



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	: YJHMS-1124G
2. Products	
Name	: Multicom Stationary 2.4G (MTT Stationary T-1)
Model No.	: MS-11 2.4G
Variant Model No.	: CA5230-0, MS11, MS-11, MS11 2.4G, MS2.4G
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 14, 2016 to November 22, 2016
7. Date of Issue	: November 29, 2016
8. Test Laboratory	: Standard Engineering Co. Ltd. FCC Designation Number : 624439

Tested by	Approved by
	
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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.

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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 Stationary 2.4G (MTT Stationary T-1)
Model No. : MS-11 2.4G

3.3. Details of E.U.T.

Operation Frequency	: 2405 MHz to 2477 MHz
Wireless Mode	: Hopping Mode
Channel Numbers	: 145 Channels
Hopping Channel	: 16 Channels
Channel Spacing	: 500 KHz
Type of Modulation	: GFSK
Antenna Type	: Dipole Antenna (Reverse SMA type)
Antenna Gain	: 5.0 dBi
Test Software	: -
Power Supply	: DC 5.0 V
Test Voltage	: DC 5.0 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

Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy	Chann el	Freque ncy
		16	2413	36	2423	56	2433	76	2443	96	2453	116	2463	136	2473
		17	2413.5	37	2423.5	57	2433.5	77	2443.5	97	2453.5	117	2463.5	137	2473.5
		18	2414	38	2424	58	2434	78	2444	98	2454	118	2464	138	2474
		19	2414.5	39	2424.5	59	2434.5	79	2444.5	99	2454.5	119	2464.5	139	2474.5
0	2405	20	2415	40	2425	60	2435	80	2445	100	2455	120	2465	140	2475
1	2405.5	21	2415.5	41	2425.5	61	2435.5	81	2445.5	101	2455.5	121	2465.5	141	2475.5
2	2406	22	2416	42	2426	62	2436	82	2446	102	2456	122	2466	142	2476
3	2406.5	23	2416.5	43	2426.5	63	2436.5	83	2446.5	103	2456.5	123	2466.5	143	2476.5
4	2407	24	2417	44	2427	64	2437	84	2447	104	2457	124	2467	144	2477
5	2407.5	25	2417.5	45	2427.5	65	2437.5	85	2447.5	105	2457.5	125	2467.5		
6	2408	26	2418	46	2428	66	2438	86	2448	106	2458	126	2468		
7	2408.5	27	2418.5	47	2428.5	67	2438.5	87	2448.5	107	2458.5	127	2468.5		
8	2409	28	2419	48	2429	68	2439	88	2449	108	2459	128	2469		
9	2409.5	29	2419.5	49	2429.5	69	2439.5	89	2449.5	109	2459.5	129	2469.5		
10	2410	30	2420	50	2430	70	2440	90	2450	110	2460	130	2470		
11	2410.5	31	2420.5	51	2430.5	71	2440.5	91	2450.5	111	2460.5	131	2470.5		
12	2411	32	2421	52	2431	72	2441	92	2451	112	2461	132	2471		
13	2411.5	33	2421.5	53	2431.5	73	2441.5	93	2451.5	113	2461.5	133	2471.5		
14	2412	34	2422	54	2432	74	2442	94	2452	114	2462	134	2472		
15	2412.5	35	2422.5	55	2432.5	75	2442.5	95	2452.5	115	2462.5	135	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	2405MHz
Middle channel	2440MHz
Highest channel	2477MHz

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-MF1 41-SMS102-1.0 M	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	S7400JD53406 18	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 5.0V
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

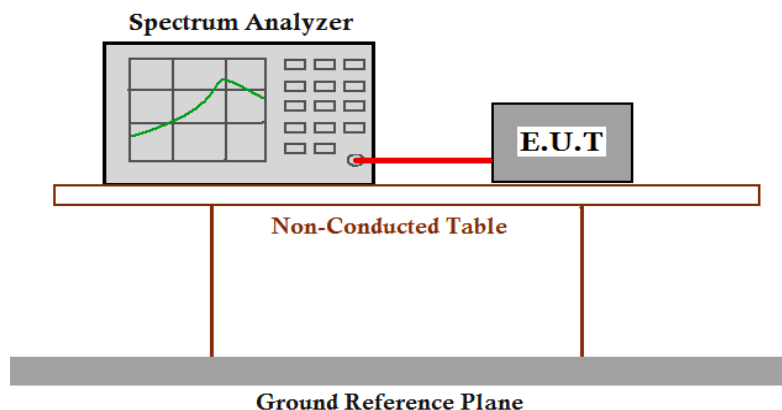
PASS

The transmitter has an Dipole Antenna (Reverse SMA type). The directional gain of the antenna is 5.0 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 (2405 MHz), middle (2440 MHz) and highest (2477 MHz) channel

Test Configuration:



Test Procedure:

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



Test result:

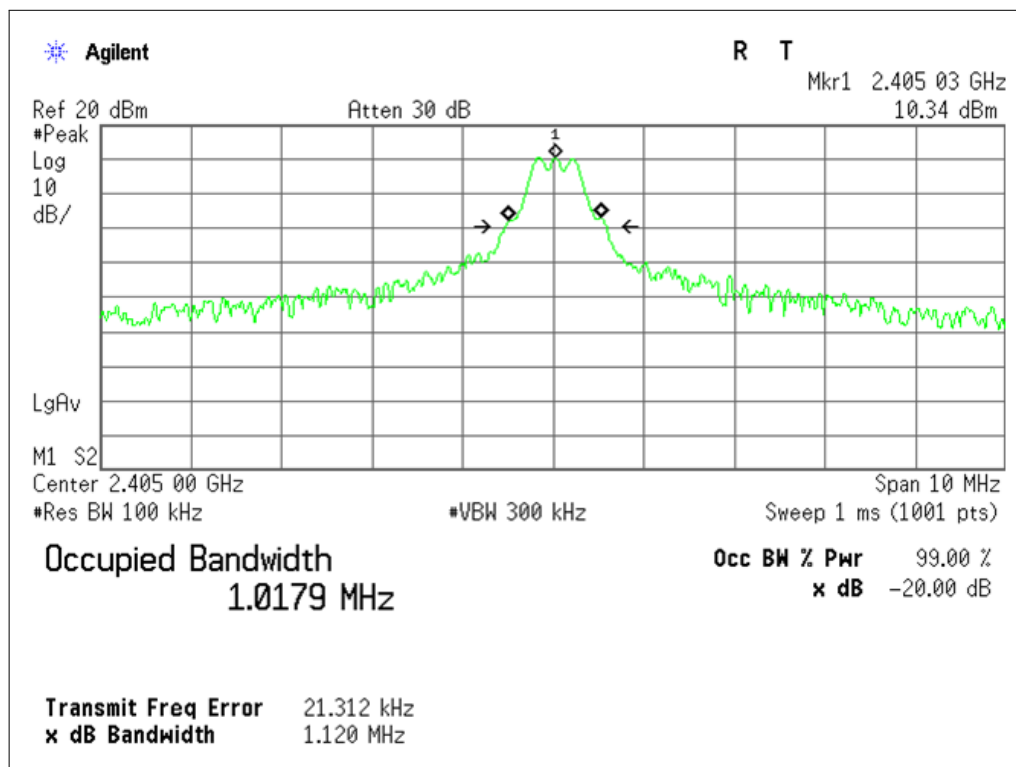
Normal mode:

Test Channel	Bandwidth(MHz)	2/3 bandwidth(MHz)
Lowest	1.120	0.746
Middle	1.080	0.720
Highest	1.078	0.718

Result plot as follows:

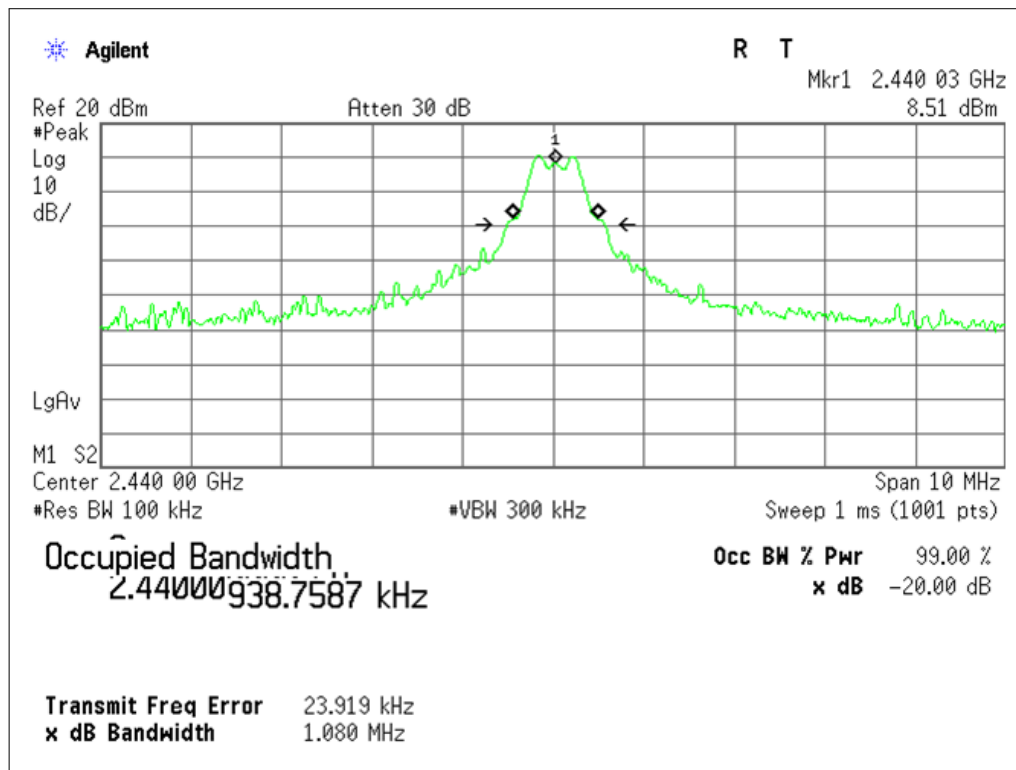
Normal mode :

Lowest Channel(2.405 GHz):

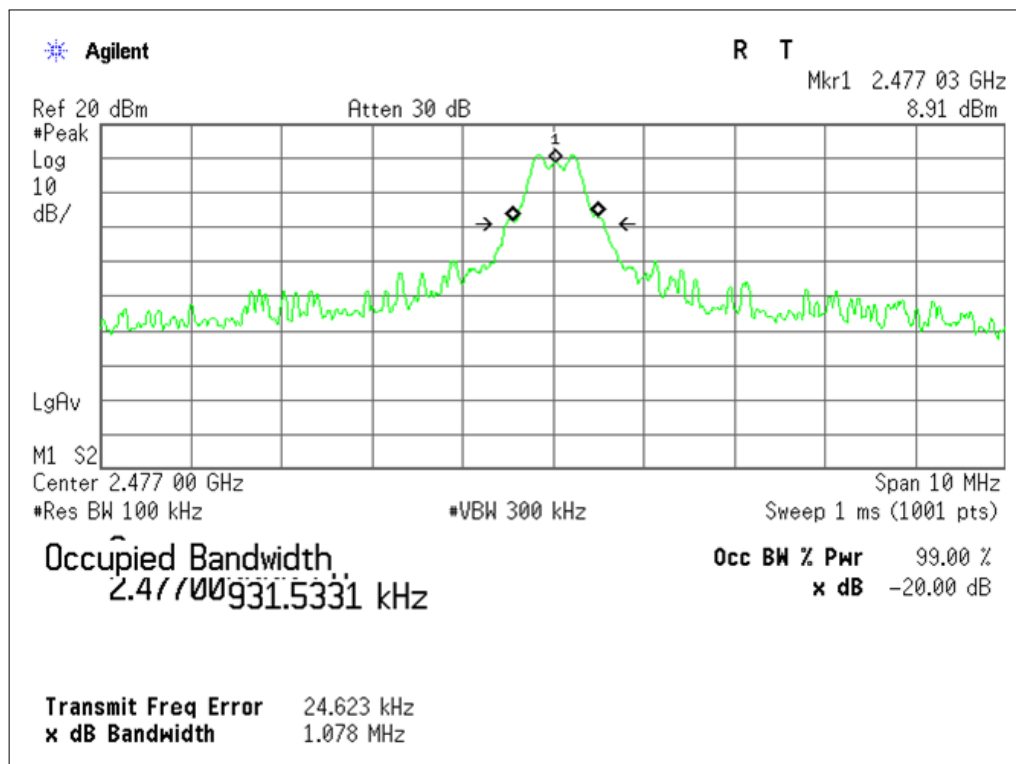




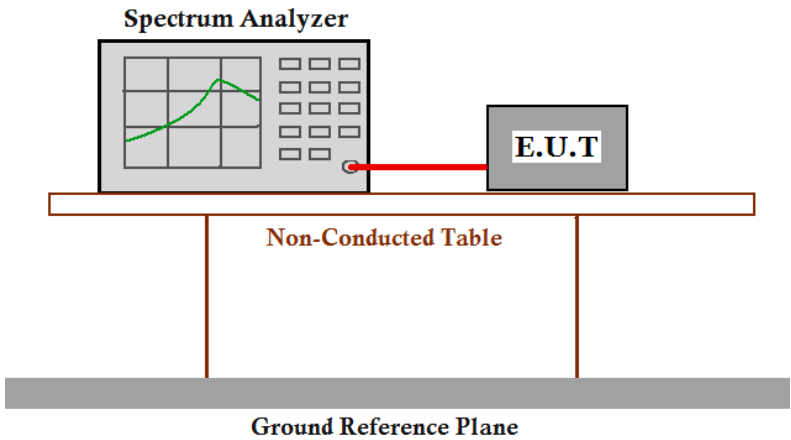
Middle Channel(2.440 GHz):



Highest Channel(2.477 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 (2405 MHz), middle (2440 MHz) and highest (2477 MHz) channel
Test Configuration:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected via a red cable to an E.U.T (Equipment Under Test). Both are placed on a Non-Conducted Table, which is supported by two vertical legs. Below the table is a Ground Reference Plane, represented by a thick grey bar.
Test Procedure:	1. Remove the antenna from the EUT and then connect a low attenuation RF cable from the antenna port to the spectrum. 2. Set the spectrum analyzer: RBW $\geq$ 1% of the span, VBW $\geq$ RBW, Sweep = auto; Detector Function = Peak. Trace = Max, hold. 3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Test result:

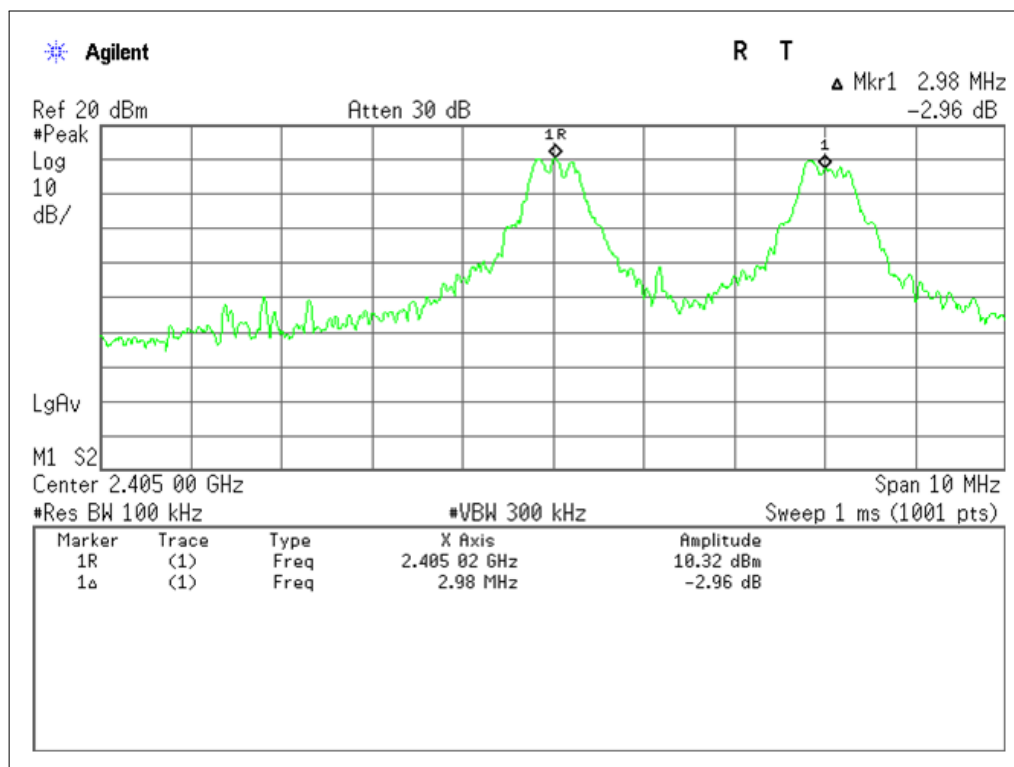
Test Channel	Carrier Frequencies Separated	Pass/Fail
Lower Channels (channel 0 and channel 1)	2.98 MHz	Pass
Middle Channels (channel 64 and channel 76)	5.00 MHz	Pass
Upper Channels (channel 136 and channel 144)	4.01 MHz	Pass

Remark:

The limit is maximum two-thirds of the 20 dB bandwidth: 746 KHz.

