

TEST REPORT

FCC/ISED LoRa Test for LSM110A
Certification

APPLICANT
SJI CO.,LTD

REPORT NO.
HCT-RF-2205-FI001

DATE OF ISSUE
May 27, 2022

Tested by
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F-TP22-03(Rev.04)

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TEST REPORT FCC / ISED LoRa Test for LSM110	REPORT NO. HCT-RF-2205-FI001
	DATE OF ISSUE May 27, 2022
	Additional Model -

Applicant	SJI CO.,LTD 54-33, Dongtanhan 1-gil, Hwaseong-si, Gyeonggi-do, Republic of Korea
Eut Type Model Name	LoRa Sigfox Module LSM110A
FCC ID IC	2AS8LLSM110A 25119-LSM110A
Average Output Power	20.63 dBm
FCC Classification	Digital Transmission System(DTS)
FCC Rule Part(s)	Part 15 subpart C 15.247
ISED Rule Part(s)	RSS-247 Issue 2 (February 2017) RSS-Gen Issue 5_Amendment 2 (March 2021)

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

This test results were applied only to the test methods required by the standard.

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	May 27, 2022	Initial Release

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC / ISED Rules under normal use and maintenance

If this report is required to confirmation of authenticity, please contact to www.hct.co.kr

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1. EUT DESCRIPTION

Model	LSM110A
EUT Type	LoRa Sigfox Module
Power Supply	DC 3.3 V
Frequency Range	US: 902 MHz – 928 MHz (TX 500 kHz : 903.0 ~ 914.2) AU: 915 MHz – 928 MHz (TX 500 kHz : 915.9 ~ 927.1)
Max. RF Output Power	<u>Peak Power</u> Low : 20.71 dBm Mid : 20.62 dBm High : 20.58 dBm <u>Average Power</u> Low : 20.63 dBm Mid : 20.58 dBm High : 20.54 dBm
Modulation Type	LoRa™
Number of Channels (500 kHz)	8 Channels uplink 8 Channels downlink
Antenna Specification	Antenna type: PCB pattern antenna Peak Gain : 1.90 dBi
Date(s) of Tests	May 02, 2022 ~ May 27, 2022
PMN (Product Marketing Number)	LSM110A
HVIN (Hardware Version Identification Number)	LSM110A
FVIN (Firmware Version Identification Number)	v1.0.0
HMN (Host Marketing Name)	N/A
EUT serial numbers	Radiated : 110AXH3UR03000096G Conducted : 110AXH3UR03000086G

2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r02 dated April 02, 2019 entitled “guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C. / RSS-Gen issue 5, RSS-247 issue 2.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1 GHz. Above 1 GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 6.6.5 of ANSI C63.10. (Version: 2013)

DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).

For ISED, test facility was accepted dated January 26, 2021 (CAB identifier: KR0032).

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR § 15.203:

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. 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 provisions of this section.”

- (1) The antennas of this E.U.T are permanently attached.
- (2) The E.U.T Complies with the requirement of § 15.203

6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of

ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k=2$ to indicate a 95 % level of confidence.

The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (\pm dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	2.00 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (9 kHz ~ 30 MHz)	4.40 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (30 MHz ~ 1 GHz)	5.74 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (1 GHz ~ 18 GHz)	5.51 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (18 GHz ~ 40 GHz)	5.92 (Confidence level about 95 %, $k=2$)
Radiated Disturbance (Above 40 GHz)	5.48 (Confidence level about 95 %, $k=2$)

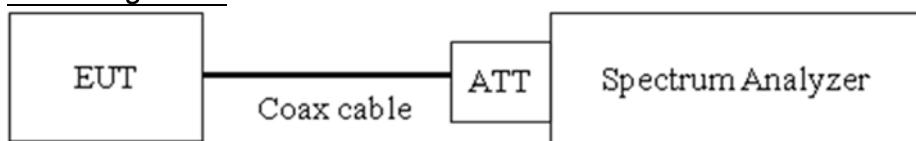
7. DESCRIPTION OF TESTS

7.1. 6 dB Bandwidth & 99 % Bandwidth

Limit

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 11.8.1 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW $\geq 3 \times$ RBW
- 3) Detector = Peak
- 4) Trace mode = Max hold
- 5) Sweep = auto couple
- 6) Allow the trace to stabilize
- 7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

Test Procedure (99 % Bandwidth for ISED)

The transmitter output is connected to the spectrum analyzer.

RBW = 1 % ~ 5 % of the occupied bandwidth

VBW $\approx 3 \times$ RBW

Detector = Peak

Trace mode = Max hold

Sweep = auto couple

Allow the trace to stabilize

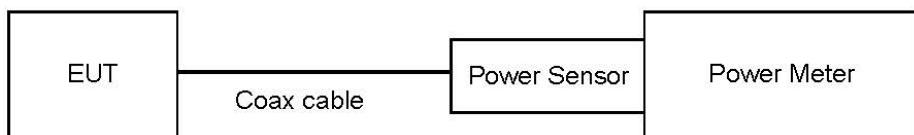
Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

7.2. Output Power

Limit

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Power Meter.

- Peak Power (Procedure 11.9.1.3 in ANSI 63.10-2013)
 - : Measure the peak power of the transmitter.

- Average Power (Procedure 11.9.2.3 in ANSI 63.10-2013)
 - 1) Measure the duty cycle.
 - 2) Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
 - 3) Add $10 \log (1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

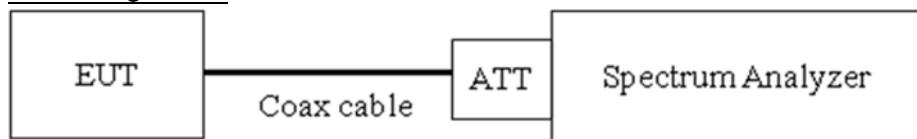
- Conducted Output Power(Peak) = Measured Value + ATT loss + Cable loss
- Conducted Output Power(Average) = Measured Value + ATT loss + Cable loss + Duty Cycle Factor

7.3. Power Spectral Density

Limit

The transmitter power density average over 1-second interval shall not be greater than 8 dBm in any 3 kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10.2 in ANSI 63.10-2013.

The spectrum analyzer is set to :

- 1) Set analyzer center frequency to DTS channel center frequency.
- 2) Span = 1.5 times the DTS channel bandwidth.
- 3) RBW = $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- 4) VBW $\geq 3 \times \text{RBW}$.
- 5) Sweep = auto couple
- 6) Detector = peak
- 7) Trace Mode = Max hold
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum amplitude level within the RBW.

If Measured Level exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculation

- Power Spectral Density = Measured Value + ATT loss + Cable loss

7.4. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

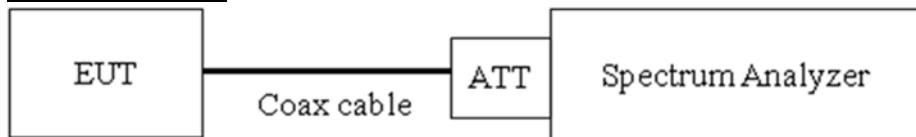
Limit

The maximum conducted (Average) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least

relative to the maximum in-band peak PSD level in 100 kHz.

[Conducted > 30 dBc]

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 11.11 in ANSI 63.10-2013)

- 1) RBW = 100 kHz
- 2) VBW \geq 3 x RBW
- 3) Set span to encompass the spectrum to be examined
- 4) Detector = Peak
- 5) Trace Mode = Max hold
- 6) Sweep time = auto couple
- 7) Ensure that the number of measurement points \geq 2 x Span/RBW
- 8) Allow trace to fully stabilize.
- 9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 10 times the operating frequency range(10 GHz) with the transmitter set to the lowest, middle, and highest channels.

Factors for frequency

Freq(MHz)	Factor(dB)
30	10.04
100	10.07
200	10.12
300	10.17
400	10.20
500	10.21
600	10.21
700	10.23
800	10.24
902	10.26
928	10.30
1 000	10.31
2 000	10.41
2 400	10.43
2 500	10.45
3 000	10.52
4 000	10.60
5 000	10.71
6 000	10.73
7 000	10.80
8 000	10.85
9 000	10.91
10 000	10.97
11 000	11.02
12 000	11.10
13 000	11.19
14 000	11.16
15 000	11.21
16 000	11.22
17 000	11.25
18 000	11.30
19 000	11.32
20 000	11.36
21 000	11.48
22 000	11.55
23 000	11.55
24 000	11.59
25 000	11.68
26 000	11.27

Note :

1. 902 ~ 928 MHz is fundamental frequency range.
2. Factor = Cable loss(1 EA) + ATT(10 dB)

7.5. Radiated Test**Limit****FCC**

Frequency (MHz)	Field Strength (μ V/m)	Measurement Distance (m)
0.009 – 0.490	$2400/F(kHz)$	300
0.490 – 1.705	$24000/F(kHz)$	30
1.705 – 30	30	30

ISED

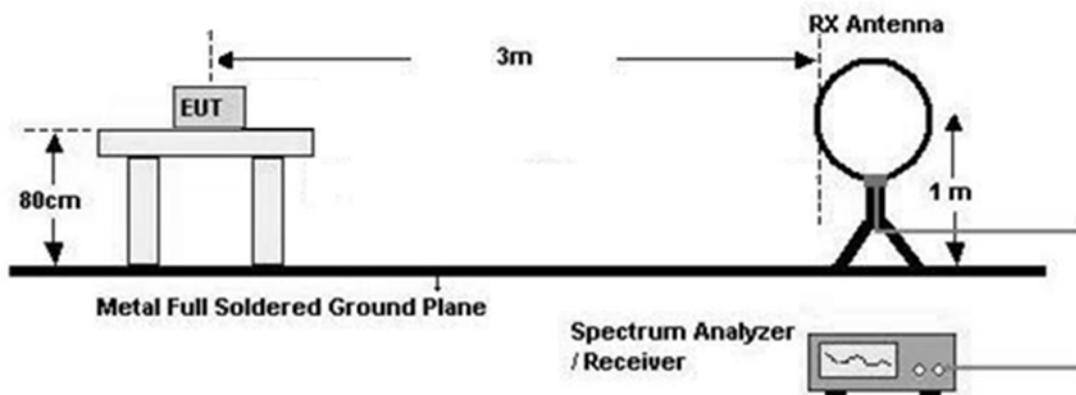
Frequency (MHz)	Field Strength (μ A/m)	Measurement Distance (m)
0.009 – 0.490	$6.37/F(kHz)$	300
0.490 – 1.705	$63.7/F(kHz)$	30
1.705 – 30	0.08	30

FCC&ISED

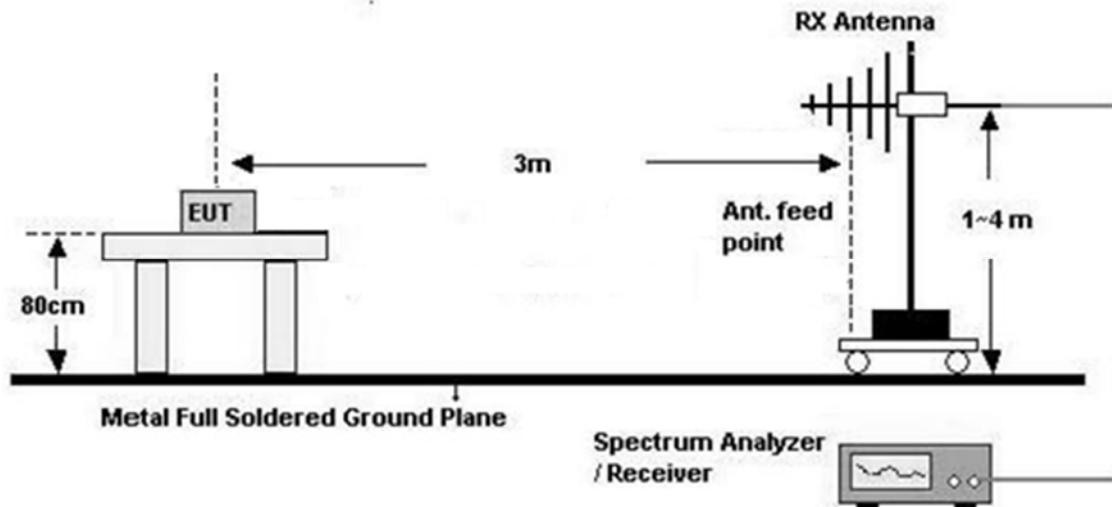
Frequency (MHz)	Field Strength (μ V/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

