TESTING LABORATORY
CERTIFICATE#4323.01

FCC PART 15.247
TEST REPORT

For

Pycom Ltd

High Point 9 Sydenham Road, Guildford Surrey GU1 3RX, Surrey, United Kingdom

FCC ID: 2AJMTLOPY4R

Report Type:	Product Type:
Original Report	LoPy4 Module

Test Engineer:	Max Min
Report Number:	RSHA180625001-00C
Report Date:	2019-03-07
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	Pycom Ltd
Tested Model	LoPy4 1.0
Product Type	LoPy4 Module
Dimension	55mm (L)* 20 mm (W)*10 mm(H)
Power Supply	DC 3.4-5.5V

**All measurement and test data in this report was gathered from production sample serial number: 20180625001. (Assigned by the BACL. The EUT supplied by the applicant was received on 2018-06-25)*

Objective

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

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

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS, Part 15.247 DSS and Part 15.249 DXX submissions with FCC ID: 2AJMTLOPY4R.

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.

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

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 for Sigfox mode:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	902.225	34	903.050	67	903.875
2	902.250	35	903.075	68	903.900
3	902.275	36	903.100	69	903.925
4	902.300	37	903.125	70	903.950
5	902.325	38	903.150	71	903.975
6	902.350	39	903.175	72	904.000
7	902.375	40	903.200	73	904.025
8	902.400	41	903.225	74	904.050
9	902.425	42	903.250	75	904.075
10	902.450	43	903.275	76	904.100
11	902.475	44	903.300	77	904.125
12	902.500	45	903.325	78	904.150
13	902.525	46	903.350	79	904.175
14	902.550	47	903.375	80	904.200
15	902.575	48	903.400	81	904.225
16	902.600	49	903.425	82	904.250
17	902.625	50	903.450	83	904.275
18	902.650	51	903.475	84	904.300
19	902.675	52	903.500	85	904.325
20	902.700	53	903.525	86	904.350
21	902.725	54	903.550	87	904.375
22	902.750	55	903.575	88	904.400
23	902.775	56	903.600	89	904.425
24	902.800	57	903.625	90	904.450
25	902.825	58	903.650	91	904.475
26	902.850	59	903.675	92	904.500
27	902.875	60	903.700	93	904.525
28	902.900	61	903.725	94	904.550
29	902.925	62	903.750	95	904.575
30	902.950	63	903.775	96	904.600
31	902.975	64	903.800	97	904.625
32	903.000	65	903.825	98	904.650
33	903.025	66	903.850	99	904.675

EUT was tested with Channel 1, 50 and 99.

EUT Exercise Software

RF test tool: SecureCRT

Power lever: Software default

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

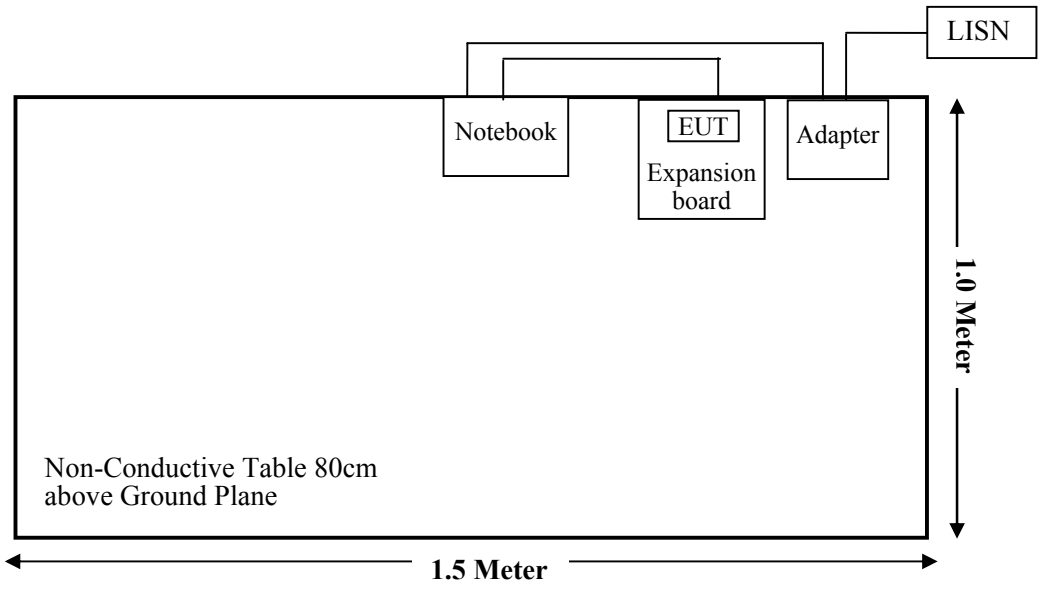
Manufacturer	Description	Model	Serial Number
DELL	Notebook	GX620	D65874152
DELL	Adapter	LA65NS0-00	DF263
Pycom Ltd	Expansion board	V3.0r	1811002240

External I/O Cable

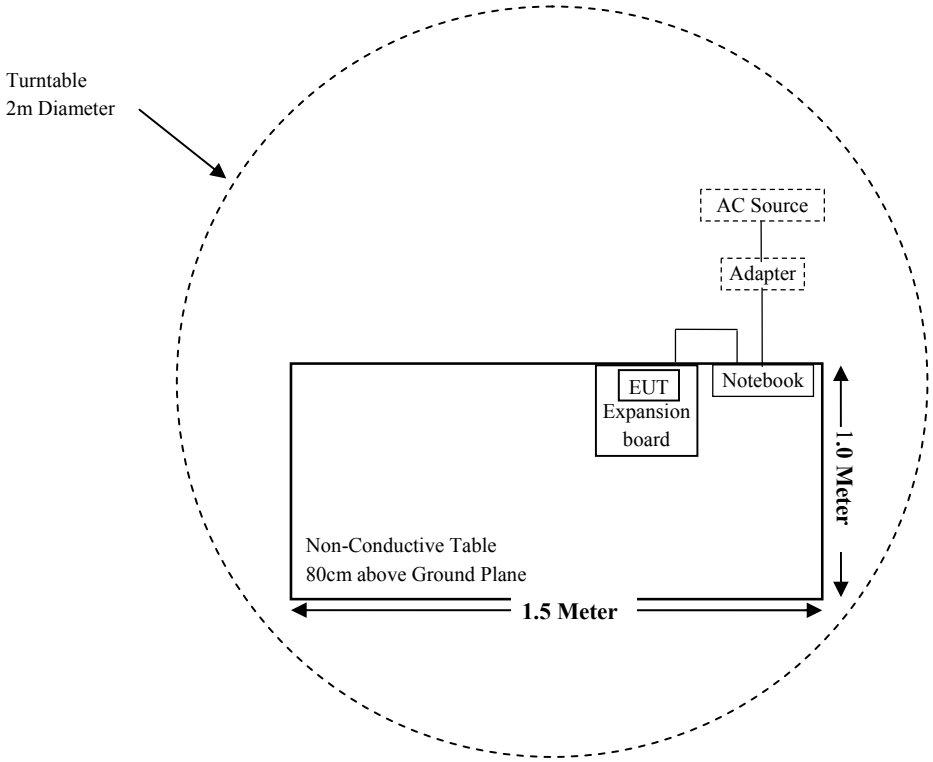
Cable Description	Length (m)	From Port	To
USB Cable	0.8	Expansion board	Notebook

Block Diagram of Test Setup

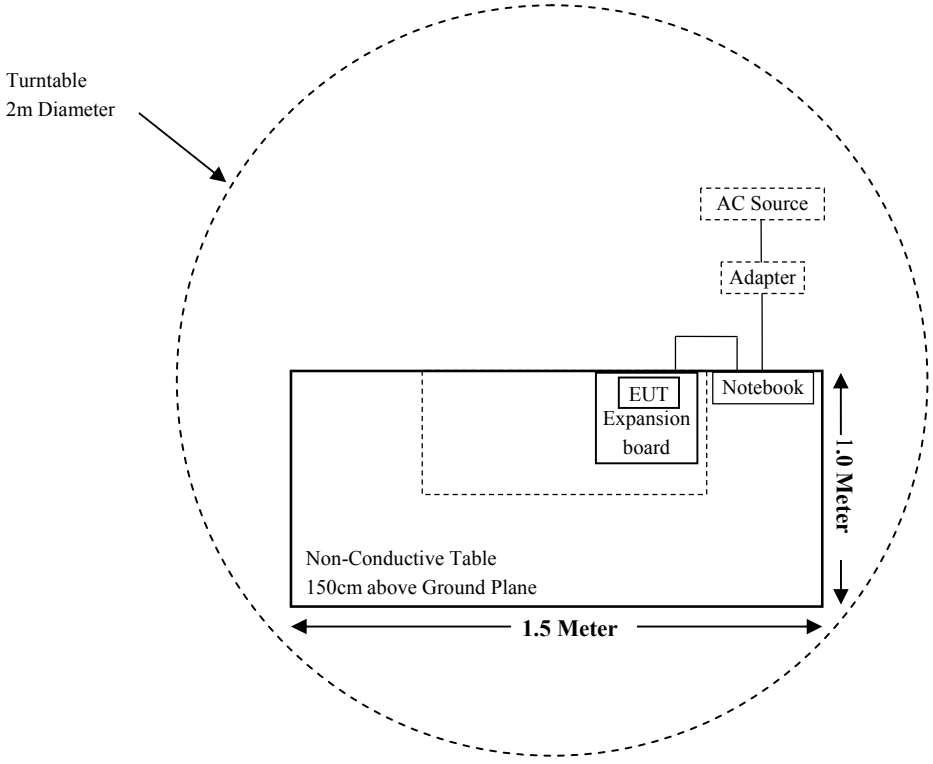
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



