TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.247
TEST REPORT

For

LANSITEC Information Technology Co., Ltd.

Room 501, No. 21 Huashen Avenue, Nanjing, China.

FCC ID: 2APPL-LSTR100

Report Type:	**Product Type:**
Original Report	LoRa & BLE Device

Test Engineer:	Sam Ye
Report Number:	RSHA190924002-00B
Report Date:	2019-11-22
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

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	LANSITEC Information Technology Co., Ltd.
Tested Model	C256U-PQ
Series Model	100-18360, 100-18361, 100-18363, 100-18364, 100-18473, 100-02046, 100-02048, 100-02049, 100-02476, 100-02490, 100-02478, 100-02533, 100-02535, 100-02538, 100-00174, 100-00160, 100-00165, 100-02386, 100-02387, 100-02388
Model Difference	Model names
Product Type	LoRa & BLE Device
Power Supply	DC 3.7V
Operating Frequency	LoRa(500kHz): 903-914.2MHz,LoRa(125kHz): 902.3-914.9MHz; BLE: 2402~2480MHz
Channel Number	LoRa 125kHz: 64, 500kHz: 8; BLE:40
Channel Separation	LoRa 125kHz: 200kHz, 500kHz: 1.6 MHz;BLE:2MHz
Modulation Type	LoRa: FSK; BLE:GFSK
Antenna Type	BLE:PCB antenna; LoRa: Spring antenna
Maximum Antenna Gain	LoRa: 0dBi; BLE:1dBi

**All measurement and test data in this report was gathered from production sample serial number: 20190924001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2019-09-24)*

Objective

This test report is prepared on behalf of *LANSITEC Information Technology 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, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

Part 15.247 DTS submissions with FCC ID: 2APPL-LSTR100.

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 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed and 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		3.19dB
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), 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)=902.3+0.2*n (0<=n<=63). The lowest, middle, highest channel numbers of the EUT used and tested in this report are below.

Channel	Frequency (MHz)
0	902.3
32	908.7
63	914.9

EUT Exercise Software

RF test software: X COM U2.0.exe.

Power level: 17.

Support Equipment List and Details

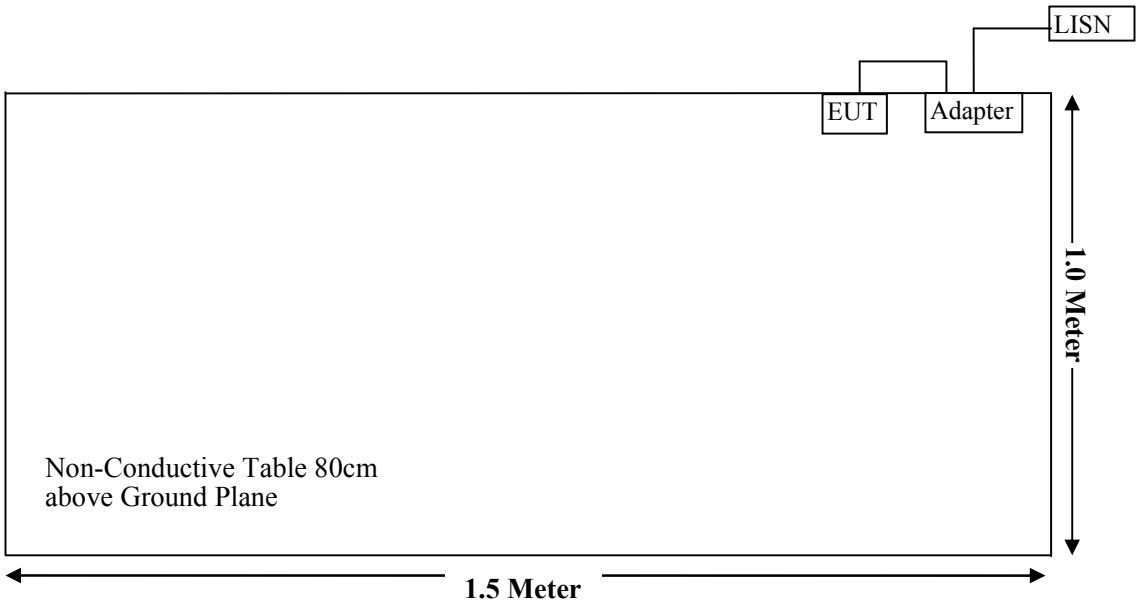
Manufacturer	Description	Model	Serial Number
Shanghai sucheng Electronic Co.,Ltd	Adapter	SC24W-1202000U	/

External I/O Cable

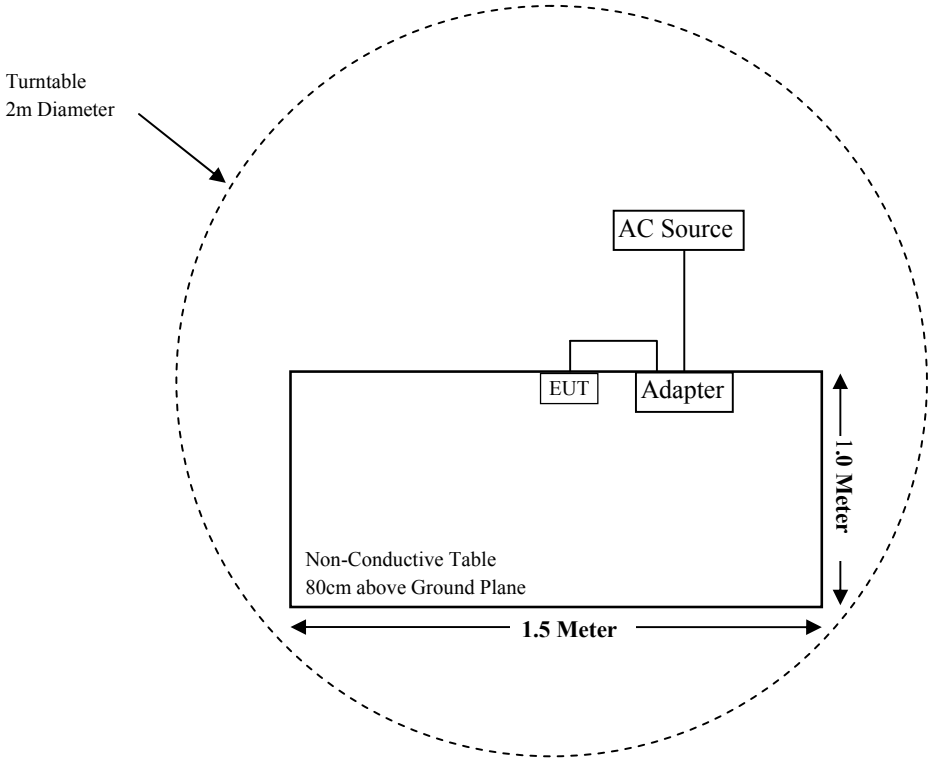
Cable Description	Length (m)	From Port	To
Power Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

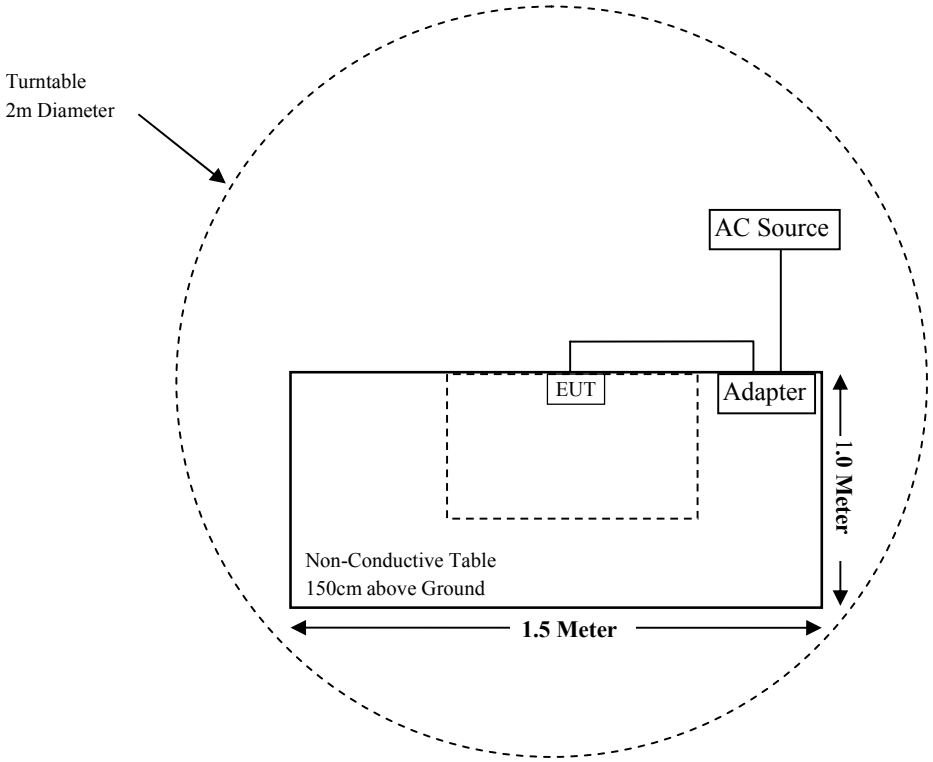
For Conducted Emissions:



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
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(i)	20 dB Emission Bandwidth	Compliant
§15.247(a)(1)(i)	Quantity of Hopping Channel Test	Compliant
§15.247(a)(1)(i)	Time of Occupancy (Dwell Time)	Compliant
§15.247(b)(2)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges Testing	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test（Chamber 1#）					
Rohde & Schwarz	EMI Test receiver	ESR	1316.3003K03-102454-Qd	2019-06-25	2020-06-24
Sunol Sciences	Bilog antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sonoma Instrunent	Pre-amplifier	310N	171205	2019-08-14	2020-08-13
Audix	Test Software	e3	V9	-	-
MICRO-COAX	Coaxial Cable	Cable-8	008	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2019-08-15	2020-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2019-05-30	2020-05-29
ETS-LINDGREN	Horn Antenna	3115	9207-3900	2017-07-15	2020-07-14
A.H.Systems, inc	Amplifier	2641-1	491	2019-02-20	2020-02-19
Narda	Attenuator	10dB	010	2019-08-15	2020-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2019-08-15	2020-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2019-08-15	2020-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2018-11-30	2019-11-29
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2019-08-05	2020-08-04
Narda	Attenuator	10dB	010	2019-08-15	2020-08-14
Lansitec	RF Cable	Lansitec C01	C01	Each Time	N/A
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESR	1316.3003K03-101746-zn	2019-07-11	2020-07-10
Audix	Test Software	e3	V9	--	--
Rohde & Schwarz	LISN	ENV216	3560655016	2018-11-30	2019-11-29
Narda	Attenuator/6dB	10690812-2	26850-6	2019-01-10	2020-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2019-08-15	2020-08-14

*** 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);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculated Data:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)	MPE ratio
		(dBi)	(numeric)	(dBm)	(mW)				
LoRa (125kHz)	902.3-914.9	0	1.00	17.50	56.23	20	0.0112	0.60	**0.0187**
LoRa (500kHz)	903-914.2	0	1.00	17.50	56.23	20	0.0112	0.60	0.0187
BLE	2402-2480	1.00	1.26	-2.00	0.63	20	0.0002	1.00	0.0002

Note: BLE& LoRa can transmit simultaneously.

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0187+0.0002=\mathbf{0.0189 < 1.0}$$

Conclusion: The device meets FCC MPE at 20 cm distance.

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 use of a standard antenna jack or electrical connector is prohibited.

Antenna Connector Construction

The EUT has a spring antenna for Lora, which the antenna gain is 0dBi; fulfill the requirement of this section. Please refer to the EUT photos.

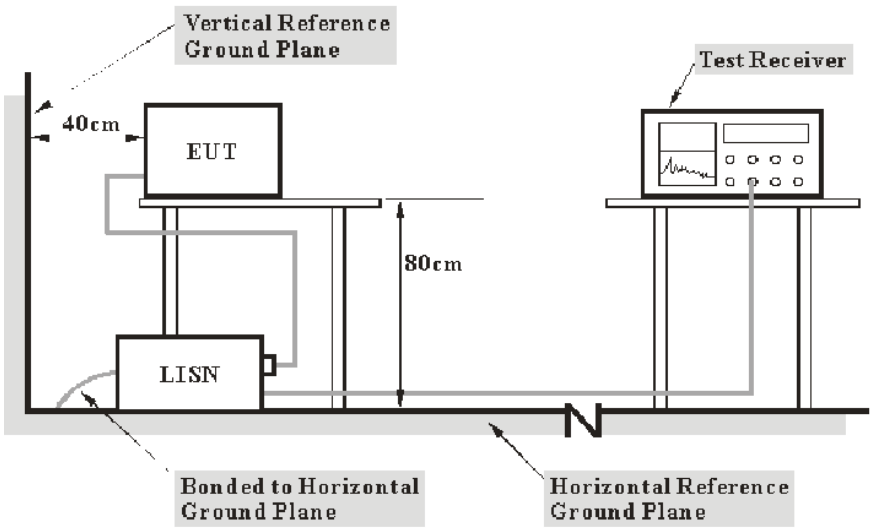
Result: Compliant.

