FCC RF Test Report

APPLICANT	:	**Relay, Inc.**
EQUIPMENT	:	**Relay**
BRAND NAME	:	**Relay**
MODEL NAME	:	**RY2268**
FCC ID	:	**2AMBHRY2268**
STANDARD	:	**FCC Part 15 Subpart C §15.247**
CLASSIFICATION	:	**(DTS) Digital Transmission System**
TEST DATE(S)	:	**Mar. 27, 2024 ~ Jun. 02, 2024**

We, Sporton International Inc. (Kunshan), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

Jason Jia

Approved by: Jason Jia

Sporton International Inc. (Kunshan)
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR250507E	Rev. 01	Initial issue of report	Jun. 26, 2024

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Report Only	-
3.2	15.247(b)(3)	Output Power	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	≤30dBc	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 13.45 dB at 619.76 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 21.22 dB at 0.507 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

1 General Description

1.1 Applicant

Relay, Inc.
4200 Six Forks Rd, Suite 1800, Raleigh, NC 27609, USA

1.2 Manufacturer

Relay, Inc.
4200 Six Forks Rd, Suite 1800, Raleigh, NC 27609, USA

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Relay
Brand Name	Relay
Model Name	RY2268
FCC ID	2AMBHRY2268
IMEI Code	Conducted: 990007570009446 Conduction: 990007570009446/990007570009453 Radiation: 990007570009388
HW Version	v01
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	904 MHz ~ 926 MHz
Number of Channels	23
Bandwidth / Spread Factor	500kHz / SF7
Maximum Average Power to Antenna	LoRa DTS : 27.05 dBm (0.5070 W)
99% Occupied Bandwidth	LoRa DTS : 0.524 MHz
Antenna Type / Gain	PIFA Antenna with gain -1.0 dBi
Type of Modulation	LoRa

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH05-KS TH01-KS	CN1257	314309

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH05-KS	AUDIX	E3	210616
2.	CO01-KS	AUDIX	E3	6.2009-8-24

1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq.(MHz)	Channel	Freq.(MHz)
904-926 MHz	1	904	13	916
	2	905	14	917
	3	906	15	918
	4	907	16	919
	5	908	17	920
	6	909	18	921
	7	910	19	922
	8	911	20	923
	9	912	21	924
	10	913	22	925
	11	914	23	926
	12	915	-	-

Note: The above EUT's information was declared by manufacturer.

2.2 Test Mode

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.

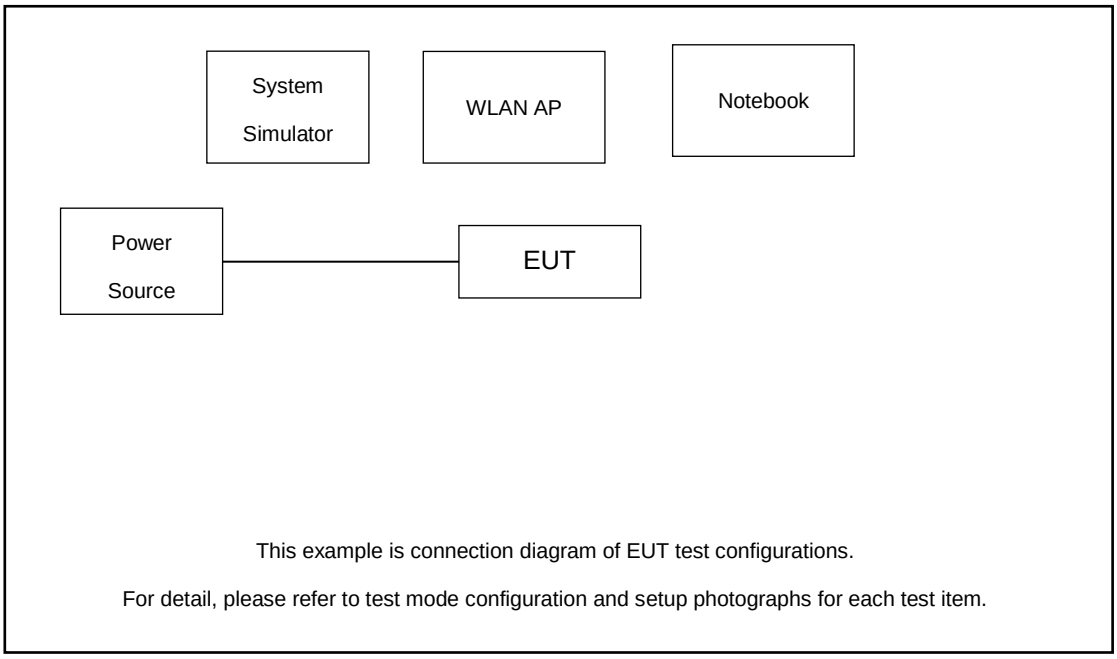
b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	**Modulation**
	Lora 500kHz DTS
Conducted TCs	Mode 1: LoRa Tx CH01_904 MHz Mode 2: LoRa Tx CH12_915 MHz Mode 3: LoRa Tx CH23_926 MHz
Radiated TCs	Mode 1: LoRa Tx CH01_904 MHz Mode 2: LoRa Tx CH12_915 MHz Mode 3: LoRa Tx CH23_926 MHz
AC Conducted Emission	Mode 1 :LTE Band 13 Link + WLAN Link(2.4G) + Lora Link + Adapter + USB cable

2.3 Connection Diagram of Test System

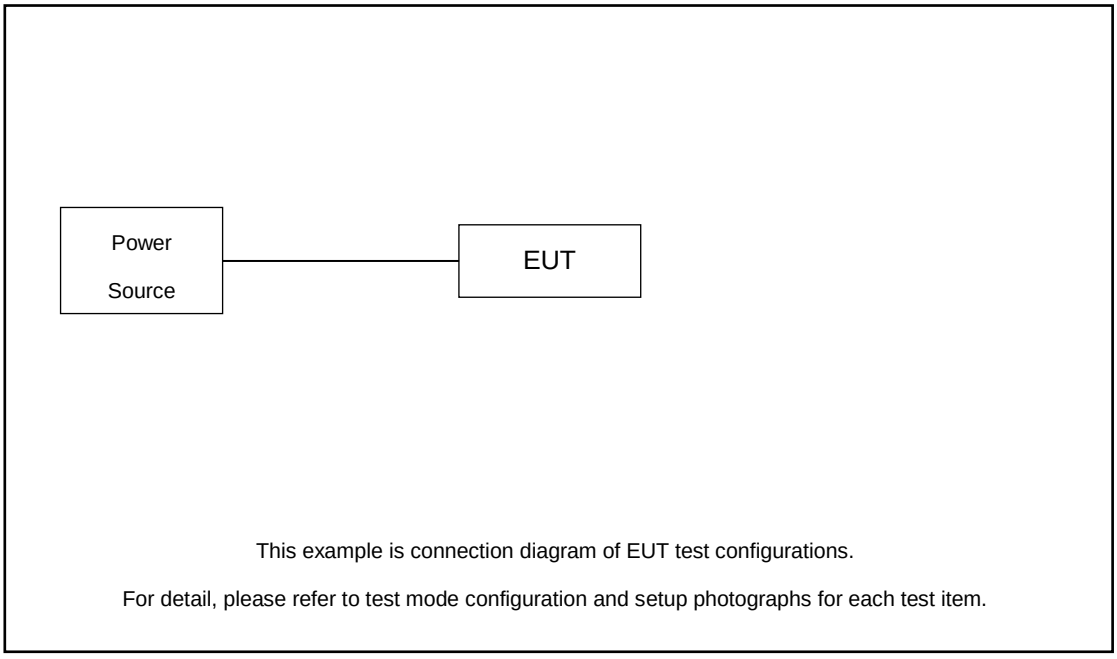
AC Conducted Emission:



This example is connection diagram of EUT test configurations.

For detail, please refer to test mode configuration and setup photographs for each test item.

Radiated Emission:



This example is connection diagram of EUT test configurations.

For detail, please refer to test mode configuration and setup photographs for each test item.

2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	LTE Base Station	Anritus	MT8821C	N/A	N/A	Unshielded,1.8m
2.	Notebook	Lenovo	G480	QDS-BRCM1050I	N/A	Shielded cable DC O/P 1.8m, Unshielded AC I/P cable 1.8m
3.	WLAN AP	D-link	DIR-655	KA21R655B1	N/A	Unshielded,1.8m
4.	Adapter	N/A	N/A	N/A	N/A	N/A
5.	USB Cable	N/A	N/A	N/A	N/A	N/A

2.5 EUT Operation Test Setup

For LoRa function, the engineering test program was provided and enabled to make EUT continuous transmit.

For AC power line conducted emissions, the EUT was set to connect with the notebook under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 0.5 dB and 10dB attenuator.

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

= 0.5 + 10 = 10.5 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

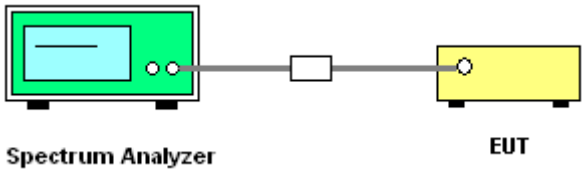
3.1.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 20kHz and set the Video bandwidth (VBW) = 100kHz.
6. Measure and record the results in the test report.

