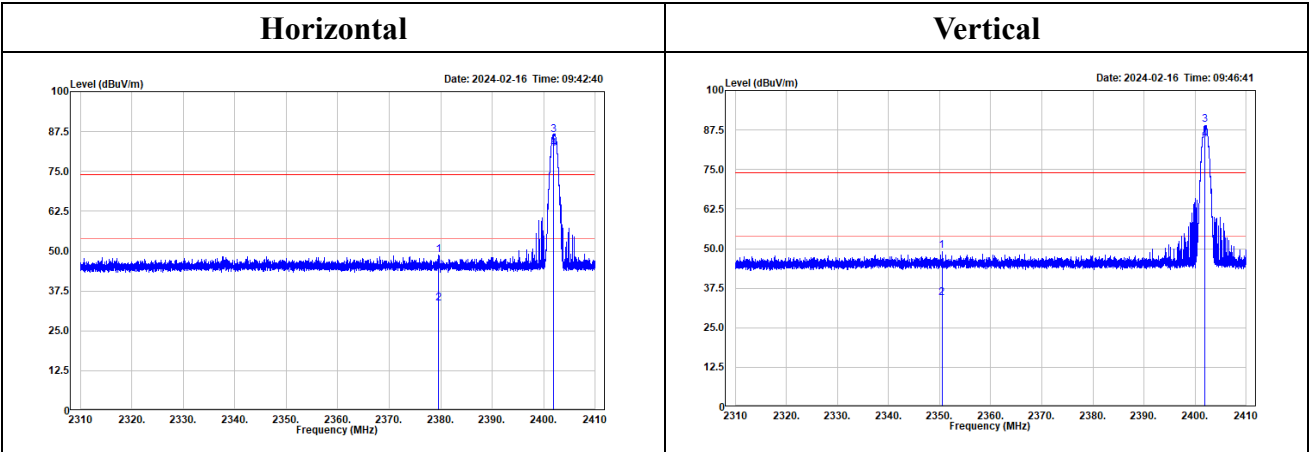
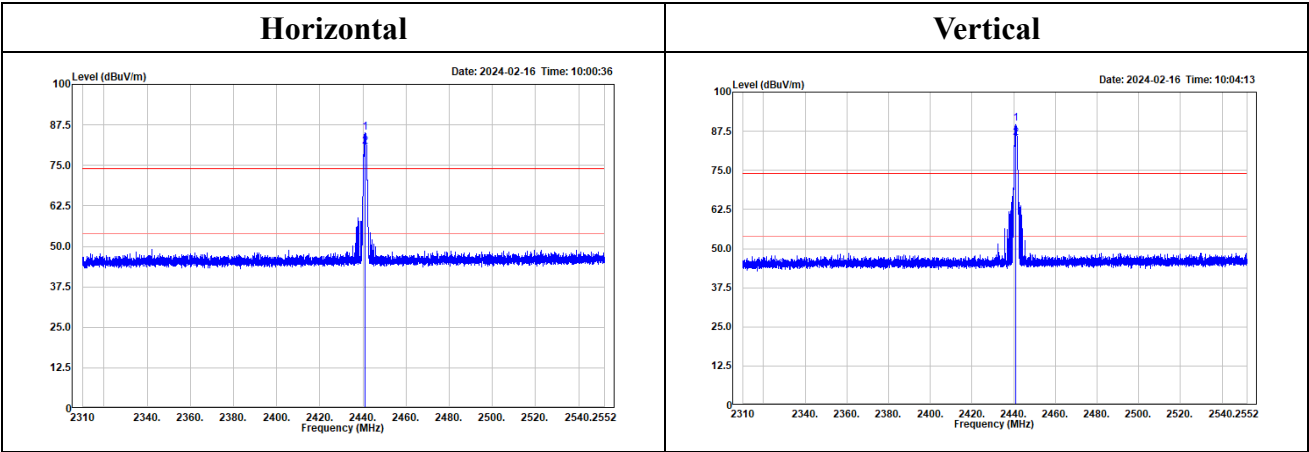


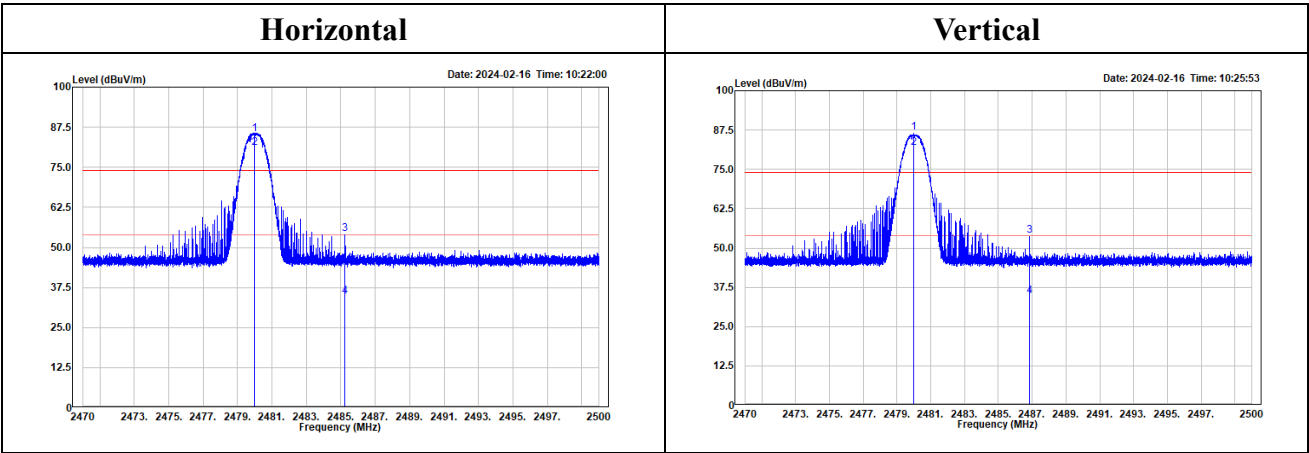
Band-Edge:
Low channel



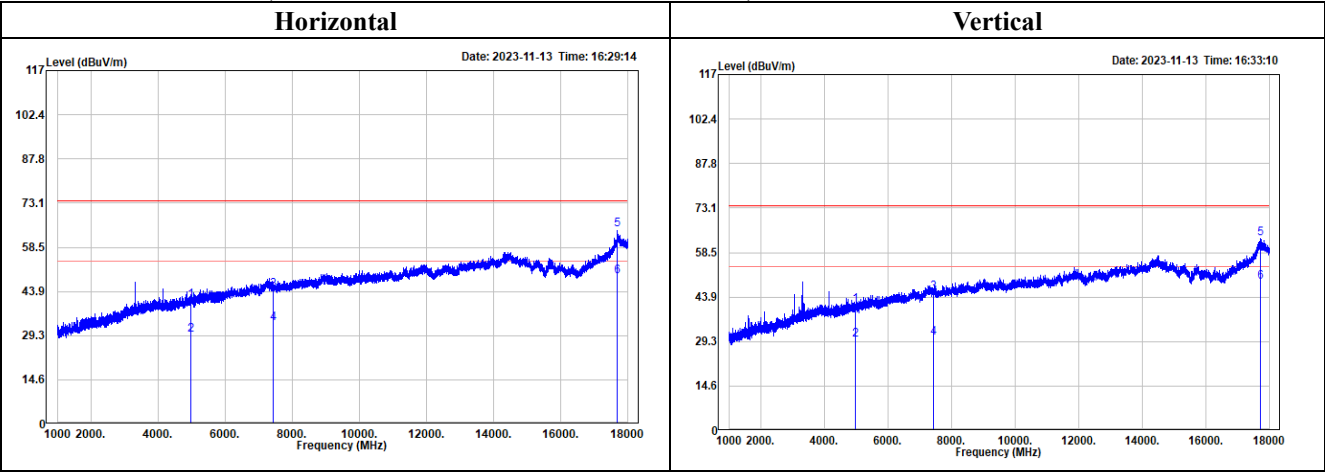
Middle channel



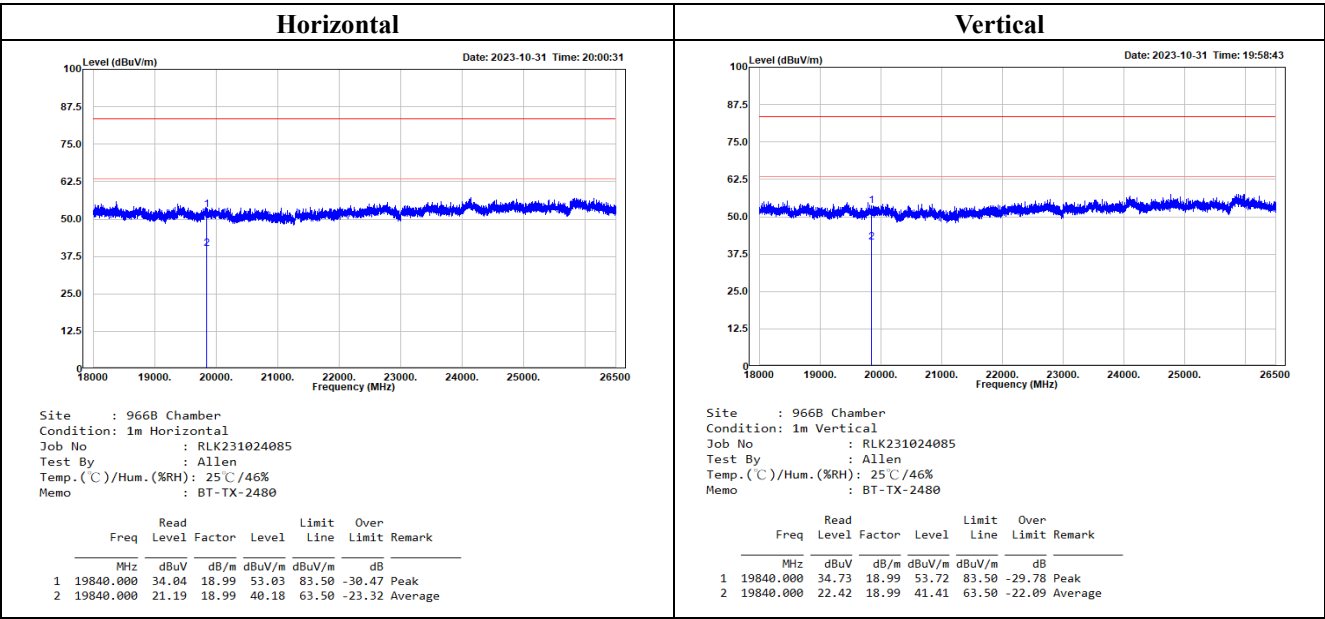
High channel



1GHz-18GHz: (worst case is BR(GFSK) mode high channel)



