ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

Applicant:	Ring LLC 12515 Cerise Ave Hawthorne California 90250 United States
Manufacturer:	Ring LLC 12515 Cerise Ave Hawthorne California 90250 United States
Product Name:	Transformer
Brand Name:	ring
Model No.: **/ISED HVIN:**	5AT1S9
ISED PMN:	5AT1S9
Report Number:	TERF2408002327E2
FCC ID	2AEUPBHALV002
IC:	20271-BHALV002
Date of EUT Received:	August 8, 2024
Date of Test:	August 8, 2024 ～ March 17, 2025
Issue Date:	April 16, 2025

Approved By Aken Huang
Aken Huang

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
TERF2408002327E2	00	C2PC for enabling a new modulation operating in 902.9-926.9MHz, and update applicant address	April 16, 2025	Yuri Tsai	

Note:

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

Contents

1 GENERAL INFORMATION

1.1 Product Description

Product Name:	Transformer
Brand Name:	ring
Model No.: /ISED HVIN:	5AT1S9
Hardware Version:	MP
Firmware Version:	5.0.3-81(rev.1)
EUT Series No.:	N/A
Power Supply:	120Vac
Test Software (Name/Version)	J-Link Commander V7.96i

1.2 RF Specification

Radio Technology:	FSK 100 Kbps
Frequency Range:	902 – 928MHz
Channel number:	31 channels
Modulation type:	FSK DTS
Transmit Power:	11.91 dBm (Peak)

1.3 Antenna Designation

Antenna Type	Freq. (MHz)	Peak Antenna Gain (dBi)
Internal Antenna	902~928	-3.8

Note: Antenna information is provided by the applicant.

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 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.

2.3.2 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

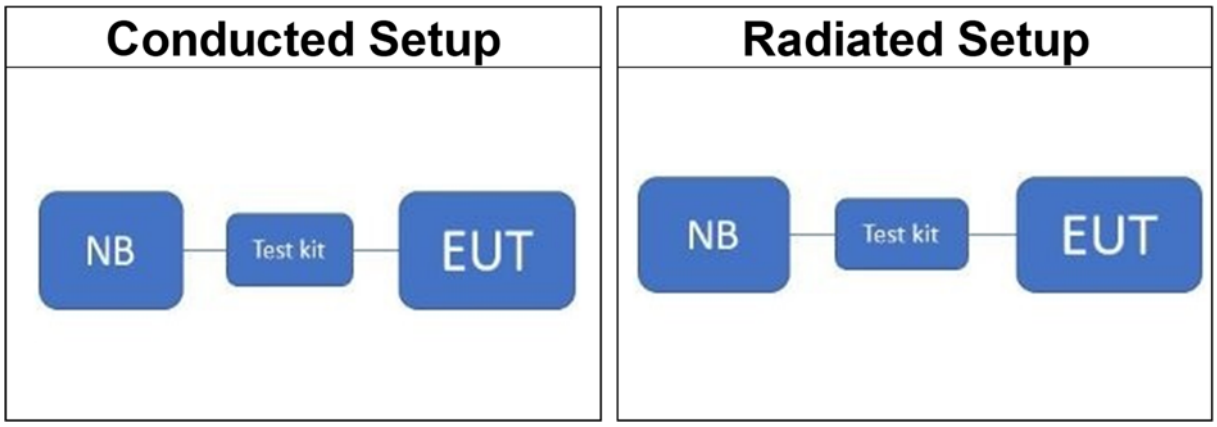
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

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 C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	Lenovo	T14	P0003332	N/A	N/A
J-LINK BASE COMPACT	SEGGER	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.
J-LINK BASE COMPACT	SEGGER	N/A	N/A	N/A	N/A
Notebook	Lenovo	T14	P0003332	N/A	N/A

3 SUMMARY OF TEST RESULTS

FCC Rules	ISED Rules	Description Of Test	Result
§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

4 DESCRIPTION OF TEST MODES

4.1 Operating Frequencies

	FSK 100Kbps	
	CH	Freq.(MHz)
Channel List	1	902.9
	2	903.7
	3	904.5
	4	905.3
	5	906.1
	6	906.9
	7	907.7
	8	908.5
	9	909.3
	10	910.1
	11	910.9
	12	911.7
	13	912.5
	14	913.3
	15	914.1
	16	914.9
	17	915.7
	18	916.5
	19	917.3
	20	918.1
	21	918.9
	22	919.7
	23	920.5
	24	921.3
	25	922.1
	26	922.9
	27	923.7
	28	924.5
	29	925.3
	30	926.1
	31	926.9

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 (kbps)
FSK 100Kbps	902 to 928	902.9,914.9,926.9	FSK DTS	100

TRANSMIT RADIATED EMISSION TEST (BELOW 1 GHz)		
MODE	AVAILABLE FREQUENCY	TESTED FREQUENCY
FSK 100Kbps	902.9 to 926.9	914.9
TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)		
MODE	AVAILABLE CHANNEL	TESTED CHANNEL
FSK 100Kbps	902.9 to 926.9	902.9,914.9,926.9

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 C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Attenuator	Woken	WATT-218FS-10	RF18	11/15/2023	11/14/2024
Attenuator	Woken	WATT-218FS-10	RF18	11/14/2024	11/13/2025
Attenuator	Woken	WATT-218FS-10	RF19	11/15/2023	11/14/2024
Attenuator	Woken	WATT-218FS-10	RF19	11/14/2024	11/13/2025
DC Block	PASTERNACK	PE8210	RF36	11/15/2023	11/14/2024
DC Block	PASTERNACK	PE8210	RF36	11/14/2024	11/13/2025
Power Meter	Anritsu	ML2496A	1804002	04/26/2024	04/25/2025
Power Sensor	Anritsu	MA2411B	1726105	04/26/2024	04/25/2025
Power Sensor	Anritsu	MA2411B	1726106	04/26/2024	04/25/2025
Spectrum Analyzer	KEYSIGHT	N9010B	MY59071573	05/24/2024	05/23/2025
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
Attenuator	Woken	WATT-218FS-10	RF17	11/15/2023	11/14/2024
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
Highpass Filter	Woken	EWT-57-0209	RF171	11/15/2023	11/14/2024
Horn Antenna	Schwarzbeck	BBHA9120D	1341	05/30/2024	05/29/2025
Notch Filter	Woken	EWT-54-0037	RF177	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC12630SE	980273	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: *No Calibration Required.*

7 PEAK OUTPUT POWER MEASUREMENT

7.1 Standard Applicable:

7.1.1 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.

7.1.2 ISED

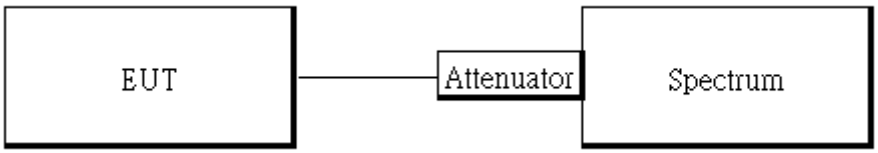
For systems using digital modulation in the 902-928 MHz bands, the limit for peak output power is 1Watt and the e.i.r.p. shall not exceed 4 W.

Note:

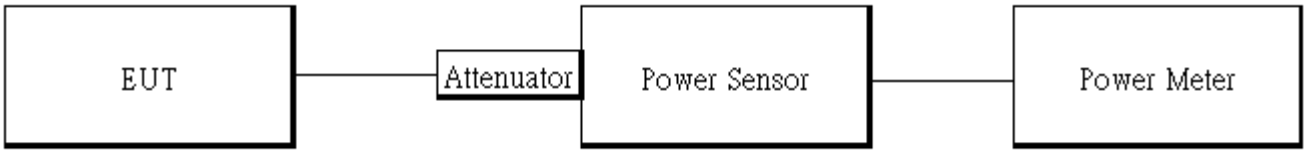
When the antenna gain is greater than 6 dBi, the power limit attenuated accordingly.

