

CERTIFICATION TEST REPORT

FCC CFR47 Part 15 Subpart C

Test Report File No.	14-IST-0299	☒ Basic	☐ Alternate
Date of Receipt	April 09, 2014	Begin of test date	May 08, 2014
Date of Issue	May 21, 2014	End of test date	May 16, 2014
Kind of Product	Bluetooth Stereo Headset		
Model(s)	Groove		
FCC ID	2ACABGROOVE		
Applicant	Byzero Inc.		
Address	Jeonpa-ro 44beon-gil 36 2F, Manan-gu, Anyang-si, Gyeonggi-do, Korea		
Manufacturer	Byzero Inc.		
Address	Jeonpa-ro 44beon-gil 36 2F, Manan-gu, Anyang-si, Gyeonggi-do, Korea		

Test Result

☒ Positive

☐ Negative

Tested By

Reviewed By




B.O. KO.

S.J. CHO

Comment (s)

- Investigations requested : Measurement to the relevant clauses of FCC rules and regulations Part 15 Subpart C.
 - The test report is consists of 40 pages.
 - The test result only responds to the tested sample.
 - It is not allowed to copy this report even partly without the allowance of IST Co., Ltd.
 - This equipment as for has been shown to be capable of continued compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.4
- I assume full responsibility for accuracy and completeness of these data.



TABLE OF CONTENTS

Table of contents	2
Information of test laboratory, Measurement Uncertainty	3
Product information	4
Summary	5
- Conducted Emission	6~10
- Peak power output	11~13
- Conducted Spurious Emissions & Band edge	14
- Conducted Spurious Emissions	15~16
- Conducted Band Edge	17~18
- 20dB BandWidth & Channel Separation & Occupied Bandwidth	19
- 20dB BandWidth	20~21
- Channel Separation	22~23
- Occupied BandWidth	24~25
- Number of hopping frequency	26~27
- Time of occupancy(Dwell time)	28~29
- Radiated Emissions	30~32
- Radiated Emissions, 9KHz to 30MHz (Magnetic Field Test)	33
- Radiated Spurious	34~37
- Radiated Restricted Band Edge	38~39
- Antenna requirements	40

Note:

INFORMATIONS OF TEST LABORATORY

EMC LABORATORY of IST Co., Ltd.
52-20, Sinjeong-ro 41beon-gil, Giheung-gu,
Yongin-si, Gyeonggi-do, Korea
TEL: +82 31 326 6700 FAX: +82 31 326 6797

VCCI Registration No. : 1739
FCC Registration No. : 400603
KCC Registration No. : KR0018
KOLAS Registration No. : KT118



Measurement Uncertainty

Conducted Emissions	$U = 2.98$ [dB] (Confidence level approximately 95 %, $k = 2$)
Radiated Emissions (Antenna - Horizontal)	$U = 3.83$ [dB] (Confidence level approximately 95 %, $k = 2$)
Radiated Emissions (Antenna - Vertical)	$U = 4.50$ [dB] (Confidence level approximately 95 %, $k = 2$)

PRODUCT INFORMATION

Bluetooth Stereo Headset(Groove)	Specification
Bluetooth	V3.0, Headset /A2DP/AVRCP Profile
Battery	3.7 V/ 250 mAh (Lithium Ion Polymer)
Standby	Max 625 hours
Distance	Within 10 m
Operating Temperature Range	-10 °C ~ 50 °C
Frequency Range	2.402 GHz ~ 2.480 GHz ISN Band
Remark	-

Test Mode :

Mode 1: Transmit (DH5)

Mode 2: Transmit (3DH5)

1. DH5 is for GFSK modulation, and 3DH5 is for Pi/4 DQPSK
2. Regards to the frequency band operation; the highest that was included the lowest, middle and highest frequency of channel were selected to perform the test, and then shown on this report.

- Please refer to user's manual.

SUMMARY

Bluetooth Mode(2402MHz ~2480MHz)

Applied Standard : FCC CRF Part 15 Subpart C

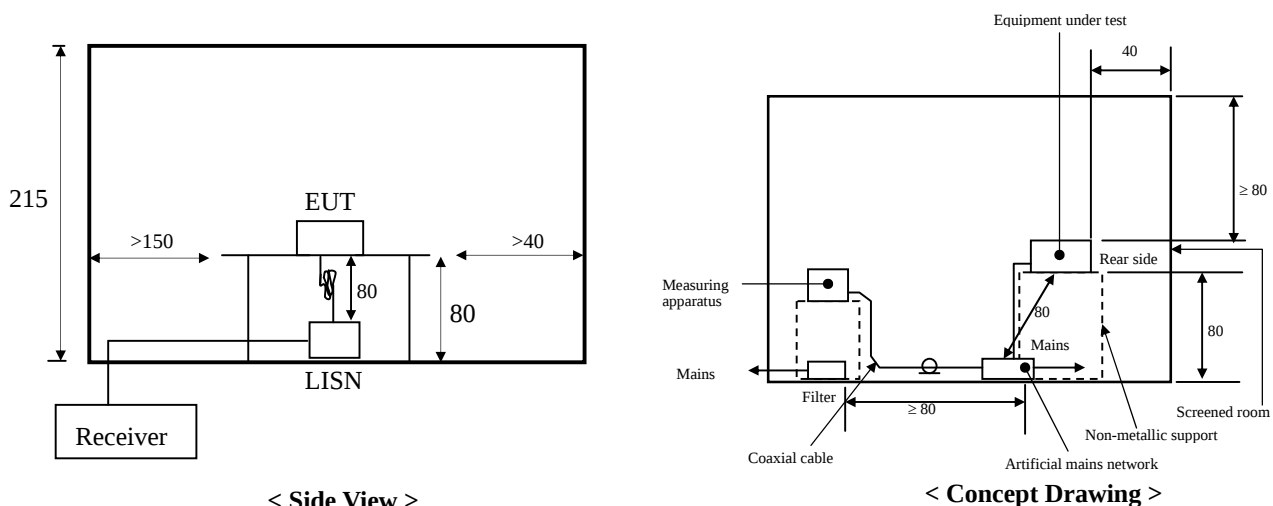
Description of Test	FCC Rule Parts	Results
AC Conducted Emission	15.207	Compliant
Carrier Frequency Separation	15.247(a)(1)	Compliant
20 dB Bandwidth	15.247(a)(1)(ii) or (iii)	Compliant
Time of Occupancy	15.247(a)(1)(ii) or (iii)	Compliant
Number of Hopping Frequencies	15.247(a)(1)(ii) or (iii)	Compliant
Conducted Maximum Peak Output Power	15.247(b)(1)	Compliant
Spurious RF Conducted Emission	15.247(d)	Compliant
Spurious Radiated Emission	15.247(d), 15.209	Compliant
Receiver Spurious Emission		Compliant
Out-of- Band Emission	15.247(d)	Compliant
Occupied Bandwidth		Compliant

Conducted Emissions:

The measurement were performed over the frequency range of 0.15 MHz to 30 MHz using a $50 \Omega/50 \mu\text{H}$ LISN as the input transducer to a Spectrum Analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 10 kHz or for "quasi-peak" & "Average" within a bandwidth of 9 KHz.

-Procedure of Test

The line-conducted facility is located inside a shielded room No.1. A 1 m X 1.5 m wooden table 80 cm height is placed 40 cm away from the vertical wall and 1.5 m away from the other wall of the shielded room. The R/S ESCI and Hyup-Rip KNW-407 LISN are bonded to bottom of the shielded room. The EUT is located on the wooden table with distance more than 80 cm from the LISN and powered from the EMCO LISN .The peripheral equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and this supply lines will be connected to the EMCO LISN. All interconnecting cables more than 1m were shortened by non-inductive bundling to a 1m length. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating conditions. The RF output of the LISN was connected to the R/S receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using Quasi-Peak mode by manual measurement, after scanned by automatic Peak mode for frequency range from 0.15 to 30 MHz. The bandwidth of the receiver was set to 10 kHz. The EUT, peripheral equipment, and interconnecting cables were arranged and manipulated to maximize each EME emission.



Limits

According to §15.207(a) except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network(LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Limits	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

* Decreases with the logarithm of the frequency.

Test specification.

According to FCC CFR Title 47 Part 15 Subpart C Section 15.207

Conducted Emissions

[Applicable]

◆ Test Equipment Used

Model Name	Description	Manufacturer	Due for Cal	Serial No.
ESCI	Test Receiver	Rohde & Schwarz	Jul. 16, 2014	100373
ENV216	LISN	Rohde & Schwarz	Dec. 09, 2014	101718

Note : The equipment used is calibrated in regular for every year.

◆ Test Accessories Used

Equipment	Type	Brand	Serial No.
Bluetooth Stereo Headset	Groove	Byzero Inc.	N/A
Laptop	LGR40	LG Electronics	705KSLP024816
Adapter (Laptop)	PA-1900-08	Dongguang Lite Power 2nd Plant	N/A
radio equipment for mobile communication	SHV-E210K	Samsung Electronics.	R33C710VHEV

Connecting Interface Cables :

AC Power Cable : 1.8 m (Unshielded)

USB Cable (Micro 5pin to USB) : 1.0 m (shielded)

◆ Test Conditions

Temperature (21.2 ± 0.2) °C
 Humidity (45.8 ± 0.2) % R.H.
 Atmosphere (1000) mbar

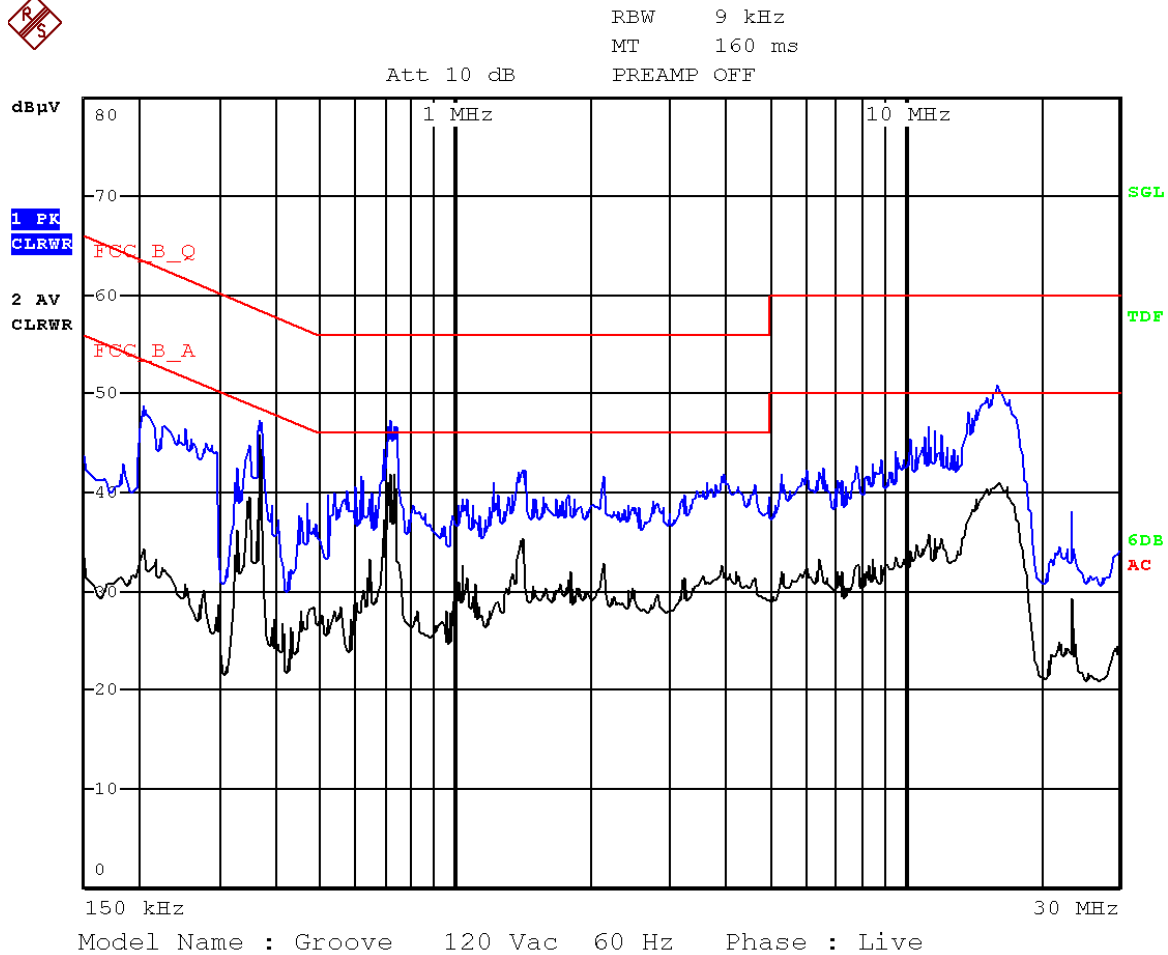
◆ Test Area Conducted Room #1

◆ Test Date May 08, 2014

Note :