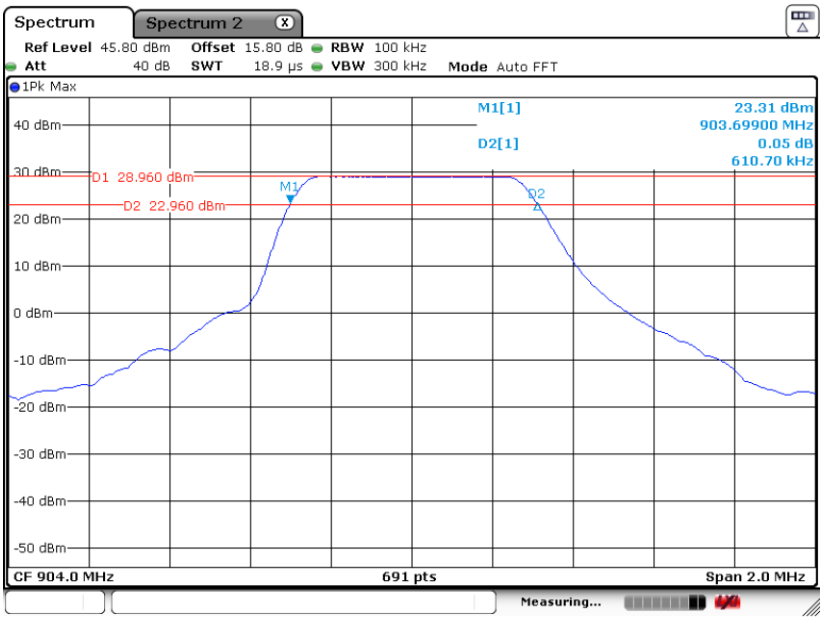
3.1.4 Test Setup



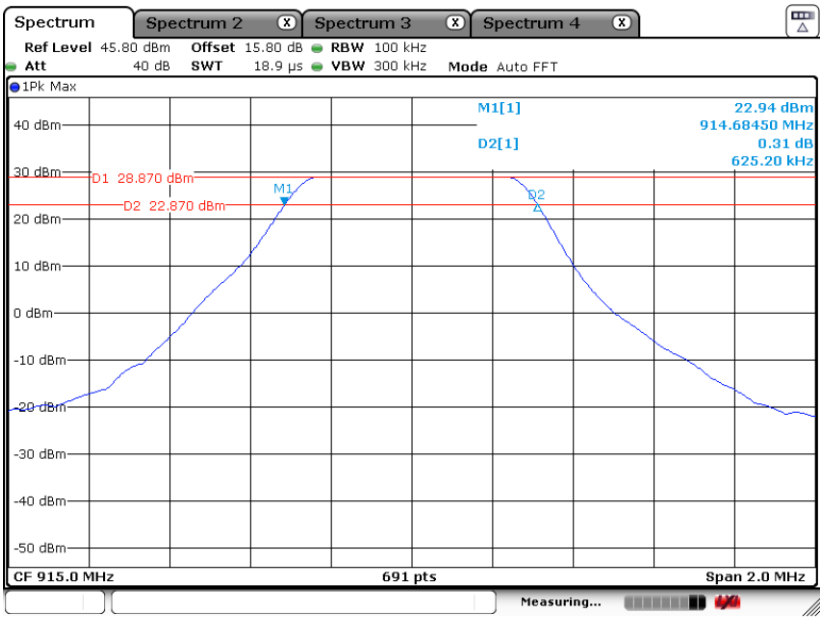
3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

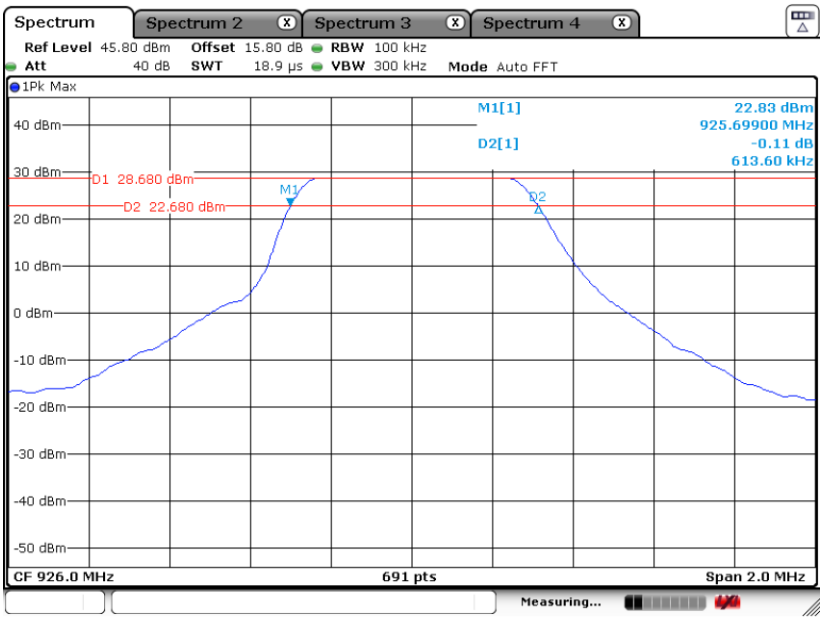
6 dB Bandwidth Plot on 904 MHz



6 dB Bandwidth Plot on 915 MHz



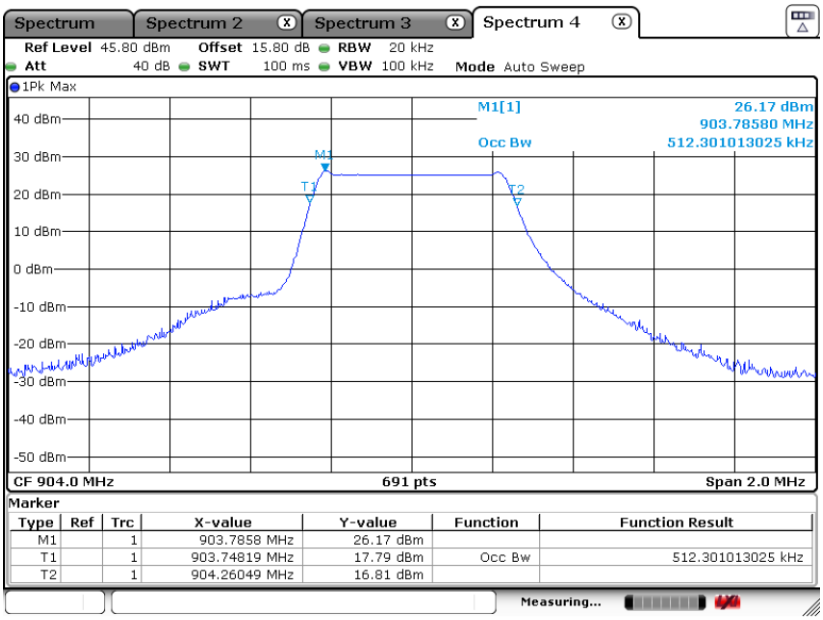
6 dB Bandwidth Plot on 926 MHz



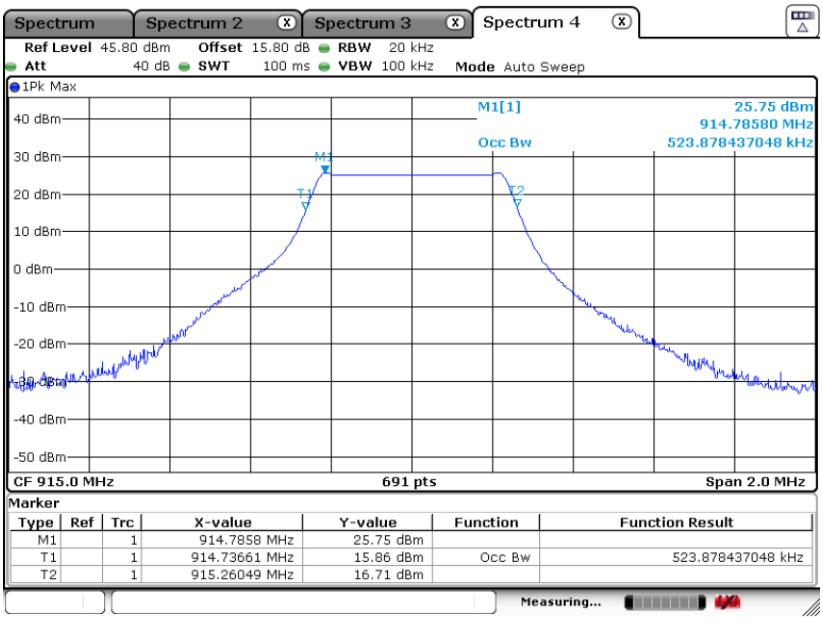
3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