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 measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

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 adapter was connected to the outlet of the LISN.

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

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

Corrected Factor & Over Limit Calculation

The Corrected 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 7dB 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

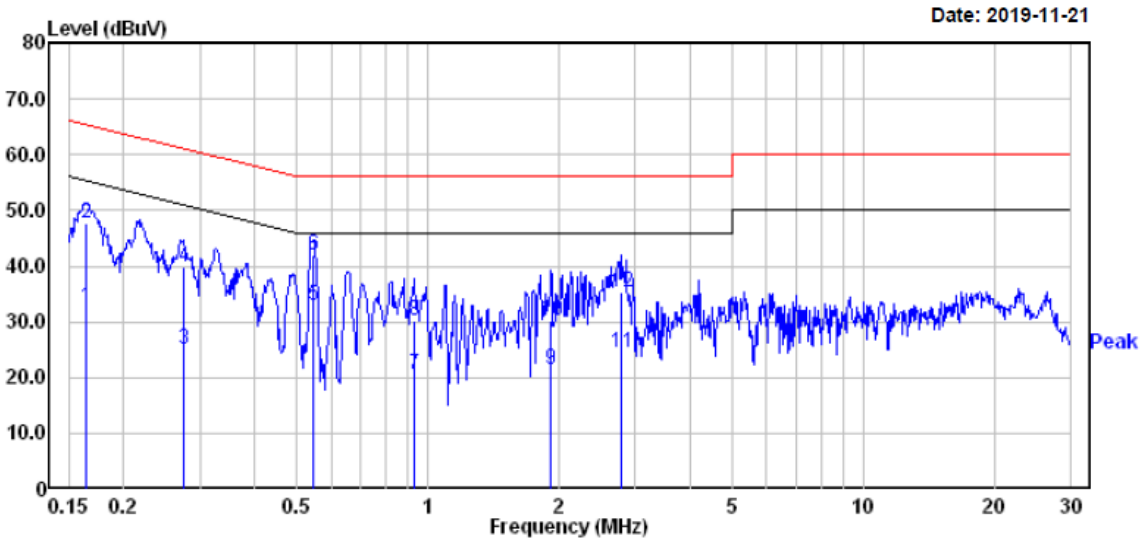
Environmental Conditions

Temperature:	22℃
Relative Humidity:	50%
ATM Pressure:	101.3kPa

The testing was performed by Sam Ye on 2019-11-21.

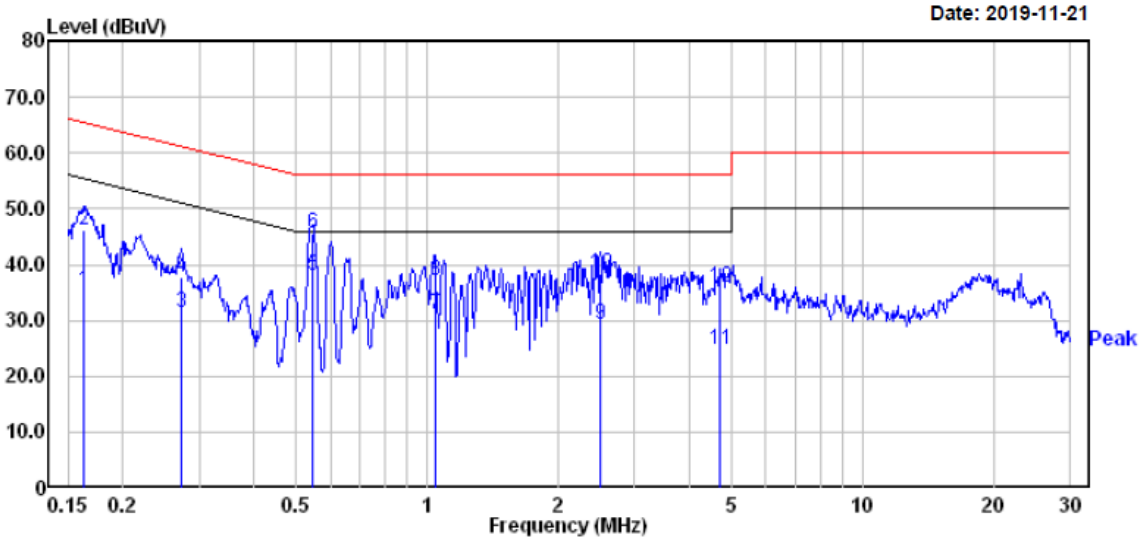
EUT operation mode: Transmitting in low channel (worst case)

AC 120V/60 Hz, Line



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.164	12.70	19.83	32.53	55.25	-22.72	Average
2	0.164	27.90	19.83	47.73	65.25	-17.52	QP
3	0.274	5.20	19.82	25.02	50.98	-25.96	Average
4	0.274	19.90	19.82	39.72	60.98	-21.26	QP
5	0.546	13.20	19.75	32.95	46.00	-13.05	Average
6	0.546	22.30	19.75	42.05	56.00	-13.95	QP
7	0.933	0.70	19.76	20.46	46.00	-25.54	Average
8	0.933	10.50	19.76	30.26	56.00	-25.74	QP
9	1.918	1.50	19.83	21.33	46.00	-24.67	Average
10	1.918	10.50	19.83	30.33	56.00	-25.67	QP
11	2.794	4.90	19.47	24.37	46.00	-21.63	Average
12	2.794	15.90	19.47	35.37	56.00	-20.63	QP

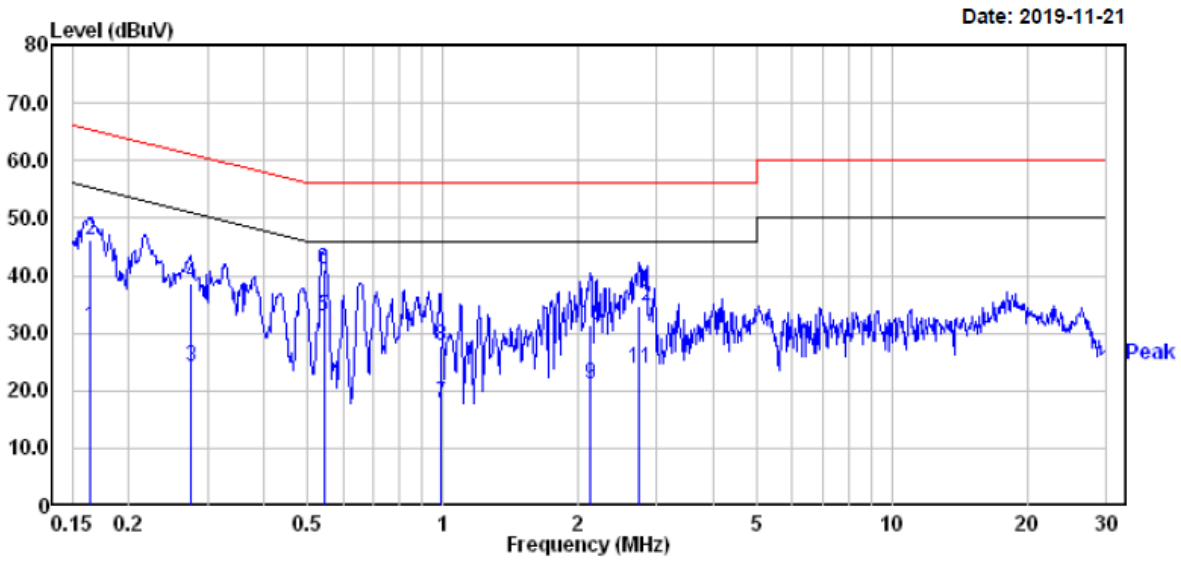
AC 120V/60 Hz, Neutral



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.163	15.40	19.83	35.23	55.30	-20.07	Average
2	0.163	26.50	19.83	46.33	65.30	-18.97	QP
3	0.273	11.60	19.82	31.42	51.03	-19.61	Average
4	0.273	18.00	19.82	37.82	61.03	-23.21	QP
5	0.546	18.41	19.75	38.16	46.00	-7.84	Average
6	0.546	25.90	19.75	45.65	56.00	-10.35	QP
7	1.043	11.40	19.82	31.22	46.00	-14.78	Average
8	1.043	17.20	19.82	37.02	56.00	-18.98	QP
9	2.500	9.90	19.48	29.38	46.00	-16.62	Average
10	2.500	18.99	19.48	38.47	56.00	-17.53	QP
11	4.721	5.19	19.49	24.68	46.00	-21.32	Average
12	4.721	16.29	19.49	35.78	56.00	-20.22	QP

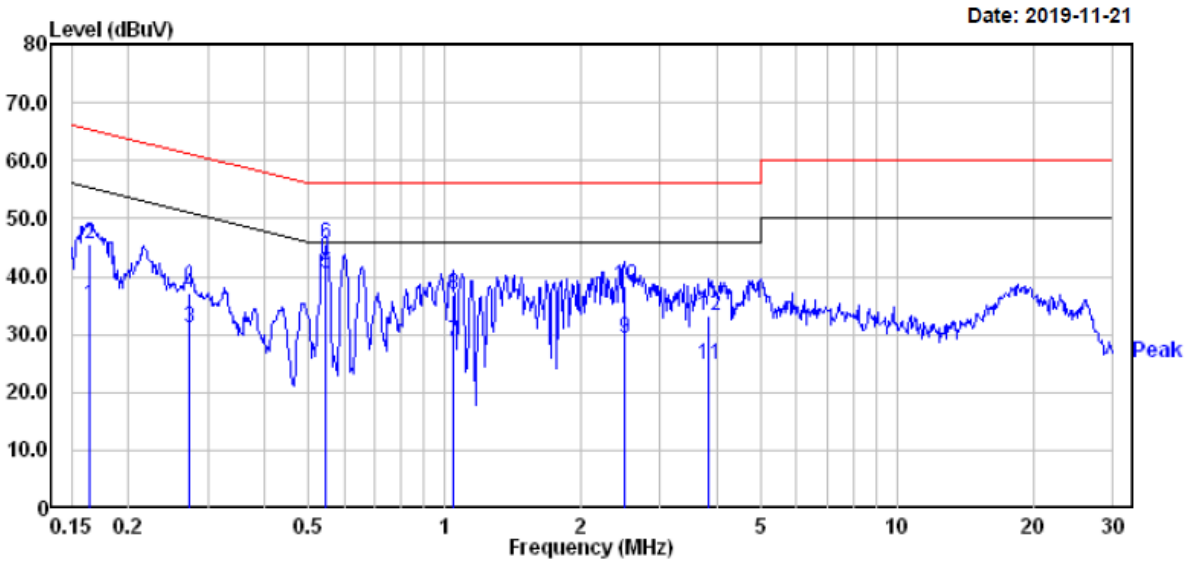
The worst case low Channel of BLE and low channel of Lora (125kHz)mode transmitting simultaneously was recorded

AC 120V/60 Hz, Line



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.164	11.20	19.83	31.03	55.25	-24.22	Average
2	0.164	26.40	19.83	46.23	65.25	-19.02	QP
3	0.274	4.40	19.82	24.22	50.98	-26.76	Average
4	0.274	18.90	19.82	38.72	60.98	-22.26	QP
5	0.544	13.10	19.75	32.85	46.00	-13.15	Average
6	0.544	21.40	19.75	41.15	56.00	-14.85	QP
7	0.989	-1.90	19.81	17.91	46.00	-28.09	Average
8	0.989	8.10	19.81	27.91	56.00	-28.09	QP
9	2.133	1.40	19.73	21.13	46.00	-24.87	Average
10	2.133	11.60	19.73	31.33	56.00	-24.67	QP
11	2.736	4.40	19.47	23.87	46.00	-22.13	Average
12	2.736	15.30	19.47	34.77	56.00	-21.23	QP

AC 120V/60 Hz, Neutral



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.164	15.30	19.83	35.13	55.25	-20.12	Average
2	0.164	25.80	19.83	45.63	65.25	-19.62	QP
3	0.273	11.30	19.82	31.12	51.03	-19.91	Average
4	0.273	17.30	19.82	37.12	61.03	-23.91	QP
5	0.546	20.61	19.75	40.36	46.00	-5.64	Average
6	0.546	25.90	19.75	45.65	56.00	-10.35	QP
7	1.043	9.00	19.82	28.82	46.00	-17.18	Average
8	1.043	16.90	19.82	36.72	56.00	-19.28	QP
9	2.500	9.69	19.48	29.17	46.00	-16.83	Average
10	2.500	18.80	19.48	38.28	56.00	-17.72	QP
11	3.840	5.40	19.47	24.87	46.00	-21.13	Average
12	3.840	13.70	19.47	33.17	56.00	-22.83	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)