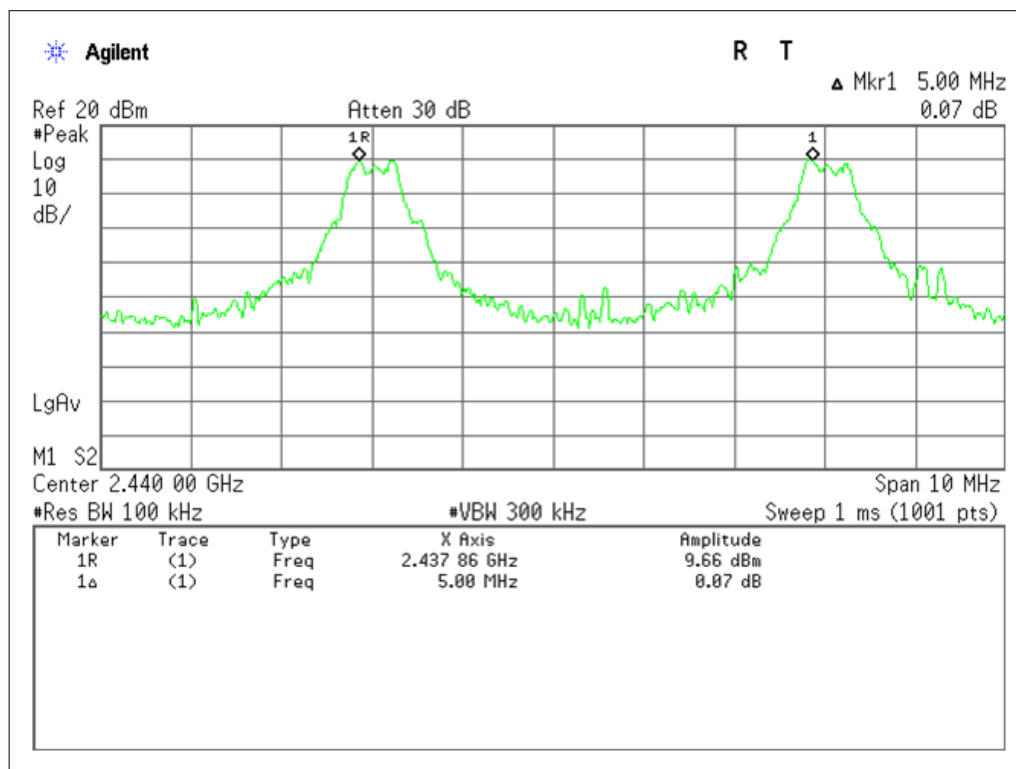
Result plot as follows:

Lowest Channels: Carrier Frequencies Separated

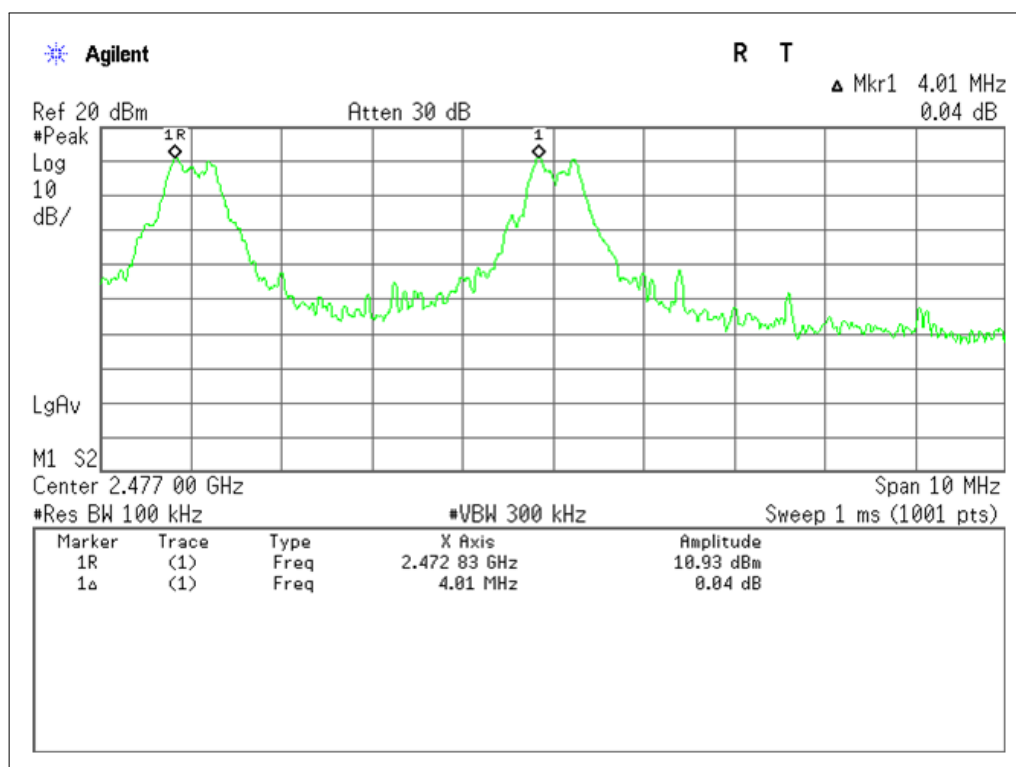




Middle Channels: Carrier Frequencies Separated



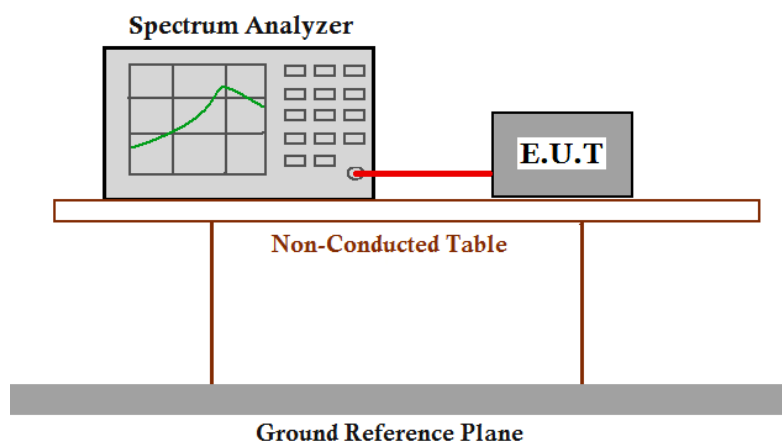
Highest Channels: Carrier Frequencies Separated



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:



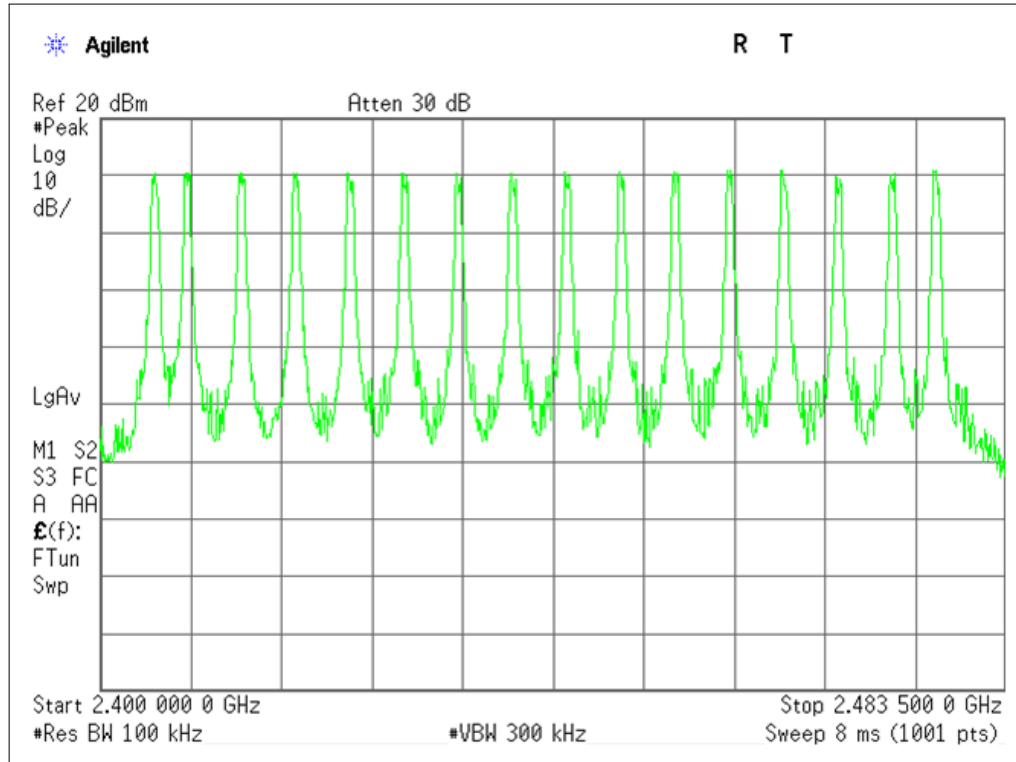
Test Procedure:

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:

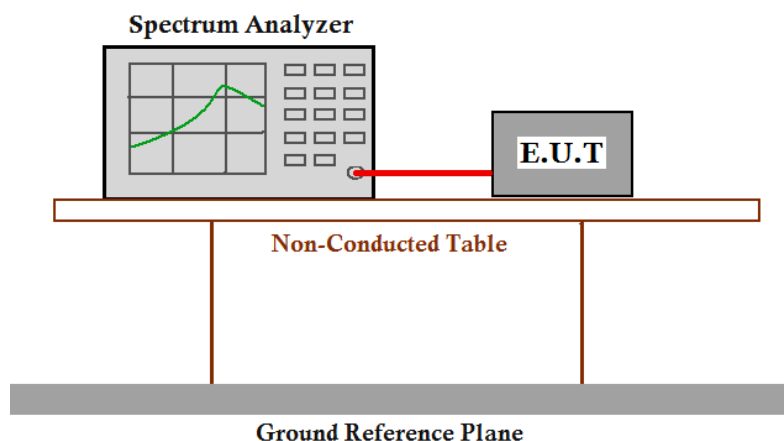
Total channels are 16 channels.



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 (2405 MHz), middle (2440 MHz) and highest (2477 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: $T = 0.4 \text{ Second/Channel} \times 16 \text{ Channel} = 6.4 \text{ s}$

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	2405 MHz	12.737	0.0250	16	6.4	127.433	≤ 400	Pass
	2440 MHz	12.814	0.0250	16	6.4	128.204	≤ 400	Pass
	2477 MHz	12.891	0.0250	16	6.4	128.974	≤ 400	Pass

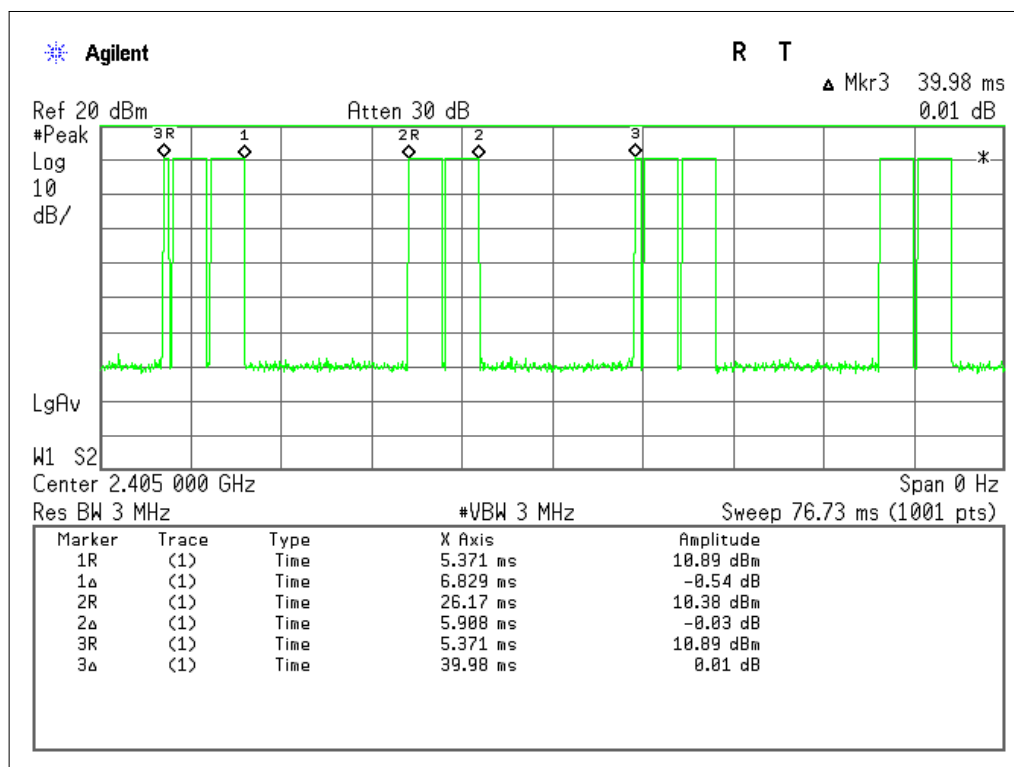
The average time of occupancy in the specified 6.4 second period is equal to pulse width*

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

Result plot as follows :

1. Lowest channel (2405 MHz):

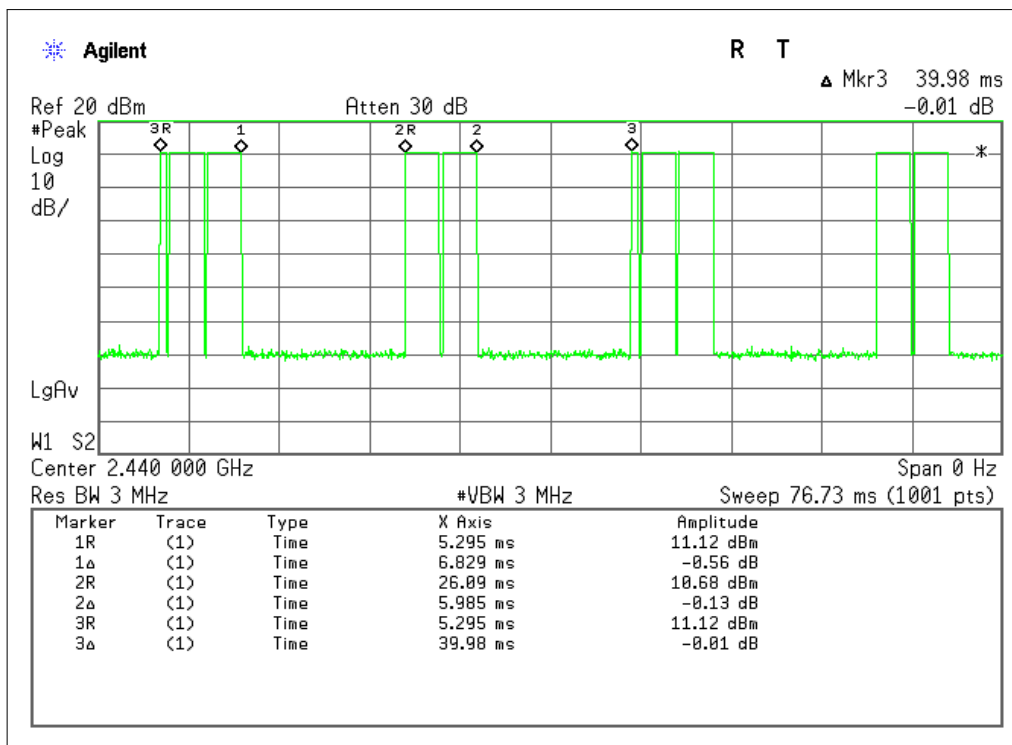
Pulse Width:





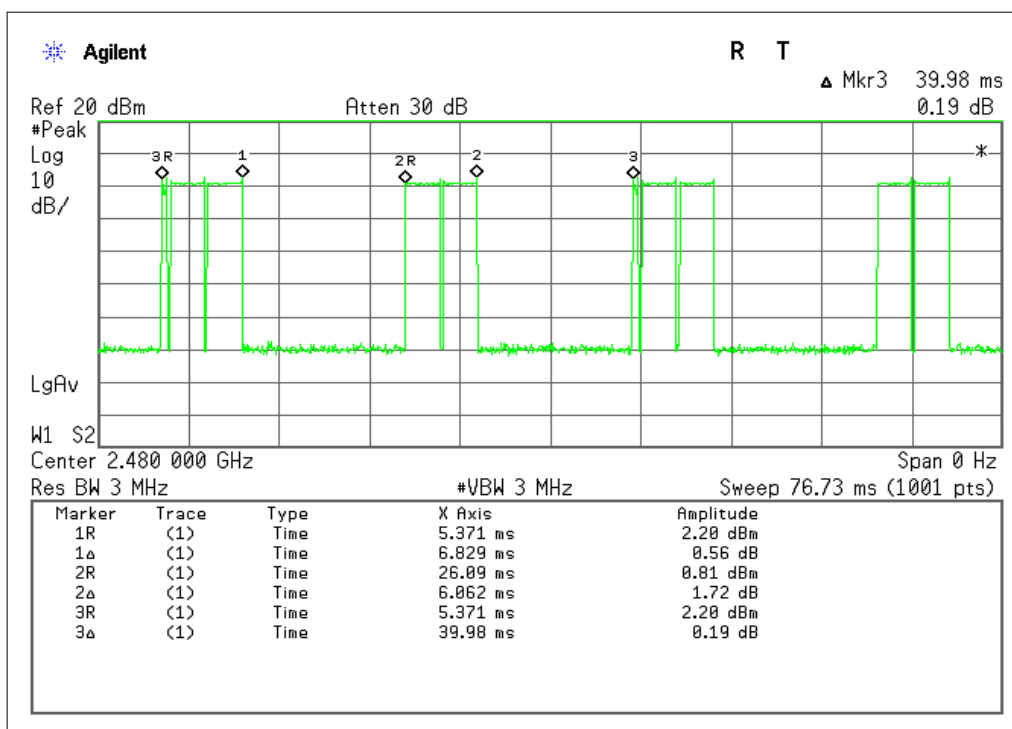
2. Middle Channel (2440 MHz)

Pulse Width:



3. Highest Channel (2477 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);  
    }  
    return seqn;
```

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.

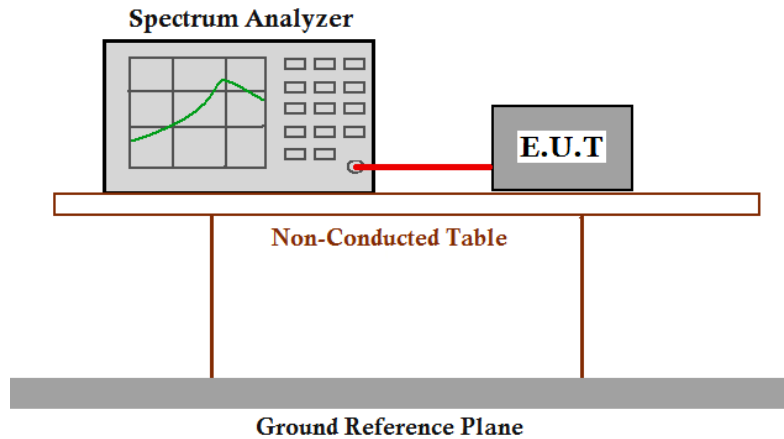
The slave follows this sequence.

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 (2405 MHz), middle (2440 MHz) and highest (2477 MHz) channel
Test Configuration:	 The diagram illustrates the test setup. A Spectrum Analyzer, shown with a grid and a green signal trace, is connected to an E.U.T. (Equipment Under Test) box by a red cable. Both the Spectrum Analyzer and the E.U.T. are placed on a brown rectangular table labeled "Non-Conducted Table". This table is supported by two vertical legs. Below the table, a thick grey horizontal bar represents the "Ground Reference Plane".
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:

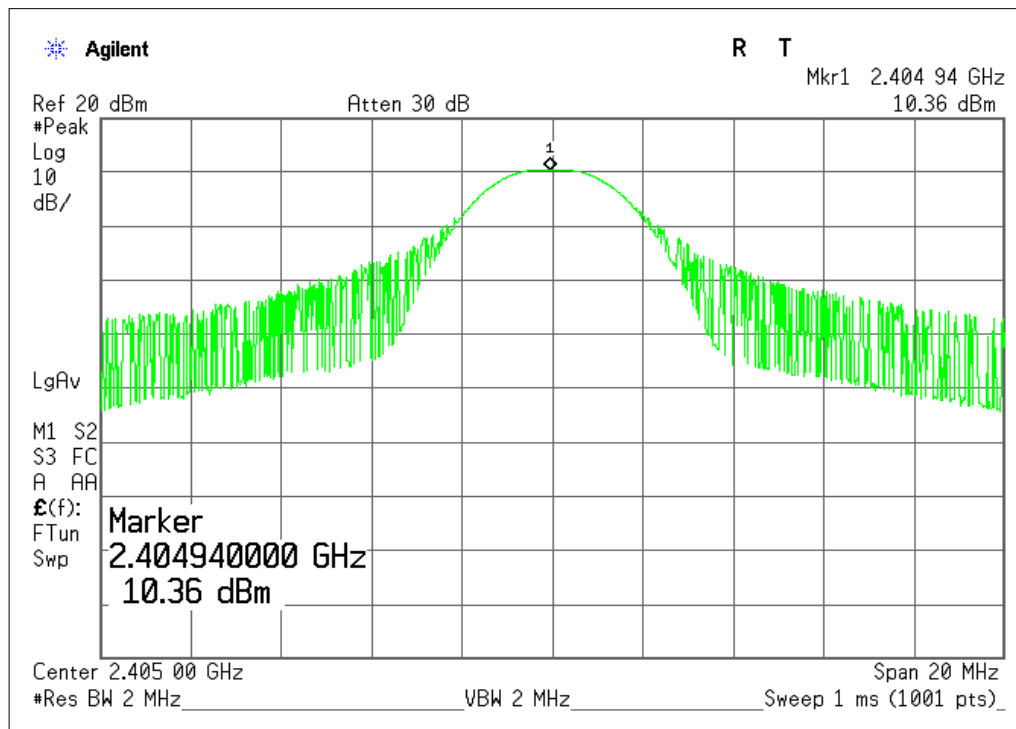
Test Channel	Fundamental Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Result
Lowest	2405	10.36	30.0	Pass
Middle	2440	10.53	30.0	Pass
Highest	2477	11.00	30.0	Pass



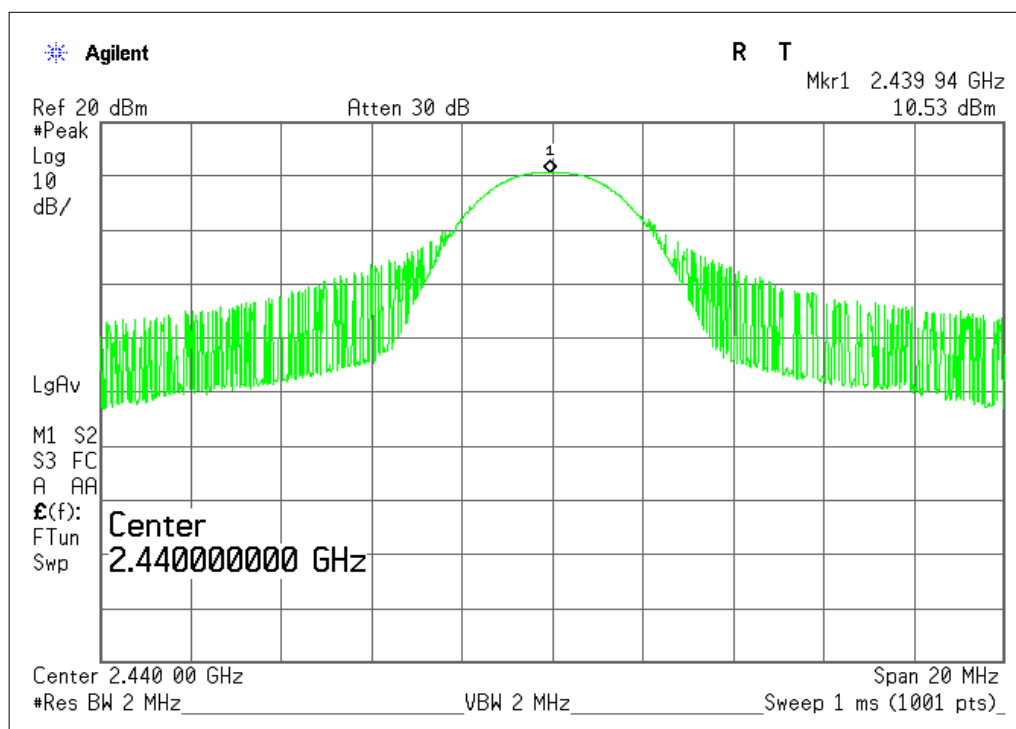
Result plot as follows :

Normal mode:

Lowest Channel(2.405 GHz):

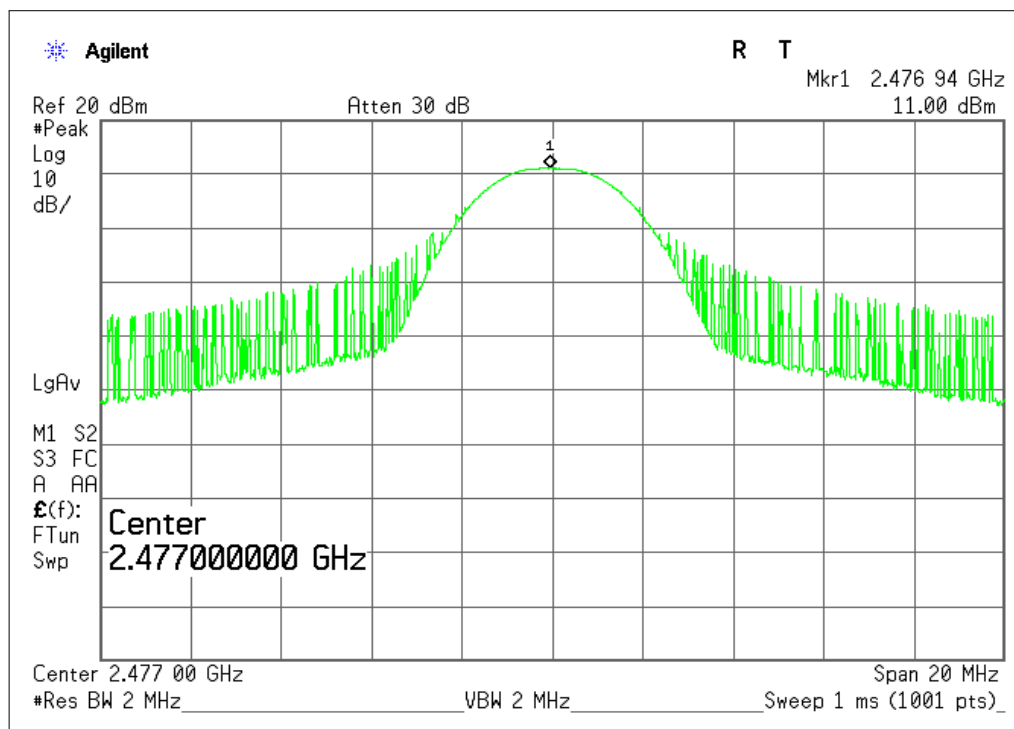


Middle Channel(2.440 GHz):





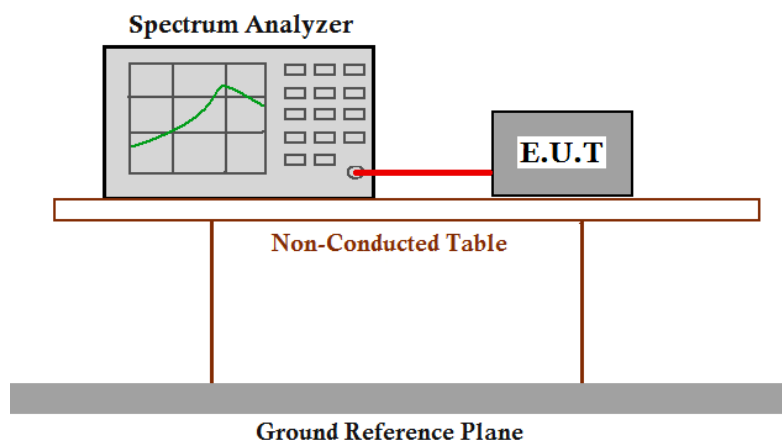
Highest Channel(2.477 GHz):



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 (2405 MHz), middle (2440 MHz) and highest (2477 MHz) channel

Test Configuration:



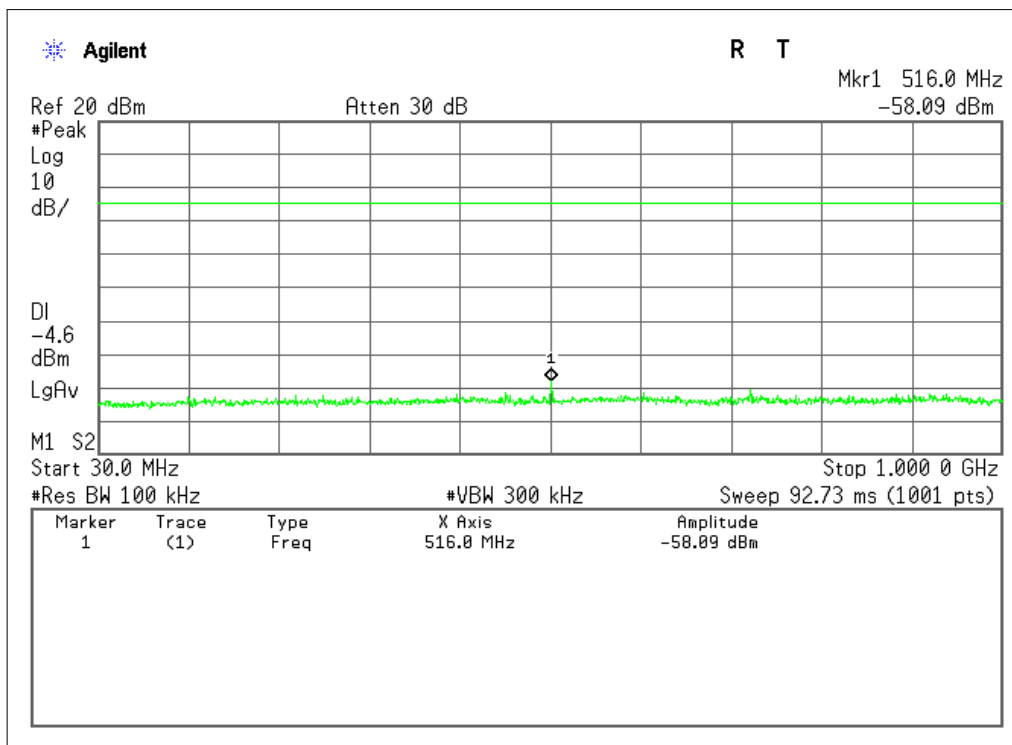
Test Procedure:

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

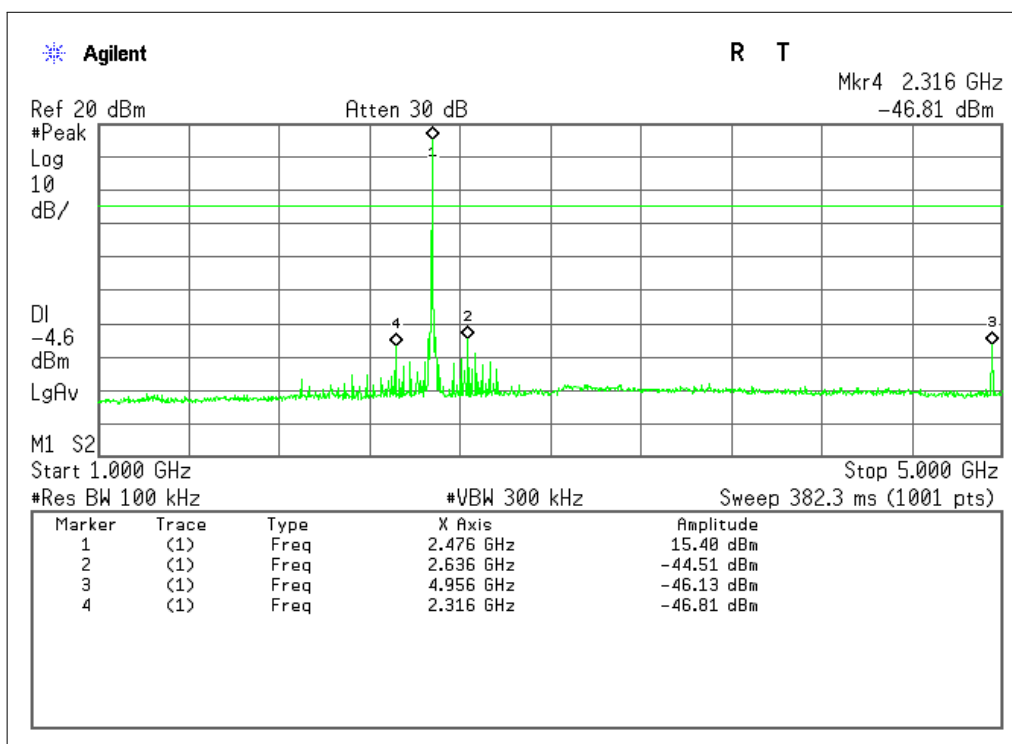


Result plot as follows :

Lowest Channel: 30 MHz to 1 GHz

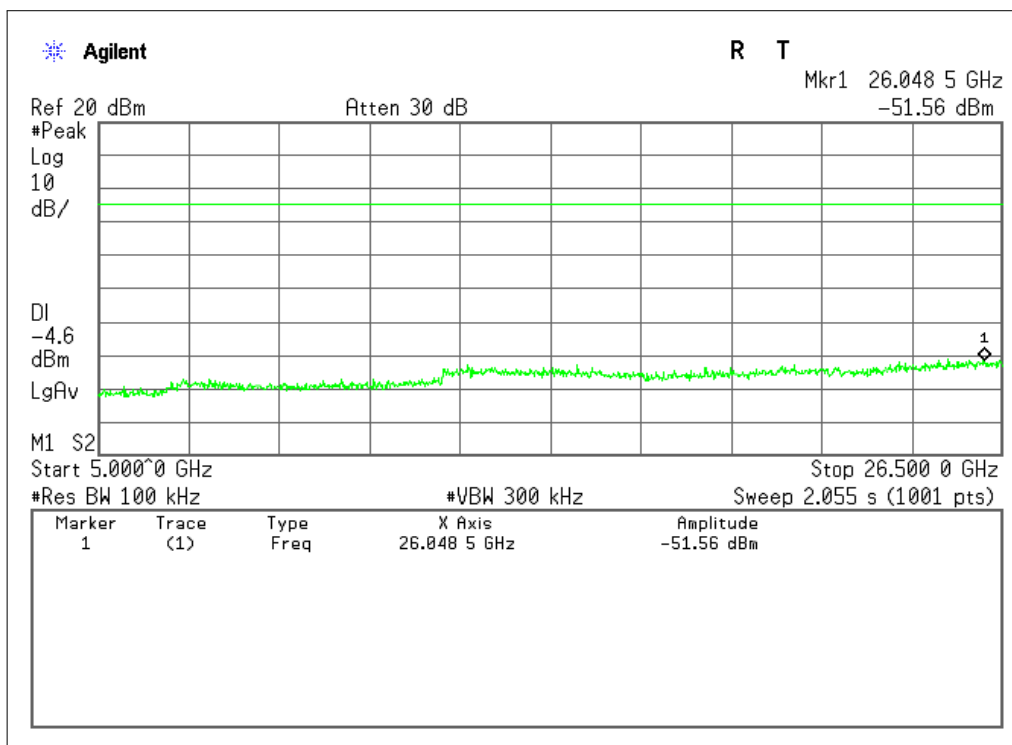


Lowest Channel: 1 GHz to 5 GHz

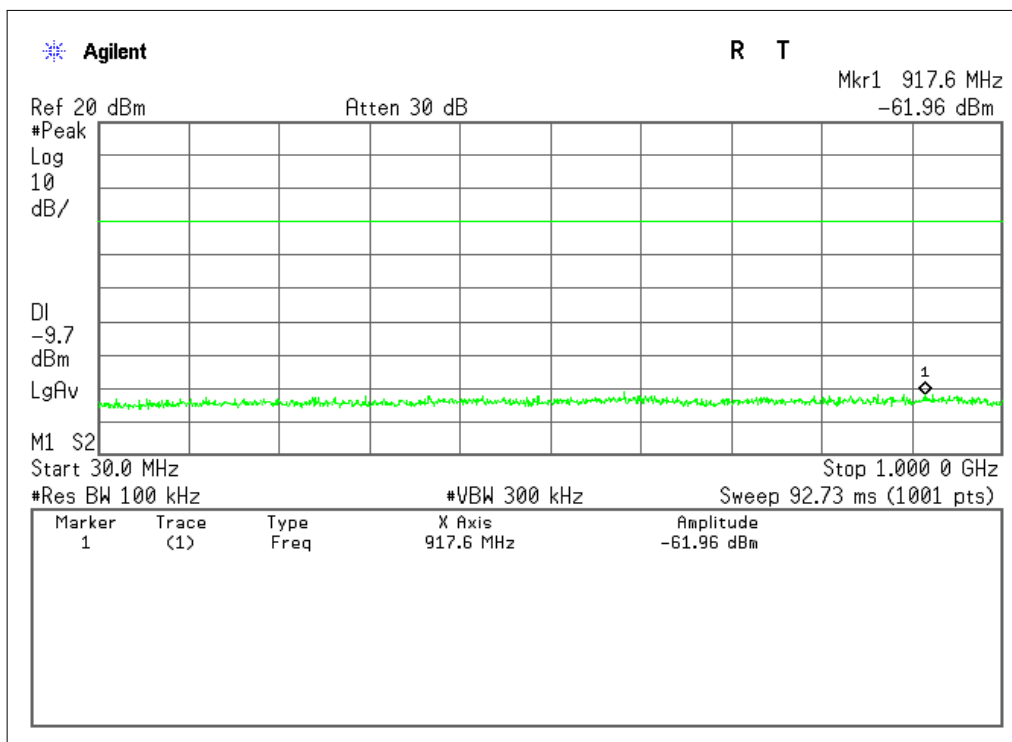




Lowest Channel: 5 GHz to 26.5 GHz

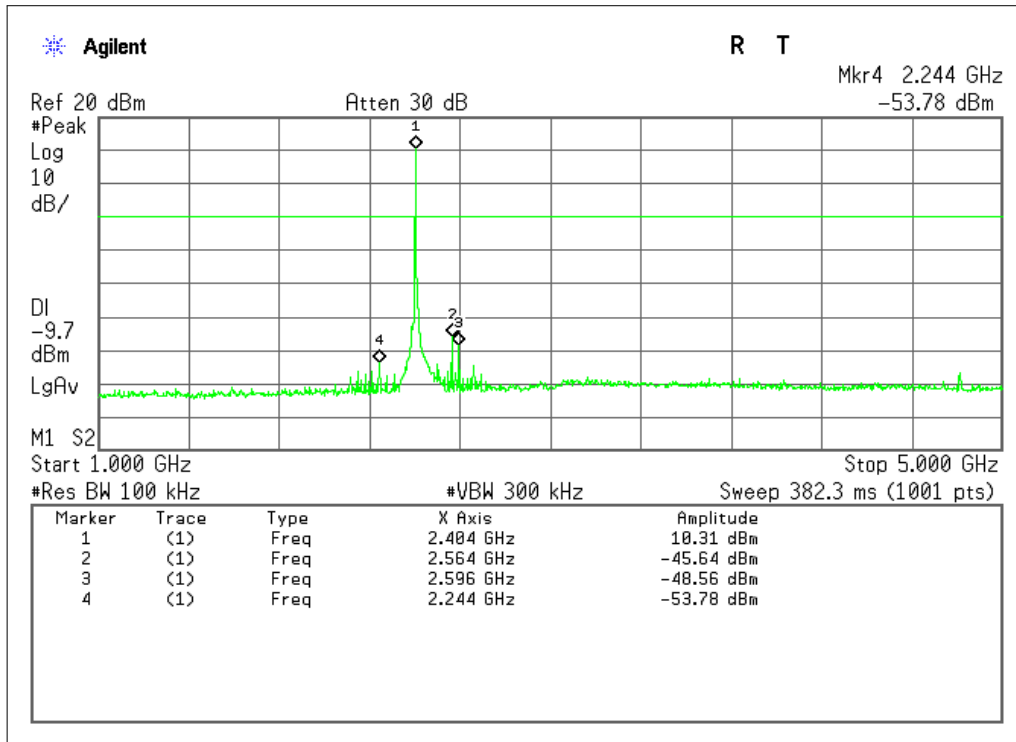


Middle Channel: 30 MHz to 1 GHz

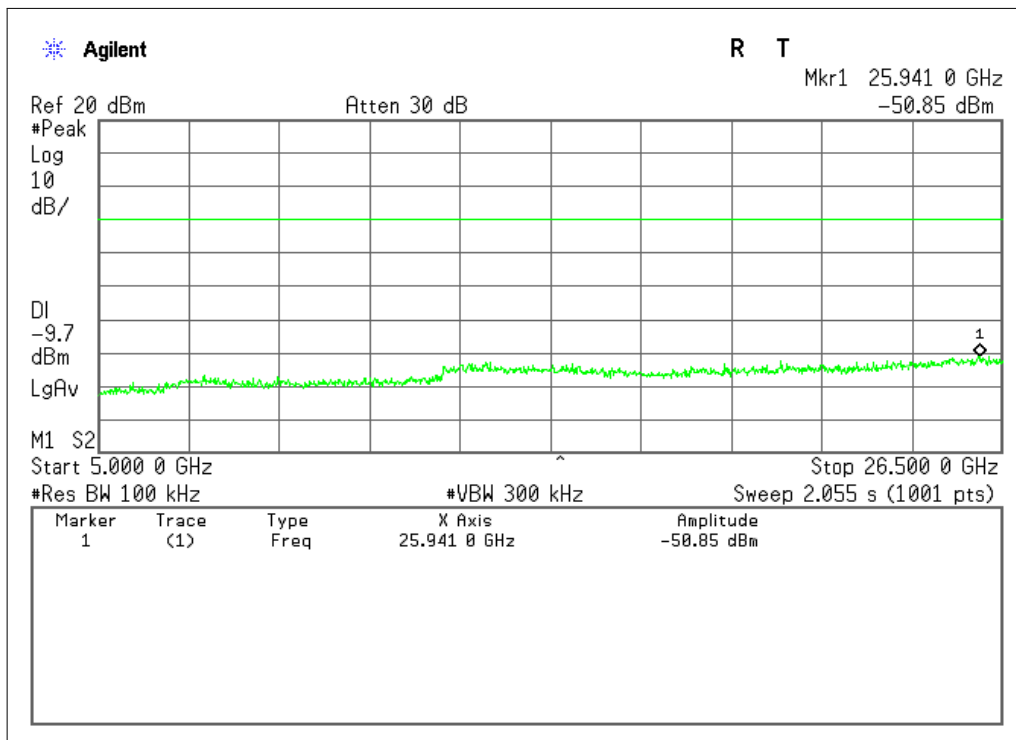




Middle Channel: 1 GHz to 5 GHz

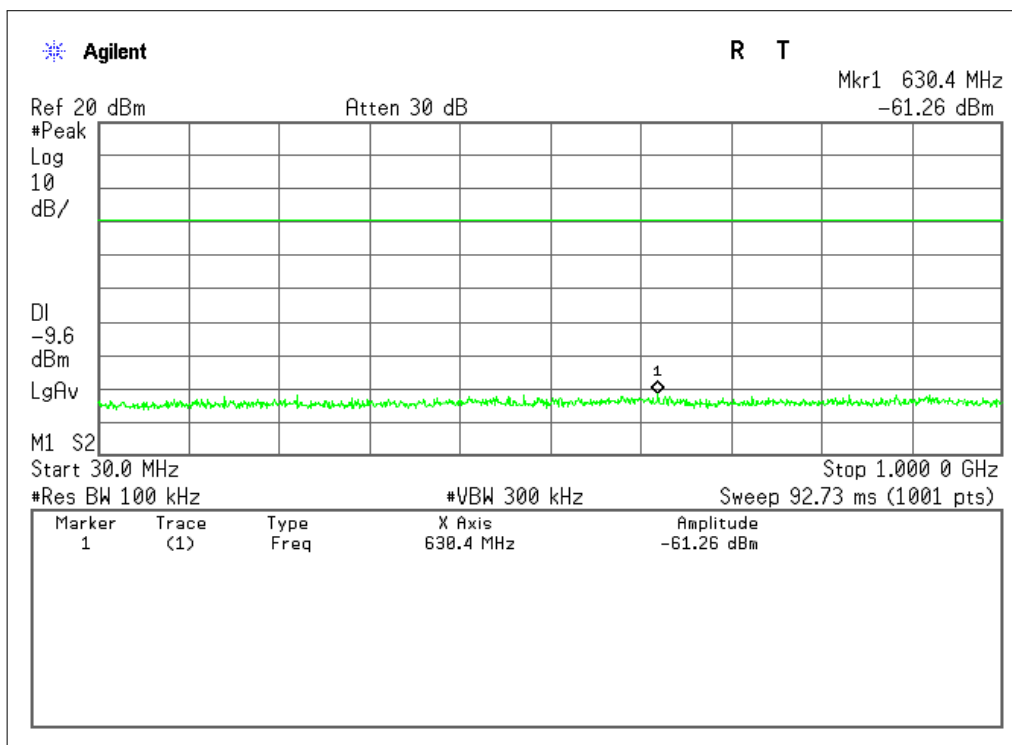


Middle Channel: 5 GHz to 26.5 GHz

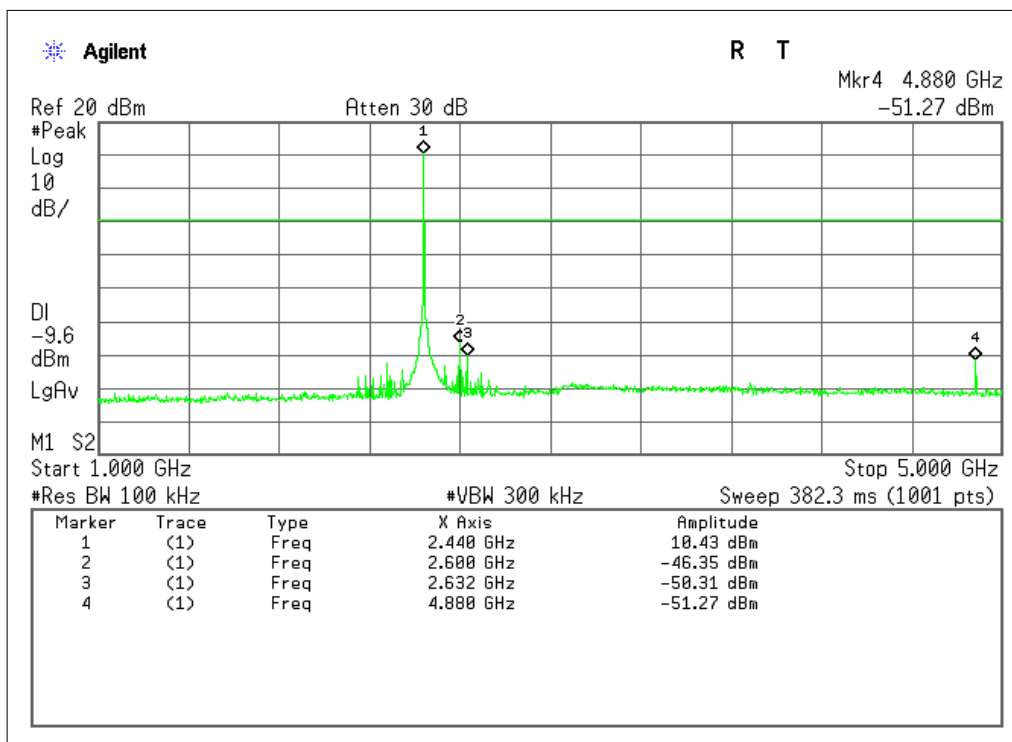




Highes Channel: 30 MHz to 1 GHz

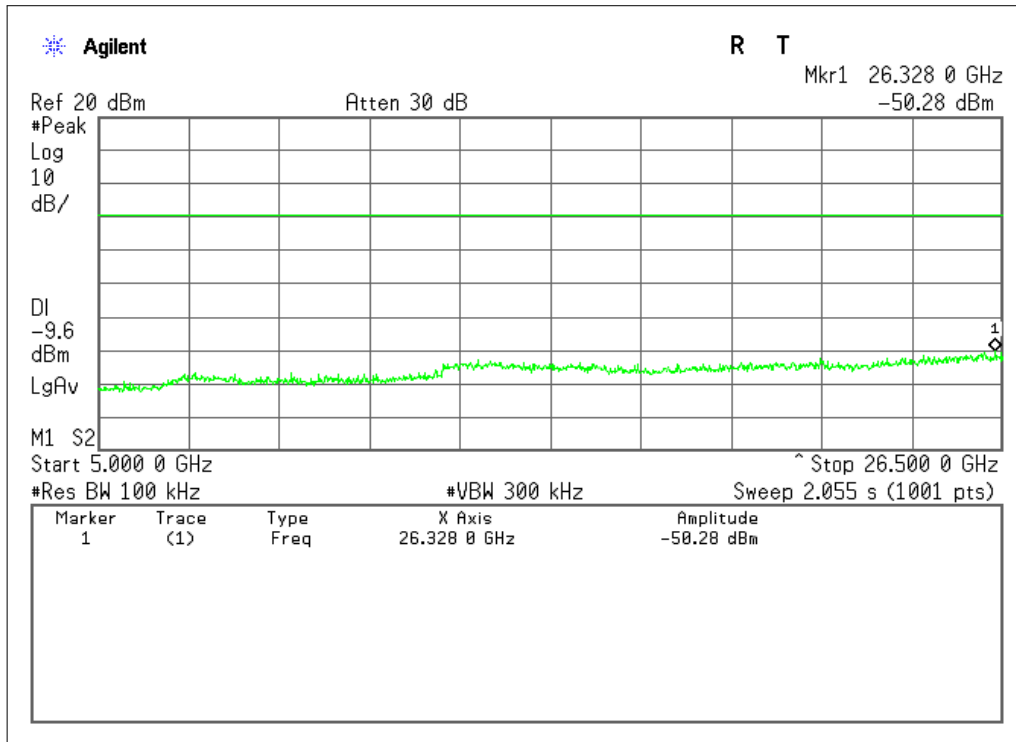


Highes Channel: 1 GHz to 5 GHz





Highes Channel: 5 GHz to 25 GHz



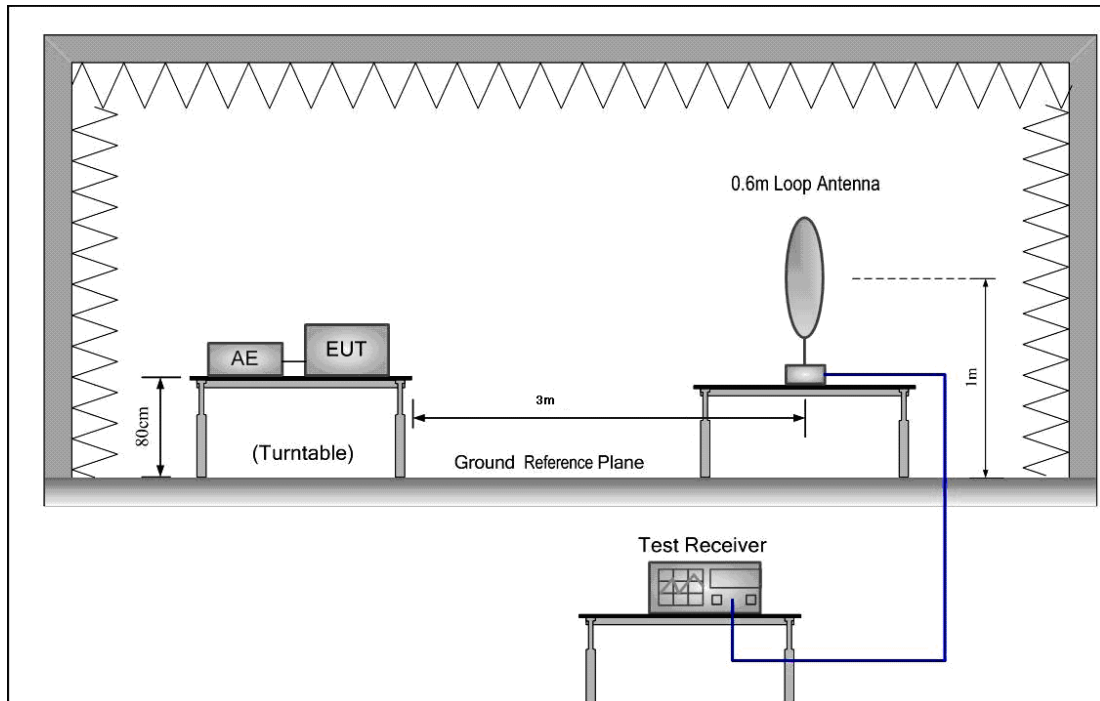