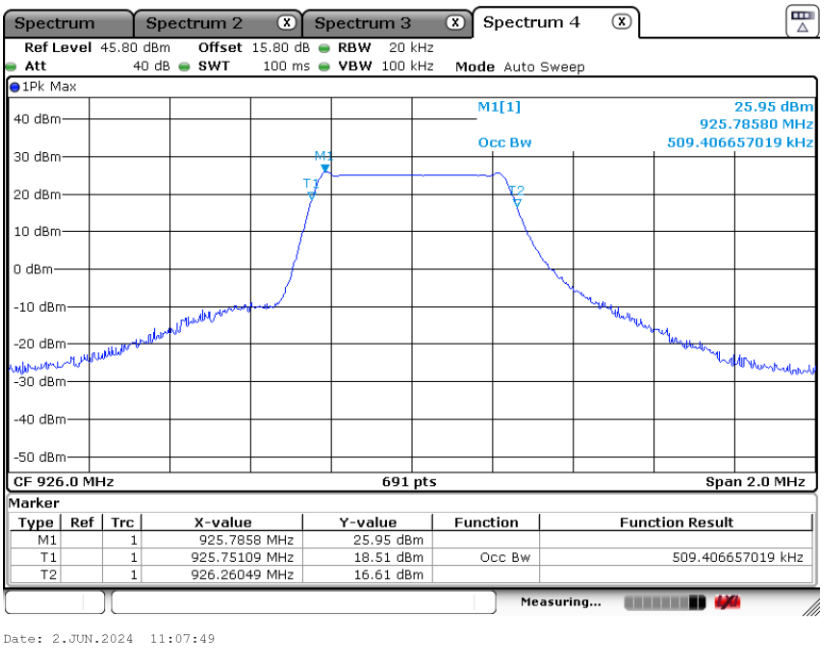
99% Occupied Bandwidth Plot on 904 MHz



99% Occupied Bandwidth Plot on 915 MHz



99% Occupied Bandwidth Plot on 926 MHz



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

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 902-928MHz, the limit for output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

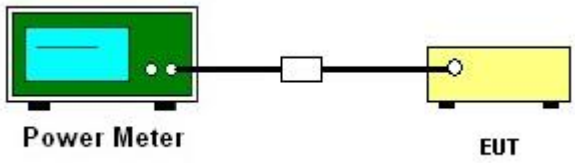
3.2.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.2.3.2 Method AVGPM-G method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Average Output Power

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

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

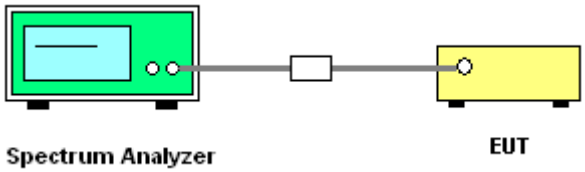
3.3.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 11.10.5 Method AVGPSD-2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = power averaging (rms), Sweep time = auto couple. Use the peak marker function to determine the maximum power level.
6. Employ trace averaging (rms) mode over a minimum of 100 traces.
7. Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
8. Measure and record the results in the test report.
9. Add [10 log (1 / D)], where D is the duty cycle.
10. The Measured power density (dBm)/ 100kHz is a reference level and used as 30dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

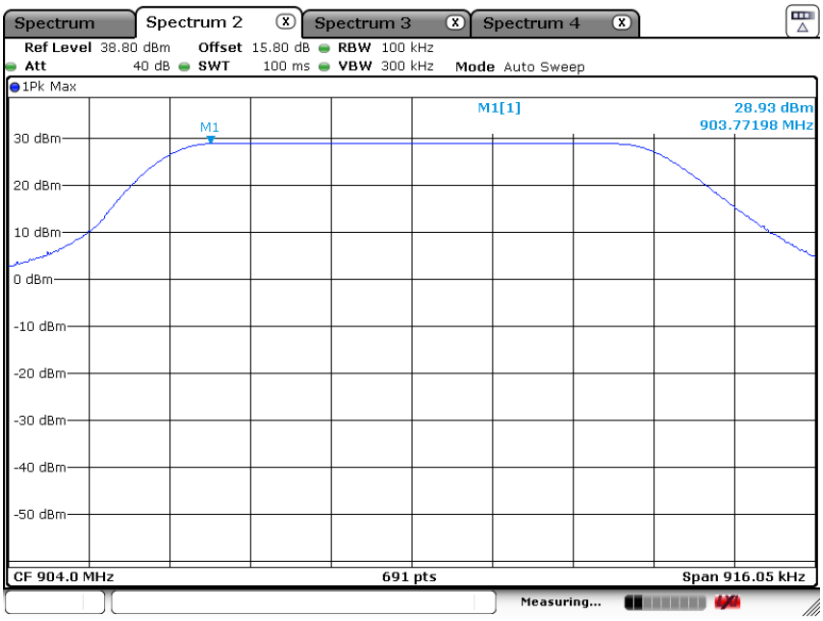


3.3.5 Test Result of Power Spectral Density

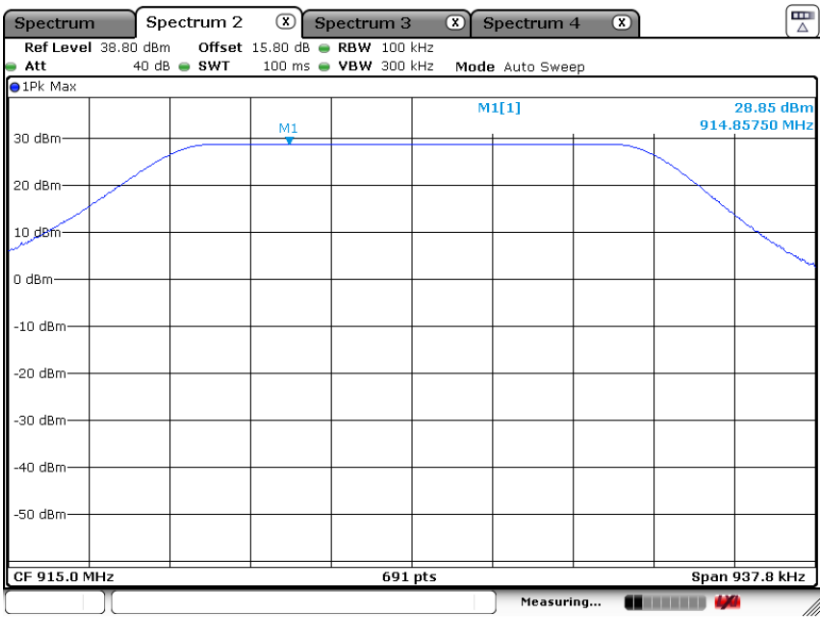
Please refer to Appendix A.