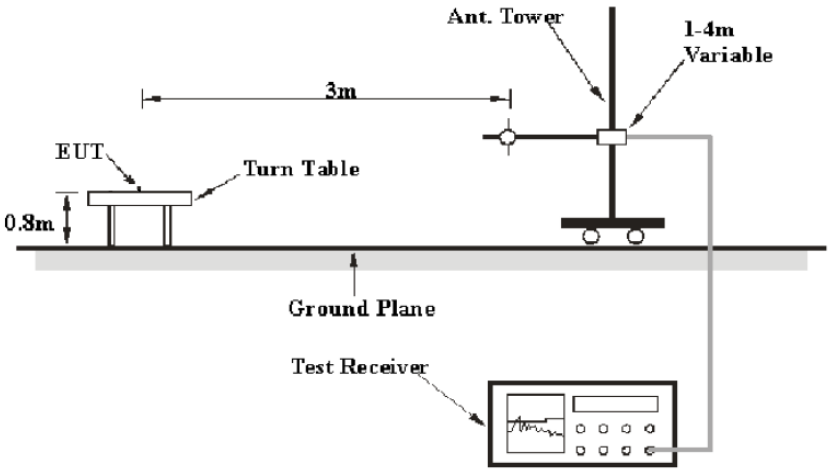
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

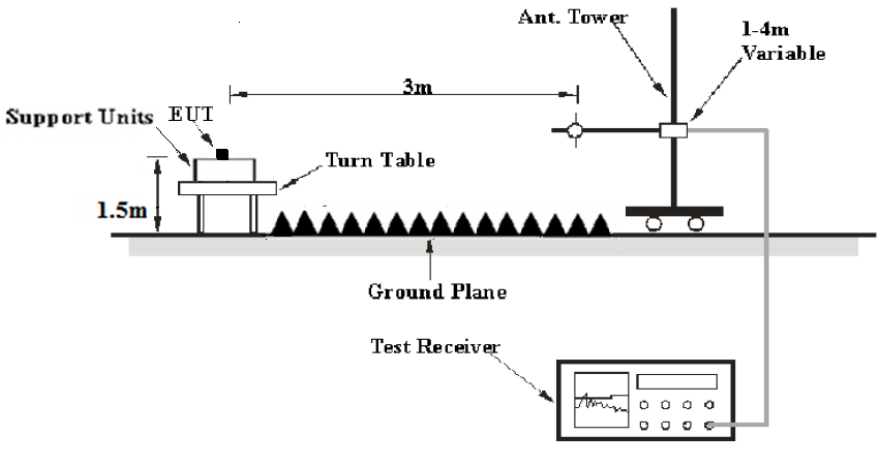
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, 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 to 10 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	/	Ave.

Test Procedure

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

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

Factor & Over Limit Calculation (for below 1GHz)

The factor is calculated by adding Antenna Factor, Cable Loss and Amplifier Gain. The basic equation is as follows:

Factor (dB) =Antenna Factor (dB/m) + Cable Loss (dB) + Amplifier Gain (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 7dB 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)

Corrected Amplitude & Margin Calculation (for above 1GHz)

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:	24.8~25.2℃
Relative Humidity:	48~50%
ATM Pressure:	101.2~101.3kPa

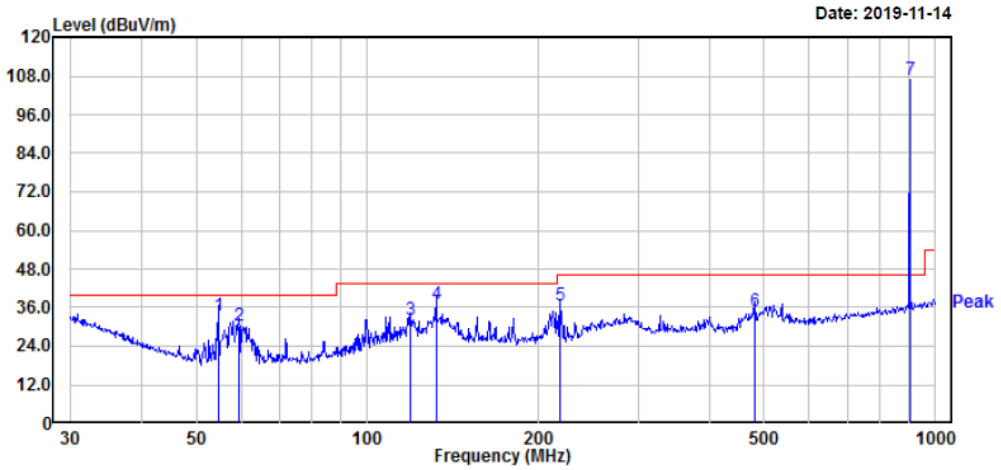
The testing was performed by Sam Ye from 2019-11-13 to 2019-11-21

EUT operation mode: Transmitting

Spurious Emission Test:

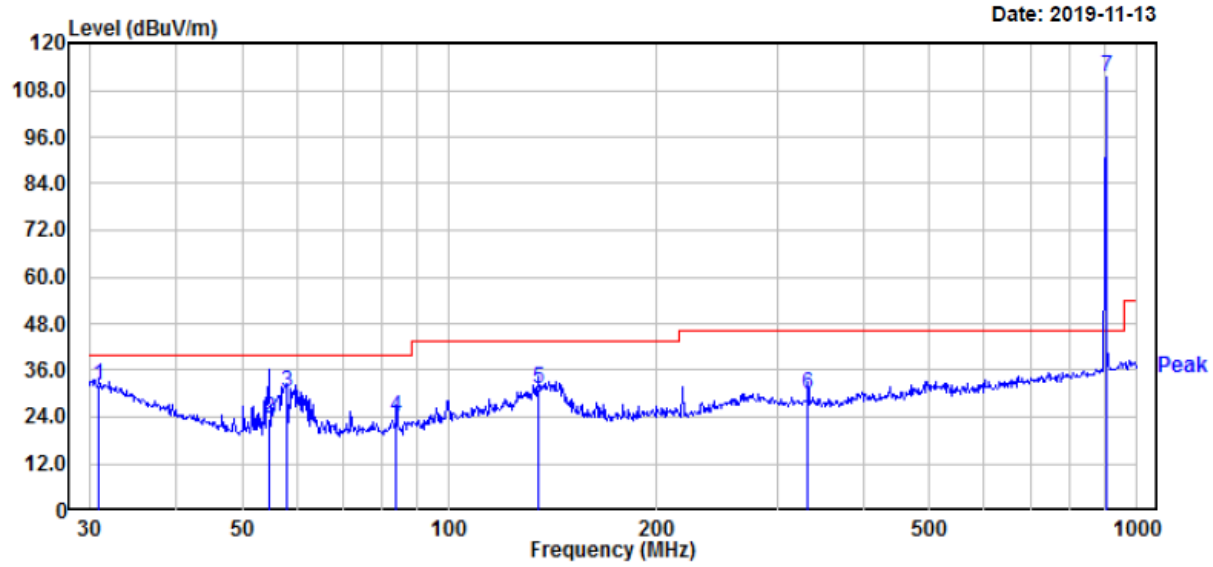
30MHz-1GHz
Horizontal

Frequency: 902.3MHz



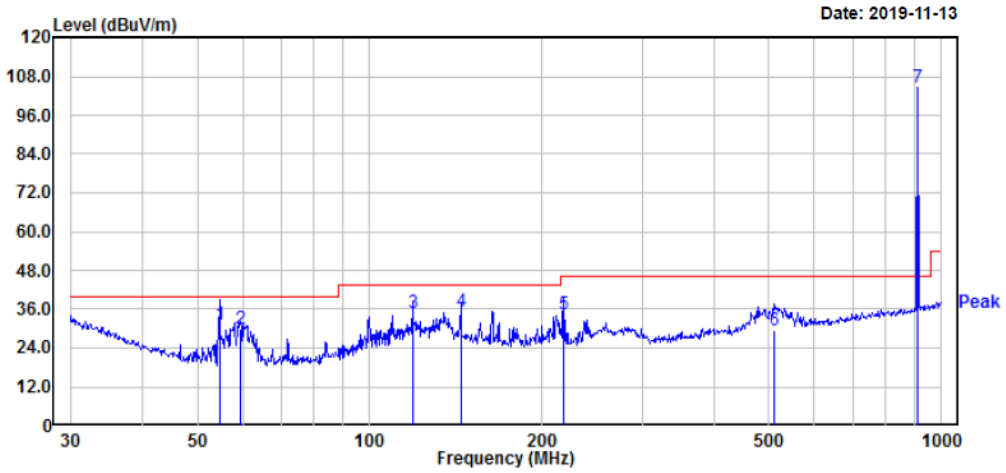
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	54.64	50.76	-17.24	33.52	40.00	-6.48	200	32	QP
2	59.44	48.01	-17.52	30.49	40.00	-9.51	200	44	QP
3	119.02	43.13	-10.85	32.28	43.50	-11.22	100	152	QP
4	132.22	48.64	-11.35	37.29	43.50	-6.21	200	1	QP
5	219.08	50.02	-13.38	36.64	46.00	-9.36	200	1	QP
6	480.53	40.95	-5.93	35.02	46.00	-10.98	200	58	QP
7	903.31	105.80	1.12	106.92	46.00	60.92	100	228	Basic Freq

Vertical



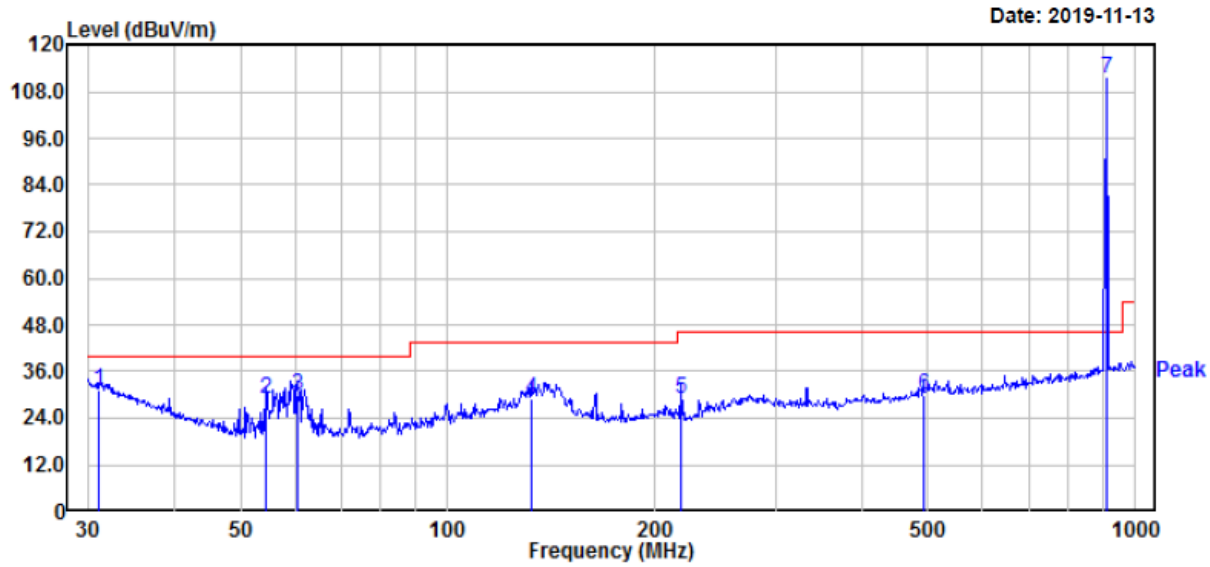
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	30.96	35.93	-3.93	32.00	40.00	-8.00	200	3	QP
2	54.64	40.81	-17.24	23.57	40.00	-16.43	100	289	QP
3	58.20	47.88	-17.45	30.43	40.00	-9.57	200	92	QP
4	83.82	41.43	-17.21	24.22	40.00	-15.78	200	300	QP
5	134.56	42.87	-11.47	31.40	43.50	-12.10	100	169	QP
6	332.52	39.42	-9.56	29.86	46.00	-16.14	100	3	QP
7	903.31	110.19	1.12	111.31	46.00	65.31	200	68	Basic Freq

Frequency: 908.7MHz



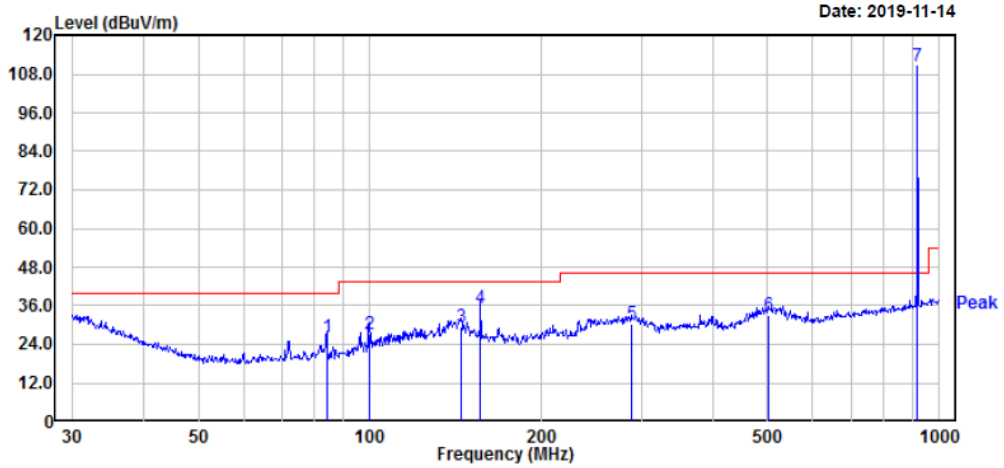
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	54.64	48.31	-17.24	31.07	40.00	-8.93	200	16	QP
2	59.44	47.59	-17.52	30.07	40.00	-9.93	200	3	QP
3	119.02	45.70	-10.85	34.85	43.50	-8.65	200	114	QP
4	144.34	47.21	-11.82	35.39	43.50	-8.11	200	3	QP
5	219.08	47.90	-13.38	34.52	46.00	-11.48	200	183	QP
6	511.84	34.78	-5.32	29.46	46.00	-16.54	200	39	QP
7	909.67	103.30	1.24	104.54	46.00	58.54	200	64	Basic Freq

