ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Ring LLC 12515 Cerise Ave, Hawthorne, CA90250 United States
Manufacturer:	Ring LLC 12515 Cerise Ave, Hawthorne, CA90250 United States
Product Name:	Mailbox Sensor
Brand Name:	ring
Model No.:	5D22E3
ISED HVIN:	MB004
Report Number:	TERF2406001609E2
FCC ID	2AEUPRBMB004
IC:	20271-RBMB004
Date of EUT Received:	May 17, 2024
Date of Test:	June 11, 2024～July 30, 2024
Issue Date:	July 31, 2024

Approved By _____
Jay Lin

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.247, ISED RSS-Gen and RSS-247.

The results of this report relate only to the sample identified in this report.

Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2406001609E2	00	Original	Jul. 31, 2024	Candice Li	

Note:

1、The remark "*" indicates modification of the report upon requests from certification body.

Contents

1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Mailbox Sensor
Brand Name:	ring
Model No.:	5D22E3
ISED HVIN:	MB004
Hardware Version:	PVT
Firmware Version:	N/A
EUT Series No.:	3000158 (Conducted) 3000036 (Radiated)
Power Supply:	4.5Vdc from AAA Battery*3
Test Software (Name/Version)	J-Link Commander V7.96i

1.2 RF Specification

Radio Technology:	LoRa: SF7 / 500 kHz, LoRa: SF11 / 500 kHz
Frequency Range:	902 – 928MHz
Channel number:	31 channels
Modulation type:	LoRa DTS
Transmit Power:	LoRa SF7: 21.49 dBm (Peak) LoRa SF11: 21.49 dBm (Peak)

1.3 Antenna Designation

Internal / External	Antenna Type	Freq. (MHz)	Peak Antenna Gain (dBi)
Internal	LTCC	902~928	-2.88
External	PIFA	902~928	0.37

Note:

1. Antenna information is provided by the applicant.
2. This block has two antennas, not operating simultaneously.

1.4 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

RSS-247 issue 3 Aug. 2023

RSS-Gen, Issue 5 April 2018, Amendment 2 (February 2021)

1.5 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.6 Special Accessories

There are no special accessories used while test was conducted.

1.7 Equipment Modifications

There was no modification incorporated into the EUT.

2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

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

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m 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 transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

2.4.1 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

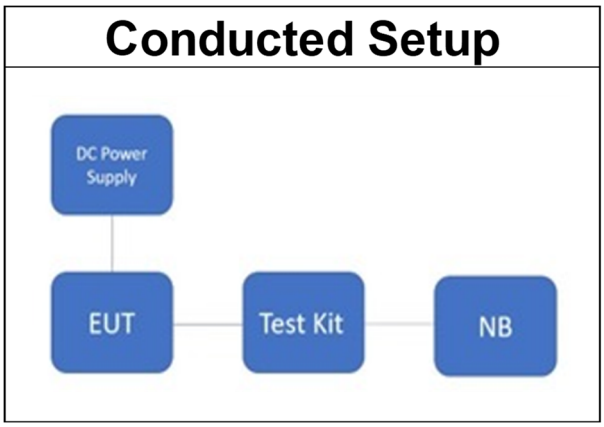
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

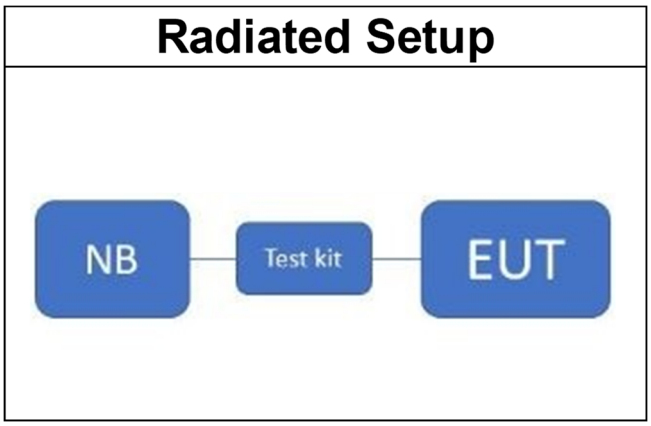
There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

2.4.2 For all conducted test items:

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

2.5 Test Configuration





2.6 Control Unit(s)

Conducted Emission Test Site: Conducted F					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	HP	HSN-Q35C-4	P0003860	N/A	N/A
Testkit	N/A	N/A	N/A	N/A	N/A

Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Testkit	N/A	N/A	N/A	N/A	N/A
Notebook	Lenovo	L480	P0002332	N/A	N/A

3 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§15.207(a)	RSS-Gen §8.8	AC Power Line Conducted Emission	Non applicable
§15.247(b) (3)	RSS-247 §5.4 d	Peak Output Power	Compliant
§15.247(a)(2)	RSS-247 §5.2 a RSS-Gen §6.7	Emission Bandwidth	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5	Conducted Band Edge and Spurious Emission	Compliant
§15.205 §15.209 §15.247(d)	RSS-247 §5.5	Radiated Band Edge and Spurious Emission	Compliant
§15.205	RSS-Gen § 8.10	Restricted Bands	Compliant
§15.247(e)	RSS-247 §5.2 b	Peak Power Density	Compliant
§15.203	N/A	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

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

4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
3. Investigation has been done on all the possible configurations for searching the worst case. The gevin UE is pre-scanned among below modes.

CONDUCTED TEST				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (Mbps)
LoRa DTS 500kHz	902 to 928	902.5,914.5,926.5	LoRa DTS	0.5

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (Mbps)
LoRa DTS 500kHz	902 to 928	914.5	LoRa DTS	0.5

RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (Mbps)
LoRa DTS 500kHz	902 to 928	902.5,914.5,926.5	LoRa DTS	0.5

Note: The field strength of radiated emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.

5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty		
AC Power Line Conducted Emission	+/-	1.54	dB
Output Power measurement	+/-	0.97	dB
Emission Bandwidth	+/-	1.38	Hz
Conducted emission measurement	+/-	0.77	dB
Peak Power Density	+/-	0.61	dB
Temperature	+/-	0.6	°C
Humidity	+/-	3	%
DC / AC Power Source	+/-	1	%

Radiated Spurious Emission Measurement Uncertainty				
Polarization: Vertical	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.15**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Polarization: Horizontal	**+/-**	**1.89**	**dB**	9kHz~30MHz
	+/-	**4.02**	**dB**	30MHz - 1000MHz
	+/-	**3.43**	**dB**	1GHz - 18GHz
	+/-	**3.86**	**dB**	18GHz - 40GHz
Radiated Spurious Emission	**+/-**	**2**	**dB**	33GHz-50GHz
	+/-	**1.59**	**dB**	50GHz-60GHz
	+/-	**1.7**	**dB**	60GHz-90GHz
	+/-	**1.64**	**dB**	90GHz-140GHz
	+/-	**3.83**	**dB**	140GHz-220GHz

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

6 MEASUREMENT EQUIPMENT USED

6.1 Conducted Measurement

Conducted Emission Test Site: Conducted F					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Attenuator	Woken	WATT-218FS-10	RF25	11/15/2023	11/14/2024
DC Block	PASTERNACK	PE8210	RF153	11/15/2023	11/14/2024
DC Power Supply	Gwinstek	SPS-3610	GEV856769	08/04/2023	08/03/2024
Power Meter	Anritsu	ML2496A	1326001	08/22/2023	08/21/2024
Power Sensor	Anritsu	MA2411B	1315048	08/22/2023	08/21/2024
Power Sensor	Anritsu	MA2411B	1315049	08/22/2023	08/21/2024
Spectrum Analyzer	KEYSIGHT	N9010B	MY60240506	06/17/2024	06/16/2025
Test Software	SGS Taiwan	Radio Test Software	Ver.21	N.C.R	N.C.R

