FCC PART 15.247
TEST REPORT

For

Hexing Electrical Co.,Ltd

1418-5 Moganshan Road Shangcheng Industrial Zone, Hangzhou City, China

FCC ID: 2AIUZ-MJN916

Report Type:	**Product Type:**
Original Report	DCU HexNet

Test Engineer:	Ada Yu
Report Number:	RKS170123003-00A
Report Date:	2017-02-10
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)

Manufacturer	Hexing Electrical Co.,Ltd.
Tested Model	MJN916
Series Model	N/A
Product Type	DCU HexNet
Dimension	100 mm(L)×75 mm(W)×31 mm(H)
Power input	DC 12V

**All measurement and test data in this report was gathered from production sample serial number: 20170123003 (Assigned by the BACL. The EUT supplied by the applicant was received on 2017-01-23)*

Objective

This test report is prepared on behalf of Hexing Electrical Co.,Ltd in accordance with Part 2-Subpart J, Part 15-Subparts A, B 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)

No related submittal(s)/grant(s)

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 DA 00-705 March 30, 2000.

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		3.26 dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	5.91dB
	1GHz~6GHz	4.68dB
	6 GHz ~18 GHz	4.92dB
	18 GHz~40 GHz	4.88dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

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.

Test site at Bay Area Compliance Laboratories Corp. (Kunshan) has been fully described in reports submitted to the Federal Communication Commission (FCC). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on November 06, 2014. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10-2013.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 815570. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For LoRa Modulation, 53 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	916.25	28	921.65
2	916.45	29	921.85
3	916.65	30	922.05
4	916.85	31	922.25
5	917.05	32	922.45
6	917.25	33	922.65
7	917.45	34	922.85
8	917.65	35	923.05
9	917.85	36	923.25
10	918.05	37	923.45
11	918.25	38	923.65
12	918.45	39	923.85
13	918.65	40	924.05
14	918.85	41	924.25
15	919.05	42	924.45
16	919.25	43	924.65
17	919.45	44	924.85
18	919.65	45	925.05
19	919.85	46	925.25
20	920.05	47	925.45
21	920.25	48	925.65
22	920.45	49	925.85
23	920.65	50	926.05
24	920.85	51	926.25
25	921.05	52	926.45
26	921.25	53	926.65
27	921.45		

EUT was tested with Channel 1, 27 and 53.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode which was controlled by the software.

EUT Exercise Software

HxZBee BZ

The worst case was performed under:

Power lever 27

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

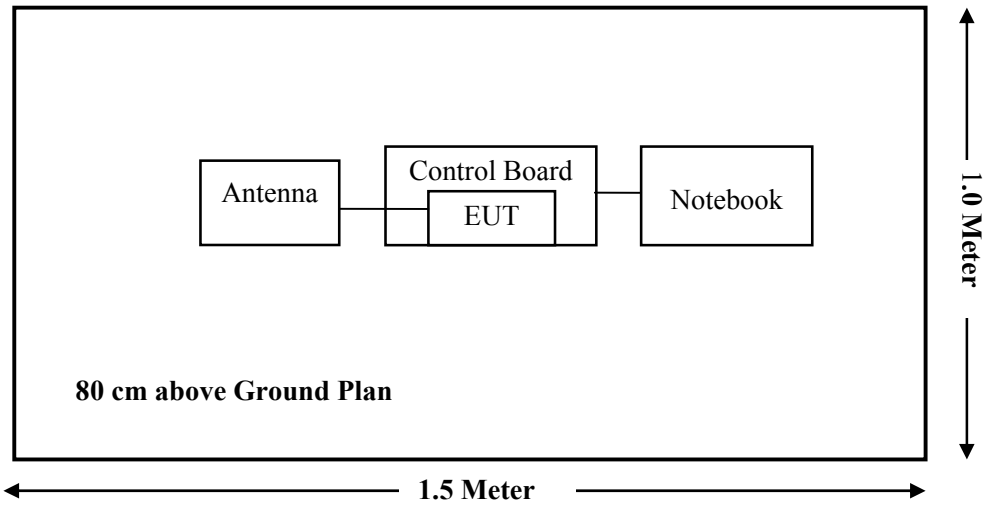
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
Hexing	Control Board	/	/

External I/O Cable

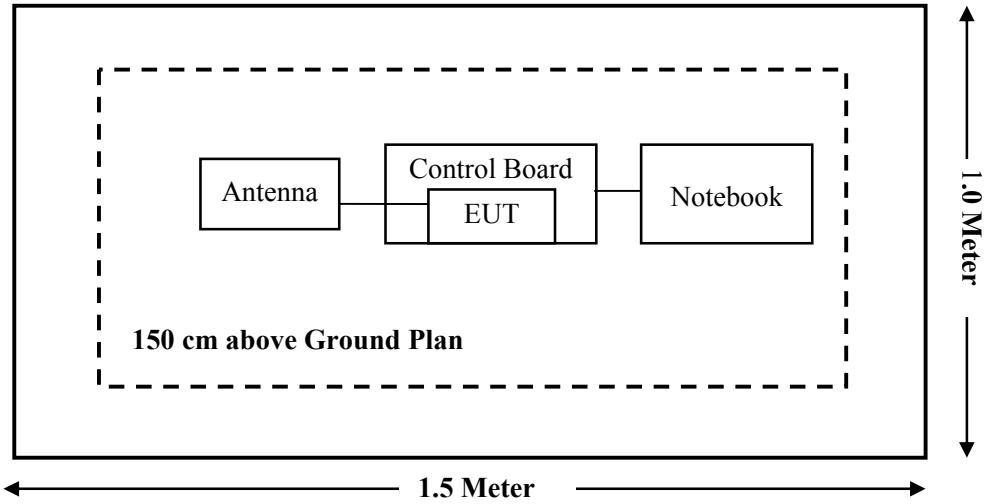
Cable Description	Shielding Type	Length (m)	From Port	To
USB Cable	Unshielding	0.8	Control Board	Notebook

Block Diagram of Test Setup

For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)(i)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)(i)	Channel Separation Test	Compliance
§15.247(a)(1)(i)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(i)	Quantity of hopping channel Test	Compliance
§15.247(b)(2)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2016-11-25	2017-11-24
Rohde & Schwarz	Signal Analyzer	FSIQ26	100048	2016-11-25	2017-11-24
Sunol Sciences	Broadband Antenna	JB3	A090314-2	2016-01-09	2019-01-08
ETS	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Sonoma Instrunent	Amplifier	330	171377	2016-12-12	2017-12-11
Narda	Pre-amplifier	AFS42-00101800	2001270	2016-12-12	2017-12-11
R&S	Auto test Software	EMC32	100361	/	/
Haojintech	Coaxial Cable	Cable-1	001	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-2	002	2016-12-12	2017-12-11
Haojintech	Coaxial Cable	Cable-3	003	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-4	004	2016-12-12	2017-12-11
MICRO-COAX	Coaxial Cable	Cable-5	005	2016-12-12	2017-12-11
RF Conducted Test					
Rohde & Schwarz	OSP120 Base Unit	OSP120	101247	2016-07-04	2017-07-03
BACL	EMC32 Version	EMC 32	09106	/	/
Rohde & Schwarz	SMBV100A Vector Signal Generator	SMBV100A	261558	2016-07-04	2017-07-03
Rohde & Schwarz	SMB 100A Signal Generator	SMB100A	110390	2016-07-04	2017-07-03
Agilent	Power Meter	N1912A	MY5000492	2016-11-18	2017-11-17
Agilent	Power Sensor	N1921A	MY54210024	2016-11-18	2017-11-17
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2016-09-21	2017-09-20
Hexing Electrical	RF Cable	N/A	N/A	2016-12-29	2017-12-28
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2016-11-25	2017-11-24
Rohde & Schwarz	LISN	ESH3-Z5	862770/011	2016-10-10	2017-10-09
ROHDE&SCHWARZ	LISN	ENV216	3560655016	2016-11-25	2017-11-24
Rohde & Schwarz	CE Test software	EMC 32	100357	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2016-09-08	2017-09-07

*** 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§15.247 (i), §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);

Measurement Result

Modulation	**Frequency Range**	**Antenna Gain**		**Output Power**		**Evaluation Distance**	**Power Density**	**MPE Limit**
	(MHz)	**(dBi)**	**(numeric)**	**(dBm)**	**(mW)**	**(cm)**	**(mW/cm^2)**	**(mW/cm^2)**
LoRa	916.25-926.65	5.0	3.16	28.00	630.96	20	0.3969	0.6108

Note: (1) The target output power:
LoRa:Peak power 27±1 dBm,which declared by the Manufacturer.

