TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.247

TEST REPORT

For

Murata Manufacturing Co., Ltd.

10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555, Japan

FCC ID: VPYLBAA0QB1SJ

Report Type:	**Product Type:**
Original Report	LoRa Module

Project Engineer:	Chao Gao
Report Number:	RKSA210416001-00B
Report Date:	2021-05-28
Reviewed By:	Oscar Ye EMC Manager
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248 Chenghu Road,Kunshan,Jiangsu province,China Tel: +86-0512-86175000 Fax: +86-0512-88934268 www.baclcorp.com.cn

TABLE OF CONTENTS

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	Murata Manufacturing Co., Ltd.
Tested Model	1SJ
Product Type	LoRa Module
Power Supply	DC 3.3V
Maximum Output Power	21.77dBm
RF Function	LoRa (500kHz)
Operating Frequency	903-914.2MHz
Channel Number	8
Channel Separation	1.6 MHz
Modulation Type	LoRa
Antenna Type	PCB antenna, FPC antenna with IPEX connector
Maximum Antenna Gain	PCB antenna/ FPC antenna: 1dBi
Firmware Version	Test FW V0.0.15

**All measurement and test data in this report was gathered from production sample serial number: RKSA210416001-1. (Assigned by the BACL. The EUT supplied by the applicant was received on 2021-04-16)*

Objective

This report is prepared on behalf of *Murata Manufacturing Co., Ltd.* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions' rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

Part 15.247 DSS submissions with FCC ID: VPYLBAA0QB1SJ

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19 dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 under the FCC KDB 974614 D01 and CAB identifier CN0004 under the ISED requirement. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The frequencies is F(MHz)=903.0+1.6*(n-64) (64<=n<=71). The lowest, middle, highest channel numbers of the EUT used and tested in this report are below.

Channel	Frequency (MHz)
64	903.0
68	909.4
71	914.2

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

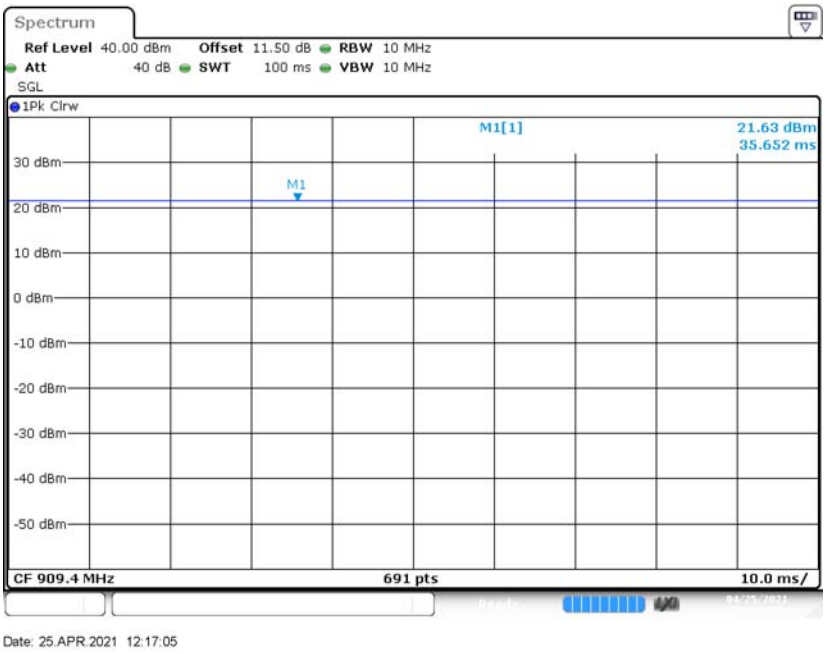
RF test tool: FSKLoRaCmd

Power Level: 22

Data rate: SF8.

Duty Cycle:

Middle Channel



Duty Cycle (%)	T(ms)	1/T(kHz)	10log(1/x)
100	/	/	0

Note: "x" means the Duty Cycle.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Murata Manufacturing Co., Ltd.	Base plate 1	JS-0909 Type1SJ EVB_PCB Antenna	/
Molex	FPC antenna	2111400100	/
ZHAOXIN	DC Power Supply	RXN-605D	DC002

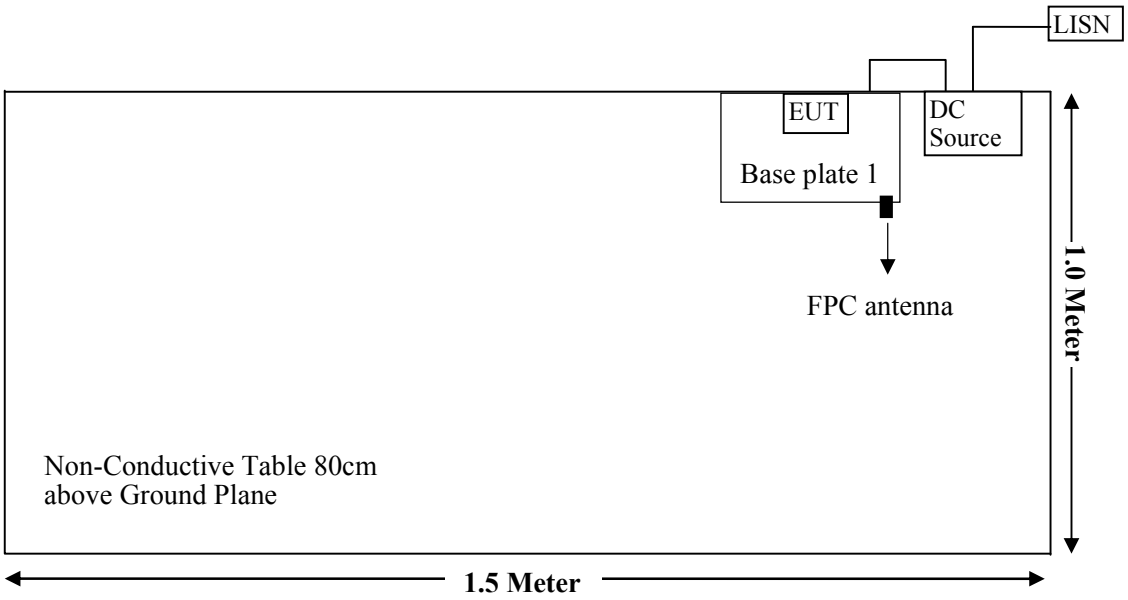
External I/O Cable

Cable Description	Length (m)	From Port	To Port
DC Cable	1.0	Base plate 1	DC Source

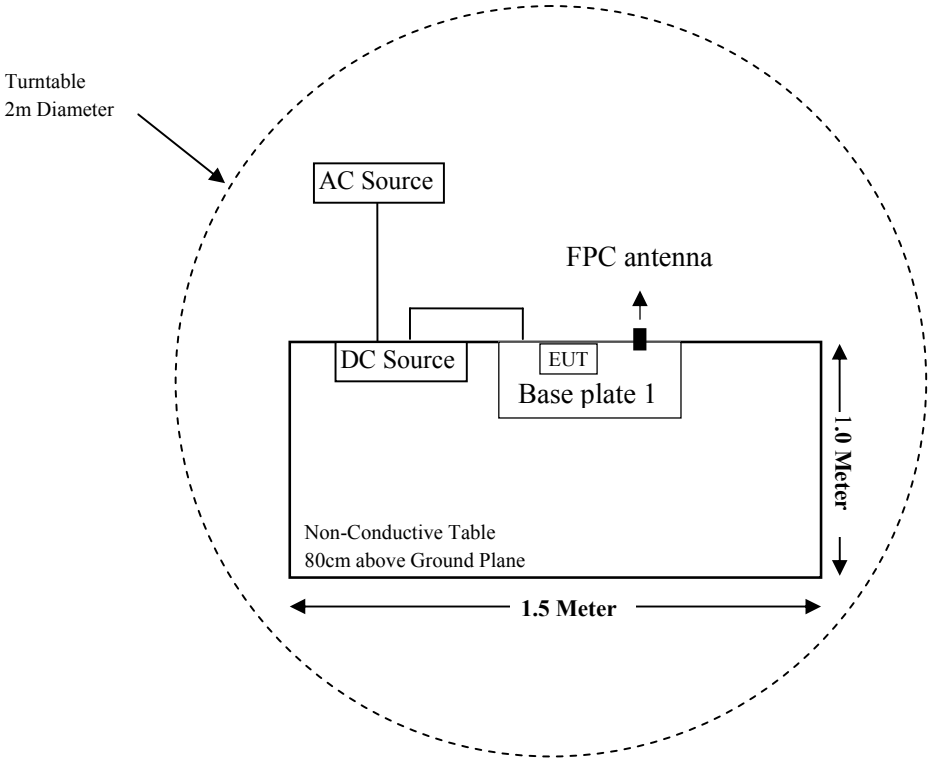
Block Diagram of Test Setup

For FPC antenna:

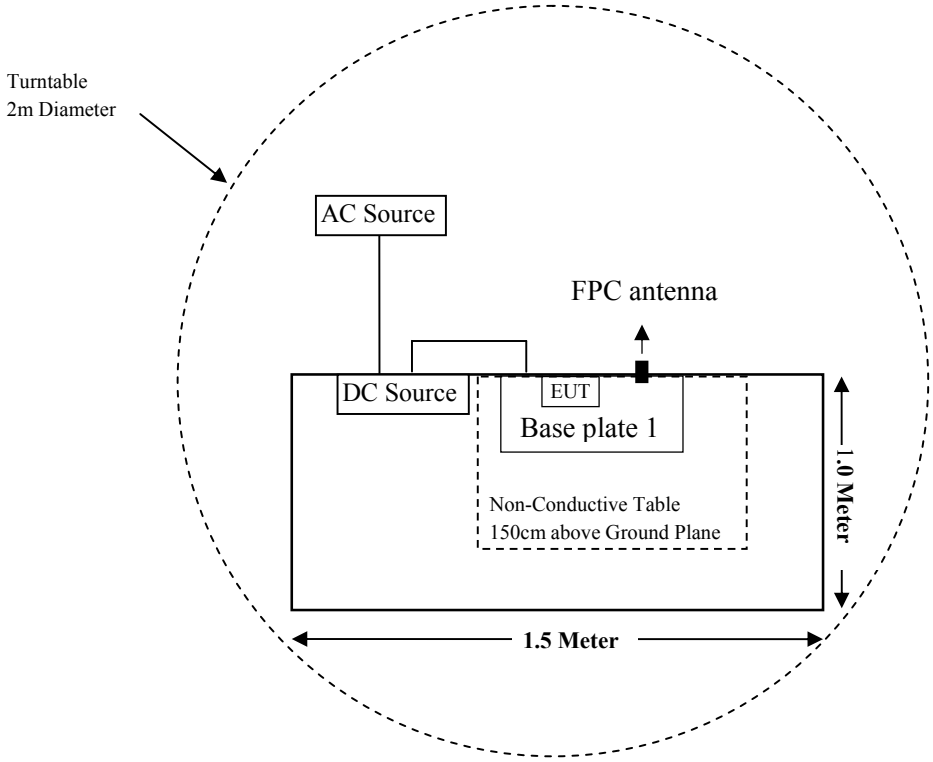
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):

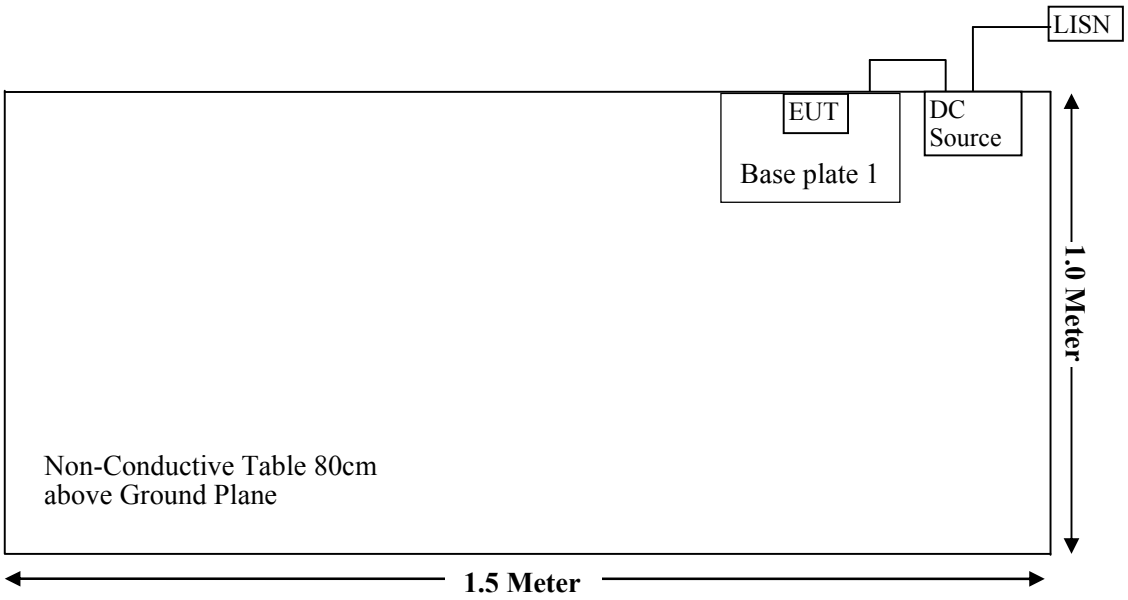


For Radiated Emissions(Above 1GHz):

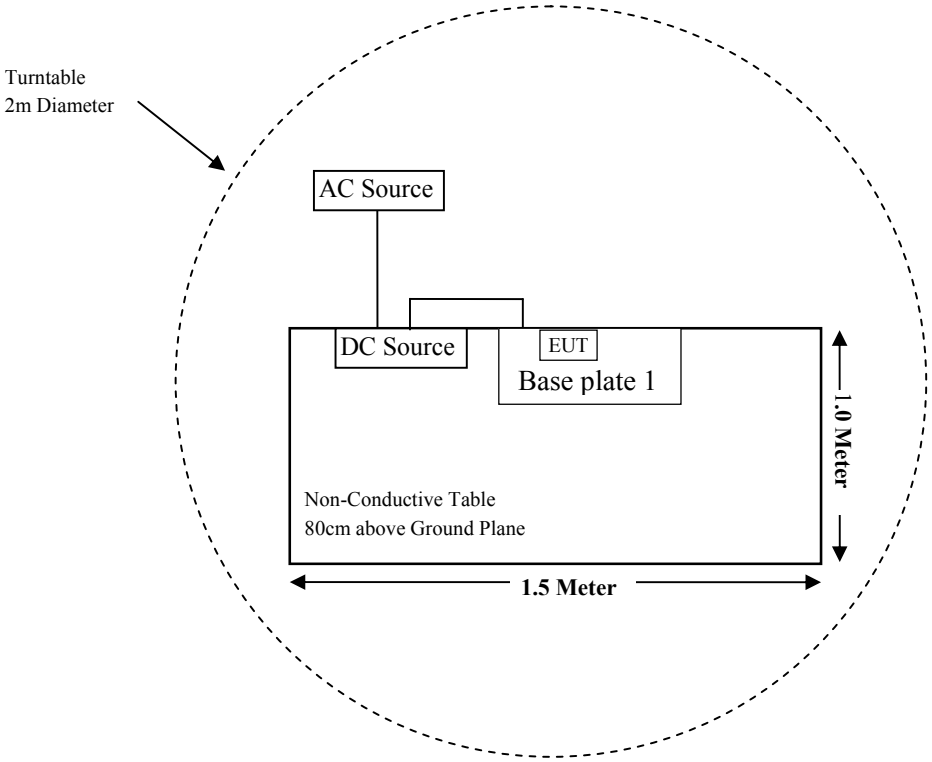


For PCB antenna:

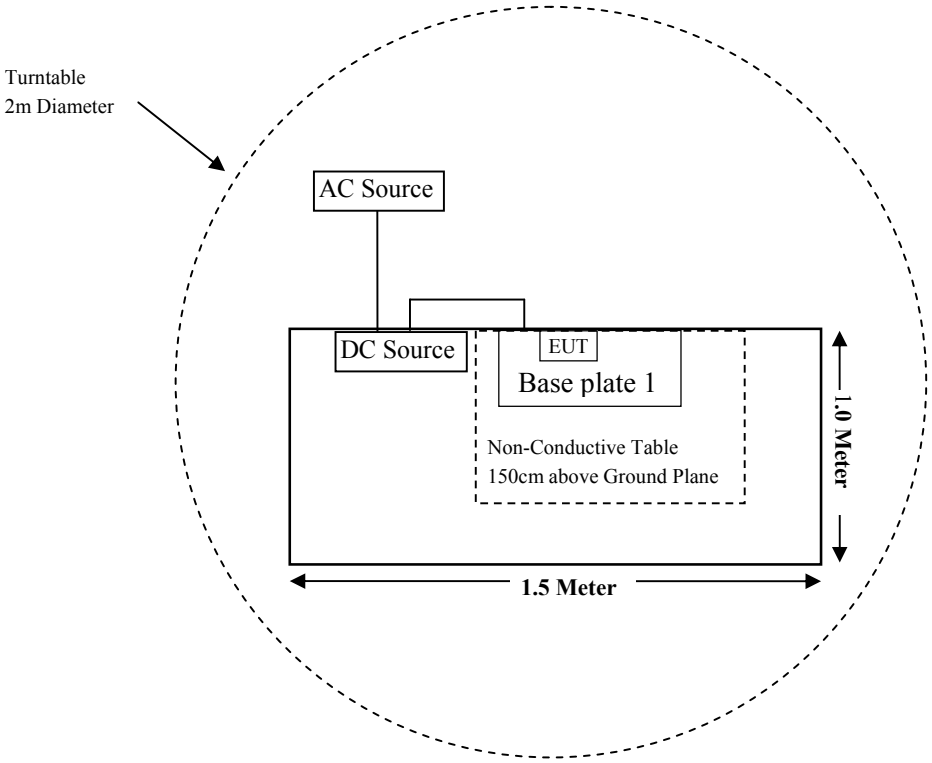
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §1.1310& §2.1091	Maximum Permissible Exposure (MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.247(d)	Spurious Emissions at Antenna Port	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	Maximum conducted (average) output power	Compliant
§15.247(d)	Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 3#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2020-12-14	2021-12-13
Sunol Sciences	Hybrid Antenna	JB3	A090314-1	2020-08-05	2023-08-04
Sonoma Instrunent	Pre-amplifier	310N	185700	2020-08-14	2021-08-13
Audix	Test Software	e3	V9	/	/
MICRO-TRONICS	Band Reject Filter	BRC50722	G013	2020-08-05	2021-08-04
MICRO-COAX	Coaxial Cable	Cable-8	008	2020-08-15	2021-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2020-08-15	2021-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2020-08-15	2021-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2021-04-01	2022-03-31
ETS-LINDGREN	Horn Antenna	3115	9311-4159	2020-07-15	2023-07-14
A.H.Systems, inc	Amplifier	2641-1	491	2021-02-20	2022-02-19
Narda	Attenuator	10dB	010	2020-08-15	2021-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-TRONICS	Band Reject Filter	BRC50722	G013	2020-08-05	2021-08-04
MICRO-COAX	Coaxial Cable	Cable-6	006	2020-12-12	2021-12-11
MICRO-COAX	Coaxial Cable	Cable-11	011	2020-08-15	2021-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2020-08-15	2021-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2020-08-15	2021-08-14
RF Conducted Test					
Agilent	Power Meter	N1912A	MY5000492	2020-11-18	2021-11-17
Agilent	Power Sensor	N1921A	MY54210024	2020-11-18	2021-11-17
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2020-07-28	2021-07-27
Narda	Attenuator	10dB	010	2020-08-15	2021-08-14
Murata	RF Cable	Murata C01	C01	Each Time	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2020-08-05	2021-08-04
Audix	Test Software	e3	V9	/	/
Rohde & Schwarz	LISN	ENV216	101115	2020-12-14	2021-12-13
Rohde & Schwarz	Pulse limiter	ESH3-Z5	862770/011	2020-11-30	2021-11-29
MICRO-COAX	Coaxial Cable	Cable-15	015	2020-08-15	2021-08-14

