NTREE Co., Ltd. (http://www.ntree.or.kr)
30, Pajangcheon-ro 44beon-gil, Jangan-gu, Suwon-si, Gyeonggi-do, 16204, Rep. of KOREA

TEST REPORT

Test Report Number:	N2102R-0806
Project Number:	A2020-14417
Applicant:	premily.inc
Address of Applicant:	19, Yeonan-ro 58beonga-gil, Dongnae-gu, Busan, Republic of Korea
Manufacturer and Country	Changzhou Fwood Intelligent Technology CO.,LTD
Address of Manufacturer/Factory:	Building 3# Ming Huang DaHua Industrial Park Hutang Town Wujin District Changzhou City

Equipment Under Test (EUT)

Product Name:	hamilpet bluetooth smart jumpingball
Model No.:	HSJ-BT

■ **FCC ID** : 2AYXN-HSJ-BT □ **IC**

Applicable standards:	FCC CFR Title 47 Part 15 Subpart C (15.247) ANSI C63.10-2013 KDB 558074 D01
Date of Test:	Jan. 20, 2021 to Feb. 01, 2021
Date of report issued:	Feb. 18, 2021
Test Result:	Compliance *

Prepared By: _____ ***Date:*** Apr. 01, 2021

Project Engineer

Check By: _____ ***Date:*** Apr. 01, 2021

Reviewer

Laboratory Manager

REPORT REVISION HISTORY

Date	Revision	Page No
Feb. 18. 2021	Originally Issued	-
Apr. 01. 2021	Revised	Several pages

Contents

1. General Information

1.1 General Description of EUT

Product Name	hamilpet bluetooth smart jumpingball
Model No.	HSJ-BT
Variant Model No.*	HSC-BT, HSDI-BT, HSBO-BT, HSPI-BT, HSWA-BT, HSHA-BT, HSST-BT, HSCA-BT
Hardware Version	1.1
Software Version	0.1.3
Operation Frequency	2402 MHz ~ 2480 MHz
Number of Channel	40
Channel separation:	2 MHz
Antenna Specification	PCB Antenna
Antenna Gain	-0.58 dBi
Power supply	3.7 V

* The PCB and electronical specification are same but only the external is different.

1.2 Number of Channel and Frequency

Operation Frequency each of channel							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2402	11	2422	21	2442	31	2462
2	2404	12	2424	22	2444	32	2464
3	2406	13	2426	23	2446	33	2466
4	2408	14	2428	24	2448	34	2468
5	2410	15	2430	25	2450	35	2470
6	2412	16	2432	26	2452	36	2472
7	2414	17	2434	27	2454	37	2474
8	2416	18	2436	28	2456	38	2476
9	2418	19	2438	29	2458	39	2478
10	2420	20	2440	30	2460	40	2480

Note:

The test was performed at low, middle and high channel and the selected channel as shown in the chart below:

Channel	Frequency [MHz]
Lowest channel	2402
Middle channel	2440
Highest channel	2480

1.3 Test Condition

	Normal voltage
DC Power	3.7 V

1.4 Test Data Rate & Target Value

Mode	Rate	Target Value		
	(Mbps)	Lowest Channel	Middle Channel	Highest Channel
BLE	1	7	7	7

* Note: This chart shows the test program setting power value66

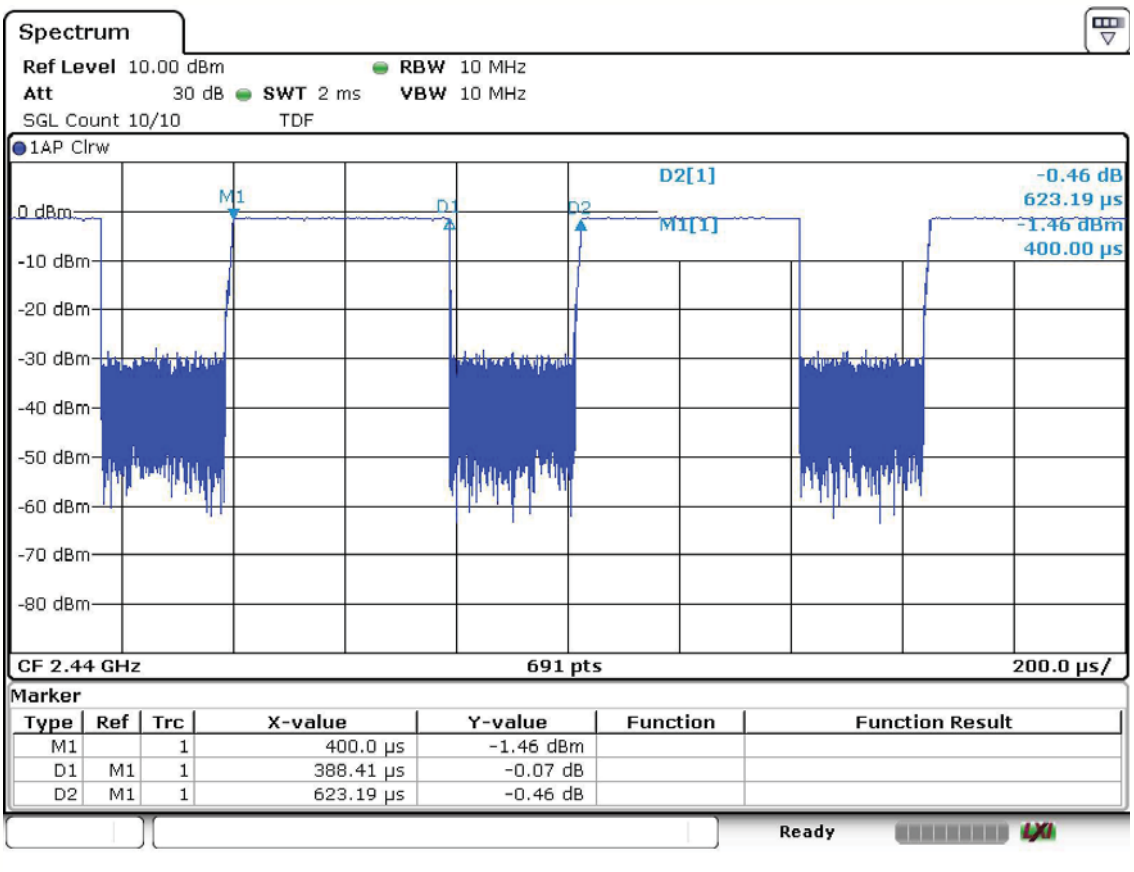
1.5 Duty Cycle

Mode	Ton (ms)	Ton+off (ms)	Duty Cycle[1] (%)	Duty Factor[2] (dB)
BLE	0.388	0.623	62.28	2.06

Note[1] : Duty Cycle = (Ton/Ton+off)*100
Note[2] : Duty Factor = 10*log(1/Duty cycle)

Test plots

BLE	Test channel:	Lowest



1.6 Test Performed

RRA Designation No.: KR0175

KOLAS Accreditation No. : KT511

Laboratory		NTREE Co., Ltd.
1st laboratory Address	:	30, Pajangcheon-ro 44beon-gil, Jangan-gu, Suwon-si, Gyeonggi-do, 16204, KOREA
Telephone	:	+82-31-893-1000
Facsimile	:	+82-31-893-0111
2nd laboratory Address	:	228-60, Saneop-ro 155beon-gil, Gwonseon-gu, Suwon-si, Gyeionggi-do, 16648, KOREA
Telephone	:	+82-31-893-0999
Facsimile	:	+82-31-297-0444

SITE MAP

1st laboratory

2nd laboratory

* The test was performed at 2nd laboratory.

