



Report No.: HKEM180600037201

Page: 1 of 61

FCC ID: 2AP8YEBHUB

TEST REPORT

Application No.:	HKEM1806000372AV
Applicant:	ENERGYBOX LIMITED
FCC ID:	2AP8YEBHUB
Product Description:	Gateway
Model No.:	EB/HUB-00/01
Country of Origin:	China
Country of Destination:	US
Standards:	47 CFR Part 15, Subpart C 15.247
Date of Receipt:	2018-06-01
Date of Test:	2018-06-14 to 2018-06-15, 2018-11-08
Date of Issue:	2018-11-08
Test Result :	Pass*

- * In the configuration tested, the EUT detailed in this report complied with the standards specified above. Please refer to section 3 of this report for further detail.

Authorized Signature:

CHEN Jian-feng, Jeffrey

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government. All test results in this report can be traceable to National or International Standards.

This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <http://www.sgs.com/en/Terms-and-Conditions/Terms-e-Document.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

2 Test Summary

Test	Test Requirement	Test method	Result
Antenna Requirement	FCC PART 15 C section 15.247 (c) and Section 15.203	FCC PART 15 C section 15.247 (c) and Section 15.203	PASS
Occupied Bandwidth	FCC PART 15 C section 15.247 (a)(1)	ANSI C63.10: Clause 6.9.1	PASS
Carrier Frequencies Separated	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10: Clause 7.8.2	PASS
Hopping Channel Number	FCC PART 15 C section 15.247(a)(1)(iii)	ANSI C63.10: Clause 7.8.3	PASS
Dwell Time	FCC PART 15 C section 15.247(a)(1)(iii)	ANSI C63.10: Clause 7.8.4	PASS
Pseudorandom Frequency Hopping Sequence	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10: Clause 7.7.5	PASS
Maximum Peak Output Power	FCC PART 15 C section 15.247(b)(1)	ANSI C63.10: Clause 7.8.5	PASS
Conducted Spurious Emission	FCC PART 15 C section 15.247(d)	ANSI C63.10: Clause 7.8.8	PASS
Radiated Spurious Emission	FCC PART 15 C section 15.247(d)	ANSI C63.10: Clause 6.10.4	PASS
Band Edges Measurement	FCC PART 15 C section 15.247 (d) &15.205	ANSI C63.10: clause 7.8.6	PASS

3 Contents

1 COVER PAGE	1
2 TEST SUMMARY	2
3 CONTENTS.....	3
4 GENERAL INFORMATION	4
4.1 Client Information	4
4.2 General Description of E.U.T.	4
4.3 Details of E.U.T.	4
4.4 Modulation configure	5
4.5 Description of Support Units	5
4.6 Deviation from Standards	5
4.7 Abnormalities from Standard Conditions	5
4.8 Other Information Requested by the Customer	5
4.9 Test Location	5
4.10 Test Facility	6
4.11 Measurement Uncertainty (95% confidence levels, k=2).....	6
5 EQUIPMENT USED DURING TEST	7
6 TEST RESULTS	9
6.1 E.U.T. test conditions.....	9
6.2 Antenna Requirement.....	13
6.3 Occupied Bandwidth	19
6.4 Carrier Frequencies Separated.....	23
6.5 Hopping Channel Number.....	27
6.6 Dwell Time	29
6.7 Pseudorandom Frequency Hopping Sequence	34
6.8 Maximum Peak Output Power.....	36
6.9 Conducted Spurious Emissions	40
6.10 Radiated Spurious Emissions	46
6.11 Band Edges Requirement	58
7 PHOTOGRAPHS	60
7.1 Radiated Spurious Emission Test Setup	60
8 EUT CONSTRUCTIONAL DETAILS	61

4 General Information

4.1 Client Information

Applicant: ENERGYBOX LIMITED
Address of Applicant: 8F, Green 18, Hong Kong Science Park,
Shatin, N.T., Hong Kong.

4.2 General Description of E.U.T.

Product Name: Gateway
Model No.: EB/HUB-00/01

4.3 Details of E.U.T.

Operating Frequency 903 MHz to 927 MHz
Type of Modulation: GFSK
Number of Channels 121 Channels
Channel Separation: 200 kHz
Dwell time Per channel is less than 0.4s.
Antenna Type Integral
Antenna gain: 3 dBi
Speciality: --
--
Function: Gateway
Power Supply: AC120V ~ 60Hz to DC 5V
Adapter: SAPA05010US
Power cord: None.

Remark: The device meets the requirements stated within Parts 15.247(g) & (h) in that they were developed under the protocol and operate as a true frequency hopping system. The device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

4.4 Modulation configure

None.

4.5 Description of Support Units

The EUT has been tested as an independent unit for fixed frequency by testing lab.

4.6 Deviation from Standards

Biconical and log periodic antennas were used instead of dipole antennas.

4.7 Abnormalities from Standard Conditions

None.

4.8 Other Information Requested by the Customer

None.

4.9 Test Location

All tests were performed at:

SGS IECC Limited (Member of the SGS Group (SGS SA))

No. 16-B, Yip Wo Street, On Lok Tsuen, Fanling, N.T., Hong Kong

Tel: +852 2305 2570 Fax: +852 2756 4480.

No tests were sub-contracted.

4.10 Test Facility

The test facility is recognized or accredited by the following organizations:

- **HOKLAS (Lab Code: 125)**

SGS IECC Limited has been accepted by HKAS Executive, on the recommendation of the Accreditation Advisory Board, as a HOKLAS Accredited Laboratory, this laboratory meets the requirements of ISO/IEC 17025:2005 and it has been accredited for performing specific test as listed in the scope of accreditation within the test category of Electrical and Electronic Products.

- **FCC Recognized Accredited Test Firm(CAB Registration No.: 446297)**

SGS IECC Limited has been accredited and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation Number: HK0010, Test Firm Registration Number: 446297.

- **Industry Canada (Registration No.: 5193A-2)**

The 3m Alternative Semi-anechoic chamber of SGS IECC Limited has been registered by Certification and Engineering of Industry Canada for radio equipment testing with Registration No. **5193A-2**.

4.11 Measurement Uncertainty (95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	Radio frequency	$\pm 7.25 \times 10^{-8}$
2	RF power (conducted)	$\pm 0.75\text{dB}$
3	Radiated Spurious emission	$\pm 4.5\text{dB}$ (30MHz-1GHz)
		$\pm 4.8\text{dB}$ (1GHz-25GHz)
4	Temperature test	$\pm 1^\circ\text{C}$
5	Humidity test	$\pm 3\%$
6	DC and low frequency voltages test	$\pm 0.5\%$

5 Equipment Used during Test

Radiated Emission			
Equipment	Manufacturer	Model / Serial No.	Cal. Due Date
3m Semi-Anechoic Chamber	ChamPro	N/A	2020/09/14
Test Receiver	Rohde & Schwarz	ESCS 30 / 100388	2019/09/26
EMI Test Receiver	Rohde & Schwarz	ESR3	2019/08/15
Signal Generator	Rohde & Schwarz	SMT03 / 832939/017	2019/06/04
Spectrum Analyzer	Rohde & Schwarz	FSP 30 / 101474	2019/05/30
Loop Antenna	Rohde & Schwarz	HFH2-Z2 / 871336/48	2019/01/22
Antenna 30-1000MHz	Schaffner	CBL6111C / 2791	2019/10/26
Antennas (30MHz-300MHz)	Schwarzbeck	BBA9106, VHA9103	2019/11/14
Log-periodic Antennas (300MHz-1000MHz)	Schwarzbeck	UHALP9107	2019/11/14
Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D / 9120D-1070	2019/01/22
Double Ridge Horn Antenna 2-18 GHz	Schwarzbeck	BBHA 9120 C	2020/03/13
Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170 / 9170-492	2019/11/23
Highpass Filter	Wainwright	WHNX3.5/26.5G-6SS / nil	2018/12/18
Band Reject Filter	Wainwright	WRCJV 2400/2500-2100/2800-40/3SS / nil	2018/12/18
Preamplifier 10MHz – 6GHz	Schwarzbeck	BBV9743 / 9743-052	2019/04/18
Preamplifier 1-18GHz	Schwarzbeck	BBV9718 / 9718-223	2019/01/22
Preamplifier 18-26.5GHz	Schwarzbeck	BBV9719 / 9719-019	2019/11/18
Coaxial Cable	--	E167	2019/10/09
RF Cable	HUBER+SUHNER	E207	2019/11/16
Boresight Mast Controller	ChamPro	AM-BS-4500-E / 060860-ABS	--
Turntable with Controller	ChamPro	EM1000 / 60860	--

Conducted Emission

Equipment	Manufacturer	Model / Serial No.	Calibration Due
Test Receiver	Rohde & Schwarz	ESHS 30 / 839667/002	2019/09/26
Signal Generator	Rohde & Schwarz	SMT03 / 832939/017	2019/06/04
Artificial Mains Network (LISN)	Schwarzbeck	NSLK 8127 / 8127309	2019/09/26
Impulse Limiter	Rohde & Schwarz	ESH-3-Z2 / 357881052	2019/01/22

RF Conducted

Equipment	Manufacturer	Model / Serial No.	Cal. Due Date
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	2019/08/12
OSP	Rohde & Schwarz	OSP-B157W8	2019/09/17
FSV40 SIGNAL ANALYZER 40GHz	Rohde & Schwarz	FSV40	2019/08/12
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	2019/08/12
Cable	Rohde & Schwarz	J12J103539-00-2	2019/08/12

6 Test Results

6.1 E.U.T. test conditions

Test Voltage: AC120V
Temperature: 20.0 -25.0 °C
Humidity: 38-50 % RH
Atmospheric Pressure: 1000 -1010 mbar
Requirements:

15.31(e): For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

15.32: Power supplies and CPU boards used with personal computers and for which separate authorizations are required to be obtained shall be tested as follows: Testing shall be in accordance with the procedures specified in Section 15.31 of this part.

Test frequencies and frequency range:

According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

According to the 15.33 (a) For an intentional radiator, the spectrum shall be investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to at least the frequency shown in the following table:

Number of fundamental frequencies to be tested in EUT transmit band

Frequency range in which device operates	Number of frequencies	Location in frequency range of operation
1 MHz or less	1	Middle
1 MHz to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom

Frequency range of radiated emission measurements

Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified

EUT channels and frequencies list:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	--	46	911.4	92	920.6
1	--	47	911.6	93	920.8
2	--	48	911.8	94	921.0
3	--	49	912.0	95	921.2
4	903.0	50	912.2	96	921.4
5	903.2	51	912.4	97	921.6
6	903.4	52	912.6	98	921.8
7	903.6	53	912.8	99	922.0
8	903.8	54	913.0	100	922.2
9	904.0	55	913.2	101	922.4
10	904.2	56	913.4	102	922.6
11	904.4	57	913.6	103	922.8
12	904.6	58	913.8	104	923.0
13	904.8	59	914.0	105	923.2
14	905.0	60	914.2	106	923.4
15	905.2	61	914.4	107	923.6
16	905.4	62	914.6	108	923.8
17	905.6	63	914.8	109	924.0
18	905.8	64	915.0	110	924.2
19	906.0	65	915.2	111	924.4
20	906.2	66	915.4	112	924.6
21	906.4	67	915.6	113	924.8
22	906.6	68	915.8	114	925.0
23	906.8	69	916.0	115	925.2
24	907.0	70	916.2	116	925.4
25	907.2	71	916.4	117	925.6
26	907.4	72	916.6	118	925.8
27	907.6	73	916.8	119	926.0
28	907.8	74	917.0	120	926.2
29	908.0	75	917.2	121	926.4

30	908.2	76	917.4	122	926.6
31	908.4	77	917.6	123	926.8
32	908.6	78	917.8	124	927.0
33	908.8	79	918.0	125	--
34	909.0	80	918.2	126	--
35	909.2	81	918.4	127	--
36	909.4	82	918.6	128	--
37	909.6	83	918.8	/	/
38	909.8	84	919.0	/	/
39	910.0	85	919.2	/	/
40	910.2	86	919.4	/	/
41	910.4	87	919.6	/	/
42	910.6	88	919.8	/	/
43	910.8	89	920.0	/	/
44	911.0	90	920.2	/	/
45	911.2	91	920.4	/	/

Test frequencies are the lowest channel: 4 channel(903.0 MHz), middle channel: 64 channel(915.0 MHz) and highest channel: 124 channel(927.0 MHz)

6.2 Antenna Requirement

Standard requirement

15.203 requirement:

For intentional device. 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.

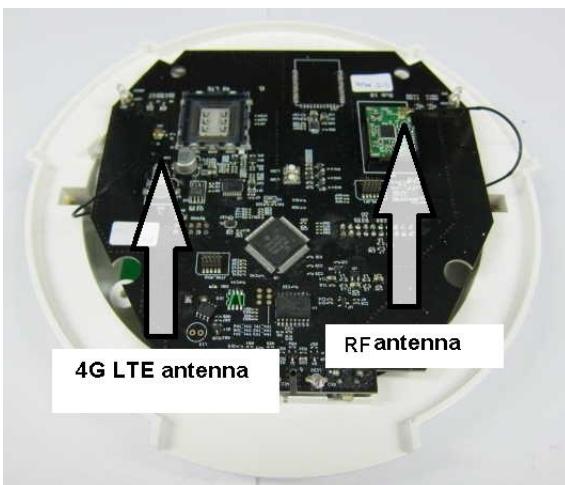
15.247(c) (1)(i) requirement:

(i) Systems operating in the 2400-2483.5 MHz bands that are used exclusively for fixed.