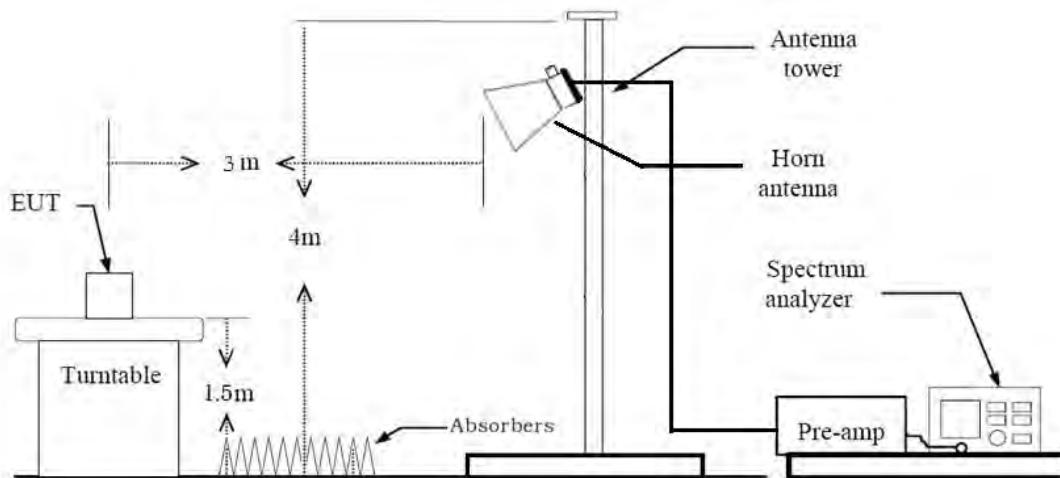
Below 30 MHz



30 MHz - 1 GHz



Above 1 GHz



Test Procedure of Radiated spurious emissions(Below 30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3 m from the EUT
3. The EUT is placed on a turntable, which is 0.8 m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor($0.009 \text{ MHz} - 0.490 \text{ MHz}$) = $40\log(3 \text{ m}/300 \text{ m}) = -80 \text{ dB}$
Measurement Distance : 3 m
7. Distance Correction Factor($0.490 \text{ MHz} - 30 \text{ MHz}$) = $40\log(3 \text{ m}/30 \text{ m}) = -40 \text{ dB}$
Measurement Distance : 3 m
8. Spectrum Setting
 - Frequency Range = 9 kHz ~ 30 MHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 9 kHz
 - VBW $\geq 3 \times \text{RBW}$
9. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

10. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

KDB 414788 OFS and Chamber Correlation Justification

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

Test Procedure of Radiated spurious emissions(Below 1 GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
 - (1) Measurement Type(Peak):
 - Measured Frequency Range : 30 MHz – 1 GHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 100 kHz
 - VBW \geq 3 x RBW
 - (2) Measurement Type(Quasi-peak):
 - Measured Frequency Range : 30 MHz – 1 GHz
 - Detector = Quasi-Peak
 - RBW = 120 kHz

※In general, (1) is used mainly

7. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L)
8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Spectrum Setting (Method 8.6 in KDB 558074 v05r02, Procedure 11.12 in ANSI 63.10-2013)

(1) Measurement Type(Peak):

- Measured Frequency Range : 1 GHz – 10th Harmonics
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW \geq 3 x RBW

(2) Measurement Type(Average): Duty cycle \geq 98 %

- Measured Frequency Range : 1 GHz – 10th Harmonics
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $<$ 98 %, duty cycle variations are less than ± 2 %

- Measured Frequency Range : 1 GHz – 10th Harmonics
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.
- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin $>$ 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

9. Distance extrapolation factor = $20\log(\text{test distance} / \text{specific distance})$ (dB)

10. Total(Measurement Type : Peak)

$$= \text{Measured Value} + \text{Antenna Factor(A.F)} + \text{Cable Loss(C.L)} - \text{Amp Gain(G)} + \text{Distance Factor(D.F)}$$

Total(Measurement Type : Average, Duty cycle \geq 98 %)

= Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

Total(Measurement Type : Average, Duty cycle $<$ 98 %)

= Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

+ Duty Cycle Factor

Test Procedure of Radiated Restricted Band Edge

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

7. Spectrum Setting**(1) Measurement Type(Peak):**

- Measured Frequency Range : 30 MHz - 1 GHz
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW \geq 3 x RBW

(2) Measurement Type(Average): Duty cycle \geq 98 %,

- Measured Frequency Range : 30 MHz - 1 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).

(3) Measurement Type(Average): Duty cycle $<$ 98 %, duty cycle variations are less than ± 2 %

- Measured Frequency Range : 30 MHz - 1 GHz
- Detector = RMS
- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW \geq 3 x RBW
- Sweep time = auto.
- Trace mode = average (at least 100 traces).
- Correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had

the test been performed at 100 percent duty cycle.

- Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.

9. Distance extrapolation factor = $20\log(\text{test distance} / \text{specific distance})$ (dB)

10. Total(Measurement Type : Peak)

= Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) – Amp Gain(A.G)

Total(Measurement Type : Average, Duty cycle $\geq 98\%$)

= Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) – Amp Gain(A.G)

Total(Measurement Type : Average, Duty cycle $< 98\%$)

= Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

+ Duty Cycle Factor – Amp Gain(A.G)

7.6. AC Power line Conducted Emissions

Limit

For an intentional radiator 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, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dB μ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56 ^(a)	56 to 46 ^(a)
0.50 to 5	56	46
5 to 30	60	50

^(a)Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.
5. The EUT is the device operating below 30 MHz.
 - For unterminated the Antenna, the AC line conducted tests are performed with the antenna connected
 - For terminated the Antenna, the AC line conducted tests are performed with a dummy load connected to the EUT antenna output terminal.

Sample Calculation

Quasi-peak(Final Result) = Measured Value + Correction Factor

7.7. Receiver Spurious Emissions

Limit

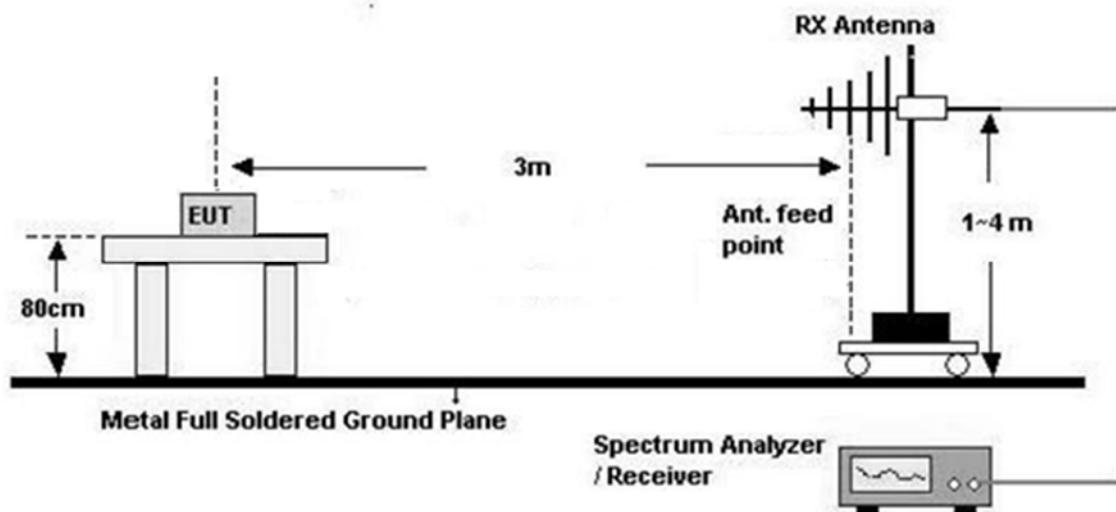
Frequency (MHz)	Field Strength (μ V/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

Measurements for compliance with the limits in table may be performed at distances other than 3 metres.

Test Configuration

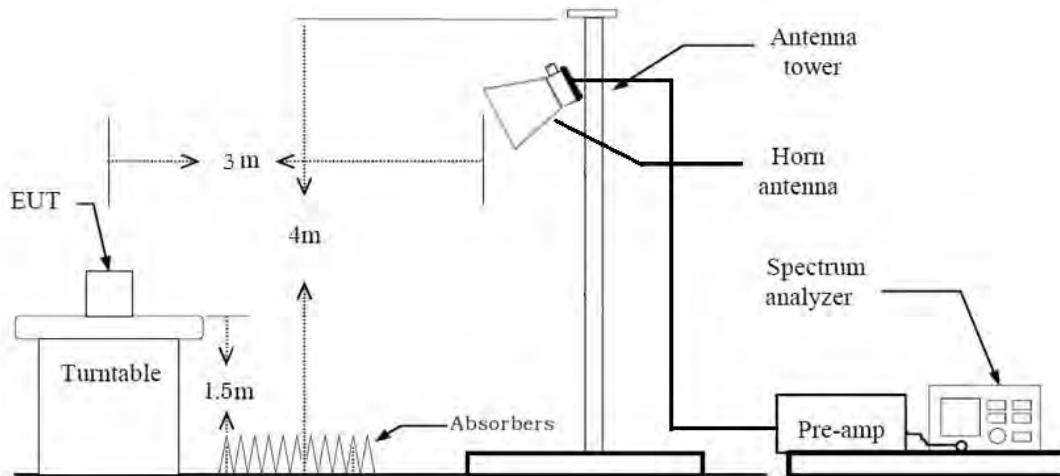
30 MHz - 1 GHz



Test Procedure of Receiver Spurious Emissions (Below 1 GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8 m above ground plane.
3. The Hybrid antenna was placed at a location 3 m from the EUT, which is varied from 1 m to 4 m to find out the highest emissions.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Spectrum Setting
 - (1) Measurement Type(Peak):
 - Measured Frequency Range : 30 MHz – 1 GHz
 - Detector = Peak
 - Trace = Max hold
 - RBW = 100 kHz
 - VBW \geq 3 x RBW
 - (2) Measurement Type(Quasi-peak):
 - Measured Frequency Range : 30 MHz – 1 GHz
 - Detector = Quasi-Peak
 - RBW = 120 kHz
7. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L)

Above 1 GHz



Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Spectrum Setting

(1) Measurement Type(Peak):

- Measured Frequency Range : 1 GHz – 10th Harmonics
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW \geq 3 x RBW

(2) Measurement Type(Average):

- We performed using a reduced video BW method was done with the analyzer in linear mode
- Measured Frequency Range : 1 GHz – 10th Harmonics

- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW $\geq 1/\tau$ Hz, where τ = pulse width in seconds

The actual setting value of VBW = 10 kHz

8. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
9. Total = Measured Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(A.G) + Distance Factor(D.F)

7.8. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.

