



# TEST REPORT

FCC/ISED LoRa Test for LORU  
Certification

**APPLICANT**  
Mueller Systems, LLC

**REPORT NO.**  
HCT-RF-2312-FI010

**DATE OF ISSUE**  
December 27, 2023

**Tested by**  
Kyung Jun Woo



**Technical Manager**  
Jong Seok Lee

Accredited by KOLAS, Republic of KOREA

**HCT CO., LTD.**

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Additional Model  
-

**Applicant** **Mueller Systems, LLC**  
1200 Abernathy Road, NE, Suite 1200. Atlanta, GA, USA, 30328

**Eut Type** Water Meter Universal Node (LoRa)  
**Model Name** LORU

**FCC ID** SM6-LORU  
**IC** 9235A-LORU

**Average Output Power** 26.65 dBm

**FCC Classification** Digital Transmission System(DTS)

**FCC Rule Part(s)** Part 15.247

**ISED Rule Part(s)** RSS-247 Issue 3 (August 2023)  
RSS-Gen Issue 5\_Amendment 2 (February 2021)

**Test Location**  Permanent Testing Lab  
(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si,  
Gyeonggi-do, Republic of Korea)  
 On Site Testing

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.

This laboratory is not accredited for the test results marked \*.

## REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	December 27, 2023	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

### Test Report Statement:

#### KOLAS Statement:

The above Test Report is the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA. (KOLAS Accreditation No. KT197)

If this report is required to confirmation of authenticity, please contact to [www.hct.co.kr](http://www.hct.co.kr)

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## 1. EUT DESCRIPTION

Model	LORU
Additional Model	-
EUT Type	Water Meter Universal Node (LoRa)
Power Supply	DC 3.60 V
Frequency Range	902.0 MHz – 928 MHz (TX 500 kHz : 903.0 ~ 914.2) (RX 500 kHz : 923.3 ~ 927.5)
Max. RF Output Power	Peak Power: 27.16 dBm
	Average Power: 26.65 dBm
Modulation Type	CSS
Number of Channels	9 Channels uplink 8 Channels downlink
Antenna Specification	Antenna type: PCB Antenna Peak Gain : 0.95 dBi
Date(s) of Tests	December 08, 2023 ~ December 27, 2023
PMN (Product Marketing Number)	Water Meter Universal Node (LoRa)
HVIN (Hardware Version Identification Number)	LORU
FVIN (Firmware Version Identification Number)	1.0
HMN (Host Marketing Name)	N/A
EUT serial numbers	Radiated : C7D912E5 Conducted : 180A58FC

## 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 3.

### 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 1.5 m 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's, 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 March 31, 2022 (CAB identifier: KR0032).

For ISED, test facility was accepted dated April 06, 2022 (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

### According to RSS-GEN(Issue 5) Section 6.8:

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.



## 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.

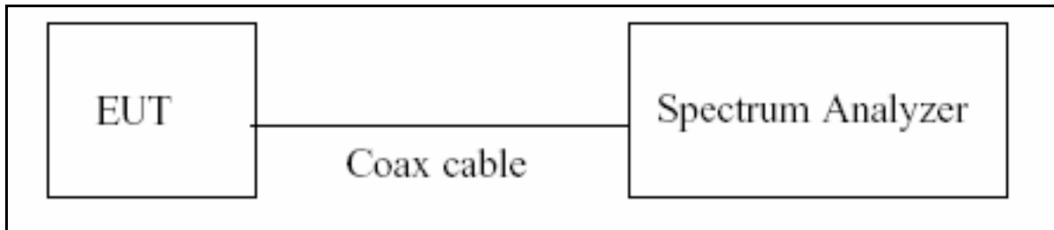
The measurement data shown herein meets or exceeds the  $U_{CISPR}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.90 ( Confidence level about 95 %, $k=2$ )
Radiated Disturbance (9 kHz ~ 30 MHz)	4.14 ( Confidence level about 95 %, $k=2$ )
Radiated Disturbance (30 MHz ~ 1 GHz)	5.82 ( Confidence level about 95 %, $k=2$ )
Radiated Disturbance (1 GHz ~ 18 GHz)	5.74 ( Confidence level about 95 %, $k=2$ )
Radiated Disturbance (18 GHz ~ 40 GHz)	5.76 ( Confidence level about 95 %, $k=2$ )
Radiated Disturbance (Above 40 GHz)	5.52 ( Confidence level about 95 %, $k=2$ )

## 7. DESCRIPTION OF TESTS

### 7.1. Duty Cycle

#### Test Configuration



#### Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v05r02.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if  $T \leq 6.25$  microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are  $> 6.25$  microseconds and both RBW and VBW are  $> 50/T$ .

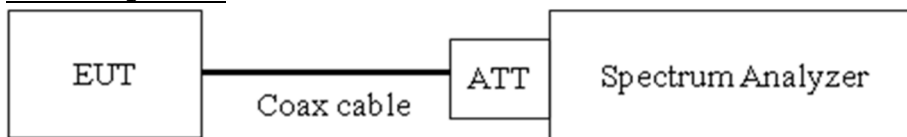
1. Set the center frequency of the instrument to the center frequency of the transmission.
2. RBW = 1 MHz (Set RBW  $\geq$  OBW if possible; otherwise, set RBW to the largest available value.)
3. VBW = 3 MHz ( $\geq$  RBW)
4. SPAN = 0 Hz
5. Detector = Peak
6. Number of points in sweep  $> 100$
7. Trace mode = Clear write
8. Measure  $T_{total}$  and  $T_{on}$
9. Calculate Duty Cycle =  $T_{on} / T_{total}$  and Duty Cycle Factor =  $10\log(1/\text{Duty Cycle})$

## 7.2. 6 dB Bandwidth & 99 % Bandwidth(ISED)

### 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 x 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  $\cong$  3 x RBW

Detector = Peak

Trace mode = Max hold

Sweep = auto couple

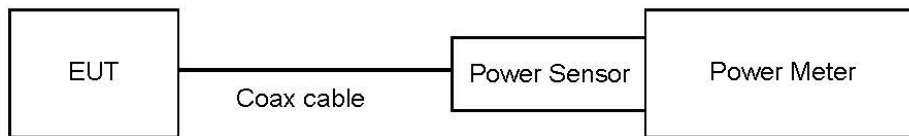
Allow the trace to stabilize

### 7.3. 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

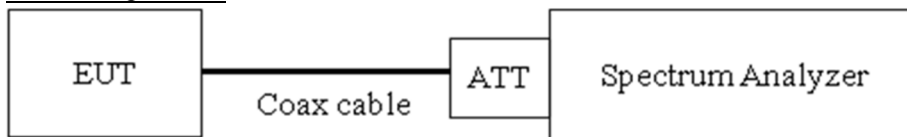
- Conducted Output Power(Peak) = Measured Value + ATT loss + Cable loss
- Conducted Output Power(Average) = Measured Value + ATT loss + Cable loss + Duty Cycle Factor

## 7.4. 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)  $RBW = 3 \text{ kHz} \leq RBW \leq 100 \text{ kHz}$ .
- 4)  $VBW \geq 3 \times RBW$ .
- 5) Sweep = auto couple
- 6) Detector = power averaging (rms) or sample detector (when rms not available).
- 7) Ensure that the number of measurement points in the sweep  $\geq [2 \times \text{span} / RBW]$ .
- 8) Employ trace averaging (rms) mode over a minimum of 100 traces
- 9) Use the peak marker function to determine the maximum amplitude level.
- 10) Use the peak marker function to determine the maximum amplitude level within the RBW.  
If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
- 11) if then duty factor shall be added to adjust the result if the duty cycle is less than 98 %

### Sample Calculation

- Power Spectral Density = Measured Value + ATT loss + Cable loss + Duty Cycle Factor

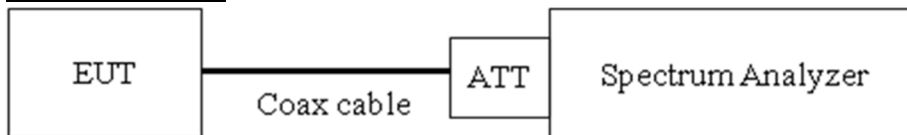
## 7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

### 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	20.10
100	20.15
200	20.19
300	20.24
400	20.30
500	20.30
600	20.31
700	20.32
800	20.33
900	20.35
902	20.35
928	20.35
1 000	20.40
2 000	20.65
2 400	20.74
2 500	20.74
3 000	20.89
4 000	21.13
5 000	21.65
5 700	21.74
5 800	21.74
6 000	21.83
7 000	21.96
8 000	21.96
9 000	22.04
10 000	22.14
11 000	22.23
12 000	22.32
13 000	22.33
14 000	22.36
15 000	22.46
16 000	22.54
17 000	22.75
18 000	22.88
19 000	22.80
20 000	22.47
21 000	22.60
22 000	22.59
23 000	22.60
24 000	22.61
25 000	22.71

Note :

1. 902 ~ 928 MHz is fundamental frequency range.
2. Factor = Cable loss + Attenuator

## 7.6. Radiated Test

### Limit

#### FCC

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	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 ( $\mu\text{A}/\text{m}$ )	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