Conducted Emissions result

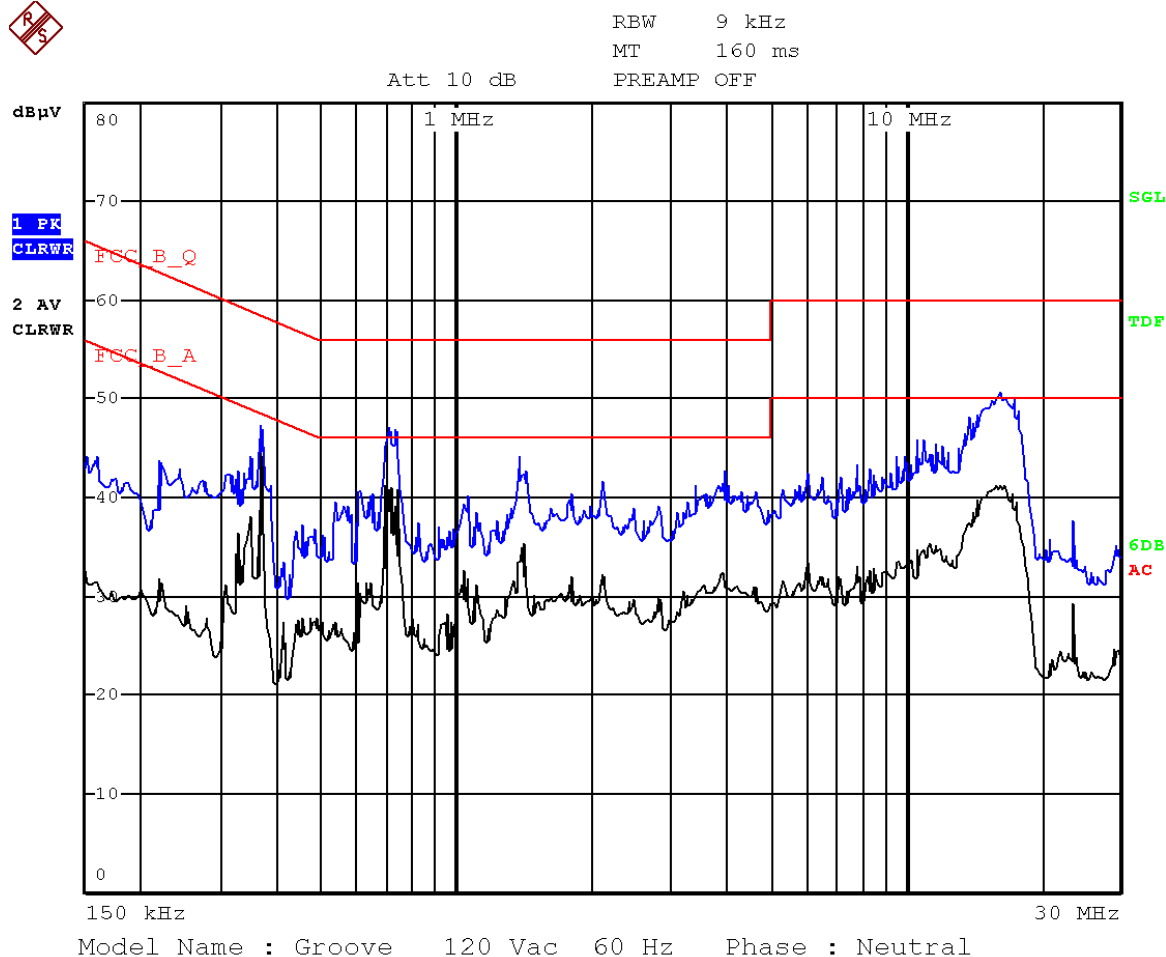
Live



Freq. [MHz]	Measurement [dB μ V]		Limit [dB μ V]		Insertion Loss	Cable Loss	Result [dB μ V]		Margin [dB]	
	Q-peak	Average	Q-peak	Average	[dB]	[dB]	Q-peak	Average	Q-peak	Average
0.366	36.76	35.09	58.59	48.59	9.55	0.13	46.44	44.77	12.15	3.82
0.714	35.55	32.20	56.00	46.00	9.56	0.09	45.20	41.85	10.80	4.15
1.412	29.73	25.47	56.00	46.00	9.56	0.10	39.39	35.13	16.61	10.87
2.134	27.03	22.61	56.00	46.00	9.57	0.11	36.71	32.29	19.29	13.71
11.334	30.46	25.15	60.00	50.00	9.61	0.16	40.24	34.93	19.77	15.08
16.058	34.99	30.37	60.00	50.00	9.65	0.25	44.88	40.26	15.12	9.74

Conducted Emissions result

Neutral



Freq. [MHz]	Measurement [dB μ V]		Limit [dB μ V]		Insertion Loss	Cable Loss	Result [dB μ V]		Margin [dB]	
	Q-peak	Average	Q-peak	Average	[dB]	[dB]	Q-peak	Average	Q-peak	Average
0.366	36.61	34.92	58.59	48.59	9.55	0.13	46.29	44.60	12.30	3.99
0.712	35.44	32.23	56.00	46.00	9.56	0.09	45.09	41.88	10.91	4.12
1.379	28.31	23.42	56.00	46.00	9.56	0.10	37.97	33.08	18.03	12.92
2.133	27.10	22.53	56.00	46.00	9.57	0.11	36.78	32.21	19.22	13.79
3.846	26.94	21.79	56.00	46.00	9.57	0.14	36.65	31.50	19.35	14.50
16.710	36.25	31.32	60.00	50.00	9.64	0.22	46.11	41.18	13.89	8.82

Peak Power Output

◆ Test Equipment

The following test equipment are used during the test:

Item	Equipment	Manufacturer	Model no/Serial No.	Due for Cal.
1	Spectrum Analyzer	ADVANTEST	R3273 / 110600587	May. 08, 2015
2	Bluetooth Tester	TESCOM	TC-3000B/3000B640056	May. 09, 2015
3	Power Divider	Agilent	11636B/54458	May. 09, 2015
4	RF ROOM			

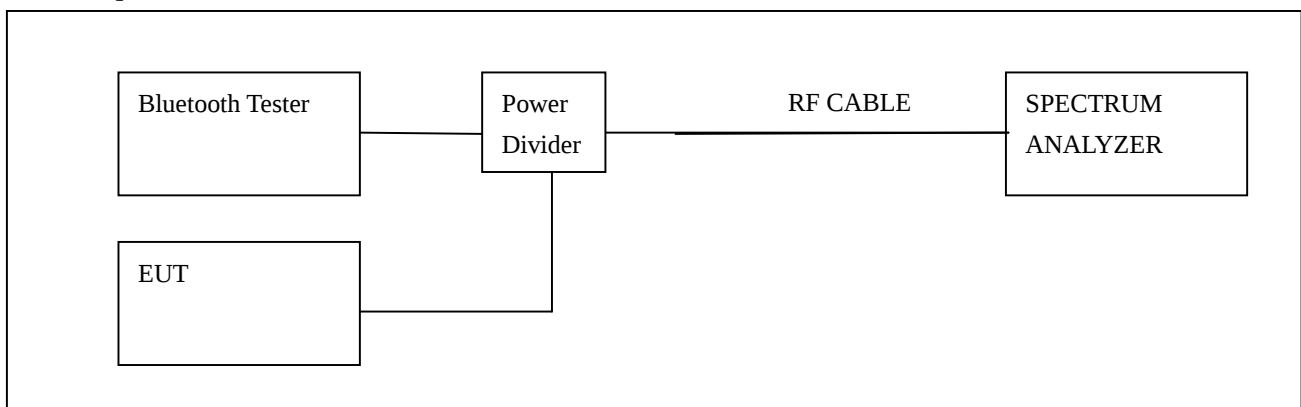
Note : All equipment upon which need to calibrated are with calibration period of 1 year.

◆ Limits

The maximum peak output power of the intentional radiator shall not exceed the following :

- According to § 15.247(b)(3), for systems using digital modulation in the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz : 1Watt.
- According to § 15.247(b)(4), the conducted output power limit specified in paragraph(b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph(c) of this section, is 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 Setup



◆ Test Procedure

The transmitter output is connected to the Spectrum analyzer using Bluetooth tester and Power divider.

The Spectrum analyzer is set to the peak power detection.

Peak Power Test result

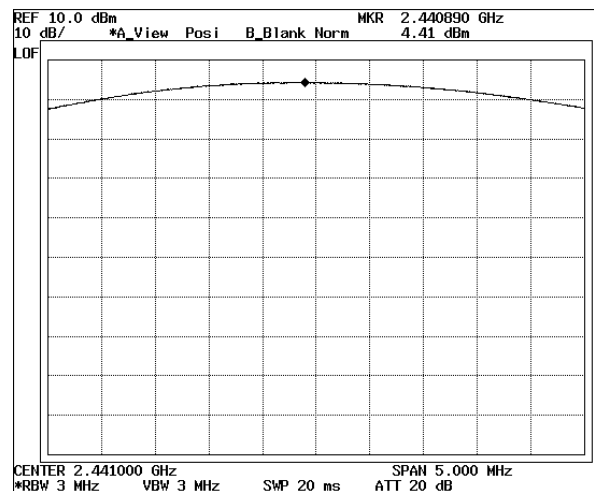
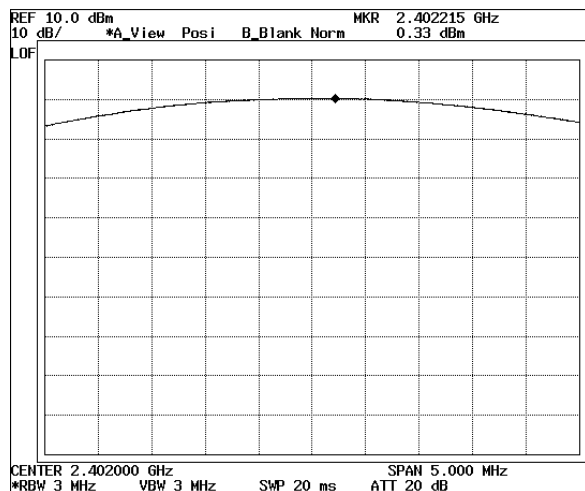
Product	Groove
Test Item	Peak Power Output
Test Mode	Tx / Channel 0, 39, 78
Test Site	RF Room
Measurement Method	Conducted

DH5

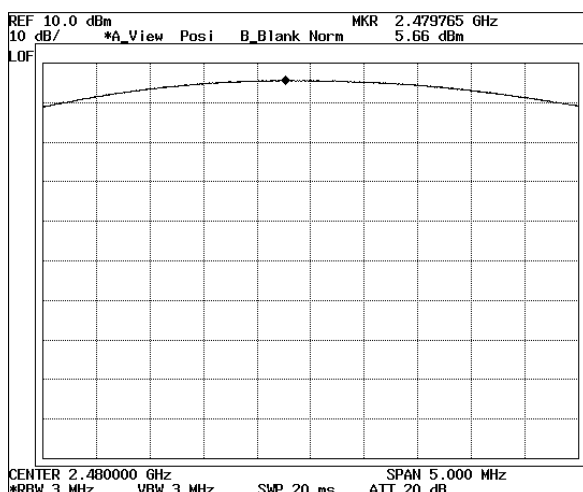
Channel No.	Frequency (MHz)	Measure Level (dBm)	Limit (dBm)	Result
0	2402	0.33	1Watt=30dBm	Pass
39	2441	4.41	1Watt=30dBm	Pass
78	2480	5.66	1Watt=30dBm	Pass