- Mode : Stand alone

2. EUT Axis

- Radiated Spurious Emissions : Y

- Radiated Restricted Band Edge : Y

3. All data rate of operation were investigated and the worst case data rate results are reported

- 500 kHz (SF 7,8,9,10,11,12)

- Worst case : 500 kHz SF 12

4. All position of loop antenna were investigated and the test result is a no critical peak found at all positions.

- Position : Horizontal, Vertical, Parallel to the ground plane

AC Power line Conducted Emissions

1. All modes of operation were investigated and the worst case configuration results are reported.

Conducted test

1. All data rate of operation were investigated and the worst case data rate results are reported

- 500 kHz (SF 7,8,9,10,11,12)

- Worst case : 500 kHz SF 7, 12

8. SUMMARY TEST OF RESULTS**FCC Part**

Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§ 15.247(a)(2)	> 500 kHz		PASS
Conducted Maximum Output Power	§ 15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§ 15.247(e)	< 8 dBm / 3 kHz Band	Conducted	PASS
Band Edge (Out of Band Emissions)	§ 15.247(d)	Conducted > 30 dBc		PASS
AC Power line Conducted Emissions	§ 15.207	cf. Section 7.7		PASS
Radiated Spurious Emissions	§ 15.247(d), 15.205, 15.209	cf. Section 7.6		PASS
Radiated Restricted Band Edge	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS

ISED Part

Test Description	ISED Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	RSS-247, 5.2	> 500 kHz	Conducted	PASS
99 % Bandwidth	RSS-GEN, 6.7	N/A		PASS
Conducted Maximum Peak Output Power And e.i.r.p.	RSS-247, 5.4.	< 1 Watt <4 Watt(e.i.r.p.)		PASS
Power Spectral Density	RSS-247, 5.2	< 8 dBm / 3 kHz Band		PASS
Band Edge(Out of Band Emissions)	RSS-247, 5.5	Conducted > 30 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	cf. Section 7.7		PASS
Radiated Spurious Emissions	RSS-GEN, 8.9	cf. Section 7.6		PASS
Receiver Spurious Emissions	RSS-GEN, 7	cf. Section 7.8		PASS
Radiated Restricted Band Edge	RSS-GEN, 8.10	cf. Section 7.6		PASS

9. TEST RESULT

9.1 6dB BANDWIDTH

Test Data (LoRa 500k FCC)

LoRa_500k_SF7		Measured Bandwidth	Minimum Bandwidth	99 % Bandwidth
Frequency [MHz]	Channel No.	[MHz]	[MHz]	[MHz]
903.0	Low	626.1	> 0.5	688.26
909.4	Mid	625.5	> 0.5	677.19
914.2	High	615.8	> 0.5	660.52

LoRa_500k_SF12		Measured Bandwidth	Minimum Bandwidth	99 % Bandwidth
Frequency [MHz]	Channel No.	[MHz]	[MHz]	[MHz]
903.0	Low	644.1	> 0.5	696.18
909.4	Mid	644.4	> 0.5	680.78
914.2	High	642.0	> 0.5	673.05

Test Data (LoRa 500k AU)

LoRa_500k_SF7		Measured Bandwidth	Minimum Bandwidth	99 % Bandwidth
Frequency [MHz]	Channel No.	[MHz]	[MHz]	[MHz]
915.9	Low	615.1	> 0.5	659.73
922.3	Mid	615.6	> 0.5	660.51
927.1	High	615.2	> 0.5	660.81

LoRa_500k_SF12		Measured Bandwidth	Minimum Bandwidth	99 % Bandwidth
Frequency [MHz]	Channel No.	[MHz]	[MHz]	[MHz]
915.9	Low	642.4	> 0.5	677.37
922.3	Mid	640.9	> 0.5	670.87
927.1	High	641.1	> 0.5	672.58

□ Test Plots (LoRa 500k FCC)

6 dB Bandwidth plot (SF7- Low)



6 dB Bandwidth plot (SF7- Mid)



6 dB Bandwidth plot (SF7- High)

**Note:**

In order to simplify the report, attached plots were only the most narrow 6 dB BW channel.

□ Test Plots (LoRa 500k AU)

6 dB Bandwidth plot (SF7- Low)



6 dB Bandwidth plot (SF7- Mid)



6 dB Bandwidth plot (SF7- High)

**Note:**

In order to simplify the report, attached plots were only the most narrow 6 dB BW channel.

9.2 OUTPUT POWER

Peak Power

1. Power Meter offset = Attenuator loss(10 dB) + Cable loss(1ea)
2. We apply to the offset in the 900 MHz range that was rounded off to the closest tenth dB.
So, 10.30 dB is offset for 900 MHz Band

Test Data (LoRa 500k FCC)

LoRa_500k_SF7		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
903.0	Low	20.66	30	
909.4	Mid	20.62	30	22
914.2	High	20.58	30	

LoRa_500k_SF12		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
903.0	Low	20.71	30	
909.4	Mid	20.61	30	22
914.2	High	20.58	30	

Test Data (LoRa 500k AU)

LoRa_500k_SF7		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
915.9	Low	20.58	30	
922.3	Mid	20.53	30	22
927.1	High	20.46	30	

LoRa_500k_SF12		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
915.9	Low	20.58	30	
922.3	Mid	20.55	30	22
927.1	High	20.45	30	

Average Power

1. Power Meter offset = Attenuator loss(10 dB) + Cable loss(1ea)
2. We apply to the offset in the 900 MHz range that was rounded off to the closest tenth dB.
So, 10.30 dB is offset for 900 MHz Band

Test Data (LoRa 500k FCC)

LoRa_500k_SF7		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
903.0	Low	20.60	30	22
909.4	Mid	20.56	30	
914.2	High	20.53	30	

LoRa_500k_SF12		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
903.0	Low	20.63	30	22
909.4	Mid	20.58	30	
914.2	High	20.54	30	

Test Data (LoRa 500k AU)

LoRa_500k_SF7		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
915.9	Low	20.49	30	
922.3	Mid	20.44	30	22
927.1	High	20.37	30	

LoRa_500k_SF12		Measured Power(dBm)	Limit (dBm)	Power Level Setting
Frequency[MHz]	Channel No.			
915.9	Low	20.51	30	
922.3	Mid	20.52	30	22
927.1	High	20.38	30	

9.3 POWER SPECTRAL DENSITY

Test Data (LoRa 500k FCC)

Mode	Frequency (MHz)	Channel No.	Test Result	
			PSD (dBm/3 kHz)	Limit (dBm/3 kHz)
SF7	903.0	Low	0.799	8
	909.4	Mid	0.706	
	914.2	High	1.169	
SF12	903.0	Low	2.172	8
	909.4	Mid	1.863	
	914.2	High	1.978	

Test Data (LoRa 500k AU)

Mode	Frequency (MHz)	Channel No.	Test Result	
			PSD (dBm/3 kHz)	Limit (dBm/3 kHz)
SF7	915.9	Low	1.158	8
	922.3	Mid	1.017	
	927.1	High	0.926	
SF12	915.9	Low	2.819	8
	922.3	Mid	1.650	
	927.1	High	2.621	

Note :

1. Spectrum Measured Value are not plot data.

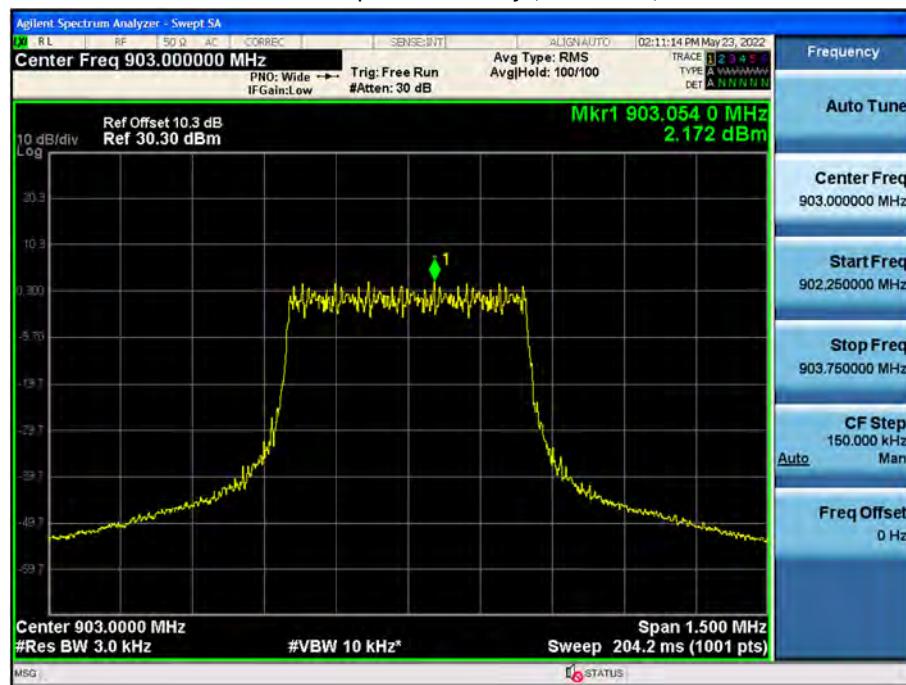
The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.

2. Spectrum offset = Attenuator loss(10 dB) + Cable loss(1ea)

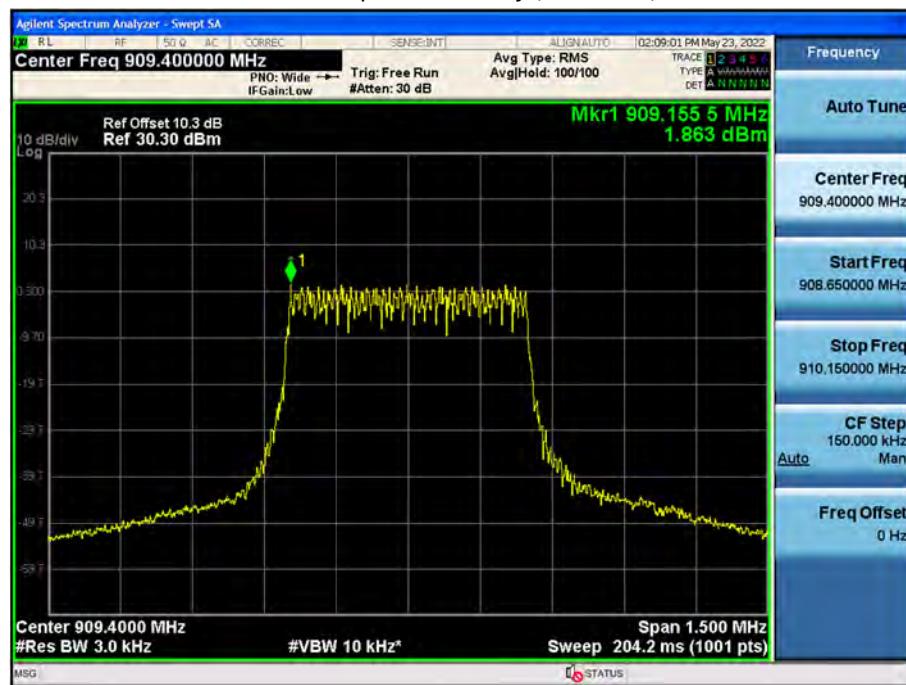
3. 10.30 dB is offset for 900 MHz Band.