Result: The device meet 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 Information

The EUT has a RP-SMA connector to attach an external antenna arrangement, which the antenna gain is 5.0 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

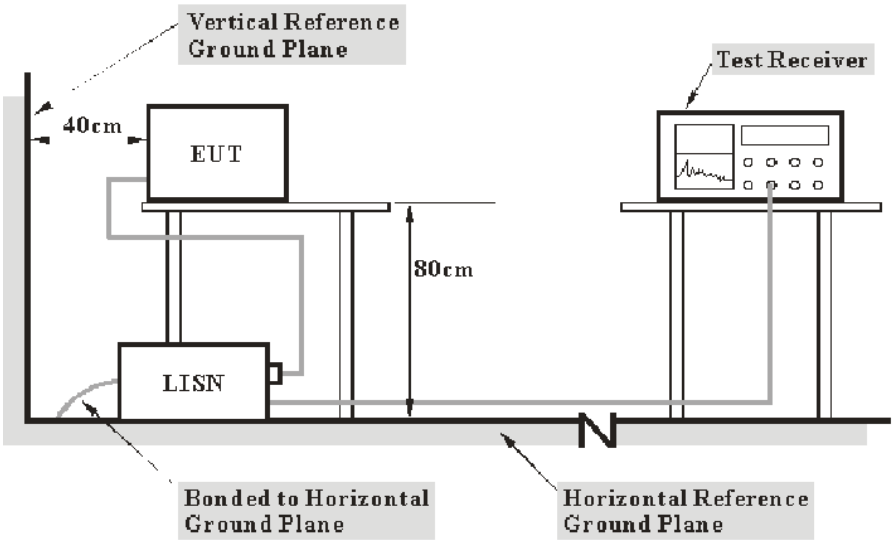
Result: Compliance.

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 & Margin 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:

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

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

Margin = Limit – Corrected Amplitude

Test Results Summary

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

Refer to CISPR16-4-2and CISPR 16-4-1, the measured level complies with the limit if

$$L_m + U_{(Lm)} \leq L_{lim} + U_{cispr}$$

In BACL, $U_{(Lm)}$ is less than U_{cispr}, if L_m is less than L_{lim}, it implies that the EUT complies with the limit.

Test Data

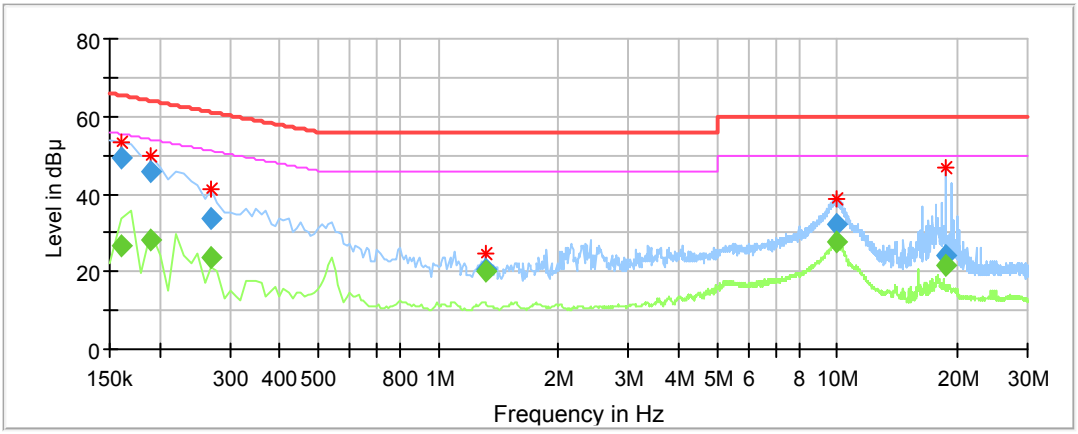
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	58 %
ATM Pressure:	101.3 kPa

The testing was performed by Ada Yu on 2017-02-08.

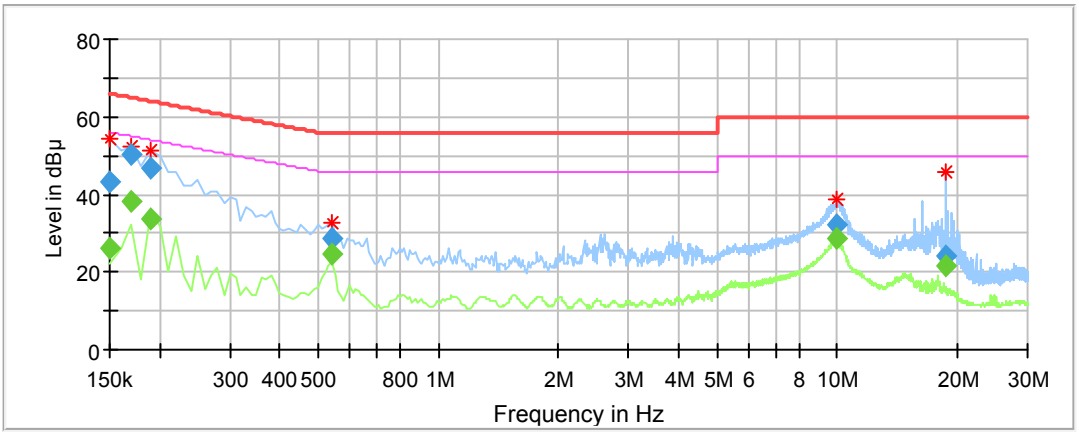
EUT operation mode: Transmitting

AC 120V/60 Hz, Line



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.160000	---	26.74	9.000	L1	10.1	28.72	55.46	Compliance
0.160000	49.23	---	9.000	L1	10.1	16.23	65.46	Compliance
0.190000	---	28.41	9.000	L1	10.0	25.63	54.04	Compliance
0.190000	45.81	---	9.000	L1	10.0	18.23	64.04	Compliance
0.270000	---	23.51	9.000	L1	10.0	27.61	51.12	Compliance
0.270000	33.94	---	9.000	L1	10.0	27.18	61.12	Compliance
1.310000	---	19.93	9.000	L1	9.8	26.07	46.00	Compliance
1.310000	20.56	---	9.000	L1	9.8	35.44	56.00	Compliance
9.930000	---	27.82	9.000	L1	10.1	22.18	50.00	Compliance
9.930000	32.37	---	9.000	L1	10.1	27.63	60.00	Compliance
18.650000	---	21.70	9.000	L1	10.4	28.30	50.00	Compliance
18.650000	24.17	---	9.000	L1	10.4	35.83	60.00	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.150000	---	26.24	9.000	N	10.1	29.76	56.00	Compliance
0.150000	43.09	---	9.000	N	10.1	22.91	66.00	Compliance
0.170000	---	38.25	9.000	N	10.2	16.71	54.96	Compliance
0.170000	50.19	---	9.000	N	10.2	14.77	64.96	Compliance
0.190000	---	33.66	9.000	N	10.3	20.38	54.04	Compliance
0.190000	46.83	---	9.000	N	10.3	17.21	64.04	Compliance
0.540000	---	24.49	9.000	N	10.1	21.51	46.00	Compliance
0.540000	28.82	---	9.000	N	10.1	27.18	56.00	Compliance
9.980000	---	28.66	9.000	N	10.0	21.34	50.00	Compliance
9.980000	32.38	---	9.000	N	10.0	27.62	60.00	Compliance
18.650000	---	21.54	9.000	N	10.1	28.46	50.00	Compliance
18.650000	23.91	---	9.000	N	10.1	36.09	60.00	Compliance

Note:
1) Corr.=LISN VDF (Voltage Division Factor) + Cable Loss
2) Corrected Amplitude = Reading + Corr.
3) Margin = Limit –Corrected Amplitude

