TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.247
TEST REPORT

For

Zhejiang Lierda Internet of Things technology Co., Ltd

Lierda IoT park, No.1326 Wenyi Xi Road, HangZhou, China

FCC ID: 2AOFDLSD4WN2L917M90

Report Type:	**Product Type:**
Original Report	LoRaWAN System Node(US915)

Test Engineer:	Max Min
Report Number:	RSHA180302001-00A
Report Date:	2018-10-25
Reviewed By:	Oscar Ye RF Leader
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	Zhejiang Lierda Internet of Things technology Co., Ltd
Tested Model	LSD4WN-2L917M90
Series Model	LSD4WN-2L217M90, LSD4WN-2LK17M90, LSD4WN-2N917M90
Model Difference	Model name
Product Type	LoRaWAN System Node(US915)
Dimension	25.5mm(L)×22.0mm(W)×3.5mm(H)
Power Supply	DC 2.5-3.6V

**All measurement and test data in this report was gathered from production sample serial number: 20180302001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2018-03-02)*

Objective

This test report is prepared on behalf of Zhejiang Lierda Internet of Things 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, 15.209 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.

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%

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. 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

Channel list:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.3	32	908.5	63	914.7	94	921.0
2	902.5	33	908.7	64	914.9	95	921.2
3	902.7	34	908.9	65	915.2	96	921.4
4	902.9	35	909.1	66	915.4	97	921.6
5	903.1	36	909.3	67	915.6	98	921.8
6	903.3	37	909.5	68	915.8	99	922.0
7	903.5	38	909.7	69	916.0	100	922.2
8	903.7	39	909.9	70	916.2	101	922.4
9	903.9	40	910.1	71	916.4	102	922.6
10	904.1	41	910.3	72	916.6	103	922.8
11	904.3	42	910.5	73	916.8	104	923.0
12	904.5	43	910.7	74	917.0	105	923.2
13	904.7	44	910.9	75	917.2	106	923.4
14	904.9	45	911.1	76	917.4	107	923.6
15	905.1	46	911.3	77	917.6	108	923.8
16	905.3	47	911.5	78	917.8	109	924.0
17	905.5	48	911.7	79	918.0	110	924.2
18	905.7	49	911.9	80	918.2	111	924.4
19	905.9	50	912.1	81	918.4	112	924.6
20	906.1	51	912.3	82	918.6	113	924.8
21	906.3	52	912.5	83	918.8	114	925.0
22	906.5	53	912.7	84	919.0	115	925.2
23	906.7	54	912.9	85	919.2	116	925.4
24	906.9	55	913.1	86	919.4	117	925.6
25	907.1	56	913.3	87	919.6	118	925.8
26	907.3	57	913.5	88	919.8	119	926.0
27	907.5	58	913.7	89	920.0	120	926.2
28	907.7	59	913.9	90	920.2	121	926.4
29	907.9	60	914.1	91	920.4	122	926.6
30	908.1	61	914.3	92	920.6	123	926.8
31	908.3	62	914.5	93	920.8	/	/

EUT was tested with Channel 1, 62 and 123.

EUT Exercise Software

RF Test tool: ComMonitor
Power level: 13

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

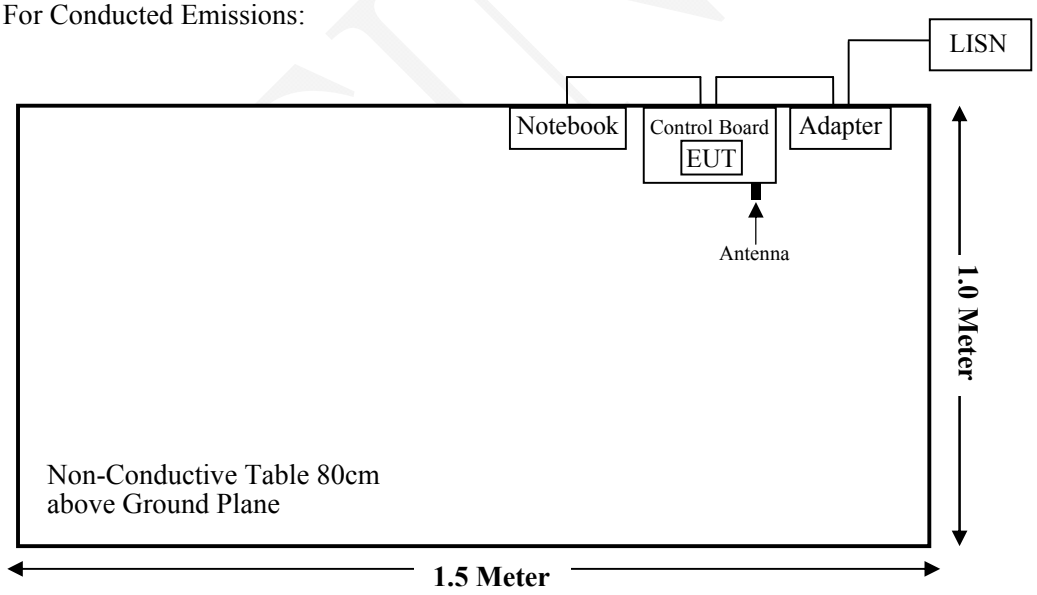
Manufacturer	Description	Model	Serial Number
Lierda	Control Board	LSD4WN-2NTESTOA_V02	/
Lierda	Antenna	/	/
DELL	Notebook	GX620	D65874152
DELL	Adapter	LA65NS0-00	DF263

External I/O Cable

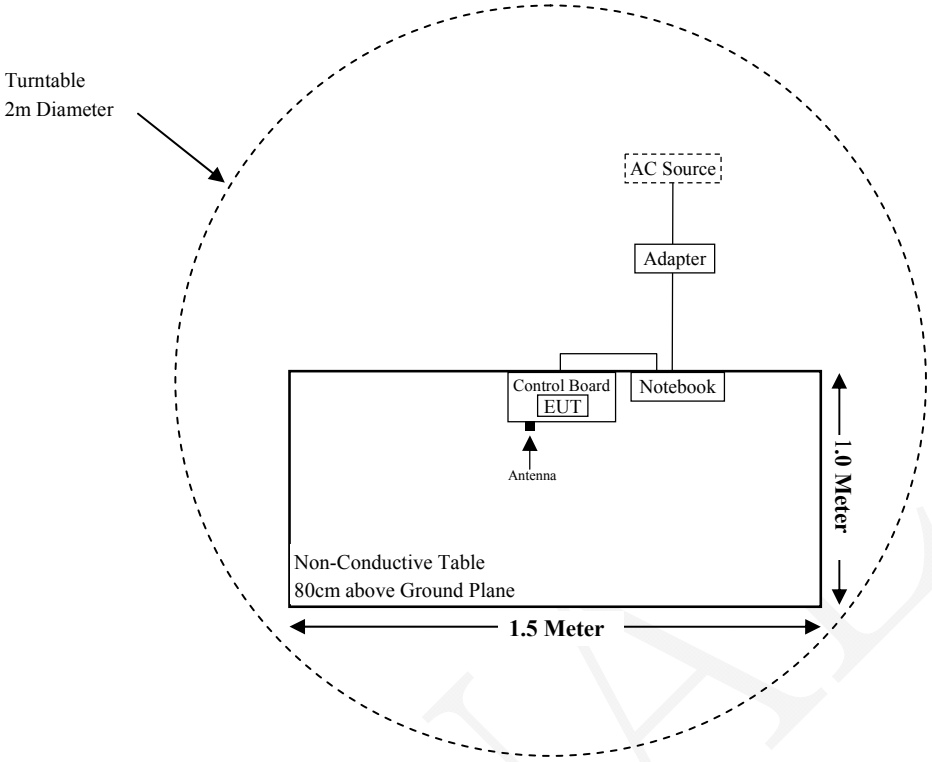
Cable Description	Length (m)	From Port	To
USB Cable	1.0	Notebook	Control Board

Block Diagram of Test Setup

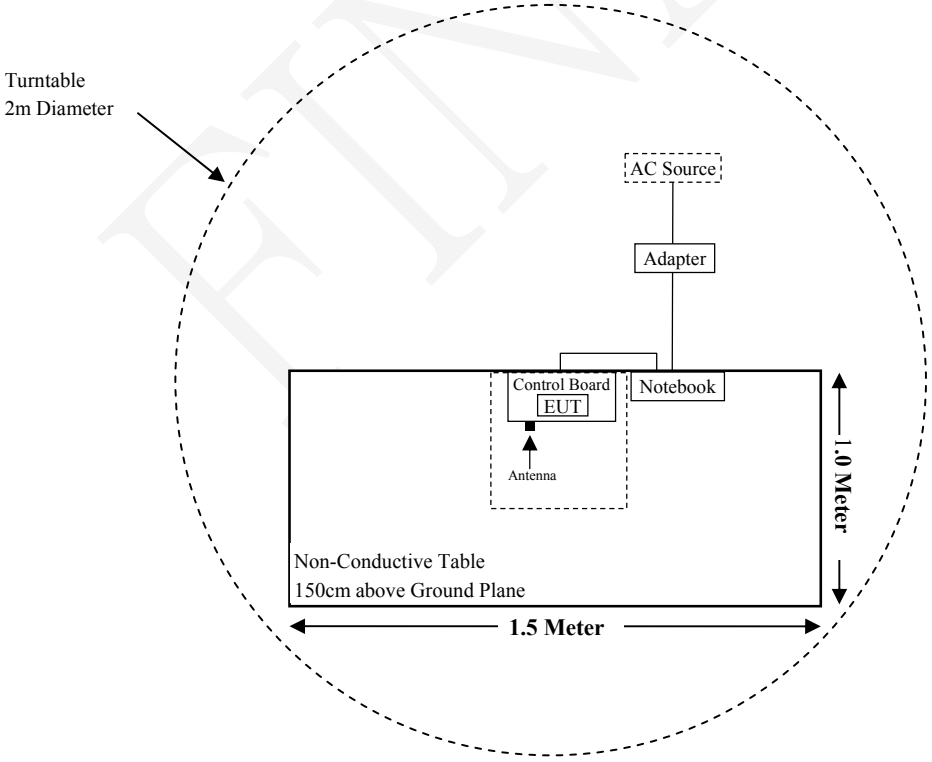
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§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（Chamber 1#）					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sonoma Instrument	Pre-amplifier	310N	171205	2018-08-15	2019-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	N/A	N/A
MICRO-COAX	Coaxial Cable	Cable-8	008	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2018-08-15	2019-08-14
Radiated Emission Test（Chamber 2#）					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2018-08-27	2019-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
A.H.Systems, inc	Amplifier	2641-1	466	2018-09-11	2019-09-10
MICRO-TRONICS	Band Reject Filter	BRC50722	G013	2018-08-05	2019-08-04
Narda	Attenuator	10dB	010	2018-08-15	2019-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	N/A	N/A
MICRO-COAX	Coaxial Cable	Cable-6	006	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2018-08-15	2019-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2018-08-15	2019-08-14
RF Conducted Test					
Rohde & Schwarz	Signal Analyzer	FSV40	101116	2018-07-23	2019-07-22
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
Zhejiang Lierda	RF Cable	LierdaC01	C01	Each Time	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2017-11-12	2018-11-11
Rohde & Schwarz	LISN	ENV216	3560655016	2017-11-15	2018-11-14
BACL	Auto test Software	BACL-EMC	CE001	N/A	N/A
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2018-08-15	2019-08-14

