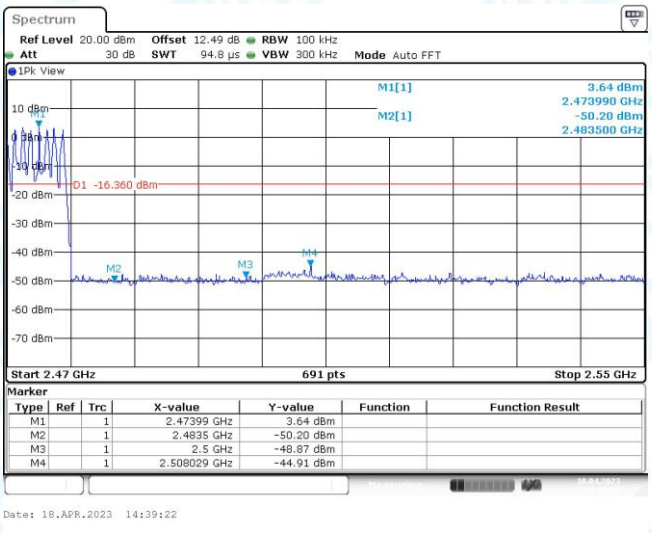
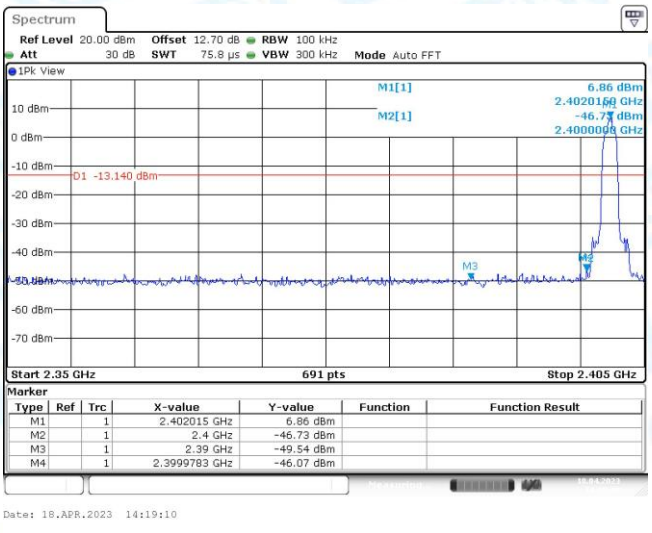


DH5_High_Hop_2480



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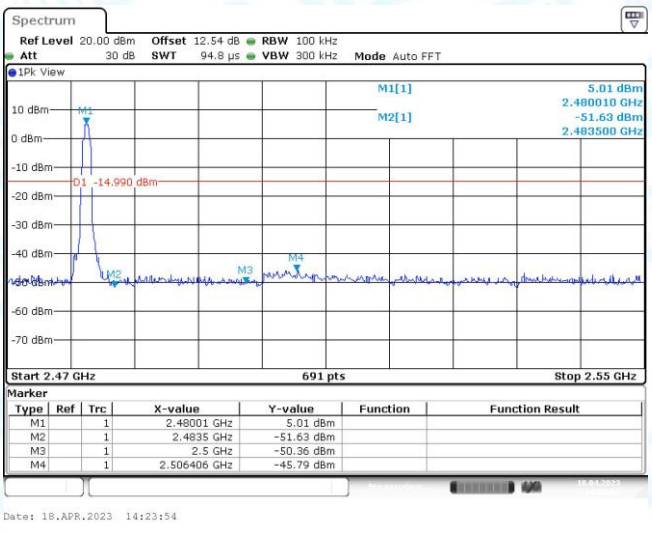

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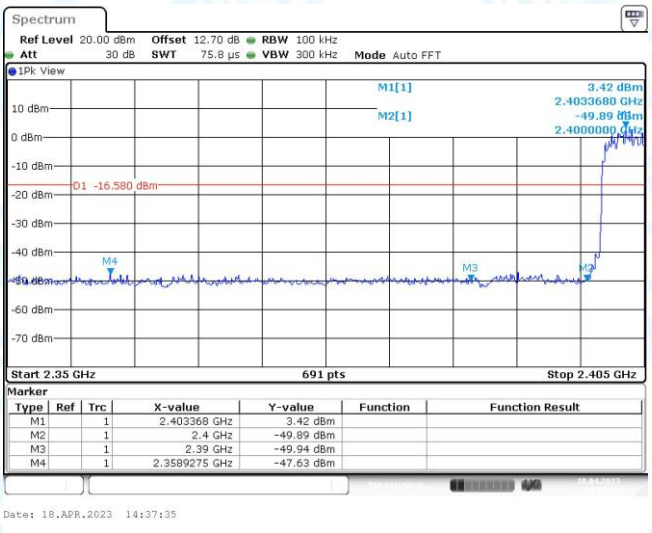

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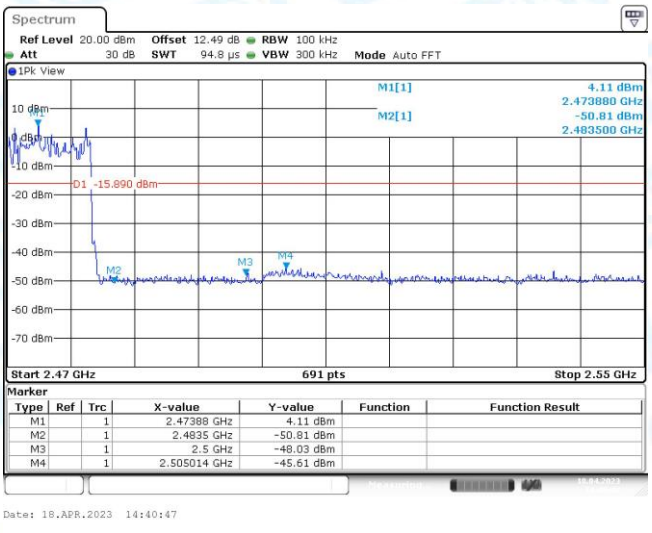

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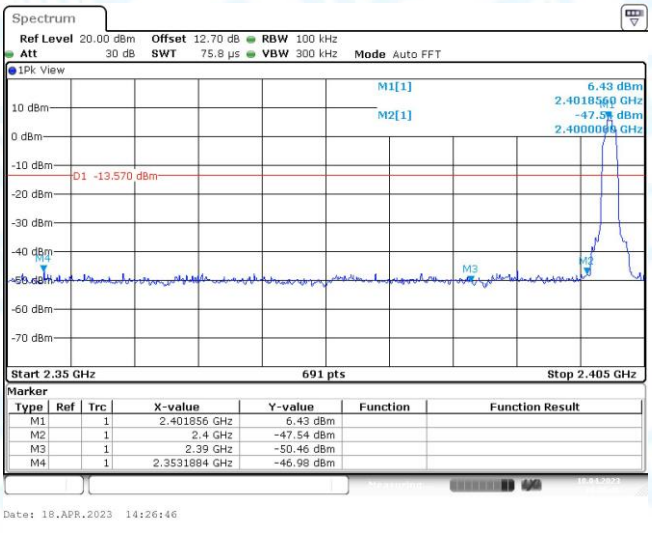

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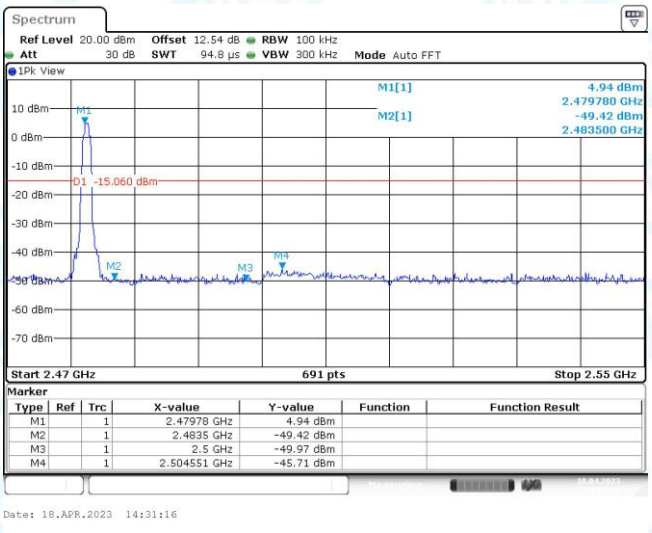

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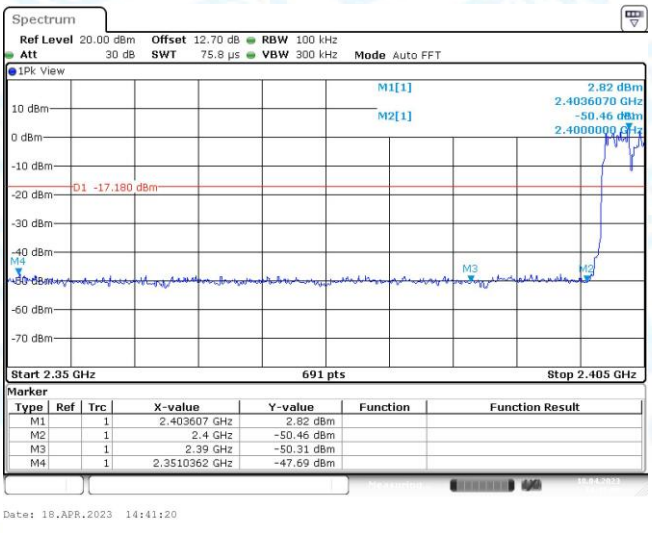

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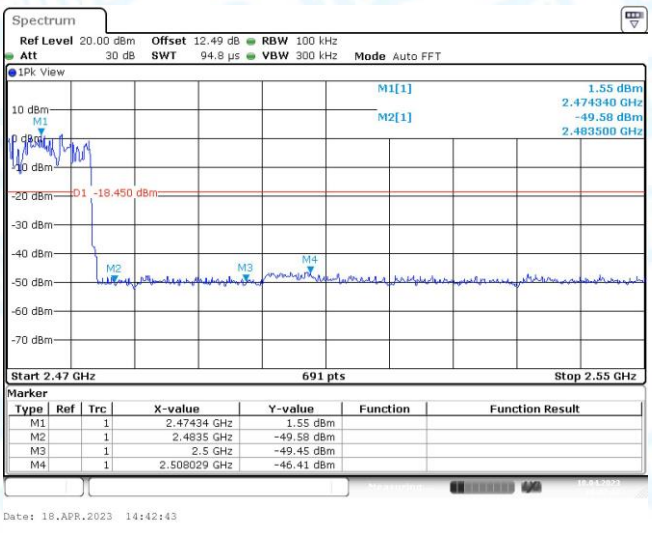


3DH5_High_Hop_2480

8. 99% Occupied and 20dB Bandwidth

8.1 Test Standard and Limit

8.1.1 Test Standard

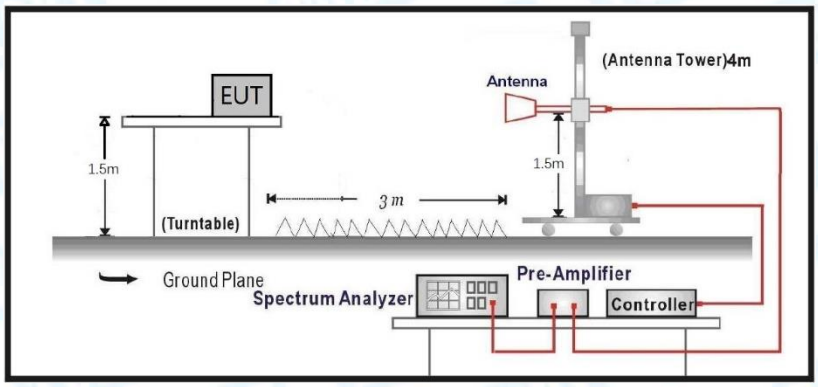
RSS-Gen 6.7 & RSS 247 5.1(a)

FCC Part 15.205 & FCC Part 15.247(a)

8.1.2 Test Limit

For an FHSS system operating in the 2400 to 2483.5 MHz band, there are no limits for 20dB bandwidth and 99% occupied bandwidth.