□ Test Plots (LoRa 500k FCC)

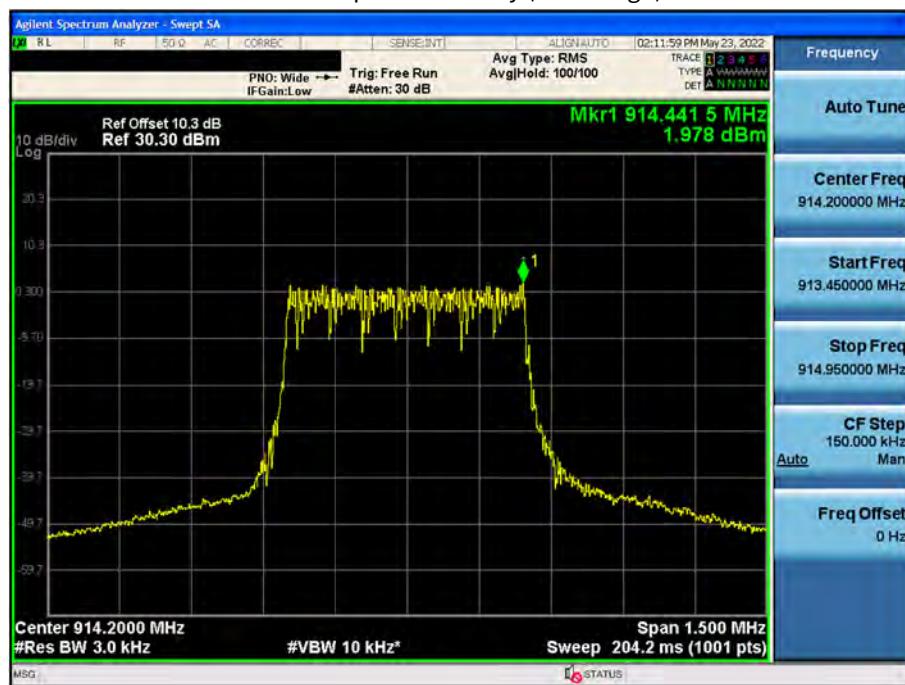
Power Spectral Density (SF12- Low)



Power Spectral Density (SF12- Mid)



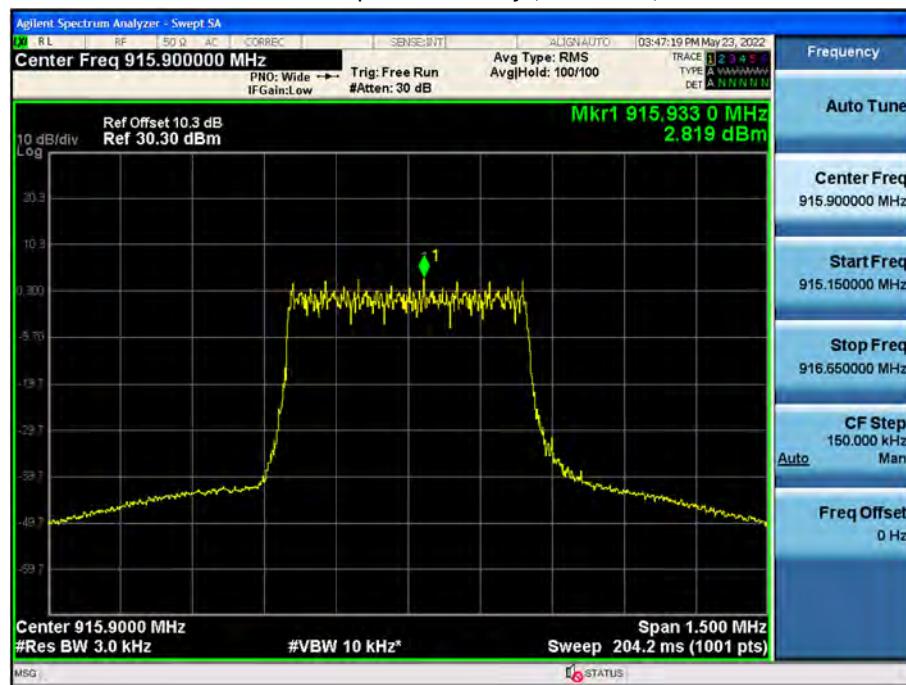
Power Spectral Density (SF12- High)

**Note :**

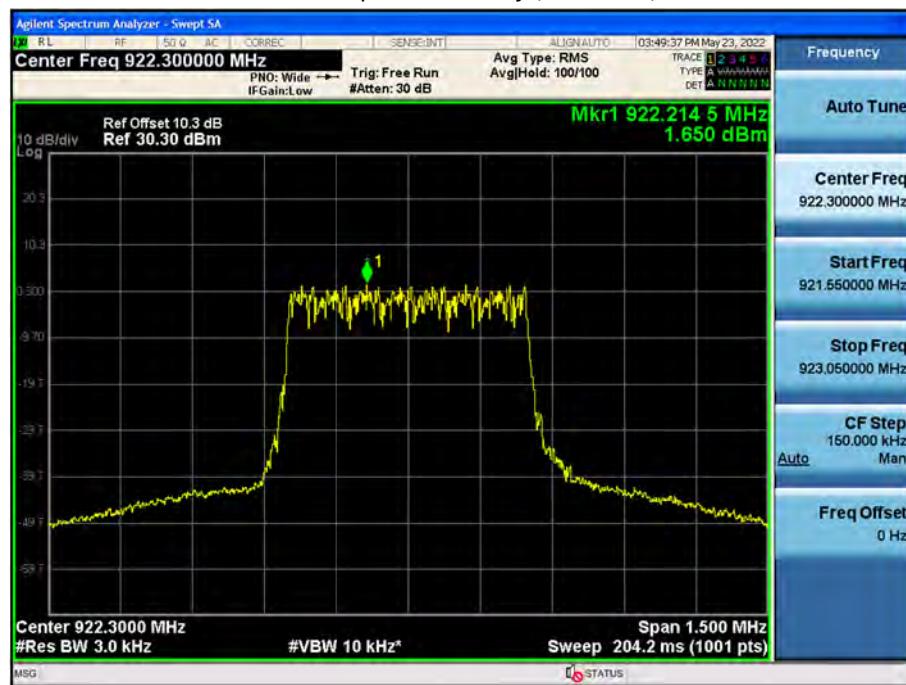
In order to simplify the report, attached plots were only the worst case PSD channel.

□ Test Plots (LoRa 500k AU)

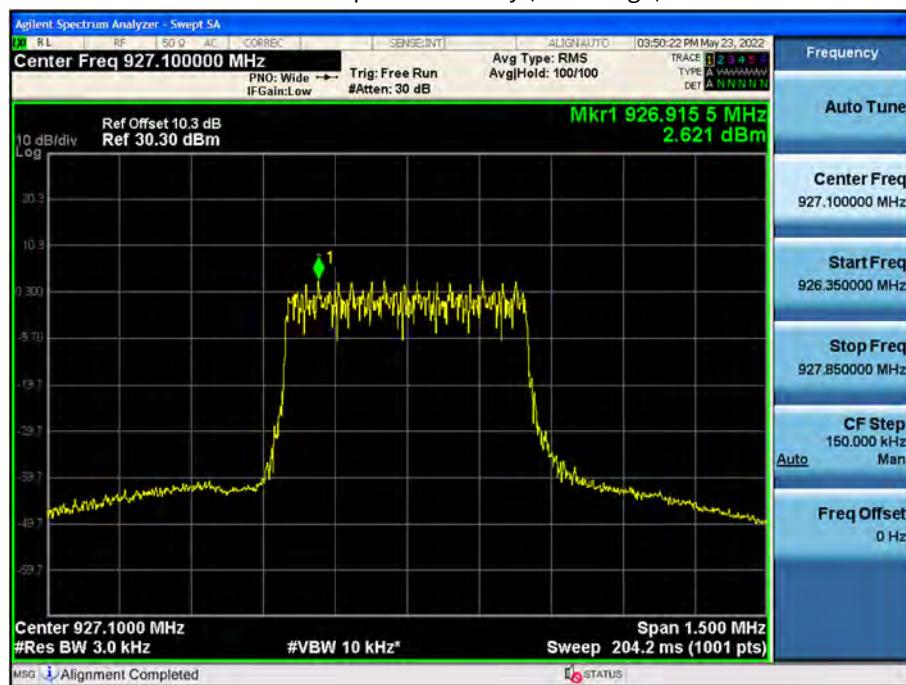
Power Spectral Density (SF12- Low)



Power Spectral Density (SF12- Mid)



Power Spectral Density (SF12- High)

**Note :**

In order to simplify the report, attached plots were only the worst case PSD channel.

9.4 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Result : please refer to the plot below.

In order to simplify the report, attached plots were only the worst case channel and data rate.

□ Test Plots(BandEdge)_LoRa 500k FCC

Band Edge (SF7- Low)



Band Edge (SF7- High)



Band Edge (SF12- Low)



Band Edge (SF12- High)

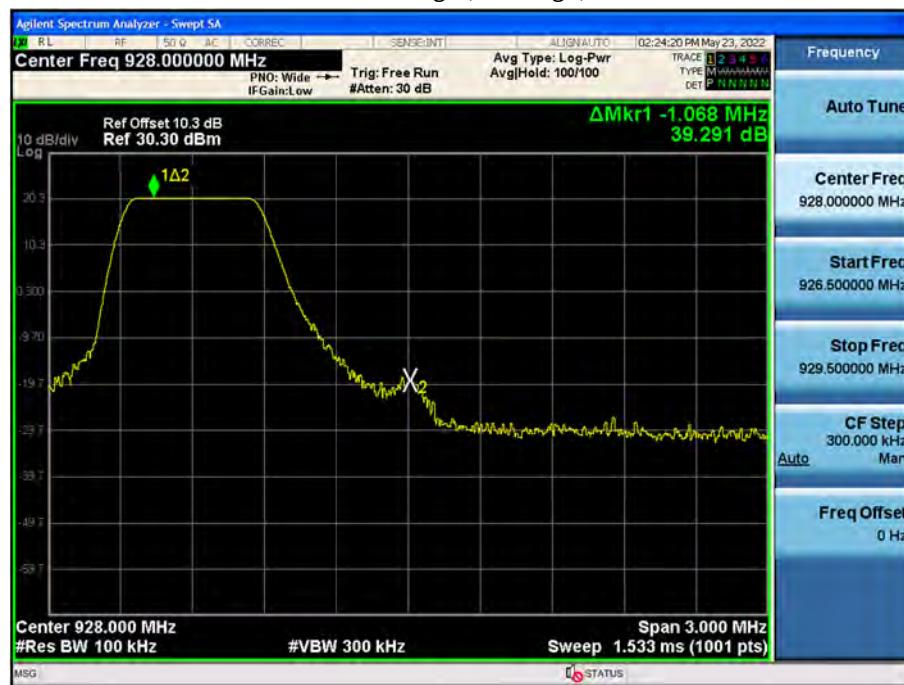


■ Test Plots(BandEdge)_LoRa 500k AU

Band Edge (SF7- Low)



Band Edge (SF7- High)



Band Edge (SF12- Low)

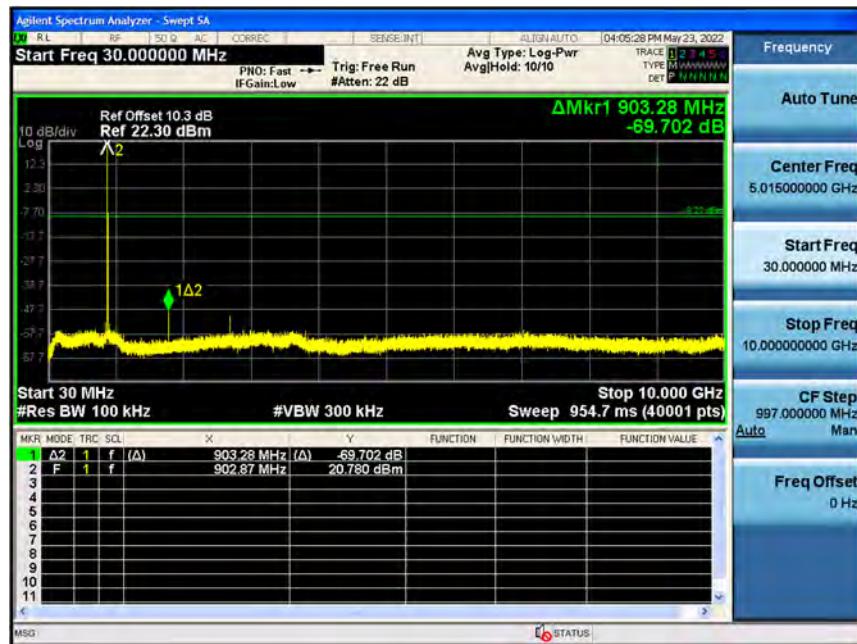


Band Edge (SF12- High)