3.3.6 Test Result of Power Spectral Density Plots (100kHz)

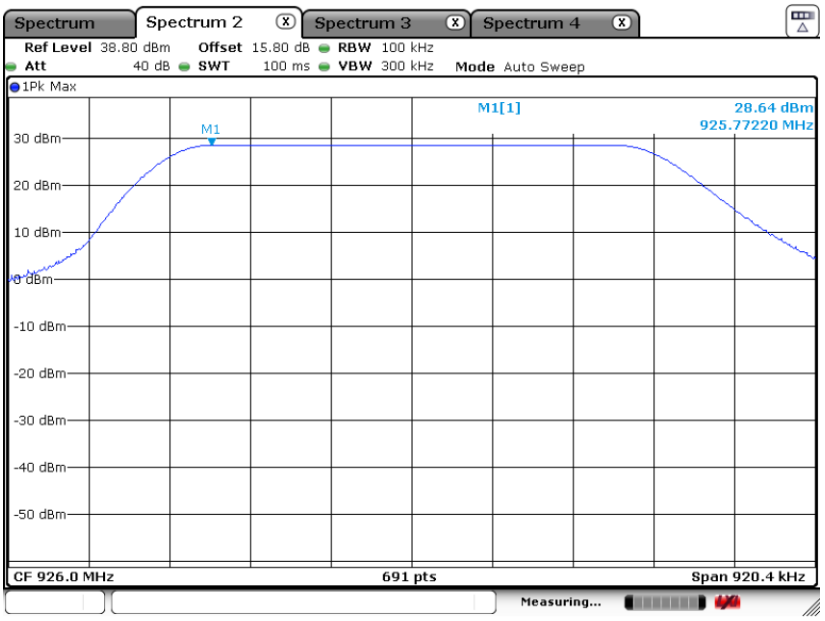
PSD 100kHz Plot on 904 MHz



PSD 100kHz Plot on 915 MHz

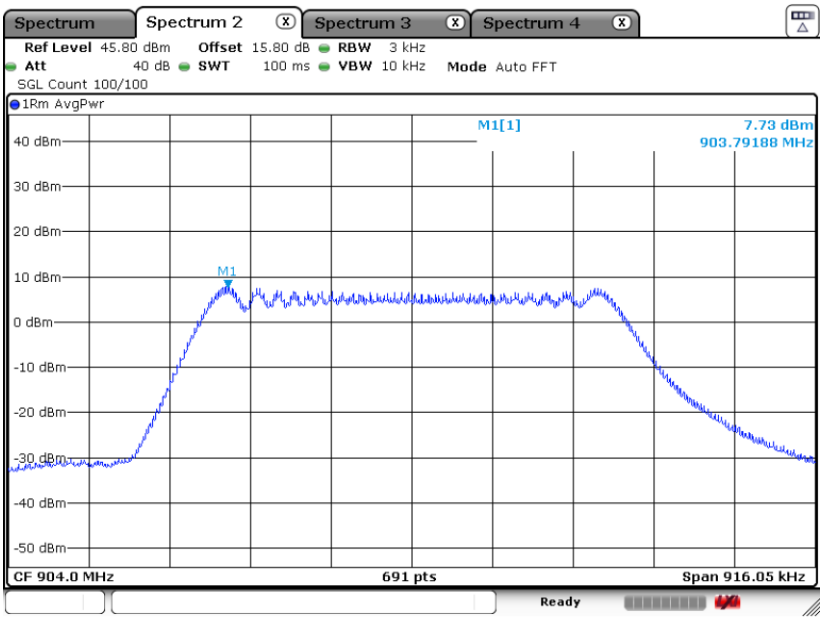


PSD 100kHz Plot on 926 MHz



3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on 904 MHz



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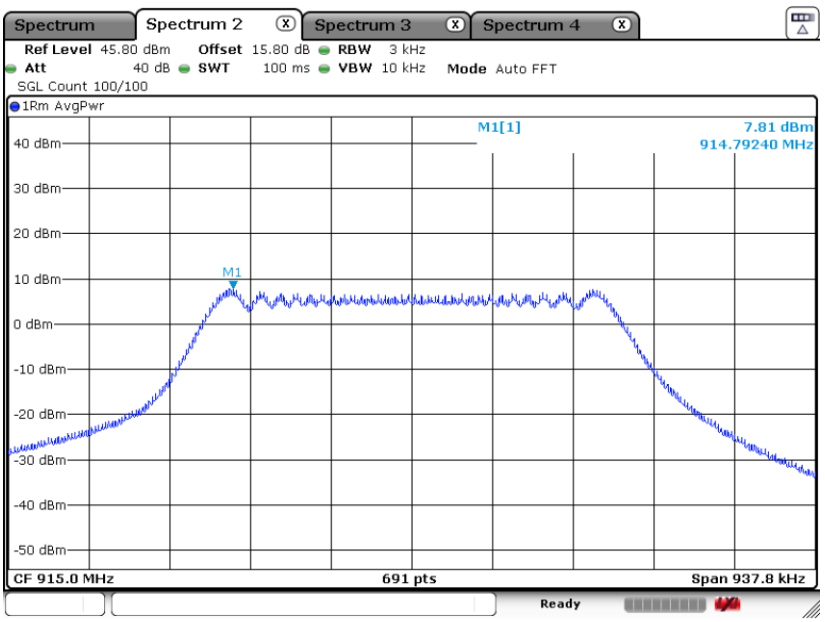
PSD 3kHz Plot on 915 MHz



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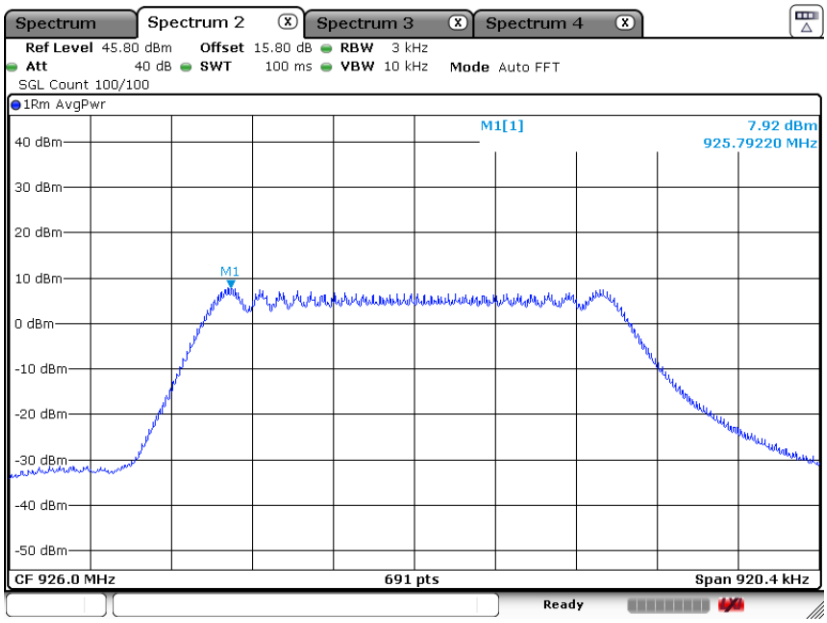
PSD 3kHz Plot on 926 MHz



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 30 dB down from the highest emission level within the authorized band.

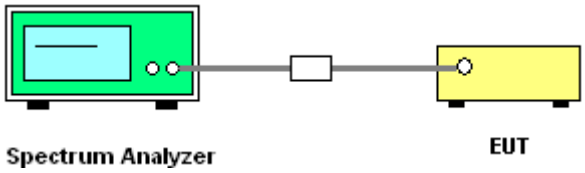
3.4.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.4.3 Test Procedure

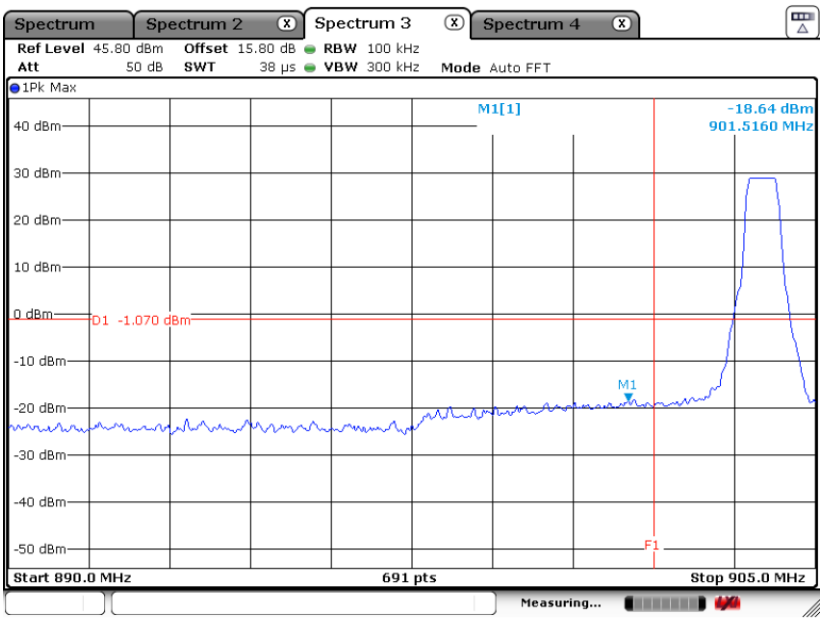
1. The testing follows ANSI C63.10-2013 clause 11.13
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz when the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup

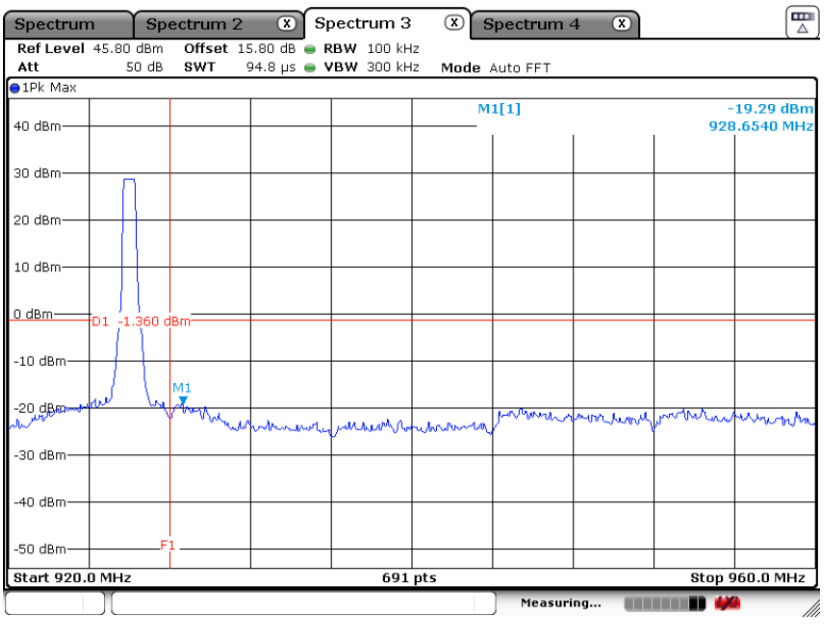


3.4.5 Test Result of Conducted Band Edges Plots

Low Band Edge Plot on 904 MHz

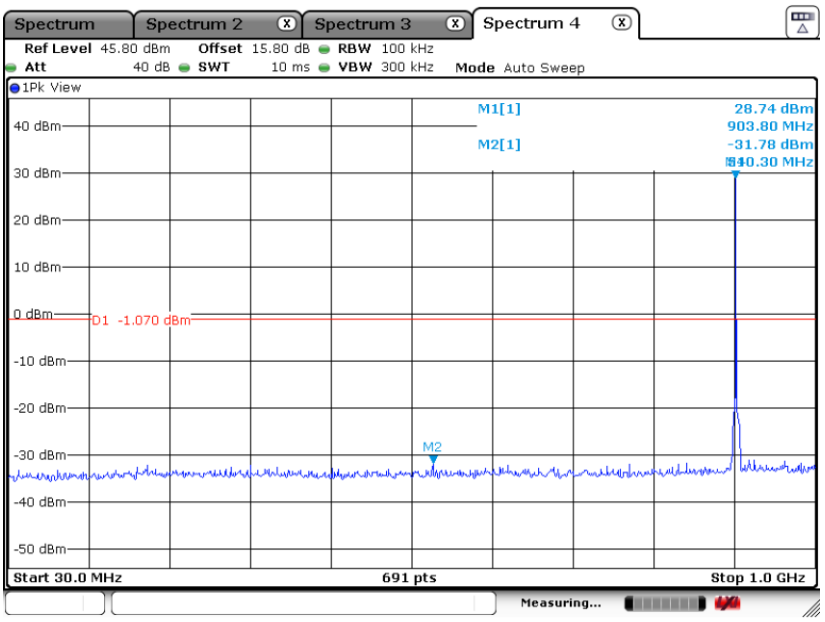


High Band Edge Plot on 926 MHz

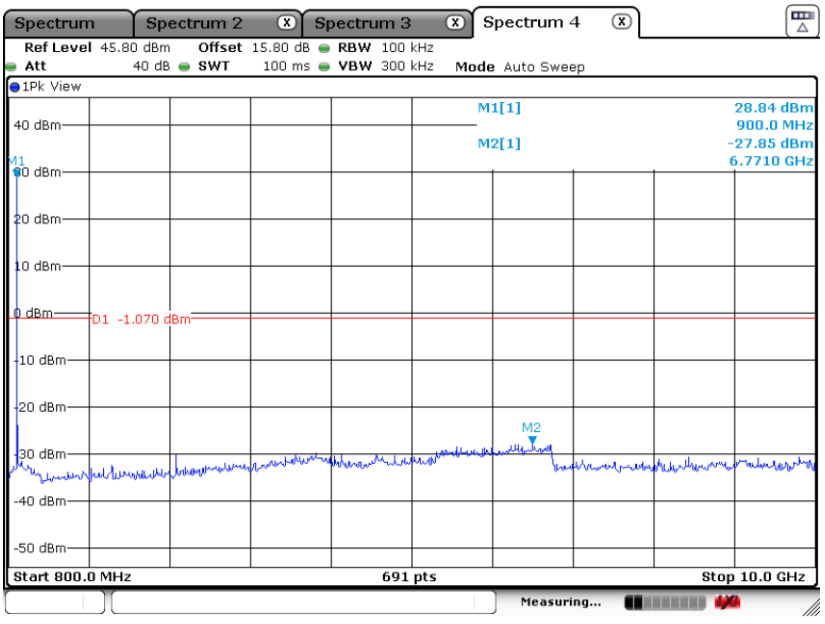


3.4.6 Test Result of Conducted Spurious Emission Plots

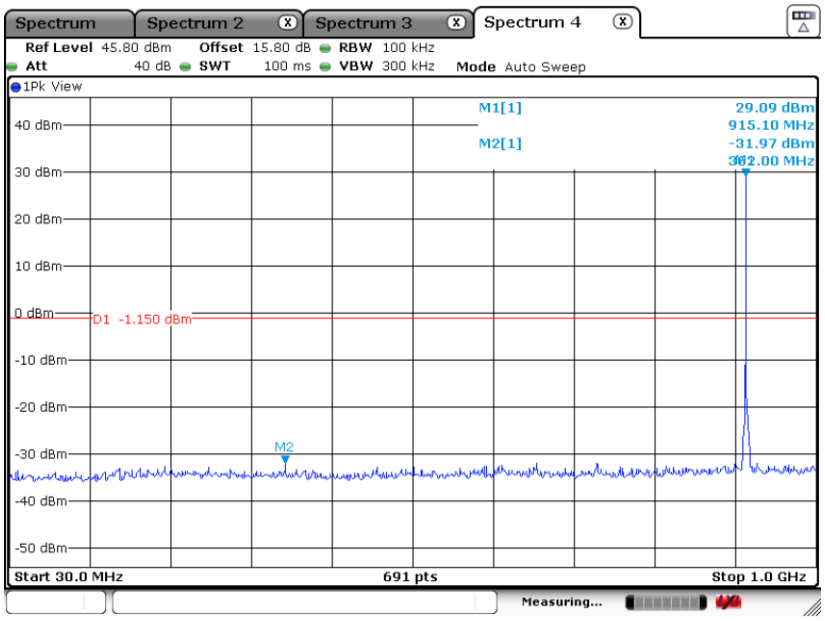
Conducted Spurious Emission Plot on 904 MHz



Conducted Spurious Emission Plot on 904 MHz



Conducted Spurious Emission Plot on 915 MHz



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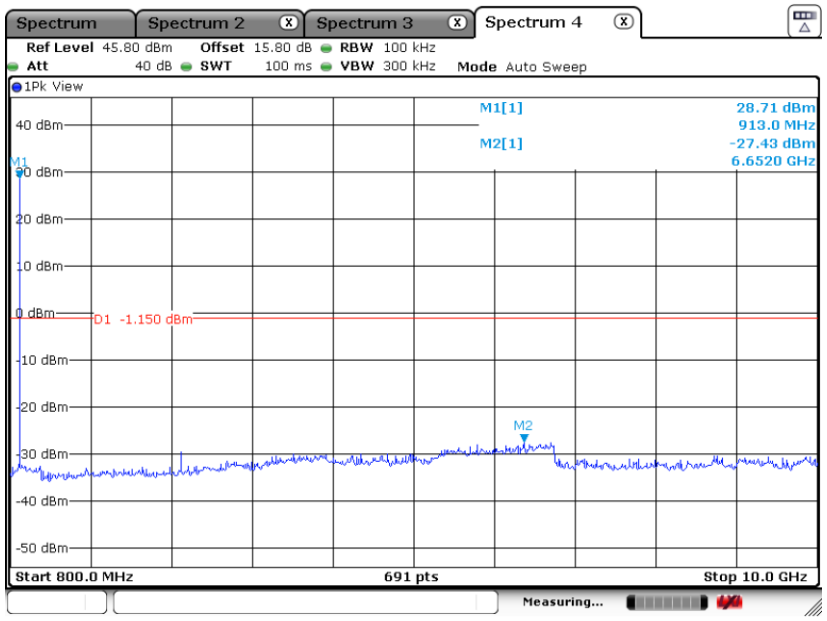
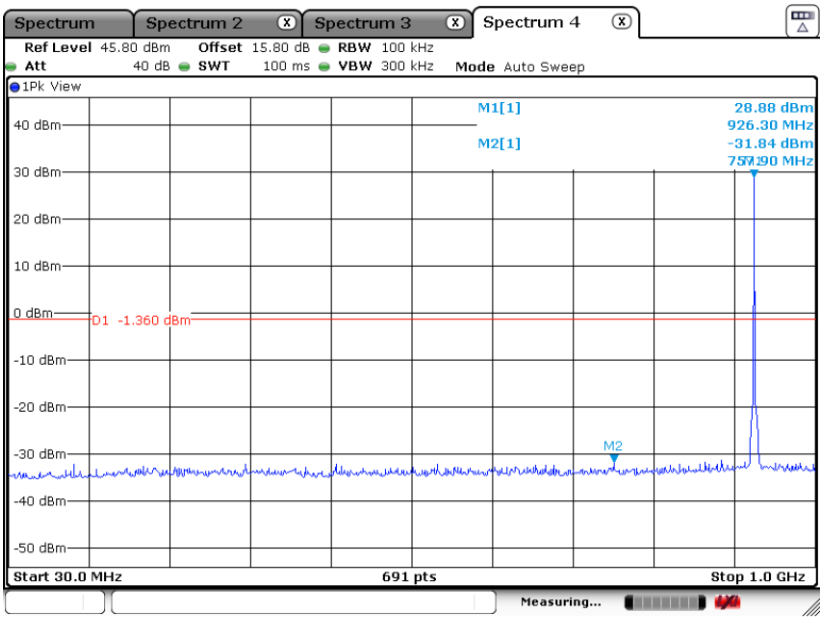
Conducted Spurious Emission Plot on 915 MHz



Date: 2.JUN.2024 10:50:04

Conducted Spurious Emission Plot on 926 MHz



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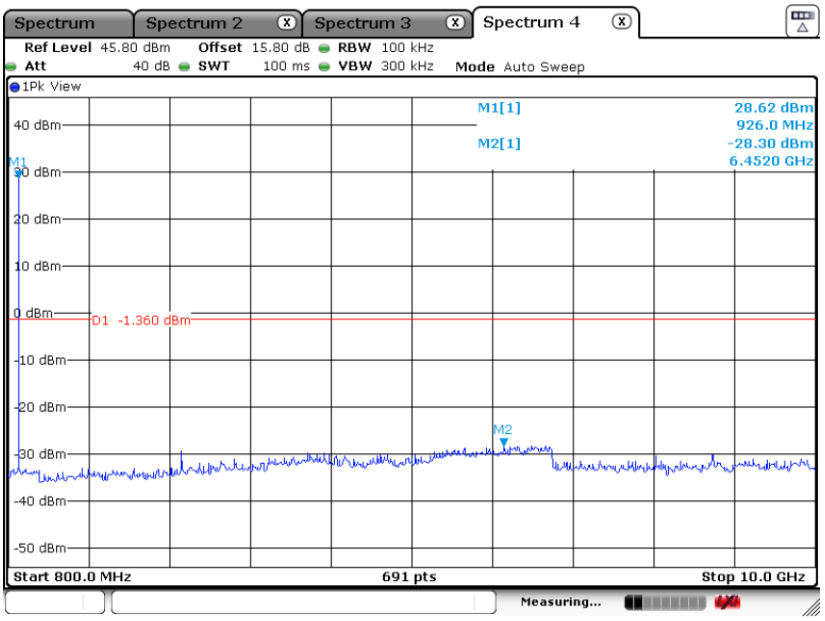
Conducted Spurious Emission Plot on 926 MHz