SUMMARY OF TEST RESULTS

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

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	2018-11-30	2019-11-29
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sonoma Instrunent	Pre-amplifier	310N	171205	2018-08-15	2019-08-14
MICRO-TRONICS	Band Reject Filter	BRC50722	G013	2018-08-05	2019-08-04
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
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	2016-12-12	2019-12-11
A.H.Systems, inc	Amplifier	2641-1	466	2018-09-11	2019-09-10
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
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
Agilent	Power Meter	N1912A	MY5000492	2018-11-18	2019-11-17
Agilent	Power Sensor	N1921A	MY54210024	2018-11-18	2019-11-17
Narda	Attenuator	6dB	006	2018-08-15	2019-08-14
Pycom Ltd	RF Cable	Pycom01	C01	Each Time	/
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2018-11-30	2019-11-29
Rohde & Schwarz	LISN	ENV216	3560655016	2018-11-30	2019-11-29
BACL	Auto test Software	BACL-EMC	CE001	/	/
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);

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

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

Calculated Data:

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Conducted Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)	Ratio
		(dBi)	(numeric)	(dBm)	(mW)				
Wi-Fi	2412-2462	1.30	1.35	23.00	199.53	20	0.0536	1.00	0.0536
	2422-2452	1.30	1.35	20.00	100.00	20	0.0269	1.00	0.0269
BLE	2402-2480	1.30	1.35	3.00	2.00	20	0.0005	1.00	0.0005
BT 3.0	2402~2480	1.30	1.35	6.00	3.98	20	0.0011	1.00	0.0011
LoRa	902-928	0.87	1.22	20.00	100.00	20	0.0243	0.60	0.0405
Sigfox	902-928	0.87	1.22	20.00	100.00	20	0.0243	0.60	0.0405

Note:

Note: Wi-Fi/ BLE/ BT 3.0 & LoRa/ Sigfox can transmit simultaneously; the worst condition is Wi-Fi & LoRa, as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0536+0.0405=0.0941 < 1.0$$

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

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

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

Antenna Information

The EUT has an external antenna for Sigfox, which is with a unique connector, and the antenna gain is 0.87 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Antenna Model	Antenna Gain	Manufacture
WIESON GY115ZH017-001	0.87dBi	WIESON TECHNOLOGIES CO., LTD.

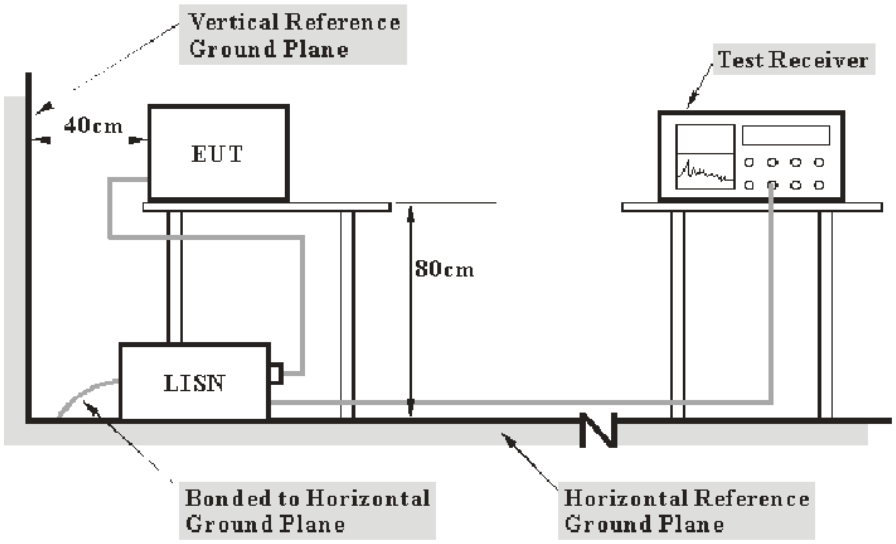
Result: Compliance.

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:

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

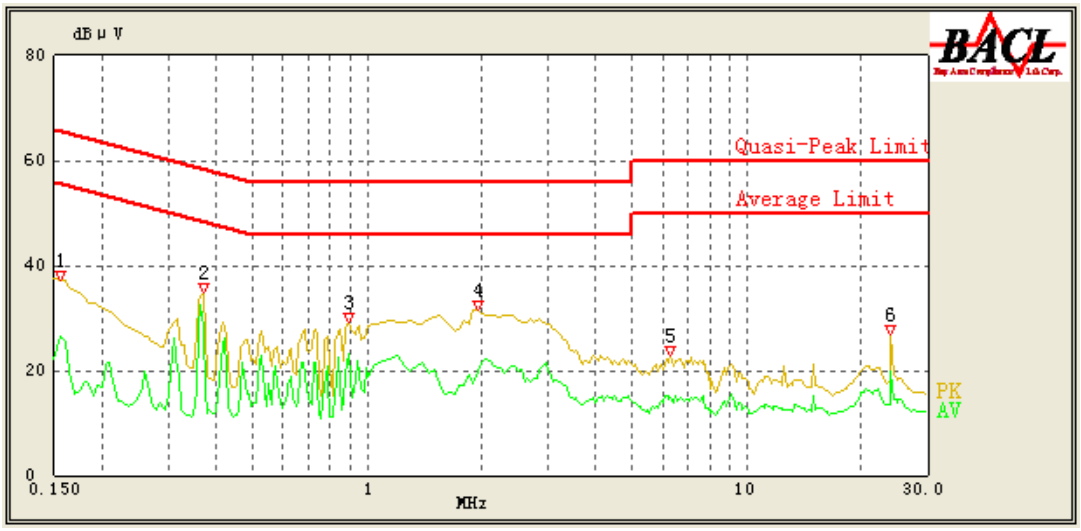
Environmental Conditions

Temperature:	23.4 ℃
Relative Humidity:	49 %
ATM Pressure:	101.1 kPa

The testing was performed by Max Min on 2018-12-23.

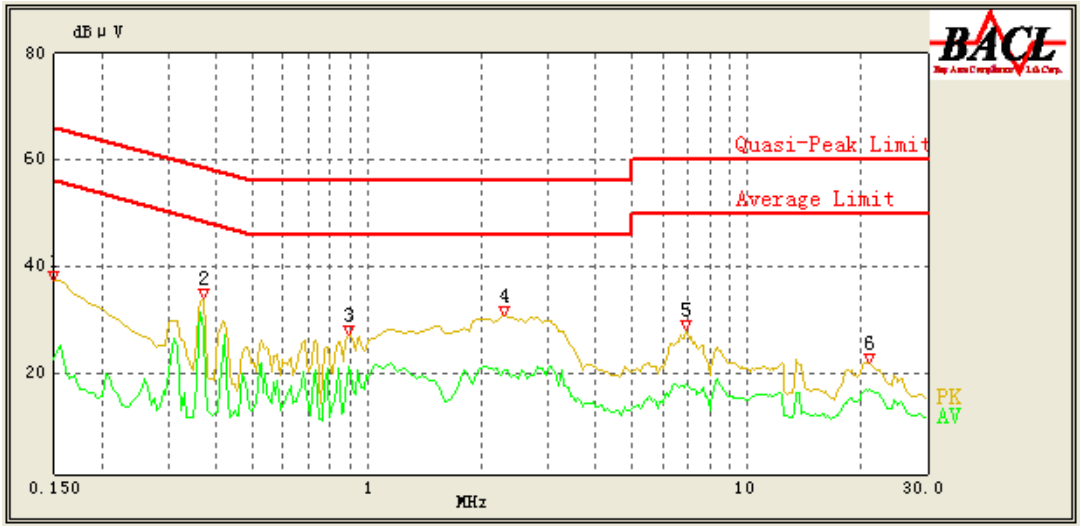
EUT operation mode: Transmitting in low channel (worst case)