*** 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 §2.1091 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:

Mode	Frequency Range (MHz)	Antenna Gain		Target Output Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
LoRa	902.3-926.8	2.50	1.78	18.50	70.79	20	0.0251	1.0

Note: The target output power was declared by the manufacturer.

Conclusion: The EUT meets exemption 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 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 been tested with a dipole antenna and the antenna gain is 2.5dBi, which uses a unique coupling to the intentional radiator, fulfill the requirement of this section. Please refer to the EUT photos.

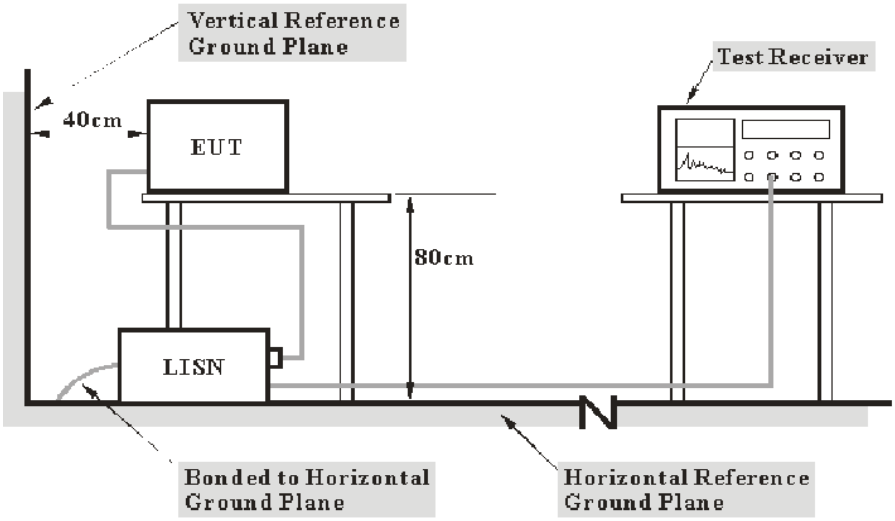
Result: Compliance.

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.

The spacing between the peripherals was 10 cm.

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

ANSI C63.10-2013 clause 6.2

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:

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

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 (dB) = Limit (dBμV) – Corrected Amplitude (dBμV)

Test Results Summary

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

Test Data

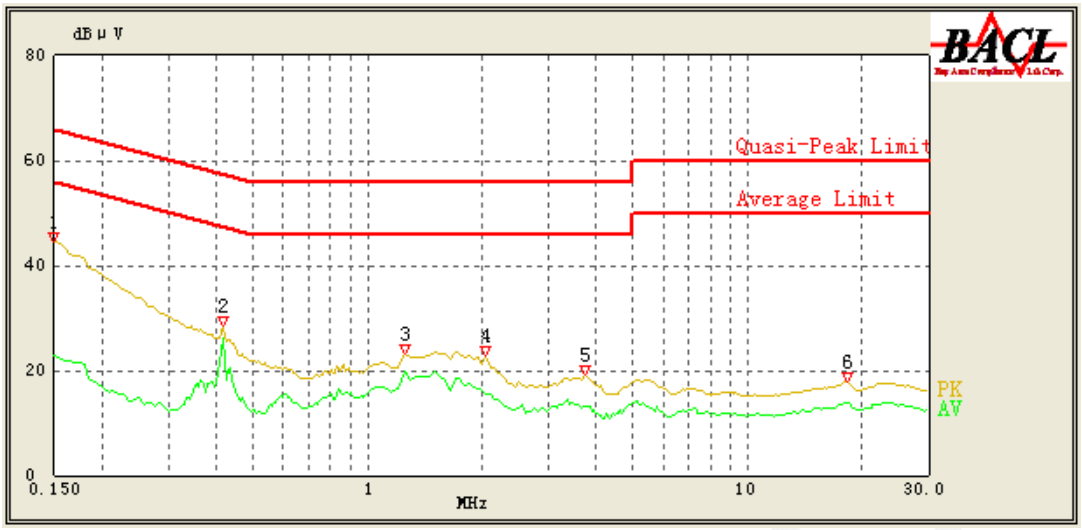
Environmental Conditions

Temperature:	20.2 ℃
Relative Humidity:	51 %
ATM Pressure:	101.3 kPa

The testing was performed by Max Min on 2018-10-22.

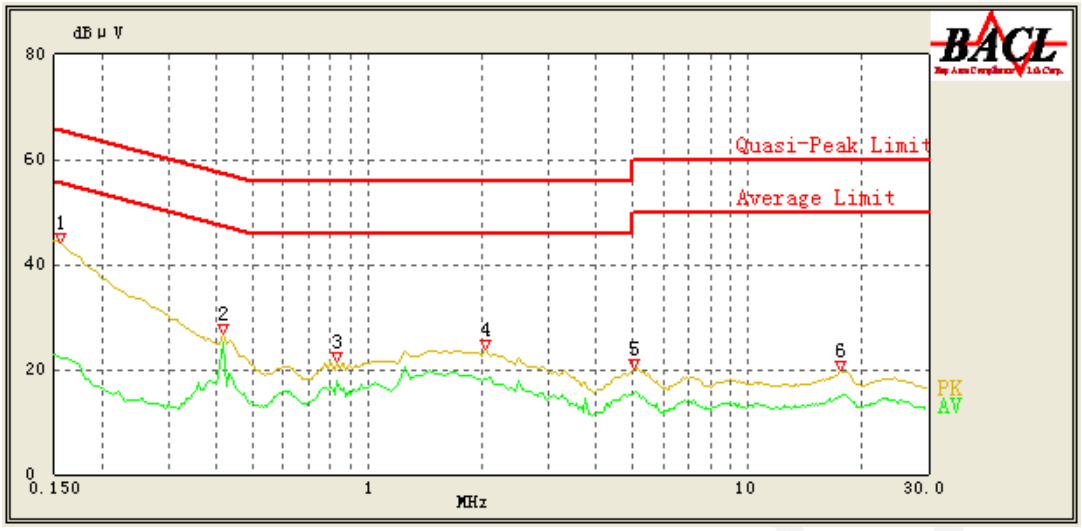
EUT operation mode: Transmitting in low channel (worst case)

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBµV)	Margin (dB)	Comment
0.150	44.58	QP	9.000	L1	16.06	66.00	21.42	Compliance
0.150	22.76	AV	9.000	L1	16.06	56.00	33.24	Compliance
0.415	28.60	QP	9.000	L1	16.06	57.55	28.95	Compliance
0.415	26.09	AV	9.000	L1	16.06	47.55	21.46	Compliance
1.250	23.26	QP	9.000	L1	15.87	56.00	32.74	Compliance
1.250	19.98	AV	9.000	L1	15.87	46.00	26.02	Compliance
2.050	22.78	QP	9.000	L1	15.85	56.00	33.22	Compliance
2.050	15.55	AV	9.000	L1	15.85	46.00	30.45	Compliance
3.750	19.32	QP	9.000	L1	15.85	56.00	36.68	Compliance
3.750	13.23	AV	9.000	L1	15.85	46.00	32.77	Compliance
18.400	17.83	QP	9.000	L1	16.37	60.00	42.17	Compliance
18.400	13.90	AV	9.000	L1	16.37	50.00	36.10	Compliance

AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBµV)	Margin (dB)	Comment
0.155	44.03	QP	9.000	N	16.06	65.86	21.83	Compliance
0.155	22.17	AV	9.000	N	16.06	55.86	33.69	Compliance
0.415	26.94	QP	9.000	N	16.09	57.55	30.61	Compliance
0.415	25.05	AV	9.000	N	16.09	47.55	22.50	Compliance
0.830	21.52	QP	9.000	N	15.97	56.00	34.48	Compliance
0.830	17.82	AV	9.000	N	15.97	46.00	28.18	Compliance
2.050	23.82	QP	9.000	N	15.91	56.00	32.18	Compliance
2.050	18.24	AV	9.000	N	15.91	46.00	27.76	Compliance
5.050	20.31	QP	9.000	N	15.87	60.00	39.69	Compliance
5.000	15.30	AV	9.000	N	15.87	46.00	30.70	Compliance
17.650	19.68	QP	9.000	N	16.09	60.00	40.32	Compliance
17.650	14.71	AV	9.000	N	16.09	50.00	35.29	Compliance

