TESTING LABORATORY
CERTIFICATE #4820.01

FCC PART 15.247

TEST REPORT

For

R9 Technology

17217 Waterview Parkway Suite 1.202Y, Dallas, Texas, United States, 75252

FCC ID: 2AQM2SN400

Report Type:	**Product Type:**
Original Report	Sensor Node

Report Number:	RDG181107004-00A
Report Date:	2018-12-17
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Type:		Sensor Node
EUT Model:		SN400
FCC ID:		2AQM2SN400
Rated Input Voltage:		DC 3V from battery or DC 3.3V from adapter
Adapter Information	**Model Name:**	GEO101U-033200
	Input:	100-240V 50/60Hz 0.2A
	Output:	3.3V DC
External Dimension:		62.8mm(L)*72.9mm(W)*21.1mm(H)
Serial Number:		181107004
EUT Received Date:		2018/11/17

Objective

This report is prepared on behalf of *R9 Technology* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules

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

Test Methodology

All measurements detailed in this test report were performed in accordance with ANSI C63.10-2013 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices" and KDB 558074 D01 15.247 Meas Guidance v05.

All emissions measurement was performed and Bay Area Compliance Laboratories Corp. (Dongguan).

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Unwanted Emissions, radiated	30M~200MHz: 4.55 dB,200M~1GHz: 5.92 dB,1G~6GHz: 4.98 dB, 6G~18GHz: 5.89 dB,18G~26.5G:5.47 dB,26.5G~40G:5.63 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1℃
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.12 dB (150 kHz to 30 MHz)

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier : CN0022.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in Engineering Mode, which was provided by the manufacturer.

The device was a hopping transmitter employes 129 hopping channels as below:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.2	44	910.8	87	919.4
2	902.4	45	911	88	919.6
3	902.6	46	911.2	89	919.8
4	902.8	47	911.4	90	920
5	903	48	911.6	91	920.2
6	903.2	49	911.8	92	920.4
7	903.4	50	912	93	920.6
8	903.6	51	912.2	94	920.8
9	903.8	52	912.4	95	921
10	904	53	912.6	96	921.2
11	904.2	54	912.8	97	921.4
12	904.4	55	913	98	921.6
13	904.6	56	913.2	99	921.8
14	904.8	57	913.4	100	922
15	905	58	913.6	101	922.2
16	905.2	59	913.8	102	922.4
17	905.4	60	914	103	922.6
18	905.6	61	914.2	104	922.8
19	905.8	62	914.4	105	923
20	906	63	914.6	106	923.2
21	906.2	64	914.8	107	923.4
22	906.4	65	915	108	923.6
23	906.6	66	915.2	109	923.8
24	906.8	67	915.4	110	924
25	907	68	915.6	111	924.2
26	907.2	69	915.8	112	924.4
27	907.4	70	916	113	924.6
28	907.6	71	916.2	114	924.8
29	907.8	72	916.4	115	925
30	908	73	916.6	116	925.2
31	908.2	74	916.8	117	925.4
32	908.4	75	917	118	925.6
33	908.6	76	917.2	119	925.8
34	908.8	77	917.4	120	926
35	909	78	917.6	121	926.2
36	909.2	79	917.8	122	926.4
37	909.4	80	918	123	926.6
38	909.6	81	918.2	124	926.8
39	909.8	82	918.4	125	927
40	910	83	918.6	126	927.2
41	910.2	84	918.8	127	927.4
42	910.4	85	919	128	927.6
43	910.6	86	919.2	129	927.8

Channel 1, 65, 129 were selected to test.

EUT Exercise Software

No Software was used in test.

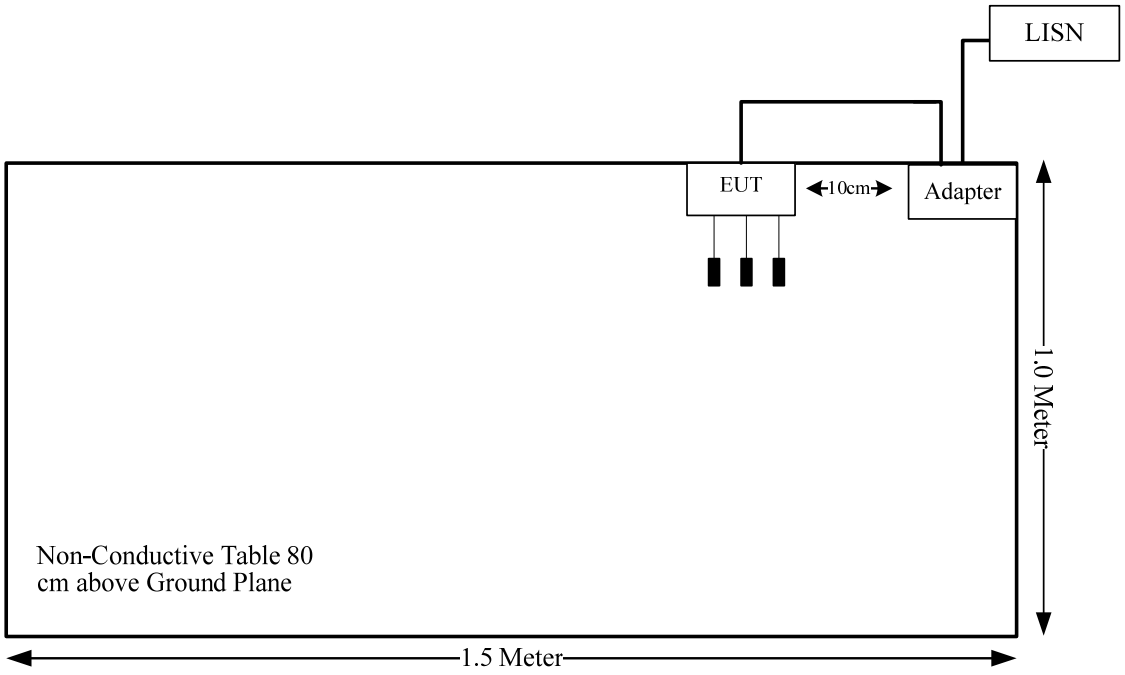
Equipment Modifications

No modification was made to the EUT.

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
Sensor cable	No	No	2.04	EUT	sensor
DC cable	No	No	3.04	Adapter	EUT

Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

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

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.

Calculation formula:

Prediction of power density at the distance of the applicable MPE limit
$S = PG/4\pi R^2$ = 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:

Frequency (MHz)	**Antenna Gain**		**Conducted output power including Tune-up Tolerance**		**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**
	(dBi)	**(numeric)**	**(dBm)**	**(mW)**			
902-928	-1	0.79	14	25.12	20.00	0.004	0.6

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 And Connector Construction

The device have an internal antenna, fulfill the requirement of this section. Please refer to the EUT photos and below information.

Antenna Type	Connector Type	input impedance (Ohm)	Antenna Gain /Frequency
ceramic	Welded	50	-1.0 dBi/902-928MHz

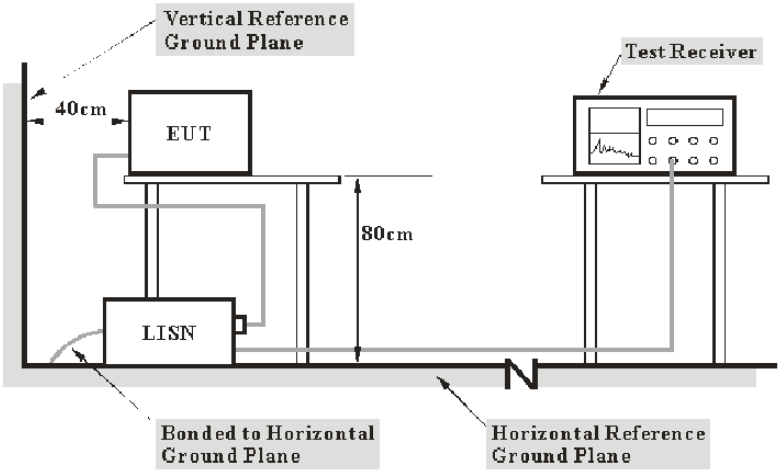
Result: Compliance.

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

The spacing between the peripherals was 10 cm.

The adapter was connected to the main LISN with a 120 V/60 Hz AC power source.

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 first LISN.

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

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

Corrected Amplitude & Margin Calculation

The basic equation is as follows:

$V_C = V_R + A_C + VDF$

Herein,
V_C: corrected voltage amplitude
V_R: reading voltage amplitude
A_c: attenuation caused by cable loss
VDF: voltage division factor of AMN or ISN

The "**Margin**" column of the following data tables indicates the degree of compliance within 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCS 30	830245/006	2017-12-11	2018-12-11
Un-known	Coaxial Cable	C-NJNJ-50	C-0200-01	2018-09-05	2019-09-05
R&S	Test Software	EMC32	Version8.53.0	N/A	N/A
R&S	Two-line V-network	ENV 216	101614	2017-12-08	2018-12-08

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

Test Data

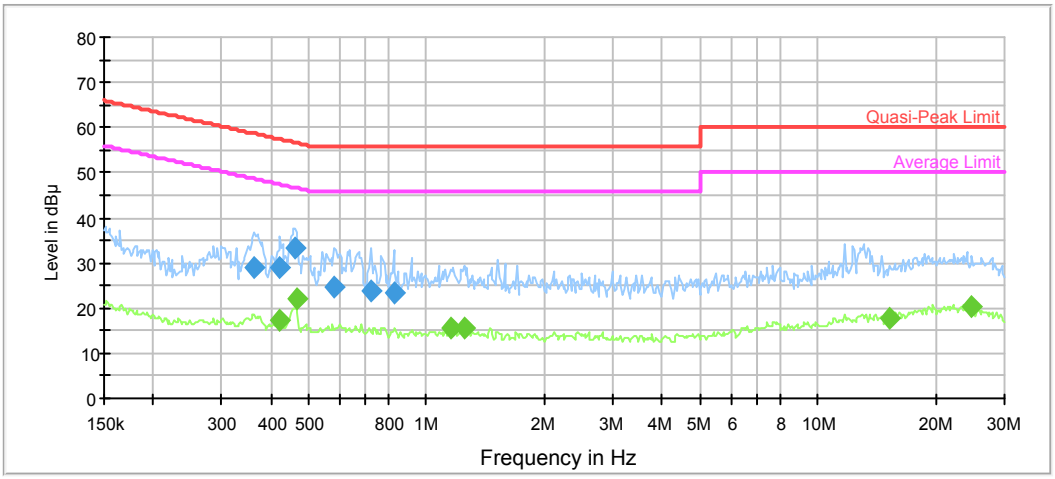
Environmental Conditions

Temperature:	27.4 °C
Relative Humidity:	59 %
ATM Pressure:	100.6 kPa

The testing was performed by Lily Xie on 2018-12-05.