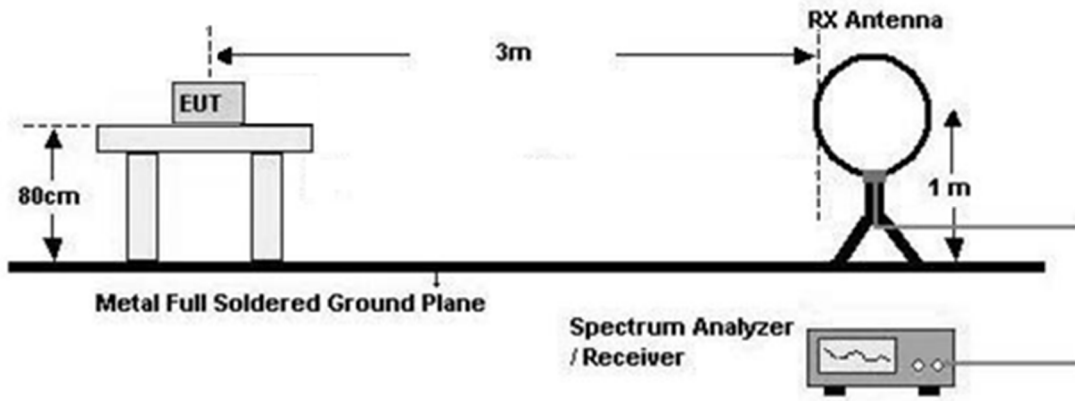
#### FCC&ISED

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

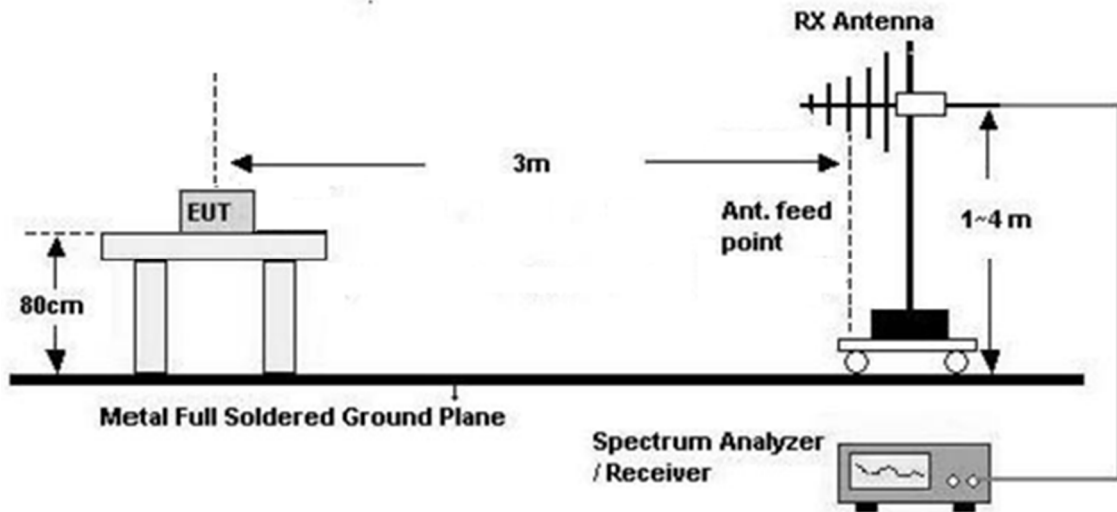


**Test Configuration**

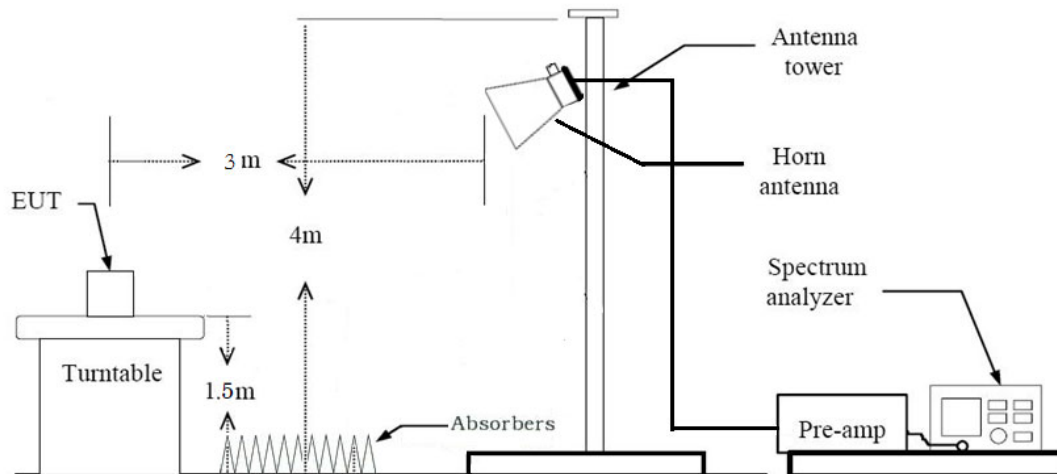
Below 30 MHz



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 MHz – 0.490 MHz) =  $40\log(3\text{ m}/300\text{ m}) = -80\text{ dB}$   
Measurement Distance : 3 m
7. Distance Correction Factor(0.490 MHz – 30 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  $\geq 3 \times$  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 – 10<sup>th</sup> 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 – 10<sup>th</sup> 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  $\pm 2$  %

- Measured Frequency Range : 1 GHz – 10<sup>th</sup> 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 =  $20\log$  (test distance / specific distance) (dB)

10. Total(Measurement Type : Peak)

= Peak Measured Value

Total(Measurement Type : Average)

= Average Measured Value + Duty Cycle Factor

- We apply to the offset in range 1 GHz - 18 GHz

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

## 7.7. 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  $\mu$ H/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dB $\mu$ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56 <sup>(a)</sup>	56 to 46 <sup>(a)</sup>
0.50 to 5	56	46
5 to 30	60	50

<sup>(a)</sup>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

### 7.8. Receiver Spurious Emissions

**Limit**

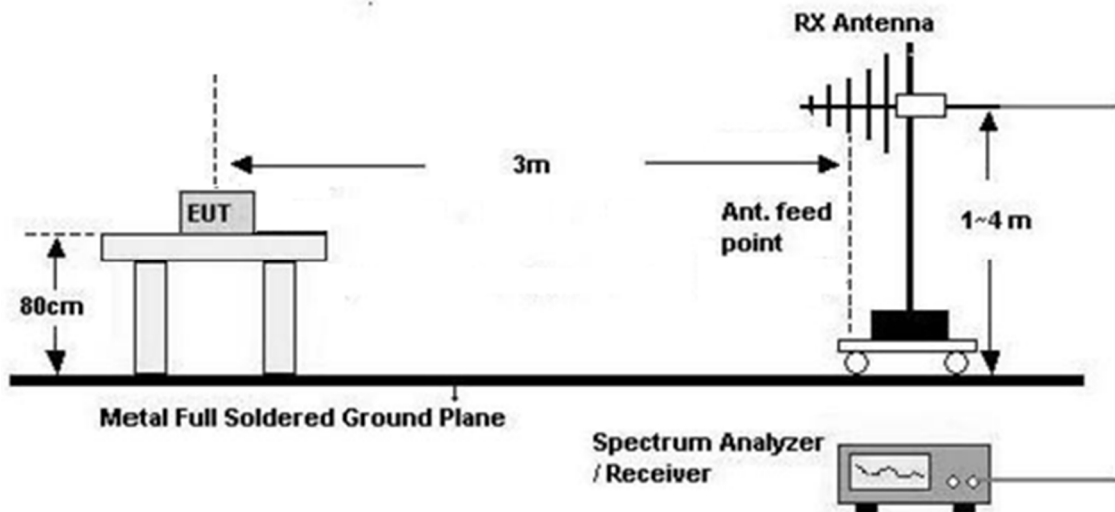
Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

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

**Test Configuration**

30 MHz - 1 GHz

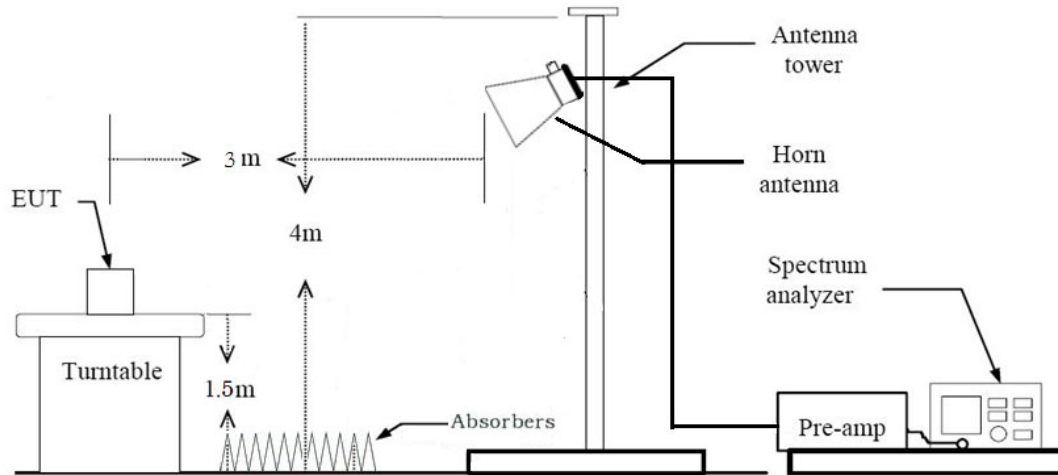




### Test Procedure of Receiver Spurious Emissions (Below 1 GHz)

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 – 10<sup>th</sup> Harmonics
- Detector = Peak
- Trace = Max hold
- RBW = 1 MHz
- VBW  $\geq$  3 x RBW

##### (2) Measurement Type(Average):

- Duty cycle < 98%, duty cycle variations are less than  $\pm 2\%$
- Measured Frequency Range : 1 GHz – 25 GHz
- Detector = RMS

- Averaging type = power (*i.e.*, RMS)
- RBW = 1 MHz
- VBW  $\geq 3 \times$  RBW
- Sweep time = auto.

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

## 7.9. 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 : X
3. All data rate of operation were investigated and the test results are worst case of each mode.
  - 500 kHz (SF 7, 8, 9, 10, 11, 12)
  - Worst case : 500 kHz SF 12
4. All Packet length of operation were investigated and the test results are worst case of each mode.
  - Packet Length : 1 to 36
  - Worst case : Packet length 36
5. 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. We don't perform powerline conducted emission test. Because EUT is used DC.

### Conducted test

1. All data rate of operation were investigated and the test results are worst case of each mode.
  - 500 kHz (SF 7, 8, 9, 10, 11, 12)
  - Worst case : 500 kHz SF 7, 12
2. All Packet length of operation were investigated and the test results are worst case of each mode.
  - Packet Length : 1 to 36
  - Worst case : Packet length 1, 36

## 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	Conducted	PASS
Conducted Maximum Output Power	§ 15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§ 15.247(e)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§ 15.247(d)	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§ 15.207	cf. Section 7.7		N/A (Note.1)
Radiated Spurious Emissions	§ 15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§ 15.247(d), 15.205, 15.209	cf. Section 7.6		PASS

### Note

1 : Not Tested

**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 > 20 dBc		PASS
AC Power line Conducted Emissions	RSS-GEN, 8.8	cf. Section 7.7		N/A (Note.1)
Radiated Spurious Emissions	RSS-GEN, 8.9	cf. Section 7.6	Radiated	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

**Note**

1 : Not Tested

## 9. TEST RESULT

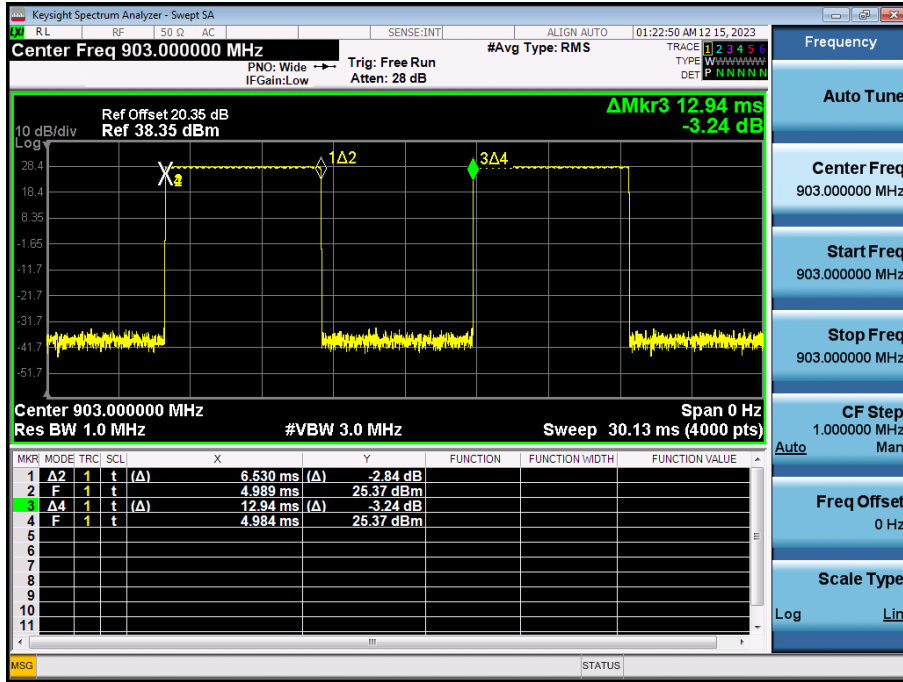
### 9.1 DUTY CYCLE

Spreading Factor	Packet length (Byte)	T <sub>on</sub> (ms)	T <sub>total</sub> (ms)	Duty Cycle	Duty Cycle Factor (dB)
SF7	1	6.530	12.940	0.505	2.970
	36	19.330	29.030	0.666	1.766
SF8	1	12.990	19.380	0.670	1.737
	36	36.030	45.640	0.789	1.027
SF9	1	25.940	32.330	0.802	0.956
	36	66.820	76.430	0.874	0.584
SF10	1	51.750	58.160	0.890	0.507
	36	123.500	133.100	0.928	0.325
SF11	1	103.500	109.800	0.943	0.257
	36	226.300	235.800	0.960	0.179
SF12	1	206.900	213.300	0.970	0.132
	36	411.900	421.400	0.977	0.099

