TEST REPORT

1. Applicant		
Name	:	Maytel Co., Ltd
Brand Name	:	N/A
Address	:	#417 Doosan Venture Digm 126-1, Pyeongchon-dong, Dongan-gu, Anyang-si, Gyeonggi-do, Republic of Korea
FCC ID	:	YJHMC-1124G
2. Products		
Name	:	Multicom 2.4G (SWATCOM Multicom)
Model No.	:	MC-11 2.4G
Variant Model No.	:	MC-11, MC11, SCMC-M11-SET, SCMC-M11, xepton TRX-1
Manufacturer	:	Maytel Co., Ltd
Address	:	#417 Doosan Venture Digm 126-1, Pyeongchon-dong, Dongan-gu, Anyang-si, Gyeonggi-do, Republic of Korea
3. Test Standard	:	47 CFR Part 15, Subpart C
4. Test Method	:	ANSI C63.10-2013
5. Test Result	:	PASS
6. Dates of Test	:	November 17, 2016 to November 25, 2016
7. Date of Issue	:	December 02, 2016
8. Test Laboratory	:	Standard Engineering Co. Ltd. FCC Designation Number : 624439

Tested by	Approved by
	
SoonHo, Kim / Test Engineer	SeongSeok, Seo / Compliance Engineer

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1. Test Summary

Test	Test Requirement	Test method	Result
Antenna Requirement	FCC PART 15 C section 15.247 (c) and Section 15.203	ANSI C63.10(2013)	PASS
Occupied Bandwidth	FCC PART 15 C section 15.247 (a)(1)	ANSI C63.10(2013)	PASS
Carrier Frequencies Separated	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10(2013)	PASS
Hopping Channel Number	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10(2013)	PASS
Dwell Time	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10(2013)	PASS
Pseudorandom frequency-hopping sequence	FCC PART 15 C section 15.247(a)(1)	ANSI C63.10(2013)	PASS
Maximum Peak Output Power	FCC PART 15 C section 15.247(b)(1)	ANSI C63.10(2013)	PASS
Conducted Spurious Emission	FCC PART 15 C section 15.247(d)	ANSI C63.10(2013)	PASS
Radiated Spurious Emission	FCC PART 15 C section 15.247(d)	ANSI C63.10(2013)	PASS
Band Edges Measurement	FCC PART 15 C section 15.247 (d) &15.205	ANSI C63.10(2013)	PASS
Conducted Emissions at Mains Terminals	FCC PART 15 C section 15.207	ANSI C63.10(2013)	PASS
Radio Frequency Exposure Procedures	FCC PART 15 C section 15.247 (i) &1.1307(b)	-	PASS

Remark:

N/A: not applicable. Refer to the relative section for the details.

EUT: In this whole report EUT means Equipment Under Test.

Tx: In this whole report Tx (or tx) means Transmitter.

Rx: In this whole report Rx (or rx) means Receiver.

RF: In this whole report RF means Radio Frequency.

ANSI C63.10: the detail version is ANSI C63.10:2013 in the whole report.

DA 00-705 was used as a guideline in preparing this Test Report.

2. TABLE OF CONTENTS

3. General Information

3.1. Client Information

Applicant : Maytel Co., Ltd
Address of Applicant : #417 Doosan Venture Digm 126-1, Pyeongchon-dong, Dongan-gu, Anyang-si, Gyeonggi-do, Republic of Korea

3.2. General Description of E.U.T.

Product Name : Multicom 2.4G (SWATCOM Multicom)
Model No. : MC-11 2.4G

3.3. Details of E.U.T.

Operation Frequency	:	2407 MHz to 2476 MHz
Wireless Mode	:	Hopping Mode
Channel Numbers	:	139 Channels
Hopping Channel	:	16 Channels
Channel Spacing	:	500 KHz
Type of Modulation	:	GFSK
Antenna Type	:	Helical Antenna
Antenna Gain	:	0 dBi
Test Software	:	-
Power Supply	:	DC 5.0 V
Test Voltage	:	DC 3.7 V

Remark:

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

3.4. Operation Frequency each of channel spacing

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
		12	2413	32	2423	52	2433	72	2443	92	2453	112	2463	132	2473
		13	2413.5	33	2423.5	53	2433.5	73	2443.5	93	2453.5	113	2463.5	133	2473.5
		14	2414	34	2424	54	2434	74	2444	94	2454	114	2464	134	2474
		15	2414.5	35	2424.5	55	2434.5	75	2444.5	95	2454.5	115	2464.5	135	2474.5
		16	2415	36	2425	56	2435	76	2445	96	2455	116	2465	136	2475
		17	2415.5	37	2425.5	57	2435.5	77	2445.5	97	2455.5	117	2465.5	137	2475.5
		18	2416	38	2426	58	2436	78	2446	98	2456	118	2466	138	2476
		19	2416.5	39	2426.5	59	2436.5	79	2446.5	99	2456.5	119	2466.5		
0	2407	20	2417	40	2427	60	2437	80	2447	100	2457	120	2467		
1	2407.5	21	2417.5	41	2427.5	61	2437.5	81	2447.5	101	2457.5	121	2467.5		
2	2408	22	2418	42	2428	62	2438	82	2448	102	2458	122	2468		
3	2408.5	23	2418.5	43	2428.5	63	2438.5	83	2448.5	103	2458.5	123	2468.5		
4	2409	24	2419	44	2429	64	2439	84	2449	104	2459	124	2469		
5	2409.5	25	2419.5	45	2429.5	65	2439.5	85	2449.5	105	2459.5	125	2469.5		
6	2410	26	2420	46	2430	66	2440	86	2450	106	2460	126	2470		
7	2410.5	27	2420.5	47	2430.5	67	2440.5	87	2450.5	107	2460.5	127	2470.5		
8	2411	28	2421	48	2431	68	2441	88	2451	108	2461	128	2471		
9	2411.5	29	2421.5	49	2431.5	69	2441.5	89	2451.5	109	2461.5	129	2471.5		
10	2412	30	2422	50	2432	70	2442	90	2452	110	2462	130	2472		
11	2412.5	31	2422.5	51	2432.5	71	2442.5	91	2452.5	111	2462.5	131	2472.5		

Note:

In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
Lowest channel	2407MHz
Middle channel	2440MHz
Highest channel	2476MHz

3.5. Description of Support Units

The EUT has been tested with corresponding accessories as below:
Supplied by Standard Engineering Laboratory.:

Description	Manufacturer	Model No.	Serial No.
Adapter	MEPOS	GPE053B-V050100-Z	-
-	-	-	-

3.6. Abnormalities from Standard Conditions

None.

3.7. Other Information Requested by the Customer

None.

3.8. Test Location

377-11, Sinjang-ri, Eumam-myeon, Seosan-si, ChoongNam 356-844, South Korea
(FCC Designation Number : 624439)
This test site is in compliance with ISO/IEC 17025 for general requirements for the competence of testing and calibration laboratories.

4. Equipment Used during Test

No.	Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Next Cal. Data	Used equipment
1	EMI Test Receiver	LIG	LSA-265	L07098033	03/08/2016	03/08/2017	■
2	EMI Test Receiver	Rhode & Schwarz	ESIB7	3311	02/11/2016	02/11/2017	■
3	Bi-log Antenna	Schwarzbeck	VULB9163	164	09/15/2014	09/30/2017	■
4	Loop Antenna	EMCO	6502	9206-2769	01/28/2016	01/28/2018	■
5	Spectrum Analyzer	Agilent	E4440A	US45303130	01/26/2016	01/26/2017	■
6	Frequency Counter	HP	5347A	3009A02742	01/26/2016	01/26/2017	□
7	Attenuator	Agilent	8495B	3308A22485	01/26/2016	01/26/2017	□
8	Power Meter	Agilent	E4418B	MY405111655	01/26/2016	01/26/2017	□
9	Power Sensor	HP	8485A	2347A02746	01/26/2016	01/26/2017	□
10	RF Cable	Gigalane	SMS102-MF141-SMS102-1.0M	PB1252301285	N/A	N/A	■
11	Signal Generator	HP	83630A	3420A00728	01/26/2016	01/26/2017	□
12	Oscilloscope	HP	54815A	US38380122	01/26/2016	01/26/2017	□
13	Pre Amplifier	Agilent	8449B	3008A02105	01/26/2016	01/26/2017	■
14	Signal Generator	Rhode & Schwarz	SML03	102330	01/26/2016	01/26/2017	□
15	Power Divider	Agilent	11636B	50309	01/26/2016	01/26/2017	□
16	Power Sensor	Seoksan Tech	SE-CT-02	S7400JD5340618	01/26/2016	01/26/2017	□
17	DC Power Supply	HP	6032A	US35420383	01/26/2016	01/26/2017	■
18	Slidacs	Sunchang Electrics	5KV	N/A	01/26/2016	01/26/2017	□
19	Bandreject Filter	K&L Microwave	50140	555	01/26/2016	01/26/2017	□
20	Horn Antenna	Schwarzbeck	BBHA9120A	346	02/05/2016	02/05/2018	■
21	Horn Antenna	A.H. SYSTEMS	SAS-572	269	09/03/2015	09/03/2017	■
22	DC Power Supply	Provice	PWS-5005D	205050	01/26/2016	01/26/2017	■
23	Pulse Limiter	Rhode & Schwarz	ESH3-Z2	100137	11/10/2016	11/10/2017	■
24	LISN	Rhode & Schwarz	ESH3-Z5	100204	11/10/2016	11/10/2017	■

5. Test Results

5.1. E.U.T. test conditions

Test Voltage:	DC 3.7V
Temperature:	20.0 -25.0 °C
Humidity:	38-50 % RH
Atmospheric Pressure:	1000 -1010 mbar
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

5.2. 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.

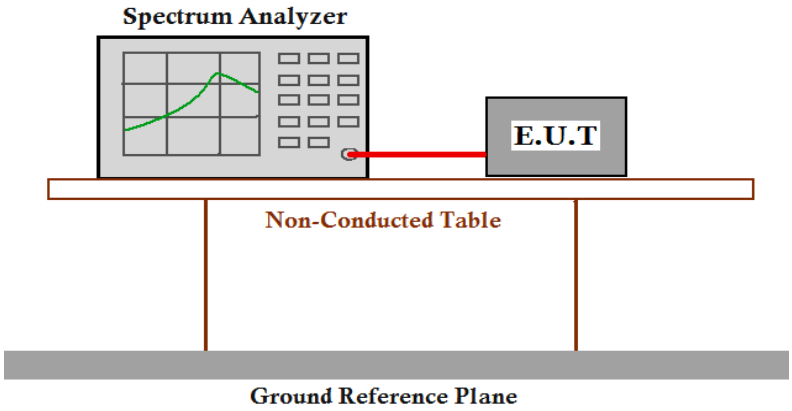
EUT Antenna **PASS**

The transmitter has an Helical Antenna. The directional gain of the antenna is 0 dBi. please refer to the EUT Internal Photos.

5.3. Occupied Bandwidth

Test Requirement:	FCC Part 15 C section 15.247 (a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
Test Method:	ANSI C63.10: Clause 7.8.7
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), middle (2440 MHz) and highest (2476 MHz) channel

Test Configuration:



Test Procedure:

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

Test result:

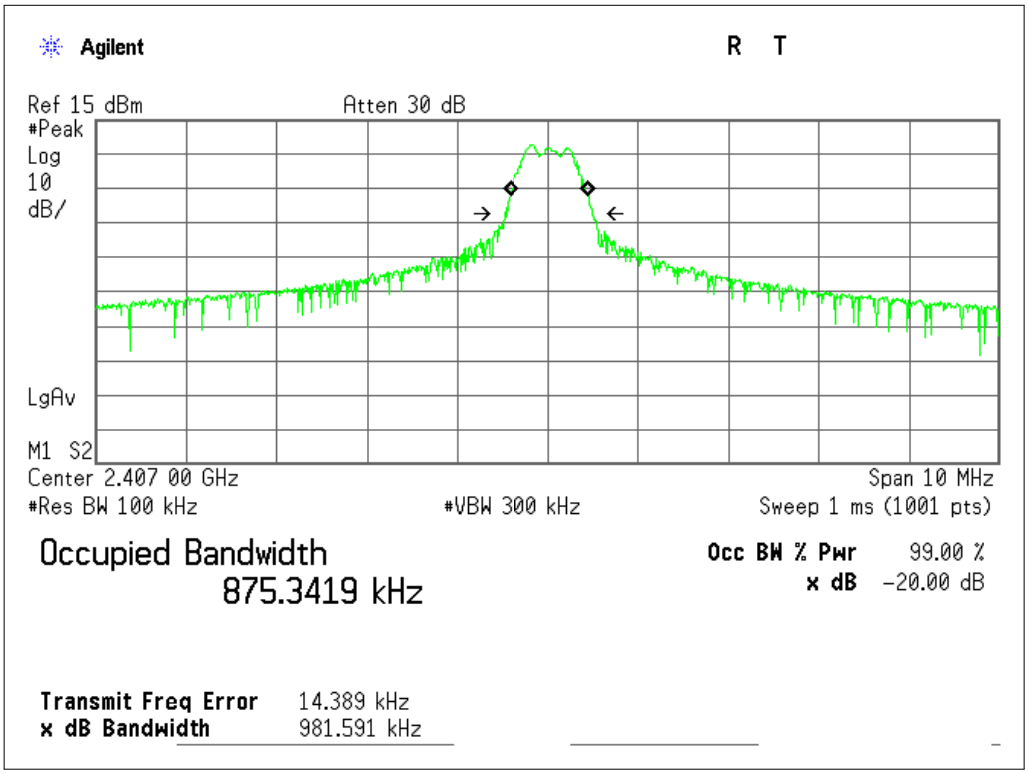
Normal mode:

Test Channel	Bandwidth(MHz)	2/3 bandwidth(MHz)
Lowest	0.981	0.654
Middle	0.988	0.658
Highest	0.986	0.657

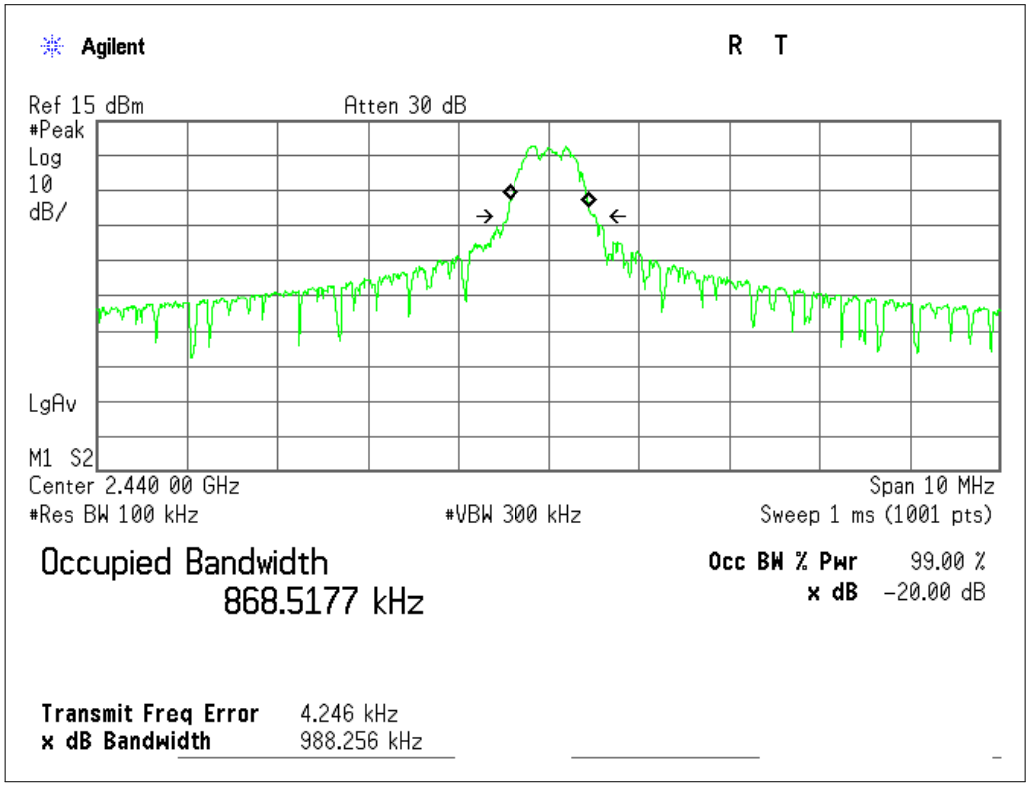
Result plot as follows:

Normal mode :