1.7 Test Instruments list

Item	Test Equipment	Manufacturer	Model No.	Serial No.	Cal.Due date (mm-dd-yy)
1	Signal Analyzer	ROHDE & SCHWARZ	FSV40	100994	03-13-21
2	DC Power Supply	Hewlett Packard	6674A	3501A00827	11-02-21
3	DC Power Supply	TOYOTECH	DP30-05CF	17050049	07-20-21
4	Signal Generator	ROHDE & SCHWARZ	SMB100A	177568	03-13-21
5	Power Sensor	ROHDE & SCHWARZ	NRP-Z85	101554	11-03-21
6	Tri-Log Antenna	ROHDE & SCHWARZ	VULB9168	9168-721	03-24-22
7	LOOP ANTENNA	ROHDE & SCHWARZ	FMZB1519	1519-051	03-27-22
8	EMI Test Receiver	ROHDE & SCHWARZ	ESR7	102035	11-02-21
9	Attenuator	AEROFLEX	40AH2W-10	203129	03-13-21
10	Horn Antenna	Schwarzbeck	BBHA 9120D	1244	03-19-21
11	Horn Antenna	Schwarzbeck	BBHA 9170	573	03-20-21
12	Amplifier	TESTEK	TK-PA1840H	140003	03-16-21
13	Amplifier	TESTEK	TK-PA18H	160006-L	03-13-21

1.8 Summary of tests

FCC Part	Parameter	Limit	Test Result
15.247 (b)(3)	Maximum Peak Output Power	<30 dBm	Pass
15.247 (a)(2)	6 dB bandwidth	>500 kHz	Pass
2.1051, 15.247 (d)	Band Edge & Conducted Spurious Emission	-20 dBc	Pass
15.247 (e)	Power Spectral Density (PSD)	<8 dBm	Pass
15.247(d), 15.205, 15.209	Radiated Spurious Emission & Restricted Band Edge	< 54 dBuV/m(Av)	Pass
15.207(a)	AC Power Line Conducted Emission	15.207(a)	N/A[1)]
15.203	Antenna Requirement	15.203	Pass

N/A[1)] This product is not operating while charging.

1.9 Measurement uncertainty

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR100028-1 [2] and shall correspond to an expansion factor (coverage factor) *k*=1.96 or *k*=2 (which provide confidence levels of respectively 95% and 95.5% in the case where the distributions characterizing the actual measurement uncertainties are normal.

Parameter	Uncertainty
Transmitter output power (Conducted)	± 1.0 dB
AC Conducted emission	± 2.0 dB
Radiated spurious emission (Below 1 GHz)	± 4.2 dB
Radiated spurious emission (Above 1 GHz)	± 5.0 dB

2. Test results

2.1 Maximum Peak Output Power

2.1.1 Limit

FCC

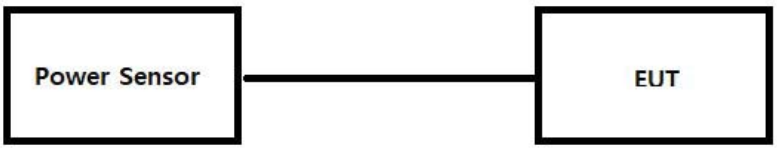
The maximum peak output power of the intentional radiator shall not exceed the following:

1. According to ∮15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band. Employing at least 75 non-overlapping hopping channels: 1Watt.
2. 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

IC

According to RSS-247 5.4(d), for DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

2.1.2 Test configration



2.1.3 Test procedure

1. PKPM1 Peak power meter method of KDB558074 D01v05r02
   The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.
2. Method AVGPM-G (Measurement using a gated RF average power meter) of KDB558074 D01v05r02
   The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Note: The measure-and-sum technique is used for test mode with multiple transmitting.

2.1.4 Test Result

Measurement Data

Test mode	Channel	Conducted output power		Max. e.i.r.p
		(dBm)	(mW)	(dBm)
BLE	Low Channel	-1.53	0.70	-2.11
	Middle Channel	-2.08	0.62	-2.66
	High Channel	-2.93	0.51	-3.51
Limit (dBm)		30		
Limit (W)		1		
Result		Pass		

Note 1: Conducted output power (dBm) = Attenuator loss + Cable loss + Duty Cycle (dB)
Note 2: Max. e.i.r.p = Conducted output power (dBm) + Antenna Gain (dBi)
Ex) -1.53 (dBm) + (-0.58 (dBi))= -2.11 (dBm)

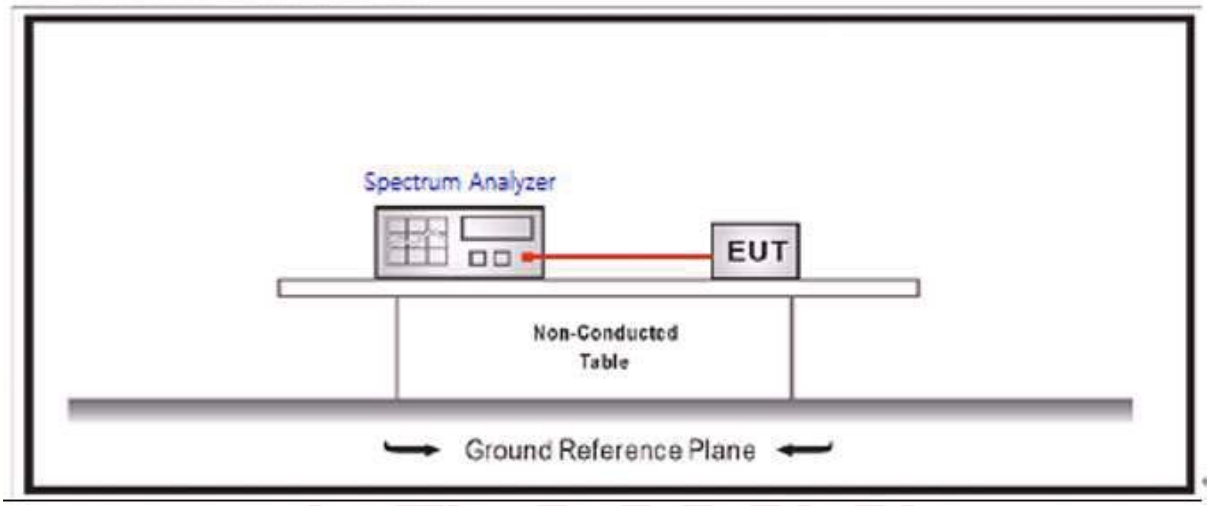
2.2 6 dB Bandwidth

2.2.1 Limit

According to 15.247(a)(2) and RSS-247 5.2(a), The minimum 6 dB bandwidth shall be 500 kHz.