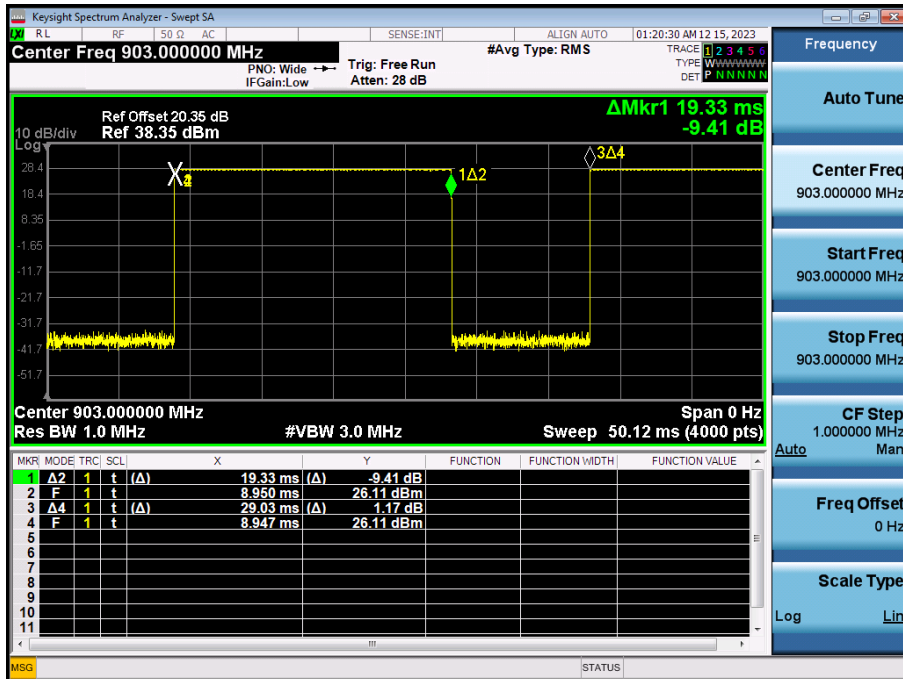


☐ Test Plots

SF7\_Packet Length 1

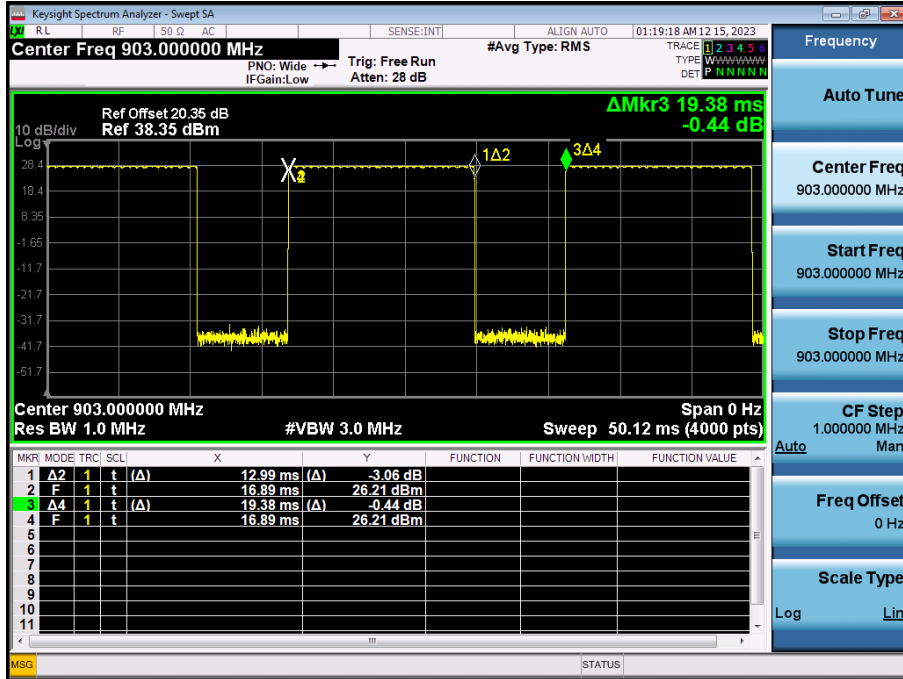


SF7\_Packet Length 36

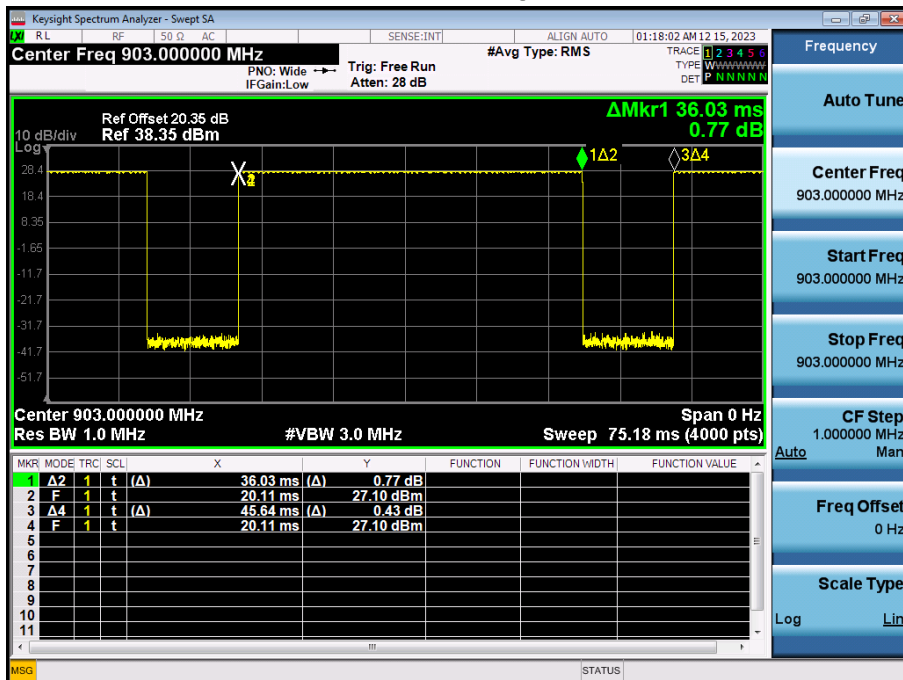




SF8\_Packet Length 1

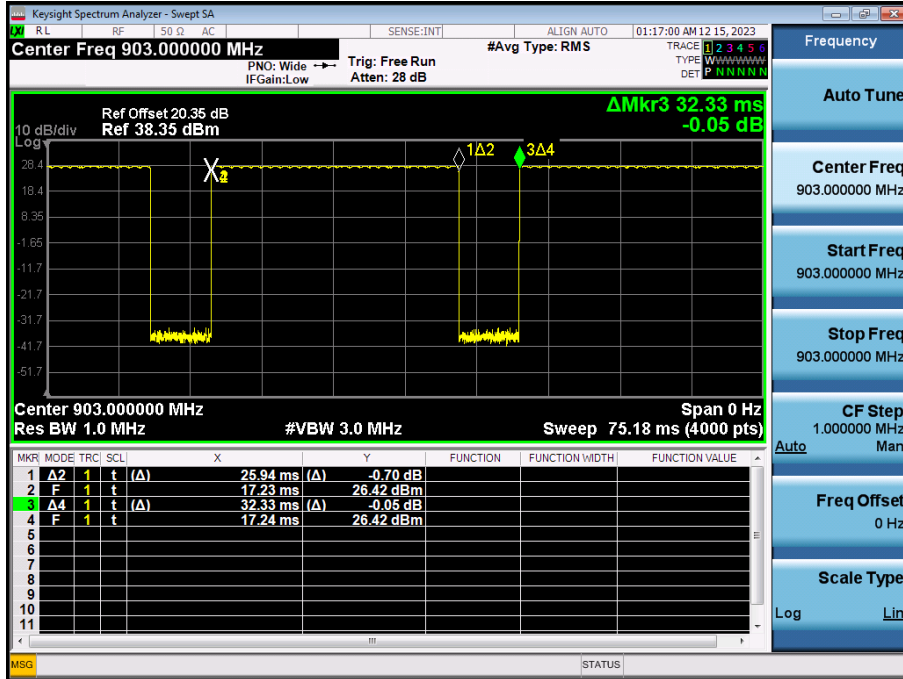


SF8\_Packet Length 36

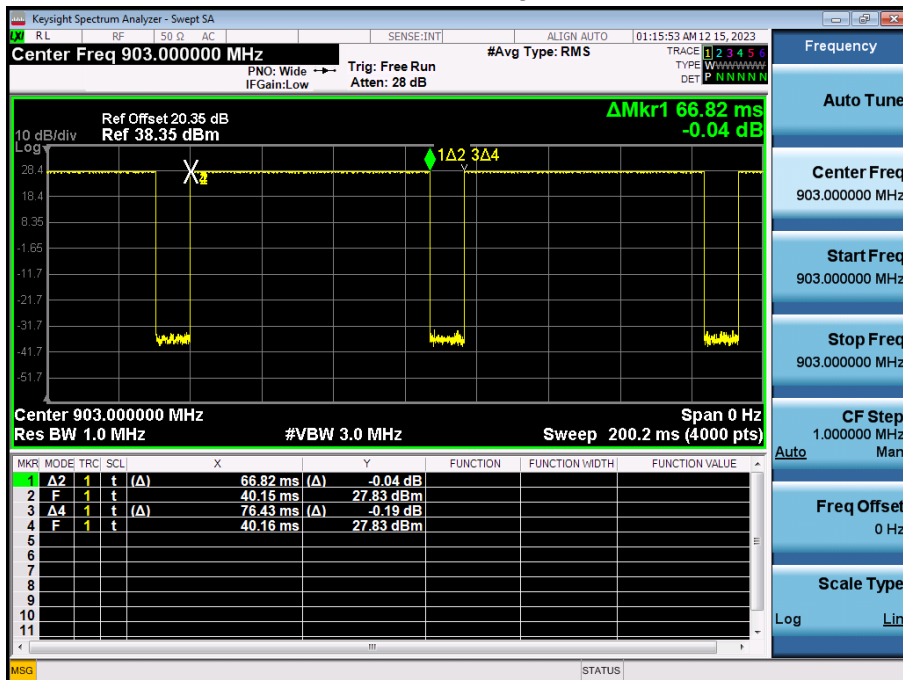




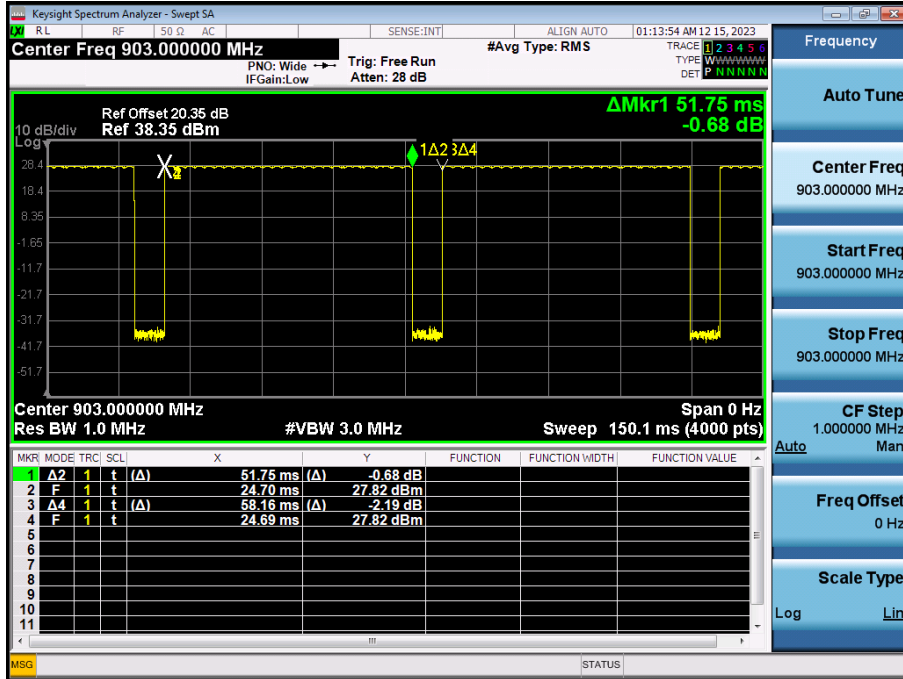
SF9\_Packet Length 1



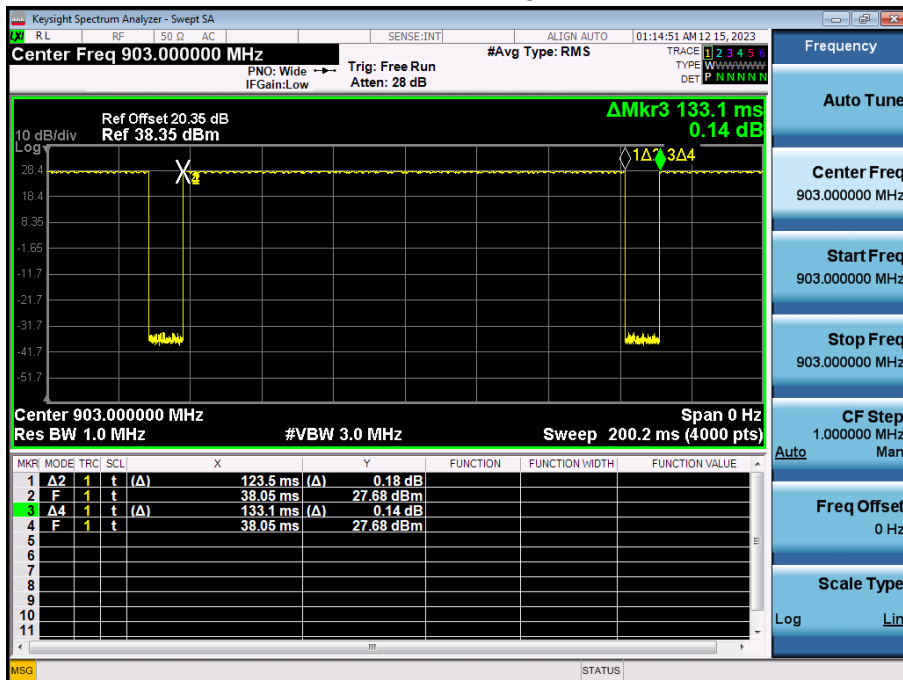
SF9\_Packet Length 36



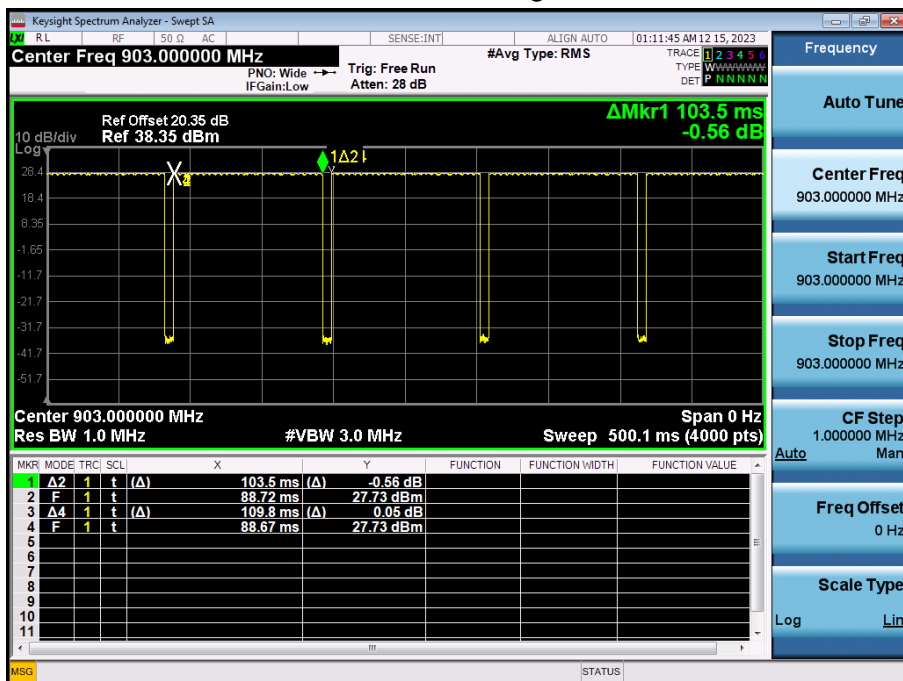