□ Test Plots(Conducted Spurious Emission) (LoRa 500k FCC)

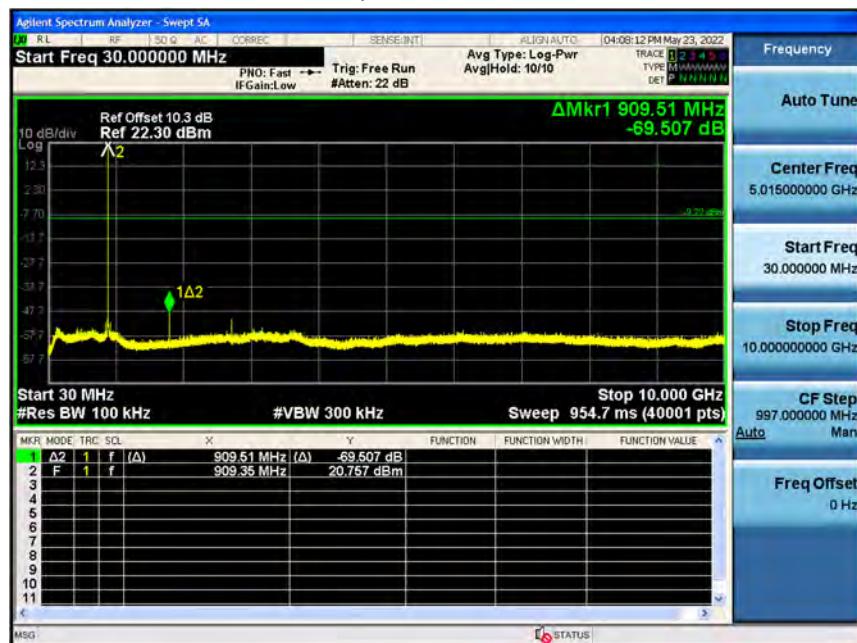
Conducted Spurious Emission (SF7 Low)



Note:

Limit : -9.22 dBm

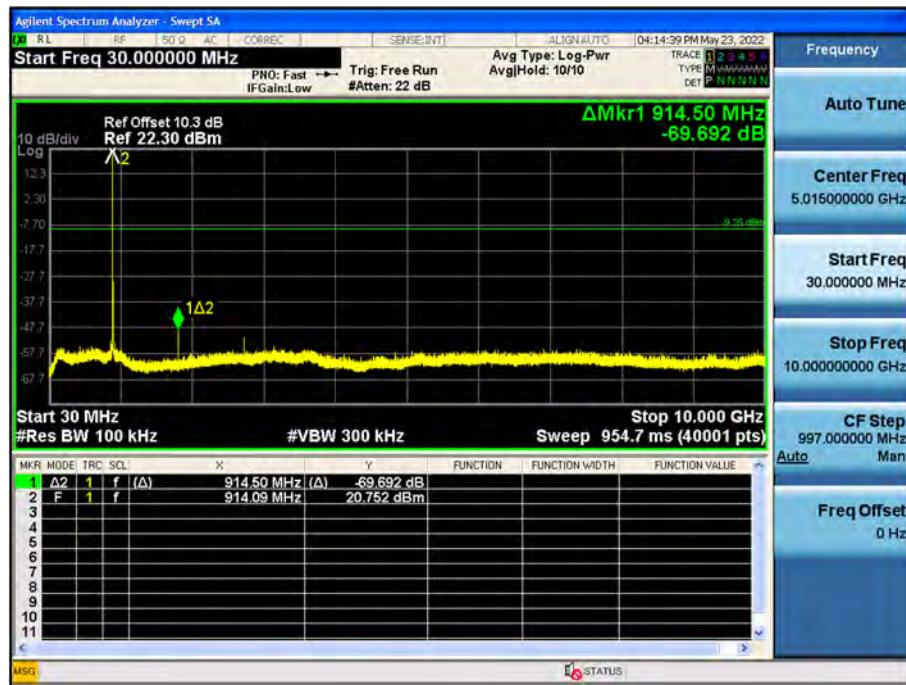
Conducted Spurious Emission (SF7 Mid)



Note:

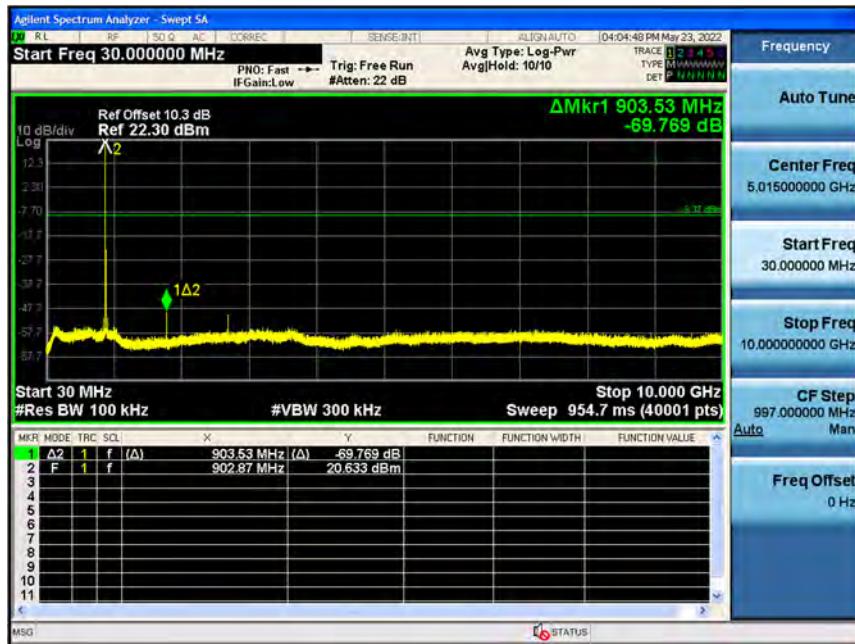
Limit : -9.22 dBm

Conducted Spurious Emission (SF7 High)

Note:

Limit : -9.25 dBm

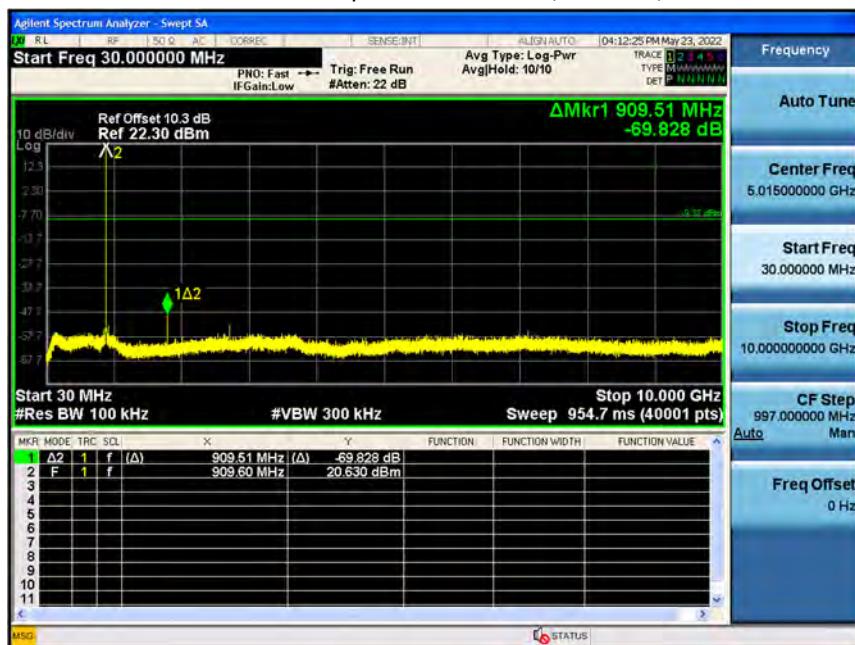
Conducted Spurious Emission (SF12 Low)



Note:

Limit : -9.37 dBm

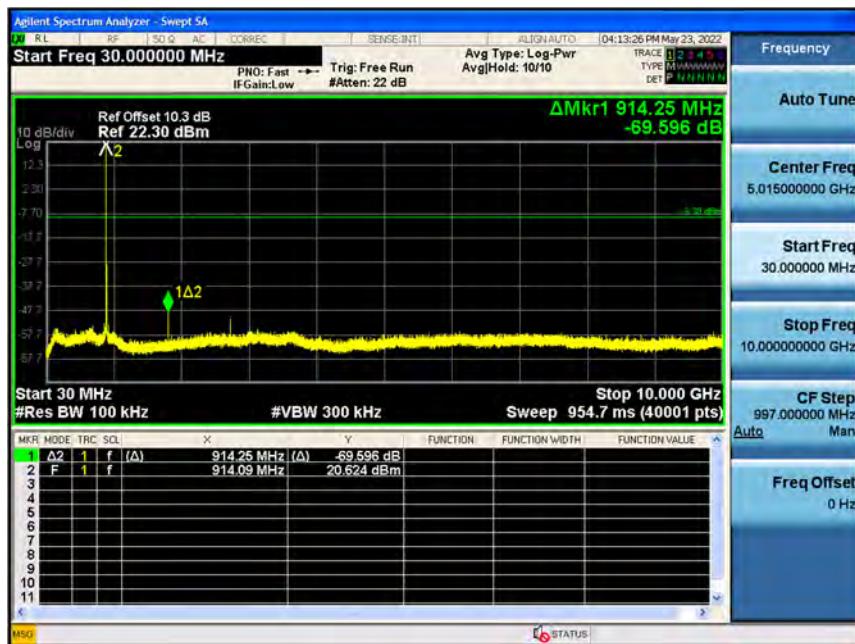
Conducted Spurious Emission (SF12 Mid)



Note:

Limit : -9.37 dBm

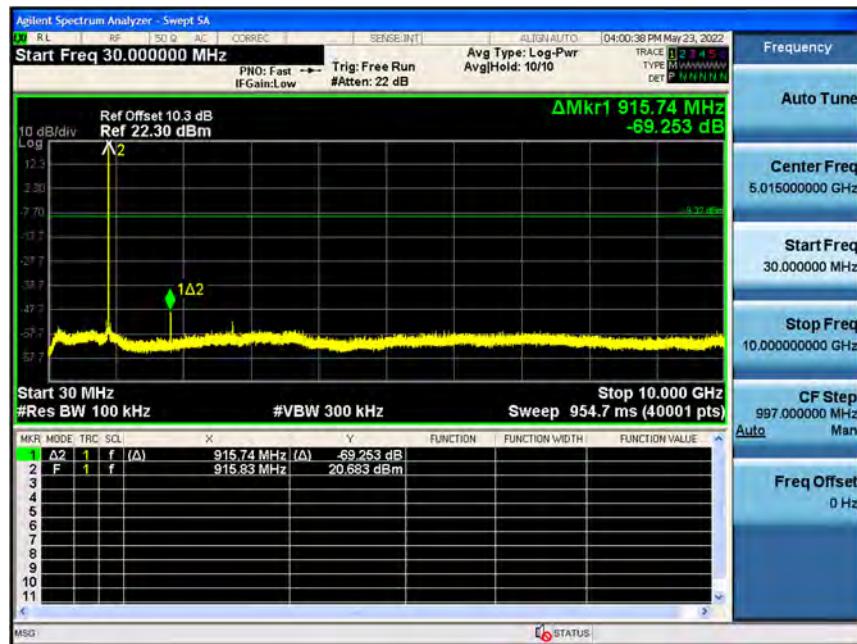
Conducted Spurious Emission (SF12 High)