6.2 Radiated Measurement

Radiated Emission Test Site: SAC D					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
3m Site NSA	SGS	966 chamber D	N/A	04/30/2024	04/29/2025
Active Loop Antenna	COM-POWER	AL-130R	10160105	12/04/2023	12/03/2024
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-617	12/14/2023	12/13/2024
Coaxial Cable	Huber+Suhner	EMC106-SM-SM-7200	150703	11/15/2023	11/14/2024
Coaxial Cable	Huber+Suhner	RG 214/U	W21.01	11/15/2023	11/14/2024
Horn Antenna	Schwarzbeck	BBHA9120D	1341	05/30/2024	05/29/2025
Pre-Amplifier	EMC Instruments	EMC12630SE	980273	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC18405SEE	980881	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC9135	980234	11/15/2023	11/14/2024
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120200	04/03/2024	04/02/2025
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R

NOTE: N.C.R refers to Not Calibrated Required.

7 CONDUCTED EMISSION TEST

7.1 Standard Applicable:

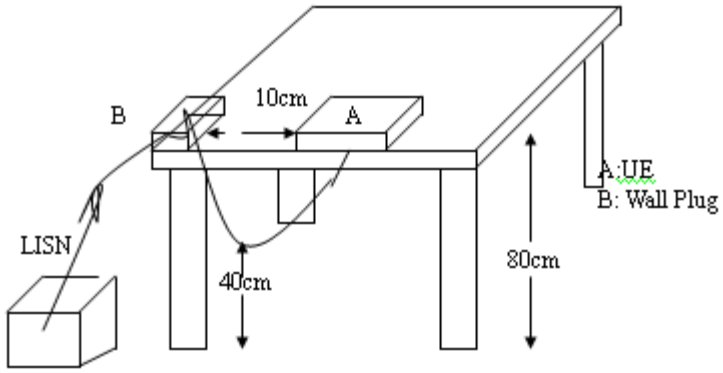
Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits (dBμV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

7.2 EUT Setup:

1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
3. The LISN was connected with 120Vac/60Hz power source.

7.3 Test Setup



7.4 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

7.5 Measurement Result:

N/A: Powered from AAA battery.

8 PEAK OUTPUT POWER MEASUREMENT

8.1 Standard Applicable:

8.1.1 FCC

For systems using digital modulation in the 902-928 MHz bands, the limit for peak output power is 1Watt.

If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi. (FCC only)

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

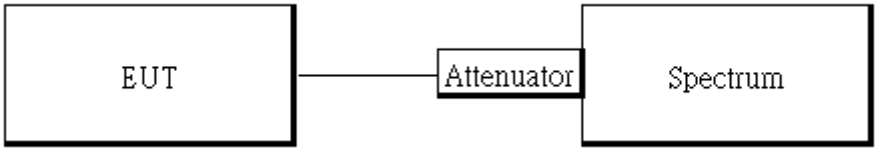
8.1.2 ISED

For systems using digital modulation in the 902-928 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

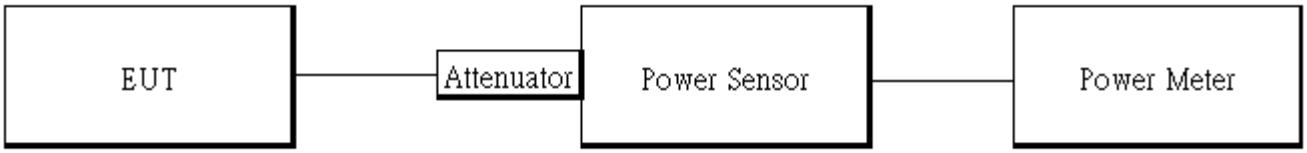
Note: When the antenna gain is greater than 6 dBi, the power limit attenuated accordingly.

8.2 Test Setup

8.2.1 Duty Cycle



8.2.2 Output Power



8.3 Measurement Procedure:

8.3.1 Duty Cycle

1. Place the EUT on the table and set it in transmitting mode.
2. Set span = Zero
3. RBW = 8MHz, VBW = 8MHz,
4. Detector = Peak

8.4 Output Power

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
4. Record the max. Reading as observed from Power Meter.
5. Repeat above procedures until all test default channel measured was complete.

8.5 Duty Factor:

LoRa SF7 Internal antenna

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
LoRa 500k	99.17	0.04	0.01	0.01

LoRa SF7 External antenna

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
LoRa 500k	99.45	0.02	0.01	0.01

LoRa SF11 Internal antenna

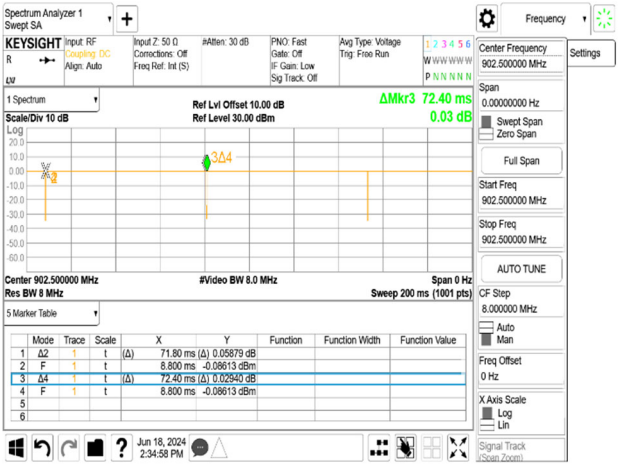
	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
LoRa 500k	100.00	0.00	0.00	0.01

LoRa SF11 External antenna

	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
LoRa 500k	100.00	0.00	0.00	0.01