2.2.2 Test Configuration

RF Conducted Measurement:



2.2.3 Test Procedure

Reference to section 11.8 in ANSI C63.10(2013): The transmitter output is connected to a spectrum analyzer with the RBW set to100KHz, the VBW >= 3 x RBW, peak detector and max hold.

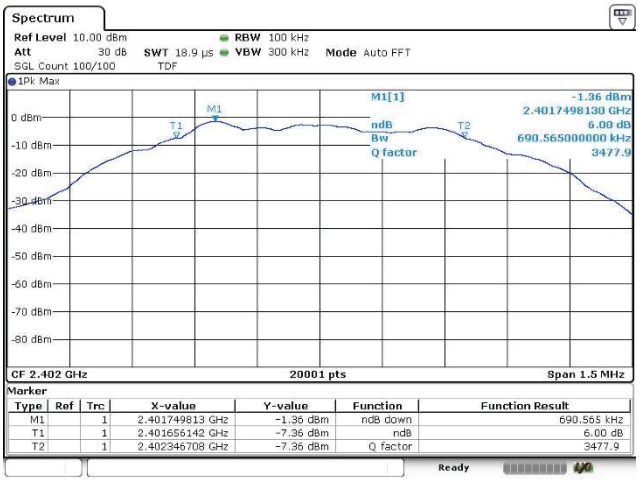
2.2.4 Test Result

Measurement Data

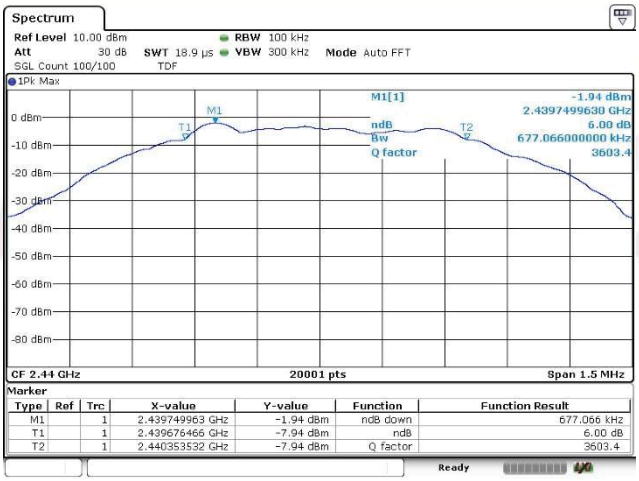
Test mode	Channel	6 dB bandwidth (MHz)	Limit (kHz)
BLE	Lowest	0.691	≥ 500
	Middle	0.677	
	Highest	0.685	
Test Result	Pass		

6 dB bandwidth plot as follows:

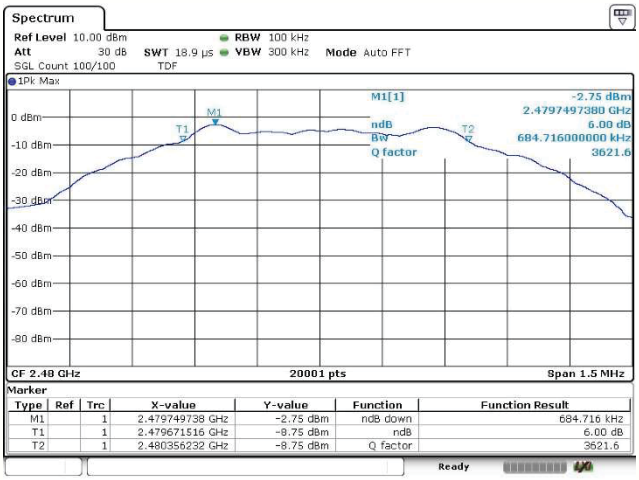
BLE	Test channel:	Lowest



BLE	Test channel:	Middle



BLE	Test channel:	Highest



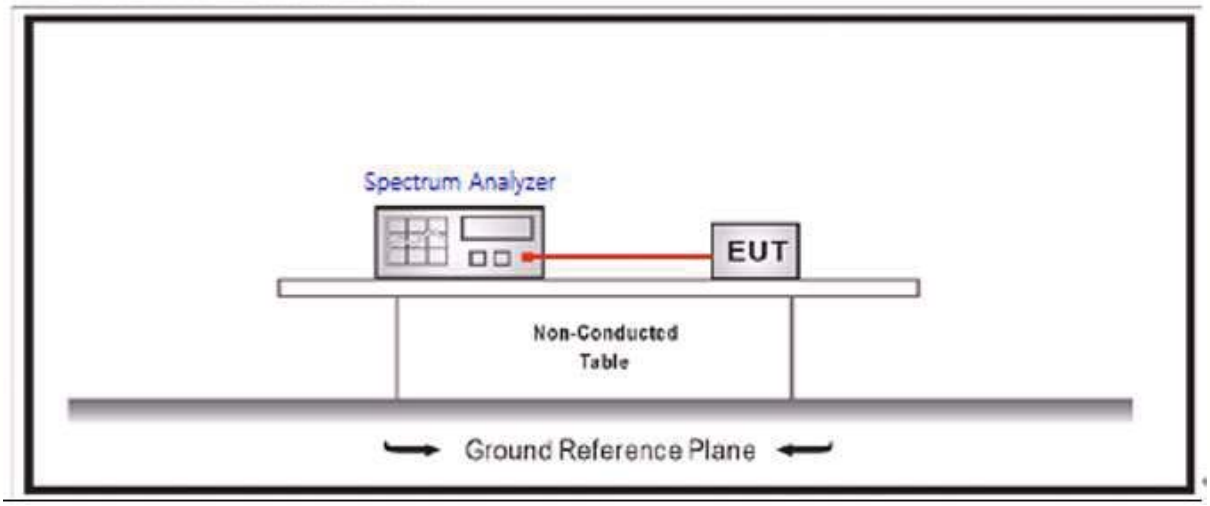
2.3 Power Spectral Density (PSD)

2.3.1 Limit

According to 15.247(e) and RSS-247 5.2(b), The transmitter power spectral density conducted from the transmitter 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 section 5.4(d),(i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

2.3.2 Test Configuration

RF Conducted Measurement:



2.3.3 Test Procedure

Power Spectral Density was performed utilizing the ANSI C63.10 section 11.10.2 (Method PKPSD).

