

FCC Test Report

Product Name	2.4GHz Dongle
Model No.	GM41WD
FCC ID	I4L-GM41WD

Applicant	MICRO-STAR INT'L Co., LTD.
Address	No.69, Lide St., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)

Date of Receipt	Jan. 04, 2021
Issued Date	Feb. 02, 2021
Report No.	2110069R-E3032110120
Report Version	V1.0



The test results relate only to the samples tested.

The test results shown in the test report are traceable to the national/international standard through the calibration report of the equipment and evaluated measurement uncertainty herein.

This report must not be used to claim product endorsement by TAF or any agency of the government.

The test report shall not be reproduced without the written approval of DEKRA Testing and Certification Co., Ltd.

Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Test Report

Issued Date: Feb. 02, 2021

Report No.: 2110069R-E3032110120



Product Name	2.4GHz Dongle
Applicant	MICRO-STAR INT'L Co., LTD.
Address	No.69, Lide St., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)
Manufacturer	Maorui Electronics (Dongguan) Co., Ltd.
Model No.	GM41WD
FCC ID	I4L-GM41WD
EUT Rated Voltage	DC 5V (Power by USB)
EUT Test Voltage	DC 5V (Power by USB)
Trade Name	msi
Applicable Standard	FCC CFR Title 47 Part 15 Subpart C ANSI C63.4: 2014, ANSI C63.10: 2013
Test Result	Complied

Documented By : Ida Tung
(Adm. Specialist / Ida Tung)

Tested By : Ivan Chuang
(Senior Engineer / Ivan Chuang)


Approved By : 
(Director / Vincent Lin)

TABLE OF CONTENTS

Description	Page
1. GENERAL INFORMATION	5
1.1. EUT Description.....	5
1.2. Tested System Details.....	7
1.3. Configuration of Test System	7
1.4. EUT Exercise Software	7
1.5. Test Facility	8
1.6. List of Test Equipment	9
1.7. Uncertainty	10
2. Conducted Emission.....	11
2.1. Test Setup	11
2.2. Limits	11
2.3. Test Procedure	12
2.4. Test Result of Conducted Emission.....	13
3. Radiated Emission.....	15
3.1. Test Setup	15
3.2. Limits	16
3.3. Test Procedure	17
3.4. Test Result of Radiated Emission.....	18
4. Band Edge	32
4.1. Test Setup	32
4.2. Limits	32
4.3. Test Procedure	33
4.4. Test Result of Band Edge	34
5. Duty Cycle.....	38
5.1. Test Setup	38
5.2. Test Result of Duty Cycle.....	39
6. EMI Reduction Method During Compliance Testing	40

Attachment 1: EUT Test Photographs

Attachment 2: EUT Detailed Photographs

Revision History

Report No.	Version	Description	Issued Date
2110069R-E3032110120	V1.0	Initial issue of report.	Feb. 02, 2021

1. GENERAL INFORMATION

1.1. EUT Description

Product Name	2.4GHz Dongle
Trade Name	msi
Model No.	GM41WD
FCC ID	I4L-GM41WD
Frequency Range	2403-2480MHz
Channel Number	78CH
Type of Modulation	GFSK
Antenna Type	PCB Antenna
Antenna Gain	Refer to the table "Antenna List"
Channel Control	Auto

Antenna List

No.	Manufacturer	Part No.	Antenna Type	Peak Gain
1	Maorui Electronics	RG-2023	PCB Antenna	2.35dBi for 2.4GHz

Note: The antenna of EUT is conform to FCC 15.203

Center Frequency of Each Channel:

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
Channel 01:	2403 MHz	Channel 21:	2423 MHz	Channel 41:	2443 MHz	Channel 61:	2463 MHz
Channel 02:	2404 MHz	Channel 22:	2424 MHz	Channel 42:	2444 MHz	Channel 62:	2464 MHz
Channel 03:	2405 MHz	Channel 23:	2425 MHz	Channel 43:	2445 MHz	Channel 63:	2465 MHz
Channel 04:	2406 MHz	Channel 24:	2426 MHz	Channel 44:	2446 MHz	Channel 64:	2466 MHz
Channel 05:	2407 MHz	Channel 25:	2427 MHz	Channel 45:	2447 MHz	Channel 65:	2467 MHz
Channel 06:	2408 MHz	Channel 26:	2428 MHz	Channel 46:	2448 MHz	Channel 66:	2468 MHz
Channel 07:	2409 MHz	Channel 27:	2429 MHz	Channel 47:	2449 MHz	Channel 67:	2469 MHz
Channel 08:	2410 MHz	Channel 28:	2430 MHz	Channel 48:	2450 MHz	Channel 68:	2470 MHz
Channel 09:	2411 MHz	Channel 29:	2431 MHz	Channel 49:	2451 MHz	Channel 69:	2471 MHz
Channel 10:	2412 MHz	Channel 30:	2432 MHz	Channel 50:	2452 MHz	Channel 70:	2472 MHz
Channel 11:	2413 MHz	Channel 31:	2433 MHz	Channel 51:	2453 MHz	Channel 71:	2473 MHz
Channel 12:	2414 MHz	Channel 32:	2434 MHz	Channel 52:	2454 MHz	Channel 72:	2474 MHz
Channel 13:	2415 MHz	Channel 33:	2435 MHz	Channel 53:	2455 MHz	Channel 73:	2475 MHz
Channel 14:	2416 MHz	Channel 34:	2436 MHz	Channel 54:	2456 MHz	Channel 74:	2476 MHz
Channel 15:	2417 MHz	Channel 35:	2437 MHz	Channel 55:	2457 MHz	Channel 75:	2477 MHz
Channel 16:	2418 MHz	Channel 36:	2438 MHz	Channel 56:	2458 MHz	Channel 76:	2478 MHz
Channel 17:	2419 MHz	Channel 37:	2439 MHz	Channel 57:	2459 MHz	Channel 77:	2479 MHz
Channel 18:	2420 MHz	Channel 38:	2440 MHz	Channel 58:	2460 MHz	Channel 78:	2480 MHz
Channel 19:	2421 MHz	Channel 39:	2441 MHz	Channel 59:	2461 MHz		
Channel 20:	2422 MHz	Channel 40:	2442 MHz	Channel 60:	2462 MHz		

Note:

1. The EUT is a 2.4GHz Dongle with a built-in 2.4GHz wireless transceiver.
2. Regarding to the operation frequency, the lowest, middle and highest frequency are selected to perform the test.
3. These tests are conducted on a sample of the equipment for the purpose of demonstrating compliance of transmitter with Part 15 Subpart C Paragraph 15.249 for spread spectrum devices.
4. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.

Test Mode	Mode 1: Transmit
	Mode 2: Normal mode

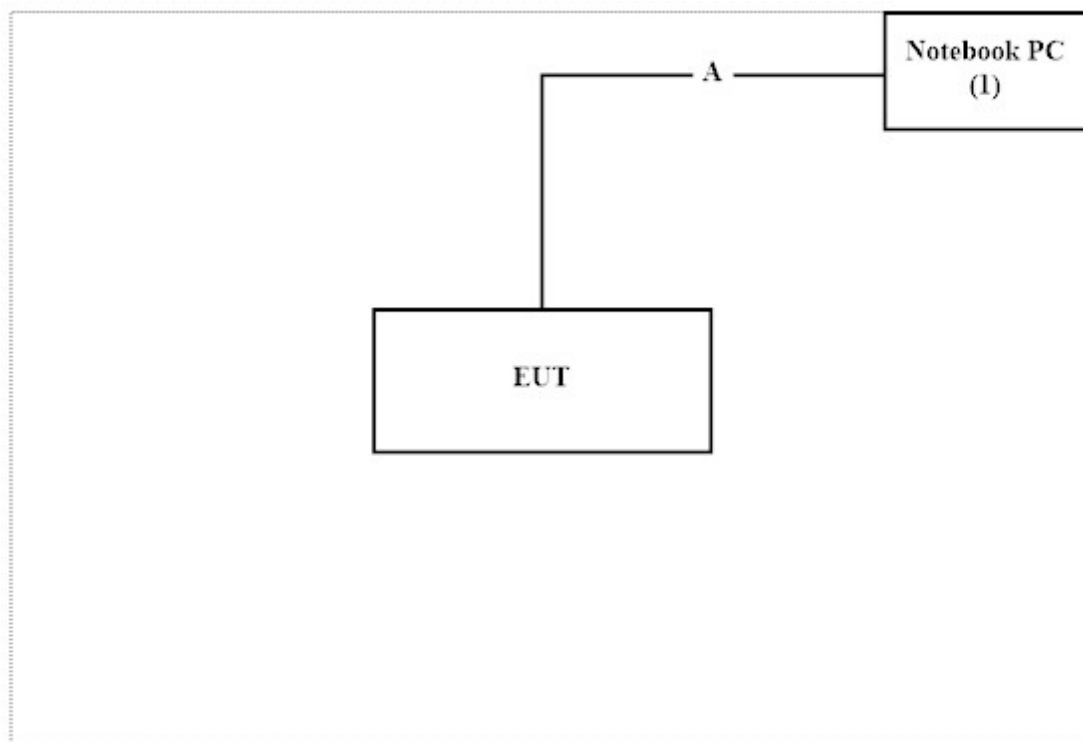
1.2. Tested System Details

The types for all equipment, plus descriptions of all cables used in the tested system (including inserted cards) are:

Product	Manufacturer	Model No.	Serial No.	Power Cord
1 Notebook PC	DELL	Latitude 5580	GDZN7H2	Non-shielded, 0.8m

Signal Cable Type	Signal cable Description
A USB Cable	Shielded, 1.8m

1.3. Configuration of Test System



1.4. EUT Exercise Software

- (1) Setup the EUT as shown in Section 1.3.
- (2) Execute “RG2023-MSI GM41W Mouse FCC Test Utility v002” program on the Notebook PC.
- (3) Configure the test mode and the test channel
- (4) Start the continuous transmit.
- (5) Verify that the EUT works properly.

1.5. Test Facility

Ambient conditions in the laboratory:

Performed Item	Items	Required	Actual
Conducted Emission	Temperature (°C)	10~40 °C	20.7 °C
	Humidity (%RH)	10~90 %	44.8 %
Radiated Emission	Temperature (°C)	10~40 °C	21.4 °C
	Humidity (%RH)	10~90 %	62.0 %
Conductive	Temperature (°C)	10~40 °C	23.2 °C
	Humidity (%RH)	10~90 %	56.0 %

USA : FCC Registration Number: TW0023

Canada : IC Registration Number: 25880

Site Description : Accredited by TAF
Accredited Number: 3023

Test Laboratory : DEKRA Testing and Certification Co., Ltd
Address : No.159, Sec. 2, Wenhua 1st Rd., Linkou Dist.,
New Taipei City 24457, Taiwan, R.O.C.