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §1.1310& §2.1091 - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247(i) and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f^2)	30
30-300	27.5	0.073	0.2	30
300-1500	/		f/1500	30
1500-100,000	/		1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g.mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

For worst case:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted average Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa (125kHz)	902.3-914.9	1	1.26	22.00	158.49	20	0.0397	0.60
LoRa (500kHz)	903-914.2	1	1.26	22.00	158.49	20	0.0397	0.60

Conclusion: The EUT meets requirement - RF exposure evaluation greater than 20cm distance specified in § 2.1091. If the device built into a host as a portable usage, the additional RF exposure evaluation may be required as specified by§ 2.1093.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.
And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has been tested with two antennas for Lora, one FPC antenna with IPEX connector which the antenna gain is 1dBi and one PCB antenna which the antenna gain is 1dBi, fulfill the requirement of this section. Please refer to the EUT photos.

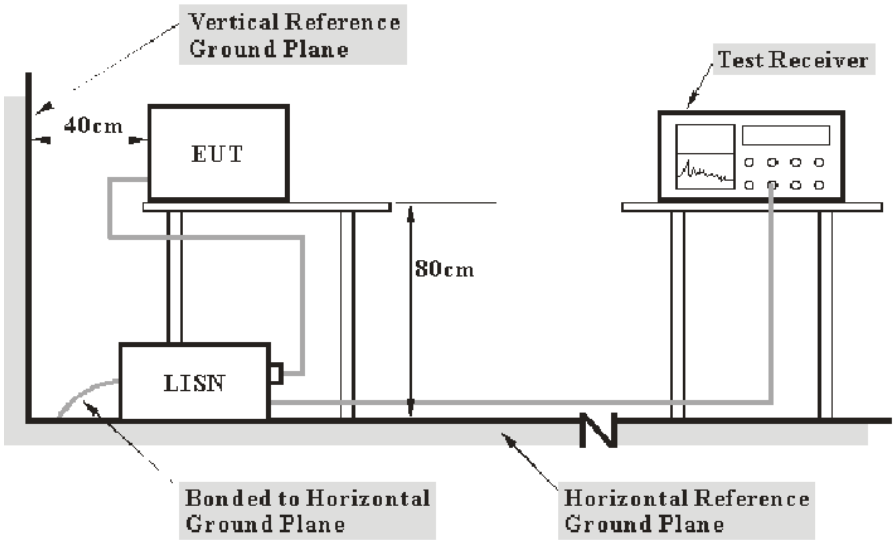
Result: Compliant.

FCC §15.207 (a) - AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207 (a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz - 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the DC Source was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Over Limit Calculation

The Factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)

The "**Over Limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of 7 dB means the emission is 7 dB above the limit. The equation for over limit calculation is as follows:

Over Limit (dB) = Read level (dBμV) + Factor (dB) - Limit (dBμV)

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

Test Data

Environmental Conditions

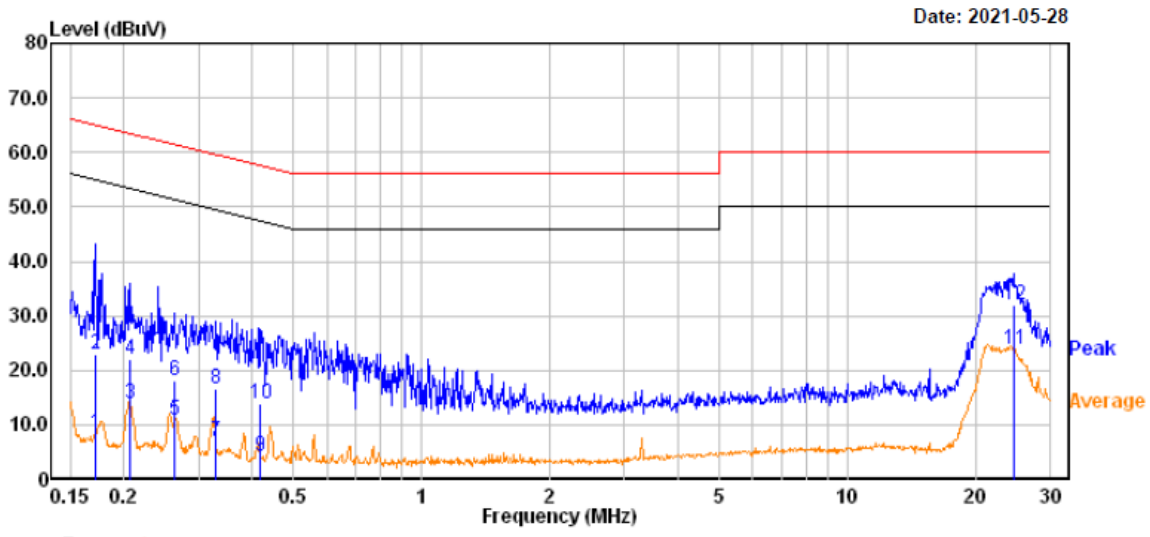
Temperature:	22.3 ℃
Relative Humidity:	49 %
ATM Pressure:	101.2 kPa

The testing was performed by Chao Gao on 2021-05-28.

EUT operation mode: Transmitting in low channel. (Worst case)

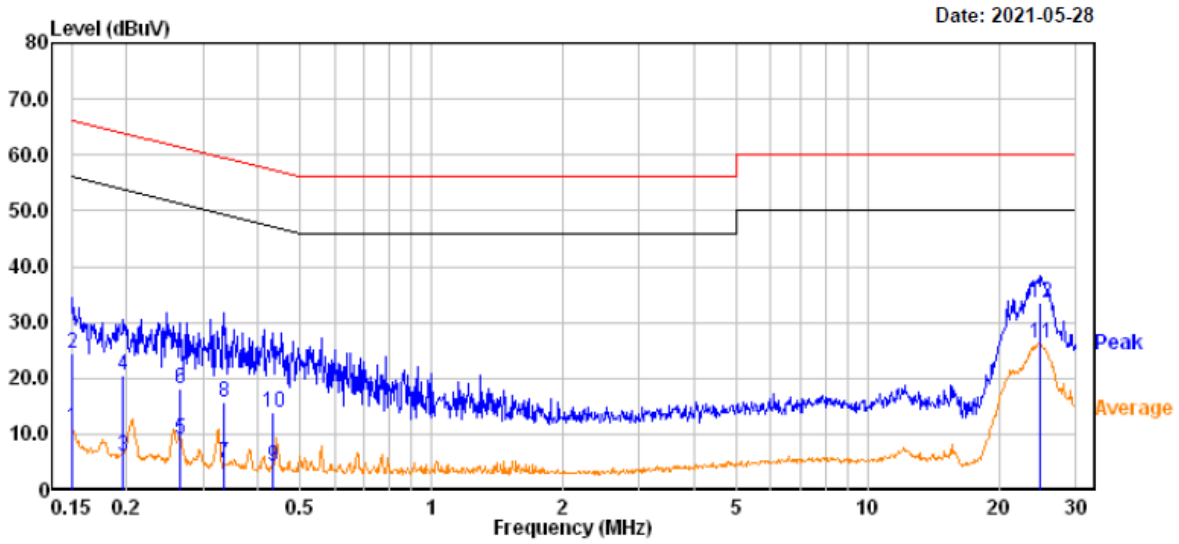
For FPC antenna

AC 120V/60 Hz, Line



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.172	-11.50	19.83	8.33	54.88	-46.55	Average
2	0.172	3.00	19.83	22.83	64.88	-42.05	QP
3	0.206	-5.80	19.82	14.02	53.35	-39.33	Average
4	0.206	2.20	19.82	22.02	63.35	-41.33	QP
5	0.262	-9.10	19.82	10.72	51.36	-40.64	Average
6	0.262	-1.70	19.82	18.12	61.36	-43.24	QP
7	0.330	-12.91	19.82	6.91	49.46	-42.55	Average
8	0.330	-3.31	19.82	16.51	59.46	-42.95	QP
9	0.419	-15.40	19.74	4.34	47.47	-43.13	Average
10	0.419	-5.80	19.74	13.94	57.47	-43.53	QP
11	24.577	4.20	19.71	23.91	50.00	-26.09	Average
12	24.577	12.40	19.71	32.11	60.00	-27.89	QP