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
0.155	37.16	QP	9.000	L1	16.06	65.73	28.57	Compliance
0.155	26.50	AV	9.000	L1	16.06	55.73	29.23	Compliance
0.370	34.83	QP	9.000	L1	16.05	58.50	23.67	Compliance
0.370	28.20	AV	9.000	L1	16.05	48.50	20.30	Compliance
0.895	29.06	QP	9.000	L1	15.90	56.00	26.94	Compliance
0.895	23.26	AV	9.000	L1	15.91	46.00	22.74	Compliance
1.950	31.59	QP	9.000	L1	15.85	56.00	24.41	Compliance
1.950	19.74	AV	9.000	L1	15.85	46.00	26.26	Compliance
6.300	22.75	QP	9.000	L1	15.93	60.00	37.25	Compliance
6.300	14.87	AV	9.000	L1	15.93	50.00	35.13	Compliance
24.000	26.87	QP	9.000	L1	16.46	60.00	33.13	Compliance
24.000	19.76	AV	9.000	L1	16.46	50.00	30.24	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
0.150	37.53	QP	9.000	N	16.06	66.00	28.47	Compliance
0.150	22.44	AV	9.000	N	16.06	56.00	33.56	Compliance
0.370	33.94	QP	9.000	N	16.08	58.50	24.56	Compliance
0.370	28.23	AV	9.000	N	16.08	48.50	20.27	Compliance
0.890	27.15	QP	9.000	N	15.96	56.00	28.85	Compliance
0.890	21.26	AV	9.000	N	15.96	46.00	24.74	Compliance
2.300	30.72	QP	9.000	N	15.91	56.00	25.28	Compliance
2.300	20.66	AV	9.000	N	15.91	46.00	25.34	Compliance
6.950	28.11	QP	9.000	N	15.92	60.00	31.89	Compliance
6.950	18.05	AV	9.000	N	15.92	50.00	31.95	Compliance
20.950	22.03	QP	9.000	N	16.18	60.00	37.97	Compliance
20.950	16.79	AV	9.000	N	16.17	50.00	33.21	Compliance

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

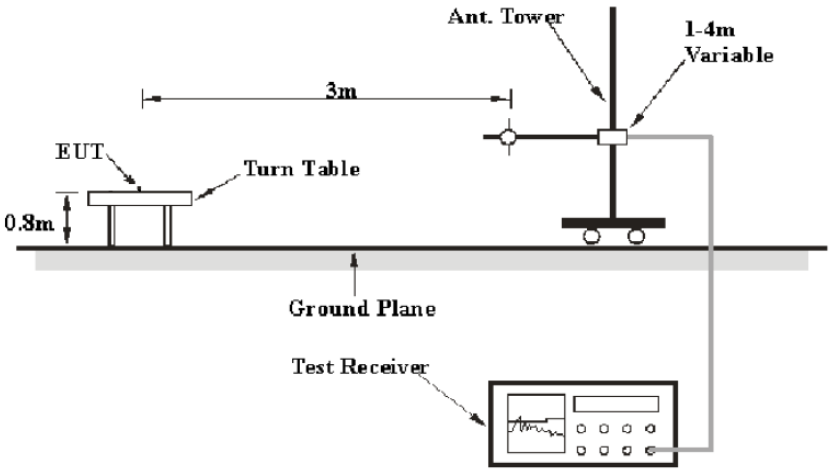
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

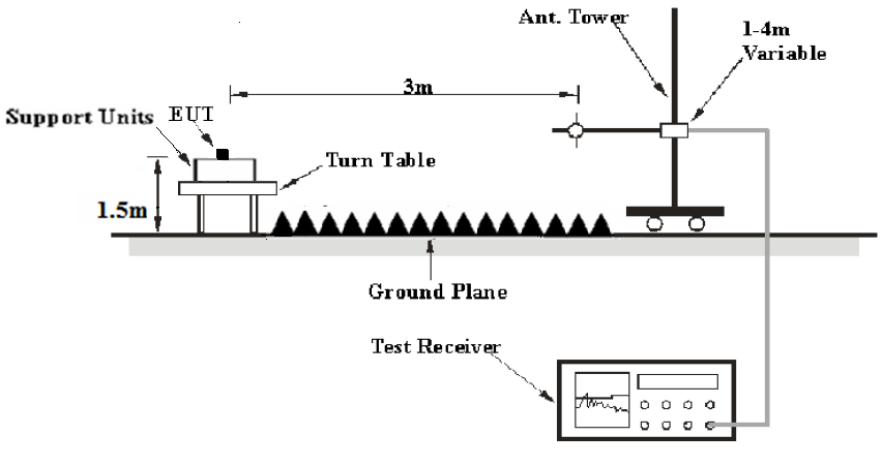
FCC §15.205; §15.209; §15.247(d)

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 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:	23.4 ℃
Relative Humidity:	49 %
ATM Pressure:	101.1 kPa

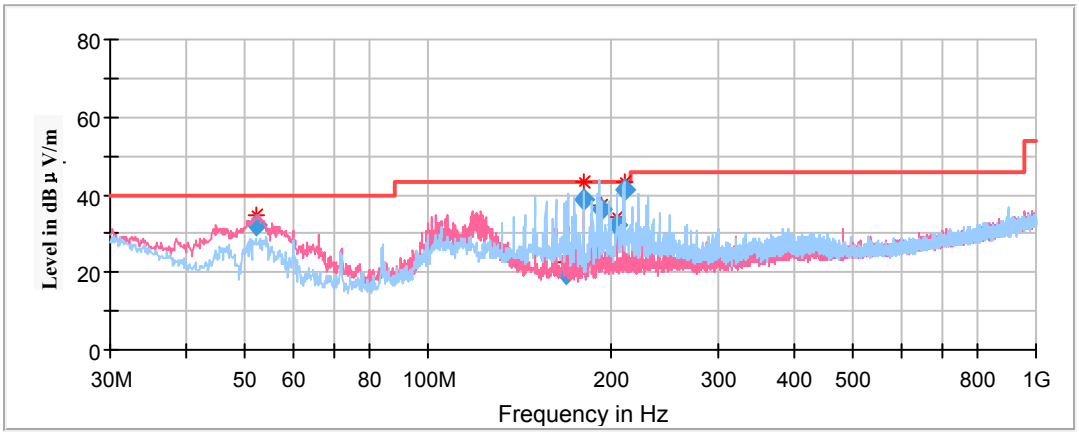
The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

Spurious Emission Test:

30MHz-1GHz:

*(Pre-scan with low, middle and high channels of operation in the X,Y and Z axes of orientation, the worst case **high channel of operation in X-axis of orientation** was recorded)*
Note:
1. This test was performed with the 902-928MHz notch filter.



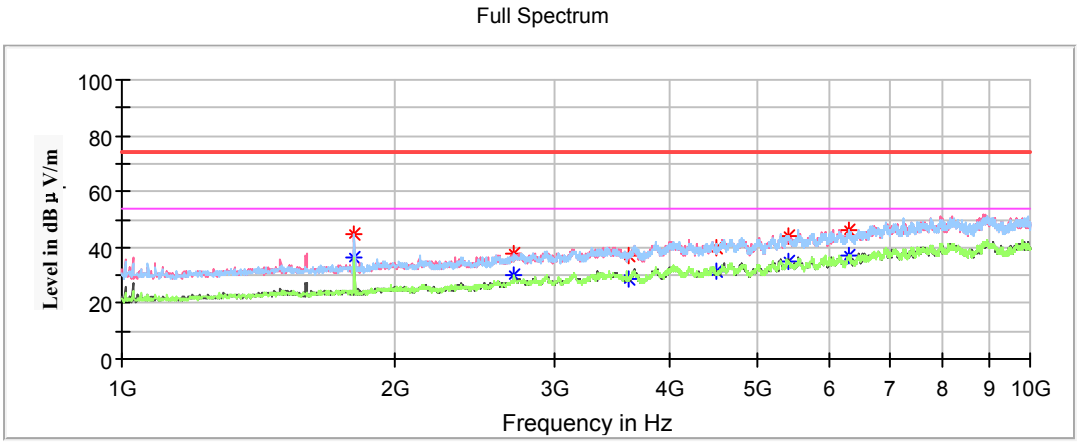
Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	Quasi-peak (dBµV/m)	Height (cm)	Polar (H/V)				
52.088100	32.09	101.0	V	80.0	-17.6	40.00	7.91
169.263050	19.68	101.0	H	34.0	-13.1	43.50	23.82
179.967450	38.60	101.0	H	29.0	-13.6	43.50	4.90
192.468050	36.25	101.0	H	60.0	-12.8	43.50	7.25
204.478950	32.33	199.0	H	143.0	-12.3	43.50	11.17
209.905950	41.09	199.0	H	143.0	-12.3	43.50	2.41

1GHz-10GHz:

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

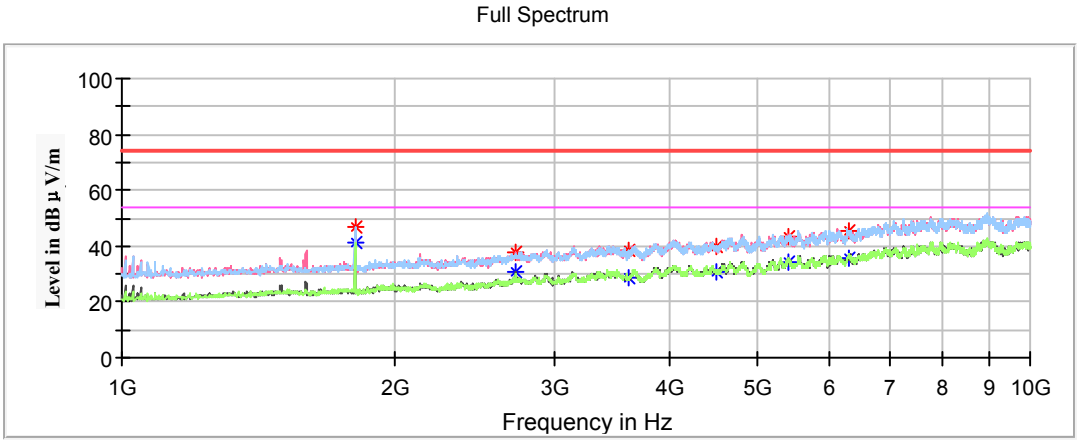
Note:
1. Corrected Factor (dB/m) = Antenna factor (RX) (dB/m) + Cable Loss (dB) – Amplifier Factor (dB) + Attenuator(dB)
   Corrected Amplitude (dBµV /m) = Corrected Factor (dB/m) + Reading (dBµV)
   Margin (dB) = Limit (dBµV/m) – Corrected Amplitude (dBµV /m)

Low Channel: 902.225 MHz



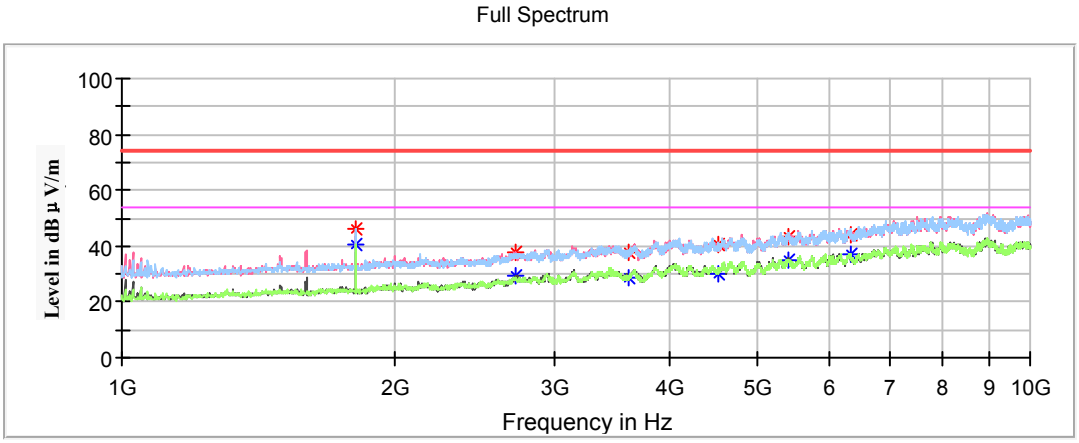
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1804.450000	44.61	---	100.0	H	45.0	-6.5	74.00	29.39
1804.450000	---	36.05	100.0	H	45.0	-6.5	54.00	17.95
2706.675000	37.78	---	150.0	H	86.0	-3.2	74.00	36.22
2706.675000	---	30.28	150.0	H	86.0	-3.2	54.00	23.72
3608.900000	---	28.64	200.0	V	357.0	-0.4	54.00	25.36
3608.900000	37.06	---	200.0	V	357.0	-0.4	74.00	36.94
4511.800000	39.63	---	200.0	V	224.0	1.5	74.00	34.37
4511.800000	---	31.48	200.0	V	224.0	1.5	54.00	22.52
5411.800000	---	34.78	100.0	H	197.0	3.6	54.00	19.22
5411.800000	44.08	---	100.0	H	197.0	3.6	74.00	29.92
6322.600000	---	36.75	200.0	H	3.0	6.0	54.00	17.25
6322.600000	46.50	---	200.0	H	3.0	6.0	74.00	27.50

Middle Channel: 903.450 MHz



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)				
1806.900000	---	41.24	200.0	H	274.0	-6.5	54.00	12.76
1806.900000	46.61	---	200.0	H	274.0	-6.5	74.00	27.39
2710.350000	37.64	---	200.0	V	90.0	-3.2	74.00	36.36
2710.350000	---	30.47	200.0	V	90.0	-3.2	54.00	23.53
3613.800000	---	28.93	100.0	H	180.0	-0.4	54.00	25.07
3613.800000	38.47	---	100.0	H	180.0	-0.4	74.00	35.53
4517.200000	---	31.04	200.0	H	80.0	1.5	54.00	22.96
4517.200000	39.63	---	200.0	H	80.0	1.5	74.00	34.37
5420.800000	---	34.04	100.0	V	270.0	3.7	54.00	19.96
5420.800000	43.33	---	100.0	V	270.0	3.7	74.00	30.67
6324.400000	---	35.84	150.0	V	76.0	6.0	54.00	18.16
6324.400000	45.18	---	150.0	V	76.0	6.0	74.00	28.82

High Channel: 904.675MHz



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)				
1809.350000	---	40.28	100.0	H	258.0	-6.5	54.00	13.72
1809.350000	46.12	---	100.0	H	258.0	-6.5	74.00	27.88
2714.025000	37.54	---	200.0	V	189.0	-3.2	74.00	36.46
2714.025000	---	29.12	200.0	V	189.0	-3.2	54.00	24.88
3618.700000	---	28.74	150.0	H	260.0	-0.4	54.00	25.26
3618.700000	37.55	---	150.0	H	260.0	-0.4	74.00	36.45
4526.200000	---	30.23	100.0	V	325.0	1.5	54.00	23.77
4526.200000	40.62	---	100.0	V	325.0	1.5	74.00	33.38
5428.000000	43.68	---	200.0	H	270.0	3.7	74.00	30.32
5428.000000	---	35.02	200.0	H	270.0	3.7	54.00	18.98
6331.600000	44.26	---	100.0	H	307.0	6.0	74.00	29.74
6331.600000	---	37.31	100.0	H	307.0	6.0	54.00	16.69

Fundamental Test & Restricted Bands Emissions:

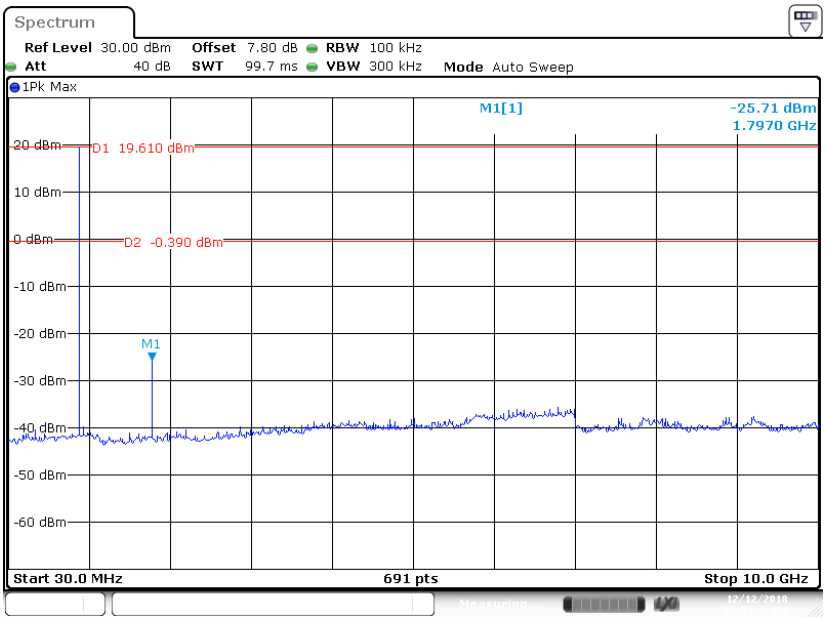
*Pre-Scan in the X,Y and Z axes of orientation,, the worst case **X-axis of orientation** was recorded*

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 (dBμV /m)	Detector (PK/QP/Ave.)	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
			Height (cm)	Polar (H/V)				
902.225MHz								
902.225000	114.85	PK	150	V	251	0.21	/	/
902.225000	113.56	PK	150	H	251	0.21	/	/
902.000000	37.56	QP	100	V	220	0.2	46	8.44
902.000000	36.15	QP	100	H	220	0.2	46	9.85
903.450MHz								
903.450000	114.91	PK	150	V	140	0.23	/	/
903.450000	113.63	PK	150	H	140	0.23	/	/
904.675MHz								
904.675000	114.83	PK	100	V	281	0.26	/	/
904.675000	113.51	PK	100	H	281	0.26	/	/
928.000000	34.78	QP	200	V	240	0.75	46	11.22
928.000000	33.53	QP	200	H	240	0.75	46	12.47