18GHz-26.5GHz:



Above 1GHz**BR (GFSK)****Horizontal**

Low channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2379.650	52.52	-3.74	48.78	74.00	-25.22	Peak
2	2379.650	37.42	-3.74	33.68	54.00	-20.32	Average
3	2402.000	90.32	-3.78	86.54	-----	-----	Peak
4	2402.000	85.89	-3.78	82.11	-----	-----	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4804.000	41.66	3.69	45.35	74.00	-28.65	Peak
2	4804.000	32.42	3.69	36.11	54.00	-17.89	Average
3	7206.000	36.64	9.62	46.26	74.00	-27.74	Peak
4	7206.000	24.17	9.62	33.79	54.00	-20.21	Average
5	17716.800	38.11	26.65	64.76	74.00	-9.24	Peak
6	17716.800	23.02	26.65	49.67	54.00	-4.33	Average

Middle channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2441.000	88.75	-3.58	85.17	-----	-----	Peak
2	2441.000	84.47	-3.58	80.89	-----	-----	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4882.000	37.69	4.00	41.69	74.00	-32.31	Peak
2	4882.000	26.32	4.00	30.32	54.00	-23.68	Average
3	7323.000	35.25	10.04	45.29	74.00	-28.71	Peak
4	7323.000	23.77	10.04	33.81	54.00	-20.19	Average
5	17704.800	36.16	26.63	62.79	74.00	-11.21	Peak
6	17704.800	23.04	26.63	49.67	54.00	-4.33	Average

High channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2480.000	88.85	-3.43	85.42	-----	-----	Peak
2	2480.000	84.57	-3.43	81.14	-----	-----	Average
3	2485.252	57.68	-3.41	54.27	74.00	-19.73	Peak
4	2485.252	38.13	-3.41	34.72	54.00	-19.28	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4960.000	36.72	4.11	40.83	74.00	-33.17	Peak
2	4960.000	25.30	4.11	29.41	54.00	-24.59	Average
3	7440.000	34.19	10.08	44.27	74.00	-29.73	Peak
4	7440.000	23.34	10.08	33.42	54.00	-20.58	Average
5	17683.300	37.73	26.48	64.21	74.00	-9.79	Peak
6	17683.300	22.42	26.48	48.90	54.00	-5.10	Average

Level = Reading + Factor.

Over Limit = Level – Limit.

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Low channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2350.430	53.07	-3.66	49.41	74.00	-24.59	Peak
2	2350.430	38.19	-3.66	34.53	54.00	-19.47	Average
3	2402.000	92.93	-3.78	89.15	-----	-----	Peak
4	2402.000	88.33	-3.78	84.55	-----	-----	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4804.000	40.05	3.69	43.74	74.00	-30.26	Peak
2	4804.000	27.74	3.69	31.43	54.00	-22.57	Average
3	7206.000	36.69	9.62	46.31	74.00	-27.69	Peak
4	7206.000	24.17	9.62	33.79	54.00	-20.21	Average
5	17758.000	36.40	26.72	63.12	74.00	-10.88	Peak
6	17758.000	22.20	26.72	48.92	54.00	-5.08	Average
Middle channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2441.000	93.65	-3.58	90.07	-----	-----	Peak
2	2441.000	88.95	-3.58	85.37	-----	-----	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4882.000	37.90	4.00	41.90	74.00	-32.10	Peak
2	4882.000	27.26	4.00	31.26	54.00	-22.74	Average
3	7323.000	35.40	10.04	45.44	74.00	-28.56	Peak
4	7323.000	23.75	10.04	33.79	54.00	-20.21	Average
5	17712.000	36.27	26.64	62.91	74.00	-11.09	Peak
6	17712.000	23.05	26.64	49.69	54.00	-4.31	Average
High channel							
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	2480.000	90.10	-3.43	86.67	-----	-----	Peak
2	2480.000	85.37	-3.43	81.94	-----	-----	Average
3	2486.860	57.34	-3.41	53.93	74.00	-20.07	Peak
4	2486.860	38.17	-3.41	34.76	54.00	-19.24	Average
	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	
1	4960.000	37.24	4.11	41.35	74.00	-32.65	Peak
2	4960.000	25.60	4.11	29.71	54.00	-24.29	Average
3	7440.000	35.34	10.08	45.42	74.00	-28.58	Peak
4	7440.000	20.33	10.08	30.41	54.00	-23.59	Average
5	17712.000	36.42	26.64	63.06	74.00	-10.94	Peak
6	17712.000	22.05	26.64	48.69	54.00	-5.31	Average

Level = Reading + Factor.

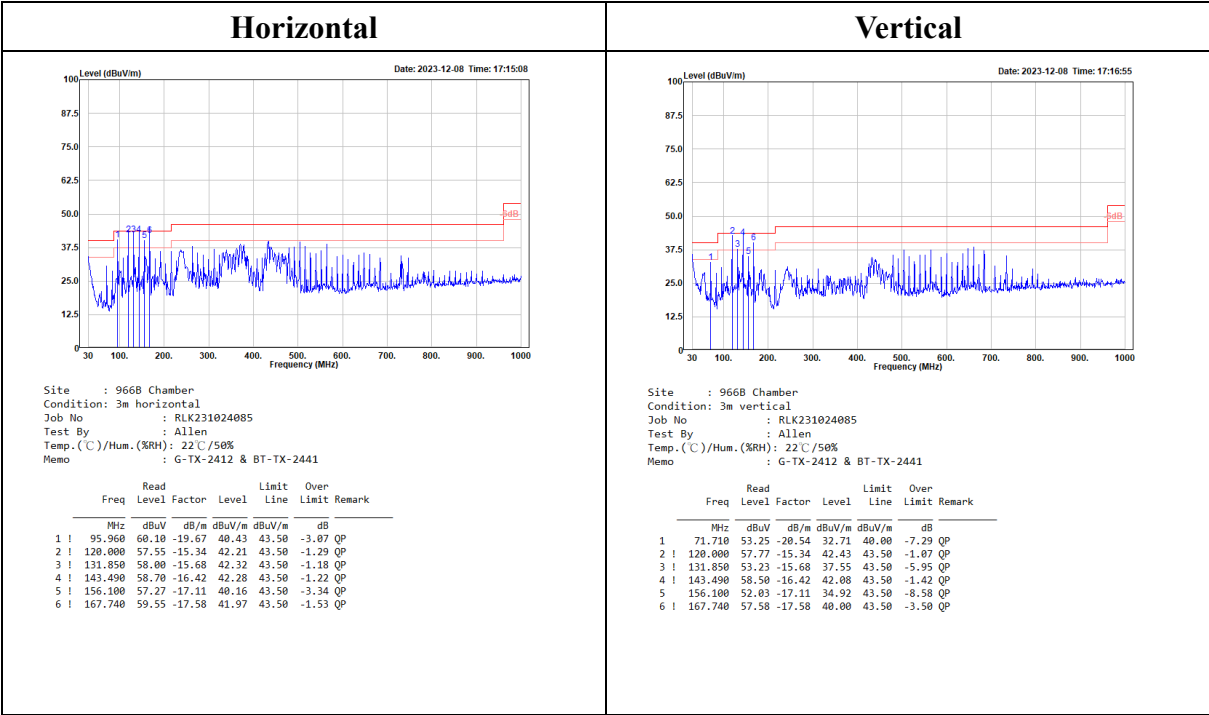
Over Limit = Level – Limit.

Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

Test Mode: simultaneous transmissions(BT+WIFI)

30MHz-1GHz:



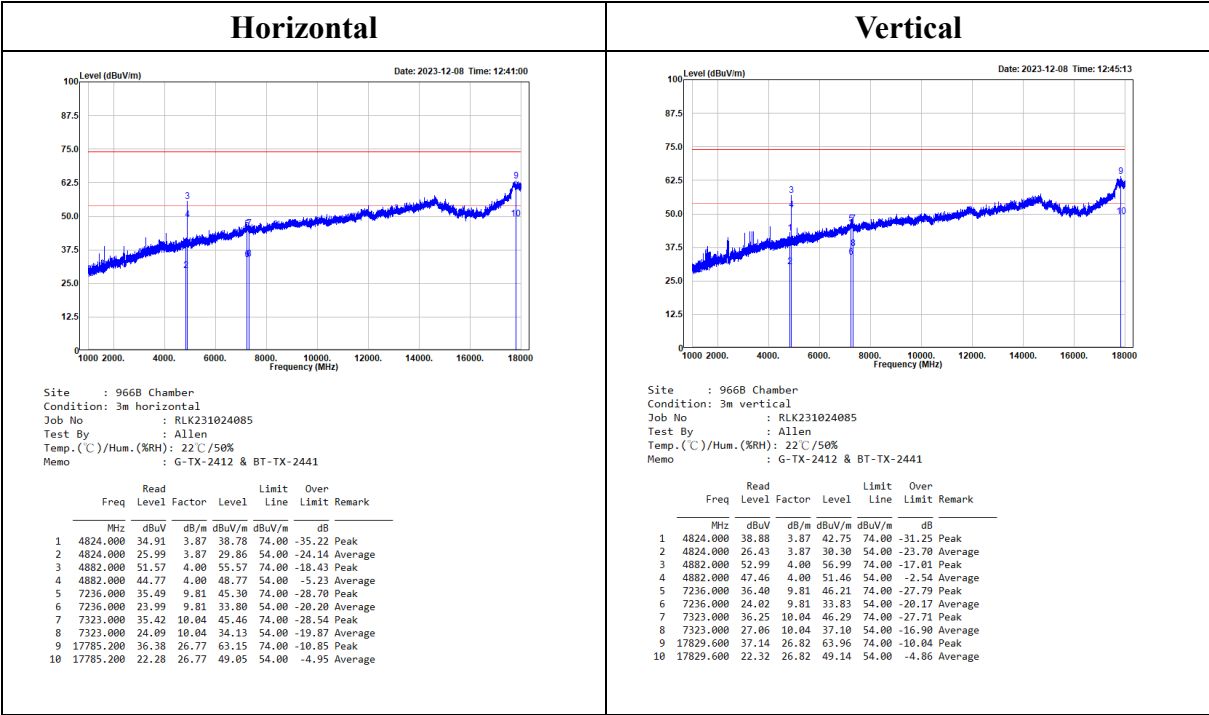
Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

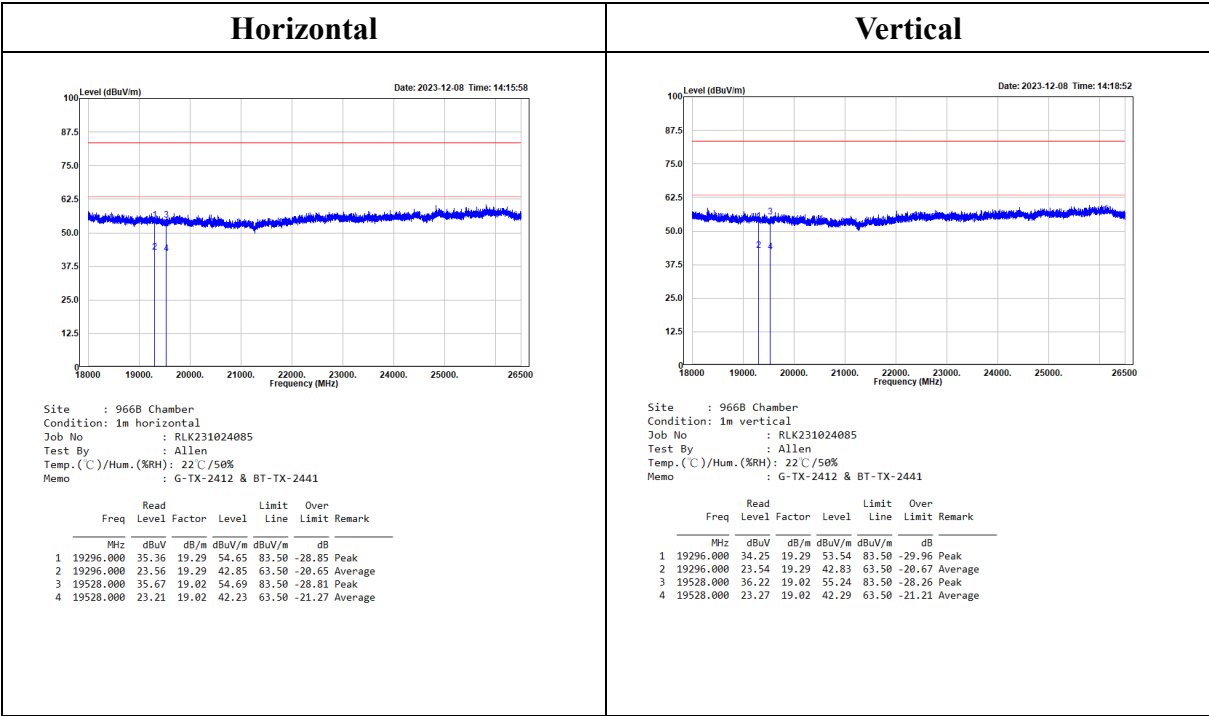
Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

1GHz-18GHz:



18GHz-26.5GHz:



Level (Result) = Reading + Factor.

Over Limit = Level – Limit.

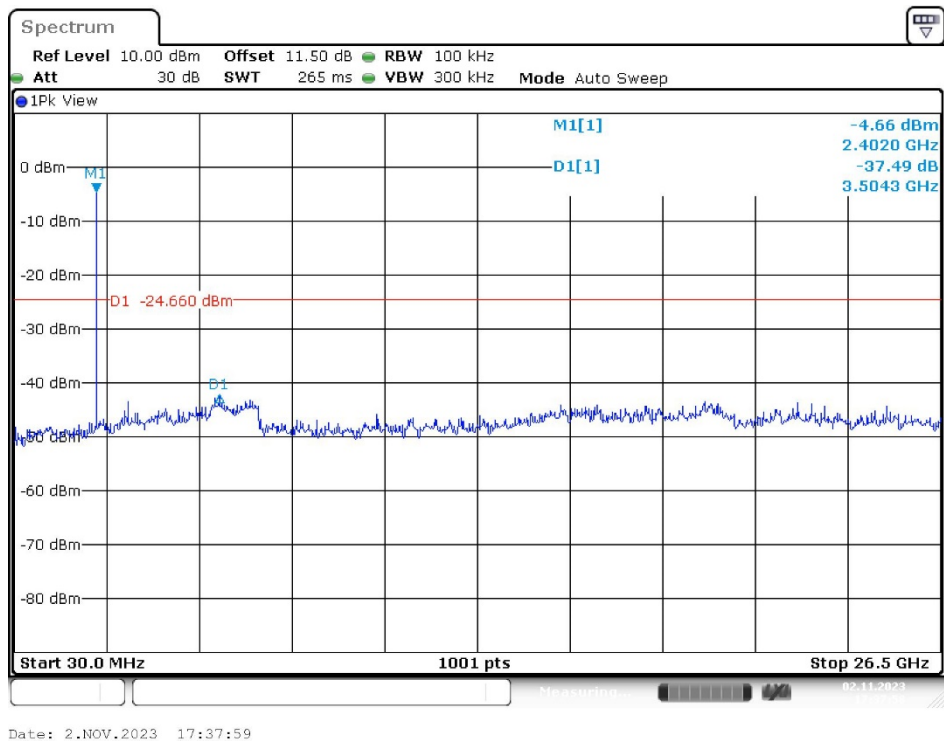
Factor = Antenna Factor + Cable Loss – Amplifier Gain.

Spurious emissions more than 20 dB below the limit were not reported.

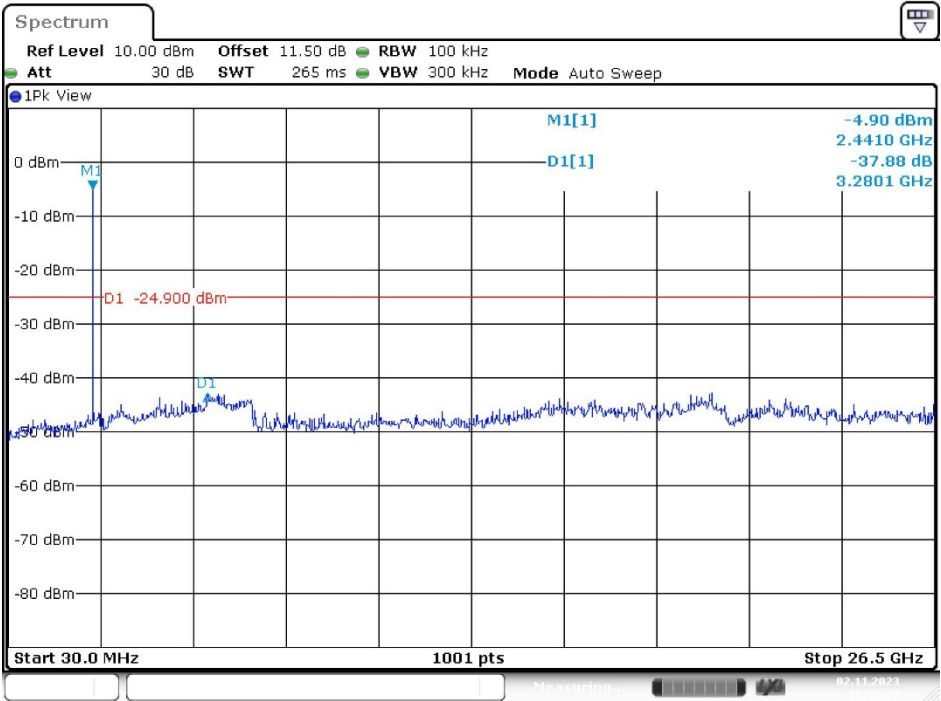
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR Mode (GFSK)				
Low	2402	37.49	≥ 20	PASS
Mid	2441	37.88	≥ 20	PASS
High	2480	35.73	≥ 20	PASS

