Microtest
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Test Report

Report No.: MTi211207007-05E1

Date of issue: Apr. 29, 2022

Applicant: Shenzhen Monster Creative Technology Co., Ltd.

Product: Bluetooth Speaker

Model(s): MS12109, M69F

FCC ID: 2AVD2-MS12109

Shenzhen Microtest Co., Ltd.

http://www.mtitest.com

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Test Result Certification	
Applicant:	**Shenzhen Monster Creative Technology Co., Ltd.**
Address:	Flat G, 3/F, Building D, The Central Avenue, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China
Manufacturer:	**Shenzhen Jonter Digital Co., Ltd**
Address:	3/F, Building4, Jinfo Industrial Park, Hezhou Village, Hangcheng Town, Bao'an District, Shenzhen, China
Factory:	**Dongguan Jonter Digital Co., Ltd.**
Address:	Building 1, No. 5, Daguizi East Street, Tangjiao Village, Chashan Town, Dongguan, China
Product description	
Product name:	Bluetooth Speaker
Trademark:	MONSTER, JONTER
Model name:	MS12109
Serial Model:	M69F
Standards:	FCC 47 CFR Part 15 Subpart C
Test method:	ANSI C63.10-2013
Date of Test	
Date of test:	2021-12-07 ~ 2022-04-29
Test result:	Pass

Test Engineer : Danny Xu

(Danny Xu)

Reviewed By: : Leon Chen

(Leon Chen)

Approved By: : Tom Xue

(Tom Xue)

1 General Description

1.1 Description of the EUT

Product name:	Bluetooth Speaker
Model name:	MS12109
Series Model:	M69F
Model difference:	All the models are the same circuit and module, except the model's name.
Electrical rating:	Input: DC 5V/2A Battery: DC 7.4V 2500mAh
Hardware version:	V1.0
Software version:	V5
Accessories:	N/A
EUT serial number:	MTi211207007-05-S0001
RF specification:	
Bluetooth version:	V5.0
Operation frequency:	2402 MHz ~ 2480 MHz
Modulation type:	GFSK, π/4-DQPSK,8DPSK
Antenna designation:	PCB antenna, antenna Gain: -0.58 dBi
Max. peak conducted output power:	5.78 dBm

1.2 Description of test modes

1.2.1 Operation channel list

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	-	-

1.2.2 Test channels

Chanel	Frequency
Lowest (CH0)	2402MHz
Middle (CH39)	2441MHz
Highest (CH78)	2480MHz

Note: The test software has been used to control EUT for working in engineering mode, that enables selectable channel, and capable of continuous transmitting mode.

1.2.3 Description of support units

Support equipment list			
Description	Model	Serial No.	Manufacturer
Adapter	HW-090200CH0	/	Huizhou BYD Electronics Co., Ltd.

1.3 Measurement uncertainty

Parameter	Measurement uncertainty
AC power line conducted emission (9 kHz~30 MHz)	±2.5 dB
Occupied Bandwidth	±3 %
Conducted RF output power	±0.16 dB
Conducted spurious emissions	±0.21 dB
Radiated emission (9 kHz ~ 30 MHz)	±4.0 dB
Radiated emission (30 MHz~1 GHz)	±4.2 dB
Radiated emission (above 1 GHz)	±4.3 dB

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

2 Summary of Test Result

No.	FCC reference	Description of test	Result
1	§ 15.203	Antenna requirement	Pass
2	§ 15.207	AC power line conducted emissions	Pass
3	15.247(a)(1)	20dB occupied bandwidth	Pass
4	15.247(b)(1)	Conducted peak output power	Pass
5	15.247(a)(1)	Carrier Frequencies Separation	Pass
6	15.247(a)(1)	Average time of occupancy (Dwell time)	Pass
7	15.247(a)(1)	Number of hopping channels	Pass
8	15.247(d)	Conducted emission at the band edge	Pass
9	15.247(d)	Conducted spurious emissions	Pass
10	15.247(d)	Radiated spurious emissions	Pass

Note: N/A means not applicable.

3 Test Facilities and Accreditations

3.1 Test laboratory

Test laboratory:	Shenzhen Microtest Co., Ltd.
Test site location:	101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Telephone:	(86-755)88850135
Fax:	(86-755)88850136
CNAS Registration No.:	CNAS L5868
FCC Registration No.:	448573

4 Equipment List

No.	Equipment	Manufacturer	Model	Serial No.	Cal. date	Cal. Due
MTi-E002	EMI Test Receiver	R&S	ESCI3	101368	2021/06/02	2022/06/01
MTi-E023	Artificial power network	Schwarzbeck	NSLK8127	NSLK8127# 841	2021/06/02	2022/06/01
MTi-E025	Artificial power network	Schwarzbeck	NSLK8127	8127183	2021/06/02	2022/06/01
MTI-E043	EMI test receiver	R&S	ESCI7	101166	2021/06/02	2022/06/01
MTI-E046	Active Loop Antenna	Schwarzbeck	FMZB 1519 B	00044	2021/05/30	2023/05/29
MTI-E044	Broadband antenna	Schwarzbeck	VULB9163	9163-1338	2021/05/30	2023/05/29
MTI-E045	Horn antenna	Schwarzbeck	BBHA9120D	9120D-2278	2021/05/30	2023/05/29
MTI-E047	Pre-amplifier	Hewlett-Packard	8447F	3113A06184	2021/06/02	2022/06/01
MTI-E048	Pre-amplifier	Agilent	8449B	3008A01120	2021/06/02	2022/06/01
MTi-E120	Broadband antenna	Schwarzbeck	VULB9163	9163-1419	2021/05/30	2023/05/29
MTi-E121	Pre-amplifier	Hewlett-Packard	8447D	2944A09365	2022/04/15	2023/04/14
MTi-E123	Pre-amplifier	Agilent	8449B	3008A04723	2021/05/06	2022/05/05
MTi-E135	Horn antenna	Schwarzbeck	BBHA 9170	00987	2021/05/30	2023/05/29
MTi-E136	Pre-amplifier	Space-Dtronics	EWLAN1840G -G45	210405001	2021/06/02	2022/06/01
MTi-E062	PXA Signal Analyzer	Agilent	N9030A	MY51350296	2021/06/23	2022/06/22
MTi-E067	RF Control Unit	Tonscend	JS0806-1	19D8060152	2021/06/02	2022/06/01
MTi-E068	RF Control Unit	Tonscend	JS0806-2	19D8060153	2021/06/02	2022/06/01
MTi-E069	Band Reject Filter Group	Tonscend	JS0806-F	19D8060160	2021/06/02	2022/06/01
MTI-E010S	EMI Measurement Software	Farad	EZ-EMC Ver. EMEC-3A1	/	/	/
MTI-E014S	RF Test System	Tonscend	TS®JS1120 V2.6.88.0330	/	/	/

5 Test Result

5.1 Antenna requirement

15.203 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Description of the antenna of EUT

The antenna of EUT is PCB antenna (Antenna Gain: -0.58 dBi). which is no consideration of replacement.

5.2 AC power line conducted emissions

5.2.1 Limits

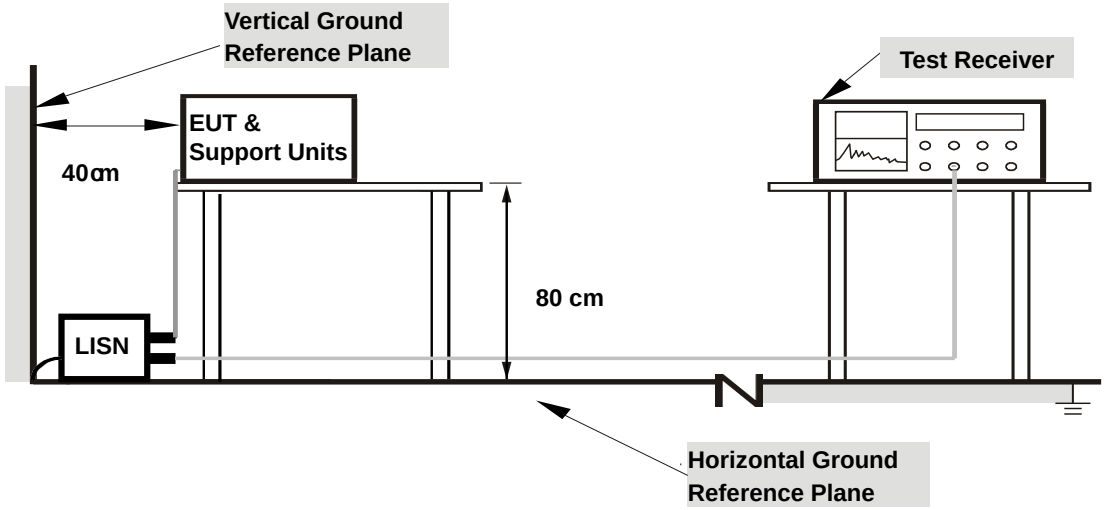
Frequency (MHz)	Detector type / Bandwidth	Limit-Quasi-peak dBµV	Limit-Average dBµV
0.15 -0.5	Average / 9 kHz	66 to 56	56 to 46
0.5 -5		56	46
5 -30		60	50

Note 1: the limit decreases with the logarithm of the frequency in the range of 0.15 MHz to 0.5 MHz.

5.2.2 Test Procedures

a) The test setup is refer to the standard ANSI C63.10-2013.
b) The EUT is connected to the main power through a line impedance stabilization network (LISN). All support equipment is powered from additional LISN(s).
c) Emissions were measured on each current carrying line of the EUT using an EMI test receiver connected to the LISN powering the EUT.
d) The test receiver scanned from 150 kHz to 30 MHz for emissions in each of the test modes described in Item 1.2.
e) The test data of the worst-case condition(s) was recorded.