AC 120V/60 Hz, Neutral



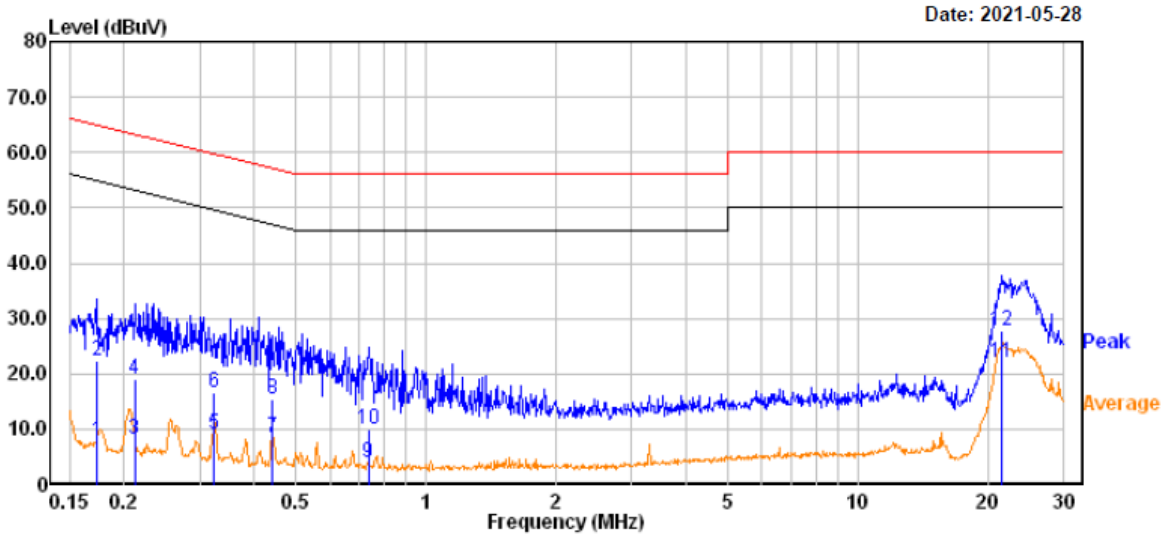
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.151	-8.60	19.82	11.22	55.96	-44.74	Average
2	0.151	4.50	19.82	24.32	65.96	-41.64	QP
3	0.196	-13.80	19.82	6.02	53.76	-47.74	Average
4	0.196	0.80	19.82	20.62	63.76	-43.14	QP
5	0.265	-10.80	19.82	9.02	51.28	-42.26	Average
6	0.265	-1.80	19.82	18.02	61.28	-43.26	QP
7	0.335	-14.91	19.82	4.91	49.33	-44.42	Average
8	0.335	-4.11	19.82	15.71	59.33	-43.62	QP
9	0.432	-15.50	19.75	4.25	47.22	-42.97	Average
10	0.432	-6.00	19.75	13.75	57.22	-43.47	QP
11	24.824	6.70	19.70	26.40	50.00	-23.60	Average
12	24.824	13.80	19.70	33.50	60.00	-26.50	QP

Note:

1) Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)
2) Over Limit (dB) = Read level (dBµV) + Factor (dB) - Limit (dBµV)

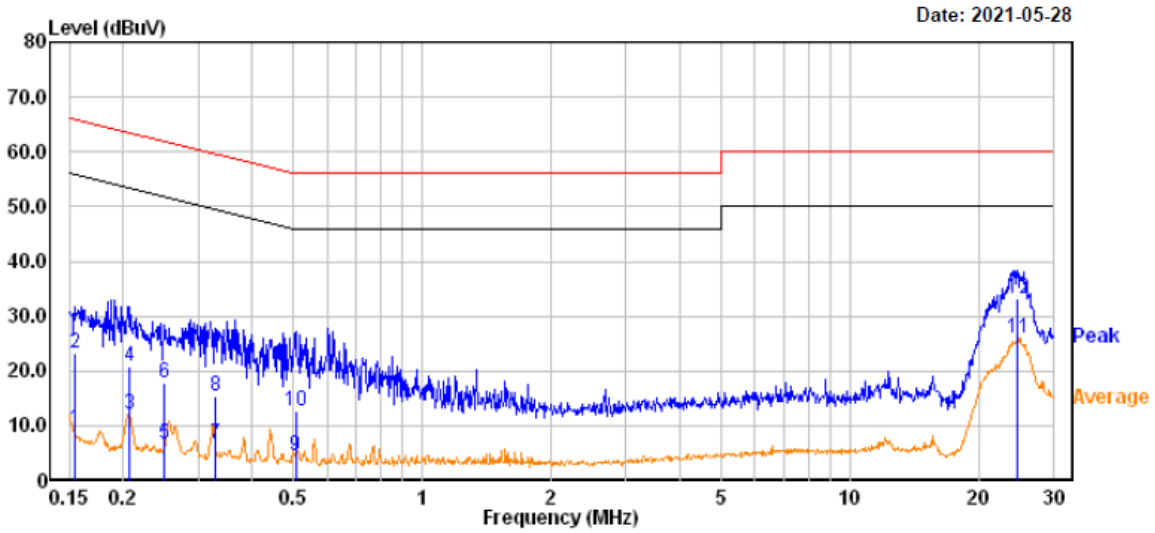
For PCB antenna

AC 120V/60 Hz, Line



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.172	-11.90	19.83	7.93	54.84	-46.91	Average
2	0.172	2.50	19.83	22.33	64.84	-42.51	QP
3	0.212	-11.60	19.82	8.22	53.14	-44.92	Average
4	0.212	-0.80	19.82	19.02	63.14	-44.12	QP
5	0.322	-10.90	19.82	8.92	49.67	-40.75	Average
6	0.322	-3.20	19.82	16.62	59.67	-43.05	QP
7	0.442	-11.20	19.75	8.55	47.02	-38.47	Average
8	0.442	-4.50	19.75	15.25	57.02	-41.77	QP
9	0.736	-15.90	19.73	3.83	46.00	-42.17	Average
10	0.736	-9.80	19.73	9.93	56.00	-46.07	QP
11	21.483	2.20	19.87	22.07	50.00	-27.93	Average
12	21.483	7.80	19.87	27.67	60.00	-32.33	QP

AC 120V/60 Hz, Neutral



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.154	-10.60	19.82	9.22	55.79	-46.57	Average
2	0.154	3.50	19.82	23.32	65.79	-42.47	QP
3	0.207	-7.60	19.82	12.22	53.31	-41.09	Average
4	0.207	1.00	19.82	20.82	63.31	-42.49	QP
5	0.249	-13.10	19.82	6.72	51.78	-45.06	Average
6	0.249	-2.10	19.82	17.72	61.78	-44.06	QP
7	0.330	-13.11	19.82	6.71	49.46	-42.75	Average
8	0.330	-4.31	19.82	15.51	59.46	-43.95	QP
9	0.506	-15.30	19.76	4.46	46.00	-41.54	Average
10	0.506	-7.00	19.76	12.76	56.00	-43.24	QP
11	24.577	6.40	19.71	26.11	50.00	-23.89	Average
12	24.577	13.50	19.71	33.21	60.00	-26.79	QP

Note:

1) Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)
2) Over Limit (dB) = Read level (dBµV) + Factor (dB) - Limit (dBµV)

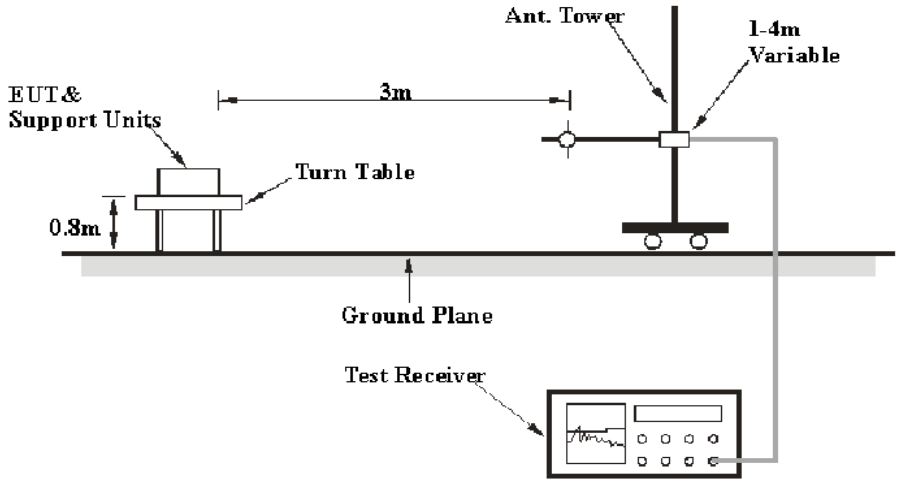
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

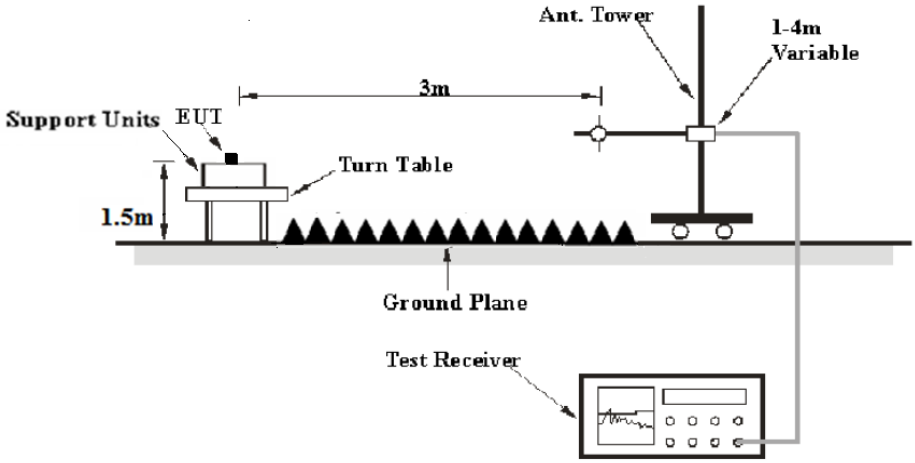
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver Setup

The system was investigated from 30 MHz to10 GHz.