5.12. Radiated Spurious Emissions

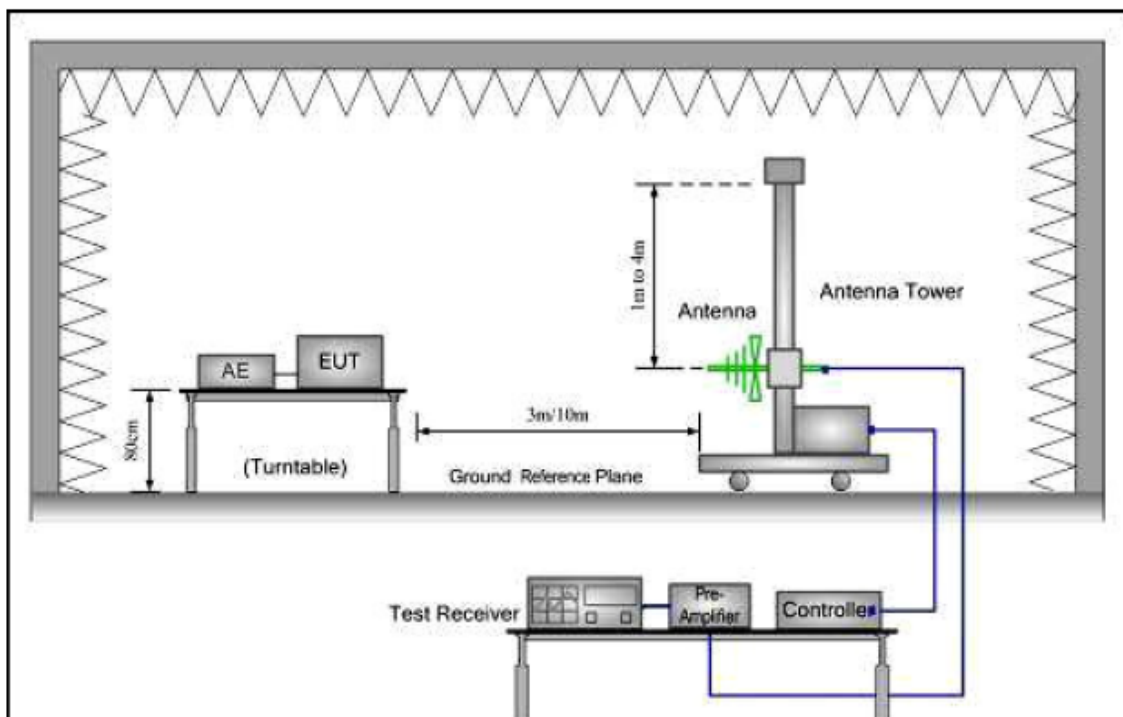
Test Requirement:	FCC Part15 C section 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating. The radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that Contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, and provided the transmitter demonstrates compliance with the peak conducted power limits.
Test Method:	ANSI C63.10: Clause 6.4, 6.5 and 6.6
Test Status:	Pre-test the EUT in continuous transmitting mode at the lowest (2405 MHz), middle (2440 MHz) and highest (2477 MHz) channel
Detector:	For PK value: RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz VBW $\geq$ RBW Sweep = auto Detector function = peak Trace = max hold For AV value: RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz VBW = 10 Hz Sweep = auto Detector function = peak Trace = max hold
15.209 Limit:	40.0 dB μ V/m between 30MHz & 88MHz 43.5 dB μ V/m between 88MHz & 216MHz 46.0 dB μ V/m between 216MHz & 960MHz 54.0 dB μ V/m above 960MHz

Test Configuration:

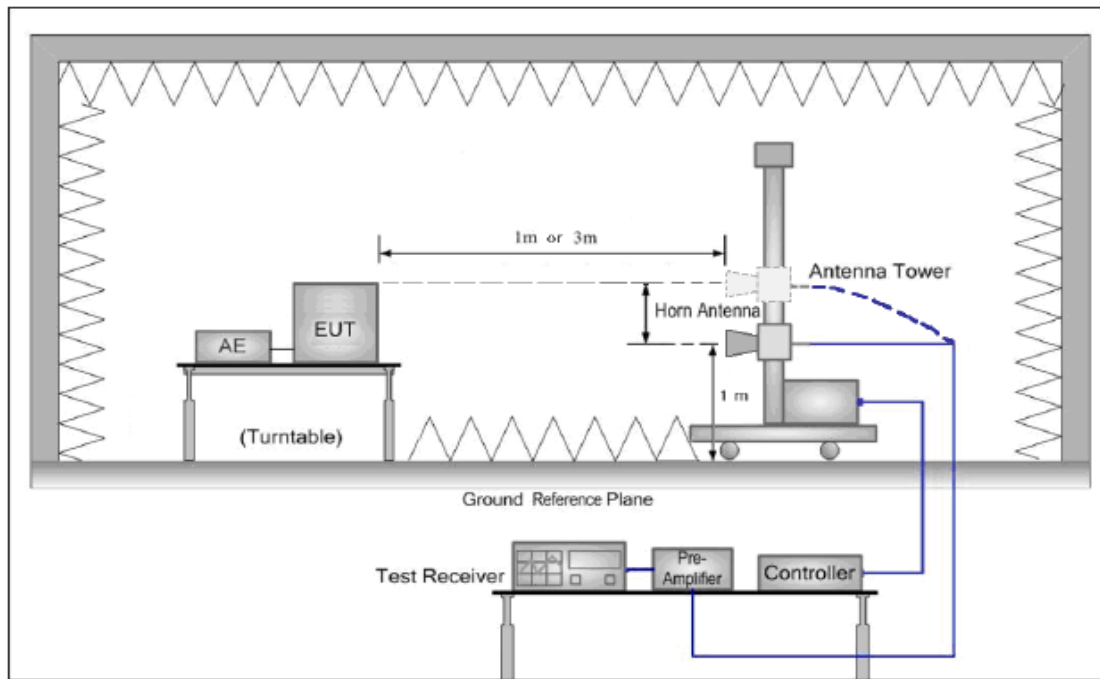
1) 9 kHz to 30 MHz emissions:



2) 30 MHz to 1 GHz emissions:



3) 1 GHz to 25 GHz emissions:



Test Procedure:

Test site with RF absorbing material covering the ground plane that met the site validation criterion called out in CISPR 16-1-4:2007 was used to perform radiated emission test above 1 GHz. The receiver scanned from the lowest frequency generated within the EUT to 25GHz. When an emission was found, the table was rotated to produce the maximum signal strength. An initial pre-scan was performed for in peak detection mode using the receiver. The EUT was measured for both the Horizontal and Vertical polarities and performed a pre-test three orthogonal planes. For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. The worst case emissions were reported.

For hand-held or body-worn devices rotated through three orthogonal axes(X,Y,Z) to determine which attitude (orientation) and equipment arrangement produces the highest emission relative to the limit; the attitude and equipment arrangement that produces the highest emission relative to the limit was used in making final radiated emission measurements. Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

5.12.1. Harmonic and other spurious emissions