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

Applicable Standard

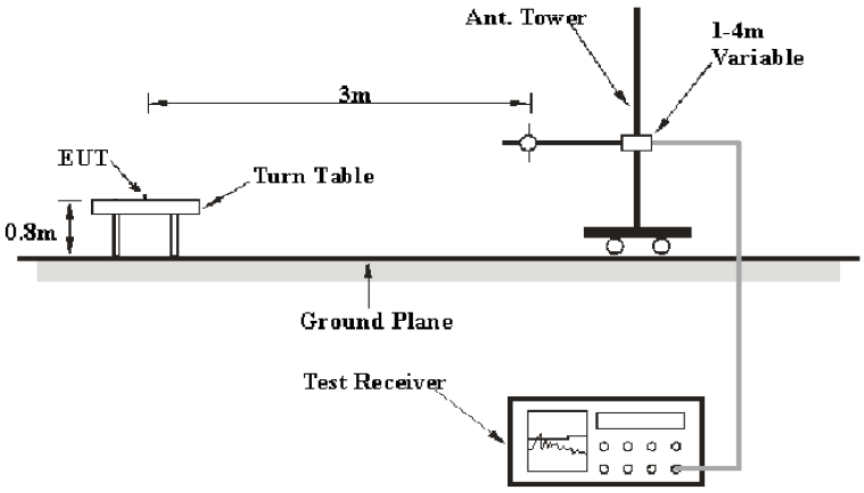
FCC §15.205; §15.209; §15.247(d)

Measurement Uncertainty

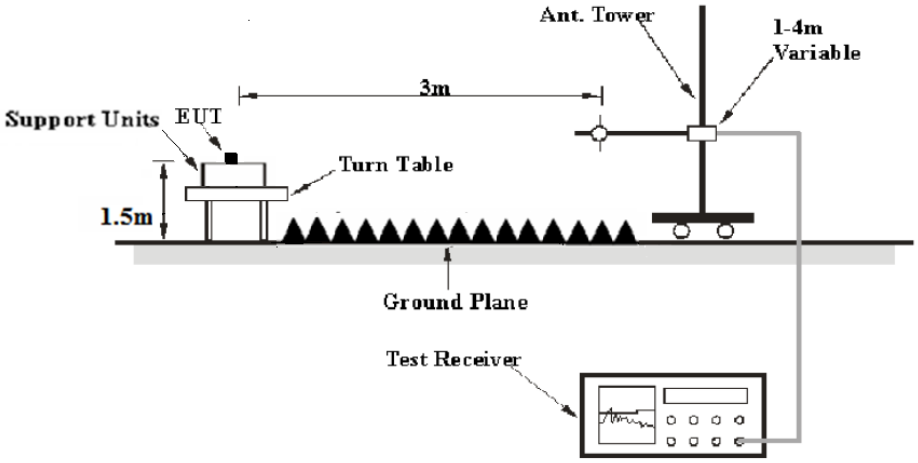
All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

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 & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 10 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were 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

Frequency Range	RBW	Video B/W	Duty cycle	Detector
1GHz – 10GHz	1MHz	3 MHz	Any	PK
	1MHz	10 Hz	>98%	Ave.
	1MHz	1/T	<98%	

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.

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 = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

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 = Limit – Corrected Amplitude

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.

Refer to CISPR16-4-2 and CISPR 16-4-1, the measured level complies with the limit if

L_m ++ $U_{(Lm)} \leq L_{lim}$ ++ U_{cispr}

In BACL, $U_{(Lm)}$ is less than + U_{cispr}, if L_m is less than L_{lim}, it implies that the EUT complies with the limit.

Test Data

Environmental Conditions

Temperature:	23.8 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Ada Yu on 2017-02-07.

EUT operation mode: Transmitting

30MHz -10 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB)	Corrected Amplitude (dBμV/m)	FCC Part 15.247/205/209	
	Reading (dBμV)	Detector (PK/QP/Ave.)		Height (cm)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (916.25 MHz)									
39.99	30.17	QP	334	204	V	-4.88	25.29	40	14.71
82.79	35.98	QP	75	112	V	-11.17	24.81	40	15.19
621.45	26.11	QP	317	227	V	1.10	27.21	46	18.79
916.25	85.20	PK	110	144	H	24.68	109.88	/	/
916.25	96.71	PK	174	235	V	24.68	121.39	/	/
902.00	39.35	PK	223	103	H	24.47	63.82	74	10.18
902.00	39.93	PK	162	226	V	24.47	64.40	74	9.60
1832.50	76.12	PK	53	222	H	-7.88	68.24	74	5.76
1832.50	75.27	PK	318	159	V	-7.88	67.39	74	6.61
2748.75	51.23	PK	57	197	H	-4.61	46.62	74	27.38
2748.75	51.11	PK	90	209	V	-4.61	46.50	74	27.50
Middle Channel (921.45 MHz)									
39.99	31.08	QP	287	219	V	-4.88	26.20	40	13.80
82.79	36.14	QP	245	186	V	-11.17	24.97	40	15.03
621.45	27.58	QP	129	137	V	1.1	28.68	46	17.32
921.45	86.54	PK	104	125	H	24.76	111.30	/	/
921.45	94.25	PK	4	154	V	24.76	119.01	/	/
1842.90	75.26	PK	251	200	H	-7.83	67.43	74	6.57
1842.90	74.17	PK	174	222	V	-7.83	66.34	74	7.66
2764.35	50.31	PK	198	169	H	-4.53	45.78	74	28.22
2764.35	49.28	PK	164	174	V	-4.53	44.75	74	29.25
High Channel (926.65 MHz)									
39.99	31.25	QP	127	141	V	-4.88	26.37	40	13.63
82.79	36.57	QP	27	177	V	-11.17	25.40	40	14.60
621.45	27.23	QP	118	205	V	1.10	28.33	46	17.67
926.65	86.19	PK	148	221	H	24.84	111.03	/	/
926.65	92.16	PK	176	115	V	24.84	117.00	/	/
928.00	38.90	PK	231	220	H	24.86	63.76	74	10.24
928.00	38.91	PK	99	198	V	24.86	63.77	74	10.23
1853.30	75.26	PK	102	220	H	-7.78	67.48	74	6.52
1853.30	74.19	PK	42	163	V	-7.78	66.41	74	7.59
2779.95	53.16	PK	335	241	H	-4.44	48.72	74	25.28
2779.95	54.29	PK	245	141	V	-4.44	49.85	74	24.15

Note: The fundermental test is without Amplifier

Frequency (MHz)	Peak Measurement@3m (dBμV/m)	Polar (H/V)	Duty Cycle	Duty Cycle Correction Factor (dB)	Corrected Ampitude (dBμV/m)	FCC Part 15.249/205/209	
						Limit (dBμV/m)	Margin (dB)
Low Channel (916.25 MHz)							
916.25	109.88	H	0.1683	-15.48	94.40	/	/
916.25	121.39	V	0.1683	-15.48	105.91	/	/
902.00	63.82	H	0.1683	-15.48	48.34	54	5.66
902.00	64.40	V	0.1683	-15.48	48.92	54	5.08
1832.50	68.24	H	0.1683	-15.48	52.76	54	1.24
1832.50	67.39	V	0.1683	-15.48	51.91	54	2.09
2748.75	46.62	H	0.1683	-15.48	31.14	54	22.86
2748.75	46.50	V	0.1683	-15.48	31.02	54	22.98
Middle Channel (921.45 MHz)							
921.45	111.30	H	0.1683	-15.48	95.82	/	/
921.45	119.01	V	0.1683	-15.48	103.53	/	/
1842.90	67.43	H	0.1683	-15.48	51.95	54	2.05
1842.90	66.34	V	0.1683	-15.48	50.86	54	3.14
2764.35	45.78	H	0.1683	-15.48	30.30	54	23.70
2764.35	44.75	V	0.1683	-15.48	29.48	54	24.52
High Channel (926.65 MHz)							
926.65	111.03	H	0.1683	-15.48	95.55	/	/
926.65	117.00	V	0.1683	-15.48	101.52	/	/
928.00	63.76	H	0.1683	-15.48	48.28	54	5.72
928.00	63.77	V	0.1683	-15.48	48.29	54	5.71
1853.30	67.48	H	0.1683	-15.48	52.00	54	2.00
1853.30	66.41	V	0.1683	-15.48	50.93	54	3.07
2779.95	48.72	H	0.1683	-15.48	33.24	54	20.76
2779.95	49.85	V	0.1683	-15.48	34.37	54	19.63