8.2 Test Setup



8.3 Test Procedure

●The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

8.4 Deviation From Test Standard

No deviation

8.5 EUT Operating Mode

Please refer to the description of test mode.

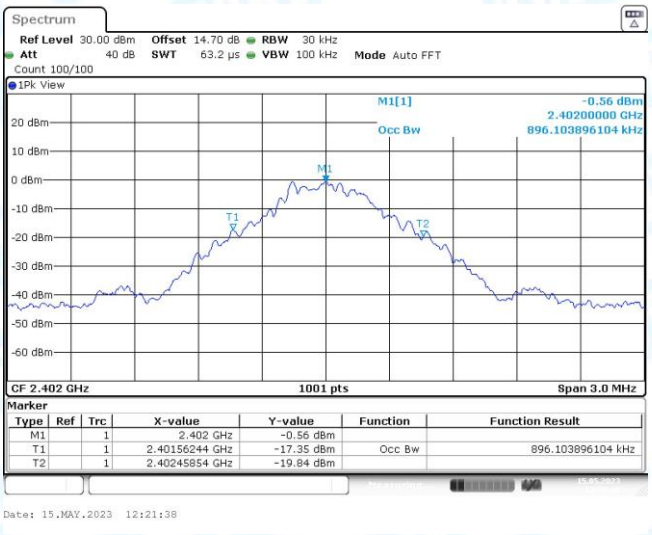
8.6 Test Data

Please refer to the following pages.

---99% and 20dB Bandwidth Test (Radiation Measurements)

Test Mode	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	2402	0.896	2401.5624	2402.4585	---	---
	2441	0.896	2440.5624	2441.4585	---	---
	2480	0.902	2479.5594	2480.4615	---	---
2DH5	2402	1.193	2401.4126	2402.6054	---	---
	2441	1.193	2440.4126	2441.6054	---	---
	2480	1.187	2479.4156	2480.6024	---	---
3DH5	2402	1.205	2401.4036	2402.6084	---	---
	2441	1.205	2440.4006	2441.6054	---	---
	2480	1.193	2479.4126	2480.6054	---	---

Test Mode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.96	---	---
		2441	0.96	---	---
		2480	0.96	---	---
2DH5	Ant1	2402	1.31	---	---
		2441	1.31	---	---
		2480	1.29	---	---
3DH5	Ant1	2402	1.30	---	---
		2441	1.30	---	---
		2480	1.30	---	---



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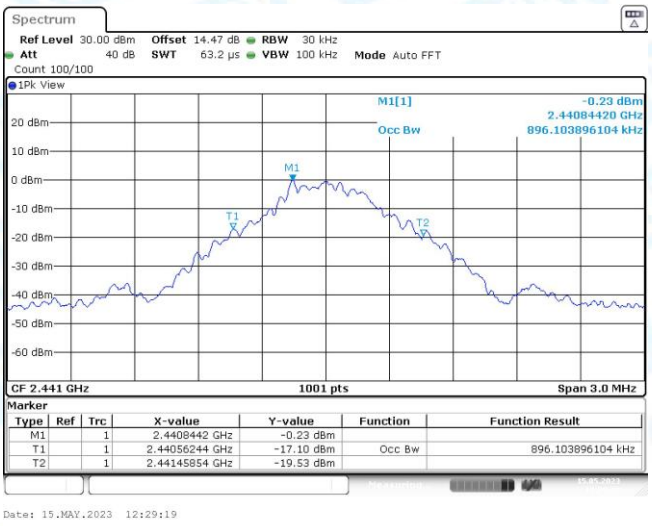

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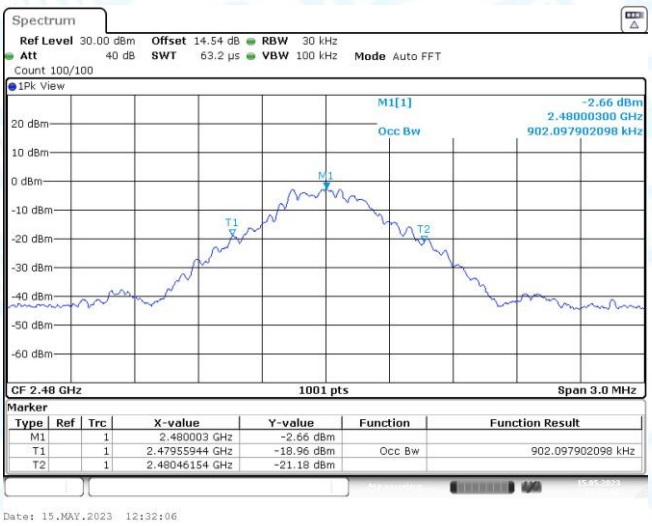

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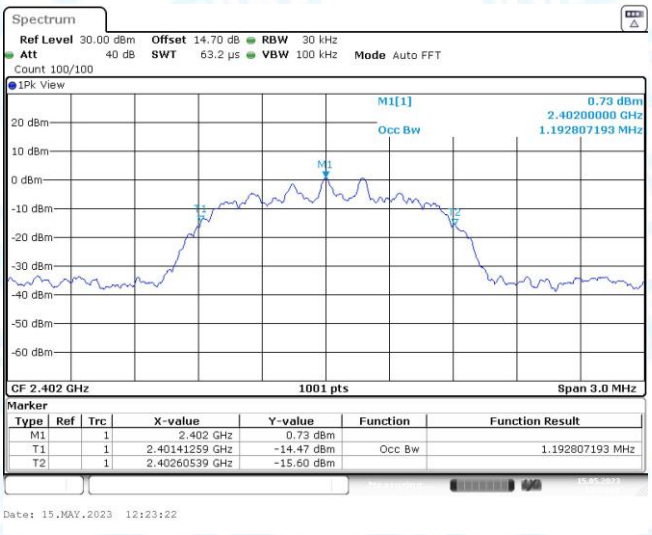

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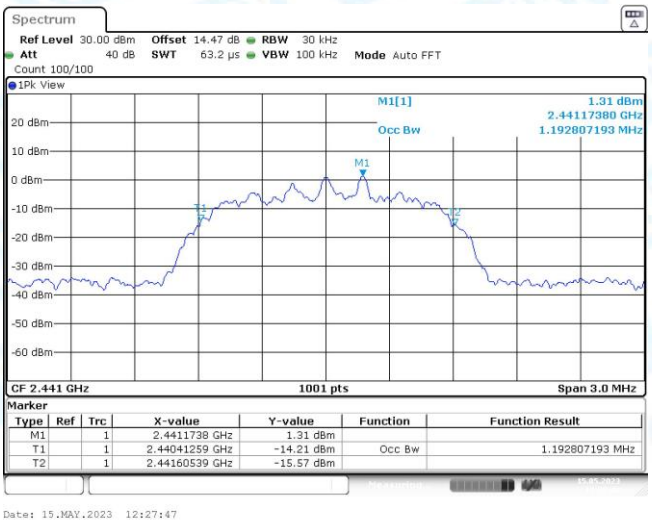

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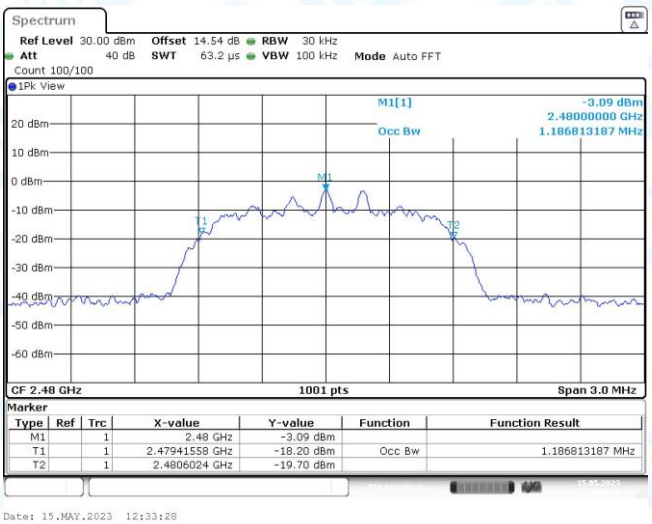

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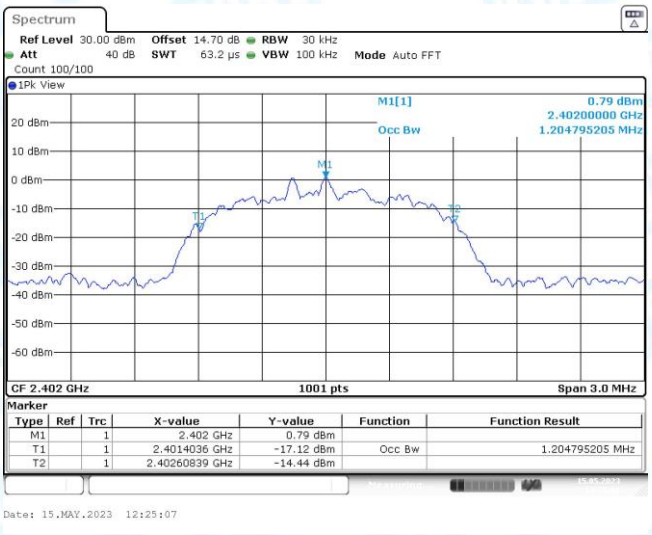