7.2 Test Setup

7.2.1 Duty Cycle



7.2.2 Output Power



7.3 Measurement Procedure:

7.3.1 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

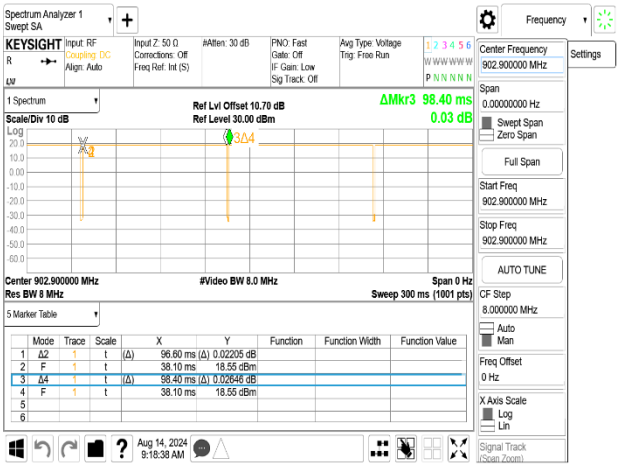
7.4 Output Power

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.

7.5 Duty Factor:

LoRa	Duty Cycle (%) = Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
FSK 100Kbps	98.17	0.08	0.01	0.01

FSK_100Kbps_LowCH-902.9MHz



7.6 Output Power:

7.6.1 Peak & Avg

LoRa 100Kbps 190kHz 950bytes 249 bytes

CH	Frequency (MHz)	Power Setting	Peak Output Power (dBm)	Required Limit (dBm)
Low	902.9	10	11.79	30
Mid	914.9	10	11.55	30
High	926.9	11	11.91	30
CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Required Limit (dBm)
Low	902.9	10	11.69	30
Mid	914.9	10	11.43	30
High	926.9	11	11.82	30

**Note:*

1.Measured by power meter, cable loss 10.7 dB + Duty cycle factor has been offseted to the power meter for Avg. power and cable loss has been offseted for Peak power measurement.

7.6.2 EIRP

EIRP LoRa 100Kbps 190kHz 950bytes 249 bytes

CH	Frequency (MHz)	Power Setting	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	Limit		
Low	902.9	10	11.69	-3.80	7.89	4W=	36	dBm
Mid	914.9	10	11.43	-3.80	7.63	4W=	36	dBm
High	926.9	11	11.82	-3.80	8.02	4W=	36	dBm

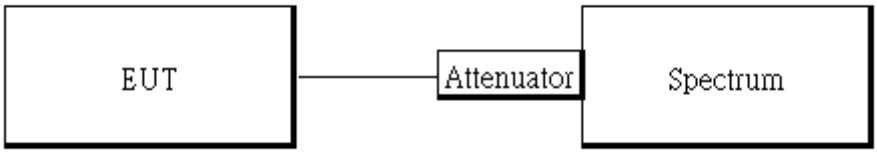
** Note:* EIRP = Average Power + Gain

8 EMISSION BANDWIDTH MEASUREMENT

8.1 Standard Applicable

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

8.2 Test Setup



8.3 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.

8.3.1 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.

8.3.2 99% BW measurements

1. The testing follows the Measurement Procedure 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.

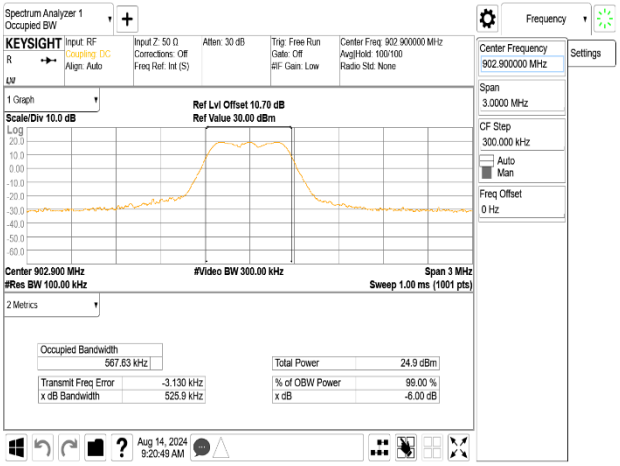
8.4 Measurement Result:

8.4.1 6dB BW measurements

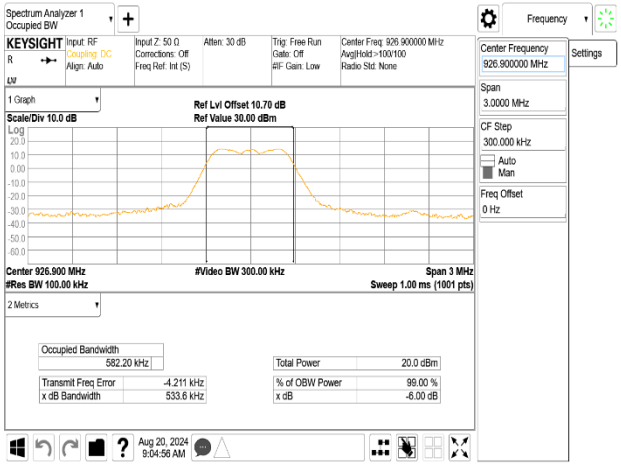
FSK 100Kbps

Frequency (MHz)	6dB BW (MHz)	Required BW (MHz)	Result
902.9	0.5259	≧ 0.5	PASS
914.9	0.5255	≧ 0.5	PASS
926.9	0.5336	≧ 0.5	PASS