During the radiated emission test, the EMI test receiver Setup was set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz - 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	PK
	1MHz	3 MHz	1MHz	AVG.

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz - 1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude (dBμV /m) = Meter Reading (dBμV) + Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB)

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin (dB) = Limit (dBμV/m) - Corrected Amplitude (dBμV /m)

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

Environmental Conditions

Temperature:	21.8~23.2 ℃
Relative Humidity:	48~50 %
ATM Pressure:	101.2~101.3 kPa

The testing was performed by Chao Gao from 2021-04-25 to 2021-04-30.

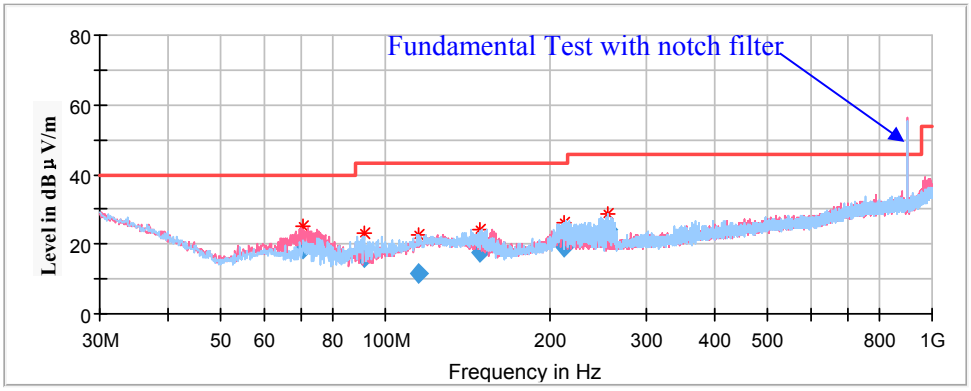
EUT operation mode: Transmitting

For FPC antenna:

Spurious Emission Test:

30MHz-1GHz

Pre-scan with low, middle, high channel of operation in the X,Y and Z axes of orientation, the worst case ***low channel in X-axis of orientation*** *was recorded*



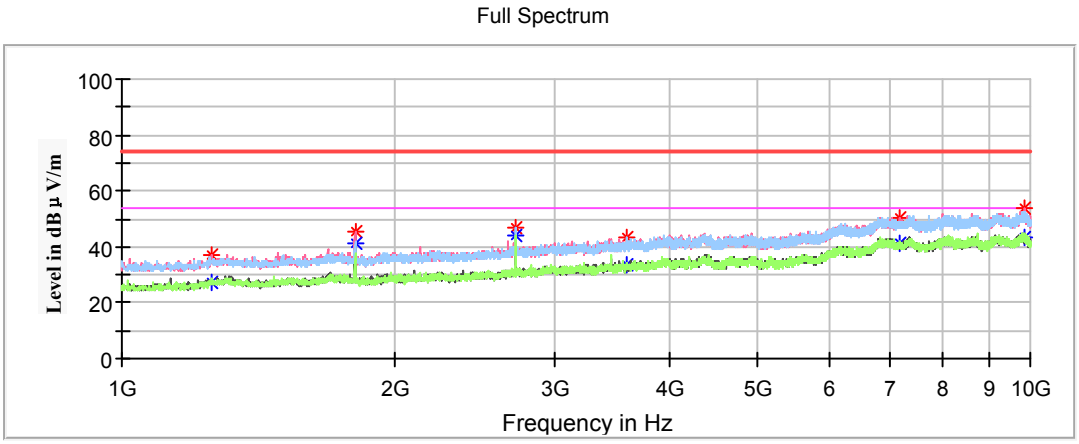
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	QuasiPeak (dBµV/m)	Height (cm)	Polar (H/V)				
70.400200	18.66	100.0	V	308.0	-16.8	40.00	21.34
91.547900	16.18	199.0	H	38.0	-16.6	43.50	27.32
115.199950	11.46	199.0	H	44.0	-11.7	43.50	32.04
149.020300	17.48	199.0	H	56.0	-12.8	43.50	26.02
212.723150	18.98	100.0	H	220.0	-12.0	43.50	24.52
255.981700	24.36	100.0	H	250.0	-11.8	46.00	21.64

1GHz-10GHz

*Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded.*

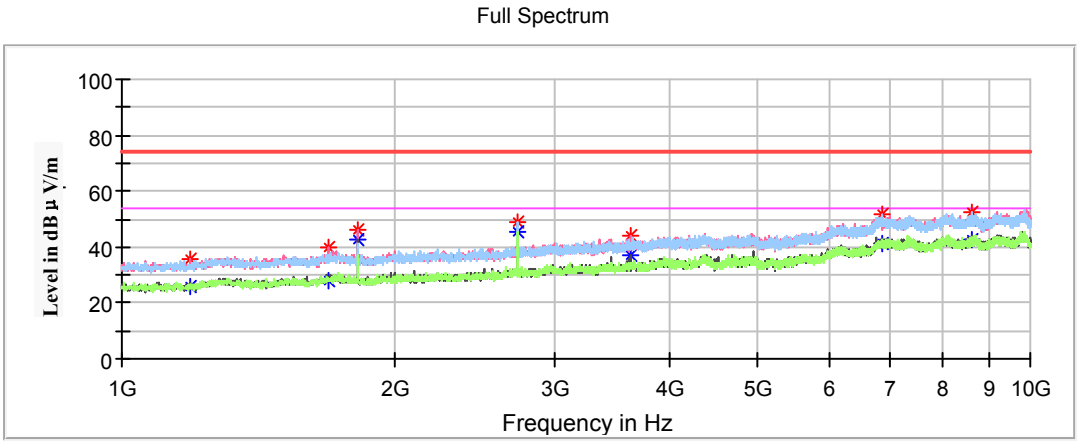
Note:
1. The test was performed with a 10dB Attenuator.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB) + Attenuator(dB)
   Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
   Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

Low Channel: 903.0MHz



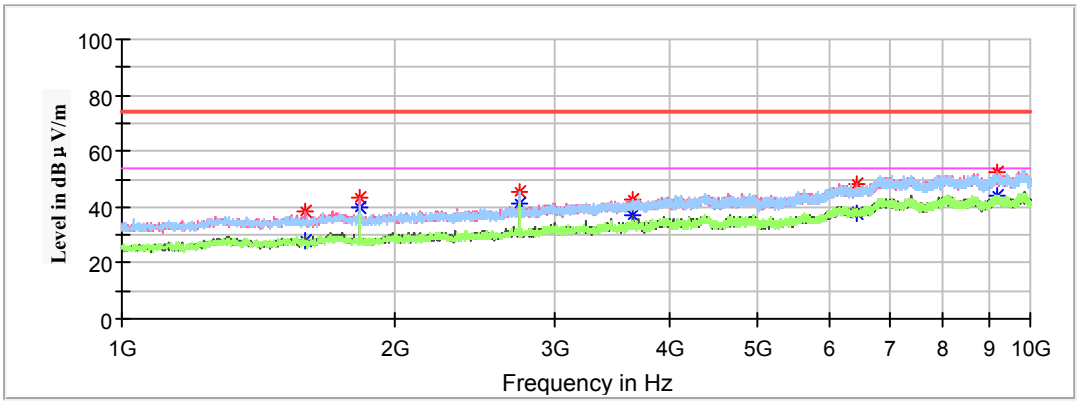
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1257.400000	---	27.44	200.0	H	188.0	-10.9	54.00	26.56
1257.400000	37.01	---	200.0	H	188.0	-10.9	74.00	36.99
1806.400000	---	41.31	150.0	V	72.0	-8.3	54.00	12.69
1806.400000	45.52	---	150.0	V	72.0	-8.3	74.00	28.48
2709.100000	---	44.39	200.0	H	0.0	-4.7	54.00	9.61
2709.100000	47.19	---	200.0	H	0.0	-4.7	74.00	26.81
3602.800000	---	33.68	200.0	V	262.0	-1.3	54.00	20.32
3602.800000	43.67	---	200.0	V	262.0	-1.3	74.00	30.33
7171.300000	---	41.44	150.0	V	0.0	9.0	54.00	12.56
7171.300000	50.39	---	150.0	V	0.0	9.0	74.00	23.61
9876.700000	---	43.51	200.0	V	313.0	11.9	54.00	10.49
9876.700000	53.58	---	200.0	V	313.0	11.9	74.00	20.42

Middle Channel: 909.4MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Average (dBµV/m)	Height (cm)	Polar (H/V)				
1190.800000	---	26.02	200.0	H	35.0	-11.3	54.00	27.98
1190.800000	35.69	---	200.0	H	35.0	-11.3	74.00	38.31
1686.700000	---	28.09	200.0	V	2.0	-8.8	54.00	25.91
1686.700000	39.58	---	200.0	V	2.0	-8.8	74.00	34.42
1819.000000	---	42.58	200.0	V	41.0	-8.3	54.00	11.42
1819.000000	45.84	---	200.0	V	41.0	-8.3	74.00	28.16
2728.000000	---	45.26	200.0	H	359.0	-4.6	54.00	8.74
2728.000000	48.77	---	200.0	H	359.0	-4.6	74.00	25.23
3637.900000	44.22	---	150.0	V	8.0	-1.2	74.00	29.78
3637.900000	---	36.94	150.0	V	8.0	-1.2	54.00	17.06
6852.700000	51.70	---	200.0	H	354.0	8.3	74.00	22.30
6852.700000	---	41.38	200.0	H	354.0	8.3	54.00	12.62
8631.100000	---	42.35	150.0	H	195.0	10.7	54.00	11.65
8631.100000	52.77	---	150.0	H	195.0	10.7	74.00	21.23