Test Mode: *Transmitting*

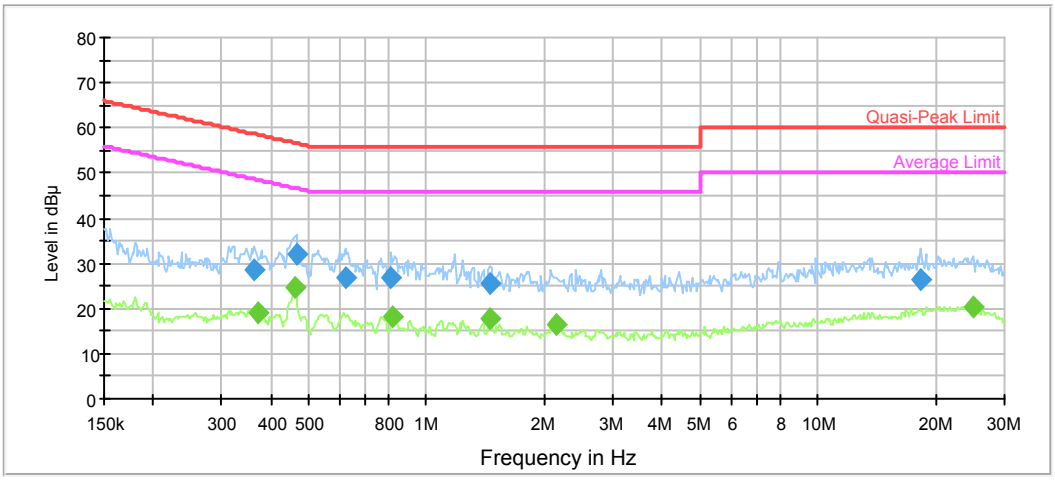
AC120V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.363254	29.0	9.000	L1	10.0	29.7	58.7	Compliance
0.422630	28.8	9.000	L1	9.9	28.6	57.4	Compliance
0.461346	33.5	9.000	L1	9.9	23.2	56.7	Compliance
0.581275	24.7	9.000	L1	9.8	31.3	56.0	Compliance
0.720803	23.6	9.000	L1	9.8	32.4	56.0	Compliance
0.825364	23.4	9.000	L1	9.8	32.6	56.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.422630	17.5	9.000	L1	9.9	29.9	47.4	Compliance
0.465037	21.9	9.000	L1	9.9	24.7	46.6	Compliance
1.153421	15.6	9.000	L1	9.8	30.4	46.0	Compliance
1.249088	15.7	9.000	L1	9.8	30.3	46.0	Compliance
15.247554	17.8	9.000	L1	9.9	32.2	50.0	Compliance
24.594166	20.2	9.000	L1	10.1	29.8	50.0	Compliance

AC120V, 60 Hz, Neutral:



Frequency (MHz)	QuasiPeak (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.363254	28.4	9.000	N	10.0	30.3	58.7	Compliance
0.465037	31.9	9.000	N	9.9	24.7	56.6	Compliance
0.619536	26.8	9.000	N	9.8	29.2	56.0	Compliance
0.812315	26.7	9.000	N	9.8	29.3	56.0	Compliance
1.453260	25.6	9.000	N	9.8	30.4	56.0	Compliance
18.314388	26.4	9.000	N	10.0	33.6	60.0	Compliance

Frequency (MHz)	Average (dBµV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.372042	19.1	9.000	N	10.0	29.4	48.5	Compliance
0.461346	24.7	9.000	N	9.9	22.0	46.7	Compliance
0.818813	18.2	9.000	N	9.8	27.8	46.0	Compliance
1.453260	17.9	9.000	N	9.8	28.1	46.0	Compliance
2.147382	16.3	9.000	N	9.8	29.7	46.0	Compliance
24.989247	20.5	9.000	N	10.1	29.5	50.0	Compliance

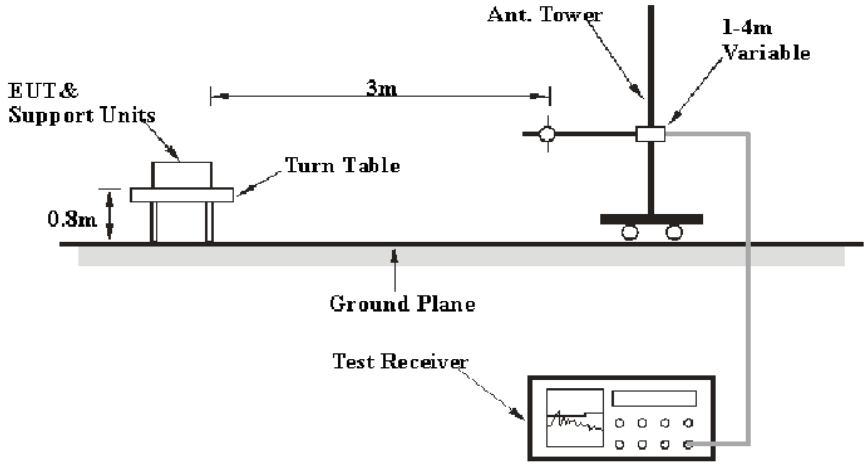
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

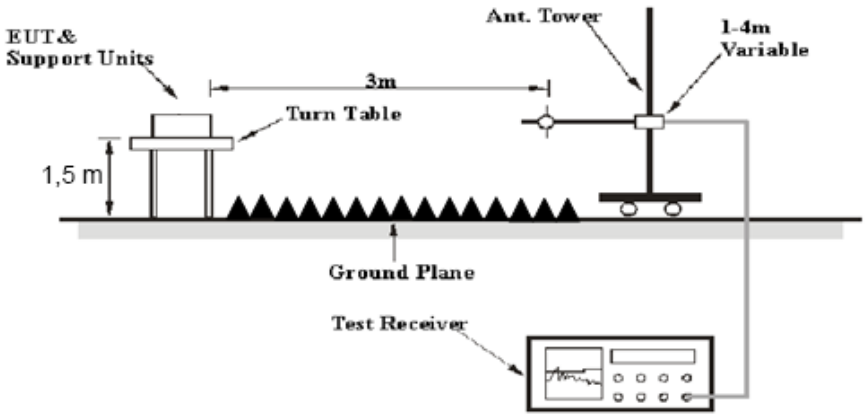
FCC §15.247 (d); §15.209; §15.205

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission below 1GHz tests were performed in the 3 meters chamber test site A, above 1GHz tests were performed in the 3 meters chamber test site B, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

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	Measurement
30 MHz – 1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	AV

Test Procedure

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

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

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100035	2018-08-03	2019-08-03
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2019-07-21
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-2200-01	2018-09-05	2019-09-05
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-01-04	2019-01-04
Farad	Test Software	EZ-EMC	V1.1.4.2	N/A	N/A
ETS-Lindgren	Horn Antenna	3115	000 527 35	2016-01-05	2019-01-04
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2018-09-05	2019-09-05
MITEQ	Amplifier	AFS42-00101800-25-S-42	2001271	2018-09-05	2019-09-05

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

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 Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	59 %
ATM Pressure:	100.5kPa

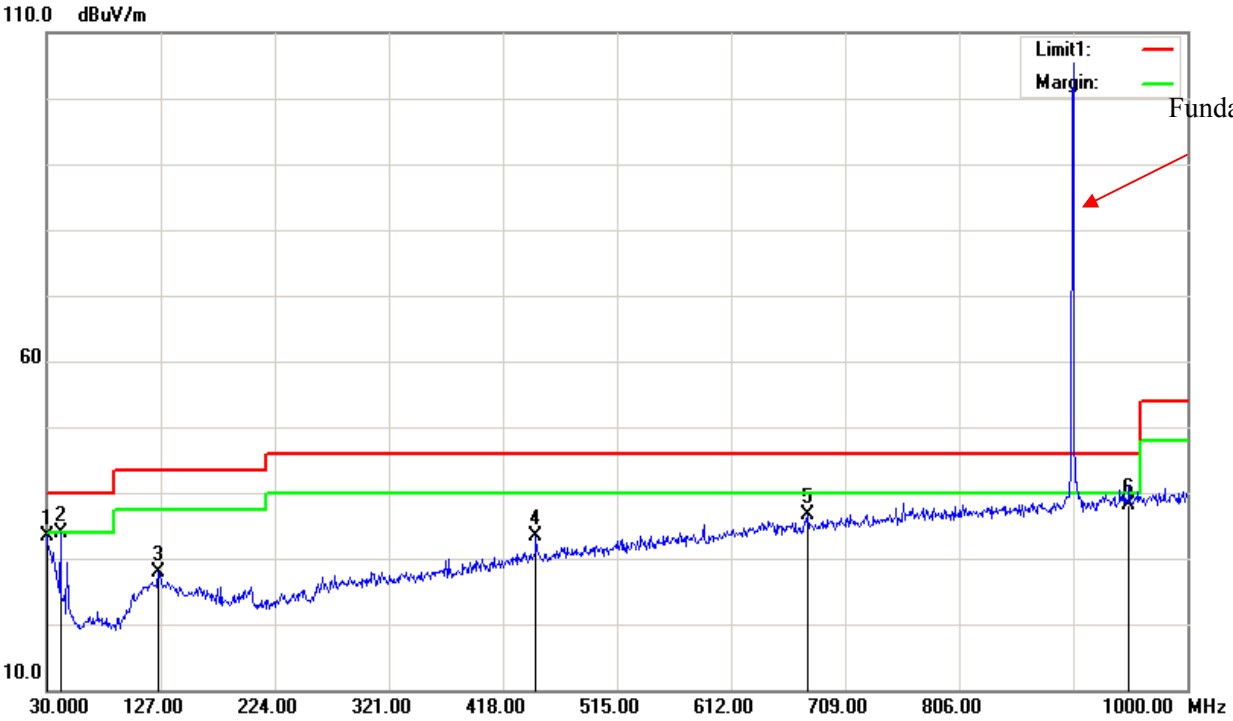
** The testing was performed by Vern Shen & Tyler Pan from 2018-12-06.*