Vertical



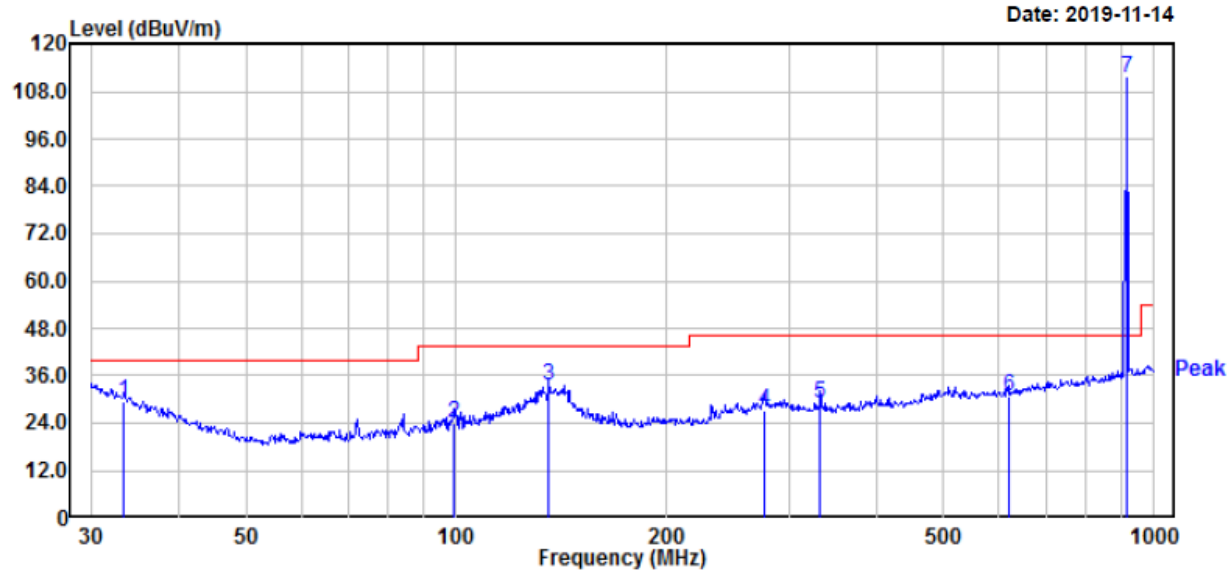
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	31.18	35.54	-4.11	31.43	40.00	-8.57	100	360	QP
2	54.45	46.03	-17.22	28.81	40.00	-11.19	200	102	QP
3	60.49	47.36	-17.53	29.83	40.00	-10.17	200	145	QP
4	132.22	40.29	-11.35	28.94	43.50	-14.56	100	0	QP
5	219.08	42.54	-13.38	29.16	46.00	-16.84	200	283	QP
6	492.47	35.76	-5.66	30.10	46.00	-15.90	100	202	QP
7	909.67	110.20	1.24	111.44	46.00	65.44	200	79	Basic Freq

Frequency: 914.9MHz



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	84.11	43.44	-17.20	26.24	40.00	-13.76	200	127	QP
2	99.88	41.85	-14.65	27.20	43.50	-16.30	200	6	QP
3	144.34	41.47	-11.82	29.65	43.50	-13.85	100	166	QP
4	156.46	47.48	-11.98	35.50	43.50	-8.00	200	133	QP
5	287.99	40.88	-10.45	30.43	46.00	-15.57	100	4	QP
6	502.94	38.54	-5.45	33.09	46.00	-12.91	200	51	QP
7	916.07	108.95	1.38	110.33	46.00	64.33	100	228	Basic Freq

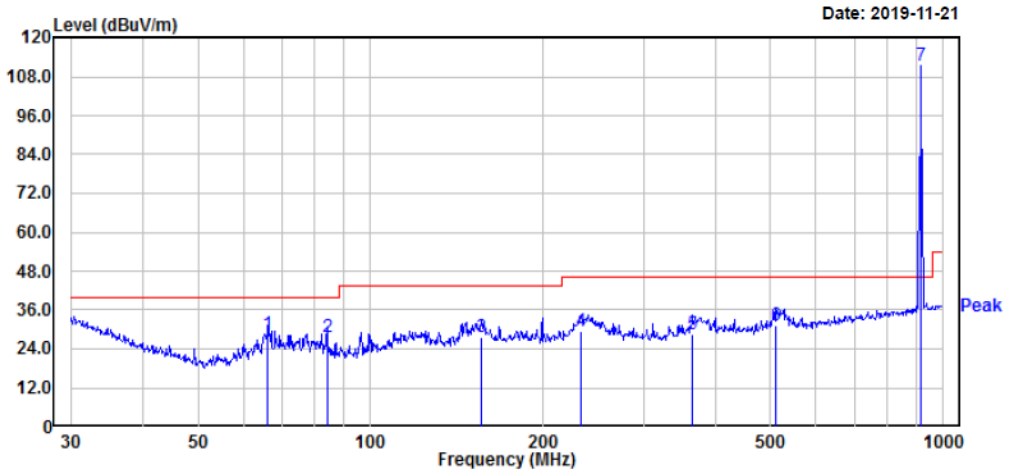
Vertical



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	33.45	35.58	-5.99	29.59	40.00	-10.41	200	192	QP
2	99.53	38.69	-14.74	23.95	43.50	-19.55	100	309	QP
3	135.98	45.22	-11.54	33.68	43.50	-9.82	100	335	QP
4	276.12	38.06	-10.78	27.28	46.00	-18.72	200	356	QP
5	332.52	38.75	-9.56	29.19	46.00	-16.81	200	356	QP
6	618.54	34.37	-3.64	30.73	46.00	-15.27	200	356	QP
7	916.07	110.13	1.38	111.51	46.00	65.51	200	78	Basic Freq

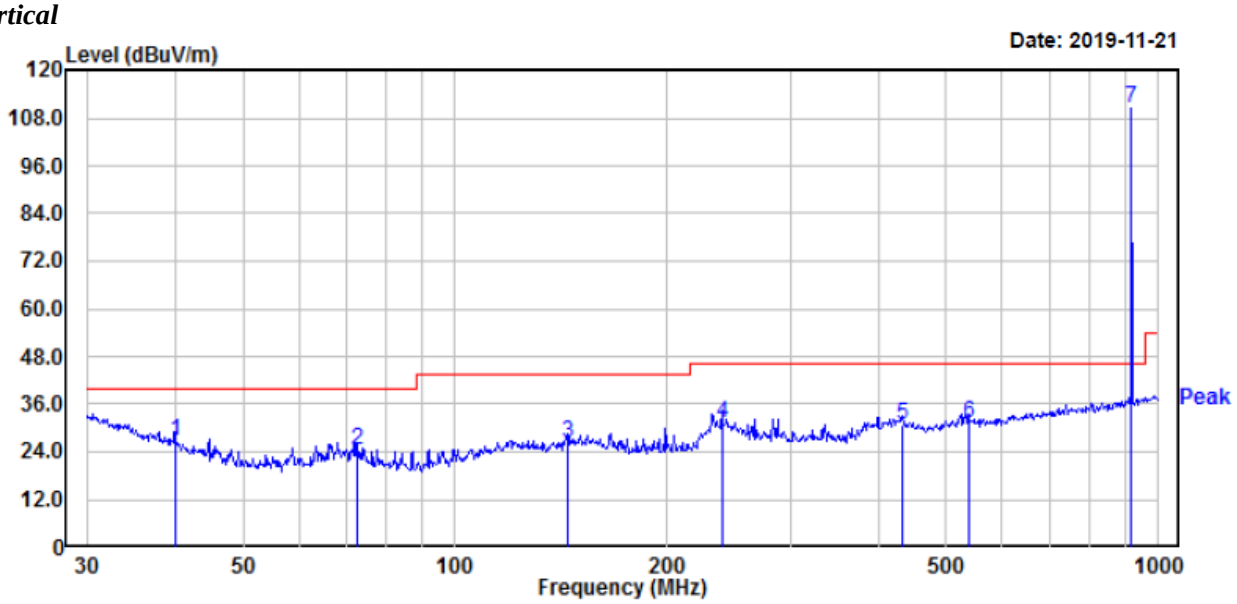
The worst case low Channel of BLE and low channel of Lora (125kHz) mode transmitting simultaneously was recorded

Horizontal



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	66.27	45.49	-17.13	28.36	40.00	-11.64	200	165	QP
2	84.11	44.88	-17.20	27.68	40.00	-12.32	200	215	QP
3	155.91	39.74	-11.98	27.76	43.50	-15.74	200	77	QP
4	233.35	42.63	-13.01	29.62	46.00	-16.38	200	355	QP
5	365.54	37.01	-8.68	28.33	46.00	-17.67	100	355	QP
6	511.84	36.60	-5.32	31.28	46.00	-14.72	200	22	QP
7	916.07	110.13	1.38	111.51	46.00	65.51	100	0	Basic Freq

Vertical



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	APos	TPos	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	39.99	38.23	-11.44	26.79	40.00	-13.21	100	279	QP
2	72.85	41.21	-16.96	24.25	40.00	-15.75	100	290	QP
3	144.34	38.13	-11.82	26.31	43.50	-17.19	200	287	QP
4	239.99	44.02	-12.74	31.28	46.00	-14.72	200	1	QP
5	434.07	37.81	-6.93	30.88	46.00	-15.12	100	359	QP
6	537.59	36.41	-4.95	31.46	46.00	-14.54	100	135	QP
7	916.07	108.91	1.38	110.29	46.00	64.29	100	358	Basic Freq

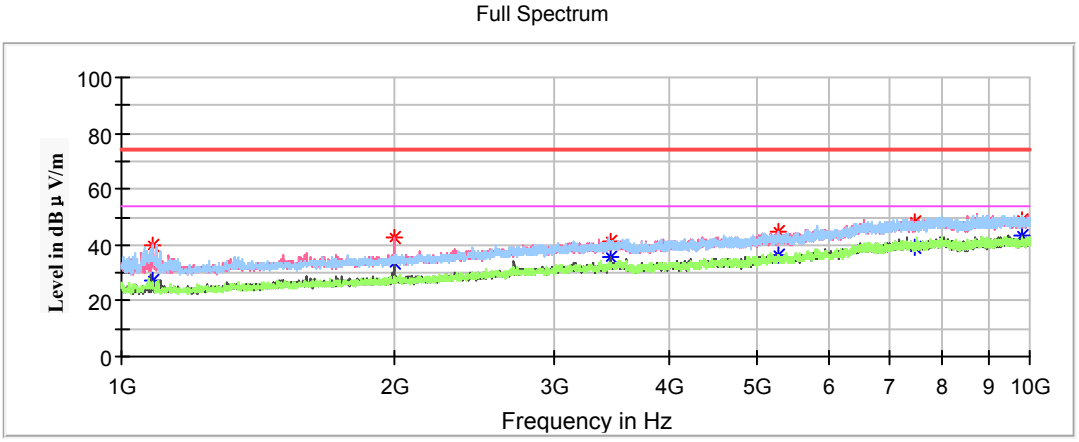
Note:
1) Factor (dB) =Antenna Factor (dB/m) + Cable Loss (dB) + Amplifier Gain (dB)
2) Over Limit (dB) = Read level (dBμV) + Factor (dB) - Limit (dBμV)

1GHz-10GHz

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

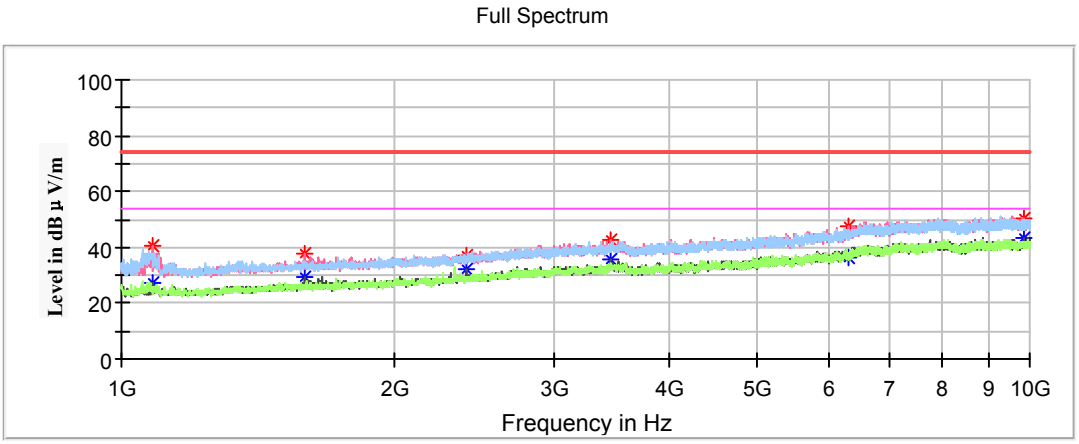
Note:
1. The test was performed with a 10dB Attenuator.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB) + Attenuator(dB)
   Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
   Margin (dB) = Limit (dBμV/m) – Corrected Amplitude (dBμV/m)