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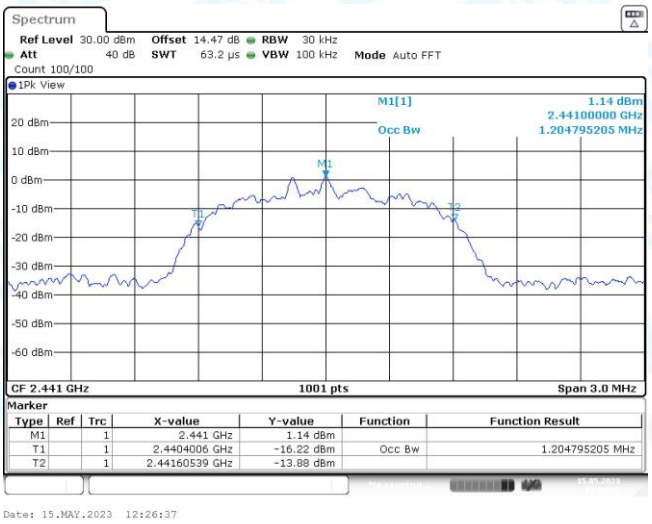

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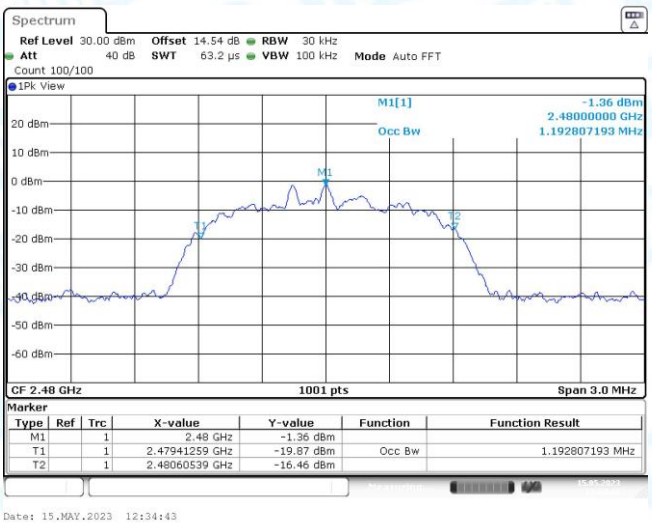

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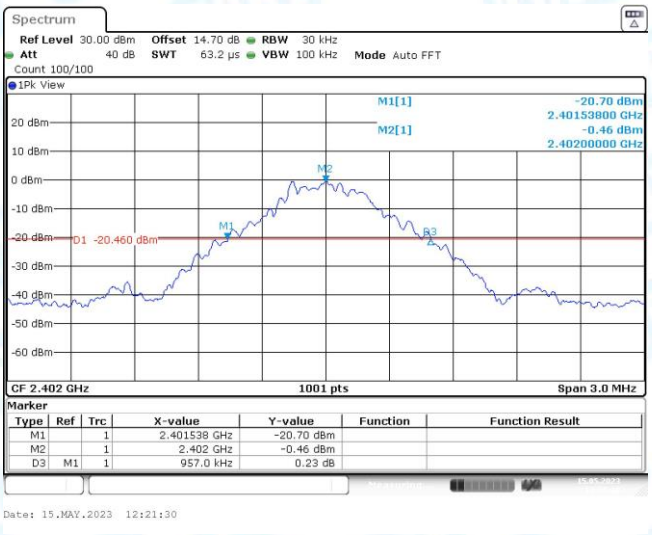

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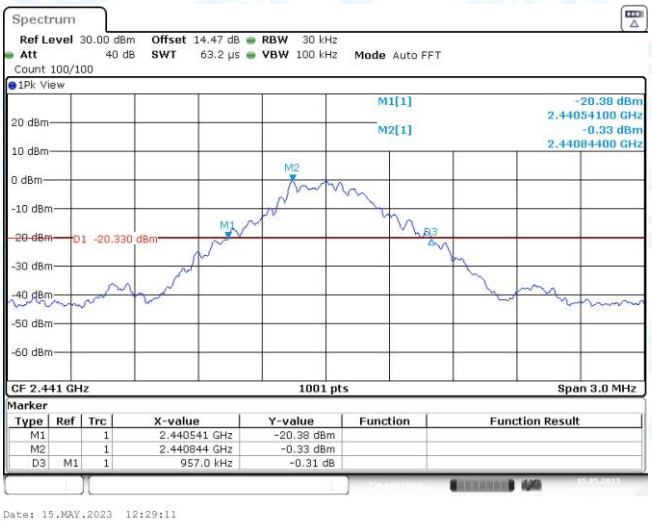

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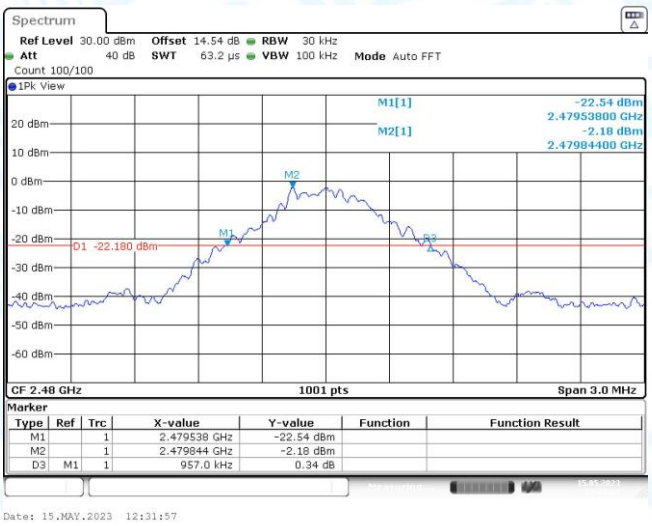

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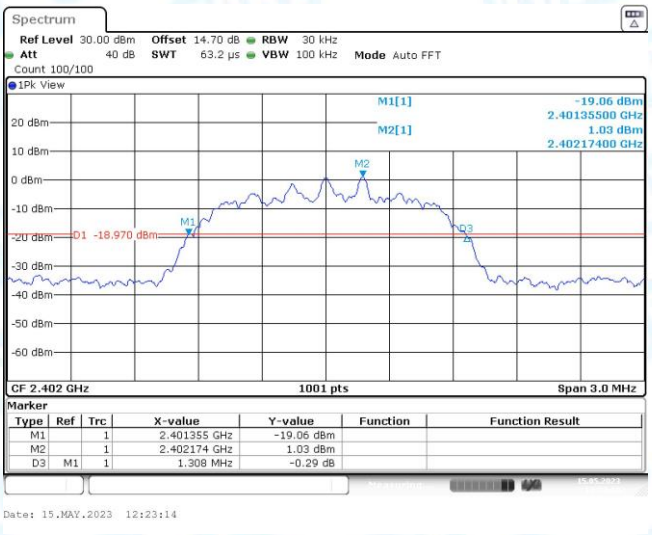

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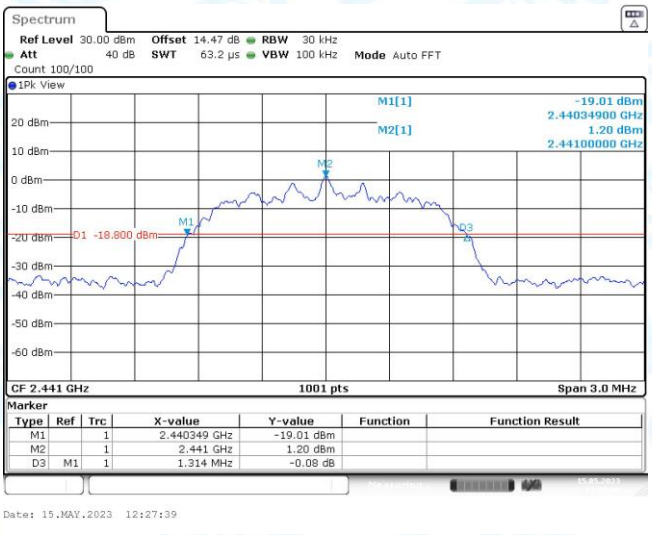

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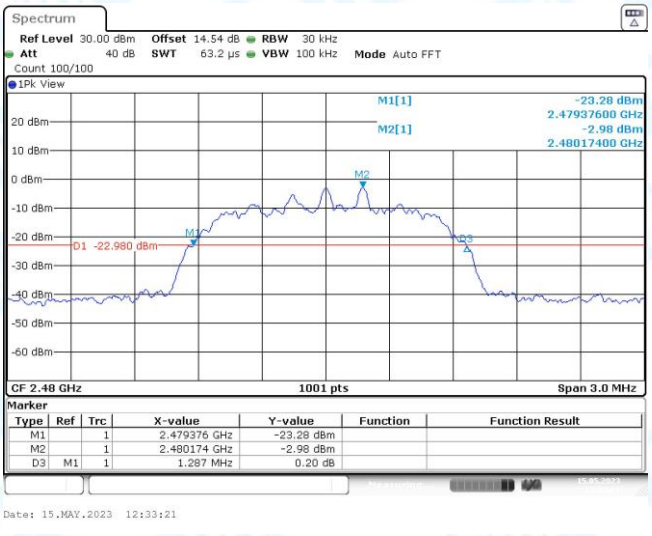

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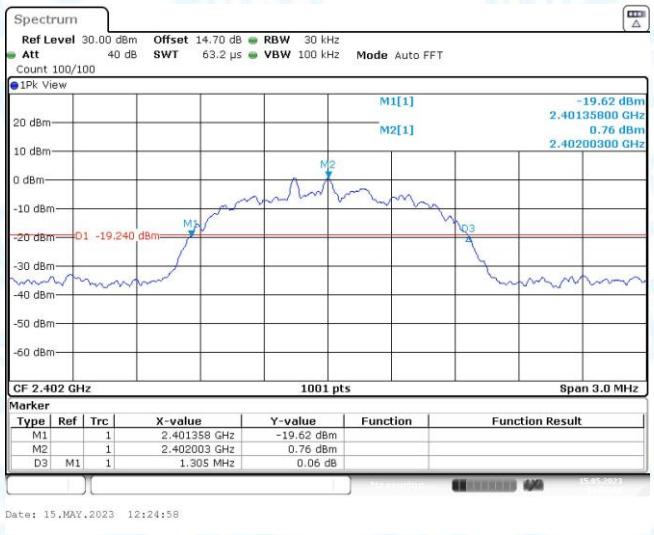