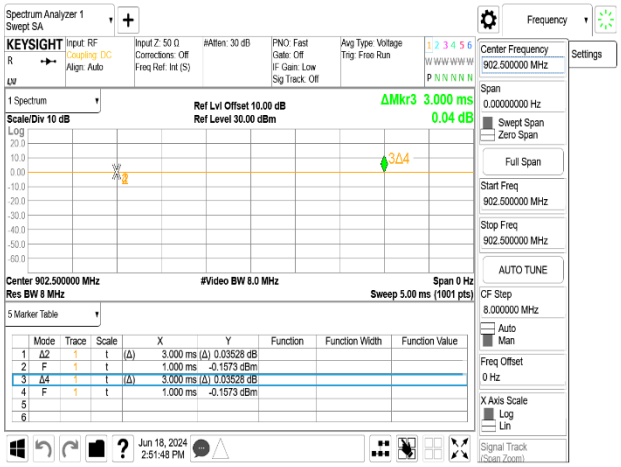
LoRa SF7 Internal antenna

LoRa_LowCH-902.5MHz



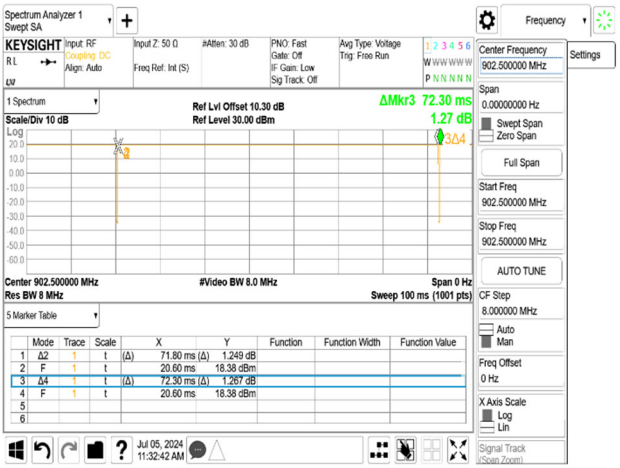
LoRa SF11 Internal antenna

LoRa_LowCH-902.5MHz



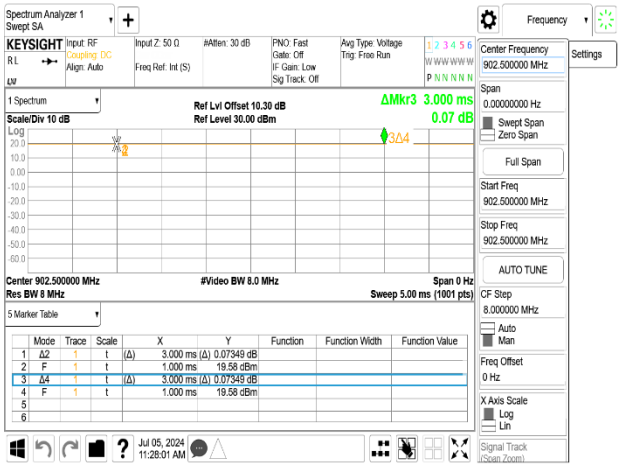
LoRa SF7 External antenna

LoRa_LowCH-902.5MHz



LoRa SF11 External antenna

LoRa_LowCH-902.5MHz



8.6 Output Power:

8.6.1 Peak & Avg

LoRa SF7 Internal antenna

LoRa 500k mode(Payload S=2):

CH	Frequency (MHz)	Power set	Peak Output Power (dBm)	Required Limit (dBm)
Low	902.5	20	**21.49**	30
Mid	914.5	20	21.44	30
High	926.5	20	21.41	30
CH	**Frequency (MHz)**	**Power set**	**Avg. Output Power (dBm)**	**Required Limit (dBm)**
Low	902.5	20	20.99	30
Mid	914.5	20	20.93	30
High	926.5	20	20.90	30

Note:

1.Measured by power meter, cable loss 10 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

LoRa SF7 External antenna

LoRa 500k mode(Payload S=2):

CH	Frequency (MHz)	Power set	Peak Output Power (dBm)	Required Limit (dBm)
Low	902.5	20	**21.22**	30
Mid	914.5	20	21.19	30
High	926.5	20	21.14	30
CH	**Frequency (MHz)**	**Power set**	**Avg. Output Power (dBm)**	**Required Limit (dBm)**
Low	902.5	20	20.71	30
Mid	914.5	20	20.65	30
High	926.5	20	20.59	30

Note:

1.Measured by power meter, cable loss 10.3 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

LoRa SF11 Internal antenna

LoRa 500k mode(Payload S=2):

CH	Frequency (MHz)	Power set	Peak Output Power (dBm)	Required Limit (dBm)
Low	902.5	20	**21.49**	30
Mid	914.5	20	21.44	30
High	926.5	20	21.42	30
CH	**Frequency (MHz)**	**Power set**	**Avg. Output Power (dBm)**	**Required Limit (dBm)**
Low	902.5	20	21.43	30
Mid	914.5	20	21.39	30
High	926.5	20	21.35	30

Note:

1.Measured by power meter, cable loss 10 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

LoRa SF11 External antenna

LoRa 500k mode(Payload S=2):

CH	Frequency (MHz)	Power set	Peak Output Power (dBm)	Required Limit (dBm)
Low	902.5	20	**21.44**	30
Mid	914.5	20	21.36	30
High	926.5	20	21.41	30
CH	**Frequency (MHz)**	**Power set**	**Avg. Output Power (dBm)**	**Required Limit (dBm)**
Low	902.5	20	21.36	30
Mid	914.5	20	21.31	30
High	926.5	20	21.33	30

Note:

1.Measured by power meter, cable loss 10.3 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

8.6.2 EIRP

LoRa SF7 Internal antenna

EIRP LoRa 500k mode(Payload S=2)

CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	902.5	20	20.99	-2.88	18.11	4W= 36 dBm
Mid	914.5	20	20.93	-2.88	18.05	4W= 36 dBm
High	926.5	20	20.90	-2.88	18.02	4W= 36 dBm

* ***Note:*** EIRP = Average Power + Gain

LoRa SF7 External antenna

EIRP LoRa 500k mode(Payload S=2)

CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	902.5	20	20.71	0.37	21.08	4W= 36 dBm
Mid	914.5	20	20.65	0.37	21.02	4W= 36 dBm
High	926.5	20	20.59	0.37	20.96	4W= 36 dBm

* ***Note:*** EIRP = Average Power + Gain

LoRa SF11 Internal antenna

EIRP LoRa 500k mode(Payload S=2)

CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	902.5	20	21.43	-2.88	18.55	4W= 36 dBm
Mid	914.5	20	21.39	-2.88	18.51	4W= 36 dBm
High	926.5	20	21.35	-2.88	18.47	4W= 36 dBm

* ***Note:*** EIRP = Average Power + Gain

LoRa SF11 External antenna

EIRP LoRa 500k mode(Payload S=2)

CH	Frequency (MHz)	Power set	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit
Low	902.5	20	21.36	0.37	21.73	4W= 36 dBm
Mid	914.5	20	21.31	0.37	21.68	4W= 36 dBm
High	926.5	20	21.33	0.37	21.70	4W= 36 dBm

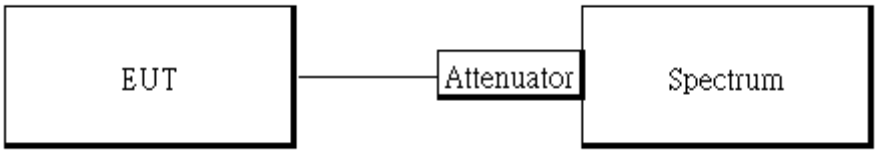
* ***Note:*** EIRP = Average Power + Gain

9 EMISSION BANDWIDTH MEASUREMENT

9.1 Standard Applicable

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

9.2 Test Setup



9.3 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

9.3.1 6dB BW measurements

1. The testing follows the Measurement Procedure of the KDB 558074 D01.
2. Set the spectrum analyzer as
   RBW= 100 kHz ,
   VBW = 3 X RBW,
   Span= 2 to 5 times of the OBW,
   Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of -6dB.
4. Repeat above procedures until all test default channel is completed.

9.3.2 99% BW measurements

1. The testing follows the Measurement Procsedure of the RSS-Gen section 6.7.
2. Set the spectrum analyzer as
   RBW= 1 % to 5% of 99%,
   VBW ≥ 3 X RBW,
   Span= large enough to capture all products of the modulation process
   Sweep=auto, Detector = Peak, and Max hold.
3. Mark the upper and lower frequencies of 99%.
4. Repeat above procedures until all test default channel is completed.

