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 performed from May 22, 2022 to Aug. 17, 2022. We, Sporton International Inc. EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in a

ccordance 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 from Sporton International Inc. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

Table of Contents

History of this test report

Report No.	Version	Description	Issue Date
FR120337-09B	01	Initial issue of report	Sep. 28, 2022

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	-
3.1	2.1049	99% Occupied Bandwidth	Reporting only	-
3.2	15.247(b)(3)	Power Output Measurement	Pass	-
3.3	15.247(e)	Power Spectral Density	Pass	-
3.4	15.247(d)	Conducted Band Edges	Pass	-
		Conducted Spurious Emission	Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	3.19 dB under the limit at 2743.500 MHz
3.6	15.207	AC Conducted Emission	Pass	3.30 dB under the limit at 0.499 MHz
3.7	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:
1. 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. 2. 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: Cindy Liu

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 made to the EUT during the testing.

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 declared by 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 the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.

2 Test Configuration of Equipment Under Test

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.

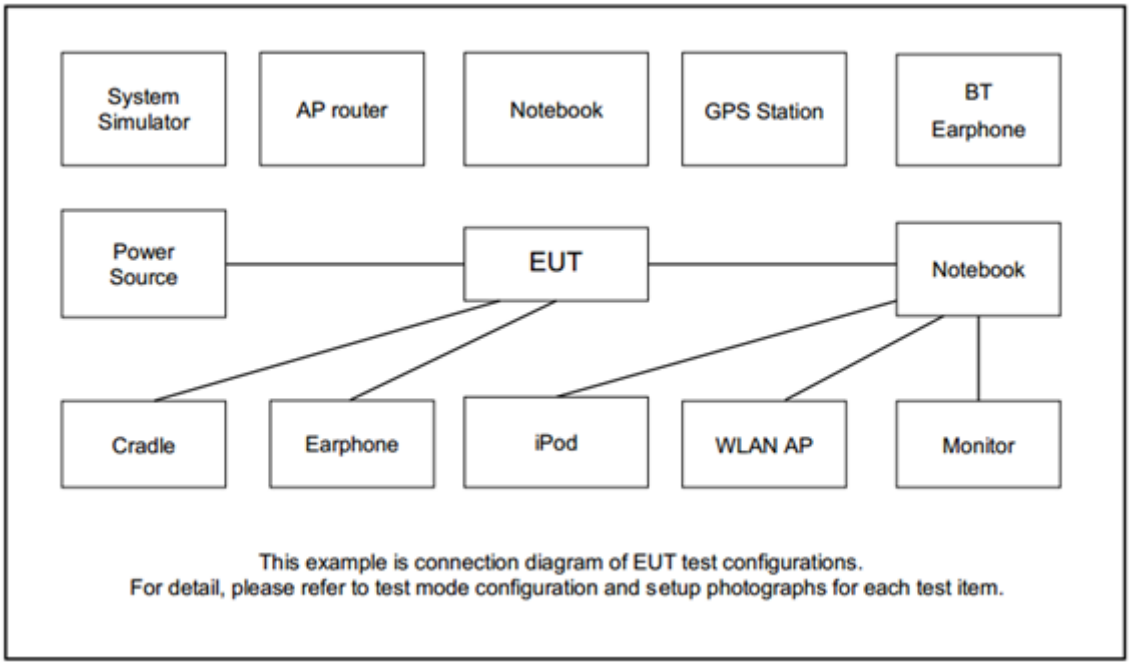
2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
902 – 928 MHz	1	902.5	17	915.3
	2	903.3	18	916.1
	3	904.1	19	916.9
	4	904.9	20	917.7
	5	905.7	21	918.5
	6	906.5	22	919.3
	7	907.3	23	920.1
	8	908.1	24	920.9
	9	908.9	25	921.7
	10	909.7	26	922.5
	11	910.5	27	923.3
	12	911.3	28	924.1
	13	912.1	29	924.9
	14	912.9	30	925.7
	15	913.7	31	926.5
	16	914.5		

2.2 Test Mode

Summary table of Test Cases		
Test Item	**Feature**	**LoRa**
Conducted Test Cases	**LoRa 500 KHz DTS_SF8**	Mode 4: CH01 Tx_902.50 MHz Mode 5: CH16 Tx_914.50 MHz Mode 6: CH31 Tx_926.50 MHz
	LoRa 500 KHz DTS_SF9	Mode 7: CH01 Tx_902.50 MHz Mode 8: CH16 Tx_914.50 MHz Mode 9: CH31 Tx_926.50 MHz
	LoRa 500 KHz DTS_SF10	Mode 10: CH01 Tx_902.50 MHz Mode 11: CH16 Tx_914.50 MHz Mode 12: CH31 Tx_926.50 MHz
	LoRa 500 KHz DTS_SF11	Mode 13: CH01 Tx_902.50 MHz Mode 14: CH16 Tx_914.50 MHz Mode 15: CH31 Tx_926.50 MHz
Radiated Test Cases	**LoRa 500 KHz DTS_SF11**	Mode 1: CH01 Tx_902.50 MHz Mode 2: CH16 Tx_914.50 MHz Mode 3: CH31 Tx_926.50 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 10 dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 4.2 + 10 = 14.2 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

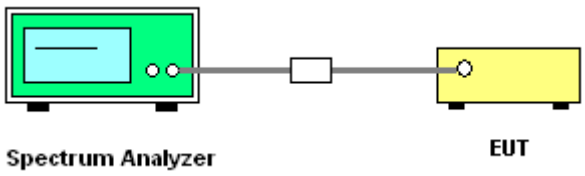
3.1.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1-5% of the emission bandwidth and set the Video bandwidth (VBW) ≥ 3 * RBW.
6. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

Please refer to Appendix A.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

Section 15.247(b)(3) For systems using digital modulation in the 902-928 MHz, the limit for peak output power is 1 watt.

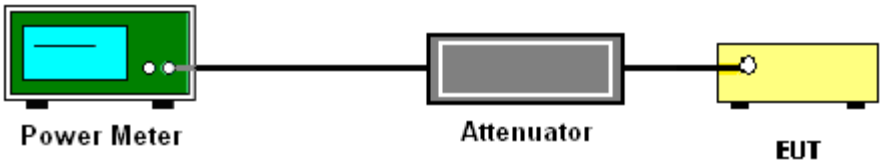
3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.2.3 Test Procedures

1. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
2. The RF output of EUT is connected to the power meter by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Average Output Power

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8 dBm in any 3 kHz band at any time interval of continuous transmission.

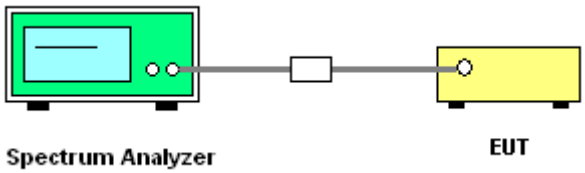
3.3.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.3.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.10.2 Method PKPSD.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

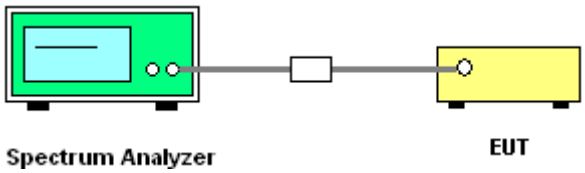
3.4.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.4.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT is connected to the spectrum analyzer by RF cable and attenuator. The path loss is compensated to the results for each measurement.
3. Set the maximum power setting and enable the EUT to transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
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.

3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Please refer to Appendix A.

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated band edge and Spurious Emission Measurement

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. If the output power of this device is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. 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

3.5.2 Measuring Instruments

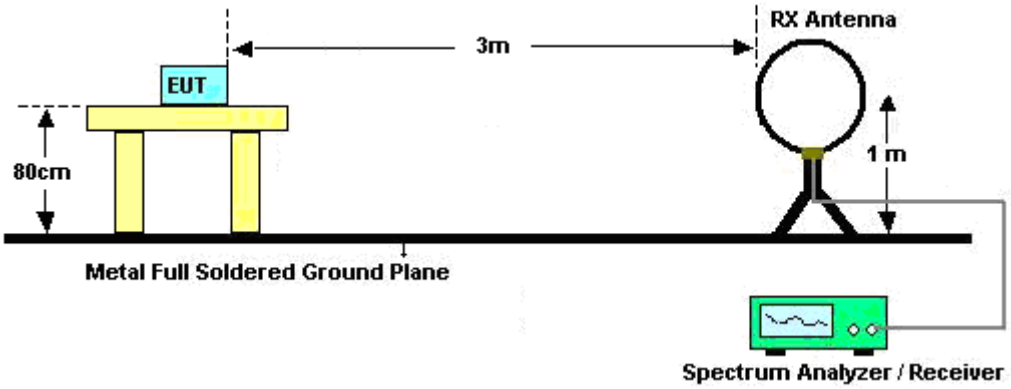
Please refer to the measuring equipment list in this test report.

3.5.3 Test Procedures

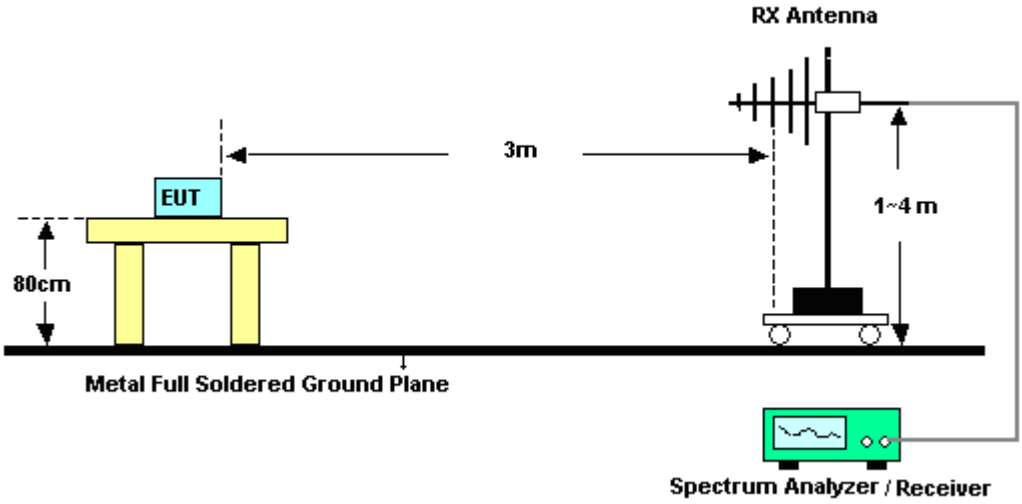
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT is arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
4. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. 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 "-".
7. 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 "-".
8. 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; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3 MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

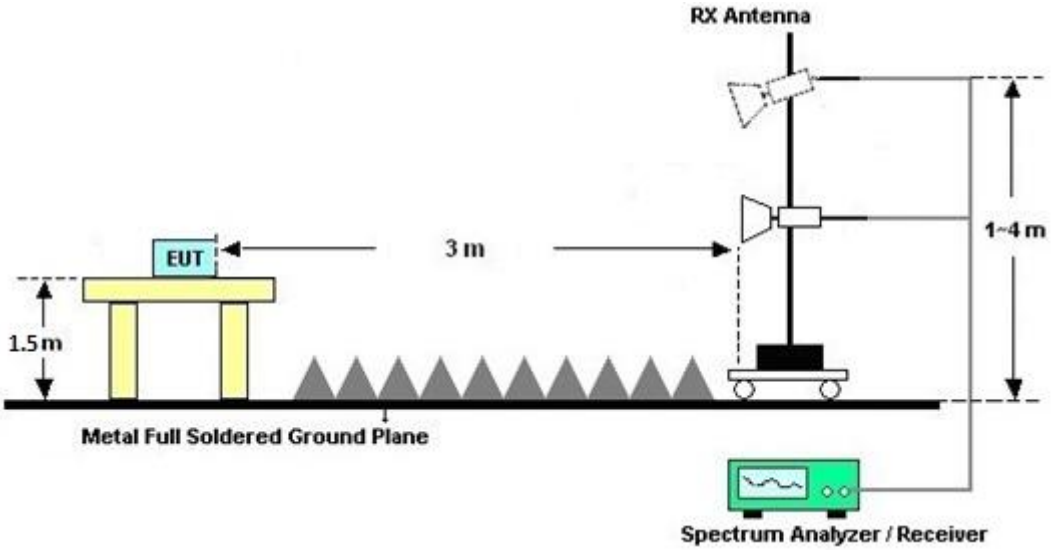
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions test above 1GHz



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

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

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

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.5.7 Duty Cycle

Please refer to Appendix E.

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

Please refer to Appendix C and D.

3.6 AC Conducted Emission Measurement

3.6.1 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.

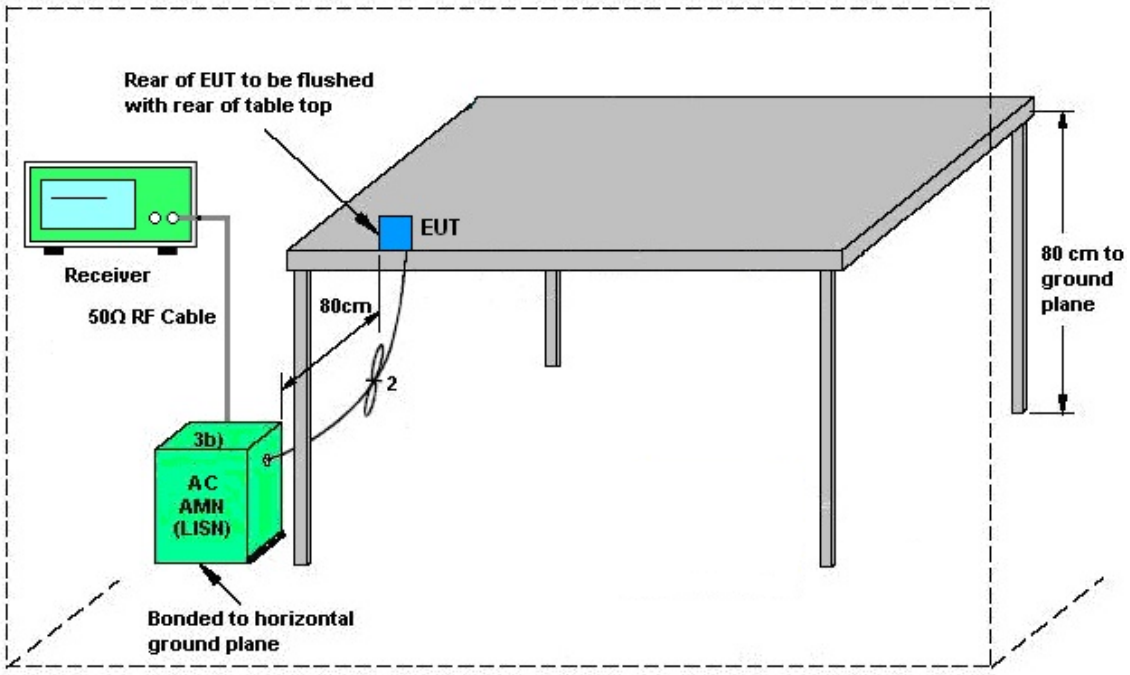
3.6.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.