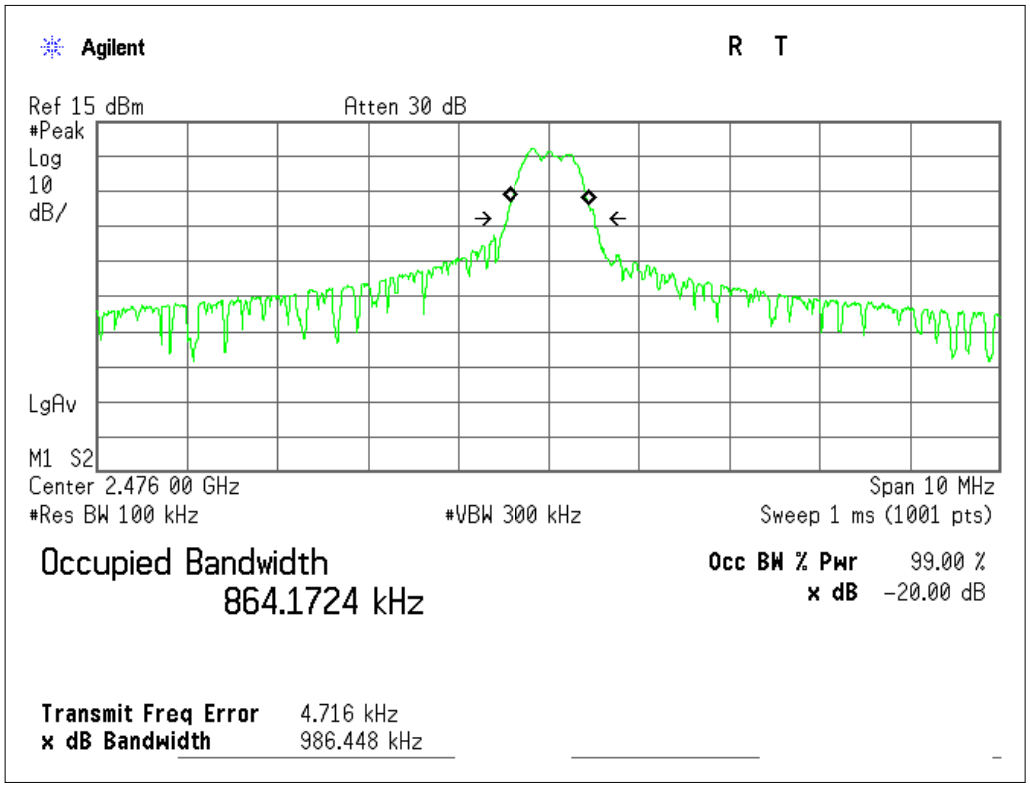
Lowest Channel(2.407 GHz):



Middle Channel(2.440 GHz):



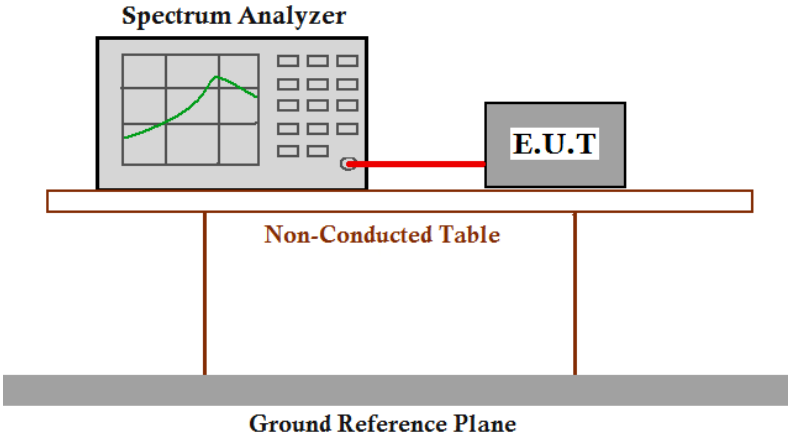
Highest Channel(2.476 GHz):



5.4. Carrier Frequencies Separated

Test Requirement:	FCC Part 15 C section 15.247 (a)(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
Test Method:	ANSI C63.10: Clause 7.8.2
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), middle (2440 MHz) and highest (2476 MHz) channel

Test Configuration:



Test Procedure:

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

Test result:

Test Channel	Carrier Frequencies Separated	Pass/Fail
Lower Channels (channel 0 and channel 1)	2.01 MHz	Pass
Middle Channels (channel 64 and channel 76)	2.00 MHz	Pass
Upper Channels (channel 136 and channel 144)	2.00 MHz	Pass

Remark:

The limit is maximum two-thirds of the 20 dB bandwidth: 658 KHz.

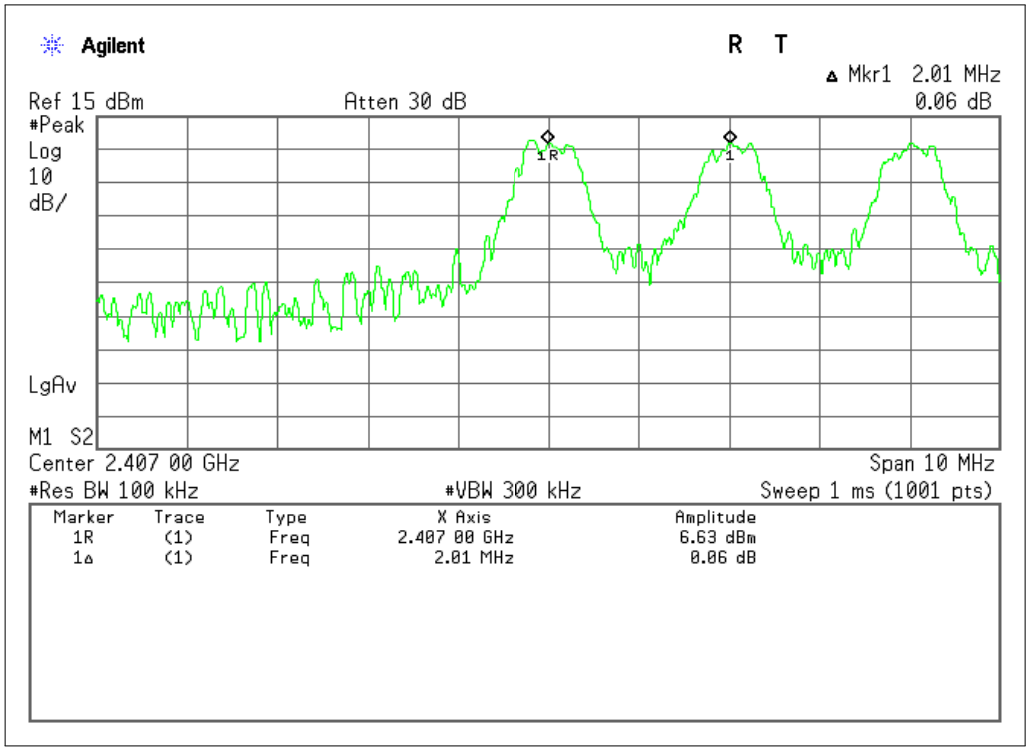
This product has a channel spacing of 500KHz.

The actual hopping is 2MHz channel spacing.

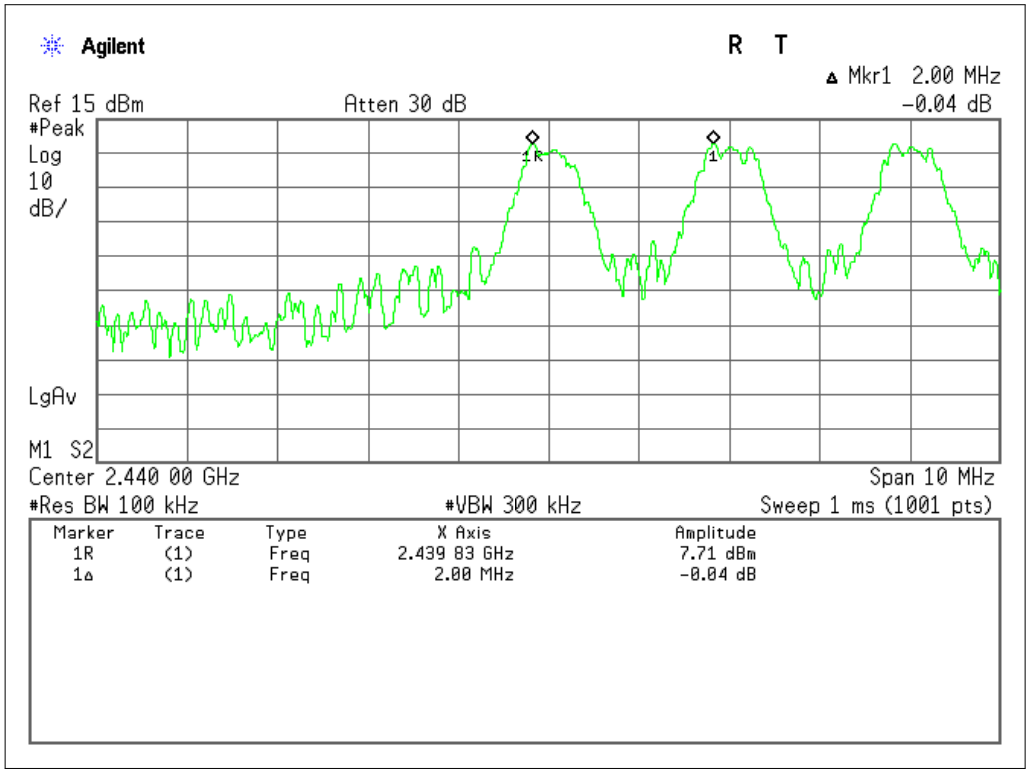
The total number of channels is 139, but the number of actual hopping channels is 16ea.

Result plot as follows:

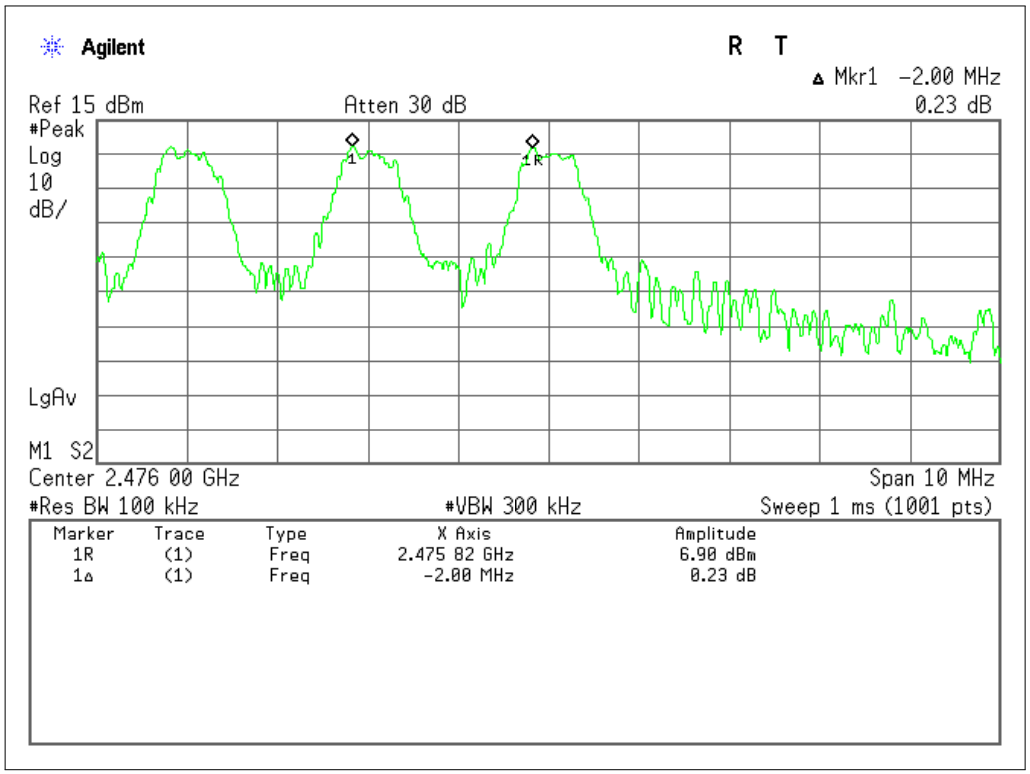
Lowest Channels: Carrier Frequencies Separated



Middle Channels: Carrier Frequencies Separated



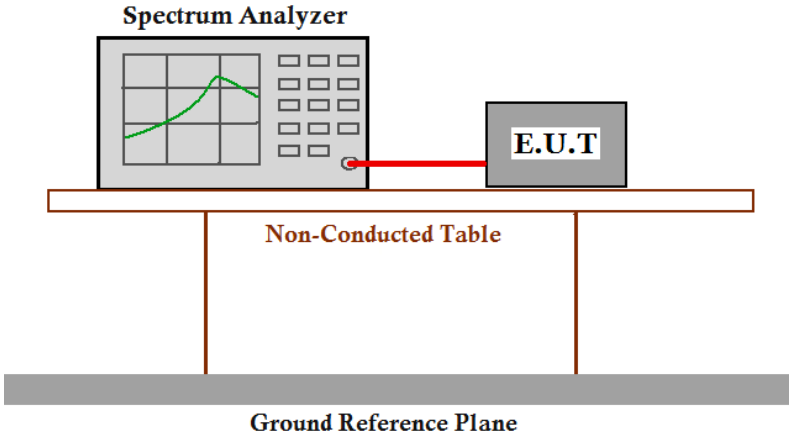
Highest Channels: Carrier Frequencies Separated



5.5. Hopping Channel Number

Test Requirement:	FCC Part15 C section 15.247 (a)(1) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.
Test Method:	ANSI C63.10: Clause 7.8.3
Test Status:	Pre-test the EUT in hopping mode

Test Configuration:

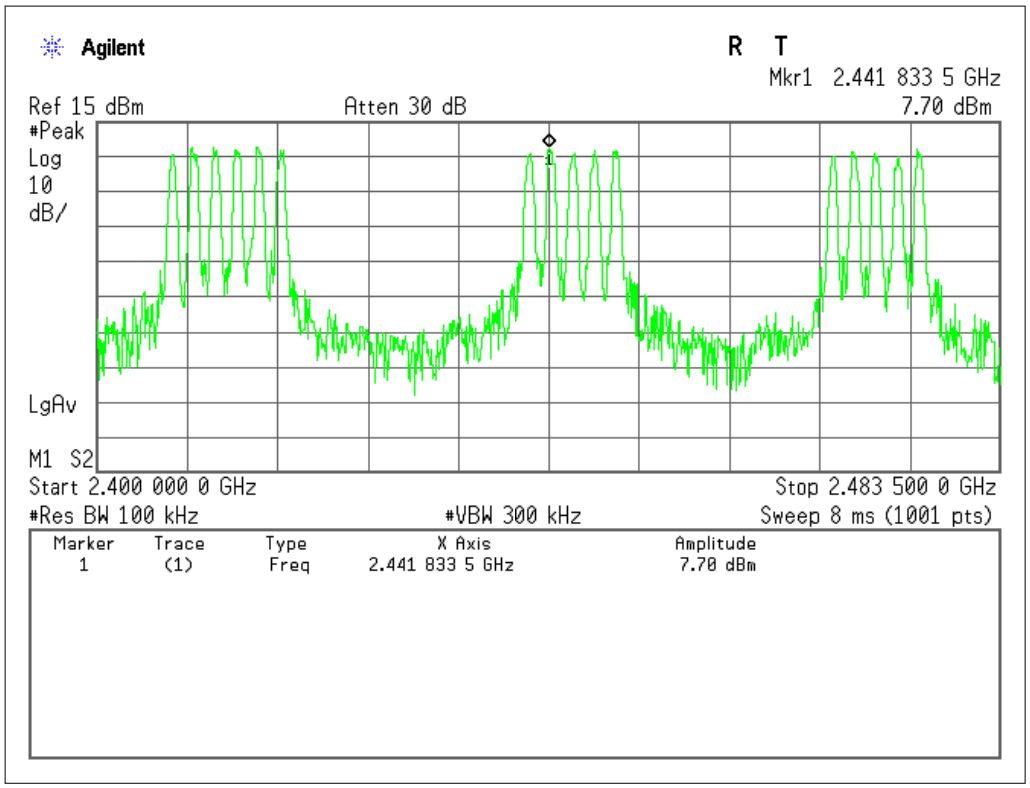


Test Procedure:

1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100 kHz. VBW = 300 kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: start frequency = 2400 MHz. stop frequency = 2483.5 MHz. Submit the test result graph.

Test result:

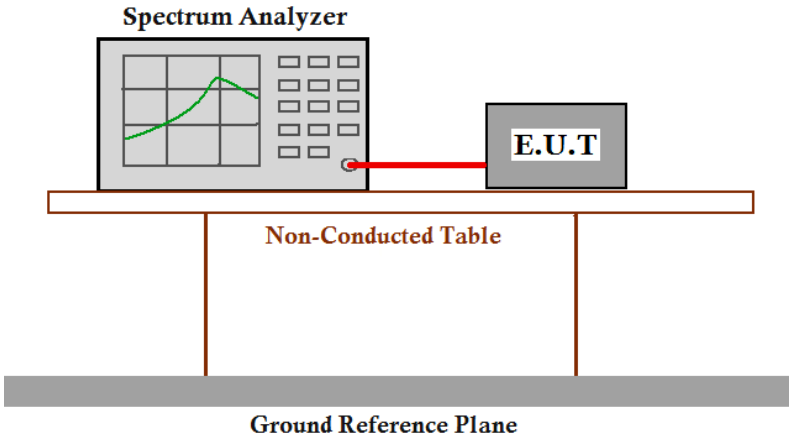
Total channels are 16 channels.