High Channel: 914.2MHz



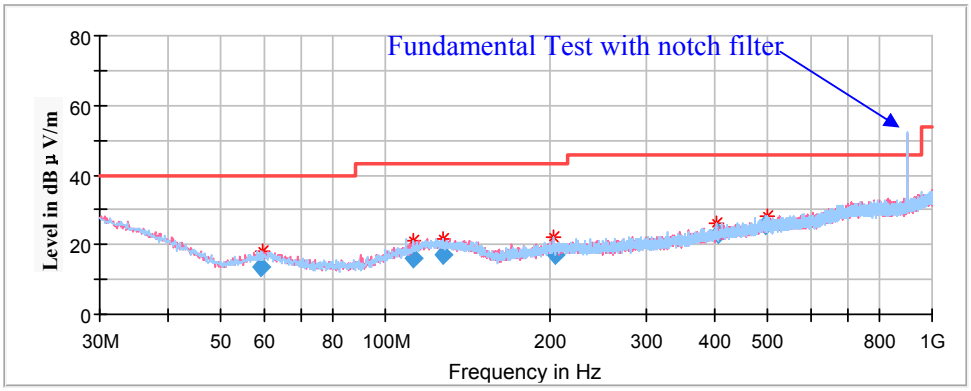
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Average (dBµV/m)	Height (cm)	Polar (H/V)				
1594.900000	---	28.19	200.0	V	267.0	-9.1	54.00	25.81
1594.900000	38.77	---	200.0	V	267.0	-9.1	74.00	35.23
1828.000000	---	40.02	200.0	V	34.0	-8.3	54.00	13.98
1828.000000	43.66	---	200.0	V	34.0	-8.3	74.00	30.34
2742.400000	---	41.05	150.0	H	326.0	-4.5	54.00	12.95
2742.400000	45.29	---	150.0	H	326.0	-4.5	74.00	28.71
3657.700000	---	37.38	150.0	V	359.0	-1.1	54.00	16.62
3657.700000	42.91	---	150.0	V	359.0	-1.1	74.00	31.09
6451.300000	---	37.76	150.0	H	1.0	6.6	54.00	16.24
6451.300000	48.53	---	150.0	H	1.0	6.6	74.00	25.47
9174.700000	---	43.75	200.0	V	205.0	11.1	54.00	10.25
9174.700000	52.42	---	200.0	V	205.0	11.1	74.00	21.58

For PCB antenna:

Spurious Emission Test:

30MHz-1GHz

Pre-scan with low, middle, high channel of operation in the X,Y and Z axes of orientation, the worst case ***low channel in X-axis of orientation*** *was recorded*



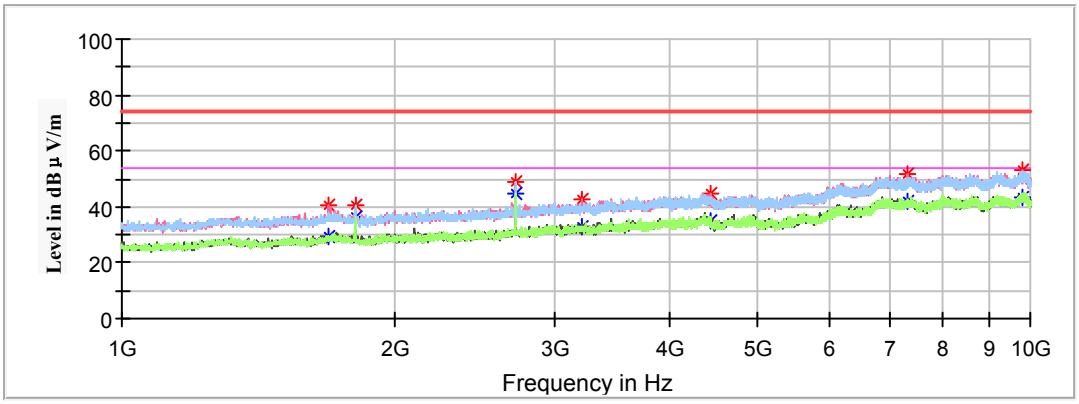
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	QuasiPeak (dBµV/m)	Height (cm)	Polar (H/V)				
59.381050	13.66	100.0	H	111.0	-14.6	40.00	26.34
112.327800	16.14	100.0	H	27.0	-12.3	43.50	27.36
127.858650	17.31	200.0	H	15.0	-11.1	43.50	26.19
204.349950	16.94	200.0	H	292.0	-12.0	43.50	26.56
405.471200	22.90	200.0	H	179.0	-7.9	46.00	23.10
497.378650	25.87	100.0	H	123.0	-5.6	46.00	20.13

1GHz-10GHz

*Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded.*

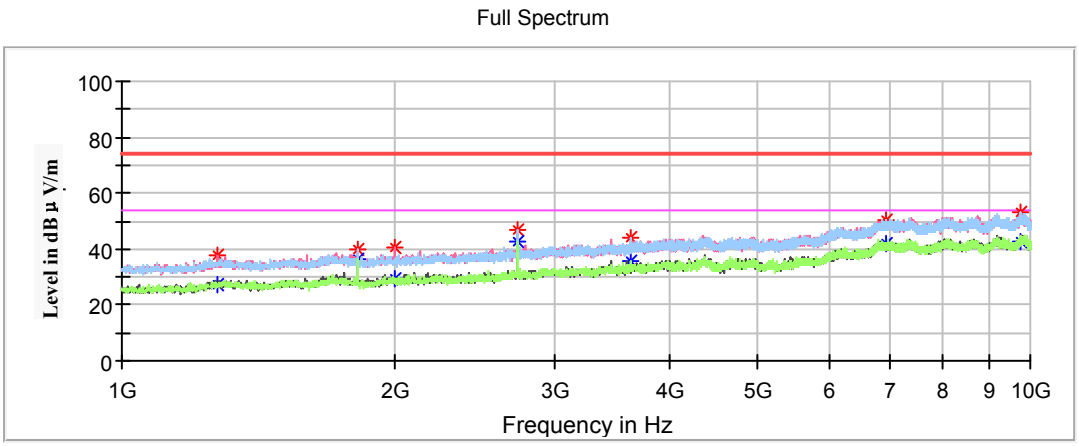
Note:
1. The test was performed with a 10dB Attenuator.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB) + Attenuator(dB)
   Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
   Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

Low Channel: 903.0MHz



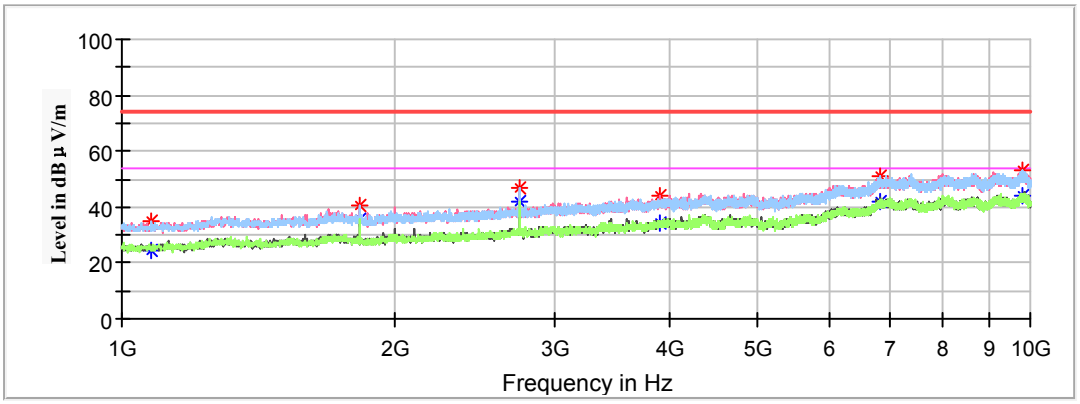
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1689.400000	---	29.42	200.0	V	282.0	-8.7	54.00	24.58
1689.400000	40.70	---	200.0	V	282.0	-8.7	74.00	33.30
1805.500000	---	36.09	150.0	H	0.0	-8.3	54.00	17.91
1805.500000	40.30	---	150.0	H	0.0	-8.3	74.00	33.70
2709.100000	---	44.80	150.0	H	0.0	-4.7	54.00	9.20
2709.100000	48.83	---	150.0	H	0.0	-4.7	74.00	25.17
3214.900000	---	32.70	150.0	V	93.0	-2.6	54.00	21.30
3214.900000	42.55	---	150.0	V	93.0	-2.6	74.00	31.45
4444.300000	44.76	---	200.0	V	7.0	0.9	74.00	29.24
4444.300000	---	34.62	200.0	V	7.0	0.9	54.00	19.38
7338.700000	---	41.72	200.0	H	6.0	9.1	54.00	12.28
7338.700000	51.56	---	200.0	H	6.0	9.1	74.00	22.44
9787.600000	---	43.44	150.0	V	313.0	11.9	54.00	10.56
9787.600000	53.36	---	150.0	V	313.0	11.9	74.00	20.64

Middle Channel: 909.4MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Average (dBµV/m)	Height (cm)	Polar (H/V)				
1276.300000	---	27.59	200.0	H	12.0	-10.8	54.00	26.41
1276.300000	37.59	---	200.0	H	12.0	-10.8	74.00	36.41
1819.000000	---	36.24	150.0	H	0.0	-8.3	54.00	17.76
1819.000000	40.16	---	150.0	H	0.0	-8.3	74.00	33.84
1999.000000	---	29.62	150.0	V	171.0	-7.7	54.00	24.38
1999.000000	40.32	---	150.0	V	171.0	-7.7	74.00	33.68
2728.000000	46.75	---	150.0	H	15.0	-4.6	74.00	27.25
2728.000000	---	42.99	150.0	H	343.0	-4.6	54.00	11.01
3637.000000	---	35.54	200.0	H	46.0	-1.2	54.00	18.46
3637.000000	43.86	---	200.0	H	46.0	-1.2	74.00	30.14
6935.500000	---	41.84	150.0	H	331.0	8.6	54.00	12.16
6935.500000	50.63	---	150.0	H	331.0	8.6	74.00	23.37
9743.500000	---	42.89	200.0	H	59.0	11.9	54.00	11.11
9743.500000	53.16	---	200.0	H	59.0	11.9	74.00	20.84