3.6.3 Test Procedures

1. The EUT is placed 0.4 meter away from the conducting wall of the shielding room, and is 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 shall be used.
6. Both Line and Neutral shall be tested in order to find out the maximum conducted emission.
7. The frequency range from 150 kHz to 30 MHz is scanned.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF bandwidth = 9kHz) with Maximum Hold Mode.

3.6.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting Antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. 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.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 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	SCHWARZBECK	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	1710001800055007	1GHz~18GHz	Jun. 16, 2021	May 30, 2022~ May 31, 2022	Jun. 15, 2022	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55-303	1710001800055007	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(MXE)	MY55420170	20MHz~8.4GHz	Jul. 15, 2021	May 30, 2022~ May 31, 2022	Jul. 14, 2022	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	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	WLK4-1000-1530-8000-40SS	SN11	1.53G Low Pass	Sep. 13, 2021	May 30, 2022~ Aug. 17, 2022	Sep. 12, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN3	3GHz High Pass Filter	Sep. 13, 2021	May 30, 2022~ Aug. 17, 2022	Sep. 12, 2022	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-900-1000-15000-60SS	SN12	1GHz High Pass Filter	Nov. 04, 2021	May 30, 2022~ Aug. 17, 2022	Nov. 03, 2022	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Nov. 26, 2021	May 30, 2022~ Aug. 17, 2022	Nov. 25, 2022	Radiation (03CH11-HY)
Hygrometer	TECPEL	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~ Jul. 31, 2022	Mar. 17, 2023	Conducted (TH02-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101564	10Hz~40GHz	Aug. 30, 2021	May 22, 2022~ Jul. 31, 2022	Aug. 29, 2022	Conducted (TH02-HY)
Power Meter	Anritsu	ML2495A	932001	N/A	Sep. 30, 2021	May 22, 2022~ Jul. 31, 2022	Sep. 29, 2022	Conducted (TH02-HY)
Power Sensor	Anritsu	MA2411B	846202	300MHz~40GHz	Sep. 30, 2021	May 22, 2022~ Jul. 31, 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:	21~26	°C
Test Date:	2022/5/22~2022/7/31	Relative Humidity:	49~56	%

<LoRa 500kHz>

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
Lora	SF8	1	1	902.5	0.537	0.641	0.50	Pass
Lora	SF8	1	16	914.5	0.537	0.637	0.50	Pass
Lora	SF8	1	31	926.5	0.539	0.649	0.50	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
Lora	SF8	1	1	902.5	24.86	30.00	-0.83	24.03	36.00	Pass
Lora	SF8	1	16	914.5	24.68	30.00	-0.83	23.85	36.00	Pass
Lora	SF8	1	31	926.5	24.30	30.00	-0.83	23.47	36.00	Pass

TEST RESULTS DATA
Average Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Average PSD (dBm /3kHz)	DG (dBi)	Average PSD Limit (dBm /3kHz)	Pass/Fail
Lora	SF8	1	1	902.5	24.77	5.12	-0.83	8.00	Pass
Lora	SF8	1	16	914.5	24.50	4.85	-0.83	8.00	Pass
Lora	SF8	1	31	926.5	24.08	4.52	-0.83	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
Lora	SF9	1	1	902.5	0.541	0.645	0.50	Pass
Lora	SF9	1	16	914.5	0.541	0.643	0.50	Pass
Lora	SF9	1	31	926.5	0.547	0.649	0.50	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
Lora	SF9	1	1	902.5	24.85	30.00	-0.83	24.02	36.00	Pass
Lora	SF9	1	16	914.5	24.65	30.00	-0.83	23.82	36.00	Pass
Lora	SF9	1	31	926.5	24.30	30.00	-0.83	23.47	36.00	Pass

TEST RESULTS DATA
Average Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Average PSD (dBm /3kHz)	DG (dBi)	Average PSD Limit (dBm /3kHz)	Pass/Fail
Lora	SF9	1	1	902.5	24.61	5.87	-0.83	8.00	Pass
Lora	SF9	1	16	914.5	25.29	5.68	-0.83	8.00	Pass
Lora	SF9	1	31	926.5	24.94	4.99	-0.83	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
Lora	SF10	1	1	902.5	0.543	0.649	0.50	Pass
Lora	SF10	1	16	914.5	0.541	0.647	0.50	Pass
Lora	SF10	1	31	926.5	0.545	0.655	0.50	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
Lora	SF10	1	1	902.5	24.84	30.00	-0.83	24.01	36.00	Pass
Lora	SF10	1	16	914.5	24.66	30.00	-0.83	23.83	36.00	Pass
Lora	SF10	1	31	926.5	24.30	30.00	-0.83	23.47	36.00	Pass

TEST RESULTS DATA
Average Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Average PSD (dBm /3kHz)	DG (dBi)	Average PSD Limit (dBm /3kHz)	Pass/Fail
Lora	SF10	1	1	902.5	25.54	6.92	-0.83	8.00	Pass
Lora	SF10	1	16	914.5	25.37	6.64	-0.83	8.00	Pass
Lora	SF10	1	31	926.5	25.01	6.03	-0.83	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
Lora	SF11	1	1	902.5	0.545	0.649	0.50	Pass
Lora	SF11	1	16	914.5	0.545	0.645	0.50	Pass
Lora	SF11	1	31	926.5	0.545	0.653	0.50	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
Lora	SF11	1	1	902.5	24.88	30.00	-0.83	24.05	36.00	Pass
Lora	SF11	1	16	914.5	24.66	30.00	-0.83	23.83	36.00	Pass
Lora	SF11	1	31	926.5	24.30	30.00	-0.83	23.47	36.00	Pass

TEST RESULTS DATA
Average Power Density

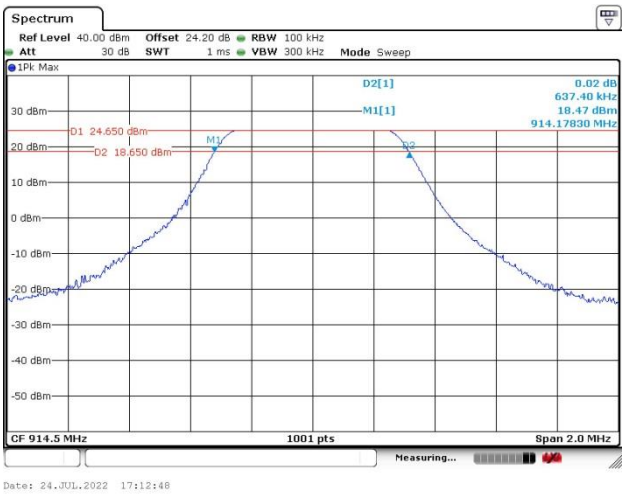
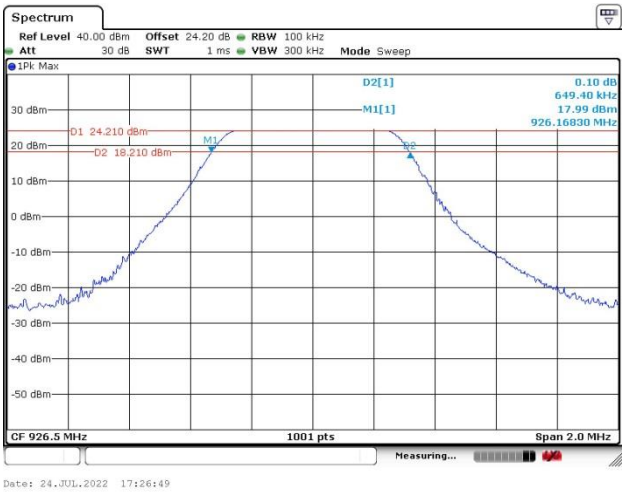
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Average PSD (dBm /3kHz)	DG (dBi)	Average PSD Limit (dBm /3kHz)	Pass/Fail
Lora	SF11	1	1	902.5	25.59	6.98	-0.83	8.00	Pass
Lora	SF11	1	16	914.5	25.38	6.75	-0.83	8.00	Pass
Lora	SF11	1	31	926.5	25.00	6.16	-0.83	8.00	Pass

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 30dBc limit.

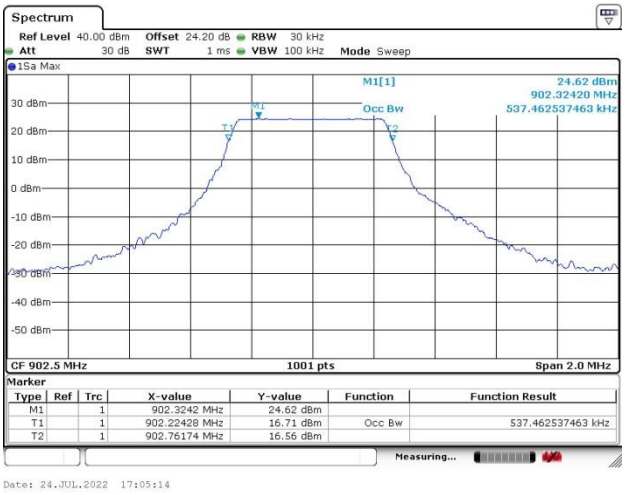
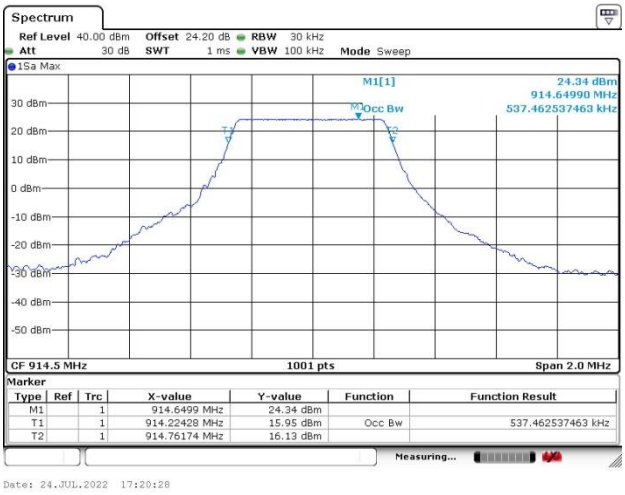
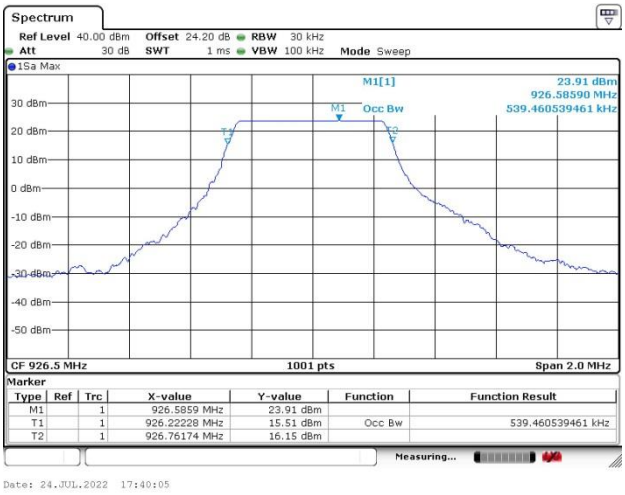
<LoRa 500kHz DTS>

<Data Rate: SF8>

6dB Bandwidth

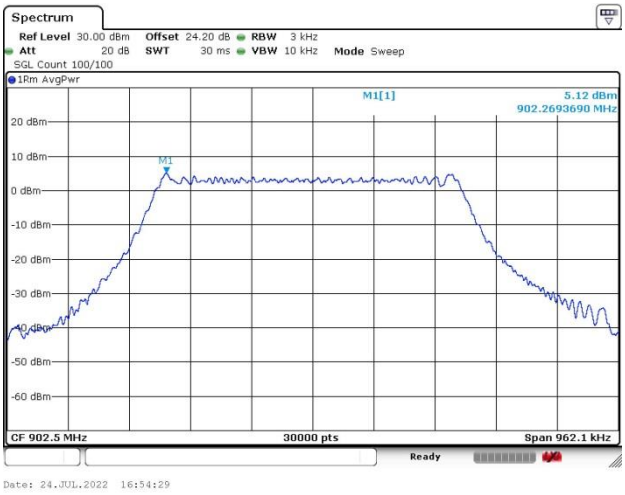
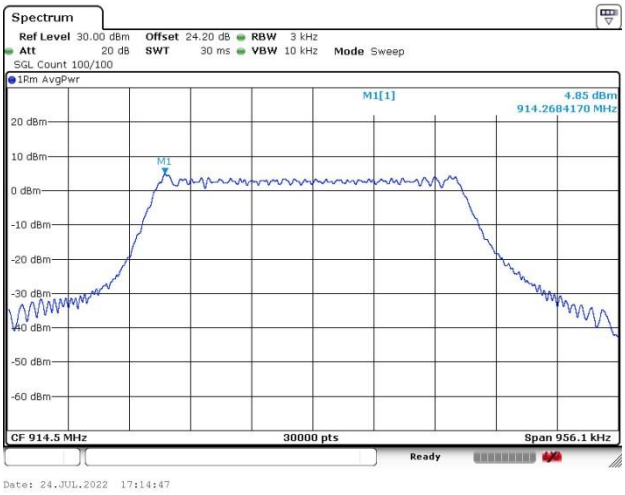
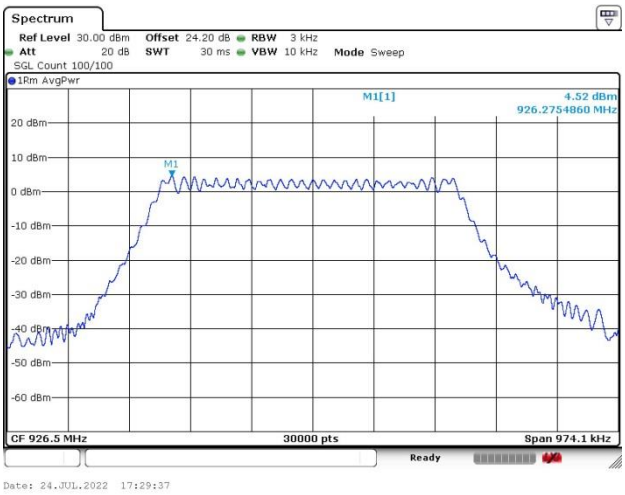
Lora 500KHz SF8	
6 dB Bandwidth Plot on Channel 1	**6 dB Bandwidth Plot on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