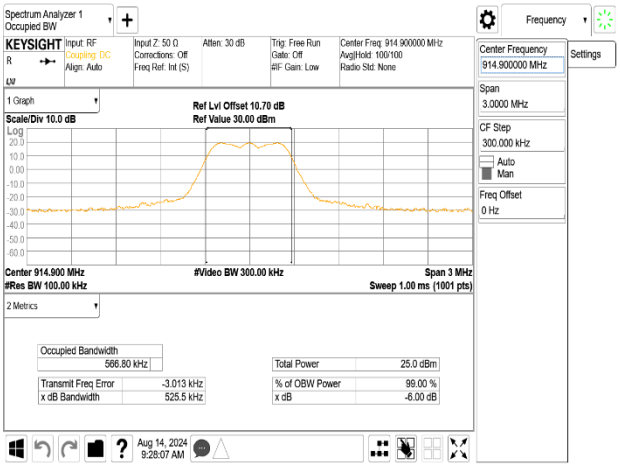
OBW_FSK_100Kbps_LowCH-902.9MHz



OBW_FSK_100Kbps_HighCH-926.9MHz



OBW_FSK_100Kbps_MidCH-914.9MHz

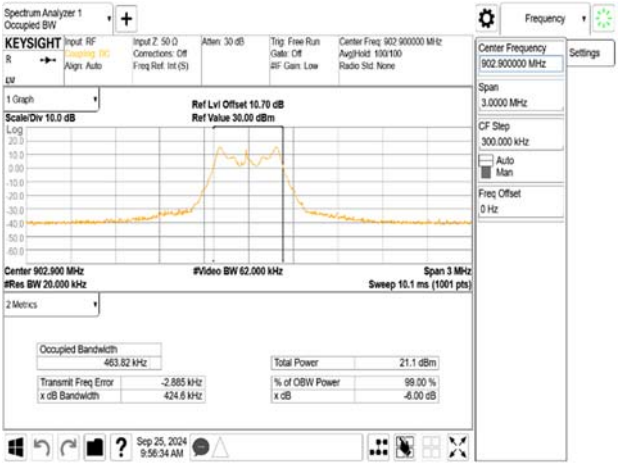


8.4.2 99% Bandwidth

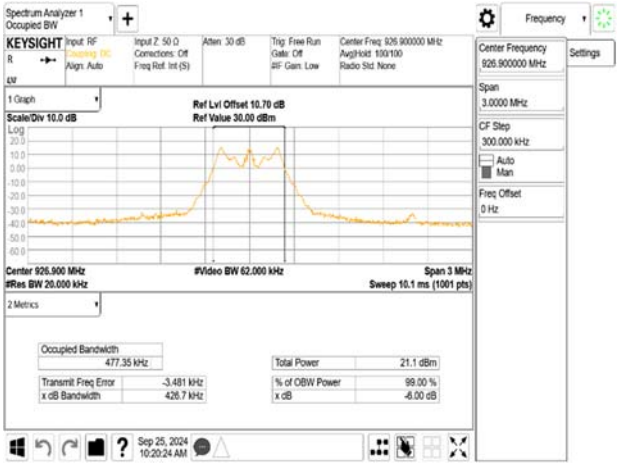
FSK 100Kbps

Frequency (MHz)	99%Bandwidth (MHz)
902.9	0.46382
914.9	0.46209
926.9	0.47735

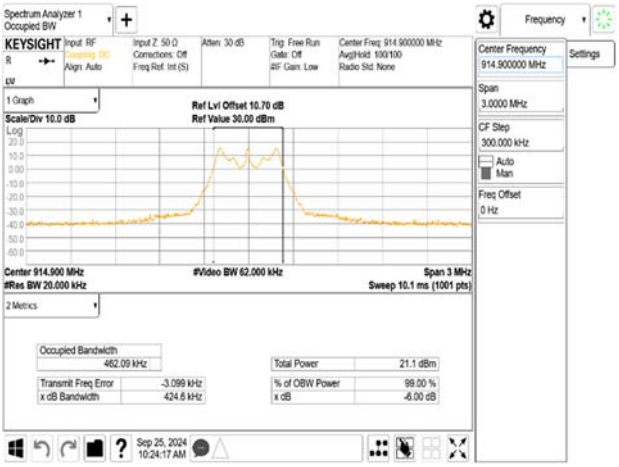
IC OBW_FSK_100Kbps_LowCH-902.9MHz



IC OBW_FSK_100Kbps_HighCH-926.9MHz



IC OBW_FSK_100Kbps_MidCH-914.9MHz

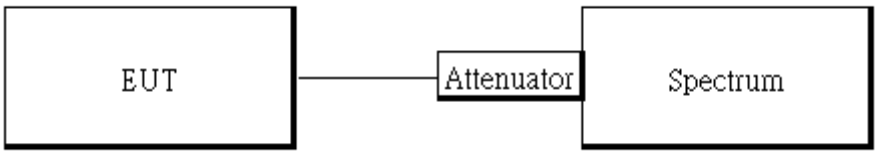


9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

9.1 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. 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.

9.2 Test Setup



9.3 Measurement Procedure

9.3.1 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.

9.3.2 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 =
   Reading on marker of reference level measurement – 30dBm
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.

9.3.3 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.

9.4 Measurement Result

LoRa 100Kbps 190kHz 950bytes 249 bytes

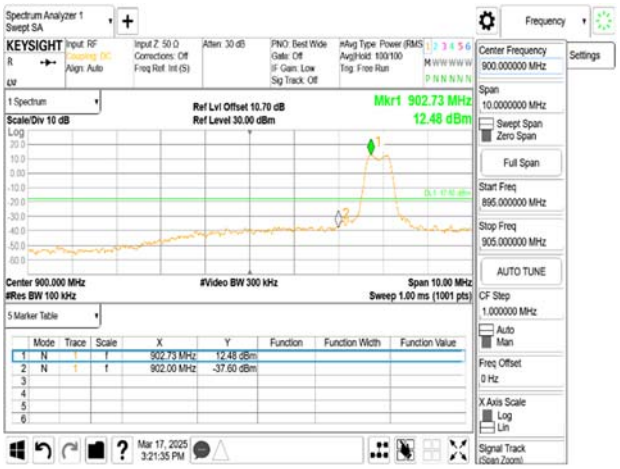
Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 30dB (dBm)
902.9	12.20	-17.80
914.9	11.87	-18.13
926.9	12.35	-17.65

**Note:*

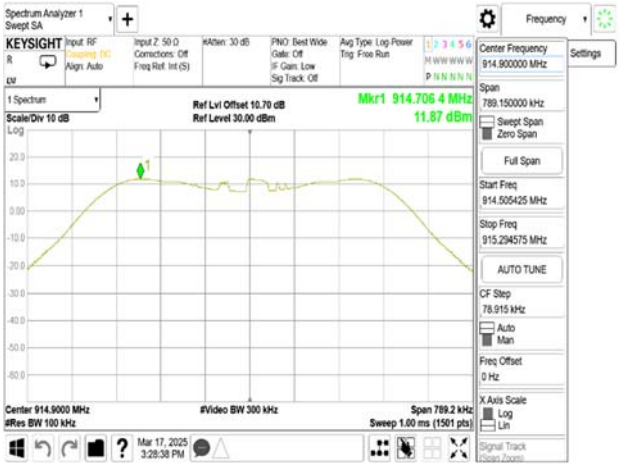
1.cable loss as 10.7dB that offsets in the spectrum
2.Refer to next page for plots.

Reference Level _FSK_100Kbps_LowCH-902.9MHz

Band Edge_FSK_100Kbps_LowCH-902.9MHz



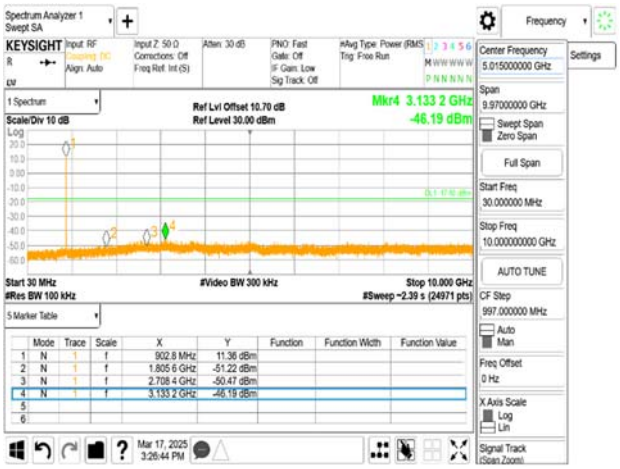
Reference Level _FSK_100Kbps_MidCH-914.9MHz



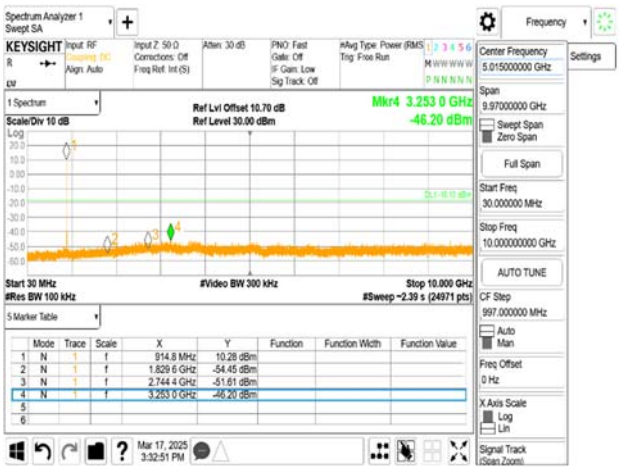
Band Edge_FSK_100Kbps_HighCH-926.9MHz

Reference Level _FSK_100Kbps_HighCH-926.9MHz

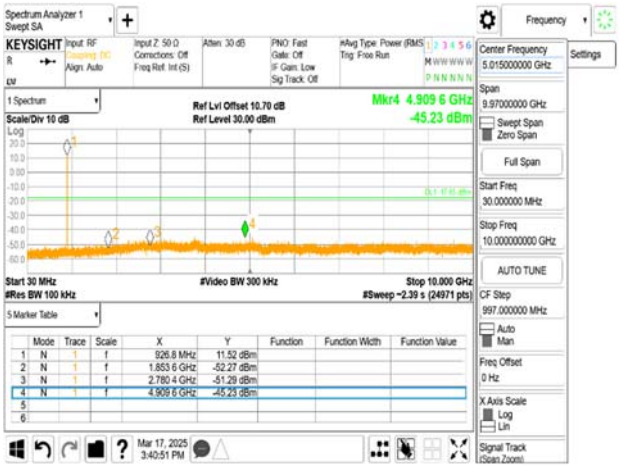
Spurious Emission_FSK_100Kbps_LowCH-902.9MHz