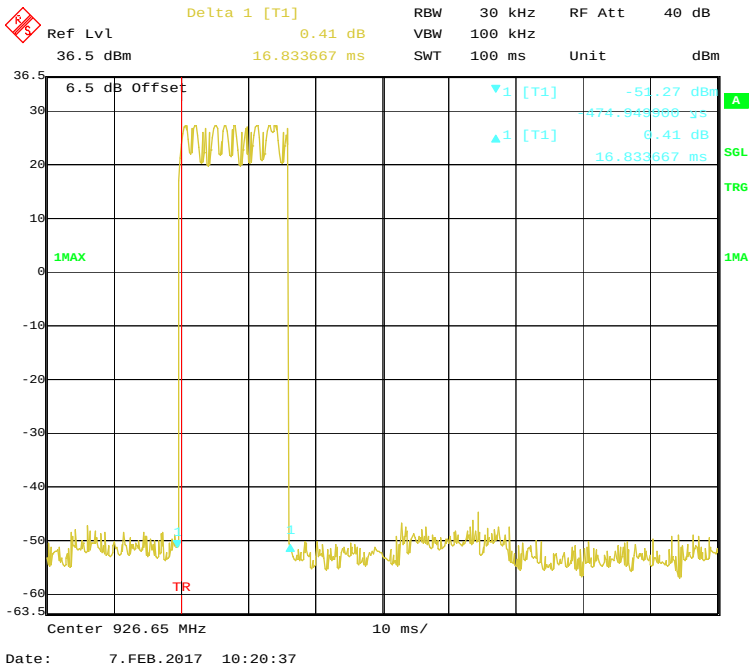
Max Duty cycle = 16.83ms/100ms=0.1683

Duty Cycle Correction Factor = 20*lg (dutycycle) = -15.48

AV = PK + Duty Cycle Correction Factor

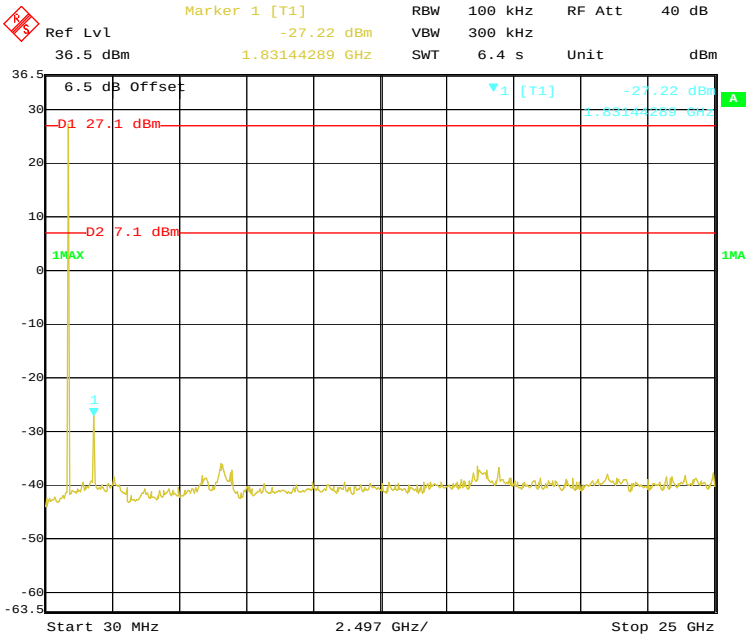
Please refer to following plot for Duty cycle:

duty cycle

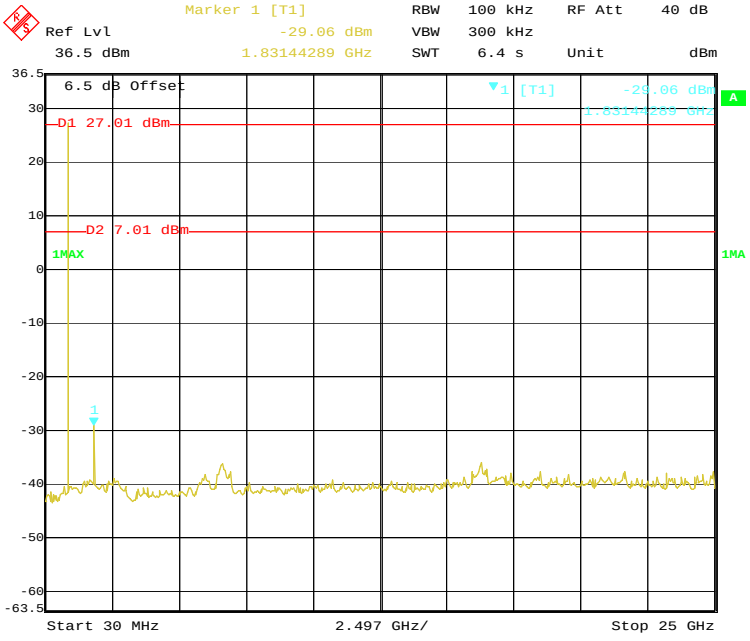

Delta 1 [T1]
RBW 30 kHz
RF Att 40 dB
Ref Lvl
0.41 dB
VBW 100 kHz
36.5 dBm
16.833667 ms
SWT 100 ms
Unit dBm
6.5 dB Offset
1 [T1] -53.27 dBm
1 [T1] 0.41 dB
16.833667 ms
A
SGL
TRG
1MAX
1MA
TR
Center 926.65 MHz
10 ms/
Date: 7.FEB.2017 10:20:37

Spurious Emissions at Antenna Port:

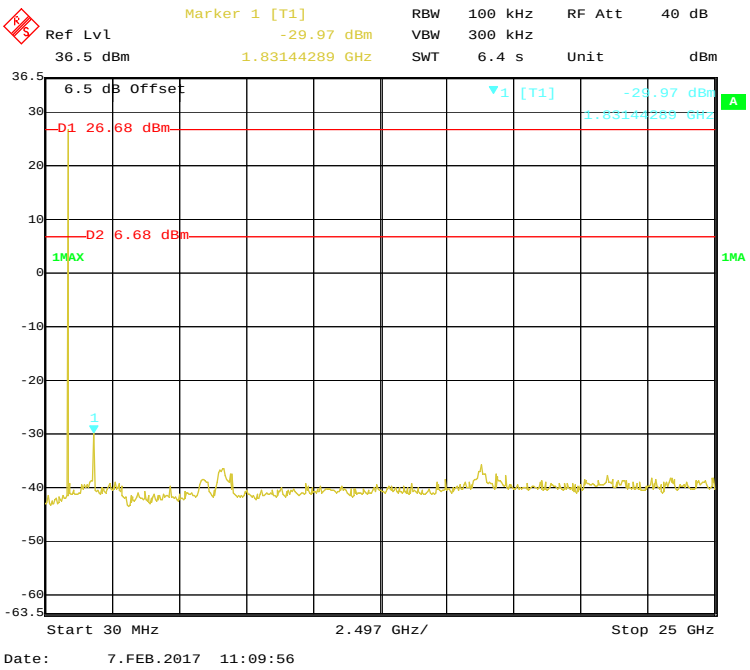
Low Channel



Middle Channel



High Channel



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

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	24.1 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Ada Yu on 2017-02-07.

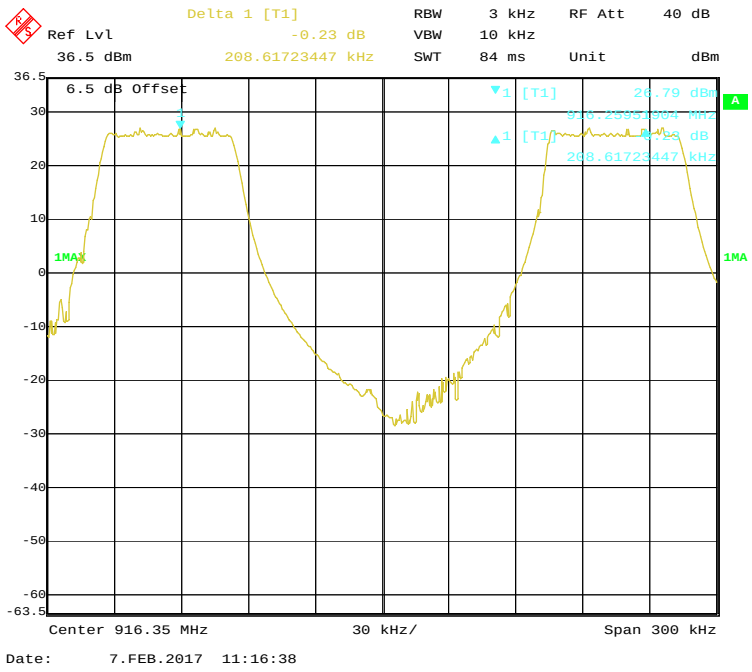
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following tables and plots