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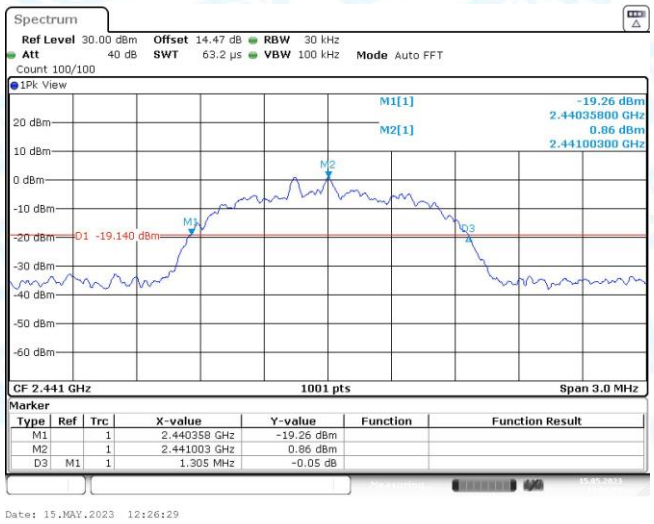

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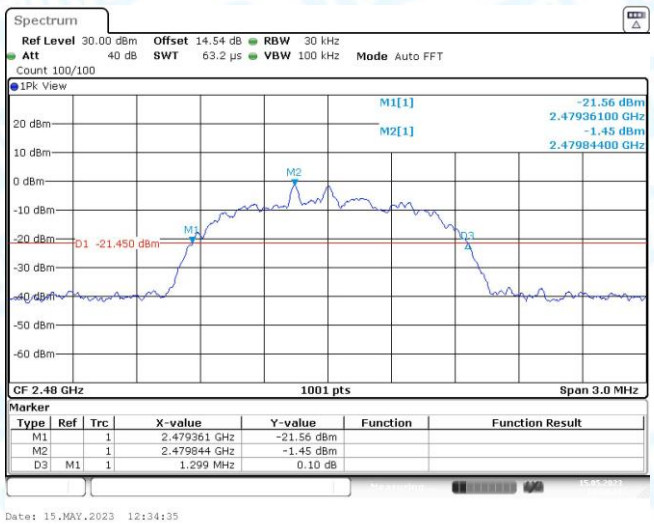


3DH5_2480

9. Peak Output Power Test

9.1 Test Standard and Limit

9.1.1 Test Standard

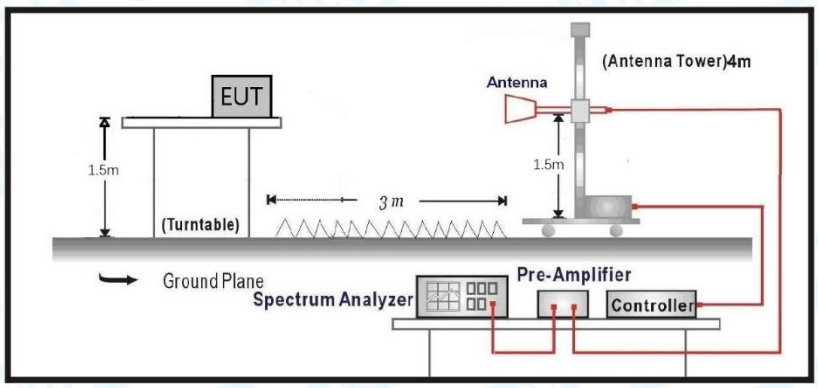
RSS 247 5.4(2)

FCC Part 15.247(b)(1)

9.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Peak Output Power	$P_{max\text{-}pk} \leq 1$ W $N_{ch} \geq 75$ f ≥ MAX { 25 kHz, BW_{20dB} } max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	2400~2483.5
	$P_{max\text{-}pk} \leq 0.125$ W $N_{ch} \geq 15$ f ≥ [MAX{25 kHz, $0.67 * BW_{20dB}$} OR MAX{25 kHz, BW_{20dB}}] max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; □ f = hopping channel carrier frequency separation		

9.2 Test Setup



9.3 Test Procedure

●This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:

1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping

channel.

2) RBW > 20 dB bandwidth of the emission being measured.

3) VBW≥ RBW.

4) Sweep: Auto.

5) Detector function: Peak.

6) Trace: Max hold.

b) Allow trace to stabilize.

c) Use the marker-to-peak function to set the marker to the peak of the emission.

d) The indicated level is the peak output power, after any corrections for external attenuators and cables.

e) A plot of the test results and setup description shall be included in the test report.

NOTE-A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

9.4 Deviation From Test Standard

No deviation

9.5 EUT Operating Mode

Please refer to the description of test mode.

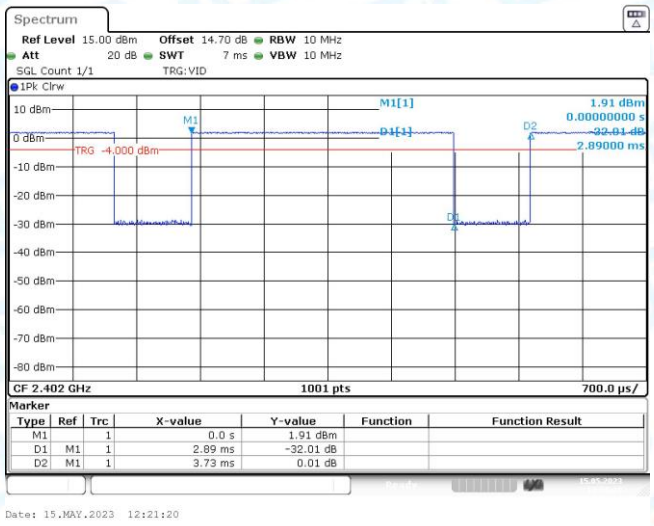
9.6 Test Data

Please refer to the following pages.

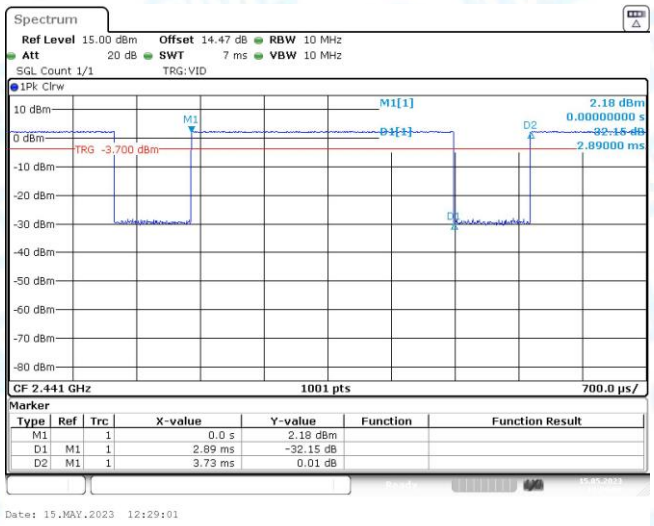
---Peak Output Power (Radiation Measurements)

Test Mode	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]	1/T [kHz]
DH5	2402	2.89	3.73	77.48	0.346
	2441	2.89	3.73	77.48	0.346
	2480	2.89	3.73	77.48	0.346
2DH5	2402	2.89	3.74	77.27	0.346
	2441	2.89	3.73	77.48	0.346
	2480	2.89	3.73	77.48	0.346
3DH5	2402	2.89	3.73	77.48	0.346
	2441	2.89	3.73	77.48	0.346
	2480	2.89	3.74	77.27	0.346

Test Mode	Channel	EIRP [dBm]	Gain [dBi]	Conducted power [dBm]	Limit[dBm]	Verdict
DH5	2402	2.19	0.85	1.34	≤21	PASS
	2441	2.48	0.85	1.63	≤21	PASS
	2480	2.18	0.85	1.33	≤21	PASS
2DH5	2402	4.12	0.85	3.27	≤21	PASS
	2441	4.38	0.85	3.53	≤21	PASS
	2480	3.48	0.85	2.63	≤21	PASS
3DH5	2402	4.27	0.85	3.42	≤21	PASS
	2441	4.62	0.85	3.77	≤21	PASS
	2480	3.70	0.85	2.85	≤21	PASS
Note: Conducted Power=EIRP-Gain						



DH5_2402



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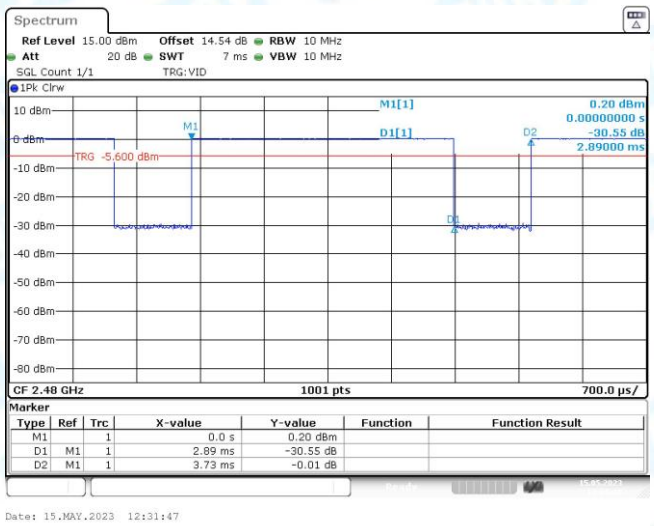

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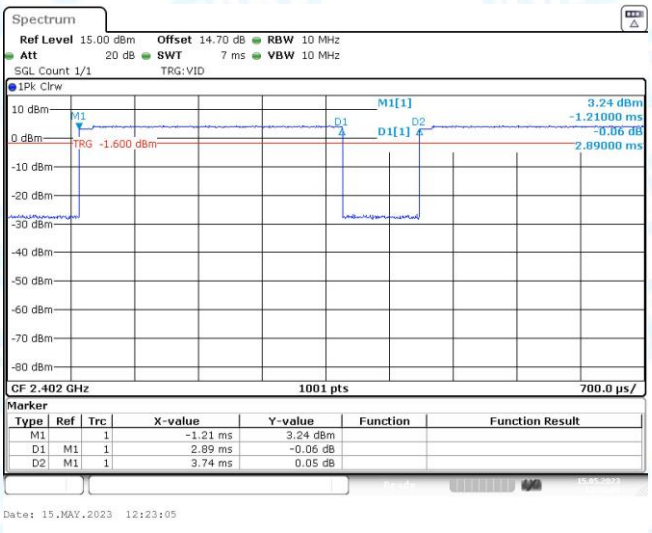