Channel 0

Channel 39



Channel 78



Note : Measurement level = reading level + correct factor

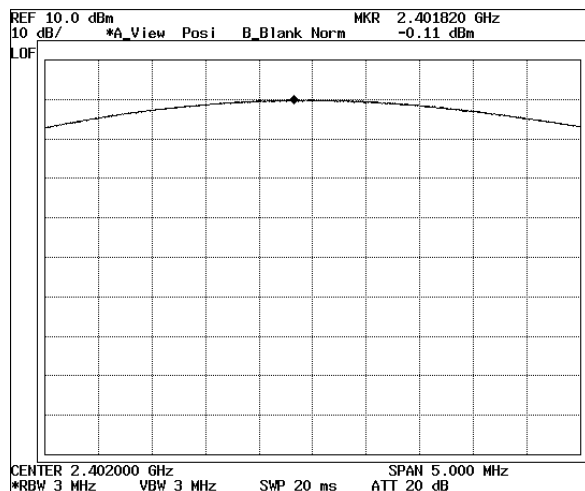
Peak Power Test result

Product	Groove
Test Item	Peak Power Output
Test Mode	Tx / Channel 0, 39, 78
Test Site	RF Room
Measurement Method	Conducted

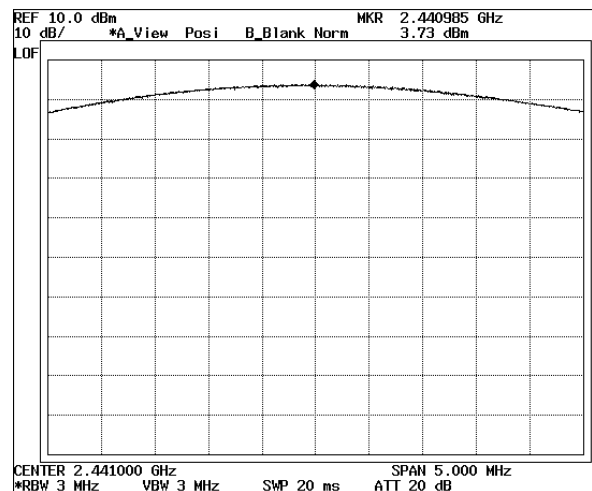
3DH5

Channel No.	Frequency (MHz)	Measure Level (dBm)	Limit (dBm)	Result
0	2402	-0.11	1Watt=30dBm	Pass
39	2441	3.73	1Watt=30dBm	Pass
78	2480	5.15	1Watt=30dBm	Pass

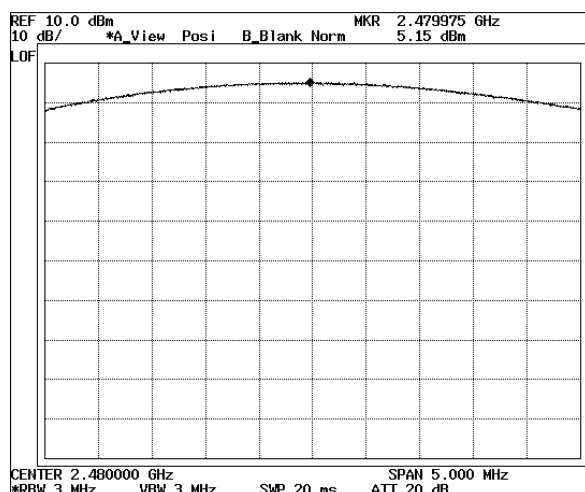
Channel 0



Channel 39



Channel 78



Note : Measurement level = reading level + correct factor

Conducted Spurious Emissions

& Band Edge

◆ TEST Equipment

The following test equipment are used during the test:

Item	Equipment	Manufacturer	Model no/Serial No.	Due for Cal.
1	Spectrum Analyzer	ADVANTEST	R3273 / 110600587	May. 08, 2015
2	Bluetooth Tester	TESCOM	TC-3000B/3000B640056	May. 09, 2015
3	Power Divider	Agilent	11636B/54458	May. 09, 2015
4	RF ROOM			

Note : 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to RRL, KRISS, KTL and HCT.

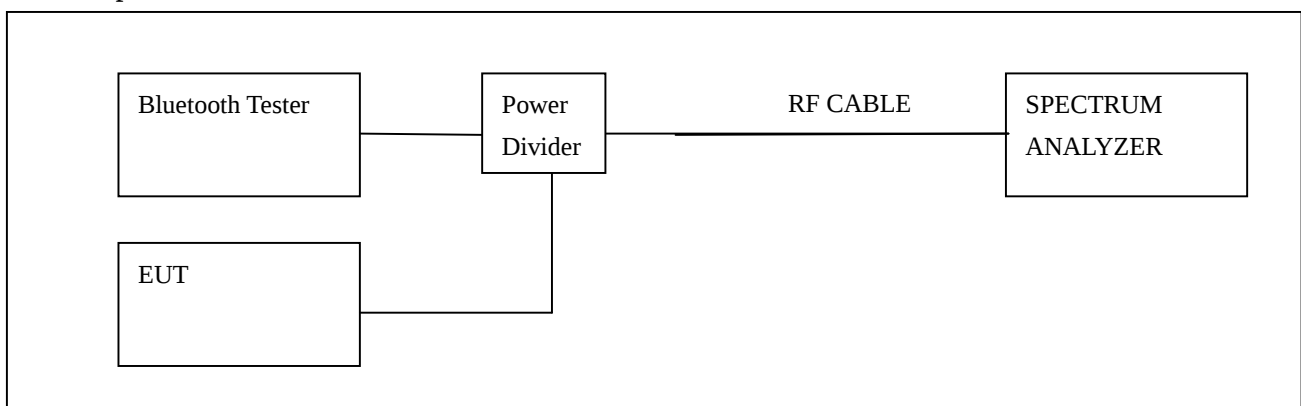
2. The calibration interval of horn ant. and loop ant. is 24 months

◆ Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

Attenuation below the general limits specified in section 15.209(a) is not required. In addition, radiated emission 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 Setup



◆ Test Procedure

The transmitter output is connected to the Spectrum analyzer using Bluetooth tester and Power divider.

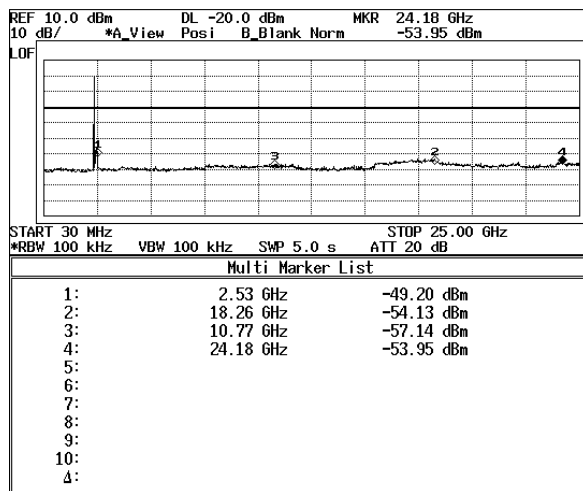
According to FCC CFR Title 47 Part 15 Subpart C Section 15.247

Conducted Spurious Emissions Test result

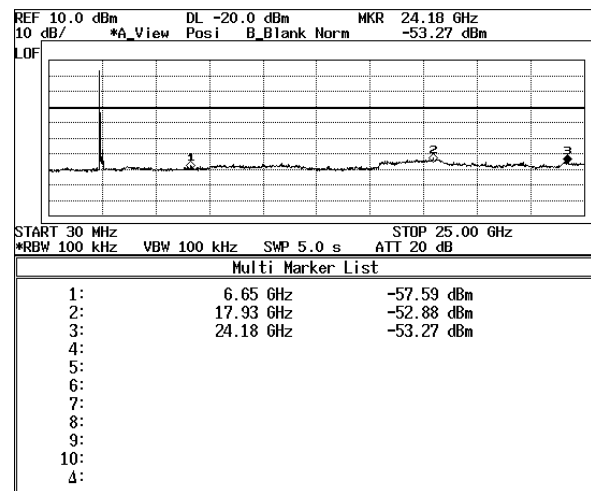
Product	Groove
Test Item	Spurious Emissions
Test Mode	Tx / Channel 0, 39, 78, Hopping
Test Site	RF Room
Measurement Method	Conducted

DH5

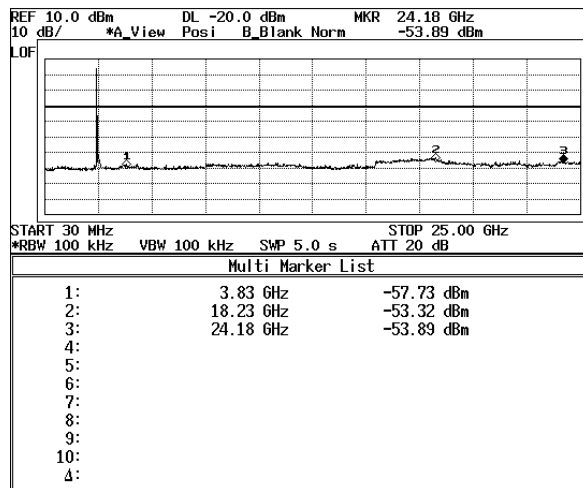
Channel 0 (2402 MHz)



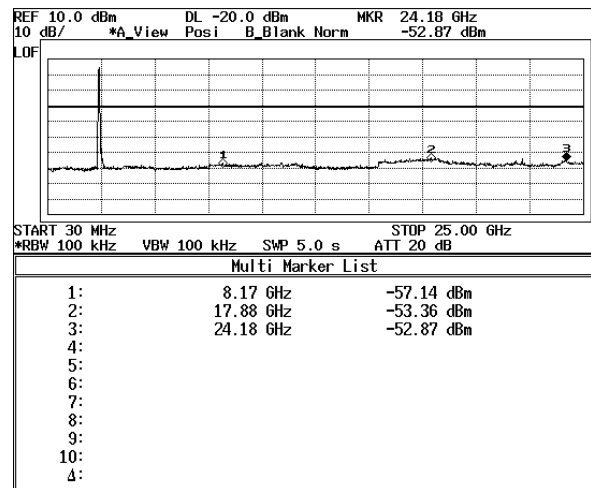
Channel 39 (2441 MHz)



Channel 78 (2480 MHz)



Hopping mode



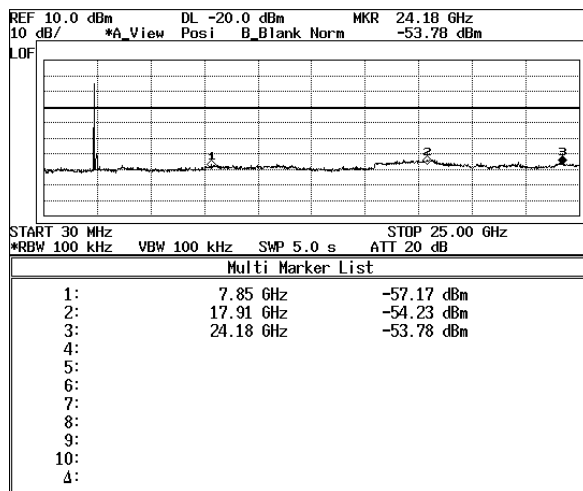
Note : Measurement level = reading level + correct factor

Conducted Spurious Emissions Test result

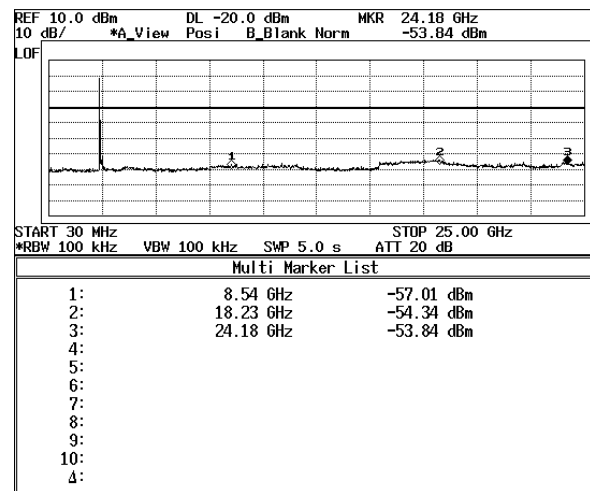
Product	Groove
Test Item	Spurious Emissions
Test Mode	Tx / Channel 0, 39, 78, Hopping
Test Site	RF Room
Measurement Method	Conducted