5.12.1.1. Test at low Channel in transmitting status

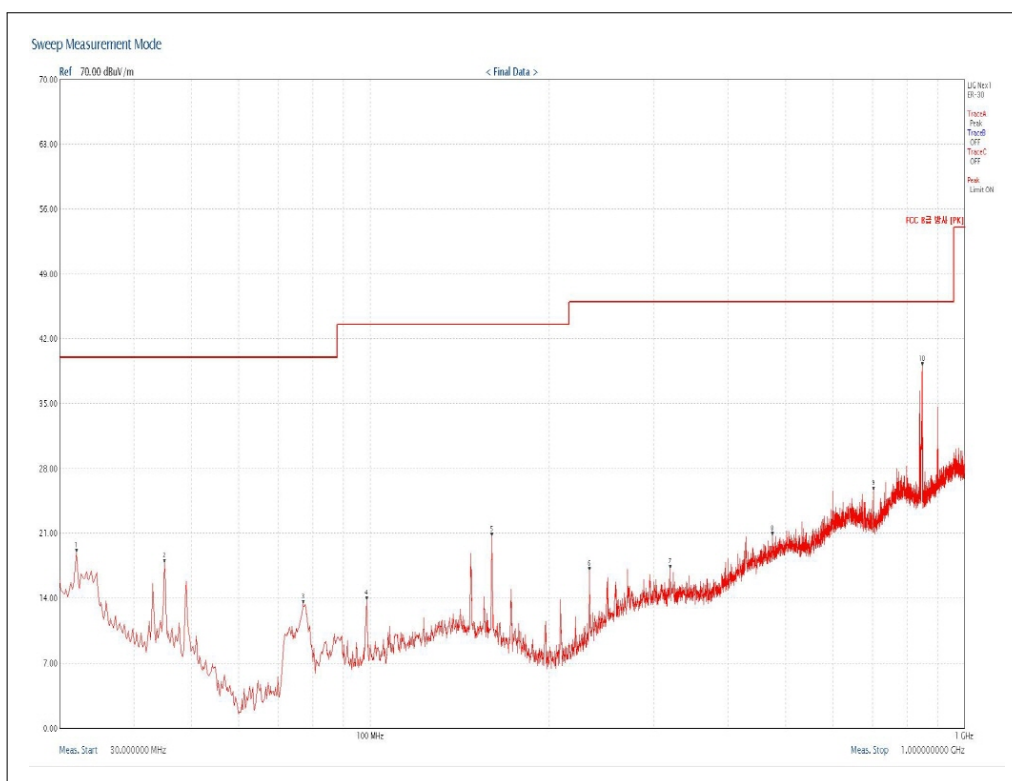
9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

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 (dB μ V/m)

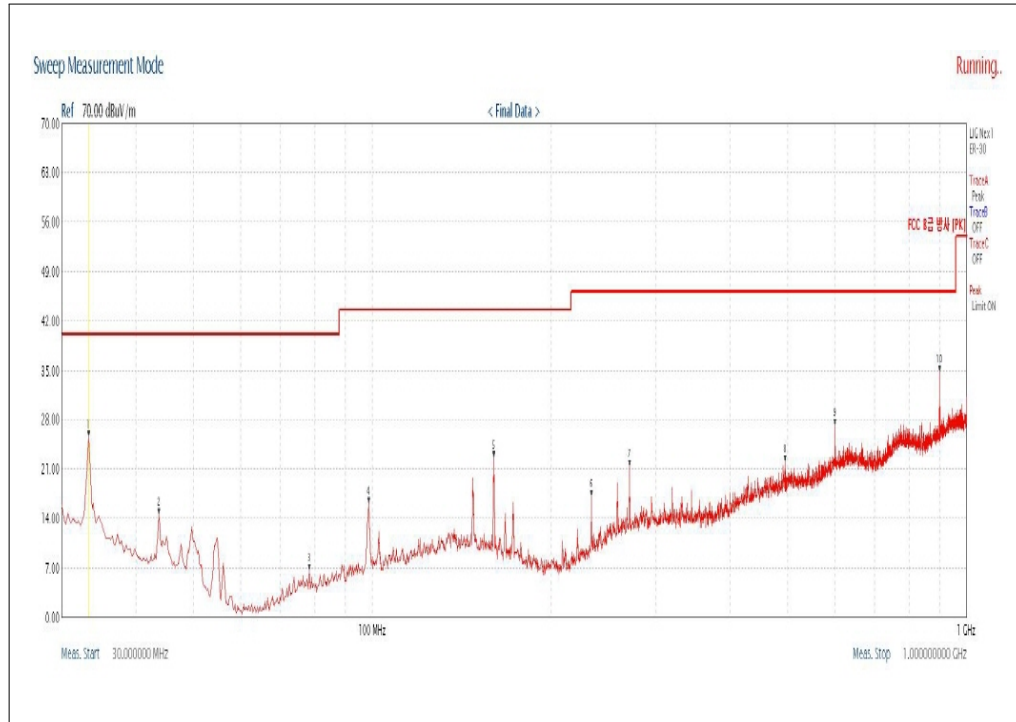


Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dB μ V/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dB μ V/m)	Limit (dB μ V/m)
45.03	QP	V	20.17	10.48	9.69	40.0
160.14	QP	V	23.58	11.47	12.11	43.5
848.41	QP	V	37.78	26.13	11.65	46.0
900.52	QP	V	37.64	26.66	10.98	46.0

Horizontal:

Level (dB μ V/m)



Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dB μ V/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dB μ V/m)	Limit (dB μ V/m)
33.31	QP	H	25.72	15.96	9.76	40.0
160.14	QP	H	23.41	11.47	11.94	43.5
233.68	QP	H	25.31	13.07	12.24	46.0
270.75	QP	H	25.77	14.87	10.90	46.0
600.20	QP	H	35.30	22.92	12.38	46.0
900.52	QP	H	67.68	26.66	41.02	46.0



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

Peak / Average Measurement:

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

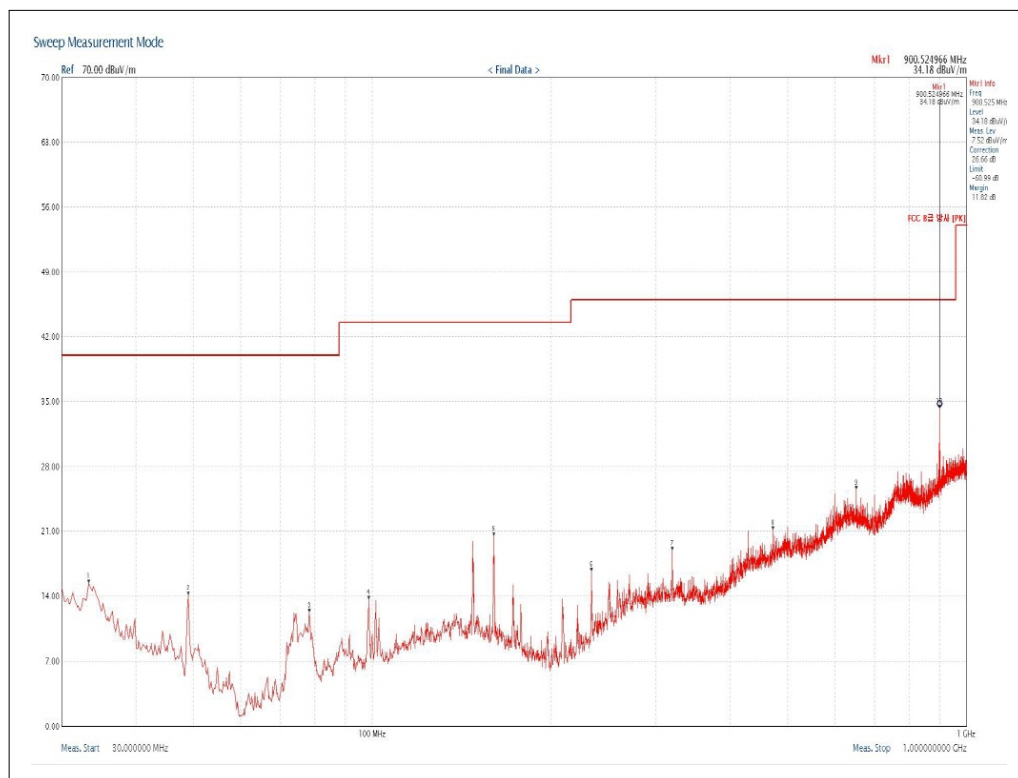
9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

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:

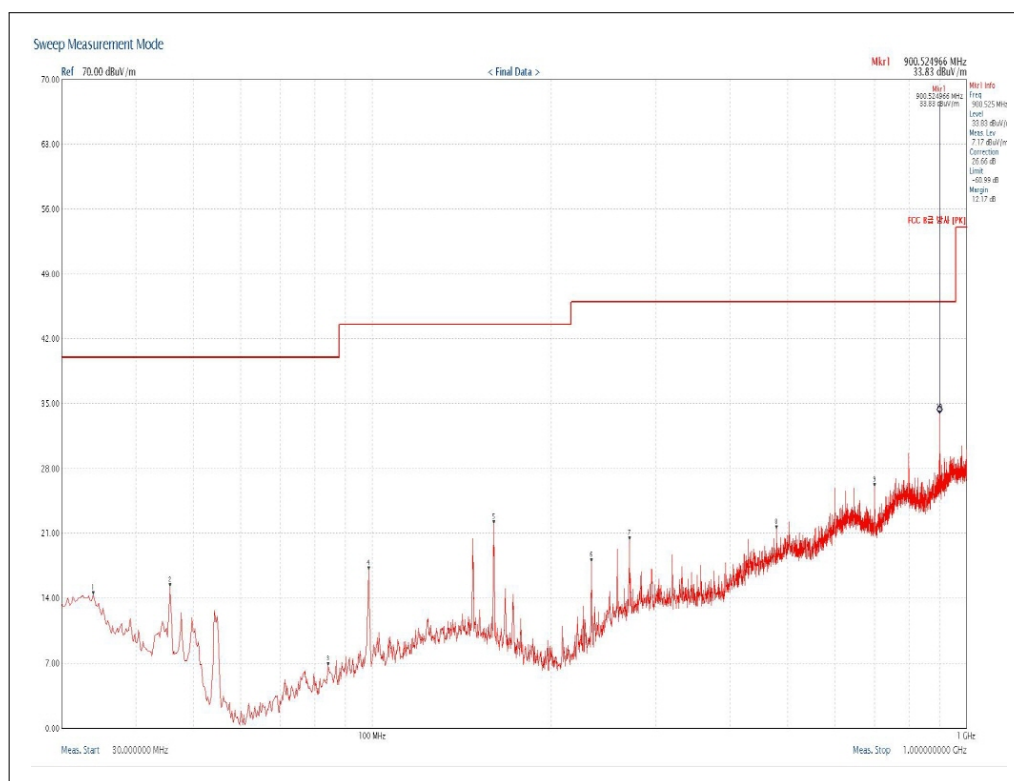
Level (dBμV/m)



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)
48.94	QP	V	17.65	8.36	9.29	40.0
141.27	QP	V	23.48	12.11	11.37	43.5
160.14	QP	V	23.58	11.47	12.11	43.5
900.52	QP	V	37.64	26.66	10.98	46.0

Horizontal:

Level (dB μ V/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)
45.63	QP	H	20.34	10.16	10.18	40.0
160.14	QP	H	23.39	11.47	11.92	43.5
233.68	QP	H	25.31	13.07	12.24	46.0
270.75	QP	H	25.76	14.87	10.89	46.0
900.52	QP	H	37.66	26.66	11.00	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

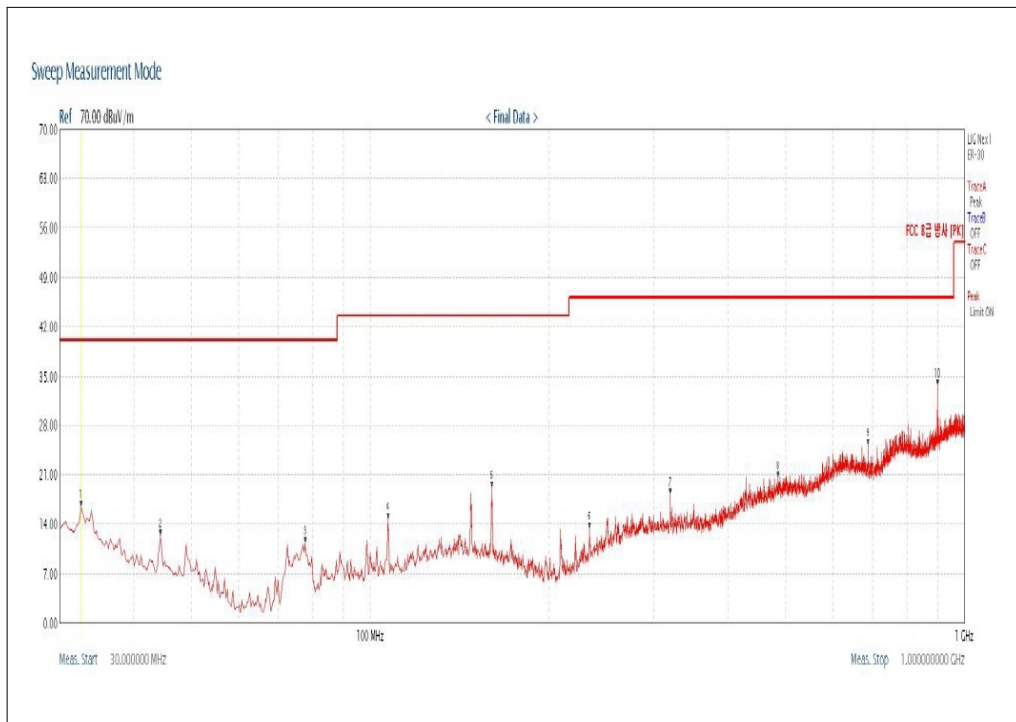
9 kHz~30 MHz Field Strength of Unwanted Emissions. Quasi-Peak Measurement

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)

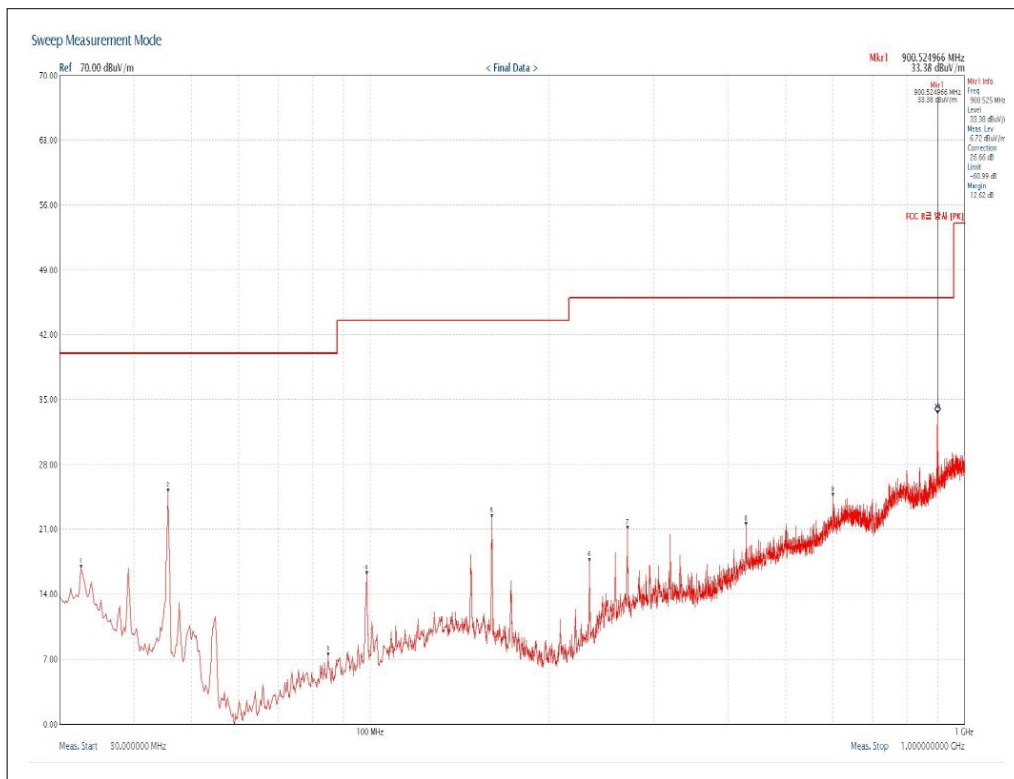


Quasi-peak measurement

Frequency (MHz)	Detect Mode	Polarization (V/H)	Measured Value (dBμV/m)	Antenna Factor + Cable Loss (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)
32.60	QP	V	25.16	16.23	8.93	40.0
147.71	QP	V	23.46	12.11	11.35	43.5
160.14	QP	V	23.48	11.47	12.01	43.5