**Note:**

Limit : -9.38 dBm

□ Test Plots(Conducted Spurious Emission) (LoRa 500k AU)

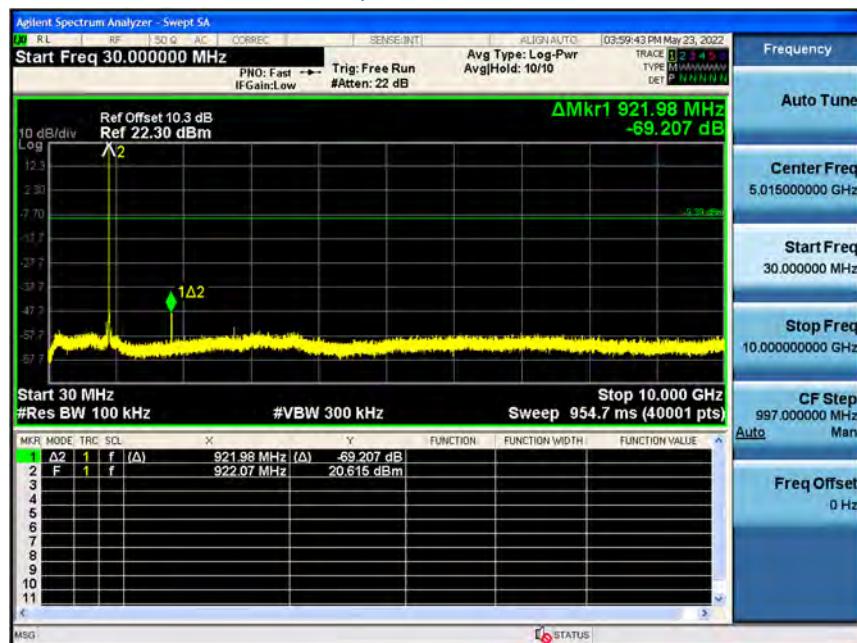
Conducted Spurious Emission (SF7 Low)



Note:

Limit : -9.32 dBm

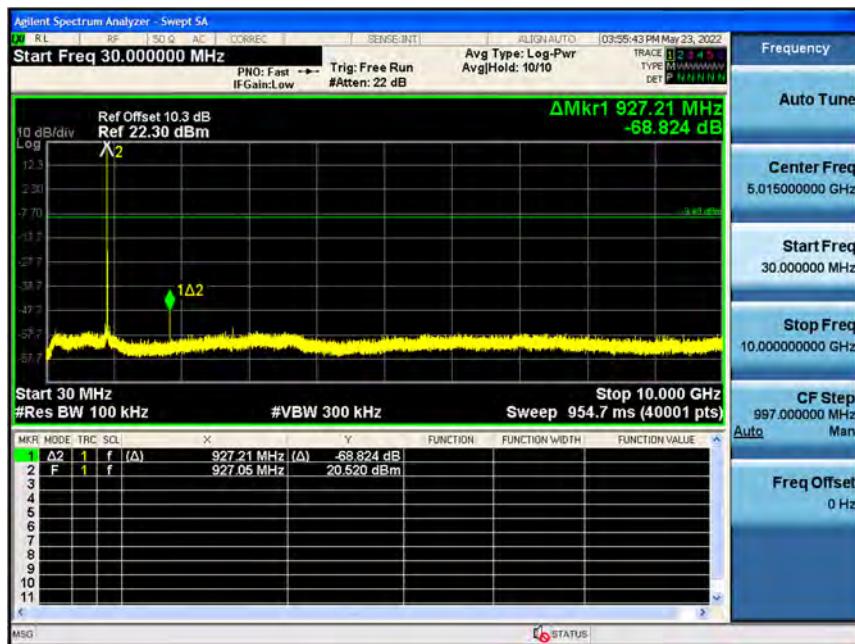
Conducted Spurious Emission (SF7 Mid)



Note:

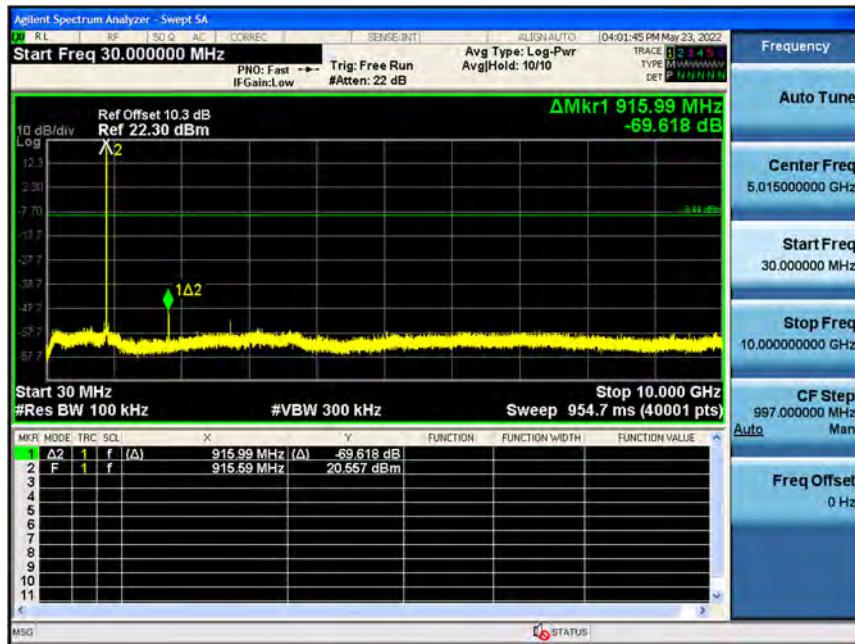
Limit : -9.39 dBm

Conducted Spurious Emission (SF7 High)

**Note:**

Limit : -9.48 dBm

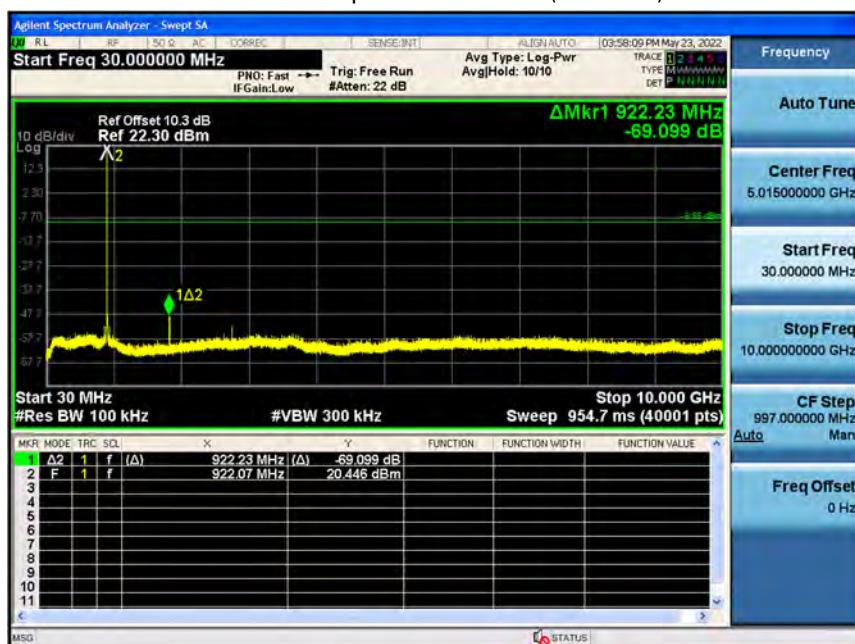
Conducted Spurious Emission (SF12 Low)



Note:

Limit : -9.44 dBm

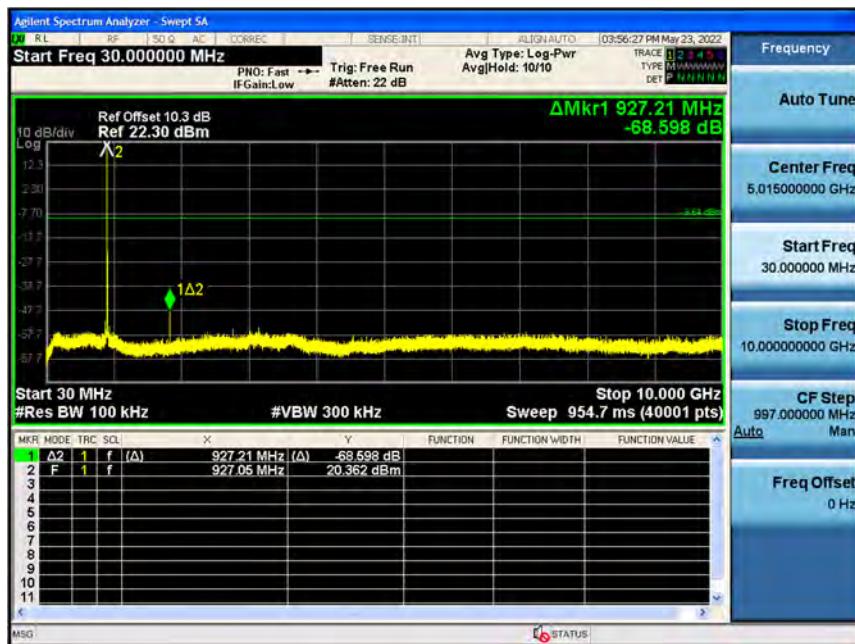
Conducted Spurious Emission (SF12 Mid)



Note:

Limit : -9.55 dBm

Conducted Spurious Emission (SF12 High)

**Note:**

Limit : -9.64 dBm

9.5 RADIATED SPURIOUS EMISSIONS

Frequency Range : 9 kHz – 30 MHz

Frequency	Measured Value	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB μ V/m	dBm/m	dB	(H/V)	dB μ V/m	dB μ V/m	dB
No Critical peaks found							

Note:

1. The Measured Value of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
2. Distance extrapolation factor = $40\log(\text{specific distance} / \text{test distance})$ (dB)
3. Limit line = specific Limits (dB μ V) + Distance extrapolation factor

Frequency Range : Below 1 GHz

Frequency	Measured Value	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB μ V/m	dBm/m	dB	(H/V)	dB μ V/m	dB μ V/m	dB
No Critical peaks found							

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Channel : SF12_Low (LoRa 500k FCC) 903.0 MHz

Frequency	Measured Value	A.F+C.L-A.G+D.F	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB μ V]	[dB]	[H/V]	[dB μ V/m]	[dB μ V/m]	[dB]	
1806.00	65.72	-9.39	V	56.33	Non restricted Band		PK
1806.00	64.30	-9.39	V	54.91	Non restricted Band		AV
<u>2709.00</u>	45.74	-6.00	V	39.74	73.98	34.24	PK
<u>2709.00</u>	39.01	-6.00	V	33.01	53.98	20.97	AV
<u>3612.00</u>	43.82	-3.18	V	40.64	73.98	33.34	PK
<u>3612.00</u>	32.88	-3.18	V	29.70	53.98	24.28	AV
<u>4515.00</u>	42.25	1.15	V	43.40	73.98	30.58	PK
<u>4515.00</u>	30.40	1.15	V	31.55	53.98	22.43	AV
<u>5418.00</u>	40.38	4.51	V	44.89	73.98	29.09	PK
<u>5418.00</u>	29.69	4.51	V	34.20	53.98	19.78	AV
6321.00	37.56	9.46	V	47.02	Non restricted Band		PK
6321.00	26.22	9.46	V	35.68	Non restricted Band		AV
7224.00	37.79	11.54	V	49.33	73.98	24.65	PK
7224.00	26.94	11.54	V	38.48	53.98	15.50	AV
<u>8127.00</u>	38.66	11.45	V	50.11	73.98	23.87	PK
<u>8127.00</u>	27.41	11.45	V	38.86	53.98	15.12	AV
9030.00	38.48	13.72	V	52.20	Non restricted Band		PK
9030.00	26.60	13.72	V	40.32	Non restricted Band		AV