5.2.3 Test setup



For the actual test configuration, please refer to the related item – Photographs of the test setup.

5.2.4 Test Result

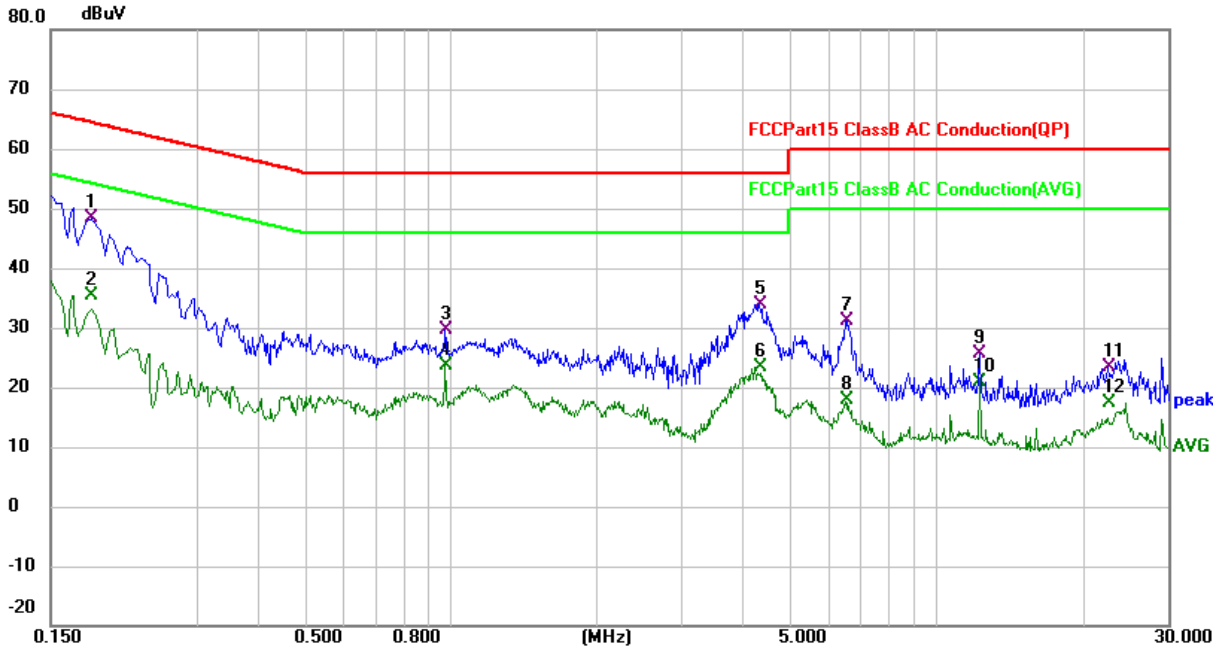
Notes:

All modes of operation of the EUT were investigated, and only the worst-case results are reported.

Calculation formula:

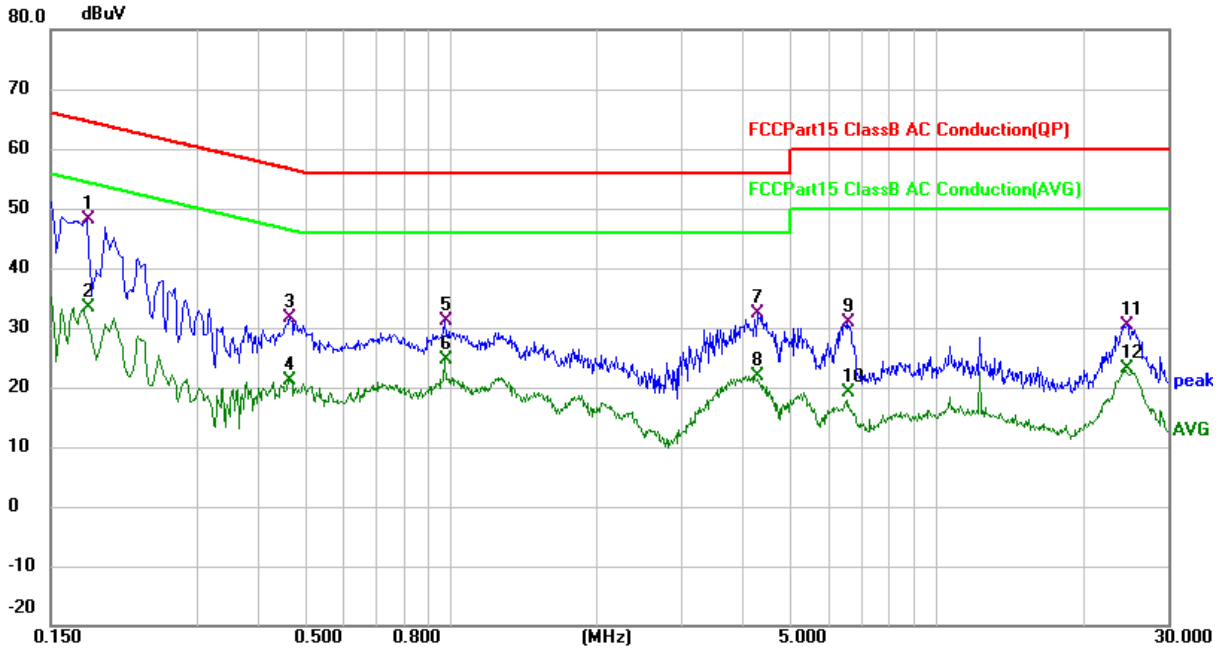
Measurement (dBµV) = Reading Level (dBµV) + Correct Factor (dB)
Over (dB) = Measurement (dBµV) – Limit (dBµV)

Test mode:	TX - 8DPSK-2480MHz	Phase:	L
Power supply:	Power by adapter AC 120V/60Hz	Test site:	CE chamber 1



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1	*	0.1819	37.30	10.97	48.27	64.40	-16.13	QP
2		0.1819	24.47	10.97	35.44	54.40	-18.96	AVG
3		0.9740	16.31	13.20	29.51	56.00	-26.49	QP
4		0.9740	10.36	13.20	23.56	46.00	-22.44	AVG
5		4.3340	22.51	11.45	33.96	56.00	-22.04	QP
6		4.3340	11.87	11.45	23.32	46.00	-22.68	AVG
7		6.5340	19.66	11.58	31.24	60.00	-28.76	QP
8		6.5340	6.26	11.58	17.84	50.00	-32.16	AVG
9		12.2900	13.86	11.65	25.51	60.00	-34.49	QP
10		12.2900	9.34	11.65	20.99	50.00	-29.01	AVG
11		22.5580	11.58	11.80	23.38	60.00	-36.62	QP
12		22.5580	5.53	11.80	17.33	50.00	-32.67	AVG

Test mode:	TX - 8DPSK-2480MHz	Phase:	N
Power supply:	Power by adapter AC 120V/60Hz	Test site:	CE chamber 1



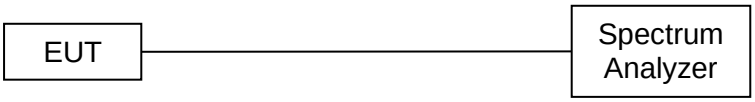
No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1	*	0.1780	37.09	10.94	48.03	64.58	-16.55	QP
2		0.1780	22.39	10.94	33.33	54.58	-21.25	AVG
3		0.4660	20.74	10.89	31.63	56.58	-24.95	QP
4		0.4660	10.28	10.89	21.17	46.58	-25.41	AVG
5		0.9740	18.03	13.13	31.16	56.00	-24.84	QP
6		0.9740	11.51	13.13	24.64	46.00	-21.36	AVG
7		4.2780	20.96	11.38	32.34	56.00	-23.66	QP
8		4.2780	10.52	11.38	21.90	46.00	-24.10	AVG
9		6.5580	19.38	11.39	30.77	60.00	-29.23	QP
10		6.5580	7.68	11.39	19.07	50.00	-30.93	AVG
11		24.6700	18.54	11.78	30.32	60.00	-29.68	QP
12		24.6700	11.29	11.78	23.07	50.00	-26.93	AVG

5.3 20dB occupied bandwidth

5.3.1 Limits

None, for reporting purposes only.

5.3.2 Test setup



5.3.3 Test procedures

a) Test method: ANSI C63.10-2013 Section 6.9.2.
b) The transmitter output of EUT is connected to the spectrum analyzer.
c) Spectrum analyzer setting: RBW=30 kHz, VBW=100 kHz, detector= Peak

5.3.4 Test results

Mode	Test channel	Frequency (MHz)	20dB Bandwidth (MHz)
GFSK	CH0	2402	0.931
	CH39	2441	0.9352
	CH78	2480	0.9358
π/4-DQPSK	CH0	2402	1.282
	CH39	2441	1.281
	CH78	2480	1.286
8DPSK	CH0	2402	1.297
	CH39	2441	1.296
	CH78	2480	1.295