Test Mode: Transmitting

30MHz-1GHz

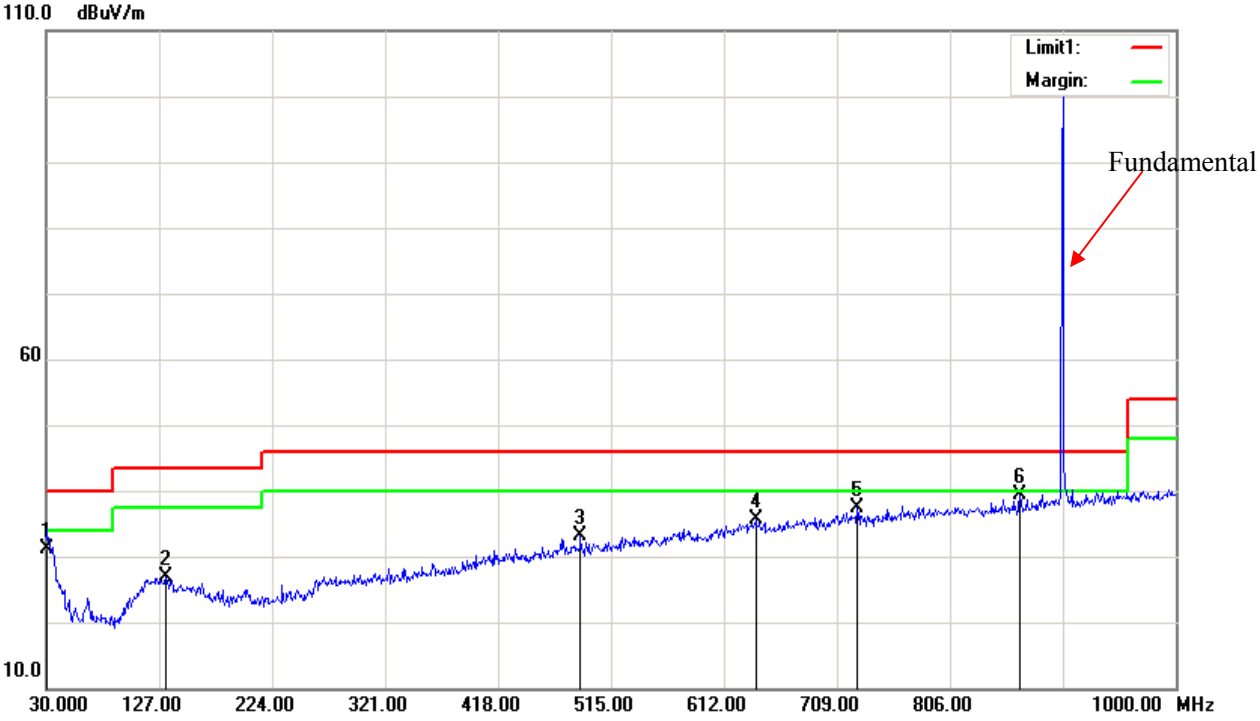
Low channel

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	5.28	QP	28.16	33.44	40.00	6.56
41.6400	14.58	QP	19.42	34.00	40.00	6.00
125.0600	6.57	QP	21.27	27.84	43.50	15.66
446.1300	8.21	QP	25.10	33.31	46.00	12.69
676.9900	7.39	QP	29.15	36.54	46.00	9.46
950.5300	15.30	QP	22.80	38.10	46.00	7.90

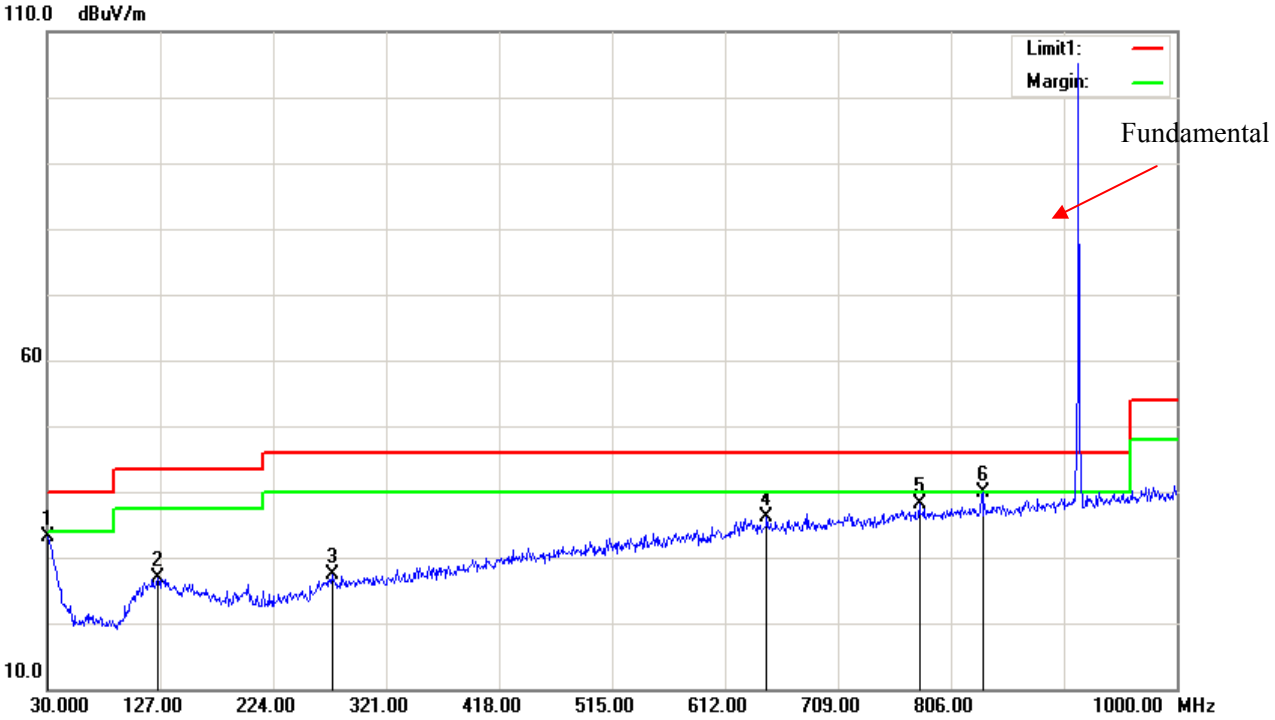
Vertical:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	3.04	QP	28.16	31.20	40.00	8.80
132.8200	6.10	QP	20.89	26.99	43.50	16.51
488.8100	7.02	QP	26.07	33.09	46.00	12.91
639.1600	6.79	QP	28.92	35.71	46.00	10.29
726.4600	7.52	QP	29.91	37.43	46.00	8.57
866.1400	11.35	QP	27.95	39.30	46.00	6.70

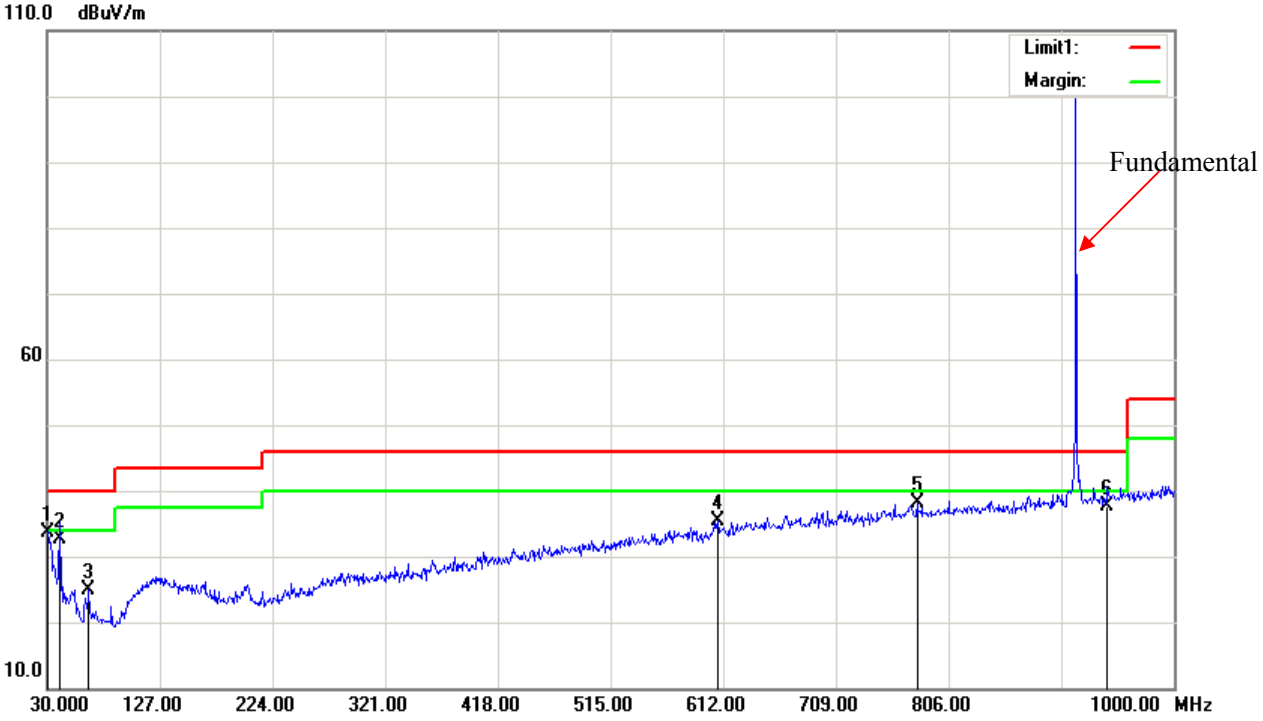
Middle channel

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	5.06	QP	28.16	33.22	40.00	6.78
125.0600	5.68	QP	21.27	26.95	43.50	16.55
274.4400	6.42	QP	21.07	27.49	46.00	18.51
647.8900	7.23	QP	28.86	36.09	46.00	9.91
778.8400	7.24	QP	30.81	38.05	46.00	7.95
833.1600	8.30	QP	31.55	39.85	46.00	6.15

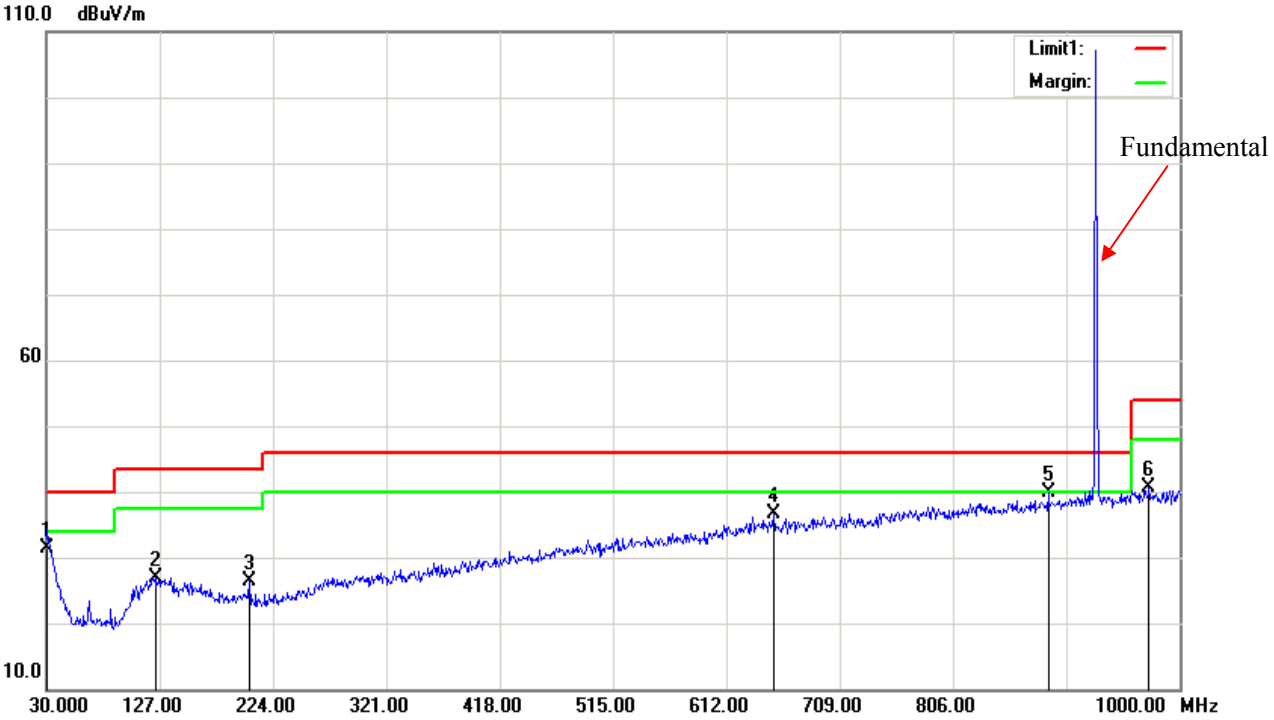
Vertical:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.9700	6.40	QP	27.35	33.75	40.00	6.25
40.6700	12.51	QP	20.09	32.60	40.00	7.40
65.8900	10.25	QP	14.61	24.86	40.00	15.14
607.1500	7.63	QP	27.73	35.36	46.00	10.64
778.8400	7.43	QP	30.81	38.24	46.00	7.76
942.7700	14.90	QP	22.70	37.60	46.00	8.40