5.6. Dwell Time

Test Requirement:	FCC Part15 C section 15.247 (a)(1) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.
Test Method:	ANSI C63.10: Clause 7.8.4
Test Status:	Test the EUT in hopping mode at the lowest (2407 MHz), middle (2440 MHz) and highest (2476 MHz) channel

Test Configuration:



Test Procedure:

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

Test Result :

Dwell time = Reading × (Hopping rate / Number of channels) × Period Time

The test period: T= 0.4 Second/Channel x 16 Channel = 6.4 s

Measured values of the Dwell Time								
Modulation	Operating frequency (MHz)	Reading (ms)	hop rate (hops/s)	Number of hopping Channels	Period Time	Dwell time (ms)	Limits (ms)	Verdict
GFSK	2407 MHz	3.497	0.0500	16	6.4	70.045	≤ 400	Pass
	2440 MHz	3.497	0.0500	16	6.4	70.045	≤ 400	Pass
	2476 MHz	3.497	0.0502	16	6.4	70.256	≤ 400	Pass

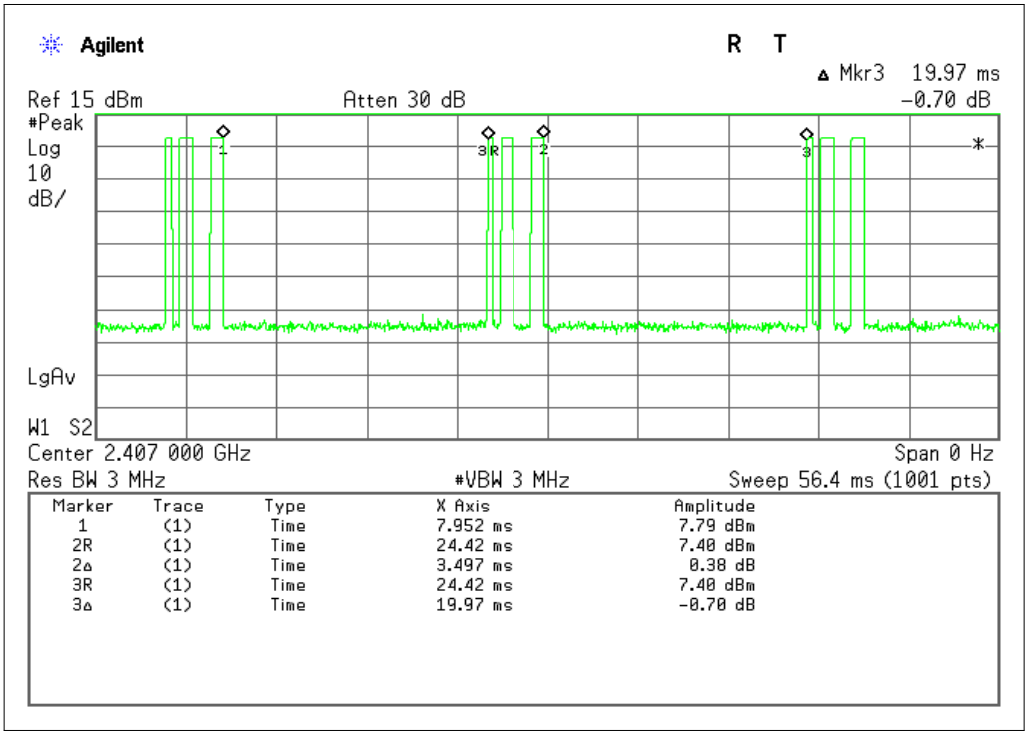
The average time of occupancy in the specified 6.4 second period is equal to pulse width*

(# of pulse in observation period)*(test period / observation period)

Result plot as follows :

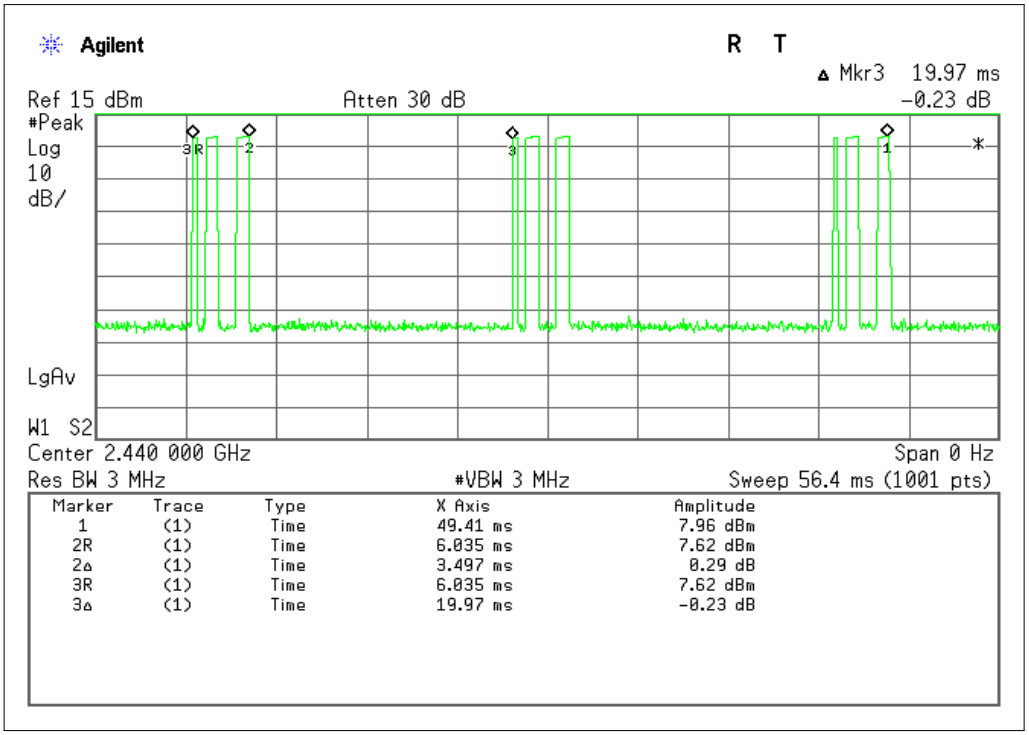
1. Lowest channel (2407 MHz):

Pulse Width:



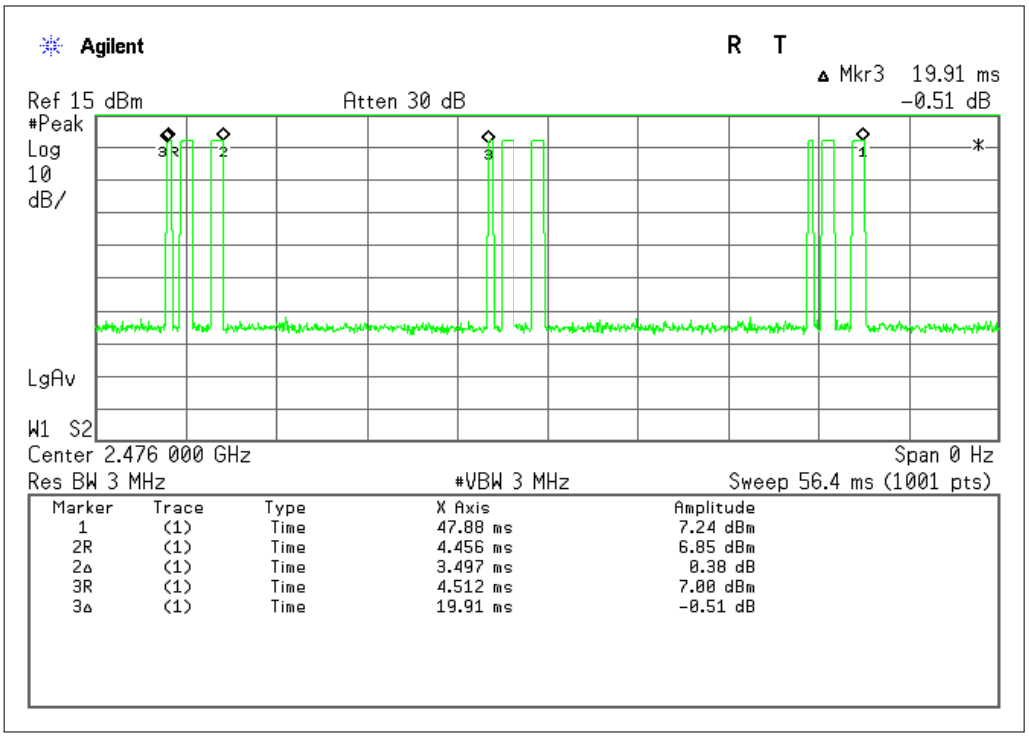
2. Middle Channel (2440 MHz)

Pulse Width:



3. Highest Channel (2476 MHz)

Pulse Width:



5.7. Pseudorandom Frequency Hopping Sequence

5.7.1. Standard requirement

15.247(a)(1) requirement:

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

Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies.

Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

5.7.2. EUT Pseudorandom Frequency Hopping Sequence

It generates a random number using a Gold code generator and Using a random number to select the frequency.

source code is as follows :

```
unsignedintModem_HoppingSeqGen(unsigned intseqn, unsigned intcnt)
{
        unsignedinti;
        unsignedintnum_of_ones;

        for(i = 0; i<cnt; i++)
        {
                num_of_ones = 0;

                if ( seqn& (1u << 31))
                        num_of_ones++;
                if ( seqn& (1 << 21))
                        num_of_ones++;
                if ( seqn& (1 << 1))
                        num_of_ones++;
                if ( seqn& (1 << 0))
                        num_of_ones++;

                if(num_of_ones& (1 << 0))
```

```
                    seqn = (seqn<< 1) | (1 << 0);
            else
                    seqn = (seqn<< 1) & (~(1 << 0));
    }
    returnseqn;
```

Actual operating results are as follows:

```
hopping channel : 14
hopping channel : 19
hopping channel : 16
hopping channel : 4
hopping channel : 18
hopping channel : 0
hopping channel : 11
hopping channel : 2
hopping channel : 10
hopping channel : 1
hopping channel : 6
hopping channel : 5
hopping channel : 7
hopping channel : 15
hopping channel : 19
hopping channel : 11
hopping channel : 20
hopping channel : 10
hopping channel : 2
hopping channel : 21
hopping channel : 20
hopping channel : 17
hopping channel : 6
hopping channel : 1
hopping channel : 12
hopping channel : 13
hopping channel : 11
hopping channel : 2
hopping channel : 9
hopping channel : 13
hopping channel : 9
hopping channel : 19
hopping channel : 6
hopping channel : 5
```

5.8. Equal hopping frequency usage

16 Hopping frequencies for channel are selected randomly with hopping seed generator of Master. As a result each of hopping channels is used equally on average.

5.9. Receiver Input Bandwidth

Master can have multiple slaves.

The master determines the hopping sequence.

Master determines the hopping sequence that clear channel can be found by scanning operation.

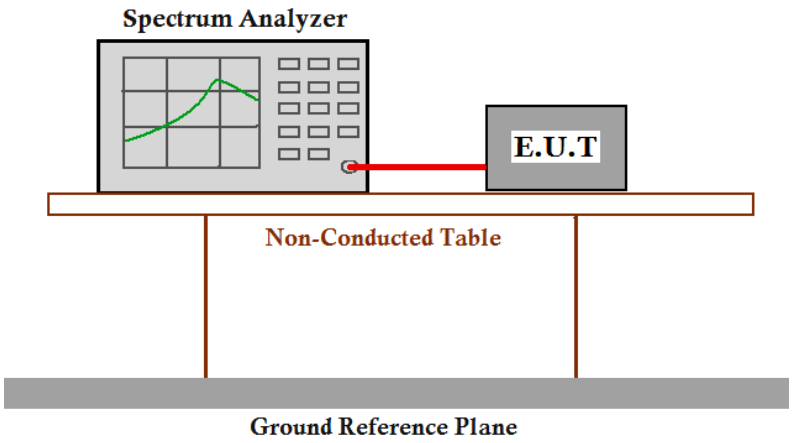
The slave follows this sequence.

Slave is receiving the sequence via ID setting

Both devices shift between RX and TX time slot according to the clock of the master

Slave scans the beacon and sets hopping frequency.

5.10. Maximum Peak Output Power

Test Requirement:	FCC Part 15 C section 15.247 (b)(1)For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts. Refer to the result "opping channel number"of this document. The 1 watt (30.0 dBm) limit applies.
Test Method:	ANSI C63.10: Clause 7.8.5
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), middle (2440 MHz) and highest (2476 MHz) channel
Test Configuration:	

Test Procedure:

1 . Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.

2 . Set the spectrum analyzer: RBW = 2 MHz. VBW = 2 MHz. Sweep = auto; Detector Function = Peak.

3 . Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

Test result :

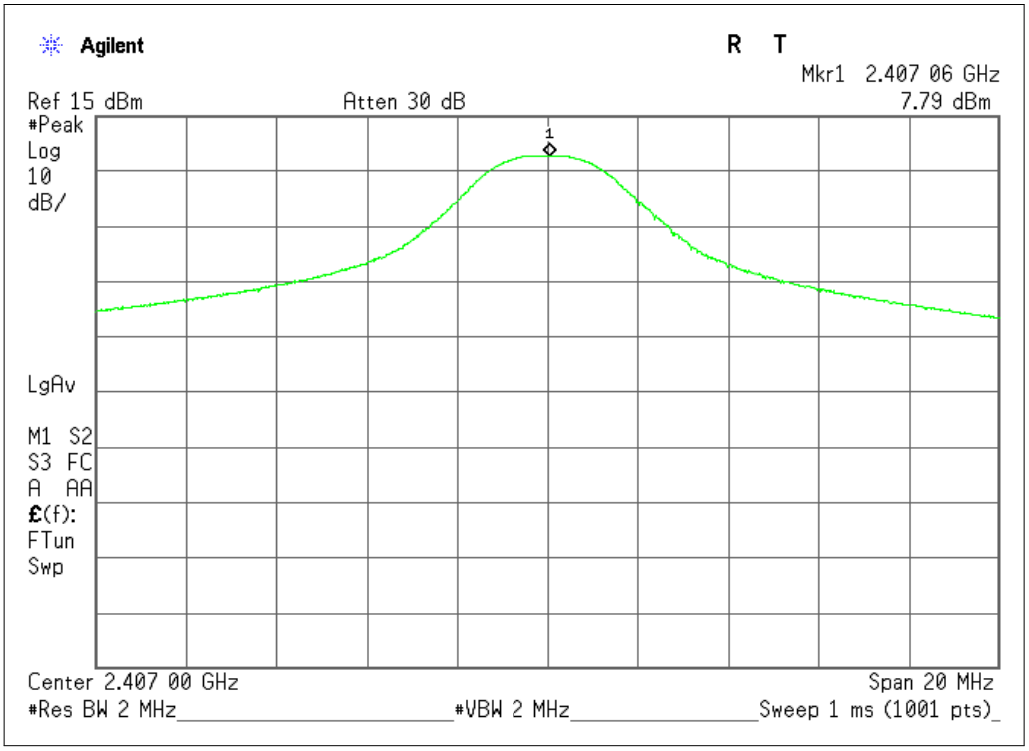
Normal mode:

Test Channel	Fundamental Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Result
Lowest	2407	7.79	30.0	Pass
Middle	2440	7.93	30.0	Pass
Highest	2476	7.23	30.0	Pass

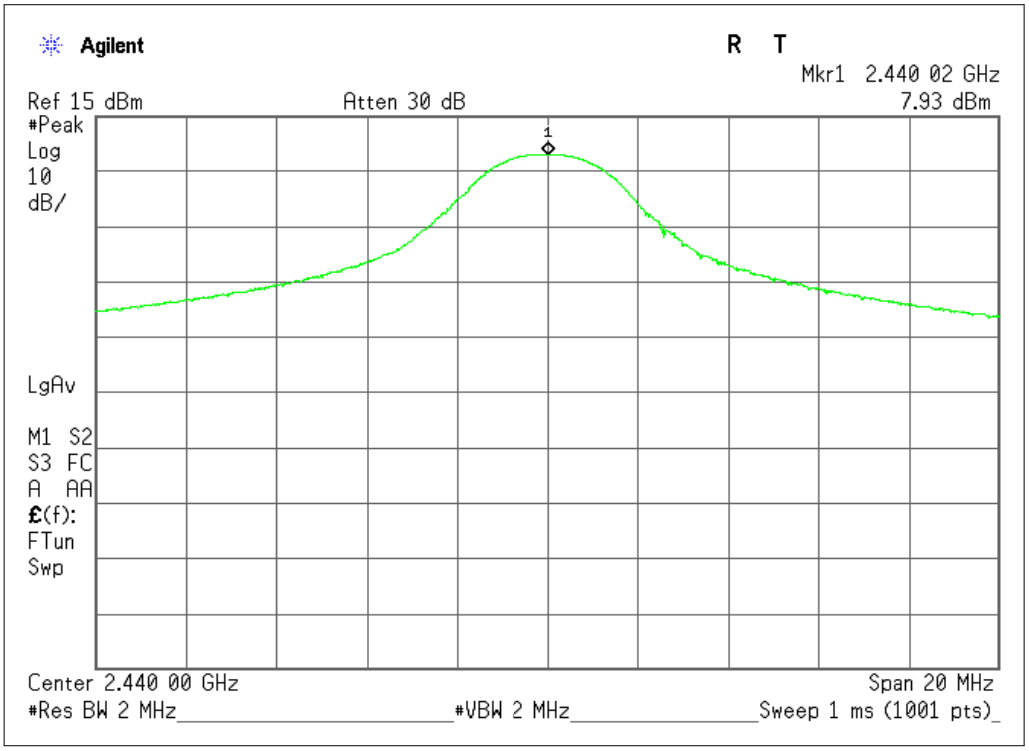
Result plot as follows :

Normal mode:

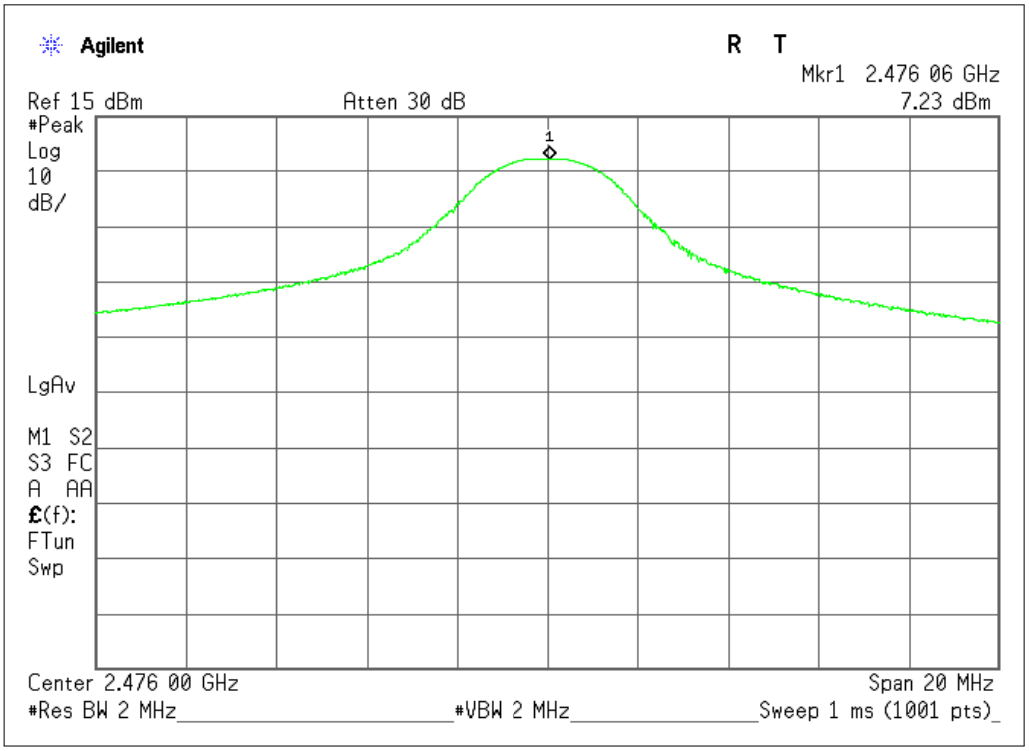
Lowest Channel(2.407 GHz):



Middle Channel(2.440 GHz):



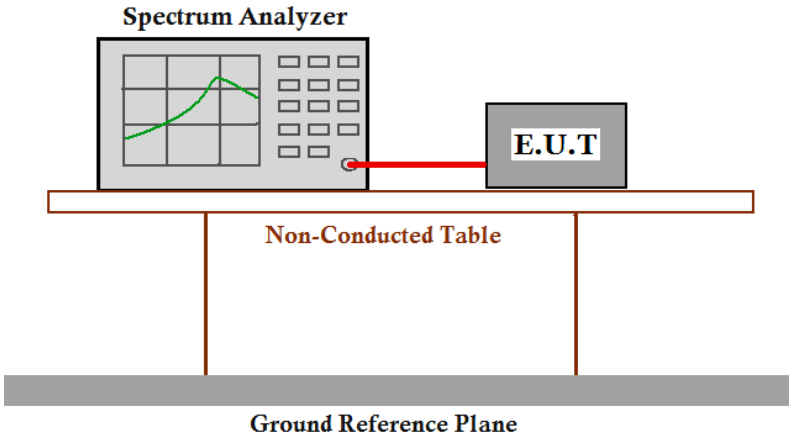
Highest Channel(2.476 GHz):



5.11. Conducted Spurious Emissions

Test Requirement:	FCC Part15 C section 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating. The radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Based on either an RF conducted or a radiated measurement. Provided the transmitter demonstrates compliance with the peak conducted power limits.
Test Method:	ANSI C63.10: Clause 7.8.8
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), middle (2440 MHz) and highest (2476 MHz) channel

Test Configuration:

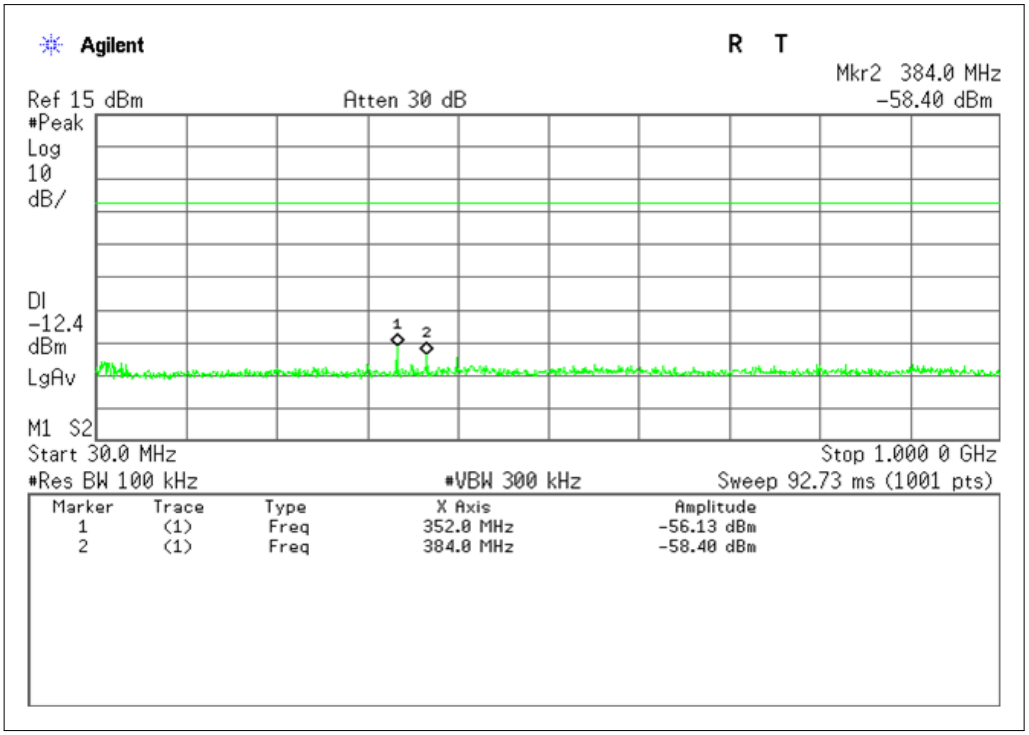


Test Procedure:

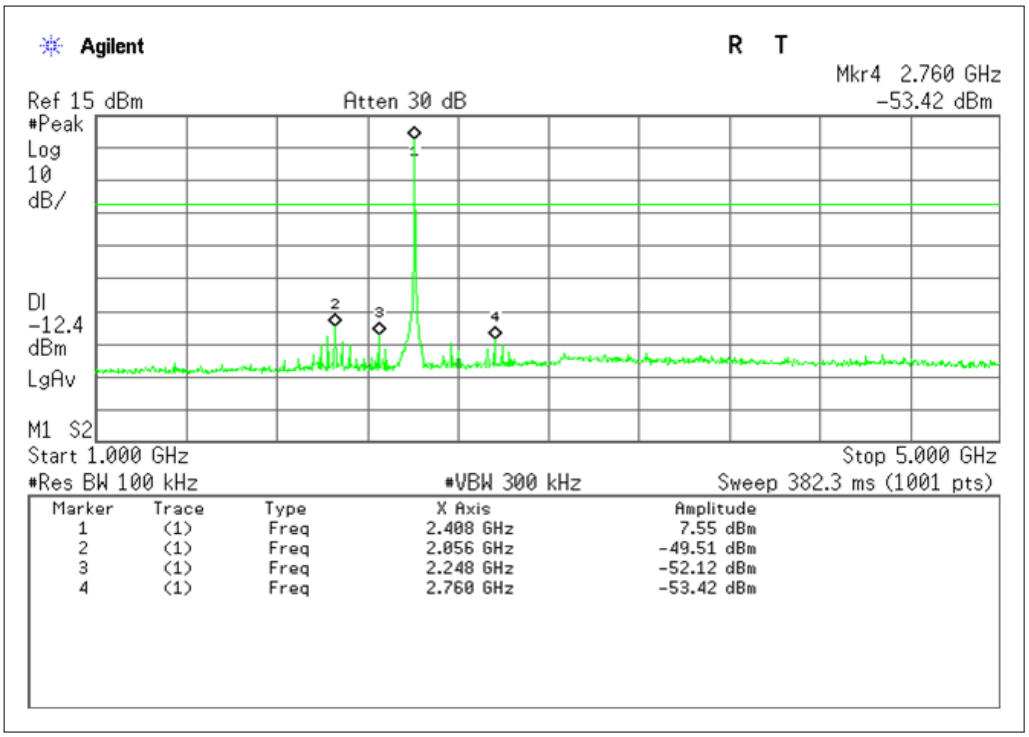
1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 100 kHz. VBW >= RBW. Sweep = auto; Detector Function = Peak (Max. hold).

Result plot as follows :