Note:
1) Corrected Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)
2) Margin (dB) = Limit (dBµV) – Corrected Amplitude (dBµV)

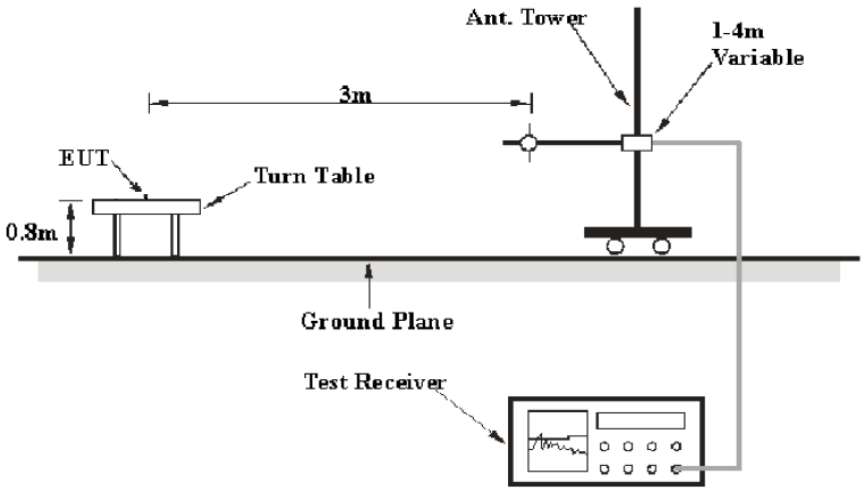
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

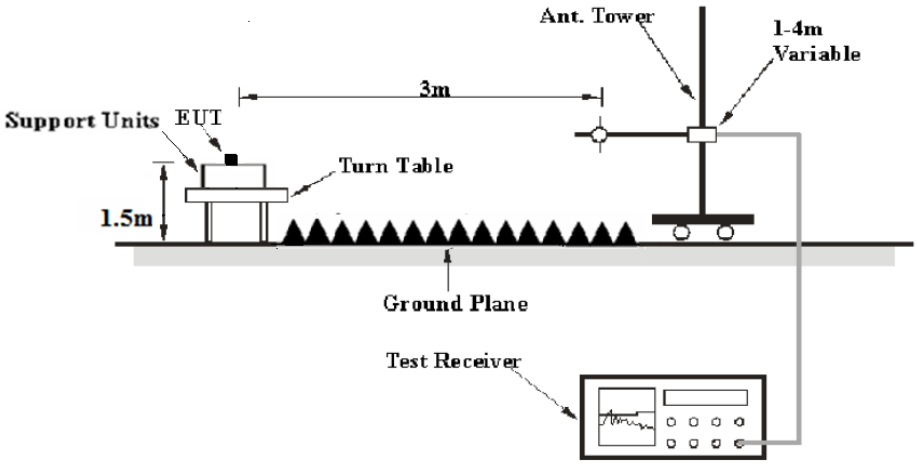
FCC §15.205; §15.209; §15.247(d)

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 & Spectrum Analyzer 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.

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:	24.2 ℃
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

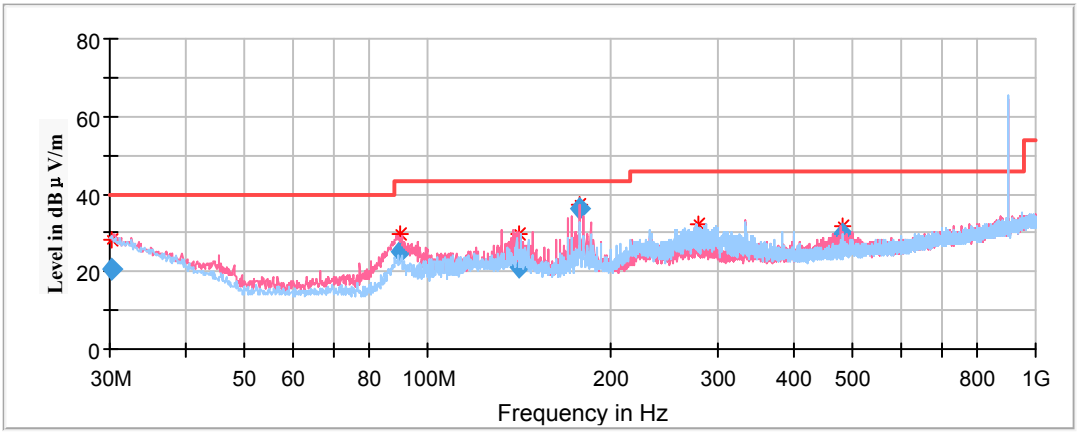
The testing was performed by Max Min on 2018-10-18.

EUT operation mode: Transmitting

Spurious Emission Test:

30MHz-1GHz:

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



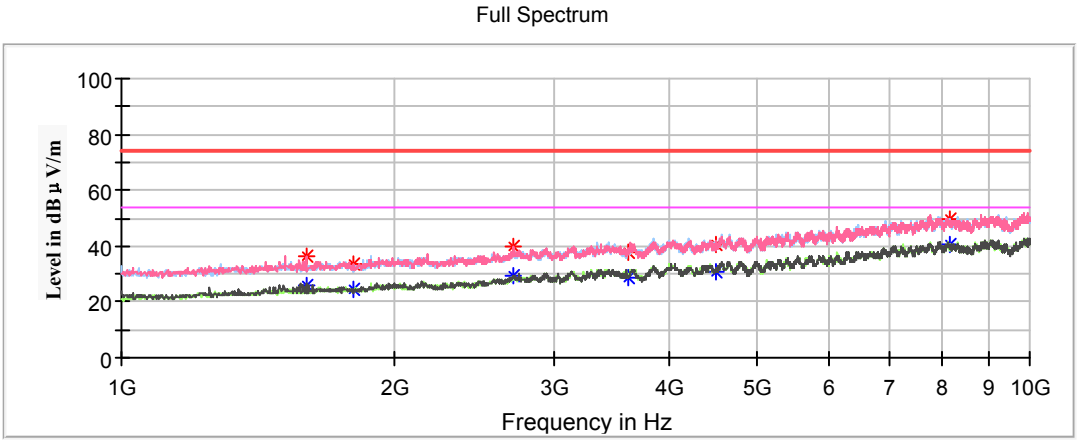
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	QuasiPeak (dBµV/m)	Height (cm)	Polar (H/V)				
30.265513	20.57	101.0	V	341.0	-4.1	40.00	19.43
89.925600	25.29	199.0	V	113.0	-17.5	43.50	18.21
140.980700	21.30	101.0	V	290.0	-12.0	43.50	22.20
177.823300	36.37	101.0	V	238.0	-13.5	43.50	7.13
278.678400	28.83	101.0	H	170.0	-11.2	46.00	17.17
479.904600	29.78	101.0	V	316.0	-6.7	46.00	16.22

1GHz-10GHz:

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

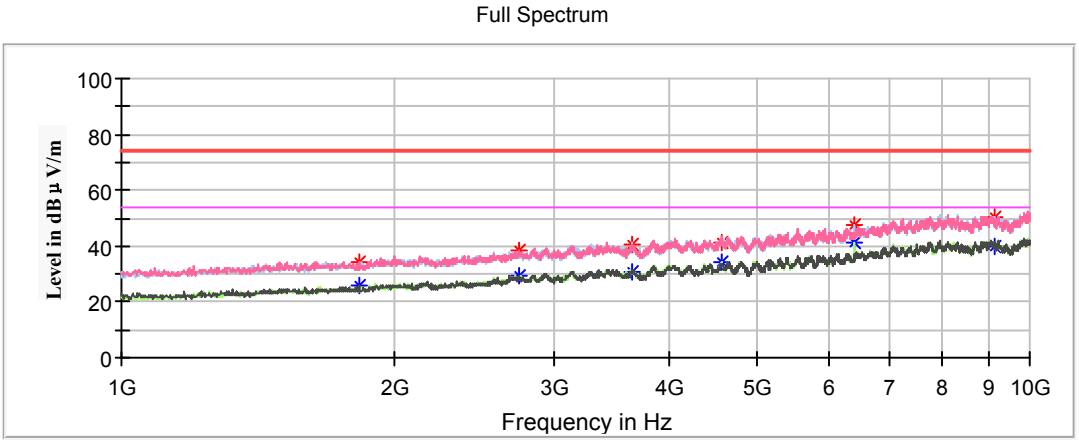
Note:
1. This test was performed with the 2.4 - 2.5GHz notch filter.
2. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) - Amplifier Factor (dB)
   Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
   Margin (dB) = Limit (dBμV/m) - Corrected Amplitude (dBμV /m)