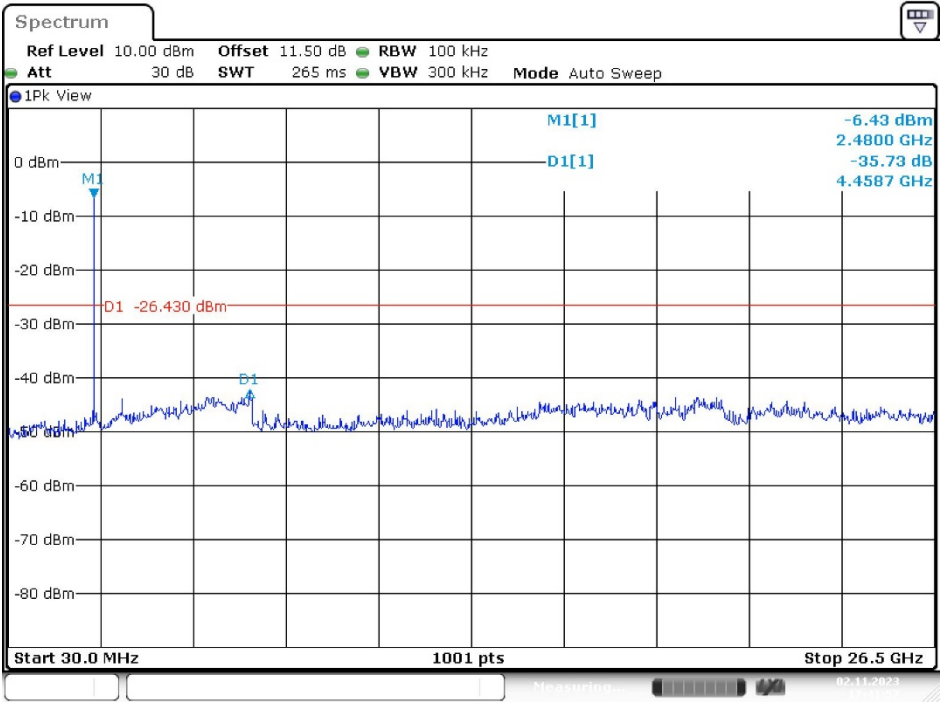
BR Mode (GFSK)
Low Channel



Middle Channel



High Channel



9. FCC §15.247(a)(1) – 20 dB Emission Bandwidth

9.1. Applicable Standard

According to FCC §15.247(a) (1) the maximum 20 dB bandwidth of the hopping channel shall be presented.

9.2. Test Procedure

- (1) Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- (2) Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- (3) Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
- (4) Repeat above procedures until all frequencies measured were complete.

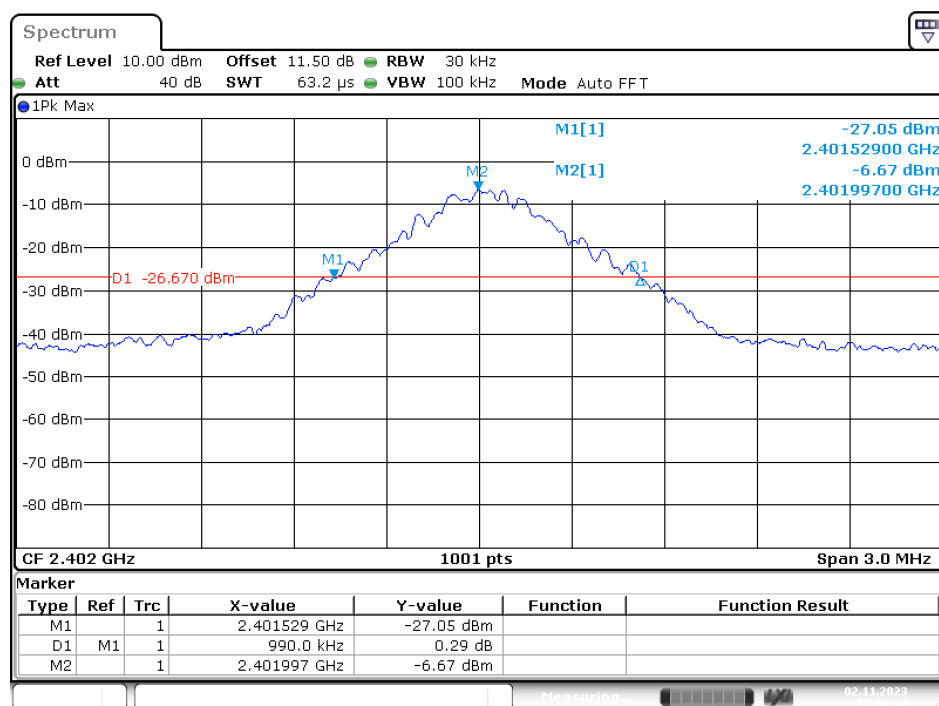
9.3. Test Results

Channel	Frequency (MHz)	20 dBc BW (MHz)
<i>BR Mode (GFSK)</i>		
Low	2402	0.99
Middle	2441	1.03
High	2480	1.05

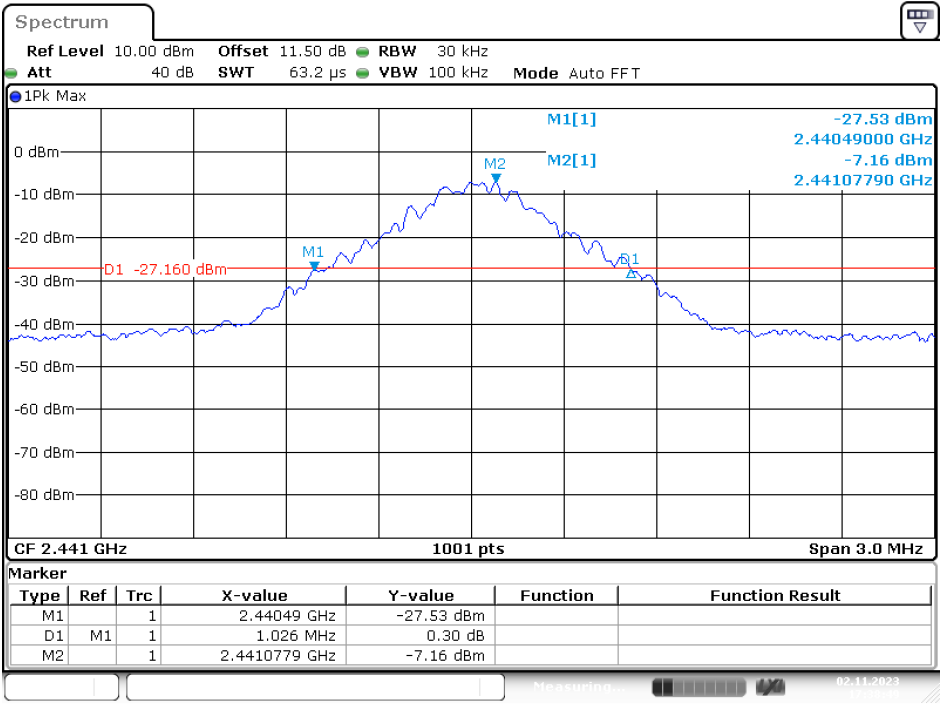
Please refer to the following plots

BR Mode (GFSK)

Low Channel

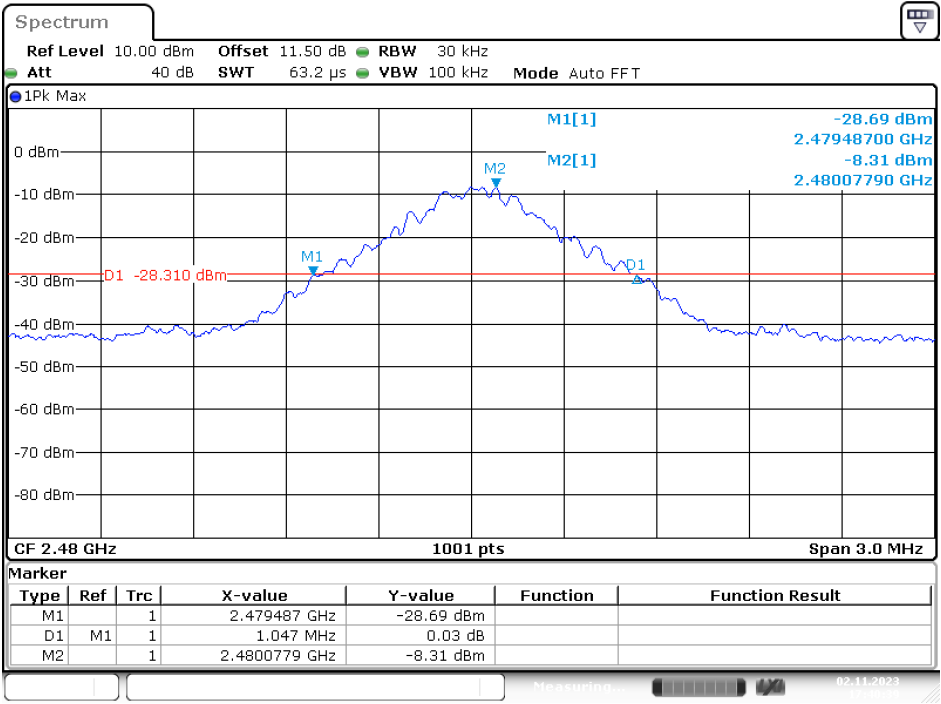


Middle Channel



Date: 2.NOV.2023 17:38:49

High Channel



Date: 2.NOV.2023 17:40:39

10. FCC §15.247(a)(1) – Channel Separation Test

10.1. Applicable Standard

According to FCC §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. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly 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.