9.4 Measurement Result:

9.4.1 6dB BW measurements

LoRa SF7 Internal antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
902.5	0.6212	≧ 0.5	PASS
914.5	0.6212	≧ 0.5	PASS
926.5	0.6259	≧ 0.5	PASS

LoRa SF7 External antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
902.5	0.6252	≧ 0.5	PASS
914.5	0.6245	≧ 0.5	PASS
926.5	0.6182	≧ 0.5	PASS

LoRa SF11 Internal antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
902.5	0.6437	≧ 0.5	PASS
914.5	0.6457	≧ 0.5	PASS
926.5	0.6434	≧ 0.5	PASS

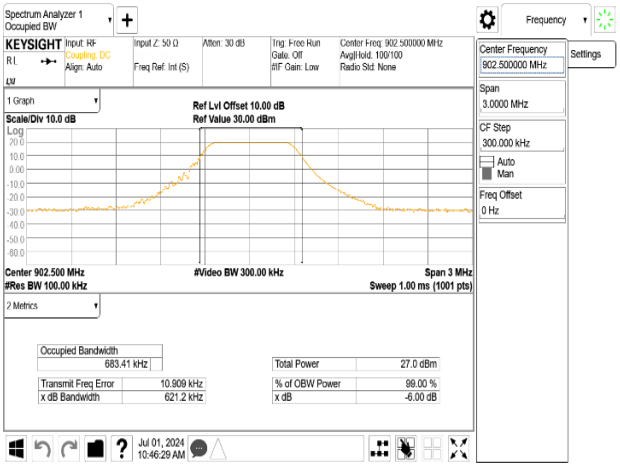
LoRa SF11 External antenna

LoRa 500k mode(Payload S=2)

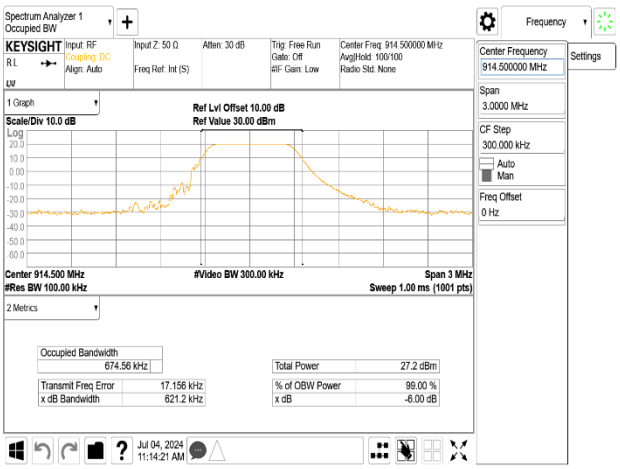
Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
902.5	0.6444	≧ 0.5	PASS
914.5	0.6456	≧ 0.5	PASS
926.5	0.6438	≧ 0.5	PASS