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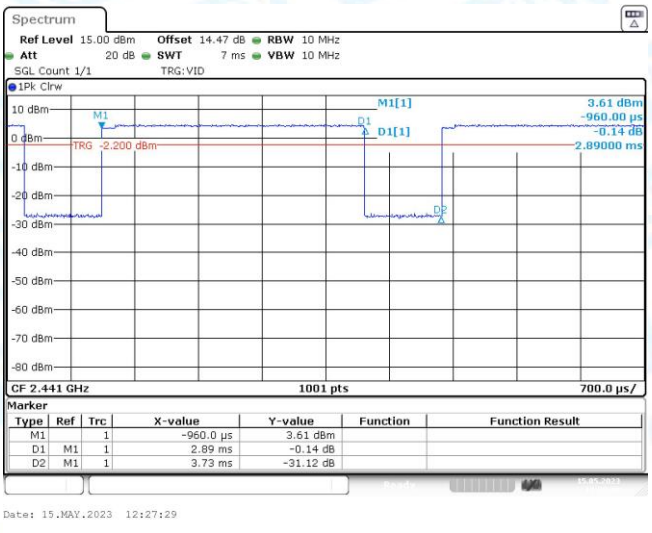

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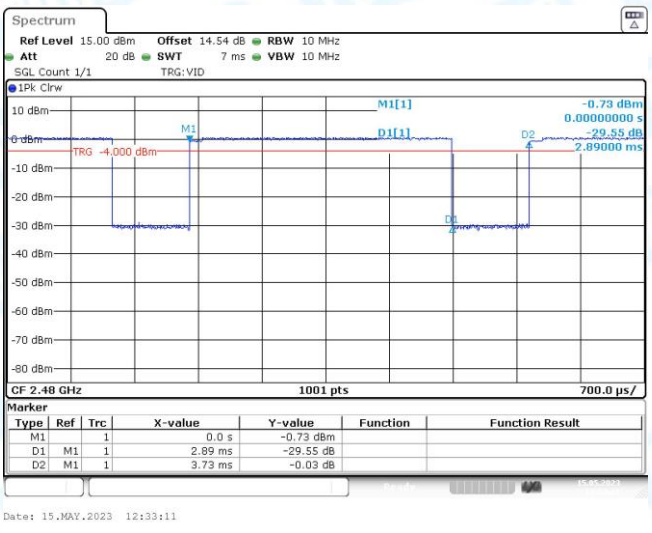

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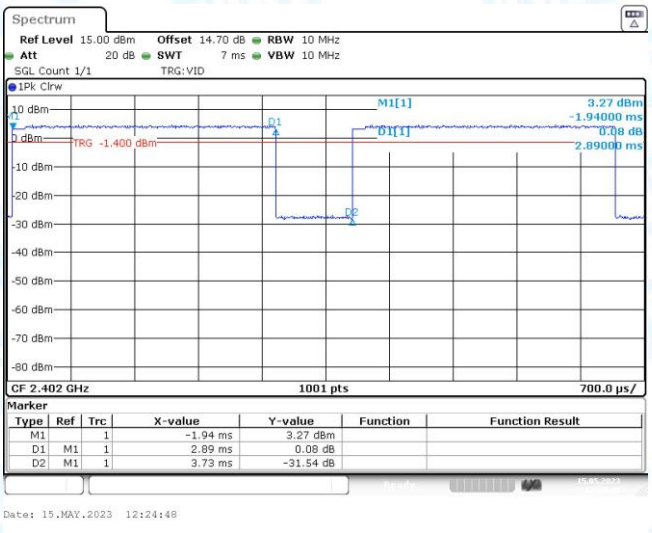

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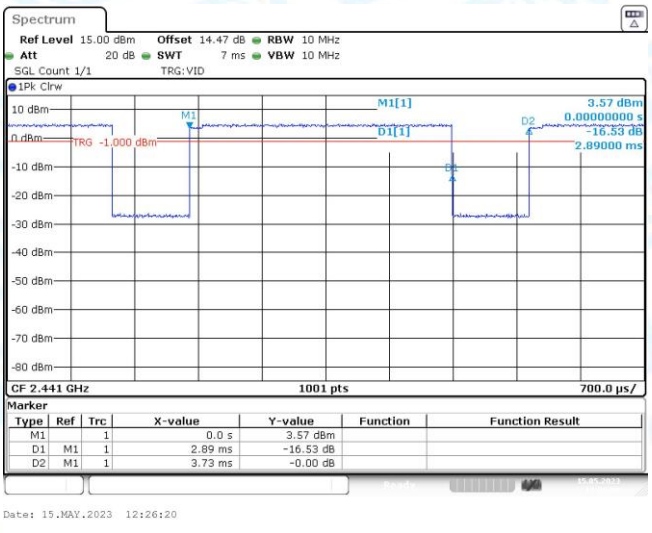

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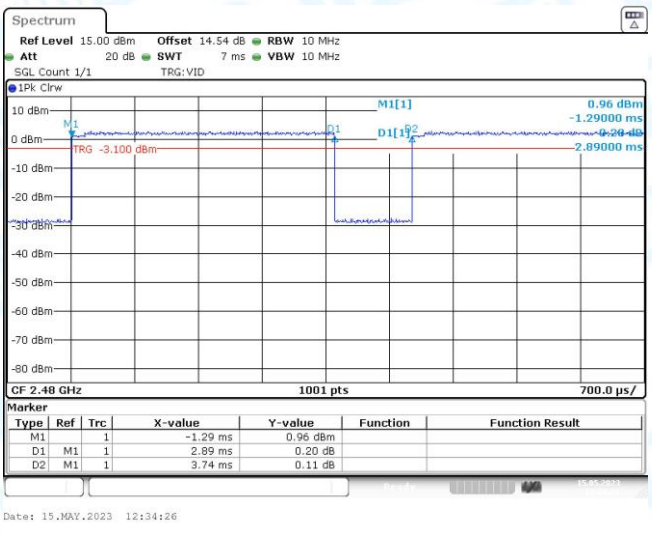

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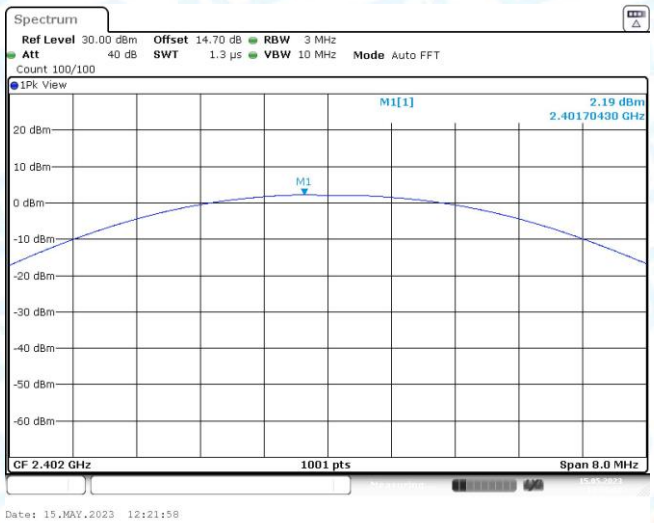

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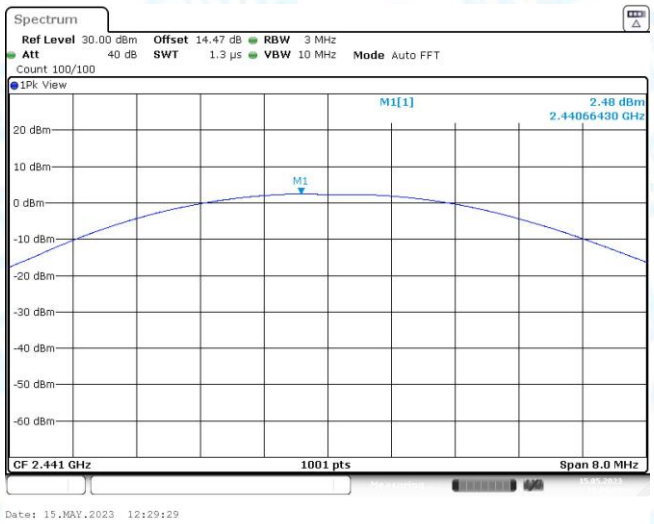

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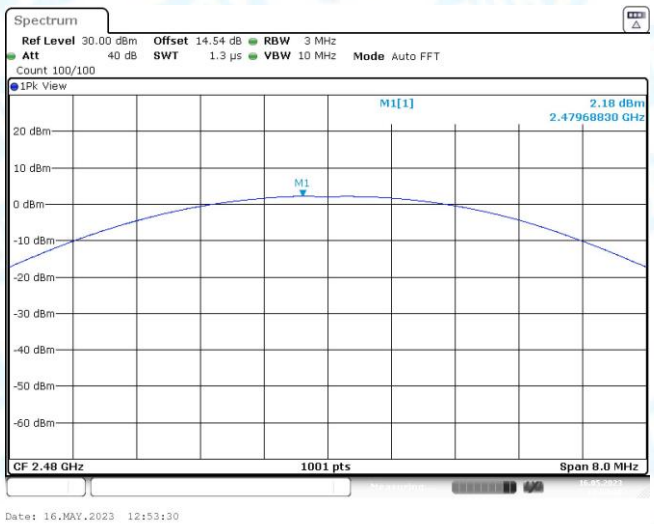

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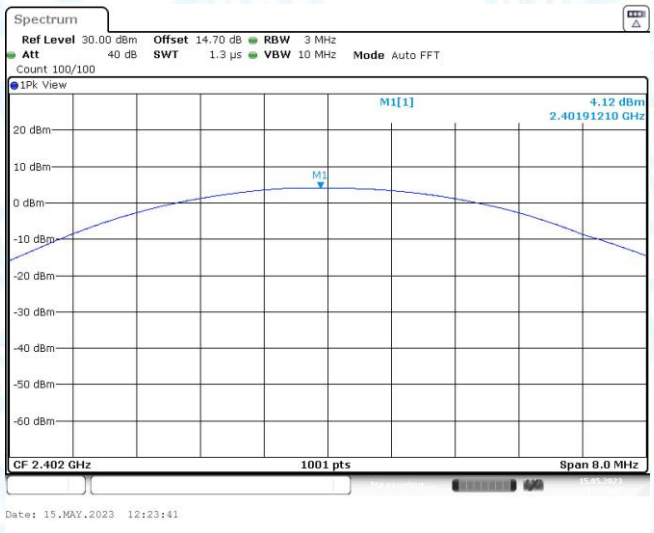