Point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna

The antenna is integrated on the main PCB and no consideration of replacement. The maximum gain of the antenna is 3 dBi.



Test result: The unit does meet the FCC requirements.

6.3 Conducted Disturbance at AC Power Line(150kHz-30MHz)

Test Requirement 47 CFR Part 15, Subpart C 15.207

Test Method: ANSI C63.10 (2013) Section 6.2

Limit:

Frequency of emission(MHz)	Conducted limit(dB μ V)
----------------------------	-----------------------------

	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

6.3.1 E.U.T. Operation

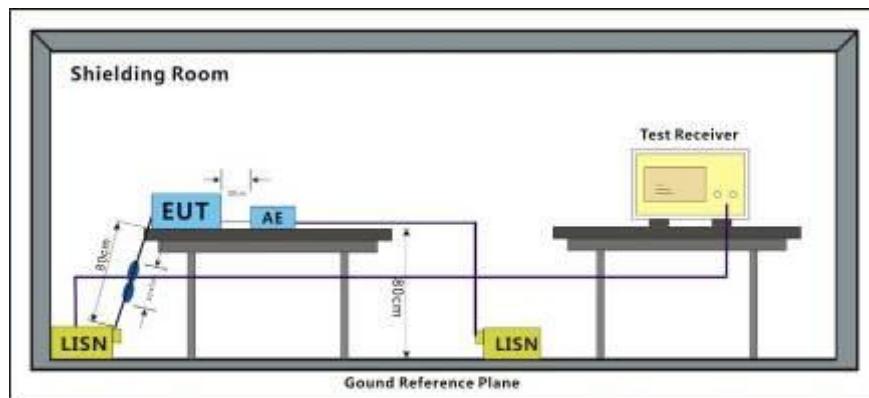
Operating Environment:

Temperature: 25.0 °C Humidity: 55 % RH Atmospheric Pressure: 1015 mbar

Test mode Pre-test the EUT in continuous transmitting mode at the lowest (903MHz), middle (915 MHz) and highest (927 MHz) channel.

The worst case Final test the EUT in continuous transmitting mode at middle (915 MHz) channel as for final test: worst case mode.

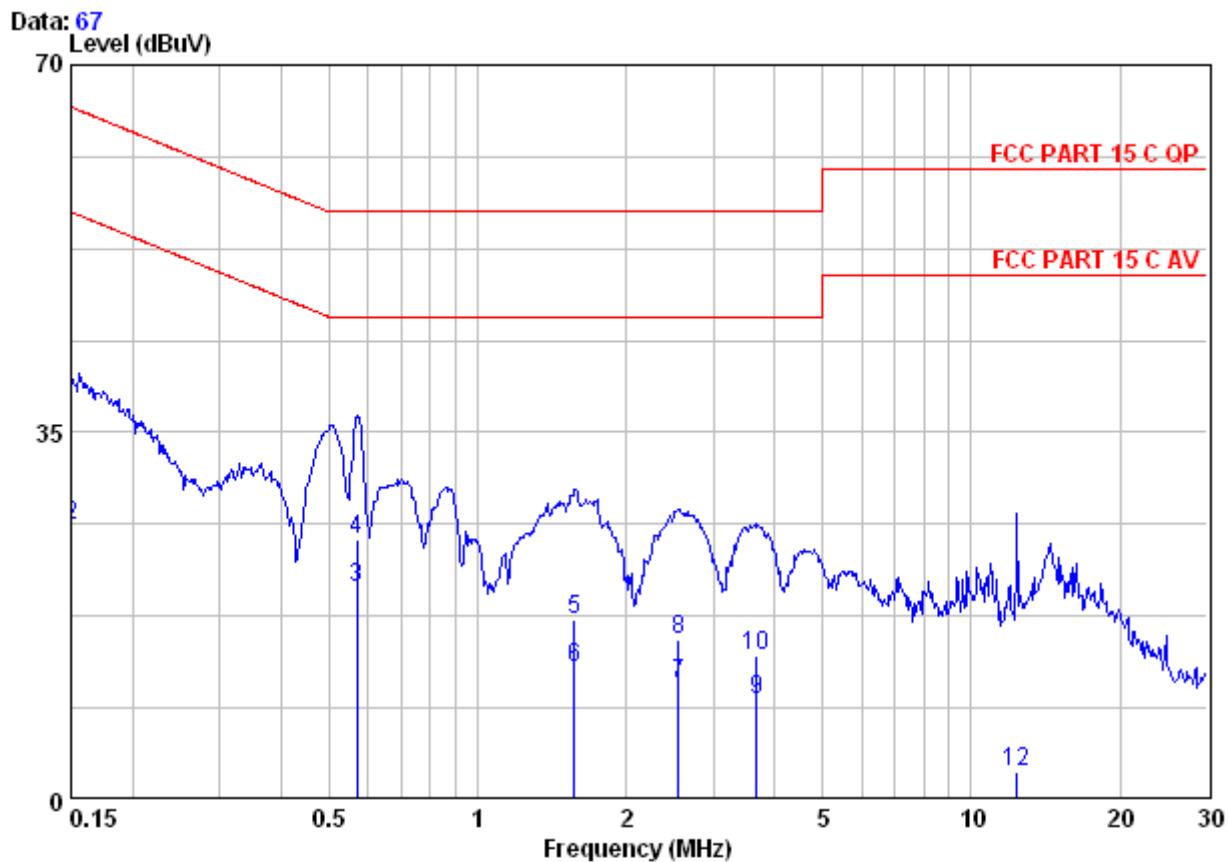
6.3.2 Test Setup Diagram



6.3.3 Measurement Data

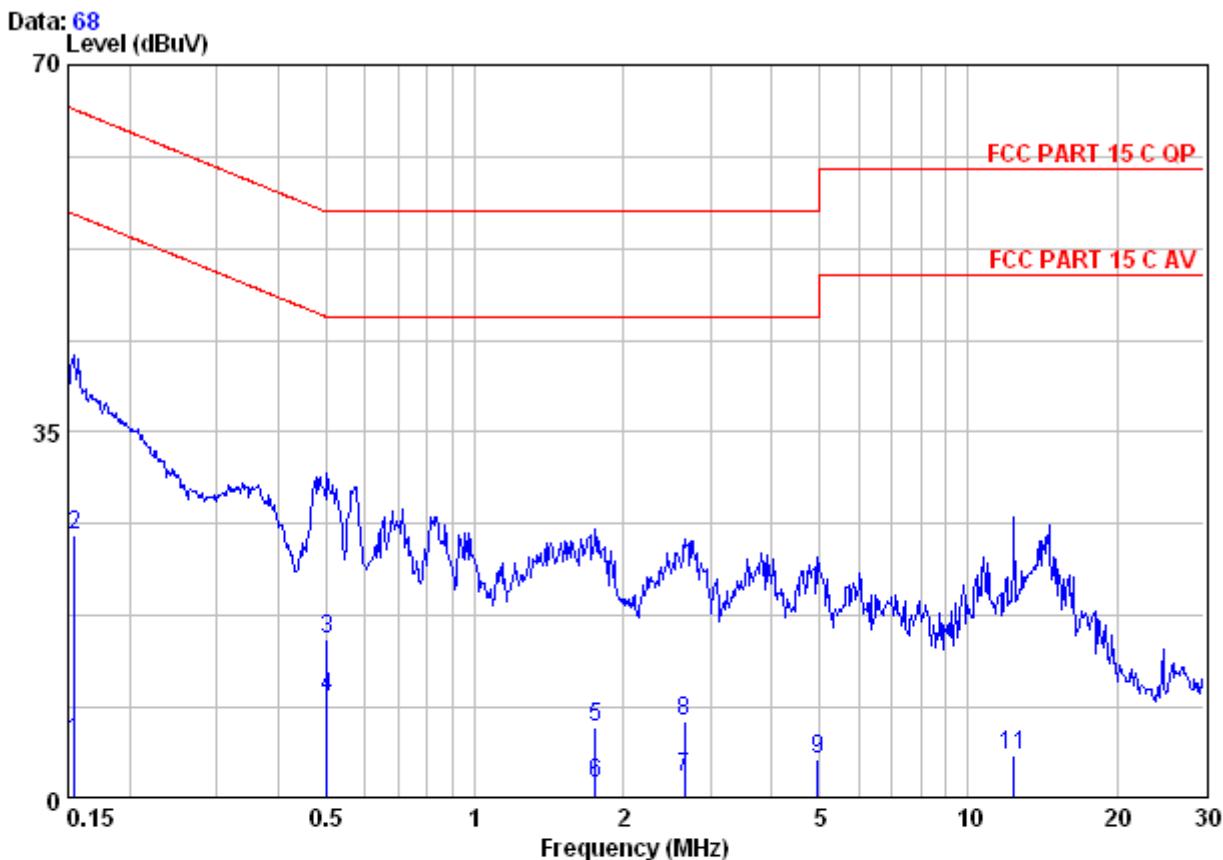
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50ohm/50 μ H + 5ohm linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Line:Live Line



	Freq	Cable Loss	LISN Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.15	0.00	0.00	9.33	9.33	56.00	-46.67	AVERAGE
2	0.15	0.00	0.00	26.22	26.22	66.00	-39.78	QP
3 peak	0.57	0.00	0.00	20.27	20.27	46.00	-25.73	AVERAGE
4	0.57	0.00	0.00	24.82	24.82	56.00	-31.18	QP
5	1.57	0.00	0.00	17.10	17.10	56.00	-38.90	QP
6	1.57	0.00	0.00	12.58	12.58	46.00	-33.42	AVERAGE
7	2.55	0.00	0.00	10.98	10.98	46.00	-35.02	AVERAGE
8	2.55	0.00	0.00	15.34	15.34	56.00	-40.66	QP
9	3.68	0.00	0.00	9.51	9.51	46.00	-36.49	AVERAGE
10	3.68	0.00	0.00	13.78	13.78	56.00	-42.22	QP
11	12.38	0.00	0.00	-6.88	-6.88	50.00	-56.88	AVERAGE
12	12.38	0.00	0.00	2.72	2.72	60.00	-57.28	QP

Line:Neutral Line



Freq	Cable	LISN	Read	Limit	Over	Remark
	MHz	dB	dB			
1	0.15	0.00	0.00	5.54	5.54	55.74 -50.20 AVERAGE
2	0.15	0.00	0.00	25.10	25.10	65.74 -40.64 QP
3	0.50	0.00	0.00	15.28	15.28	56.00 -40.72 QP
4 peak	0.50	0.00	0.00	9.80	9.80	46.00 -36.20 AVERAGE
5	1.75	0.00	0.00	6.92	6.92	56.00 -49.08 QP
6	1.75	0.00	0.00	1.49	1.49	46.00 -44.51 AVERAGE
7	2.66	0.00	0.00	2.07	2.07	46.00 -43.93 AVERAGE
8	2.66	0.00	0.00	7.36	7.36	56.00 -48.64 QP
9	4.95	0.00	0.00	3.82	3.82	56.00 -52.18 QP
10	4.95	0.00	0.00	-2.84	-2.84	46.00 -48.84 AVERAGE
11	12.38	0.00	0.00	4.26	4.26	60.00 -55.74 QP
12	12.38	0.00	0.00	-7.60	-7.60	50.00 -57.60 AVERAGE

6.4 Occupied Bandwidth

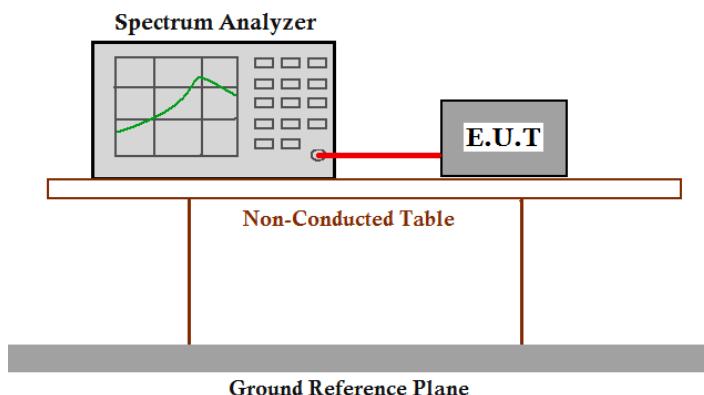
Test Requirement: FCC Part 15 C section 15.247

(a)(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.

Test Method: ANSI C63.10: Clause 6.9.1

Test Status: Pre-test the EUT in continuous transmitting mode at the lowest (903MHz), middle (915 MHz) and highest (927 MHz) channel.