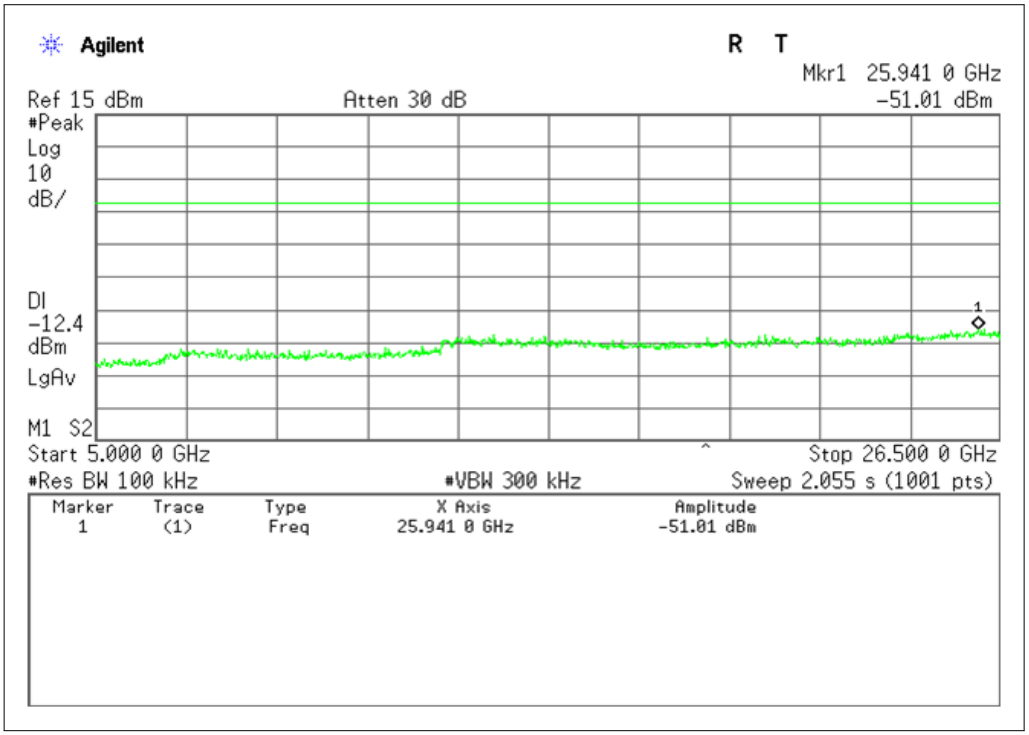
Lowest Channel: 30 MHz to 1 GHz



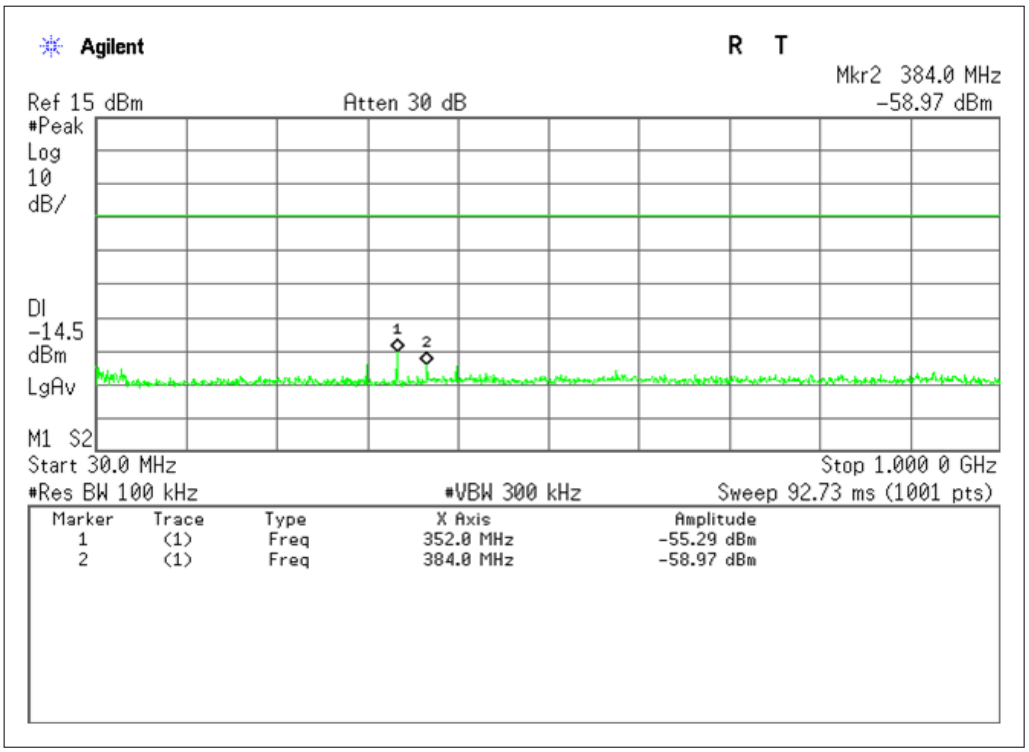
Lowest Channel: 1 GHz to 5 GHz



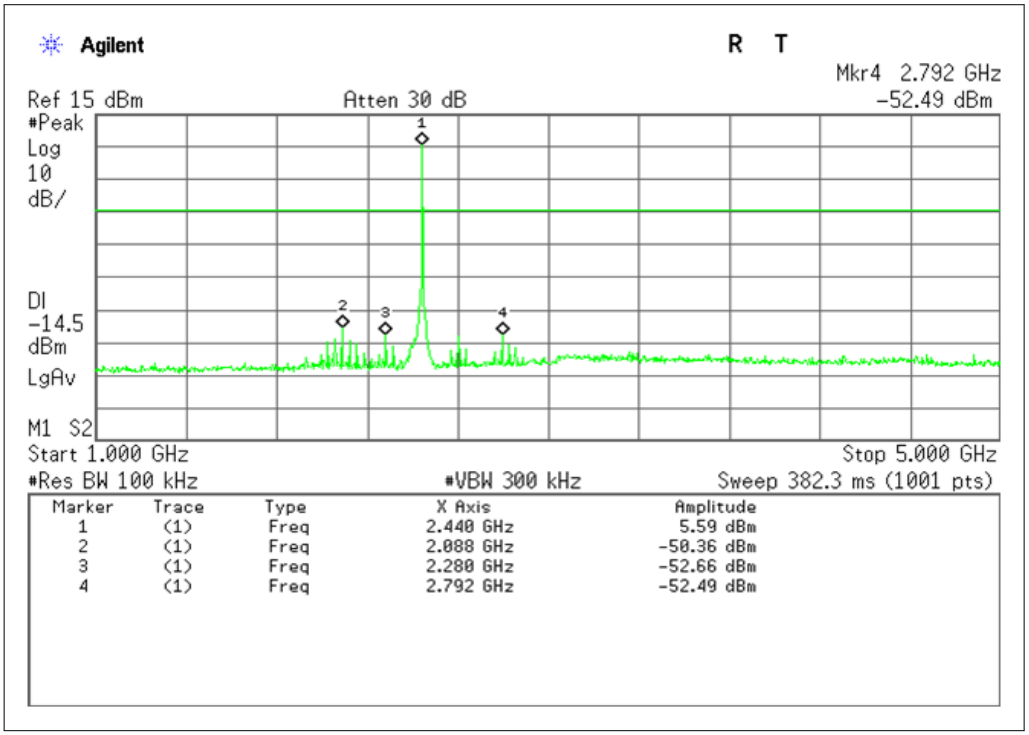
Lowest Channel: 5 GHz to 26.5 GHz



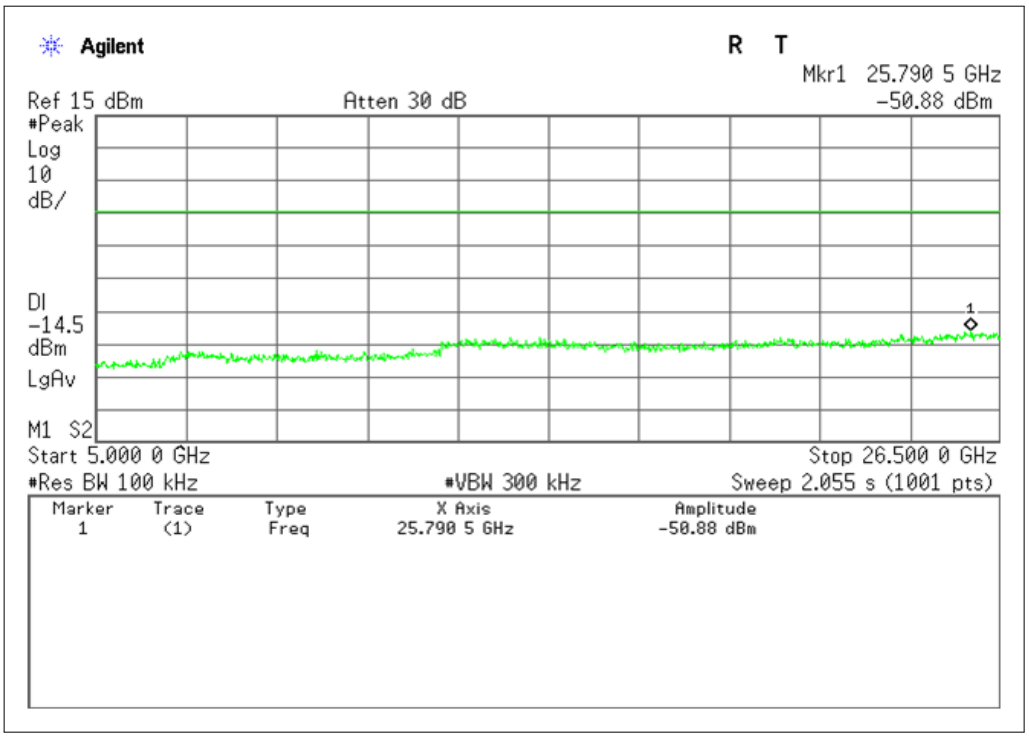
Middle Channel: 30 MHz to 1 GHz



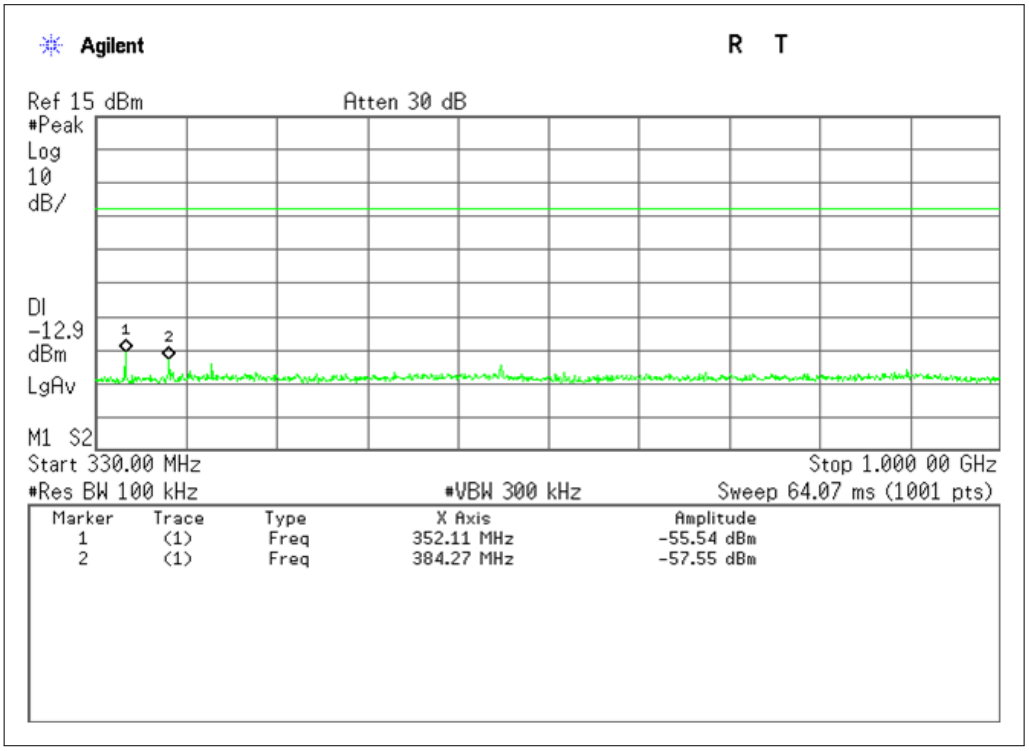
Middle Channel: 1 GHz to 5 GHz



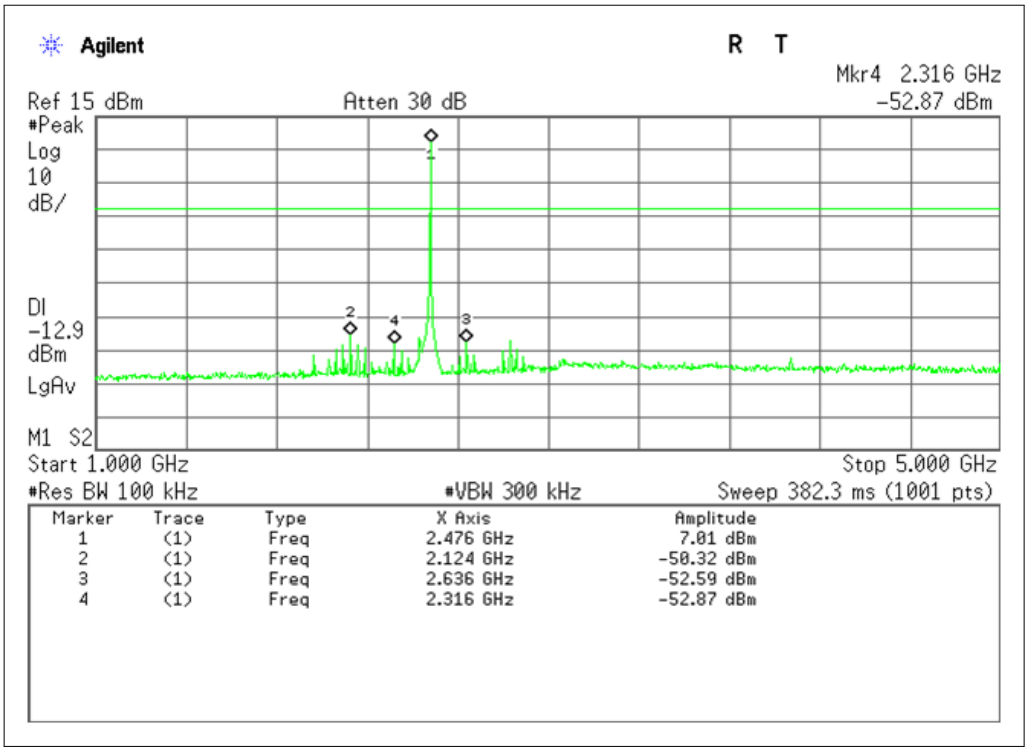
Middle Channel: 5 GHz to 26.5 GHz



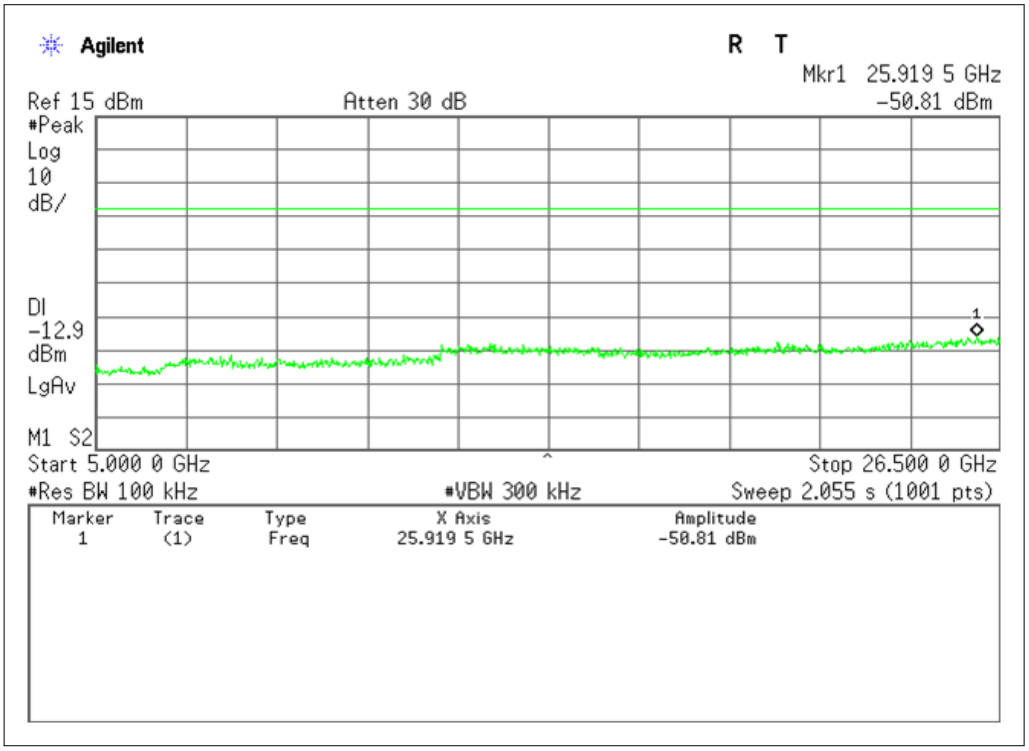
Highes Channel: 30 MHz to 1 GHz



Highes Channel: 1 GHz to 5 GHz



Highes Channel: 5 GHz to 25 GHz

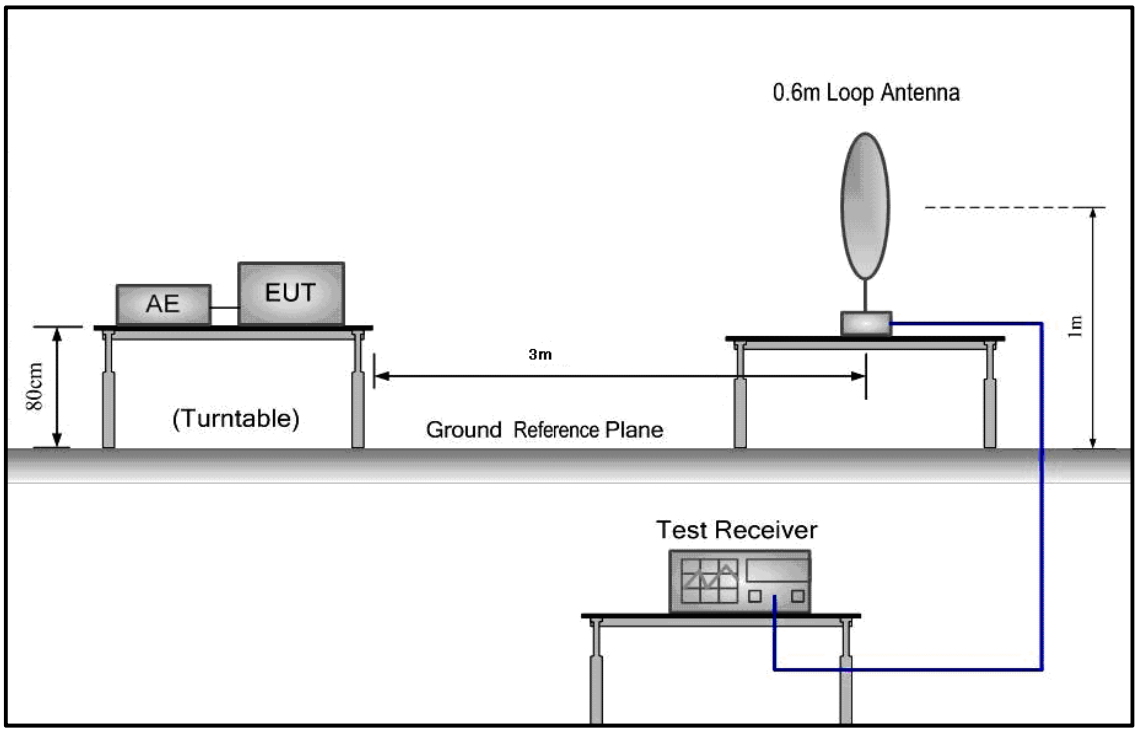


5.12. Radiated Spurious Emissions

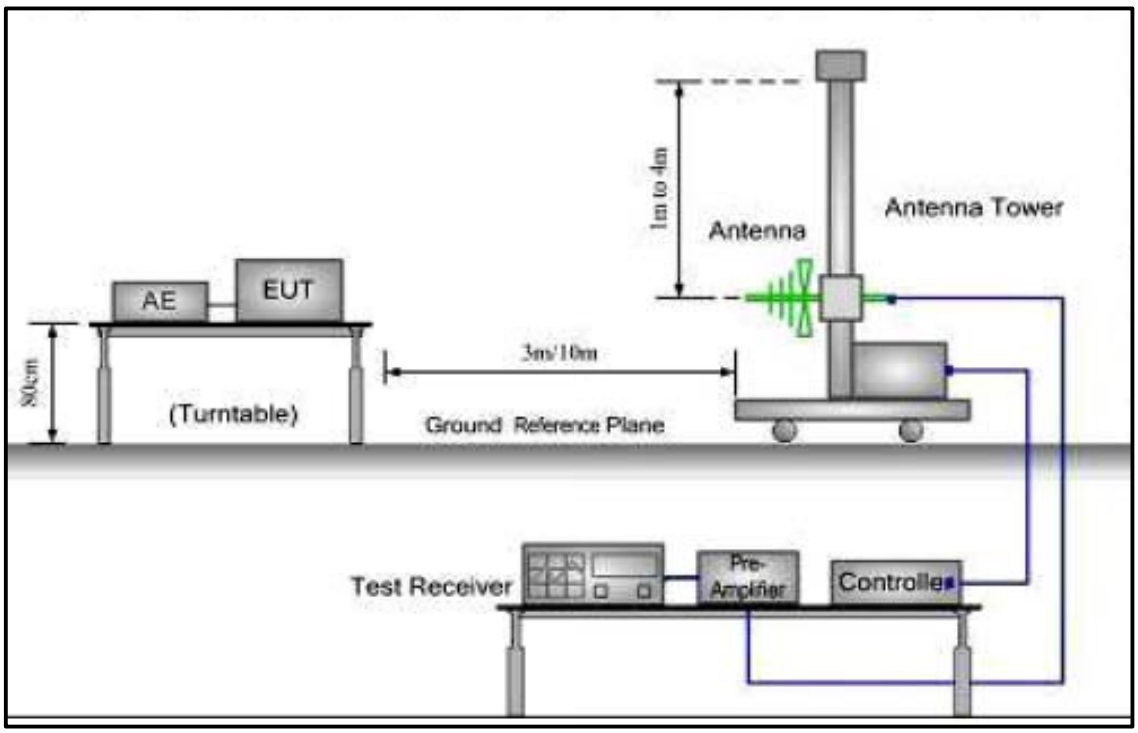
Test equirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10 2013				
Test Site:	Measurement Distance: 3m				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	100kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz	Average
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				

Test Configuration:

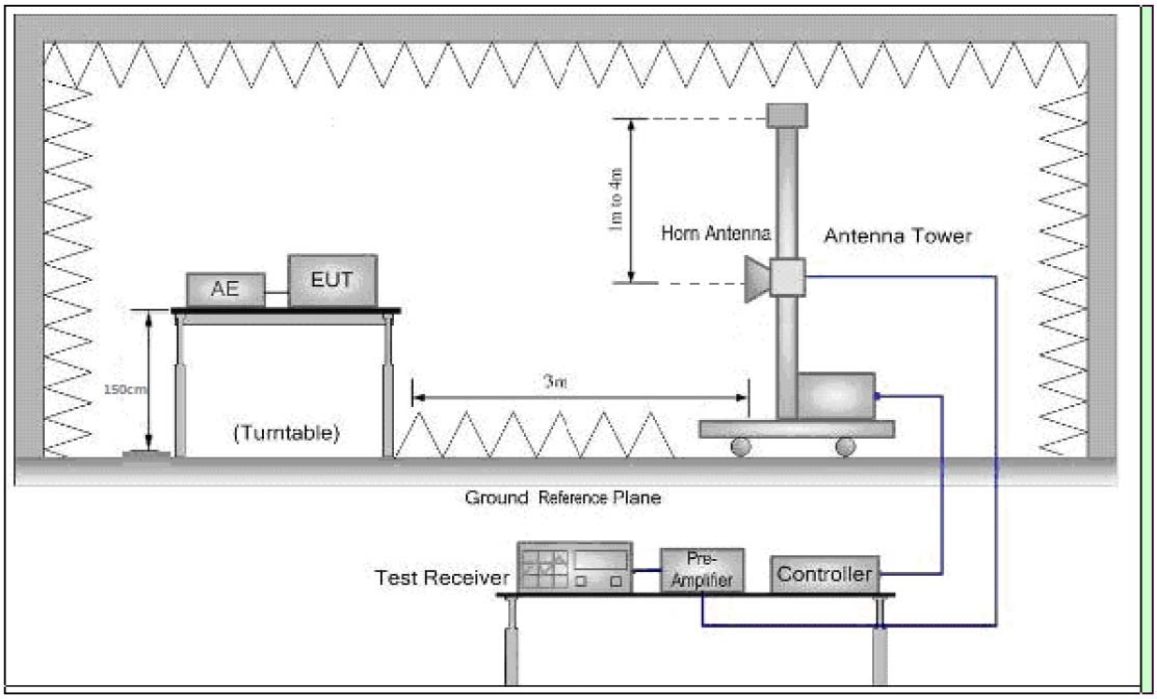
1) 9 kHz to 30 MHz emissions:



2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 25 GHz emissions:



Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter OATS. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement. d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

Test Procedure:	e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. h. Test the EUT in the lowest channel (2407MHz),the middle channel (2440MHz),the Highest channel (2476MHz) i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Test Mode:	Transmitting mode.
Test Results:	Pass