Phone number : 886-2-2602-7968
Fax number : 866-2-2602-3286
Email address : info.tw@dekra.com
Website : <http://www.dekra.com.tw>

1.6. List of Test Equipment

For Conduction measurements /ASR1

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	EMI Test Receiver	R&S	ESR7	101601	2020.05.28	2021.05.27
X	Two-Line V-Network	R&S	ENV216	101306	2020.03.25	2021.03.24
X	Two-Line V-Network	R&S	ENV216	101307	2020.04.17	2021.04.16
X	Coaxial Cable	DEKRA	RG400_BNC	RF001	2020.05.24	2021.05.23

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.
3. Test Software version : DEKRA Testing System V2.0

For Conducted measurements /ASR2

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	Spectrum Analyzer	Keysight	N9010B	MY59071415	2020.08.15	2021.08.14
	Power Meter	Anritsu	ML2496A	1548002	2020.02.10	2021.02.09
	Power Sensor	Anritsu	MA2411B	1531022	2020.02.10	2021.02.09
	Power Sensor	Anritsu	MA2411B	1531023	2020.02.10	2021.02.09

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.
3. Test Software version : DEKRA Conduction Test System V9.0.5

For Radiated measurements /ACB1

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	Loop Antenna	AMETEK	HLA6121	49611	2020.03.16	2021.03.15
X	Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-675	2020.07.20	2021.07.19
X	Horn Antenna	ETS-Lindgren	3117	00201366	2020.09.21	2021.09.20
X	Horn Antenna	Com-Power	AH-840	101088	2020.09.11	2021.09.10
X	Pre-Amplifier	EMCI	EMC001330	980301	2020.06.04	2021.06.03
X	Pre-Amplifier	EMCI	EMC051835SE	980313	2020.11.25	2021.11.24
X	Pre-Amplifier	EMCI	EMC05820SE	980310	2020.06.24	2021.06.23
X	Pre-Amplifier	EMCI	EMC051845SE	980632	2020.08.21	2021.08.20
X	Filter	MICRO TRONICS	BRM50702	G251	2020.09.17	2021.09.16
	Filter	MICRO TRONICS	BRM50716	G188	2020.09.17	2021.09.16
X	EMI Test Receiver	R&S	ESR7	101601	2020.05.28	2021.05.27
X	Spectrum Analyzer	R&S	FSV40	101148	2020.03.16	2021.03.15
X	Coaxial Cable	SUHNER	SUCOFLEX 106	RF002	2020.07.03	2021.07.02
X	Mircoflex Cable	HUBER SUHNER	SUCOFLEX 102	MY3381/2	2020.06.10	2021.06.09

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with “X” are used to measure the final test results.
3. Test Software version : DEKRA Testing System V2.0

1.7. Uncertainty

Uncertainties have been calculated according to the DEKRA internal document, and is described in each test chapter of this report.

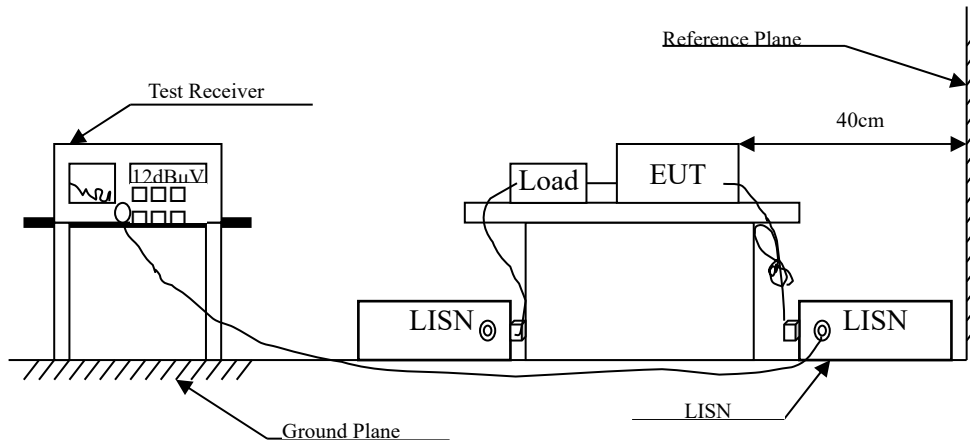
The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Test item	Uncertainty	
Conducted Emission	± 3.42 dB	
Radiated Emission	Under 1GHz ± 4.06 dB	Above 1GHz ± 3.73 dB
Band Edge	Under 1GHz ± 4.06 dB	Above 1GHz ± 3.73 dB
Duty Cycle	± 2.31 ms	

2. Conducted Emission

2.1. Test Setup



2.2. Limits

FCC Part 15 Subpart C Paragraph 15.207 (dB μ V) Limit		
Frequency MHz	Limits	
	QP	AV
0.15 - 0.50	66-56	56-46
0.50-5.0	56	46
5.0 - 30	60	50

Remarks: In the above table, the tighter limit applies at the band edges.

2.3. Test Procedure

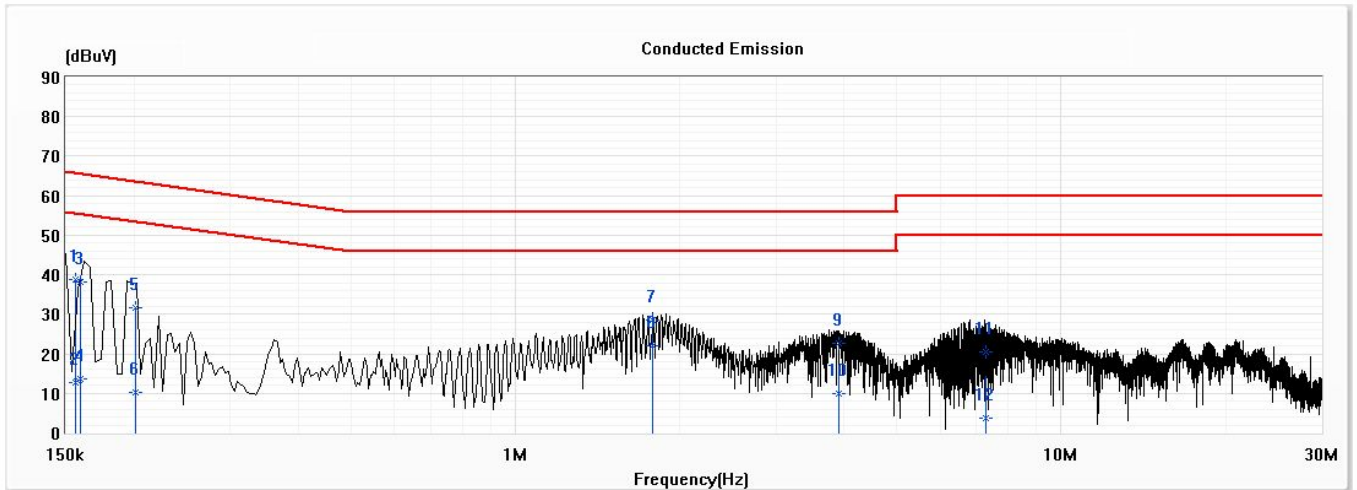
The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm /50uH coupling impedance with 50ohm termination. (Please refers to the block diagram of the test setup and photographs.)

Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2014 on conducted measurement.

Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

2.4. Test Result of Conducted Emission

Product : 2.4GHz Dongle
 Test Item : Conducted Emission Test
 Power Line : L 1
 Test Date : 2021/01/29
 Test Mode : Mode 1: Transmit (2441 MHz)

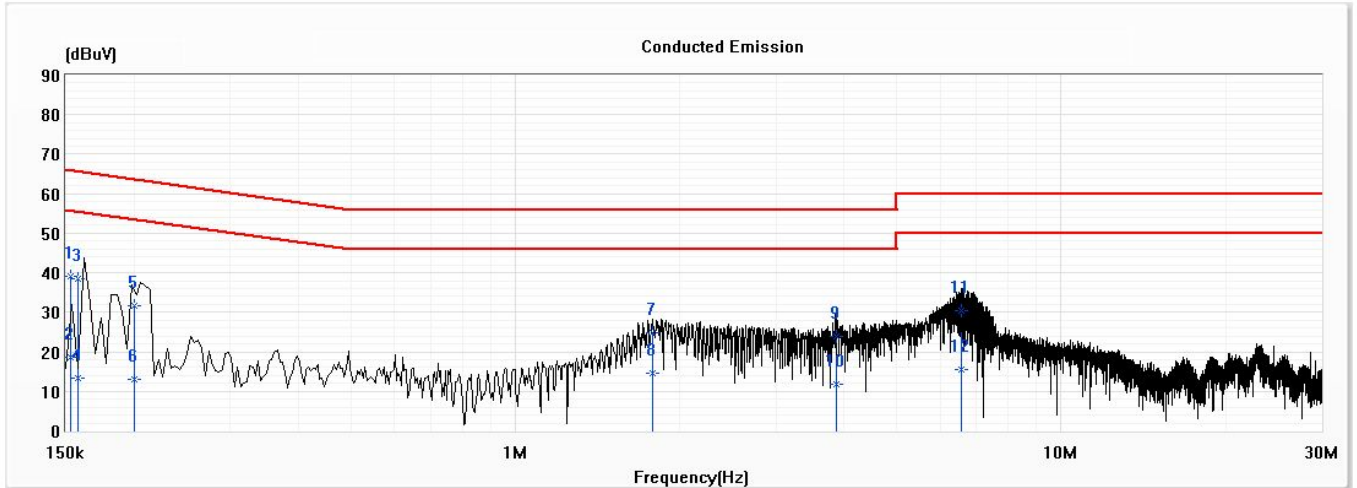


No	Frequency (MHz)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	0.156	38.71	65.67	-26.96	29.05	9.66	QP
2	0.156	12.84	55.67	-42.82	3.18	9.66	AV
3	0.160	38.17	65.47	-27.30	28.52	9.66	QP
4	0.160	13.56	55.47	-41.91	3.90	9.66	AV
5	0.201	31.63	63.56	-31.93	21.98	9.65	QP
6	0.201	10.09	53.56	-43.47	0.44	9.65	AV
7	1.782	28.65	56.00	-27.35	18.93	9.71	QP
*8	1.782	21.88	46.00	-24.12	12.17	9.71	AV
9	3.904	22.67	56.00	-33.33	12.90	9.77	QP
10	3.904	9.88	46.00	-36.12	0.11	9.77	AV
11	7.260	20.48	60.00	-39.52	10.64	9.84	QP
12	7.260	3.64	50.00	-46.36	-6.20	9.84	AV

Note:

1. All Reading Levels are Quasi-Peak and average value.
2. “ * “ means the worst emission level.
3. Measurement Level = Reading Level + Correct Factor

Product : 2.4GHz Dongle
 Test Item : Conducted Emission Test
 Power Line : N
 Test Date : 2021/01/29
 Test Mode : Mode 1: Transmit (2441 MHz)