Spurious Emission_FSK_100Kbps_MidCH-914.9MHz



Spurious Emission_FSK_100Kbps_HighCH-926.9MHz



10 RADIATED BANDEDGE 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. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 and RSS-Gen §8.9 Table 5 and 6 limit as below.

And according to §15.33(a) (1) & RSS-Gen §6.13.2.a, for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

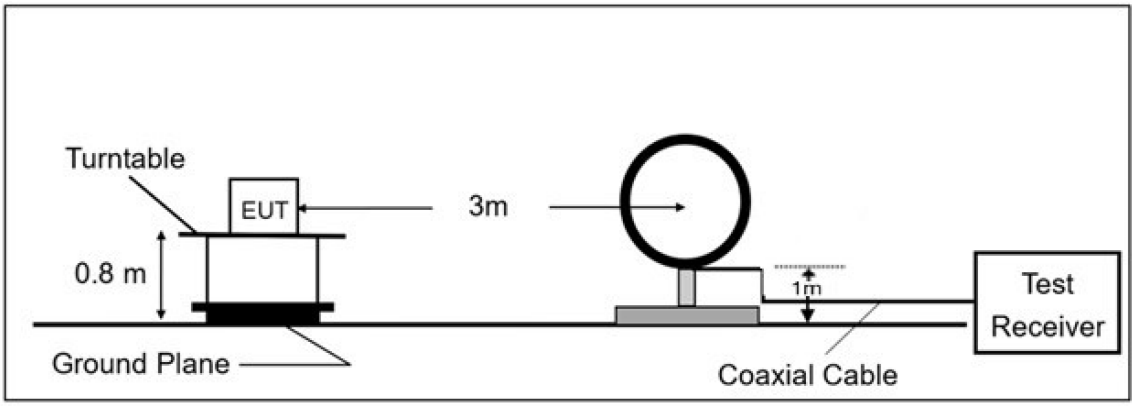
Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note:

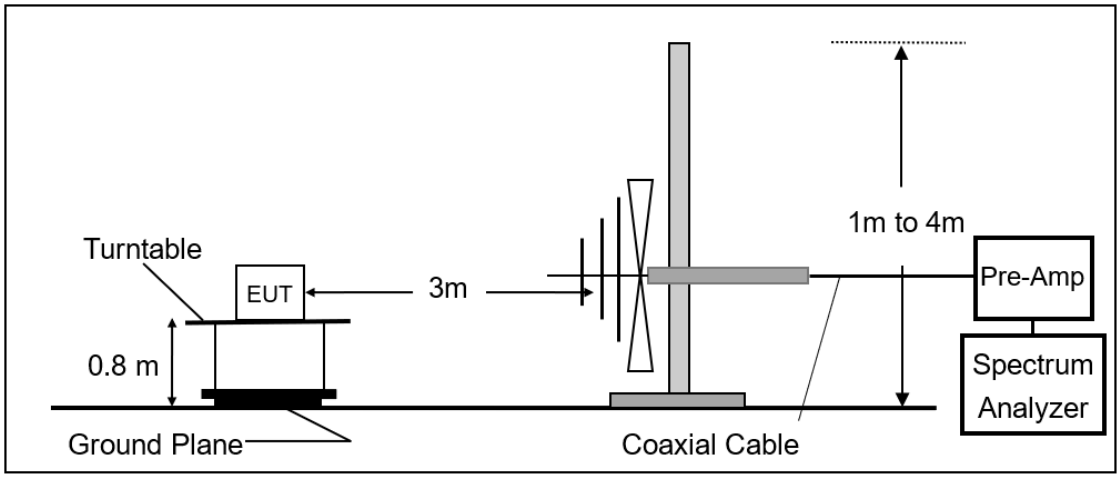
1. The lower limit shall apply at the transition frequencies.

10.2 Test Setup

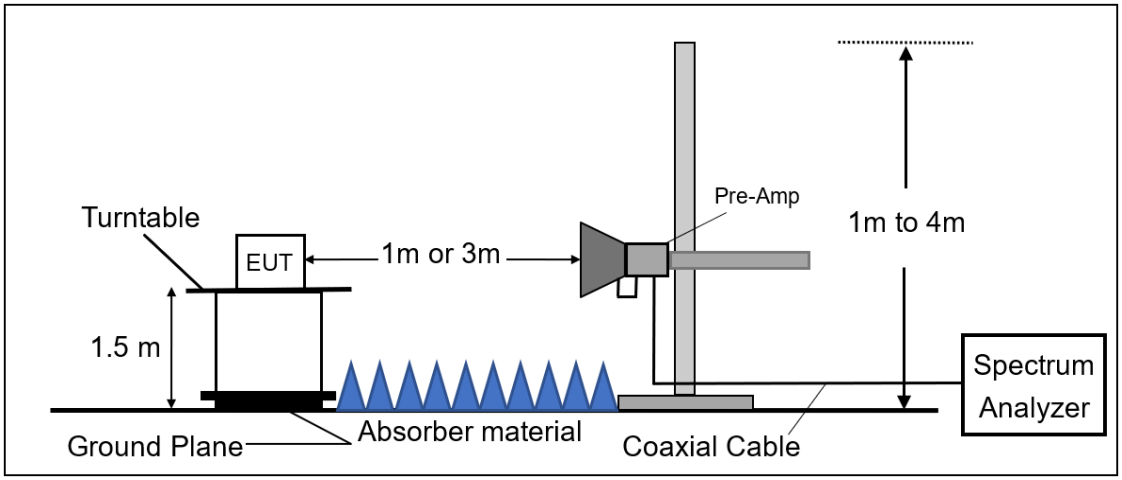
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



(C) Radiated Emission Test Set-Up, Frequency Above 1GHz.



10.3 Measurement Procedure

1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plane.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
6. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Maximum Emission Measurements at frequency above 1 GHz.
8. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Emission Measurements at frequency above 1 GHz.
9. When 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.
10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
12. Repeat above procedures until all default test channel measured were complete.