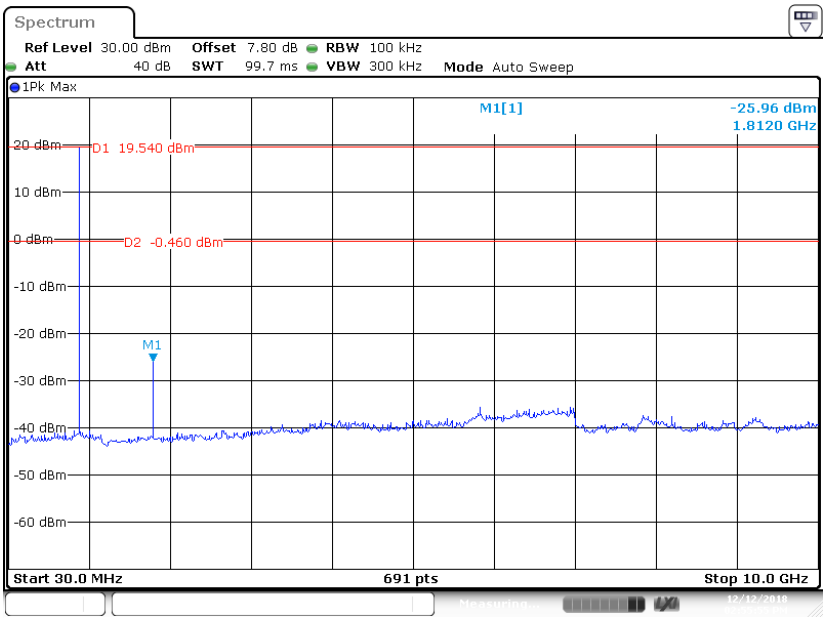
Spurious Emissions at Antenna Port:

Low Channel



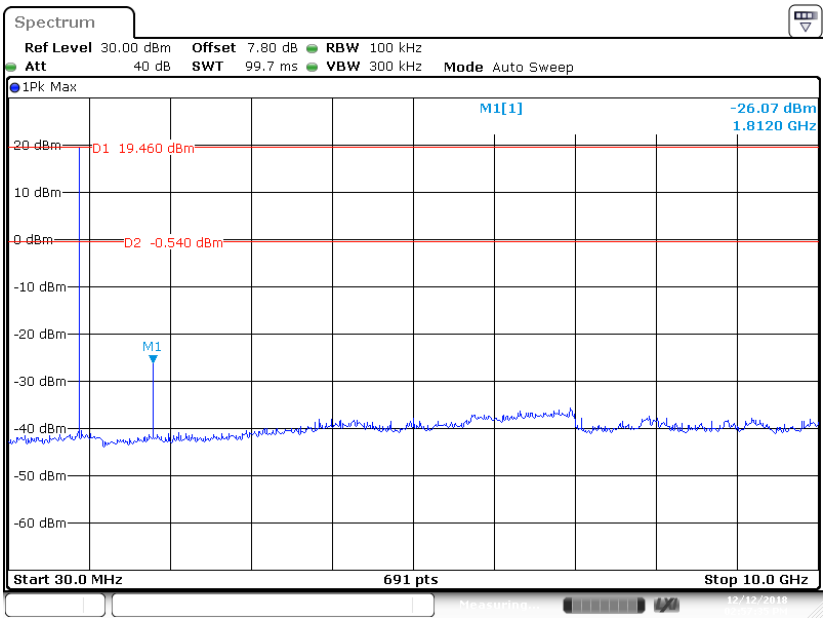
Date: 12.DEC.2018 14:53:46

Middle Channel



Date: 12.DEC.2018 14:55:55

High Channel



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

Applicable Standard

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

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

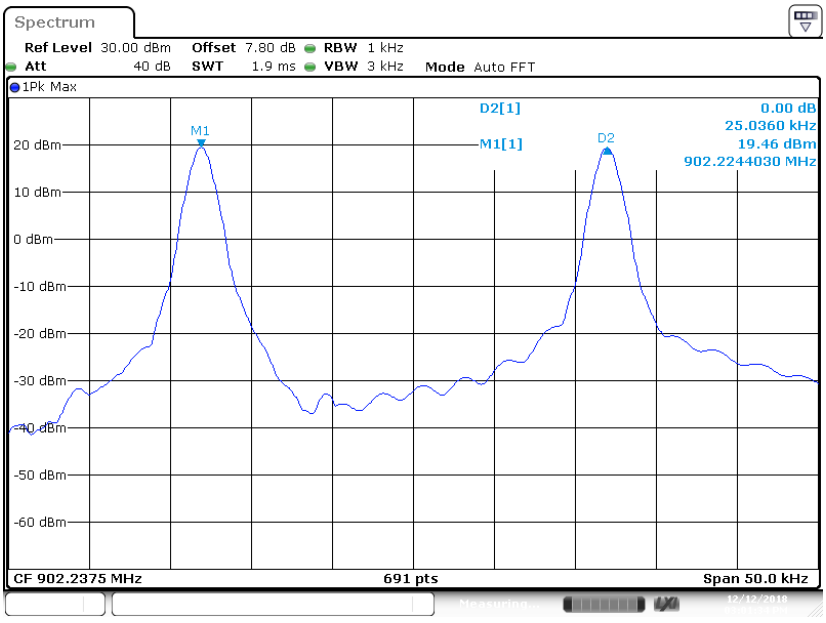
The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

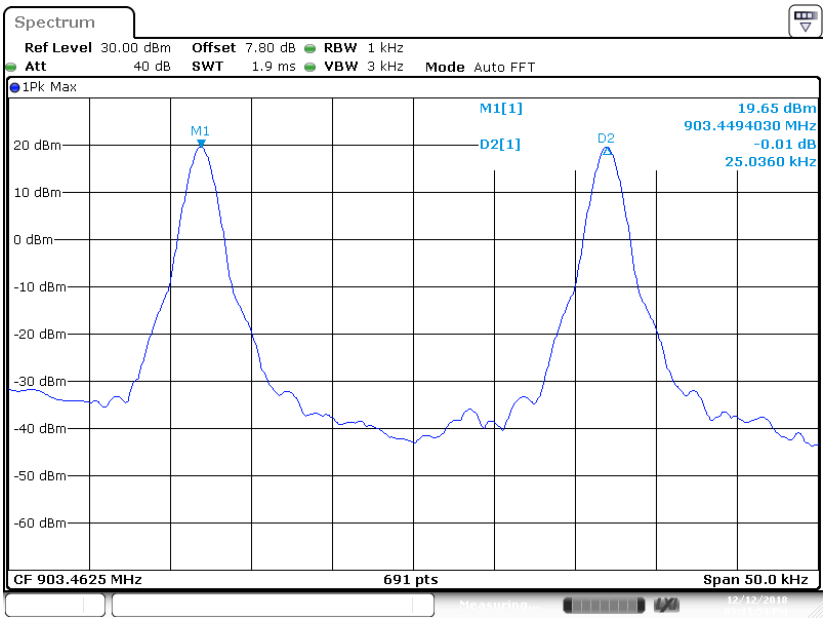
Test Result: Compliance.

Channel	Frequency (MHz)	Channel Separation (kHz)	Limit (kHz)	Result
Low	902.225	25.036	≥25	Pass
Adjacent	902.250			
Middle	903.450	25.036	≥25	Pass
Adjacent	903.475			
Adjacent	904.650	25.036	≥25	Pass
High	904.675			

Low Channel

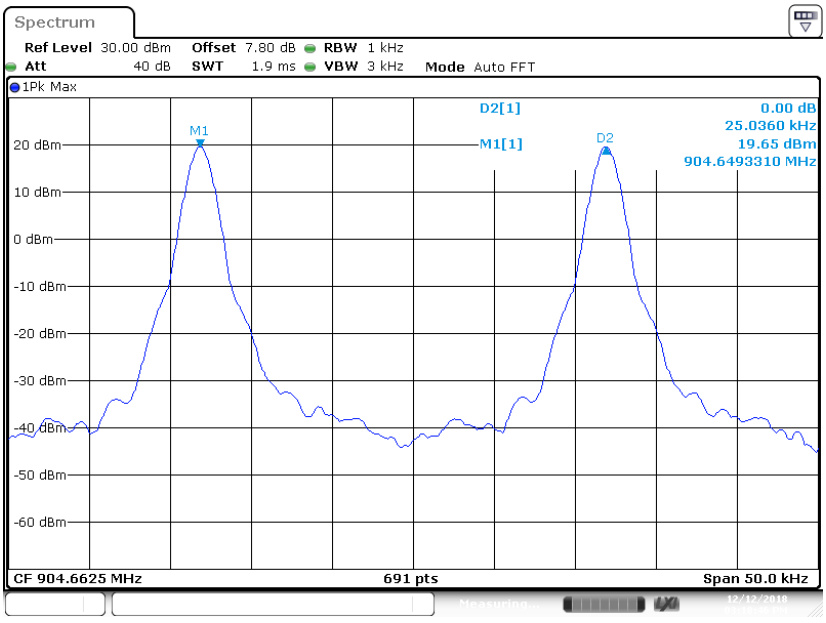


Middle Channel



Date: 12.DEC.2018 15:11:51

High Channel



Date: 12.DEC.2018 15:18:46

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

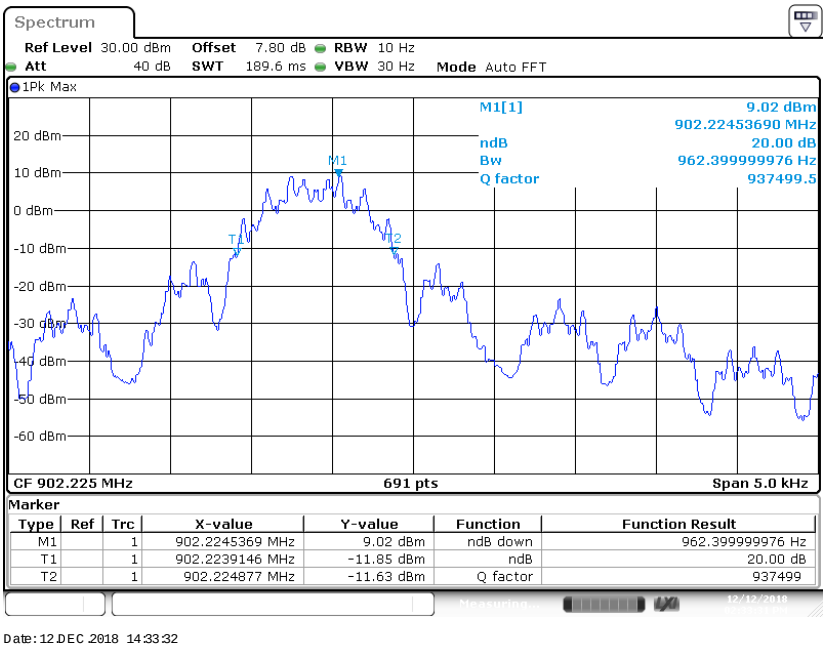
The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