Low Channel: 902.3MHz



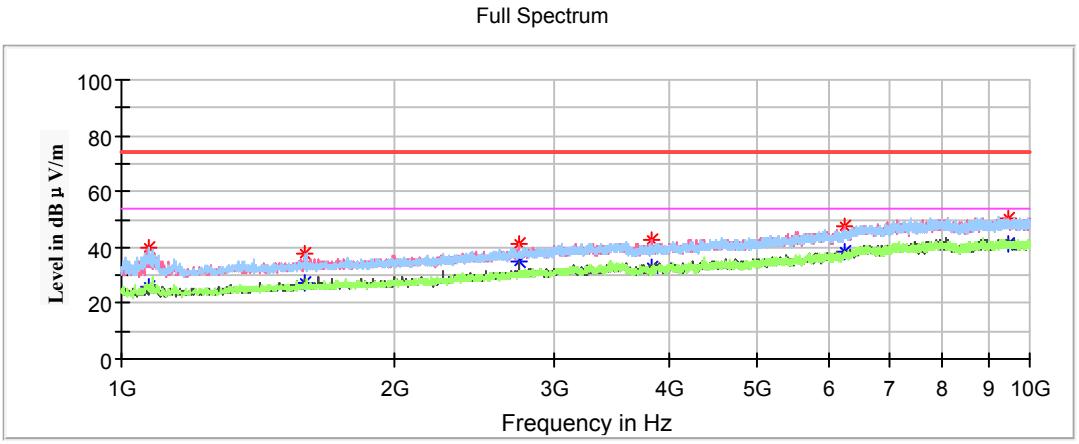
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV/m)	Average (dBμV/m)	Height (cm)	Polar (H/V)				
1084.60	---	27.59	200	V	268	-12.2	54.00	26.41
1084.60	40.09	---	200	V	268	-12.2	74.00	33.91
1999.90	---	33.75	150	V	77	-8.2	54.00	20.25
1999.90	42.40	---	150	V	77	-8.2	74.00	31.60
3456.10	---	35.77	200	V	81	-3.6	54.00	18.23
3456.10	41.58	---	200	V	81	-3.6	74.00	32.42
5290.30	---	36.38	150	H	252	0.7	54.00	17.62
5290.30	44.74	---	100	H	352	0.7	74.00	29.26
7481.80	---	39.26	200	V	54	6.1	54.00	14.74
7481.80	48.50	---	200	V	54	6.1	74.00	25.50
9820.00	---	43.27	200	V	95	8.0	54.00	10.73
9820.00	49.26	---	200	V	95	8.0	74.00	24.74

Middle Channel: 908.7MHz



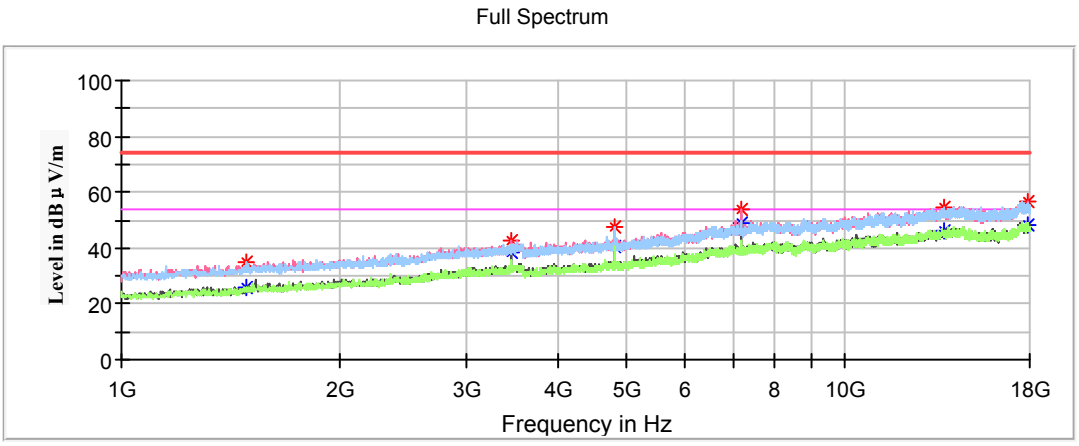
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV/m)	Average (dBµV/m)	Height (cm)	Polar (H/V)				
1081.90	---	27.00	200	V	266	-12.2	54.00	27.00
1081.90	40.63	---	200	V	266	-12.2	74.00	33.37
1593.10	---	29.03	100	H	193	-9.6	54.00	24.97
1593.10	37.89	---	100	H	193	-9.6	74.00	36.11
2398.60	---	32.00	100	V	346	-7.2	54.00	22.00
2398.60	36.72	---	100	V	346	-7.2	74.00	37.28
3456.10	---	36.00	150	V	252	-3.6	54.00	18.00
3456.10	42.44	---	150	V	252	-3.6	74.00	31.56
6315.40	---	36.19	100	V	77	3.6	54.00	17.81
6315.40	47.39	---	100	V	77	3.6	74.00	26.61
9843.40	---	43.30	150	V	180	8.0	54.00	10.70
9843.40	50.19	---	150	V	180	8.0	74.00	23.81

High Channel: 914.9MHz



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)				
1073.80	---	26.18	150	H	210	-12.2	54.00	27.82
1073.80	40.01	---	150	H	210	-12.2	74.00	33.99
1594.90	---	27.18	200	V	77	-9.6	54.00	26.82
1594.90	37.90	---	200	V	77	-9.6	74.00	36.10
2744.20	---	34.62	100	V	358	-5.7	54.00	19.38
2744.20	41.22	---	100	V	358	-5.7	74.00	32.78
3835.90	---	32.74	200	V	284	-2.4	54.00	21.26
3835.90	42.36	---	200	V	284	-2.4	74.00	31.64
6265.00	---	38.31	200	V	136	3.4	54.00	15.69
6265.00	47.59	---	200	V	136	3.4	74.00	26.41
9451.00	---	41.06	150	V	243	7.6	54.00	12.94
9451.00	50.65	---	150	V	243	7.6	74.00	23.35

The worst case low Channel of BLE and low channel of Lora (125kHz) mode transmitting simultaneously was recorded.



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)				
1489.60	---	25.98	200	H	304	-10.0	54.00	28.02
1489.60	34.77	---	200	H	304	-10.0	74.00	39.23
3454.80	---	38.18	150	V	230	-3.6	54.00	15.82
3454.80	42.73	---	150	V	230	-3.6	74.00	31.27
4802.90	---	40.72	200	H	332	-0.6	54.00	13.28
4802.90	47.43	---	200	H	332	-0.6	74.00	26.57
7205.00	---	48.89	100	V	341	5.7	54.00	5.11
7205.00	54.16	---	100	V	341	5.7	74.00	19.84
13666.70	---	45.86	150	H	3	12.1	54.00	8.14
13666.70	54.83	---	150	H	3	12.1	74.00	19.17
17862.30	56.84	---	100	V	324	13.7	74.00	17.16
17862.30	---	47.91	100	V	324	13.7	54.00	6.09

Restricted Bands Emissions Test:

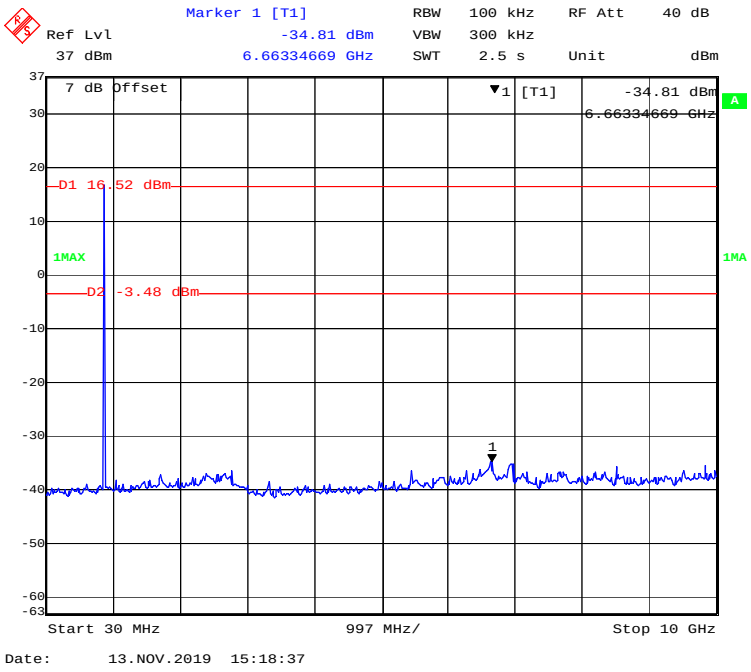
*(Pre-scan in the X,Y and Z axes of orientation, the worst case **X-axis of orientation** was recorded.)*

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

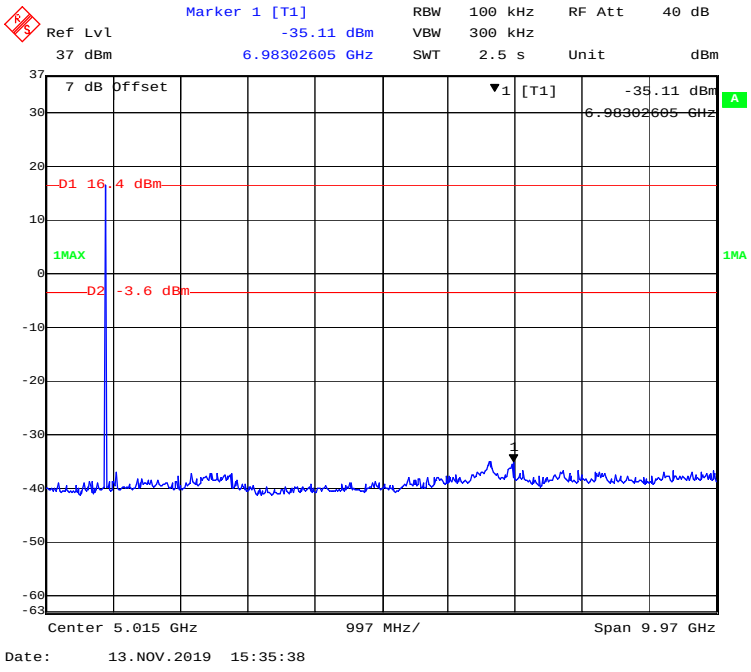
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	QuasiPeak (dBμV/m)	Height (cm)	Polar (H/V)				
902.3MHz							
902.00	34.42	100	V	134	0.2	46	11.58
902.00	36.87	150	H	142	0.2	46	9.13
914.9MHz							
928.00	34.38	200	H	208	0.8	46	11.62
928.00	36.52	200	V	212	0.8	46	9.48

Conducted Spurious Emissions at Antenna Port:

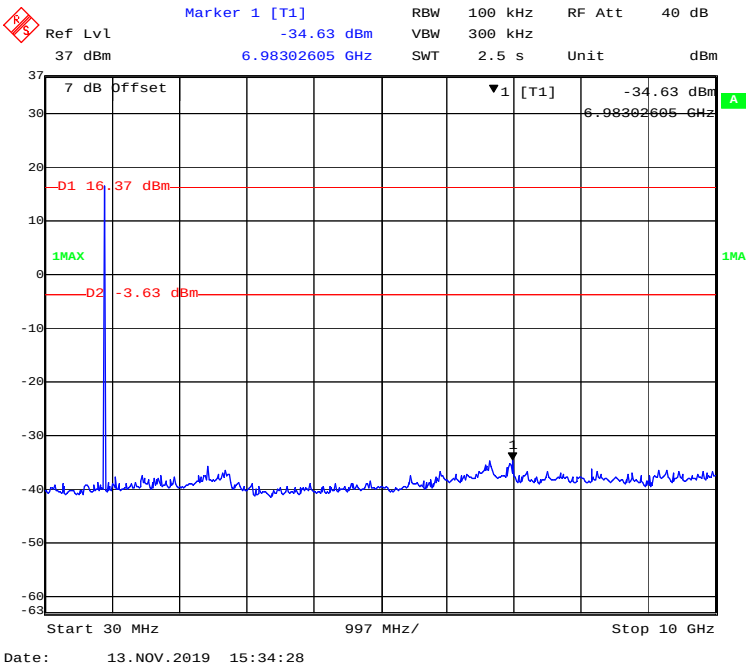
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) -CHANNEL SEPARATION TEST

Applicable Standard

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a. Span: Wide enough to capture the peaks of two adjacent channels.
b. RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c. Video (or average) bandwidth (VBW) ≥ RBW.
d. Sweep: Auto.
e. Detector function: Peak.
f. Trace: Max hold.
g. Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Test Data

Environmental Conditions

Temperature:	22.8~23.2 ℃
Relative Humidity:	48~50 %
ATM Pressure:	101.1~101.3 kPa

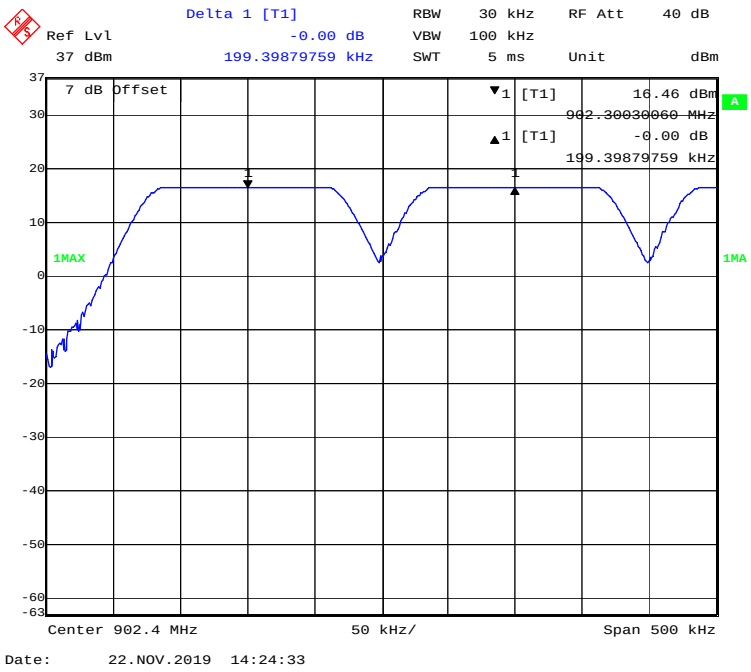
The testing was performed by Sam Ye from 2019-11-13 to 2019-11-22.