LoRa SF7 Internal antenna

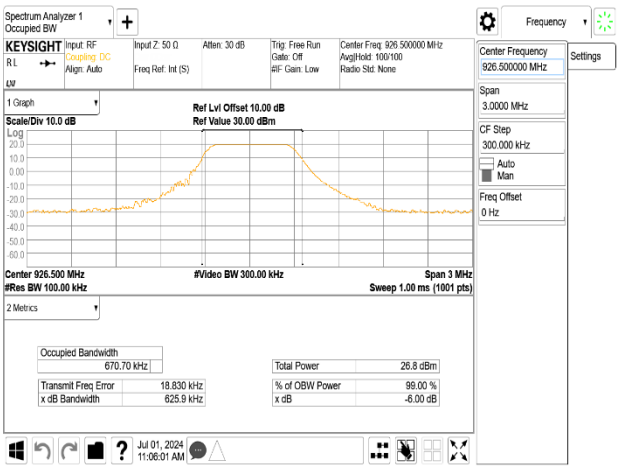
OBW_LoRa_LowCH-902.5MHz



OBW_LoRa_MidCH-914.5MHz

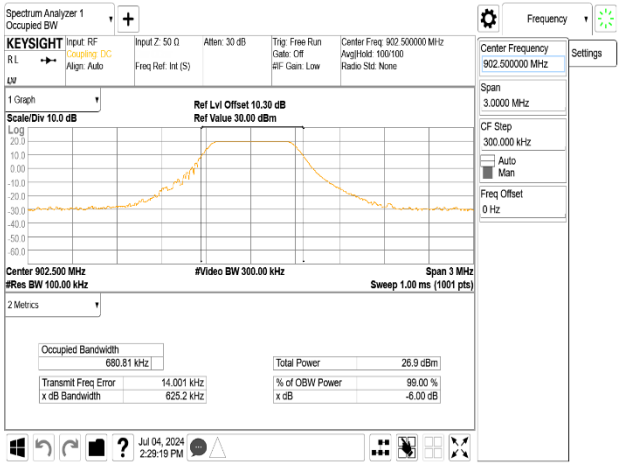


OBW_LoRa_HighCH-926.5MHz

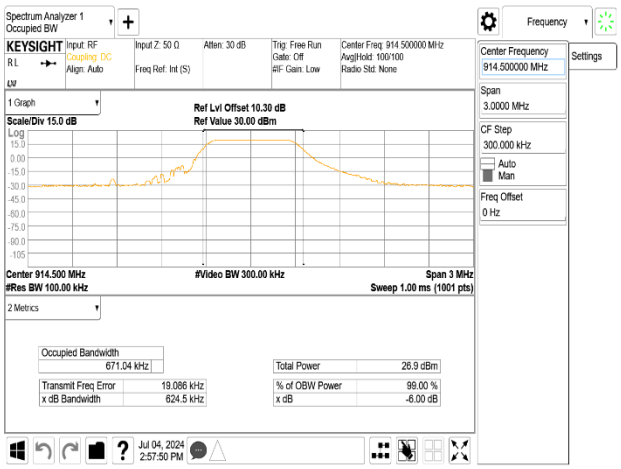


LoRa SF7 External antenna

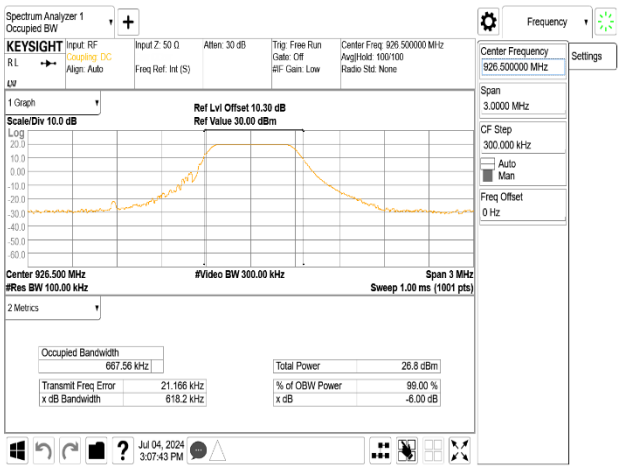
OBW_LoRa_LowCH-902.5MHz



OBW_LoRa_MidCH-914.5MHz

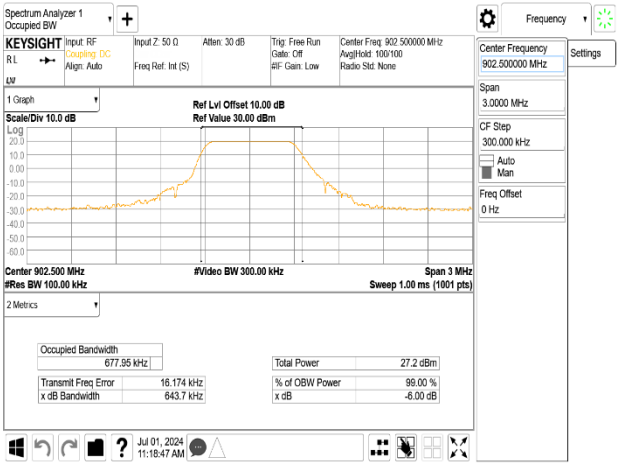


OBW_LoRa_HighCH-926.5MHz

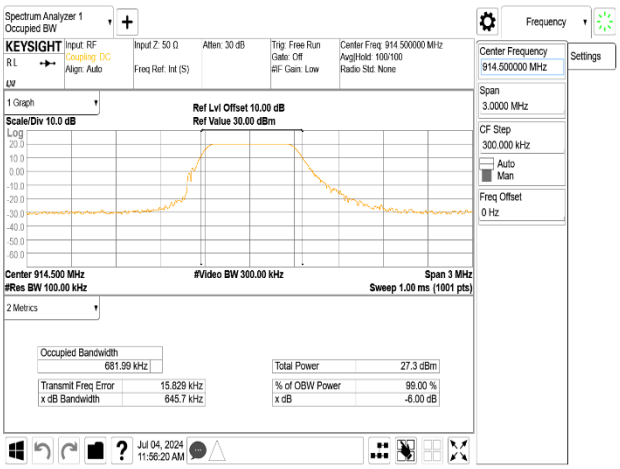


LoRa SF11 Internal antenna

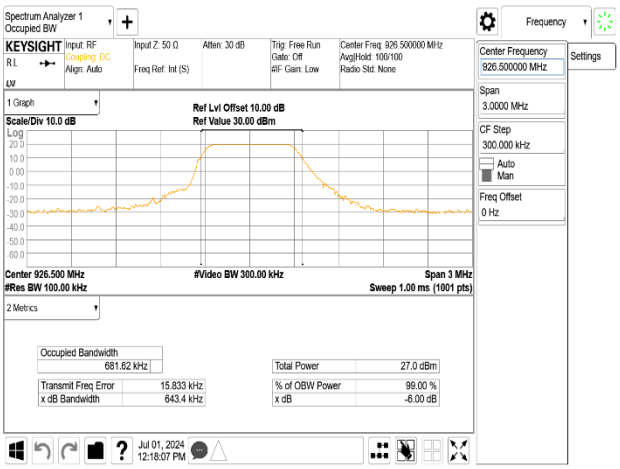
OBW_LoRa_LowCH-902.5MHz



OBW_LoRa_MidCH-914.5MHz

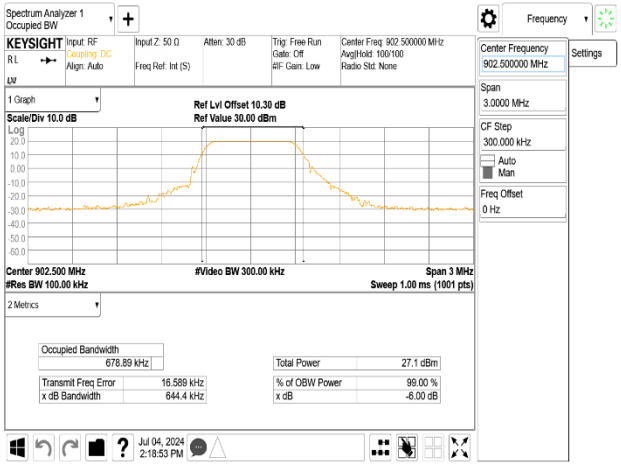


OBW_LoRa_HighCH-926.5MHz

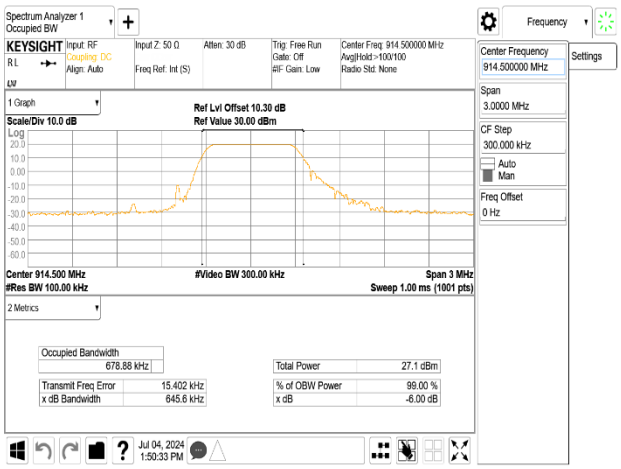


LoRa SF11 External antenna

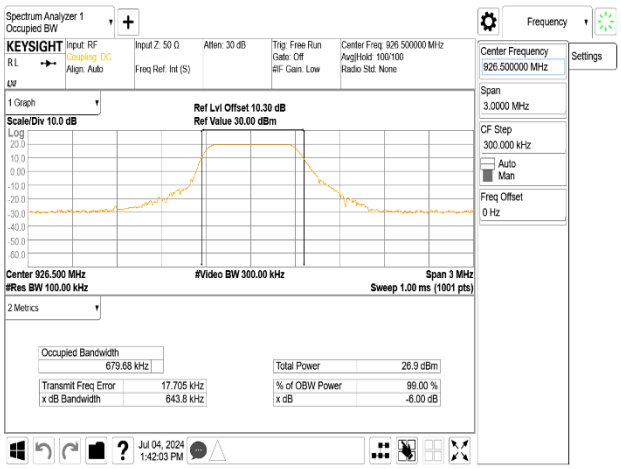
OBW_LoRa_LowCH-902.5MHz



OBW_LoRa_MidCH-914.5MHz



OBW_LoRa_HighCH-926.5MHz



9.4.2 99% Bandwidth

LoRa SF7 Internal antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	99%Bandwidth (MHz)
902.5	0.52266
914.5	0.52475
926.5	0.52267

LoRa SF7 External antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	99%Bandwidth (MHz)
902.5	0.52490
914.5	0.52306
926.5	0.52152

LoRa SF11 Internal antenna

LoRa 500k mode(Payload S=2)

Frequency (MHz)	99%Bandwidth (MHz)
902.5	0.53775
914.5	0.53844
926.5	0.53854

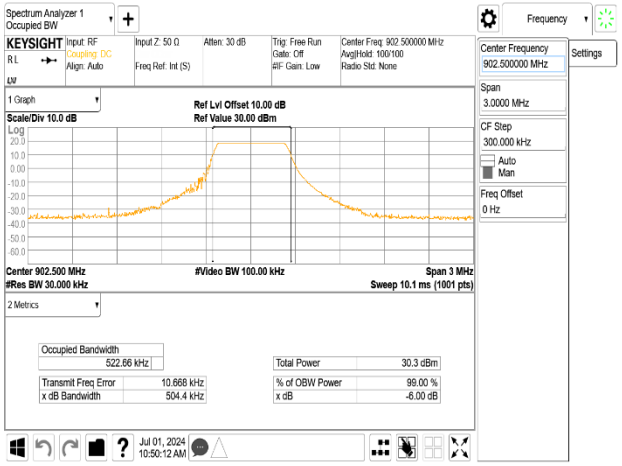
LoRa SF11 External antenna

LoRa 500k mode(Payload S=2)