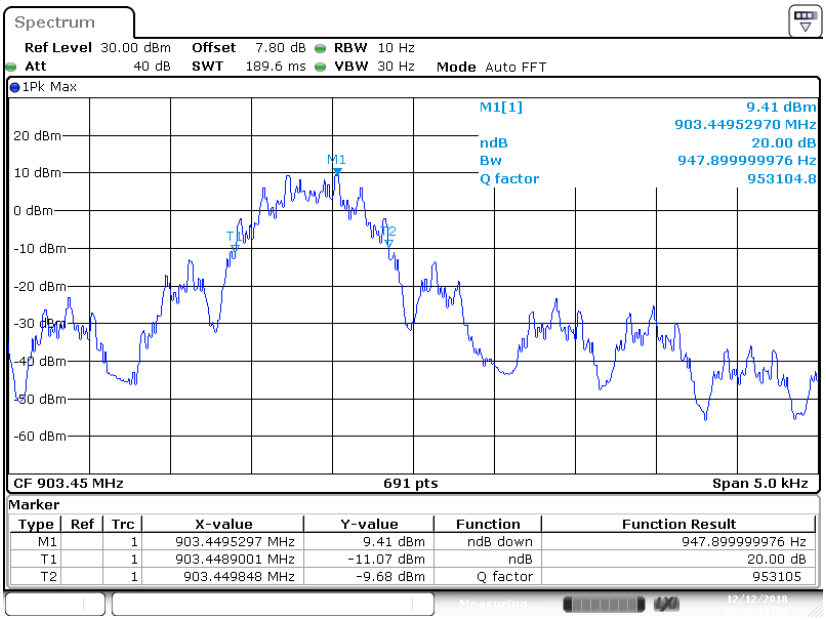
Test Result: Compliance.

Channel	Frequency (MHz)	20 dB Emission Bandwidth (kHz)	Limit (kHz)
Low	902.225	0.962	≤500
Middle	903.450	0.948	≤500
High	904.675	0.955	≤500

Low Channel

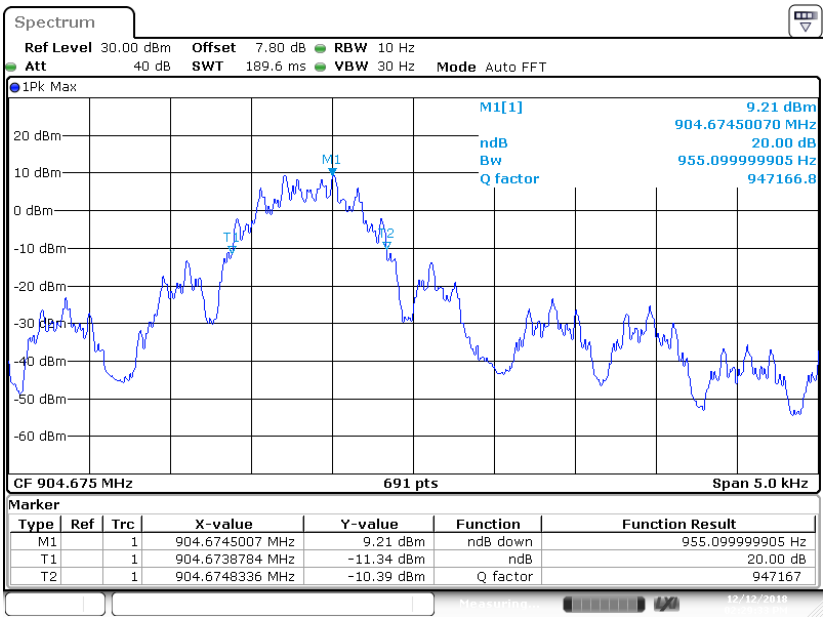


Middle Channel



Date: 12.DEC.2018 14:32:14

High Channel



Date: 12.DEC.2018 14:29:34

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

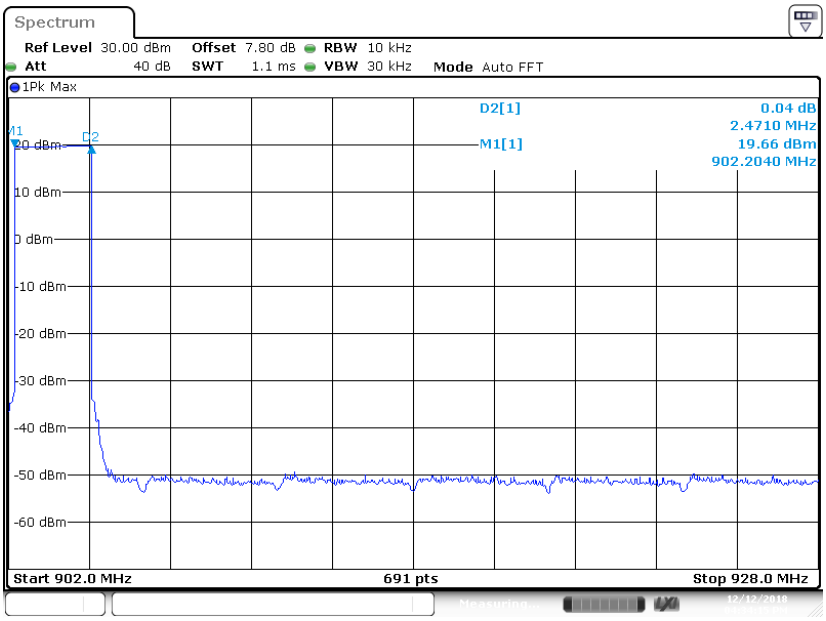
The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

Test Result: Compliance.

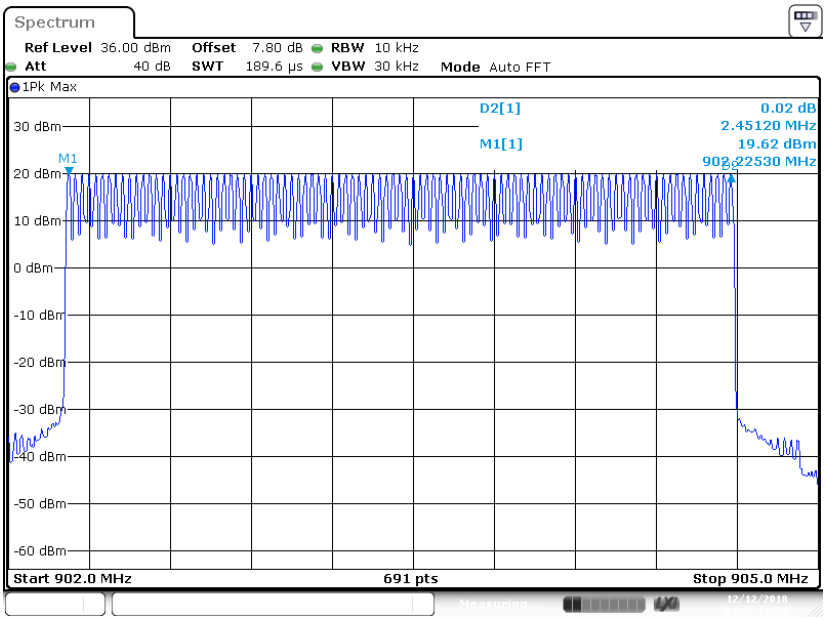
Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
902~928	99	≥50