### SF10\_Packet Length 1



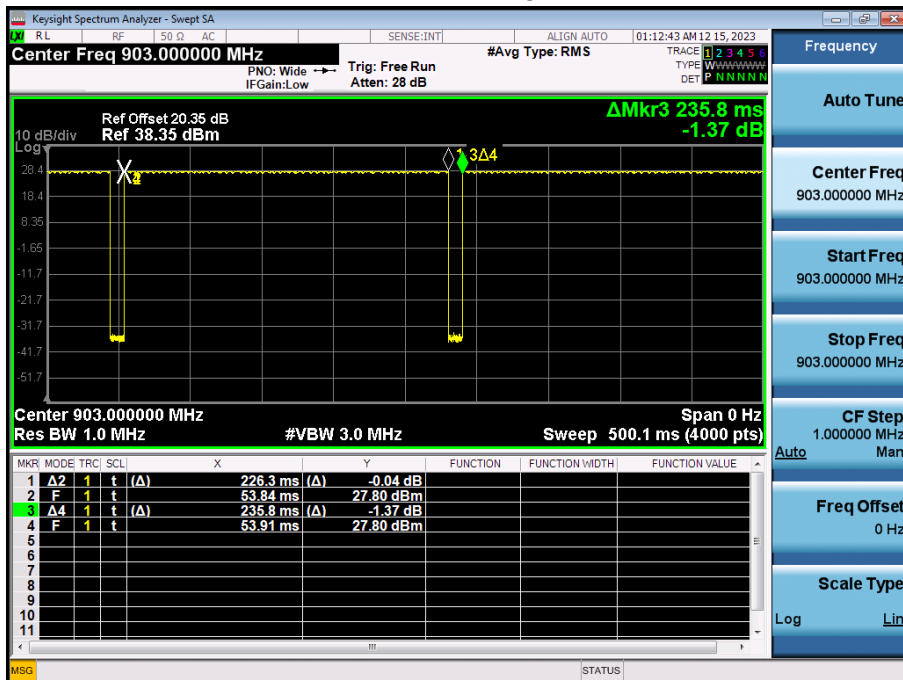
### SF10\_Packet Length 36



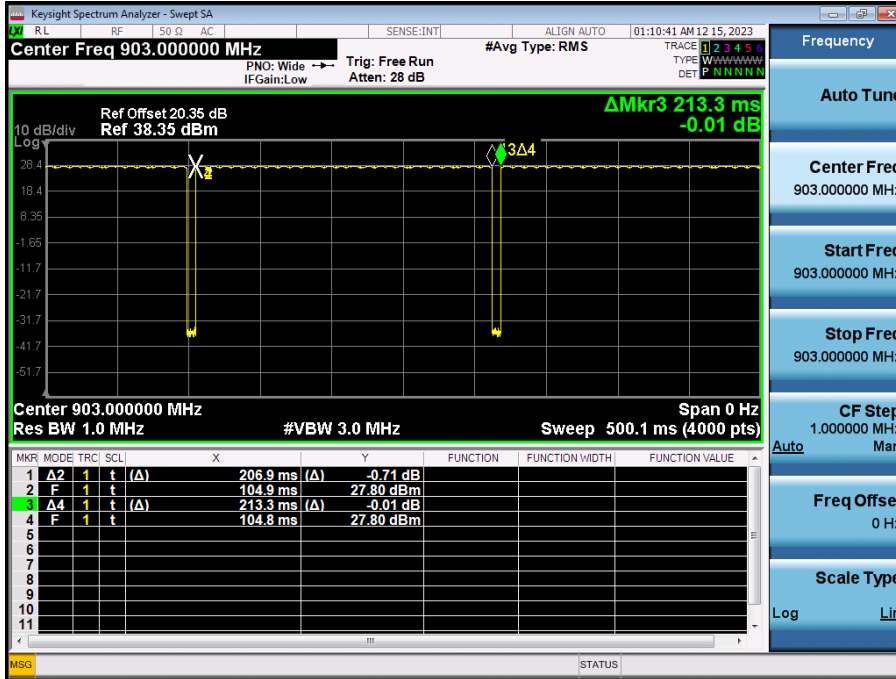
### SF11\_Packet Length 1



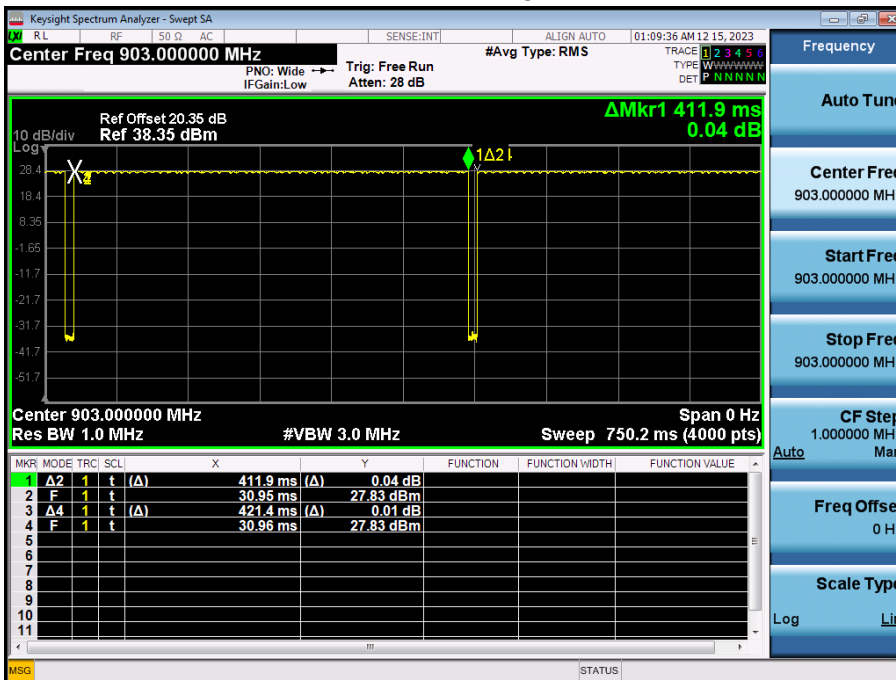
### SF11\_Packet Length 36



SF12\_Packet Length 1



SF12\_Packet Length 36





### 9.2 6 dB BANDWIDTH & 99 % BANDWIDTH

**FCC**

LoRa_500k_SF7		6 dB Bandwidth [kHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.		
903.0	64	624.2	> 0.5
909.4	68	622.7	> 0.5
915.725525	Private Ch.	629.4	> 0.5