900.52	QP	V	37.67	26.66	11.01	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)
45.61	QP	H	21.15	10.16	10.99	40.0
160.14	QP	H	23.40	11.47	11.93	43.5
233.68	QP	H	25.33	13.07	12.26	46.0
270.75	QP	H	25.79	14.87	10.92	46.0
900.52	QP	H	37.64	26.66	10.98	46.0

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

Peak / Average Measurement:

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

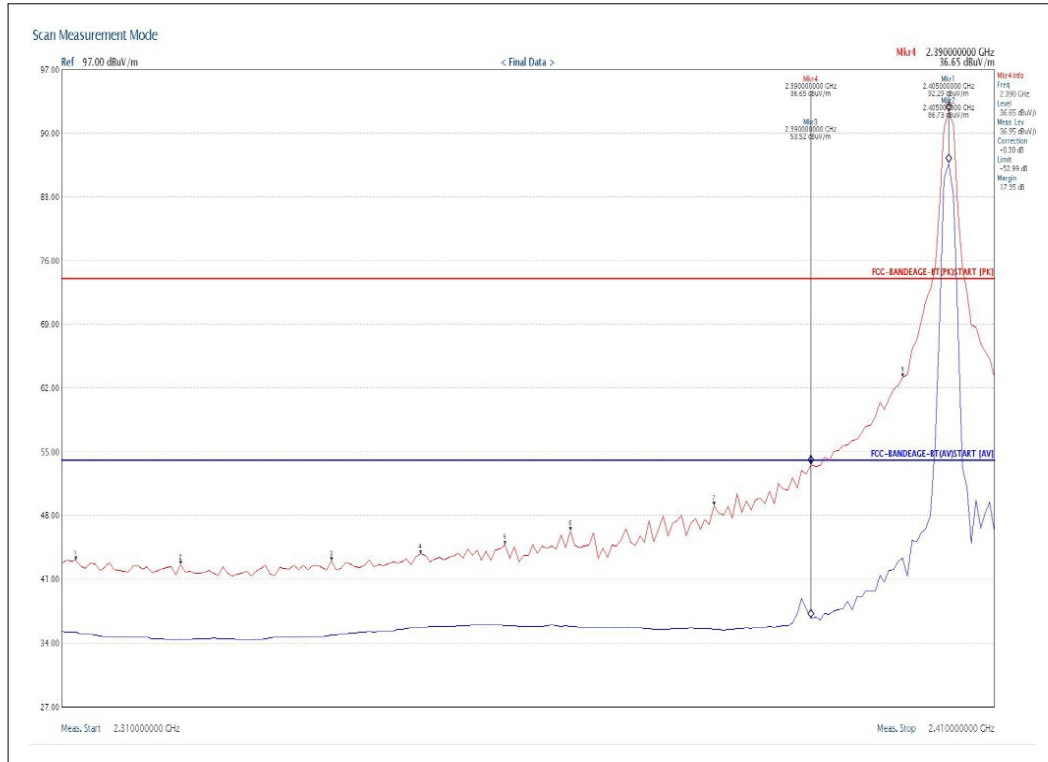
5.12.2. Radiated Emissions which fall in the restricted bands

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 (2405 MHz), and highest (2477 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 $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz VBW $\geq$ RBW Sweep = auto Detector function = peak Trace = max hold For AV value: RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz VBW = 10 Hz Sweep = auto Detector function = peak Trace = max hold

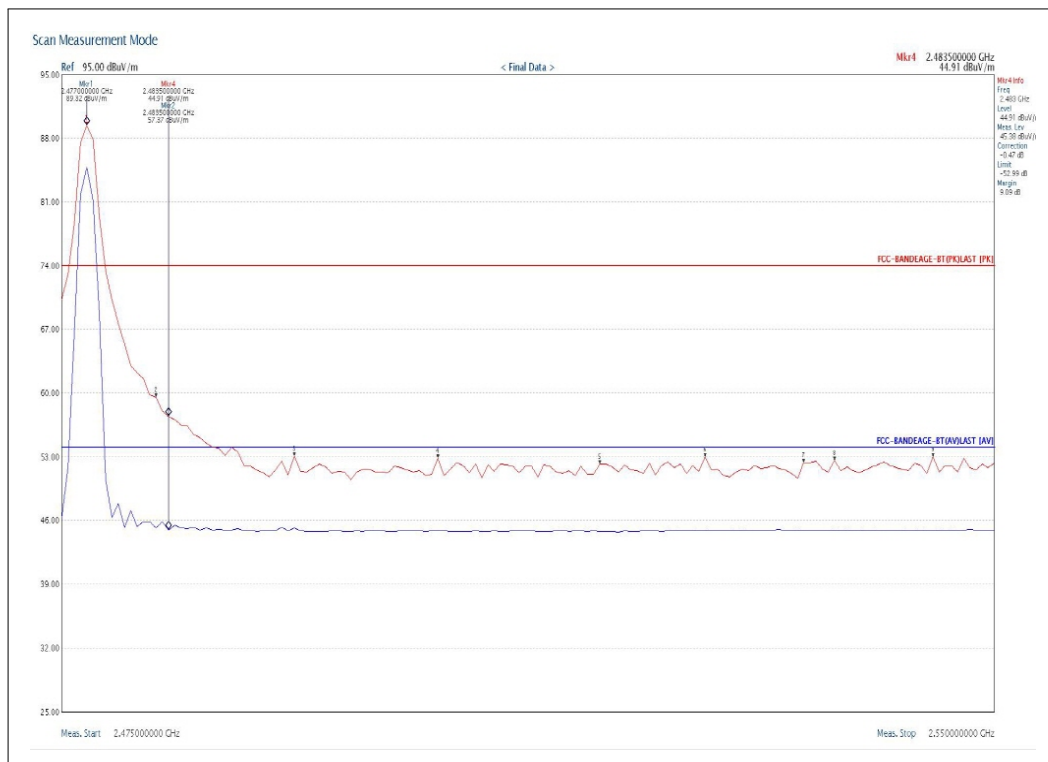


Measurement Result :

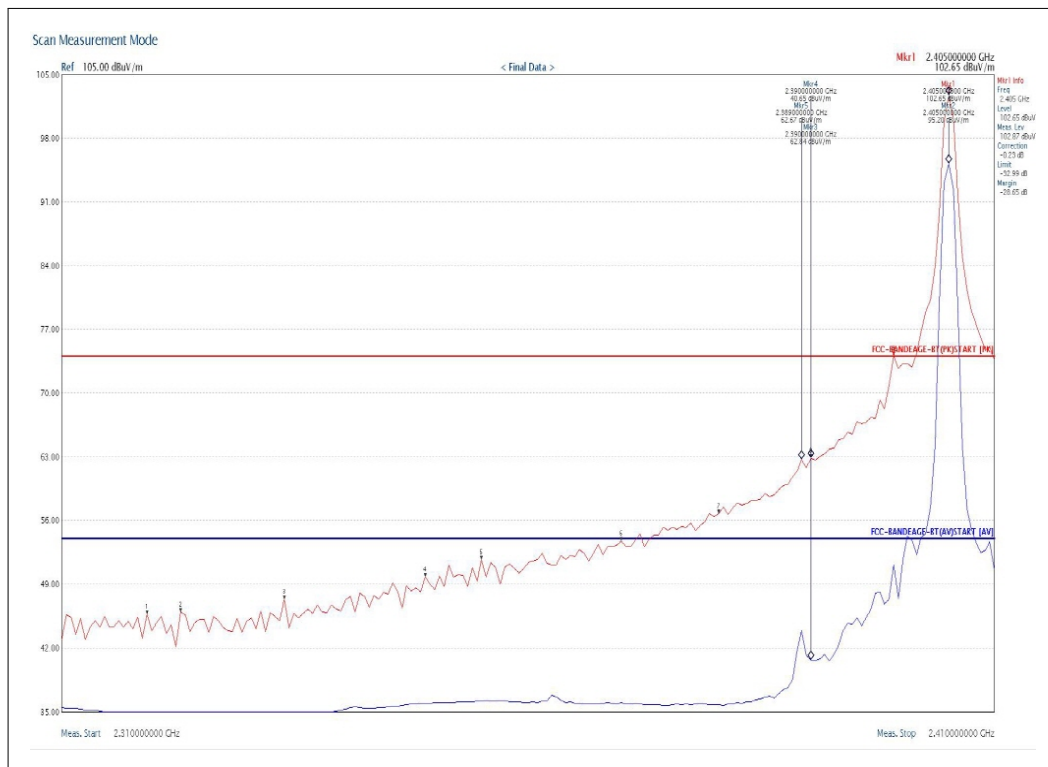
Low Channel (2405 MHz) , Horizontal , Peak/ Average Detector



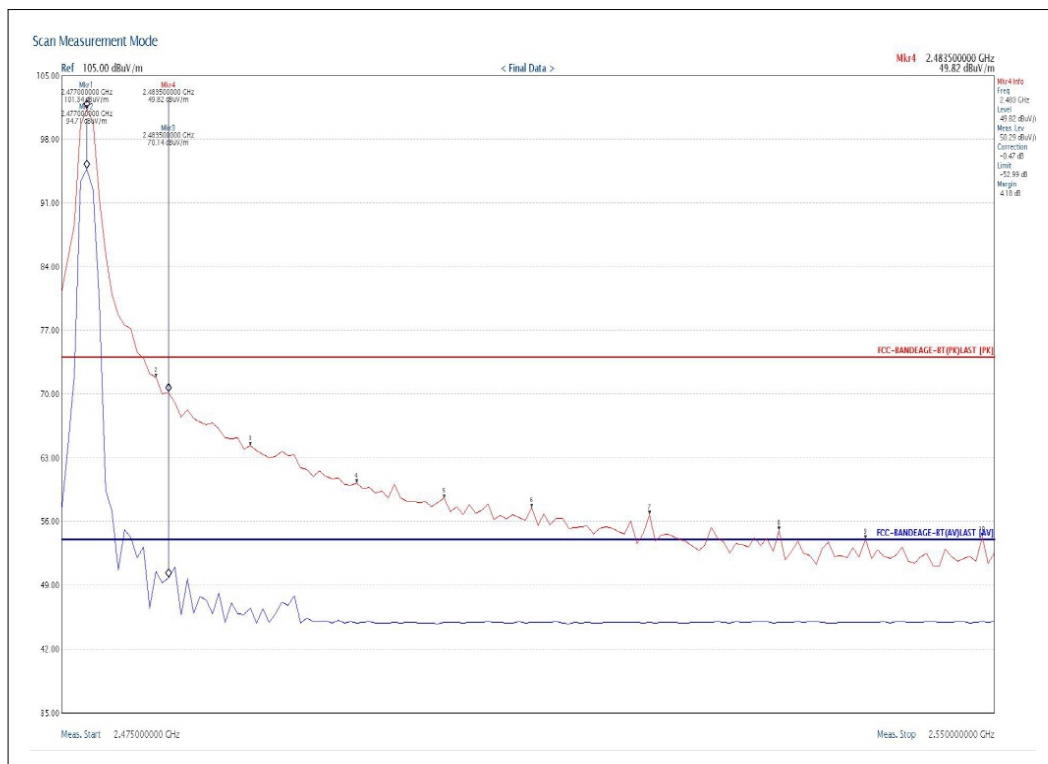
High Channel (2477MHz) , Horizontal , Peak/ Average Detector



Low Channel (2405 MHz) , Vertical , Peak/ Average Detector



High Channel (2477MHz) , Vertical , Peak/ Average Detector



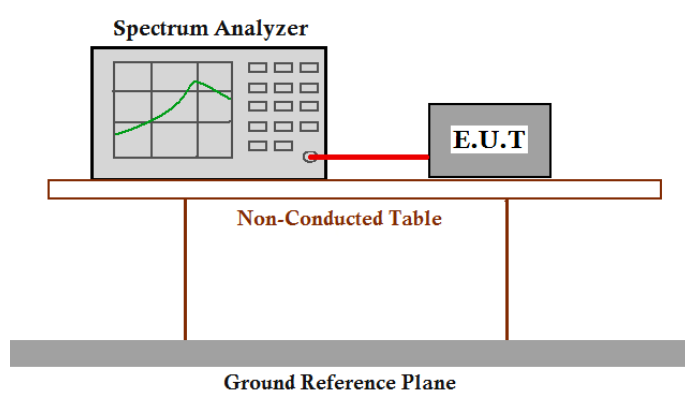


Section 15.205 Restricted bands of operation.

(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 (2405 MHz), and highest (2477 MHz) channel and hopping mode
Test Configuration:	 The diagram illustrates the test setup. A Spectrum Analyzer and an E.U.T. (Equipment Under Test) are connected by a red cable. They are positioned on a table labeled 'Non-Conducted Table'. This table is supported by two vertical legs, which are connected to a 'Ground Reference Plane' at the bottom.
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.

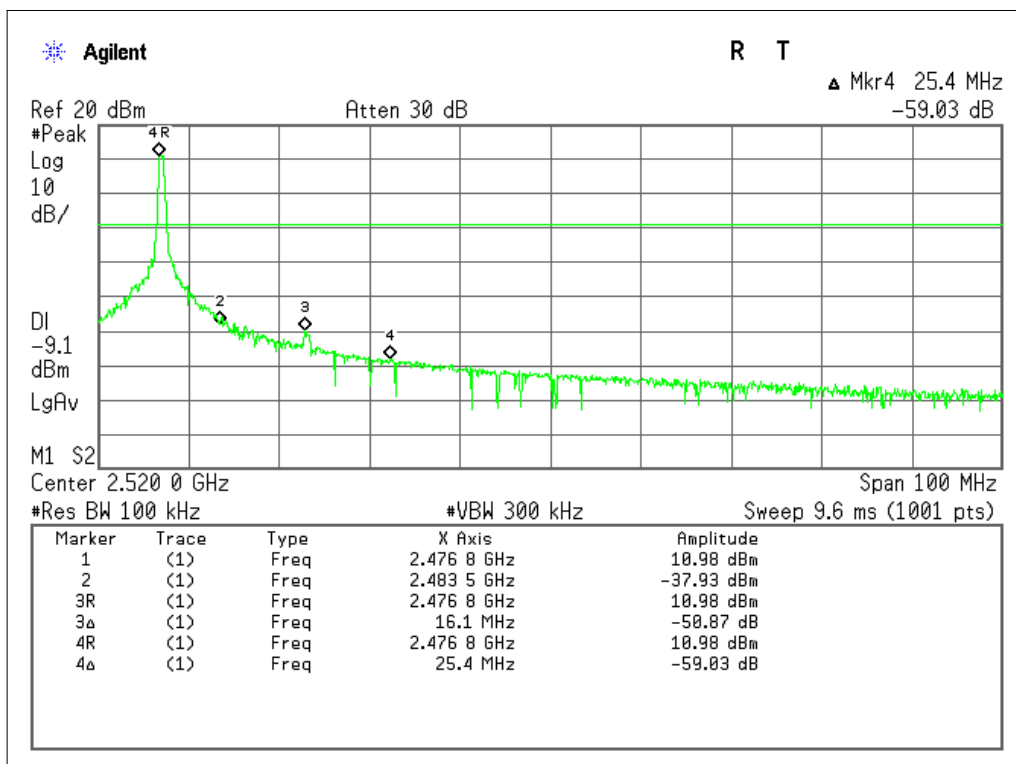
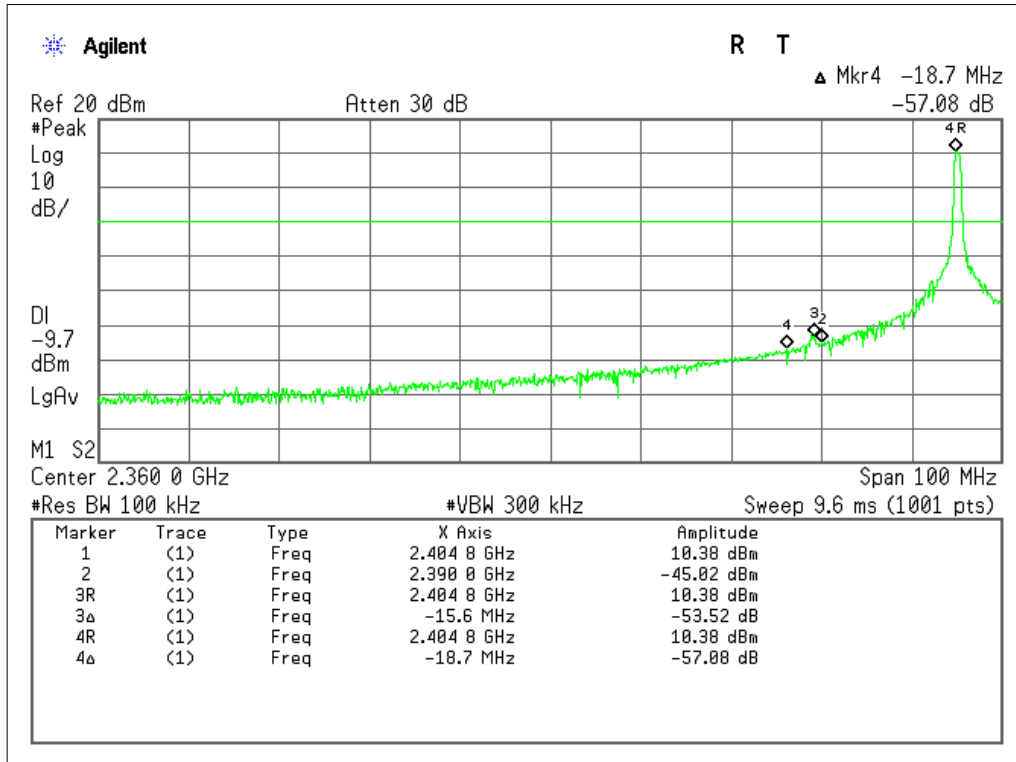
The Upper Edges attenuated more than 20dB.

The graph as below. Represents the emissions take for this device.



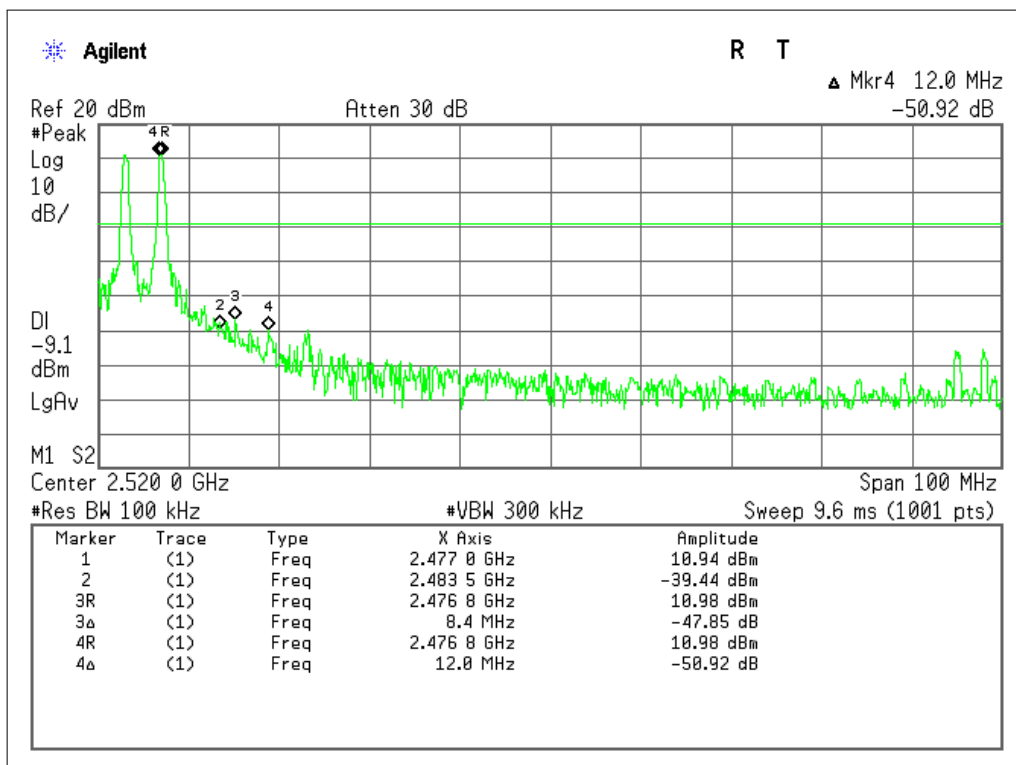
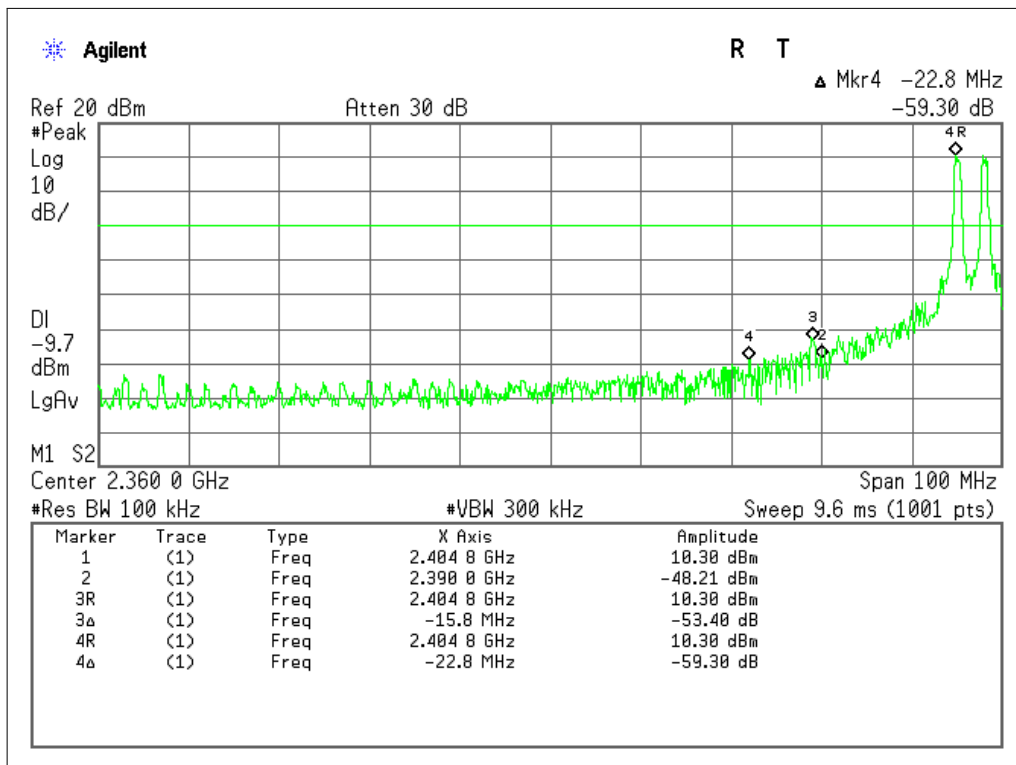
Result plot as follows :

Lowest Channel(2.405 GHz):





Highest Channel(2.477 GHz):





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

