



Report No.: HKEM180700055402

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FCC ID: 2AO4U-RT1

## TEST REPORT

<b>Application No.:</b>	HKEM1807000554HS
<b>Applicant:</b>	ROOT ROBOTICS, INC.
<b>FCC ID:</b>	2AO4U-RT1
<b>Product Description:</b>	Root Robot
<b>Model No.:</b>	RT1
<b>Country of Origin:</b>	China
<b>Country of Destination:</b>	US
<b>Age Grading:</b>	Above 3yrs
<b>Standards:</b>	47 CFR Part 15, Subpart C 15.247
<b>Date of Receipt:</b>	2018-07-06
<b>Date of Test:</b>	2018-07-20 to 2018-07-23
<b>Date of Issue:</b>	2018-07-23
<b>Test Result :</b>	<b>Pass*</b>

\* 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.

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## 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
6 dB Bandwidth	FCC PART 15 C section 15.247 (a)(2)	ANSI C63.10 Clause 11.8.1	PASS
Maximum Peak Output Power	FCC PART 15 C section 15.247(b)(3)	ANSI C63.10 Clause 11.9.1.1	PASS
Peak Power Spectral Density	FCC PART 15 C section 15.247(e)	ANSI C63.10 Clause 11.10.2	PASS
Conducted Spurious Emission	FCC PART 15 C section 15.209 &15.247(d)	ANSI C63.10 Clause 11.11	PASS
Radiated Spurious Emission	FCC PART 15 C section 15.209 &15.247(d)	ANSI C63.10 Clause 6.10.5	PASS
Band Edges Measurement	FCC PART 15 C section 15.247 (d) &15.205	ANSI C63.10 clause 11.13.3.2	PASS

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## 4 General Information

### 4.1 Client Information

Applicant: ROOT ROBOTICS, INC.  
Address of Applicant: 2067 MASSACHUSETTS AVE.5<sup>TH</sup> FLOOR,  
Cambridge, MA, 02140, United states

### 4.2 General Description of E.U.T.

Product Name: Root Robot  
Model No.: RT1

### 4.3 Details of E.U.T.

Operating Frequency 2402 MHz to 2480 MHz  
Type of Modulation: GFSK  
DSSS with Adaptive  
Equipment types: (Only one adaptive mode is implemented and could not operate in a non-adaptive mode.)  
Number of Channels 40 Channels  
Channel Separation: 2 MHz  
Duty Cycle: Continuous operation possible for testing purposes  
Antenna Type Integral antenna  
Antenna gain: 0dBi  
Speciality: V4.0 BLE  
This test report is for BLE mode  
Function: Bluetooth  
Power Supply: DC 3.7V (Rechargeable batt. x 1)  
Normal Test Voltage: DC 3.7V  
Adapter: --  
Power cord: unscreened USB cable :100cm for battery charging

#### **4.4 Description of Support Units**

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

#### **4.5 Deviation from Standards**

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

#### **4.6 Abnormalities from Standard Conditions**

None.

#### **4.7 Other Information Requested by the Customer**

None.

#### **4.8 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.

#### 4.9 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.

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

No.	Item	Measurement Uncertainty
1	Radio frequency	7.25 x 10 <sup>-8</sup>
2	RF power (conducted)	0.75dB
3	Radiated Spurious emission	4.5dB (30MHz-1GHz)
		4.8dB (1GHz-25GHz)
4	Temperature test	1°C
5	Humidity test	3%
6	DC and low frequency voltages test	0.5%

## 5 Equipment Used during Test

Equipment	Manufacturer	Model / Serial No.	Cal. Due Date
EMI Test Receiver 9kHz to 3.6GHz	Rohde & Schwarz	ESR3 / 102326	2018/08/15
Antenna	Schaffner	CBL6111C / 2791	2018/10/26
Loop Antenna	Rohde & Schwarz	HFH2-Z2 / 871336/48	2019/01/22
Antenna	Schwarzbeck	BBA9106 / TE039A	2020/01/29
Antenna	Schwarzbeck	UHALP9107 / TE039B	2020/01/29
Millivoltmeter	Rohde & Schwarz	URV5 / 846254/013	2018/09/24
100V insertion Unit	Rohde & Schwarz	URV5-Z4 / 100138	2018/09/24
Amplifier	TESEQ	CBAIG-070 / T43859	--
Antenna Mast System	Schwarzbeck	AM9104 / -	--
Turntable with Controller	Drehtisch	DT312 / -	--
Spectrum Analyzer	Rohde & Schwarz	FSP30 / 101474	2019/05/30
Horn Antenna	Schwarzbeck	BBHA9120D / 9120D-1070	2020/01/29
Horn Antenna	Schwarzbeck	BBHA9170 / 9170-492	2019/10/16
Preamplifier	Schwarzbeck	BBV9718 / 9718-223	2019/01/28
Preamplifier	Schwarzbeck	BBV9719 / 9719-019	2018/12/20
Highpass Filter	Wainwright	WHNX3.5/26.5G-6SS / nil	2018/12/18
Band Reject Filter	Wainwright	WRCJV 2400/2500-2100/2800-40/3S S / nil	2018/12/18
RF cable	HUBER+SUHNER	SF104-26.5/2	2018/12/26

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## 6 Test Results

### 6.1 E.U.T. test conditions

<b>Test Voltage:</b>	DC 3.7V
<b>Temperature:</b>	20.0 - 25.0 °C
<b>Humidity:</b>	38-50 % RH
<b>Atmospheric Pressure:</b>	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)
0	2402	27	2456
1	2404	28	2458
2	2406	29	2460
3	2408	30	2462
4	2410	31	2464
5	2412	32	2466
6	2414	33	2468
7	2416	34	2470
8	2418	35	2472
9	2420	36	2474
10	2422	37	2476
11	2424	38	2478
12	2426	39	2480
13	2428	40	/
14	2430	41	/
15	2432	42	/
16	2434	43	/
17	2436	44	/
18	2438	45	/
19	2440	46	/
20	2442	47	/
21	2444	48	/
22	2446	49	/
23	2448	50	/
24	2450	51	/
25	2452	52	/
26	2454	53	/

Test frequencies are the lowest channel: 0 channel(2402MHz), middle channel: 19 channel (2440 MHz) and highest channel: 39 channel(2480 MHz)

## 6.2 Antenna Requirement

### Standard requirement

15.203 requirement:

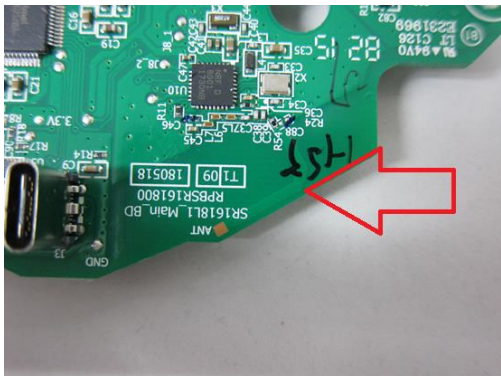
For intentional device. According to 15.203. an intentional radiator shall be designed to Ensure that no antenna other than that furnished by the responsible party shall be used with the device.

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 PCB Layout antenna and no consideration of replacement. The best-case gain of the antenna is 0dBi.



**Test result: The unit does meet the FCC requirements.**

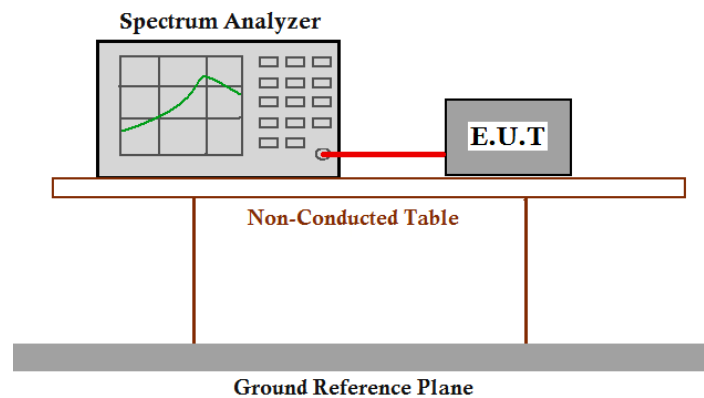
### 6.3 6 dB Bandwidth

Test Requirement: FCC Part 15 C section 15.247  
(a)(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Method: ANSI C63.10 Clause 11.8.1

Test Status: Enter test mode for the product. Test in Channel lowest (2402MHz), middle (2440MHz) and highest (2480MHz), keep in continuously transmitting status.