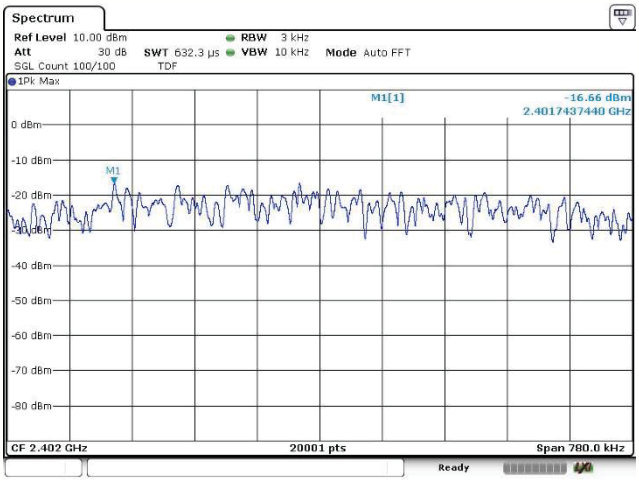
2.3.4 Test Result

Test mode	Channel	PSD (dBm)	Limit
BLE	Lowest	-16.66	8 dBm/3 kHz
	Middle	-17.25	
	Highest	-18.06	
Test Result	**Pass**		

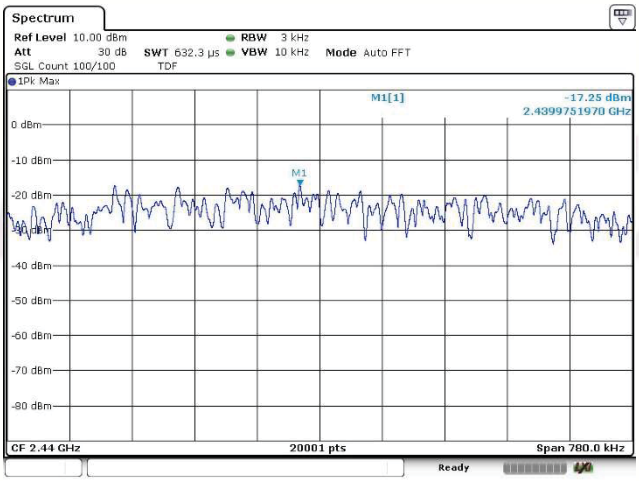
Note 1: The PSD results in plot is already included the actual values of cable loss and attenuator.

PSD test plot as follows:

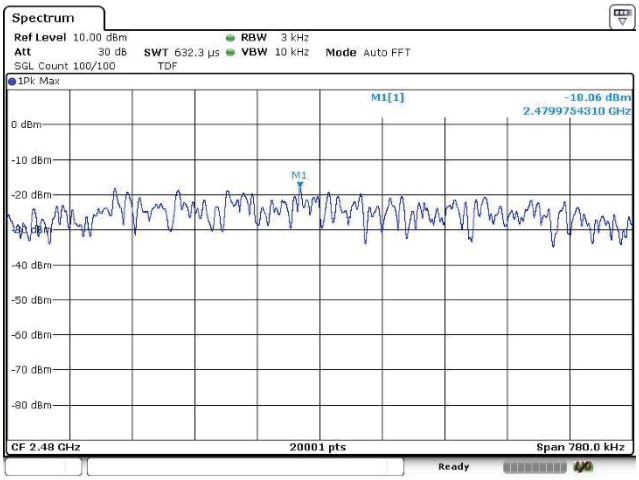
BLE	Test Channel:	Lowest



BLE	Test Channel:	Middle



BLE	Test Channel:	Highest



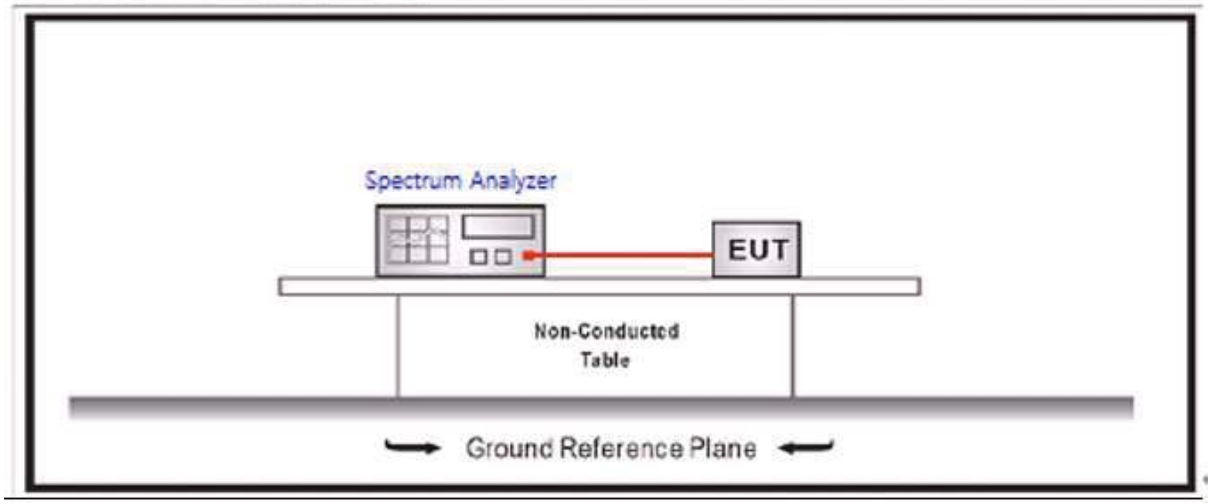
2.4 Conducted Spurious Emissions and Band Edge

2.4.1 Requirement

According to 15.247(d) and RSS-247 5.5, 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 base on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of thes section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in 15.209(a) is not required.

2.4.2 Test configuration

RF Conducted Measurement:



2.4.3 Test Procedure

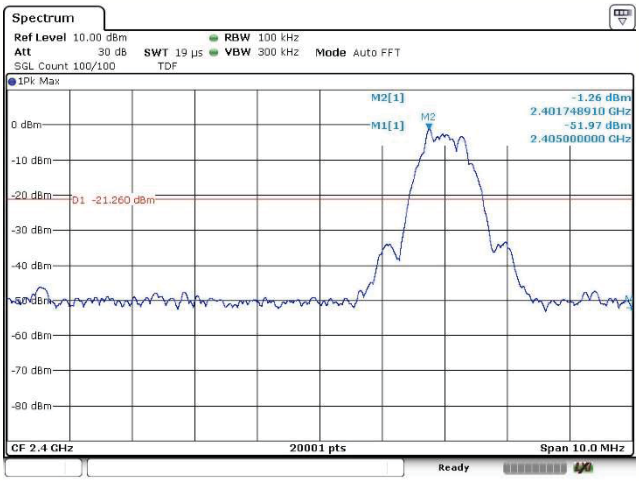
The transmitter output is connected to a spectrum analyzer with RBW = 100 kHz, VBW = 300 kHz, peak detector, and max hold. Measurements utilizing these settings are made of the in-band reference level, bandedge (where measurements to the general radiated limits will not be made) and out-of-band emissions.