#Note :

1. Non Restricted Band refer to Conducted Spurious emission test result (30dBc)
2. _ : Restricted band

Channel : SF12_Low (LoRa 500k FCC) 903.0 MHz

Frequency	Measured Value	A.F+C.L-A.G+D.F	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB μ V]	[dB]	[H/V]	[dB μ V/m]	[dB μ V/m]	[dB]	
1806.00	65.49	-9.39	H	56.10	Non restricted Band		PK
1806.00	62.54	-9.39	H	53.15	Non restricted Band		AV
2709.00	45.35	-6.00	H	39.35	73.98	34.63	PK
2709.00	38.23	-6.00	H	32.23	53.98	21.75	AV
3612.00	43.66	-3.18	H	40.48	73.98	33.50	PK
3612.00	32.61	-3.18	H	29.43	53.98	24.55	AV
4515.00	41.87	1.15	H	43.02	73.98	30.96	PK
4515.00	30.33	1.15	H	31.48	53.98	22.50	AV
5418.00	40.45	4.51	H	44.96	73.98	29.02	PK
5418.00	29.58	4.51	H	34.09	53.98	19.89	AV
6321.00	37.22	9.46	H	46.68	Non restricted Band		PK
6321.00	26.12	9.46	H	35.58	Non restricted Band		AV
7224.00	38.91	11.54	H	50.45	Non restricted Band		PK
7224.00	26.89	11.54	H	38.43	Non restricted Band		AV
8127.00	38.41	11.45	H	49.86	73.98	24.12	PK
8127.00	27.35	11.45	H	38.80	53.98	15.18	AV
9030.00	38.39	13.72	H	52.11	Non restricted Band		PK
9030.00	26.57	13.72	H	40.29	Non restricted Band		AV

#Note :

1. Non Restricted Band refer to Conducted Spurious emission test result (30dBc)

2. _ : Restricted band

Channel : SF12_High (LoRa 500k AU) 927.1 MHz

Frequency	Measured Value	A.F+C.L-A.G+D.F	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB μ V]	[dB]	[H/V]	[dB μ V/m]	[dB μ V/m]	[dB]	
1854.20	62.91	-8.88	V	54.03	Non restricted Band	PK	
1854.20	61.34	-8.88	V	52.46	Non restricted Band	AV	
<u>2781.30</u>	44.48	-6.19	V	38.29	73.98	35.69	PK
<u>2781.30</u>	36.68	-6.19	V	30.49	53.98	23.49	AV
<u>3708.40</u>	41.69	-2.50	V	39.19	73.98	34.79	PK
<u>3708.40</u>	33.02	-2.50	V	30.52	53.98	23.46	AV
<u>4635.50</u>	41.11	1.61	V	42.72	73.98	31.26	PK
<u>4635.50</u>	29.95	1.61	V	31.56	53.98	22.42	AV
5562.60	38.07	5.77	V	43.84	Non restricted Band	PK	
5562.60	28.80	5.77	V	34.57	Non restricted Band	AV	
6489.70	35.14	10.53	V	45.67	Non restricted Band	PK	
6489.70	25.93	10.53	V	36.46	Non restricted Band	AV	
<u>7416.80</u>	36.63	10.57	V	47.20	73.98	26.78	PK
<u>7416.80</u>	27.14	10.57	V	37.71	53.98	16.27	AV
<u>8343.90</u>	39.55	12.22	V	51.77	73.98	22.21	PK
<u>8343.90</u>	27.34	12.22	V	39.56	53.98	14.42	AV
9271.00	35.57	14.49	V	50.06	Non restricted Band	PK	
9271.00	25.99	14.49	V	40.48	Non restricted Band	AV	

#Note :

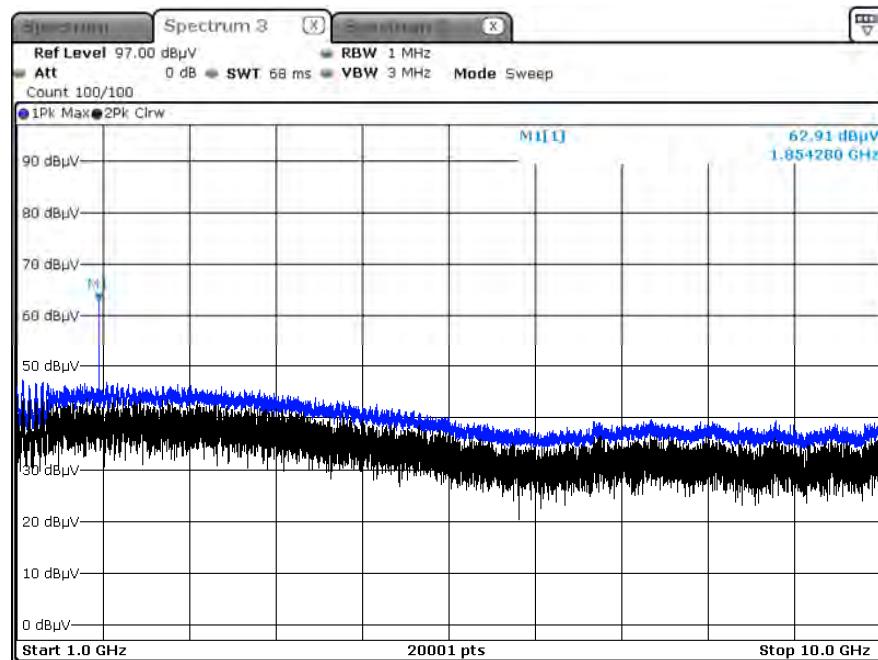
1. Non Restricted Band refer to Conducted Spurious emission test result (30dBc)
2. _ : Restricted band

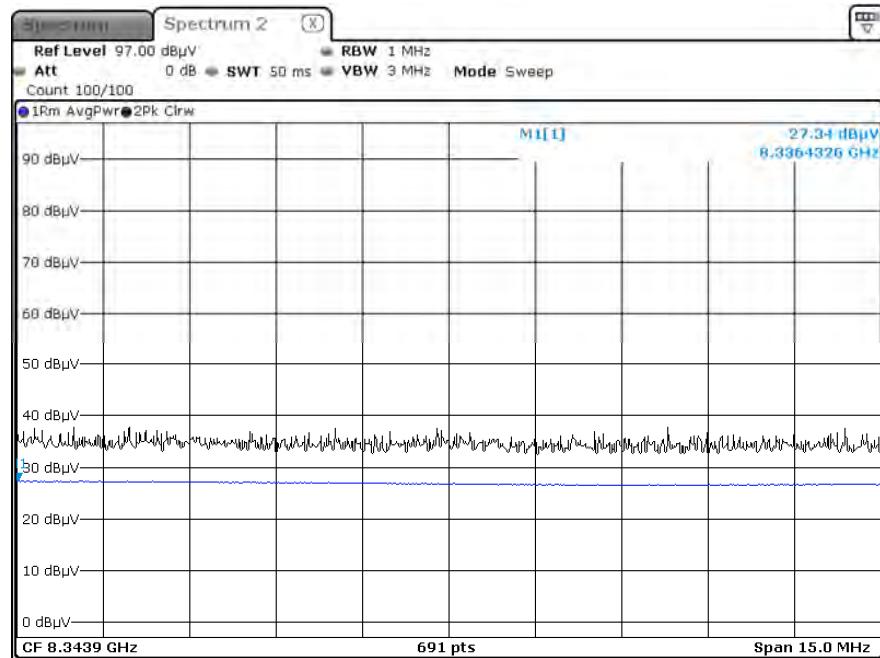
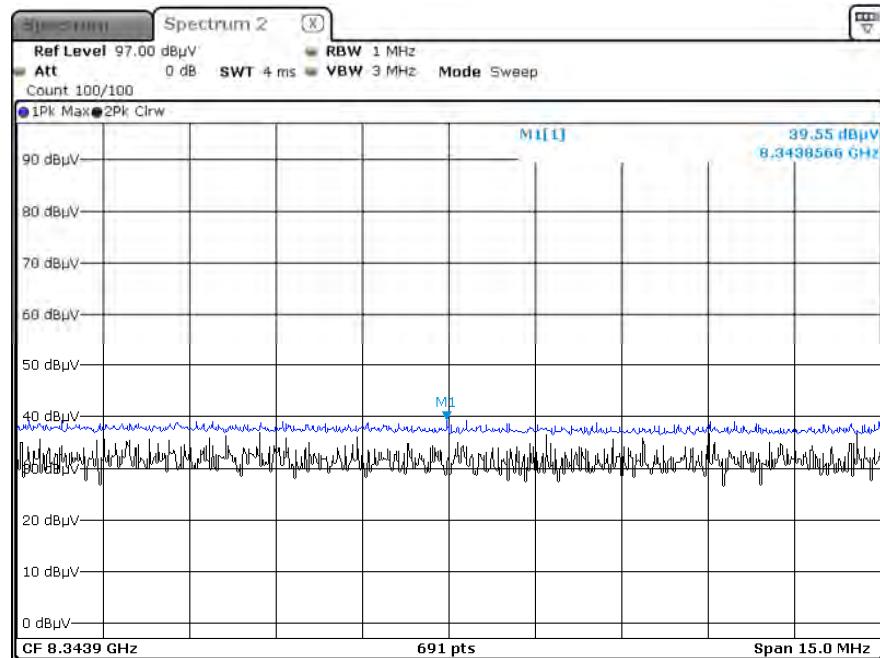
Channel : SF12_High (LoRa 500k AU) 927.1 MHz

Frequency	Measured Value	A.F+C.L-A.G+D.F	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB μ V]	[dB]	[H/V]	[dB μ V/m]	[dB μ V/m]	[dB]	
1854.20	62.23	-8.88	H	53.35	Non restricted Band	PK	
1854.20	60.26	-8.88	H	51.38	Non restricted Band	AV	
<u>2781.30</u>	42.78	-6.19	H	36.59	73.98	37.39	PK
<u>2781.30</u>	36.54	-6.19	H	30.35	53.98	23.63	AV
<u>3708.40</u>	41.99	-2.50	H	39.49	73.98	34.49	PK
<u>3708.40</u>	33.09	-2.50	H	30.59	53.98	23.39	AV
<u>4635.50</u>	40.73	1.61	H	42.34	73.98	31.64	PK
<u>4635.50</u>	29.92	1.61	H	31.53	53.98	22.45	AV
5562.60	37.89	5.77	H	43.66	Non restricted Band	PK	
5562.60	28.75	5.77	H	34.52	Non restricted Band	AV	
6489.70	34.91	10.53	H	45.44	Non restricted Band	PK	
6489.70	25.88	10.53	H	36.41	Non restricted Band	AV	
<u>7416.80</u>	36.18	10.57	H	46.75	73.98	27.23	PK
<u>7416.80</u>	27.11	10.57	H	37.68	53.98	16.30	AV
<u>8343.90</u>	35.69	12.22	H	47.91	73.98	26.07	PK
<u>8343.90</u>	26.77	12.22	H	38.99	53.98	14.99	AV
9271.00	34.94	14.49	H	49.43	Non restricted Band	PK	
9271.00	25.92	14.49	H	40.41	Non restricted Band	AV	

#Note :

1. Non Restricted Band refer to Conducted Spurious emission test result (30dBc)
2. _ : Restricted band

■ Test Plots**Radiated Spurious Emissions plot –****[927.1 MHz 500k SF12]LoRa 1 GHz~10 GHz pk(No Peak)**

Radiated Spurious Emissions plot – Average Result (SF12 9th Harmonic)Radiated Spurious Emissions plot – Peak Result (SF12 9th Harmonic)**Note:**

Plot of worst case are only reported.