No	Frequency (MHz)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
*1	0.153	39.12	65.83	-26.72	29.45	9.67	QP
2	0.153	18.62	55.83	-37.21	8.95	9.67	AV
3	0.158	38.62	65.56	-26.94	28.95	9.67	QP
4	0.158	13.27	55.56	-42.29	3.60	9.67	AV
5	0.200	31.54	63.60	-32.06	21.87	9.67	QP
6	0.200	13.05	53.60	-40.56	3.37	9.67	AV
7	1.788	24.85	56.00	-31.15	15.13	9.72	QP
8	1.788	14.52	46.00	-31.48	4.80	9.72	AV
9	3.870	23.87	56.00	-32.13	14.09	9.78	QP
10	3.870	11.79	46.00	-34.21	2.02	9.78	AV
11	6.559	30.44	60.00	-29.56	20.59	9.85	QP
12	6.559	15.60	50.00	-34.40	5.76	9.85	AV

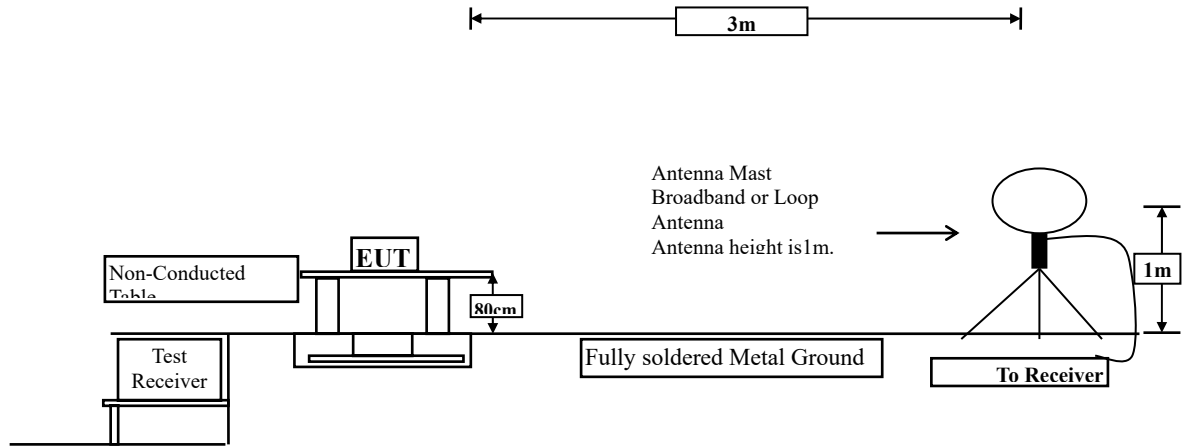
Note:

1. All Reading Levels are Quasi-Peak and average value.
2. “ * “ means the worst emission level.
3. Measurement Level = Reading Level + Correct Factor

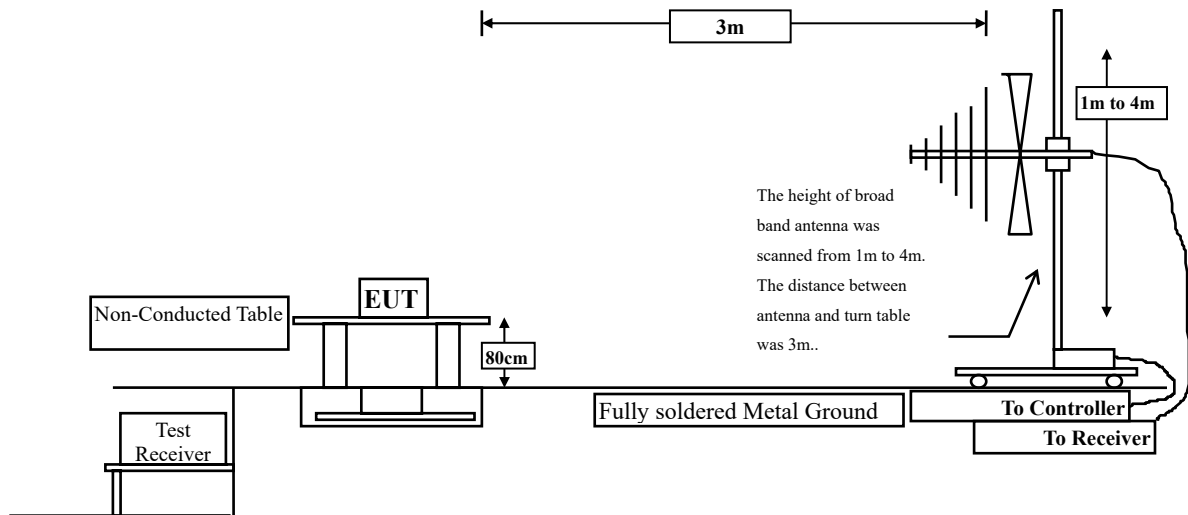
3. Radiated Emission

3.1. Test Setup

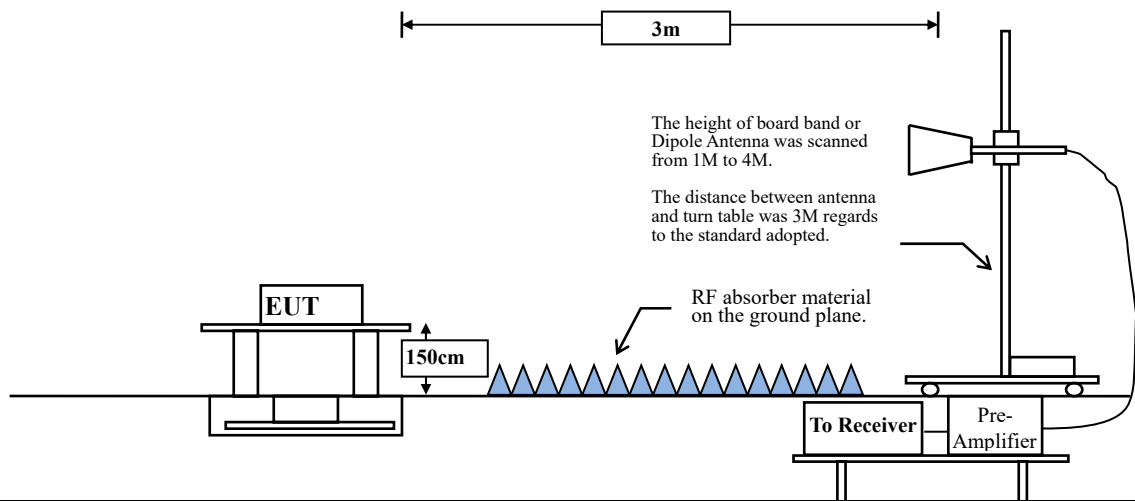
Radiated Emission Under 30MHz



Radiated Emission Below 1GHz



Radiated Emission Above 1GHz



3.2. Limits

➤ Fundamental and Harmonics Emission Limits

FCC Part 15 Subpart C Paragraph 15.249 Limits				
Frequency MHz	Field Strength of Fundamental		Field Strength of Harmonics	
	(mV/m @3m)	(dB μ V /m @3m)	(uV/m @3m)	(dB μ V /m @3m)
902-928	50	94	500	54
2400-2483.5	50	94	500	54
5725-5875	50	94	500	54
24000-24250	250	108	2500	68

- Remarks :
1. RF Voltage (dB μ V /m) = 20 log RF Voltage (uV/m)
 2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

➤ General Radiated Emission Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

FCC Part 15 Subpart C Paragraph 15.209(a) Limits		
Frequency MHz	Field strength (microvolts/meter)	Measurement distance (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remarks: E field strength (dB μ V /m) = 20 log E field strength (uV/m)

3.3. Test Procedure

The EUT was setup according to ANSI C63.10, 2013 and tested compliance to FCC 47CFR 15.249 requirements.

Measuring the frequency range below 1GHz, the EUT is placed on a turn table which is 0.8 meter above ground, when measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level.

This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10: 2013 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is 9kHz and 30MHz~1GHz is 120kHz and above 1GHz is 1MHz.

Radiated emission measurements below 30MHz are made using Loop Antenna and 30MHz~1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

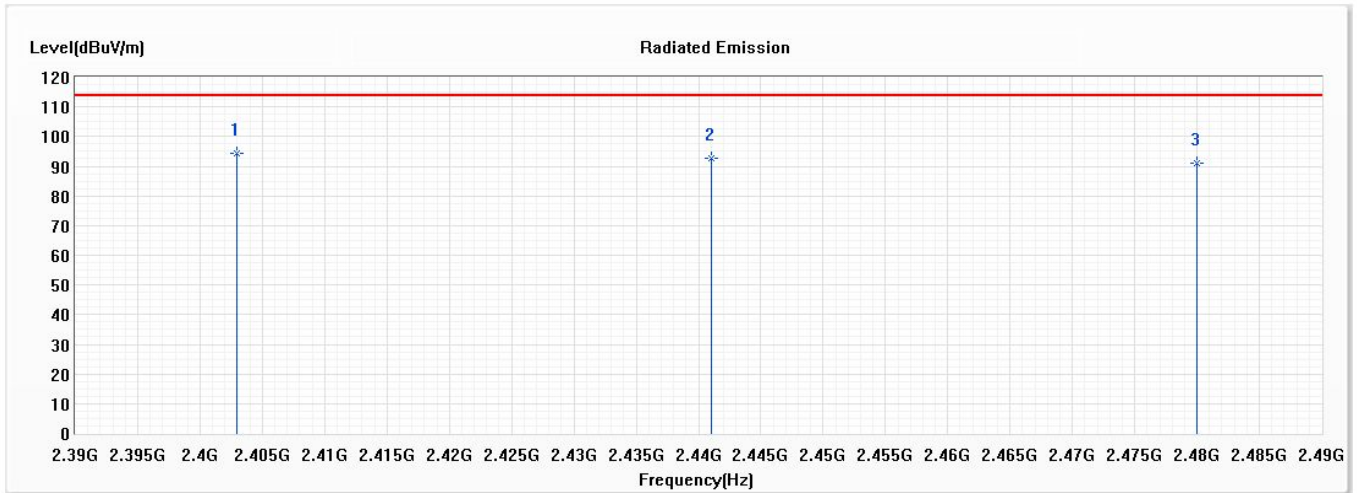
The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

The measurement frequency range from 9kHz - 10th Harmonic of fundamental was investigated.