GFSK mode - 20dB occupied bandwidth

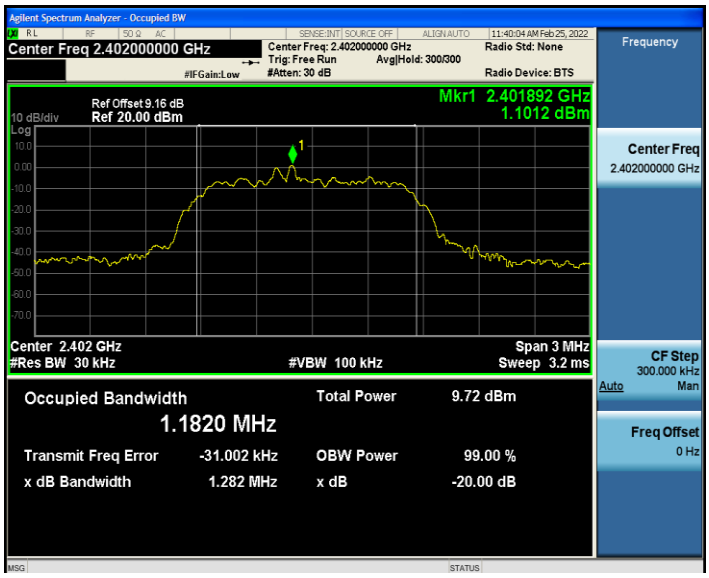
CH0

CH39

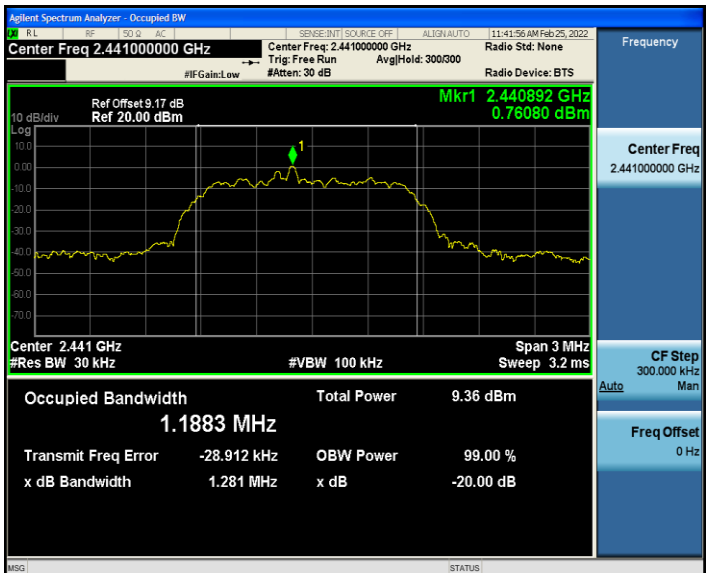
CH78

π/4-DQPSK mode - 20dB occupied bandwidth

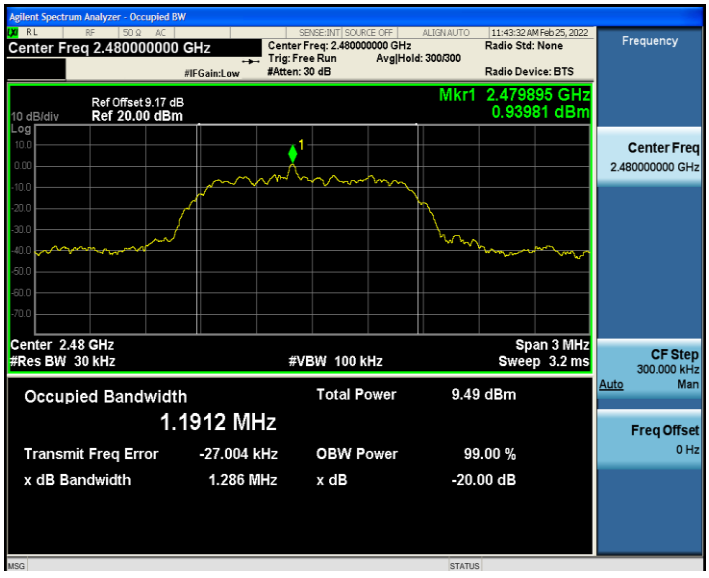
CH0



CH39

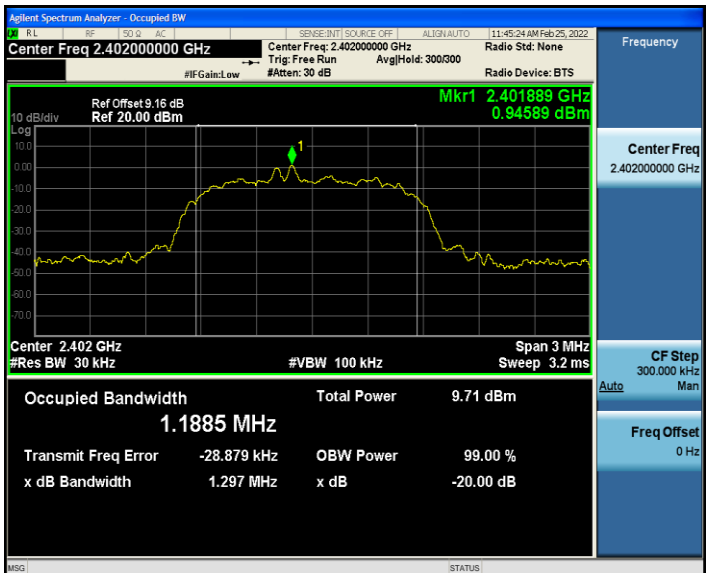


CH78

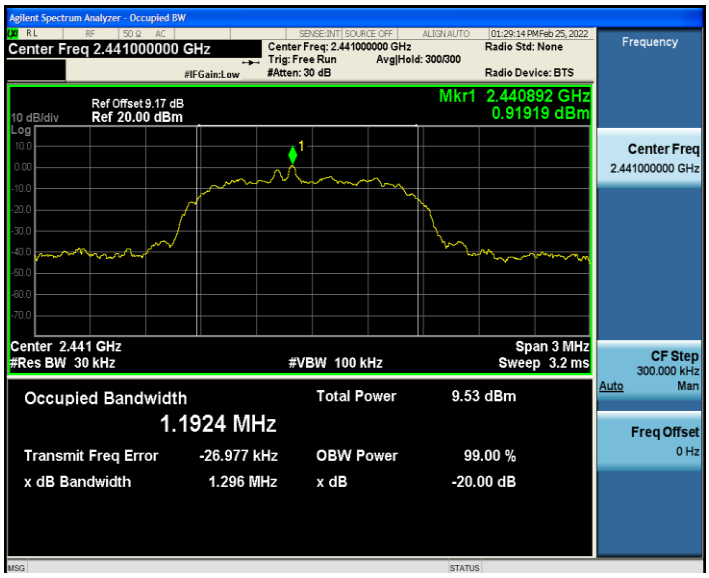


8DPSK mode - 20dB occupied bandwidth

CH0



CH39



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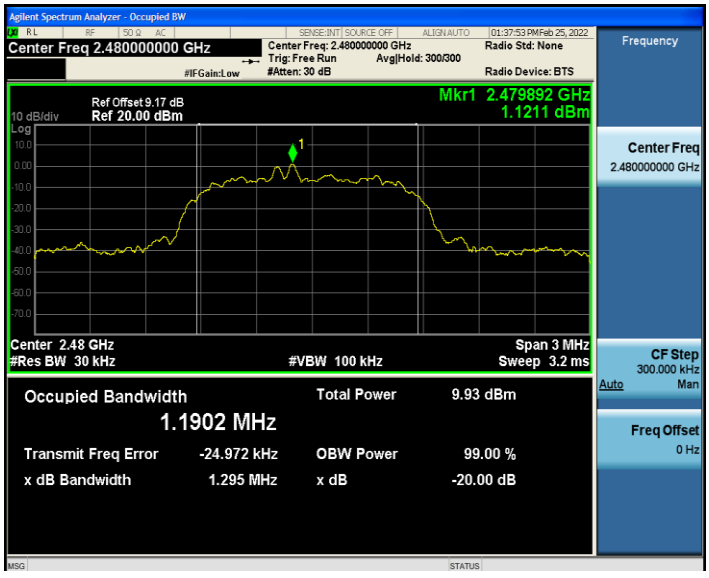
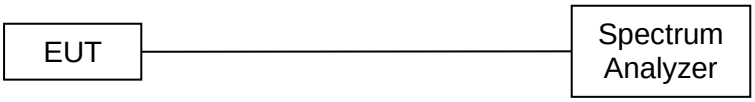


5.4 Conducted peak output power

5.4.1 Limits

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.4.2 Test setup



5.4.3 Test procedure

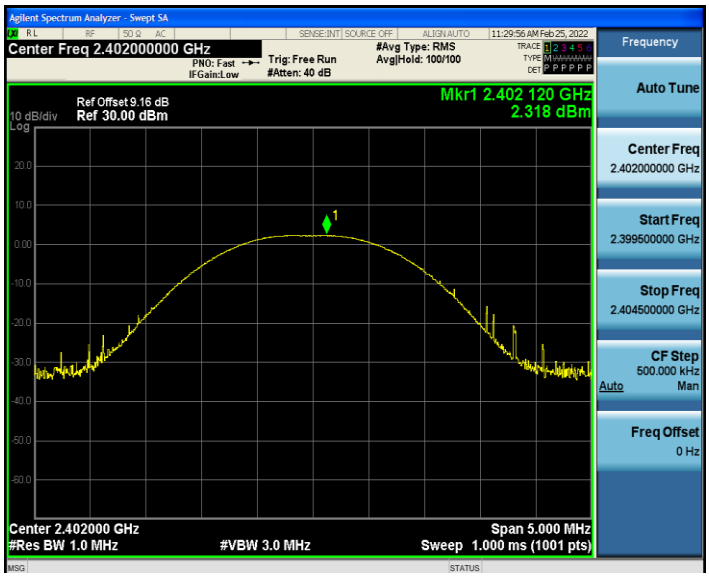
a) Test method: ANSI C63.10-2013 Section 7.8.5.
b) The EUT was set to continuously transmitting in the max power during the test.
c) The transmitter output of EUT is connected to the spectrum analyzer.
d) Spectrum analyzer setting: RBW > 20dB occupied bandwidth, VBW ≥ RBW, detector= Peak