Low Channel: 902.3MHz



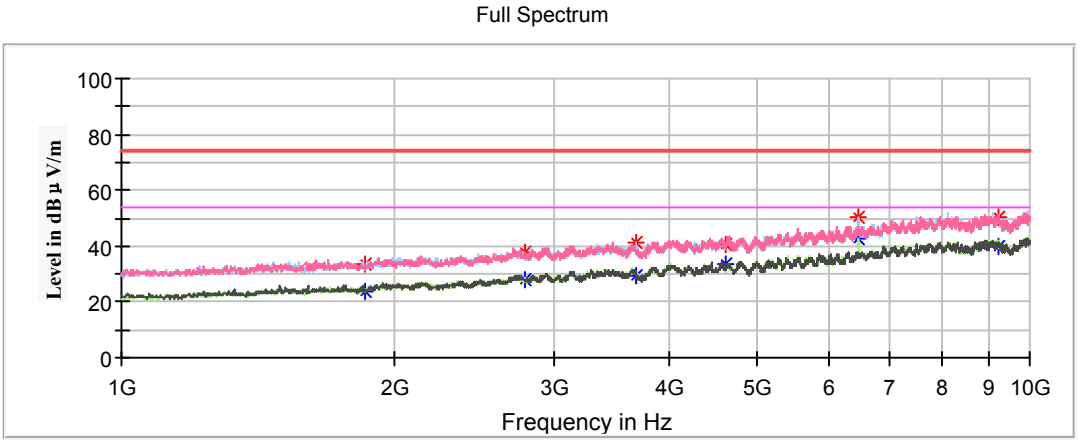
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1595.800000	36.43	---	100.0	V	109.0	-7.2	74.00	37.57
1595.800000	---	26.14	100.0	V	109.0	-7.2	54.00	27.86
1804.600000	33.41	---	100.0	H	323.0	-6.5	74.00	40.59
1804.600000	---	24.44	100.0	H	323.0	-6.5	54.00	29.56
2706.900000	39.75	---	250.0	V	4.0	-3.2	74.00	34.25
2706.900000	---	29.03	250.0	V	4.0	-3.2	54.00	24.97
3609.200000	---	28.84	150.0	H	347.0	-0.4	54.00	25.16
3609.200000	37.86	---	150.0	H	347.0	-0.4	74.00	36.14
4511.500000	---	31.08	200.0	H	252.0	1.5	54.00	22.92
4511.500000	40.71	---	200.0	H	252.0	1.5	74.00	33.29
8158.600000	---	40.46	100.0	H	19.0	10.6	54.00	13.54
8158.600000	49.47	---	100.0	H	19.0	10.6	74.00	24.53

Middle Channel: 914.5MHz



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)				
1829.000000	---	25.54	200.0	V	54.0	-6.4	54.00	28.46
1829.000000	34.08	---	200.0	V	54.0	-6.4	74.00	39.92
2743.500000	---	29.11	100.0	V	5.0	-3.0	54.00	24.89
2743.500000	38.66	---	100.0	V	5.0	-3.0	74.00	35.34
3658.000000	---	30.64	100.0	H	130.0	-0.3	54.00	23.36
3658.000000	40.45	---	100.0	H	130.0	-0.3	74.00	33.55
4572.500000	41.48	---	250.0	V	332.0	1.5	74.00	32.52
4572.500000	---	34.04	250.0	H	332.0	1.5	54.00	19.96
6401.800000	---	41.51	100.0	H	270.0	6.3	54.00	12.49
6401.800000	47.73	---	100.0	H	270.0	6.3	74.00	26.27
9145.000000	---	40.03	250.0	H	79.0	11.6	54.00	13.97
9145.000000	50.42	---	250.0	H	79.0	11.6	74.00	23.58

High Channel: 926.8MHz



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)				
1853.600000	---	24.07	250.0	H	29.0	-6.3	54.00	29.93
1853.600000	33.81	---	250.0	H	29.0	-6.3	74.00	40.19
2780.400000	---	28.29	100.0	V	11.0	-2.8	54.00	25.71
2780.400000	37.74	---	100.0	V	11.0	-2.8	74.00	36.26
3707.200000	---	29.14	200.0	H	92.0	-0.2	54.00	24.86
3707.200000	40.92	---	200.0	H	92.0	-0.2	74.00	33.08
4634.000000	---	33.54	250.0	V	278.0	1.6	54.00	20.46
4634.000000	40.63	---	250.0	V	278.0	1.6	74.00	33.37
6488.200000	---	42.96	150.0	H	290.0	6.6	54.00	11.04
6488.200000	50.61	---	150.0	H	290.0	6.6	74.00	23.39
9258.400000	---	39.99	200.0	V	313.0	11.5	54.00	14.01
9258.400000	50.09	---	200.0	V	313.0	11.5	74.00	23.91

Fundamental Test & Restricted Bands Emissions:

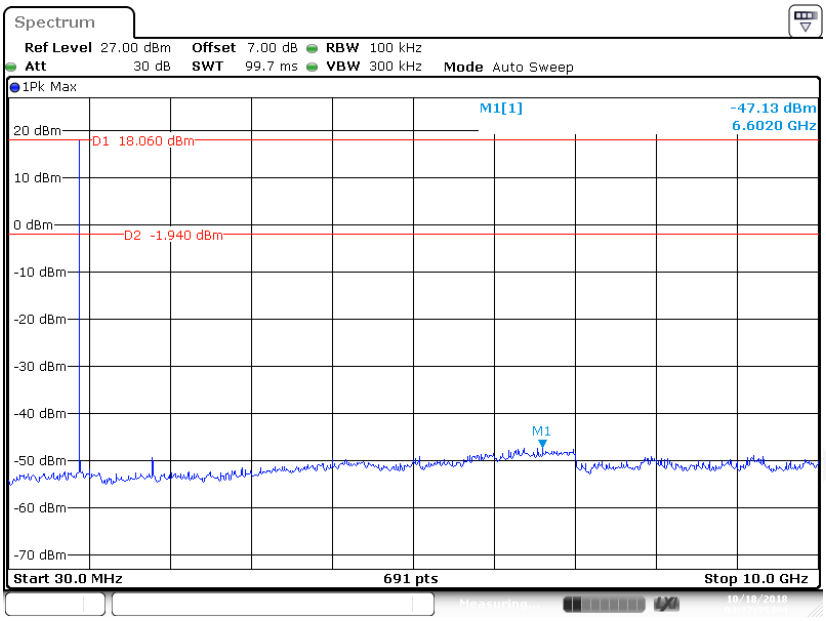
*Pre-Scan in the X,Y and Z axes of orientation, the worst case **in X-axis of orientation** was recorded*

Note:
1. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) - Amplifier Factor (dB)
   Corrected Amplitude (dBμV/m) = Corrected Factor (dB/m) + Reading (dBμV)
   Margin (dB) = Limit (dBμV/m) - Corrected Amplitude (dBμV /m)

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	QuasiPeak (dBμV /m)	Height (cm)	Polar (H/V)				
Low Channel: 902.3MHz								
902.300000	118.54	---	200.0	H	192.0	0.2	/	/
902.300000	115.29	---	200.0	V	192.0	0.2	/	/
902.000000	---	37.60	250.0	H	161.0	0.2	46.00	8.40
902.000000	---	34.87	250.0	V	161.0	0.2	46.00	11.13
Middle Channel: 914.5MHz								
914.500000	117.96	---	250.0	H	113.0	0.5	/	/
914.500000	115.03	---	250.0	V	113.0	0.5	/	/
High Channel: 926.8MHz								
926.800000	116.99	---	200.0	H	266.0	0.7	/	/
926.800000	113.82	---	200.0	V	266.0	0.7	/	/
928.000000	---	35.88	200.0	H	202.0	0.8	46.00	10.12
928.000000	---	33.04	200.0	V	202.0	0.8	46.00	12.96

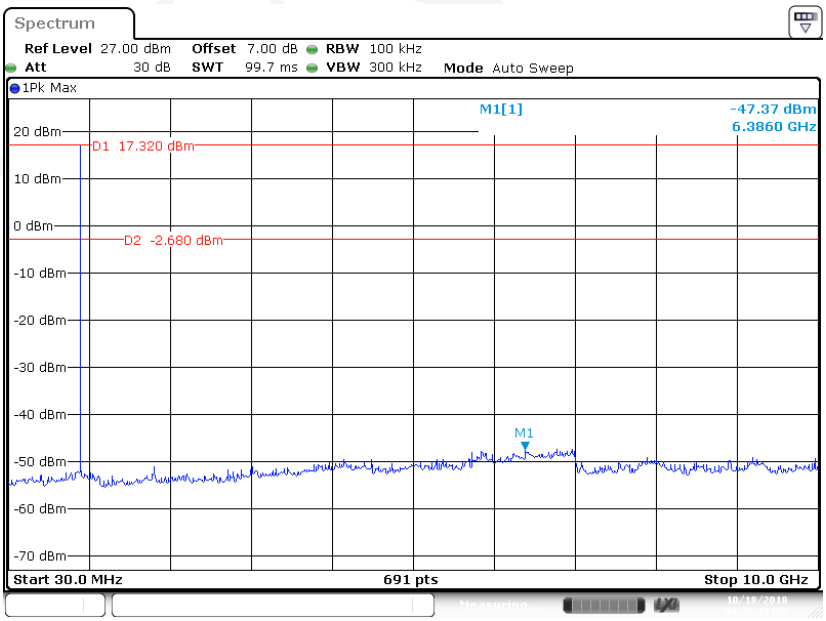
Conducted Spurious Emissions at Antenna Port:

Low Channel



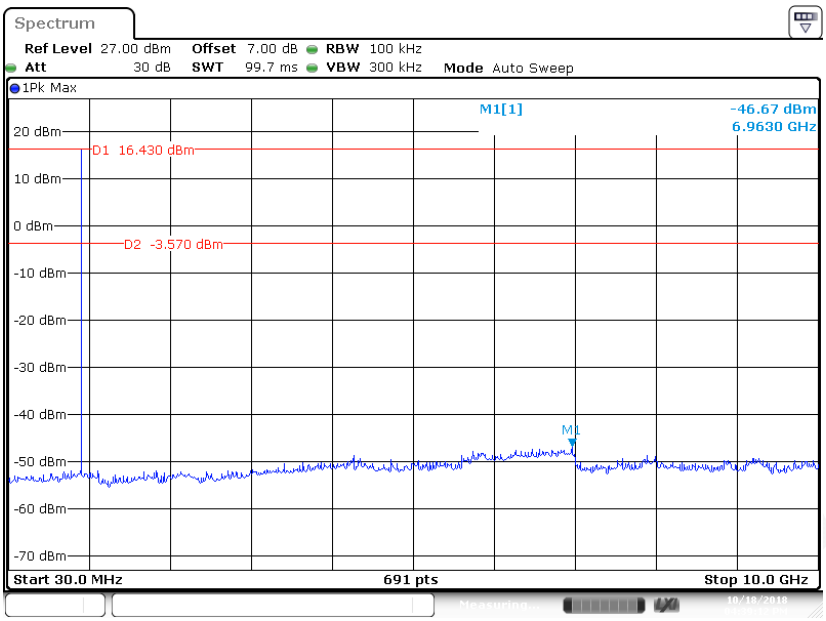
Date:18.OCT.2018 16:37:35

Middle Channel



Date:18.OCT.2018 16:38:13

High Channel



Date: 18.OCT.2018 16:39:12

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

Applicable Standard

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:	24.2 ℃
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2018-10-18.