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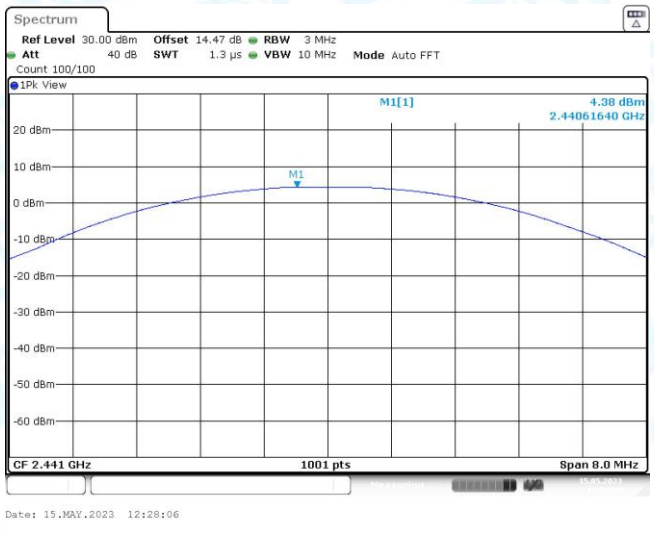
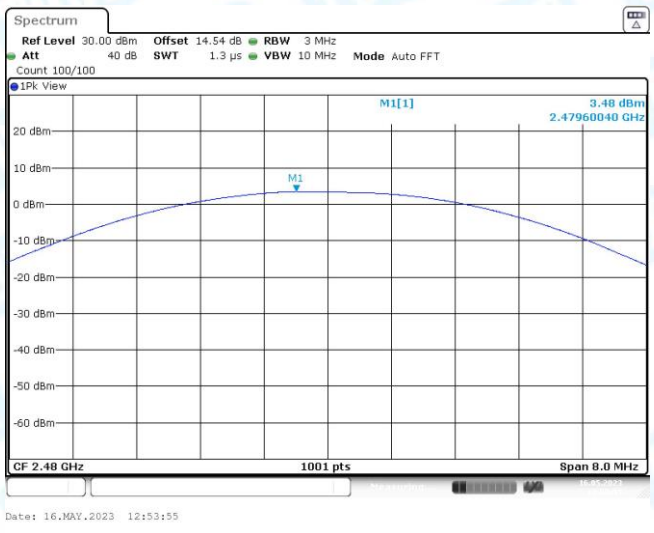
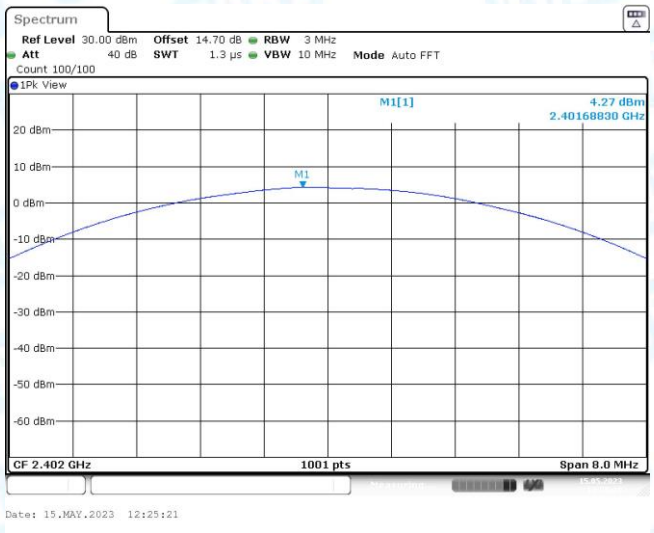


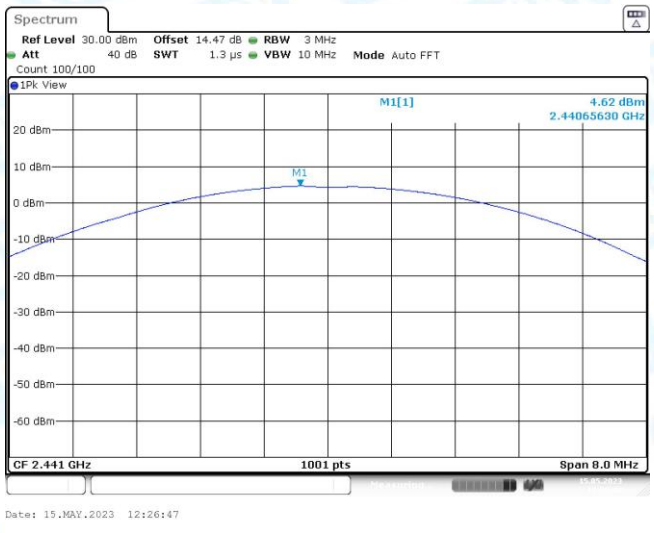
2DH5_2441



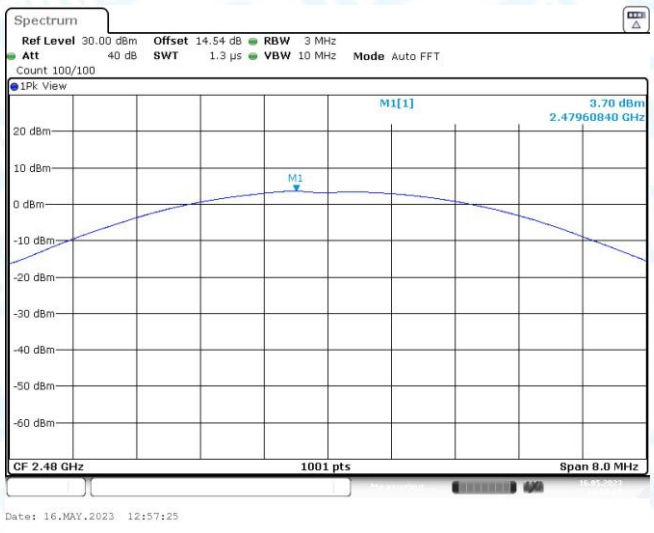
2DH5_2480



3DH5_2402



3DH5_2441



3DH5_2480

10. Carrier frequency separation

10.1 Test Standard and Limit

10.1.1 Test Standard

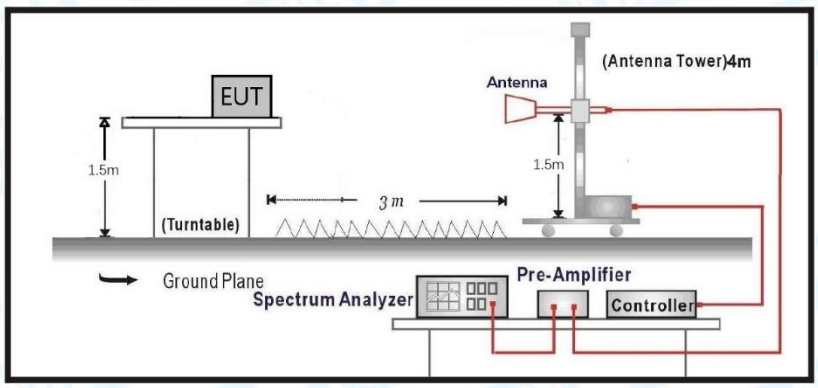
RSS 247 5.1(2)

FCC Part 15.247(a)(1)

10.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Carrier frequency separation	$P_{max\text{-}pk} \leq 1$ W $N_{ch} \geq 75$ f ≥ MAX { 25 kHz, BW_{20dB} } max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	2400~2483.5
	$P_{max\text{-}pk} \leq 0.125$ W $N_{ch} \geq 15$ f ≥ [MAX{25 kHz, 0.67*BW_{20dB}} OR MAX{25 kHz, BW_{20dB}}] max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; □ f = hopping channel carrier frequency separation		

10.2 Test Setup



10.3 Test Procedure

●The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.

b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.

c) Video (or average) bandwidth (VBW) ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max hold.

g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

10.4 Deviation From Test Standard

No deviation

10.5 Antenna Connected Construction

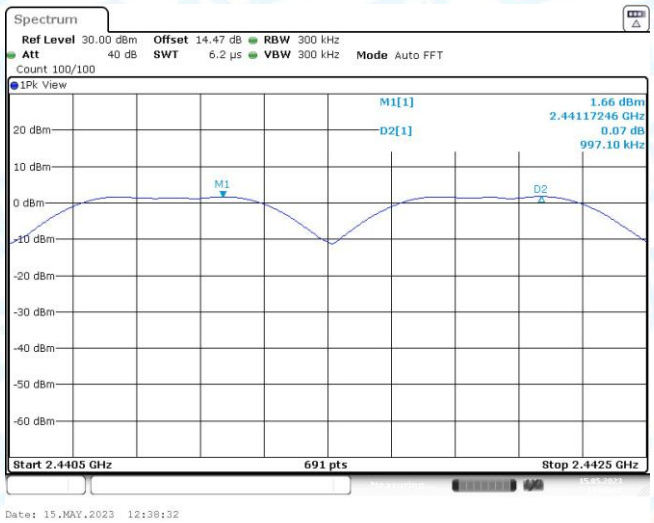
Please refer to the description of test mode.

10.6 Test Data

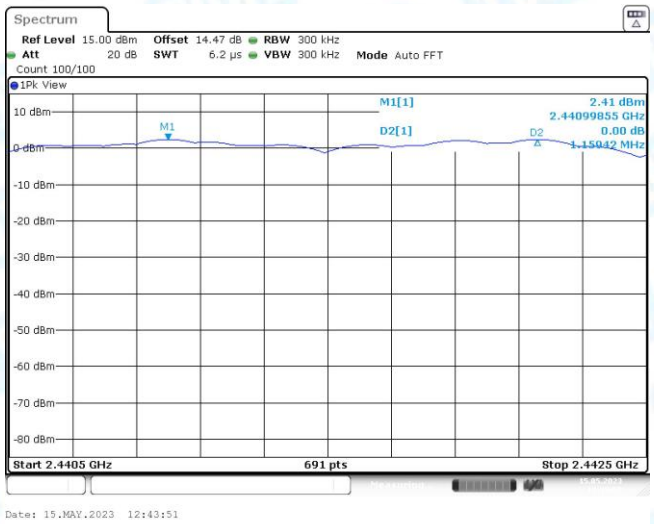
Please refer to the following pages.