EUT operation mode: Transmitting

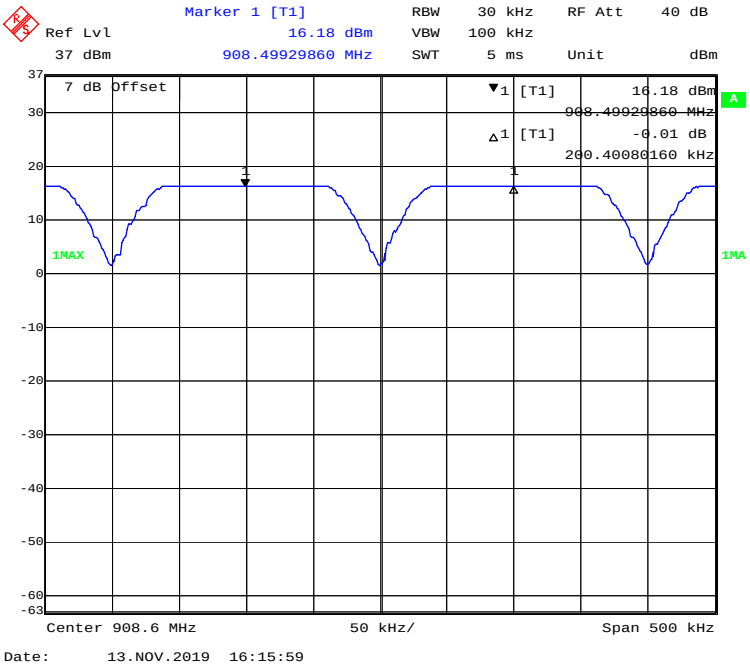
Test Result: Compliant.

Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
Low	902.3	0.199	0.142	Pass
Adjacent	902.5			
Middle	908.7	0.200	0.143	Pass
Adjacent	908.5			
High	914.9	0.200	0.142	Pass
Adjacent	914.7			

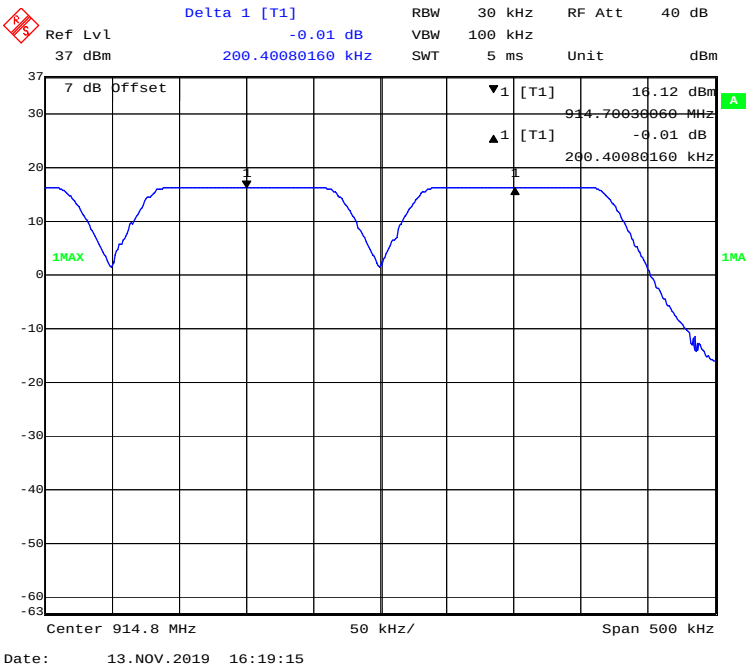
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) (i)– 20 dB EMISSION BANDWIDTH

Applicable Standard

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

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 it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	23.2 ℃
Relative Humidity:	50 %
ATM Pressure:	101.3 kPa

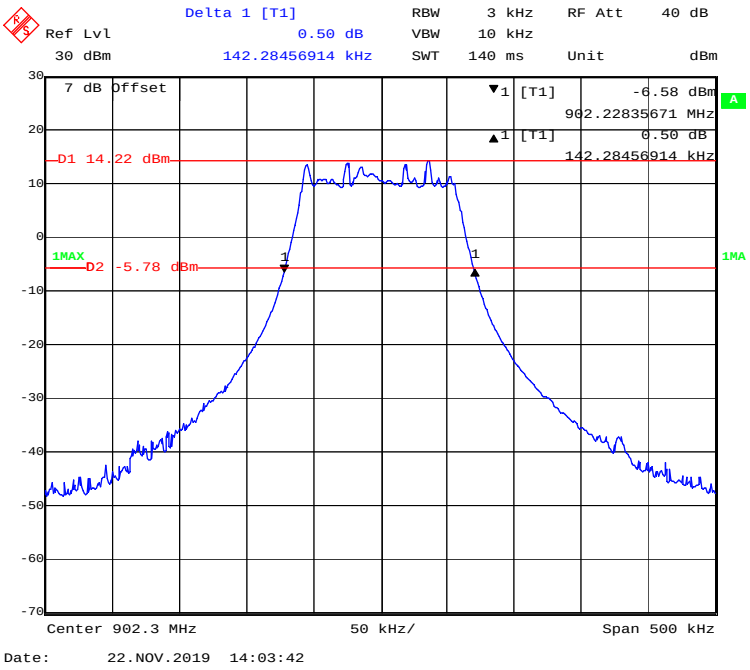
The testing was performed by Sam Ye on 2019-11-22.

EUT operation mode: Transmitting

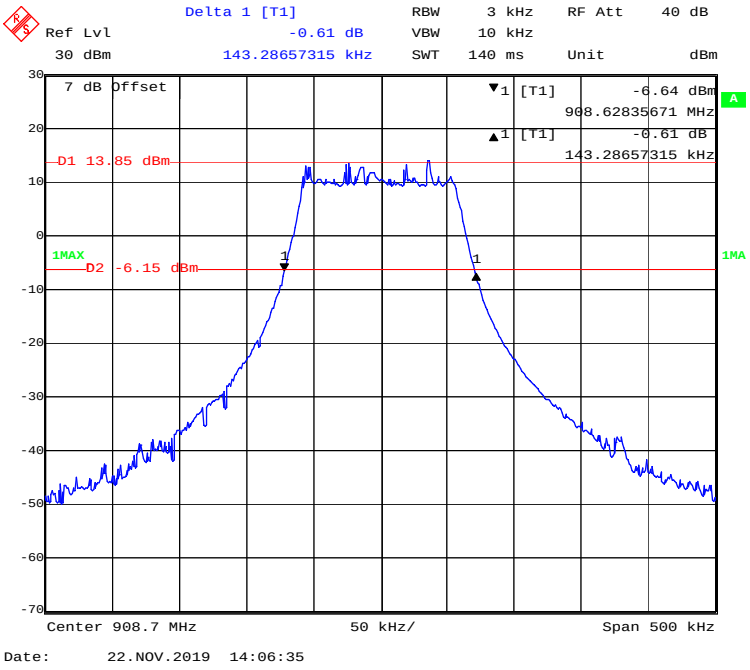
Test Result: Compliant.

Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
Low	902.3	0.142
Middle	908.7	0.143
High	914.9	0.142

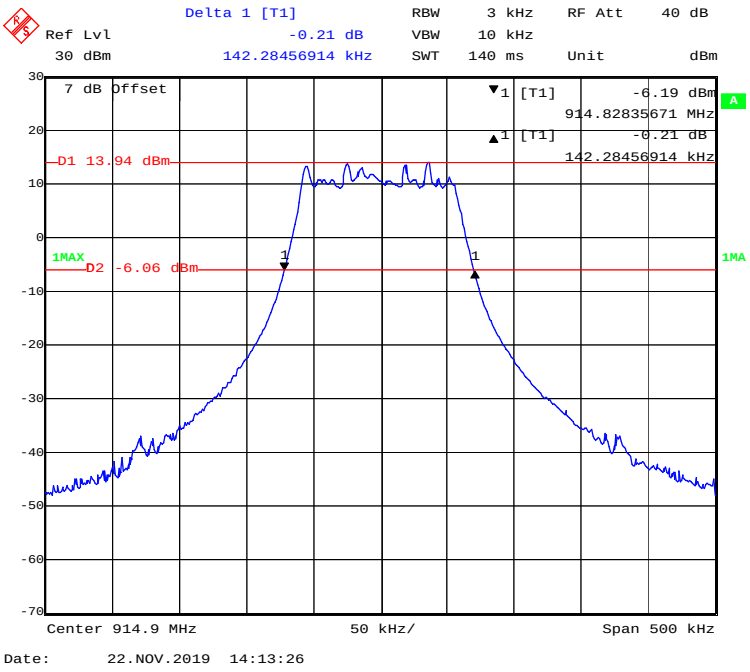
Low Channel



Middle Channel



High Channel



FCC §15.247(a) (1) (i)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b. RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c. VBW ≥ RBW.
d. Sweep: Auto.
e. Detector function: Peak.
f. Trace: Max hold.
g. Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies.

Test Data

Environmental Conditions

Temperature:	22.6~23.2 ℃
Relative Humidity:	48~50 %
ATM Pressure:	101.1~101.3 kPa

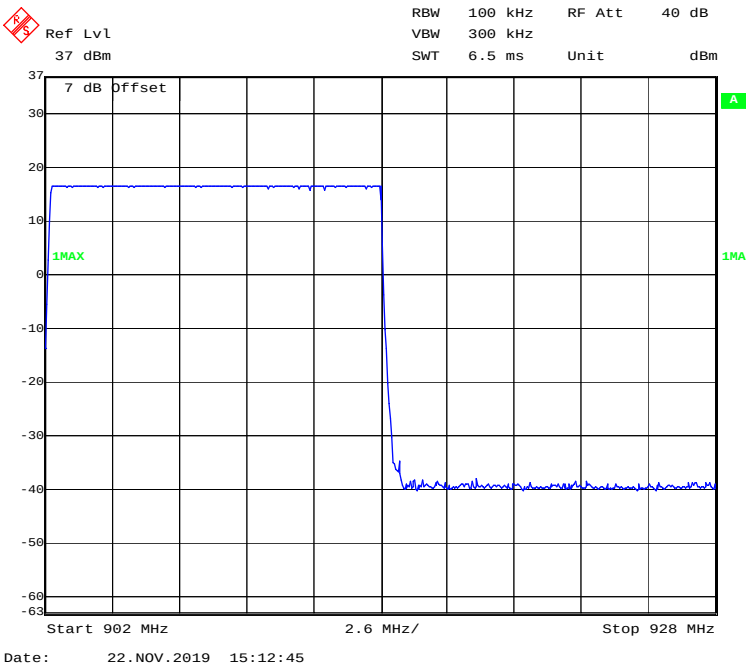
The testing was performed by Sam Ye from 2019-11-13 to 2019-11-22.