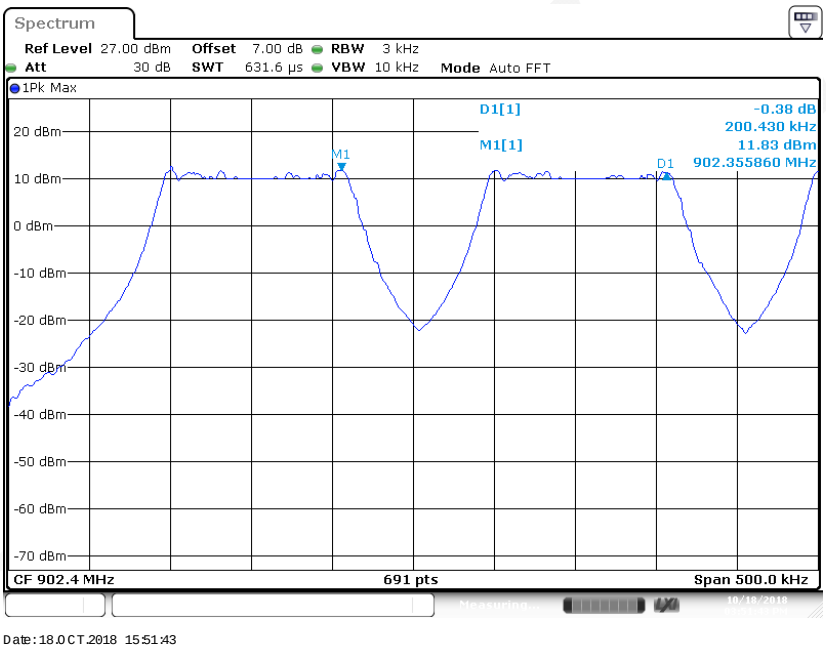
EUT operation mode: Hopping

Test Result: Compliance.

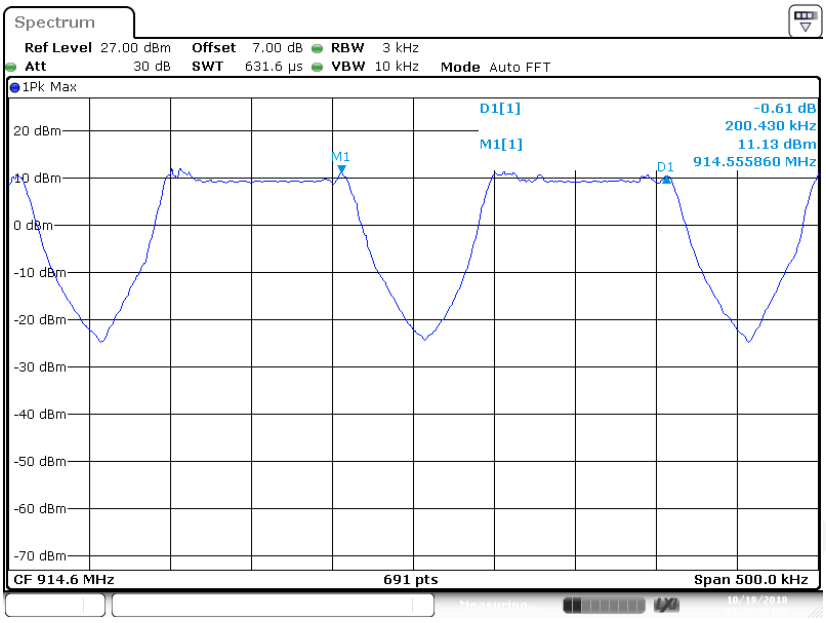
Modulation	Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)	Result
LoRa	Low	902.3	0.200	≥0.137	Pass
	Adjacent	902.5			
	Middle	914.5	0.200	≥0.138	Pass
	Adjacent	914.7			
	Adjacent	926.6	0.200	≥0.138	Pass
	High	926.8			

The limit = 20dB Bandwidth

Low Channel

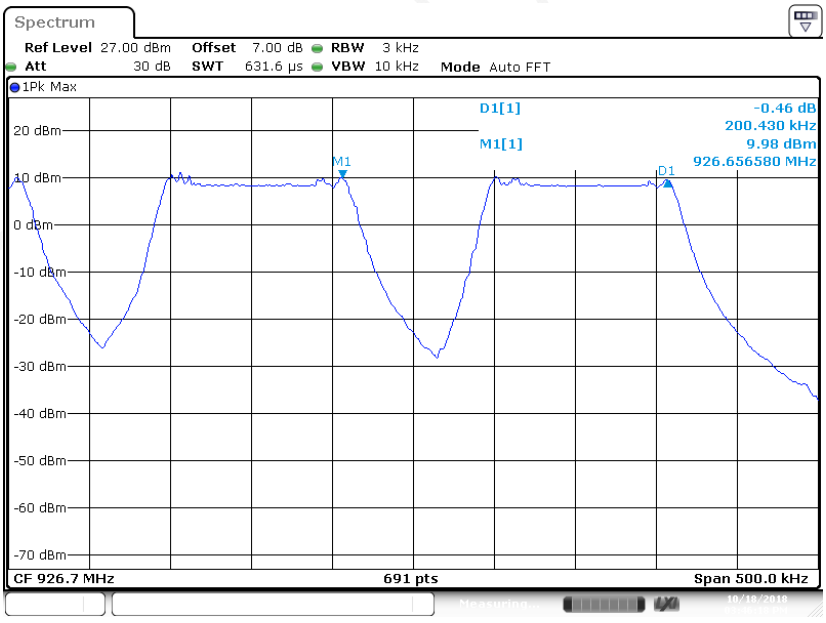


Middle Channel



Date:18.OCT.2018 15:28:55

High Channel



Date:18.OCT.2018 15:46:19

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

Applicable Standard

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:	24.2 ℃
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

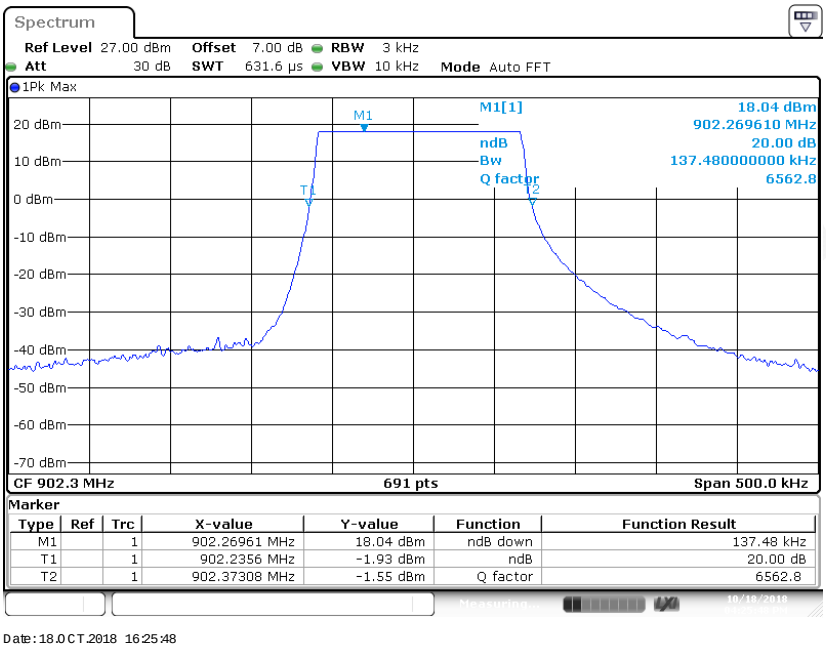
The testing was performed by Max Min on 2018-10-18.

EUT operation mode: Transmitting

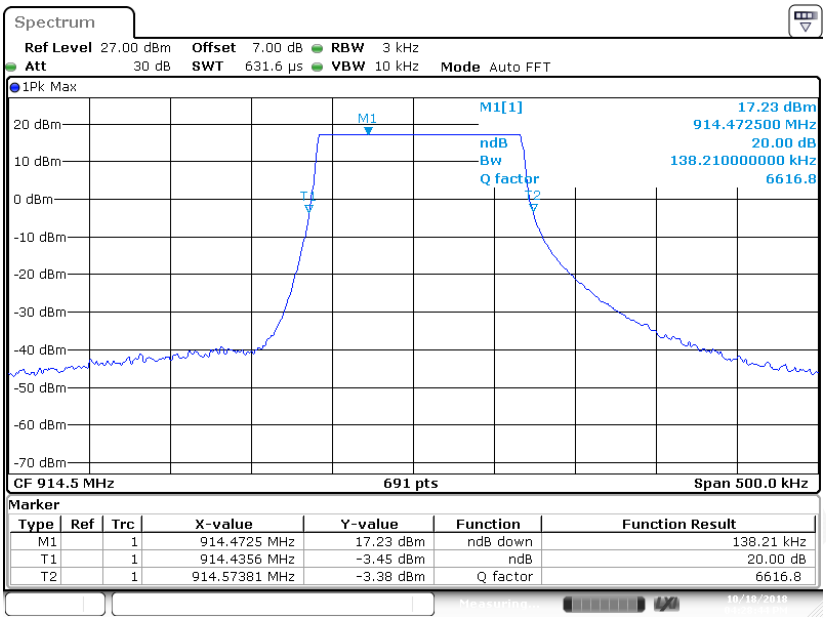
Test Result: Compliance.