LoRa_500k_SF12		6 dB Bandwidth [kHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.		
903.0	64	642.8	> 0.5
909.4	68	642.9	> 0.5
915.725525	Private Ch.	646.9	> 0.5

**Note:**

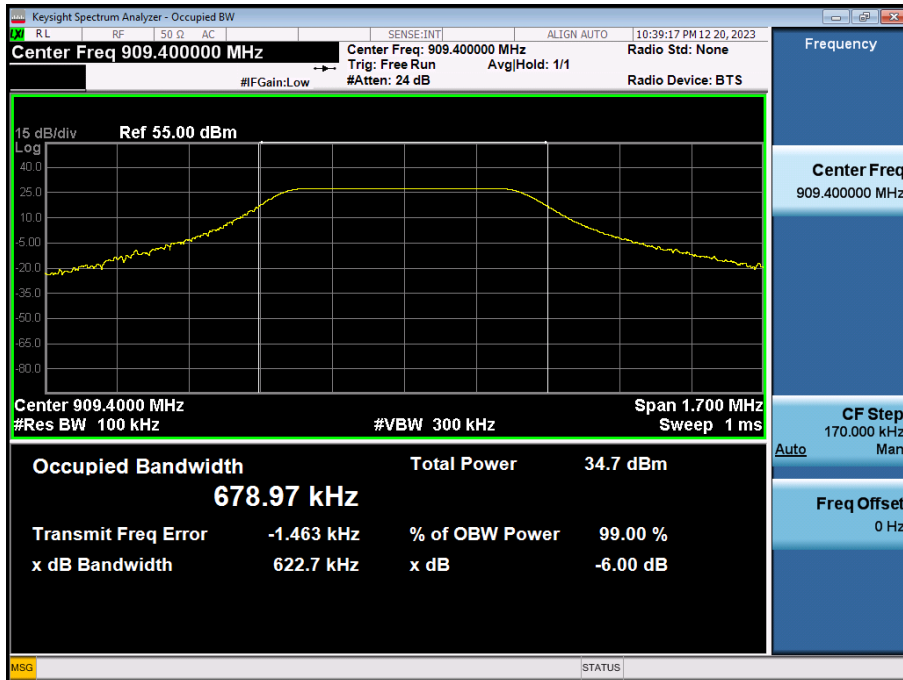
In order to simplify the report, attached plots were only the most narrow 6 dB BW channel.

Test Plots

6 dB Bandwidth plot (SF7 - Channel 64)



6 dB Bandwidth plot (SF7 - Channel 68)



6 dB Bandwidth plot (SF7 - Private Channel)





**99 % Bandwidth & (ISED)**

LoRa_500k_SF7		6 dB Bandwidth [kHz]	99 % Bandwidth [kHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.			
903.0	64	501.1	519.66	> 0.5
909.4	68	501.4	519.14	> 0.5
915.725525	Private Ch.	502.0	527.50	> 0.5

LoRa_500k_SF12		6 dB Bandwidth [kHz]	99 % Bandwidth [kHz]	Minimum Bandwidth [MHz]
Frequency [MHz]	Channel No.			
903.0	64	540.0	537.85	> 0.5
909.4	68	540.2	538.20	> 0.5
915.725525	Private Ch.	542.3	541.87	> 0.5

**Note:**

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

Test Plots

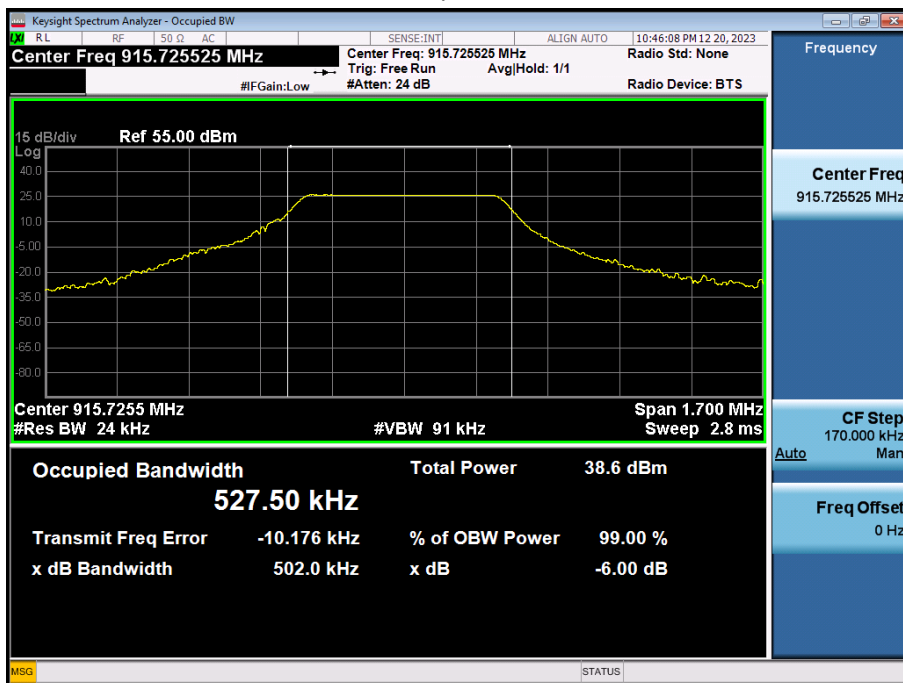
99 % & 6 dB Bandwidth plot (SF7 - Channel 64)



99 % & 6 dB Bandwidth plot (SF7 - Channel 68)



99 % & 6 dB Bandwidth plot (SF7 - Private Channel)



### 9.3 OUTPUT POWER

#### Peak Power

LoRa_500k_SF7		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	26.83	30
	36	26.98	
909.4	1	26.80	
	36	26.81	
915.725525	1	26.78	
	36	26.79	

LoRa_500k_SF8		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	26.90	30
	36	26.90	
909.4	1	26.81	
	36	26.85	
915.725525	1	26.75	
	36	26.78	



LoRa_500k_SF9		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	26.88	30
	36	26.89	
909.4	1	26.75	
	36	26.81	
915.725525	1	26.73	
	36	26.75	

LoRa_500k_SF10		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	26.85	30
	36	26.90	
909.4	1	26.80	
	36	26.77	
915.725525	1	26.75	
	36	26.71	

LoRa_500k_SF11		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	26.78	30
	36	26.79	
909.4	1	26.83	
	36	26.86	
915.725525	1	26.75	
	36	26.77	

LoRa_500k_SF12		Measured Power(dBm)	Limit (dBm)
Frequency [MHz]	Packet Length (Byte)		
903.0	1	27.13	30
	36	27.16	
909.4	1	26.95	
	36	26.94	
915.725525	1	26.85	
	36	26.91	

**Average Power**

LoRa_500k_SF7		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	23.58	2.97	26.55	30
	36	24.81	1.77	26.58	
909.4	1	23.44	2.97	26.41	
	36	24.67	1.77	26.44	
915.725525	1	23.42	2.97	26.39	
	36	24.65	1.77	26.42	

LoRa_500k_SF8		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	24.76	1.74	26.50	30
	36	25.43	1.03	26.46	
909.4	1	24.65	1.74	26.39	
	36	25.29	1.03	26.32	
915.725525	1	24.62	1.74	26.36	
	36	25.28	1.03	26.31	

LoRa_500k_SF9		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	25.54	0.96	26.50	30
	36	25.95	0.58	26.53	
909.4	1	25.45	0.96	26.41	
	36	25.88	0.58	26.46	
915.725525	1	25.43	0.96	26.39	
	36	25.85	0.58	26.43	

LoRa_500k_SF10		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	26.01	0.51	26.52	30
	36	26.24	0.33	26.57	
909.4	1	25.91	0.51	26.42	
	36	26.12	0.33	26.45	
915.725525	1	25.87	0.51	26.38	
	36	26.09	0.33	26.42	



LoRa_500k_SF11		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	26.19	0.26	26.45	30
	36	26.32	0.18	26.50	
909.4	1	26.18	0.26	26.44	
	36	26.30	0.18	26.48	
915.725525	1	26.11	0.26	26.37	
	36	26.25	0.18	26.43	

LoRa_500k_SF12		Max. Avg Ouput Power (dBm)			Limit (dBm)
Frequency [MHz]	Packet Length(Byte)	Measured Power [dBm]	Duty Cycle Factor [dB]	Total Power [dBm]	
903.0	1	26.46	0.13	26.59	30
	36	26.55	0.10	26.65	
909.4	1	26.35	0.13	26.48	
	36	26.41	0.10	26.51	
915.725525	1	26.29	0.13	26.42	
	36	26.38	0.10	26.48	



### 9.4 POWER SPECTRAL DENSITY

**Note:**

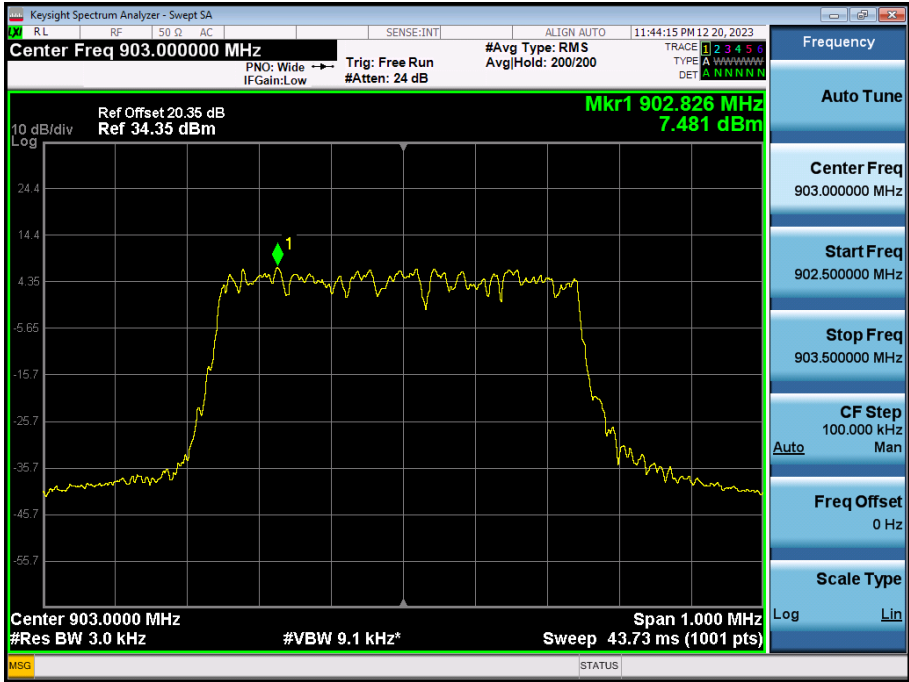
1. In order to simplify the report, The table was recorded at the highest power.