Test Configuration:



Test Procedure:

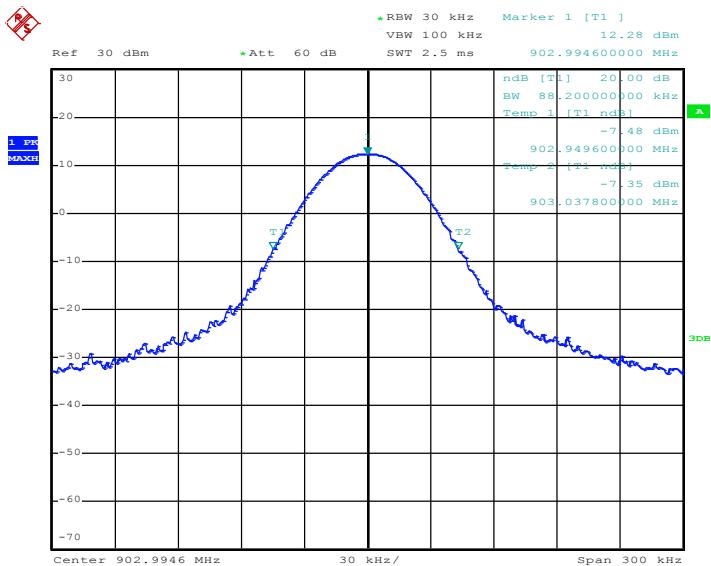
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: Span = approximately 2 to 3 times the 20dB bandwidth, centring on a hopping channel;
3. Set the spectrum analyzer: RBW \geq 1% of the 20dB bandwidth VBW \geq RBW. Sweep = auto; Detector Function = Peak. Trace = Max Hold.
4. Mark the peak frequency and -20 dB points bandwidth.

Test result:

Test Channel	Bandwidth(kHz)	Limit(KHz)
Lowest	88.2	Less than 250
Middle	88.2	Less than 250
Highest	88.2	Less than 250

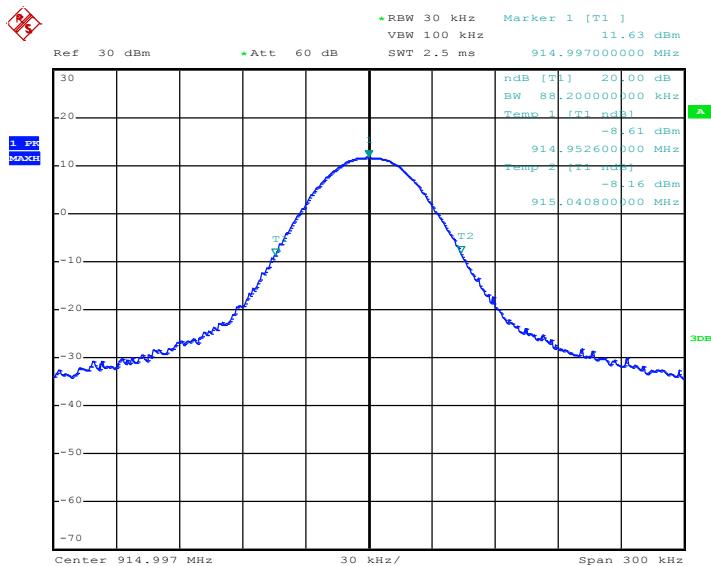
Result plot as follows:

Lowest Channel (903 MHz):



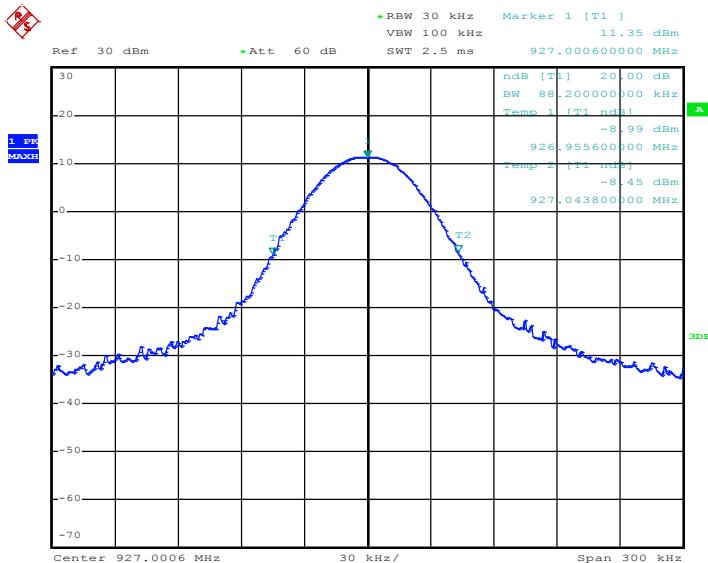
Date: 14.JUN.2018 11:55:51

Middle Channel (915 MHz):



Date: 14.JUN.2018 11:59:02

Highest Channel (927 MHz):



Date: 14.JUN.2018 12:00:00

6.5 Carrier Frequencies Separated

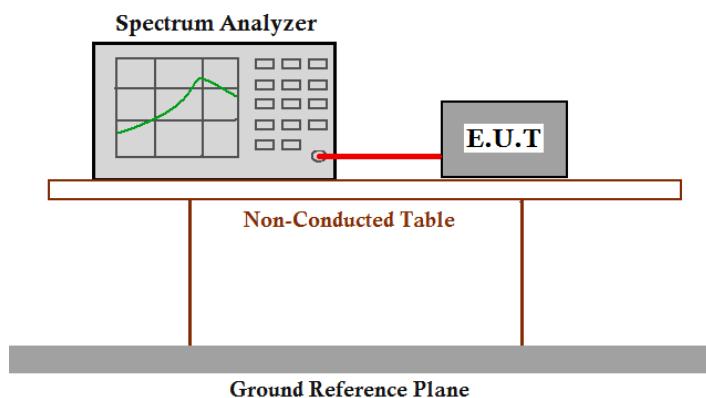
Test Requirement: FCC Part 15 C section 15.247

(a),(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.

Test Method: ANSI C63.10: Clause 7.7.2

Test Status: Pre-test the EUT in hopping mode.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW \geq 1% of the span, VBW \geq RBW. Sweep = auto; Detector Function = Peak. Trace = Max, hold.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Test result:

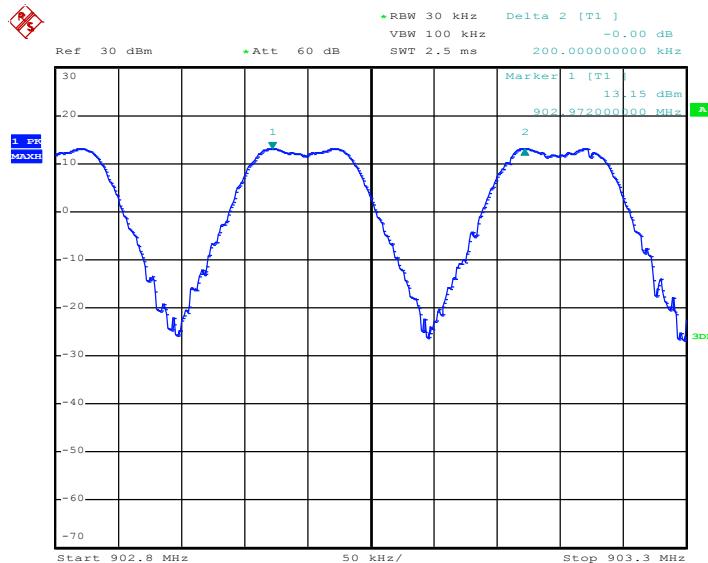
Test Channel	Carrier Frequencies Separated (kHz)	Limit①(kHz)	Pass/Fail
Lower Channels (channel 4 and channel 5)	200.0	58.8	Pass
Middle Channels (channel 64 and channel 65)	200.0	58.8	Pass
Upper Channels (channel 124 and channel 125)	200.0	58.8	Pass

Remark:

- ① The limit is two-thirds of the 20 dB bandwidth.

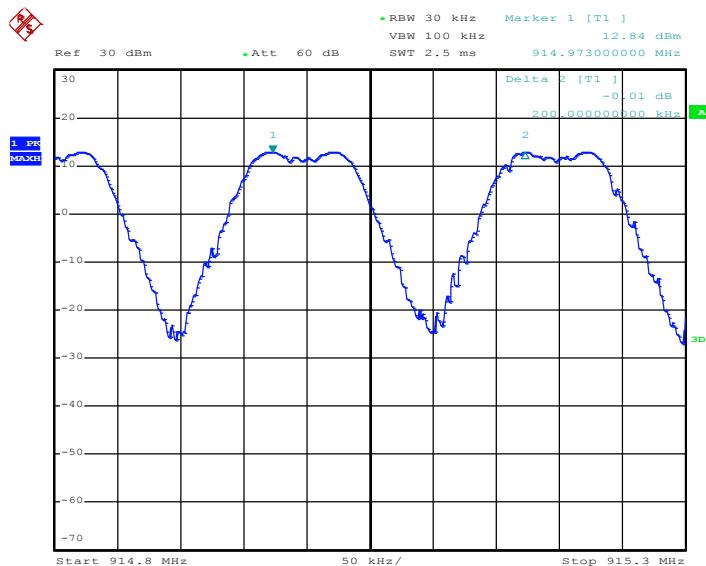
Result plot as follows:

Lowest Channels: Carrier Frequencies Separated

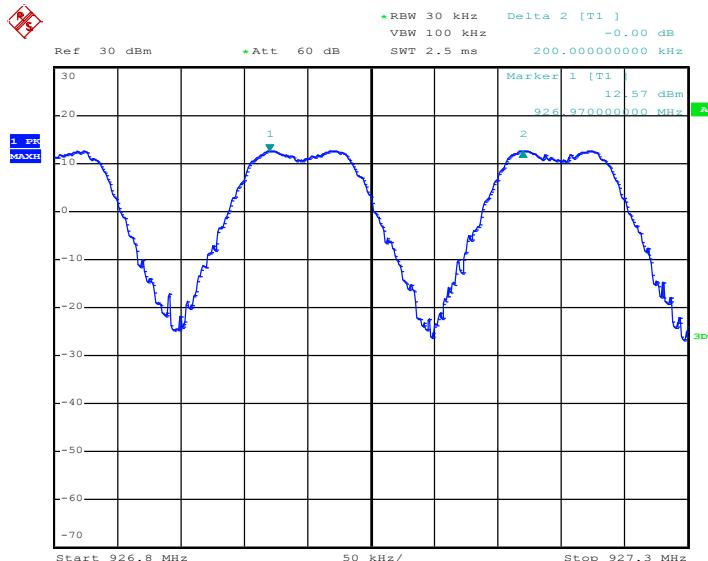


Date: 14.JUN.2018 12:25:43

Middle Channels: Carrier Frequencies Separated



Date: 14.JUN.2018 12:34:25

Highest Channels: Carrier Frequencies Separated

Date: 14.JUN.2018 12:36:51

Test result: The unit does meet the FCC requirements.

6.6 Hopping Channel Number

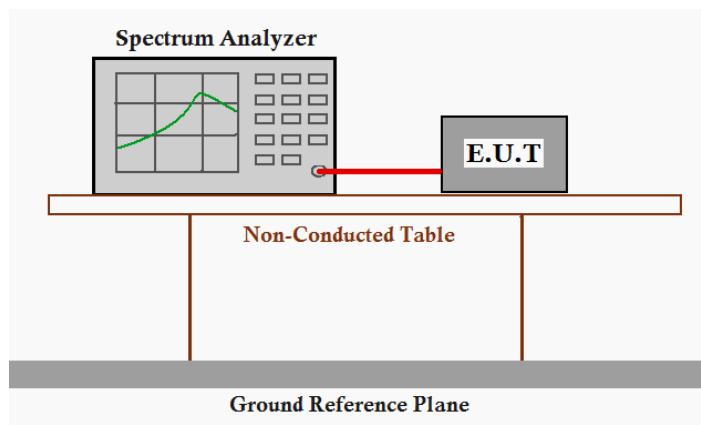
Test Requirement: FCC Part15 C section 15.247

(a)(1)(iii) Frequency hopping systems in the 903-927 MHz band shall use at least 15 channels.

Test Method: ANSI C63.10: Clause 7.7.3

Test Status: Pre-test the EUT in hopping mode.

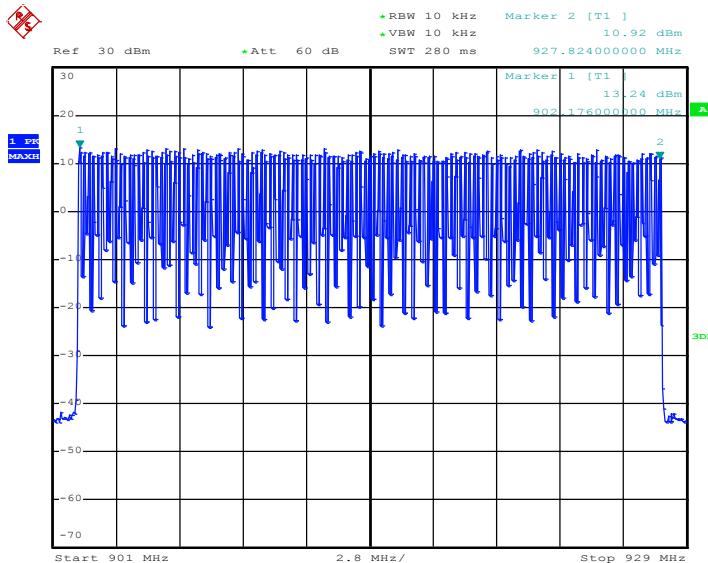
Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 10 kHz. VBW = 10 kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: start frequency = 901 MHz. stop frequency = 929 MHz. Submit the test result graph.