3DH5

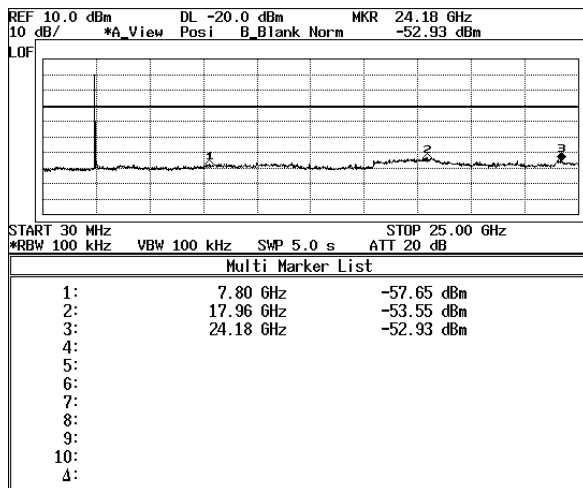
Channel 0 (2402 MHz)



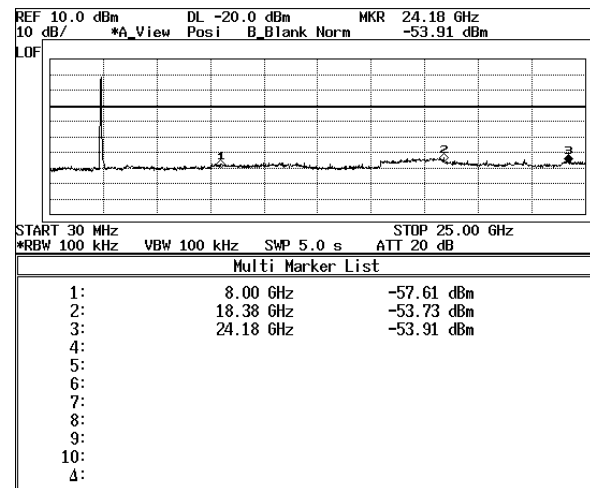
Channel 39 (2441 MHz)



Channel 78 (2480 MHz)



Hopping mode



Note : Measurement level = reading level + correct factor

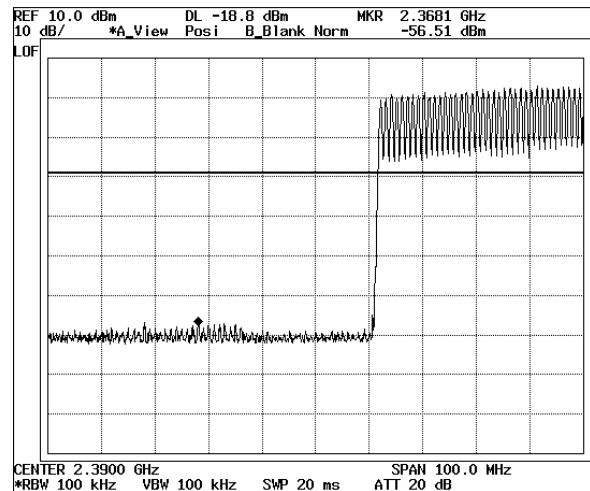
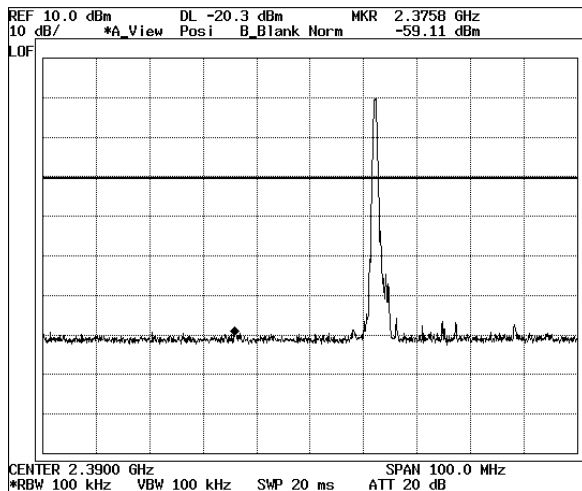
Band Edge Test result

Product	Groove
Test Item	Band Edge
Test Mode	Tx / Channel 0, 78, Hopping
Test Site	RF Room
Measurement Method	Conducted

DH5

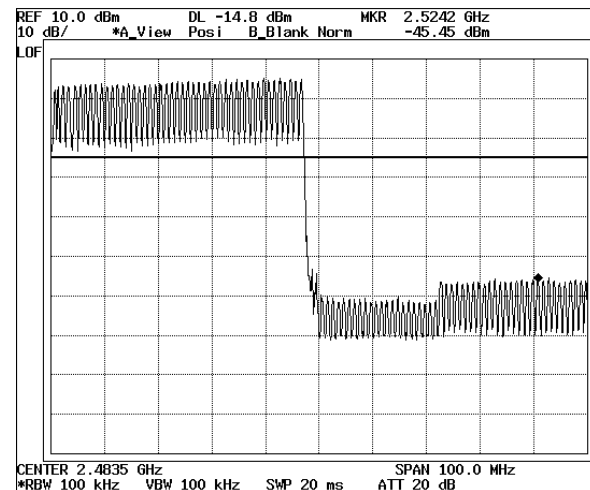
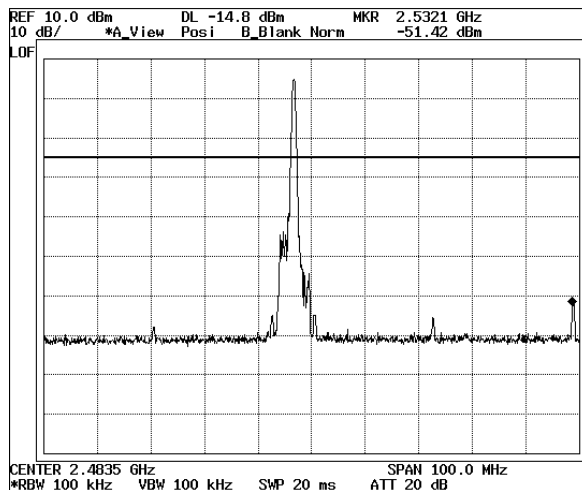
Channel : 0 CH(2402 MHz)

Hopping mode



Channel : 78 CH(2480 MHz)

Hopping mode



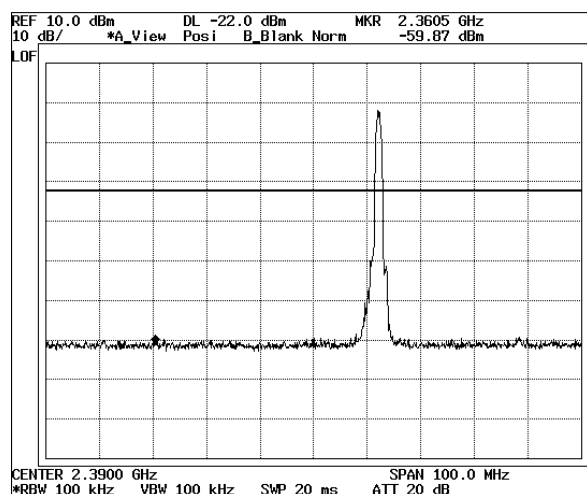
Note : Measurement level = reading level + correct factor

Band Edge Test result

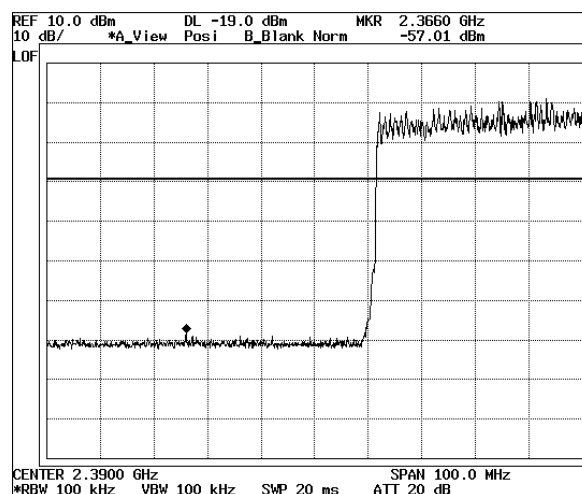
Product	Groove
Test Item	Band Edge
Test Mode	Tx / Channel 0, 78, Hopping
Test Site	RF Room
Measurement Method	Conducted

3DH5

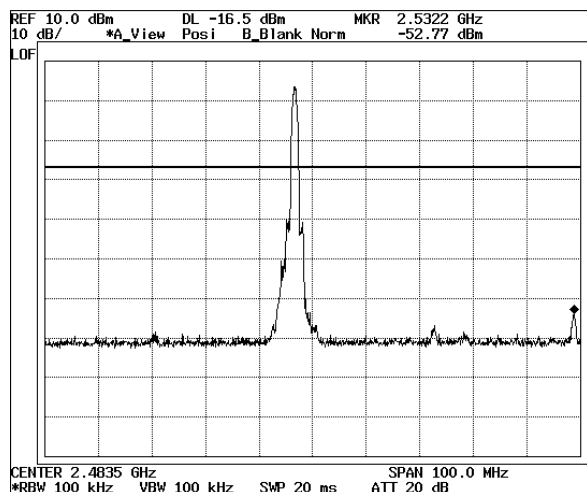
Channel : 0 CH(2402 MHz)



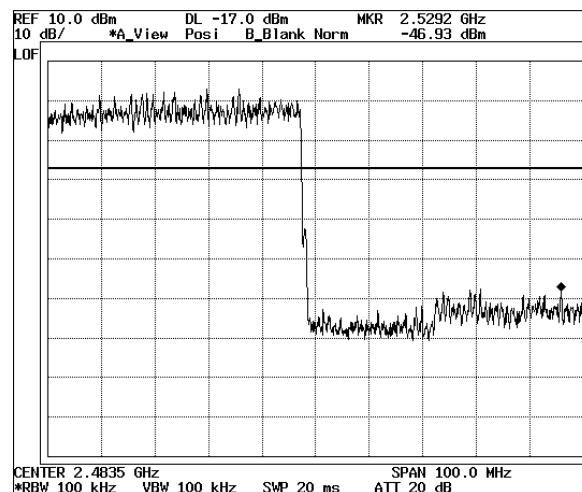
Hopping mode



Channel : 78 CH(2480 MHz)



Hopping mode



Note : Measurement level = reading level + correct factor

20dB BandWidth &

Channel Separation & Occupied Bandwidth

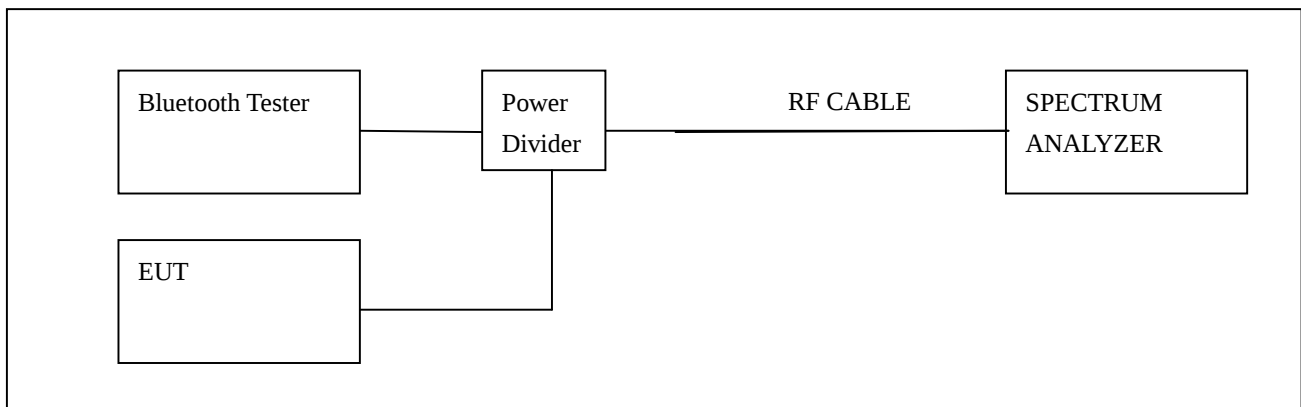
◆ Test Equipment

The following test equipment are used during the test:

Item	Equipment	Manufacturer	Model no/Serial No.	Due for Cal.
1	Spectrum Analyzer	ADVANTEST	R3273 / 110600587	May. 08, 2015
2	Bluetooth Tester	TESCOM	TC-3000B/3000B640056	May. 09, 2015
3	Power Divider	Agilent	11636B/54458	May. 09, 2015
4	RF ROOM			

Note : All equipment upon which need to calibrated are with calibration period of 1 year.