99% Occupied Bandwidth

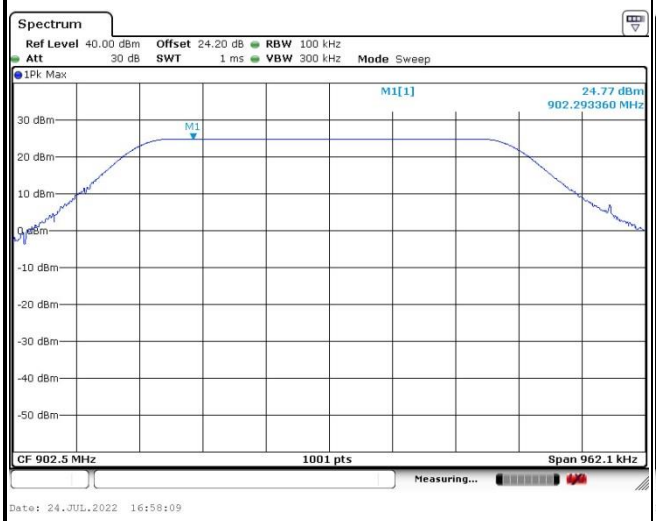
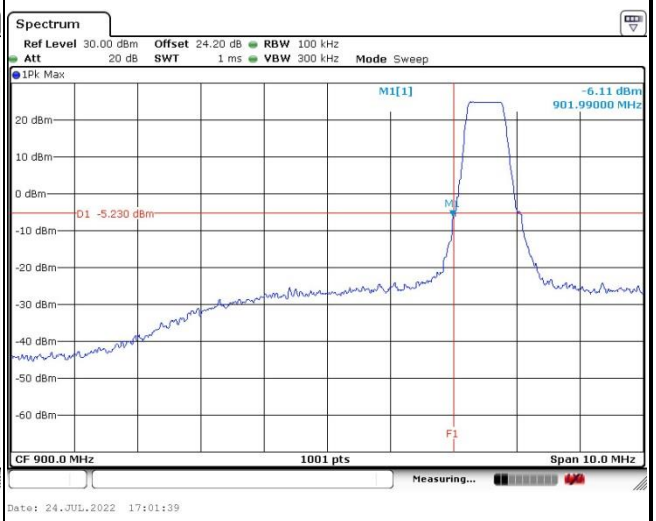
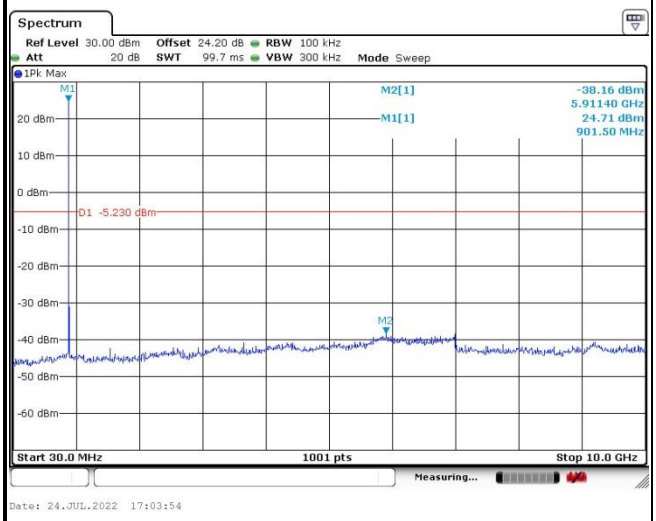
Lora 500KHz SF8	
99% Occupied Bandwidth Plot on Channel 1	**99% Occupied Plot Bandwidth on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

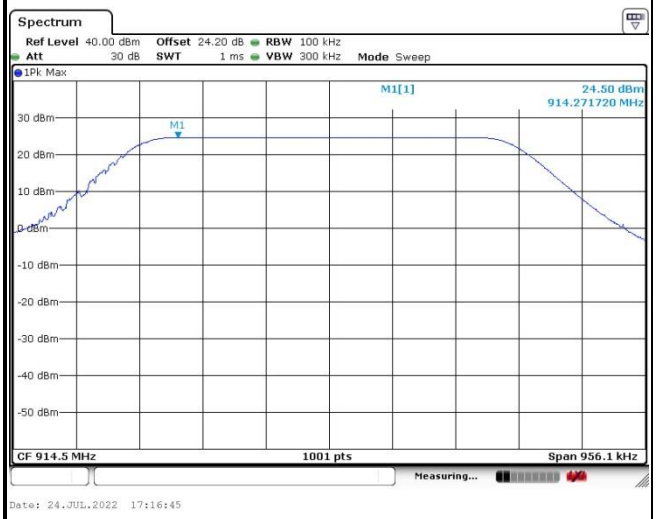
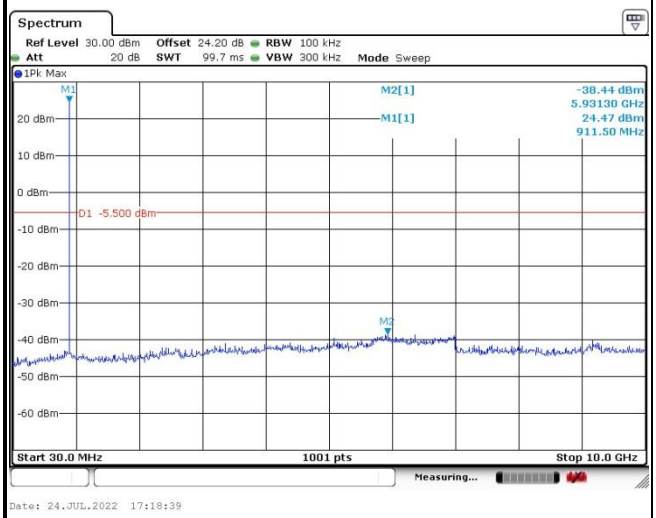
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

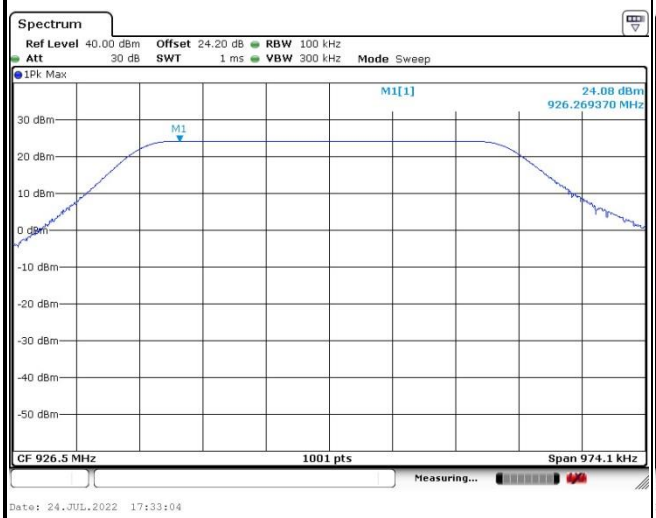
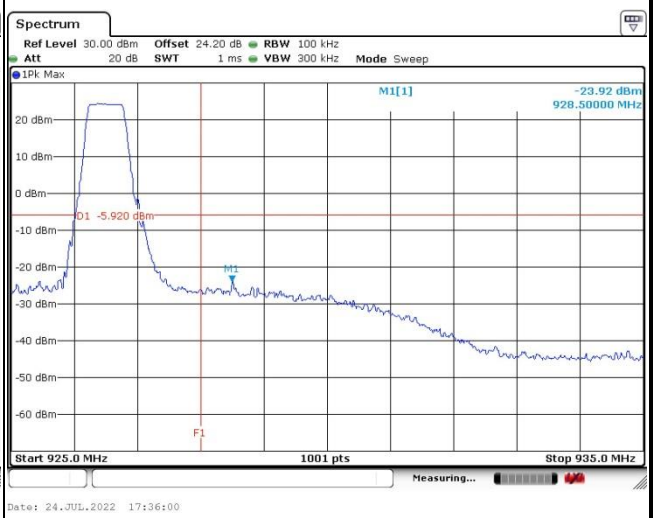
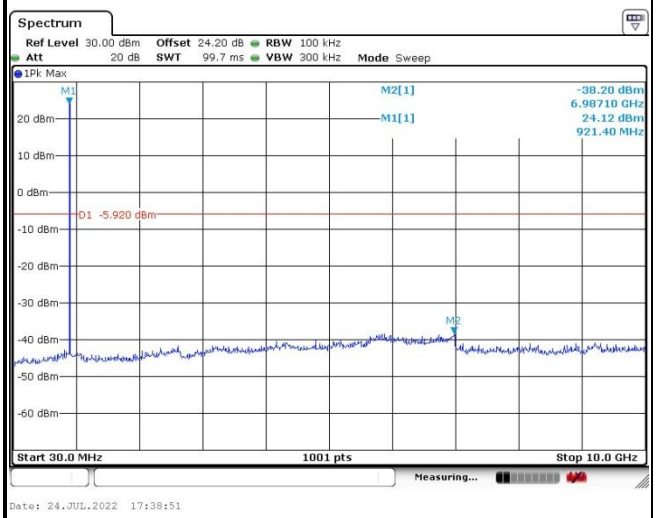
Power Spectral Density (dBm/3kHz)

Lora 500KHz SF8	
Power Density (dBm/3kHz) Plot Channel 1	**Power Density (dBm/3kHz) Plot Channel 16**
	
Power Density (dBm/3kHz) Plot Channel 31	
	**N/A**

Band Edge and Spurious Emission

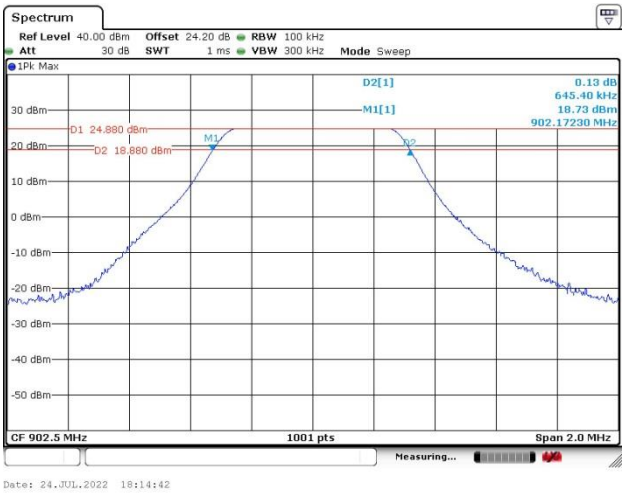
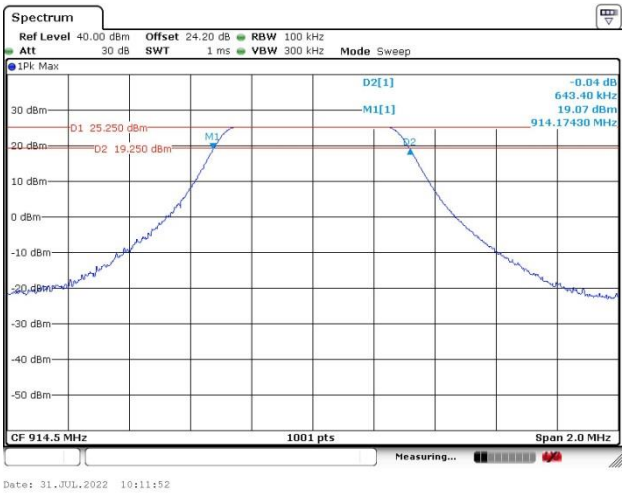
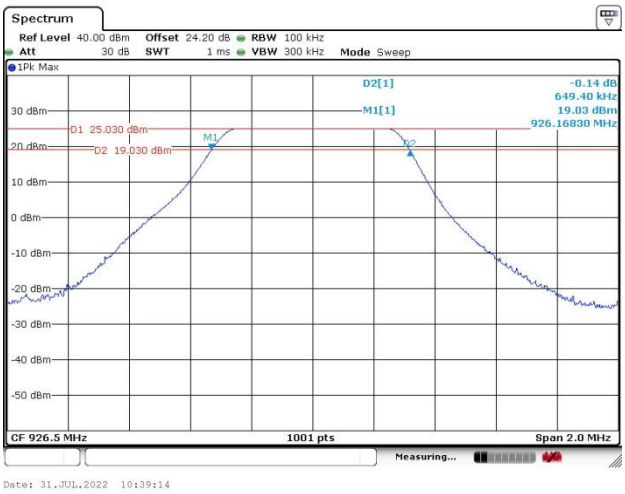
Lora 500KHz SF8 Channel 1	
100kHz PSD reference Level Plot	**Low Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

Lora 500KHz SF8 Channel 16	
100kHz PSD reference Level Plot	**Middle Channel Plot**
	**N/A**
Spurious Emission 30MHz~10GHz Plot	
	