Test Configuration:



Test Procedure:

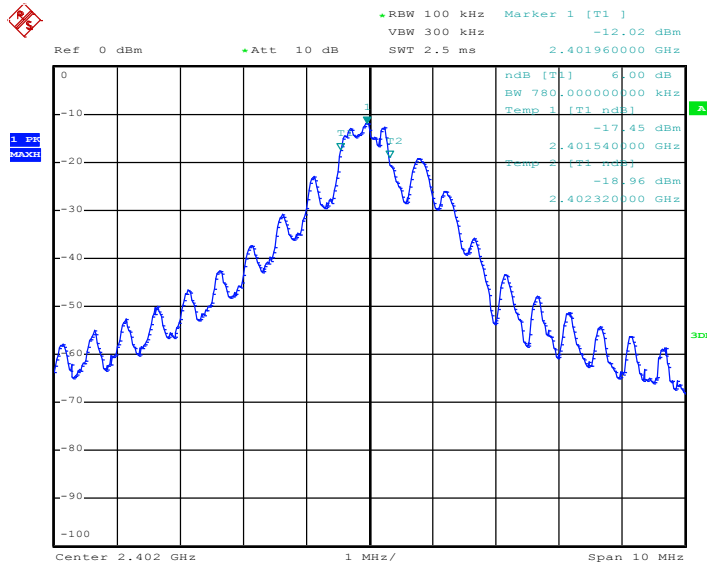
1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable (cable loss =1.5dB) from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW=100KHz. VBW = 300KHz. Sweep = auto; Detector Function = Peak. Trace = Max Hold, Set span to encompass the entire emission bandwidth of the signal.
3. Mark the peak power frequency and -6dB (upper and lower) power frequency.
4. Repeat until all the test status is investigated.
5. Report the worst case.

Channel No.	Frequency (MHz)	Mode	Data Rate	Measured 6dB bandwidth (kHz)	Limit	Result
0	2402	GFSK	1 Mbps	780	≥500KHz	Pass
19	2440		1 Mbps	780		Pass
39	2480		1 Mbps	700		Pass

**Test result: The unit does meet the FCC requirements.**

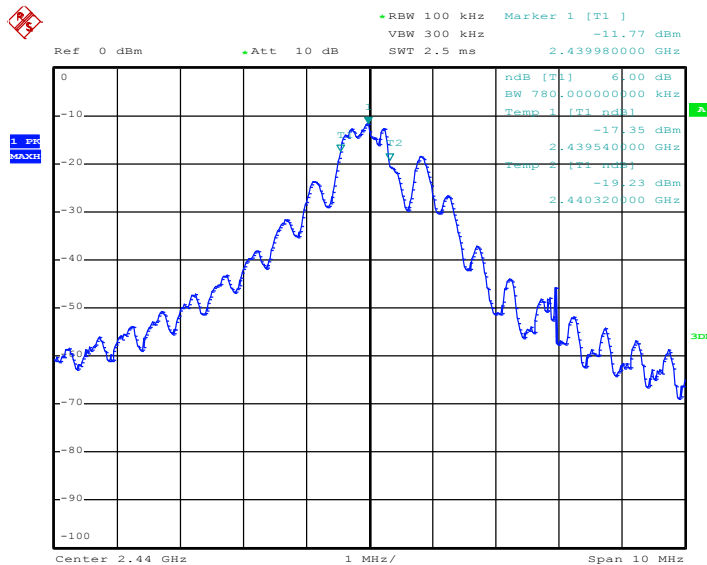
Result plot as follows:

Channel 0:2.402GHz:



Date: 20.JUL.2018 16:00:50

Channel 19:2.440GHz:

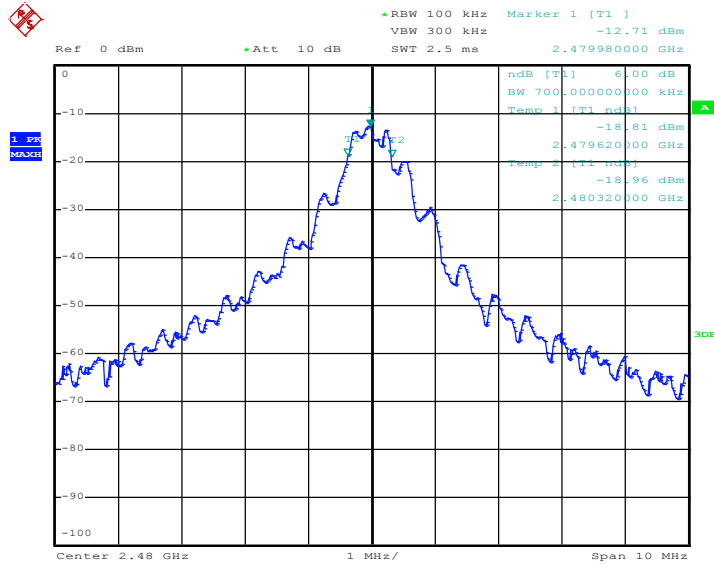


Date: 20.JUL.2018 16:00:13

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Channel 39:2.480GHz:



Date: 20.JUL.2018 16:01:17

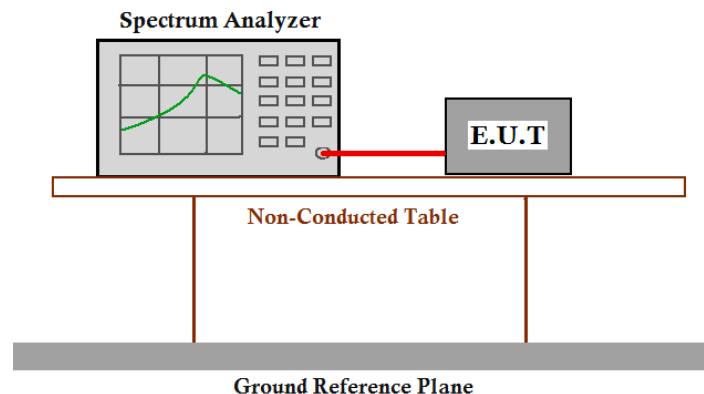
## 6.4 Maximum Peak Output Power

**Test Requirement:** FCC Part 15 C section 15.247  
 (b)(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.  
 Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b) (1), (b) (2), and (b) (3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

**Test Method:** ANSI C63.10 Clause 11.9.1.1

**Test Status:** Enter test mode for the product. Test in Channel lowest (2402MHz), middle (2440MHz) and highest (2480MHz), keep in continuously transmitting status.

**Test Configuration:**





**Test Procedure:**

1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable  
 (Cable loss =1.5dB) from the antenna port to the spectrum.
2. Set the RBW $\geq$ DTS bandwidth
3. Set the VBW  $\geq$  3 x RBW
4. Set the span  $\geq$  3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Use peak marker function to determine the peak amplitude level.
9. Report the worst case.

**Test result:**

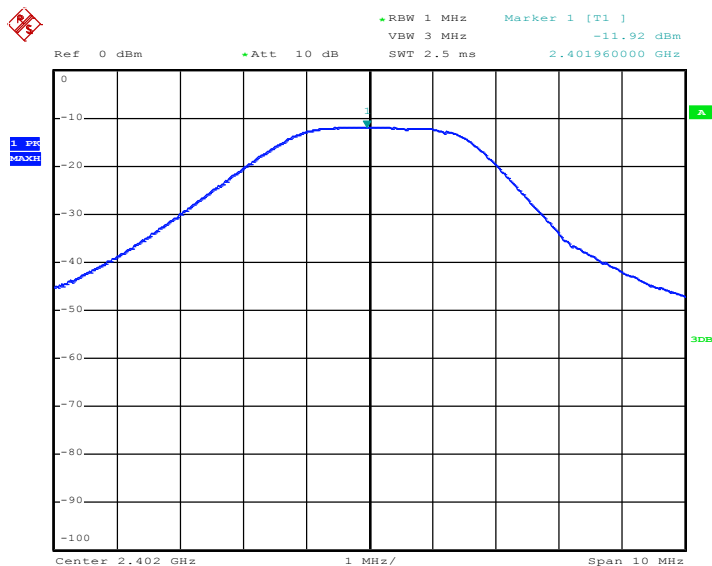
Channel No.	Frequency (MHz)	Mode	Data Rate	Measured Channel Power (dBm)	Limit	Result
0	2402	GFSK	1Mbps	-11.92	1W(30dBm)	Pass
19	2440		1Mbps	<b><u>-11.71</u></b>		Pass
39	2480		1Mbps	-12.53		Pass