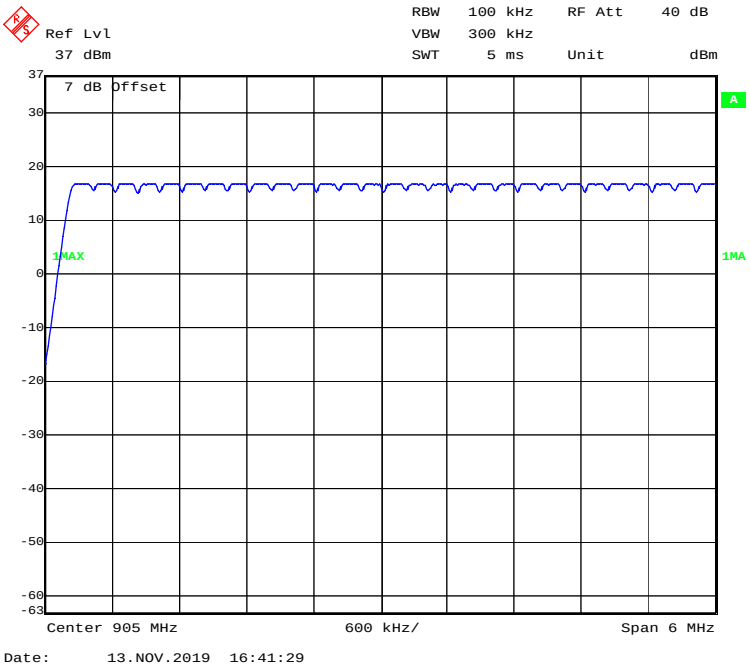
EUT operation mode: Hopping

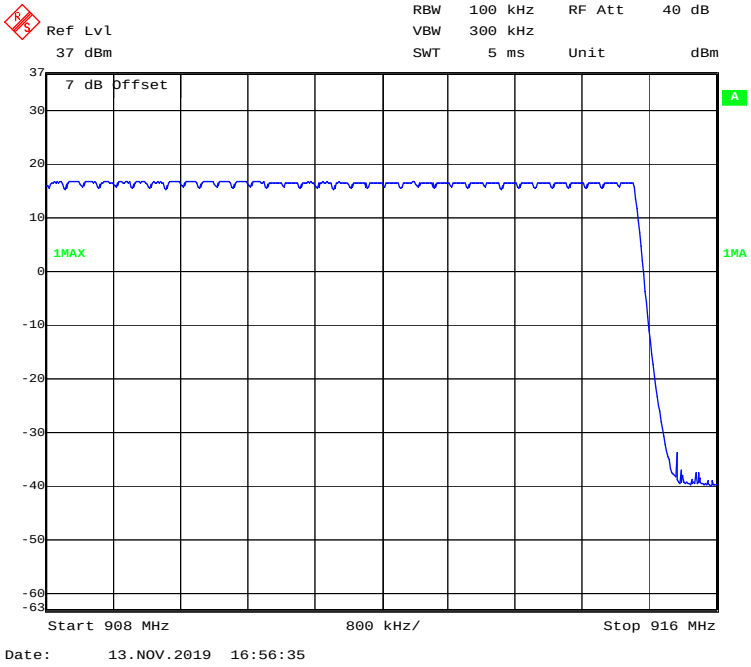
Test Result: Compliant.

Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
902~928MHz	64	≥50

Number of Hopping Channels






RBW 100 kHz
RF Att 40 dB
VBW 300 kHz
Ref Lvl
37 dBm
SWT 5 ms
Unit dBm
7 dB Offset
A
1MAX
1MA
37
30
20
10
0
-10
-20
-30
-40
-50
-60
-63
Start 908 MHz
800 kHz/
Stop 916 MHz
Date: 13.NOV.2019 16:56:35

FCC §15.247(a) (1) (i) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

(i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a Span: Zero span, centered on a hopping channel.
b RBW shall be ≤ channel spacing and where possible RBW should be set ≥ 1 / T, where T is the expected dwell time per channel.
c Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d Detector function: Peak.
e Trace: Max hold.

Test Data

Environmental Conditions

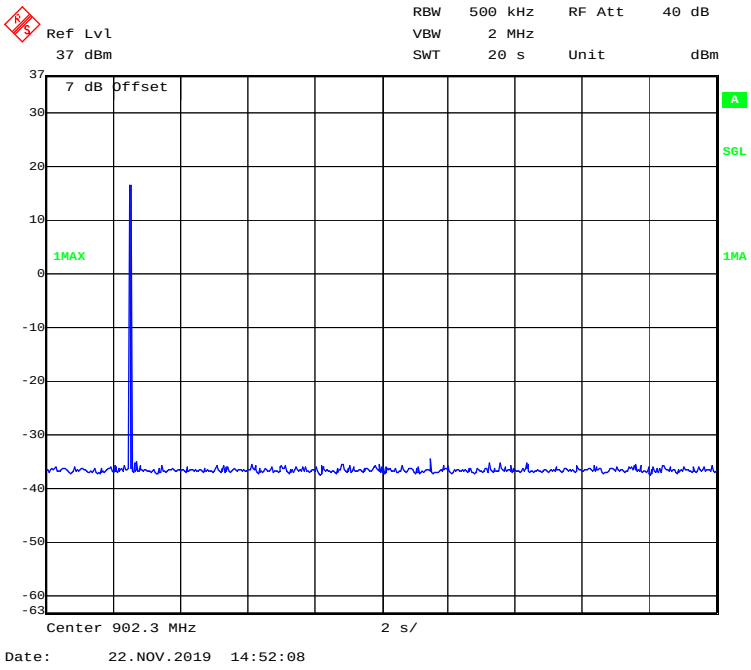
Temperature:	24.2~25.3℃
Relative Humidity:	48~50%
ATM Pressure:	101.1~101.3kPa

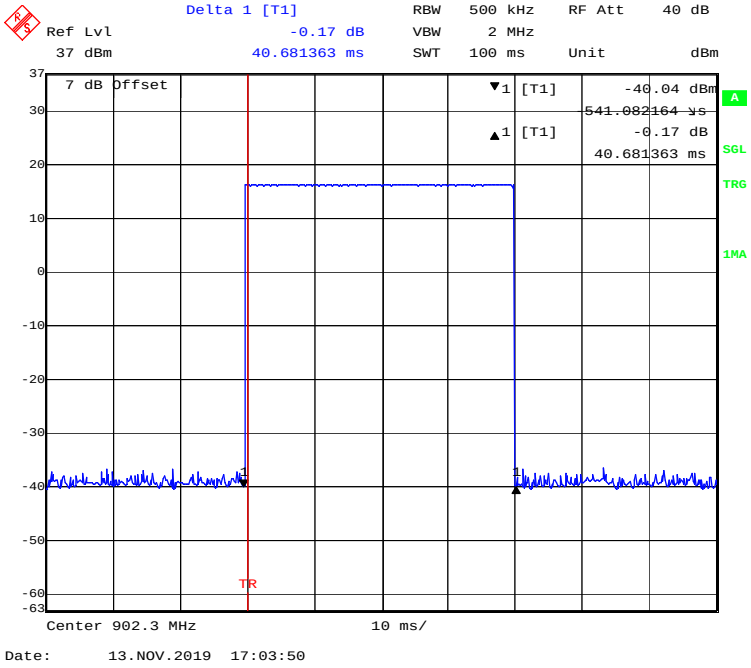
The testing was performed by Sam Ye from 2019-11-13 to 2019-11-22.

EUT operation mode: Hopping

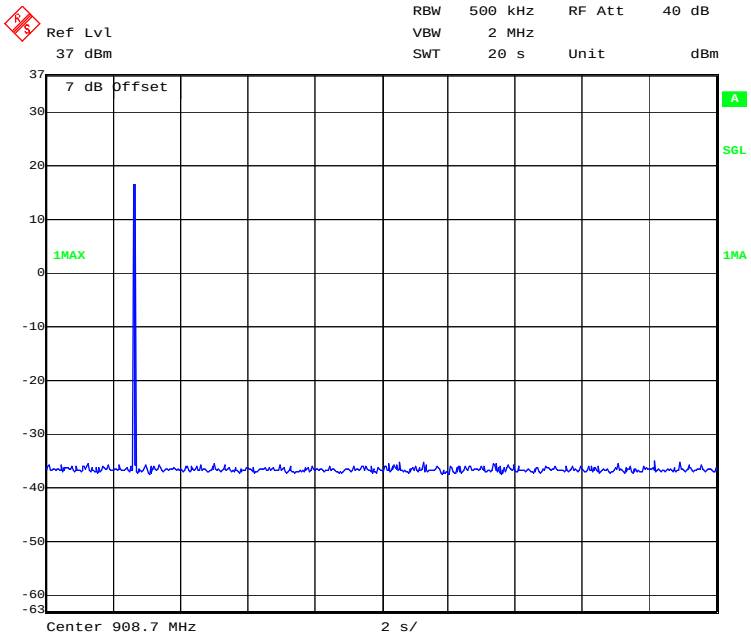
Channel	Dwell Time (s)	Limit (s)	Result
Low	0.041	0.4	Pass
Middle	0.041	0.4	Pass
High	0.041	0.4	Pass

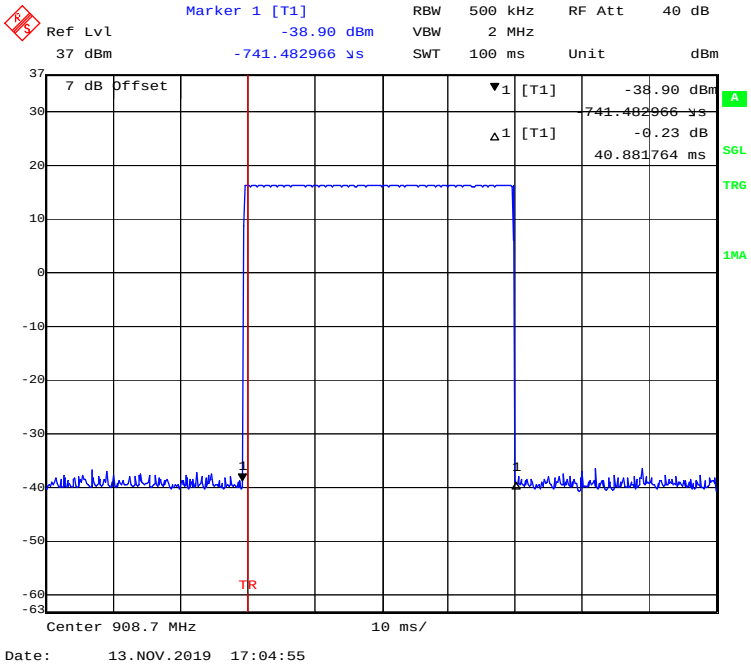
Low Channel


RBW 500 kHz
RF Att 40 dB
Ref Lvl
VBW 2 MHz
37 dBm
SWT 20 s
Unit dBm
7 dB Offset
A
SGL
1MAX
1MA
37
30
20
10
0
-10
-20
-30
-40
-50
-60
-63
Center 902.3 MHz
2 s/
Date: 22.NOV.2019 14:52:08

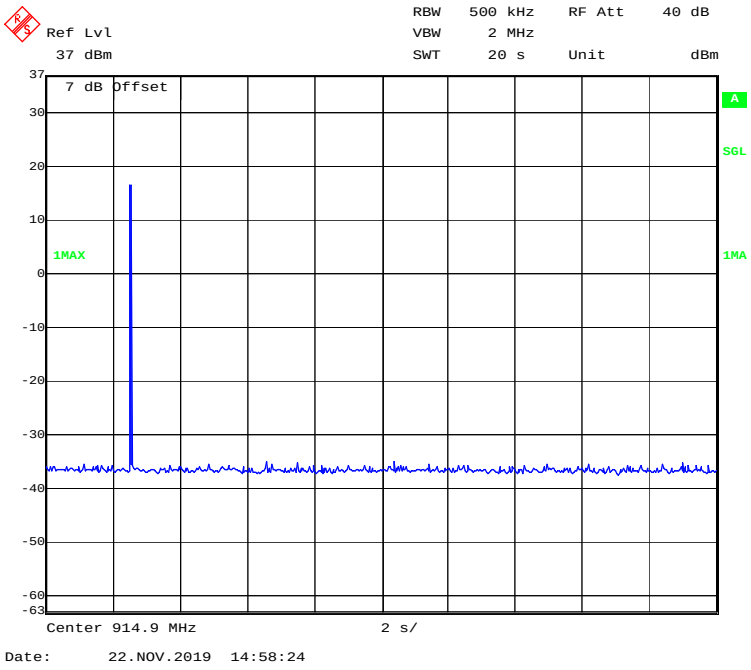

Delta 1 [T1]
RBW 500 kHz
RF Att 40 dB
Ref Lvl
-0.17 dB
VBW 2 MHz
37 dBm
40.681363 ms
SWT 100 ms
Unit dBm
7 dB Offset
1 [T1]
-40.04 dBm
541.082164 µs
1 [T1]
-0.17 dB
40.681363 ms
A
SGL
TRG
1MA
TR
37
30
20
10
0
-10
-20
-30
-40
-50
-60
-63
Center 902.3 MHz
10 ms/
Date: 13.NOV.2019 17:03:50

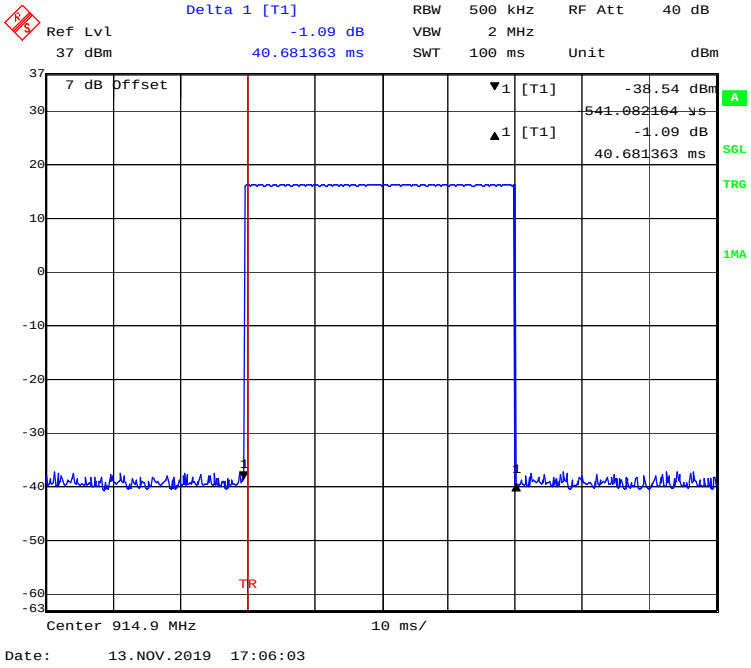
Middle Channel





High Channel





FCC §15.247(b) (2) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Test Procedure

a. Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b. Allow trace to stabilize.
c. Use the marker-to-peak function to set the marker to the peak of the emission.
d. The indicated level is the peak output power, after any corrections for external attenuators and cables.
e. A plot of the test results and setup description shall be included in the test report.