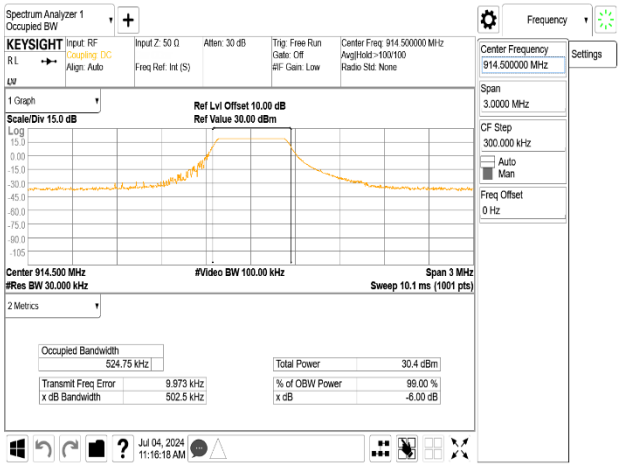
Frequency (MHz)	99%Bandwidth (MHz)
902.5	0.53761
914.5	0.54001
926.5	0.53892

LoRa SF7 Internal antenna

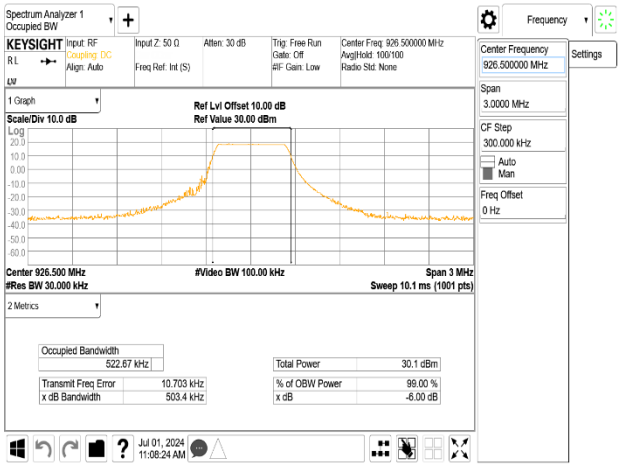
IC OBW_LoRa_LowCH-902.5MHz



IC OBW_LoRa_MidCH-914.5MHz

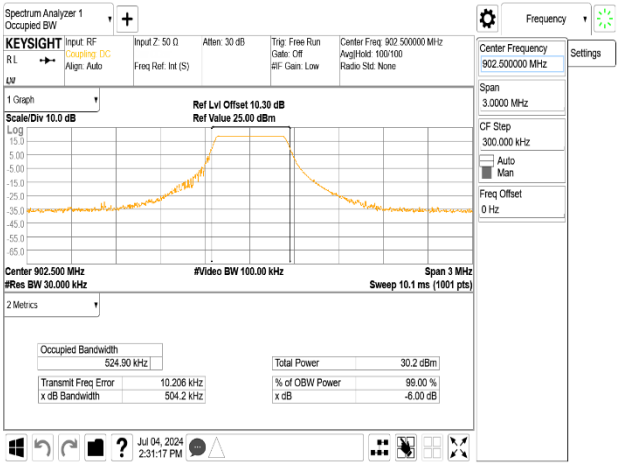


IC OBW_LoRa_HighCH-926.5MHz

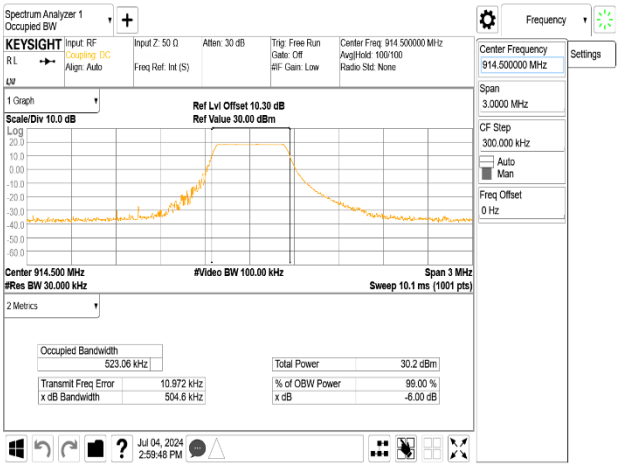


LoRa SF7 External antenna

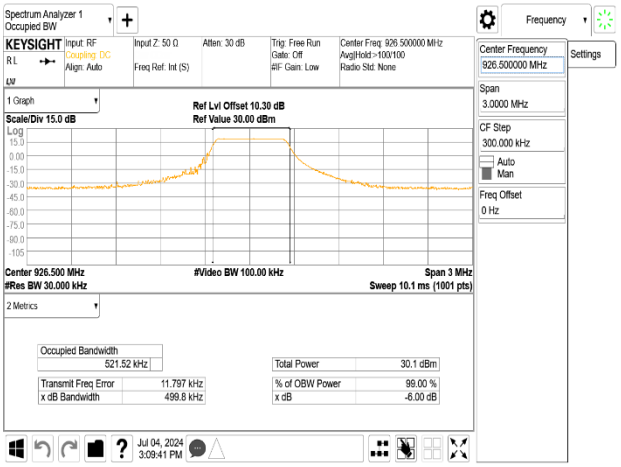
IC OBW_LoRa_LowCH-902.5MHz



IC OBW_LoRa_MidCH-914.5MHz

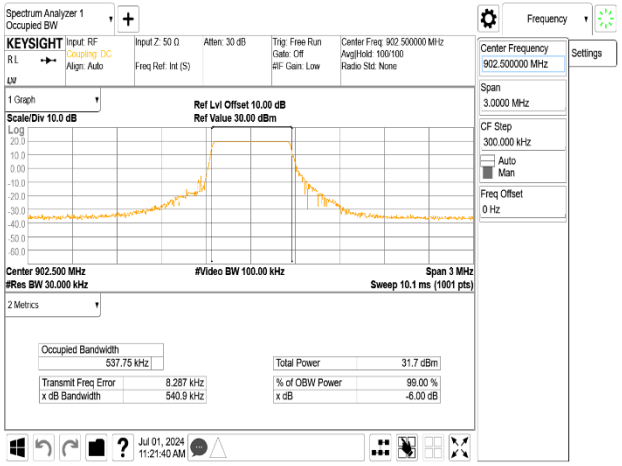


IC OBW_LoRa_HighCH-926.5MHz

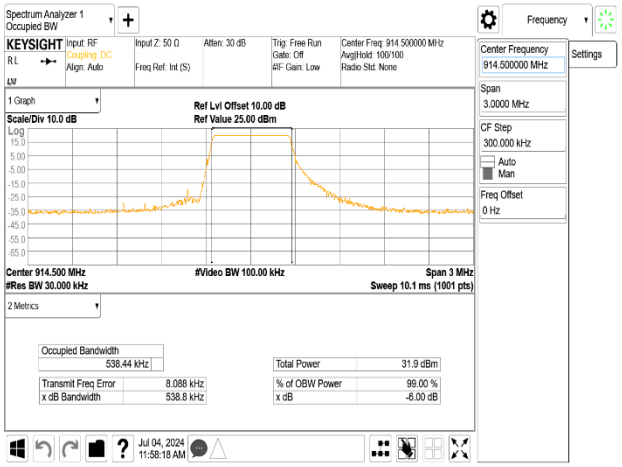


LoRa SF11 Internal antenna

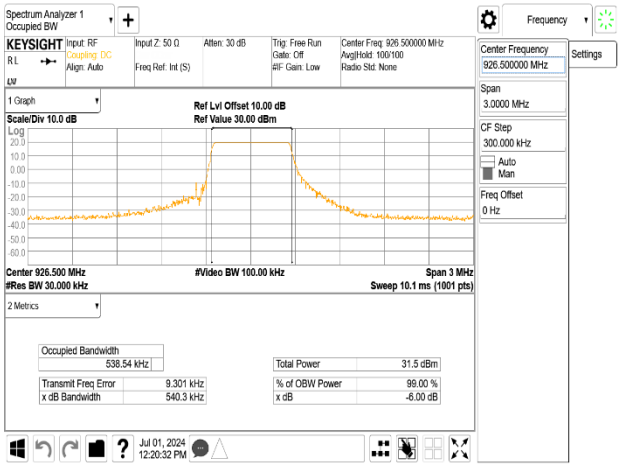
IC OBW_LoRa_LowCH-902.5MHz



IC OBW_LoRa_MidCH-914.5MHz

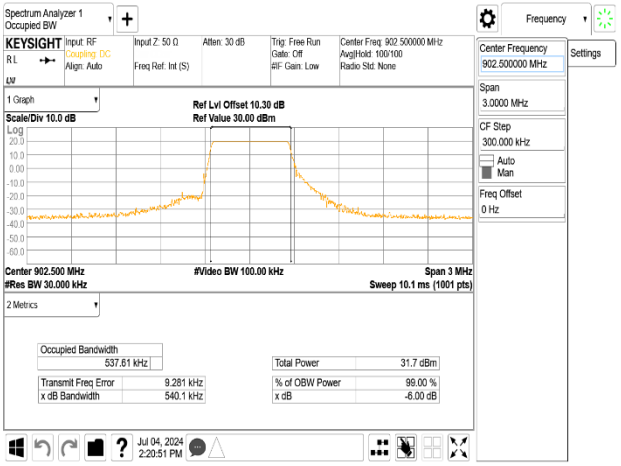


IC OBW_LoRa_HighCH-926.5MHz

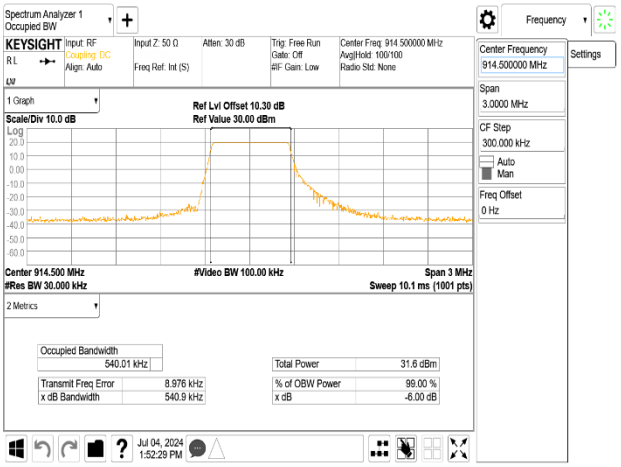


LoRa SF11 External antenna

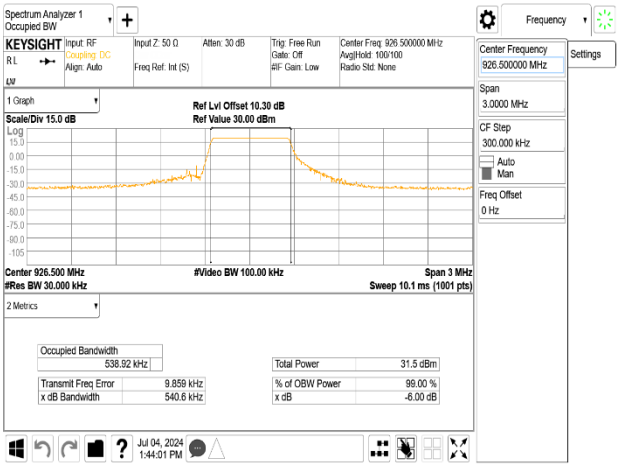
IC OBW_LoRa_LowCH-902.5MHz



IC OBW_LoRa_MidCH-914.5MHz



IC OBW_LoRa_HighCH-926.5MHz

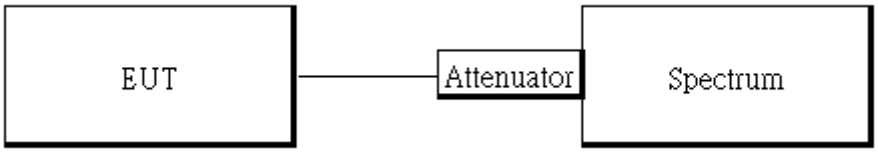


10 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) & RSS-Gen §8.10, must also comply with the radiated emission limits specified in §15.209(a) & RSS-Gen §8.9..

10.2 Test Setup



10.3 Measurement Procedure

10.3.1 Reference Level of Emission Limit:

1. Set analyzer center frequency to DTS channel center frequency.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set the span to 1.5 times the DTS channel bandwidth.
4. Set the RBW = 100kHz & VBW = 300 kHz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