◆ Test Setup



◆ Limits

According to 15.247(a)(1), Frequency hopping systems operation in the 2400-2483.5 MHz band may have hopping carrier frequencies that are separated by 25 KHz or two-third of 20 dB band width of hopping channel, is greater.

◆ Test Procedure

The transmitter output is connected to the Spectrum analyzer using Bluetooth tester and Power divider.

According to FCC CFR Title 47 Part 15 Subpart C Section 15.247

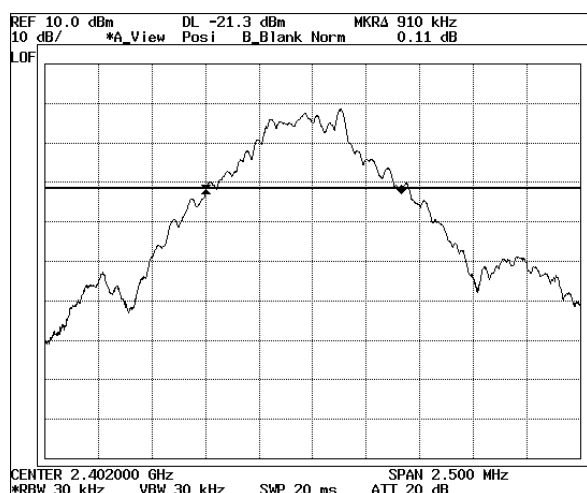
20dB BandWidth Test result

Product	Groove
Test Item	20dB Bandwidth
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

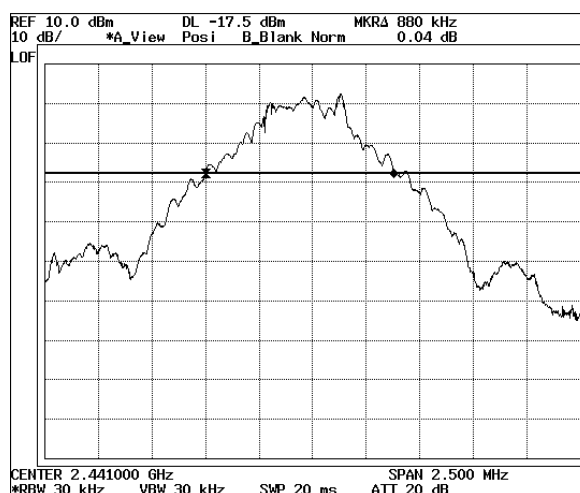
DH5

Channel	20dB Band width (KHz)	Result
Low CH	910	Pass
Middle CH	880	
High CH	830	

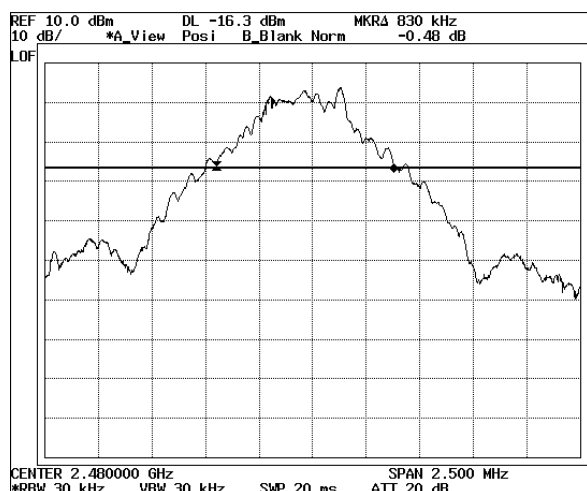
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

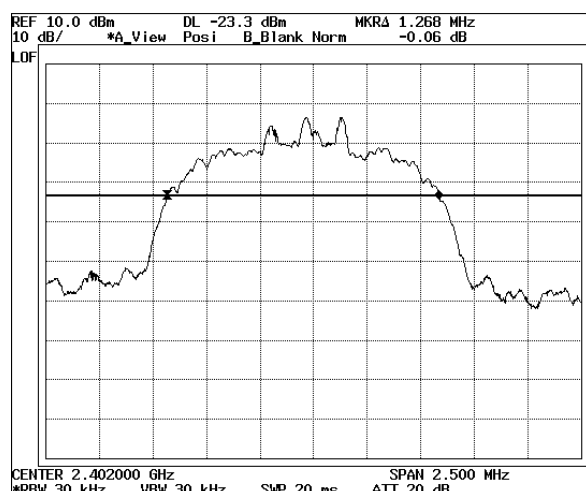
20dB BandWidth Test result

Product	Groove
Test Item	20dB Bandwidth
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

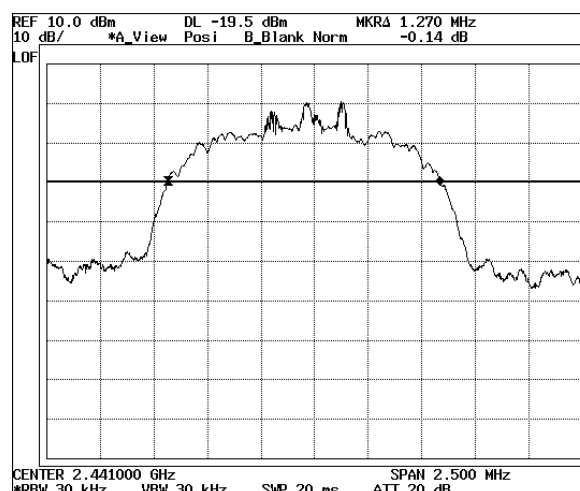
3DH5

Channel	20dB Band width (KHz)	Result
Low CH	1268	Pass
Middle CH	1270	
High CH	1270	

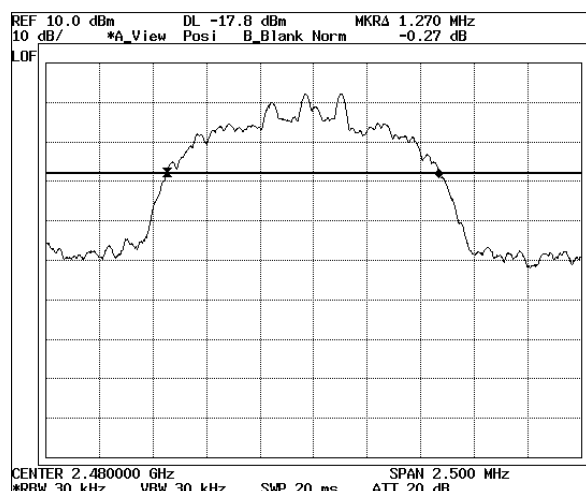
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

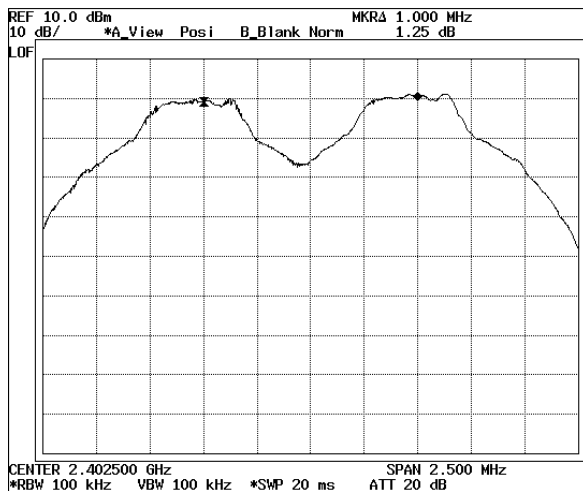
Channel Separation Test result

Product	Groove
Test Item	Channel Separation
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

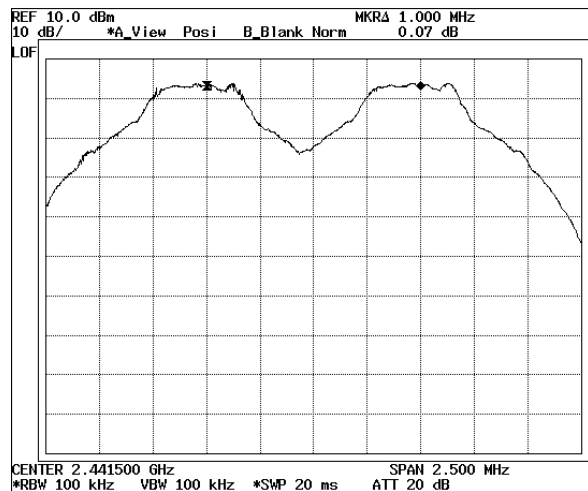
DH5

Channel	Channel Separation (KHz)	20dB bandwidth (KHz)	Limit (KHz)	Result
Low CH	1000	910	>25 or >2/3 of the 20dB BW	Pass
Middle CH	1000	880		
High CH	1000	830		

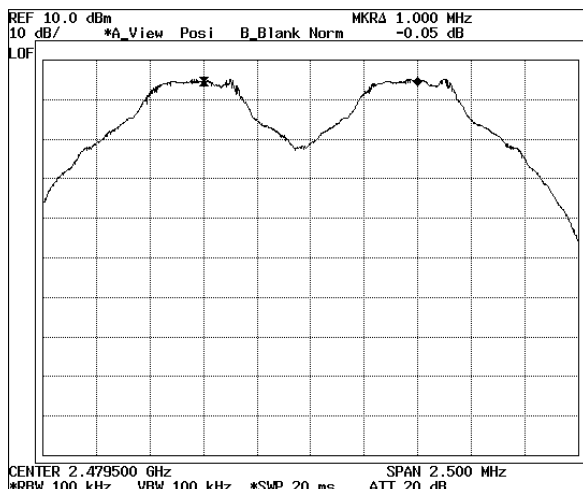
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

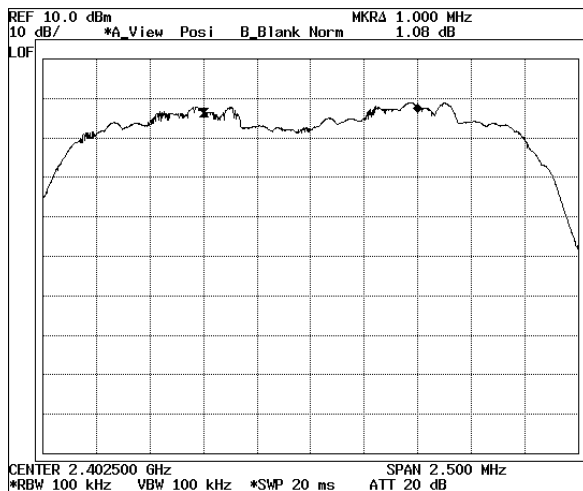
Channel Separation Test result

Product	Groove
Test Item	Channel Separation
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

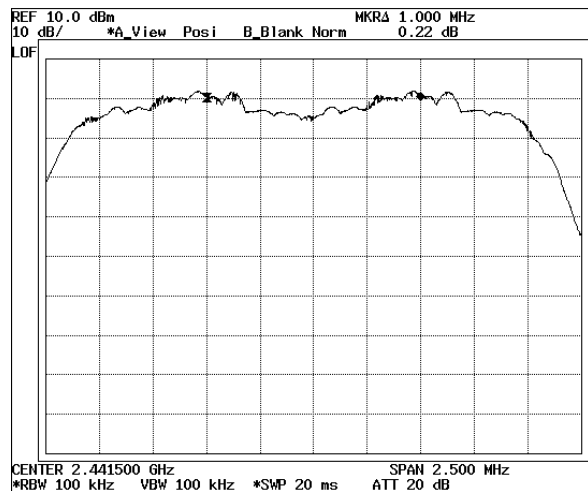
3DH5

Channel	Channel Separation (KHz)	20dB bandwidth (KHz)	Limit (KHz)	Result
Low CH	1000	1268	>25 or >2/3 of the 20dB BW	Pass
Middle CH	1000	1270		
High CH	1000	1270		