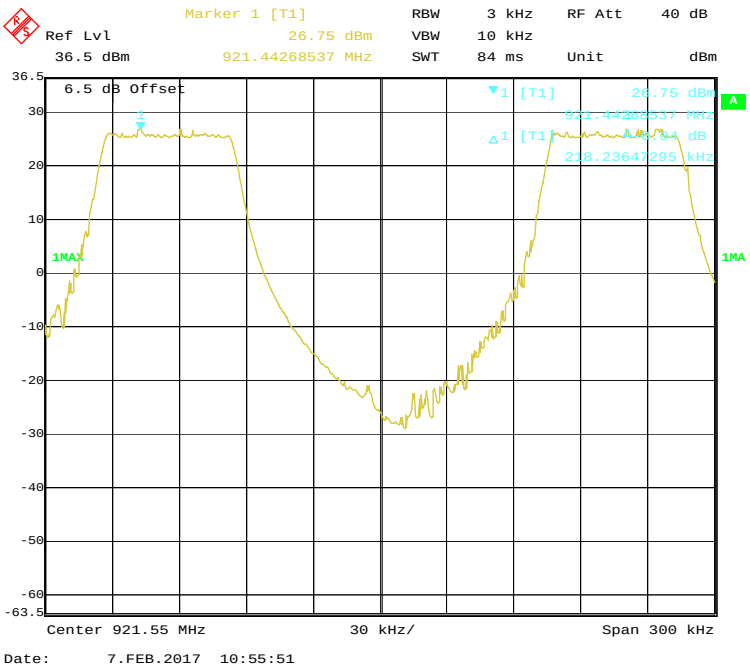
Modulation	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
LoRa	Low	916.25	0.2086	0.07535	Pass
	Adjacent	916.45			
	Middle	921.45	0.2182	0.07535	Pass
	Adjacent	921.65			
	Adjacent	926.45	0.2008	0.07615	Pass
	High	926.65			

The limit = 20dB Bandwidth

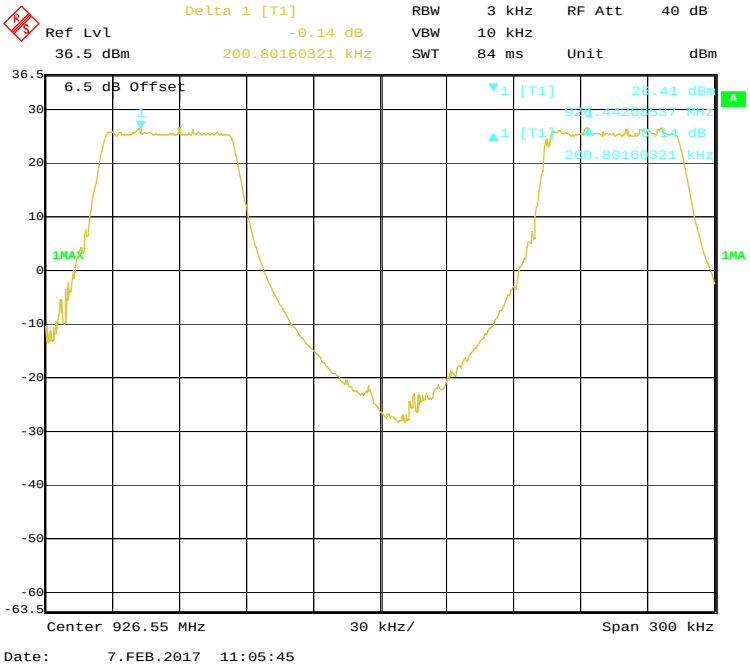
Low Channel



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:	24.5 ℃
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

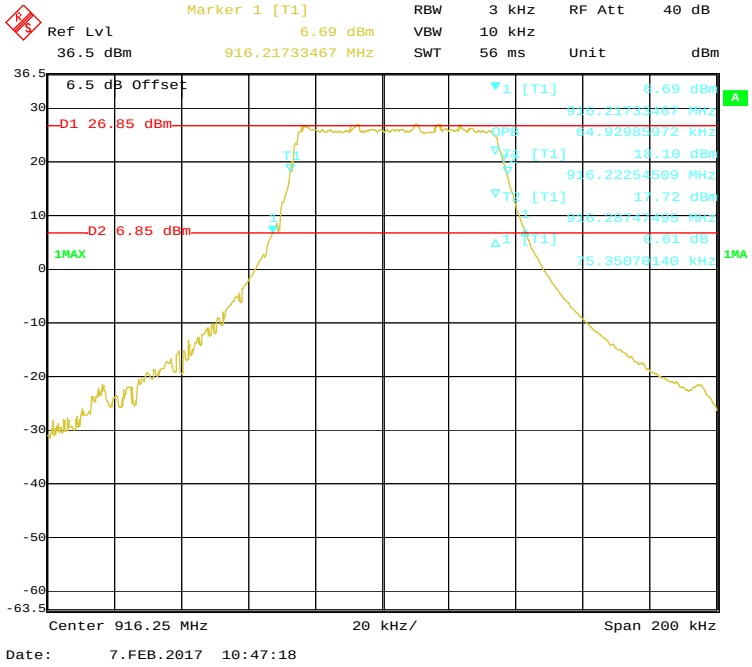
The testing was performed by Ada Yu on 2017-02-07

EUT operation mode: Transmitting

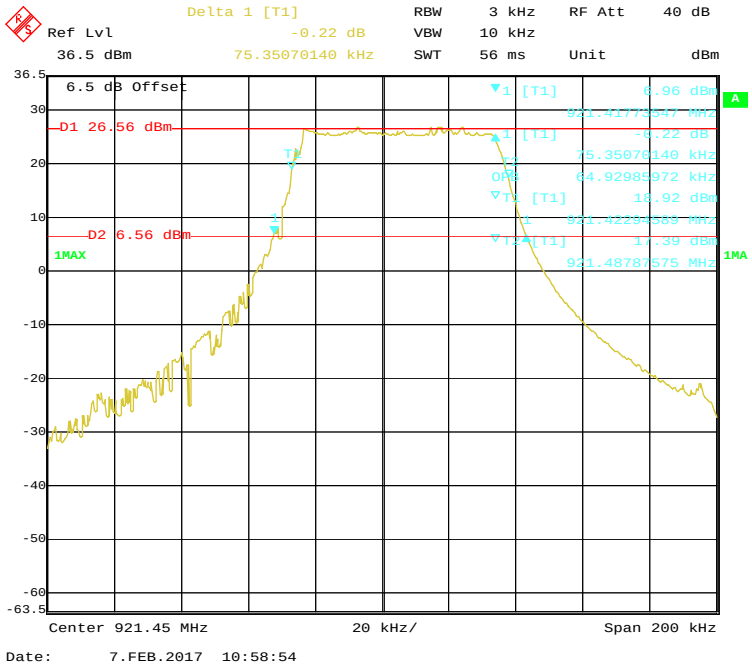
Test Result: Compliance. Please refer to following tables and plots

Modulation	Channel	Frequency (MHz)	20 dB Emission Bandwidth (kHz)	Limit (kHz)
LoRa	Low	916.25	75.35	≤500
	Middle	921.45	75.35	≤500
	High	926.65	76.15	≤500