Test result: Total channels are 129 channels.



Date: 14.JUN.2018 13:41:50

Test result: The unit does meet the FCC requirements.

6.7 Dwell Time

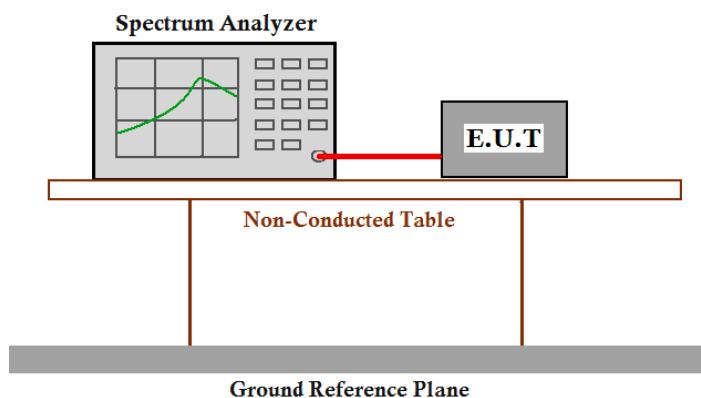
Test Requirement: FCC Part 15 C section 15.247

(a)(1)(iii) Frequency hopping systems in the 902-928 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Method: ANSI C63.10: Clause 7.7.4

Test Status: Test the EUT in hopping mode at the lowest (903 MHz), middle (915 MHz) and highest (927 MHz) channel.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. centered on a hopping channel;
3. Set RBW = 100 kHz and VBW = 100 kHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Detector Function = Peak. Trace = Max hold;
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g. data rate, modulation format, etc.). Repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s). An oscilloscope may be used instead of a spectrum analyzer.

Test Result:

The test period: T= 20 s

1. Channel 4: 903 MHz

time slot = 10.23 (ms) * 4 = 40.92 ms

2. Channel 64: 915 MHz

time slot = 10.23 (ms) * 5 * = 51.15 ms

3. Channel 124: 927 MHz

time slot = 10.23 (ms) * 5 * = 51.15 ms

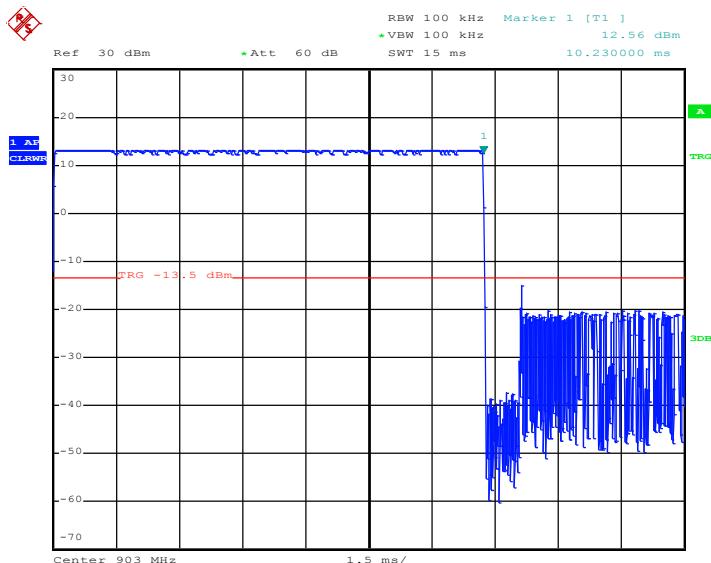
The results are not greater than 0.4 seconds.

The unit does meet the FCC requirements.

Result plot as follows:

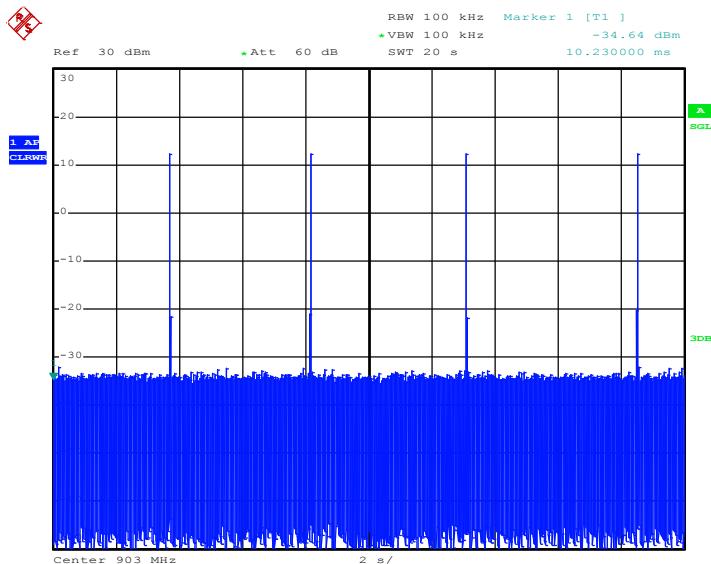
1. Lowest channel (903 MHz):

Pulse Width:



Date: 14.JUN.2018 14:25:48

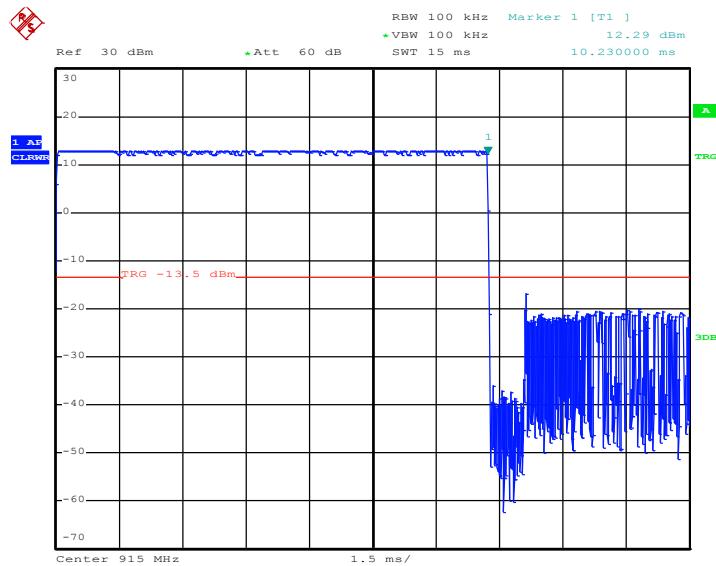
Number of Pulses in 20s observation period:



Date: 14.JUN.2018 14:30:56

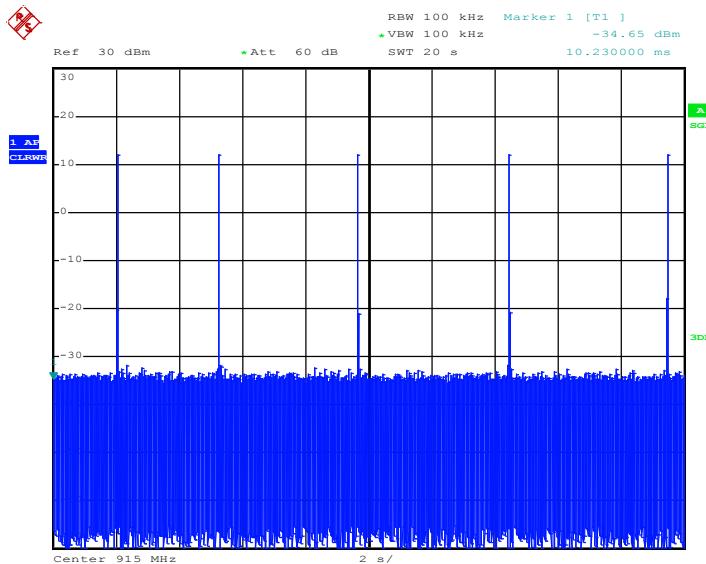
2. Middle Channel (915 MHz):

Pulse Width:



Date: 14.JUN.2018 14:26:18

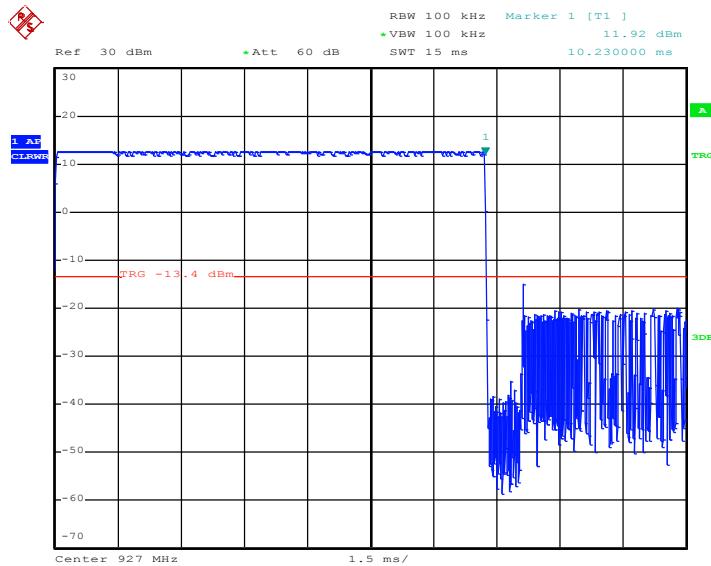
Number of Pulses in 20s observation period:



Date: 14.JUN.2018 14:30:17

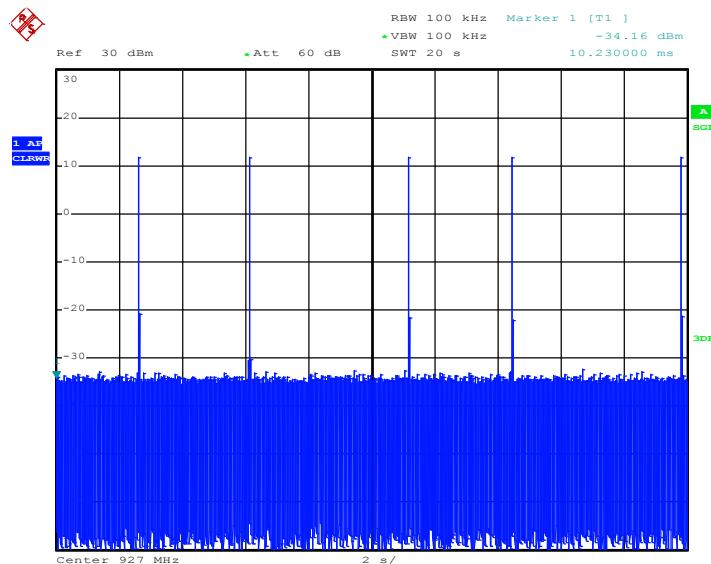
2. Highest Channel (927 MHz):

Pulse Width:



Date: 14.JUN.2018 14:27:25

Number of Pulses in 20s observation period:



Date: 14.JUN.2018 14:29:37

6.8 Pseudorandom Frequency Hopping Sequence

6.8.1 Standard requirement

15.247(a)(1) requirement:

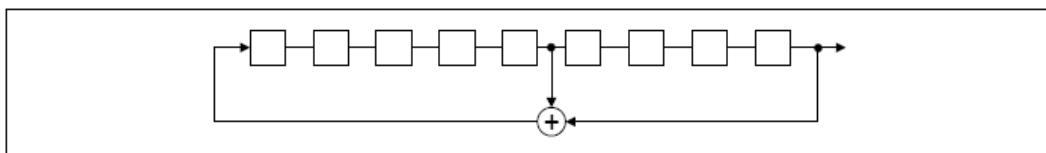
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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 Pseudorandom 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.

6.8.2 EUT Pseudorandom Frequency Hopping Sequence

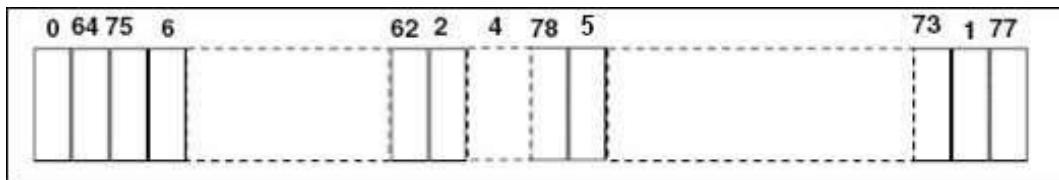
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.

The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

6.9 Maximum Peak Output Power

Test Requirement: FCC Part 15 C section 15.247

(b)(1) 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.