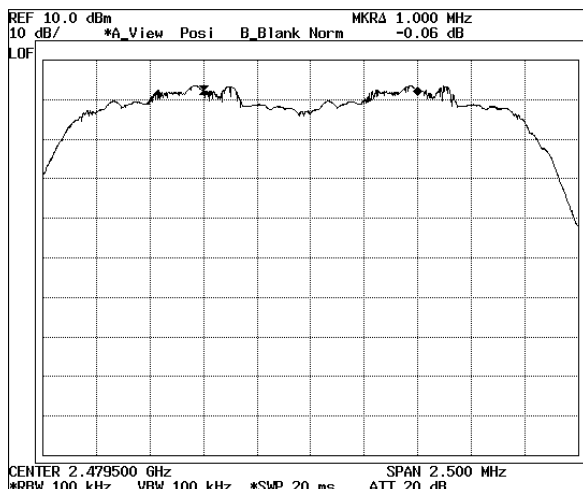
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

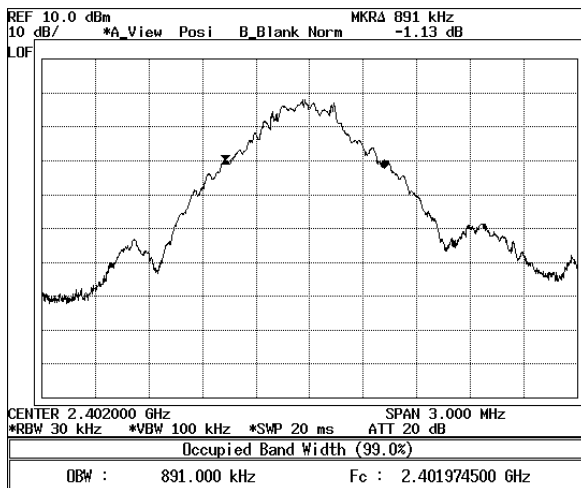
Occupied BandWidth Test result

Product	Groove
Test Item	Occupied Bandwidth
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

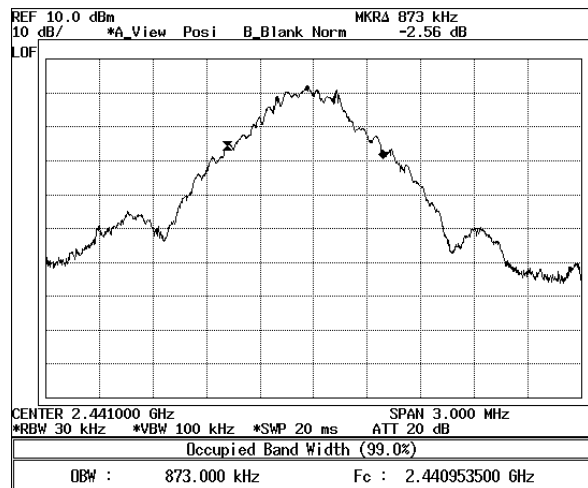
DH5

Channel	99% BW(KHz)	Result
Low CH	891	Pass
Middle CH	873	
High CH	879	

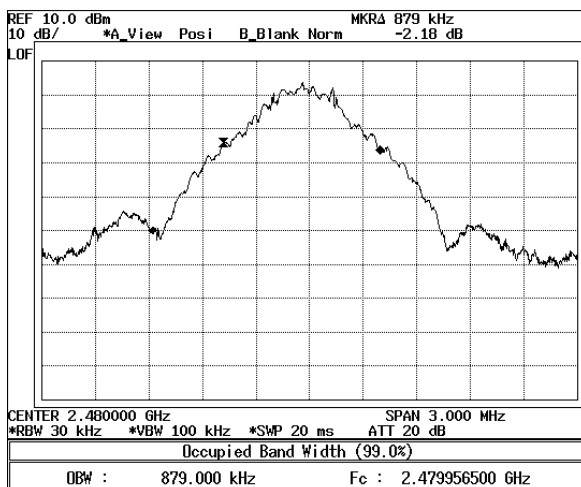
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

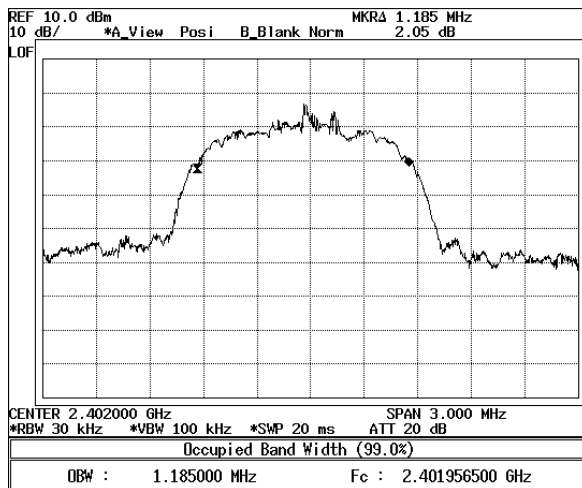
Occupied BandWidth Test result

Product	Groove
Test Item	Occupied Bandwidth
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

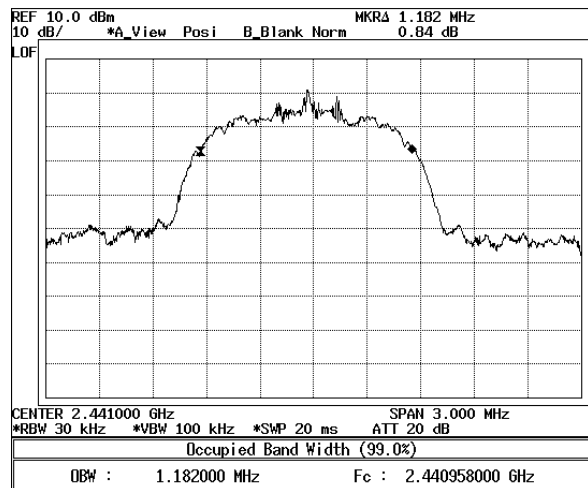
3DH5

Channel	99% BW(KHz)	Result
Low CH	1185	Pass
Middle CH	1182	
High CH	1182	

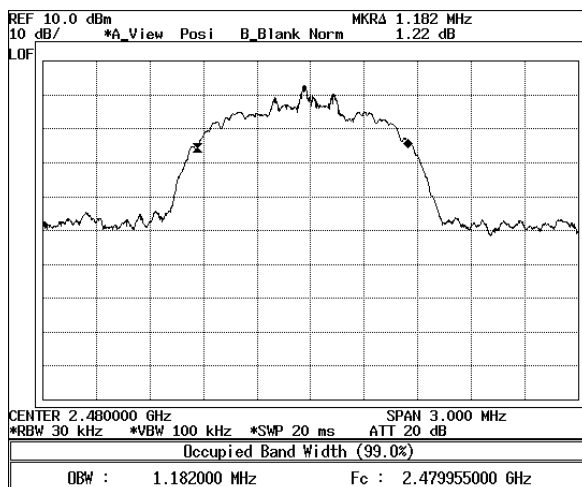
Low Channel



Mid Channel



High Channel



Note : Measurement level = reading level + correct factor

Number of Hopping Frequency

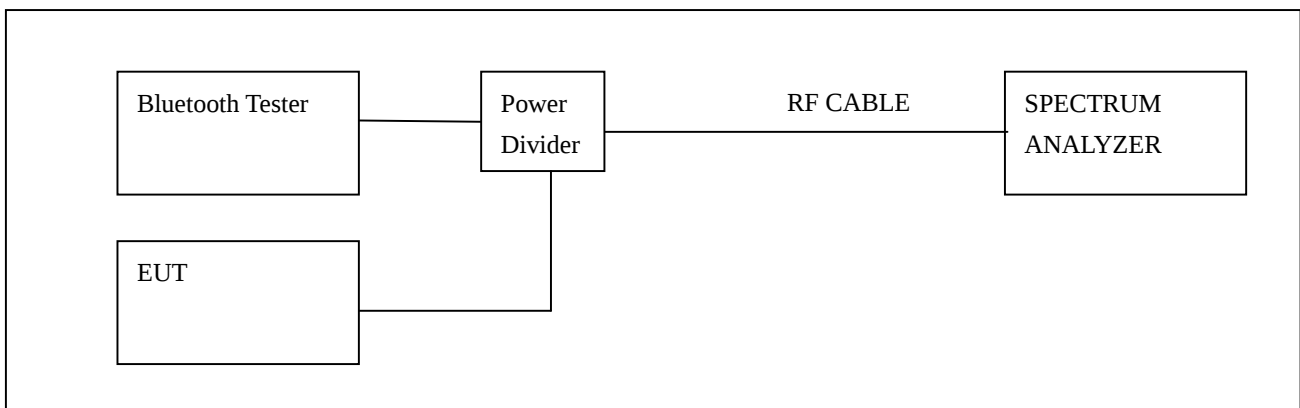
◆ Test Equipment

The following test equipment are used during the test:

Item	Equipment	Manufacturer	Model no/Serial No.	Due for Cal.
1	Spectrum Analyzer	ADVANTEST	R3273 / 110600587	May. 08, 2015
2	Bluetooth Tester	TESCOM	TC-3000B/3000B640056	May. 09, 2015
3	Power Divider	Agilent	11636B/54458	May. 09, 2015
4	RF ROOM			

Note : All equipment upon which need to calibrated are with calibration period of 1 year.

◆ Test Setup



◆ Limits

According to 15.247(a)(1)(ii), Frequency hopping systems operation in the 2400-2483.5 MHz bands shall use at least 15 hopping frequencies.

◆ Test Procedure

The transmitter output is connected to the Spectrum analyzer using Bluetooth tester and Power divider.

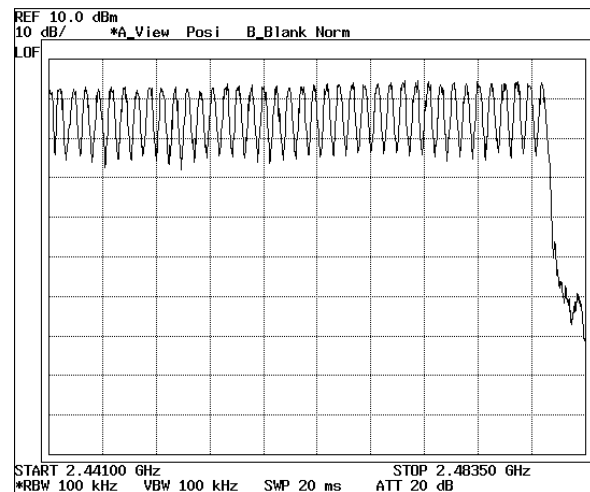
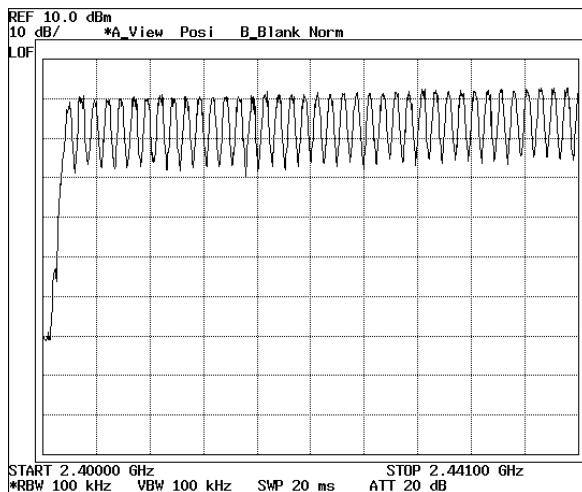
According to FCC CFR Title 47 Part 15 Subpart C Section 15.247