Test Data

Environmental Conditions

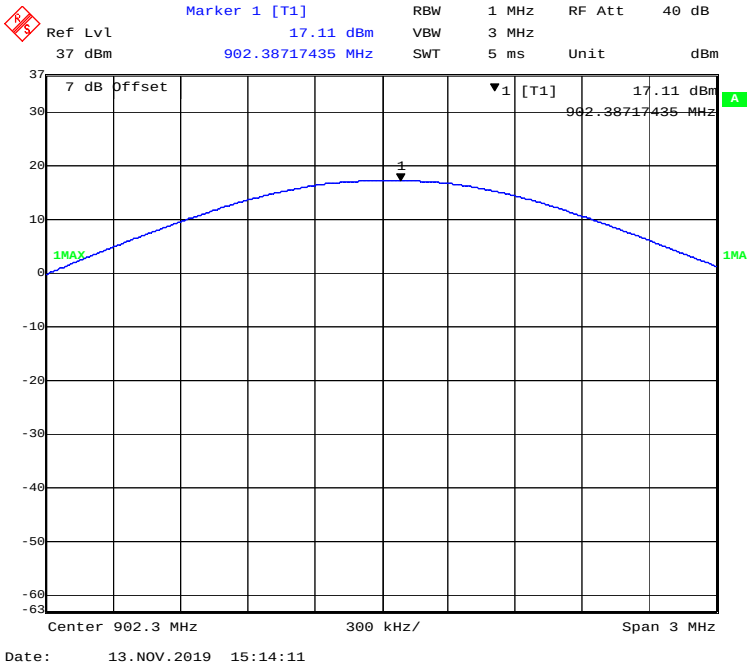
Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

The testing was performed by Sam Ye on 2019-11-13.

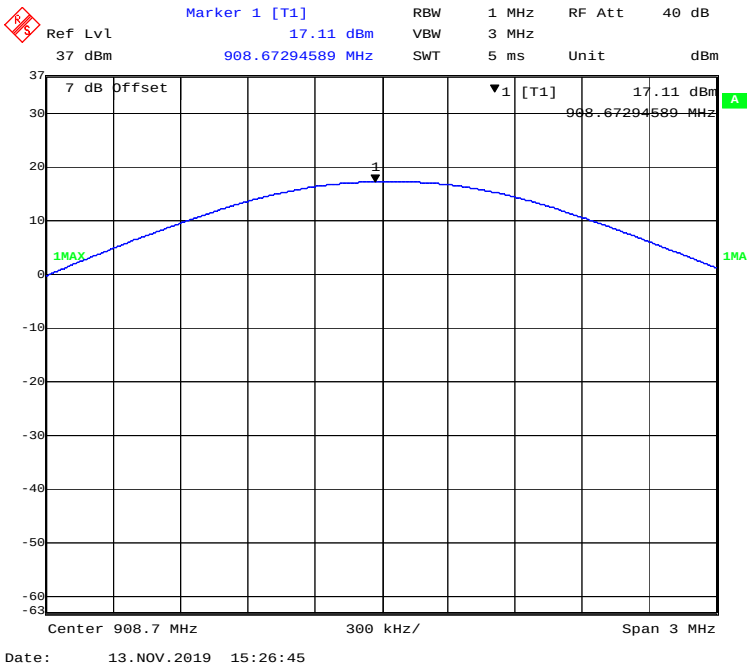
EUT operation mode: Transmitting

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
Low	902.3	17.11	30	Pass
Middle	908.7	17.11	30	Pass
High	914.9	16.99	30	Pass

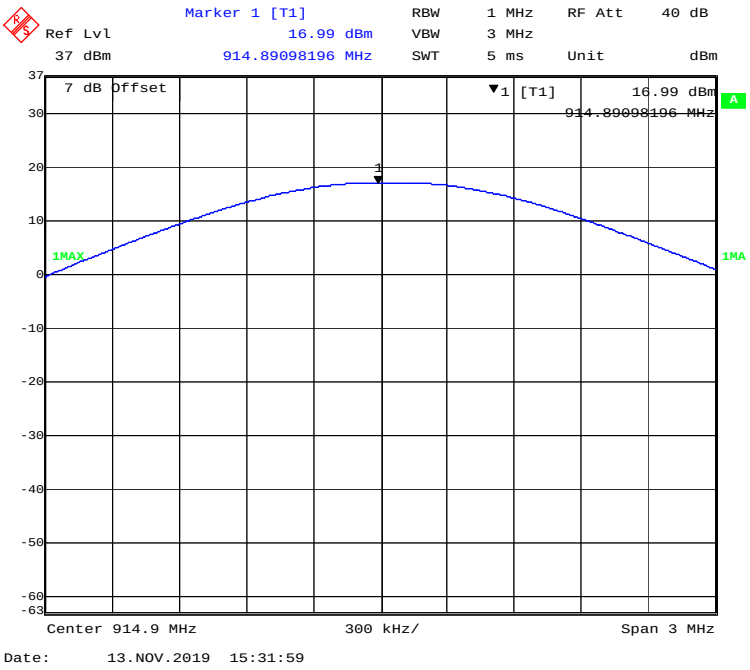
Low Channel



Middle Channel



High Channel



FCC §15.247(d) - BAND EDGES TESTING

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

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

Temperature:	24.2℃
Relative Humidity:	51 %
ATM Pressure:	101.2 kPa

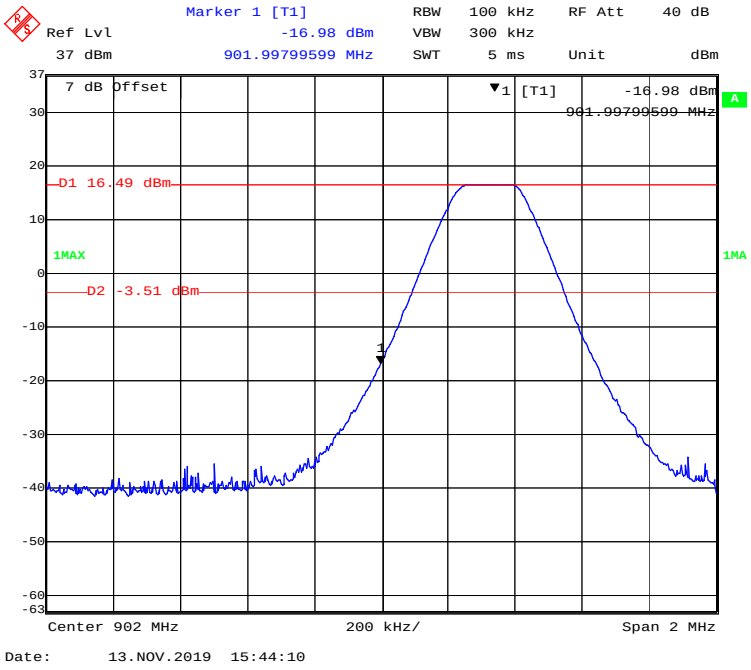
The testing was performed by Sam Ye on 2019-11-13.

EUT operation mode: Transmitting & Hopping

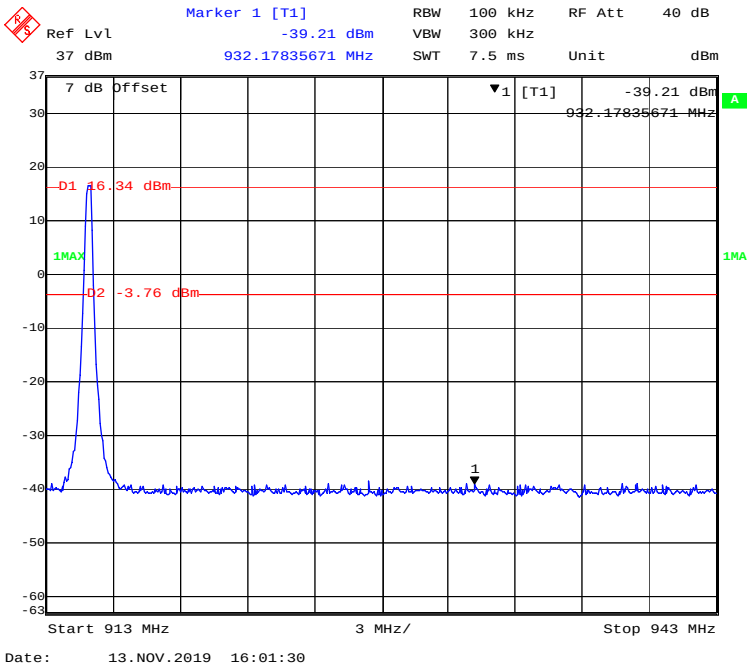
Test Result: Compliant.

Band Edge

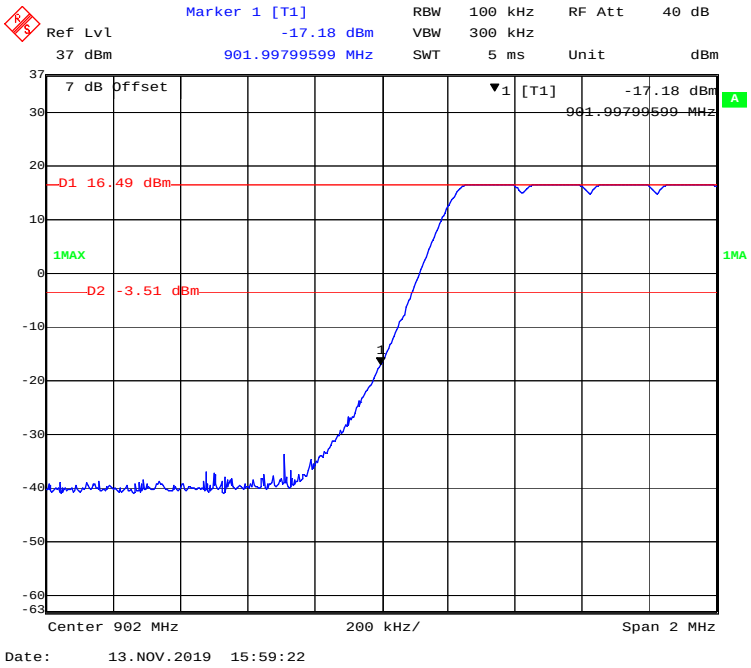
Left Side - Transmitting



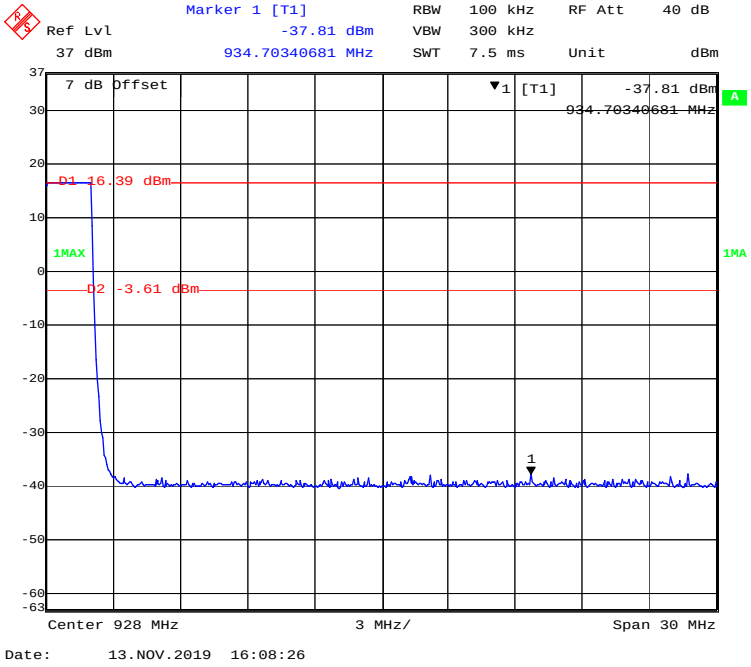
Right Side - Transmitting



Left Side - Hopping



Right Side- Hopping



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