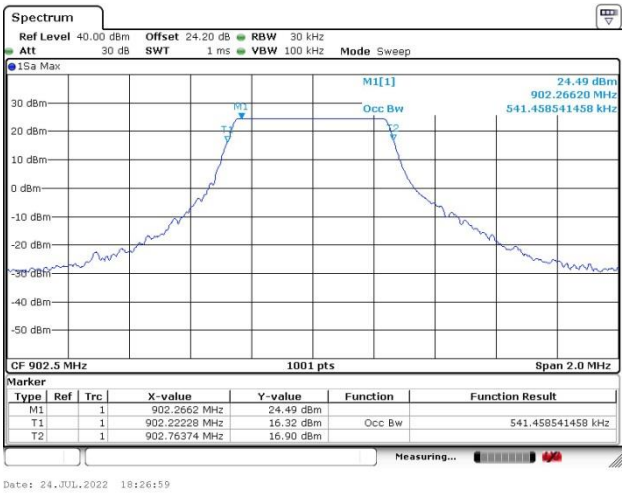
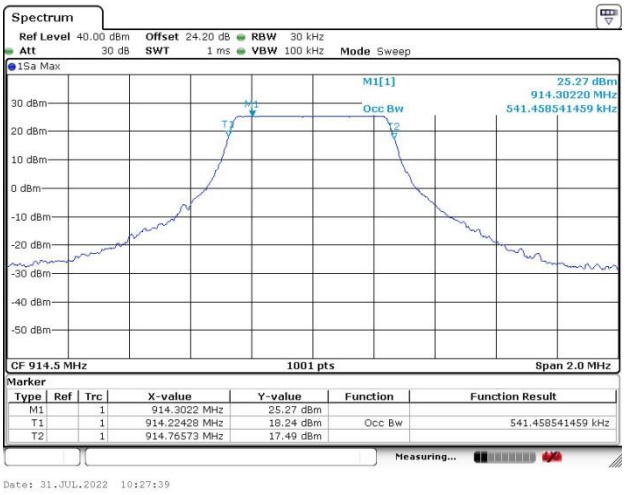
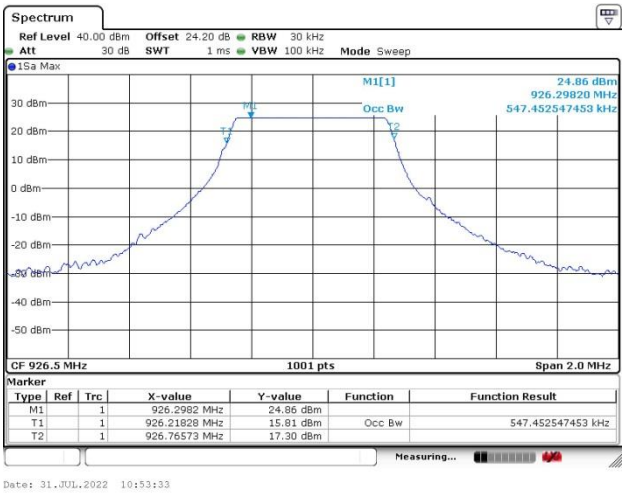
Lora 500KHz SF8 Channel 31	
100kHz PSD reference Level Plot	**High Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

<Data Rate: SF9>

6dB Bandwidth

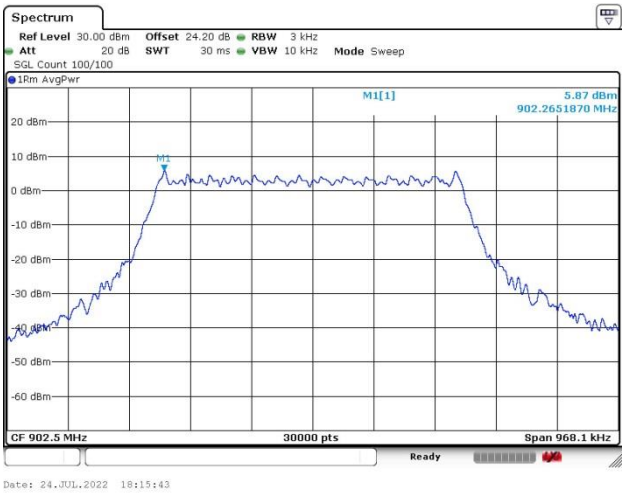
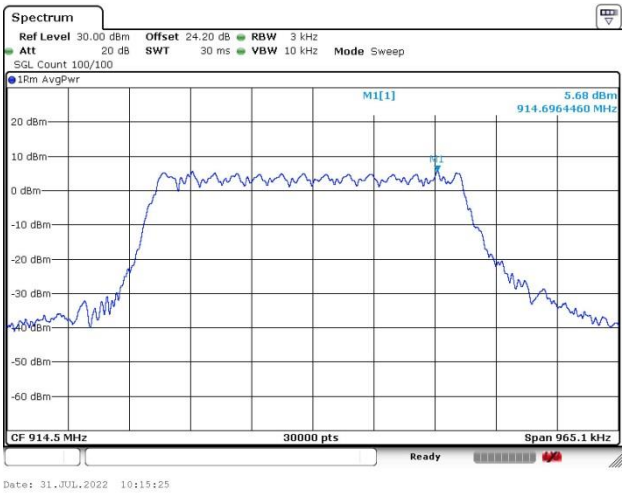
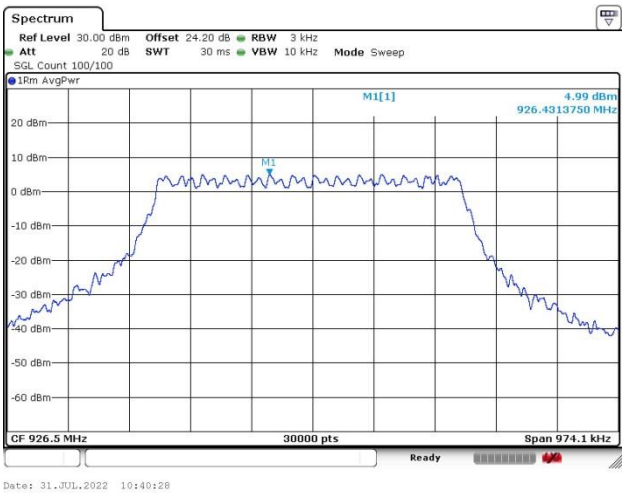
Lora 500KHz SF9	
6 dB Bandwidth Plot on Channel 1	**6 dB Bandwidth Plot on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

99% Occupied Bandwidth

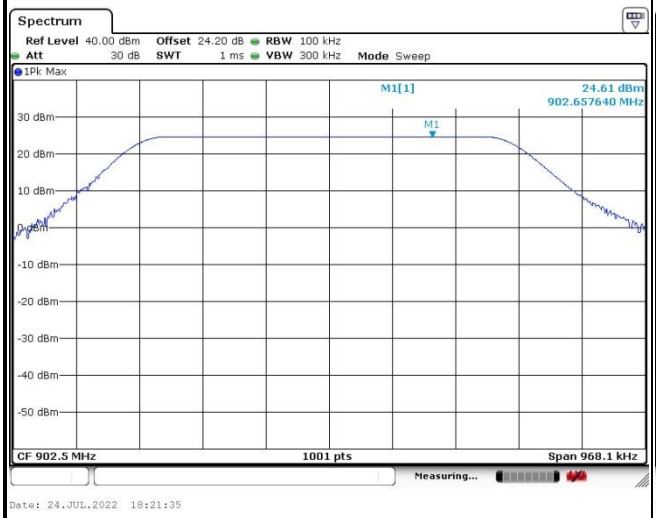
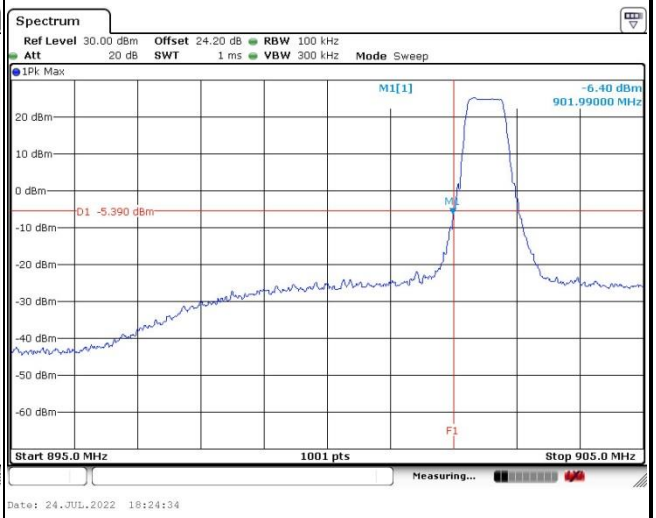
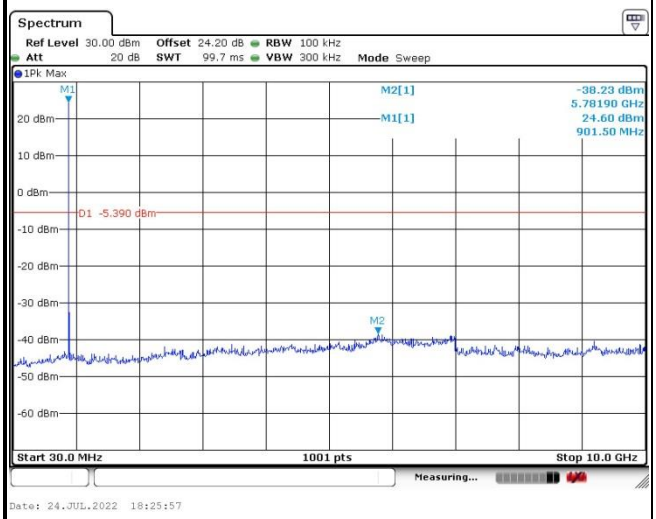
Lora 500KHz SF9	
99% Occupied Bandwidth Plot on Channel 1	**99% Occupied Plot Bandwidth on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

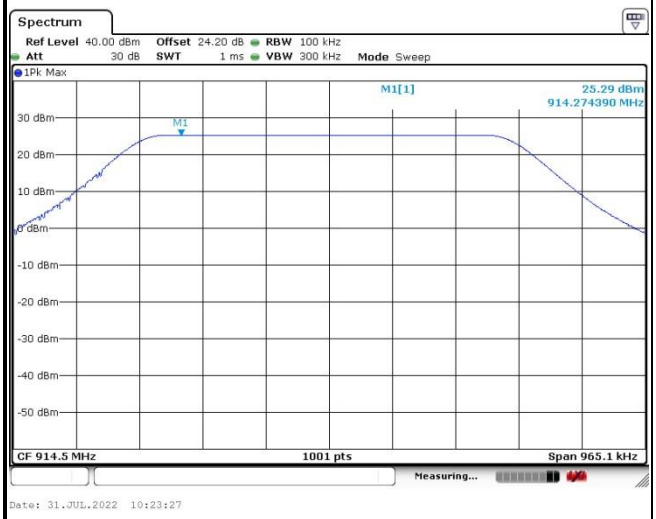
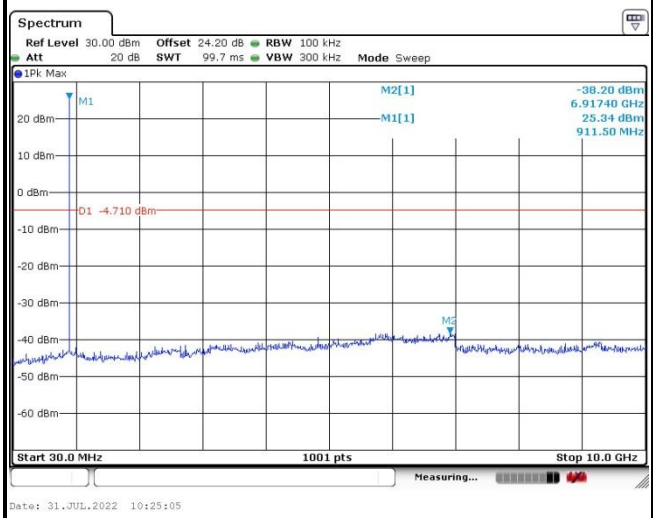
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

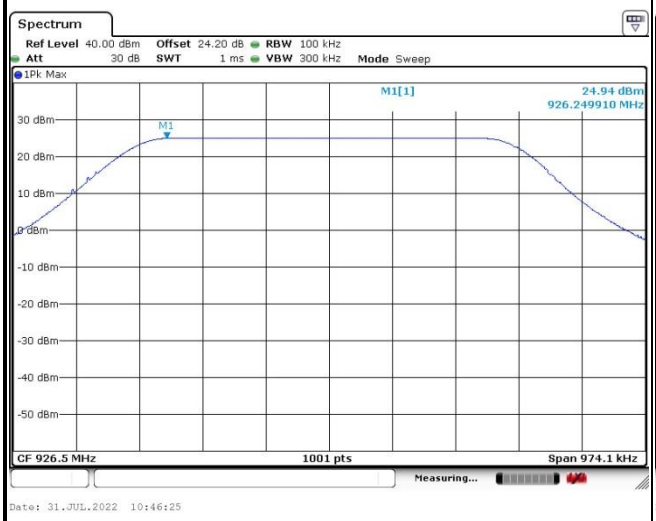
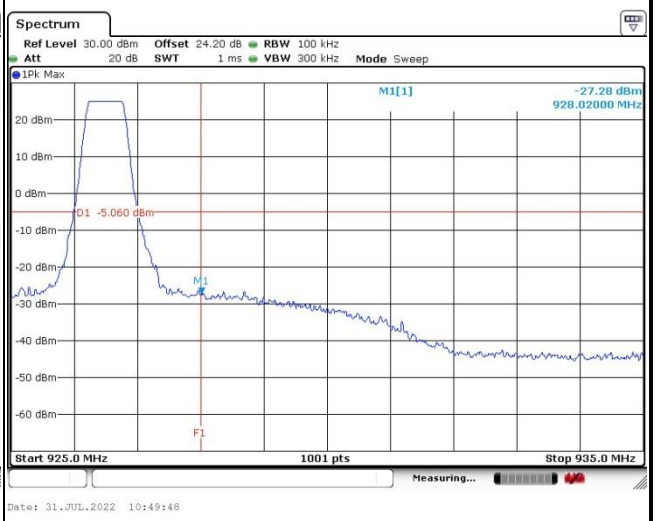
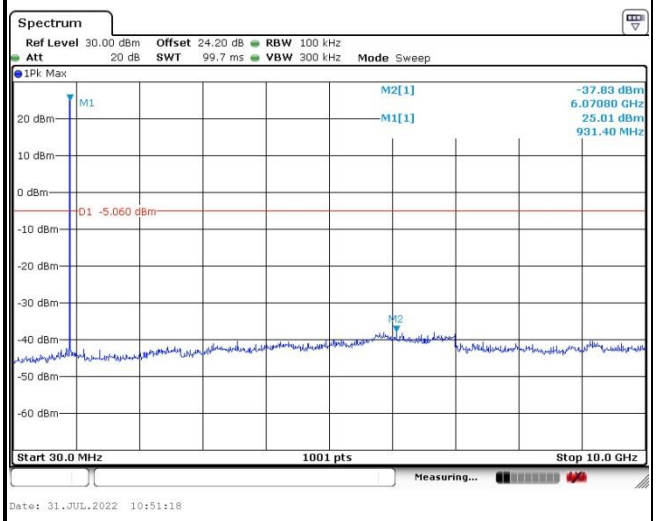
Power Spectral Density (dBm/3kHz)

Lora 500KHz SF9	
Power Density (dBm/3kHz) Plot Channel 1	**Power Density (dBm/3kHz) Plot Channel 16**
	