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3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.5.2 Measuring Instruments

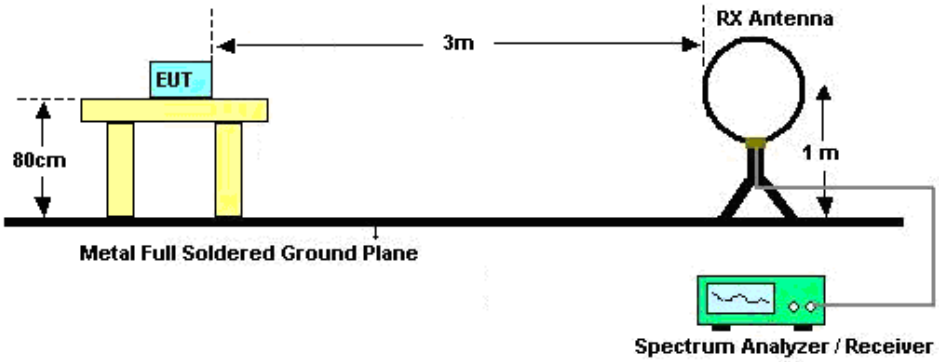
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.5.3 Test Procedures

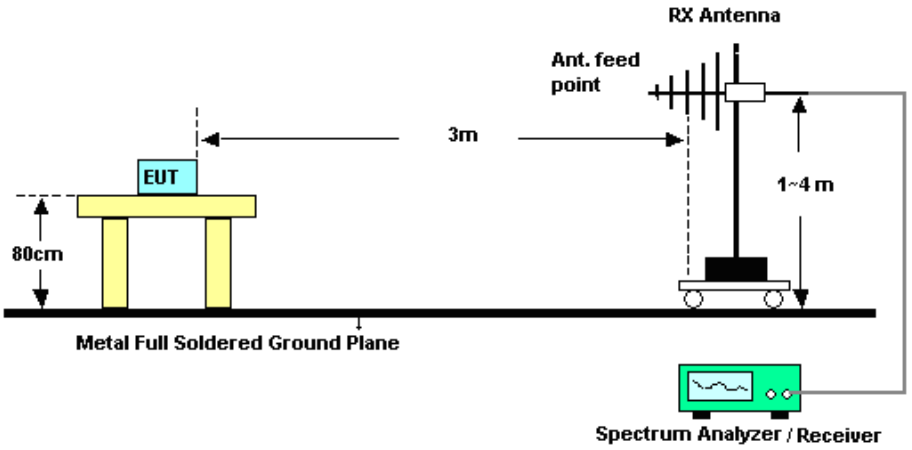
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

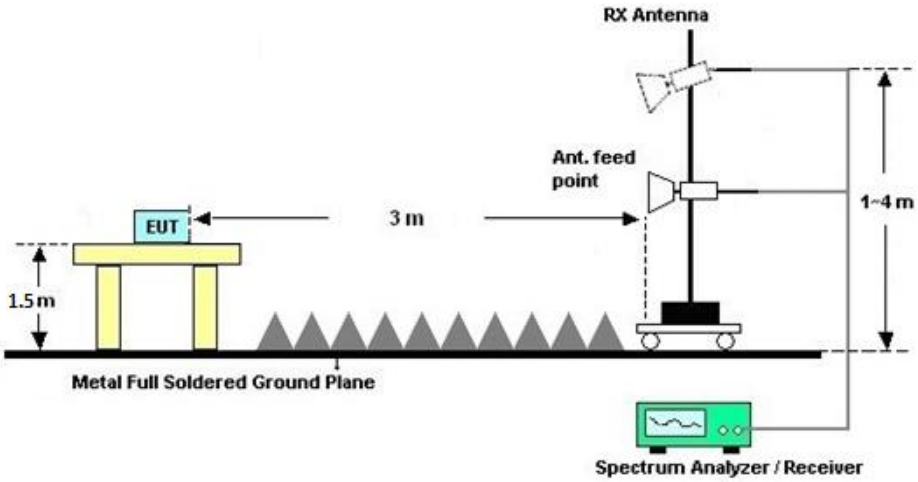
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 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 line was not reported.

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

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C&D.

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

Please refer to Appendix C&D.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

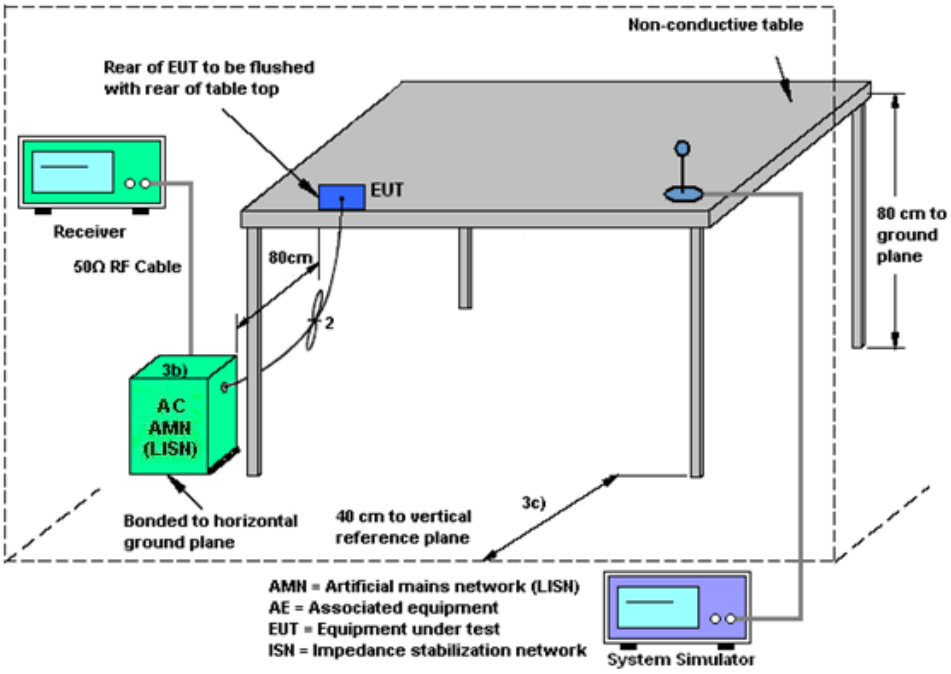
3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Oct. 11, 2023	Jun. 02, 2024	Oct. 10, 2024	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 02, 2024	Jun. 02, 2024	Jan. 01, 2025	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 02, 2024	Jun. 02, 2024	Jan. 01, 2025	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 10, 2023	Mar. 30, 2024	Oct. 09, 2024	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010B	MY60242126	10Hz-44GHz	Oct. 10, 2023	Mar. 30, 2024	Oct. 09, 2024	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Oct. 10, 2023	Mar. 30, 2024	Oct. 09, 2024	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	59913	30MHz-1GHz	Aug. 19, 2023	Mar. 30, 2024	Aug. 18, 2024	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	75957	1GHz~18GHz	Oct. 23, 2023	Mar. 30, 2024	Oct. 22, 2024	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	380826	9KHz-1GHz	Jul. 06, 2023	Mar. 30, 2024	Jul. 05, 2024	Radiation (03CH05-KS)
high gain Amplifier	EM	EM01G18GA	060839	1Ghz-18Ghz	Oct. 10, 2023	Mar. 30, 2024	Oct. 09, 2024	Radiation (03CH05-KS)
Amplifier	EM	EM01G18GA	060833	1Ghz-18Ghz	Jan. 03, 2024	Mar. 30, 2024	Jan. 02, 2025	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Mar. 30, 2024	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Mar. 30, 2024	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Mar. 30, 2024	NCR	Radiation (03CH05-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	May 16, 2023	Mar. 27, 2024	May 15, 2024	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 11, 2023	Mar. 27, 2024	Oct. 10, 2024	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060105	9kHz~30MHz	May 16, 2023	Mar. 27, 2024	May 15, 2024	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 11, 2023	Mar. 27, 2024	Oct. 10, 2024	Conduction (CO01-KS)

NCR: No Calibration Required.