5.12.1. Harmonic and other spurious emissions

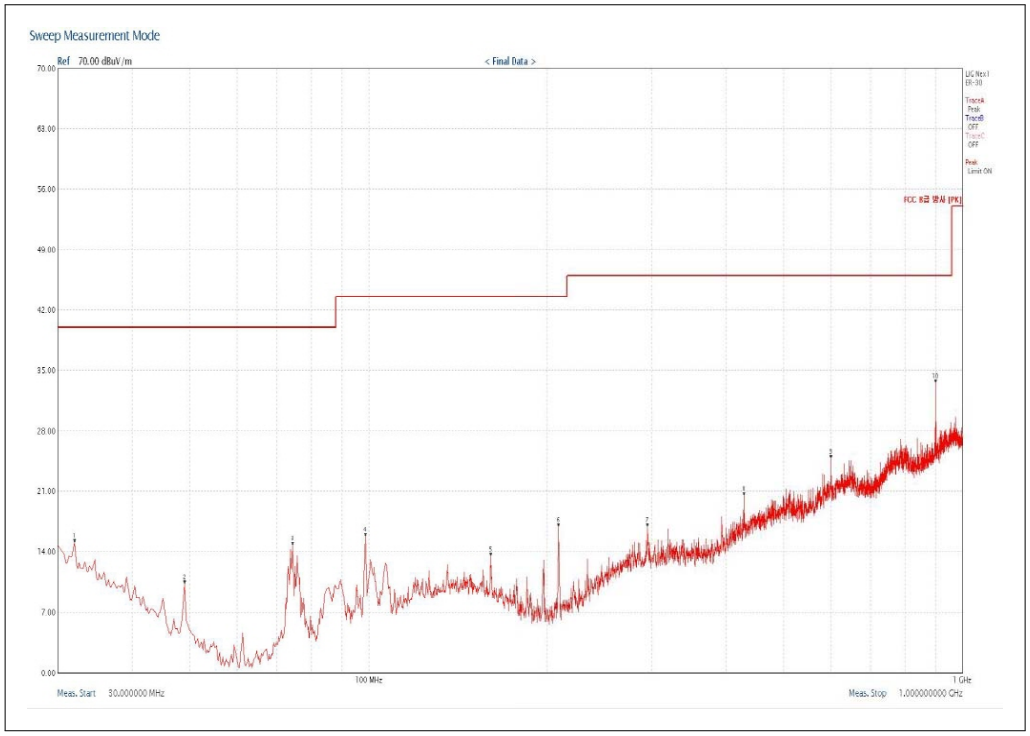
5.12.1.1. Test at low Channel in transmitting status

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

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

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

Vertical: Level (dBμV/m)

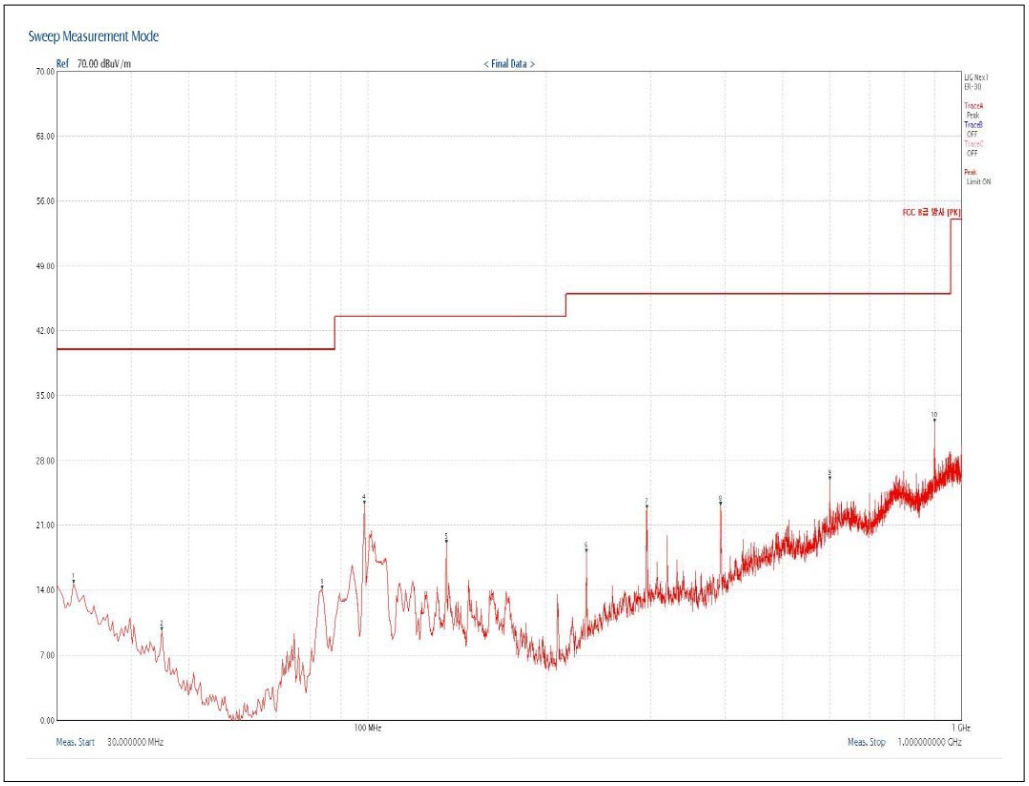


Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.28	QP	V	30.35	10.61	19.74	40.0
159.74	QP	V	25.05	11.49	13.56	43.5
208.88	QP	V	32.85	10.95	21.90	43.5
294.90	QP	V	28.32	15.33	12.99	46.0
428.01	QP	V	35.39	18.96	16.43	46.0
599.96	QP	V	36.80	22.92	13.88	46.0
899.96	QP	V	42.56	26.65	15.91	46.0

Horizontal:

Level (dBμV/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.28	QP	H	37.23	10.61	26.62	40.0
135.18	QP	H	28.41	12.41	16.00	43.5
233.68	QP	H	25.41	13.07	12.34	46.5
393.20	QP	H	38.73	18.02	20.71	46.5
600.20	QP	H	35.07	22.92	12.15	46.5
900.52	QP	H	37.44	26.66	10.78	46.5

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

Peak / Average Measurement:

Frequency (MHz)	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Amplifier Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

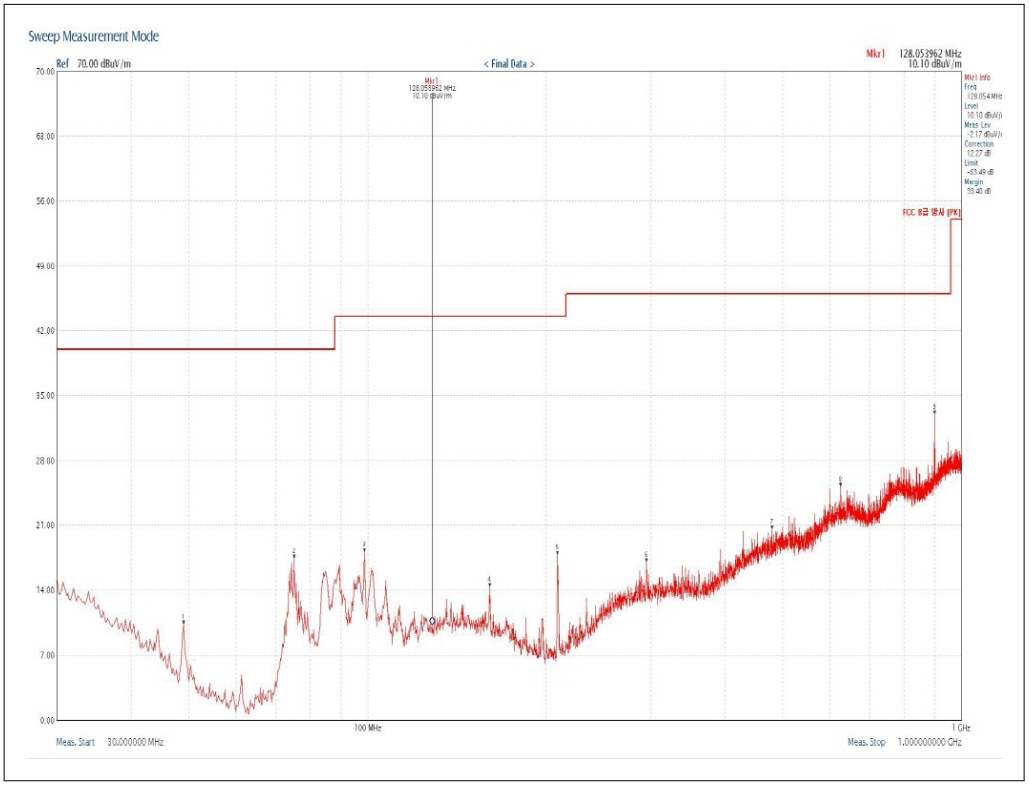
5.12.1.2. Test at middle Channel in transmitting status

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

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

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

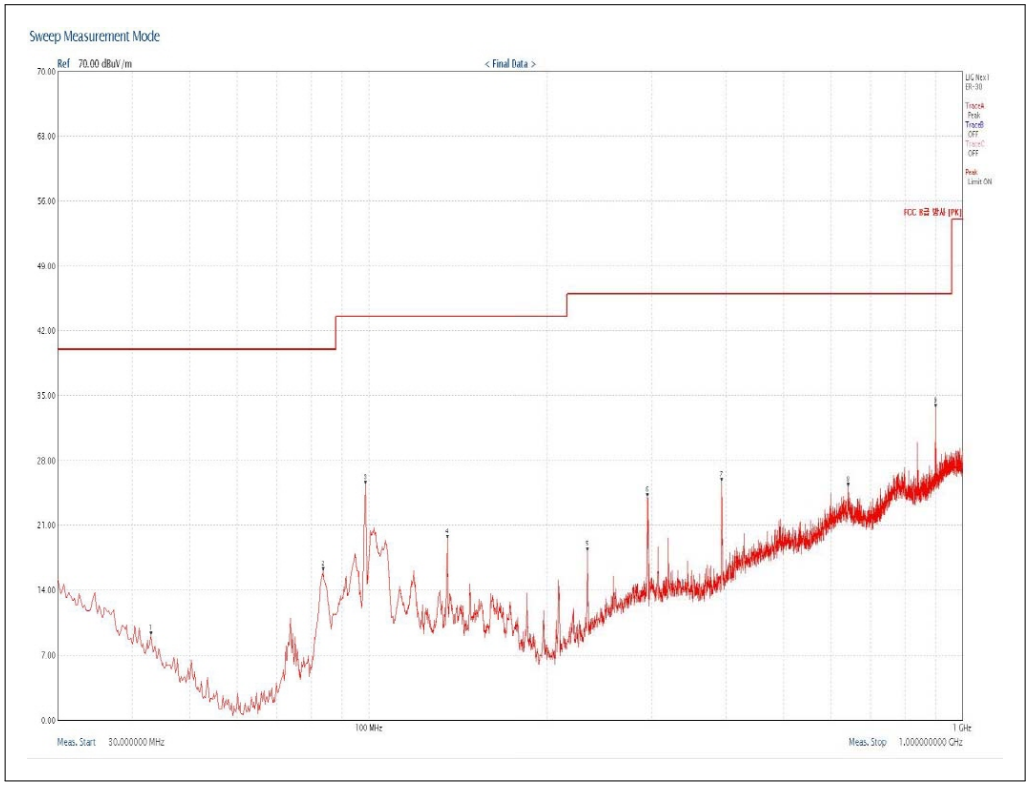
Vertical: Level (dBμV/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.29	QP	V	31.41	10.61	20.8	40.0
159.77	QP	V	25.78	11.49	14.29	43.5
208.89	QP	V	33.33	10.95	22.38	43.5
294.92	QP	V	28.94	15.33	13.61	46.0
900.02	QP	V	42.81	26.65	16.16	46.0

Horizontal: Level (dBμV/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.26	QP	H	36.22	10.61	25.61	40.0
135.15	QP	H	28.35	12.41	15.94	43.5
233.45	QP	H	31.44	13.05	18.39	46.0
294.90	QP	H	36.36	15.33	21.03	46.0
393.20	QP	H	36.04	18.02	18.02	46.0
900.02	QP	H	42.76	26.65	16.11	46.0

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

Peak / Average Measurement:

Frequency (MHz)	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Amplifier Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

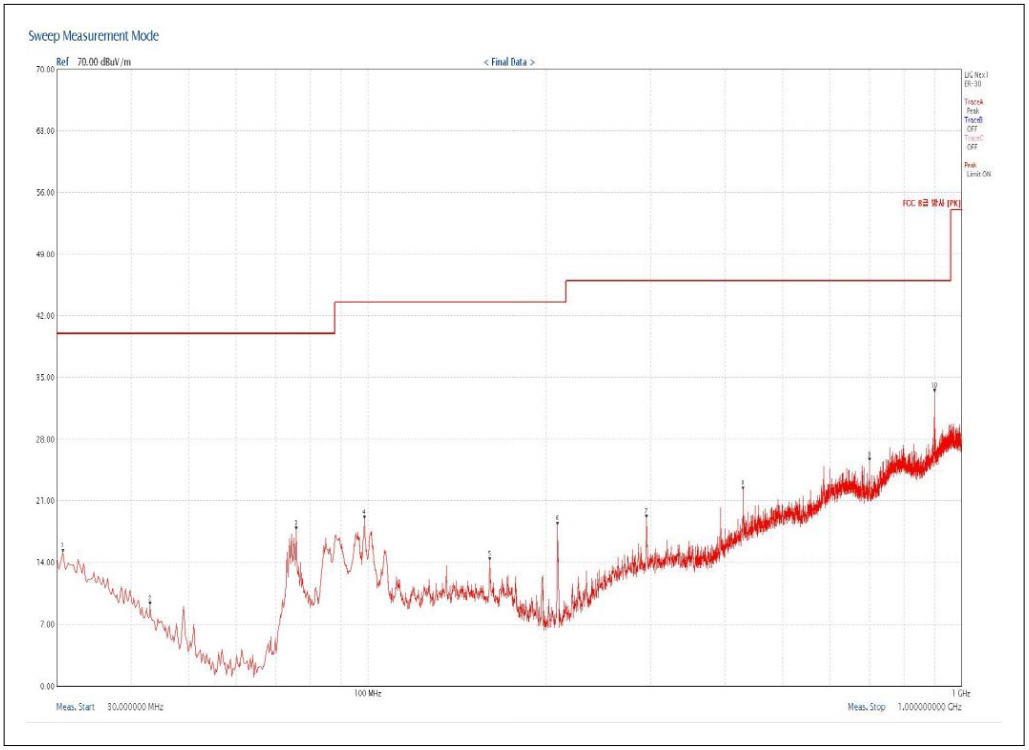
5.12.1.3. Test at high Channel in transmitting status

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

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

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

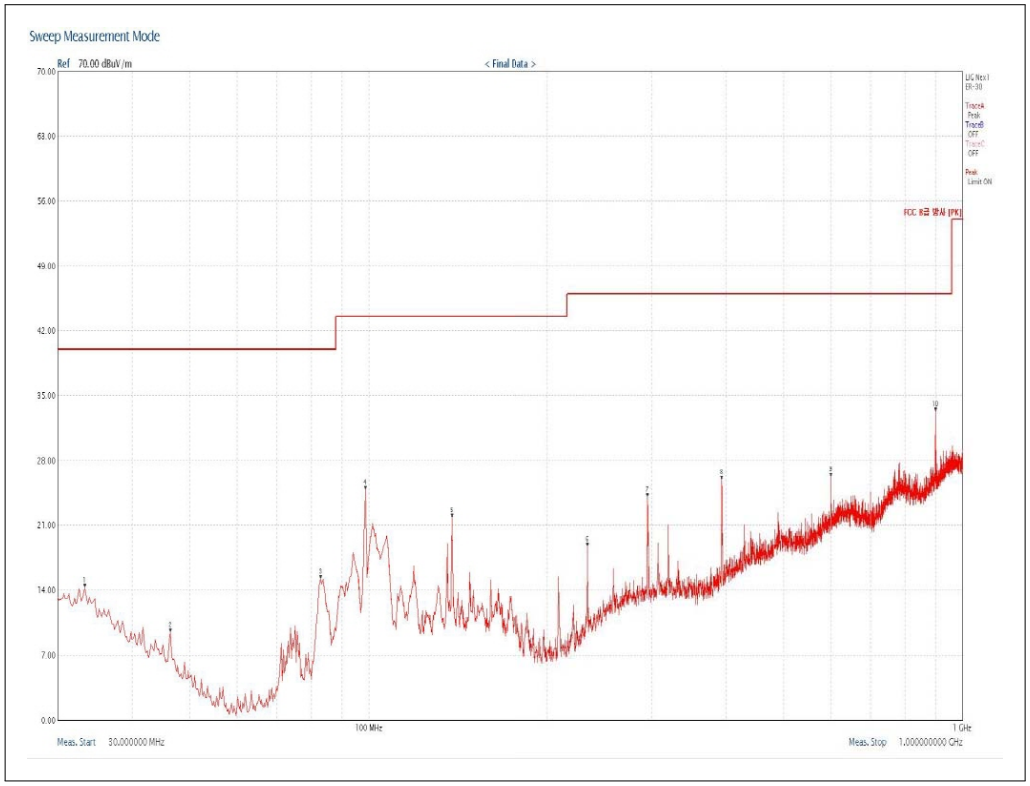
Vertical: Level (dBμV/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.29	QP	V	31.37	10.61	20.76	40.0
159.73	QP	V	27.74	11.49	16.25	43.5
208.88	QP	V	33.18	10.95	22.23	43.5
294.91	QP	V	29.86	15.33	14.53	46.0
427.99	QP	V	35.53	18.95	16.58	46.0
699.99	QP	V	39.17	24.10	15.07	46.0
900.02	QP	V	42.78	26.65	16.13	46.0

Horizontal: Level (dBμV/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
98.68	QP	H	23.46	10.64	12.82	40.0
137.88	QP	H	22.91	12.47	10.44	43.5
233.68	QP	H	25.16	13.07	12.09	46.0
393.22	QP	H	37.23	18.02	19.21	46.0
900.52	QP	H	37.45	26.66	10.79	46.0

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

Peak / Average Measurement:

Frequency (MHz)	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Amplifier Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

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 = Measured Value + Antenna Factor + Cable Loss –Amplifier Gain.