2.4.4 Test Result

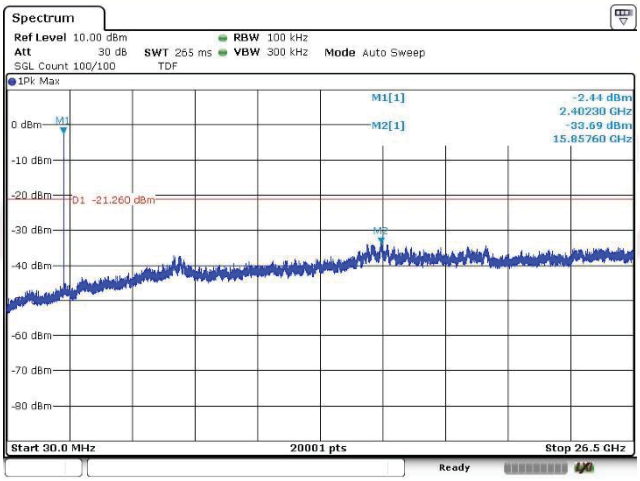
Test mode	Channel	Max. Out of band Emission (dBm)	Carrier level (dBm)	Calculated -20dBc limit (dBm)
BLE	Lowest Channel	-1.26	-33.69	-21.26
	Middle Channel	-1.95	-33.08	-21.95
	Highest Channel	-2.71	-32.73	-22.71
Result		Pass		

Test plot as follows:

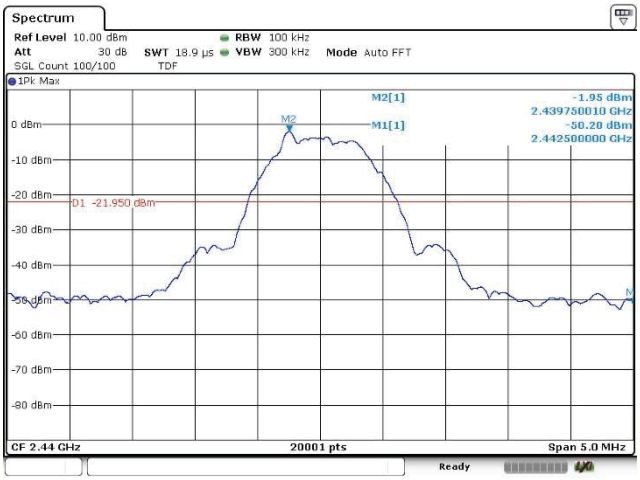
Band Edge	Test Channel:	Lowest



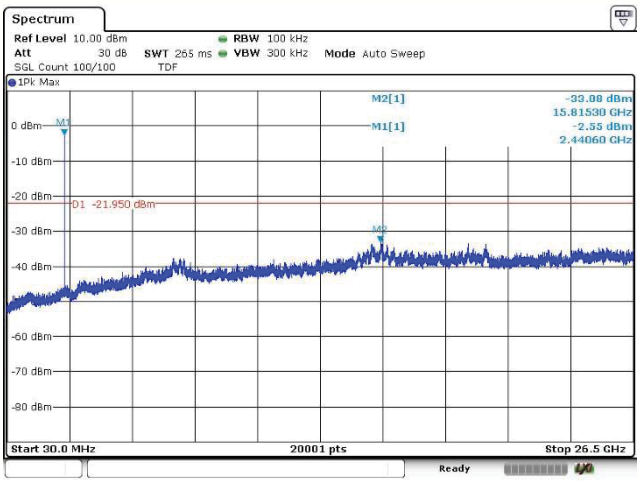
Conducted Spurious	Test Channel:	Lowest



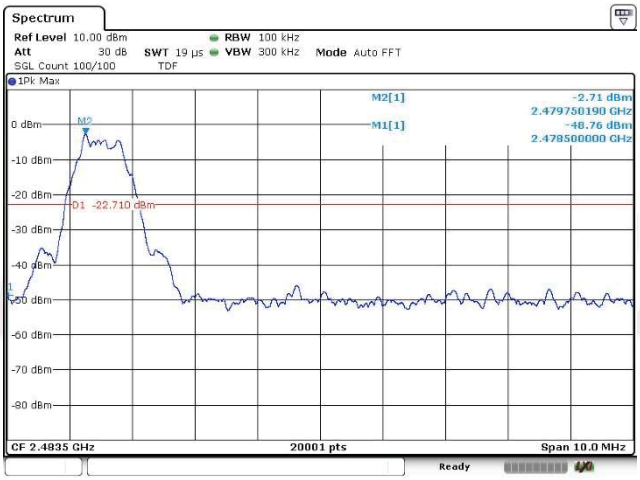
Band Edge	Test Channel:	Middle



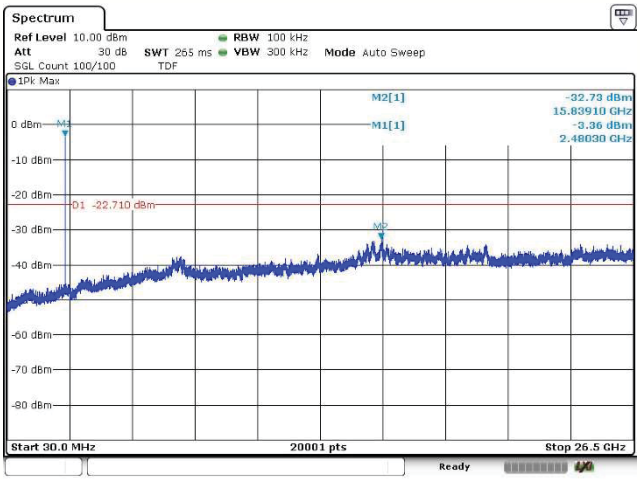
Conducted Spurious	Test Channel:	Middle



Band Edge	Test Channel:	Highest



Conducted Spurious	Test Channel:	Highest



2.5 Radiated Spurious Emission and Restricted Band Edge

The measurement was performed over the frequency range of 30 MHz to 1 GHz 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 120 kHz.
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 Semi-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 30 MHz to 1000 MHz using bi-log antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used.
Final measurements were made with 3-meters test distance using bi-log antenna or horn antenna. The 3 m Full Chamber have been verified in regular for its normalized site attenuation. The test equipment was placed on a 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 120 kHz or 1 MHz 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 m 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 1 GHz setting on the field strength meter is 120 kHz and above 1 GHz is 1 MHz)

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 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 m 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.