**Remark: Level = Read Level + Cable Loss.**

**The unit does meet the FCC requirements.**

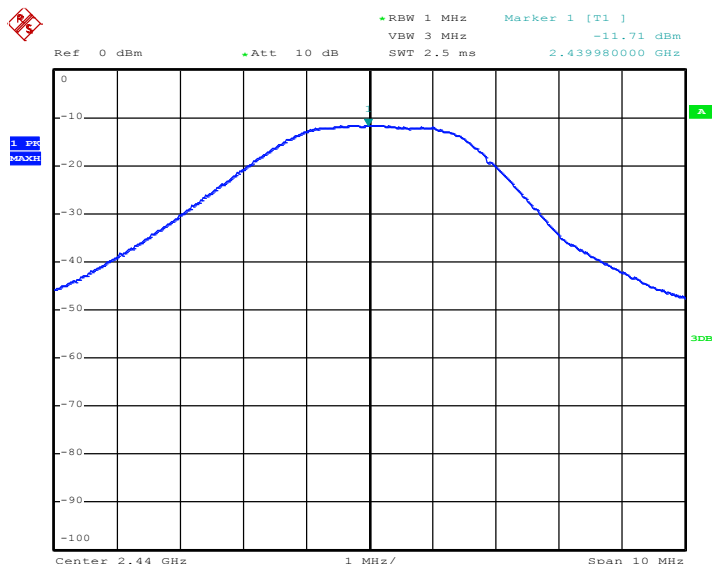
Result plot as follows:

Channel 0:2.402GHz:



Date: 20.JUL.2018 16:02:27

Channel 19:2.440GHz:

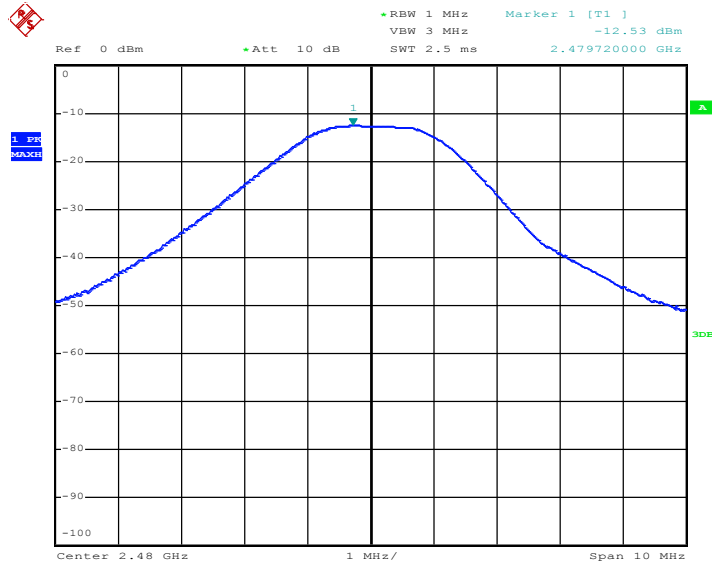


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Channel 39:2.480GHz:



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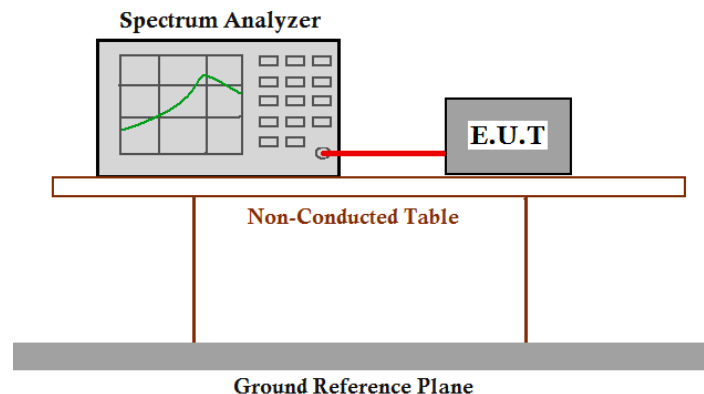
## 6.5 Peak Power Spectral Density

**Test Requirement:** FCC Part 15 C section 15.247  
 (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.  
 This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

**Test Method:** ANSI C63.10 Clause 11. 10. 2

**Test Status:** Enter test mode for the product. Test in lowest Channel 2402MHz, middle Channel 2440MHz and highest Channel 2480MHz, keep in continuously transmitting status.

**Test Configuration:**



**Test Procedure:**

1. Remove the antenna from the EUT and then connect a low attention attenuation RF cable (cable loss =1.5dB) from the antenna port to the spectrum analyzer or power meter.
2. Set the spectrum analyzer:
  - a) Set CENTER FREQUENCY = Frequency from Power Spectral Density Test Matrix (see 6.10.2)
  - b) Set SPAN = 20 MHz (For devices with a nominal 40 MHz BW, 50 MHz span will be needed)
  - c) Set REFERENCE LEVEL = 20 dBm
  - d) Set ATTENUATION = 0 dB (add internal attenuation, if necessary)
  - e) Set SWEEP TIME = Coupled
  - f) Set RBW = 3 kHz
  - g) Set VBW = 10 kHz
  - h) Set DETECTOR = Peak
  - i) Set MKR = Center Frequency
  - j) Set TRACE = CLEAR WRITE

Place the radio in continuous transmit mode. Set the TRACE to MAX HOLD, and after the trace stabilizes, the TRACE to VIEW. Set the marker on the peak of the signal and then adjust the center frequency of the spectrum analyzer to the marker frequency.

After viewing the EUT waveform on the spectrum analyzer, perform the following spectrum analyzer functions to capture the trace:

Set SPAN = 300 kHz

Set SWEEP TIME = 100 s

Set TRACE = MAX HOLD

Set MKR = PEAK SEARCH

3. Measure the Power Spectral Density of the test frequency with special test status.
4. Repeat until all the test status is investigated.
5. Report the worse case.

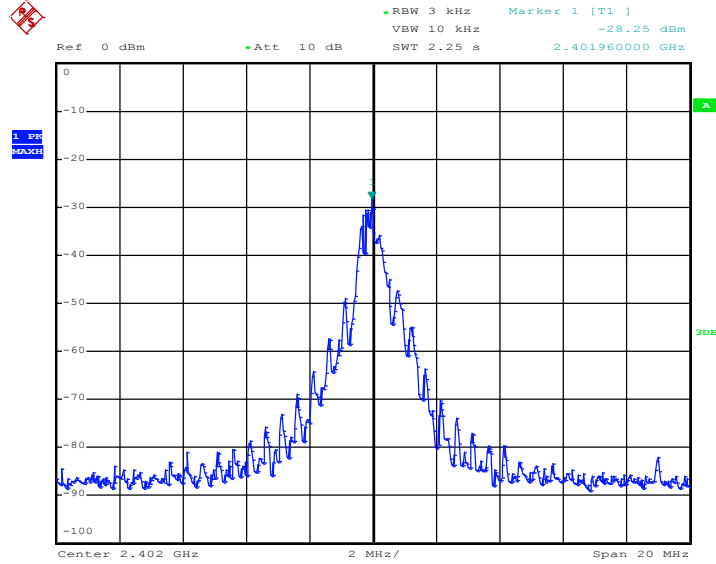
Channel No.	Frequency (MHz)	Mode	Data Rate	Measured Peak Power		Result
				Spectral Density (dBm/3kHz)	Limit	
0	2402	GFSK	1 Mbps	-25.78	8dBm/3kHz	Pass
19	2440		1 Mbps	-26.16		Pass
39	2480		1 Mbps	-26.45		Pass

**Test result: Level = Read Level + Cable Loss.**

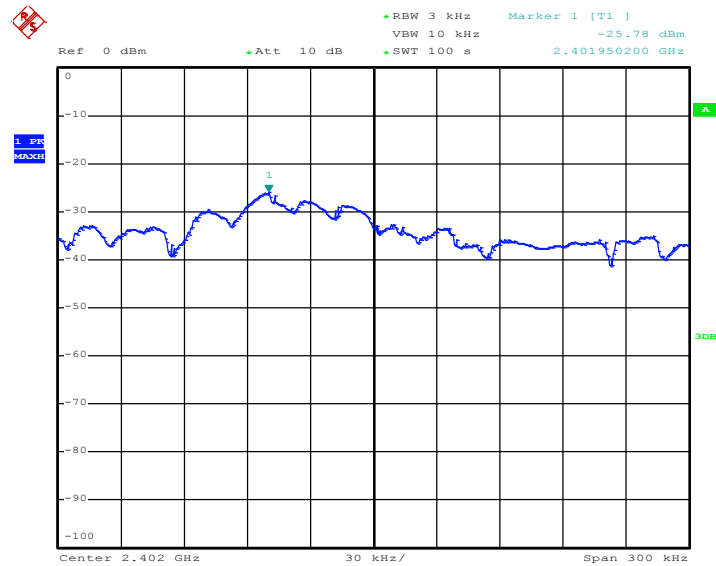
**The unit does meet the FCC requirements.**

Result plot as follows:

Channel 0:2.402 GHz:



Date: 20.JUL.2018 16:07:33

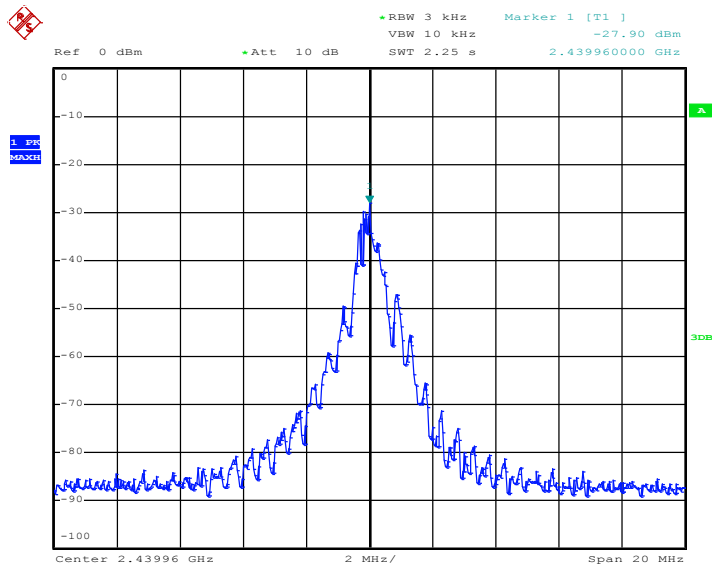


Date: 20.JUL.2018 16:10:26

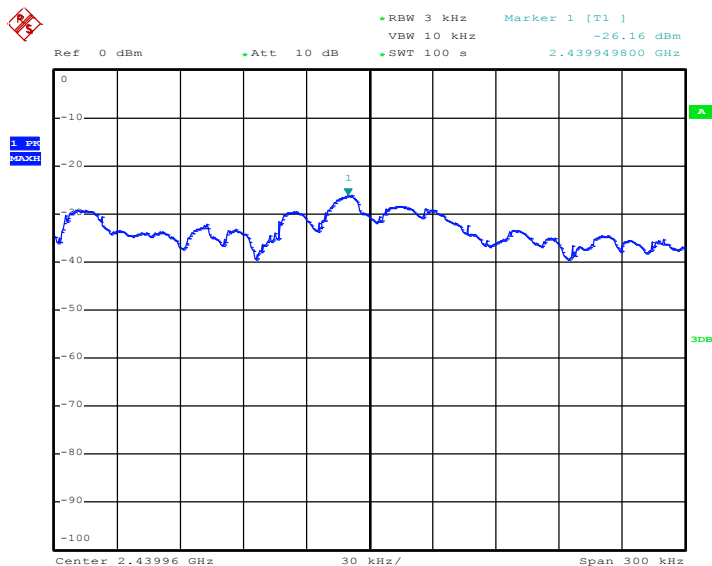
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Channel 19:2.440 GHz:



Date: 20.JUL.2018 16:04:27



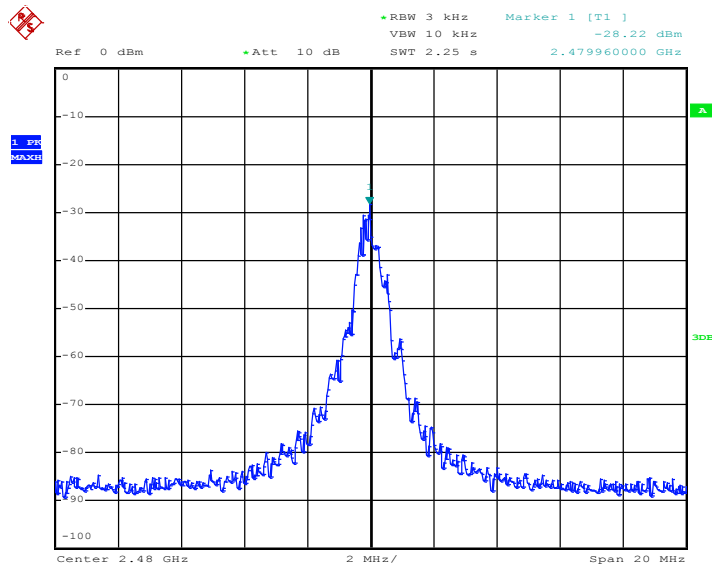
Date: 20.JUL.2018 16:06:41

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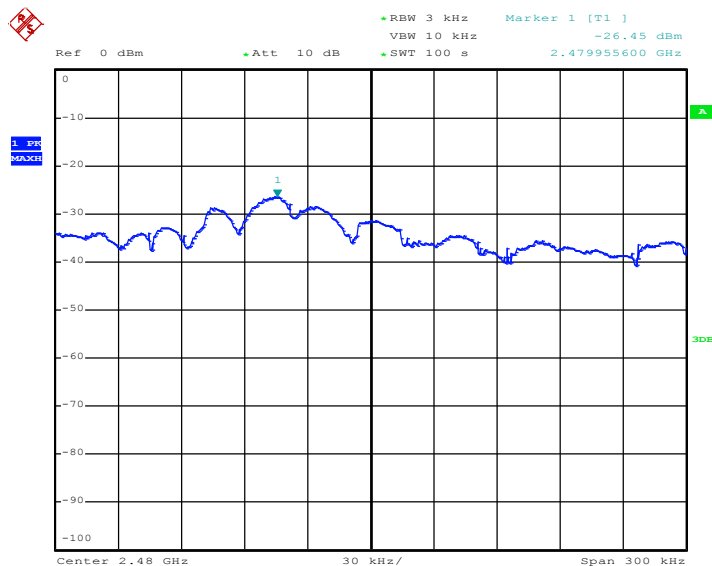
Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.



Channel 39:2.480 GHz:



Date: 20.JUL.2018 16:14:07



Date: 20.JUL.2018 16:18:10

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## 6.6 Conducted Spurious Emissions

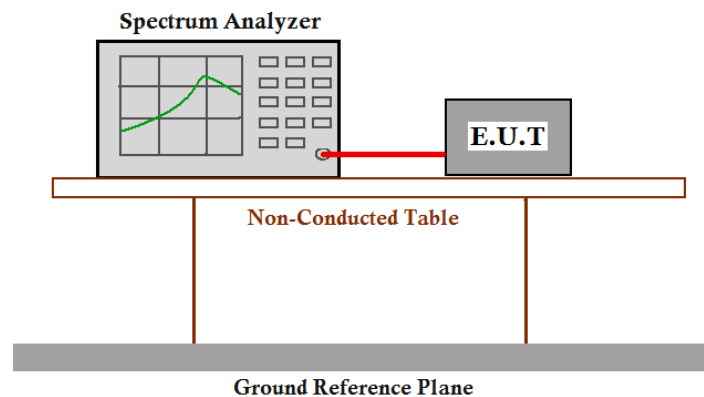
Test Requirement: FCC Part 15 C section 15.247

(d) In any 100kHz 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 100kHz 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 11.11

Test Status: Enter test mode for the product. Test in lowest Channel 2402MHz, middle Channel 2440MHz and highest Channel 2480MHz, keep in continuously transmitting status.

Test Configuration:



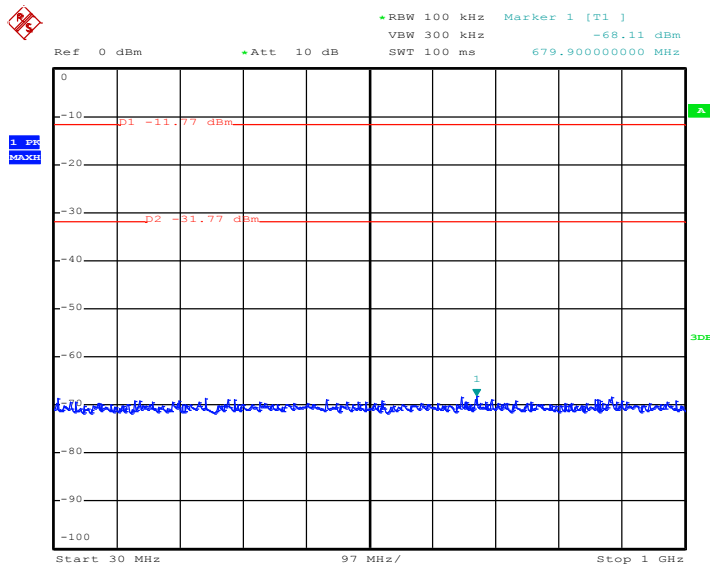
Test Procedure:

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum analyzer or power meter.
2. Set the spectrum analyzer: RBW=100 kHz, VBW = 300kHz. Sweep = auto; Detector Function = Peak. Trace = Max Hold, Scan up through 10th harmonic.
3. Measure the Conducted Spurious Emissions of the test frequency with special test status.
4. Repeat until all the test status is investigated.
5. Report the worse case.