10.2. Test Procedure

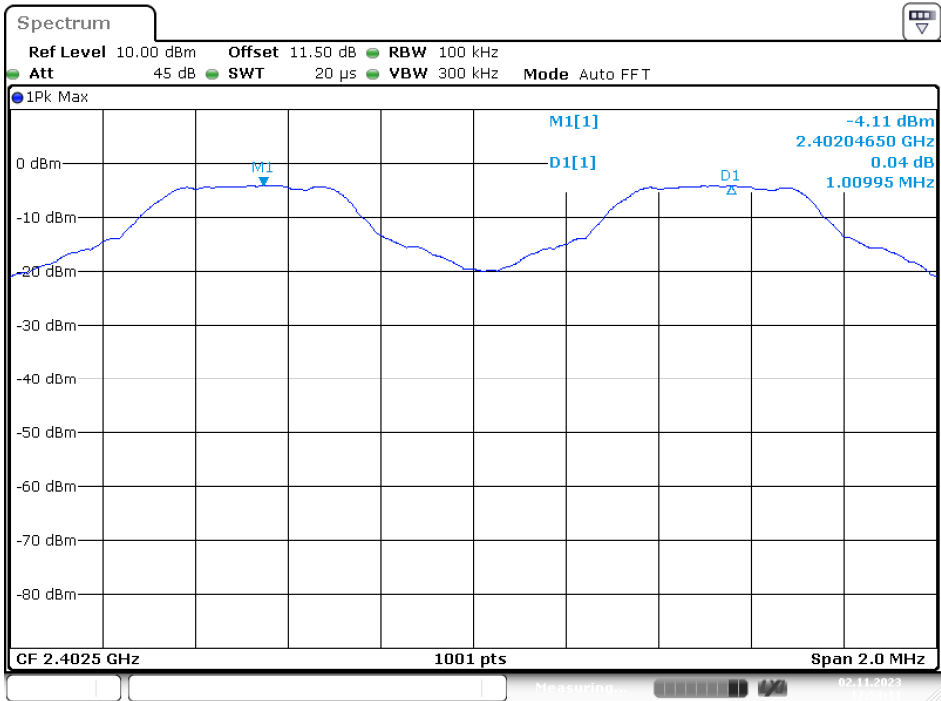
1. Set the EUT in transmitting mode, max hold the channel.
2. Set the adjacent channel of the EUT and max hold another trace.
3. Measure the channel separation.

10.3. Test Results

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
BR Mode (GFSK)					
Low	1.010	0.99	0.660	>two-thirds of the 20 dB bandwidth	Compliance
Middle	0.998	1.03	0.684	>two-thirds of the 20 dB bandwidth	Compliance
High	1.004	1.05	0.698	>two-thirds of the 20 dB bandwidth	Compliance

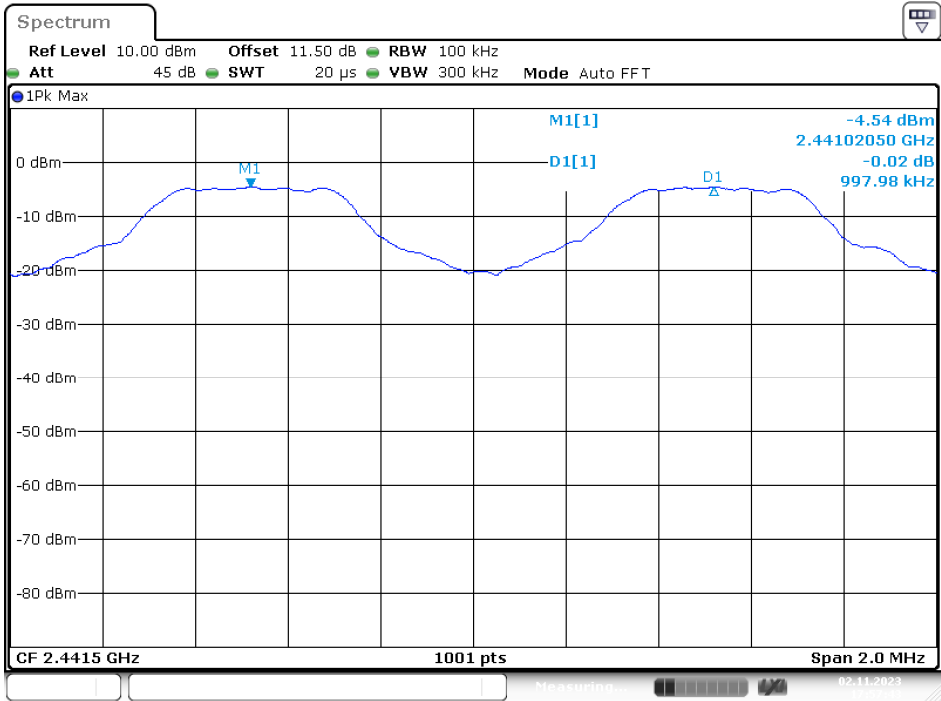
Please refer to the following plots.

BR Mode (GFSK)
Low Channel



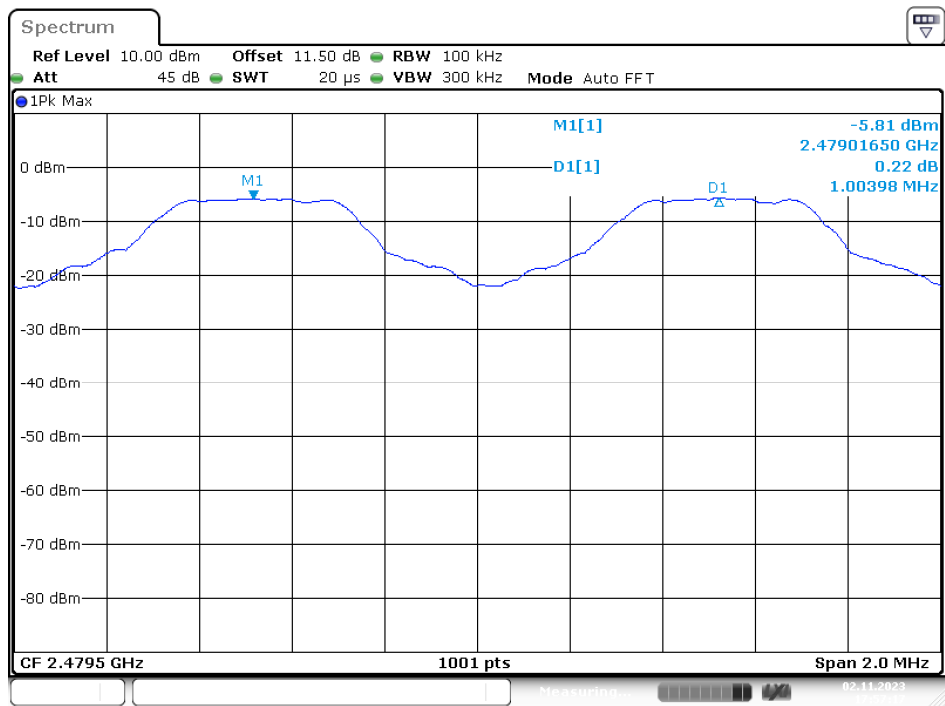
Date: 2.NOV.2023 17:58:12

Middle Channel



Date: 2.NOV.2023 17:57:43

High Channel



Date: 2.NOV.2023 17:57:18

11. FCC§15.247(a)(1)(iii) –Time of Occupancy (Dwell Time)

11.1. Applicable Standard

According to FCC §15.247(a) (1) (iii).

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.

11.2. Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel $RBW \leq$ channel spacing and where possible RBW should be set $\gg 1/T$, where T is the expected dwell time per channel Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak 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. 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.

11.3. Test Results

Test mode: BR mode / 2402 ~ 2480MHz (GFSK)						
Mode	Pulse Time (ms)	Hopping Number	Period Time (s)	Total of Dwell (ms)	Limit (ms)	Result
DH1	0.406	590	31.6	238.95	<400	PASS
DH3	1.609	130	31.6	209.17	<400	PASS
DH5	2.806	120	31.6	336.72	<400	PASS

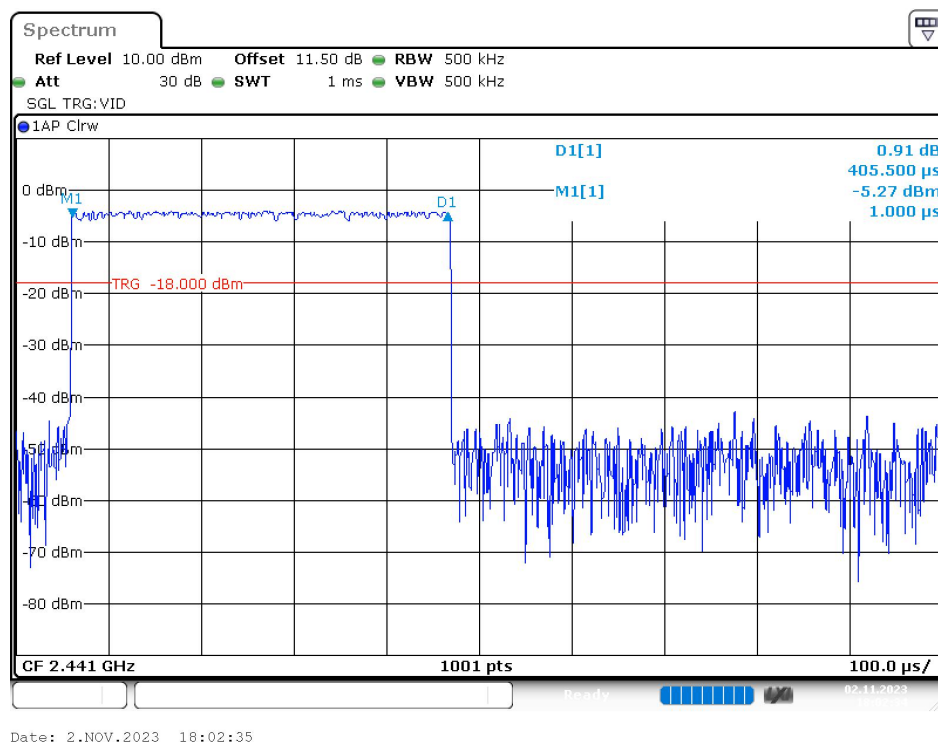
Note 1: A period time = $0.4 \times 79 = 31.6$ (s), Total of Dwell = Pulse Time * Hopping Number