10.4 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where *FS = Field Strength* *CL = Cable Attenuation Factor (Cable Loss)*
RA = Reading Amplitude *AG = Amplifier Gain*
AF = Antenna Factor

*The limit of the emission level is expressed in dBuV/m, which converts 20*log(uV/m)*

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

10.5 Test Results of Radiated Spurious Emissions from 9 kHz to 30 MHz

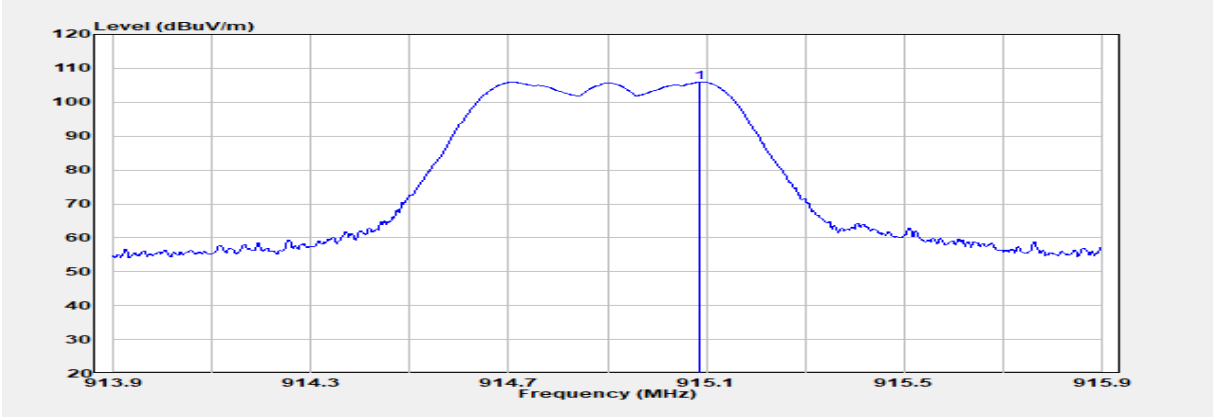
The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) & RSS-GEN §6.13.2 was not reported.

10.6 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

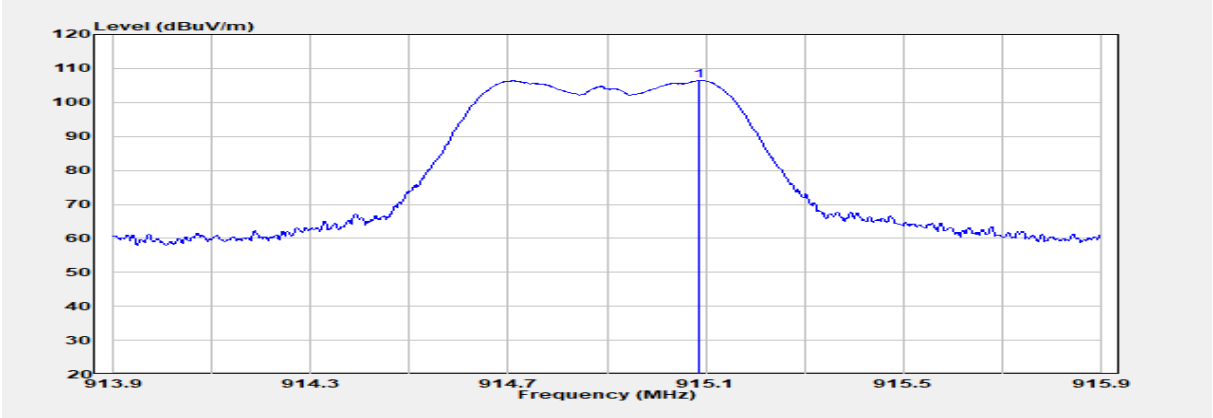
10.6.1 Radiated Main and Band Edge Measurement Result

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Main	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



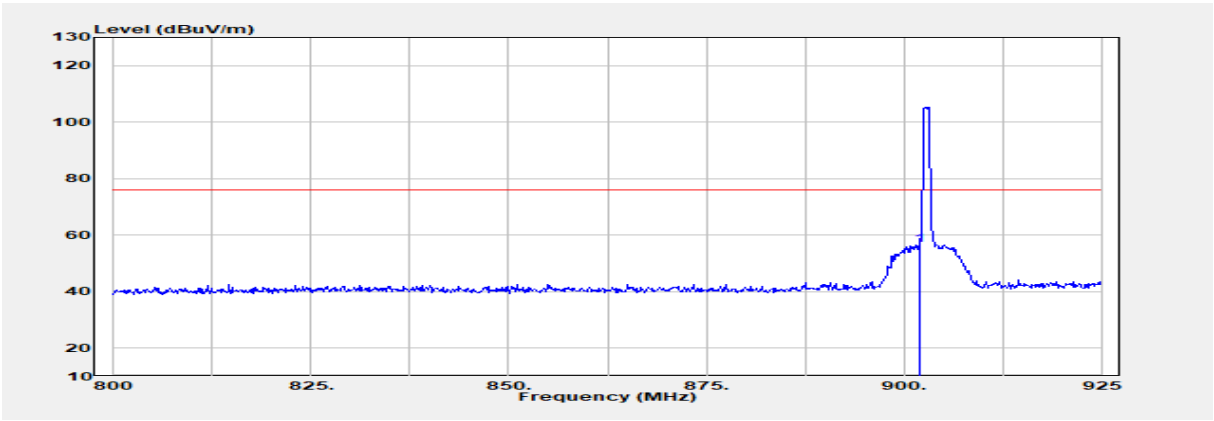
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
915.088	Peak	110.63	-4.66	105.97	-	-

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Main	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



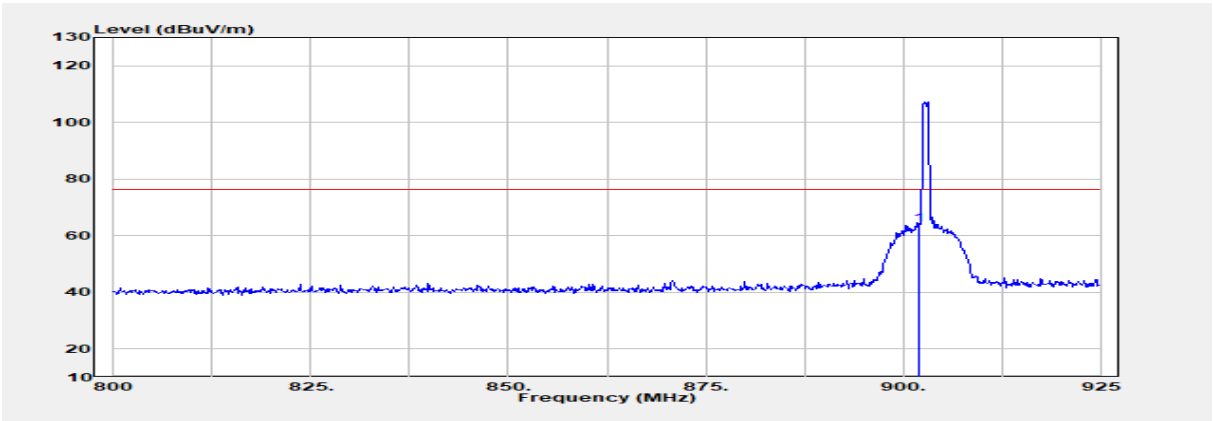
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
915.088	Peak	111.02	-4.66	106.36	-	-

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:902.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Bandedge	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



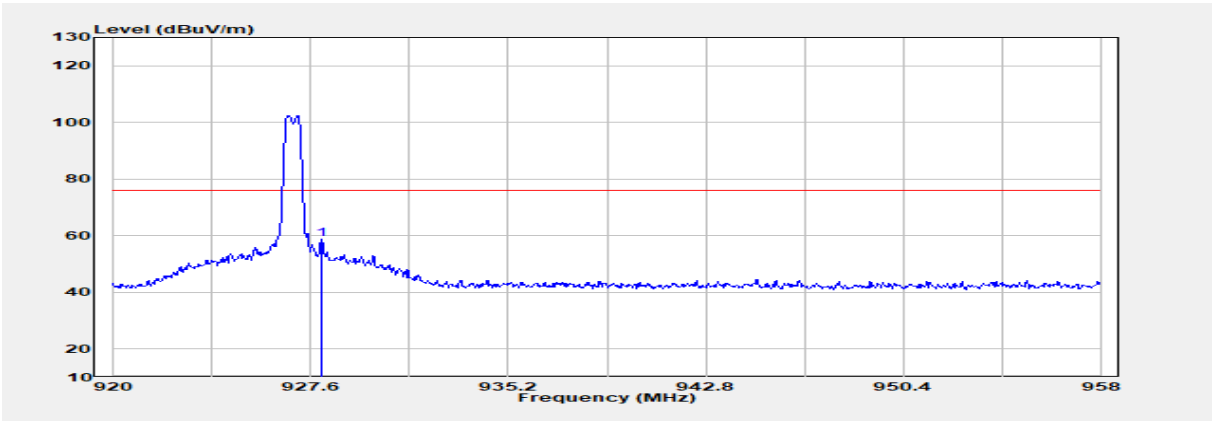
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
902.000	Peak	61.99	-5.34	56.65	75.97	-19.32