Result plot as follows:

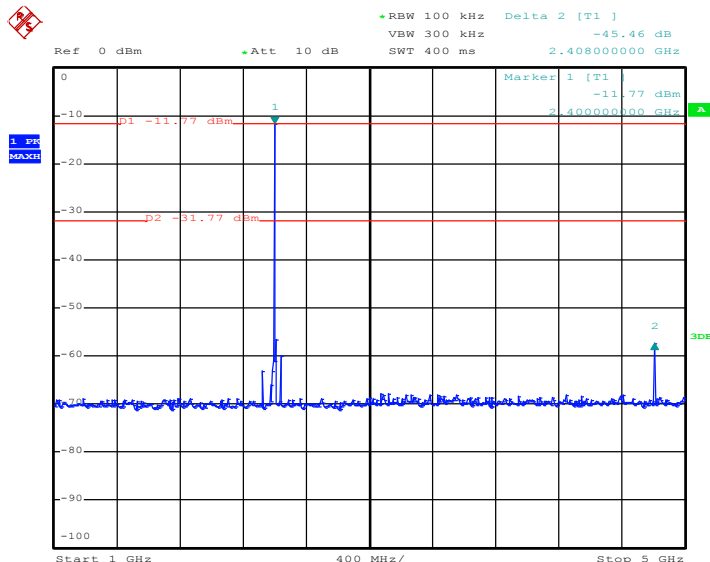
Channel 0: 2.402 GHz

30 MHz to 1GHz



Date: 20.JUL.2018 16:23:28

1GHz to 5GHz

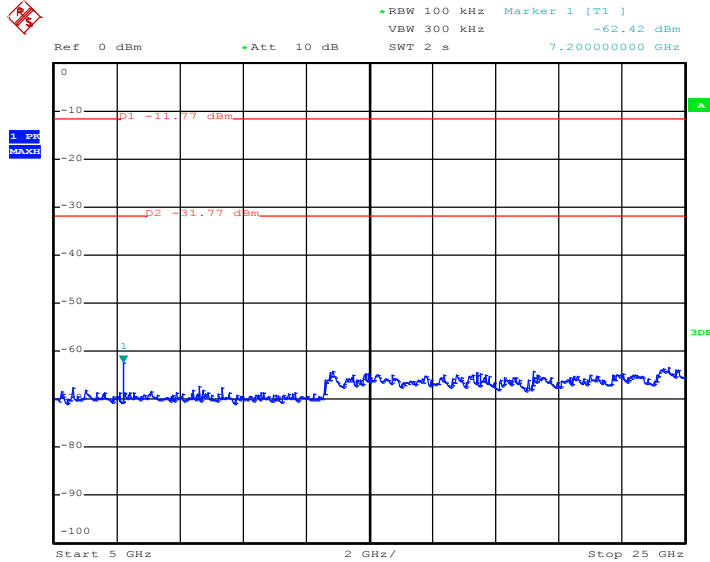


Date: 20.JUL.2018 16:22:51

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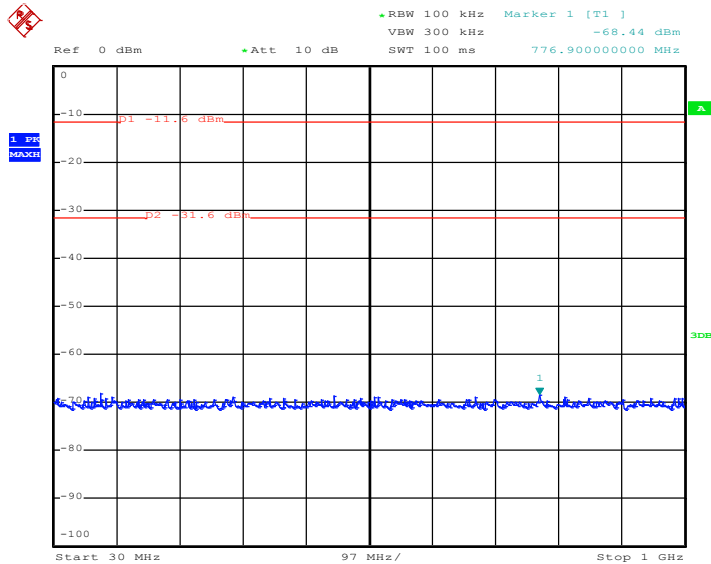
**5GHz to 25GHz**



Date: 20.JUL.2018 16:24:20

**Channel 19:2.440GHz**

**30 MHz to 1GHz**

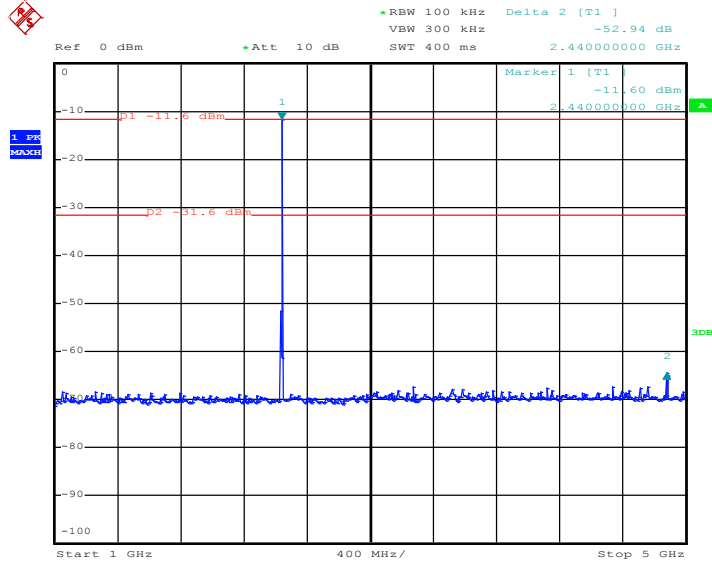


Date: 20.JUL.2018 16:30:00

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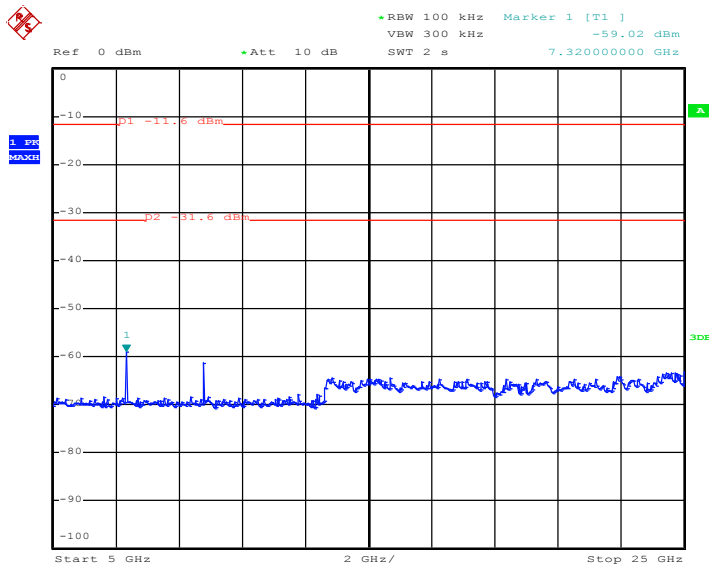
Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