Note 2: Hopping Number = Hopping Number/10 * 10

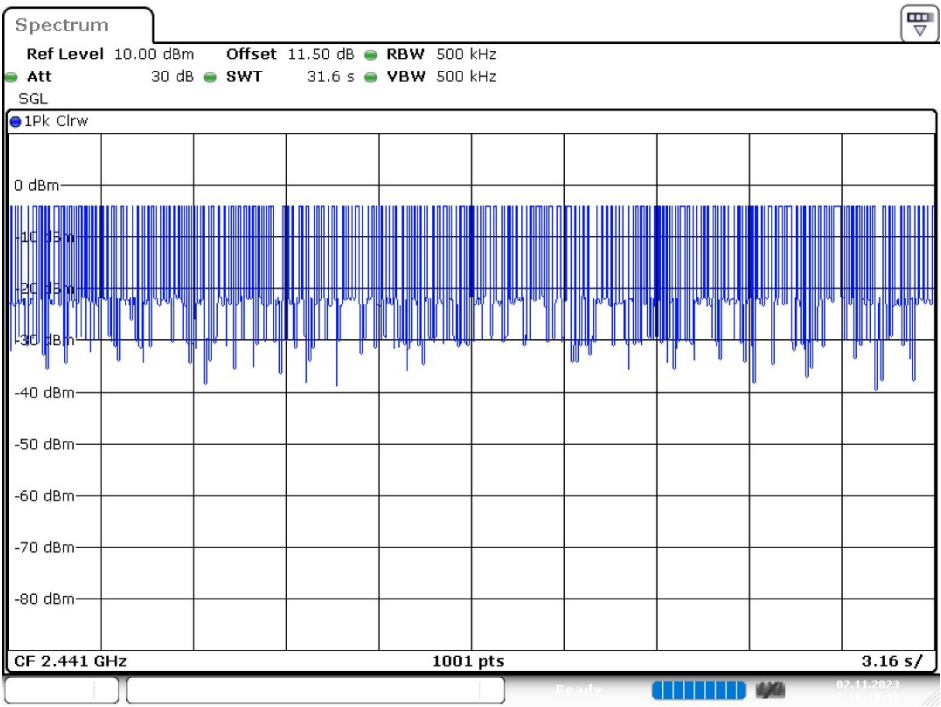
Note 3: Hopping Number/10 = Total of highest signals in 3.16s. (Second high signals were other channel)

Please refer to the following plots

BR Mode (GFSK) DH1: Pulse Width



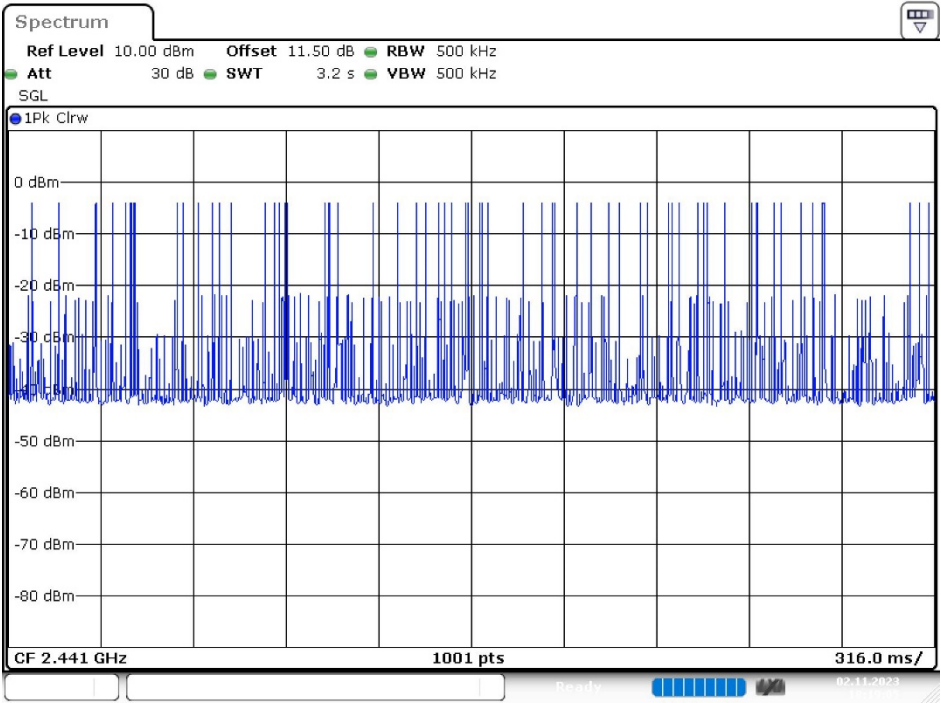
DH1: Hopping Number



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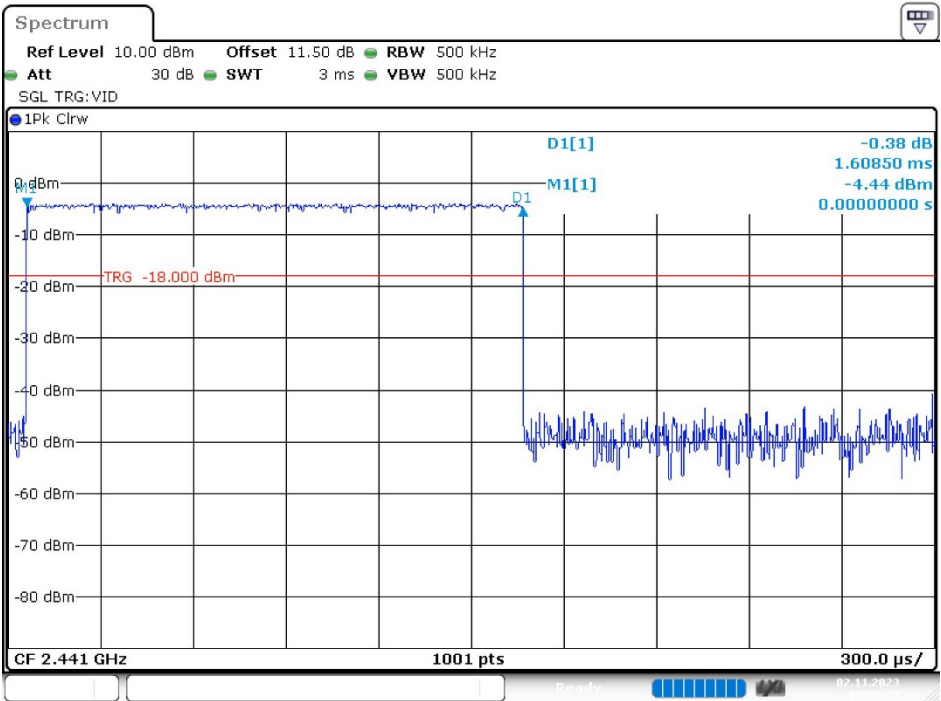
DH1: Hopping Number /10

(Hopping Number = 59 in 1/10 period of highest signals, Second High signals were other channel)