LoRa_500k_SF12		Max. Power Spectral Density			Limit (dBm/3kHz)
Frequency [MHz]	Packet Length(Byte)	Measured PSD (dBm/3 kHz)	Duty Cycle Factor [dB]	Total PSD (dBm/3 kHz)	
903.0	1	7.481	0.132	7.613	8
	36	7.564	0.099	7.663	
909.4	1	7.431	0.132	7.563	
	36	7.518	0.099	7.617	
915.725525	1	7.404	0.132	7.536	
	36	7.484	0.099	7.583	

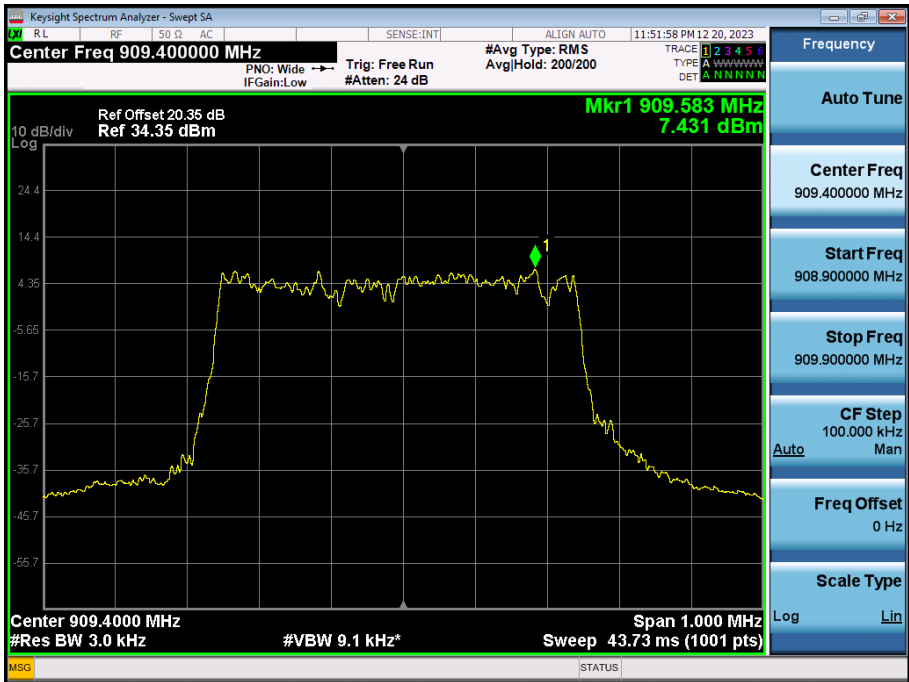


Test Plots

Power Spectral Density (SF12\_Packet Length 1\_Channel 64)



Power Spectral Density (SF12\_Packet Length 1\_Channel 68)



Power Spectral Density (SF12\_Packet Length 1\_Private Channel)

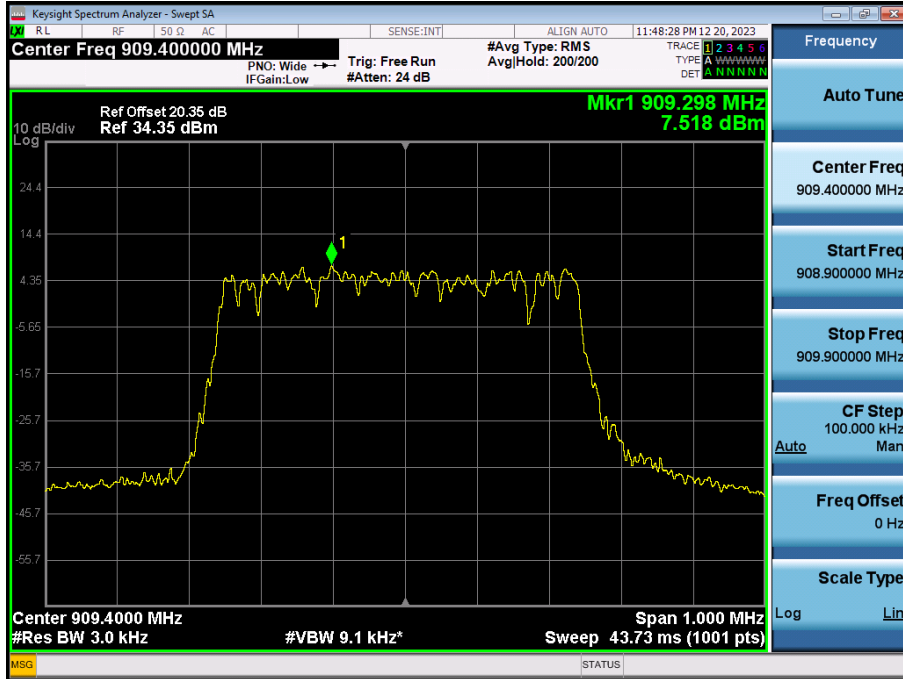


Power Spectral Density (SF12\_Packet Length 36\_Channel 64)

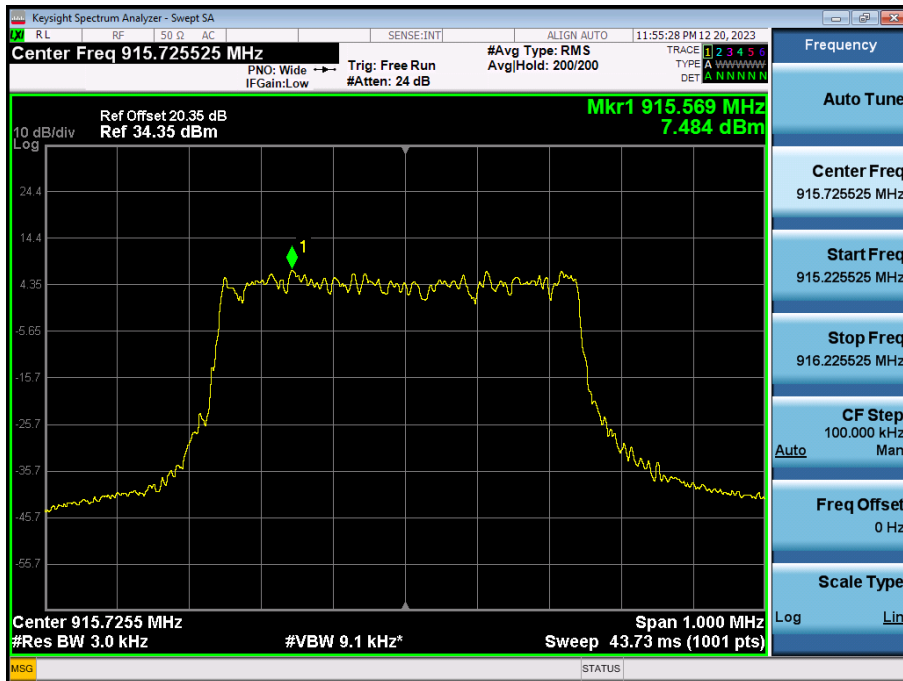




Power Spectral Density (SF12\_Packet Length 36\_Channel 68)



Power Spectral Density (SF12\_Packet Length 36\_Private Channel)



### 9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

**[BAND EDGE]**

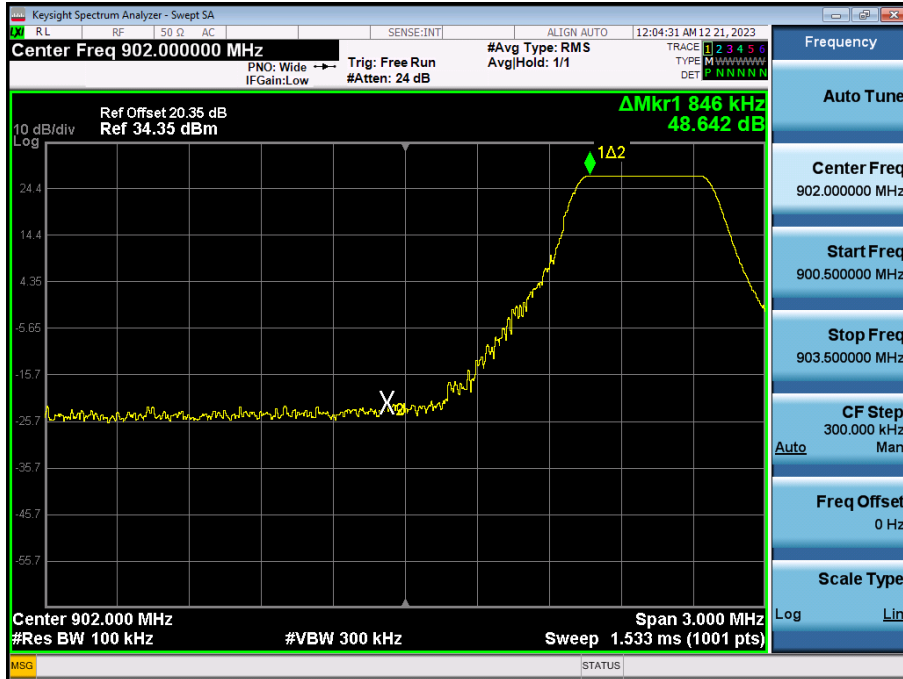
Frequency (MHz)	Channel No.	Mode	Band Edge Position	SF7 Test Result		
				Measured Level (dB)	Limit (dBc)	Pass/Fail
903.0	64	LoRa 500k	Lower	48.642	30	Pass
915.725525	Private Ch.		Upper	67.484	30	Pass

Frequency (MHz)	Channel No.	Mode	Band Edge Position	SF12 Test Result		
				Measured Level (dB)	Limit (dBc)	Pass/Fail
903.0	64	LoRa 500k	Lower	47.949	30	Pass
915.725525	Private Ch.		Upper	67.489	30	Pass