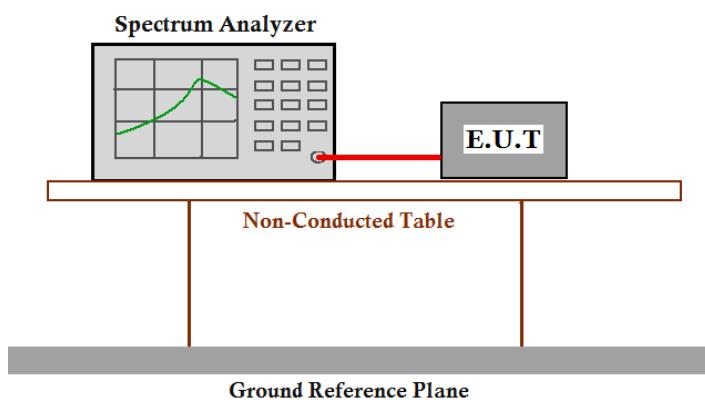
Refer to the result "Hopping channel number" of this document. The 1 watt (30.0 dBm) limit applies.

Test Method: ANSI C63.10: Clause 6.10.1

Test Limit:

Test mode: Pre-test the EUT in continuous transmitting mode at the lowest (903 MHz), middle (915 MHz) and highest (927 MHz) channel.

Test Configuration:



Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 300 kHz. VBW = 300 kHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

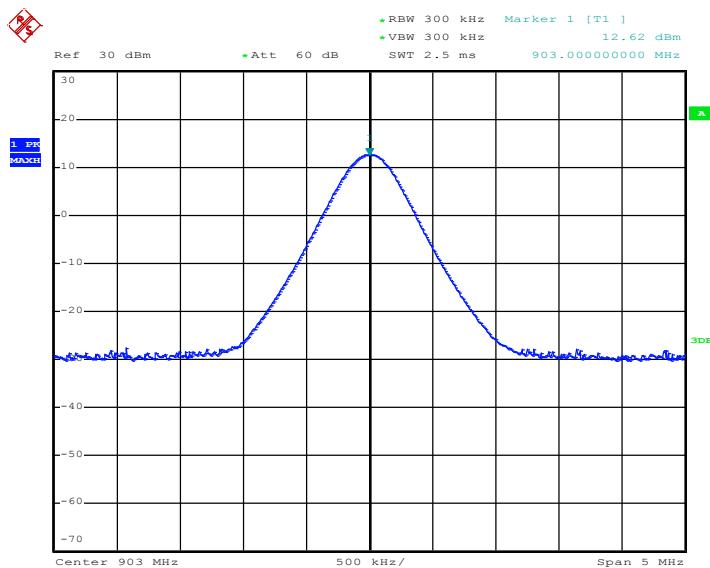
Test Result:				
Test Channel	Fundamental Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Result
Lowest	903	<u>12.62</u>	30.0	Pass
Middle	915	12.00	30.0	Pass
Highest	927	11.69	30.0	Pass

Remark: cable lose=1.5 dB

Test result: The unit does meet the FCC requirements.

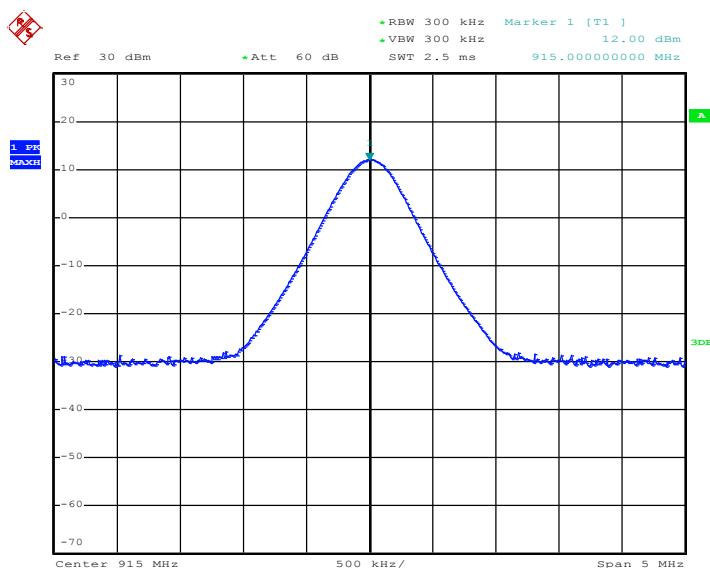
Result plot as follows:

Lowest Channel (903 MHz):



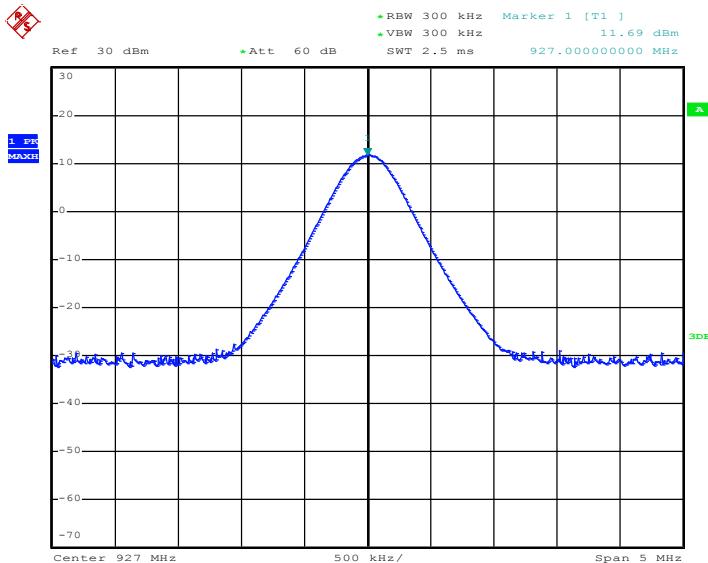
Date: 14.JUN.2018 14:41:06

Middle Channel (915 GHz):



Date: 14.JUN.2018 14:42:14

Highest Channel (927 GHz):



Date: 14.JUN.2018 14:42:49

6.10 Conducted Spurious Emissions

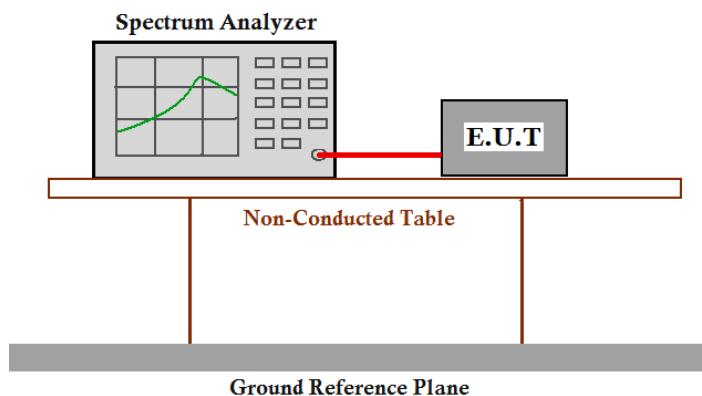
Test Requirement: FCC Part15 C section 15.247

(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.

Test Method: ANSI C63.10: Clause 6.7

Test Status: Pre-test the EUT in continuous transmitting mode at the lowest (903 MHz), middle (915 MHz) and highest (927 MHz) channel.

Test Configuration:

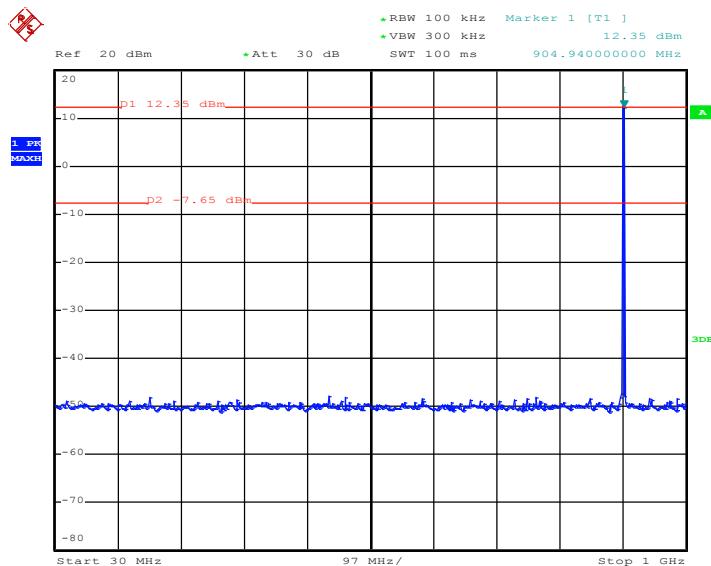


Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100 kHz. VBW \geq RBW. Sweep = auto; Detector Function = Peak (Max. hold).

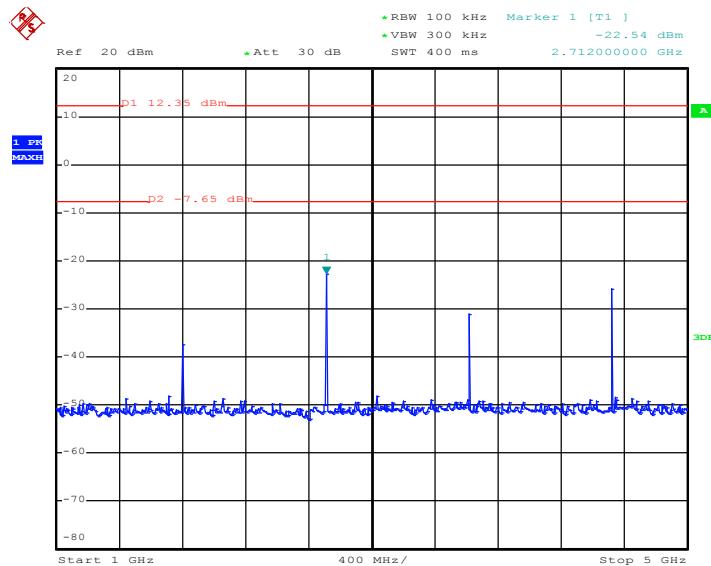
Result plot as follows:

Lowest Channel: 30 MHz to 1 GHz



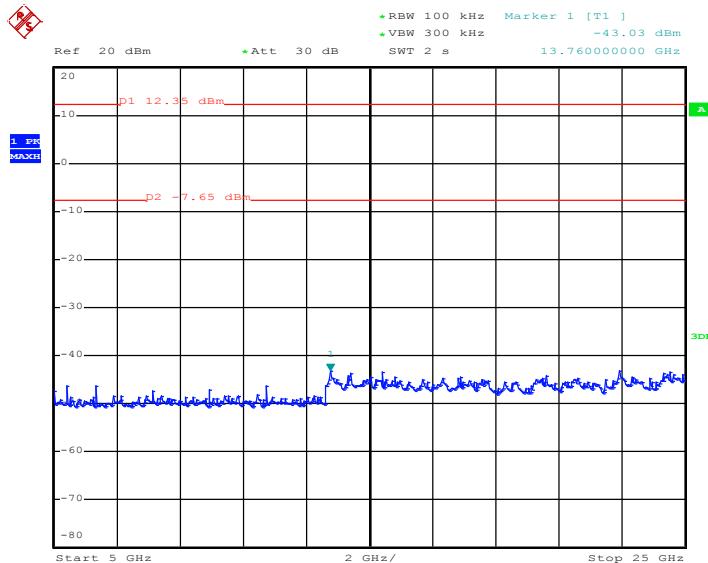
Date: 14.JUN.2018 14:54:49

Lowest Channel: 1 GHz to 5 GHz



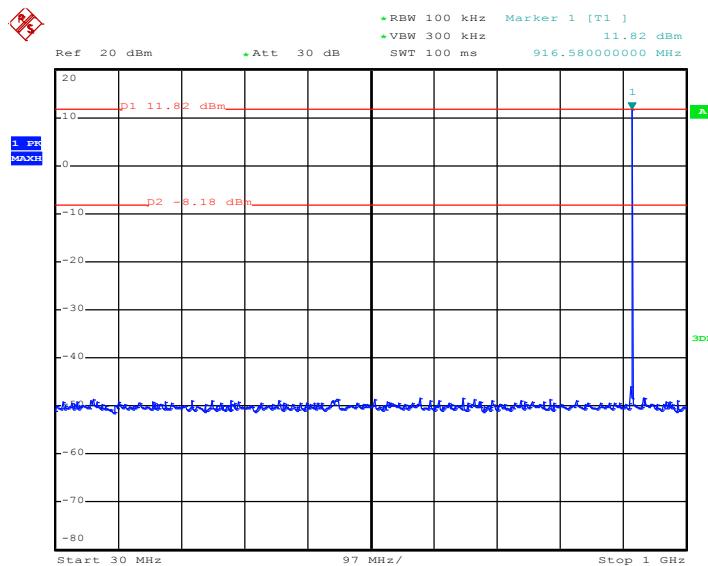
Date: 14.JUN.2018 14:55:12

Lowest Channel: 5 GHz to 25 GHz



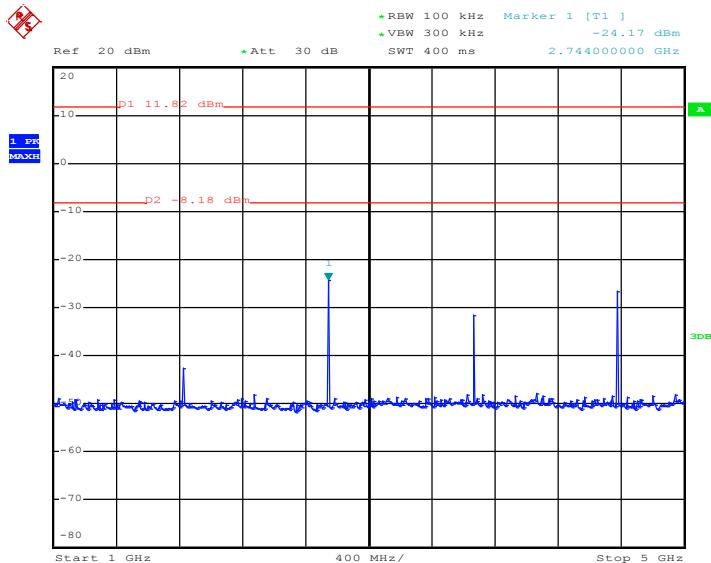
Date: 14.JUN.2018 14:55:57

Middle Channel: 30 MHz to 1 GHz



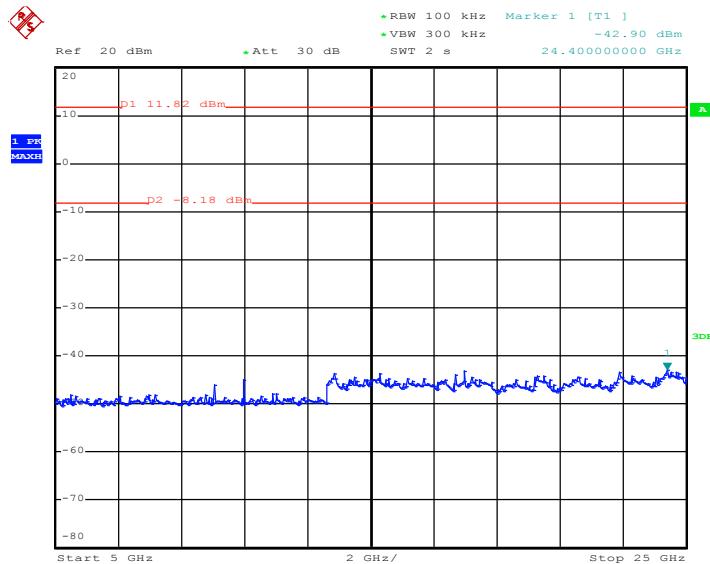
Date: 14.JUN.2018 14:50:37

Middle Channel: 1 GHz to 5 GHz



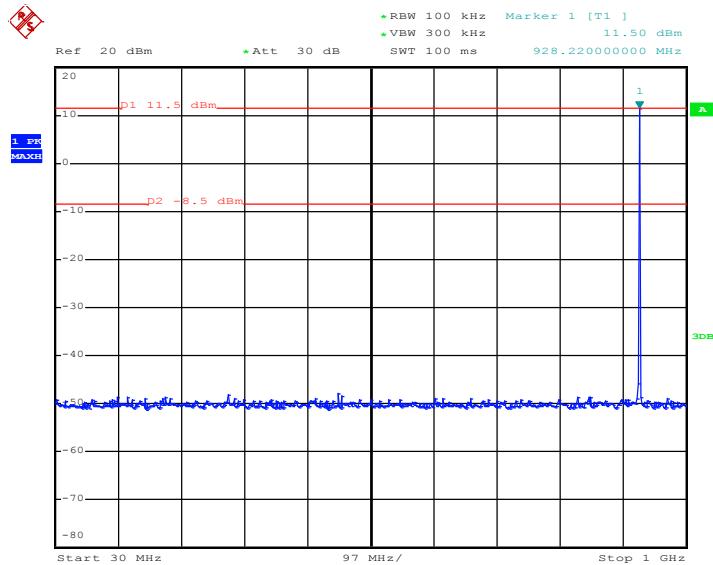
Date: 14.JUN.2018 14:51:14

Middle Channel: 5 GHz to 25 GHz



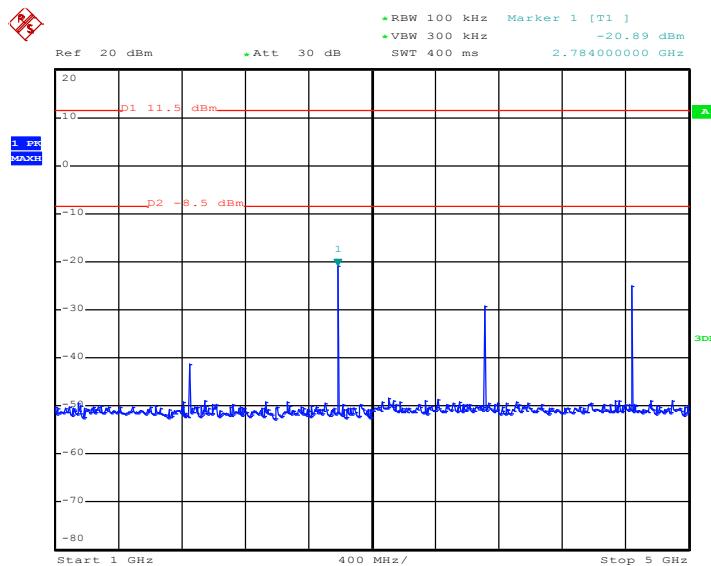
Date: 14.JUN.2018 14:52:34

Highest Channel: 30 MHz to 1 GHz



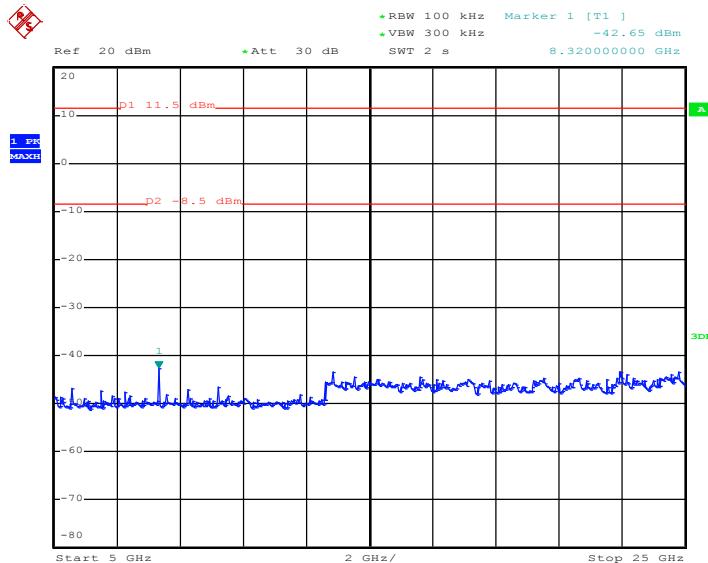
Date: 14.JUN.2018 14:48:25

Highest Channel: 1 GHz to 5 GHz



Date: 14.JUN.2018 14:48:43

Highest Channel: 5 GHz to 25 GHz



Date: 14.JUN.2018 14:49:10

6.11 Radiated Spurious Emissions

Test Requirement: FCC Part15 C section 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, and provided the transmitter demonstrates compliance with the peak conducted power limits.

Test Method: ANSI C63.10: Clause 6.4, 6.5 and 6.6

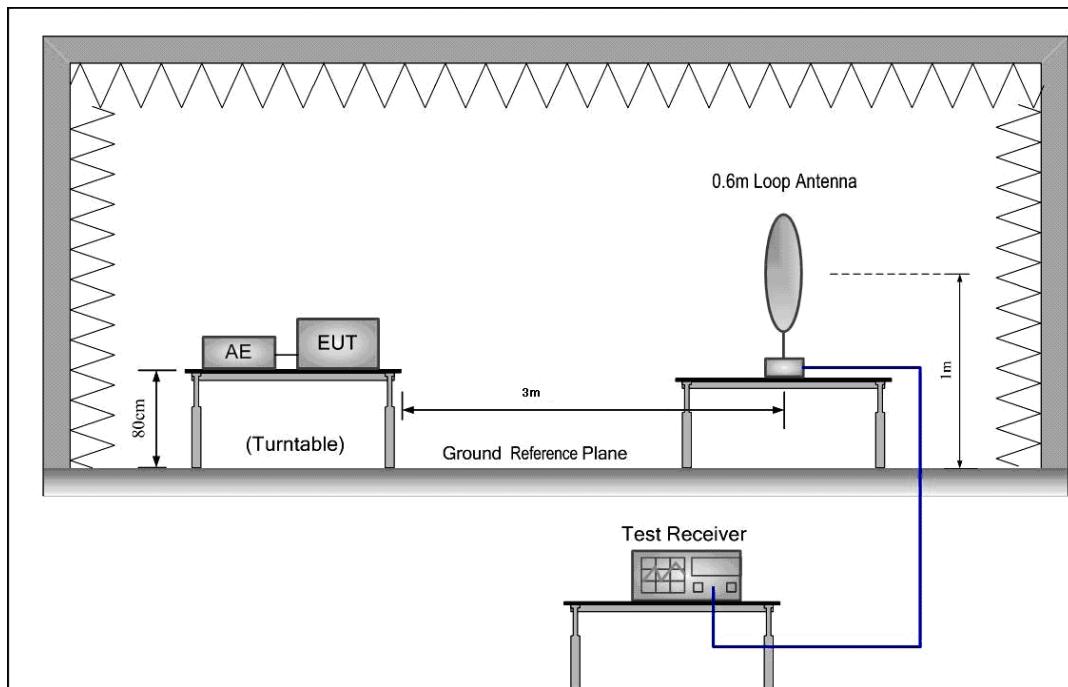
Test Status: Pre-test the EUT in continuous transmitting mode at the lowest (903 MHz), middle (915 MHz) and highest (927 MHz) channel.

Detector: For PK value:
RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz
VBW \geq RBW
Sweep = auto
Detector function = peak
Trace = max hold
For AV value:
RBW = 1 MHz for $f \geq 1$ GHz,
VBW = 10 Hz
Sweep = auto
Detector function = peak
Trace = max hold

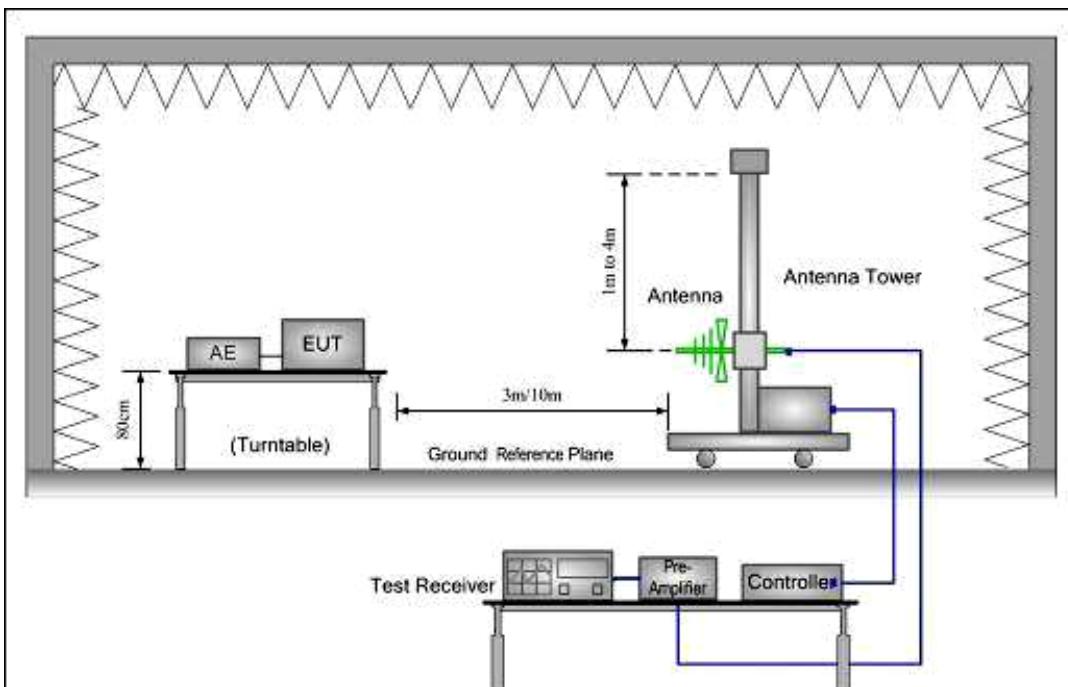
15.209 Limit: 40.0 dB μ V/m between 30MHz & 88MHz
43.5 dB μ V/m between 88MHz & 216MHz
46.0 dB μ V/m between 216MHz & 960MHz
54.0 dB μ V/m above 960MHz

Test Configuration:

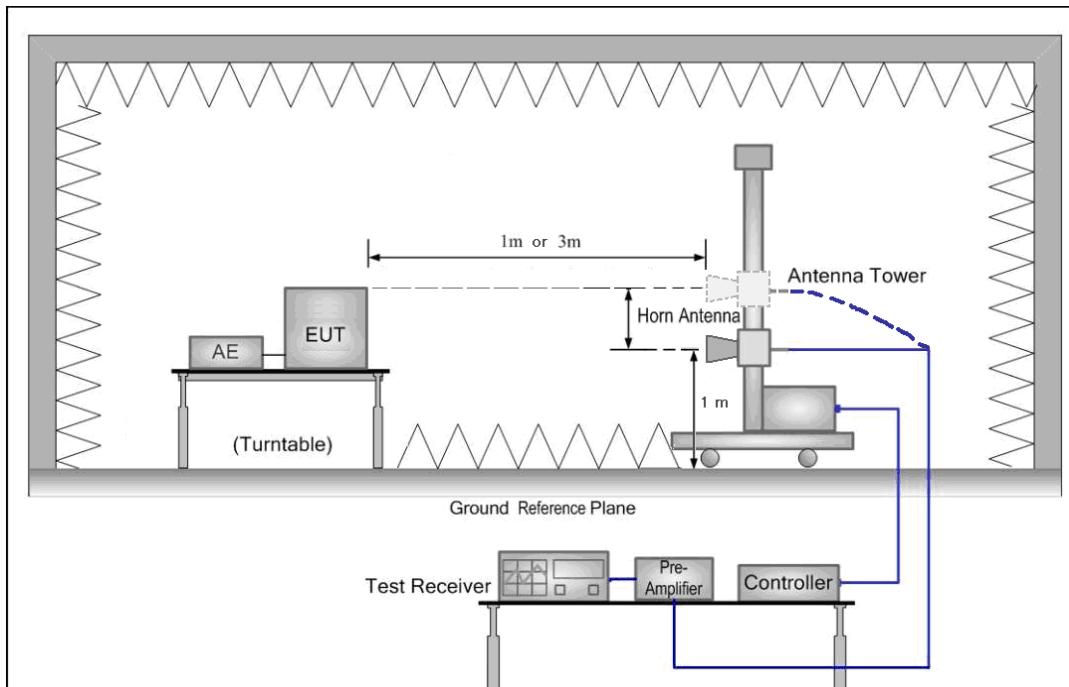
- 1) 9 kHz to 30 MHz emissions:



- 2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 40 GHz emissions:

**Test Procedure:**

Test site with RF absorbing material covering the ground plane that met the site validation criterion called out in CISPR 16-1-4:2007 was used to perform radiated emission test above 1 GHz.

The receiver scanned from the lowest frequency generated within the EUT to 25GHz. When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test three orthogonal planes. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst-case emissions were reported.

Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit.

Submit this data.

6.11.1 Harmonic and other spurious emissions

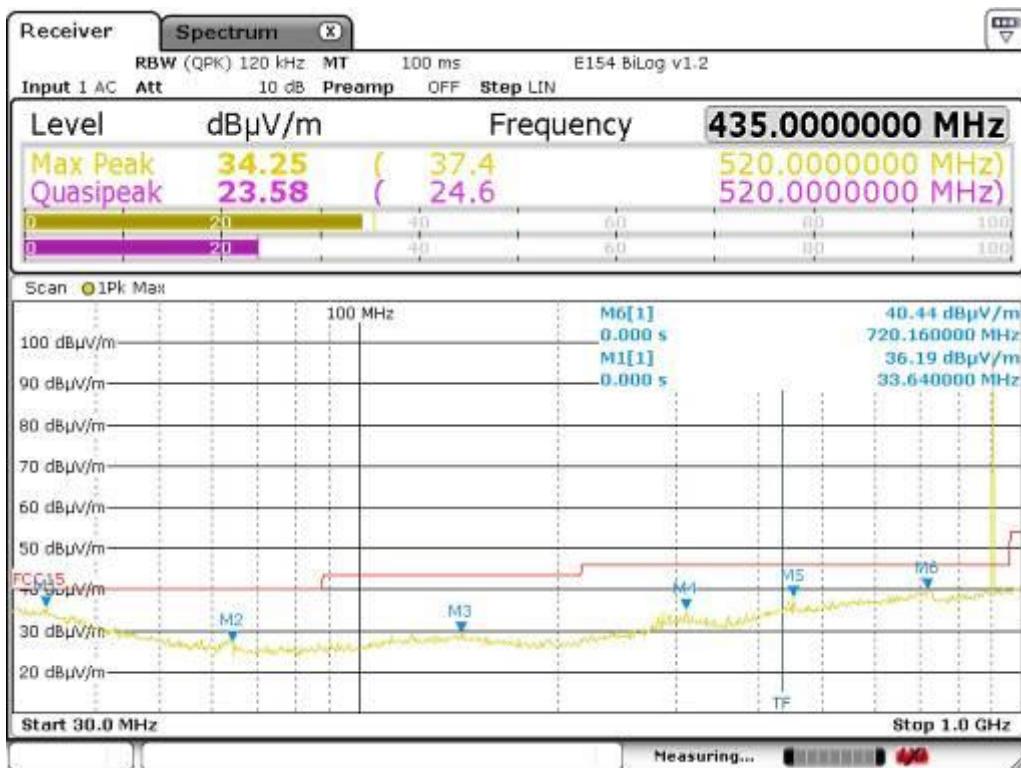
6.11.1.1 Test the lowest Channel in transmitting status

9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20dB below the limit, so the test data were not recorded in the test report.

30 MHz~1 GHz Spurious Emissions .Quasi-Peak Measurement

Quasi-peak measurement:



Frequency (MHz)	Antenna Polarization	Correction Factor (dB/m)	Receiver QP Reading (dBμV)	Emission Level (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)
31.850	V	18.1	8.5	26.6	40	-13.4
62.220	V	9.5	25.1	34.6	40	-5.4
142.630	V	11.0	7.2	18.2	43.5	-25.3
308.860	H	13.2	6.7	19.9	46	-26.1
449.600	H	17.0	6.9	23.9	46	-22.1
720.020	V	19.6	8.0	27.6	46	-18.4

1. All readings are Quasi-Peak values.

2. Correction Factor = Antenna Factor + Cable Loss.

1~25 GHz Harmonics & Spurious Emissions. Peak & Average Measurement:

Frequency (MHz)	Antenna Polarization	Emission Level (dB μ V/m)		Limit (dB μ V/m)		Remark
		Peak	Average	Peak	Average	
1806.00	H	53.90	37.97	74	54	Pass
3122.00	H	42.12	22.22	74	54	Pass
3612.00	V	59.39	45.41	74	54	Pass
4515.00	V	63.61	49.62	74	54	Pass
5418.00	V	50.29	31.76	74	54	Pass
6321.00	V	59.15	41.60	74	54	Pass

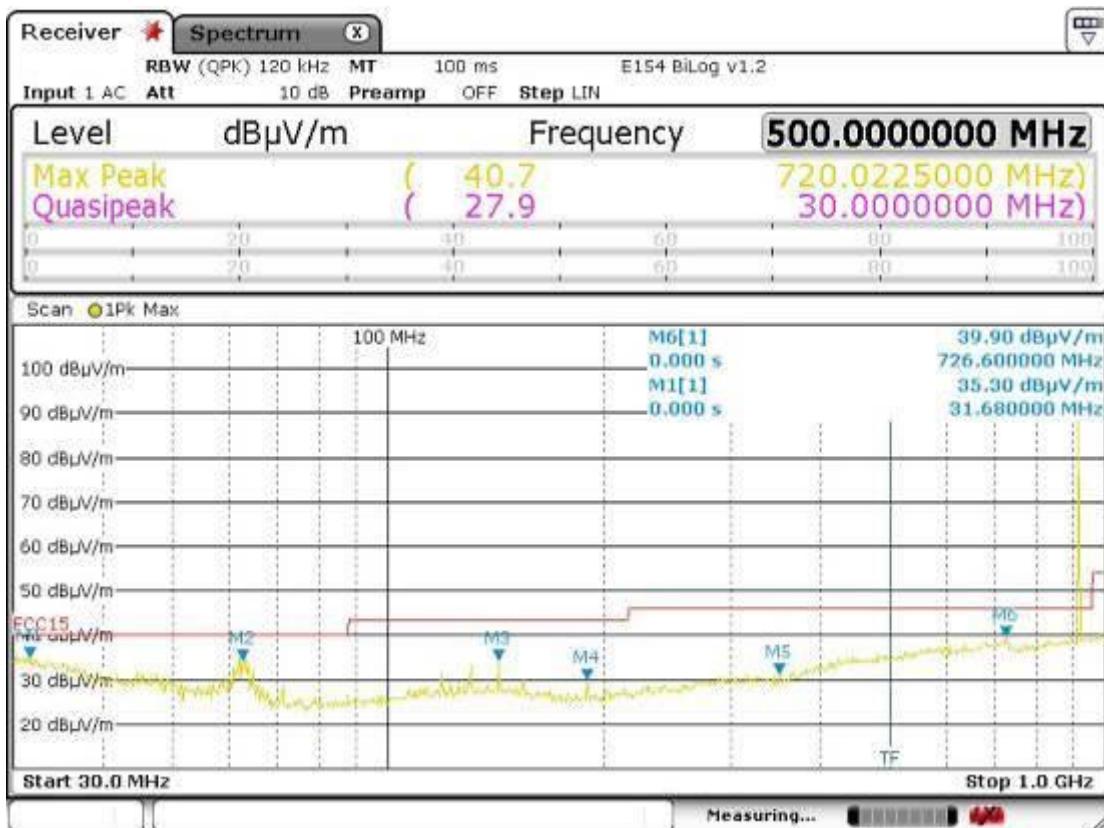
6.11.1.2 Test the middle Channel in transmitting status

9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20dB below the limit, so the test data were not recorded in the test report.

30 MHz~1 GHz Spurious Emissions .Quasi-Peak Measurement

Quasi-peak measurement:



Frequency (MHz)	Antenna Polarization	Correction Factor (dB/m)	Receiver QP Reading (dBµV)	Emission Level (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)
30.700	V	18.6	7.2	25.8	40	-14.2
62.930	V	9.4	27.0	36.4	40	-3.6
142.100	V	11.0	23.6	34.6	43.5	-8.9
189.720	V	8.7	19.1	27.8	43.5	-15.7
351.800	H	13.1	7.8	20.9	46	-25.1
728.120	H	19.7	9.7	29.4	46	-16.6

1. All readings are Quasi-Peak values.
 2. Correction Factor = Antenna Factor + Cable Loss.

1~25 GHz Harmonics & Spurious Emissions. Peak & Average Measurement:

Frequency (MHz)	Antenna Polarization	Emission Level (dB μ V/m)		Limit (dB μ V/m)		Remark
		Peak	Average	Peak	Average	
1830.00	V	29.45	20.96	74	54	Pass
2648.00	V	32.54	18.02	74	54	Pass
3660.00	V	60.28	40.76	74	54	Pass
4564.00	V	64.03	46.39	74	54	Pass
5490.00	V	50.50	32.13	74	54	Pass
6213.00	H	41.90	25.12	74	54	Pass

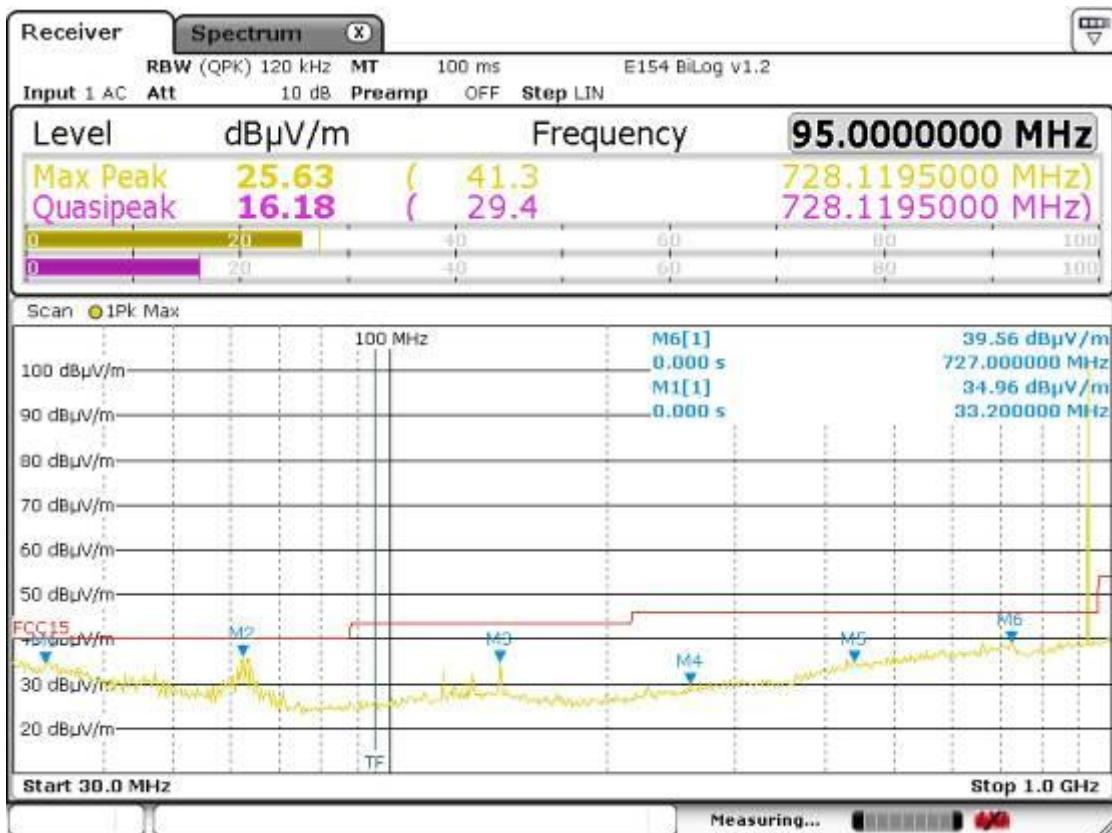
6.11.1.3 Test the highest Channel in transmitting status

9 kHz~30 MHz Field Strength of Unwanted Emissions.Quasi-Peak Measurement

The measurements with active loop antenna were greater than 20dB below the limit, so the test data were not recorded in the test report.