5.4.4 Test results

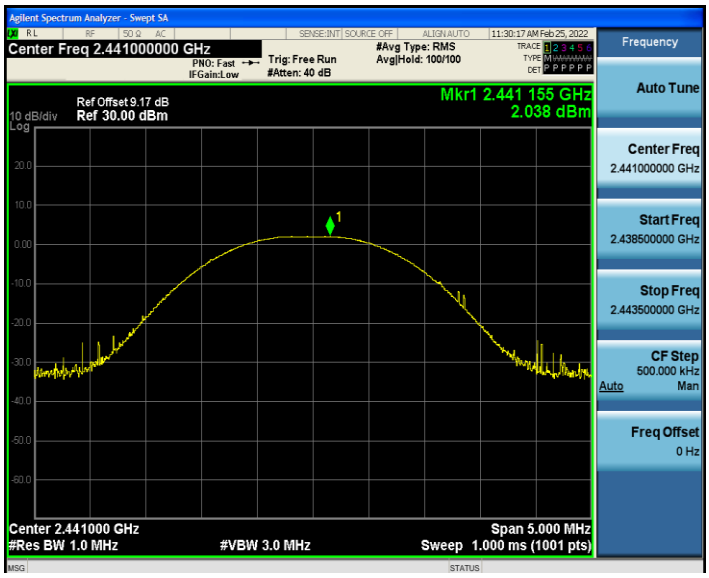
Mode	Test channel	Frequency (MHz)	Conducted peak output power (dBm)	Limit (dBm)
GFSK	CH0	2402	2.32	≤ 20.97
	CH39	2441	2.04	≤ 20.97
	CH78	2480	2.27	≤ 20.97
π/4-DQPSK	CH0	2402	5.05	≤ 20.97
	CH39	2441	5.05	≤ 20.97
	CH78	2480	5.31	≤ 20.97
8DPSK	CH0	2402	5.36	≤ 20.97
	CH39	2441	5.41	≤ 20.97
	CH78	2480	5.78	≤ 20.97

GFSK mode - peak conducted output power

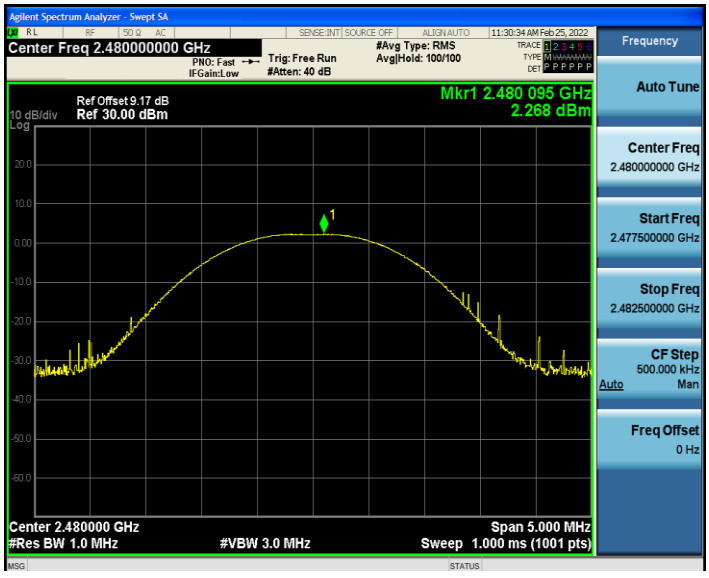
CH0



CH39



CH78

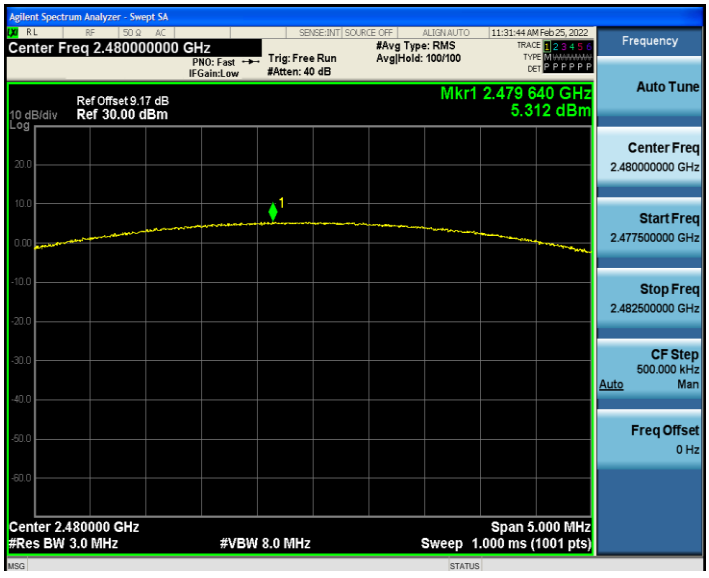


π/4-DQPSK mode - peak conducted output power

CH0

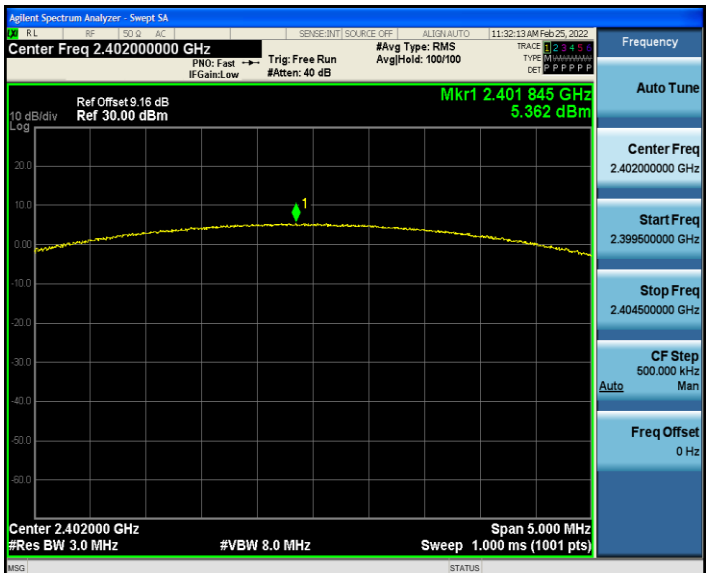
CH39

CH78

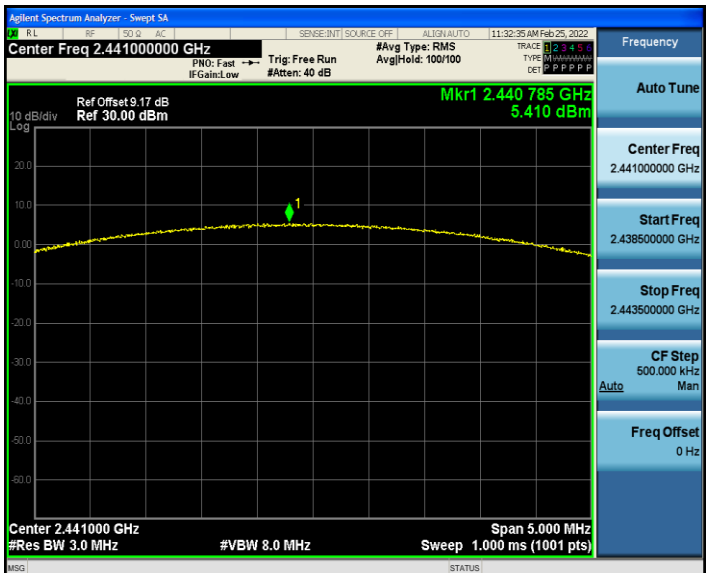


8DPSK mode – peak conducted output power

CH0



CH39



CH78

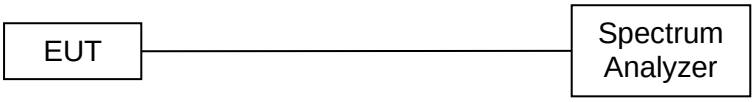
5.5 Carrier frequency separation

5.5.1 Limits

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

5.5.2 Test setup



5.5.3 Test procedure

a) Test method: ANSI C63.10-2013 Section 7.8.2.
b) The EUT was set to hopping mode during the test.
c) The transmitter output of EUT is connected to the spectrum analyzer.
d) Spectrum Setting: RBW = 30 kHz, VBW = 100 kHz, detector= Peak.

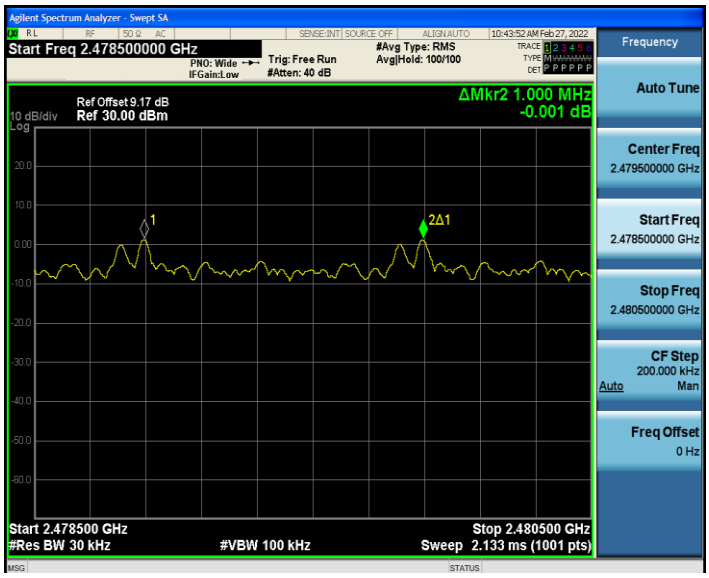
5.5.4 Test results

Mode	Test channel	Test Result (MHz)	Limit (MHz)	Result
GFSK	Hop-mode	1	>=0.624	Pass
π/4-DQPSK	Hop-mode	1	>=0.857	Pass
8DPSK	Hop-mode	0.998	>=0.865	Pass