Modulation	Channel	Frequency (MHz)	20 dB Emission Bandwidth (kHz)	Limit
LoRa	Low	902.3	137	<250kHz
	Middle	914.5	138	<250kHz
	High	926.8	138	<250kHz

Low Channel

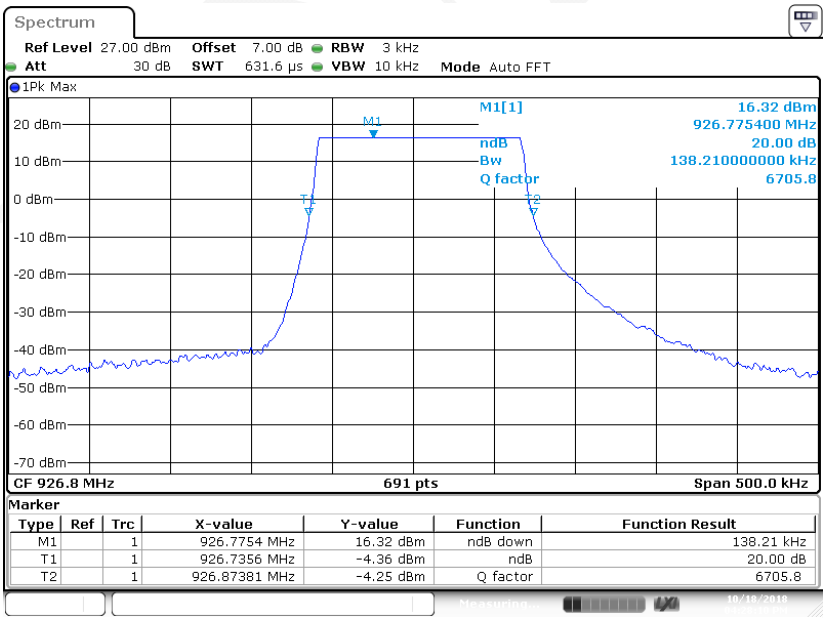


Middle Channel



Date:18.OCT.2018 16:28:43

High Channel



Date:18.OCT.2018 16:28:10

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

Applicable Standard

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:	24.2 ℃
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

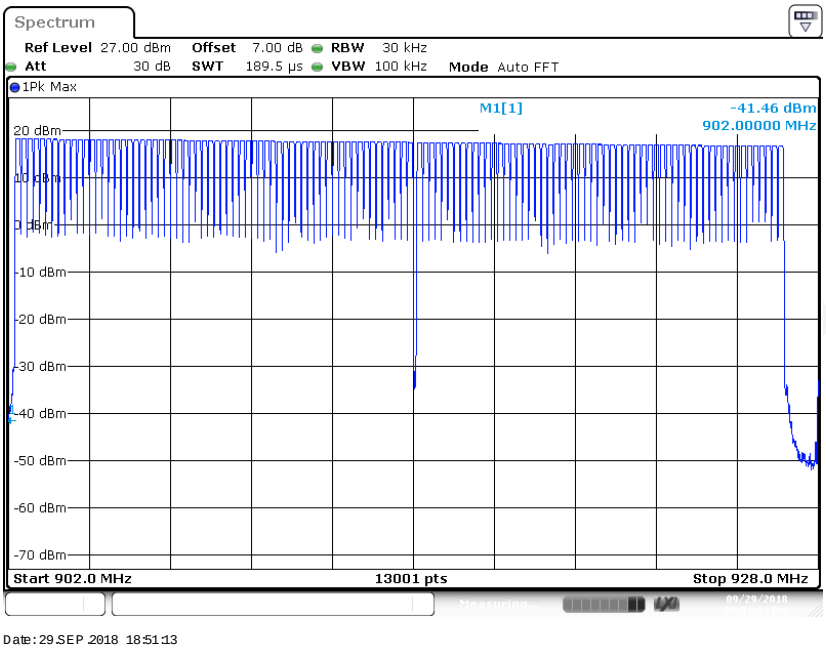
The testing was performed by Max Min on 2018-09-29.

EUT operation mode: Hopping

Test Result: Compliance.

Modulation	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
LoRa	902-928	123	⩾50

Number of Hopping Channels



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

Applicable Standard

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 ℃
Relative Humidity:	50%
ATM Pressure:	101.2 kPa

The testing was performed by Max Min on 2018-10-18.

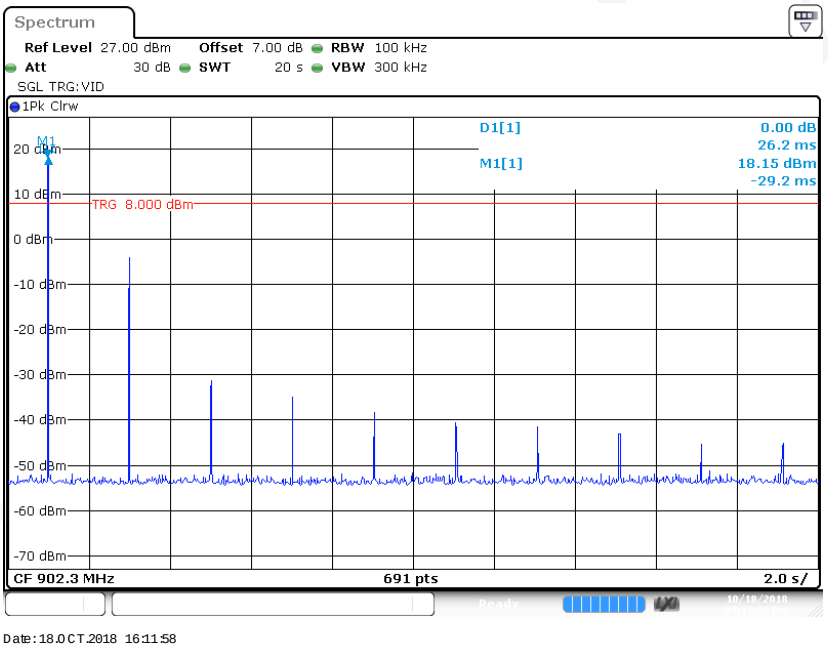
EUT operation mode: Hopping

Test Result: Compliance.

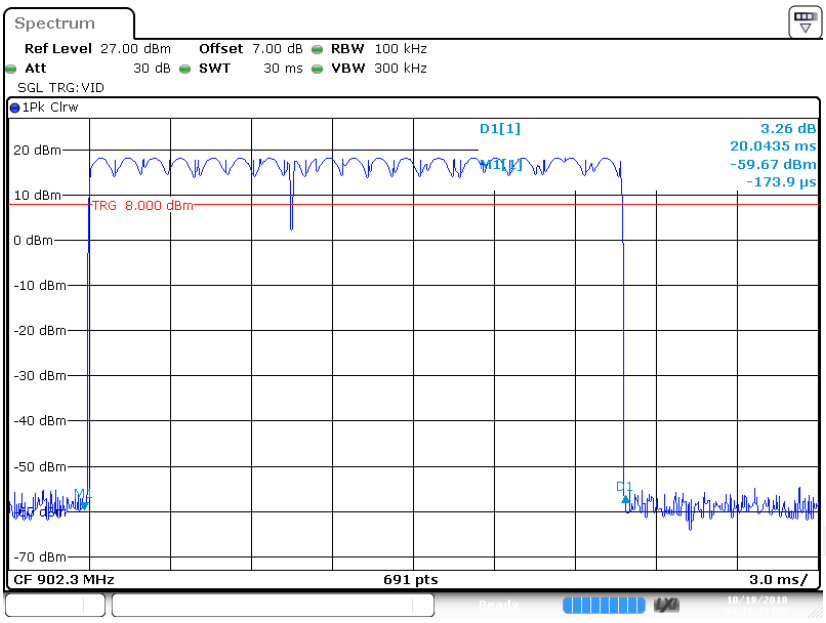
Modulation	Channel	Pulse Width (ms)	Pulse Number	Dwell Time (ms)	Limit (s)	Result
LoRa	Low	20.044	1	20.044	≤0.4	Pass
	Middle	20.044	1	20.044	≤0.4	Pass
	High	20.044	1	20.044	≤0.4	Pass
	Note:Dwell time = Pulse time*N					