10.3.2 Conducted Band Edge:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
6. Set DL as the limit = OFDM 4M & 8M reading on marker of reference level measurement -20dBm.
7. Mark the highest readings of the emissions outside of 902-928 MHz.
8. Repeat above procedures until all default test channel (low, middle, and high) was complete.

10.3.3 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

10.4 Measurement Result

LoRa SF7 Internal antenna

LoRa 500k(Payload S=2)_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
902.5	19.52	-0.48
914.5	19.69	-0.31
926.5	19.37	-0.63

Note:

1.cable loss as 10dB that offsets in the spectrum
2.Refer to next page for plots.

LoRa SF7 External antenna

LoRa 500k(Payload S=2)_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
902.5	19.49	-0.51
914.5	19.40	-0.60
926.5	19.33	-0.67

Note:

1.cable loss as 10.3dB that offsets in the spectrum
2.Refer to next page for plots.

LoRa SF11 Internal antenna

LoRa 500k(Payload S=2)_Reference Level of Limit

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
902.5	19.54	-0.46
914.5	19.72	-0.28
926.5	19.34	-0.66

Note:

1.cable loss as 10dB that offsets in the spectrum
2.Refer to next page for plots.

LoRa SF11 External antenna

LoRa 500k(Payload S=2)_Reference Level of Limit

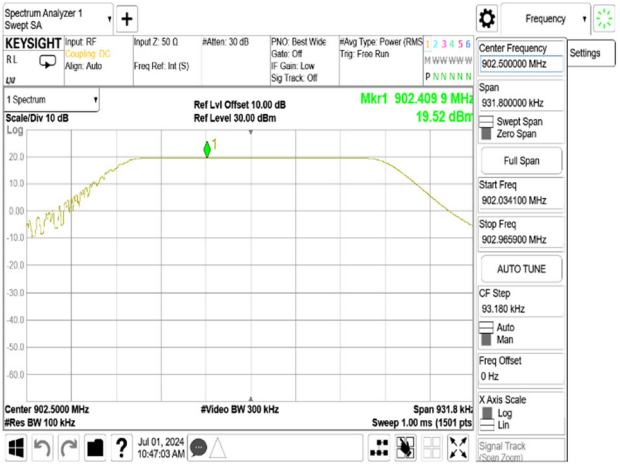
Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
902.5	19.52	-0.48
914.5	19.46	-0.54
926.5	19.34	-0.66

Note:

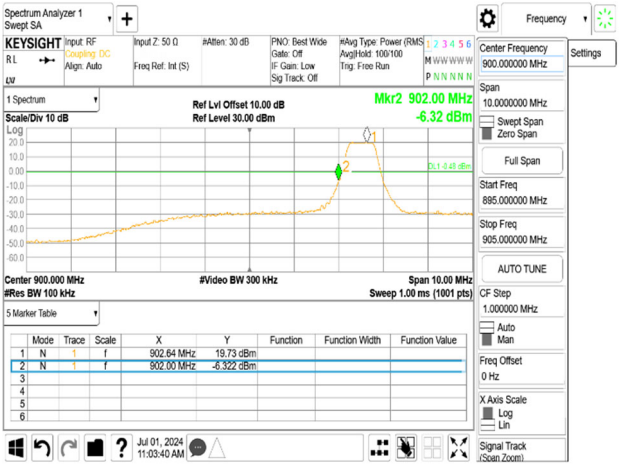
1.cable loss as 10.3dB that offsets in the spectrum
2.Refer to next page for plots.