9.6 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

Frequency	Measured Value	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB μ V/m	dBm/m	dB	(H/V)	dB μ V/m	dB μ V/m	dB

No Critical peaks found

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Frequency	Measured Value	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dB μ V/m	dBm/m	dB	(H/V)	dB μ V/m	dB μ V/m	dB

No Critical peaks found

9.7 POWERLINE CONDUCTED EMISSIONS

Conducted Emissions (Line 1)

Test

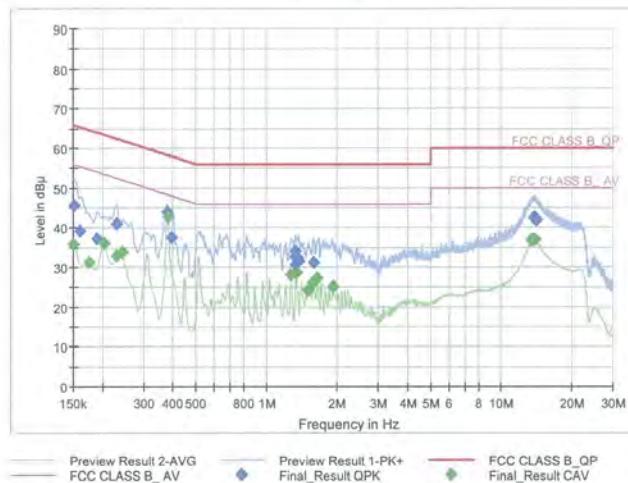
1 / 2

Test Report

Common Information

EUT : LSM110A
Manufacturer : SEONG JI
Test Site: SHIELD ROOM
Operating Conditions : LoRa L1

Full Spectrum



Final_Result QPK

Frequency (MHz)	QuasiPeak (dB μ V)	Limit (dB μ V)	Margin (dB)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.1523	45.61	65.88	20.27	9.000	L1	OFF	9.6
0.1613	39.33	65.40	26.07	9.000	L1	OFF	9.6
0.1905	37.23	64.02	26.79	9.000	L1	OFF	9.6
0.2310	40.95	62.41	21.46	9.000	L1	OFF	9.6
0.3773	43.92	58.34	14.42	9.000	L1	OFF	9.6
0.3930	37.42	58.00	20.58	9.000	L1	OFF	9.6
1.3235	30.61	56.00	25.39	9.000	L1	OFF	9.6
1.3303	32.63	56.00	23.37	9.000	L1	OFF	9.6
1.3370	33.99	56.00	22.01	9.000	L1	OFF	9.6
1.3595	32.20	56.00	23.80	9.000	L1	OFF	9.6
1.3708	31.46	56.00	24.54	9.000	L1	OFF	9.6
1.5980	31.11	56.00	24.89	9.000	L1	OFF	9.6
13.7953	42.34	60.00	17.66	9.000	L1	OFF	9.8
13.8493	42.47	60.00	17.53	9.000	L1	OFF	9.8
13.8583	42.51	60.00	17.49	9.000	L1	OFF	9.8
13.8718	42.50	60.00	17.50	9.000	L1	OFF	9.8
13.9348	42.42	60.00	17.58	9.000	L1	OFF	9.8
14.1710	41.96	60.00	18.04	9.000	L1	OFF	9.8

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Test

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Final_Result_CAV

Frequency (MHz)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.1500	35.75	56.00	20.25	9.000	L1	OFF	9.6
0.1748	31.28	54.73	23.45	9.000	L1	OFF	9.6
0.2040	35.98	53.45	17.47	9.000	L1	OFF	9.6
0.2288	32.99	52.50	19.50	9.000	L1	OFF	9.6
0.2423	33.85	52.02	18.17	9.000	L1	OFF	9.6
0.3795	42.58	48.29	5.72	9.000	L1	OFF	9.6
1.2718	27.96	46.00	18.04	9.000	L1	OFF	9.6
1.3393	28.65	46.00	17.35	9.000	L1	OFF	9.6
1.5125	24.25	46.00	21.75	9.000	L1	OFF	9.6
1.5823	25.97	46.00	20.03	9.000	L1	OFF	9.6
1.6475	27.08	46.00	18.92	9.000	L1	OFF	9.6
1.9198	25.01	46.00	20.99	9.000	L1	OFF	9.6
13.4893	36.58	50.00	13.42	9.000	L1	OFF	9.8
13.5545	36.82	50.00	13.18	9.000	L1	OFF	9.8
13.6445	36.92	50.00	13.08	9.000	L1	OFF	9.8
13.9325	37.05	50.00	12.95	9.000	L1	OFF	9.8
13.9618	36.96	50.00	13.04	9.000	L1	OFF	9.8
13.9685	36.94	50.00	13.06	9.000	L1	OFF	9.8

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Conducted Emissions (Line 2)

Test

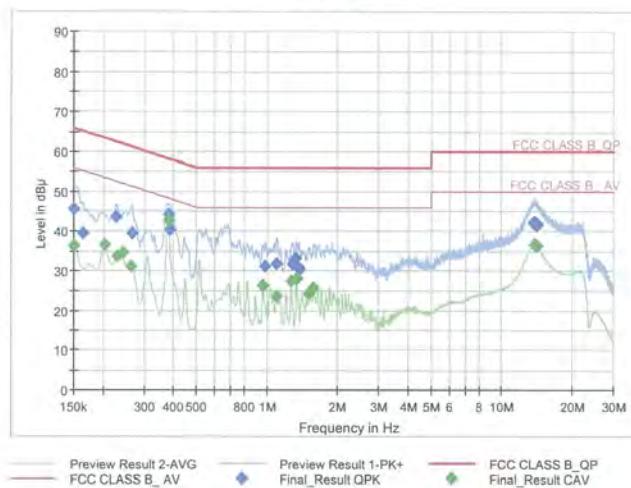
1 / 2

Test Report

Common Information

EUT : LSM110A
 Manufacturer : SEOONG JI
 Test Site: SHIELD ROOM
 Operating Conditions : LoRa N

Full Spectrum



Final_Result QPK

Frequency (MHz)	QuasiPeak (dB μ V)	Limit (dB μ V)	Margin (dB)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.1500	45.52	66.00	20.48	9.000	N	OFF	9.6
0.1635	39.61	65.28	25.67	9.000	N	OFF	9.6
0.2265	43.45	62.58	19.13	9.000	N	OFF	9.6
0.2648	39.62	61.28	21.66	9.000	N	OFF	9.6
0.3795	44.24	58.29	14.05	9.000	N	OFF	9.6
0.3863	40.35	58.14	17.79	9.000	N	OFF	9.6
0.9860	31.22	56.00	24.78	9.000	N	OFF	9.6
1.0963	31.74	56.00	24.26	9.000	N	OFF	9.6
1.2898	31.78	56.00	24.22	9.000	N	OFF	9.6
1.3348	33.16	56.00	22.84	9.000	N	OFF	9.6
1.3595	30.78	56.00	25.22	9.000	N	OFF	9.6
1.3708	30.34	56.00	25.66	9.000	N	OFF	9.6
13.6715	42.09	60.00	17.91	9.000	N	OFF	9.8
13.6760	42.04	60.00	17.96	9.000	N	OFF	9.8
13.7908	42.22	60.00	17.78	9.000	N	OFF	9.8
13.9685	42.01	60.00	17.99	9.000	N	OFF	9.8
14.1328	41.76	60.00	18.24	9.000	N	OFF	9.8
14.1710	41.66	60.00	18.34	9.000	N	OFF	9.8

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Test

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Final Result_CAV

Frequency (MHz)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.1500	36.26	56.00	19.74	9.000	N	OFF	9.6
0.2040	36.61	53.45	16.84	9.000	N	OFF	9.6
0.2288	33.61	52.50	18.88	9.000	N	OFF	9.6
0.2423	34.47	52.02	17.55	9.000	N	OFF	9.6
0.2625	31.03	51.35	20.33	9.000	N	OFF	9.6
0.3795	42.71	48.29	5.58	9.000	N	OFF	9.6
0.9613	26.17	46.00	19.83	9.000	N	OFF	9.6
1.0963	23.62	46.00	22.38	9.000	N	OFF	9.6
1.2695	27.50	46.00	18.50	9.000	N	OFF	9.6
1.3393	27.96	46.00	18.04	9.000	N	OFF	9.6
1.5103	24.13	46.00	21.87	9.000	N	OFF	9.6
1.5800	25.82	46.00	20.18	9.000	N	OFF	9.6
13.7750	36.71	50.00	13.29	9.000	N	OFF	9.8
13.7908	36.75	50.00	13.25	9.000	N	OFF	9.8
13.8853	36.70	50.00	13.30	9.000	N	OFF	9.8
13.9730	36.65	50.00	13.35	9.000	N	OFF	9.8
13.9955	36.63	50.00	13.37	9.000	N	OFF	9.8
14.1688	36.33	50.00	13.67	9.000	N	OFF	9.8

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10. LIST OF TEST EQUIPMENT

Conducted Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	08/23/2022	Annual
EMI Test Receiver	ESR	Rohde & Schwarz	101910	06/17/2022	Annual
Temperature Chamber	SU-642	ESPAC	0093008124	03/04/2023	Annual
Signal Analyzer	N9030A	Agilent	MY49431210	01/11/2023	Annual
Power Measurement Set	OSP 120	Rohde & Schwarz	101231	07/02/2022	Annual
Power Meter	N1911A	Agilent	MY45100523	03/24/2023	Annual
Power Sensor	N1921A	Keysight	MY57820067	03/24/2023	Annual
Directional Coupler	87300B	Agilent	3116A03621	11/02/2022	Annual
Power Splitter	11667B	Hewlett Packard	05001	05/18/2023	Annual
DC Power Supply	E3632A	Hewlett Packard	KR75306225	01/03/2023	Annual
Attenuator(10 dB)	8493C	Hewlett Packard	07560	06/18/2022	Annual
Software	EMC32	Rohde & Schwarz	N/A	N/A	N/A
FCC WLAN&BT&BLE Conducted Test Software v3.0	N/A	HCT CO., LTD.	N/A	N/A	N/A

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

Radiated Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
Controller(Antenna mast)	CO3000	Innco system	CO3000-4p	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco system	N/A	N/A	N/A
Controller	EM1000	Audix	060520	N/A	N/A
Turn Table	N/A	Audix	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-333	03/17/2024	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	760	02/22/2023	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	02299	03/24/2024	Biennial
Horn Antenna (15 GHz ~ 40 GHz)	BBHA9170	Schwarzbeck	BBHA9170541	11/16/2023	Biennial
Spectrum Analyzer	FSV40-N	Rohde & Schwarz	102168	07/05/2022	Annual
Signal Analyzer	N9030A	Agilent	MY49431210	01/11/2023	Annual
High Pass Filter	WHK1.2/15G-10EF	Wainwright Instruments	2	07/27/2022	Annual
Attenuator (3 dB)	18B-03	Api tech.	1	01/21/2023	Annual
Attenuator(10 dB)	8493C-10	Agilent	08285	01/21/2023	Annual
Power Amplifier	CBLU1183540	CERNEX	22964	01/21/2023	Annual
Power Amplifier	CBL06185030	CERNEX	22965	01/21/2023	Annual
Power Amplifier	CBL18265035	CERNEX	22966	12/02/2022	Annual
Power Amplifier	CBL26405040	CERNEX	25956	03/11/2023	Annual

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.
3. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5(Version : 2017)

11. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2205-FI001-P