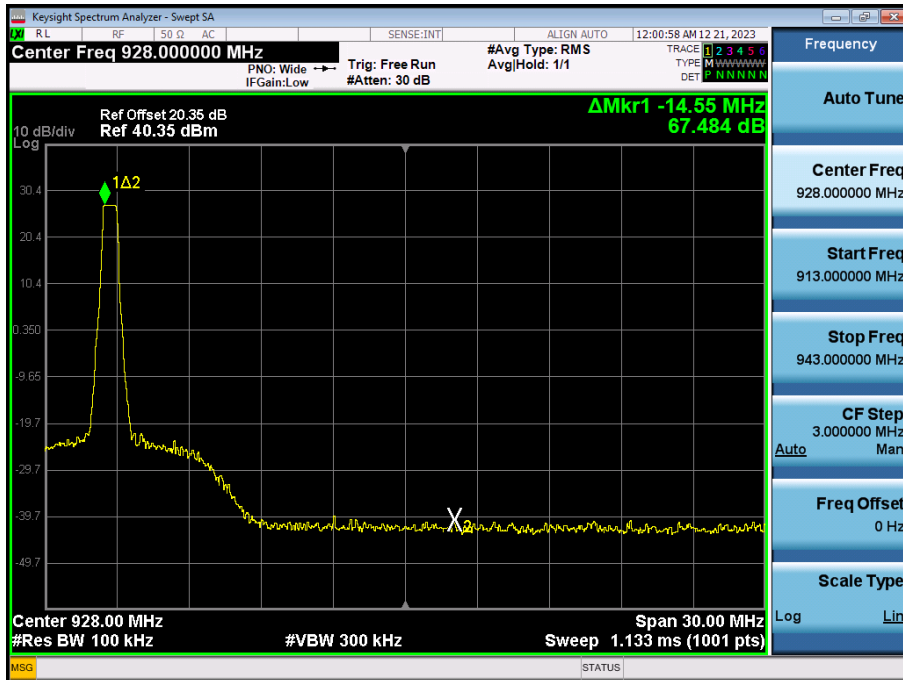


Test Plots

Lower Band Edge(SF 7- Channel 64)

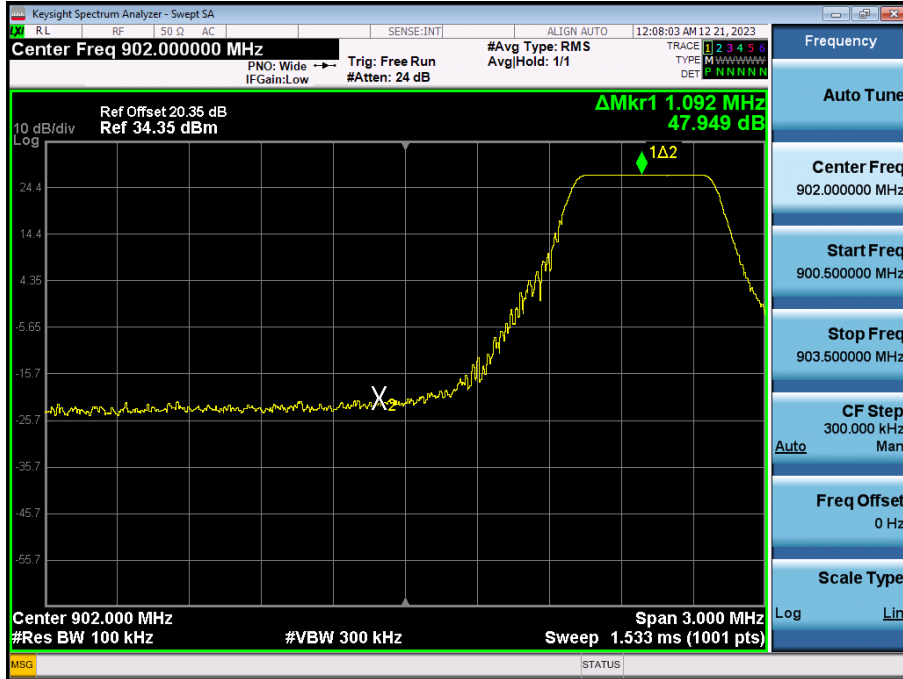


Upper Band Edge(SF 7- Private Channel)

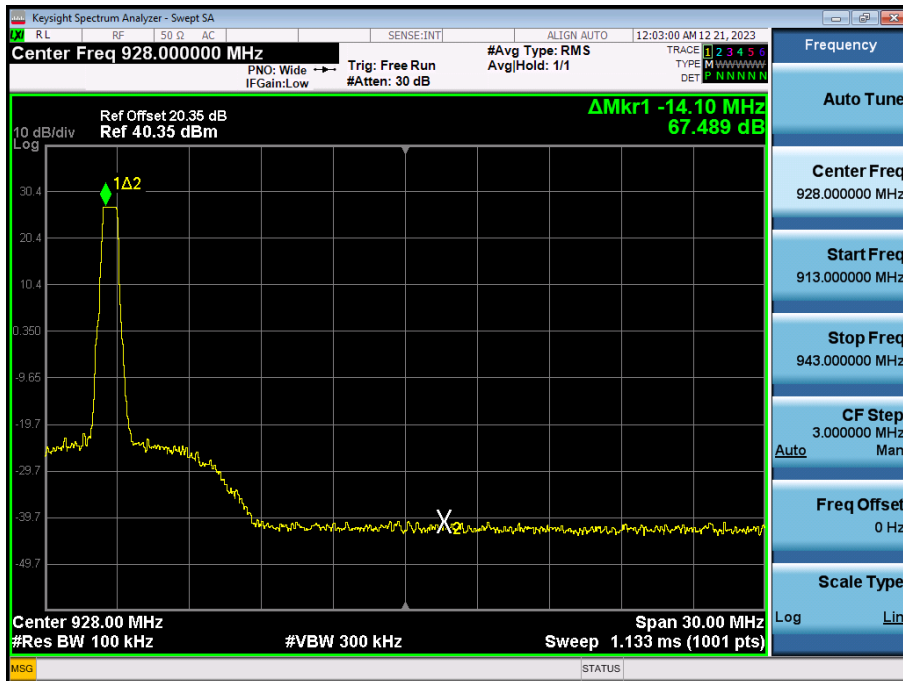




Lower Band Edge(SF 12- Channel 64)



Upper Band Edge(SF 12- Private Channel)



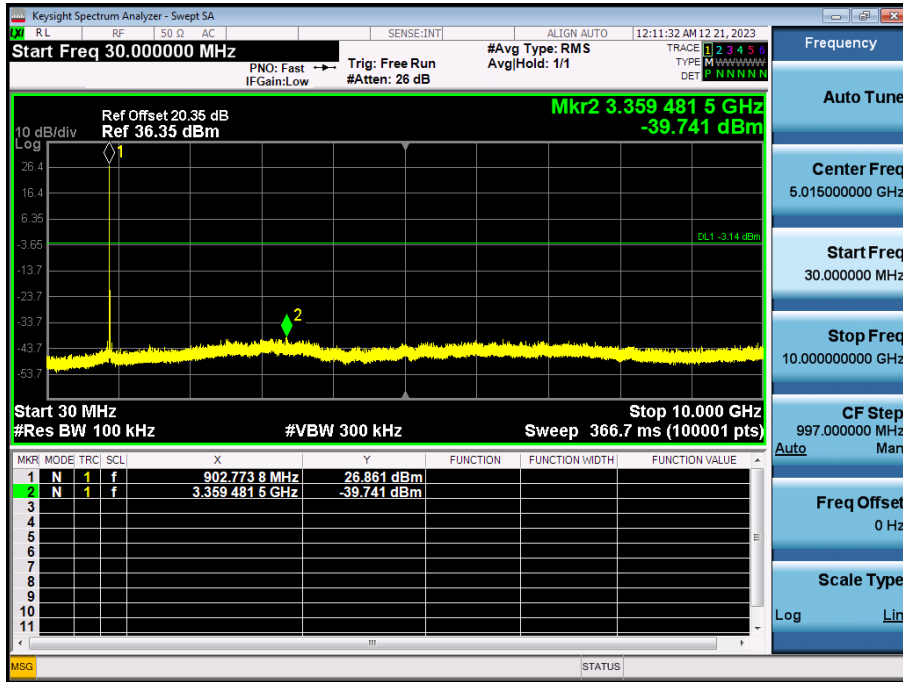


[CONDUCTED SPURIOUS EMISSIONS]

Worst case Mode : SF12\_Lengh 36\_Channel 64(903.0 MHz)

☐ Test Plots

30 MHz ~ 26 GHz



Note :

Limit : -3.139 dBm

### 9.6 RADIATED SPURIOUS EMISSIONS

#### Frequency Range : 9 kHz – 30 MHz

Frequency	Measured Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
[MHz]	[dB $\mu$ V/m]	[dB/m]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ V/m]	[dB]
No Critical peaks found							

**Note:**

1. The Measured Level 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 = 40log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dB $\mu$ V) + Distance extrapolation factor

#### Frequency Range : Below 1 GHz

Frequency	Measured Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
[MHz]	[dB $\mu$ V/m]	[dB/m]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ 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 64(903.0 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB $\mu$ V]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ V/m]	[dB]	
2 709.00	54.74	0.00	H	54.74	73.98	19.24	PK
2 709.00	47.38	0.10	H	47.48	53.98	6.50	AV
3 612.00	47.15	0.00	H	47.15	73.98	26.83	PK
3 612.00	38.20	0.10	H	38.30	53.98	15.68	AV
4 515.00	49.58	0.00	H	49.58	73.98	24.40	PK
4 515.00	41.08	0.10	H	41.18	53.98	12.80	AV
5 418.00	47.99	0.00	H	47.99	73.98	25.99	PK
5 418.00	36.01	0.10	H	36.11	53.98	17.87	AV
8 127.00	52.75	0.00	H	52.75	73.98	21.23	PK
8 127.00	40.93	0.10	H	41.03	53.98	12.95	AV
9 030.00	53.67	0.00	H	53.67	73.98	20.31	PK
9 030.00	41.79	0.10	H	41.89	53.98	12.09	AV

**Note :**

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

**Channel 64(903.0 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dBμV]	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
2 709.00	54.02	0.00	V	54.02	73.98	19.96	PK
2 709.00	43.25	0.10	V	43.35	53.98	10.63	AV
3 612.00	47.65	0.00	V	47.65	73.98	26.33	PK
3 612.00	37.68	0.10	V	37.78	53.98	16.20	AV
4 515.00	49.33	0.00	V	49.33	73.98	24.65	PK
4 515.00	40.19	0.10	V	40.29	53.98	13.69	AV
5 418.00	48.02	0.00	V	48.02	73.98	25.96	PK
5 418.00	36.02	0.10	V	36.12	53.98	17.86	AV
8 127.00	52.95	0.00	V	52.95	73.98	21.03	PK
8 127.00	40.99	0.10	V	41.09	53.98	12.89	AV
9 030.00	53.16	0.00	V	53.16	73.98	20.82	PK
9 030.00	41.51	0.10	V	41.61	53.98	12.37	AV

**Note :**

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

**Channel 68(909.4 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dB $\mu$ V]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ V/m]	[dB]	
2 728.20	54.93	0.00	H	54.93	73.98	19.05	PK
2 728.20	47.58	0.10	H	47.68	53.98	6.30	AV
3 637.60	47.36	0.00	H	47.36	73.98	26.62	PK
3 637.60	38.18	0.10	H	38.28	53.98	15.70	AV
4 547.00	50.06	0.00	H	50.06	73.98	23.92	PK
4 547.00	40.49	0.10	H	40.59	53.98	13.39	AV
5 456.40	47.28	0.00	H	47.28	73.98	26.70	PK
5 456.40	35.49	0.10	H	35.59	53.98	18.39	AV
7 275.20	54.13	0.00	H	54.13	73.98	19.85	PK
7 275.20	42.99	0.10	H	43.09	53.98	10.89	AV
8 184.60	54.83	0.00	H	54.83	73.98	19.15	PK
8 184.60	42.52	0.10	H	42.62	53.98	11.36	AV
9 094.00	53.94	0.00	H	53.94	73.98	20.04	PK
9 094.00	41.71	0.10	H	41.81	53.98	12.17	AV