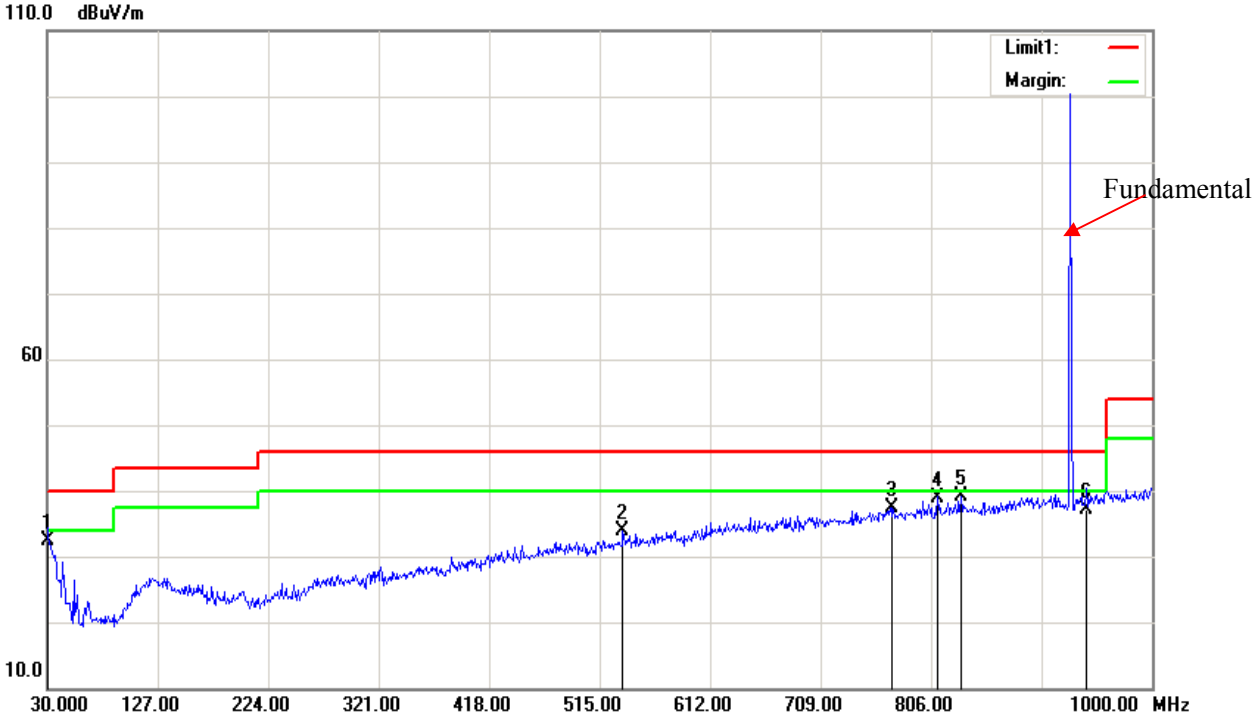
High channel

Horizontal:



Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	3.34	QP	28.16	31.50	40.00	8.50
123.1200	5.62	QP	21.35	26.97	43.50	16.53
203.6300	7.25	QP	19.12	26.37	43.50	17.13
652.7400	7.76	QP	28.79	36.55	46.00	9.45
887.4800	7.69	QP	32.26	39.95	46.00	6.05
973.8100	7.20	QP	33.41	40.61	54.00	13.39

Vertical:

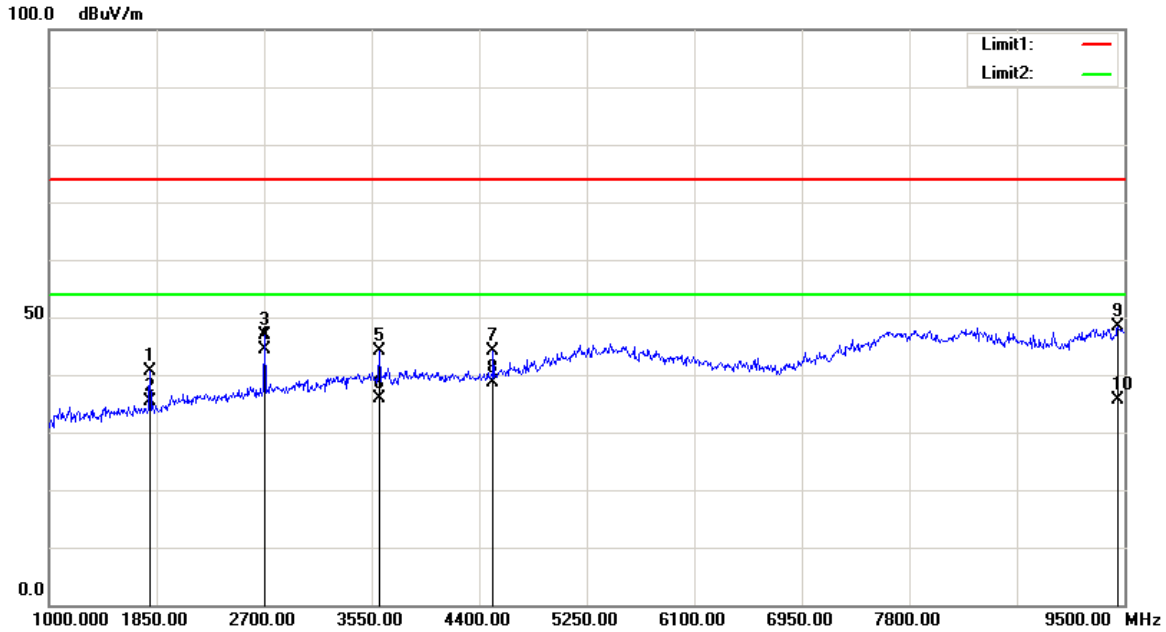


Frequency (MHz)	Receiver Reading (dBµV)	Detector	Correction Factor (dB/m)	Cord. Amp. (dBµV/m)	Limit (dBµV/m)	Margin (dB)
30.0000	4.24	QP	28.16	32.40	40.00	7.60
535.3700	7.07	QP	26.89	33.96	46.00	12.04
772.0500	6.69	QP	30.80	37.49	46.00	8.51
811.8200	7.70	QP	31.30	39.00	46.00	7.00
832.1900	7.51	QP	31.53	39.04	46.00	6.96
942.7700	14.50	QP	22.70	37.20	46.00	8.80

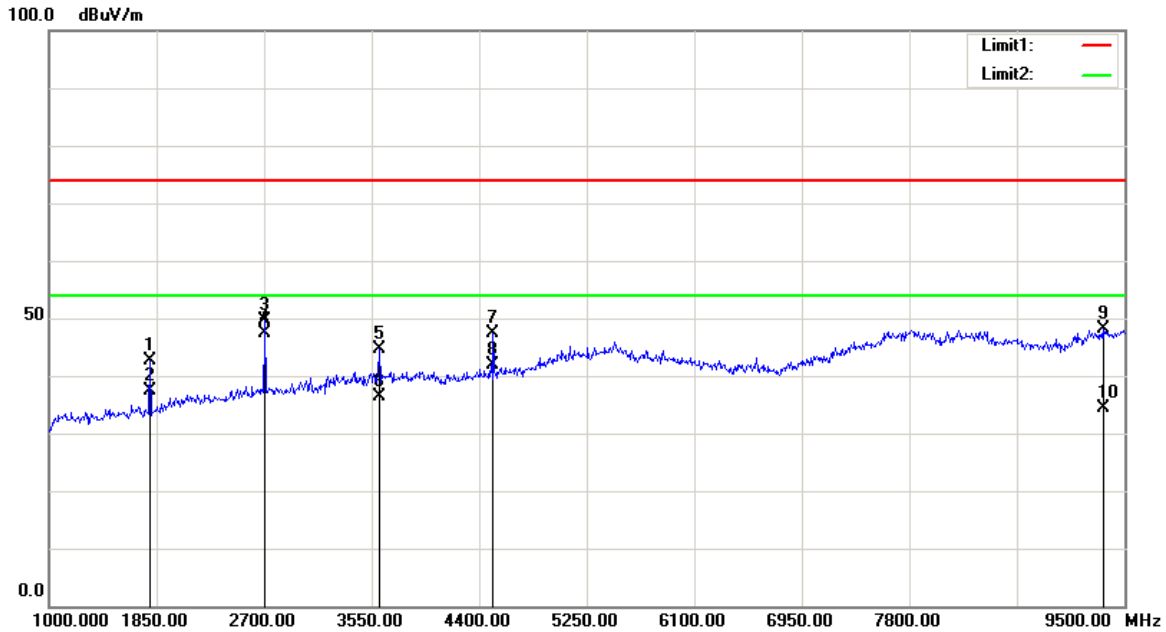
2) Fundamental, bandedge, and above 1GHz:

Frequency (MHz)	Receiver		Rx Antenna		Cable loss (dB)	Amplifier Gain (dB)	Corrected Amplitude (dBµV/m)	Limit (dBµV/m)	Margin (dB)
	Reading (dBµV)	Detector	Polar (H/V)	Factor (dB/m)					
Low Channel: 902.2 MHz									
902.20	80.20	QP	H	22.34	4.29	0.00	106.83	N/A	N/A
902.20	74.10	QP	V	22.34	4.29	0.00	100.73	N/A	N/A
902.00	34.50	QP	H	22.34	4.29	0.00	61.13	86.83	25.70
1804.40	50.32	PK	H	26.48	1.66	35.90	42.56	74.00	31.44
1804.40	45.23	AV	H	26.48	1.66	35.90	37.47	54.00	16.53
2706.60	55.15	PK	H	29.04	1.88	36.47	49.60	74.00	24.40
2706.60	53.02	AV	H	29.04	1.88	36.47	47.47	54.00	6.53
3608.80	47.69	PK	H	31.54	2.41	37.11	44.53	74.00	29.47
3608.80	39.60	AV	H	31.54	2.41	37.11	36.44	54.00	17.56
4511.00	49.18	PK	H	32.32	3.02	37.14	47.38	74.00	26.62
4511.00	43.67	AV	H	32.32	3.02	37.14	41.87	54.00	12.13
Middle Channel: 915 MHz									
915.00	79.80	QP	H	22.40	4.21	0.00	106.41	N/A	N/A
915.00	74.00	QP	V	22.40	4.21	0.00	100.61	N/A	N/A
1830.00	49.63	PK	H	26.59	1.66	35.95	41.93	74.00	32.07
1830.00	44.40	AV	H	26.59	1.66	35.95	36.70	54.00	17.30
2745.00	55.19	PK	H	29.18	1.91	36.51	49.77	74.00	24.23
2745.00	52.78	AV	H	29.18	1.91	36.51	47.36	54.00	6.64
3660.00	47.72	PK	H	31.65	2.50	37.06	44.81	74.00	29.19
3660.00	39.60	AV	H	31.65	2.50	37.06	36.69	54.00	17.31
4575.00	48.49	PK	H	32.45	3.08	37.13	46.89	74.00	27.11
4575.00	42.98	AV	H	32.45	3.08	37.13	41.38	54.00	12.62
High Channel: 927.8 MHz									
927.80	80.50	QP	H	22.56	4.34	0.00	107.40	N/A	N/A
927.80	74.50	QP	V	22.56	4.34	0.00	101.40	N/A	N/A
928.00	36.50	QP	H	22.56	4.34	0.00	63.40	87.40	24.00
1855.60	49.37	PK	H	26.69	1.66	36.00	41.72	74.00	32.28
1855.60	44.03	AV	H	26.69	1.66	36.00	36.38	54.00	17.62
2783.40	55.15	PK	H	29.32	1.94	36.55	49.86	74.00	24.14
2783.40	52.80	AV	H	29.32	1.94	36.55	47.51	54.00	6.49
3711.20	47.86	PK	H	31.76	2.57	37.02	45.17	74.00	28.83
3711.20	39.75	AV	H	31.76	2.57	37.02	37.06	54.00	16.94
4639.00	48.57	PK	H	32.58	3.08	37.11	47.12	74.00	26.88
4639.00	43.12	AV	H	32.58	3.08	37.11	41.67	54.00	12.33