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Measurement

Test Item	Uncertainty
Conducted Spurious Emission & Bandedge	±2.26 dB
Occupied Channel Bandwidth	±0.1%
Conducted Power	±0.46 dB
Conducted Power Spectral Density	±0.88 dB
Frequency	±0.4 Hz

Uncertainty of AC Conducted Emission Measurement (0.15 MHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.84 dB

Uncertainty of Radiated Emission Measurement (9 KHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	3.30 dB

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	6.28 dB

Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.88 dB

---------- THE END ----------

Appendix A. Conducted Test Results

Report Number : FR250507E

LoRa-DTS-Spreading Factor 7

Test Engineer:	Jiang Jun	Temperature:	20~26	°C
Test Date:	2024.6.2	Relative Humidity:	40~51	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Channel	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
SF7	L	904Mhz	0.512	0.611	0.50	Pass
SF7	M	915Mhz	0.524	0.625	0.50	Pass
SF7	H	926Mhz	0.509	0.614	0.50	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Channel	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	Pass /Fail	Power Setting
SF7	L	904Mhz	0.00	27.05	30.00	Pass	P3
SF7	M	915Mhz	0.00	27.03	30.00	Pass	P4
SF7	H	926Mhz	0.00	26.87	30.00	Pass	P5

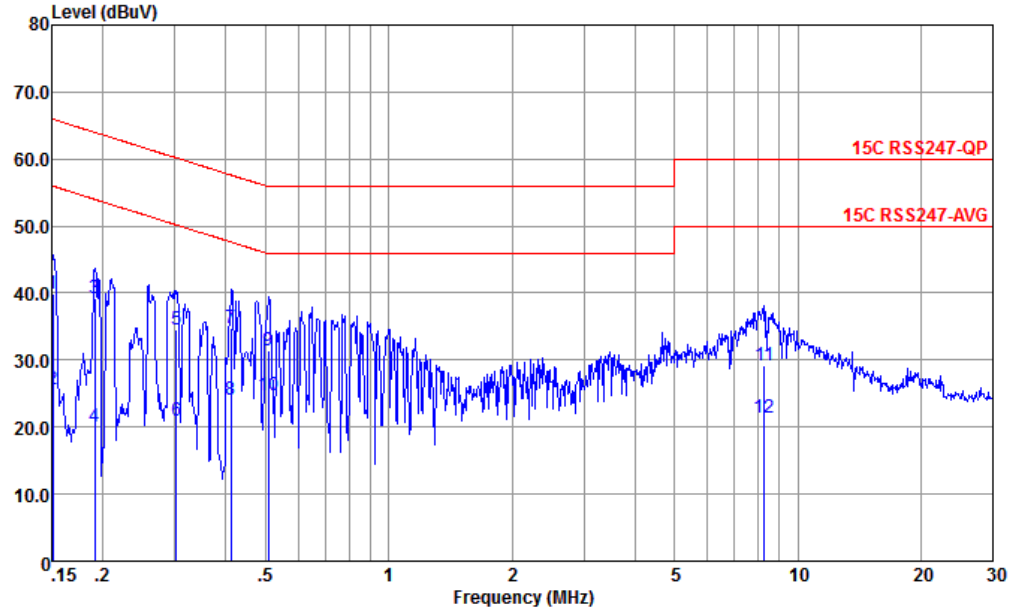
TEST RESULTS DATA
Peak Power Density

Mod.	Channel	Freq. (MHz)	Peak PSD (dBm /100kHz)	PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail
SF7	L	904Mhz	28.93	7.73	-1.00	8.00	Pass
SF7	M	915Mhz	28.85	7.81	-1.00	8.00	Pass
SF7	H	926Mhz	28.64	7.92	-1.00	8.00	Pass

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

Appendix B. AC Conducted Emission Test Results

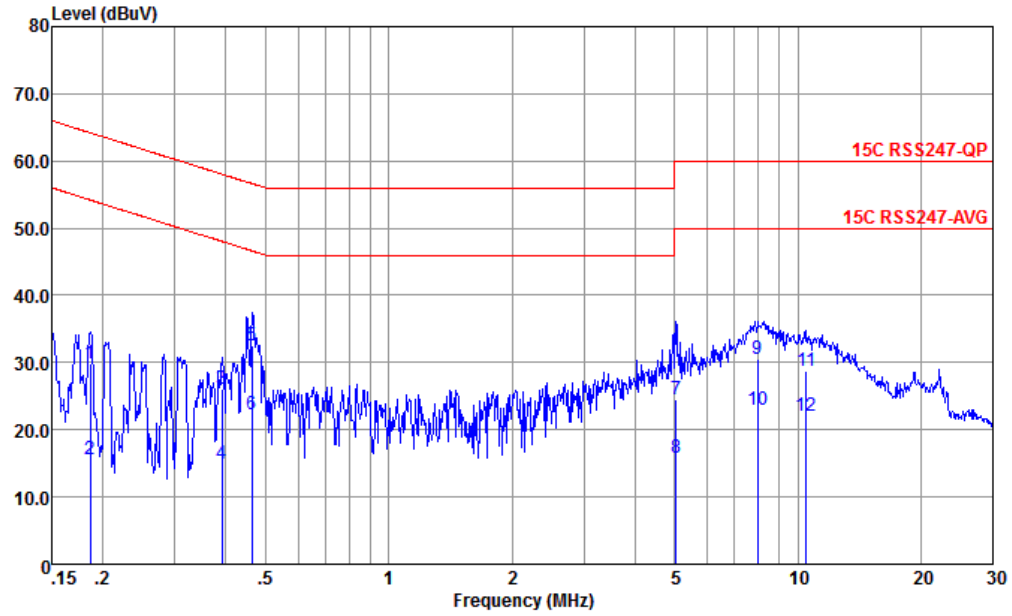
Test Engineer :	Amos Zhang	**Temperature :**	25.3~26.2℃
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line



Site : CO01-KS
Condition : 15C RSS247-QP LISN-060105-L 2023 LINE

		Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
		MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1		0.151	39.97	-25.99	65.96	29.50	0.05	10.42	QP
2		0.151	25.67	-30.29	55.96	15.20	0.05	10.42	Average
3		0.191	39.24	-24.74	63.98	28.80	0.03	10.41	QP
4		0.191	20.04	-33.94	53.98	9.60	0.03	10.41	Average
5		0.302	34.57	-25.62	60.19	24.20	0.04	10.33	QP
6		0.302	20.97	-29.22	50.19	10.60	0.04	10.33	Average
7		0.410	34.87	-22.77	57.64	24.60	0.00	10.27	QP
8		0.410	24.07	-23.57	47.64	13.80	0.00	10.27	Average
9		0.507	31.38	-24.62	56.00	21.19	-0.03	10.22	QP
10	*	0.507	24.78	-21.22	46.00	14.59	-0.03	10.22	Average
11		8.279	29.09	-30.91	60.00	18.80	-0.15	10.44	QP
12		8.279	21.49	-28.51	50.00	11.20	-0.15	10.44	Average

Test Engineer :	Amos Zhang	Temperature :	25.3~26.2℃
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral



Site : CO01-KS
Condition : 15C RSS247-QP LISN-060105-N 2023 NEUTRAL

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.186	29.96	-34.24	64.20	19.50	0.05	10.41	QP
2	0.186	15.66	-38.54	54.20	5.20	0.05	10.41	Average
3	0.391	26.13	-31.90	58.03	15.91	-0.06	10.28	QP
4	0.391	14.83	-33.20	48.03	4.61	-0.06	10.28	Average
5 *	0.464	32.47	-24.16	56.63	22.30	-0.07	10.24	QP
6	0.464	22.37	-24.26	46.63	12.20	-0.07	10.24	Average
7	5.031	24.43	-35.57	60.00	14.50	-0.13	10.06	QP
8	5.031	15.83	-34.17	50.00	5.90	-0.13	10.06	Average
9	7.977	30.47	-29.53	60.00	20.21	-0.14	10.40	QP
10	7.977	22.87	-27.13	50.00	12.61	-0.14	10.40	Average
11	10.508	28.75	-31.25	60.00	18.20	-0.19	10.74	QP
12	10.508	22.15	-27.85	50.00	11.60	-0.19	10.74	Average

Note:

1. Level(dBμV) = Read Level(dBμV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBμV) – Limit Line(dBμV)

Appendix C. Radiated Spurious Emission

904~926MHz

LoRa DTS 500KHz SF=7 (Band Edge @ 3m)

	Note	Frequency (MHz)	Level (dBµV/m)	Over Limit (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
904MHz		466.50	28.70	-17.30	46.00	35.56	23.20	3.14	33.20	-	-	P	H
		903.97	117.67	-	-	116.73	29.03	4.49	32.58	-	-	P	H
		619.76	32.55	-13.45	46.00	36.42	25.97	3.68	33.52	-	-	P	V
		903.97	113.11	-	-	112.17	29.03	4.49	32.58	-	-	P	V
915MHz		483.96	28.16	-17.84	46.00	34.77	23.54	3.14	33.29	-	-	P	H
		915.61	117.77	-	-	116.33	29.33	4.52	32.41	-	-	P	H
		562.53	29.69	-16.31	46.00	33.86	26.09	3.30	33.56	-	-	P	V
		915.61	113.39	-	-	111.95	29.33	4.52	32.41	-	-	P	V
926MHz		630.43	32.47	-13.53	46.00	36.02	26.29	3.69	33.53	-	-	P	H
		926.28	117.77	-	-	115.86	29.63	4.54	32.26	-	-	P	H
		644.98	32.35	-13.65	46.00	35.88	26.28	3.72	33.53	-	-	P	V
		905.31	113.73	-	-	111.88	29.59	4.54	32.28	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