30 MHz~1 GHz Spurious Emissions .Quasi-Peak Measurement

Quasi-peak measurement:



Frequency (MHz)	Antenna Polarization	Correction Factor (dB/m)	Receiver QP Reading (dBμV/m)	Emission Level (dBμV/m)	Limit (dBμV/m)	Over Limit (dB)
30.750	V	18.6	7.1	25.7	40	-14.3
62.450	V	9.5	26.9	36.4	40	-3.6
141.600	V	11.1	21.0	32.1	43.5	-11.4
258.990	H	11.5	7.5	19.0	46	-27.0
437.990	V	16.5	7.4	23.9	46	-22.1
726.770	H	19.7	9.6	29.3	46	-16.7

1. All readings are Quasi-Peak values.

2. Correction Factor = Antenna Factor + Cable Loss.

1~25 GHz Harmonics & Spurious Emissions. Peak & Average Measurement:

Frequency (MHz)	Antenna Polarization	Emission Level (dB μ V/m)		Limit (dB μ V/m)		Remark
		Peak	Average	Peak	Average	
1854.00	H	44.83	27.63	74	54	Pass
3708.00	H	54.81	32.69	74	54	Pass
4635.00	V	64.88	46.95	74	54	Pass
5562.00	V	49.29	31.49	74	54	Pass
6489.00	V	51.24	35.92	74	54	Pass
8343.00	V	55.63	40.00	74	54	Pass

Remark:

1). The field strength is calculated by adding the Antenna Factor. Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Loss –Preamplifier Factor.

2). As shown in Section, for frequencies above 1000 MHz. the above field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

3). The test only perform the EUT in transmitting status since the test frequencies were over 1GHz only required transmitting status.

Test result: The unit does meet the FCC requirements.

6.11.2 Radiated Emissions which fall in the restricted bands

Test Requirement: FCC Part15 C Section 15.247

(d) In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Test Method: ANSI C63.10: Clause 6.4, 6.5 and 6.6

Test Status: Pre-test the EUT in continuous transmitting mode at the lowest (903 MHz) and highest (927 MHz) channel.

Measurement Distance: 3m (Semi-Anechoic Chamber)

Limit:

Section 15.209(a)
40.0 dB μ V/m between 30MHz & 88MHz;
43.5 dB μ V/m between 88MHz & 216MHz;
46.0 dB μ V/m between 216MHz & 960MHz;
54.0 dB μ V/m above 960MHz.

Detector: For PK value:

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For AV value:

RBW = 1 MHz for $f \geq 1$ GHz,

VBW = 10 Hz

Sweep = auto

Detector function = peak

Trace = max hold

Test Result:

Test at lowest Channel (903 MHz) in transmitting status

Frequency (MHz)	Antenna Polarization	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Remark
		QP	QP	
902	H	35.9	46	PASS
902	V	43.8	46	PASS

Test at highest Channel (927 MHz) in transmitting status

Frequency (MHz)	Antenna Polarization	Emission Level (dB μ V/m)	Limit (dB μ V/m)	Remark
		QP	QP	
928.0	H	35.8	46	PASS
928.0	V	41.1	46	PASS

Remark: above table only record the worse data of emissions in restricted frequency bands.

Test result: The unit does meet the FCC requirements.

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	
13.36 - 13.41			

6.12 Band Edges Requirement

Test Requirement: FCC Part15 C section 15.247

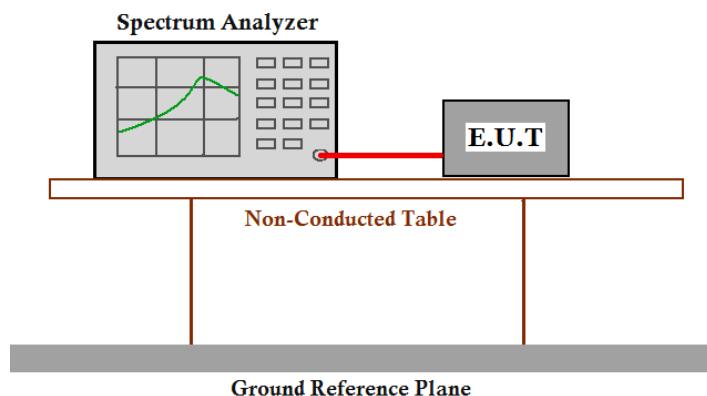
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Frequency Band: 902 MHz to 928 MHz

Test Method: ANSI C63.10 (2013) Section 7.8.6

Test Status: Pre-test the EUT in continuous transmitting mode at the lowest (2402 MHz), and highest (2480 MHz) channel and hopping mode with different data packet. Compliance test in continuous transmitting mode with normal (DH5) and EDR mode (3DH5) as the worst case was found.

Test Configuration:



Test Procedure:

Use the following spectrum analyzer settings:

Span = 10MHz (wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation.)

RBW = 100 kHz (1% of the span) and VBW = 300 kHz

Sweep = auto

Detector function = peak

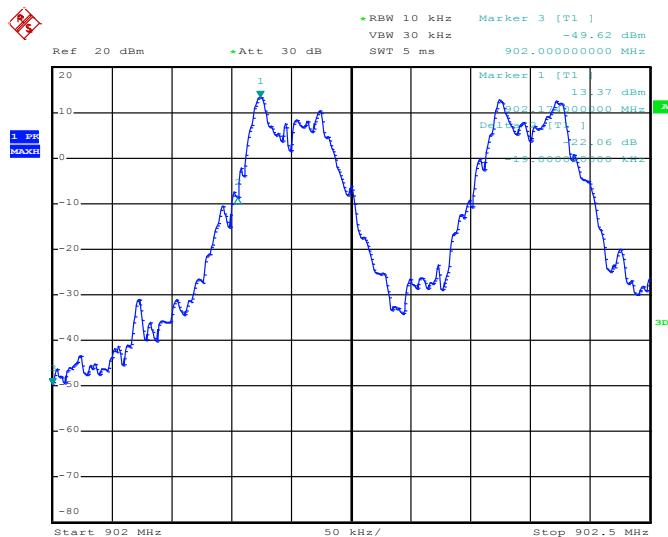
Trace = max hold

Test Result:

Compare with the output power of the lowest frequency, the Lower Edges attenuated more than 20dB

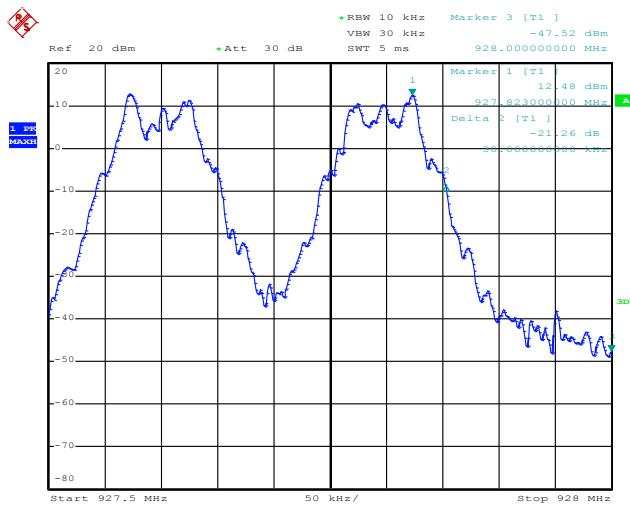
Compare with the output power of the highest frequency, the Upper Edges attenuated more than 20dB.

Lowest channel (903 MHz):



Date: 14.JUN.2018 15:07:33

Highest Channel (927 MHz):

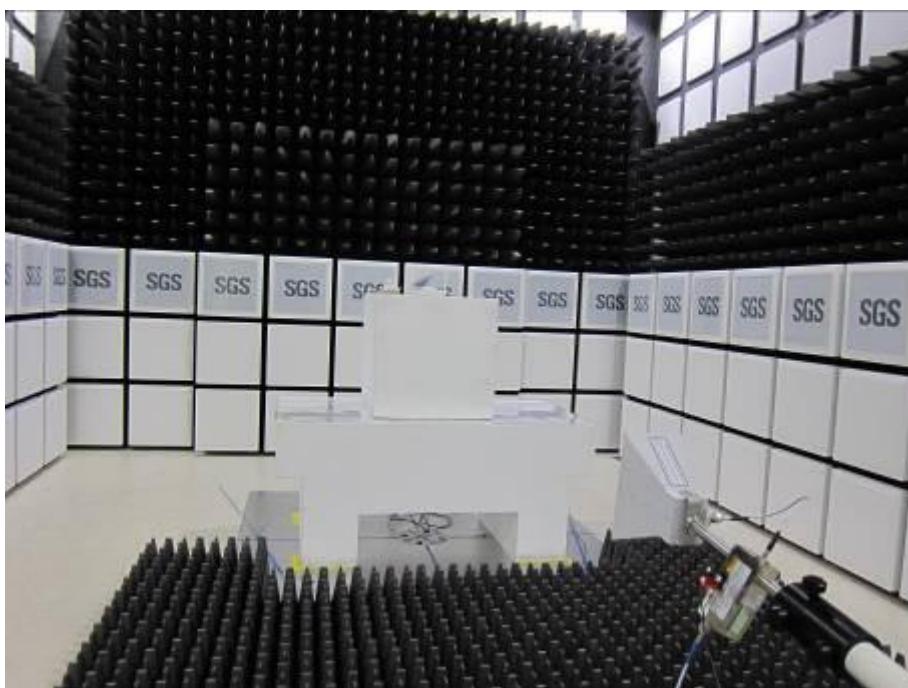
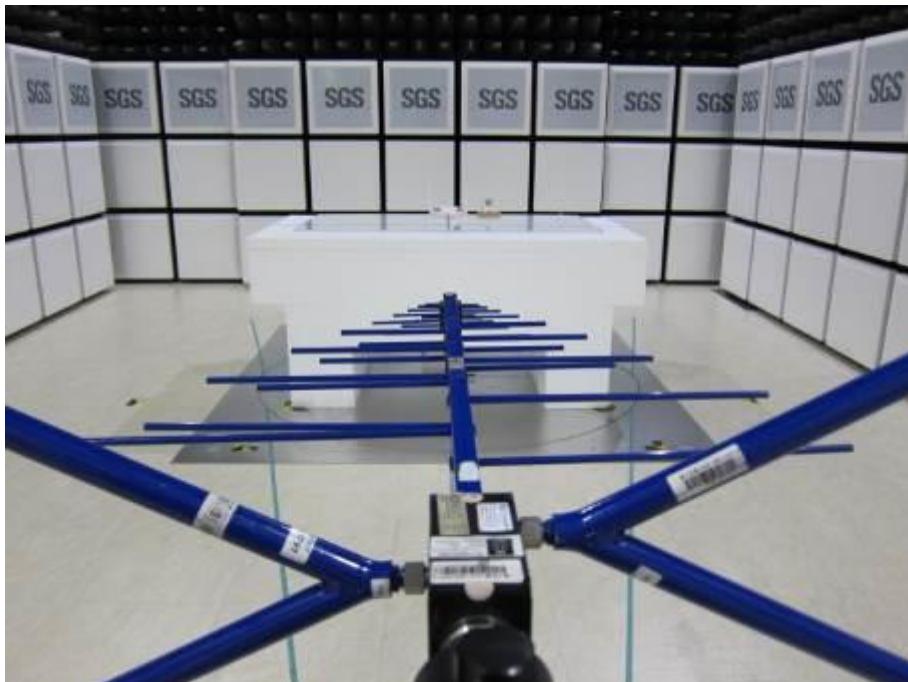


Date: 14.JUN.2018 15:09:23

Test result: The unit does meet the FCC requirements.

7 Photographs

7.1 Radiated Spurious Emission Test Setup



8 EUT Constructional Details



--End of Report--