Worst plots(High channel)
Horizontal



Vertical



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

Applicable Standard

According to FCC §15.247(a) (1)

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.50 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Procedure

1. Set the EUT in transmitting mode, spectrum Bandwidth was set at 30 kHz, maxhold the channel.
2. Set the adjacent channel of the EUT maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	59 %
ATM Pressure:	100.5kPa

** The testing was performed by Vern Shen & Tyler Pan from 2018-12-06.*

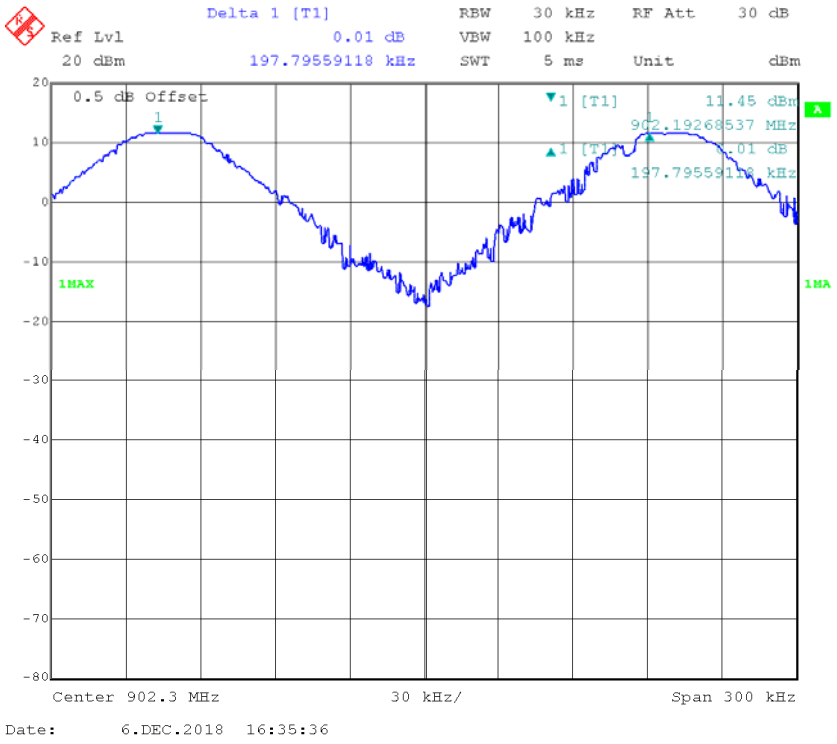
Test Result: Compliance.

Please refer to following tables and plots

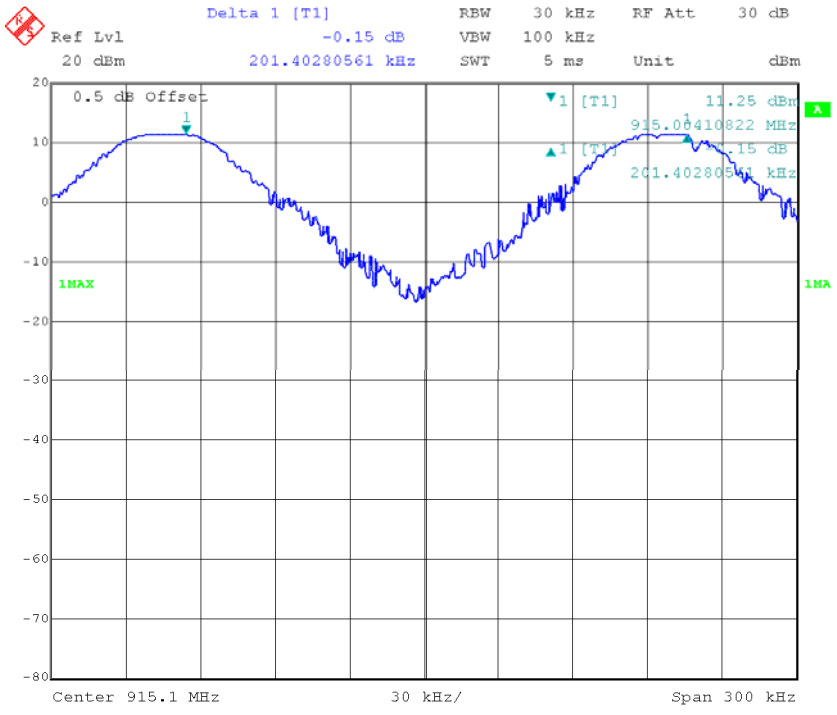
Test Mode: Transmitting

Channel	Frequency (MHz)	Channel Separation (MHz)	Limit (MHz)
Low	902.2	0.198	0.025
Middle	915	0.201	0.025
High	927.8	0.200	0.025

Low Channel

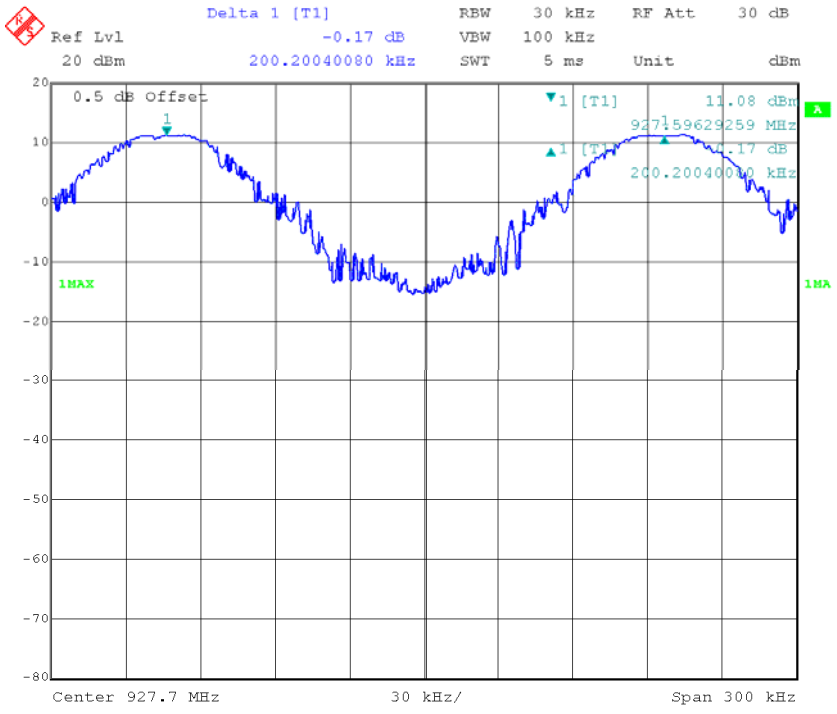


Middle Channel



Date: 6.DEC.2018 16:38:08

High Channel



Date: 6.DEC.2018 16:41:47

FCC §15.247(a) (1) – 20 dB BANDWIDTH TESTING

Applicable Standard

According to FCC §15.247(a) (1)

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.50 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW.

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 on the test table without connection to measurement instrument. Turn on the EUT. 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. Use Occupied bandwidth test function, measure the 99% Occupied bandwidth.
5. Repeat above procedures until all frequencies measured were complete.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data

Environmental Conditions

Temperature:	22~26.5°C
Relative Humidity:	40~59 %
ATM Pressure:	99.5~100.5kPa

** The testing was performed by Vern Shen & Tyler Pan from 2018-12-06 to 2018-12-15.*

Test Result: Compliance.

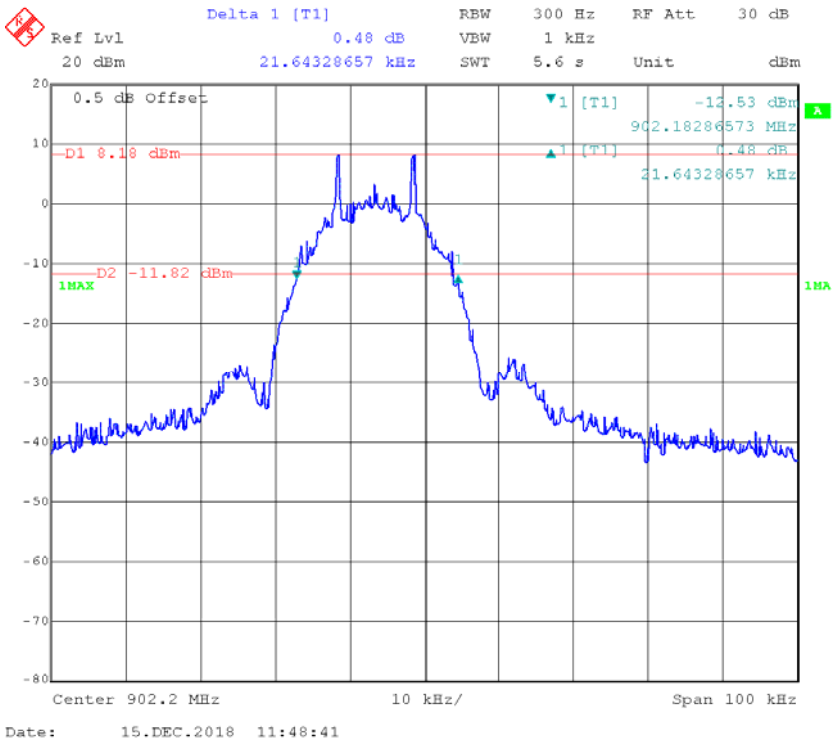
Please refer to following tables and plots

