46.00	16.49	L1	OFF	19.7
2.458500	37.90	---	56.00	18.10	L1	OFF	19.7
2.539500	---	29.92	46.00	16.08	L1	OFF	19.7
2.539500	38.32	---	56.00	17.68	L1	OFF	19.7
2.627250	---	29.79	46.00	16.21	L1	OFF	19.7
2.627250	37.82	---	56.00	18.18	L1	OFF	19.7
2.710500	---	30.03	46.00	15.97	L1	OFF	19.7
2.710500	38.25	---	56.00	17.75	L1	OFF	19.7
2.791500	---	29.98	46.00	16.02	L1	OFF	19.7
2.791500	38.27	---	56.00	17.73	L1	OFF	19.7
2.881500	---	29.70	46.00	16.30	L1	OFF	19.7
2.881500	37.60	---	56.00	18.40	L1	OFF	19.7
2.967000	---	29.28	46.00	16.72	L1	OFF	19.7
2.967000	36.99	---	56.00	19.01	L1	OFF	19.7
3.050250	---	29.39	46.00	16.61	L1	OFF	19.7
3.050250	37.27	---	56.00	18.73	L1	OFF	19.7
3.138000	---	29.11	46.00	16.89	L1	OFF	19.7
3.138000	36.65	---	56.00	19.35	L1	OFF	19.7
3.225750	---	28.62	46.00	17.38	L1	OFF	19.8
3.225750	36.07	---	56.00	19.93	L1	OFF	19.8
3.300000	---	28.48	46.00	17.52	L1	OFF	19.8
3.300000	36.08	---	56.00	19.92	L1	OFF	19.8
3.392250	---	27.93	46.00	18.07	L1	OFF	19.8
3.392250	34.58	---	56.00	21.42	L1	OFF	19.8
3.484500	---	28.94	46.00	17.06	L1	OFF	19.8
3.484500	34.36	---	56.00	21.64	L1	OFF	19.8
17.616750	---	28.02	50.00	21.98	L1	OFF	20.4
17.616750	33.20	---	60.00	26.80	L1	OFF	20.4

EUT Information

Report NO : 120337-09
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Neutral

Full Spectrum



Final_Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.170250	---	34.91	54.95	20.04	N	OFF	19.6
0.170250	50.98	---	64.95	13.97	N	OFF	19.6
0.348000	---	32.29	49.01	16.72	N	OFF	19.6
0.348000	43.59	---	59.01	15.42	N	OFF	19.6
0.388500	---	28.60	48.10	19.50	N	OFF	19.6
0.388500	40.86	---	58.10	17.24	N	OFF	19.6
0.429000	---	29.83	47.27	17.44	N	OFF	19.6
0.429000	42.86	---	57.27	14.41	N	OFF	19.6
0.451500	---	28.79	46.85	18.06	N	OFF	19.6
0.451500	41.42	---	56.85	15.43	N	OFF	19.6
0.469500	---	28.44	46.52	18.08	N	OFF	19.6
0.469500	40.90	---	56.52	15.62	N	OFF	19.6
0.498750	---	42.72	46.02	3.30	N	OFF	19.6
0.498750	45.13	---	56.02	10.89	N	OFF	19.6
0.519000	---	31.04	46.00	14.96	N	OFF	19.6
0.519000	43.13	---	56.00	12.87	N	OFF	19.6
0.555000	---	28.07	46.00	17.93	N	OFF	19.6
0.555000	41.22	---	56.00	14.78	N	OFF	19.6
0.597750	---	28.93	46.00	17.07	N	OFF	19.6
0.597750	40.42	---	56.00	15.58	N	OFF	19.6
0.624750	---	28.67	46.00	17.33	N	OFF	19.6