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:902.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Bandedge	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



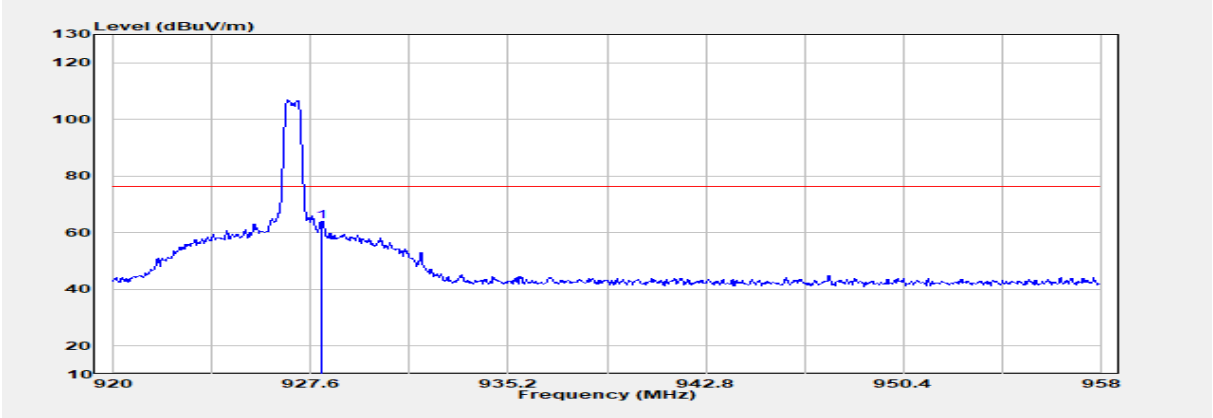
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
902.000	Peak	69.25	-5.34	63.91	76.36	-12.45

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:926.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Bandedge	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
928.000	Peak	62.91	-4.24	58.67	75.97	-17.30

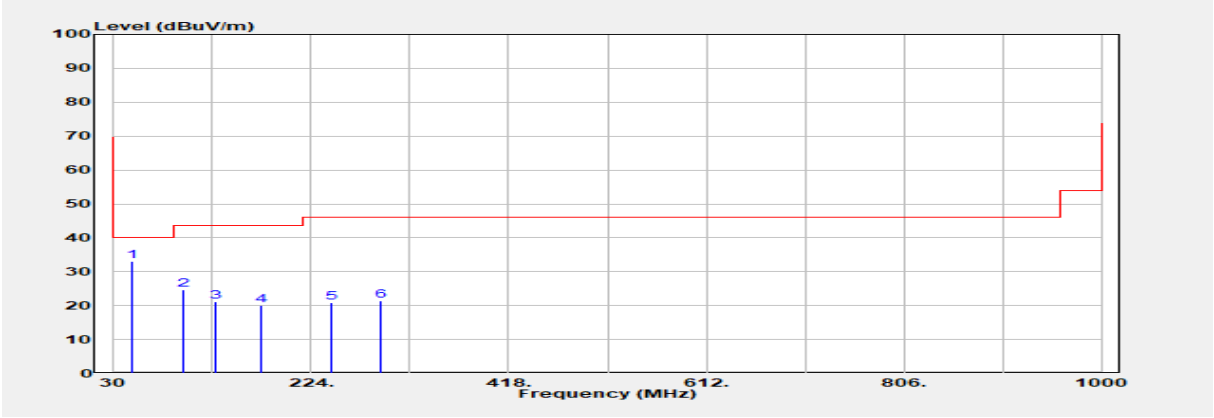
Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:926.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Bandedge	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
928.000	Peak	68.07	-4.24	63.83	76.36	-12.53

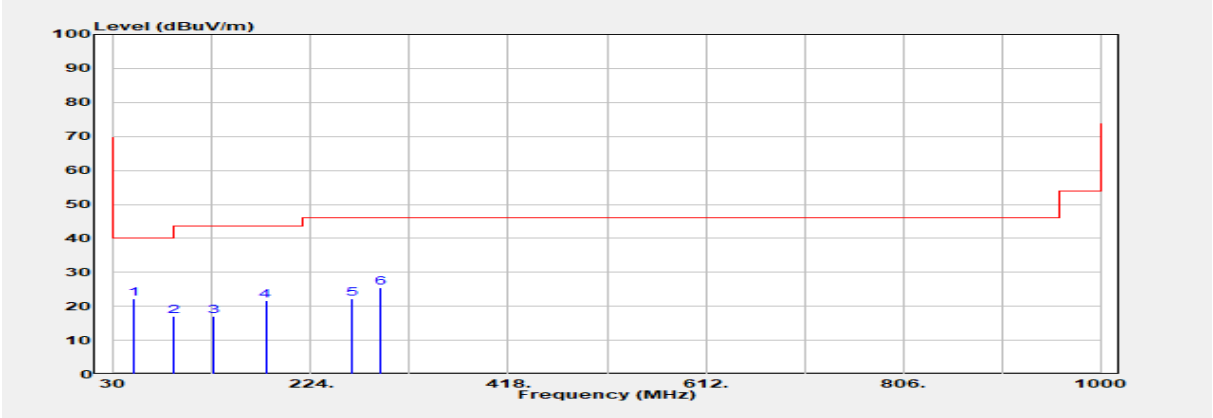
10.6.2 Radiated Spurious Emission

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



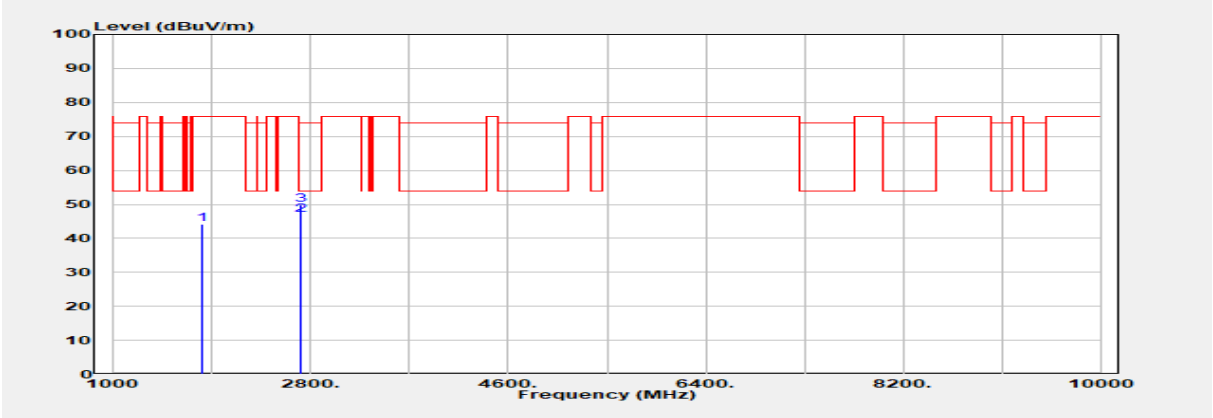
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
47.460	Peak	49.84	-16.83	33.01	40.00	-6.99
97.900	Peak	46.84	-22.18	24.66	43.50	-18.84
129.910	Peak	38.86	-17.61	21.26	43.50	-22.24
175.500	Peak	37.39	-17.34	20.05	43.50	-23.45
243.400	Peak	38.51	-17.63	20.88	46.00	-25.12
291.900	Peak	37.26	-15.85	21.42	46.00	-24.58