### 1GHz to 5GHz



Date: 20.JUL.2018 16:29:15

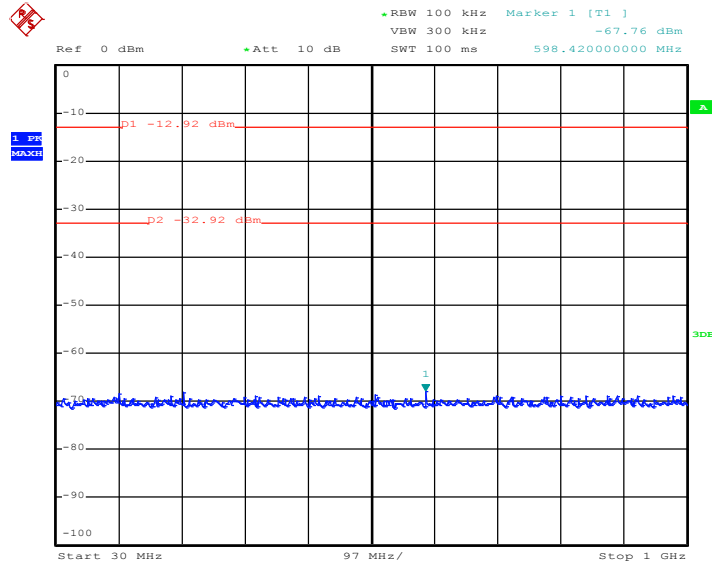
### 5GHz to 25GHz



Date: 20.JUL.2018 16:30:54

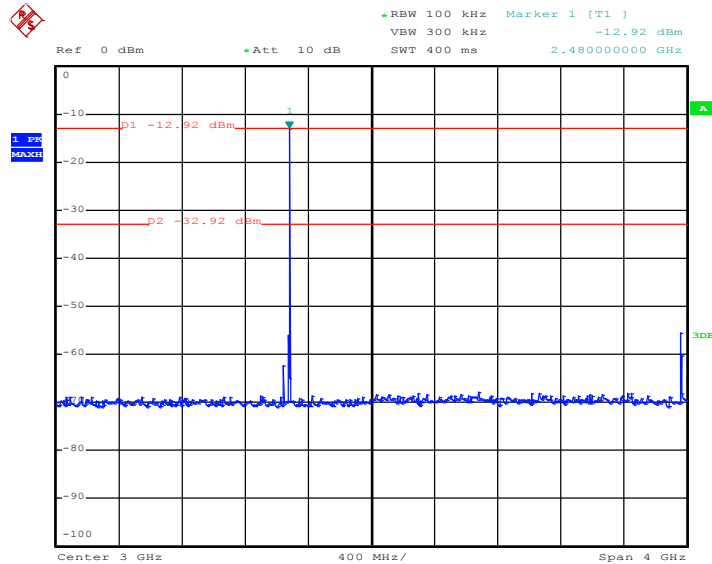
Channel 39:2.480GHz

30 MHz to 1GHz



Date: 20.JUL.2018 16:33:14

1GHz to 5GHz

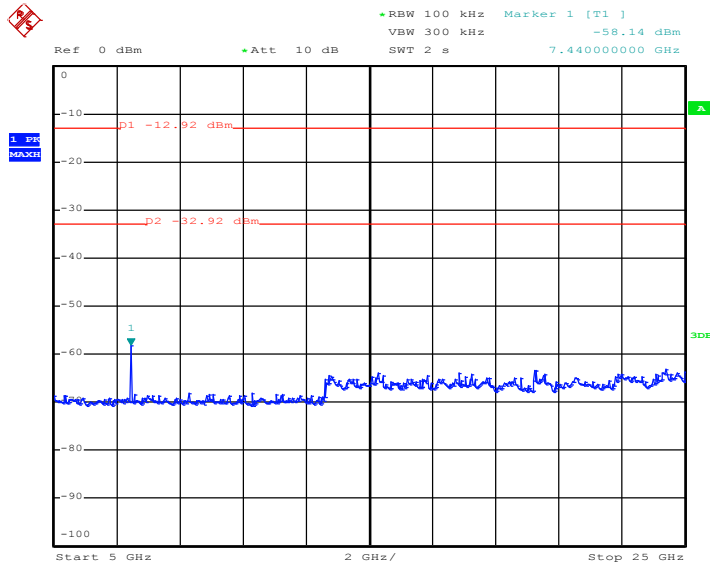


Date: 20.JUL.2018 16:32:27

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5GHz to 25GHz



Date: 20.JUL.2018 16:34:04

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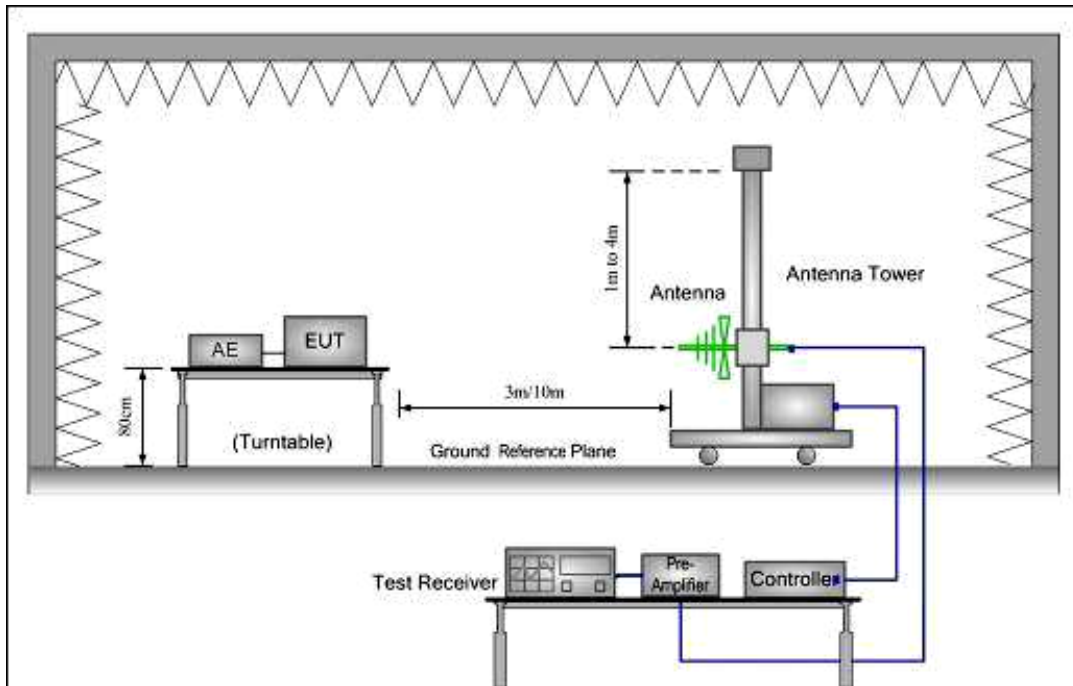
## 6.7 Radiated Spurious Emissions

Test Requirement:	FCC Part 15 C section 15.247 (d) In any 100kHz 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 100kHz 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:	Enter test mode for the product. Test in lowest channel 2402 MHz and highest channel 2480 MHz, keep in continuously transmitting status with GFSK modulation.
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, 100 kHz for $f < 1$ GHz VBW = 10Hz Sweep = auto Detector function = peak Trace = max hold
15.209 Limit:	40.0 dB $\mu$ V/m between 30MHz & 88MHz 43.5 dB $\mu$ V/m between 88MHz & 216MHz 46.0 dB $\mu$ V/m between 216MHz & 960MHz 54.0 dB $\mu$ V/m above 960MHz

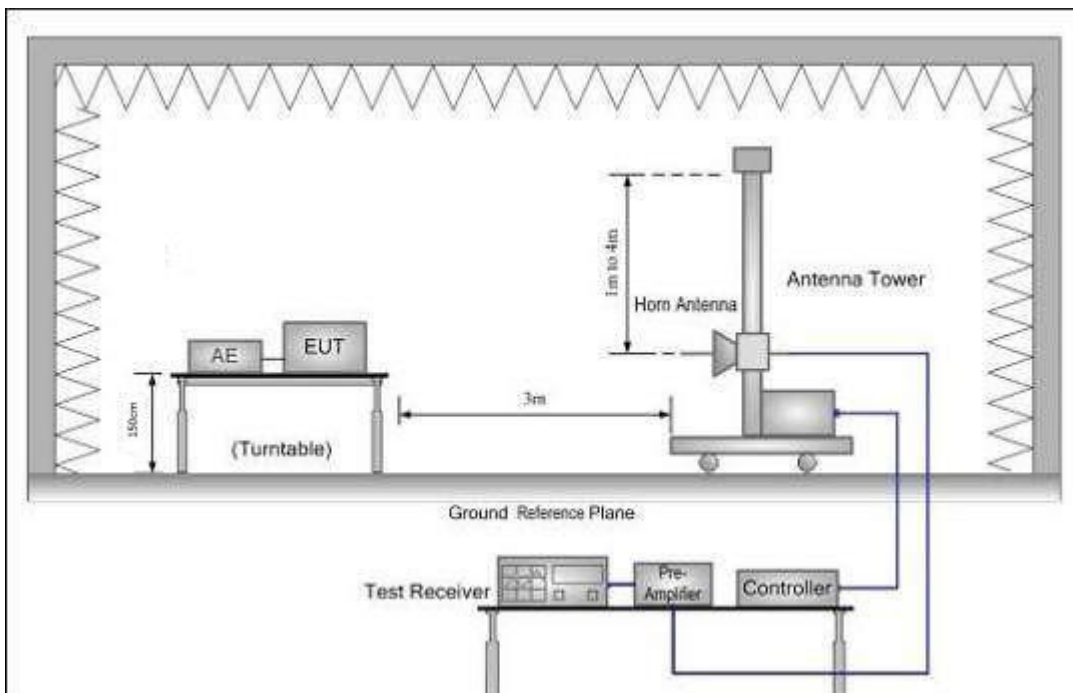


**Test Configuration:**

1) 30 MHz to 1 GHz emissions:



2) 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.

From 30MHz to 1GHz, read the Quasi-Peak field strength of the emissions with receiver QP detector RBW=120KHz.

Above 1GHz, read the Peak field strength and Average field strength.

Read the Peak field strength through RBW=1MHz,VBW=3MHz in spectrum analyzer setting;

Read the Average field strength through RBW=1MHz,VBW=10Hz in spectrum analyzer setting;

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 average field strength 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.