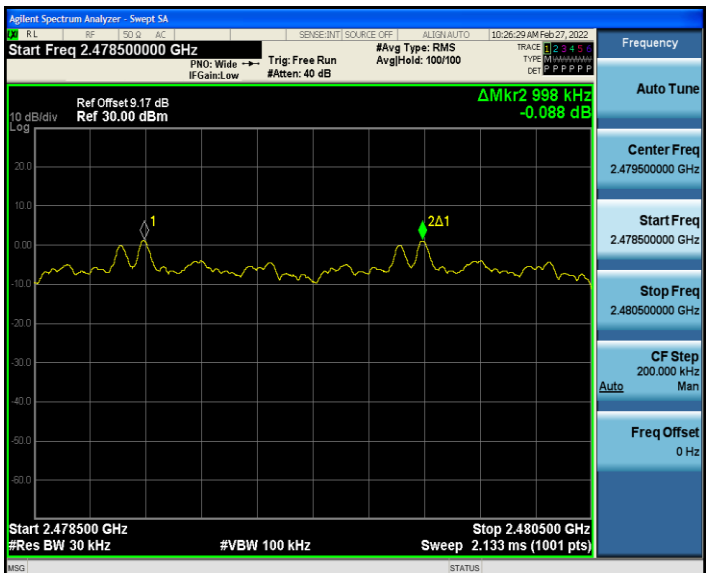
Carrier frequency separation

GFSK

π/4-DQPSK



8DPSK

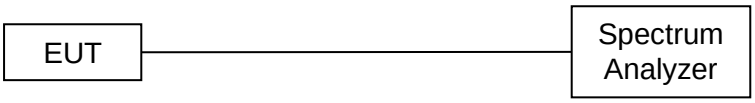


5.6 Average time of occupancy

5.6.1 Limits

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.

5.6.2 Test setup



5.6.3 Test procedure

a) Test method: ANSI C63.10-2013 Section 7.8.4

b) The EUT was set to hopping mode during the test.

c) The tranistter output of EUT is connneted to the specturm analyzer.

d) Spectrum analyzer setting: RBW = 1MHz, VBW = 3MHz, Span = 0Hz, Detector = Peak, weep time: As necessary to capture the entire dwell time per hopping channel.

e) 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:

f) 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.

5.6.4 Test results

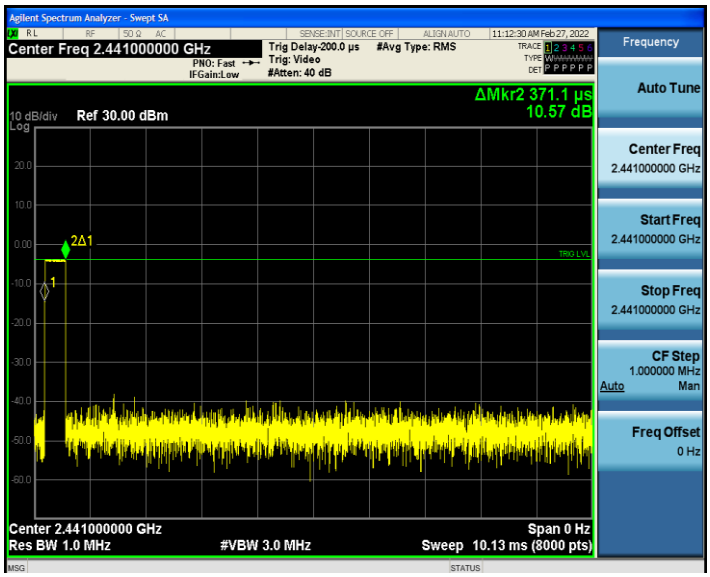
Mode	Data Packet	Frequency (MHz)	Pulse width (ms)	Number of pulses in 3.16 s	Average time of occupancy (s)	Limit (s)	Result
GFSK	DH1	2441	0.37	32	0.0118	<=0.4	Pass
	DH3	2441	1.63	20	0.0326	<=0.4	Pass
	DH5	2441	2.88	12	0.0346	<=0.4	Pass
π/4-DQPSK	2DH1	2441	0.38	33	0.0125	<=0.4	Pass
	2DH3	2441	1.63	14	0.0228	<=0.4	Pass
	2DH5	2441	2.88	10	0.0288	<=0.4	Pass
8DPSK	3DH1	2441	0.39	32	0.0125	<=0.4	Pass
	3DH3	2441	1.66	16	0.0266	<=0.4	Pass
	3DH5	2441	2.92	11	0.0321	<=0.4	Pass

Notes:

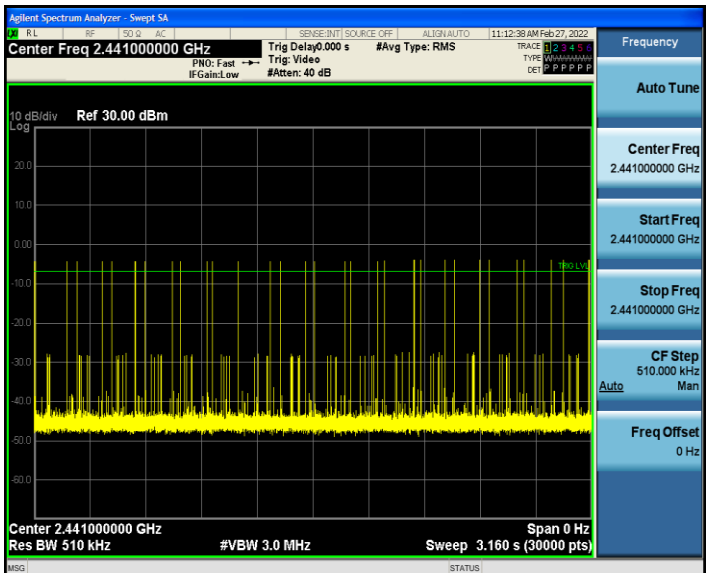
1. Period time = 0.4 (s) * 79 = 31.6(s)
2. Average time of occupancy = Pulse width * Number of pulses in 3.16s * 10