Power Density (dBm/3kHz) Plot Channel 31	
	**N/A**

Band Edge and Spurious Emission

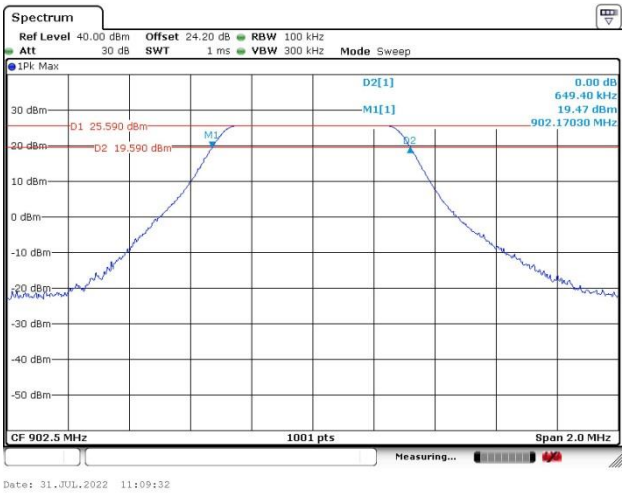
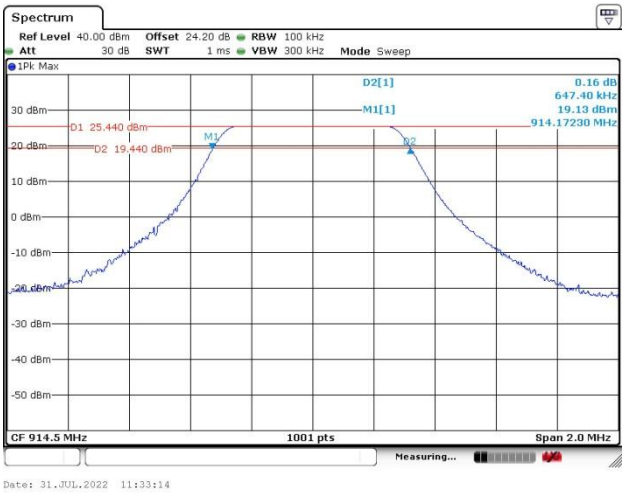
Lora 500KHz SF9 Channel 1	
100kHz PSD reference Level Plot	**Low Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

Lora 500KHz SF9 Channel 16	
100kHz PSD reference Level Plot	**Middle Channel Plot**
	**N/A**
Spurious Emission 30MHz~10GHz Plot	
	

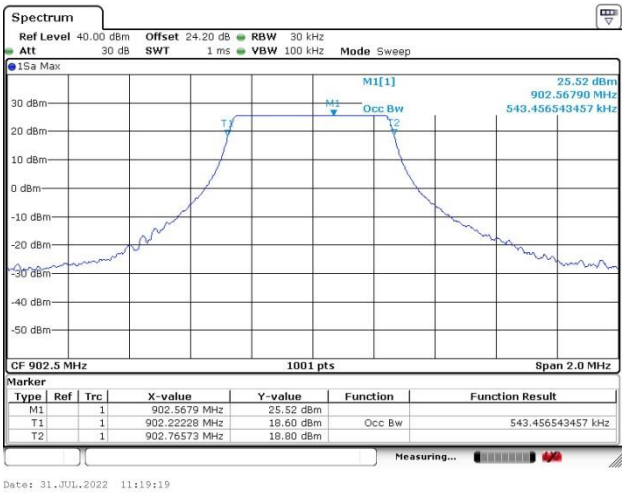
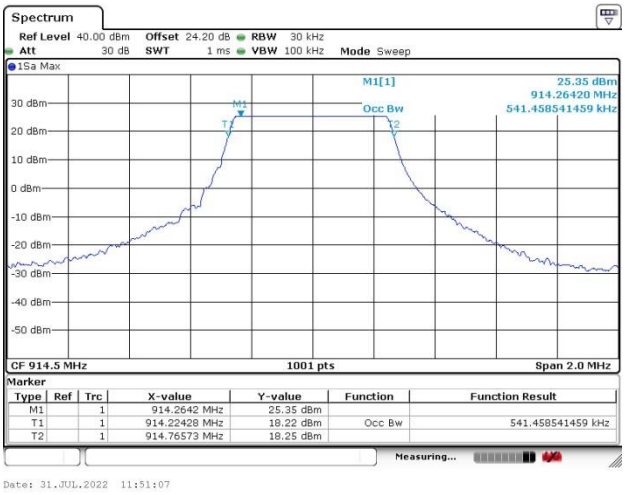
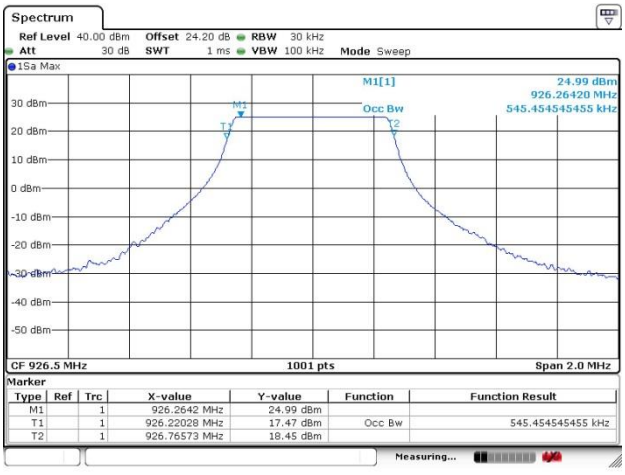
Lora 500KHz SF9 Channel 31	
100kHz PSD reference Level Plot	**High Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

<Data Rate: SF10>

6dB Bandwidth

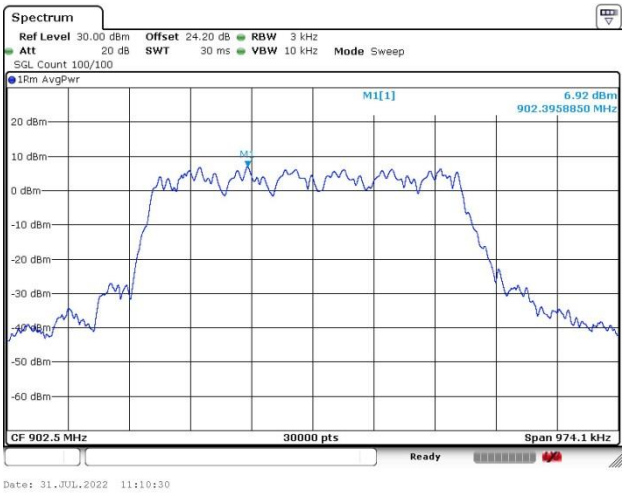
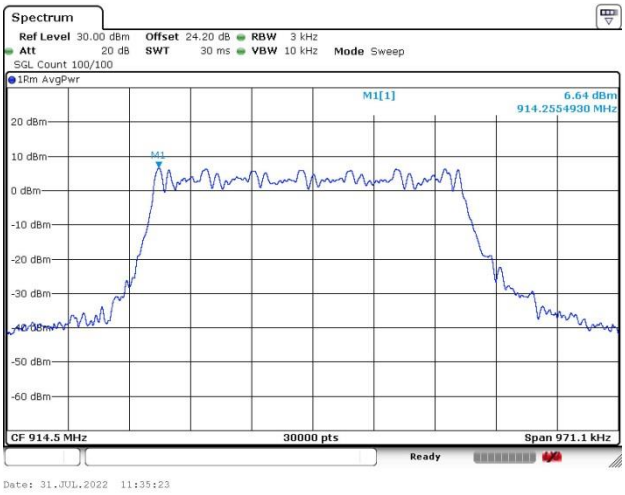
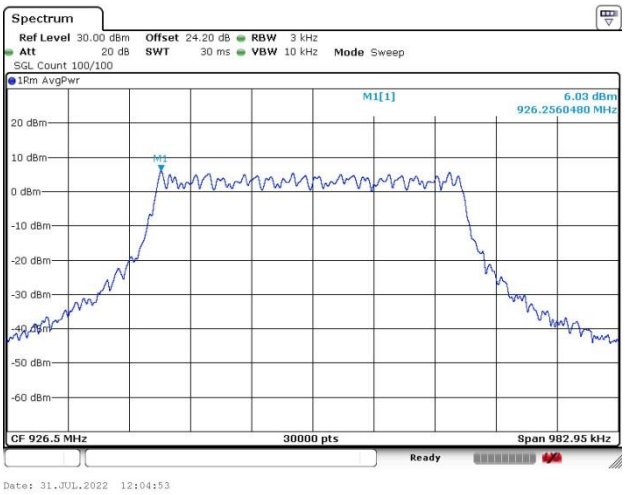
Lora 500KHz SF10	
6 dB Bandwidth Plot on Channel 1	**6 dB Bandwidth Plot on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

99% Occupied Bandwidth

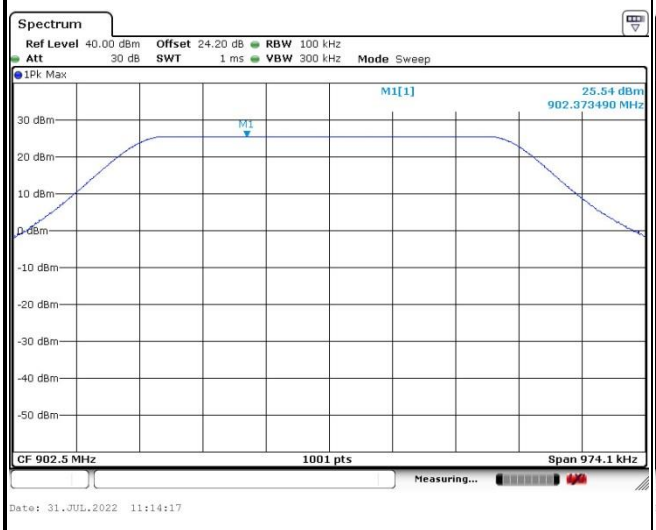
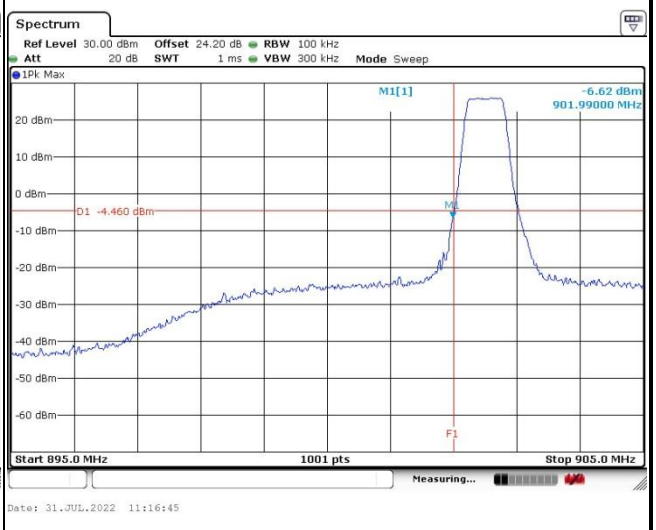
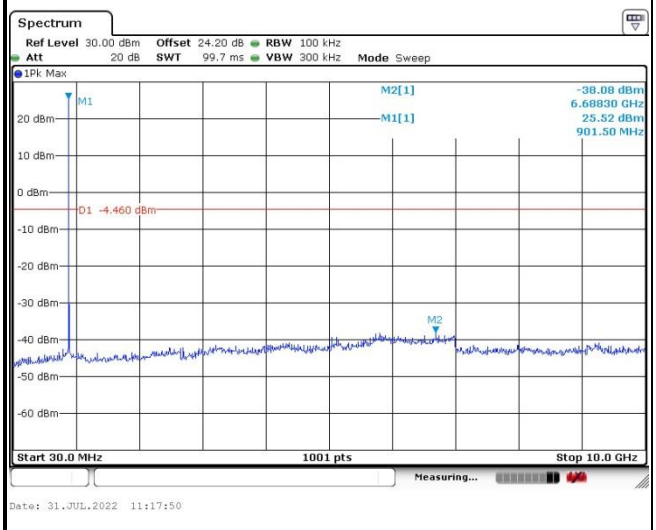
Lora 500KHz SF10	
99% Occupied Bandwidth Plot on Channel 1	**99% Occupied Plot Bandwidth on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

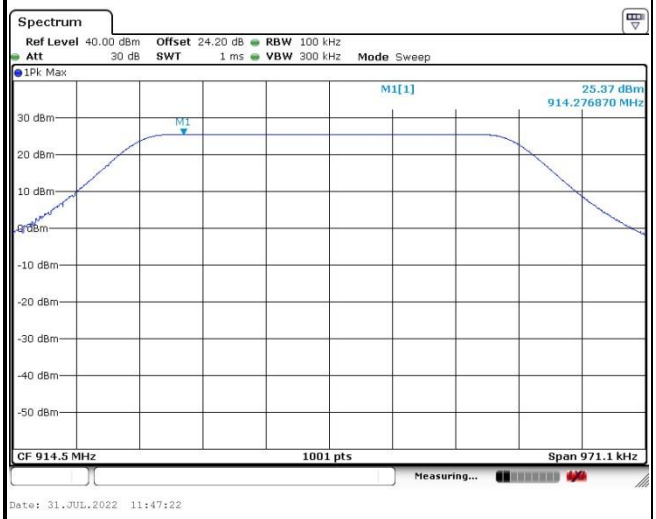
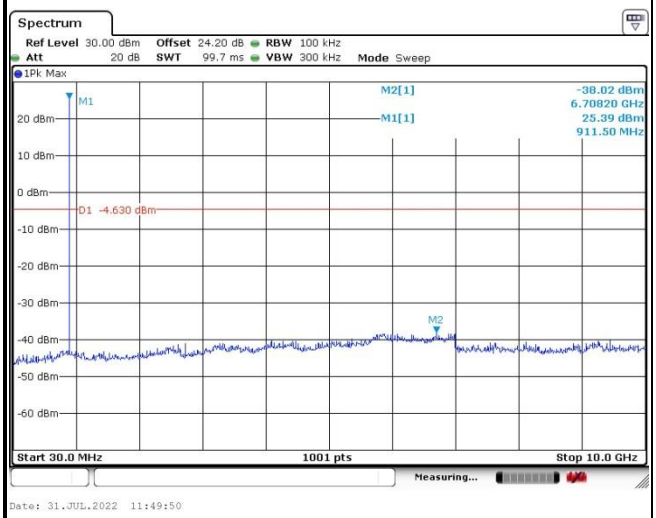
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