---Carrier Frequency Separation (Radiation Measurements)

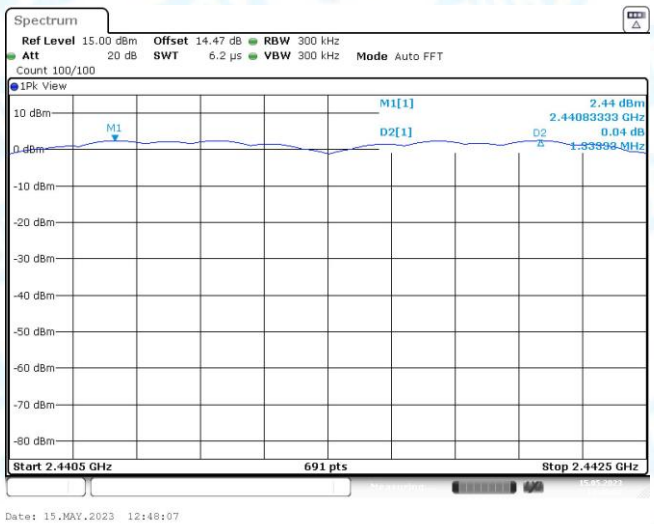
Test Mode	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Hop	0.997	≥0.960	PASS
2DH5	Hop	1.159	≥0.873	PASS
3DH5	Hop	1.333	≥0.866	PASS
Note: Limit=2/3*20dB BW (when 20dB BW＜1MHz, The limit=20dB BW)				



DH5_Hop



2DH5_Hop



3DH5_Hop

11. Time of occupancy (dwell time)

11.1 Test Standard and Limit

11.1.1 Test Standard

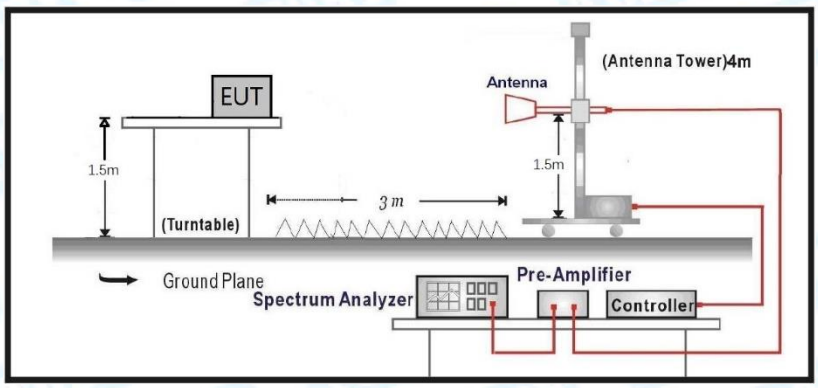
RSS 247 5.1(2)

FCC Part 15.247(a)(1)

11.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Time of occupancy (dwell time)	$P_{max-pk} \leq 1$ W $N_{ch} \geq 75$ f ≥ MAX { 25 kHz, BW_{20dB} } max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	2400~2483.5
	$P_{max-pk} \leq 0.125$ W $N_{ch} \geq 15$ f ≥ [MAX{25 kHz, 0.67*BW_{20dB}} OR MAX{25 kHz, BW_{20dB}}] max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; □ f = hopping channel carrier frequency separation		

11.2 Test Setup



11.3 Test Procedure

●The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: Zero span, centered on a hopping channel.

b) RBW shall be channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.

c) Sweep: As necessary to capture the entire dwell time per hopping channel; where

possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.

d) Detector function: Peak.

e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =

(number of hops on spectrum analyzer)x(period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

11.4 Deviation From Test Standard

No deviation

11.5 Antenna Connected Construction

Please refer to the description of test mode.

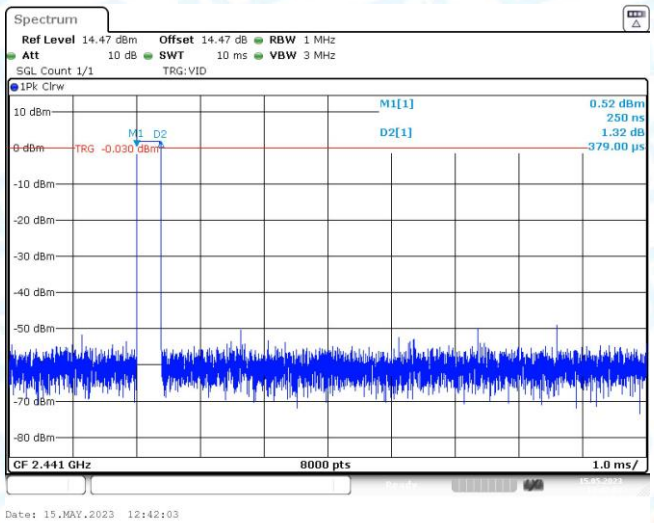
11.6 Test Data

Please refer to the following pages.

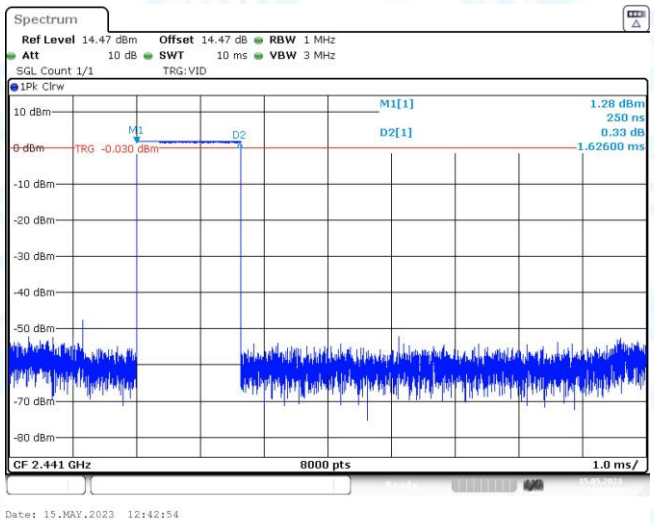
---Time of Occupancy (Radiation Measurements)

Test Mode	Channel	Burst Width [ms]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.379	0.121	≤0.4	PASS
DH3	Hop	1.626	0.260	≤0.4	PASS
DH5	Hop	2.868	0.306	≤0.4	PASS
2DH1	Hop	0.388	0.124	≤0.4	PASS
2DH3	Hop	1.633	0.261	≤0.4	PASS
2DH5	Hop	2.872	0.306	≤0.4	PASS
3DH1	Hop	0.388	0.124	≤0.4	PASS
3DH3	Hop	1.631	0.261	≤0.4	PASS
3DH5	Hop	2.874	0.307	≤0.4	PASS

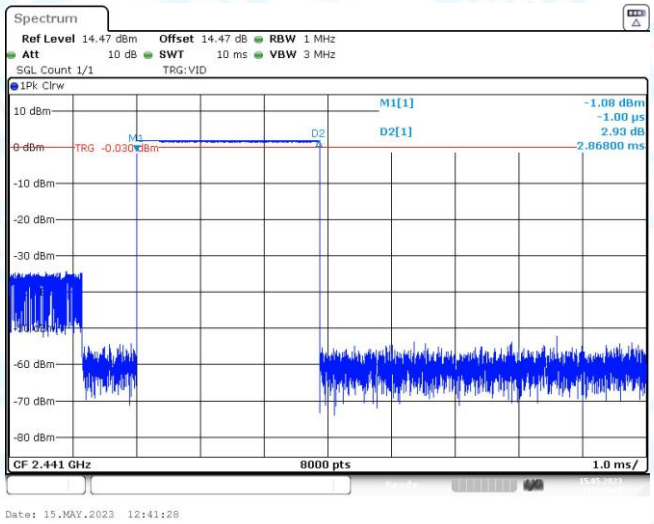
DH1&2DH1&3DH1 Total of Dwell= Pulse Time(1600/2)*31.6/79*
DH3&2DH3&3DH3 Total of Dwell= Pulse Time(1600/4)*31.6/79*
DH5&2DH5&3DH5 Total of Dwell= Pulse Time(1600/6)*31.6/79*