**Note :**

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

**Channel 68(909.4 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dBμV]	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
2 728.20	53.87	0.00	V	53.87	73.98	20.11	PK
2 728.20	45.25	0.10	V	45.35	53.98	8.63	AV
3 637.60	47.01	0.00	V	47.01	73.98	26.97	PK
3 637.60	36.77	0.10	V	36.87	53.98	17.11	AV
4 547.00	49.67	0.00	V	49.67	73.98	24.31	PK
4 547.00	40.25	0.10	V	40.35	53.98	13.63	AV
5 456.40	47.34	0.00	V	47.34	73.98	26.64	PK
5 456.40	35.55	0.10	V	35.65	53.98	18.33	AV
7 275.20	53.86	0.00	V	53.86	73.98	20.12	PK
7 275.20	42.61	0.10	V	42.71	53.98	11.27	AV
8 184.60	54.06	0.00	V	54.06	73.98	19.92	PK
8 184.60	42.48	0.10	V	42.58	53.98	11.40	AV
9 094.00	53.80	0.00	V	53.80	73.98	20.18	PK
9 094.00	41.66	0.10	V	41.76	53.98	12.22	AV

**Note :**

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

**Private Channel(915.72525 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dBμV]	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
2 747.18	54.86	0.00	H	54.86	73.98	19.12	PK
2 747.18	47.14	0.10	H	47.24	53.98	6.74	AV
3 662.90	46.85	0.00	H	46.85	73.98	27.13	PK
3 662.90	37.20	0.10	H	37.30	53.98	16.68	AV
4 578.63	49.20	0.00	H	49.20	73.98	24.78	PK
4 578.63	40.42	0.10	H	40.52	53.98	13.46	AV
7 325.80	54.34	0.00	H	54.34	73.98	19.64	PK
7 325.80	43.26	0.10	H	43.36	53.98	10.62	AV
8 241.53	55.96	0.00	H	55.96	73.98	18.02	PK
8 241.53	45.16	0.10	H	45.26	53.98	8.72	AV
9 157.26	54.75	0.00	H	54.75	73.98	19.23	PK
9 157.26	42.22	0.10	H	42.32	53.98	11.66	AV

**Note :**

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

**Private Channel(915.72525 MHz)**

Frequency	Measured Value	Duty Cycle Factor	ANT. POL	Total	Limit	Margin	Detect
[MHz]	[dBμV]	[dB]	[H/V]	[dBμV/m]	[dBμV/m]	[dB]	
2 747.18	52.72	0.00	V	52.72	73.98	21.26	PK
2 747.18	45.39	0.10	V	45.49	53.98	8.49	AV
3 662.90	47.45	0.00	V	47.45	73.98	26.53	PK
3 662.90	37.81	0.10	V	37.91	53.98	16.07	AV
4 578.63	49.08	0.00	V	49.08	73.98	24.90	PK
4 578.63	39.99	0.10	V	40.09	53.98	13.89	AV
7 325.80	52.13	0.00	V	52.13	73.98	21.85	PK
7 325.80	40.12	0.10	V	40.22	53.98	13.76	AV
8 241.53	55.15	0.00	V	55.15	73.98	18.83	PK
8 241.53	43.74	0.10	V	43.84	53.98	10.14	AV
9 157.26	54.33	0.00	V	54.33	73.98	19.65	PK
9 157.26	42.21	0.10	V	42.31	53.98	11.67	AV

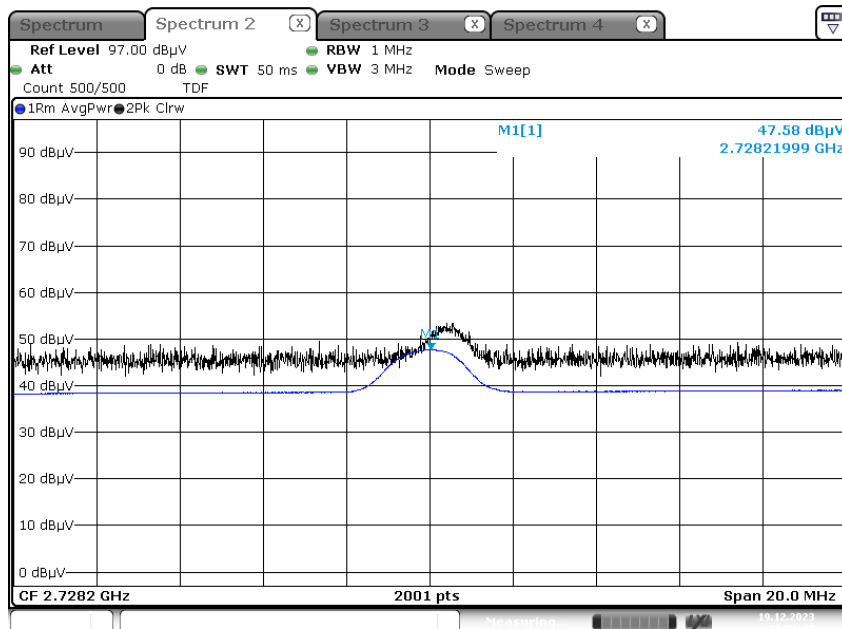
**Note :**

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



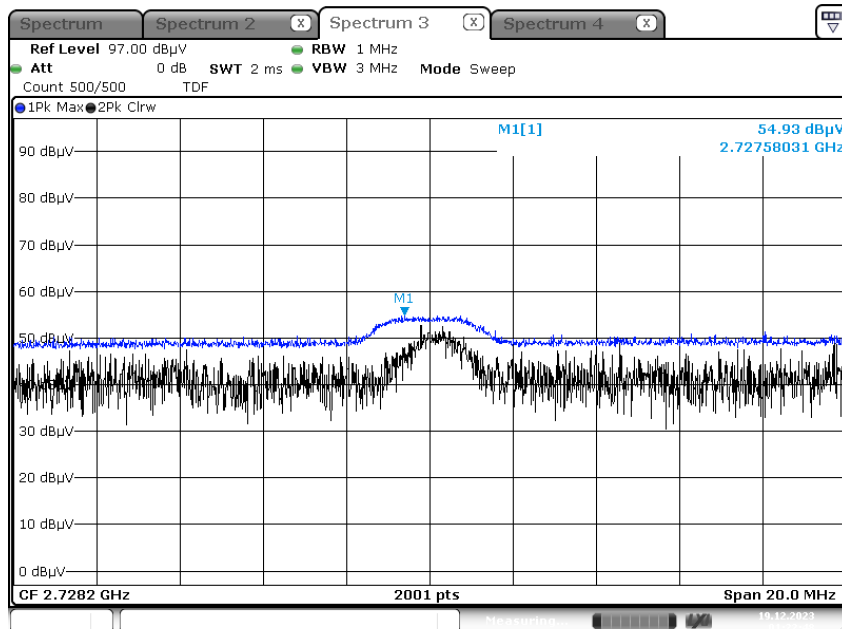
**RESULT PLOTS**

Radiated Spurious Emissions plot – Average Result (SF12 3<sup>rd</sup> Harmonic)



Date: 19.DEC.2023 01:21:43

Radiated Spurious Emissions plot – Peak Result (SF12 3<sup>rd</sup> Harmonic)



Date: 19.DEC.2023 01:22:48

**Note:**

Plots of worst case are only reported.

### 9.7 RECEIVER SPURIOUS EMISSIONS

#### Frequency Range : Below 1 GHz

Frequency	Measured Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
[MHz]	[dB $\mu$ V/m]	[dB/m]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ 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 Level	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
[MHz]	[dB $\mu$ V/m]	[dB/m]	[dB]	[H/V]	[dB $\mu$ V/m]	[dB $\mu$ V/m]	[dB]

No Critical peaks found

## 10. LIST OF TEST EQUIPMENT

### Conducted Test

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
LISN	ENV216	Rohde & Schwarz	102245	08/02/2024	Annual
EMI Test Receiver	ESR	Rohde & Schwarz	101910	05/26/2024	Annual
Temperature Chamber	SU-642	ESPEC	93008124	02/22/2024	Annual
Signal Analyzer	N9030A	Keysight	MY55410508	09/04/2024	Annual
Power Meter	N1911A	Agilent	MY45100523	03/06/2024	Annual
Power Sensor	N1921A	Agilent	MY57820067	03/06/2024	Annual
Directional Coupler	87300B	Agilent	3116A03621	10/30/2024	Annual
Power Splitter	11667B	Hewlett Packard	10545	02/06/2024	Annual
DC Power Supply	E3632A	Agilent	KR75305528	01/03/2024	Annual
Attenuator(10 dB)(DC-26.5 GHz)	8493C-010	Agilent	08285	06/02/2024	Annual
Attenuator(20 dB)	18N-20dB	Rohde & Schwarz	8	03/08/2024	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
Bluetooth Tester	CBT	Rohde & Schwarz	100808	02/16/2024	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.

**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	S3AM	08/03/2025	Biennial
Controller	EM2090	Emco	060520	N/A	N/A
Turn Table	N/A	Ets	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-333	03/17/2024	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	08/16/2024	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	9120D-1191	11/07/2025	Biennial
Horn Antenna(15 GHz ~ 40 GHz)	BBHA9170	Schwarzbeck	BBHA9170124	03/28/2025	Biennial
Amp & Filter Bank Switch Controller	FBSM-01A	TNM system	0	N/A	N/A
Band Reject Filter	WRCJV2400/2483.5-2370/2520-60/12SS	Wainwright Instruments	2	01/05/2024	Annual
Band Reject Filter	WRCJV12-4900-5100-5900-6100-50SS	Wainwright Instruments	5	06/12/2024	Annual
Band Reject Filter	WRCJV12-4900-5100-5900-6100-50SS	Wainwright Instruments	6	06/12/2024	Annual
Band Reject Filter	WRCJV5100/5850-40/50-8EEK	Wainwright Instruments	1	02/09/2024	Annual
RF Switching System	FBSR-03A (3G HPF+LNA)	T&M SYSTEM	S3L1	11/17/2024	Annual
RF Switching System	FBSR-03A (10dB ATT+LNA)	T&M SYSTEM	S3L2	11/17/2024	Annual
RF Switching System	FBSR-03A (7G HPF+LNA)	T&M SYSTEM	S3L3	11/17/2024	Annual
RF Switching System	FBSR-03A (3dB ATT+LNA)	T&M SYSTEM	S3L4	11/17/2024	Annual
Power Amplifier	CBL18265035	CERNEX	22966	11/17/2024	Annual
Power Amplifier	CBL26405040	CERNEX	25956	03/02/2024	Annual
Bluetooth Tester	TC-3000C	TESCOM	3000C000175	03/28/2024	Annual
Spectrum Analyzer	FSVA40 (10 Hz ~ 40 GHz)	Rohde & Schwarz	101502	03/17/2024	Annual
Spectrum Analyzer	FSV40 (10 Hz ~ 40 GHz)	Rohde & Schwarz	100900	12/06/2024	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-2312-FI010-P