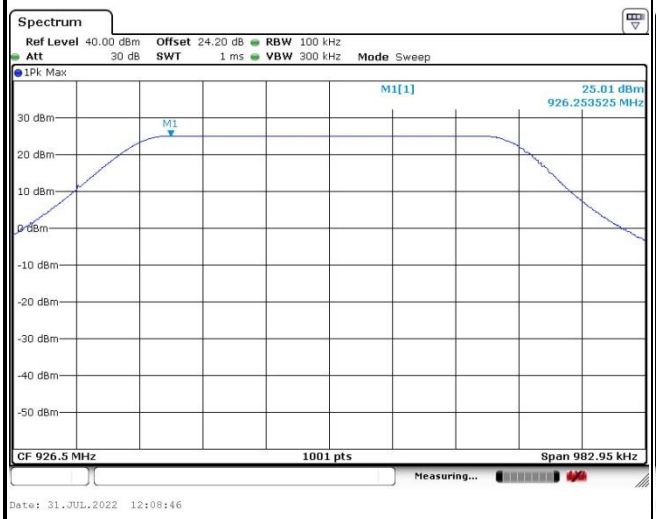
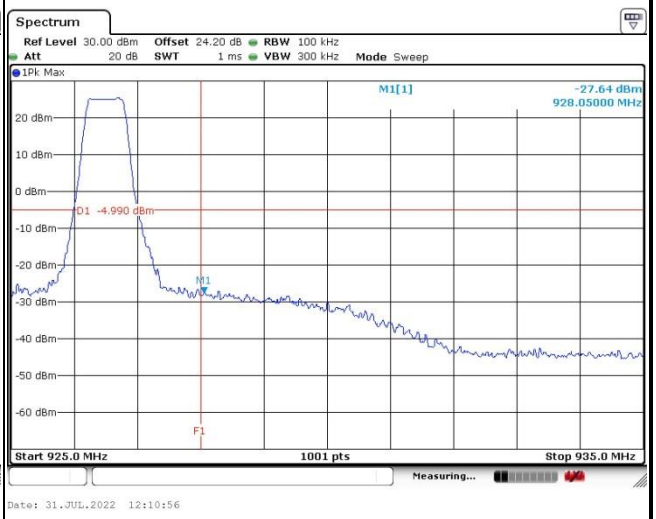
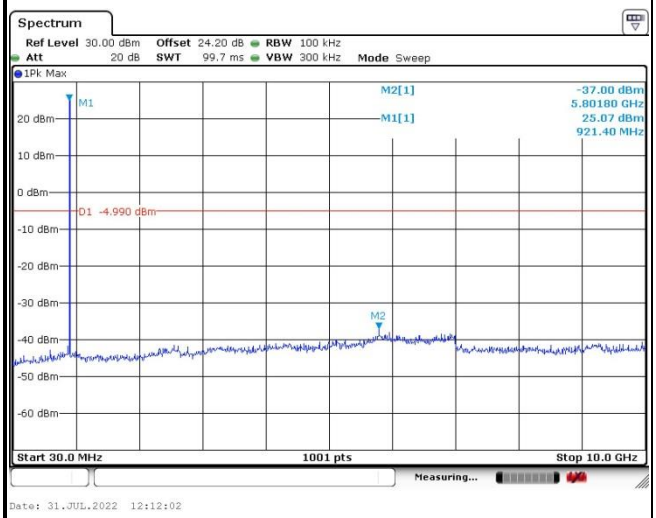
Power Spectral Density (dBm/3kHz)

Lora 500KHz SF10	
Power Density (dBm/3kHz) Plot Channel 1	**Power Density (dBm/3kHz) Plot Channel 16**
	
Power Density (dBm/3kHz) Plot Channel 31	
	**N/A**

Band Edge and Spurious Emission

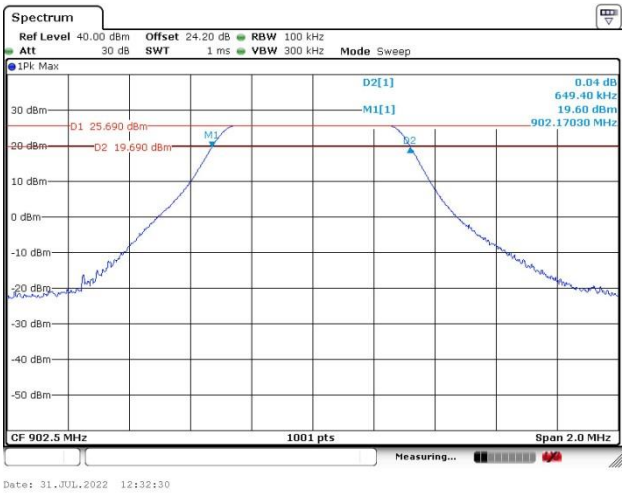
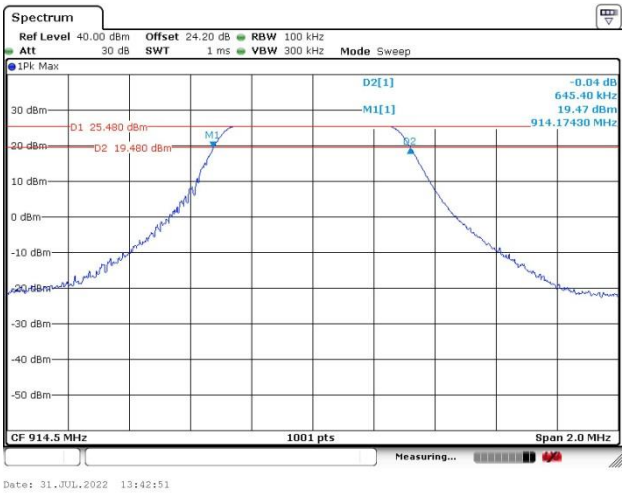
Lora 500KHz SF10 Channel 1	
100kHz PSD reference Level Plot	**Low Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

Lora 500KHz SF10 Channel 16	
100kHz PSD reference Level Plot	**Middle Channel Plot**
	**N/A**
Spurious Emission 30MHz~10GHz Plot	
	

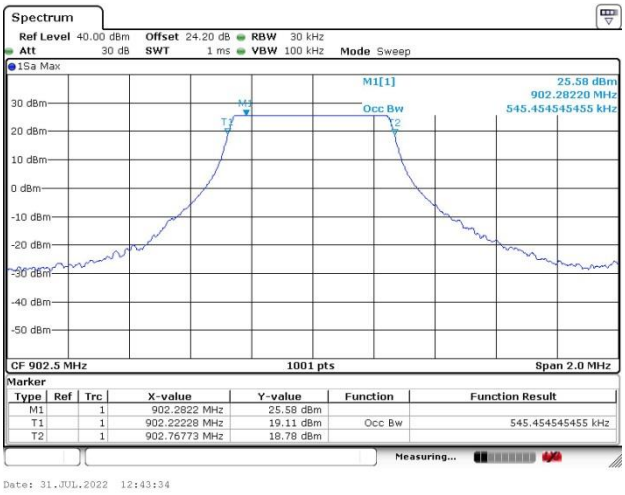
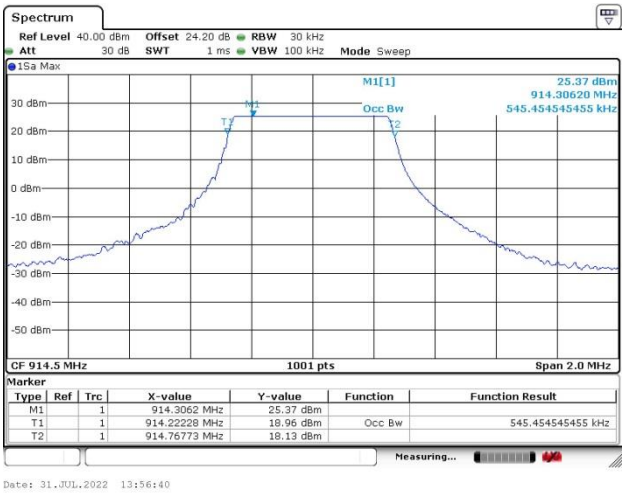
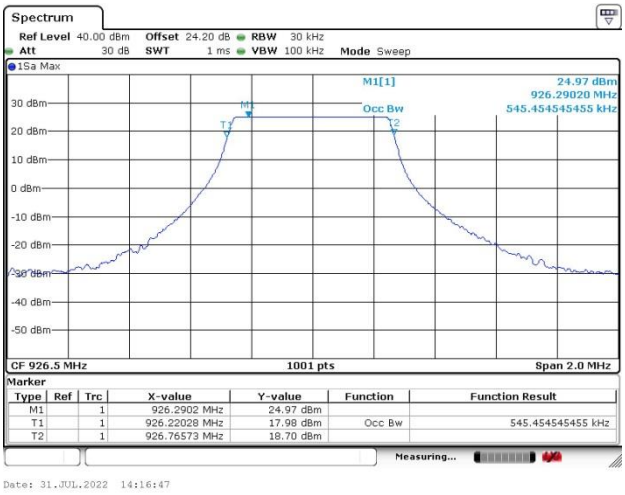
Lora 500KHz SF10 Channel 31	
100kHz PSD reference Level Plot	**High Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

<Data Rate: SF11>

6dB Bandwidth

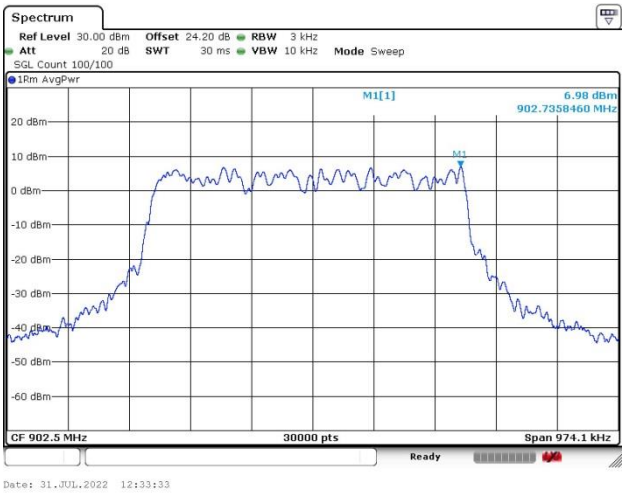
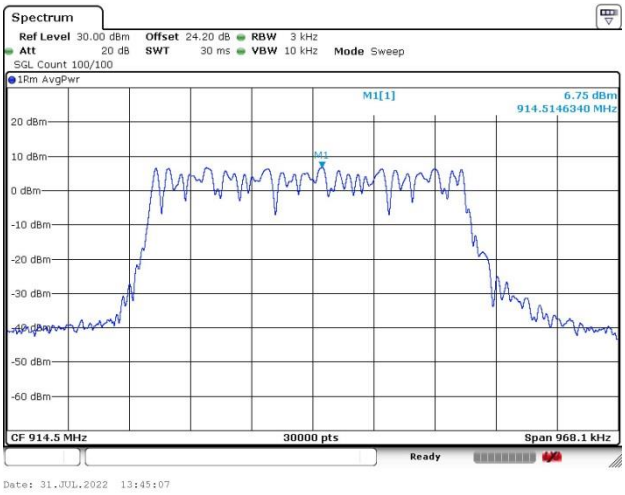
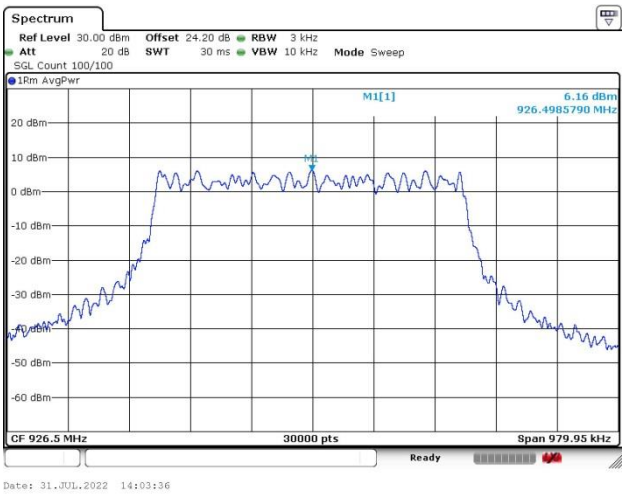
Lora 500KHz SF11	
6 dB Bandwidth Plot on Channel 1	**6 dB Bandwidth Plot on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

99% Occupied Bandwidth

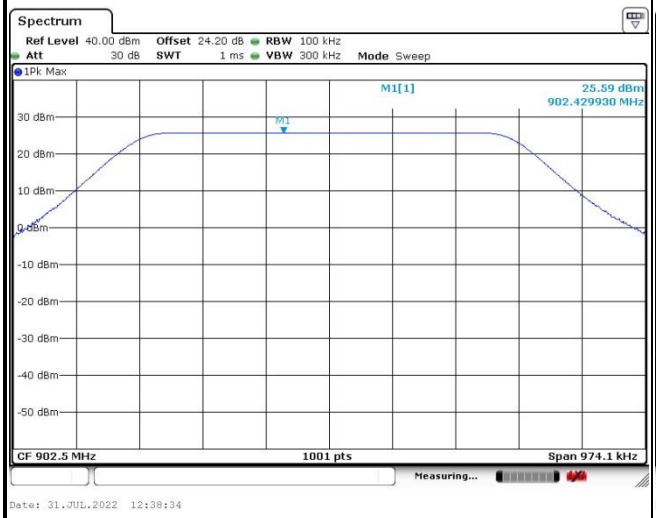
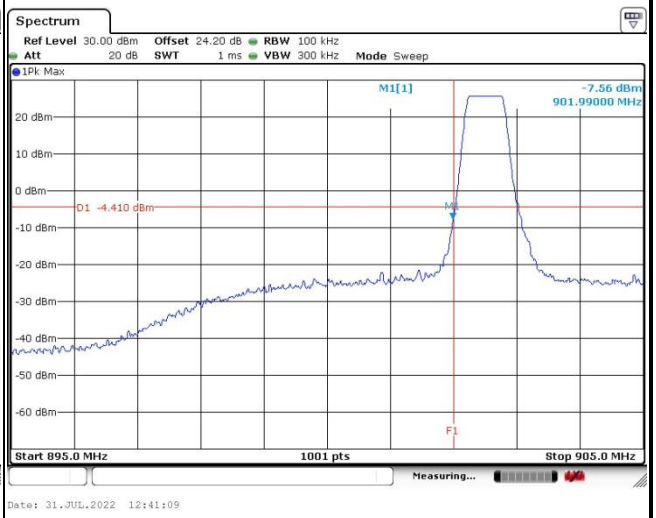
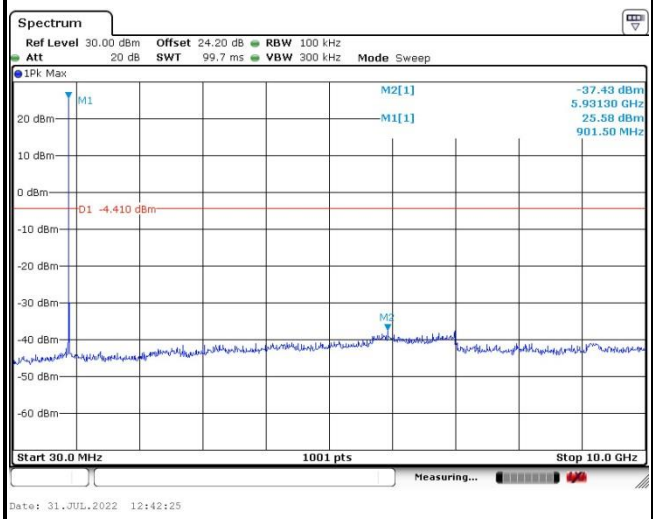
Lora 500KHz SF11	
99% Occupied Bandwidth Plot on Channel 1	**99% Occupied Plot Bandwidth on Channel 16**
	