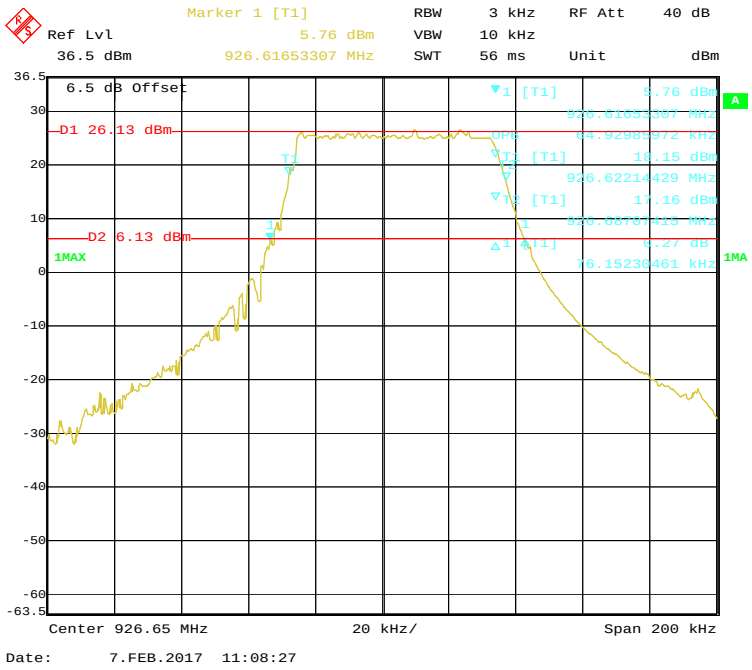
Low Channel



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

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

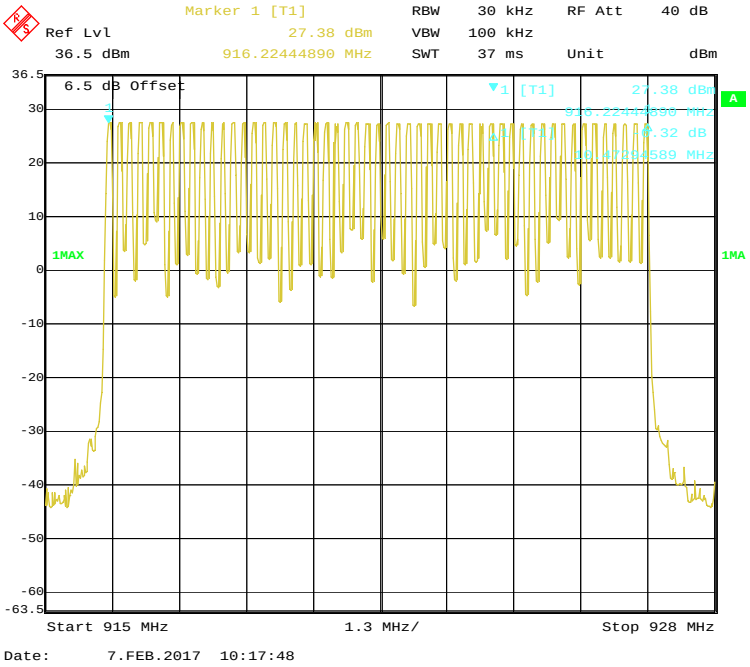
The testing was performed by Ada Yu on 2017-02-07

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following tables and plots

Modulation	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
LoRa	902~928	53	≥50

Number of Hopping Channels



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 was worked in channel hopping; Spectrum SPAN was set as 0. Sweep was set as 0.4 X channel no. (s), the quantity of pulse was get from single sweep. In addition, the time of single pulses was tested.

Test Data

Environmental Conditions

Temperature:	24.2 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

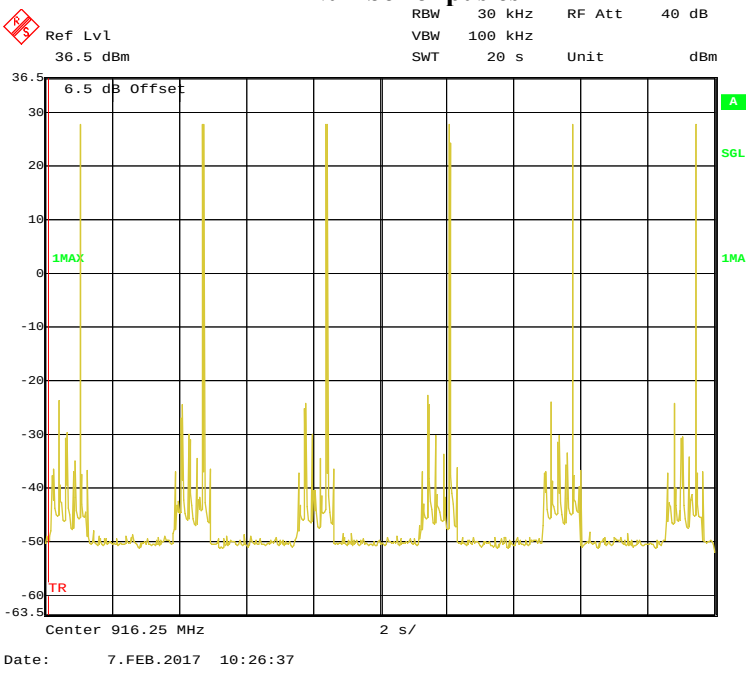
The testing was performed by Ada Yu on 2017-02-07.

EUT operation mode: Transmitting

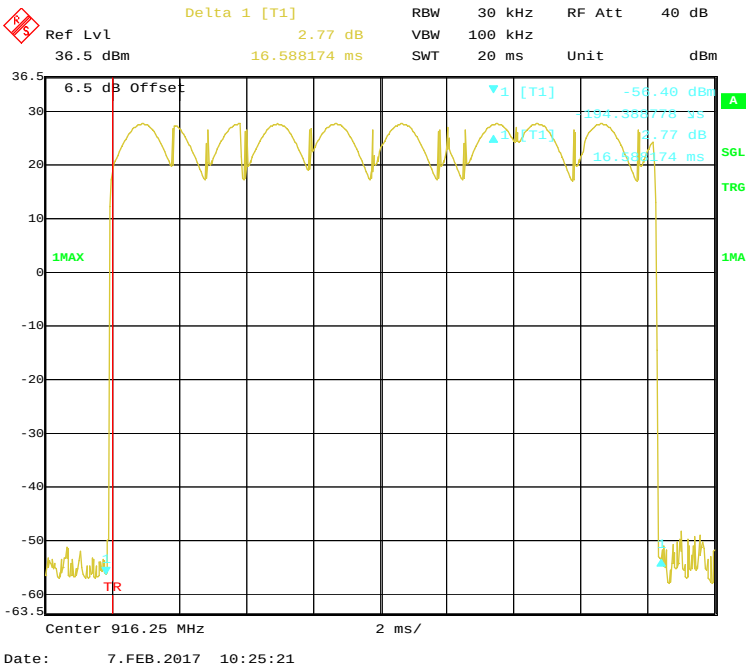
Test Result: Compliance. Please refer to following tables and plots

Modulation	Channel	Pulse Width (ms)	Pulse Number	Dwell Time (S)	Limit (S)	Result
LoRa	Low	16.588	6	0.100	≤0.4	Pass
	Middle	16.588	6	0.100	≤0.4	Pass
	High	16.829	6	0.101	≤0.4	Pass
	Note:Dwell time = Pulse time*N					