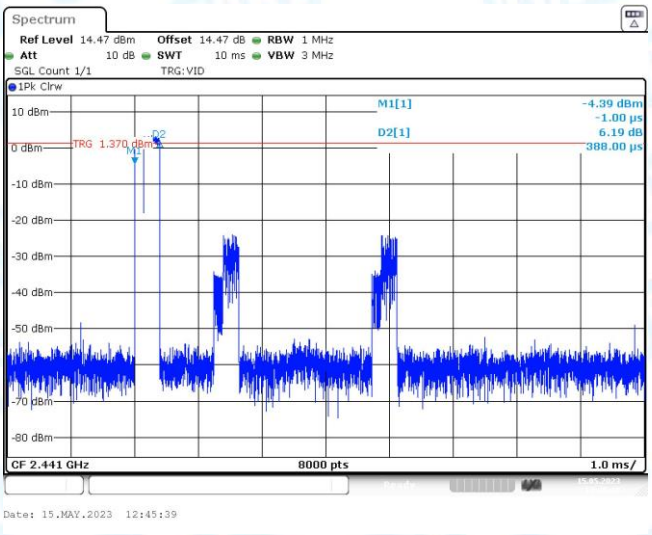
DH1_Hop



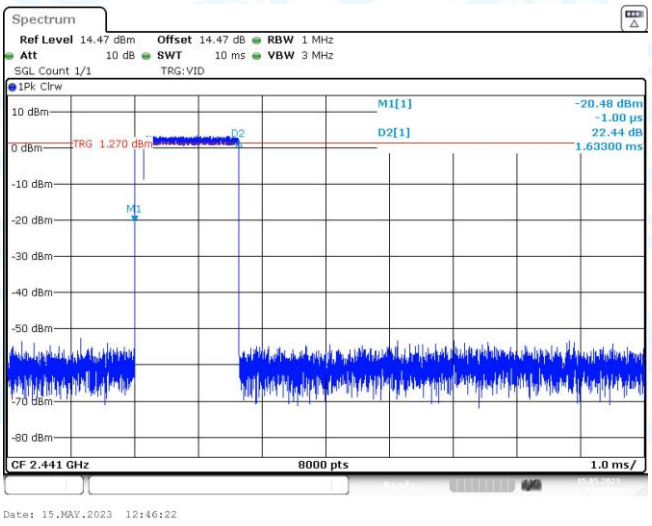
DH3_Hop



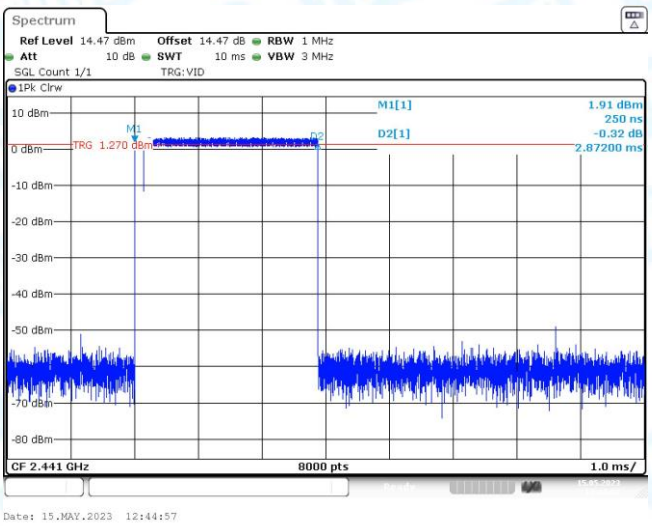
DH5_Hop



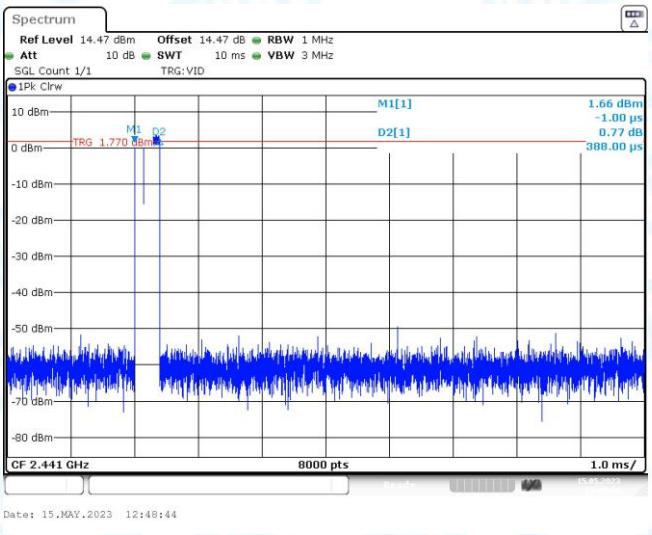
2DH1_Hop



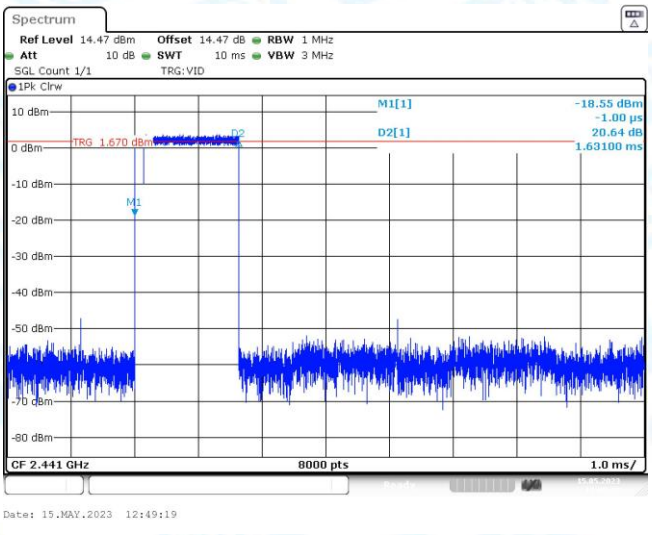
2DH3_Hop



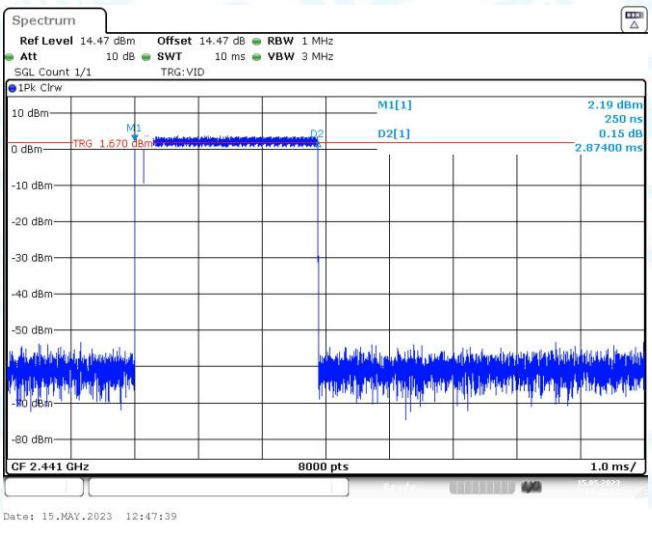
2DH5_Hop



3DH1_Hop



3DH3_Hop



3DH5_Hop

12. Number of hopping frequencies

12.1 Test Standard and Limit

12.1.1 Test Standard

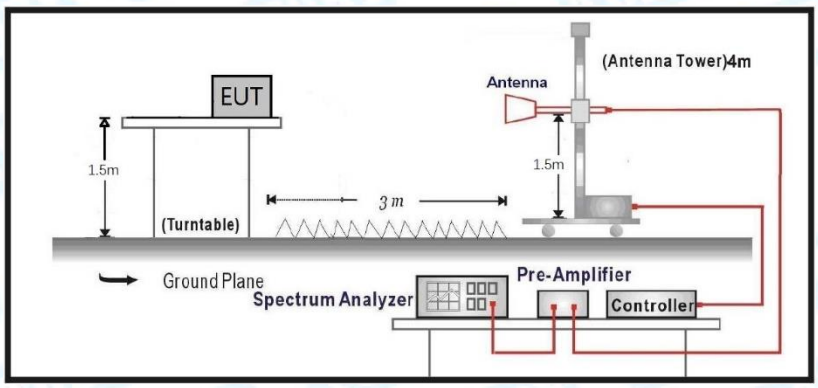
RSS 247 5.1(4)

FCC Part 15.247(b)(1)

12.1.2 Test Limit

Test Item	Limit	Frequency Range(MHz)
Carrier frequency separation	$P_{max\text{-}pk} \leq 1$ W $N_{ch} \geq 75$ f ≥ MAX { 25 kHz, BW_{20dB} } max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	2400~2483.5
	$P_{max\text{-}pk} \leq 0.125$ W $N_{ch} \geq 15$ f ≥ [MAX{25 kHz, 0.67*BW_{20dB}} OR MAX{25 kHz, BW_{20dB}}] max. BW_{20dB} not specified $t_{ch} \leq 0.4$ s for $T = 0.4 * N_{ch}$	
t_{ch} = average time of occupancy; T = period; N_{ch} = # hopping frequencies; BW = bandwidth; □ f = hopping channel carrier frequency separation		

12.2 Test Setup



12.3 Test Procedure

●The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.

b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the

channel spacing or the 20 dB bandwidth, whichever is smaller.

c) VBW ≥ RBW.

d) Sweep: Auto.

e) Detector function: Peak.

f) Trace: Max hold.

g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies.

Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

12.4 Deviation From Test Standard

No deviation

12.5 Antenna Connected Construction

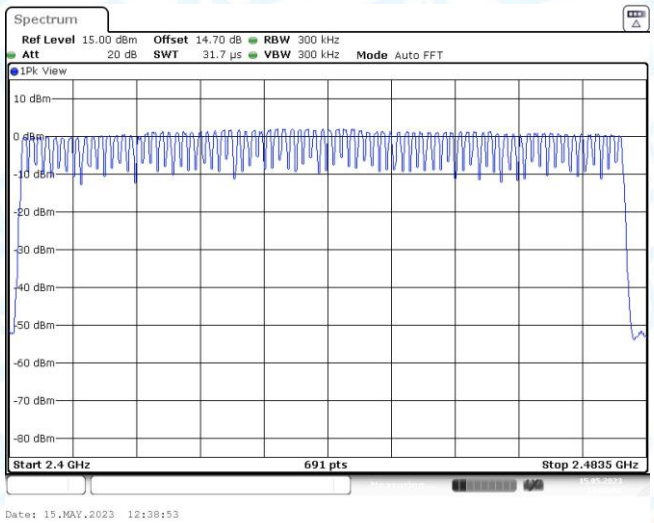
Please refer to the description of test mode.

12.6 Test Data

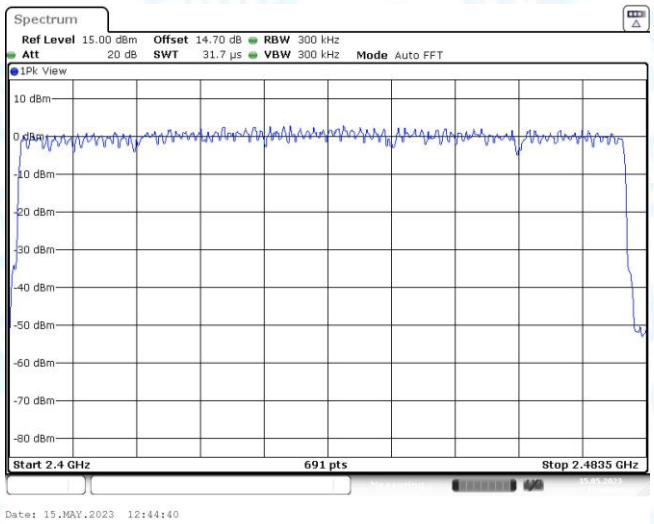
Please refer to the following pages.

---Number of Hopping Frequencies (Radiation Measurements)

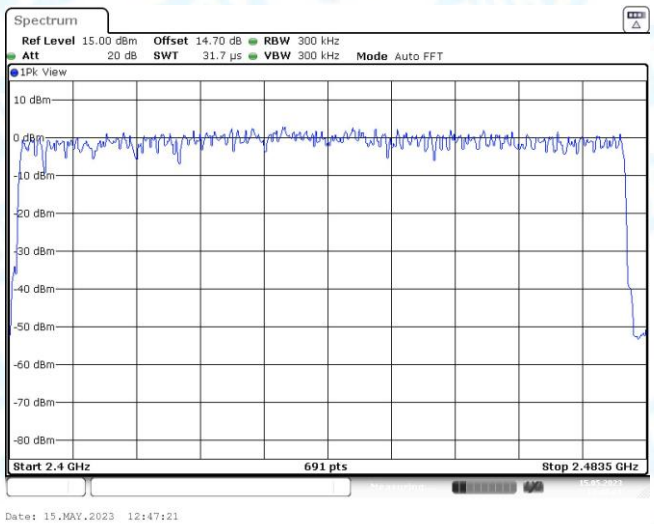
Test Mode	Channel	Result[Num]	Limit[Num]	Verdict
DH5	Hop	79	≥15	PASS
2DH5	Hop	79	≥15	PASS
3DH5	Hop	79	≥15	PASS



DH5_Hop



2DH5_Hop



3DH5_Hop

13. Antenna Requirement

13.1 Test Standard and Limit

11.1.1 Test Standard

RSS 247 6.8

FCC Part 15.203

11.1.2 Requirement

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

13.2 Deviation From Test Standard

No deviation

13.3 Antenna Connected Construction

The gains of the antenna used for transmitting is 0.85dBi, and the antenna de-signed with permanent attachment and no consideration of replacement. Please see the EUT photo for details.

13.4 Test Data

The EUT antenna is a PCB Antenna. It complies with the standard requirement.

Antenna Type
☒Permanent attached antenna
☐Unique connector antenna
☐Professional installation antenna

-----END OF THE REPORT------