3.4. Test Result of Radiated Emission

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Horizontal_X-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	94.53	114.00	-19.47	82.55	11.98	PK
2	2441.000	92.74	114.00	-21.26	80.61	12.13	PK
3	2480.000	90.92	114.00	-23.08	78.69	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

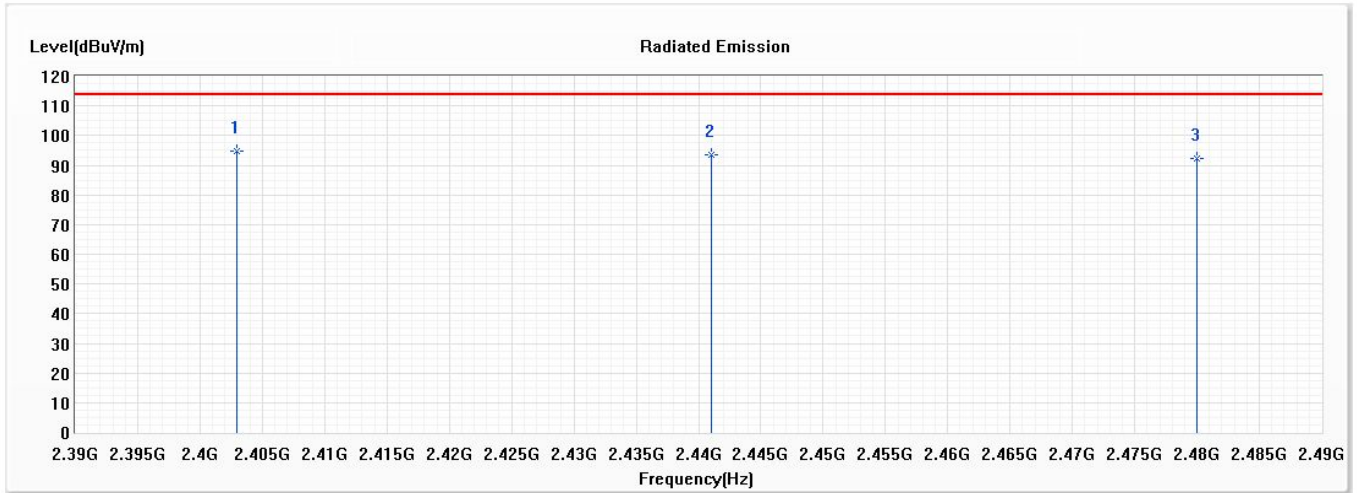
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	94.53	-25.449	69.081	-24.919	94.000
2441	92.74	-25.449	67.291	-26.709	94.000
2480	90.92	-25.449	65.471	-28.529	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Vertical_X-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	94.64	114.00	-19.36	82.66	11.98	PK
2	2441.000	93.55	114.00	-20.45	81.42	12.13	PK
3	2480.000	92.47	114.00	-21.53	80.24	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

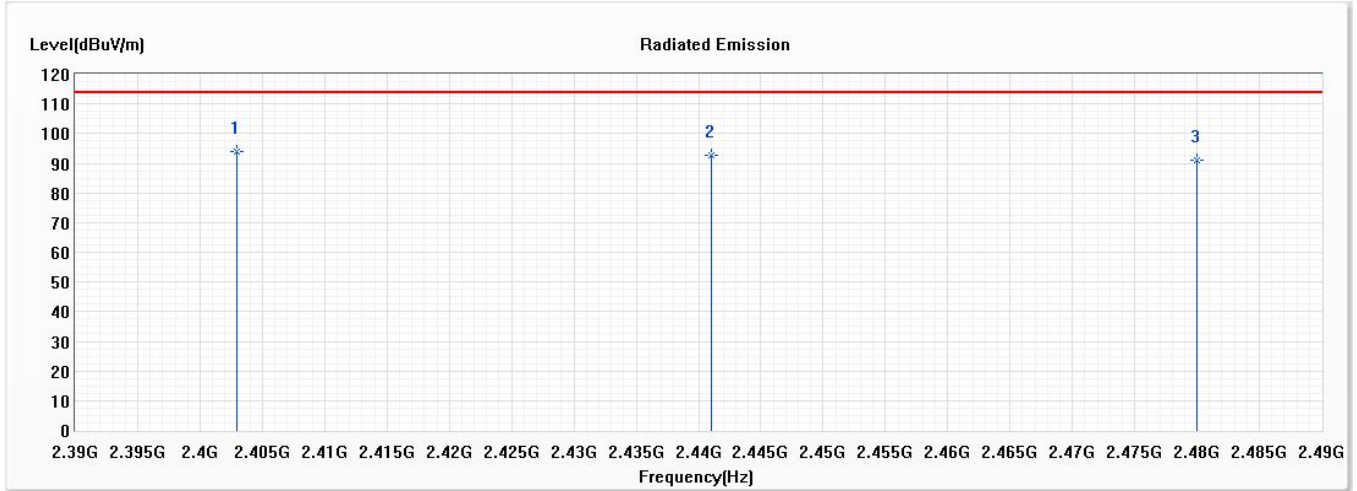
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	94.64	-25.449	69.191	-24.809	94.000
2441	93.55	-25.449	68.101	-25.899	94.000
2480	92.47	-25.449	67.021	-26.979	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Horizontal_Y-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	94.05	114.00	-19.95	82.07	11.98	PK
2	2441.000	92.53	114.00	-21.47	80.40	12.13	PK
3	2480.000	90.88	114.00	-23.12	78.65	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

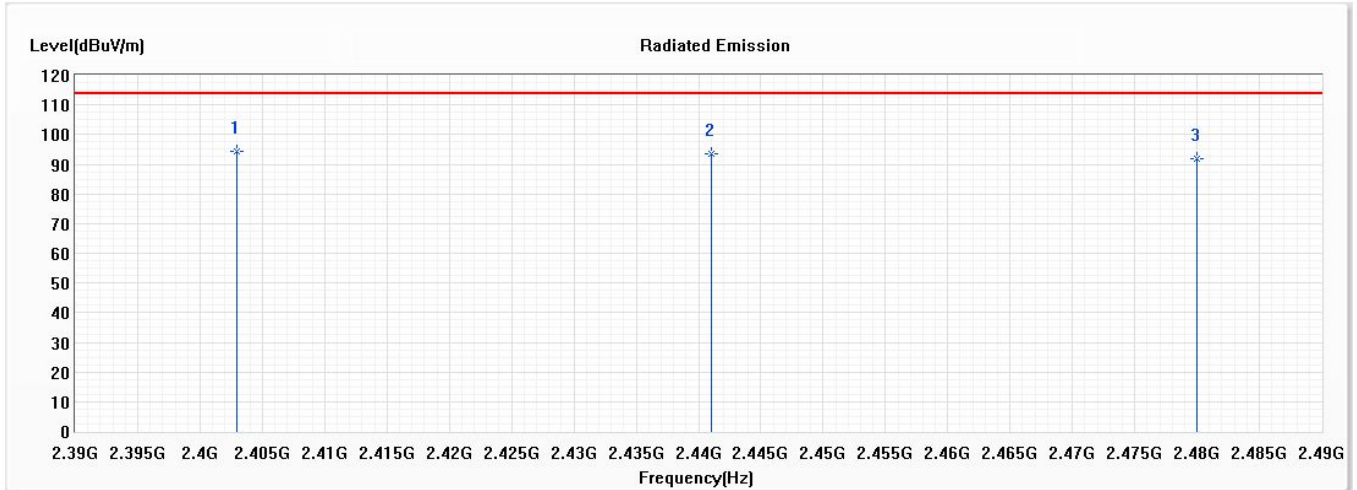
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	94.05	-25.449	68.601	-25.399	94.000
2441	92.53	-25.449	67.081	-26.919	94.000
2480	90.88	-25.449	65.431	-28.569	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Vertical_Y-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	94.17	114.00	-19.83	82.19	11.98	PK
2	2441.000	93.45	114.00	-20.55	81.32	12.13	PK
3	2480.000	92.00	114.00	-22.00	79.77	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

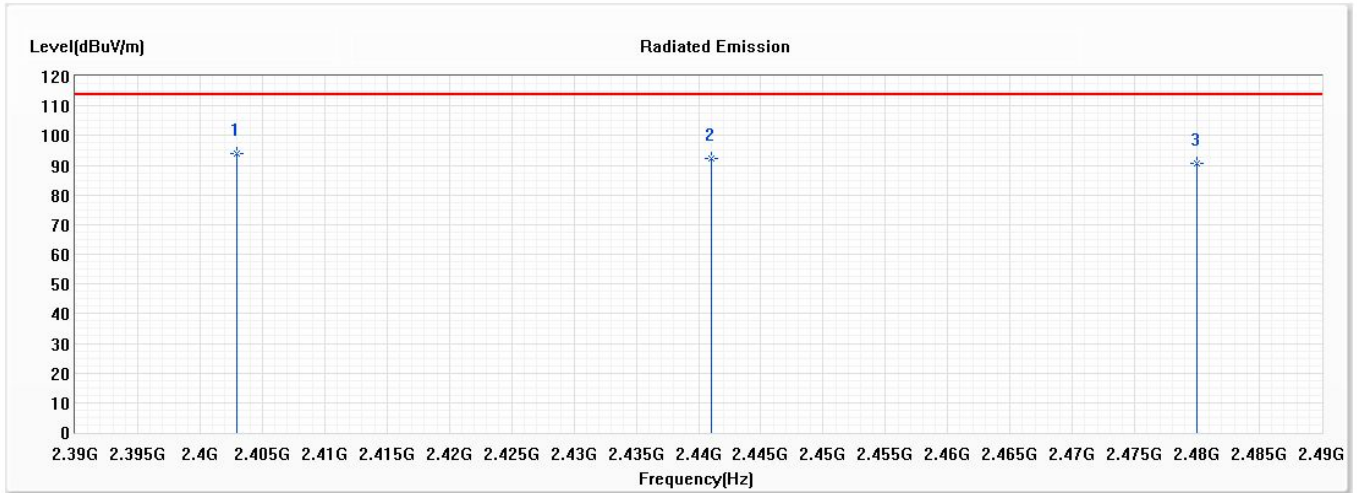
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	94.17	-25.449	68.721	-25.279	94.000
2441	93.45	-25.449	68.001	-25.999	94.000
2480	92.00	-25.449	66.551	-27.449	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Horizontal_Z-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	93.74	114.00	-20.26	81.76	11.98	PK
2	2441.000	92.36	114.00	-21.64	80.23	12.13	PK
3	2480.000	90.47	114.00	-23.53	78.24	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

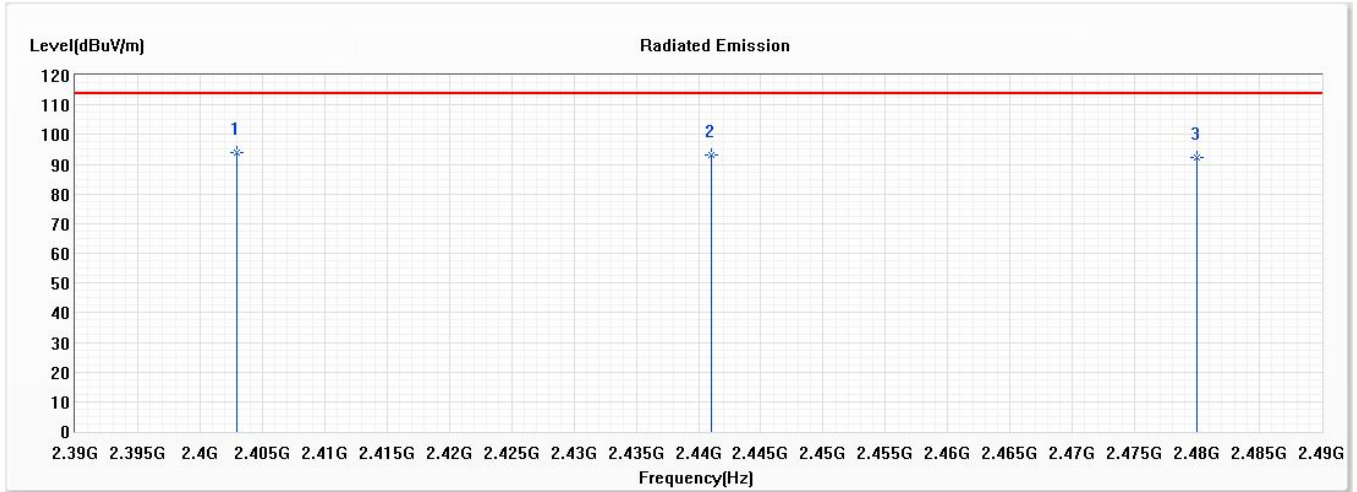
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	93.74	-25.449	68.291	-25.709	94.000
2441	92.36	-25.449	66.911	-27.089	94.000
2480	90.47	-25.449	65.021	-28.979	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Fundamental Radiated Emission
 Test Date : 2021/01/26
 Test Mode : Mode 1: Transmit

Vertical_Z-Axis



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	2403.000	93.79	114.00	-20.21	81.81	11.98	PK
2	2441.000	93.18	114.00	-20.82	81.05	12.13	PK
3	2480.000	92.24	114.00	-21.76	80.01	12.23	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.