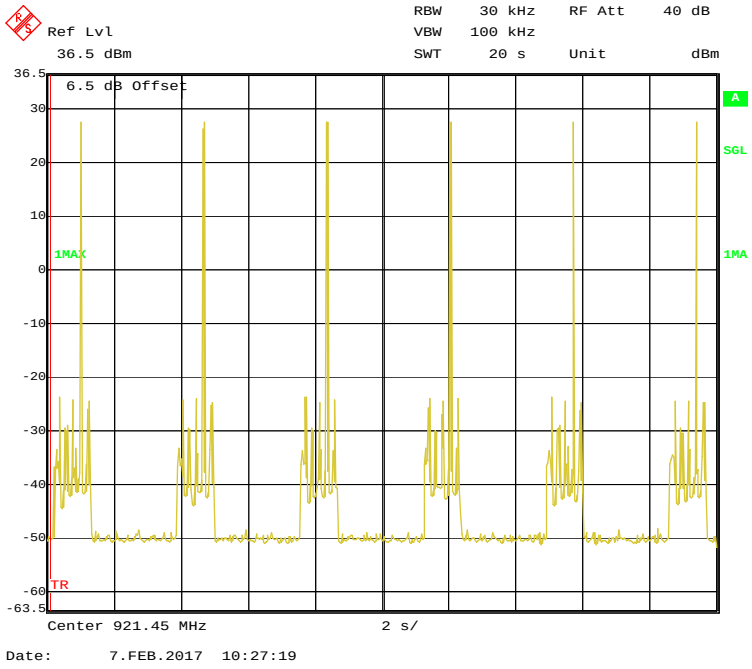
Low Channel
Number of pusles



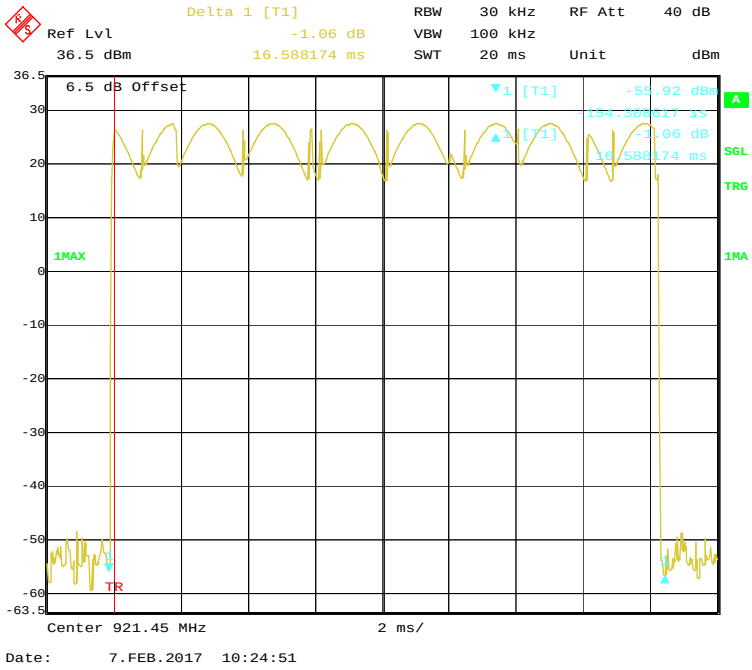
Single Pusle



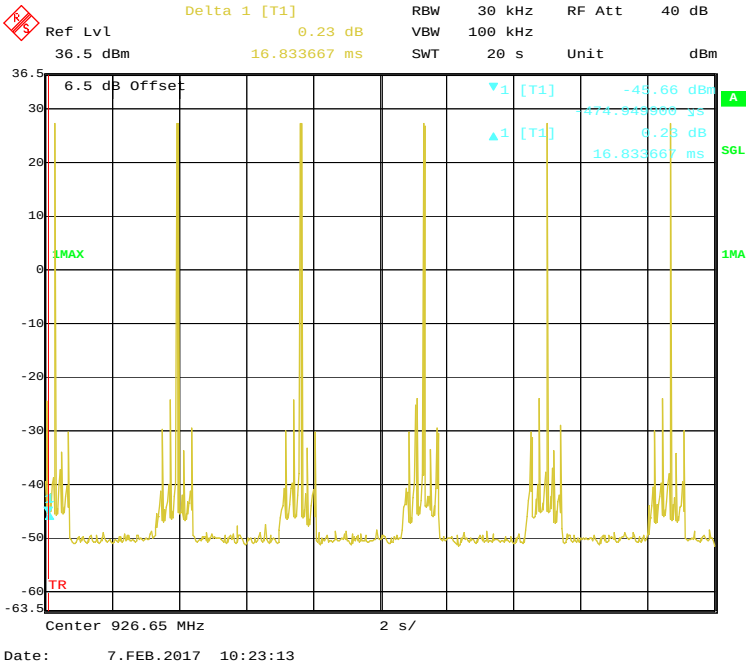
Middle Channel
Number of pusles



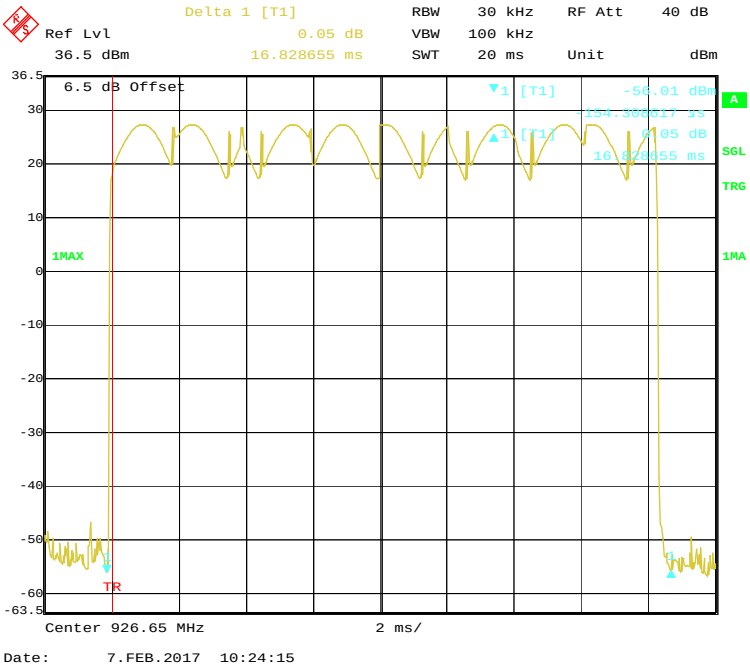
Single Pusle



High Channel
Number of pusles



Single Pusle



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

Applicable Standard

According to §15.247(b) (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

1. Place the EUT on a bench and set 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 correction factor to the display.

Test Data

Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

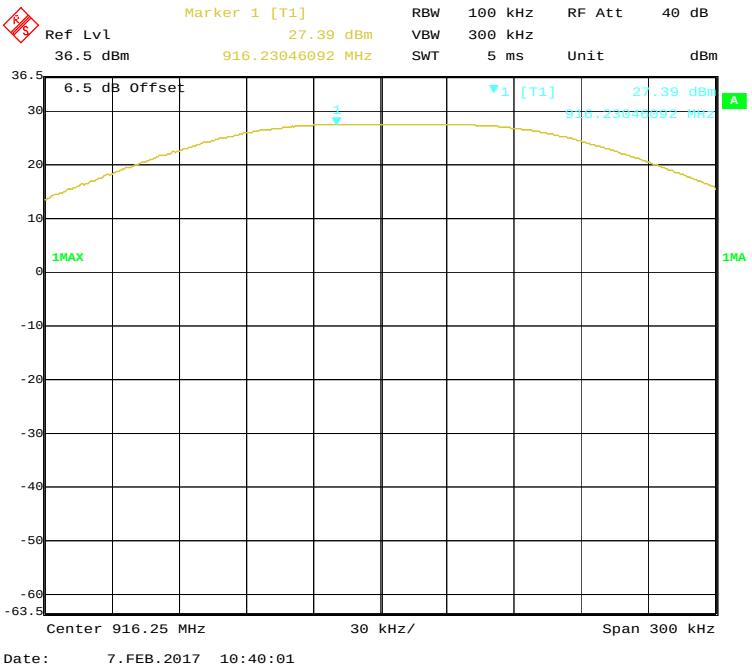
The testing was performed by Ada Yu on 2017-02-07.

EUT operation mode: Transmitting

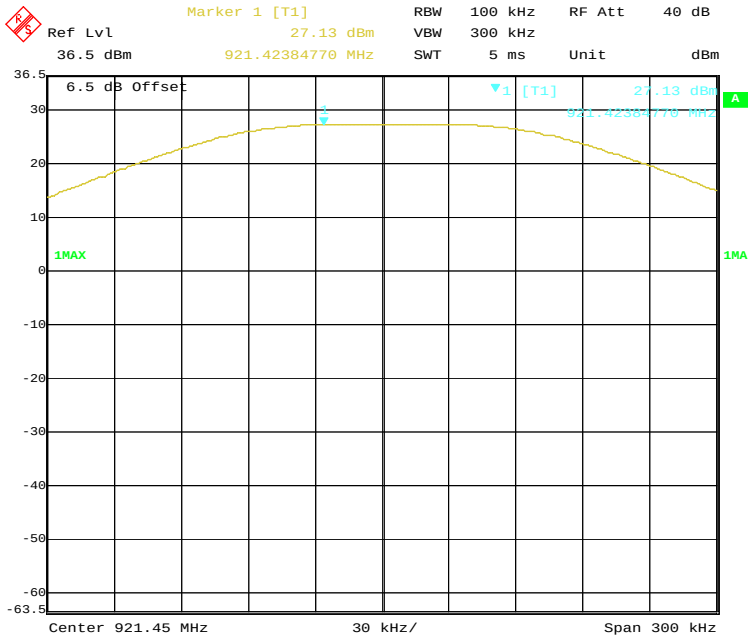
Test Result: Compliance. Please refer to following tables and plots