Test Mode: Transmitting

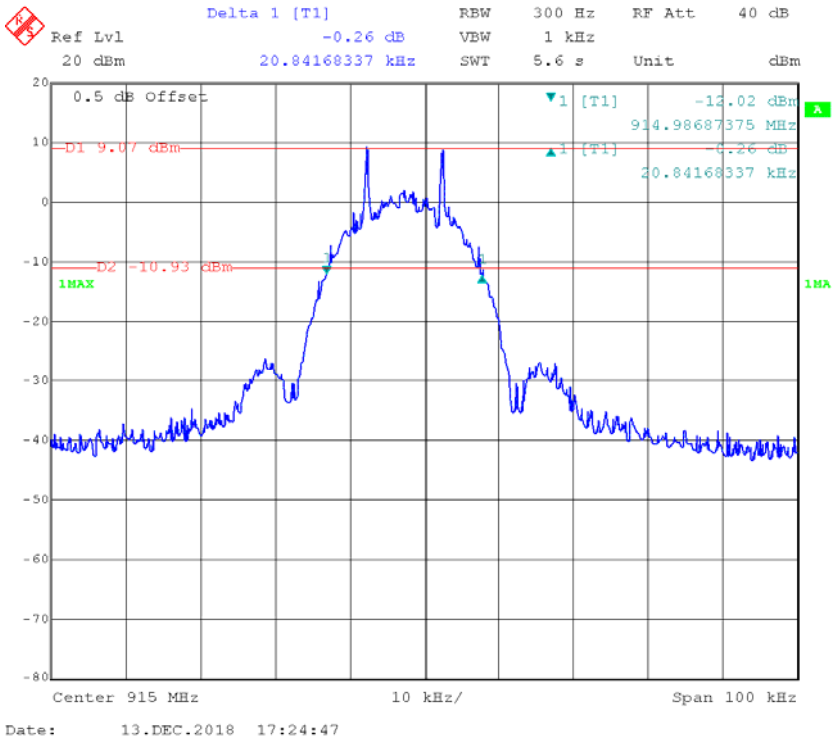
Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
Low	902.2	21.64
Middle	915	20.84
High	927.8	21.24

20dB Bandwidth:

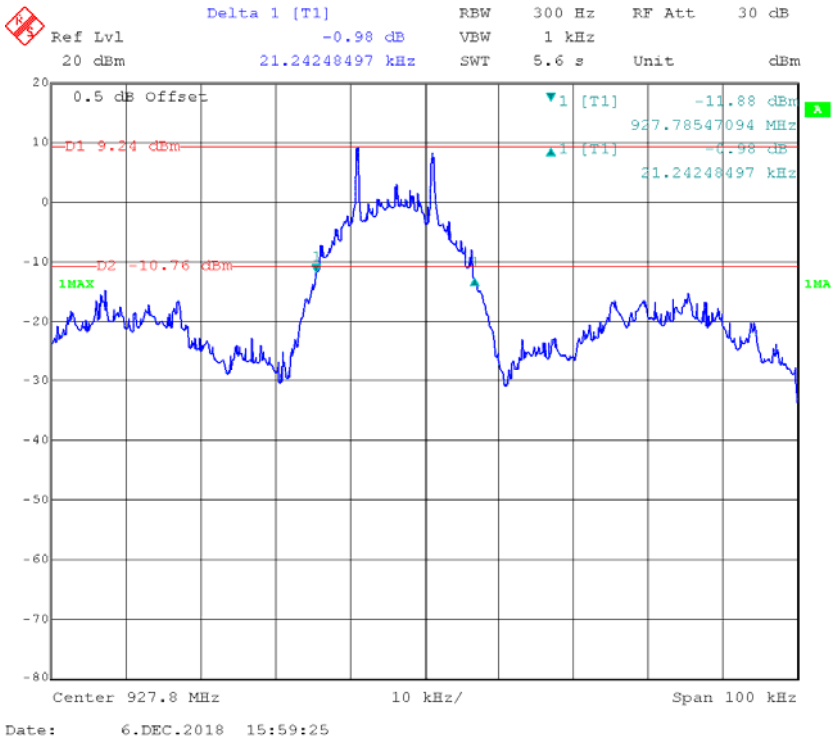
Low Channel



Middle Channel



High Channel



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

Applicable Standard

According to FCC §15.247(a) (1) (i)

(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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data

Environmental Conditions

Temperature:	22~22.2°C
Relative Humidity:	40~42 %
ATM Pressure:	99.7~99.9kPa

** The testing was performed by Vern Shen & Tyler Pan from 2018-12-13 to 2018-12-14.*

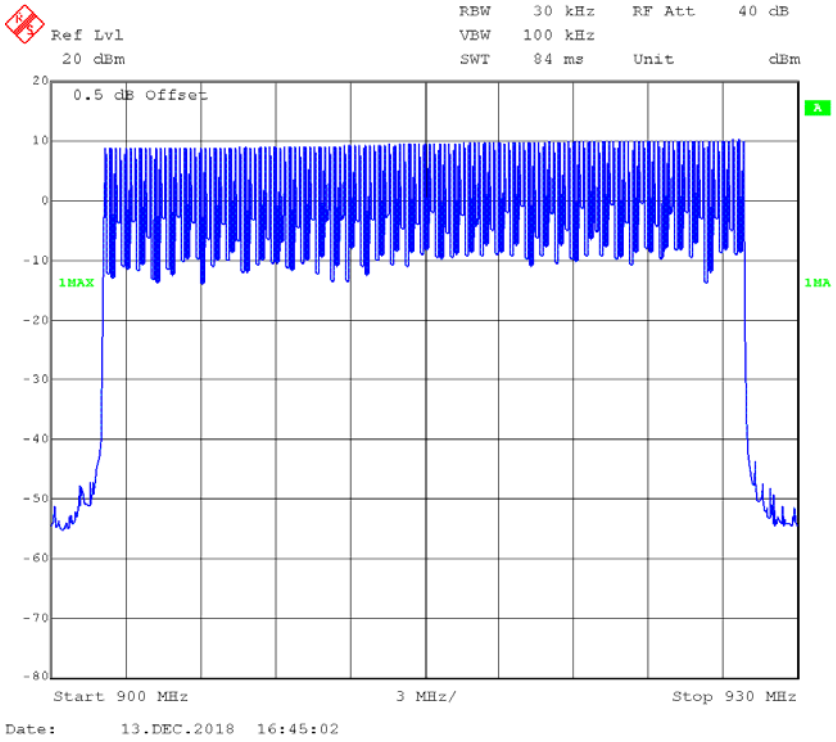
Test Result: Compliance.

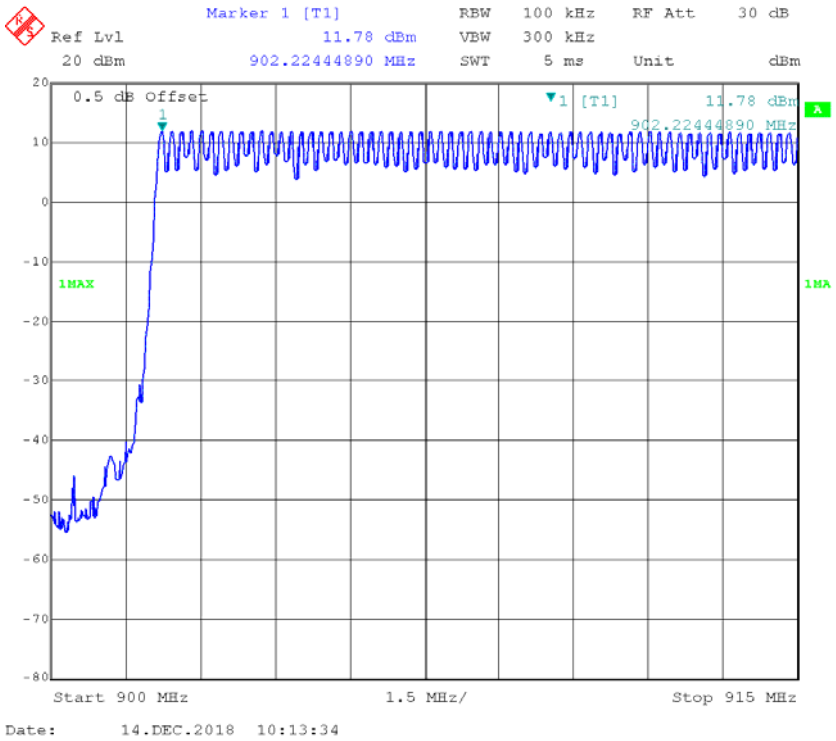
Please refer to following tables and plots

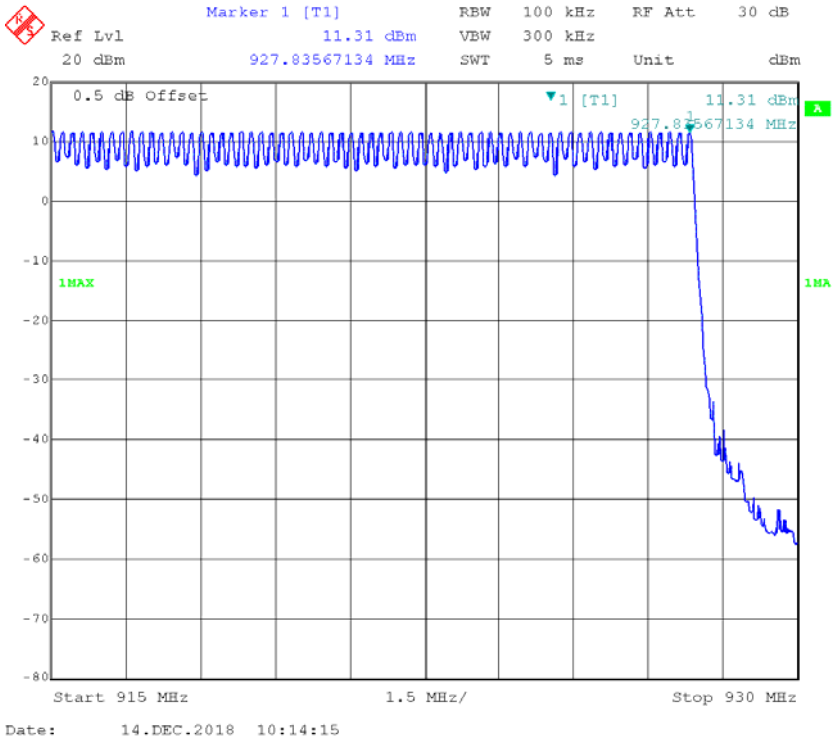
Test Mode: Transmitting

Frequency Range (MHz)	Number of Hopping Channel	Limit
902-928	129	≥50

Number of Hopping Channels




Marker 1 [T1]
RBW 100 kHz
RF Att 30 dB
Ref Lvl
11.78 dBm
VBW 300 kHz
20 dBm
902.22444890 MHz
SWT 5 ms
Unit dBm
0.5 dB Offset
1 [T1]
11.78 dBm
902.22444890 MHz
1MAX
1MA
Start 900 MHz
1.5 MHz/
Stop 915 MHz
Date: 14.DEC.2018 10:13:34


Marker 1 [T1]
RBW 100 kHz
RF Att 30 dB
Ref Lvl
11.31 dBm
VBW 300 kHz
20 dBm
927.83567134 MHz
SWT 5 ms
Unit dBm
0.5 dB Offset
1 [T1]
11.31 dBm
927.83567134 MHz
1MAX
1MA
Start 915 MHz
1.5 MHz/
Stop 930 MHz
Date: 14.DEC.2018 10:14:15

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

Applicable Standard

According to FCC §15.247(a) (1) (i)

(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; the time of single pulses was tested.