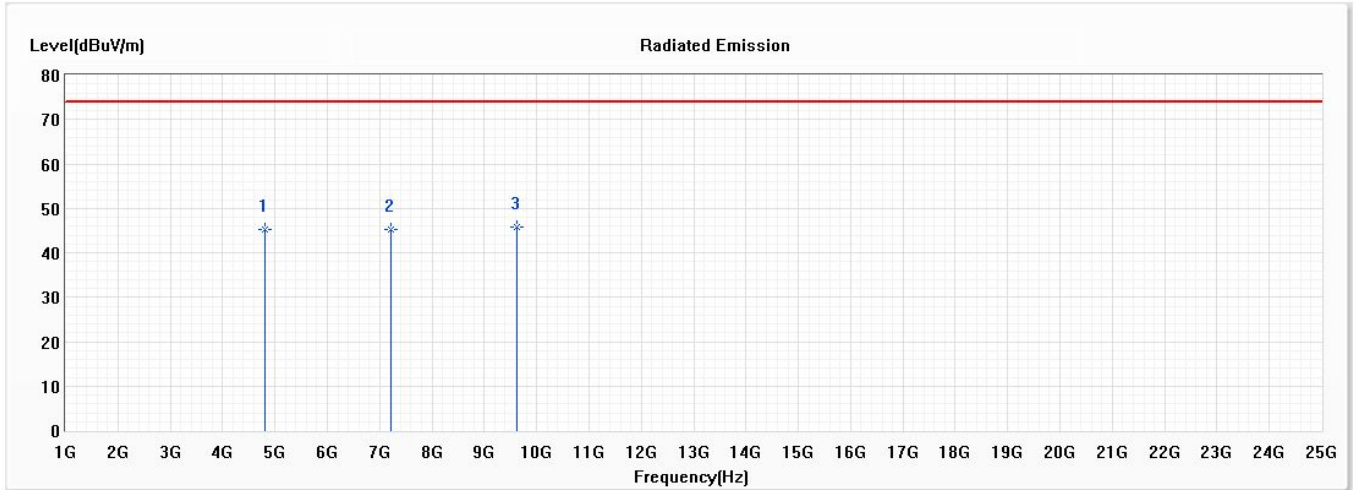
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)
2403	93.79	-25.449	68.341	-25.659	94.000
2441	93.18	-25.449	67.731	-26.269	94.000
2480	92.24	-25.449	66.791	-27.209	94.000

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2403 MHz)

Horizontal



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	4806.000	45.13	74.00	-28.87	58.16	-13.03	PK
2	7209.000	45.14	74.00	-28.86	56.83	-11.69	PK
* 3	9612.000	45.67	74.00	-28.33	56.85	-11.18	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
5. The average measurement was not performed when the peak measured data under the limit of average detection.
6. The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
---------------	-------------------------	----------------------	----------------------------	-----------	-------------------	----------------------

Average Detector:

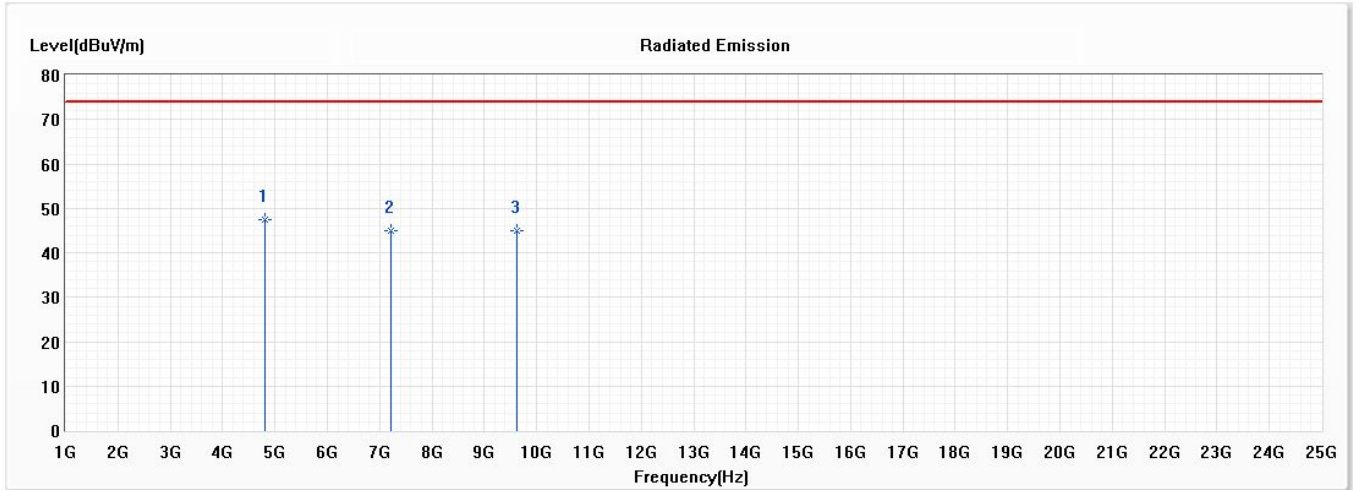
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2403 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	4806.000	47.49	74.00	-26.51	60.52	-13.03	PK
2	7209.000	44.95	74.00	-29.05	56.64	-11.69	PK
3	9612.000	45.07	74.00	-28.93	56.25	-11.18	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
5. The average measurement was not performed when the peak measured data under the limit of average detection.
6. The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
---------------	-------------------------	----------------------	----------------------------	-----------	-------------------	----------------------

Average Detector:

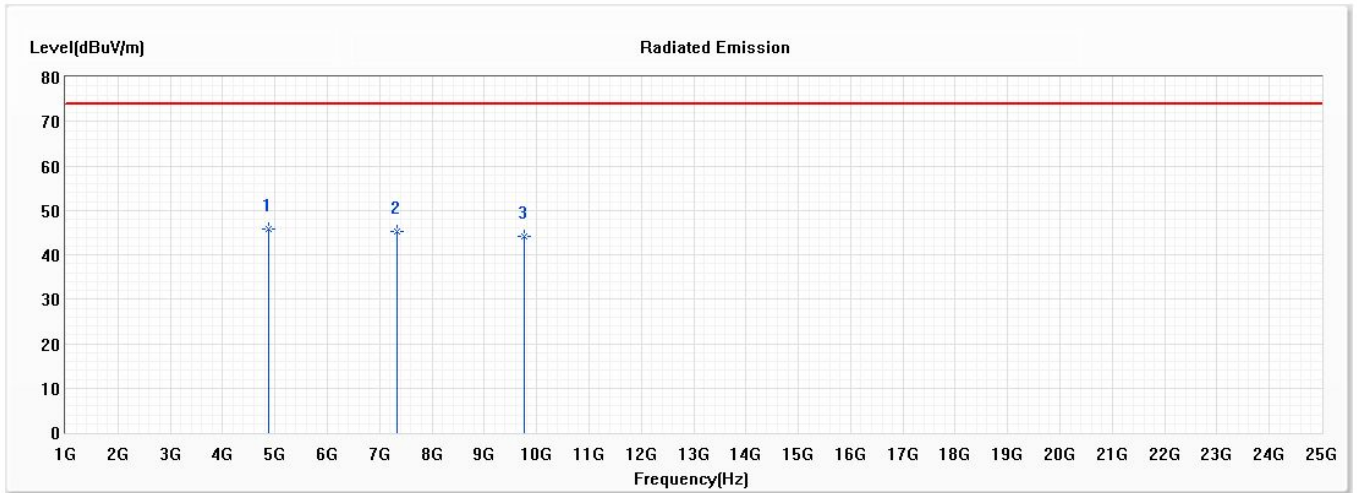
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2441 MHz)

Horizontal



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	4882.000	45.70	74.00	-28.30	58.71	-13.01	PK
2	7323.000	45.20	74.00	-28.80	57.15	-11.95	PK
3	9764.000	44.19	74.00	-29.81	55.14	-10.95	PK

Note:

- All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
- Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
- Measurement Level = Reading Level + Correct Factor.
- Correct Factor = Antenna factor + Cable loss – Amplifier gain.
- The average measurement was not performed when the peak measured data under the limit of average detection.
- The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
---------------	-------------------------	----------------------	----------------------------	-----------	-------------------	----------------------

Average Detector:

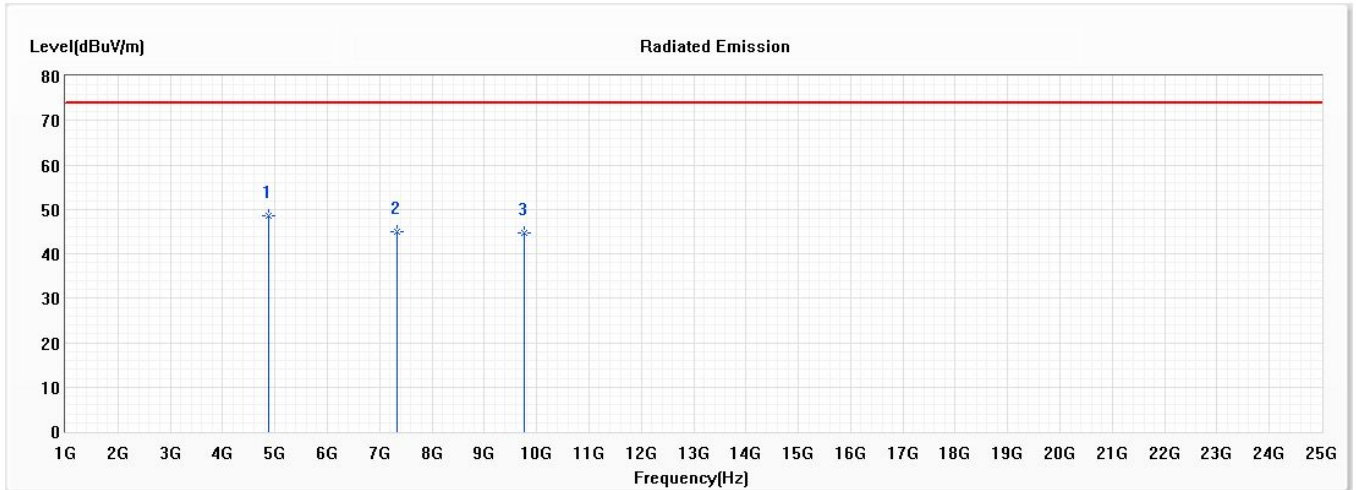
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

- AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
- The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2441 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	4882.000	48.47	74.00	-25.53	61.48	-13.01	PK
2	7323.000	45.01	74.00	-28.99	56.96	-11.95	PK
3	9764.000	44.68	74.00	-29.32	55.63	-10.95	PK

Note:

- All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
- Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
- Measurement Level = Reading Level + Correct Factor.
- Correct Factor = Antenna factor + Cable loss – Amplifier gain.
- The average measurement was not performed when the peak measured data under the limit of average detection.
- The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
---------------	-------------------------	----------------------	----------------------------	-----------	-------------------	----------------------

Average Detector:

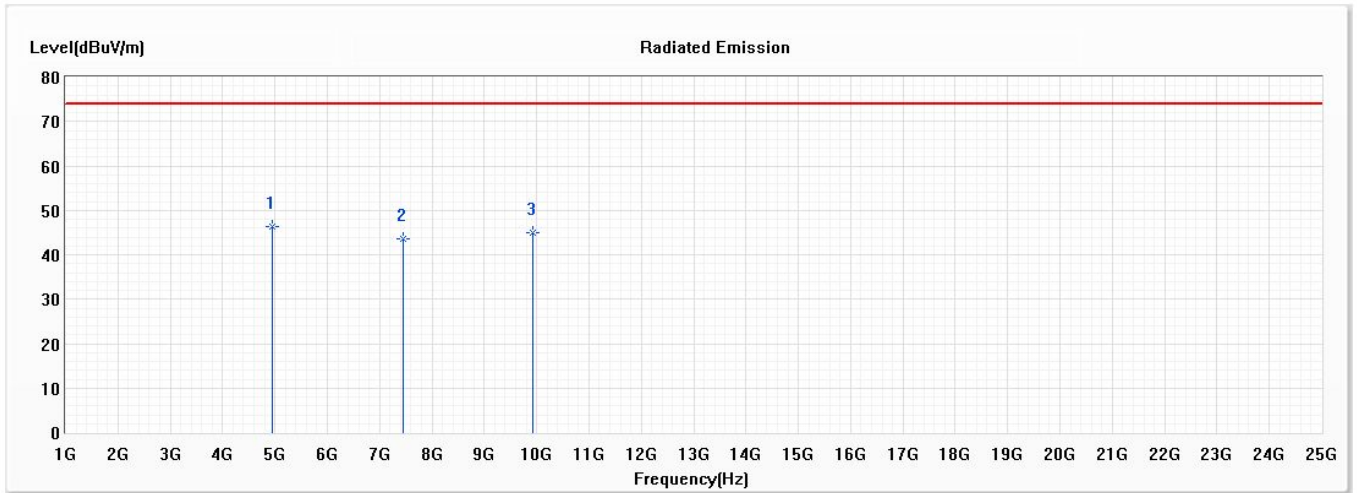
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

- AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
- The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2480 MHz)

Horizontal



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	4960.000	46.35	74.00	-27.65	59.06	-12.71	PK
2	7440.000	43.56	74.00	-30.44	55.64	-12.08	PK
3	9920.000	44.94	74.00	-29.06	55.81	-10.87	PK

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
5. The average measurement was not performed when the peak measured data under the limit of average detection.
6. The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
------------------	-------------------------------	----------------------------	----------------------------------	--------------	-------------------------	----------------------------

Average Detector:

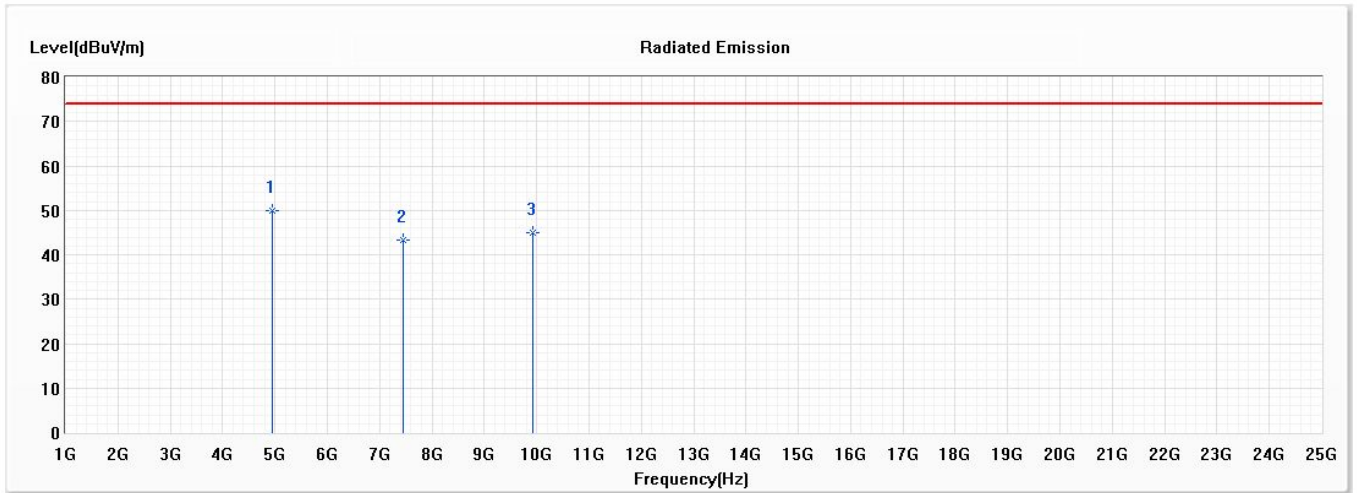
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

1. AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Harmonic Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2480 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
* 1	4960.000	49.90	74.00	-24.10	62.61	-12.71	PK
2	7440.000	43.29	74.00	-30.71	55.37	-12.08	PK
3	9920.000	44.85	74.00	-29.15	55.72	-10.87	PK

Note:

- All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
- Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
- Measurement Level = Reading Level + Correct Factor.
- Correct Factor = Antenna factor + Cable loss – Amplifier gain.
- The average measurement was not performed when the peak measured data under the limit of average detection.
- The emission levels of other frequencies are very lower than the limit and not show in test report.

Frequency MHz	Peak Measurement dBμV/m	Duty Cycle Factor dB	Average Measurement dBμV/m	Margin dB	Peak Limit dBμV/m	Average Limit dBμV/m
---------------	-------------------------	----------------------	----------------------------	-----------	-------------------	----------------------

Average Detector:

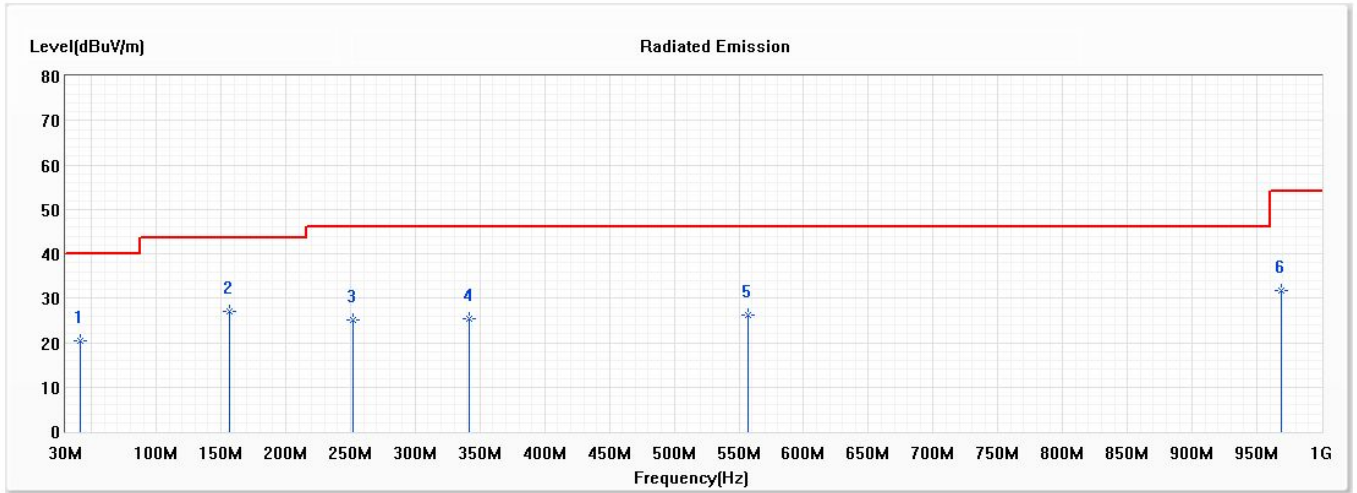
--	--	--	--	--	74.000	54.000
----	----	----	----	----	--------	--------

Note:

- AVG Measurement=Peak Measurement + Duty Cycle Correct Factor
- The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : General Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2441 MHz)

Horizontal



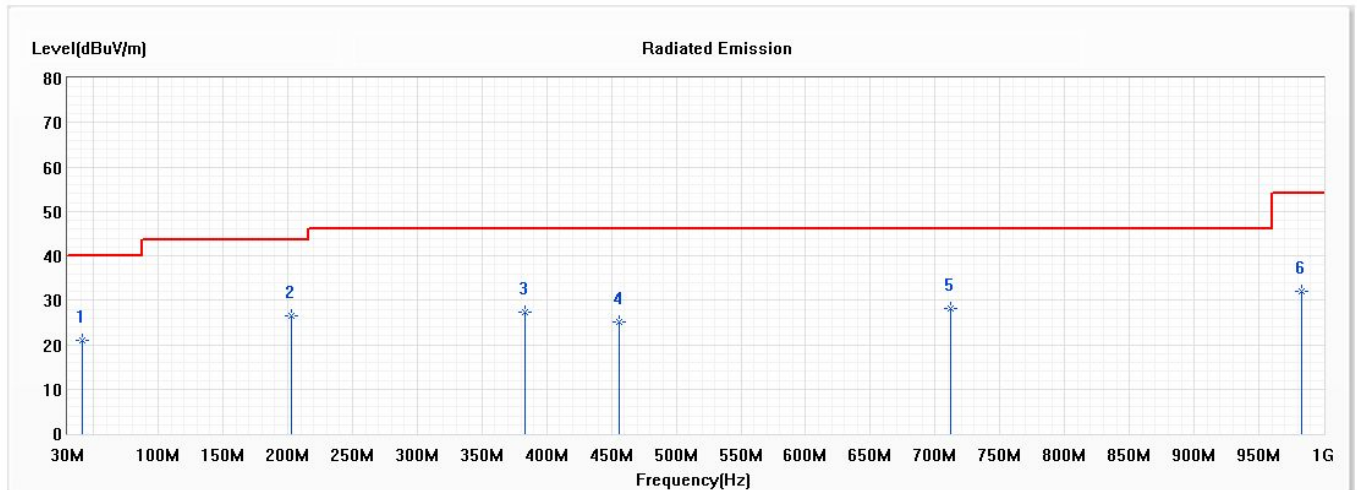
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	41.246	20.31	40.00	-19.69	31.25	-10.94	QP
* 2	156.522	27.02	43.50	-16.48	37.82	-10.80	QP
3	252.116	25.01	46.00	-20.99	36.58	-11.57	QP
4	342.087	25.37	46.00	-20.63	34.17	-8.80	QP
5	557.174	26.10	46.00	-19.90	30.36	-4.26	QP
6	969.072	31.75	54.00	-22.25	30.34	1.41	QP

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Measurement Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The emission levels of other frequencies are very lower than the limit and not show in test report.
5. No emission found between lowest internal used/generated frequency to 30MHz.