High Channel: 914.2MHz



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Average (dBµV/m)	Height (cm)	Polar (H/V)				
1078.300000	---	24.79	150.0	H	91.0	-12.0	54.00	29.21
1078.300000	35.31	---	150.0	H	91.0	-12.0	74.00	38.69
1828.900000	---	35.53	150.0	V	146.0	-8.3	54.00	18.47
1828.900000	40.27	---	150.0	V	146.0	-8.3	74.00	33.73
2743.300000	---	42.00	200.0	H	9.0	-4.5	54.00	12.00
2743.300000	46.99	---	200.0	H	9.0	-4.5	74.00	27.01
3911.500000	---	33.98	200.0	V	109.0	0.0	54.00	20.02
3911.500000	44.26	---	200.0	V	109.0	0.0	74.00	29.74
6833.800000	---	41.79	150.0	V	33.0	8.2	54.00	12.21
6833.800000	50.82	---	150.0	V	33.0	8.2	74.00	23.18
9818.200000	---	43.85	150.0	H	164.0	11.9	54.00	10.15
9818.200000	53.12	---	150.0	H	164.0	11.9	74.00	20.88

Bandedge Emissions Test:

*(Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded.)*

Note:
1. The test is performed with a 10dB Attenuator.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor+ Attenuator
   Corrected Amplitude = Corrected Factor + Reading
   Margin = Limit - Corrected. Amplitude

For FPC antenna:

Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	QuasiPeak (dBμV/m)	Height (cm)	Polar (H/V)				
903.0MHz							
902.00	33.07	100	H	217	1.02	46	12.93
902.00	33.16	100	V	16	1.02	46	12.84
914.2MHz							
928.00	32.91	200	H	359	1.68	46	13.09
928.00	33.44	200	V	148	1.68	46	12.56

For PCB antenna:

Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	QuasiPeak (dBμV/m)	Height (cm)	Polar (H/V)				
903.0MHz							
902.00	34.62	100	H	127	1.02	46	11.38
902.00	34.15	200	V	46	1.02	46	34.05
914.2MHz							
928.00	35.73	100	H	121	1.68	46	10.27
928.00	35.1	100	V	156	1.68	46	10.9

FCC §15.247(a) (2) - 6 dB EMISSION BANDWIDTH

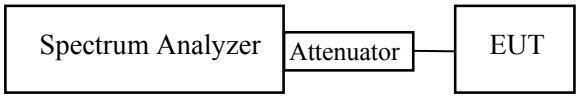
Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 * RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.



Test Data

Environmental Conditions

Temperature:	21.2 ℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

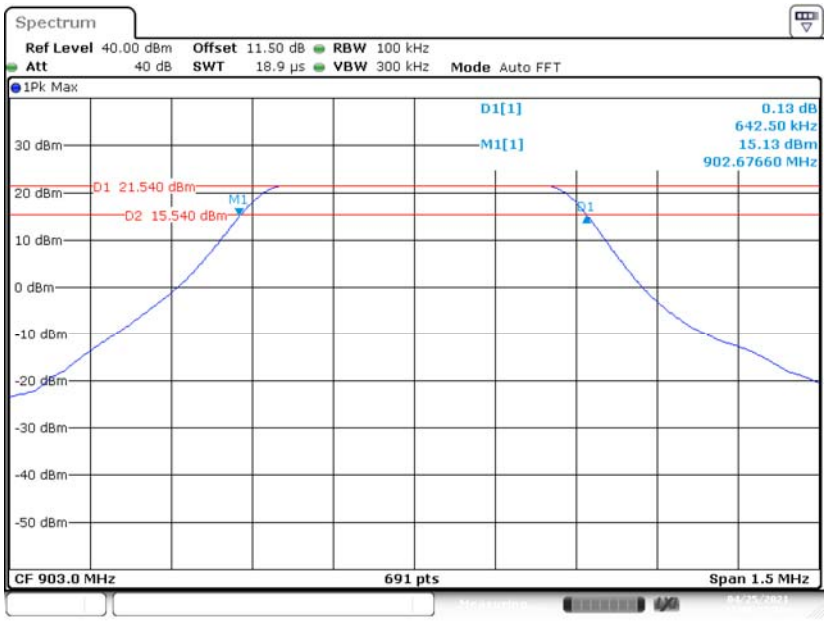
The testing was performed by Chao Gao on 2021-04-25.

EUT operation mode: Transmitting

Test Result: Compliant.

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
Low	903.00	0.643	≥0.5
Middle	909.40	0.634	≥0.5
High	914.20	0.630	≥0.5

Low Channel



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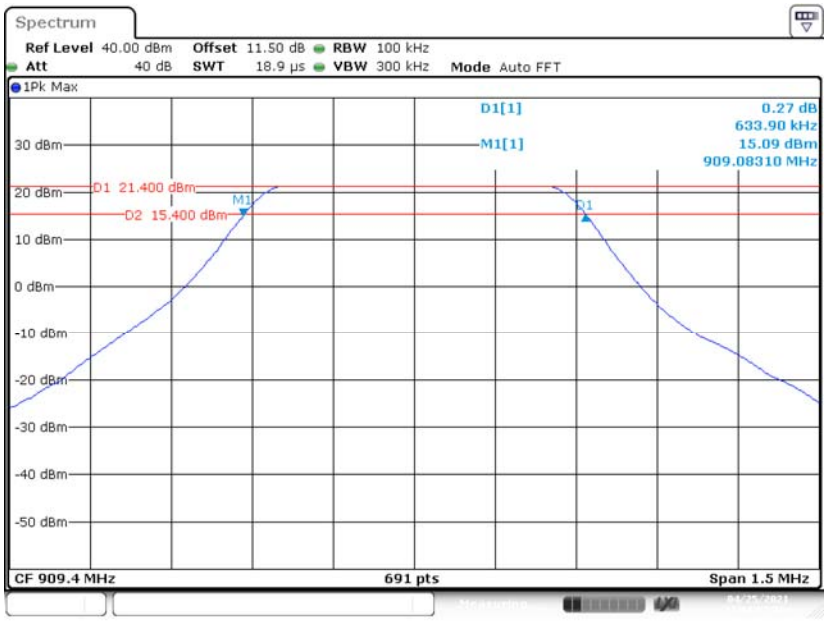
Middle Channel



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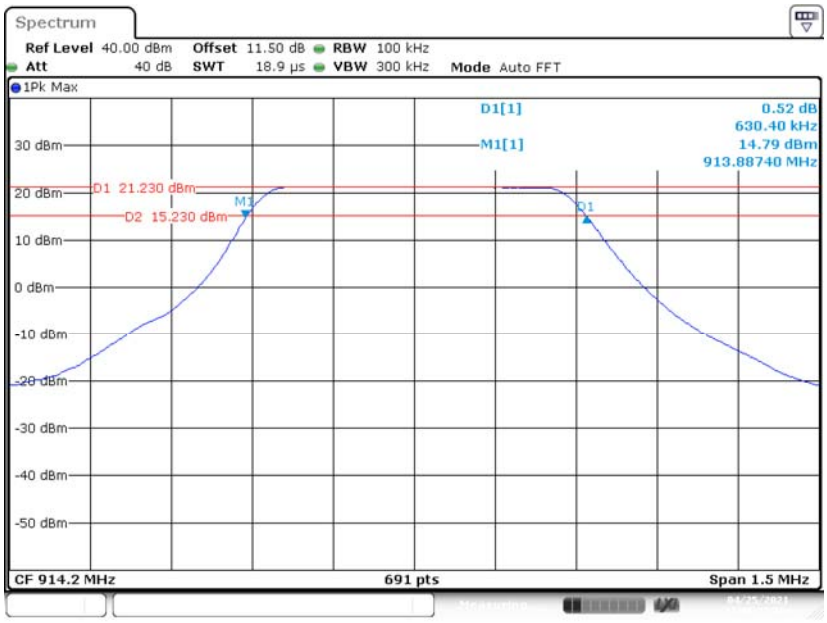
High Channel



FCC §15.247(b) (3) - MAXIMUM CONDUCTED (AVERAGE) OUTPUT POWER

Applicable Standard

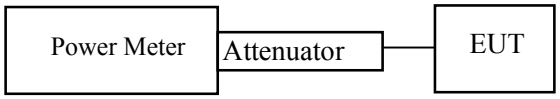
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.9.2.3.1

The maximum average conducted output power may be measured using a wideband RF average power
The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

1. Place the EUT on a bench 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 one test equipment.
3. Add a duty factor to the display.



Test Data

Environmental Conditions

Temperature:	21.2 ℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Chao Gao on 2021-04-26.