GFSK mode - Average time of occupancy

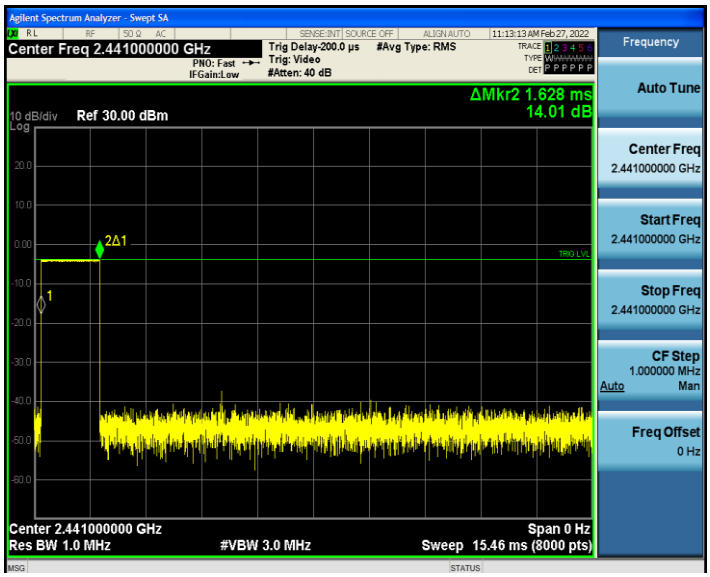
Pulse width – DH1



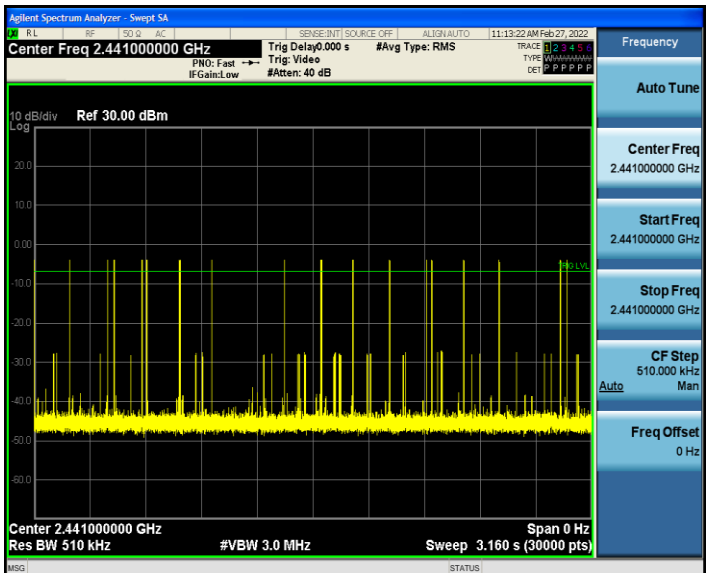
Number of pulses in 3.16 s – DH1



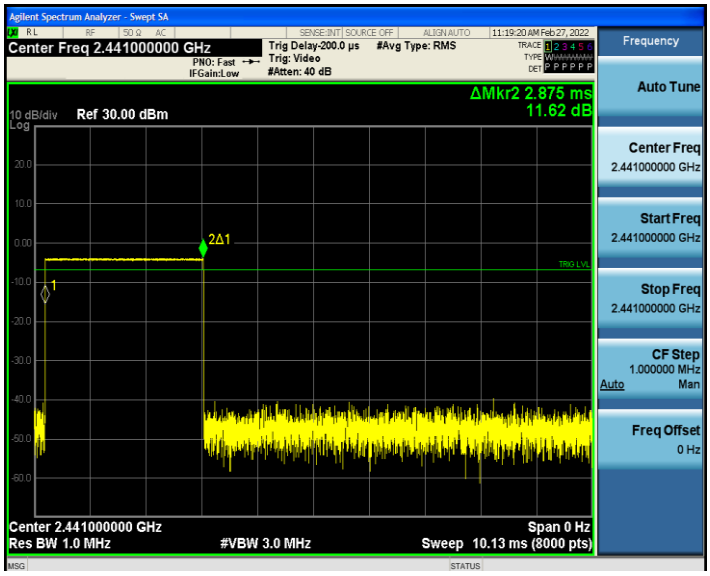
Pulse width – DH3



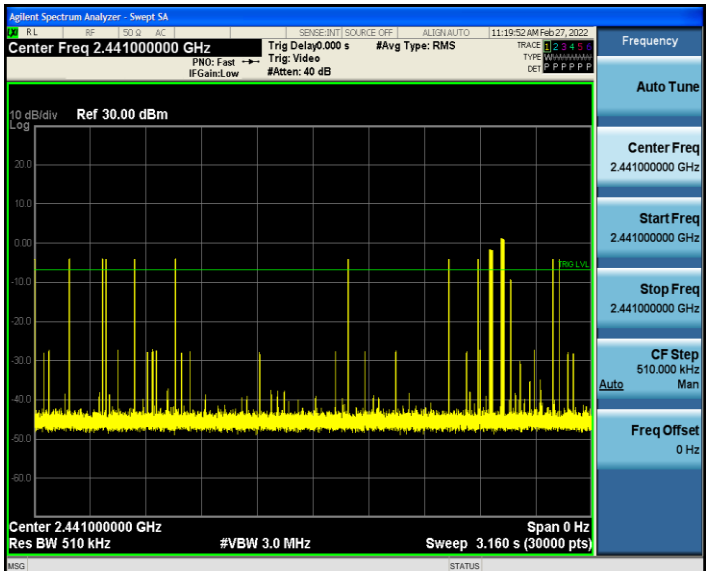
Number of pulses in 3.16 s – DH3



Pulse width – DH5

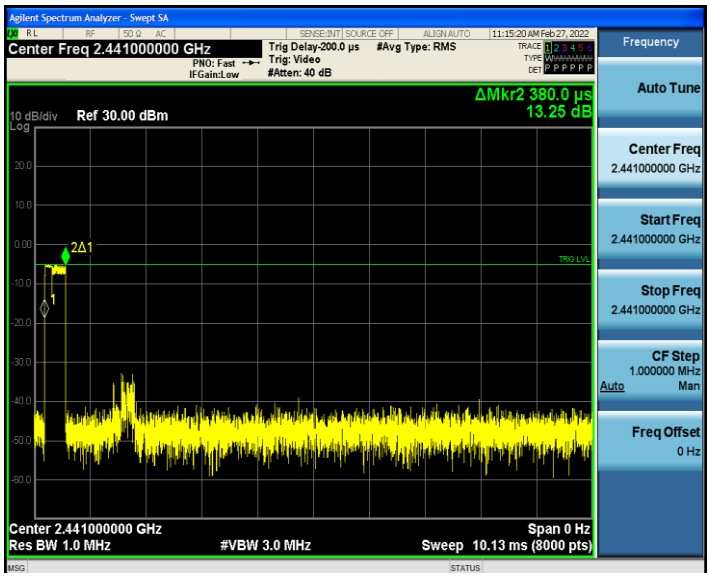


Number of pulses in 3.16 s – DH5

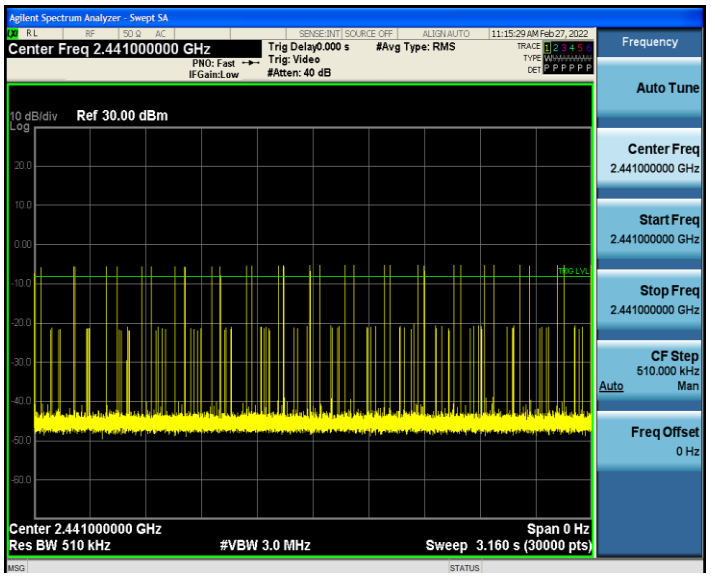


π/4-DQPSK - Average time of occupancy

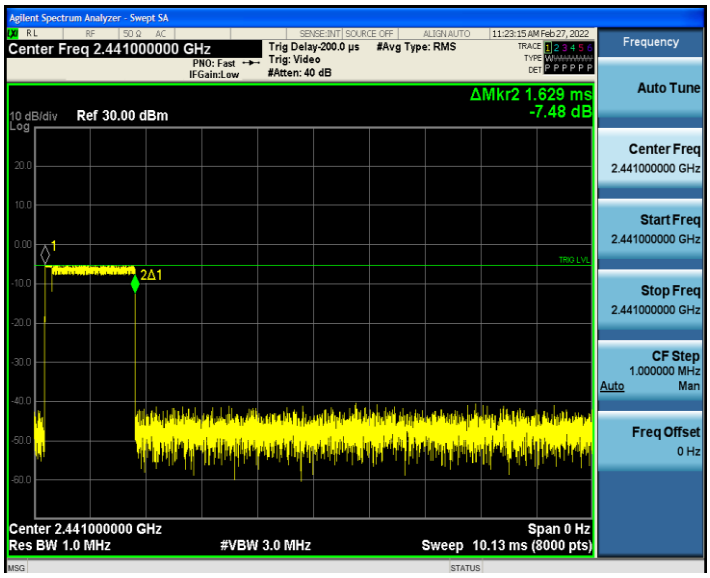
Pulse width – 2DH1



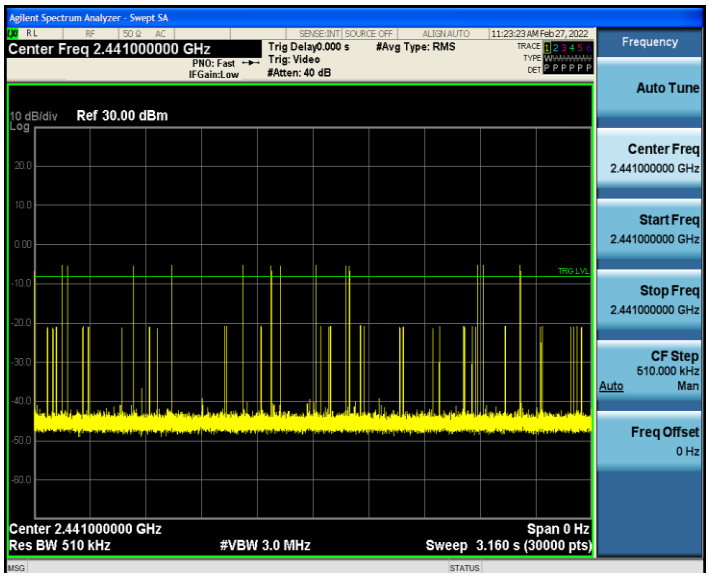
Number of pulses in 3.16 s – 2DH1



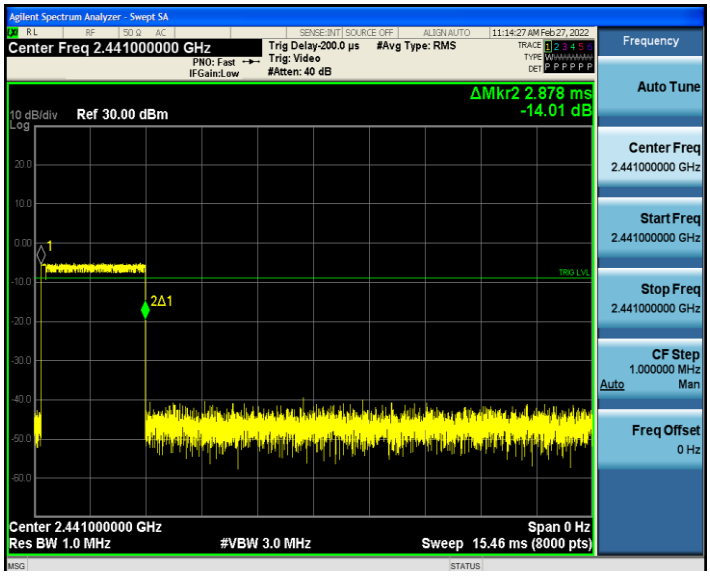
Pulse width – 2DH3



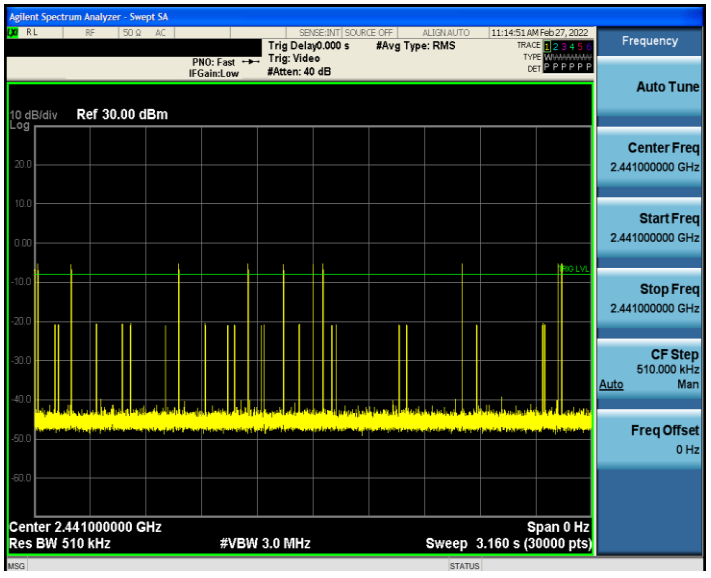