Number of Hopping Channels



Date: 12.DEC.2018 16:34:15

Number of Hopping Channels



Date: 12.DEC.2018 16:42:44

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

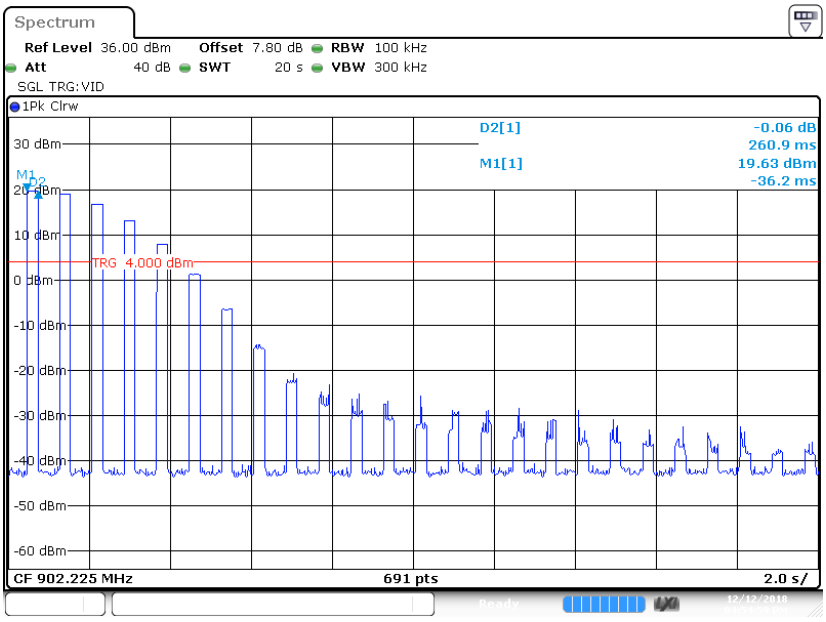
The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

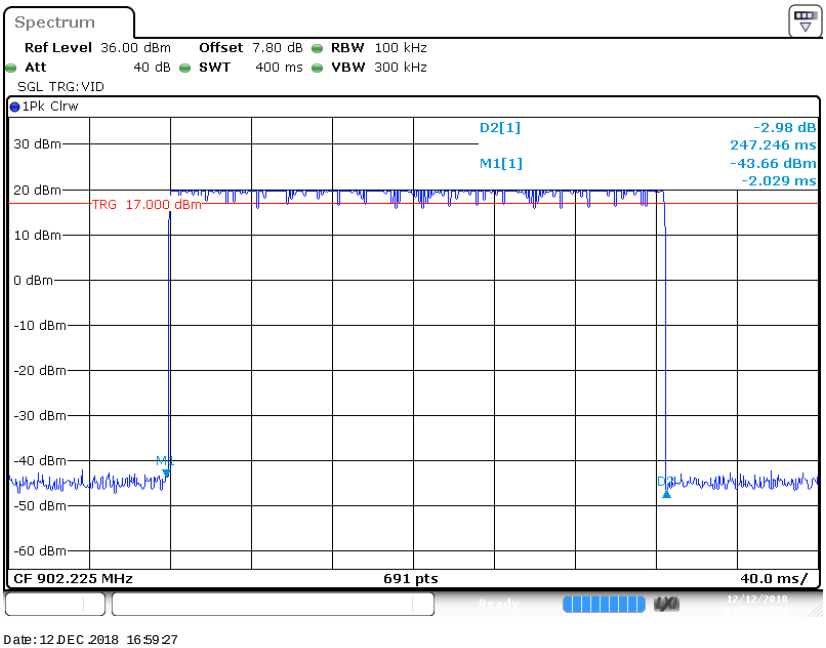
Test Result: Compliance.

Channel	Pulse Width (ms)	Pulse Number	Dwell Time (s)	Limit (s)	Result
Low	247.2	1	0.2472	≤0.4	Pass
Middle	247.5	1	0.2475	≤0.4	Pass
High	248.1	1	0.2481	≤0.4	Pass
Note:Dwell time = Pulse time*N					

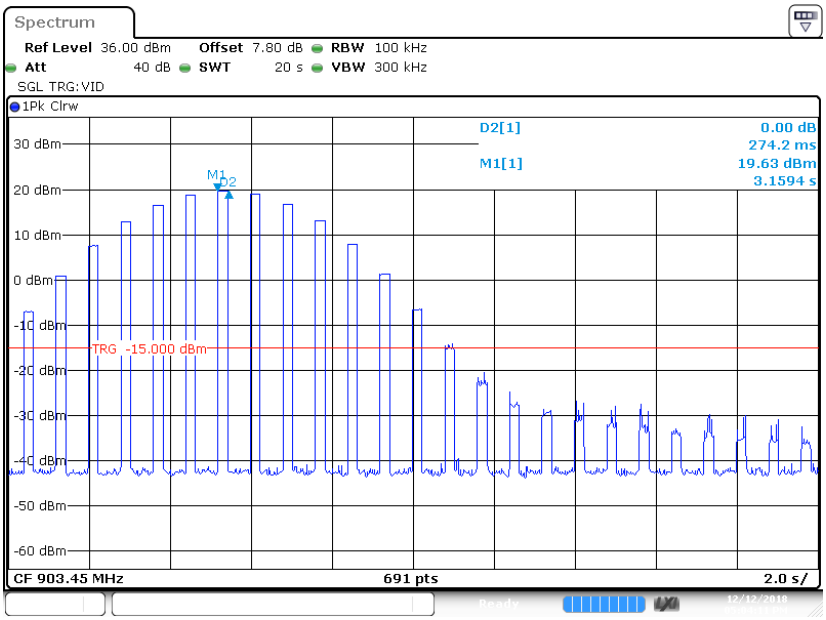
Low Channel



Note: *The lower power level pulse near the highest level pusle is the adjacent channel.*

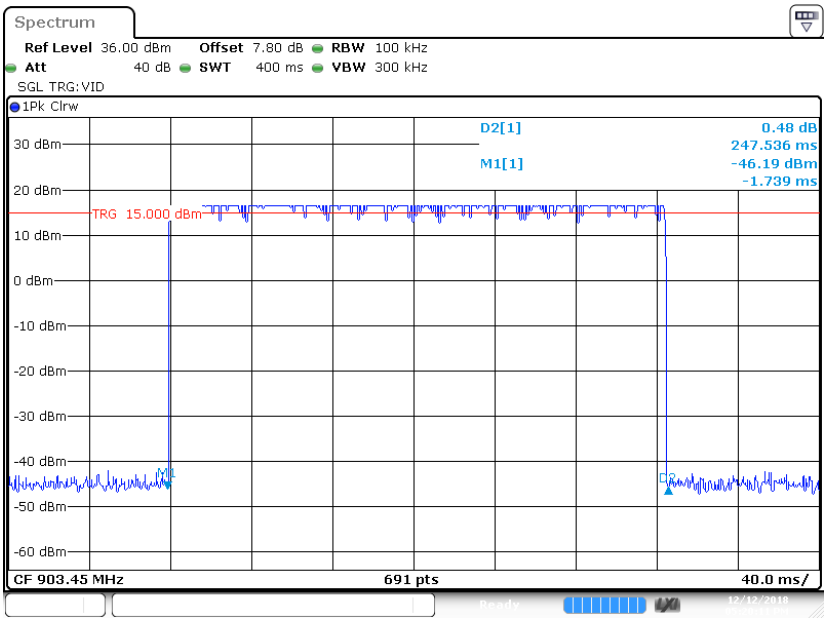


Middle Channel



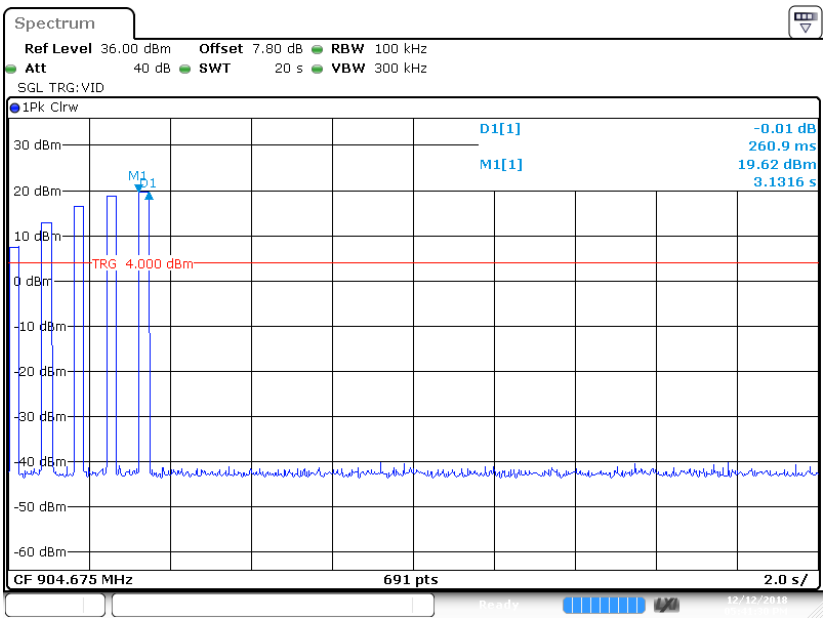
Date: 12.DEC.2018 17:04:12

Note: *The lower power level pulse near the highest level pusle is the adjacent channel.*