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data

Environmental Conditions

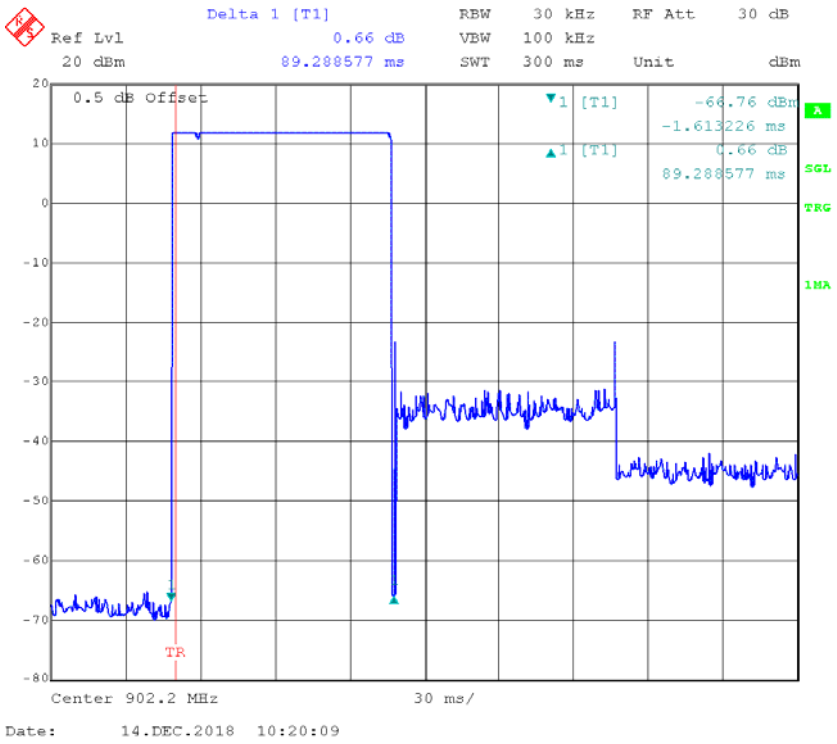
Temperature:	26.5 °C
Relative Humidity:	59 %
ATM Pressure:	100.5kPa

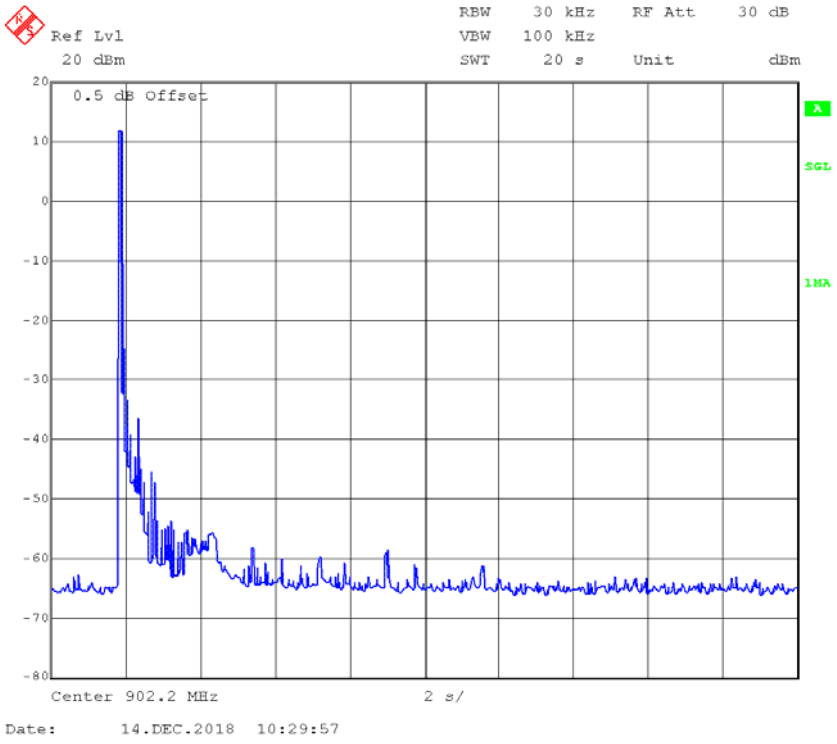
** The testing was performed by Tiago Huang from 2018-12-14.*

Test Mode: Transmitting

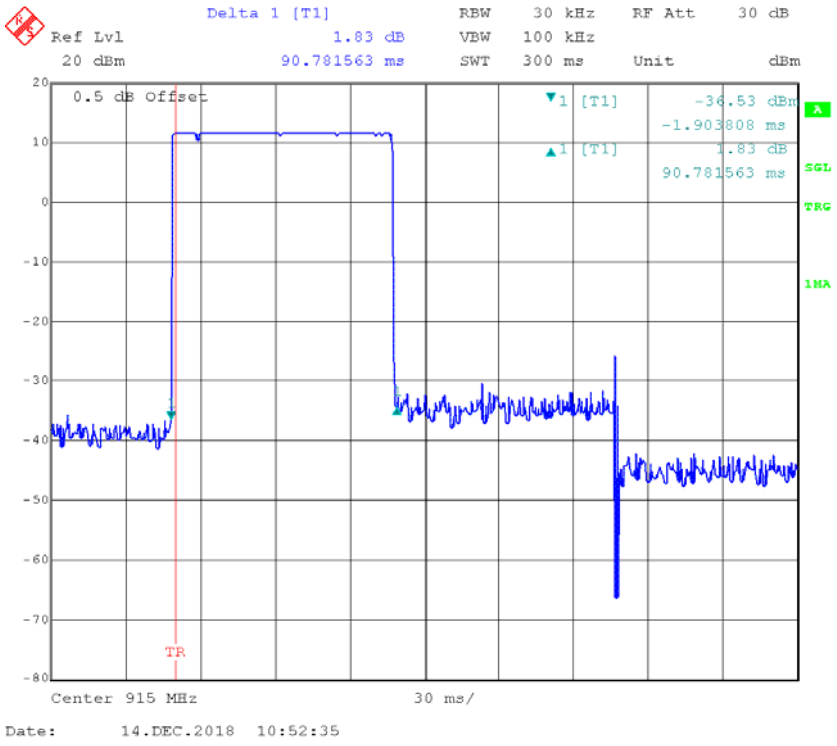
Channel	Frequency (MHz)	Pulse Width (ms)	Real Observed Period(s)	Hopping number in Observed Period	Dwell Time (s)	Limit (s)	Result
Low	902.2	89.288	20	1	0.089288	0.4	Compliance
High	915.0	90.781	20	1	0.090781	0.4	Compliance
High	927.6	89.579	20	1	0.089579	0.4	Compliance
Note: Dwell time=Pulse width × hopping number per channel in Observed Period Observed Period=20s							