LoRa DTS 500KHz SF=7 (Harmonic @ 3m)

	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
904MHz		2711.80	37.32	-36.68	74.00	62.20	32.26	7.59	64.73	-	-	P	H
		2711.80	37.70	-36.30	74.00	62.58	32.26	7.59	64.73	-	-	P	V
915MHz		2475.10	38.00	-36.00	74.00	62.92	32.16	7.63	64.71	-	-	P	H
		2475.10	37.80	-36.20	74.00	62.72	32.16	7.63	64.71	-	-	P	V
926MHz		2778.40	38.26	-35.74	74.00	63.21	32.06	7.68	64.69	-	-	P	H
		2778.40	37.93	-36.07	74.00	62.88	32.06	7.68	64.69	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
902.5MHz		2708.20	51.89	-22.11	74	76.80	33.05	7.58	65.54	333	243	P	H
		2708.20	50.19	-3.81	54	75.10	33.05	7.58	65.54	333	243	A	H

1. Level(dBμV/m) = Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2708.20MHz:

1. Level(dBμV/m)

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

= 33.05(dB/m) + 7.58(dB) + 76.80(dBμV) – 65.54 (dB)

= 51.89 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 51.89(dBμV/m) – 74(dBμV/m)

= -22.11(dB)

For Average Limit @ 2708.20MHz:

1. Level(dBμV/m)

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

= 33.05(dB/m) + 7.58(dB) + 75.10(dBμV) – 65.54 (dB)

= 50.19 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 50.19(dBμV/m) – 54(dBμV/m)

= -3.81(dB)

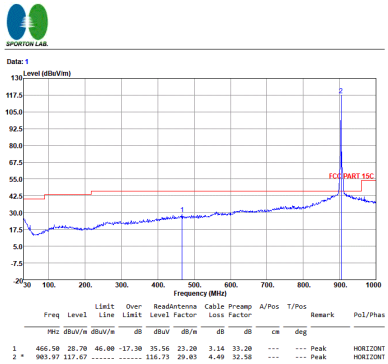
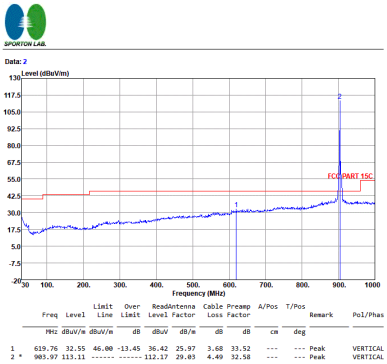
Both peak and average measured complies with the limit line, so test result is “PASS”.

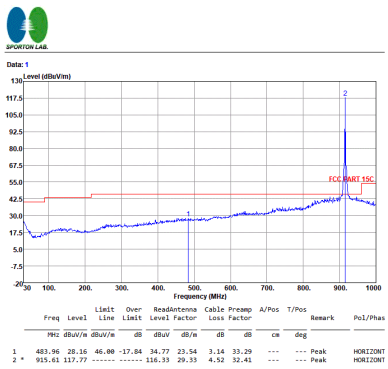
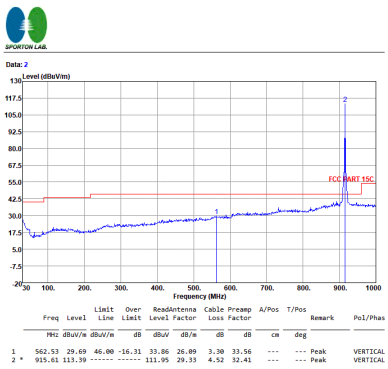
Appendix D. Radiated Spurious Emission Plots

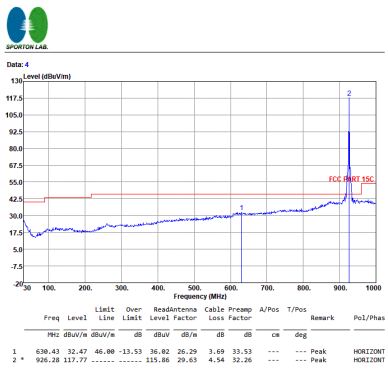
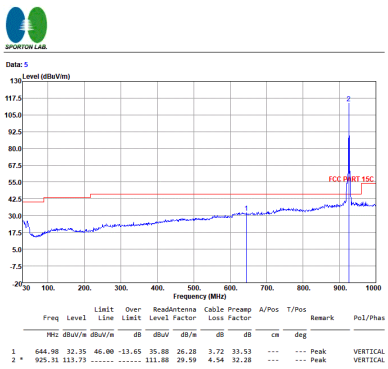
Note symbol

-L	**Low channel location**
-R	**High channel location**

LoRa 500KHz DTS SF=7 (Band Edge @ 3m)

LoRa	904~926 Band Edge @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH01 904	
8	Horizontal	Vertical
Peak		

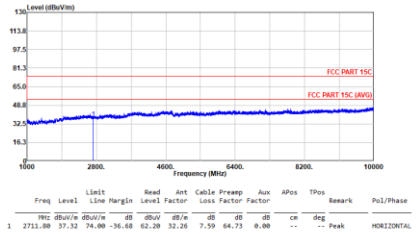
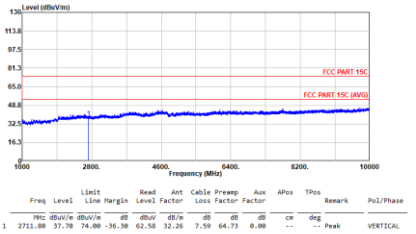
LoRa	904~926 Band Edge @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH12 915	
8	Horizontal	Vertical
Peak		

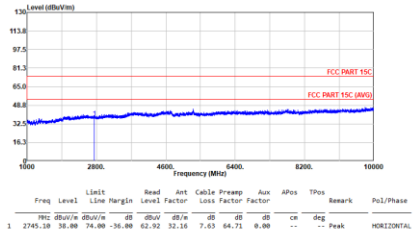
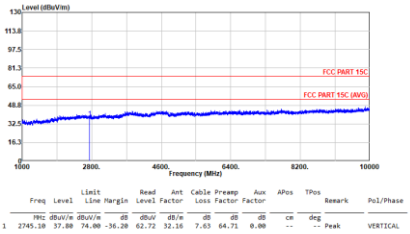
LoRa	904~926 Band Edge @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH23 926	
8	Horizontal	Vertical
Peak		

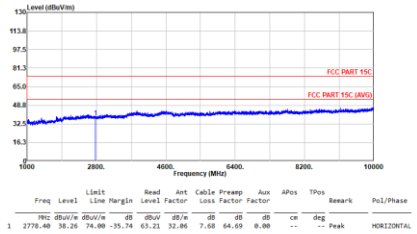
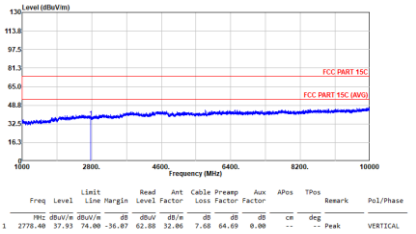
	Freq	Level	Limit Line	Over Limit	Read Level	Antenna Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phas
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg		
1	630.43	32.47	46.00	-13.53	36.02	26.29	3.69	33.53	---	---	Peak	HORIZONT
2 *	926.28	117.77	------	------	115.86	29.63	4.54	32.26	---	---	Peak	HORIZONT

	Freq	Level	Limit Line	Over Limit	Read Level	Antenna Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark	Pol/Phas
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg		
1	644.98	32.35	46.00	-13.65	35.88	26.28	3.72	33.53	---	---	Peak	VERTICAL
2 *	925.31	113.73	------	------	111.88	29.59	4.54	32.28	---	---	Peak	VERTICAL

LoRa 500KHz DTS SF=7 (Harmonic @ 3m)

LoRa	904~926 Harmonic @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH01 904	
8	Horizontal	Vertical
Peak	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor Aux Factor APos TPos Remark Pol/Phase MHz dBuV/m dBuV/m dB dBuV dB/m dB dB dB cm deg 1 2711.80 37.32 74.00 -36.68 62.20 32.26 7.59 64.73 0.00 -- -- Peak HORIZONTAL	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor Aux Factor APos TPos Remark Pol/Phase MHz dBuV/m dBuV/m dB dBuV dB/m dB dB dB cm deg 1 2711.80 37.70 74.00 -36.30 62.58 32.26 7.59 64.73 0.00 -- -- Peak VERTICAL

LoRa	904~926 Harmonic @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH12 915	
8	Horizontal	Vertical
Peak		

LoRa	904~926 Harmonic @ 3m	
ANT	LoRa 500KHz DTS SF=7 CH23 926	
8	Horizontal	Vertical
Peak	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor Aux Factor APos TPos Remark Pol/Phase MHz dBuV/m dBuV/m dB dBuV dB/m dB dB dB cm deg 1 2778.40 38.26 74.00 -35.74 63.21 32.86 7.68 64.69 0.00 -- -- Peak HORIZONTAL	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor Aux Factor APos TPos Remark Pol/Phase MHz dBuV/m dBuV/m dB dBuV dB/m dB dB dB cm deg 1 2778.40 37.93 74.00 -36.07 62.88 32.86 7.68 64.69 0.00 -- -- Peak VERTICAL