0.624750	41.64	---	56.00	14.36	N	OFF	19.6
0.665250	---	27.02	46.00	18.98	N	OFF	19.6
0.665250	40.12	---	56.00	15.88	N	OFF	19.6
0.694500	---	31.30	46.00	14.70	N	OFF	19.6
0.694500	43.44	---	56.00	12.56	N	OFF	19.6
0.728250	---	29.72	46.00	16.28	N	OFF	19.6
0.728250	41.86	---	56.00	14.14	N	OFF	19.6
0.771000	---	30.59	46.00	15.41	N	OFF	19.6
0.771000	41.89	---	56.00	14.11	N	OFF	19.6
0.802500	---	28.83	46.00	17.17	N	OFF	19.6
0.802500	41.41	---	56.00	14.59	N	OFF	19.6
0.856500	---	29.48	46.00	16.52	N	OFF	19.6
0.856500	40.50	---	56.00	15.50	N	OFF	19.6
0.910500	---	28.04	46.00	17.96	N	OFF	19.6
0.910500	40.29	---	56.00	15.71	N	OFF	19.6
0.942000	---	29.65	46.00	16.35	N	OFF	19.6
0.942000	42.05	---	56.00	13.95	N	OFF	19.6
0.996000	---	41.40	46.00	4.60	N	OFF	19.6
0.996000	45.15	---	56.00	10.85	N	OFF	19.6
1.041000	---	31.31	46.00	14.69	N	OFF	19.6
1.041000	42.70	---	56.00	13.30	N	OFF	19.6
1.079250	---	29.94	46.00	16.06	N	OFF	19.6
1.079250	40.74	---	56.00	15.26	N	OFF	19.6
1.108500	---	29.56	46.00	16.44	N	OFF	19.6
1.108500	39.45	---	56.00	16.55	N	OFF	19.6
1.158000	---	29.72	46.00	16.28	N	OFF	19.6
1.158000	39.80	---	56.00	16.20	N	OFF	19.6
1.198500	---	29.07	46.00	16.93	N	OFF	19.6
1.198500	39.68	---	56.00	16.32	N	OFF	19.6
1.243500	---	29.11	46.00	16.89	N	OFF	19.6
1.243500	41.58	---	56.00	14.42	N	OFF	19.6
1.284000	---	29.16	46.00	16.84	N	OFF	19.7
1.284000	40.62	---	56.00	15.38	N	OFF	19.7
1.365000	---	29.10	46.00	16.90	N	OFF	19.7
1.365000	39.90	---	56.00	16.10	N	OFF	19.7
1.450500	---	28.47	46.00	17.53	N	OFF	19.7
1.450500	38.77	---	56.00	17.23	N	OFF	19.7
1.536000	---	28.96	46.00	17.04	N	OFF	19.7
1.536000	40.27	---	56.00	15.73	N	OFF	19.7
1.621500	---	29.02	46.00	16.98	N	OFF	19.7
1.621500	40.15	---	56.00	15.85	N	OFF	19.7
1.707000	---	29.27	46.00	16.73	N	OFF	19.7
1.707000	38.94	---	56.00	17.06	N	OFF	19.7
1.797000	---	29.02	46.00	16.98	N	OFF	19.7
1.797000	39.37	---	56.00	16.63	N	OFF	19.7
1.864500	---	29.59	46.00	16.41	N	OFF	19.7
1.864500	40.46	---	56.00	15.54	N	OFF	19.7
1.963500	---	29.25	46.00	16.75	N	OFF	19.7
1.963500	38.37	---	56.00	17.63	N	OFF	19.7
2.049000	---	28.76	46.00	17.24	N	OFF	19.7
2.049000	38.55	---	56.00	17.45	N	OFF	19.7
2.139000	---	29.11	46.00	16.89	N	OFF	19.7
2.139000	39.66	---	56.00	16.34	N	OFF	19.7
2.222250	---	28.59	46.00	17.41	N	OFF	19.7
2.222250	37.78	---	56.00	18.22	N	OFF	19.7
2.305500	---	28.27	46.00	17.73	N	OFF	19.7
2.305500	37.13	---	56.00	18.87	N	OFF	19.7
2.395500	---	28.78	46.00	17.22	N	OFF	19.7
2.395500	38.52	---	56.00	17.48	N	OFF	19.7
2.474250	---	28.63	46.00	17.37	N	OFF	19.7
2.474250	37.69	---	56.00	18.31	N	OFF	19.7
2.559750	---	28.05	46.00	17.95	N	OFF	19.7
2.559750	36.17	---	56.00	19.83	N	OFF	19.7
2.649750	---	28.14	46.00	17.86	N	OFF	19.7
2.649750	37.61	---	56.00	18.39	N	OFF	19.7
2.816250	---	26.98	46.00	19.02	N	OFF	19.7
2.816250	33.48	---	56.00	22.52	N	OFF	19.7
2.901750	---	26.90	46.00	19.10	N	OFF	19.7
2.901750	34.75	---	56.00	21.25	N	OFF	19.7
3.075000	---	25.95	46.00	20.05	N	OFF	19.7
3.075000	30.16	---	56.00	25.84	N	OFF	19.7