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.

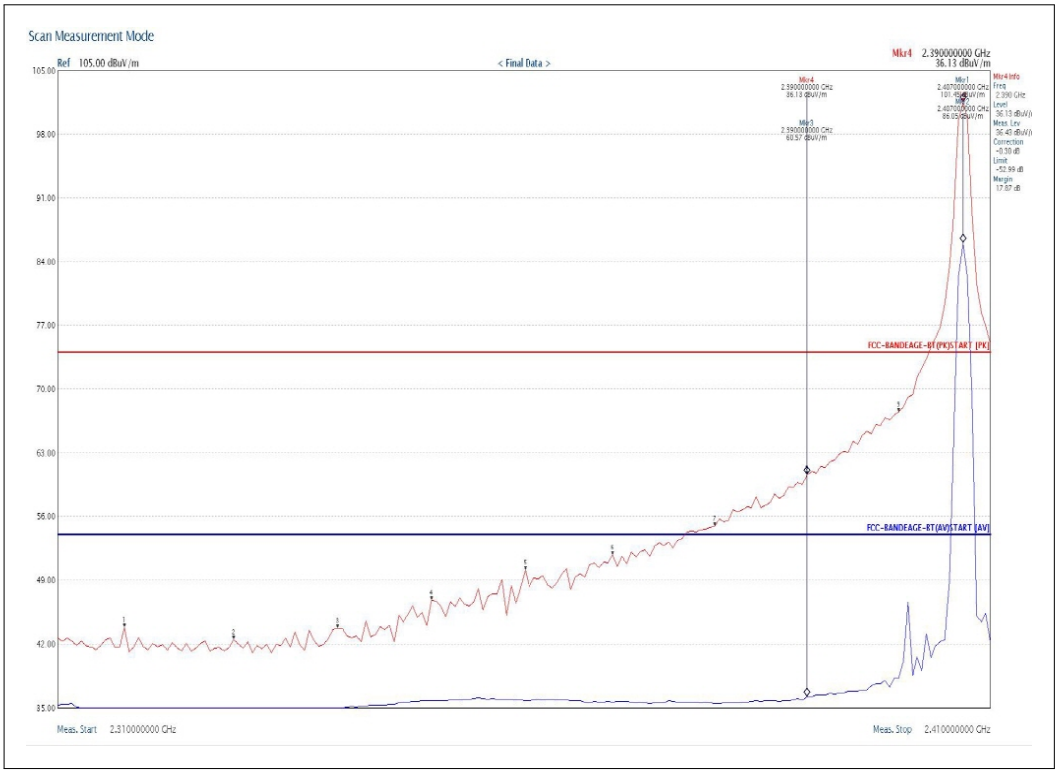
3). The test only perform the EUT in transmitting status since the test frequencies were over 1GHz only required transmitting status.

5.12.2. Radiated Emissions which fall in the restricted bands

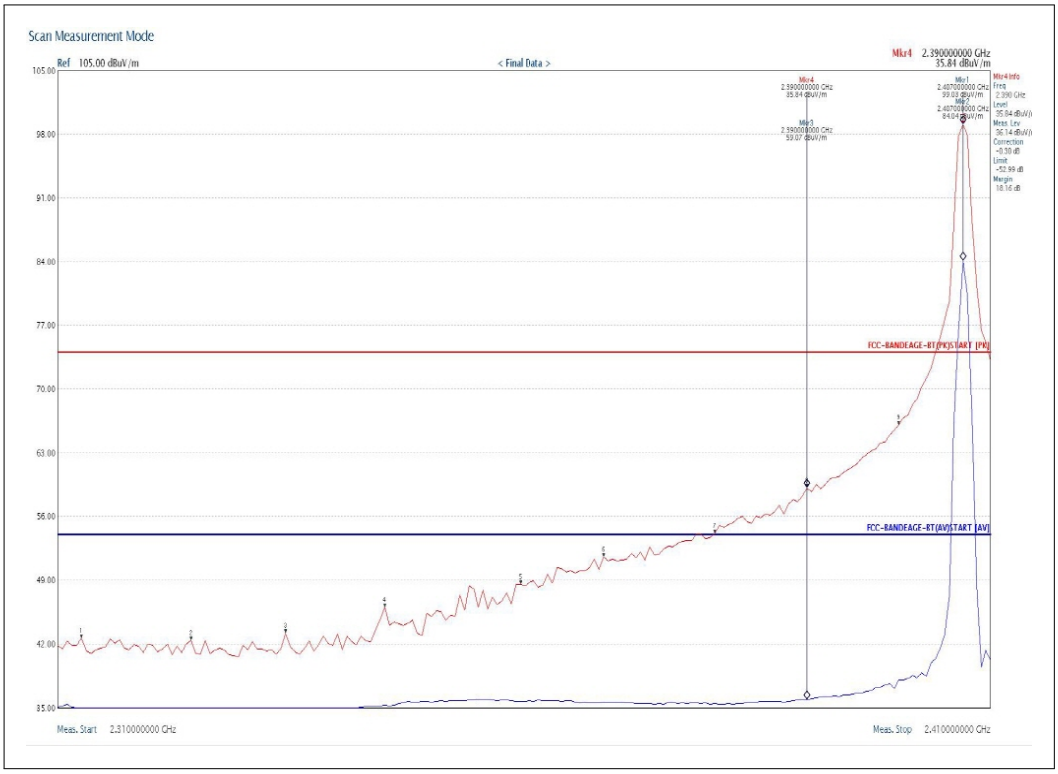
Test Requirement:	FCC Part15 C Section 15.247 (d) In addition, radiated emissions which fall in the restricted bands. as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), and highest (2476 MHz) channel
Measurement	3m (Semi-Anechoic Chamber)
Limit:	Section 15.209(a) 40.0 dBμV/m between 30MHz & 88MHz; 43.5 dBμV/m between 88MHz & 216MHz; 46.0 dBμV/m between 216MHz & 960MHz; 54.0 dBμV/m above 960MHz.
Detector:	For PK value: RBW = 1 MHz for f ³ 1 GHz, 100 kHz for f < 1 GHz VBW ³ RBW Sweep = auto Detector function = peak Trace = max hold For AV value: RBW = 1 MHz for f ³ 1 GHz, 100 kHz for f < 1 GHz VBW =10 Hz Sweep = auto Detector function = peak Trace = max hold

Measurement Result :

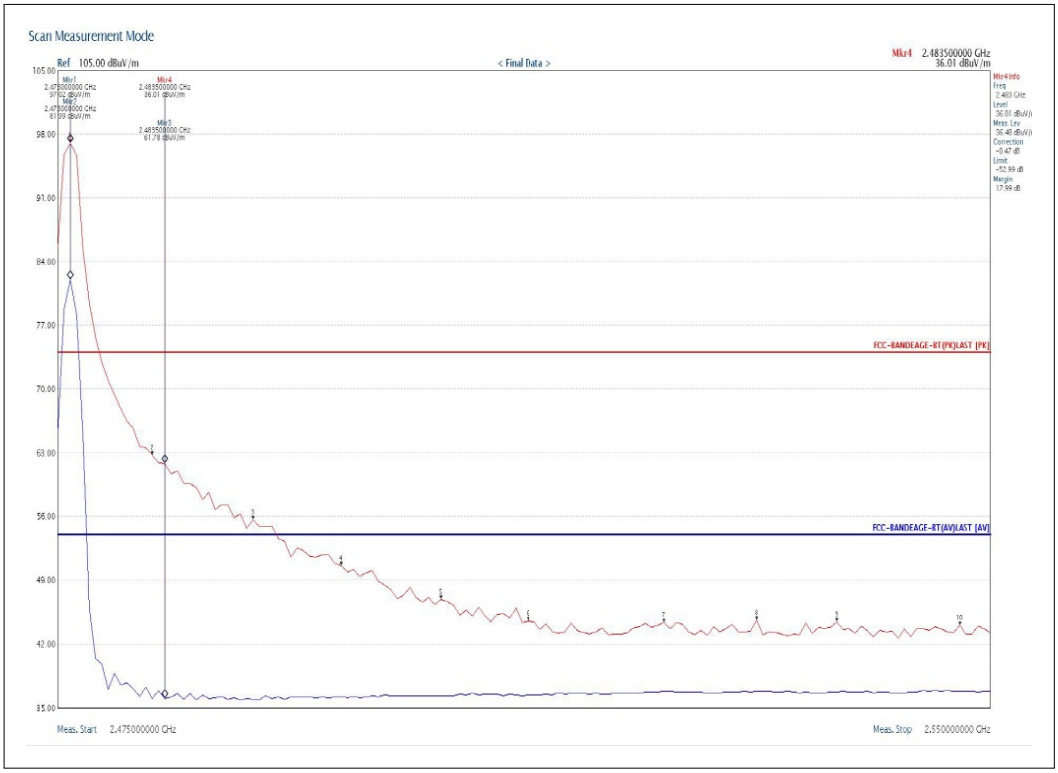
Low Channel (2407 MHz) , Horizontal , Peak/ Average Detector



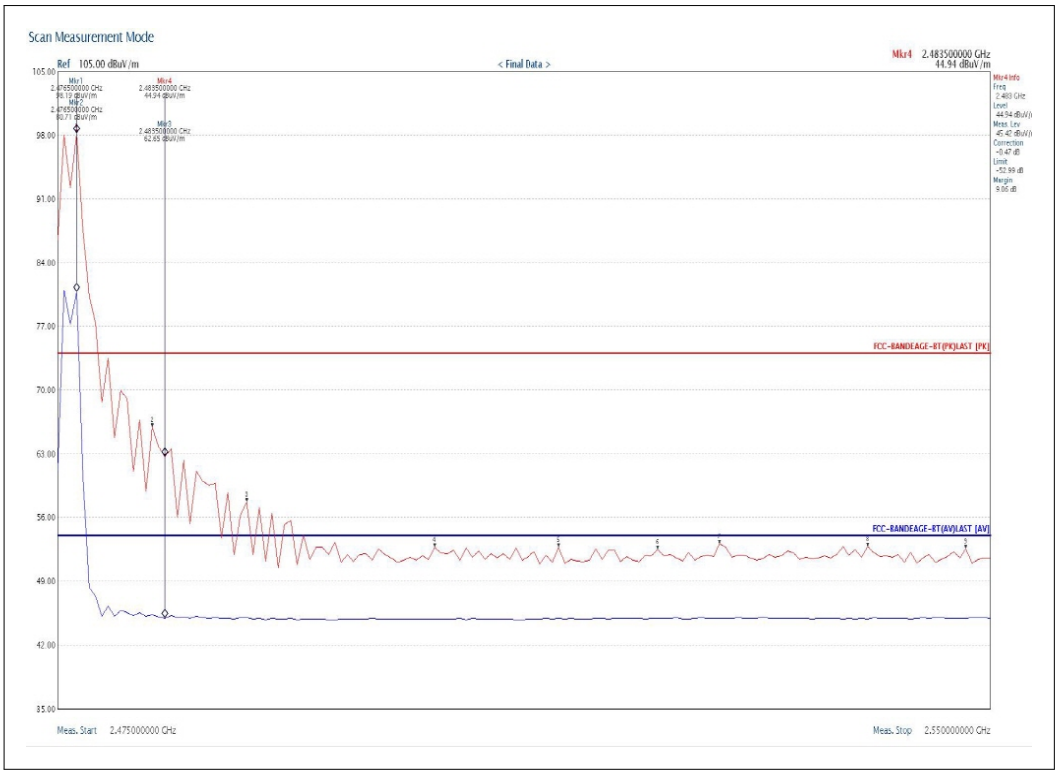
High Channel (2476MHz) , Horizontal , Peak/ Average Detector



Low Channel (2407 MHz) , Vertical , Peak/ Average Detector



High Channel (2476MHz) , Vertical , Peak/ Average Detector

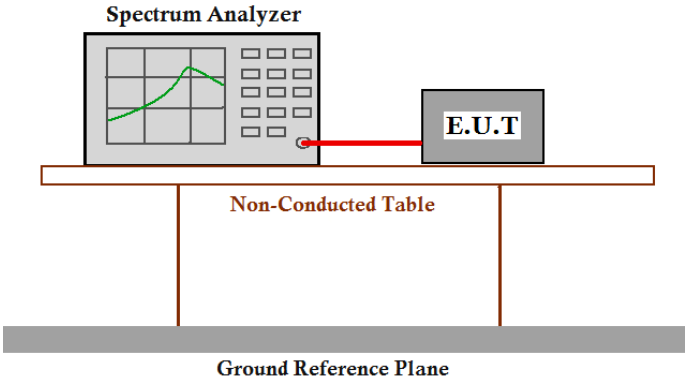


Section 15.205 Restricted bands of operation.

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

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

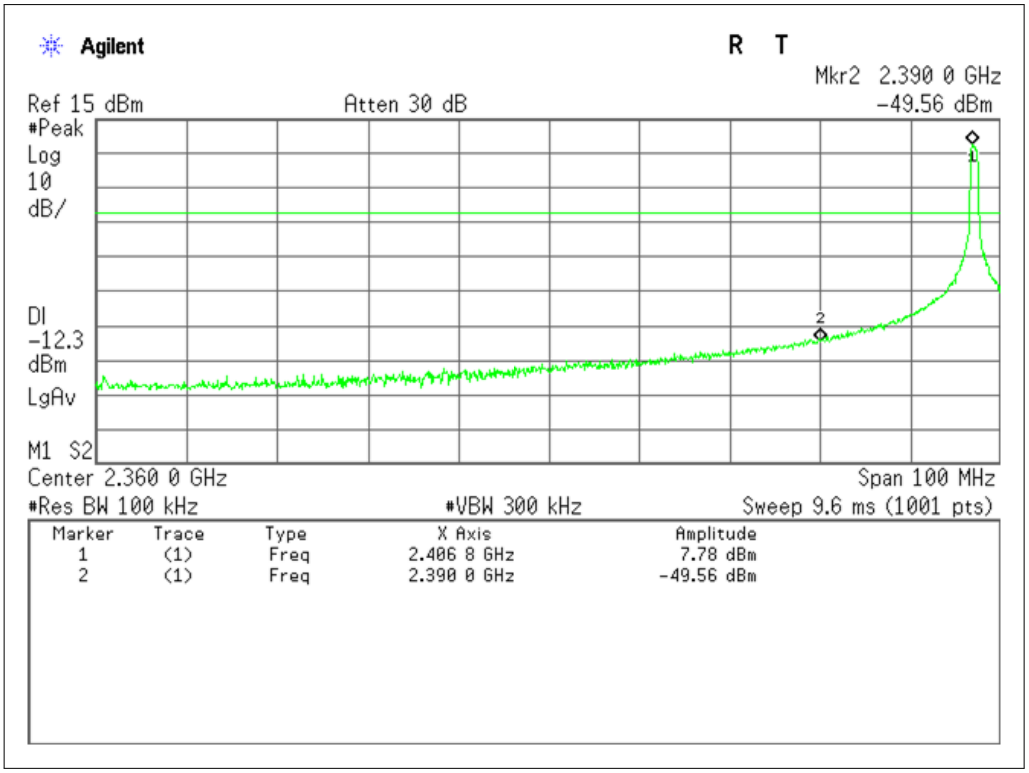
5.13. Band Edges Requirement

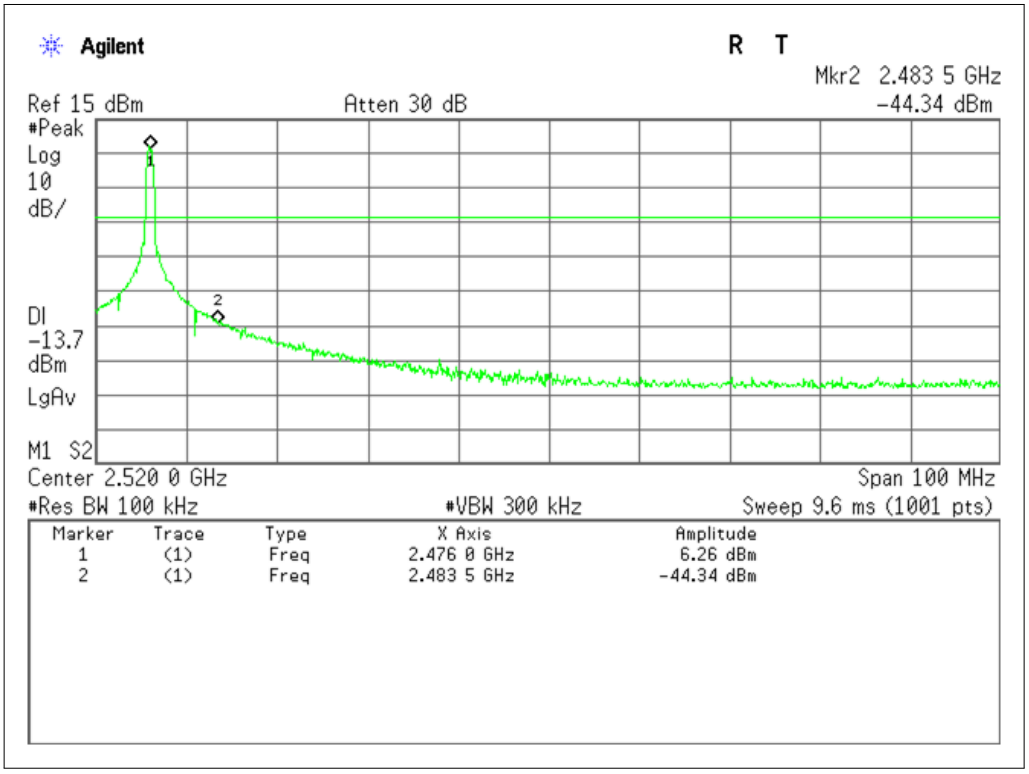
Test Requirement:	FCC Part15 C section 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Frequency Band:	2400 MHz to 2483.5 MHz
Test Method:	ANSI C63.10: Clause 6.9.2
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2407 MHz), and highest (2476 MHz) channel and hopping mode
Test Configuration:	
Test Procedure:	Set RBW of spectrum analyzer to 100 kHz and VBW of spectrum analyzer to 100 kHz with suitable frequency span including 100 kHz bandwidth from band edge.