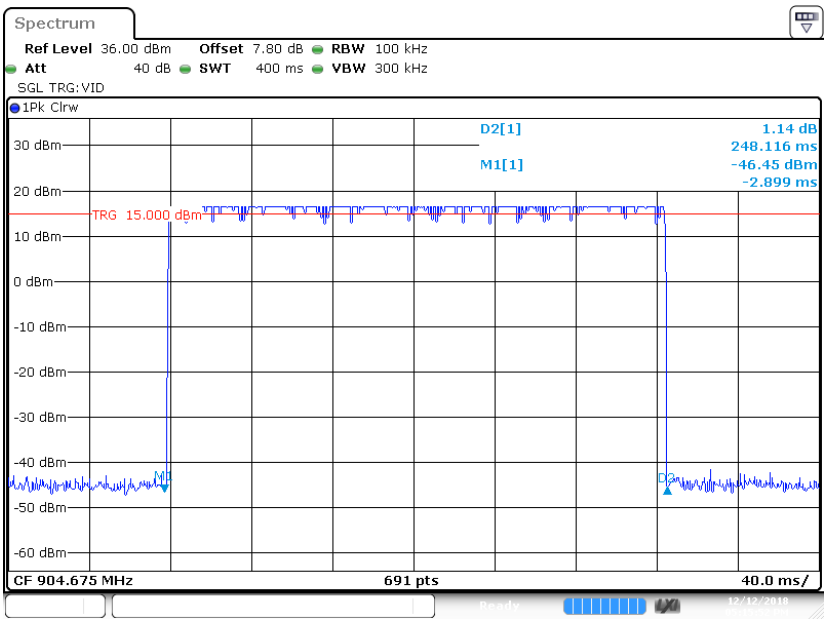
Date: 12.DEC.2018 17:20:12

High Channel



Date: 12.DEC.2018 17:41:31

Note: *The lower power level pulse near the highest level pusle is the adjacent channel.*



Date: 12.DEC.2018 17:15:52

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 Max Min on 2018-12-12.

EUT operation mode: Transmitting

Test Result: Compliance.

Channel	Peak Conducted Output Power		Limit (mW)
	(dBm)	(mW)	
Low	19.71	93.54	≤1000
Middle	19.72	93.76	≤1000
High	19.73	93.97	≤1000

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

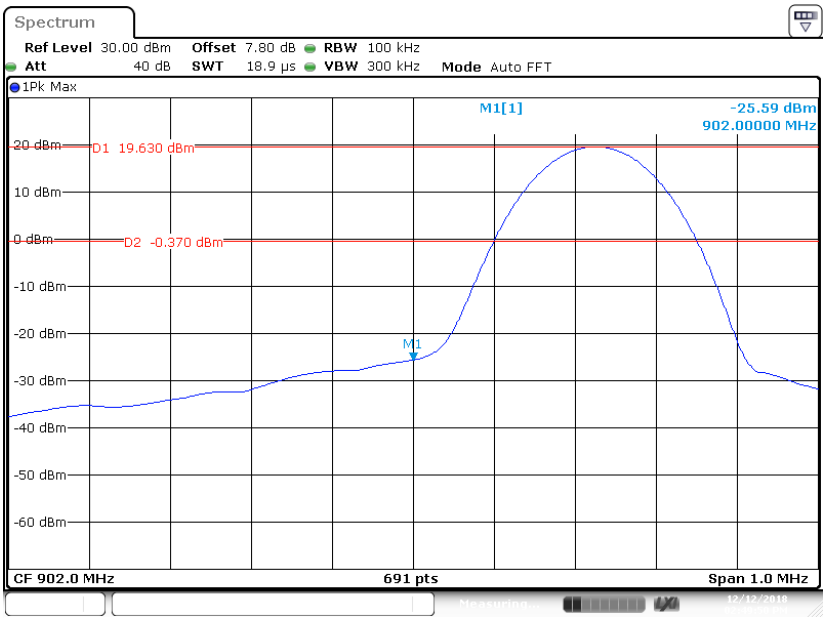
Temperature:	24 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Max Min on 2018-12-12.

EUT operation mode: Transmitting

Test Result: Compliance.

Band Edge-Left Side



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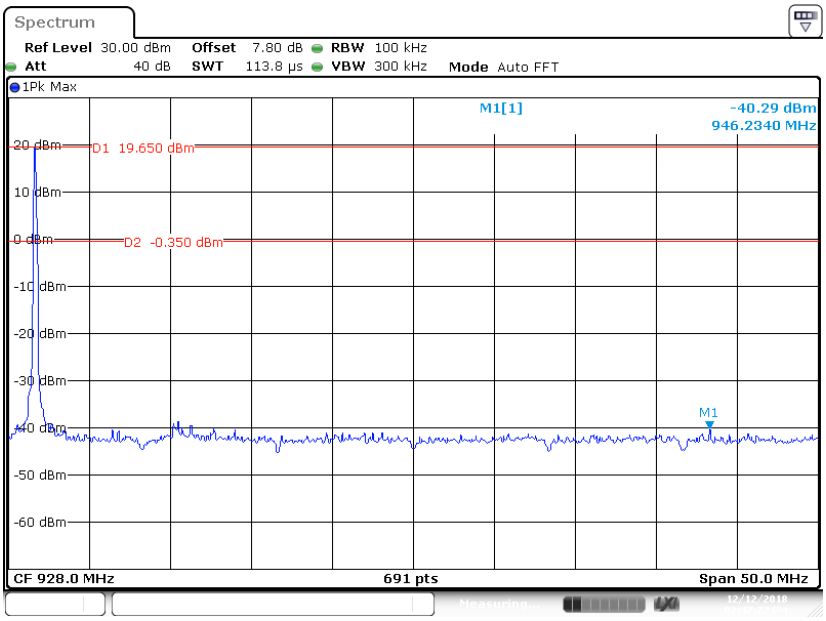
Band Edge-Right Side



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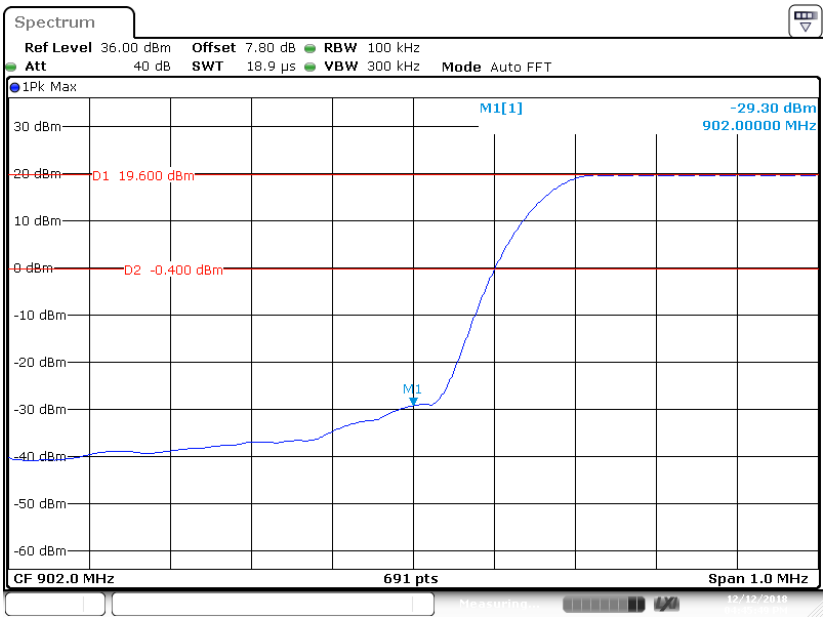
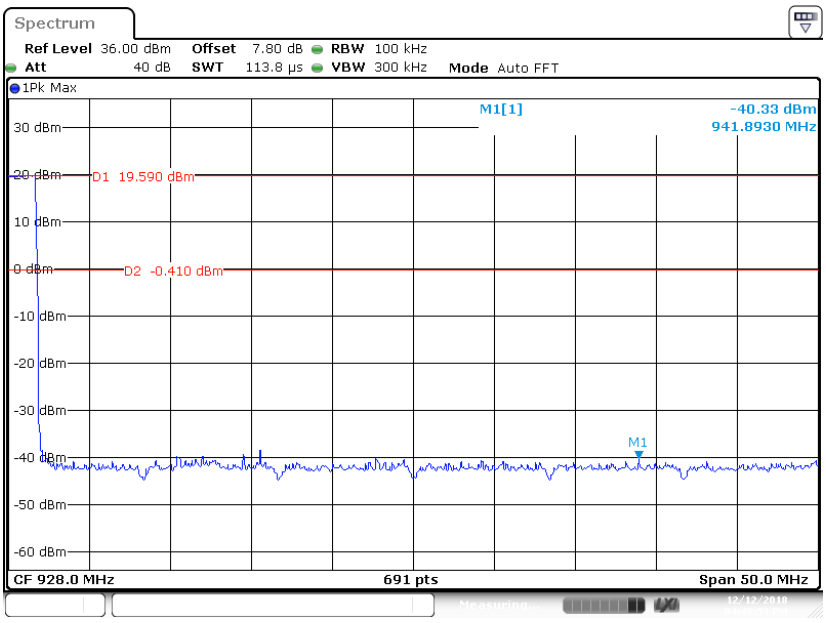
Band Edge-Left Side (Hopping)



Band Edge-Right Side (Hopping)



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