EUT operation mode: Transmitting

Channel	Frequency (MHz)	Average Output Power (dBm)	Limit (dBm)	Result
Low	903.00	21.77	30	Pass
Middle	909.40	21.61	30	Pass
High	914.20	21.44	30	Pass

FCC §15.247(d) - BAND EDGE

Applicable Standard

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), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

According to ANSI C63.10-2013 sub-clause 6.10.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the middleest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the middleest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

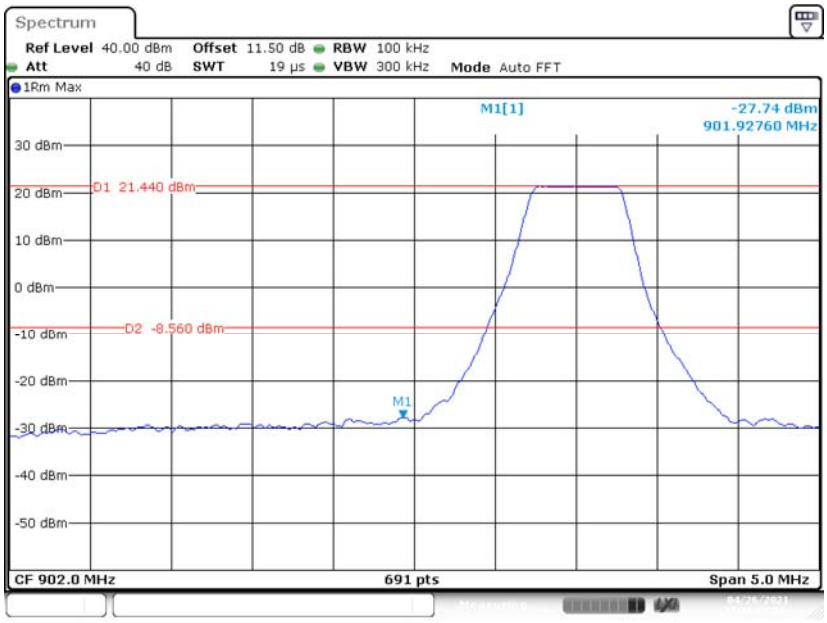
Temperature:	21.2 ℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Chao Gao on 2021-04-26.

EUT operation mode: Transmitting

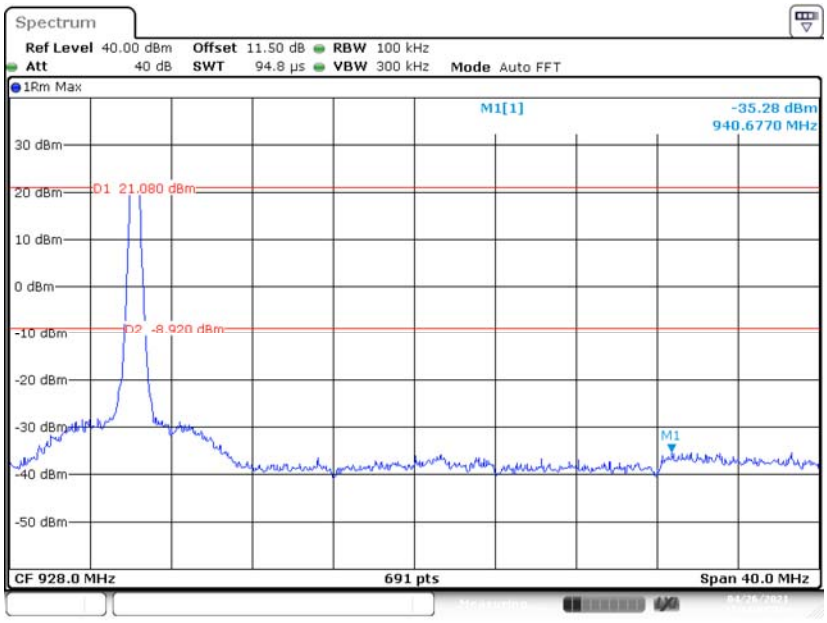
Test Result: Compliant.

Left Side



Date: 26.APR.2021 11:16:56

Right Side



Date: 26.APR.2021 11:14:09

FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

a) Set instrument center frequency to DTS channel center frequency.
b) Set span to at least 1.5 times the OBW.
c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d) Set VBW ≥ [3 × RBW].
e) Detector = power averaging (rms)
f) Ensure that the number of measurement points in the sweep ≥ [2 × span / RBW].
g) Manually set the sweep time to: ≥ [10 × (number of measurement points in sweep) × (transmission symbol period)], but no less than the auto sweep time.
h) Perform the measurement over a single sweep.
i) Use the peak marker function to determine the maximum amplitude level.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

Test Data

Environmental Conditions

Temperature:	24.2 ℃
Relative Humidity:	49 %
ATM Pressure:	101.3 kPa

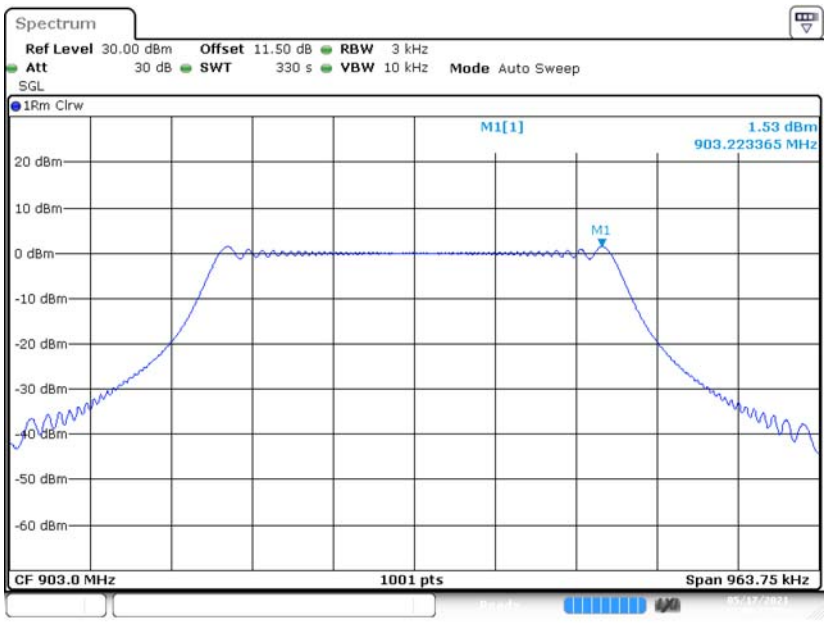
The testing was performed by Chao Gao on 2021-05-17.

EUT operation mode: Transmitting

Test Result: Compliant.

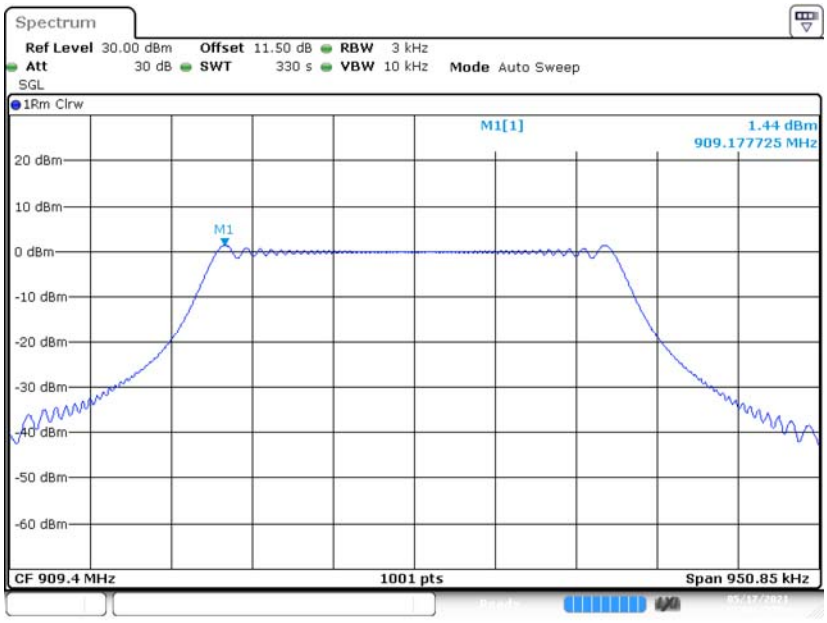
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	903.00	1.53	≤ 8
Middle	909.40	1.44	≤ 8
High	914.20	1.23	≤ 8

Low Channel



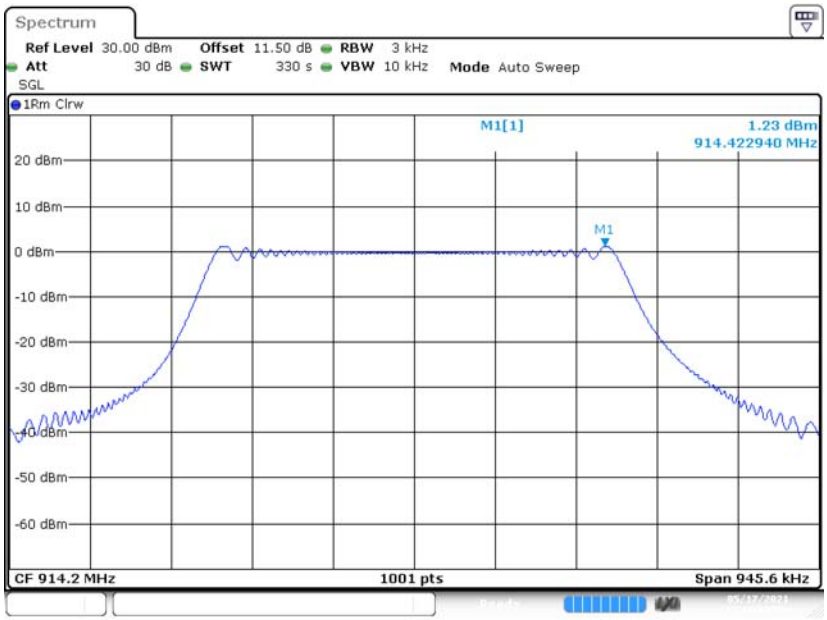
Date: 17.MAY.2021 12:05:18

Middle Channel



Date: 17.MAY.2021 12:11:41

High Channel



Declarations

1: BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk'*'. Customer model name, addresses, names, trademarks etc. are not considered data.

2: Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

3: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

4: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

5: This report cannot be reproduced except in full, without prior written approval of the Company.

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******* END OF REPORT *******