2.5.1 Limit

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))
All emission from a digital device, including any network of conductors and apparatus connected thereto shall not exceed the level of field strength specified below:

FCC Part 15 Subpart C paragraph 15.247(a) Limit

Fundamental Frequency (MHz)	Field Strength of Harmonics (3 m)		
	(mV/m)	(dBuV/m)	
2400 - 2483.5	500	54 (Avg.)	74 (Peak)

Note : 1. RF Field Strength (dBuV) = 20log RF Voltage(uV)
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.
3. The emission limit in this paragraph is based on measurement instrumentation employing an average detector

Frequencies in restricted band are complied to limit on Paragraph 15.209

Frequency Range (MHz)	Distance (m)	Field strength (dBuV/m)
0.009-0.490	300	20log 2400/F (kHz) + 80
0.490-1.705	30	20log 24000/F (kHz) + 40
1.705-30	30	20log 30 + 40
30-88	3	40.0
88-216	3	43.5
216-960	3	46.0
Above 960	3	54.0

Note : 1. RF voltage (dBuV) = 20 log RF Voltage (uV)
2. In the Above Table, the tighter limit applies at the band edges.
3. Distance refers to the distance in meters between the measuring instrument antenna and the EUT
4. This device used to install a within vehicular. The location of EUT measurements has the Y-plane(Stand).
5. All scanning using PK detector. And the final emission level was get using QP detector for frequency range from 30 – 1000 MHz. As to 1 – 26.5 GHz, the final emission level got using PK and AV detector.
6. If measurement is made at 3m distance.

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor Cable loss 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:

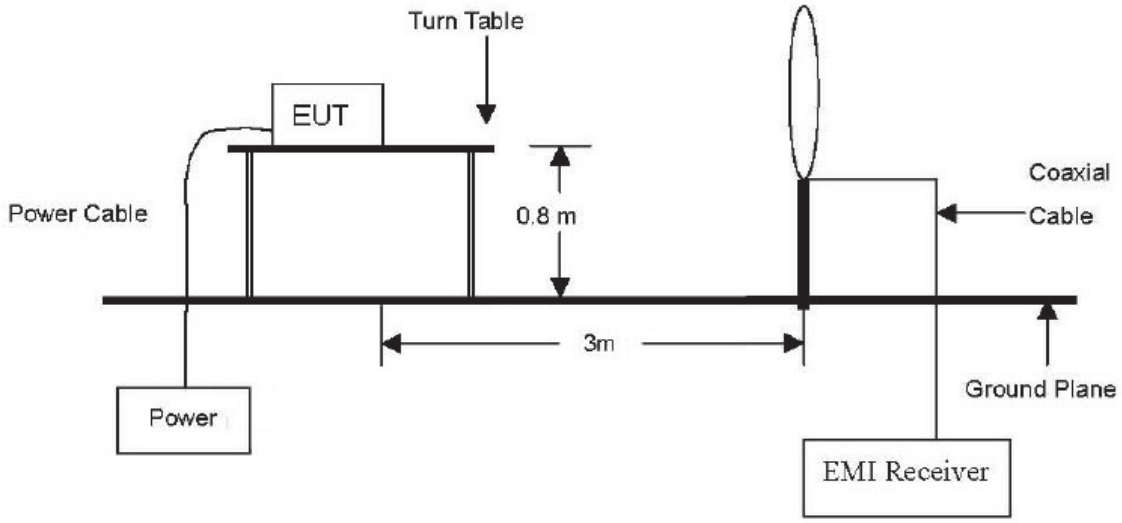
Peak = Reading + Corrected Factor

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

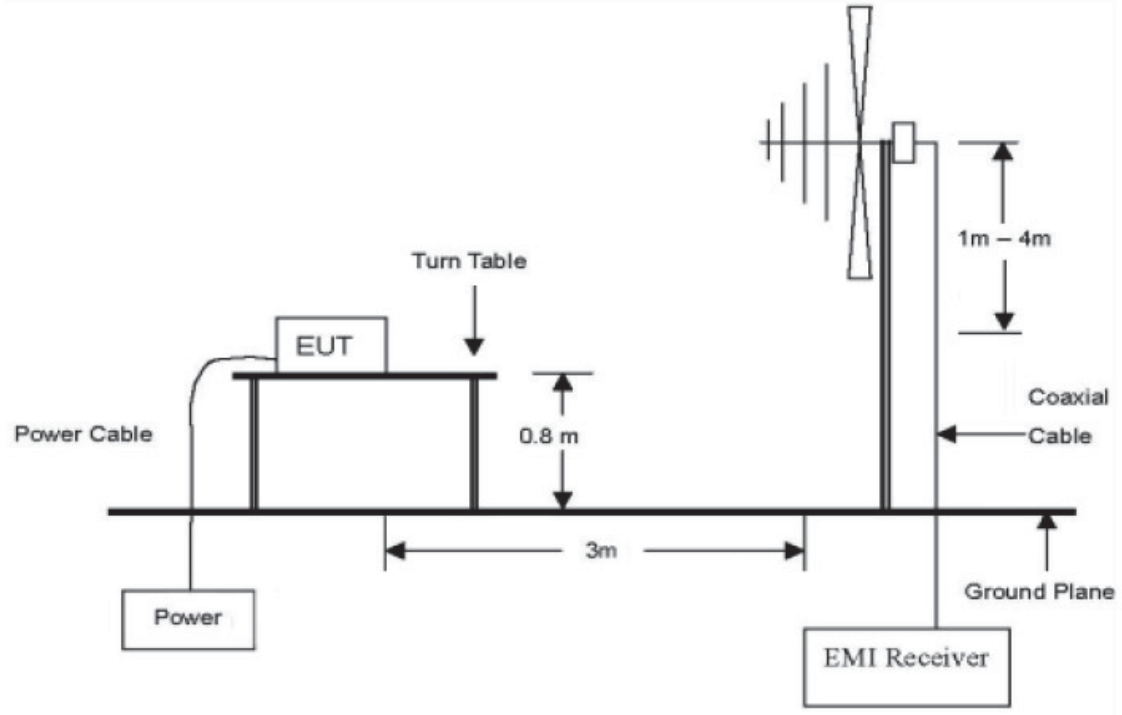
Note: Example of Field strength = 20log 2400/F + 80 = 129