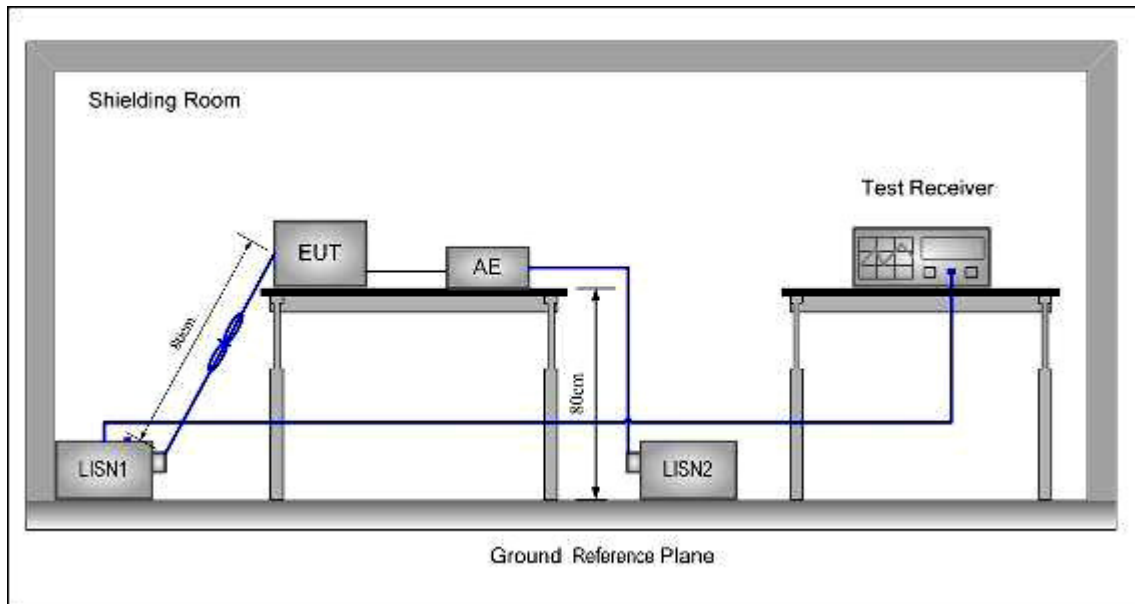
Test Requirement:	FCC Part 15 C section 15.207
Test Method:	ANSI C63.10:2013
Frequency Range:	150 kHz to 30 MHz
Detector:	Peak for pre-scan (9 kHz Resolution Bandwidth)

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).
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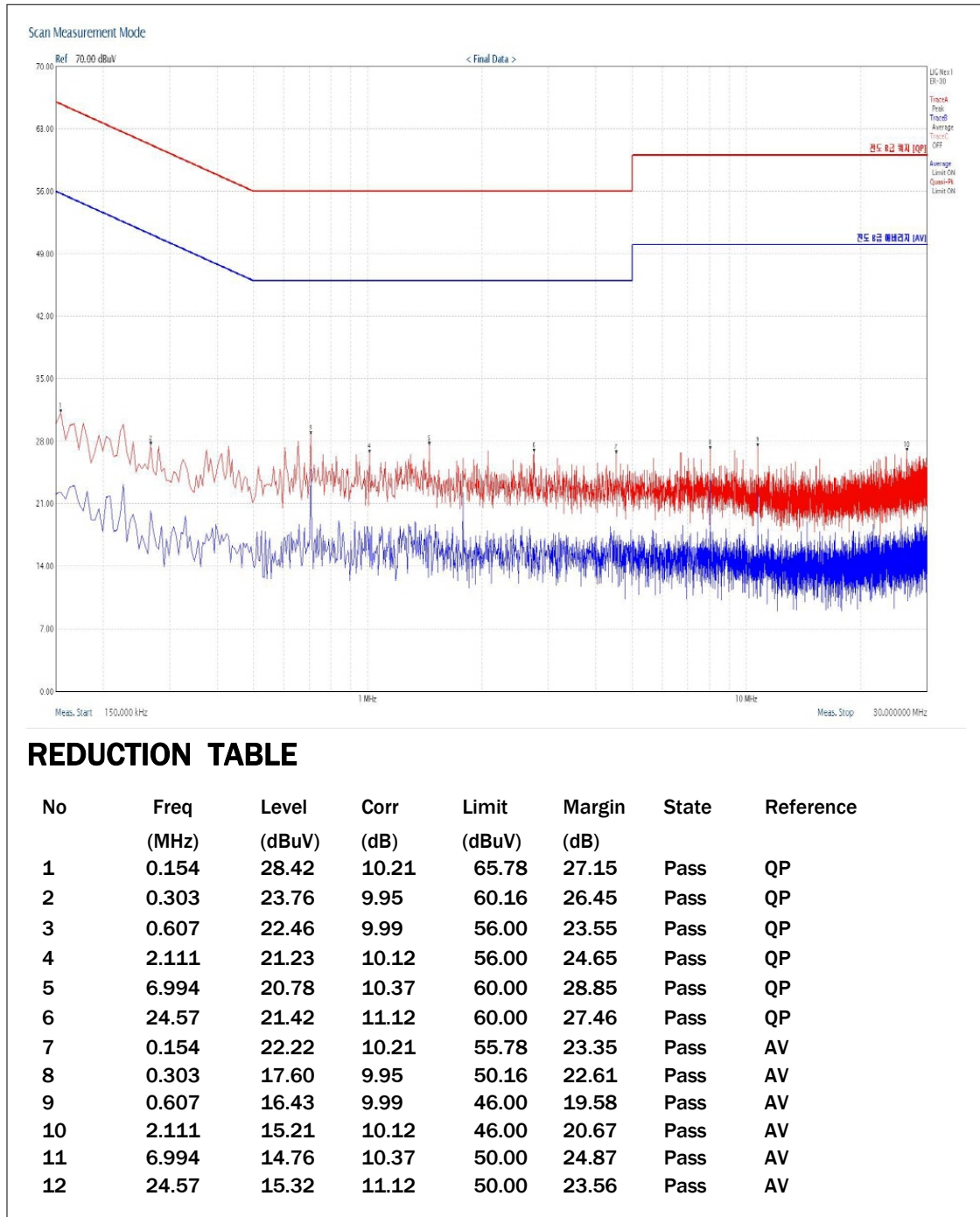
Test Configuration:**Test procedure:**

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 $50/50\mu\text{H} + 5\text{linear}$ impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
 3. The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, 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.

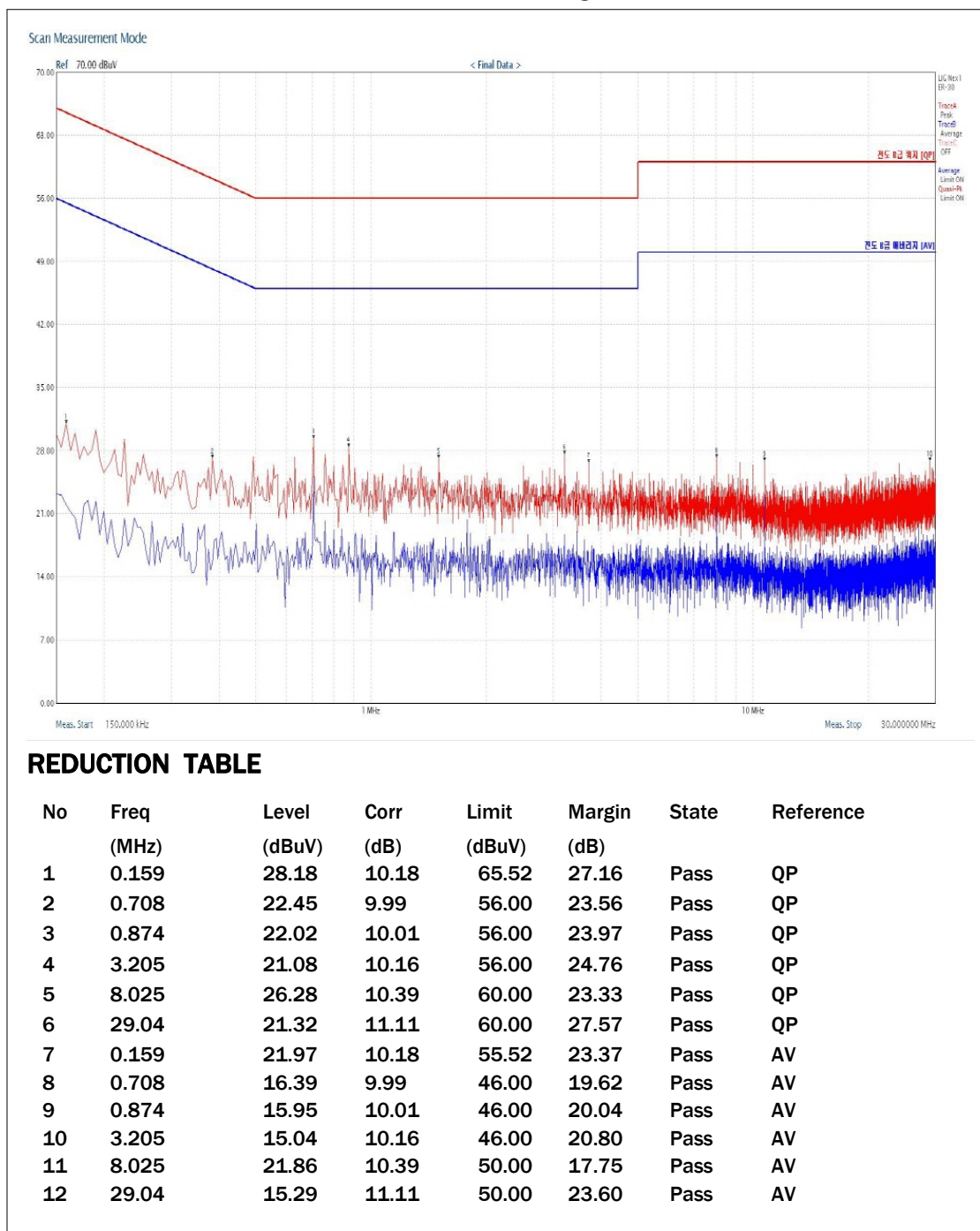
5.14.1. Measurement Data

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(QuasiPeak and Average detector used)



Neutral – PE(QuasiPeak and Average detector used)



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 §2.1091, §2.1093 and §1.1307(b), 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 level in excess of the Commission's guidelines.

Table 1—Limits for Maximum Permissible Exposure (MPE)

Frequency range(MHz)	Electric field strength(V/m)	Magnetic field strength(A/m)	Power density (mW/cm ²)	Averaging time (minutes)
<i>(A) Limits for Occupational/Controlled Exposures</i>				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
<i>(B) Limits for General Population/Uncontrolled Exposure</i>				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1 to Table 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

$$S = \frac{PG}{4\pi R^2}$$

Where S = power density in mW/cm²

P = transmit power in mW

G = numeric gain of transmit antenna (numeric gain=Log-1(dB antenna gain/10))

R = distance (cm)

The calculations in the table below use the highest gain of antenna for client EUT. These calculations represent worst case in terms of the exposure levels.



Measurement Data

Channel Frequency	Power		Antenna Gain	Numeric antenna gain	R	S	Limits
(MHz)	(dBm)	(mW)	(dBi)	(mW)	(cm)	(mW/cm ²)	(mW/cm ²)
2402	10.36	10.864	5.0	3.16	20	0.0068	1.0
2440	10.53	11.297	5.0	3.16	20	0.0071	1.0
2480	11.00	12.589	5.0	3.16	20	0.0079	1.0

Note: 1.0 mW/cm² from 1.310 §Table 1

The worst MPE = 0.0079 mW/cm² < 1.0 mW/cm².

Conclusion : The SAR measurement is exempt.

APPENDIX

1. EUT photo