Number of pulses in 3.16 s – 2DH3



Pulse width – 2DH5

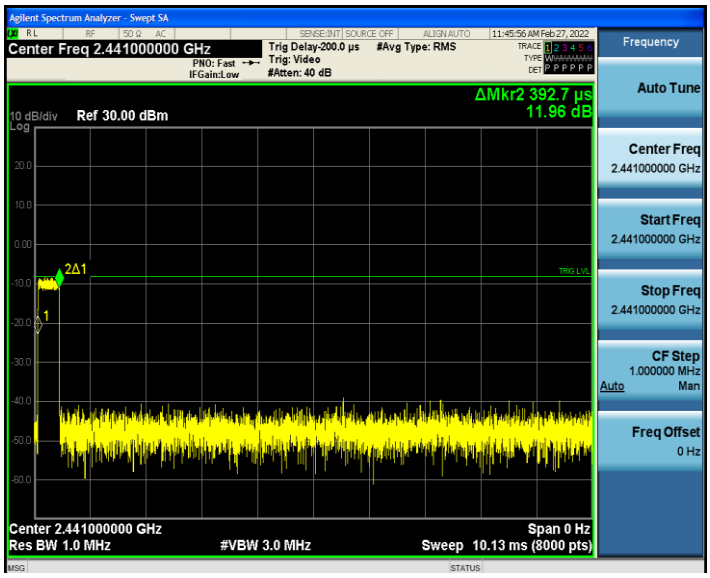


Number of pulses in 3.16 s – 2DH5

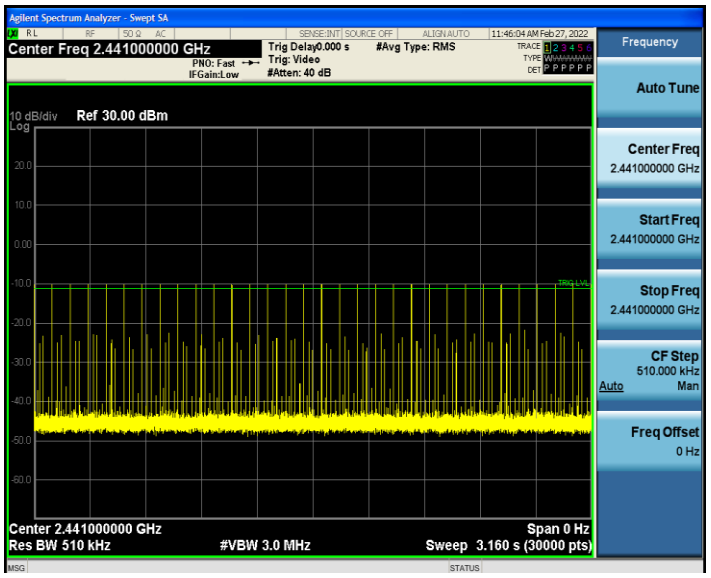


8DPSK - Average time of occupancy

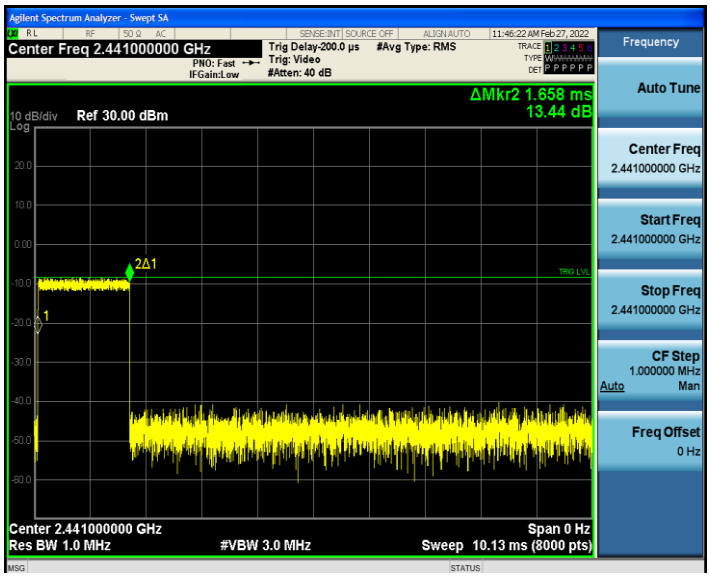
Pulse width – 3DH1



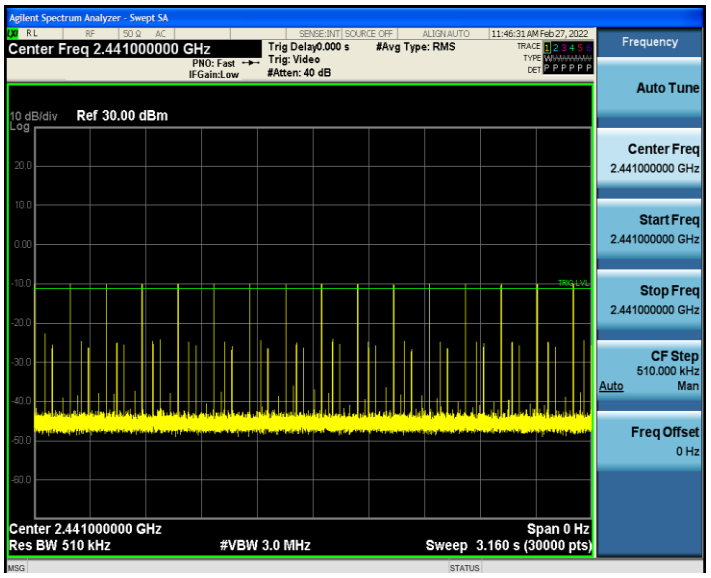
Number of pulses in 3.16 s – 3DH1



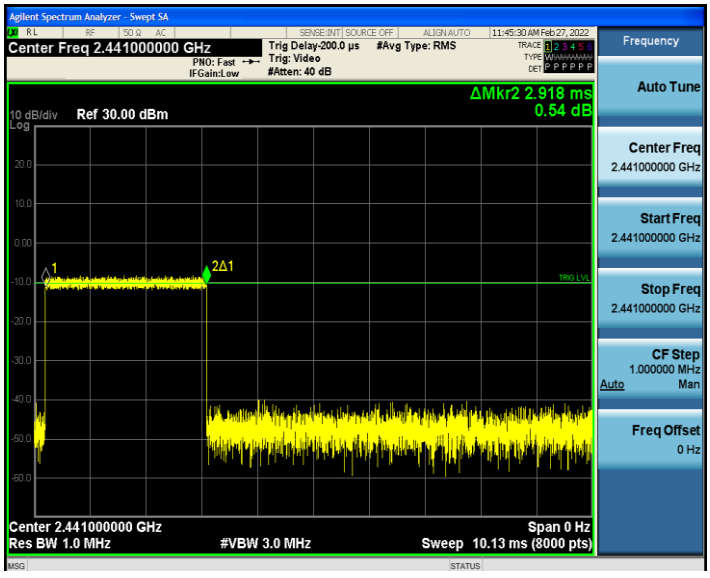
Pulse width – 3DH3



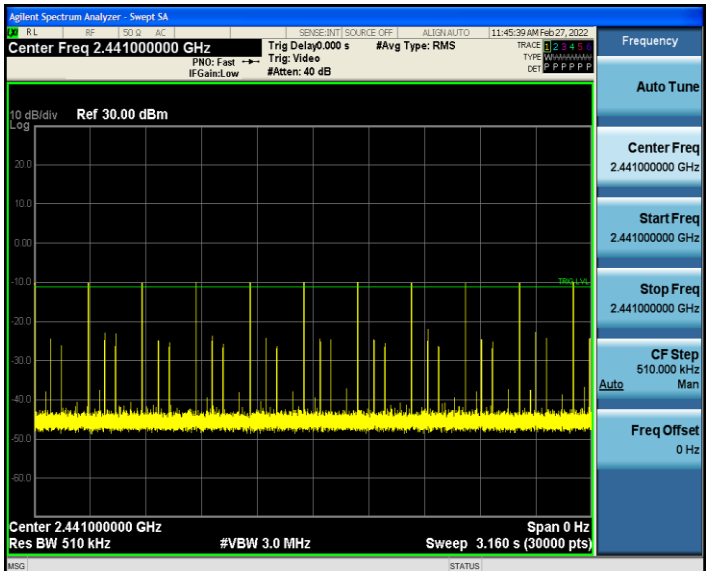
Number of pulses in 3.16 s – 3DH3



Pulse width – 3DH5



Number of pulses in 3.16 s – 3DH5

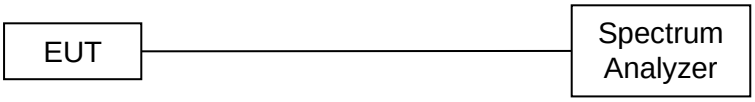


5.7 Number of hopping channels

5.7.1 Limit

Frequency hopping systems in the 2400-2483.5MHz band shall use at least 15 channels.