2.5.2 Test Configuration

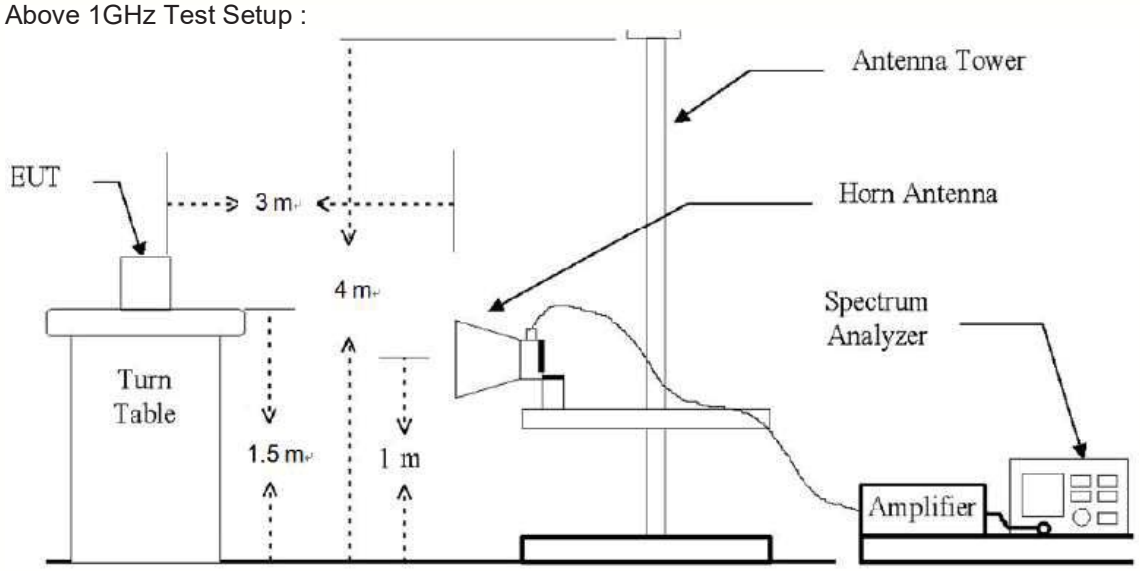
Below 30 MHz



Below 1 GHz test setup:



Above 1GHz Test Setup :



2.5.3 Test Procedure

The EUT is placed on a non-conducting table 80 cm above the ground plane for below 1GHz and 150 cm for above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.
For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.
For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and add duty cycle factor for average measurements. (Restriced bandedge, Final detection of spurious harmonic emissions)
Duty cycle factor = 10 log (1/x). For this sample: DCF = 10log(1/0.62)=2.06 dB(Spectrum Analyzer round it up to 2.06 dB).
1/T minimum VBW = 1/Duty cycle. For this sample: minimum VBW = 1/0.38 = 0.01 kHz
Pre-scans to detect harmonic and spurious emissions, the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.
The spectrum from 1 GHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in the 2.4 GHz band.
(From 30MHz to 1GHz, test was performed with the EUT set to transmit at the channel with highest output power)
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth.
The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission.
Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

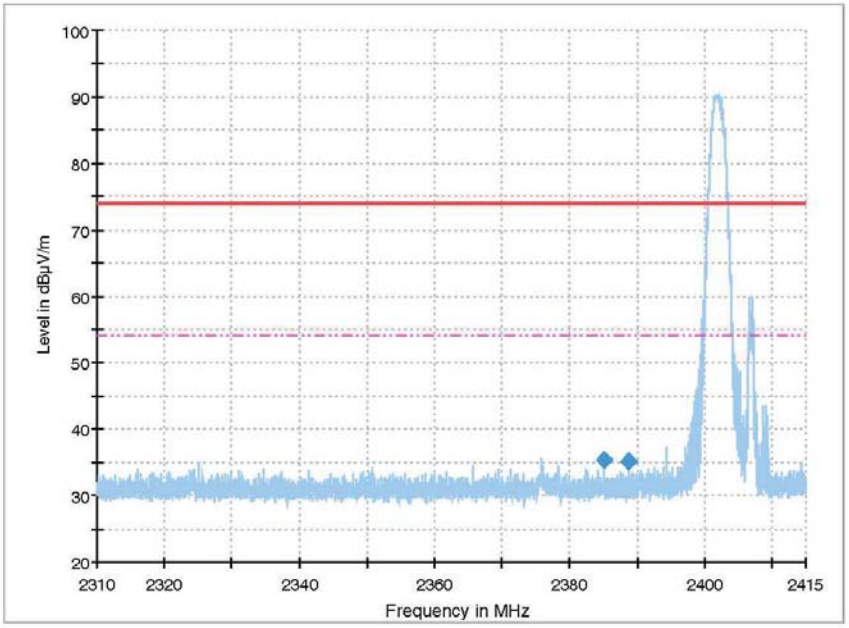
2.5.4 Test Result (Restricted Band Edge Above 1 GHz)

F1_PK_H 2021-01-27

Test Report

Common Information

Test Description:
Test Mode:
Test Standard:
Environment Conditions:
Operator Name:
Comment:



Frequency (MHz)	Reading (dBuV/m)	DCCF (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2385.050	35.43	0	35.43	74	38.57
2388.660	35.14	0	35.14	74	38.86

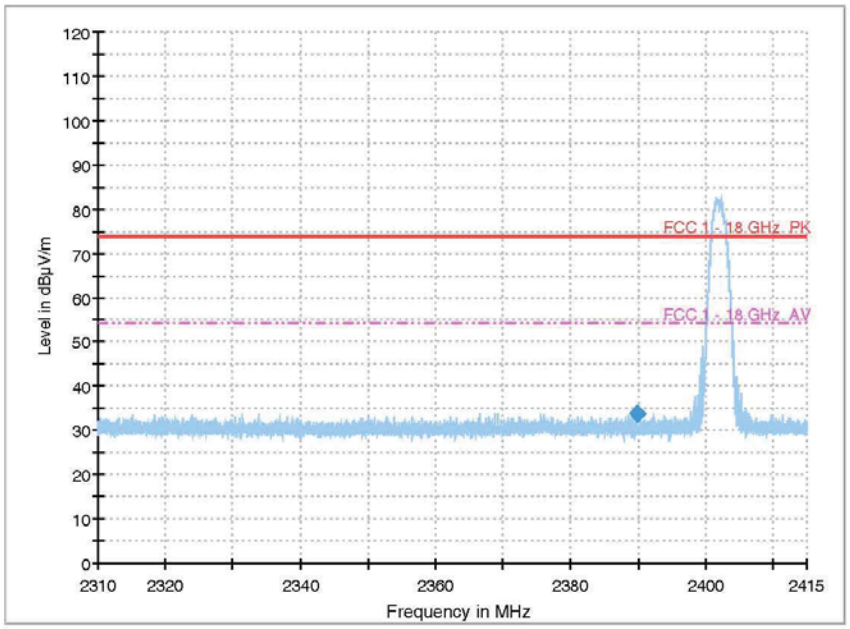
Note: The test performed worst axis (X axis)