7.192500	---	26.36	50.00	23.64	N	OFF	19.9
7.192500	28.43	---	60.00	31.57	N	OFF	19.9



Appendix C. Radiated Spurious Emission

Test Engineer :	Fu Chen and Troy Hsieh	Temperature :	20.1~21.5°C
		Relative Humidity :	58.1~67.6%

Lora 902~928MHz
Lora FHSS 125k (Band Edge @ 3m)

Lora SF8	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
Lora FHSS 125k CH 01 902.2MHz		74.62	24.07	-15.93	40	32.84	12.5	11.17	32.44	-	-	P	H	
		115.36	36.6	-6.9	43.5	40.42	17.05	11.53	32.4	255	161	Q	H	
		144.46	31.88	-11.62	43.5	35.52	17.05	11.76	32.45	-	-	P	H	
		184.23	29.43	-14.07	43.5	35.39	14.56	11.99	32.51	-	-	P	H	
		491.72	35.37	-10.63	46	30.48	23.72	13.27	32.1	-	-	P	H	
		573.2	36.56	-9.44	46	29.95	25.69	13.6	32.68	-	-	P	H	
	*	902.2	120.47	-	-	108.27	28.84	14.58	31.22	154	198	P	H	
														H
														H
														H
			41.64	35.32	-4.68	40	38.58	18.37	10.81	32.44	100	356	Q	V
			74.62	29.38	-10.62	40	38.15	12.5	11.17	32.44	-	-	P	V
			115.36	32.58	-10.92	43.5	36.4	17.05	11.53	32.4	-	-	P	V
			180.35	28.38	-15.12	43.5	34.21	14.7	11.97	32.5	-	-	P	V
			502.39	34.76	-11.24	46	29.78	23.84	13.3	32.16	-	-	P	V
			562.53	35.87	-10.13	46	28.95	25.95	13.57	32.6	-	-	P	V
	*	902.2	116.95	-	-	104.75	28.84	14.58	31.22	109	254	P	V	
														V
													V	
													V	

Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against limit line. Non restricted band limit is radio frequency level down 30db. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.
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Lora SF8	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)	
Lora FHSS 125k CH 65 915MHz		72.68	24.02	-15.98	40	33.06	12.24	11.16	32.44	-	-	P	H	
		114.39	36.43	-7.07	43.5	40.38	16.94	11.51	32.4	256	164	Q	H	
		145.43	31.49	-12.01	43.5	35.15	17.02	11.77	32.45	-	-	P	H	
		185.2	30.3	-13.2	43.5	36.24	14.57	12	32.51	-	-	P	H	
		486.87	35.28	-10.72	46	30.48	23.64	13.24	32.08	-	-	P	H	
		564.47	36.69	-9.31	46	29.8	25.93	13.58	32.62	-	-	P	H	
	*	915	120.25	-	-	107.81	28.96	14.61	31.13	147	195	P	H	
														H
														H
														H
														H
														H
														H
			41.64	35.33	-4.67	40	38.59	18.37	10.81	32.44	100	356	Q	V
			74.62	29.57	-10.43	40	38.34	12.5	11.17	32.44	-	-	P	V
			115.36	32.5	-11	43.5	36.32	17.05	11.53	32.4	-	-	P	V
			155.13	29.39	-14.11	43.5	33.5	16.56	11.79	32.46	-	-	P	V
			564.47	36.47	-9.53	46	29.58	25.93	13.58	32.62	-	-	P	V
			591.63	36.83	-9.17	46	30.56	25.44	13.65	32.82	-	-	P	V
*		915	116.78	-	-	104.34	28.96	14.61	31.13	107	258	P	V	
													V	
													V	
													V	
													V	
													V	
													V	
Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against limit line. Non restricted band limit is radio frequency level down 30db. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only. 													



Lora FHSS 125k (Harmonic @ 3m)

Lora SF8	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
Lora FHSS 125k CH 01 902.2MHz		2707.5	49.99	-24.01	74	47.98	27.93	7.98	33.9	100	227	P	H
		2707.5	45.83	-8.17	54	43.82	27.93	7.98	33.9	100	227	A	H
		3610	38.77	-35.23	74	57.47	29.72	10.78	59.2	-	-	P	H
		4512.5	38.12	-35.88	74	53.74	31.7	11.08	58.4	-	-	P	H
		5415	38.15	-35.85	74	52	32.9	12.08	58.83	-	-	P	H
		8122.5	42.61	-31.39	74	50.02	37.1	14.37	58.88	-	-	P	H
		9025	45.16	-28.84	74	50.1	38.05	15.83	58.82	-	-	P	H
		2707.5	45.62	-28.38	74	43.61	27.93	7.98	33.9	100	201	P	V
		2707.5	41.12	-12.88	54	39.11	27.93	7.98	33.9	100	201	A	V
		3610	36.94	-37.06	74	55.64	29.72	10.78	59.2	-	-	P	V
		4512.5	38.32	-35.68	74	53.94	31.7	11.08	58.4	-	-	P	V
		5415	37.88	-36.12	74	51.73	32.9	12.08	58.83	-	-	P	V
		8122.5	42.94	-31.06	74	50.35	37.1	14.37	58.88	-	-	P	V
		9025	44.6	-29.4	74	49.54	38.05	15.83	58.82	-	-	P	V
Lora FHSS 125k CH 65 915MHz		2745	48.71	-25.29	74	46.48	28.08	8.05	33.9	100	233	P	H
		2745	44.64	-9.36	54	42.41	28.08	8.05	33.9	100	233	A	H
		3660	37.03	-36.97	74	55.46	29.82	10.86	59.11	-	-	P	H
		4575	37.6	-36.4	74	53.57	31.7	10.75	58.42	-	-	P	H
		7320	41.36	-32.64	74	50.07	37.02	13.44	59.17	-	-	P	H
		8235	42.94	-31.06	74	50.14	37.24	14.41	58.85	-	-	P	H
		9150	44.78	-29.22	74	49.66	38.2	15.84	58.92	-	-	P	H
		2745	46.44	-27.56	74	44.21	28.08	8.05	33.9	100	198	P	V
		2745	42.34	-11.66	54	40.11	28.08	8.05	33.9	100	198	A	V
		3660	36.52	-37.48	74	54.95	29.82	10.86	59.11	-	-	P	V
		4575	38.34	-35.66	74	54.31	31.7	10.75	58.42	-	-	P	V
		7320	41.91	-32.09	74	50.62	37.02	13.44	59.17	-	-	P	V
	8235	42.43	-31.57	74	49.63	37.24	14.41	58.85	-	-	P	V	
	9150	45.18	-28.82	74	50.06	38.2	15.84	58.92	-	-	P	V	