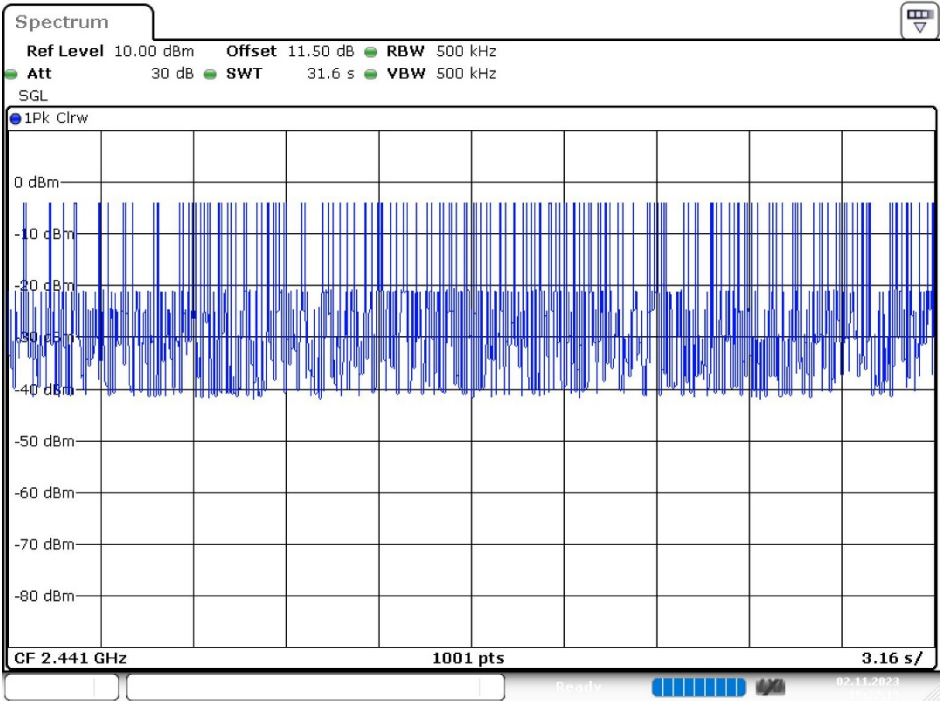


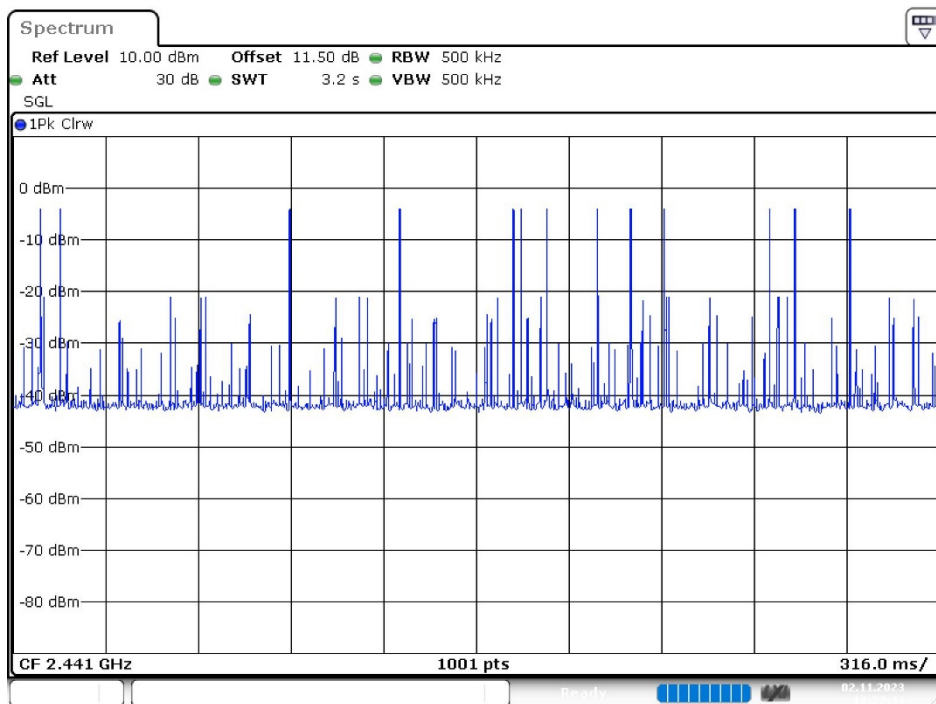
Date: 2.NOV.2023 18:19:06

DH3: Pulse Width

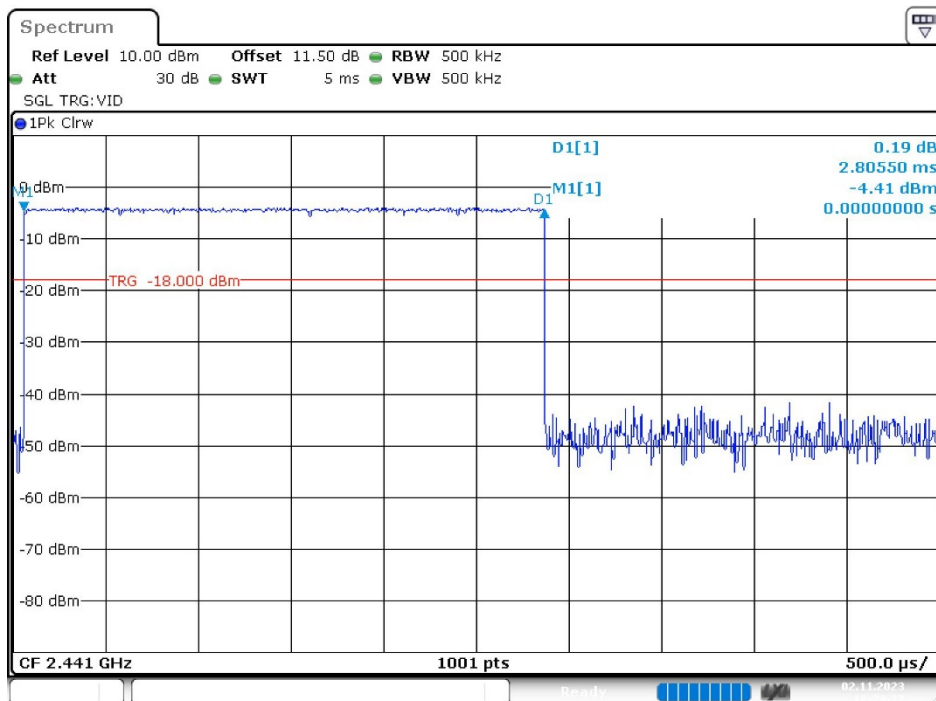


DH3: Hopping Number



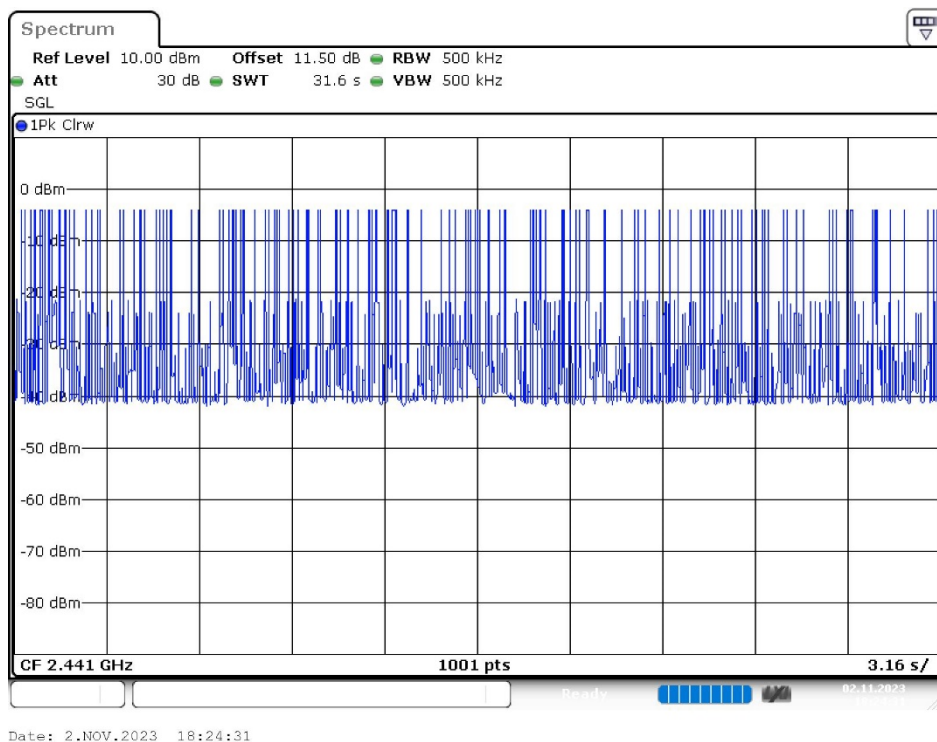
DH3: Hopping Number /10**(Hopping Number = 13 in 1/10 period of highest signals, Second High signals were other channel)**

Date: 2.NOV.2023 18:22:43

DH5: Pulse Width

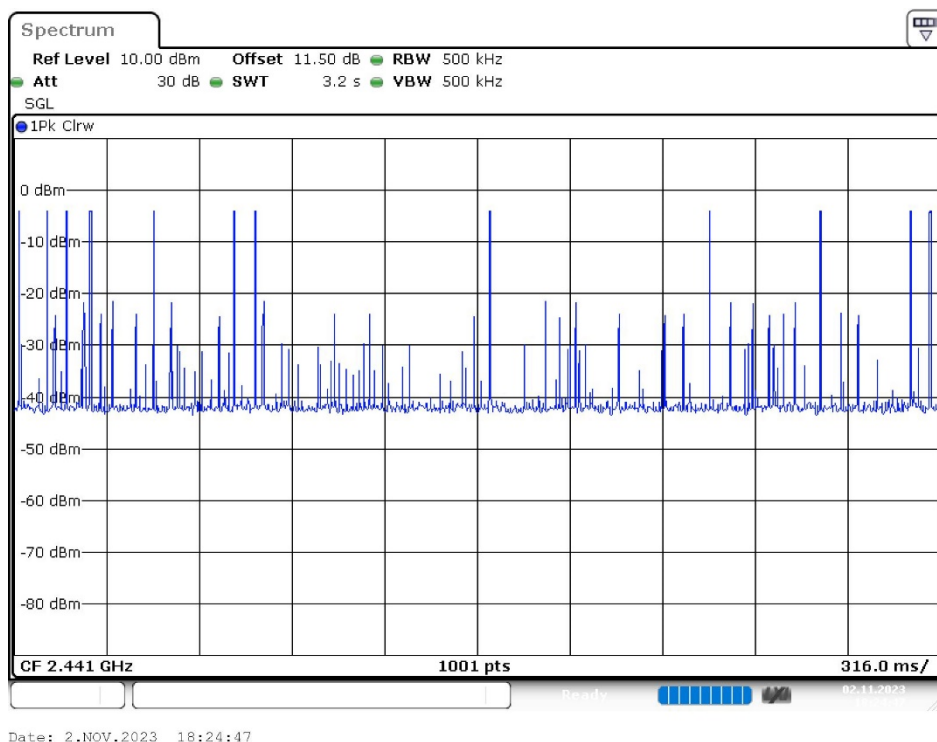
Date: 2.NOV.2023 18:23:27

DH5: Hopping Number



DH5: Hopping Number /10

(Hopping Number = 12 in 1/10 period of highest signals, Second High signals were other channel)



12. FCC §15.247(a)(1)(iii) –Quantity of hopping channel Test

12.1. Applicable Standard

According to FCC §15.247(a) (1) (iii).