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



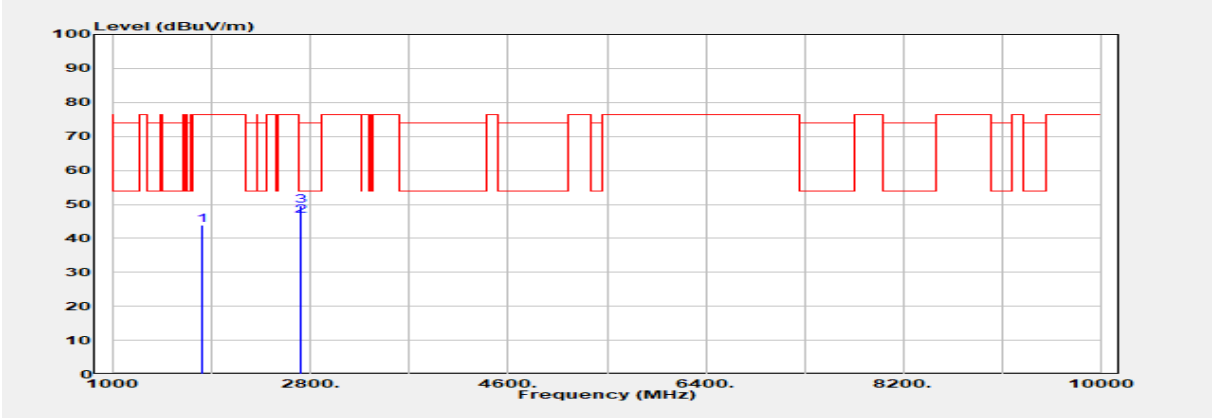
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
50.370	Peak	38.97	-16.73	22.23	40.00	-17.77
88.200	Peak	39.75	-22.72	17.03	43.50	-26.47
128.940	Peak	34.93	-17.80	17.12	43.50	-26.38
179.380	Peak	39.56	-17.94	21.63	43.50	-21.87
264.740	Peak	39.22	-16.99	22.23	46.00	-23.77
292.870	Peak	41.18	-15.82	25.36	46.00	-20.64

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:902.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



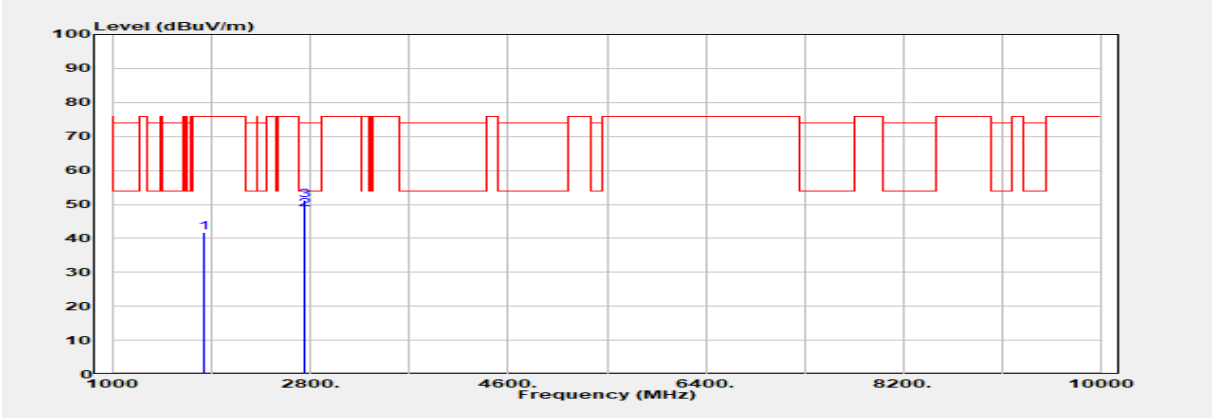
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1805.800	Peak	51.88	-7.80	44.08	75.97	-31.89
2708.700	Average	50.76	-3.80	46.95	54.00	-7.05
2708.700	Peak	53.78	-3.80	49.97	74.00	-24.03

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:902.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



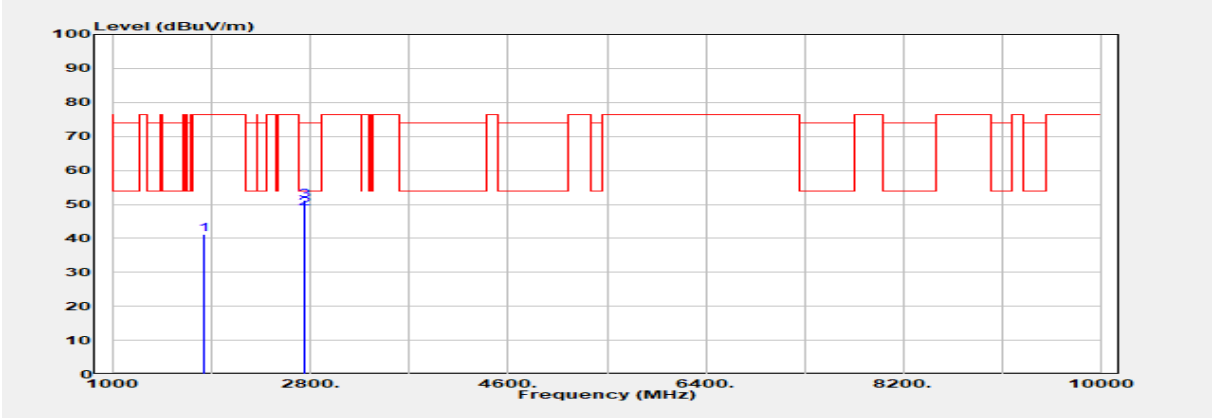
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1805.800	Peak	51.75	-7.80	43.95	76.36	-32.41
2708.700	Average	50.48	-3.80	46.68	54.00	-7.32
2708.700	Peak	53.50	-3.80	49.69	74.00	-24.31

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



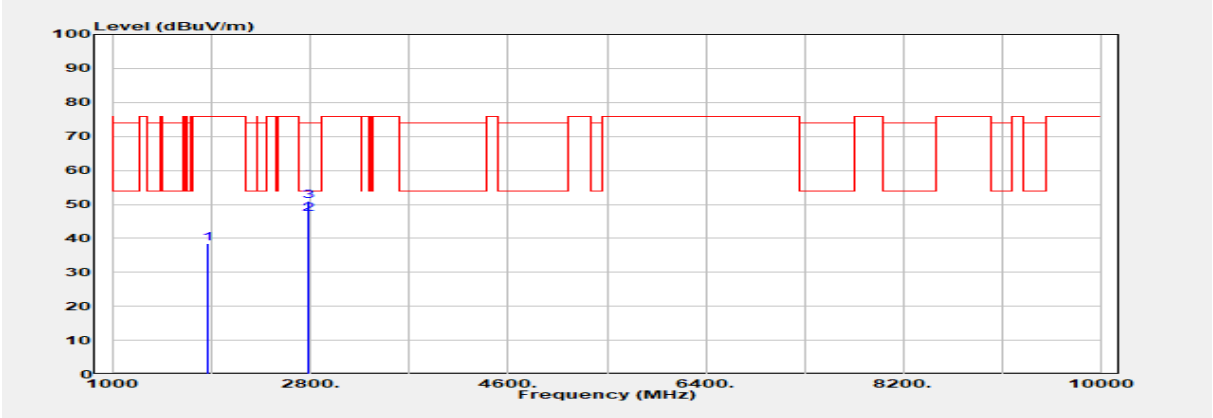
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1829.800	Peak	49.42	-7.71	41.71	75.97	-34.26
2744.700	Average	52.70	-4.08	48.62	54.00	-5.38
2744.700	Peak	55.38	-4.08	51.30	74.00	-22.70