The band edges was measured and recorded Result:
The Lower Edges attenuated more than 20dB.
The Upper Edges attenuated more than 20dB.
The graph as below. Represents the emissions take for this device.

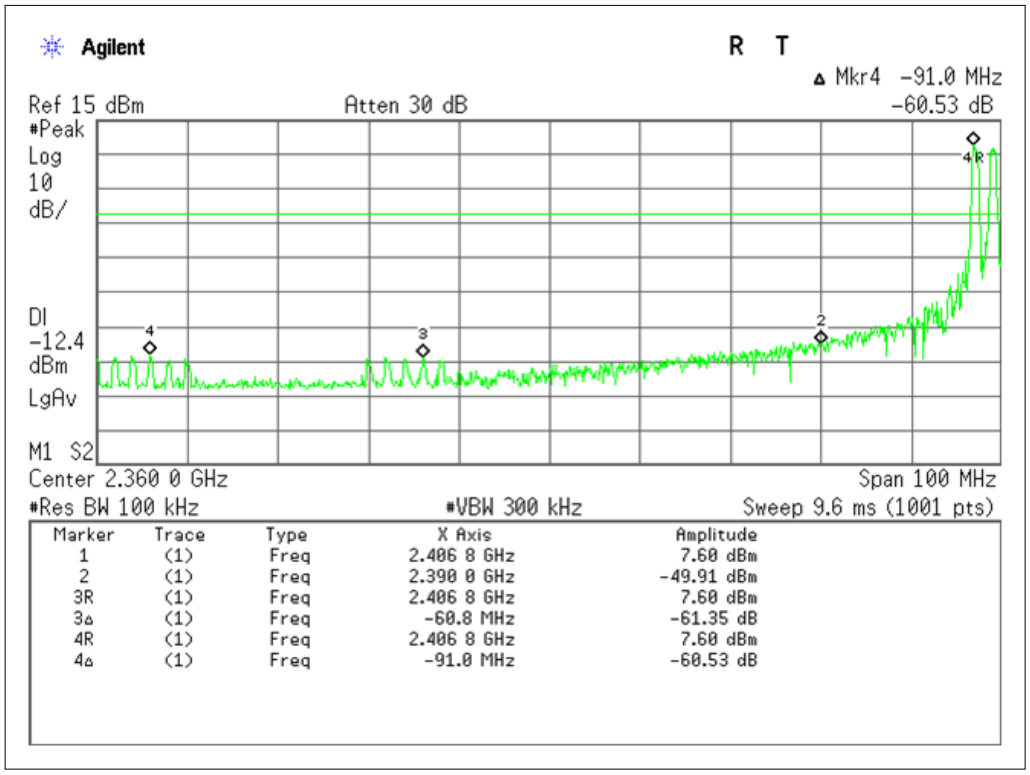
Result plot as follows :

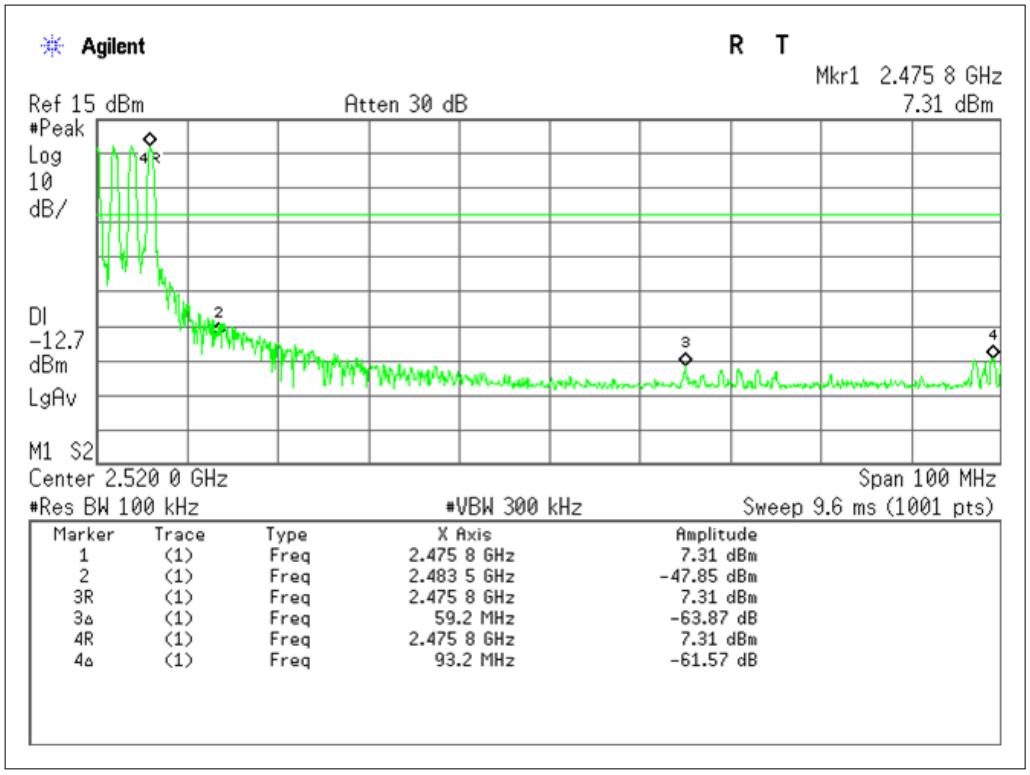
Lowest Channel(2.407 GHz):





Highest Channel(2.476 GHz):





5.14. Conducted Emissions at Mains Terminals 150 kHz to 30 MHz

Test Requirement:	FCC Part 15 C section 15.207
Test Method:	ANSI C63.10:2013
Frequency Range:	150 kHz to 30 MHz
Detector:	Peak for pre-scan (9 kHz Resolution Bandwidth)

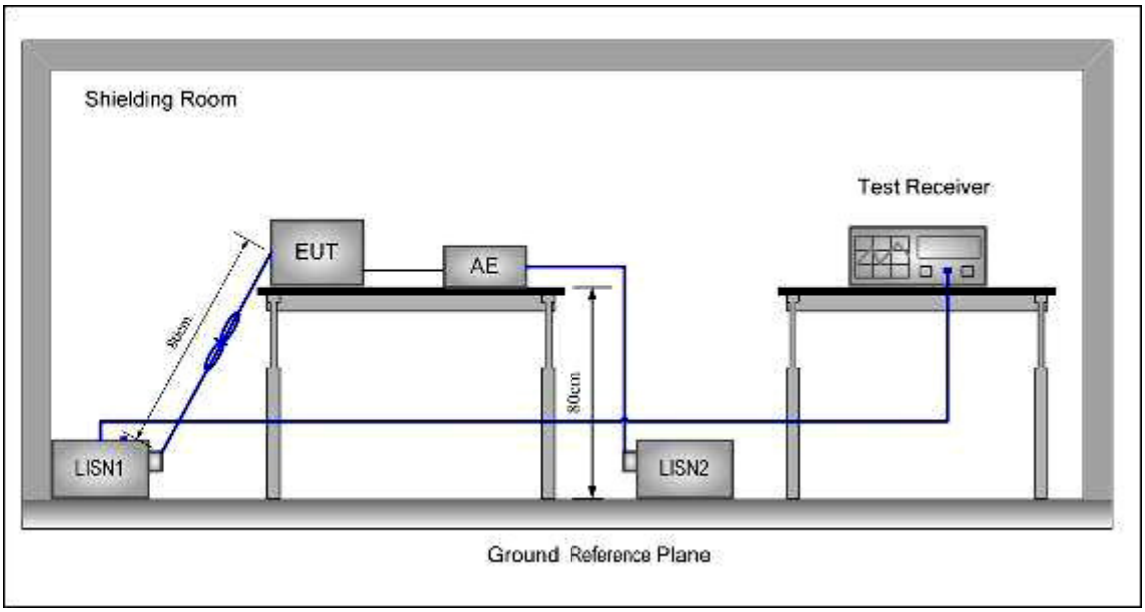
Test Limit

Limits for conducted disturbance at the mains ports of class B

Frequency Range (MHz)	Class B Limit dB(μV)	
	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
NOTE 1 The limit decreases linearly with the logarithm of the frequency in the range 0,15 MHz to 0,50 MHz.		

EUT Operation:	Test in normal operating mode. 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. Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Test Configuration:



Test procedure:

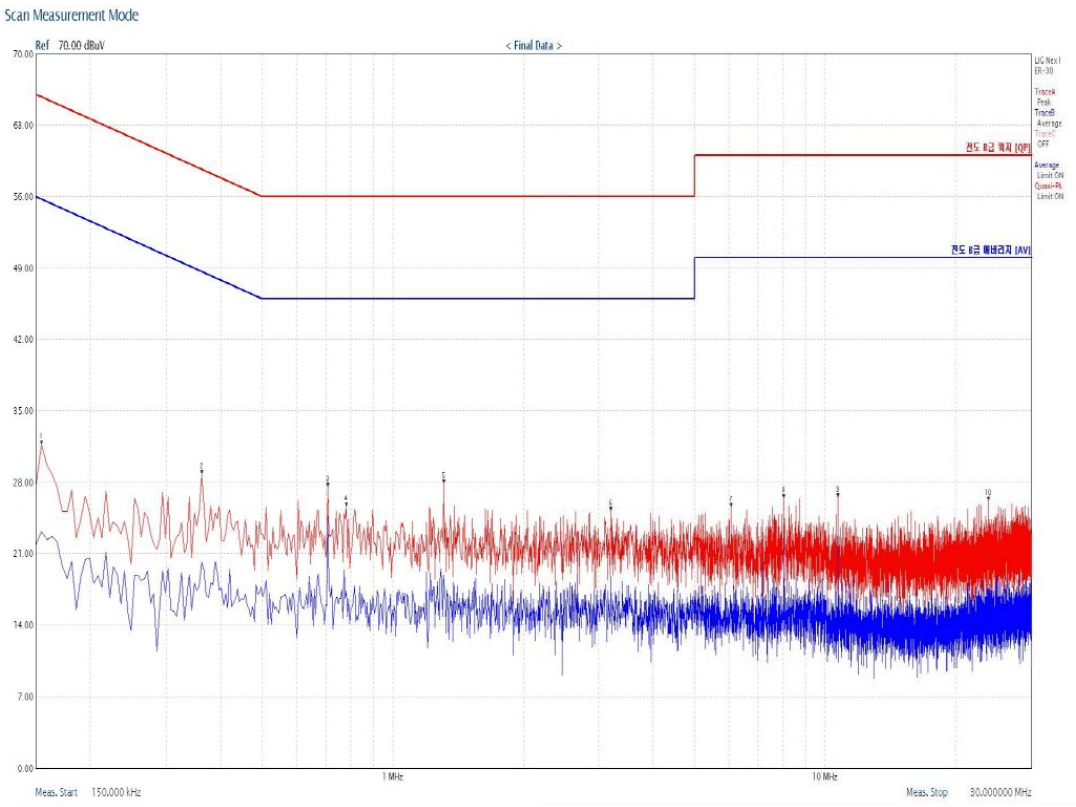
1. The mains terminal disturbance voltage test was conducted in a shielded room.
2. The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50/50μH + 5linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, but separated from metallic contact with the ground reference plane by 0.1m of insulation.
4. The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0,4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0,8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane.

This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0,8 m from the LISN 2.

5.14.1. Measurement Data

Pre-scan was performed with peak detected on all ports, Quasi-peak & average measurements were performed at the frequencies at which maximum peak emission level were detected. Please see the attached Quasi-peak and Average test results.

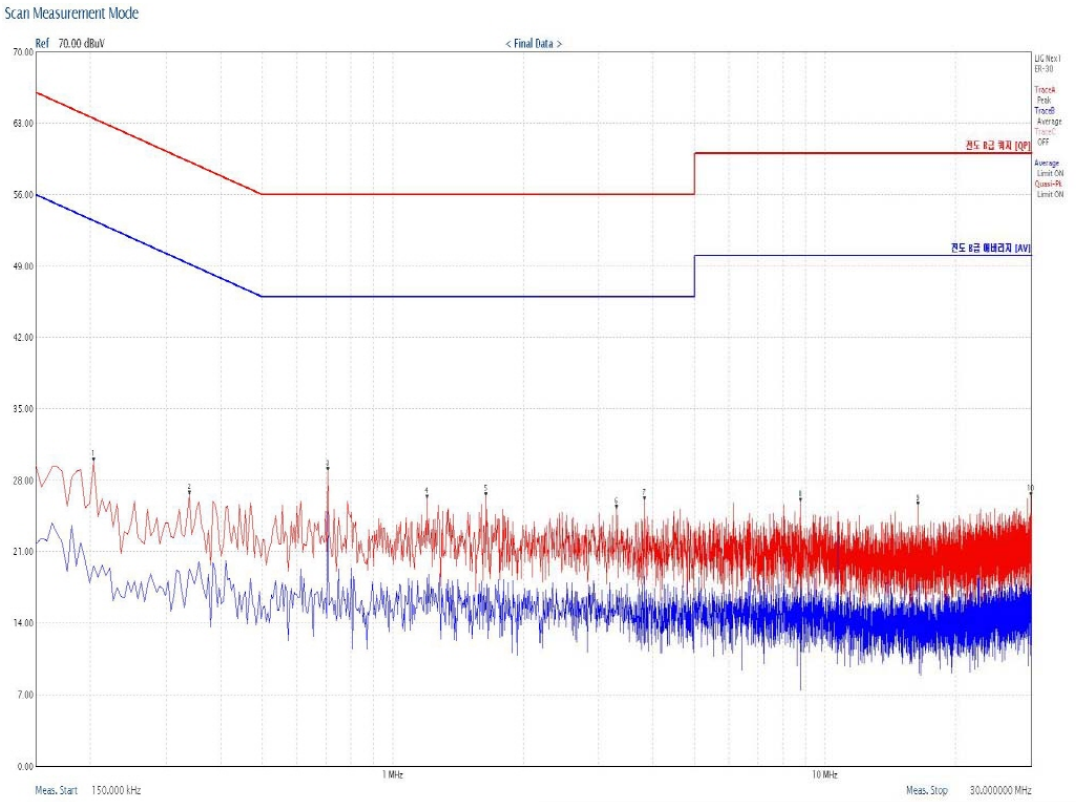
Line - PE(QusiPeak and Average detector used)



REDUCTION TABLE

No	Freq (MHz)	Level (dBuV)	Corr (dB)	Limit (dBuV)	Margin (dB)	State	Reference
1	0.154	28.29	10.21	65.78	37.49	Pass	QP
2	0.708	22.43	9.99	56.00	33.57	Pass	QP
3	1.175	22.23	10.04	56.00	33.77	Pass	QP
4	8.025	26.33	10.39	60.00	33.67	Pass	QP
5	10.698	26.11	10.47	60.00	33.89	Pass	QP
6	0.154	22.17	10.21	55.78	33.61	Pass	AV
7	0.708	16.39	9.99	46.00	29.61	Pass	AV
8	1.175	16.17	10.04	46.00	29.83	Pass	AV
9	8.025	22.14	10.39	50.00	27.86	Pass	AV
10	10.698	23.24	10.47	50.00	26.76	Pass	AV

Neutral – PE(QusiPeak and Average detector used)



REDUCTION TABLE

No	Freq (MHz)	Level (dBuV)	Corr (dB)	Limit (dBuV)	Margin (dB)	State	Reference
1	0.204	25.55	9.94	63.45	37.90	Pass	QP
2	0.708	22.45	9.99	56.00	33.55	Pass	QP
3	8.772	20.85	10.41	60.00	39.15	Pass	QP
4	10.698	26.13	10.47	60.00	33.87	Pass	QP
5	0.204	19.47	9.94	53.45	33.98	Pass	AV
6	0.708	16.36	9.99	46.00	29.64	Pass	AV
7	8.772	14.73	10.41	50.00	35.27	Pass	AV
8	10.698	23.24	10.47	50.00	26.76	Pass	AV

Measurement data:

* Detector function was set into Quasi-peak & Average mode.

* Corr = LISN Factor + Cable loss + Pulse Limiter

5.15. Radio Frequency Exposure Procedures

Regulation

According to §15.247(i) and § 1.1307(b)(1) , systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

KDB 447498 D01: Approximate SAR test exclusion power thresholds at selected frequencies and test separation distances are illustrated in the following table:

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Maximum Measured Transmitter Power :

Channel Frequency (MHz)	Maximum Peak Conducted Output Power		Max Antenna Gain (dBi)	Numeric antenna gain (mW)
	(dBm)	(mW)		
2440	7.93	6.208	0	1.00

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] = 6.208/5*√2.440 = 1.939 ≤ 3.0

Threshold at which no SAR required is 10mW and ≤ 3.0 for 1-g SAR, Separation distance is 5mm.

Conclusion : The SAR measurement is exempt.

Conclusion : The SAR measurement is exempt.

APPENDIX

1. EUT photo