6 dB Bandwidth Plot on Channel 31	
	**N/A**

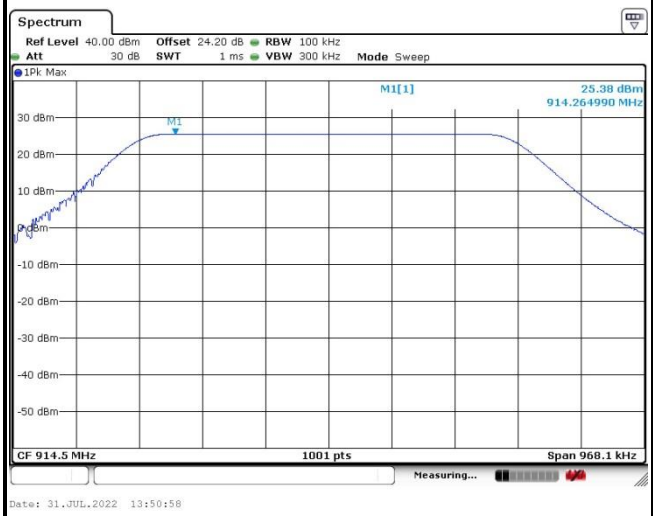
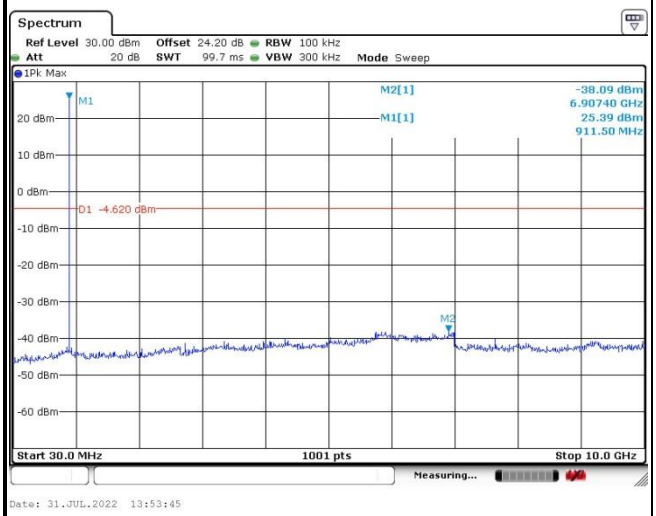
Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

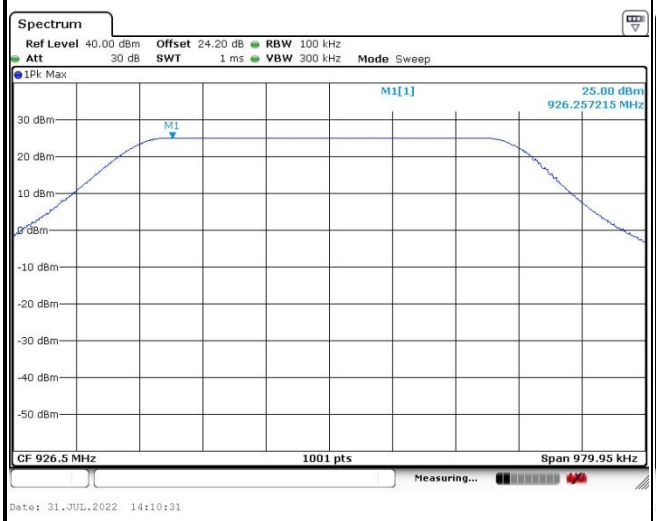
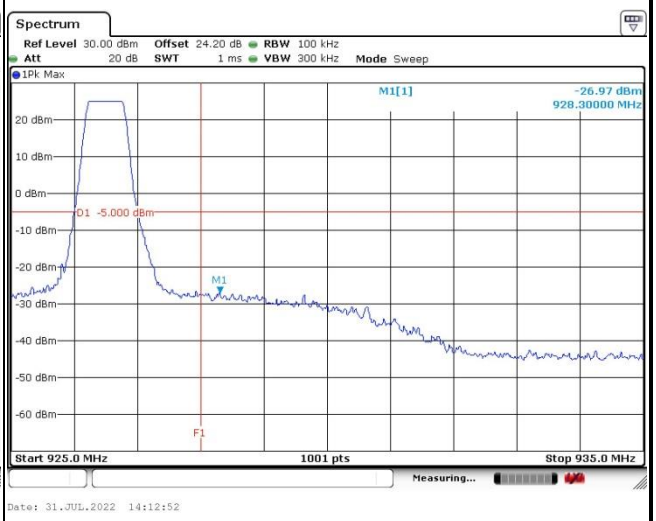
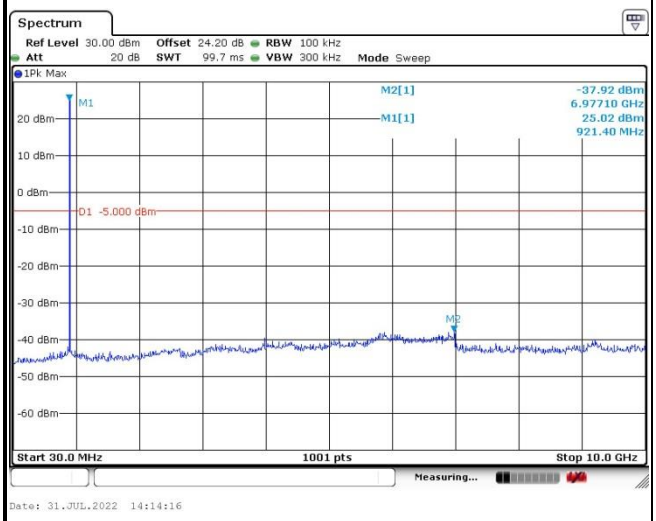
Power Spectral Density (dBm/3kHz)

Lora 500KHz SF11	
Power Density (dBm/3kHz) Plot Channel 1	**Power Density (dBm/3kHz) Plot Channel 16**
	
Power Density (dBm/3kHz) Plot Channel 31	
	**N/A**

Band Edge and Spurious Emission

Lora 500KHz SF11 Channel 1	
100kHz PSD reference Level Plot	**Low Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

Lora 500KHz SF11 Channel 16	
100kHz PSD reference Level Plot	**Middle Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

Lora 500KHz SF11 Channel 31	
100kHz PSD reference Level Plot	**High Channel Plot**
	
Spurious Emission 30MHz~10GHz Plot	
	

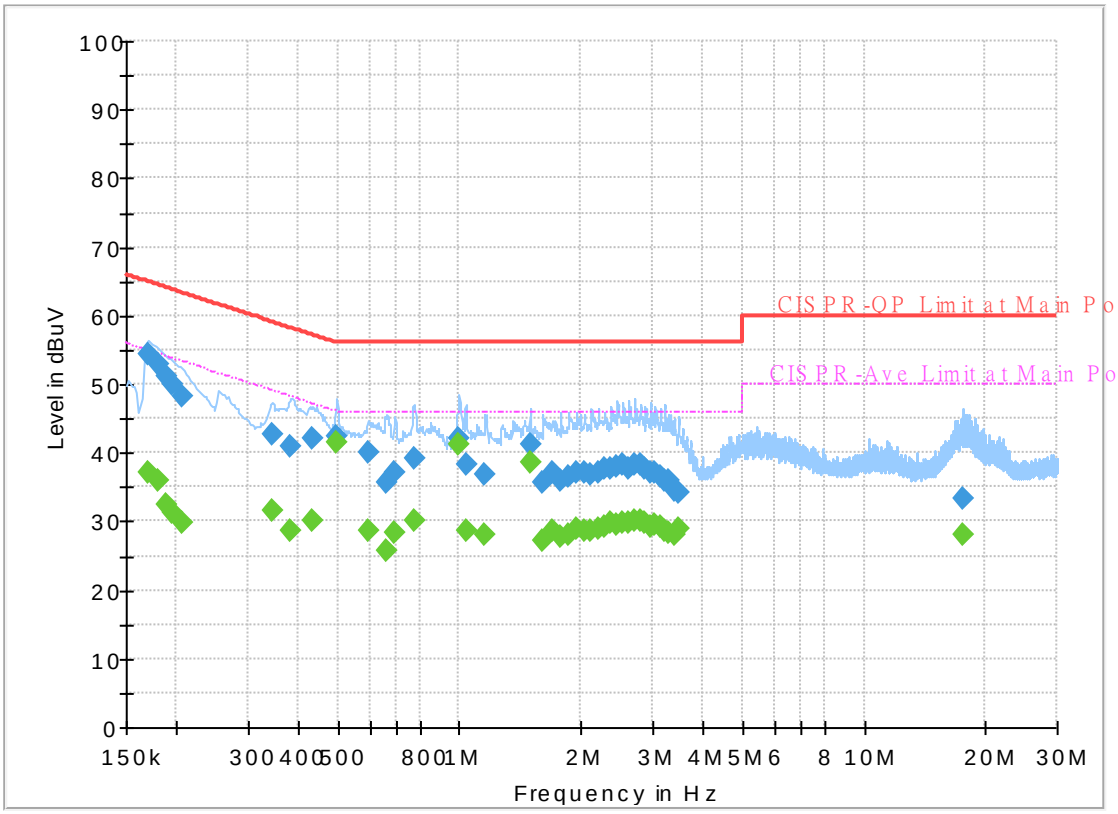
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Tom Lee	**Temperature :**	23~26℃
		Relative Humidity :	45~55%

EUT Information

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

Full Spectrum



Final_Result

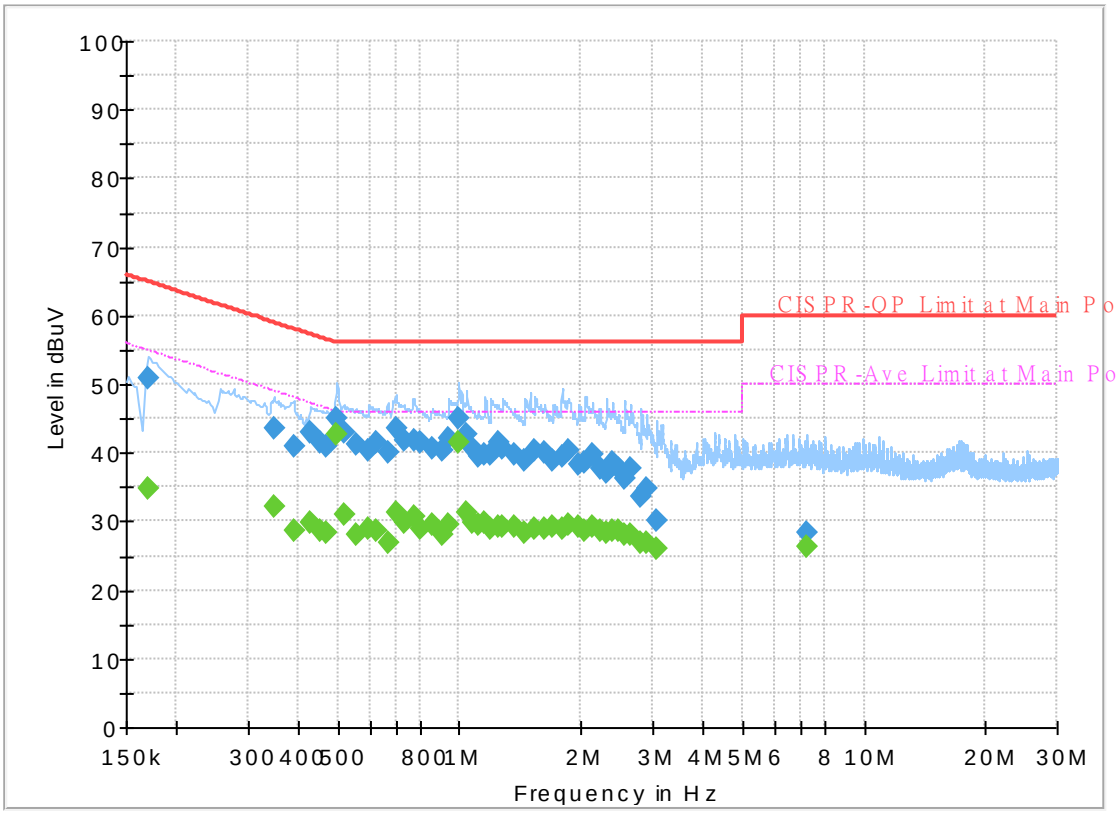
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.170250	---	37.13	54.95	17.82	L1	OFF	19.6
0.170250	54.50	---	64.95	10.45	L1	OFF	19.6
0.179250	---	35.93	54.52	18.59	L1	OFF	19.6
0.179250	52.78	---	64.52	11.74	L1	OFF	19.6
0.188250	---	32.56	54.11	21.55	L1	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 :	Yuan Lee, Fu Chen and Troye Hsieh	Temperature :	20.1~21.5°C
		Relative Humidity :	57.2~67.6%

Lora 902~928MHz

Lora DTS 500k (Band Edge @ 3m)