Low Channel

Number of Pulses



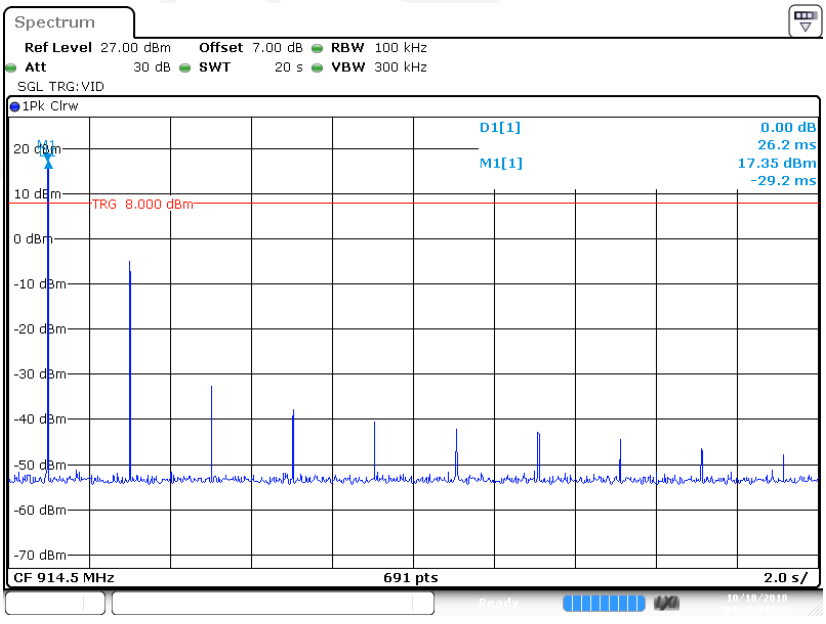
Single Pulse



Date:18.OCT.2018 16:21:39

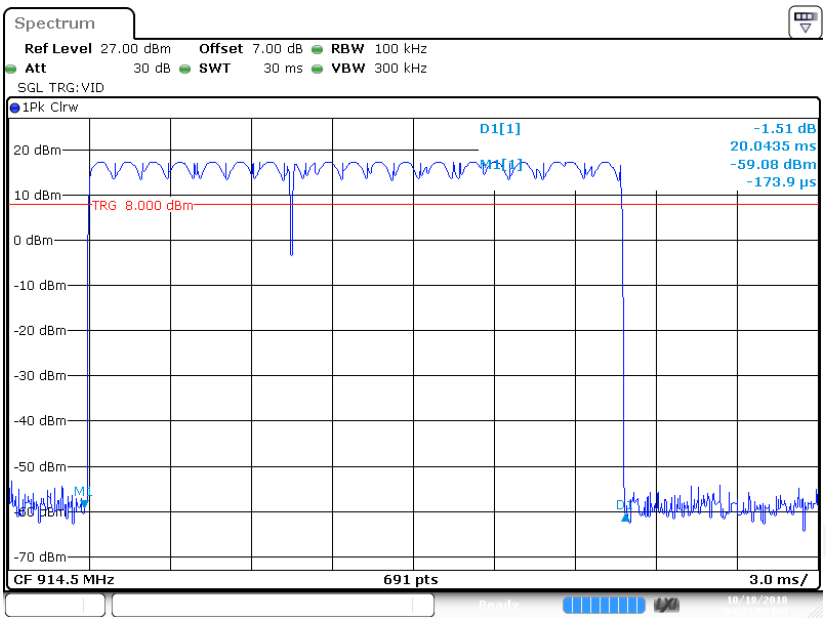
Middle Channel

Number of Pulses



Date:18.OCT.2018 16:18:45

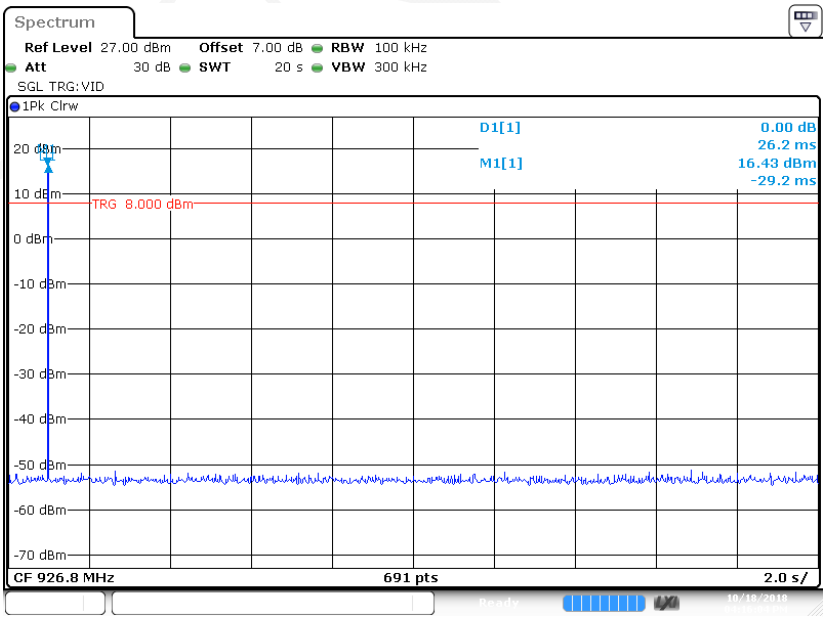
Single Pulse



Date:18.OCT.2018 16:23:57

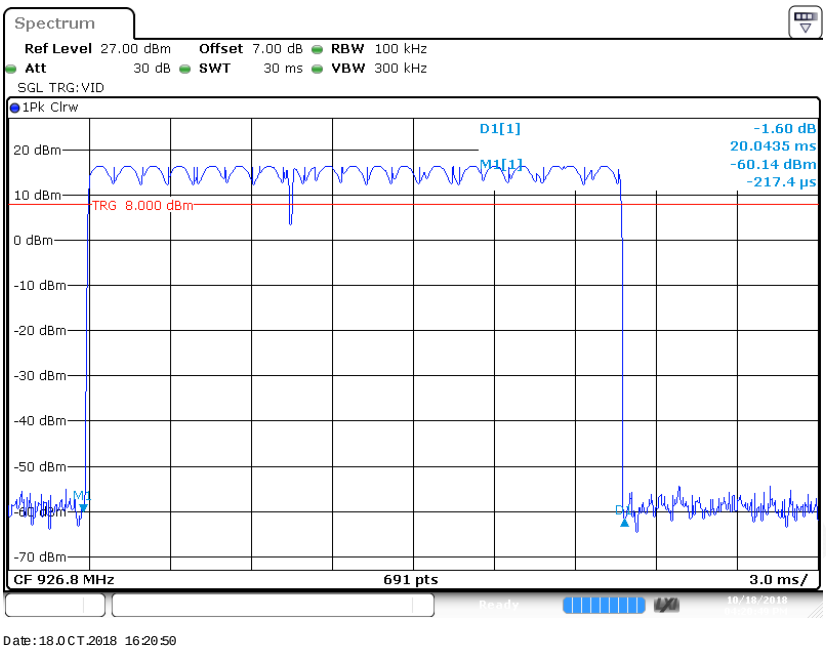
High Channel

Number of Pulses



Date:18.OCT.2018 16:16:05

Single Pulse



Date:18.OCT.2018 16:20:50

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

Applicable Standard

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:	50%
ATM Pressure:	101.2 kPa

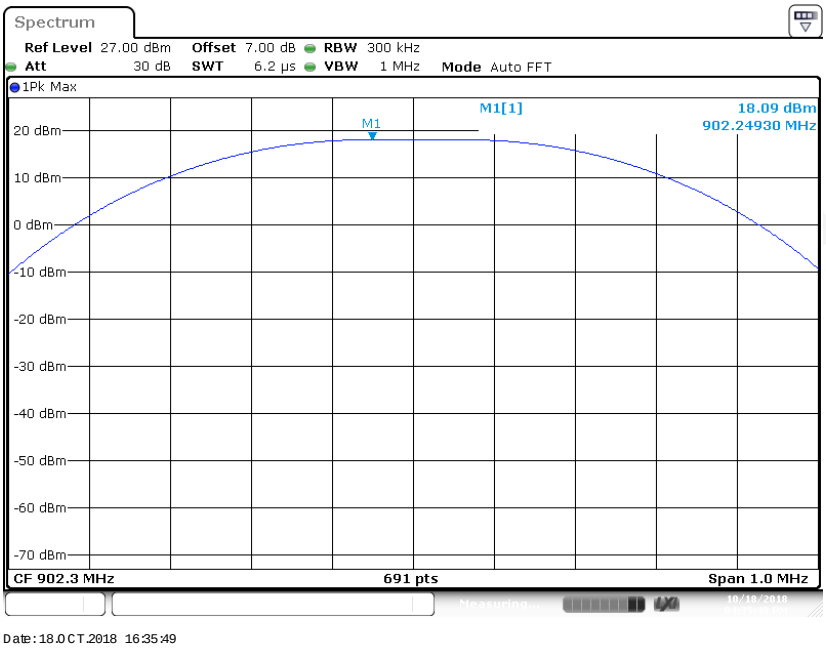
The testing was performed by Max Min on 2018-10-18.

EUT operation mode: Transmitting

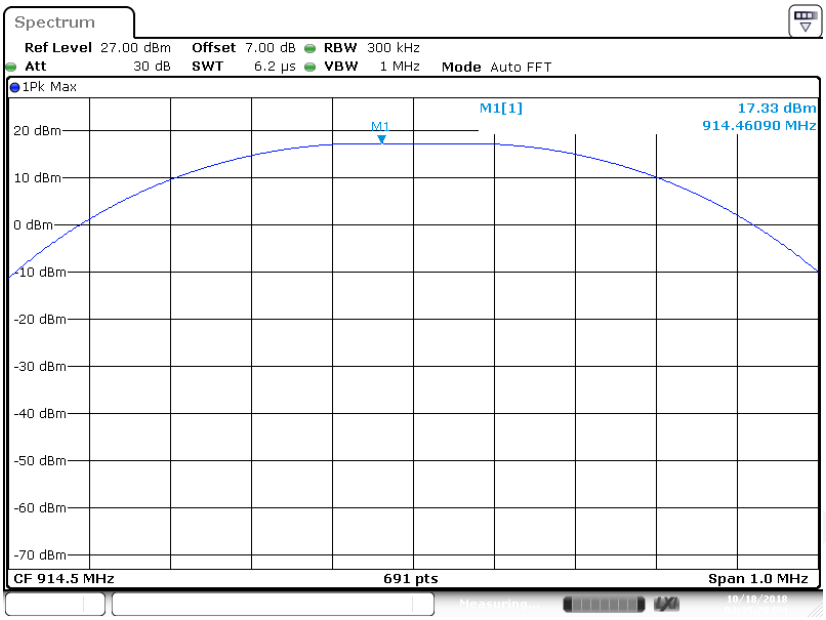
Test Result: Compliance.