### 6.7.1 Harmonic and other spurious emissions

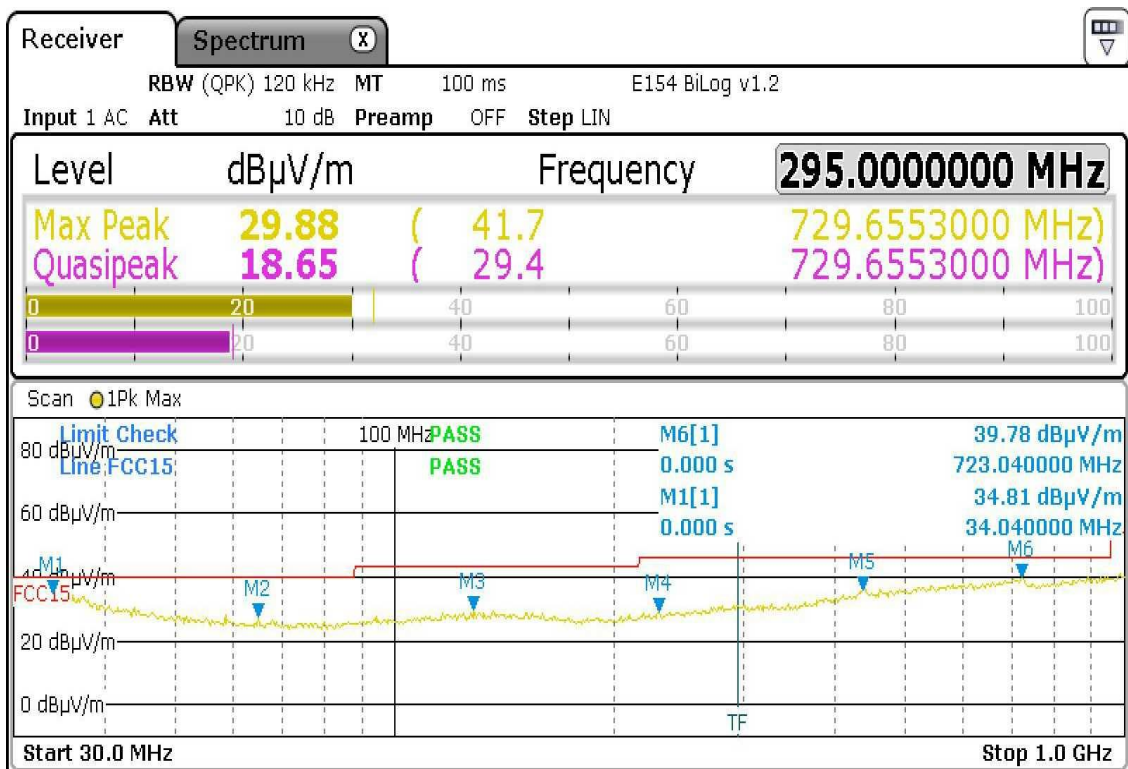
#### Test at Channel 1 (2.402 GHz) in transmitting status

#### 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)
31.800	H	18.1	8.5	26.6	40	-13.4
62.570	V	9.5	6.4	15.9	40	-24.1
130.600	V	11.0	7.1	18.1	43.5	-25.4
229.700	V	10.1	7.8	17.9	46	-28.1
437.910	V	16.5	7.2	23.7	46	-22.3
721.090	V	19.6	7.8	27.4	46	-18.6

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

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

Frequency (MHz)	Antenna Polarization	Emission Level (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Remark
		Peak	Average	Peak	Average	
4804	H	44.75	27.20	74	54	Pass
6473	V	43.69	26.40	74	54	Pass
7206	H	49.96	33.24	74	54	Pass
8647	V	49.94	32.39	74	54	Pass
9620	V	49.28	32.41	74	54	Pass
10655	V	53.14	34.90	74	54	Pass

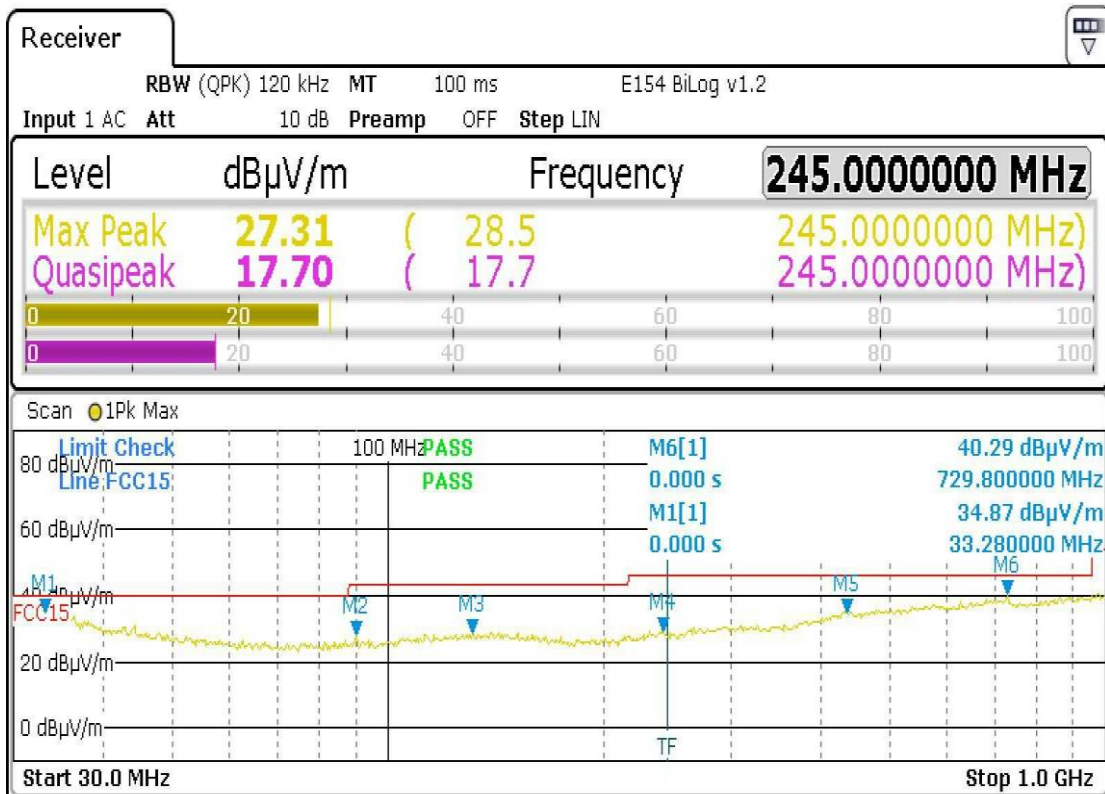
**Test at Channel39 (2.440 GHz) in transmitting status**

**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)
30.920	V	18.5	7.1	25.6	40	-14.4
92.250	H	9.2	6.6	15.8	43.5	-27.7
132.190	H	11.1	7.0	18.1	43.5	-25.4
239.700	V	10.6	7.9	18.5	46	-27.5
438.660	V	16.5	7.4	23.9	46	-22.1
729.660	V	19.7	9.6	29.3	46	-16.7

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

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

Frequency (MHz)	Antenna Polarization	Emission Level (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Remark
		Peak	Average	Peak	Average	
4880	H	42.63	23.39	74	54	Pass
5662	V	43.92	25.31	74	54	Pass
7320	H	49.89	31.40	74	54	Pass
8655	H	49.97	31.93	74	54	Pass
9760	V	53.42	33.50	74	54	Pass
10472	H	54.21	36.05	74	54	Pass