Product : 2.4GHz Dongle
 Test Item : General Radiated Emission Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2441 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	41.246	21.07	40.00	-18.93	32.01	-10.94	QP
* 2	202.913	26.59	43.50	-16.91	39.68	-13.09	QP
3	382.855	27.29	46.00	-18.71	35.00	-7.71	QP
4	455.957	25.01	46.00	-20.99	31.16	-6.15	QP
5	711.812	28.12	46.00	-17.88	29.96	-1.84	QP
6	983.130	31.97	54.00	-22.03	30.32	1.65	QP

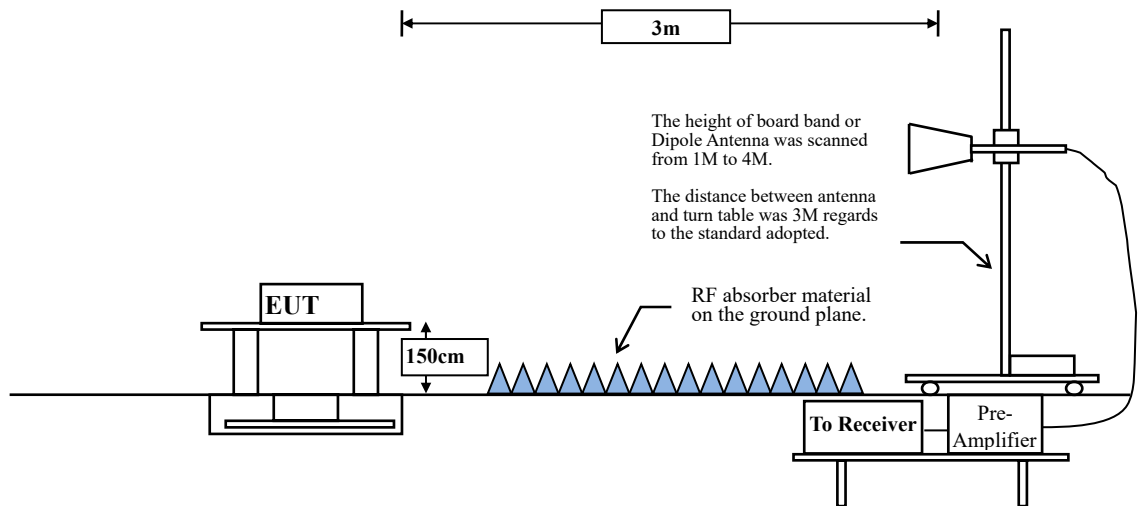
Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Measurement Level = Reading Level + Correct Factor.
3. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
4. The emission levels of other frequencies are very lower than the limit and not show in test report.
5. No emission found between lowest internal used/generated frequency to 30MHz.

4. Band Edge

4.1. Test Setup

RF Radiated Measurement:



4.2. Limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

FCC Part 15 Subpart C Paragraph 15.209(a) Limits		
Frequency MHz	Field strength (microvolts/meter)	Measurement distance (meter)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remarks: E field strength (dBμV /m) = 20 log E field strength (uV/m)

4.3. Test Procedure

The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna can move up and down between 1 meter and 4 meters to find out the maximum emission level.

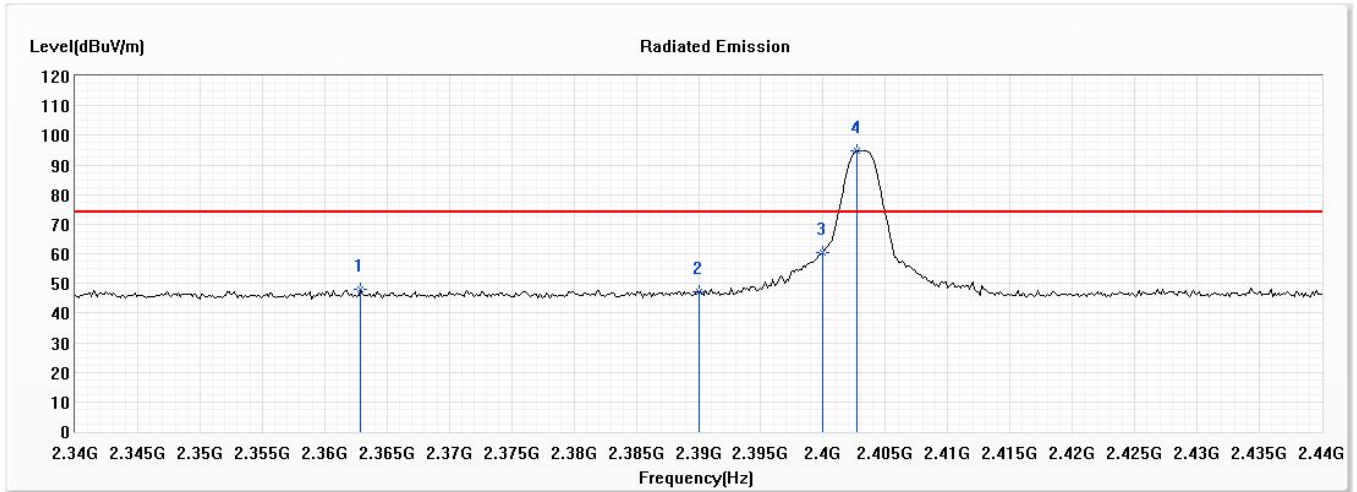
Both horizontal and vertical polarization of the antenna are set on measurement. In order to find the maximum emission, all of the interface cables must be manipulated according to ANSI C63.10: 2013 on radiated measurement.

The bandwidth setting below 1GHz and above 1GHz on the field strength meter is 120 kHz and 1MHz, respectively.

4.4. Test Result of Band Edge

Product : 2.4GHz Dongle
 Test Item : Band Edge Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2403 MHz)

Horizontal



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	2362.899	48.11	74.00	-25.89	36.33	11.78	PK
2	2390.000	47.35	74.00	-26.65	35.43	11.92	PK
3	2400.000	60.43	74.00	-13.57	48.47	11.96	PK
4	2402.754	94.67	--	--	82.69	11.98	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. The average measurement was not performed when the peak measured data under the limit of average detection.

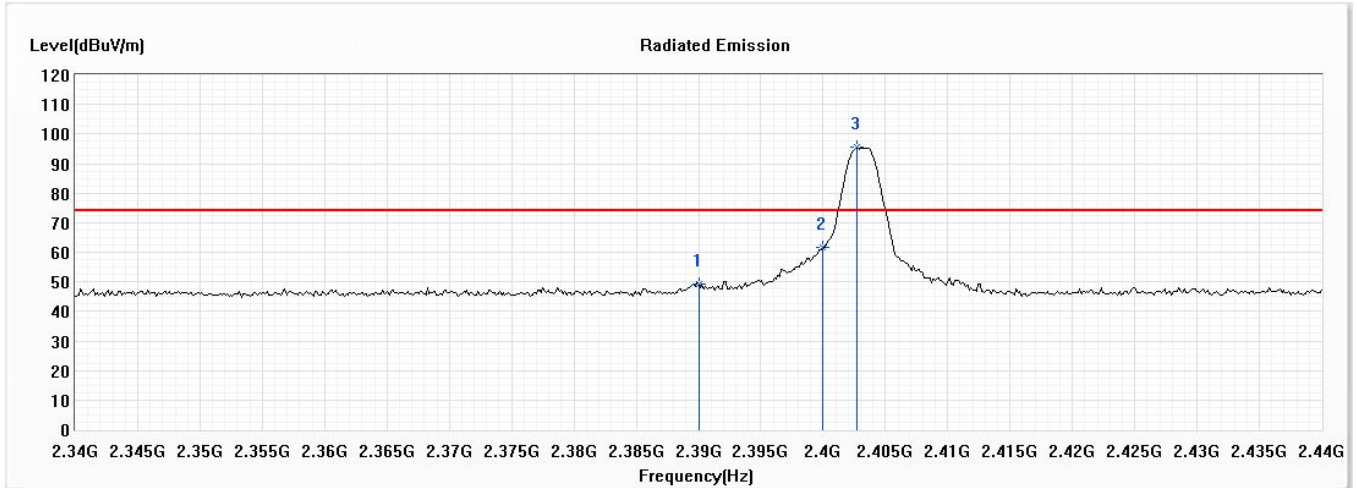
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)	Result
2362.899	48.11	-25.449	22.661	-31.339	54.000	Pass
2390	47.35	-25.449	21.901	-32.099	54.000	Pass
2400	60.43	-25.449	34.981	-19.019	54.000	Pass
2402.754	94.67	-25.449	69.221	--	--	Pass

Note:

1. Average Measurement=Peak Measurement + Duty Cycle Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Band Edge Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2403 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	2390.000	49.33	74.00	-24.67	37.41	11.92	PK
2	2400.000	61.51	74.00	-12.49	49.55	11.96	PK
3	2402.754	95.38	--	--	83.40	11.98	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. The average measurement was not performed when the peak measured data under the limit of average detection.