Modulation	Channel	Frequency (MHz)	Output Power		Limit (mW)
			(dBm)	(mW)	
LoRa	Low	902.3	18.09	64.42	≤ 1000
	Middle	914.5	17.33	54.08	≤ 1000
	High	926.8	16.41	43.75	≤ 1000

Low Channel

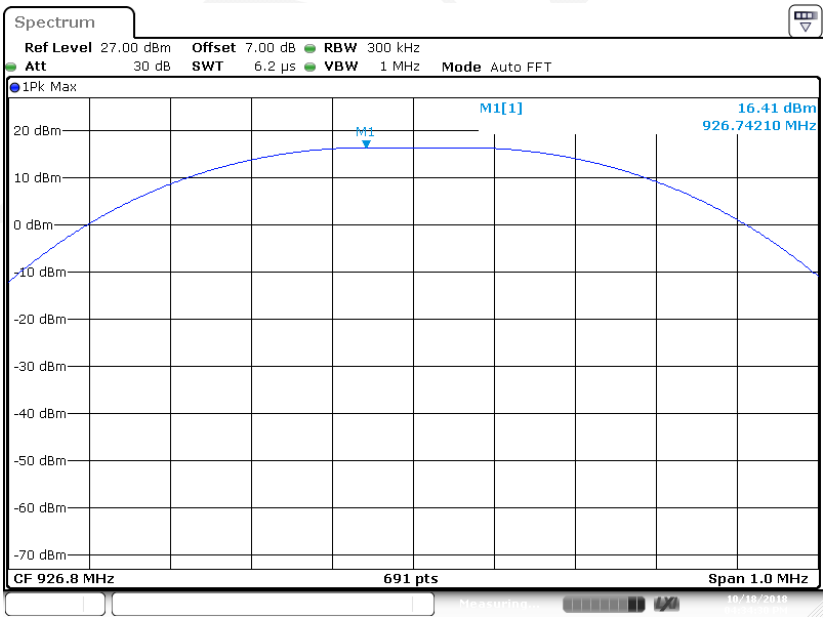


Middle Channel



Date:18.OCT.2018 16:35:20

High Channel



Date:18.OCT.2018 16:34:30

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:	50%
ATM Pressure:	101.2 kPa

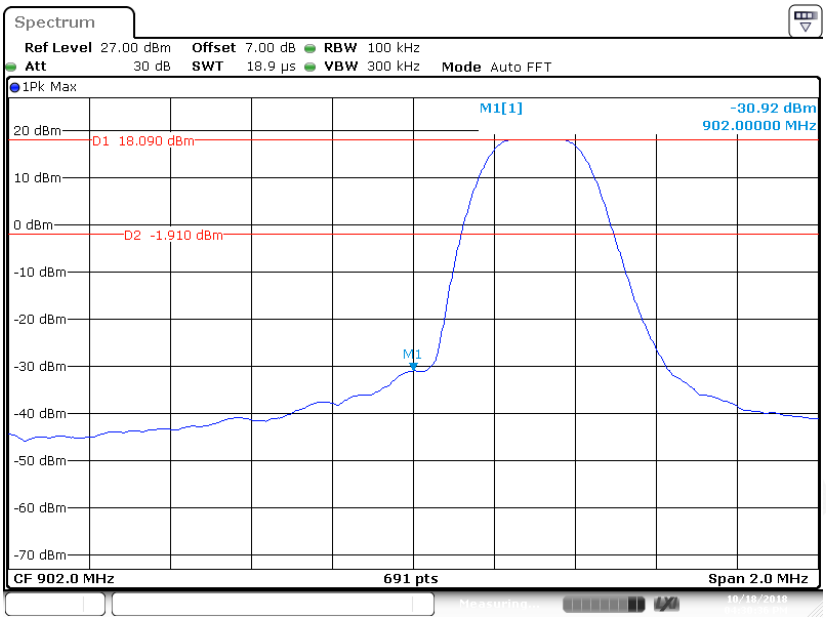
The testing was performed by Max Min on 2018-10-18.

EUT operation mode: Transmitting&Hopping

Test Result: Compliance.

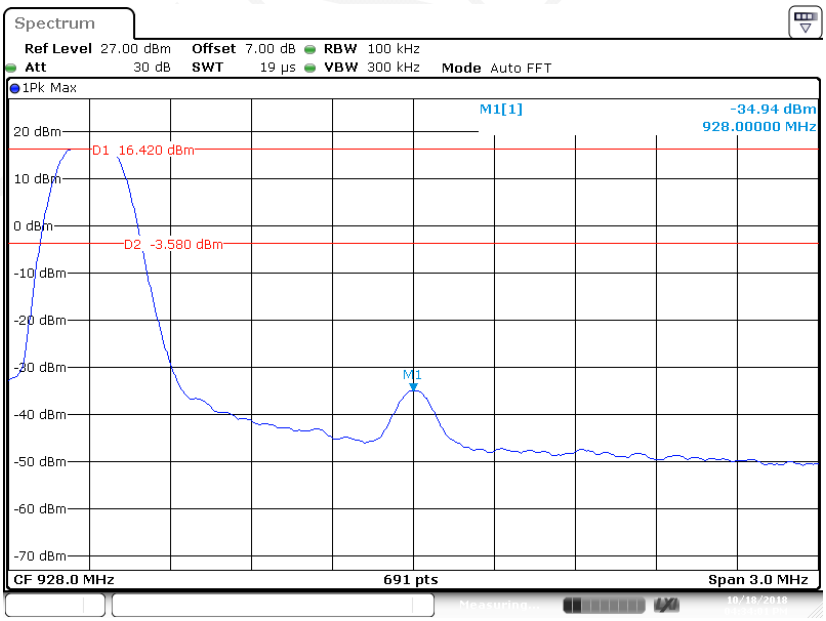
Band Edge

Left Side



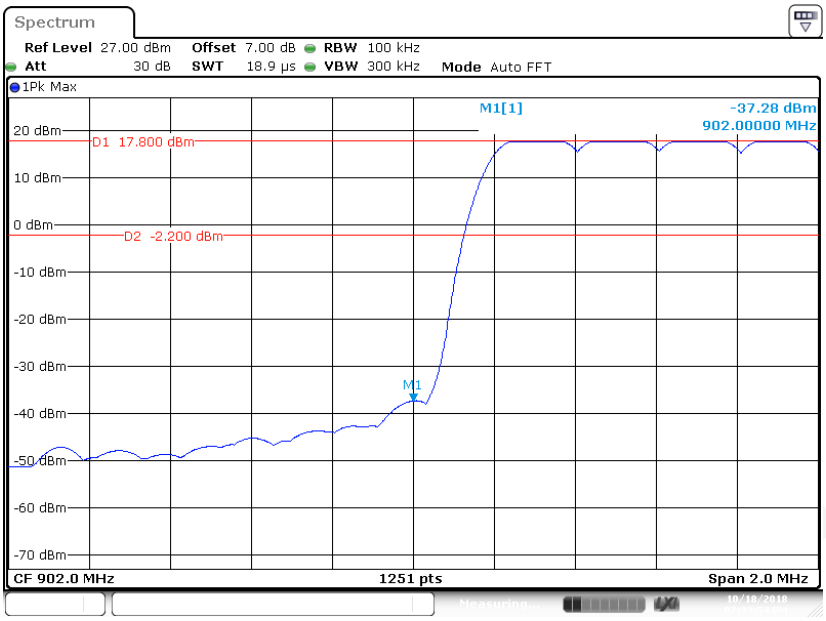
Date: 18.OCT.2018 16:30:36

Right Side



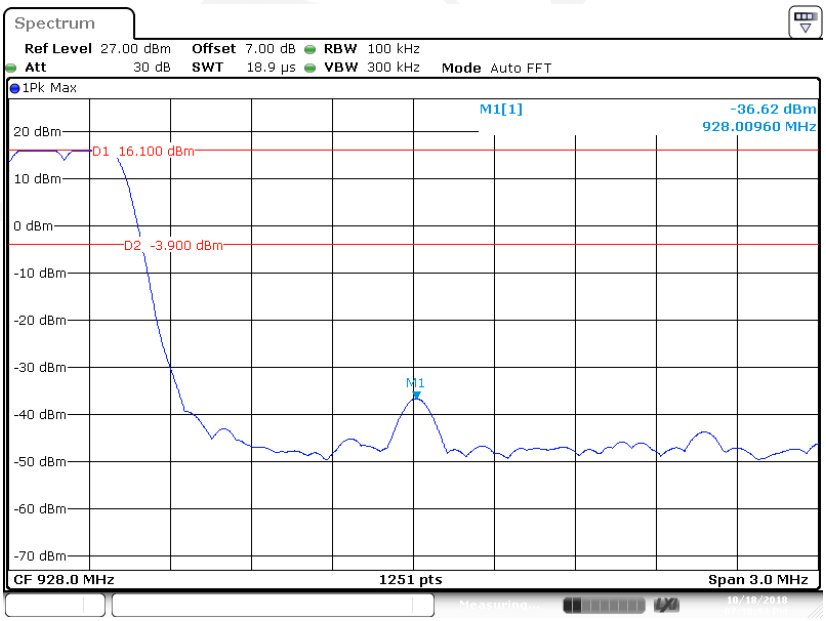
Date: 18.OCT.2018 16:34:01

Left Side-Hopping



Date:18.OCT.2018 19:33:55

Right Side-Hopping



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