Lora FHSS 125k CH 129 927.8MHz		2783.4	47.11	-26.89	74	44.78	28.1	8.12	33.89	100	218	P	H
		2783.4	42.85	-11.15	54	40.52	28.1	8.12	33.89	100	218	A	H
		3711.2	37.62	-36.38	74	55.74	29.97	10.93	59.02	-	-	P	H
		4639	37.84	-36.16	74	53.72	31.78	10.77	58.43	-	-	P	H
		7422.4	41.47	-32.53	74	50.35	36.51	13.74	59.13	-	-	P	H
		8350.2	43.39	-30.61	74	50.29	37.3	14.63	58.83	-	-	P	H
		2783.4	44.98	-29.02	74	42.65	28.1	8.12	33.89	100	200	P	V
		2783.4	40.87	-13.13	54	38.54	28.1	8.12	33.89	100	200	A	V
		3711.2	39.4	-34.6	74	57.52	29.97	10.93	59.02	-	-	P	V
		4639	37.78	-36.22	74	53.66	31.78	10.77	58.43	-	-	P	V
		7422.4	41.11	-32.89	74	49.99	36.51	13.74	59.13	-	-	P	V
	8350.2	42.63	-31.37	74	49.53	37.3	14.63	58.83	-	-	P	V	
Remark	<ol style="list-style-type: none"> 1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non restricted band limit is radio frequency level down 30db. 4. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only. 												



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:

Lora	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
Lora		2707.5	49.99	-24.01	74	47.98	27.93	7.98	33.9	100	227	P	H
CH 01		2707.5	45.83	-8.17	54	43.82	27.93	7.98	33.9	100	227	A	H
902.2MHz													

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Margin(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2707.5MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 27.93(dB/m) + 7.98(dB) + 47.98(dBμV) – 33.9 (dB)
= 49.99 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 49.99(dBμV/m) – 74(dBμV/m)
= -24.01(dB)

For Average Limit @ 2707.5MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 27.93(dB/m) + 7.98(dB) + 43.82(dBμV) – 33.9 (dB)
= 45.83 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 45.83(dBμV/m) – 54(dBμV/m)
= -8.17(dB)

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



Appendix D. Radiated Spurious Emission Plots

Test Engineer :	Fu Chen and Troy Hsieh	Temperature :	20.1~21.5°C
		Relative Humidity :	58.1~67.6%

Lora 902~928MHz
Lora FHSS 125k (Band Edge @ 3m)

Lora	Lora 902~928MHz	
	Lora FHSS 125k Ch01 902.5Mhz	
	Horizontal	Vertical
QP / Peak	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 VERTICAL</p>

Remark: The unwanted signal of mark #7 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).



Lora	Lora 920~928MHz	
	Lora FHSS 125k Ch65 915MHz	
	Horizontal	Vertical
QP / Peak	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 VERTICAL</p>

Remark: The unwanted signal of mark #7 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).



Lora	Lora 902~928MHz	
	Lora FHSS 125k Ch129 927.8MHz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : QP 3m BE-LOG 35414-211009 VERTICAL</p>

Remark: The unwanted signal of mark #7 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).



Lora 902~928MHz
Lora FHSS 125k (Harmonic @ 3m)

Lora	Lora 902~928MHz	
	Lora FHSS 125k Ch01 902.5Mhz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 VERTICAL</p>

Remark: The unwanted signal of mark #1 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).



Lora	Lora 902~928MHz	
	Lora FHSS 125k Ch65 915MHz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 VERTICAL</p>

Remark: The unwanted signal of mark #1 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).



Lora	Lora 902~928MHz	
	Lora FHSS 125k Ch129 927.8MHz	
	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 HORIZONTAL</p>	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_1212_220310 VERTICAL</p>



Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
LoRa (125KHz)_SF8	100.00	-	-	10Hz