Modulation	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
LoRa	Low	916.25	27.39	548.28	≤1000
	Middle	921.45	27.13	516.42	≤1000
	High	926.65	26.81	479.73	≤1000

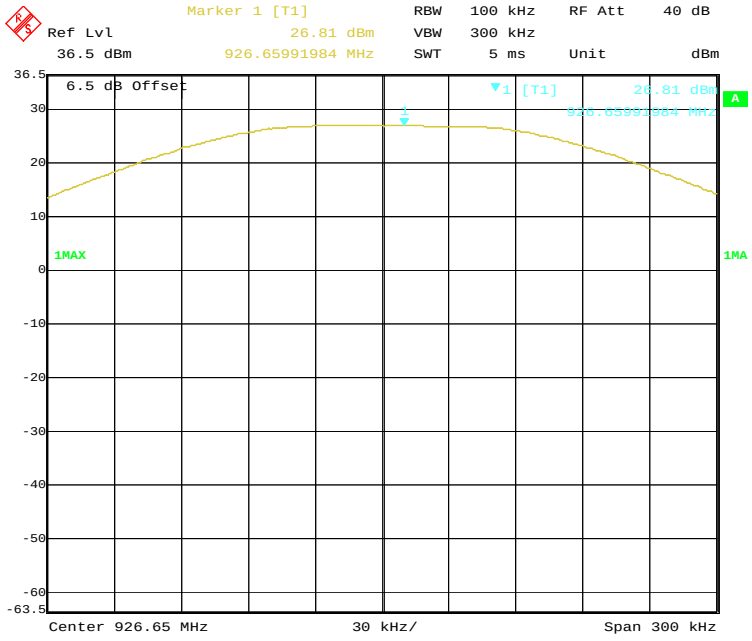
Low Channel



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

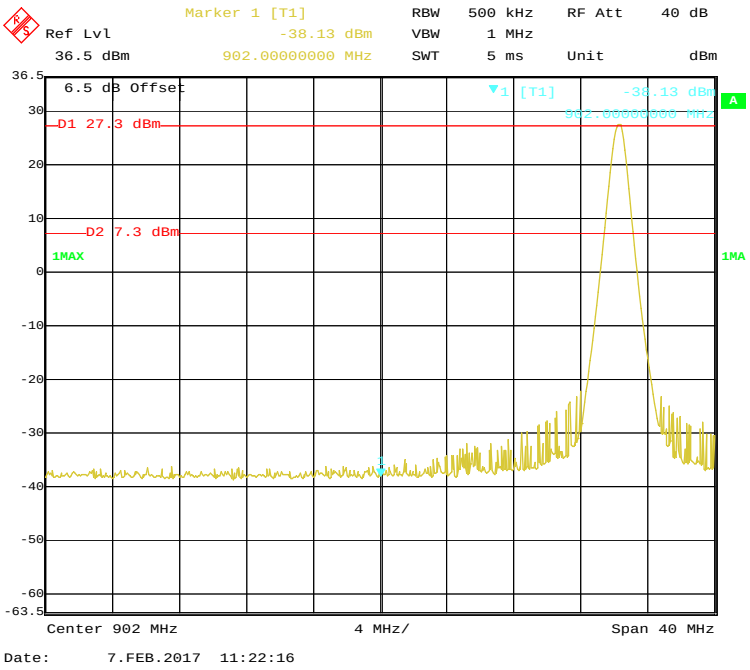
Temperature:	24 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Ada Yu on 2017-02-07.

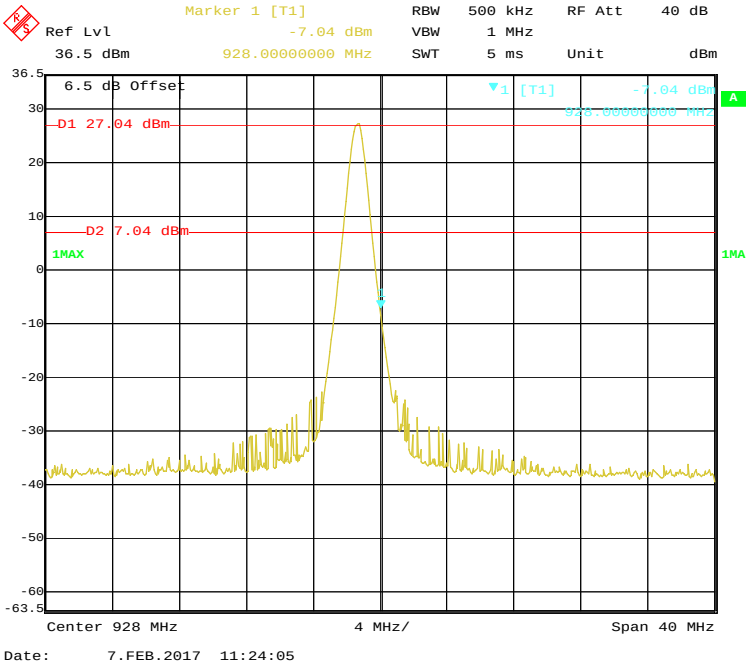
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

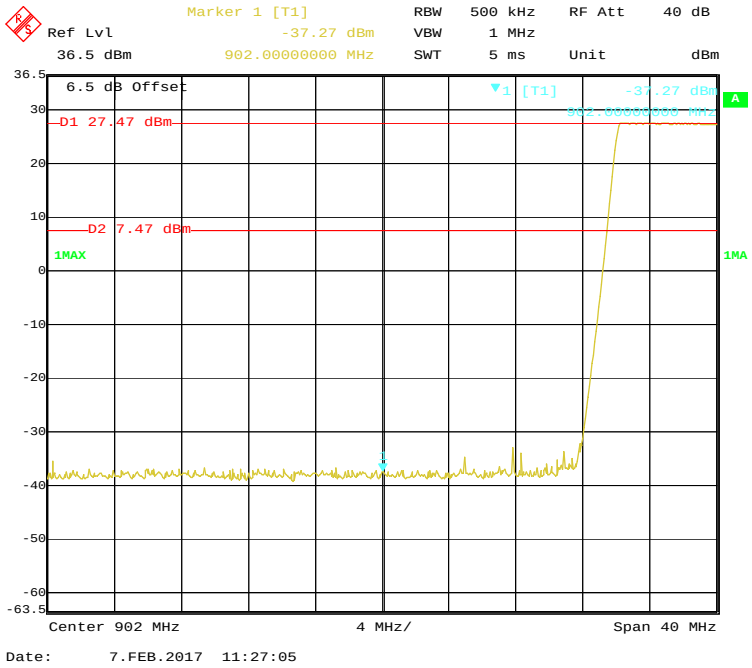
Band Edge-Left Side



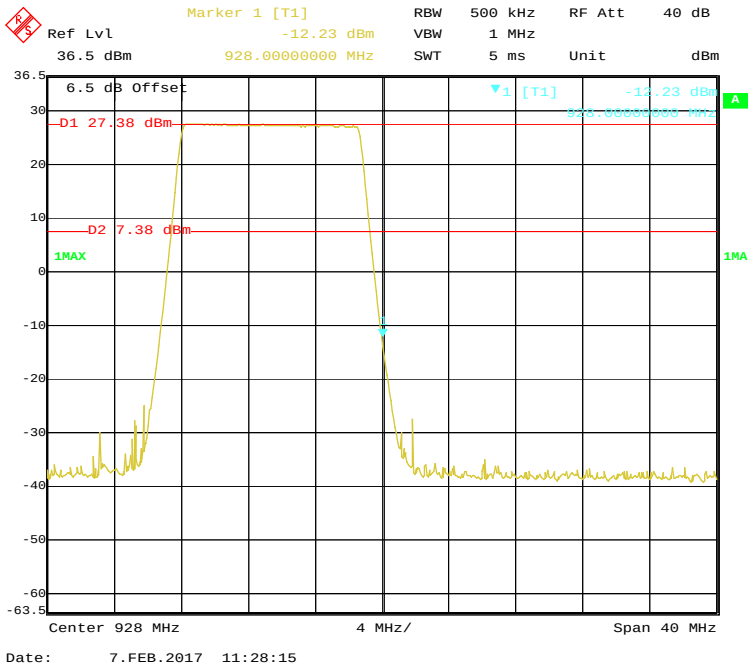
Band Edge-Right Side



Band Edge-Left Side (Hopping)



Band Edge-Right Side (Hopping)



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