LoRa SF7 Internal antenna

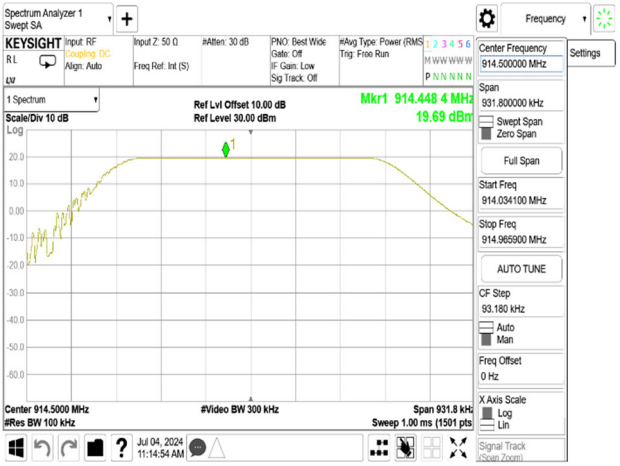
Reference Level_LoRa_LowCH-902.5MHz



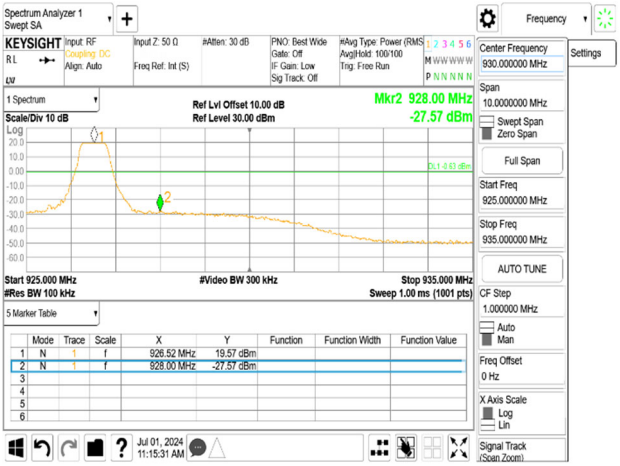
Band Edge_LoRa_LowCH-902.5MHz



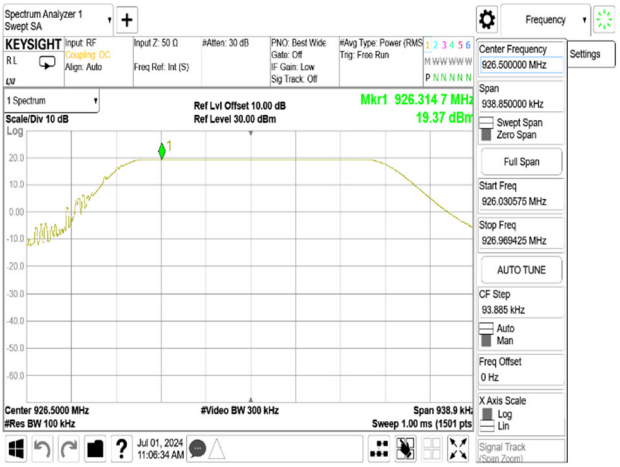
Reference Level_LoRa_MidCH-914.5MHz



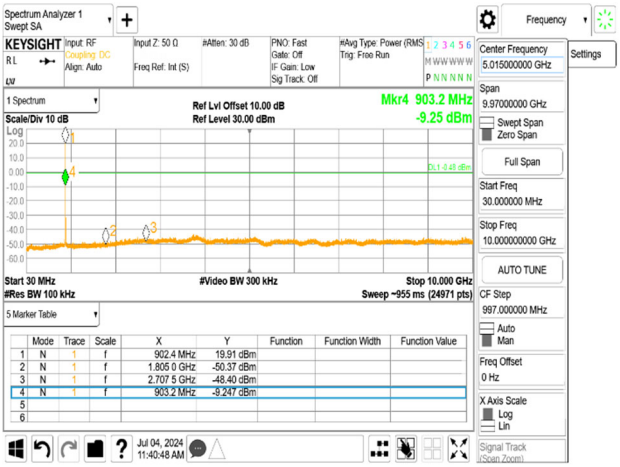
Band Edge_LoRa_HighCH-926.5MHz



Reference Level_LoRa_HighCH-926.5MHz



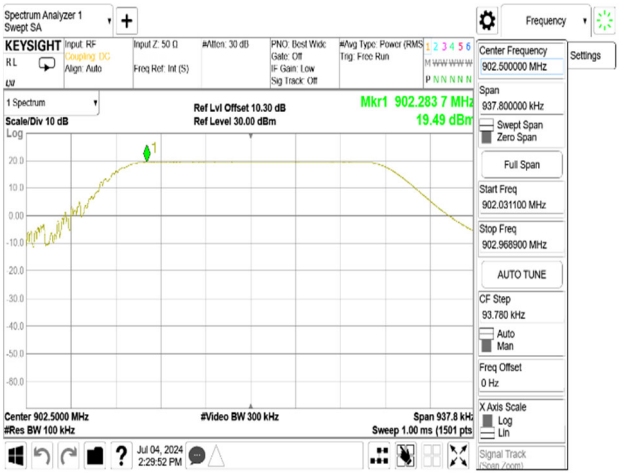
Spurious Emission_LoRa_LowCH-902.5MHz



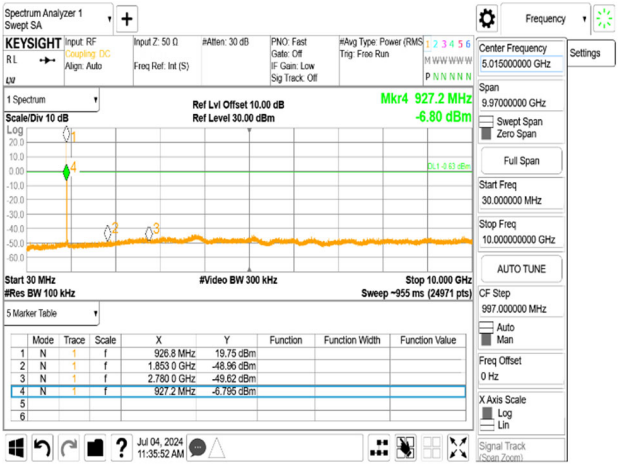
LoRa SF7 External antenna

Spurious Emission_LoRa_MidCH-914.5MHz

Reference Level_LoRa_LowCH-902.5MHz



Spurious Emission_LoRa_HighCH-926.5MHz



Reference Level_ LoRa_MidCH-914.5MHz

Reference Level_ LoRa_HighCH-926.5MHz