Test result

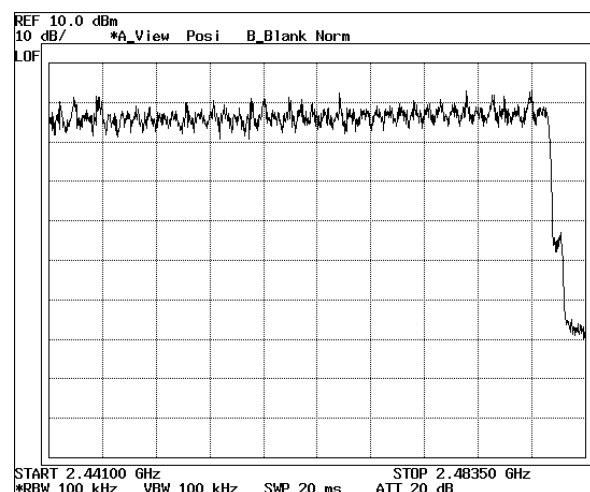
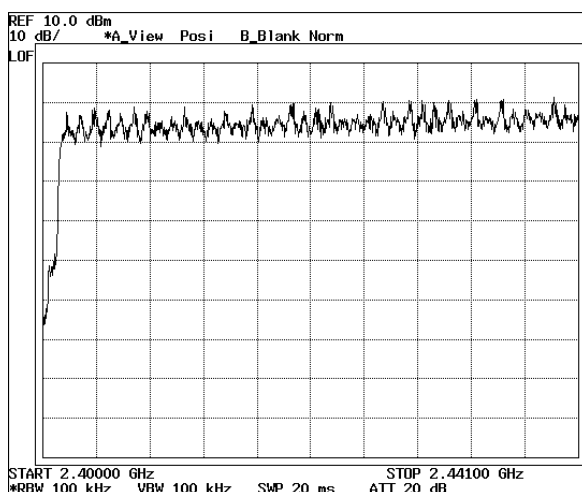
Product	Groove
Test Item	Number of hopping frequency
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

Channel (No. of channel)	Limit (No. of channel)	Result
79	>15	Pass

DH5



3DH5



Note : Measurement level = reading level + correct factor

Time of Occupancy (Dwell Time)

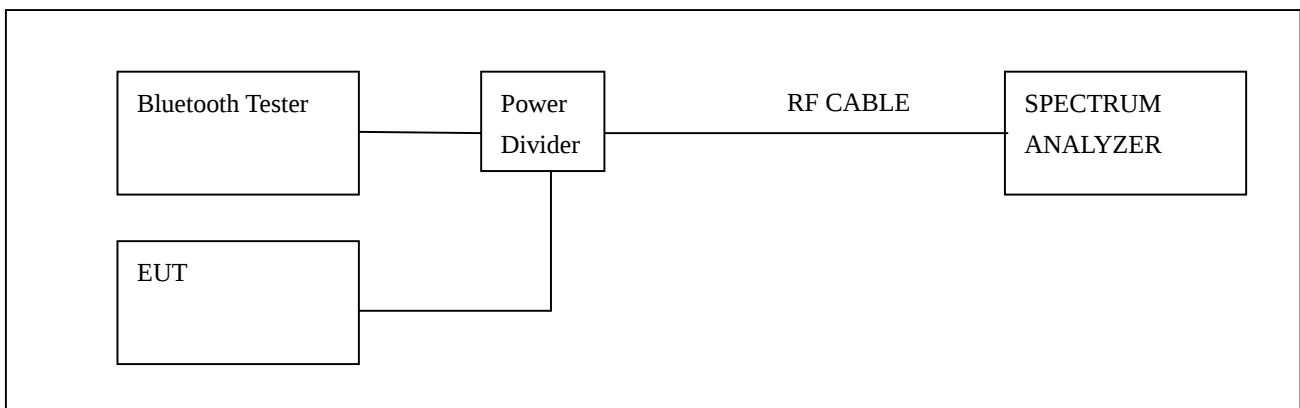
◆ Test Equipment

The following test equipment are used during the test:

Item	Equipment	Manufacturer	Model no/Serial No.	Due for Cal.
1	Spectrum Analyzer	ADVANTEST	R3273 / 110600587	May. 08, 2015
2	Bluetooth Tester	TESCOM	TC-3000B/3000B640056	May. 09, 2015
3	Power Divider	Agilent	11636B/54458	May. 09, 2015
4	RF ROOM			

Note : All equipment upon which need to calibrated are with calibration period of 1 year.

◆ Test Setup



◆ Limits

According to 15.247(a)(1)(iii), Frequency hopping systems operating in the 2400-2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4s within a period 0.4s multiplied by the number of hopping channels employed.

◆ Test Procedure

The transmitter output is connected to the Spectrum analyzer using Bluetooth tester and Power divider.

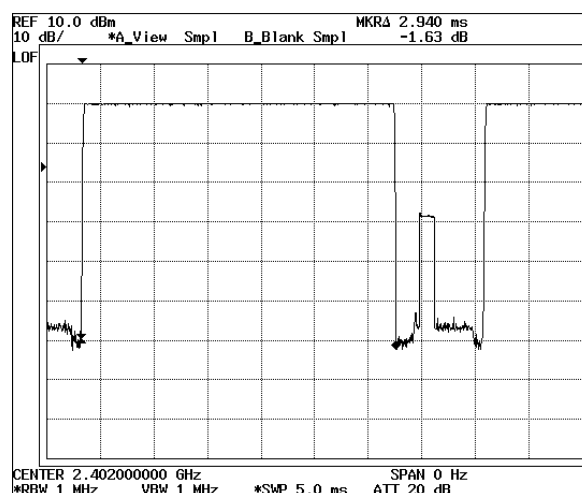
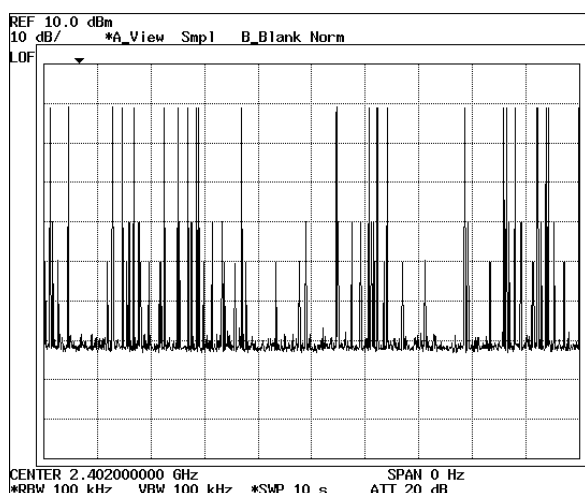
According to FCC CFR Title 47 Part 15 Subpart C Section 15.247

Dwell time Test result

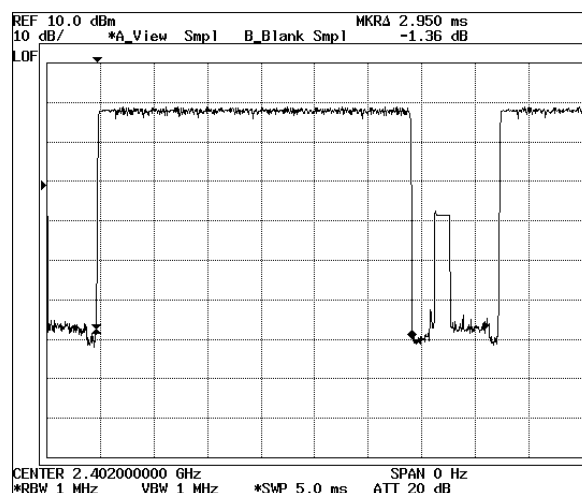
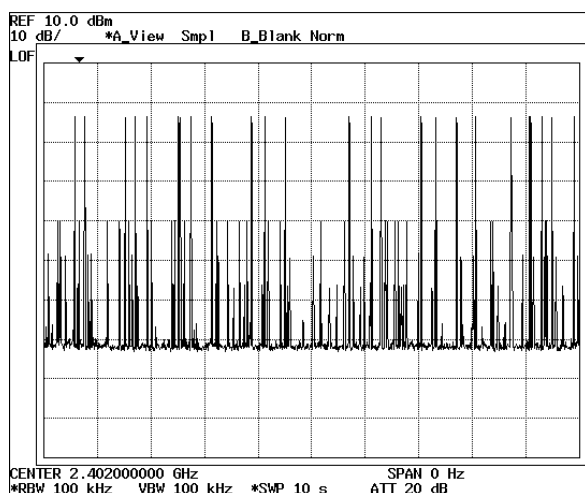
Test Item	Dwell Time
Test Mode	Transmit
Test Site	RF Room
Measurement Method	Conducted

Mode	Number of transmission in a 31.6	Length of transmission time(ms)	Result (ms)	Limit (ms)	Result
DH5	23(times/10s) *3.16 = 72.68times	2.940	213.679	400	Pass
3DH5	23(times/10s) *3.16 = 72.68times	2.950	214.406		Pass

DH5



3DH5



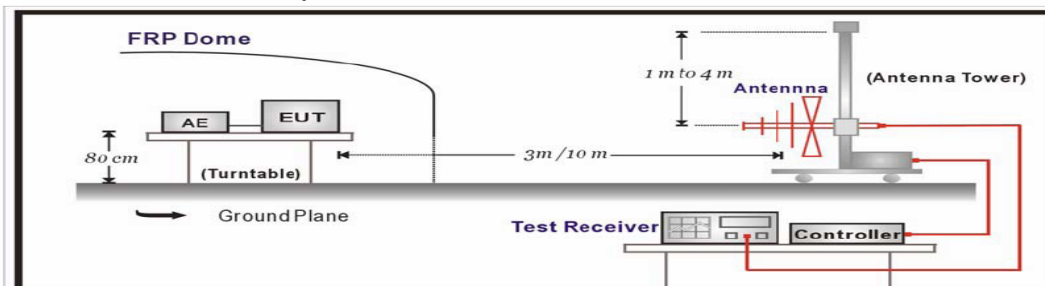
Note : Measurement level = reading level + correct factor

Radiated Emissions:

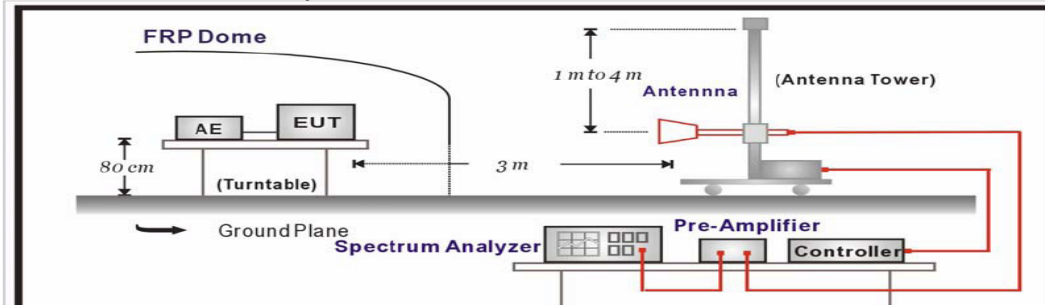
The measurement was performed over the frequency range of 30MHz to 1GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurement was made with the detector set for "quasi-peak" within a bandwidth of 120kHz. Procedure of Test

Preliminary measurements were made at 3 meter using bi-log antennas, and spectrum analyzer to determine the frequency producing the max. emission in anechoic chamber. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turn-table azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30MHz to 1000MHz using bi-log antenna. Above 1GHz, linearly polarized double ridge horn antennas were used. Final measurements were made at open site with 3-meters test distance using bi-log antenna or horn antenna. The OATS have been verified in regular for its normalized site attenuation. The test equipment was placed on a wooden table. Sufficient time for the EUT, peripheral equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The detector function was set to CISPR quasi-peak mode and the bandwidth of the receiver was set to 120kHz or 1MHz depending on the frequency of type of signal. The EUT, peripheral equipment and interconnecting cables were re-configured to the set-up producing the max. emission for the frequency and were placed on top of a 0.8-meter high nonmetallic 1 x 1.5 meter table. The EUT, peripheral equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission. Each emission was maximized by: varying the mode of operation to the EUT and/or peripheral equipment and changing the polarity of the antenna, whichever determined the worst-case emission. (The bandwidth below 1GHz setting on the field strength meter is 120KHz and above 1GHz is 1MHz.)