F1_PK_V 2021-01-27

Test Report

Common Information

Test Description:
Test Mode:
Test Standard:
Environment Conditions:
Operator Name:
Comment:



Frequency (MHz)	Reading (dBuV/m)	DCCF (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2389.930	33.88	0	33.88	74	40.12

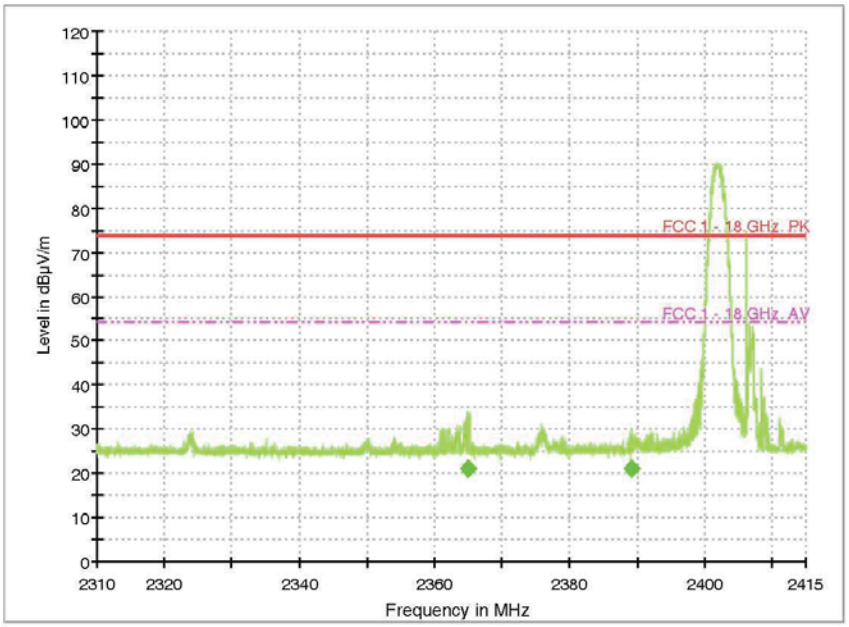
Note: The test performed worst axis (X axis)

F1_AV_H 2021-01-27

Test Report

Common Information

Test Description:
Test Mode:
Test Standard:
Environment Conditions:
Operator Name.
Comment: 2.31 - 2.415 GHz



Frequency (MHz)	Reading (dBuV/m)	DCCF (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2365.073	21.15	2.06	23.21	54	21.15
2389.265	20.95	2.06	23.01	54	20.95

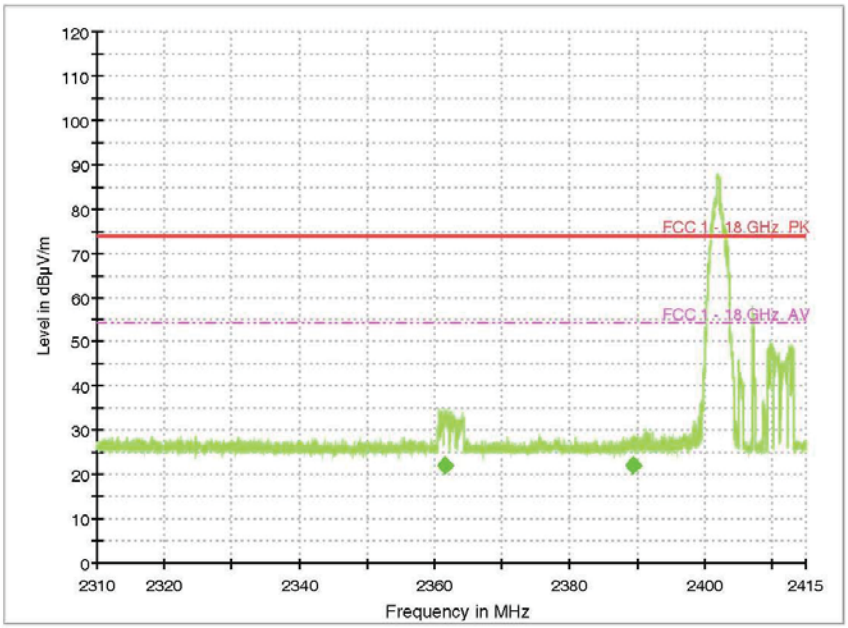
Note: The test performed worst axis (X axis)

F1_AV_V 2021-01-27

Test Report

Common Information

Test Description:
Test Mode:
Test Standard:
Environment Conditions:
Operator Name:
Comment: 2.31 - 2.415 GHz



Frequency (MHz)	Reading (dBuV/m)	DCCF (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2361.510	21.97	2.06	24.03	54	29.97
2389.410	22.16	2.06	24.22	54	29.78

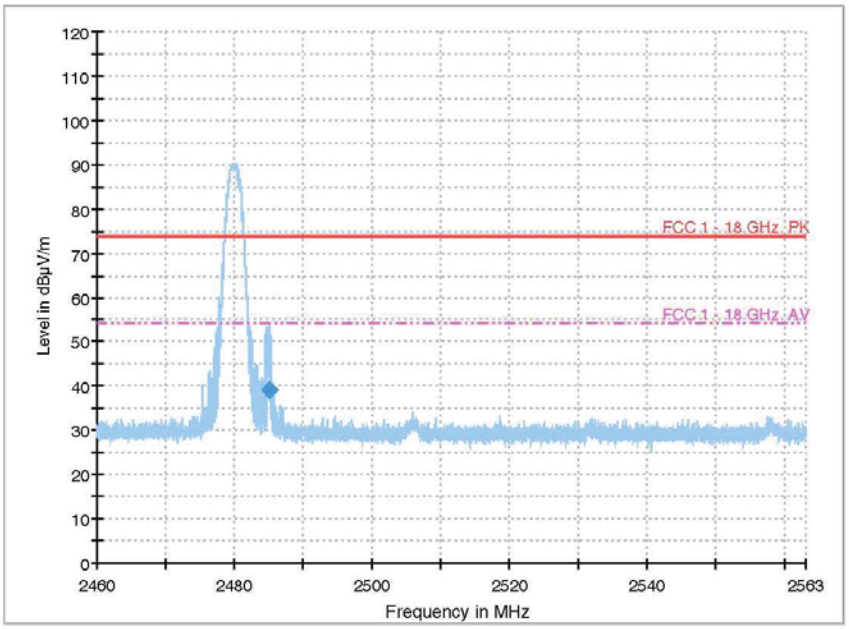
Note: The test performed worst axis (X axis)

F3_PK_H 2021-01-27

Test Report

Common Information

Test Description:
Test Mode:
Test Standard:
Environment Conditions:
Operator Name:
Comment:



Frequency (MHz)	Reading (dBuV/m)	DCCF (dB)	Total (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2485.153	39.13	0	39.13	74	34.87

Note: The test performed worst axis (X axis)