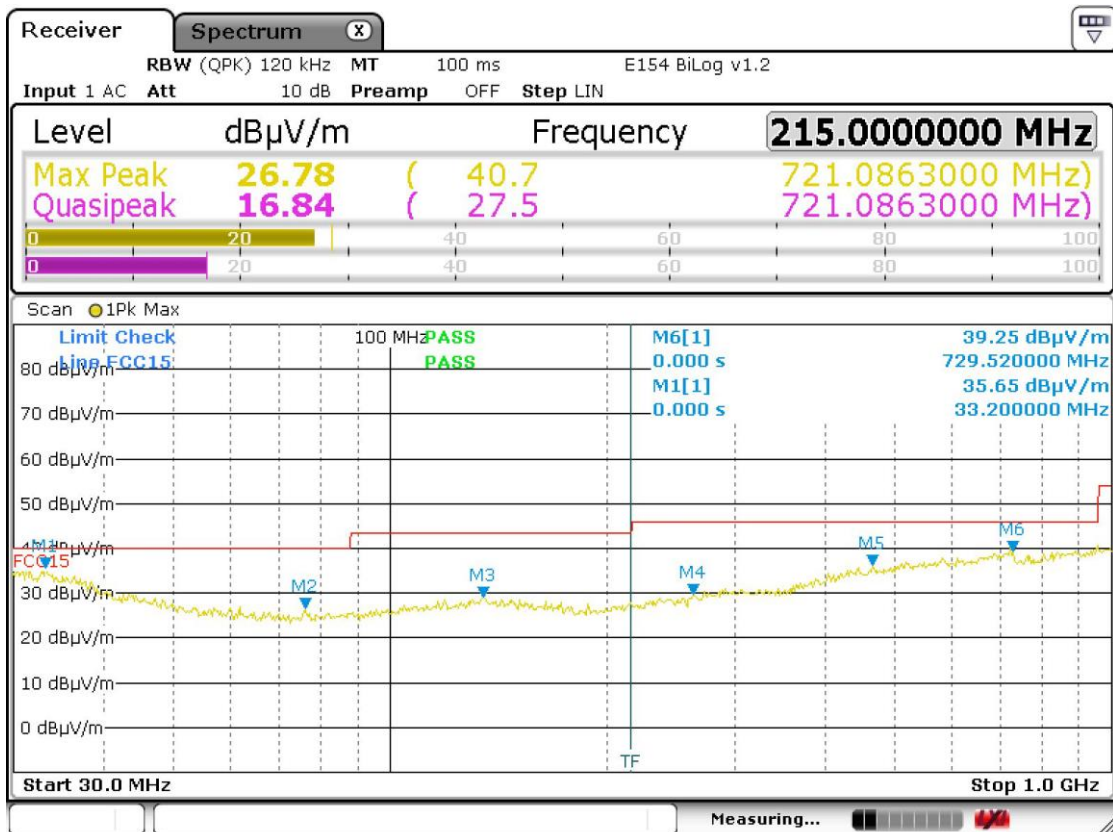
**Test at Channel79 (2.480 GHz) in transmitting status**

**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)
31.780	H	18.1	8.6	26.7	40	-13.3
74.300	H	8.8	8.2	17.0	40	-23.0
132.790	H	11.1	7.0	18.1	43.5	-25.4
262.380	H	11.7	7.2	18.9	46	-27.1
465.340	H	17.0	6.4	23.4	46	-22.6
729.090	H	19.7	9.6	29.3	46	-16.7

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

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

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
4960	H	41.70	23.35	74	54	Pass
5625	V	41.75	25.03	74	54	Pass
7440	V	48.42	31.50	74	54	Pass
8484	V	46.79	31.46	74	54	Pass
9920	V	52.41	32.81	74	54	Pass
10450	H	52.38	35.20	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.**



## 6.7.2 Radiated Emissions which fall in the restricted bands

Test Requirement:	FCC Part 15 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:	Enter test mode for the product. Test in lowest channel 2402 MHz and highest channel 2480 MHz, keep in continuously transmitting status with GFSK modulation.
Test site:	Measurement Distance: 3m (Semi-Anechoic Chamber)
Limit:	40.0 dB $\mu$ V/m between 30MHz & 88MHz; 43.5 dB $\mu$ V/m between 88MHz & 216MHz; 46.0 dB $\mu$ V/m between 216MHz & 960MHz; 54.0 dB $\mu$ 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, 100 kHz for $f < 1$ GHz VBW =10Hz Sweep = auto Detector function = peak Trace = max hold

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
10.495 - 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 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	
13.36 - 13.41	322 - 335.4		

**Test Result:**

**Test at lowest Channel (2.402 GHz) in transmitting status**

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2400.00	H	46.74	14.56	74	54	Pass
2400.00	V	31.07	12.95	74	54	Pass

**Test at highest Channel (2.480 GHz) in transmitting status**

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2483.50	H	30.09	14.66	74	54	Pass
2483.50	H	29.98	14.69	74	54	Pass

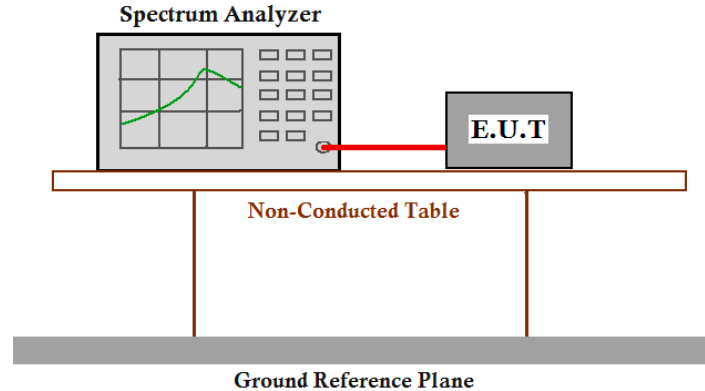
Remark: above table only record the worse data of emissions in restricted frequency bands.

**Test result: The unit does meet the FCC requirements.**

## 6.8 Band Edges Requirement

Test Requirement:	FCC Part 15 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.
Frequency Band:	2400 MHz to 2483.5 MHz
Test Method:	ANSI C63.10 clause 11.13.3.2
Test Status:	Enter test mode for the product. Test in lowest channel 2402 MHz and highest channel 2480 MHz, keep in continuously transmitting status with GFSK modulation.

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 analyzer or power meter.
2. Set instrument center frequency to the frequency of the emission to be measured (must be within 2MHz of the authorized band edge).
3. Set span to 2MHz,
4. RBW=100kHz,
5. VBW $\geq$ 3 $\times$ RBW
6. Detector=peak
7. Sweep time =auto,

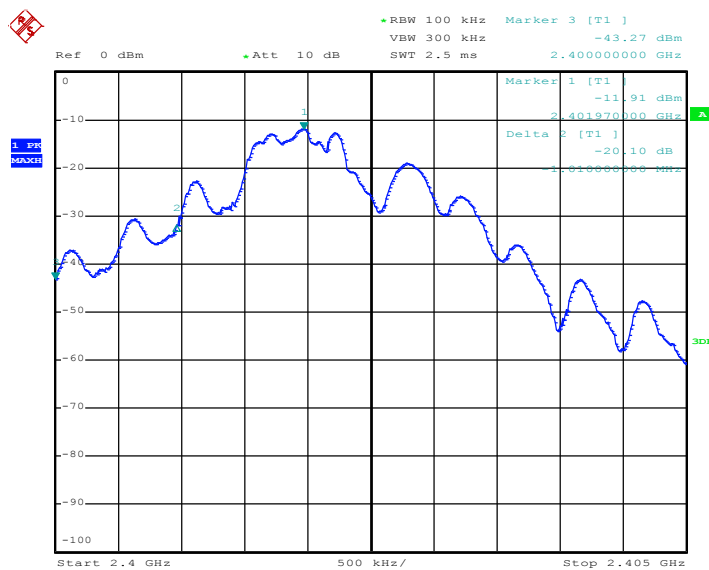
- 
8. Trace mode=max hold.
  9. Allow sweep to continue until the trace stabilizes (required measurement time may increase for low duty cycle applications)
  10. Compute the power by integrating the spectrum over 1MHz using the analyzer's band power measurement function with band limits set equal to the emission frequency( $f_{\text{emission}} \pm 0.5\text{MHz}$ ). If the instrument does not have a band power function, the sum the amplitude levels (in power units) at 100kHz intervals extending across the 1MHz spectrum defined by  $f_{\text{emission}} \pm 0.5\text{MHz}$ .

**Test result with plots as follows:**

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.

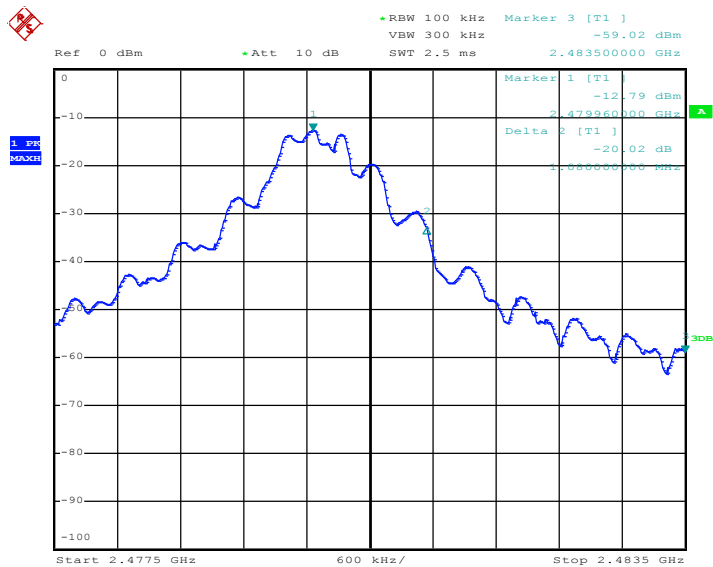
**Result plot as follows:**

Channel 0: 2.402 GHz



Date: 20.JUL.2018 16:44:31

Channel 39: 2.480GHz



Date: 20.JUL.2018 16:43:12

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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.

## 7 Photographs

### 7.1 EUT Constructional Details



--End of Report--