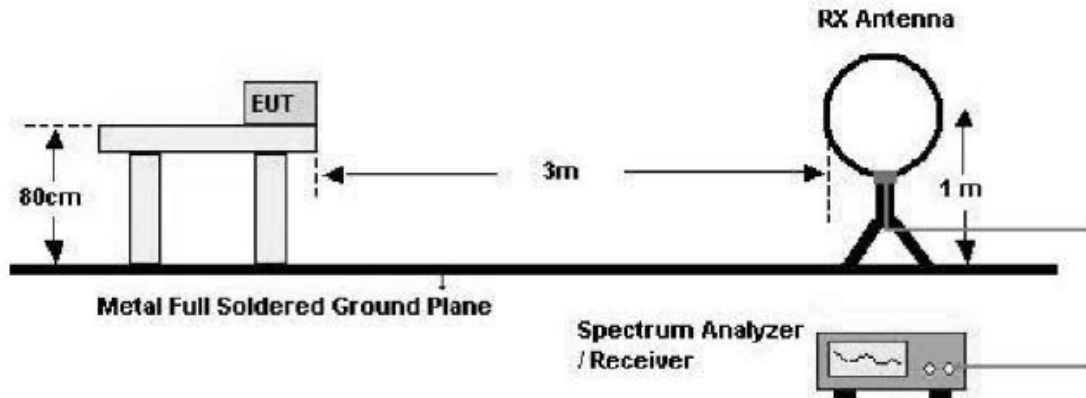
Under 1GHz Test Setup:



Above 1GHz Test Setup:



Below 30 MHz



Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, Shall be attenuated by at least 20dB below the level of the fundamental or to the General radiated emission limits in paragraph 15.209, whichever is the lesser attenuation:

FCC Part 15 Subpart C Section 15.209 Limits		
Frequency (MHz)	$\mu\text{V}/\text{meter}$	$\text{dB}\mu\text{V}/\text{meter} (3\text{m})$
0.009-0.490	$2400/F(\text{KHz})$ at 300 m	$20\log 2400/F(\text{KHz})+80$
0.490-1.705	$24000/F(\text{KHz})$ at 30m	$20\log 24000/F(\text{KHz})+40$
1.705-30	30 at 30 m	49.5
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

Remarks :

1. RF Voltage ($\text{dB}\mu\text{V}$) = $20\log$ RF Voltage (μV)
2. $\text{dB}\mu\text{V}/\text{m} = \text{ERP}(\text{dBm}) + 106.92 \text{ dB} + 20\log(10\text{m}/3\text{m}) + 2.15\text{dB}(\text{conversion Factor for E.I.R.P})$
3. In the Above Table, the tighter limit applies at the band edges.
4. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

Test specification.

According to FCC CFR Title 47 Part 15 Subpart C Section 15.209.

Radiated Spurious Emission

[Applicable]

◆ Test Equipment Used

Name	Type	Manufacturer	Due for Cal	Serial Number
EMI Receiver	ESCS30	Rohde & Schwarz	May. 08, 2015	100171
EMI Receiver	ESCI7	Rohde & Schwarz	Jul. 16, 2014	100872
SPECTRUM ANALYZER	R3273	ADVANTEST	May. 08, 2015	110600587
Bluetooth Tester	TC-3000B	TESCOM	May. 09, 2015	3000B640056
Loop Antenna	HFH2-Z2	Rohde & Schwarz	Oct. 26, 2014	8620771017
Bi-Log Antenna	VULB9160	Schwarz beck	Jun. 03, 2015	3071
HORN-Antenna	3115	EMCO	Dec. 04, 2015	9012-3602
HORN-Antenna	HF906	Rohde & Schwarz	Oct. 25, 2015	100530
PRE AMPLIFIER	8449B OPT H02	HP	Oct. 08, 2014	3008A0530

Note : 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to RRA, KRISS, KTL and HCT.

2. The calibration interval of horn ant. and loop ant. is 24 months

◆ Test Conditions

Temperature (21.6 ± 0.2) °C
 Humidity (48.3 ± 0.2) % R.H.
 Atmosphere (1008) mbar

◆ Test Area Full-Anechoic Room (3m)

◆ Test Date May 12, 2014

Note :

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. For the limit is employed average value, therefore the peak value can be transferred to average value by subtracting the duty factor. The basic equation with a sample calculation is as follows:

$$\text{Peak} = \text{Reading} + \text{Corrected Factor}$$

Where Corr. Factor = Antenna Factor + Cable Factor - Amplifier Gain (if any)

Radiated Emissions Test, 9 kHz to 30 MHz (Magnetic Field Test)

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions at a distance of 3 meters according to Section 15.31(f) (2).
2. The EUT was placed on the top of the 0.8-meter height, 1 x 1.5 meter non-metallic table.
3. Emissions from the EUT are maximized by adjusting the orientation of the Loop antenna and rotating the EUT on the turntable. Manipulating the system cables also maximizes EUT emissions if applicable.
4. To obtain the final measurement data, each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector with specified bandwidth.
5. The result was 20dB lower than the limit line 15.31(o) was not reported.

Radiated Emission Result

Frequency	Reading	P	Ant. Factor	Cable Loss	Limit	Total	Margin
MHz	dBuV	(H, V)	dB	dB	dBuV	dBuV	dB

Note : The result was 20dB lower than the limit line 15.31(o) was not reported.

Radiated Emission Result

[Applicable]

Spurious Emissions Test (Below 1GHz) :

☒ Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, packet types and antenna ports (if EUT with antenna diversity architecture), and X, Y, Z Axis.

EUT	Groove	PROBE	Below 1 GHz
POWER	3.7 Vdc	NOTE	Bluetooth mode

DH5

Frequency MHz	Reading dBuV	P (H, V)	Ant. Factor dB	Cable Loss dB	Limit dBuV	Total dBuV	Margin dB
284.082	22.10	H	12.37	2.85	46.00	37.32	-8.68
304.377	20.20	H	13.04	2.94	46.00	36.18	-9.82
316.269	21.40	H	13.34	2.99	46.00	37.73	-8.27
321.111	21.00	H	13.46	3.01	46.00	37.47	-8.53
879.730	13.50	V	22.79	5.01	46.00	41.30	-4.70

3DH5

Frequency MHz	Reading dBuV	P (H, V)	Ant. Factor dB	Cable Loss dB	Limit dBuV	Total dBuV	Margin dB
112.388	23.50	V	9.89	1.73	43.50	35.12	-8.38
126.029	21.20	V	11.19	1.83	43.50	34.22	-9.28
161.785	18.90	H	12.68	2.09	43.50	33.67	-9.83
721.631	16.40	V	20.92	4.56	46.00	41.88	-4.12
893.324	13.20	V	22.91	5.09	46.00	41.20	-4.80

Note: 1. Remark "*" means that the data is the worst emission level.
 2. All reading levels are Quasi-peak value.
 3. Measurement level = reading level + correct factor

Spurious Emissions Test (Above 1GHz) :

☒ Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, packet types and antenna ports (if EUT with antenna diversity architecture), and X, Y, Z Axis.

● **BDR**

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	0 Channel (2402 MHz)
MODE	DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.013	36.87	24.96	V	74.00	54.00	37.13	29.04
1.995	41.81	28.90	V	74.00	54.00	32.19	25.10
3.891	45.48	34.54	V	74.00	54.00	28.52	19.46
1.012	36.87	24.82	H	74.00	54.00	37.13	29.18
1.969	40.69	28.70	H	74.00	54.00	33.31	25.30
3.403	45.70	33.80	H	74.00	54.00	28.30	20.20

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	39 Channel (2441 MHz)
MODE	DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.062	38.26	21.71	V	74.00	54.00	35.74	32.29
1.536	38.83	24.92	V	74.00	54.00	35.17	29.08
5.121	46.71	35.04	V	74.00	54.00	27.29	18.96
5.63	46.4	35.86	V	74.00	54.00	27.60	18.14
1.84	38.27	24.58	H	74.00	54.00	35.73	29.42
3.784	43.35	33.35	H	74.00	54.00	30.65	20.65
5.142	45.66	35.76	H	74.00	54.00	28.34	18.24

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	78 Channel (2480 MHz)
MODE	DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.781	39.64	27.02	V	74.00	54.00	34.36	26.98
3.318	45.41	33.66	V	74.00	54.00	28.59	20.34
5.320	49.01	36.39	V	74.00	54.00	24.99	17.61
1.754	39.52	27.09	H	74.00	54.00	34.48	26.91
3.061	45.03	33.40	H	74.00	54.00	28.97	20.60
4.862	46.10	34.30	H	74.00	54.00	27.90	19.70
5.220	48.09	36.76	H	74.00	54.00	25.91	17.24

Note : Reading(dBuv) : Measurement Level + Ant Factor + Cable Loss - Amp Gain

● **EDR**

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	0 Channel (2402 MHz)
MODE	3DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.498	41.15	26.60	V	74.00	54.00	32.85	27.40
1.660	38.62	25.69	V	74.00	54.00	35.38	28.31
2.782	44.36	29.60	V	74.00	54.00	29.64	24.40
5.234	44.54	33.43	V	74.00	54.00	29.46	20.57
1.072	38.71	24.58	H	74.00	54.00	35.29	29.42
1.536	42.35	28.16	H	74.00	54.00	31.65	25.84
3.000	48.05	35.37	H	74.00	54.00	25.95	18.63

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	39 Channel (2441 MHz)
MODE	3DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.274	36.71	26.76	V	74.00	54.00	37.29	27.24
1.788	38.23	26.92	V	74.00	54.00	35.77	27.08
4.893	41.41	33.15	V	74.00	54.00	32.59	20.85
1.537	36.24	27.06	H	74.00	54.00	37.76	26.94
3.361	42.33	32.52	H	74.00	54.00	31.67	21.48
5.035	46.14	35.83	H	74.00	54.00	27.86	18.17
5.662	46.20	35.58	H	74.00	54.00	27.84	18.02

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	CHANNEL	78 Channel (2480 MHz)
MODE	3DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
1.598	39.12	25.73	V	74.00	54.00	34.88	28.27
1.993	42.18	27.85	V	74.00	54.00	31.82	26.15
3.000	47.05	33.92	V	74.00	54.00	26.95	20.08
5.846	45.83	35.32	V	74.00	54.00	28.17	18.68
1.460	41.78	26.42	H	74.00	54.00	32.22	27.58
1.599	42.74	29.36	H	74.00	54.00	31.26	24.64
4.345	46.85	34.63	H	74.00	54.00	27.15	19.37
5.542	46.15	34.68	H	74.00	54.00	27.85	19.32

Note : Reading(dBuv) : Measurement Level + Ant Factor + Cable Loss - Amp Gain

Radiated Restricted Band Edge Result

● BDR

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	NOTE	0 Channel (2402 MHz)
MODE	DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
2.379	38.46	26.58	V	74.00	54.00	35.54	27.42
2.336	38.71	26.39	H	74.00	54.00	35.29	27.61

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	NOTE	78 Channel (2480 MHz)
MODE	DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
2.490	38.62	26.22	V	74.00	54.00	35.38	27.78
2.488	37.95	26.39	H	74.00	54.00	36.05	27.61

Note : Reading(dBuv) : Measurement Level + Ant Factor + Cable Loss - Amp Gain

● EDR

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	NOTE	0 Channel (2402 MHz)
MODE	3DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
2.352	38.42	25.57	V	74.00	54.00	35.58	28.43
2.361	37.58	26.85	H	74.00	54.00	36.42	27.15

EUT	Groove	PROBE	Above 1 GHz
POWER	3.7 Vdc	NOTE	78 Channel (2480 MHz)
MODE	3DH5		

Test Data

Frequency GHz	Reading dBuV		P	Limit dBuV		Margin dB	
	Peak	AV		Peak	AV	Peak	AV
2.487	38.60	26.65	V	74.00	54.00	35.40	27.35
2.488	36.43	26.24	H	74.00	54.00	37.47	27.76

Note : Reading(dBuv) : Measurement Level + Ant Factor + Cable Loss - Amp Gain

Antenna requirements

According to FCC 47 CFR 15.203

“an intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached or an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section”

- * the antenna of this EUT are permanently attached.
- * the EUT complies with the requirement of 15.203