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.

12.2. Test Procedure

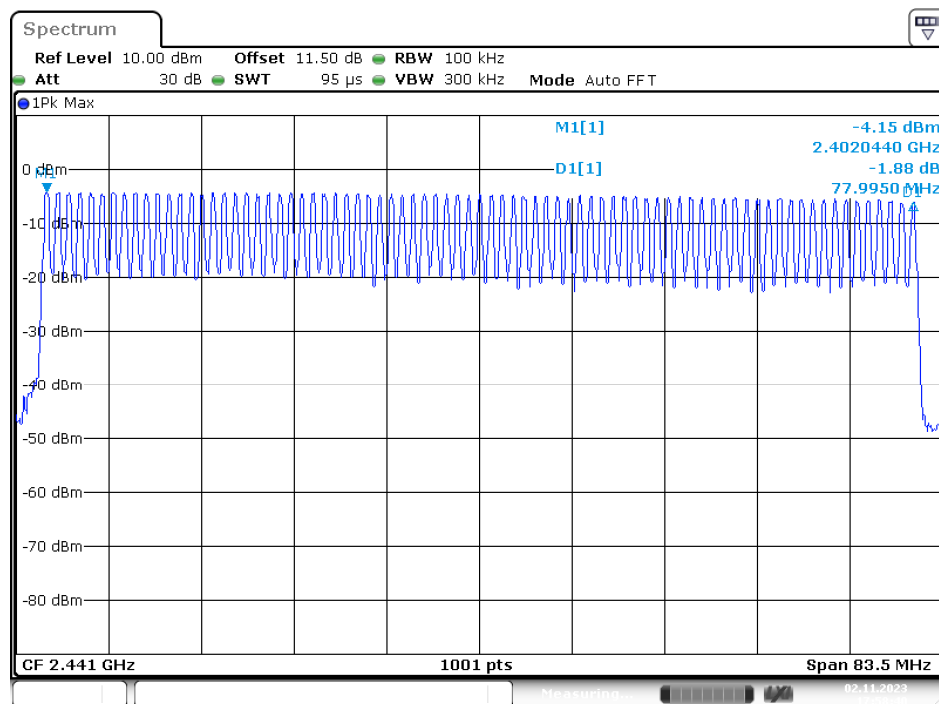
1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the Max-Hold function record the Quantity of the channel.

12.3. Test Results

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)	Result
GFSK	2402-2480	79	>15	Compliance

Please refer to the following plots

BR Mode (GFSK)



Date: 2.NOV.2023 17:58:41

13. FCC §15.247(b)(1) – Maximum Output Power

13.1. Applicable Standard

According to FCC §15.247(b) (1).

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.

13.2. Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

13.3. Test Results

Channel	Frequency (MHz)	Peak Conducted Output Power		Limit (W)	Result
		(dBm)	(W)		
BR Mode (GFSK)					
Low	2402	-2.86	0.00052	0.125	Compliance
Middle	2441	-3.31	0.00047	0.125	Compliance
High	2480	-4.26	0.00037	0.125	Compliance

14. FCC §15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

14.1. Applicable Standard

According to FCC §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emissions limits specified in §15.209(a) see §15.205(c).

14.2. Test Procedure

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

RBW = 100 kHz VBW = 300 kHz

Sweep = coupled

Detector function = peak Trace = max hold

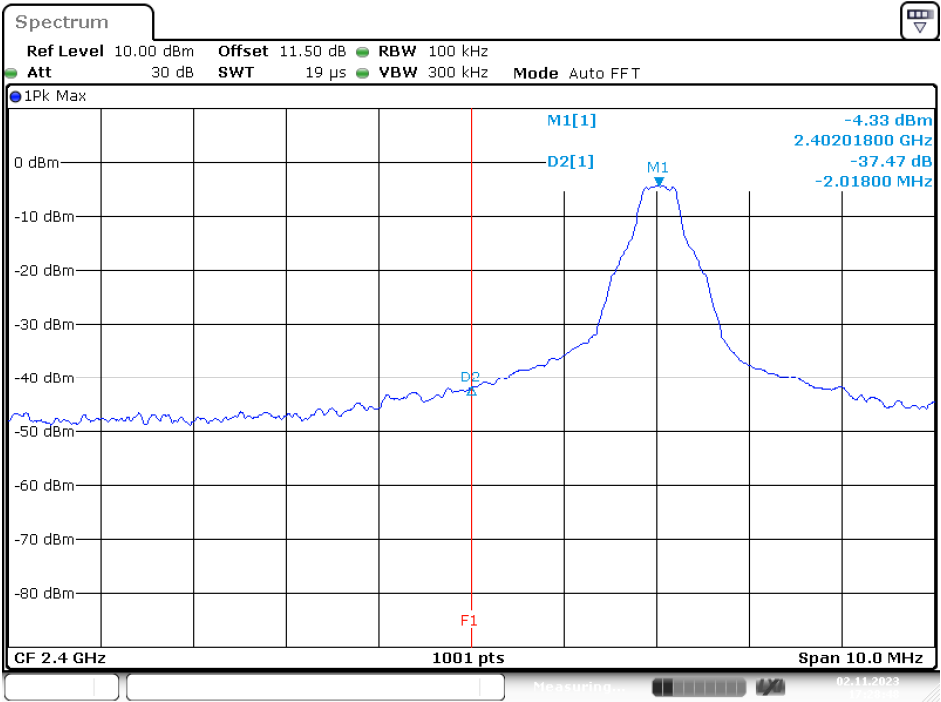
14.3. Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BR Mode (GFSK)				
Low	2402	37.47	≥ 20	PASS
High	2480	40.81	≥ 20	PASS
BR Hopping Mode (GFSK)				
Low	2402-2480	38.81	≥ 20	PASS
High	2402-2480	40.38	≥ 20	PASS

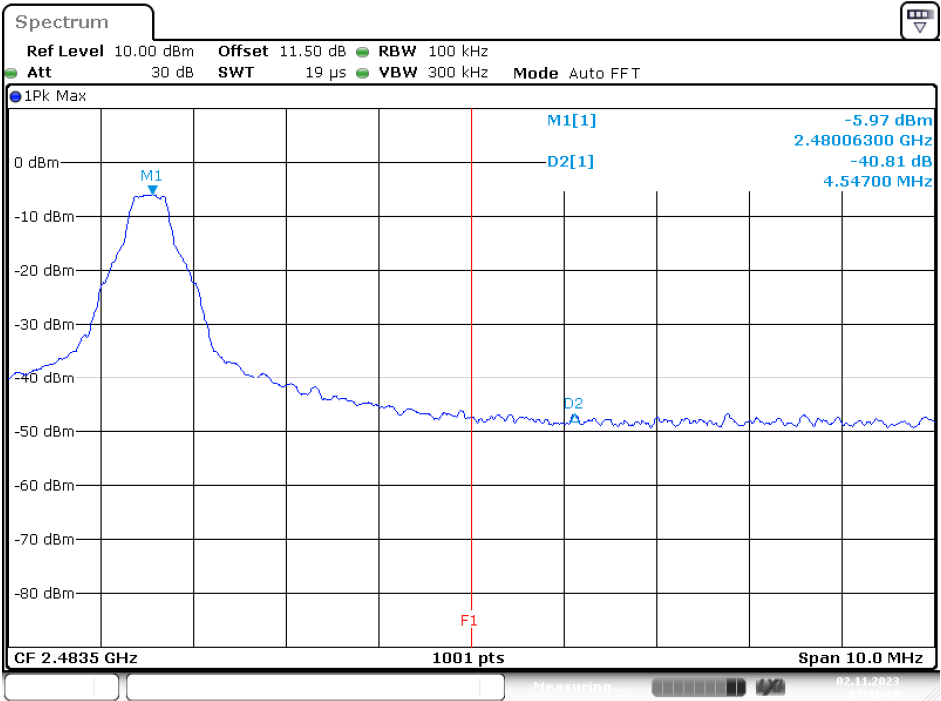
Please refer to the following plots.

BR Mode (GFSK)

Band Edge, CH Low



Band Edge, CH High



Spectrum

Ref Level 10.00 dBm Offset 11.50 dB RBW 100 kHz
 Att 30 dB SWT 19 μ s VBW 300 kHz Mode Auto FFT

1Pk Max

0 dBm
 -10 dBm
 -20 dBm
 -30 dBm
 -40 dBm
 -50 dBm
 -60 dBm
 -70 dBm
 -80 dBm

M1[1]
 D2[1]
 M1
 -4.12 dBm
 2.40201800 GHz
 -38.81 dB
 -2.06798 MHz

F1

CF 2.4 GHz 1001 pts Span 10.0 MHz

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Spectrum

Ref Level 10.00 dBm Offset 11.50 dB RBW 100 kHz
 Att 30 dB SWT 19 μ s VBW 300 kHz Mode Auto FFT

1Pk Max

M1[1] -5.69 dBm
 2.47902400 GHz
 D2[1] -40.38 dBm
 8.59552 MHz

F1

CF 2.4835 GHz 1001 pts Span 10.0 MHz

Date: 2.NOV.2023 17:56:54

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