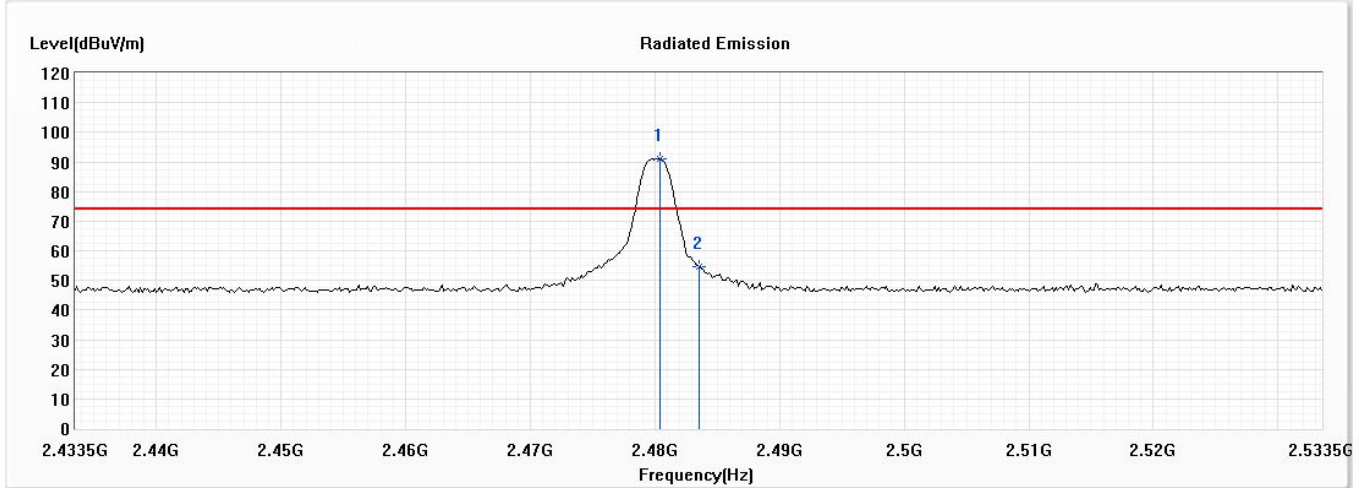
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)	Result
2390	49.33	-25.449	23.881	-30.119	54.000	Pass
2400	61.51	-25.449	36.061	-17.939	54.000	Pass
2402.754	95.38	-25.449	69.931	--	--	Pass

Note:

1. Average Measurement=Peak Measurement + Duty Cycle Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Band Edge Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2480 MHz)

Horizontal



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	2480.457	90.92	--	--	78.69	12.23	PK
2	2483.500	54.77	74.00	-19.23	42.53	12.24	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. The average measurement was not performed when the peak measured data under the limit of average detection.

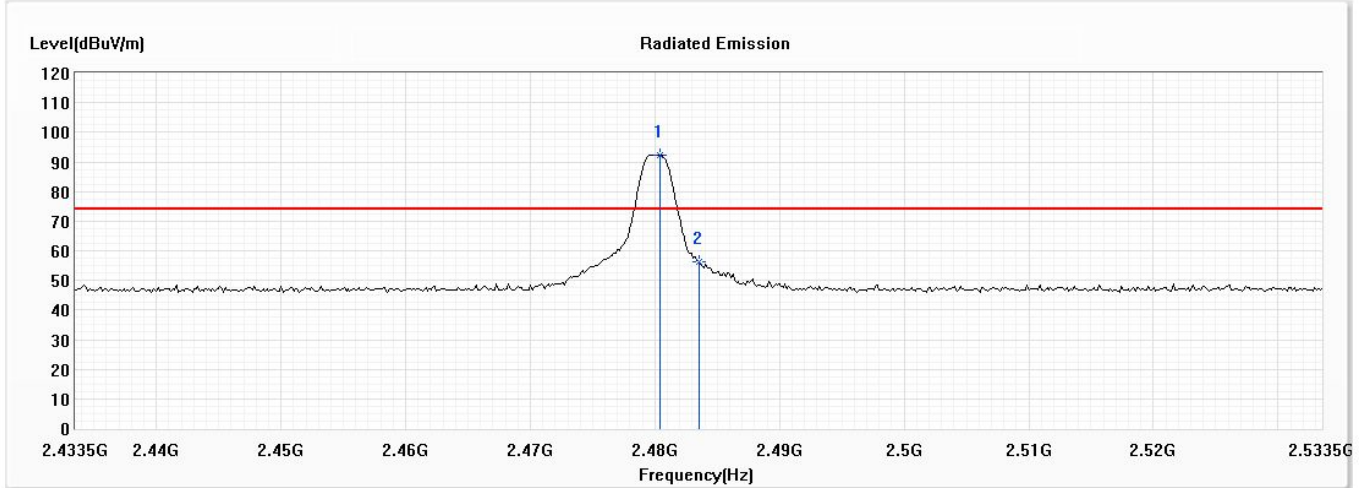
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)	Result
2480.457	90.92	-25.449	65.471	--	--	Pass
2483.5	54.77	-25.449	29.321	-24.679	54.000	Pass

Note:

1. Average Measurement=Peak Measurement + Duty Cycle Factor
2. The Duty Cycle is refer to section 5.

Product : 2.4GHz Dongle
 Test Item : Band Edge Data
 Test Date : 2021/01/22
 Test Mode : Mode 1: Transmit (2480 MHz)

Vertical



No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Reading Level (dBuV)	Correct Factor (dB)	Detector Type
1	2480.457	92.47	--	--	80.24	12.23	PK
2	2483.500	56.27	74.00	-17.73	44.03	12.24	PK

Note:

1. All readings above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Measurement Level = Reading Level + Correct Factor.
4. The average measurement was not performed when the peak measured data under the limit of average detection.

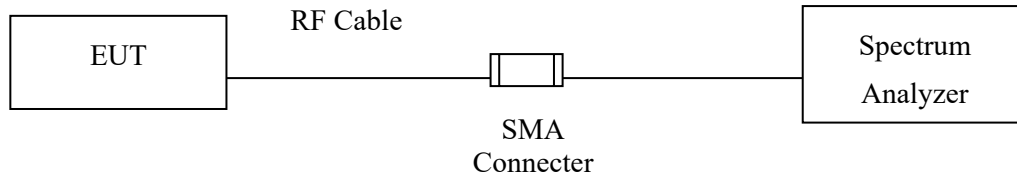
Frequency (MHz)	Peak Measurement (dBμV/m)	Duty Cycle Factor (dB)	Average Measurement (dBμV/m)	Margin (dB)	Average Limit (dBμV/m)	Result
2480.457	92.47	-25.449	67.021	--	--	Pass
2483.5	56.27	-25.449	30.821	-23.179	54.000	Pass

Note:

1. Average Measurement=Peak Measurement + Duty Cycle Factor
2. The Duty Cycle is refer to section 5.

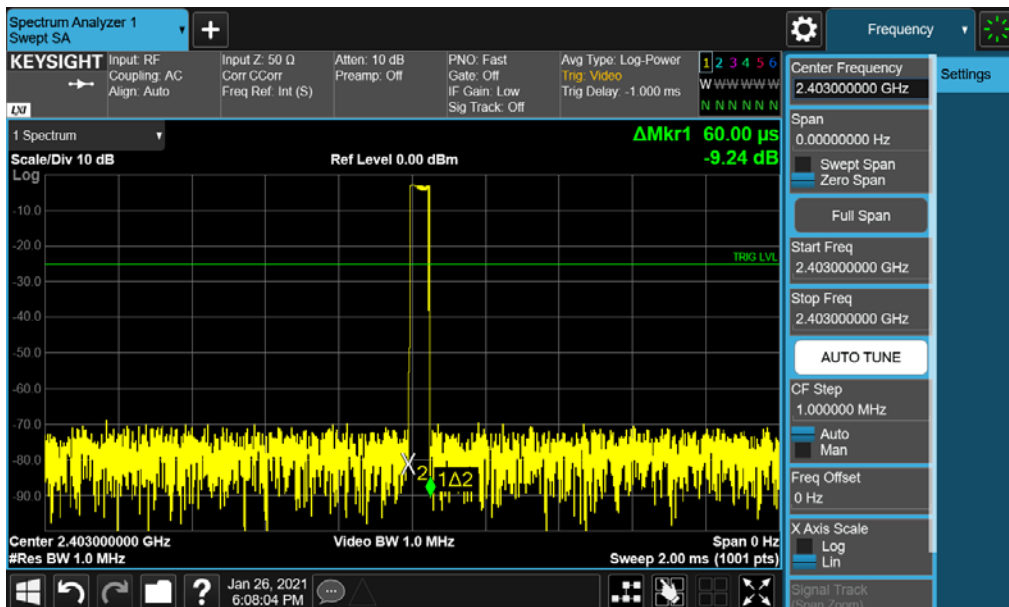
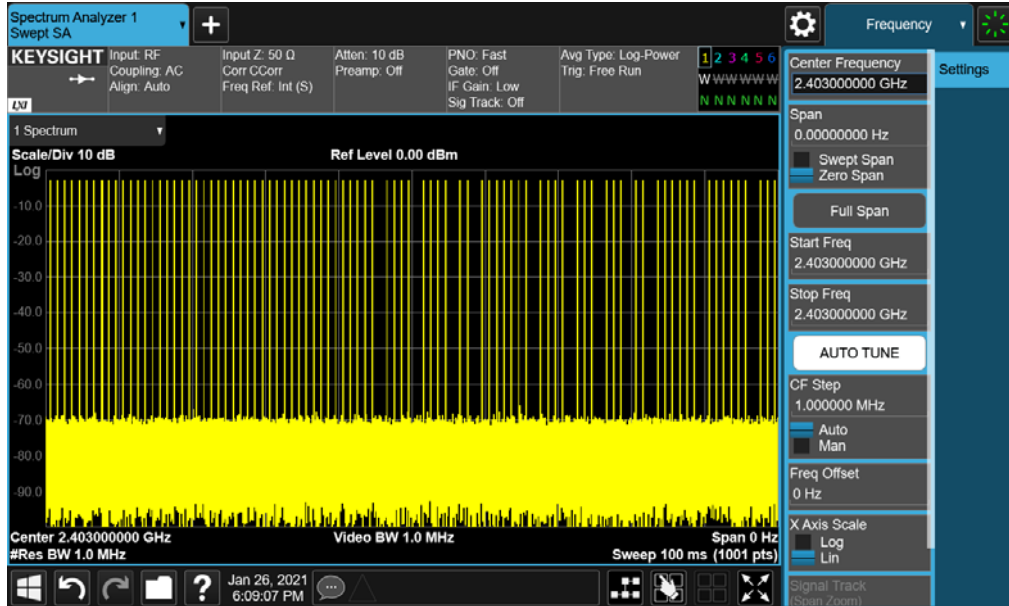
5. Duty Cycle

5.1. Test Setup



5.2. Test Result of Duty Cycle

Product : 2.4GHz Dongle
 Test Item : Duty Cycle Data
 Test Mode : Mode 2: Normal mode



Time on of 100ms= 60us*89= 5.34ms

Duty Cycle=5.34ms / 100ms= 0.0534

Duty Cycle correction factor= 20 LOG 0.0534= -25.449 dB

Duty Cycle correction factor	-25.449 dB
------------------------------	------------

6. EMI Reduction Method During Compliance Testing

No modification was made during testing.