Lora SF11	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)
		30	32.84	-7.16	40	30.1	24.27	10.83	32.36	-	-	P	H
		54.25	28.11	-11.89	40	37.17	12.43	10.99	32.48	-	-	P	H
		115.36	36.42	-7.08	43.5	40.24	17.05	11.53	32.4	281	180	Q	H
		141.55	31.86	-11.64	43.5	35.38	17.17	11.75	32.44	-	-	P	H
		568.35	36.4	-9.6	46	29.65	25.81	13.59	32.65	-	-	P	H
		743.92	39.79	-6.21	46	29.95	27.83	14.1	32.09	-	-	P	H
	*	902.5	120.2	-	-	107.97	28.85	14.59	31.21	100	188	P	H
													H
Lora													H
DTS 500k													H
CH 01		41.64	35.16	-4.84	40	38.42	18.37	10.81	32.44	100	355	Q	V
902.5MHz		71.71	31.66	-8.34	40	40.87	12.08	11.15	32.44	-	-	P	V
		115.36	32.06	-11.44	43.5	35.88	17.05	11.53	32.4	-	-	P	V
		259.89	28.95	-17.05	46	29.25	19.55	12.41	32.26	-	-	P	V
		558.65	36.61	-9.39	46	29.73	25.89	13.56	32.57	-	-	P	V
		696.39	38.2	-7.8	46	30.18	26.47	13.93	32.38	-	-	P	V
	*	902.5	117.21	-	-	104.98	28.85	14.59	31.21	112	248	P	V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 30db.
4. 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 SF11	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)
		30	33.54	-6.46	40	30.8	24.27	10.83	32.36	-	-	P	H
		53.28	27.65	-12.35	40	36.45	12.7	10.98	32.48	-	-	P	H
		114.39	36.36	-7.14	43.5	40.31	16.94	11.51	32.4	283	177	Q	H
		149.31	31.48	-12.02	43.5	35.34	16.83	11.76	32.45	-	-	P	H
		583.87	36.48	-9.52	46	30.1	25.51	13.63	32.76	-	-	P	H
		695.42	38.07	-7.93	46	30.07	26.45	13.93	32.38	-	-	P	H
	*	914.5	119.08	-	-	106.65	28.95	14.61	31.13	100	190	P	H
													H
													H
													H
Lora													H
DTS 500k													H
CH 16		30	33.82	-6.18	40	31.08	24.27	10.83	32.36	-	-	P	V
914.5MHz		41.64	35.25	-4.75	40	38.51	18.37	10.81	32.44	100	353	Q	V
		71.71	31.25	-8.75	40	40.46	12.08	11.15	32.44	-	-	P	V
		115.36	32.25	-11.25	43.5	36.07	17.05	11.53	32.4	-	-	P	V
		506.27	35.65	-10.35	46	30.65	23.86	13.33	32.19	-	-	P	V
		689.6	37.55	-8.45	46	29.64	26.41	13.91	32.41	-	-	P	V
	*	914.5	116.63	-	-	104.2	28.95	14.61	31.13	112	256	P	V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 30db.
4. 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 SF11	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)
		30	33.67	-6.33	40	30.93	24.27	10.83	32.36	-	-	P	H
		66.86	26.98	-13.02	40	36.38	11.95	11.1	32.45	-	-	P	H
		88.2	33.67	-9.83	43.5	40.69	14.07	11.32	32.41	-	-	P	H
		115.36	35.98	-7.52	43.5	39.8	17.05	11.53	32.4	283	177	Q	H
		540.22	37.86	-8.14	46	32.92	23.89	13.49	32.44	-	-	P	H
		756.53	39.3	-6.7	46	29.26	27.93	14.13	32.02	-	-	P	H
	*	926.5	120.57	-	-	107.72	29.25	14.65	31.05	150	215	P	H
													H
													H
													H
Lora													H
DTS 500k													H
CH 31		41.64	35.76	-4.24	40	39.02	18.37	10.81	32.44	100	360	Q	V
926.5MHz		67.83	33.13	-6.87	40	42.44	12.03	11.11	32.45	-	-	P	V
		88.2	36.23	-7.27	43.5	43.25	14.07	11.32	32.41	-	-	P	V
		116.33	30.69	-12.81	43.5	34.44	17.12	11.53	32.4	-	-	P	V
		702.21	37.55	-8.45	46	29.42	26.53	13.95	32.35	-	-	P	V
		797.27	40.6	-5.4	46	30.02	28.09	14.26	31.77	-	-	P	V
	*	926.5	120.16	-	-	107.31	29.25	14.65	31.05	150	141	P	V
													V
													V
													V
													V
													V

Remark

1. No other spurious found.
2. All results are PASS against limit line.
3. Non restricted band limit is radio frequency level down 30db.
4. 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 DTS 500k (Harmonic @ 3m)

Lora SF11	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 DTS 500k CH 01 902.5MHz		2707.5	51.76	-22.24	74	48.8	28.23	8.63	33.9	266	264	P	H
		2707.5	50.63	-3.37	54	47.67	28.23	8.63	33.9	266	264	A	H
		3610	38.09	-35.91	74	56.5	29.72	10.78	58.91	-	-	P	H
		4512.5	39.7	-34.3	74	54.64	31.7	11.08	57.72	-	-	P	H
		5415	39.99	-34.01	74	53.32	32.9	12.08	58.31	-	-	P	H
		8122.5	42.97	-31.03	74	49.91	37.1	14.37	58.41	-	-	P	H
		9025	46.25	-27.75	74	50.61	38.05	15.83	58.24	-	-	P	H
		2707.5	52.1	-21.9	74	49.14	28.23	8.63	33.9	114	255	P	H
		2707.5	50.06	-3.94	54	47.1	28.23	8.63	33.9	114	255	A	H
		3610	37.65	-36.35	74	56.06	29.72	10.78	58.91	-	-	P	H
		4512.5	40.29	-33.71	74	55.23	31.7	11.08	57.72	-	-	P	H
		5415	39.94	-34.06	74	53.27	32.9	12.08	58.31	-	-	P	H
		8122.5	42.94	-31.06	74	49.88	37.1	14.37	58.41	-	-	P	H
		9025	45.65	-28.35	74	50.01	38.05	15.83	58.24	-	-	P	H
Lora DTS 500k CH 16 914.5MHz		2743.5	52.62	-21.38	74	49.46	28.37	8.69	33.9	300	206	P	H
		2743.5	50.52	-3.48	54	47.36	28.37	8.69	33.9	300	206	A	H
		3658	38.47	-35.53	74	56.6	29.82	10.85	58.8	-	-	P	H
		4572.5	39.61	-34.39	74	54.92	31.7	10.76	57.77	-	-	P	H
		7316	42.66	-31.34	74	50.92	37.04	13.43	58.73	-	-	P	H
		8230.5	44.37	-29.63	74	51.1	37.22	14.4	58.35	-	-	P	H
		9145	46.25	-27.75	74	50.65	38.18	15.83	58.41	-	-	P	H
		2743.5	52.63	-21.37	74	49.47	28.37	8.69	33.9	100	211	P	V
		2743.5	50.81	-3.19	54	47.65	28.37	8.69	33.9	100	211	A	V
		3658	39.49	-34.51	74	57.62	29.82	10.85	58.8	-	-	P	V
		4572.5	39.89	-34.11	74	55.2	31.7	10.76	57.77	-	-	P	V
		7316	41.95	-32.05	74	50.21	37.04	13.43	58.73	-	-	P	V
		8230.5	44.36	-29.64	74	51.09	37.22	14.4	58.35	-	-	P	V
		9145	47.75	-26.25	74	52.15	38.18	15.83	58.41	-	-	P	V

Lora DTS 500k CH 31 926.5MHz		2779.5	51.74	-22.26	74	48.42	28.46	8.75	33.89	250	260	P	H
		2779.5	47.63	-6.37	54	44.31	28.46	8.75	33.89	250	260	A	H
		3706	38.27	-35.73	74	56.1	29.94	10.91	58.68	-	-	P	H
		4632.5	38.71	-35.29	74	54.02	31.76	10.74	57.81	-	-	P	H
		7412	43.23	-30.77	74	51.67	36.55	13.72	58.71	-	-	P	H
		8338.5	43.81	-30.19	74	50.21	37.28	14.61	58.29	-	-	P	H
		2779.5	50.61	-23.39	74	47.29	28.46	8.75	33.89	100	216	P	V
		2779.5	47.05	-6.95	54	43.73	28.46	8.75	33.89	100	216	A	V
		3706	38.53	-35.47	74	56.36	29.94	10.91	58.68	-	-	P	V
		4632.5	39.2	-34.8	74	54.51	31.76	10.74	57.81	-	-	P	V
		7412	42.38	-31.62	74	50.82	36.55	13.72	58.71	-	-	P	V
		8338.5	44.49	-29.51	74	50.89	37.28	14.61	58.29	-	-	P	V
Remark	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	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

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.
					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
LoRa CH 01 902.5MHz		910	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		910	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

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 @ 910MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 910MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Margin(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

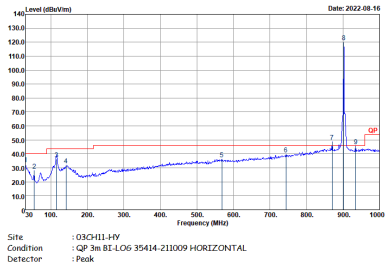
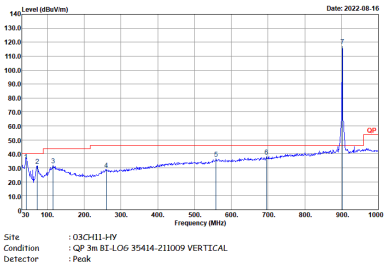
Both peak and average measured complies with the limit line, so test result is “PASS”.

Appendix D. Radiated Spurious Emission Plots

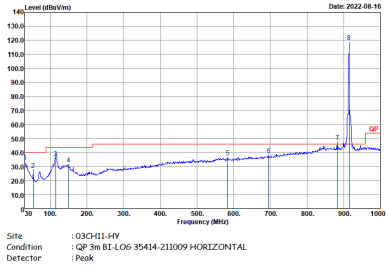
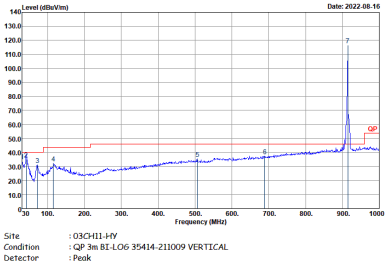
Test Engineer :	Yuan Lee, Fu Chen and Troye Hsieh	Temperature :	20.1~21.5°C
		Relative Humidity :	58.1~67.6%

Lora 902~928MHz

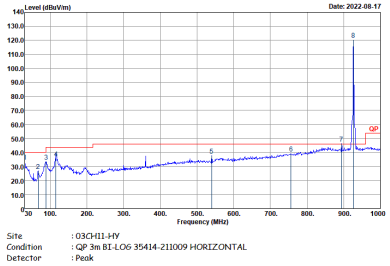
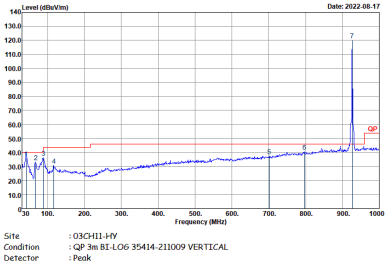
Lora DTS 500k (Band Edge @ 3m)

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch01 902.5Mhz	
	Horizontal	Vertical
QP / Peak		

Remark: The unwanted signal of mark #7.9 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).

Lora	Lora 920~928MHz	
	Lora DTS 500k Ch16 914.5MHz	
	Horizontal	Vertical
QP / Peak		

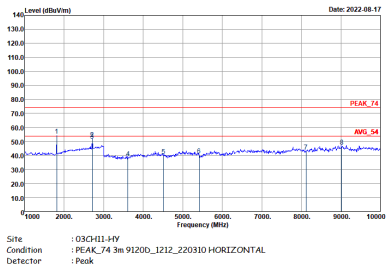
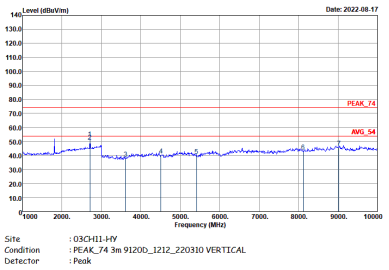
Remark: The unwanted signal of mark #7 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch31 926.5MHz	
	Horizontal	Vertical
Peak Avg.		

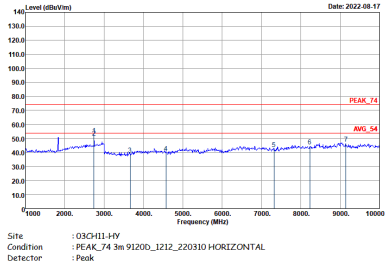
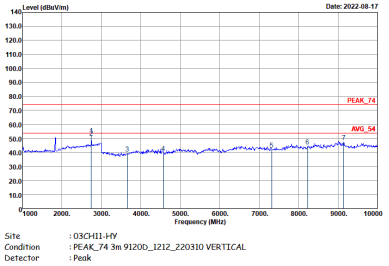
Remark: The unwanted signal of mark #7 in Horizontal plot falls within the non-restricted band and meet the requirements of 15.247 (d).

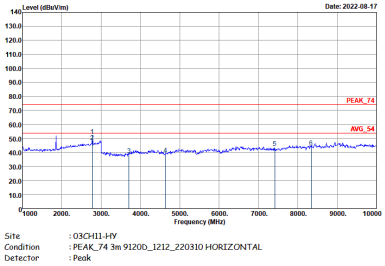
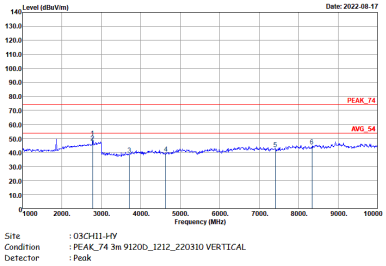
Lora 902~928MHz

Lora DTS 500k (Harmonic @ 3m)

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch01 902.5Mhz	
	Horizontal	Vertical
Peak Avg.		

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 DTS 500k Ch16 914.5MHz	
	Horizontal	Vertical
Peak Avg.		

Lora	Lora 902~928MHz	
	Lora DTS 500k Ch31 926.5MHz	
	Horizontal	Vertical
Peak Avg.		

Appendix E. Duty Cycle Plots

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
LoRa (500KHz)_SF11	96.61	18500	0.05	100Hz

LoRa (500KHz)_SF11