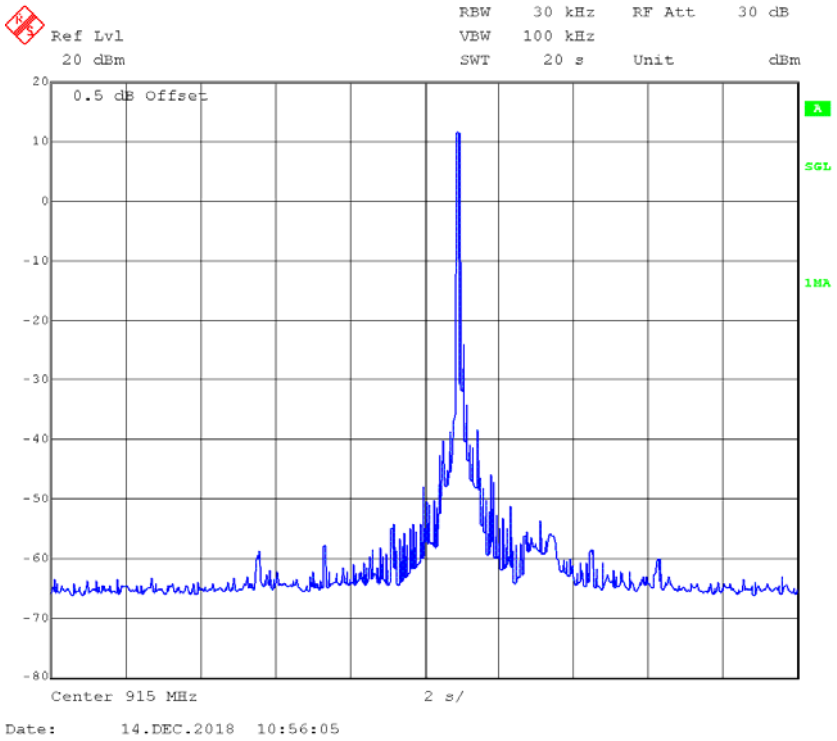
Low Channel



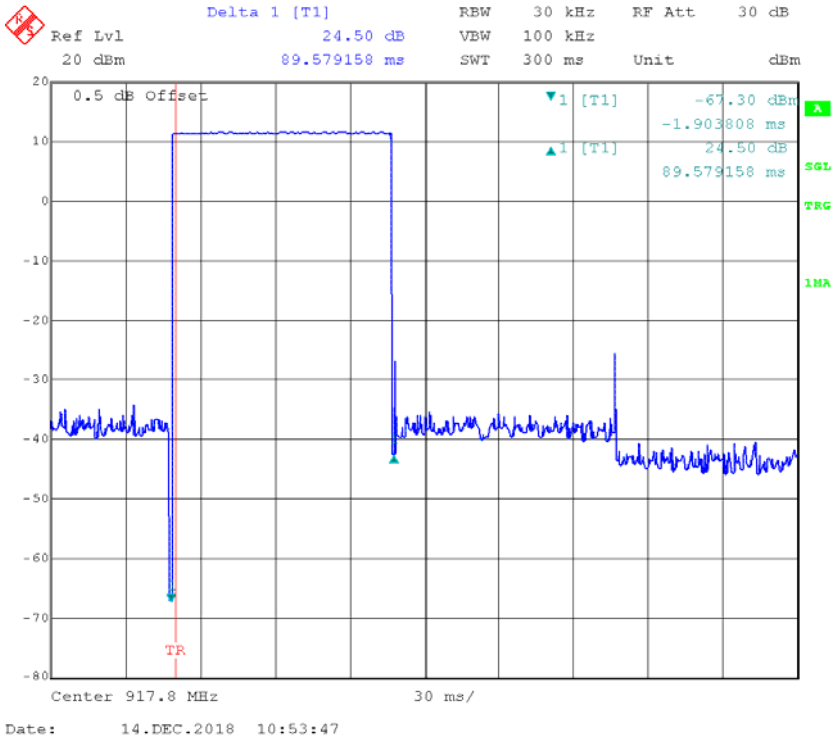


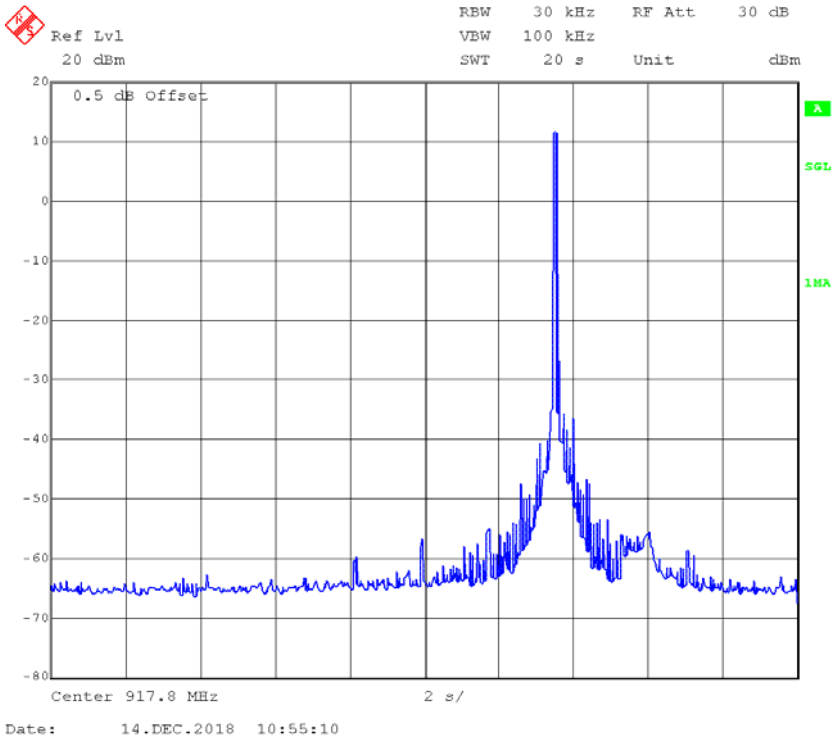
Middle Channel





High Channel




RBW 30 kHz
RF Att 30 dB
VBW 100 kHz
Ref Lvl
20 dBm
SWT 20 s
Unit dBm
0.5 dB Offset
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
A
SGL
1MA
Center 917.8 MHz
2 s/
Date: 14.DEC.2018 10:55:10

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

Applicable Standard

According to FCC §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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Agilent	USB Wideband Power Sensor	U2022XA	MY5417006	2017-12-11	2018-12-11
Unknown	Coaxial Cable	C-SJ00-0010	C0010/02	Each time	N/A

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

Test Data

Environmental Conditions

Temperature:	26.5 °C
Relative Humidity:	59 %
ATM Pressure:	100.5kPa

** The testing was performed by Tiago Huang from 2018-12-06.*

Test Result: Compliance.

Test Mode: Transmitting

Channel	Frequency (MHz)	Peak Conducted Output power (dBm)	Peak Conducted Output power Limit (dBm)
Low	902.2	12.96	30
Middle	915.0	12.02	30
High	927.8	12.65	30

Note: The data above was tested in conducted mode, the antenna gain is -1.0dBi.

FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

According to FCC §15.247(d)

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/ VBW of spectrum analyzer to 100/300 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 Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Rohde & Schwarz	Signal Analyzer	FSIQ26	831929/005	2018-08-03	2019-08-03
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A

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

Test Data

Environmental Conditions

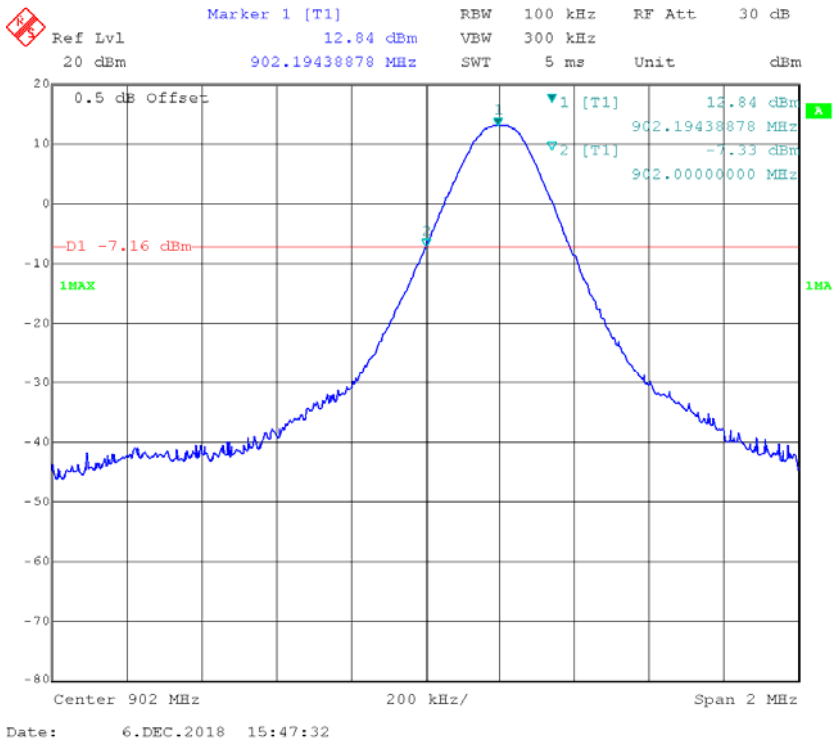
Temperature:	26.5 °C
Relative Humidity:	59 %
ATM Pressure:	100.5kPa

** The testing was performed by Tiago Huang from 2018-12-06.*

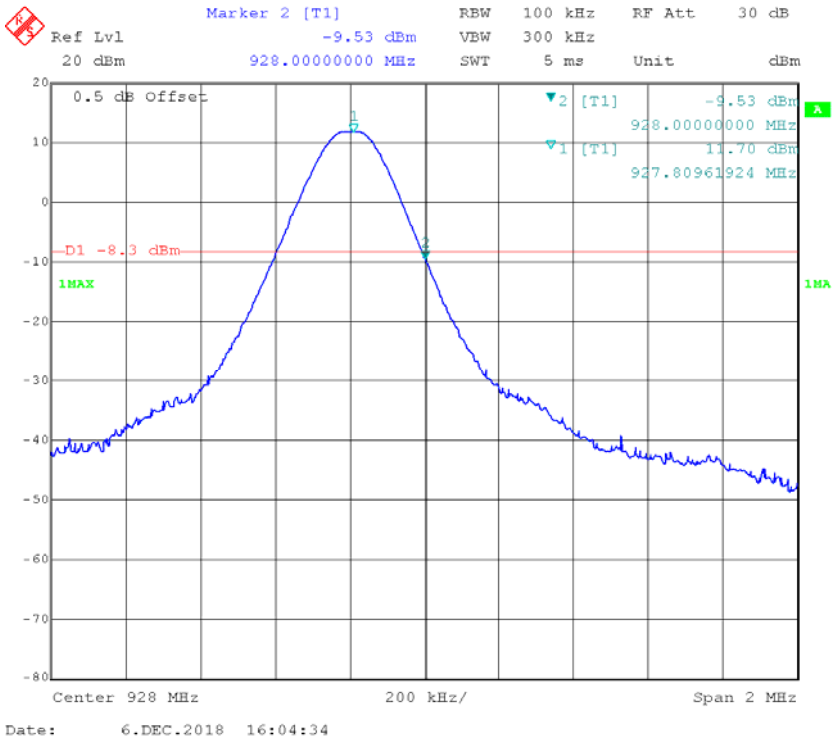
Test Result: Compliance

Single mode:

Band Edge, Left Side

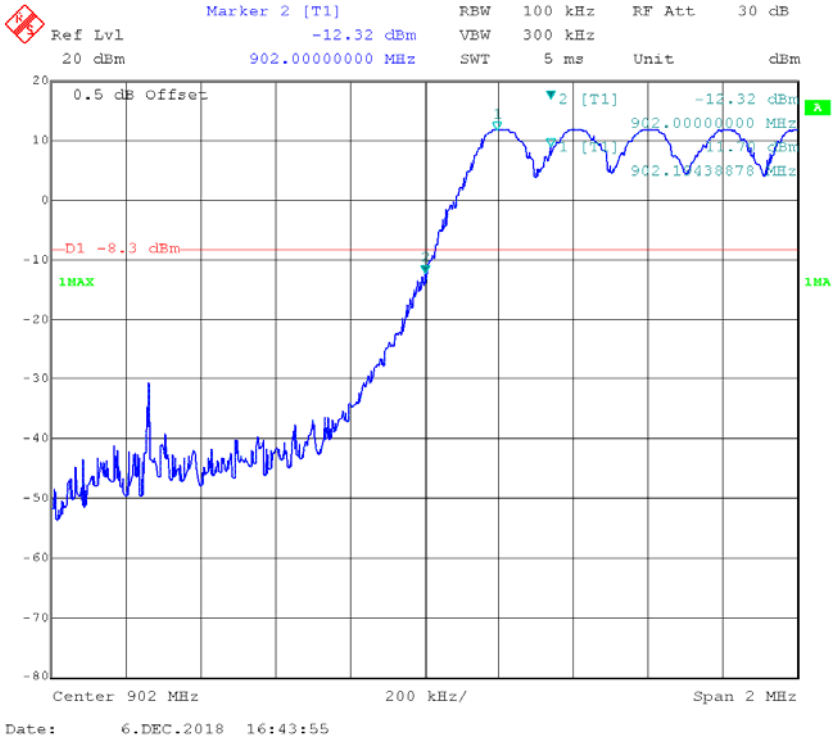


Band Edge, Right Side

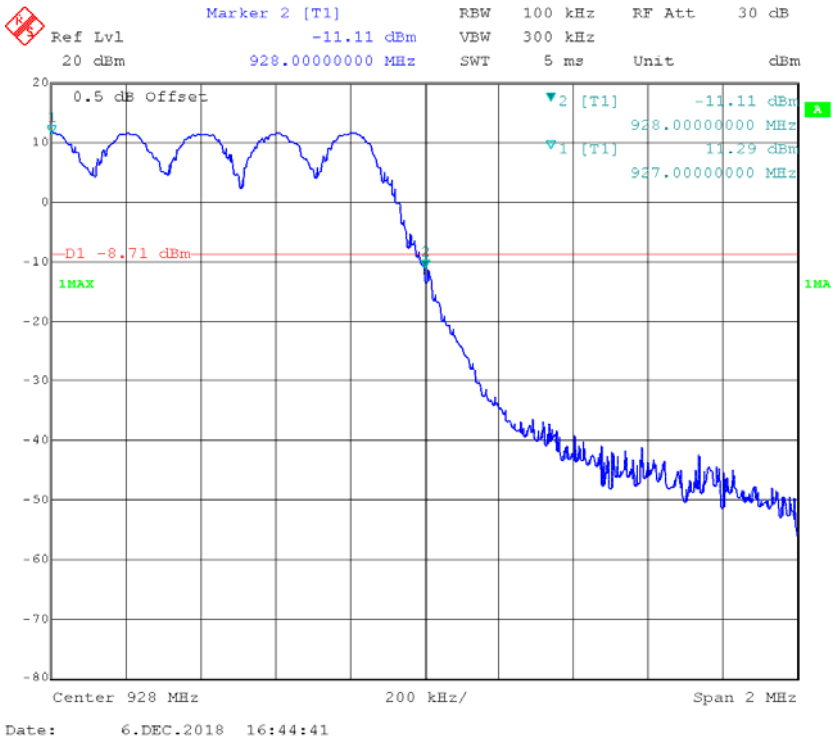


Hopping mode:

Band Edge, Left Side



Band Edge, Right Side



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