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-09-25
Test Frequency	:914.9 MHz	Temp./Humi.	:20.5℃/58%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



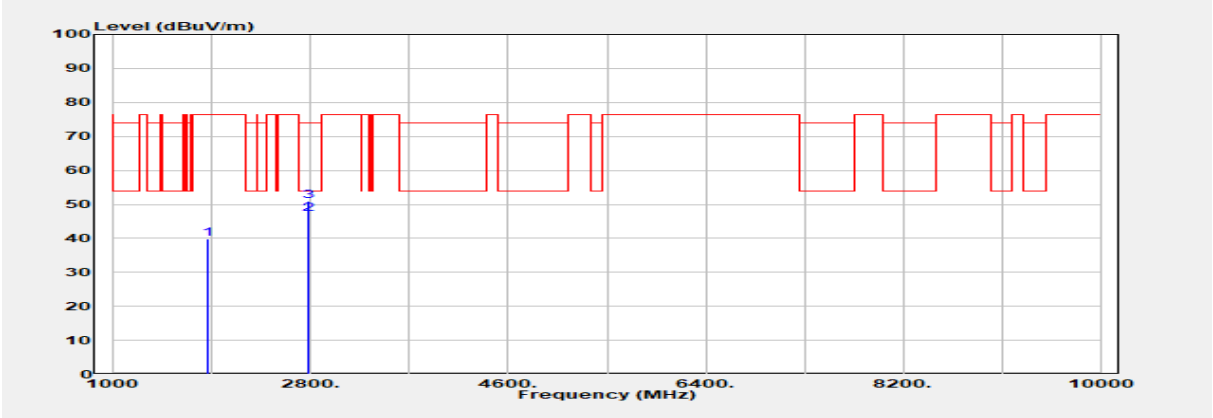
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1829.800	Peak	48.96	-7.71	41.25	76.36	-35.11
2744.700	Average	52.76	-4.08	48.69	54.00	-5.31
2744.700	Peak	55.34	-4.08	51.27	74.00	-22.73

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-08-15
Test Frequency	:926.9 MHz	Temp./Humi.	:19.5℃/67%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Howard Huang



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1853.800	Peak	46.17	-7.64	38.53	75.97	-37.44
2780.700	Average	51.22	-4.06	47.16	54.00	-6.84
2780.700	Peak	55.14	-4.06	51.08	74.00	-22.92

Report Number	:TERF2408002327E2	Test Site	:SAC D
Operation Mode	:FSK 100Kbps	Test Date	:2024-08-15
Test Frequency	:926.9 MHz	Temp./Humi.	:19.5℃/67%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Howard Huang



Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
1853.800	Peak	47.46	-7.64	39.83	76.36	-36.53
2780.700	Average	51.13	-4.06	47.07	54.00	-6.93
2780.700	Peak	55.02	-4.06	50.96	74.00	-23.04

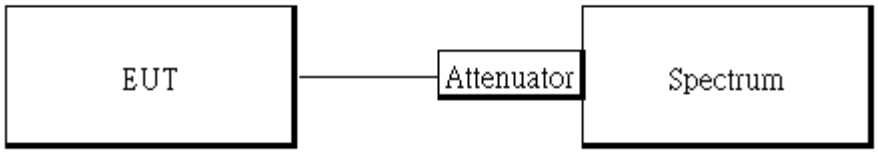
11 POWER SPECTRAL DENSITY

11.1 Standard Applicable:

Per Part 15.247 (e) & RSS-247 section 5.2 b

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

11.2 Test Setup



11.3 Measurement Procedure:

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 = 3 kHz. & the VBW = 10 kHz
5. Set Detector = average
6. Sweep time = auto couple.
7. Set Trace mode = average
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.

11.4 Measurement Result:

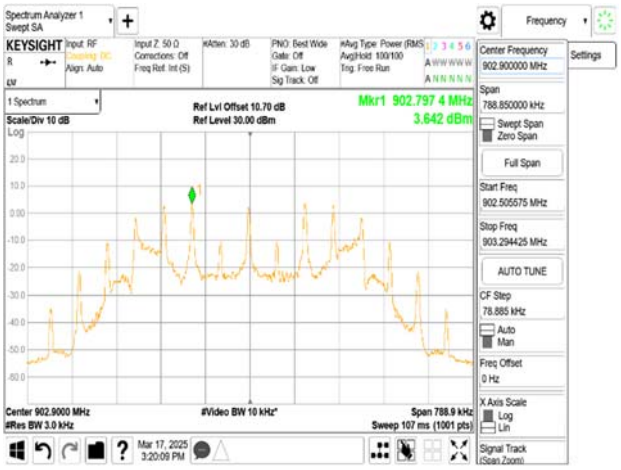
LoRa 100Kbps 190kHz 950bytes 249 bytes

Frequency (MHz)	RF Power Density (dBm/3kHz)	Maximum Limit (dBm/3kHz)	Result
902.9	3.642	8	PASS
914.9	3.418	8	PASS
926.9	3.261	8	PASS

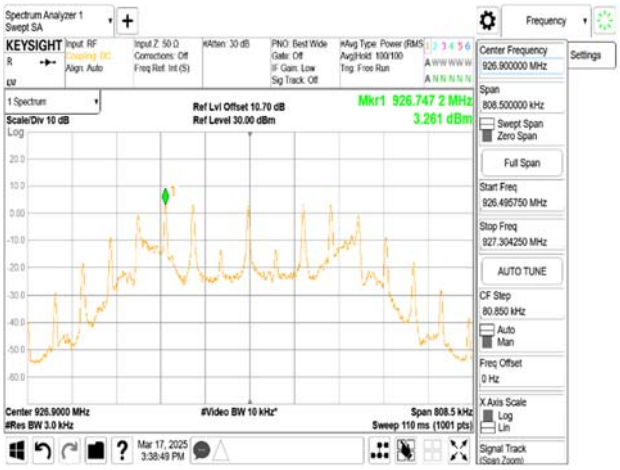
Note:

1.cable loss as 10.7dB that offsets in the spectrum

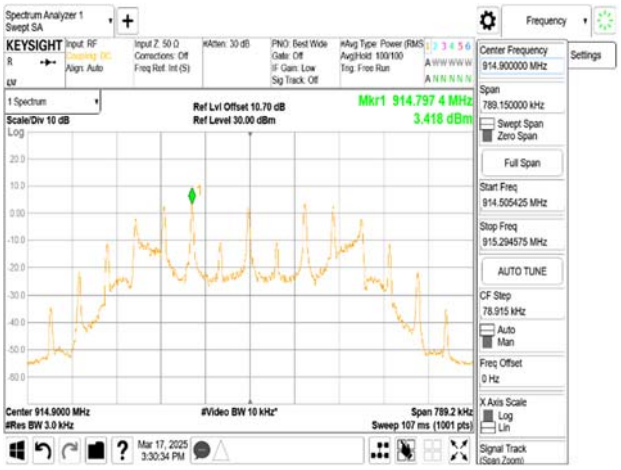
PSD_FSK_100Kbps_LowCH-902.9MHz



PSD_FSK_100Kbps_HighCH-926.9MHz



PSD_FSK_100Kbps_MidCH-914.9MHz



~ End of Report ~