5.7.2 Test setup



5.7.3 Test procedure

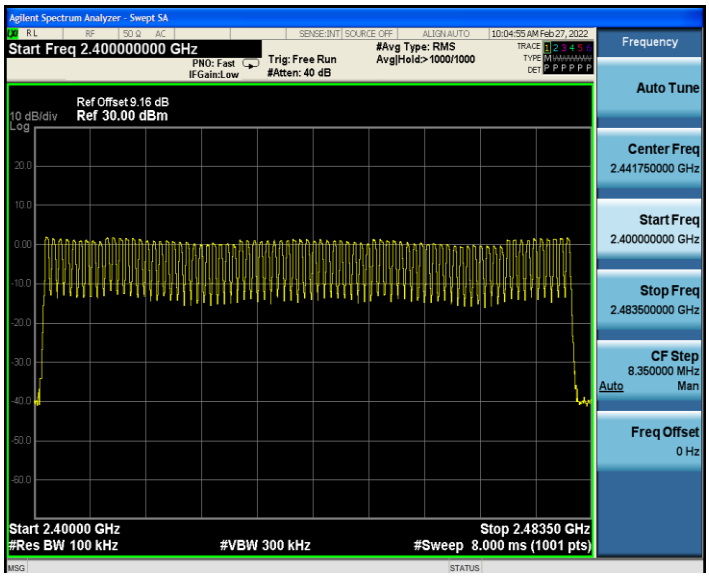
a) Test method: ANSI C63.10-2013 Section 7.8.3
b) The EUT was set to hopping mode during the test.
c) The tranistter output of EUT is connneted to the specturm analyzer.
d) Spectrum analyzer setting: RBW = 100 kHz, VBW = 300 klHz, Detector = Peak.

5.7.4 Test results

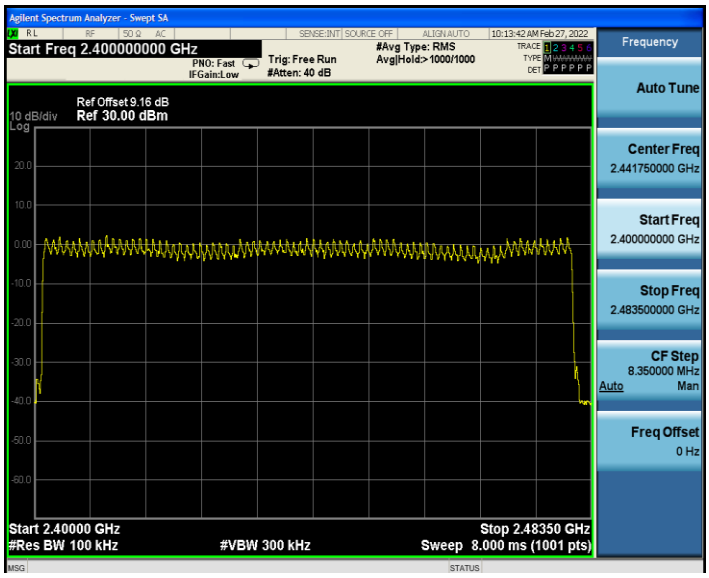
Mode	Quantity of Hopping Channel	Limit	Results
GFSK	79	≥15	Pass
π/4-DQPSK	79	≥15	Pass
8DPSK	79	≥15	Pass

Number of hopping channels

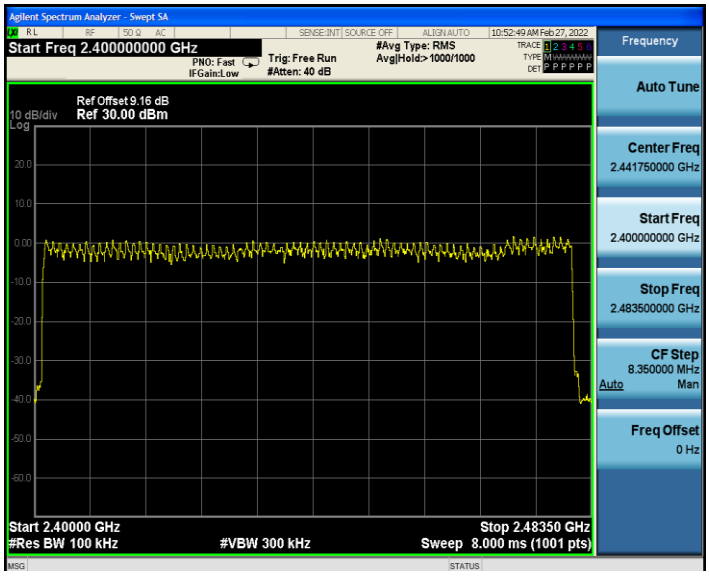
GFSK



π/4-DQPSK



8DPSK

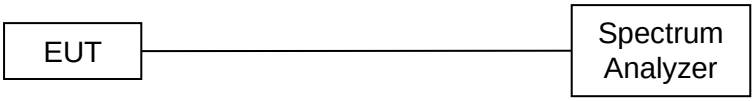


5.8 Conducted emissions at the band edge

5.8.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

5.8.2 Test setup



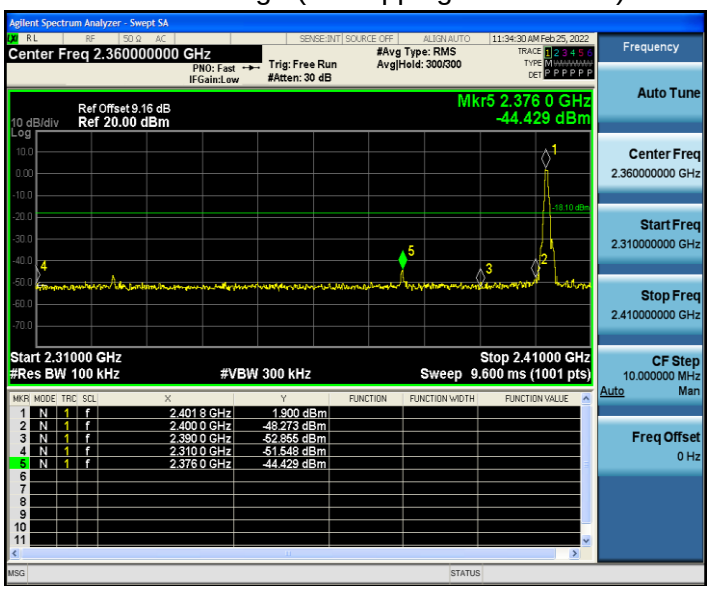
5.8.3 Test procedure

a) Test method: ANSI C63.10-2013 Section 6.10.4
b) The EUT was set to non-hopping mode & hopping mode during the test.
c) The transmitter output of EUT is connected to the spectrum analyzer.
d) Spectrum analyzer setting: RBW = 100 kHz, VBW = 300 kHz, Detector = Peak.

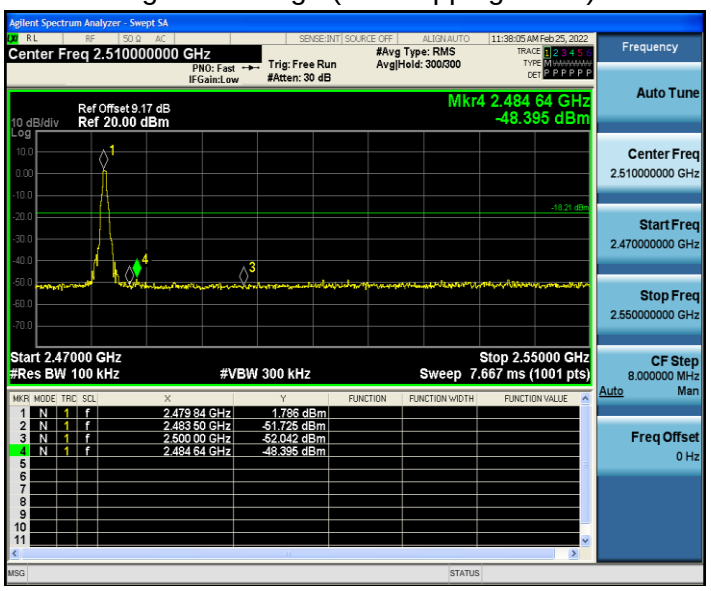
5.8.4 Test results

GFSK mode - conducted emissions at the band edge

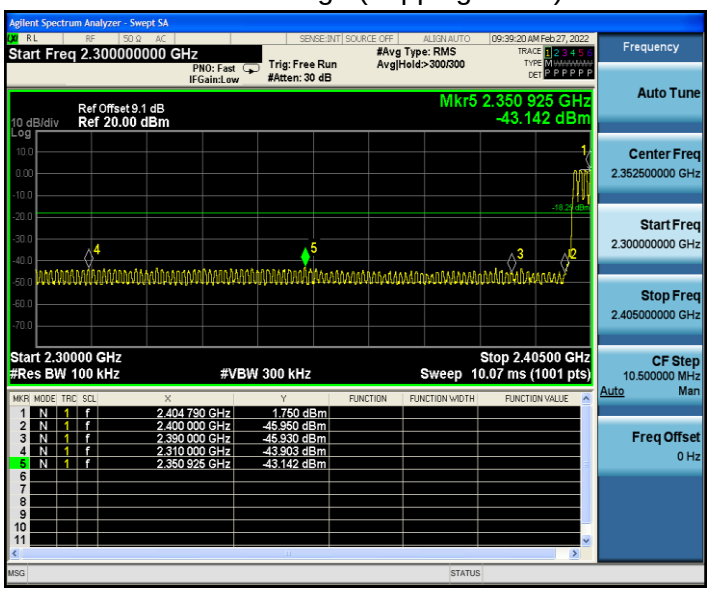
Low band-edge (no-hopping mode mode)



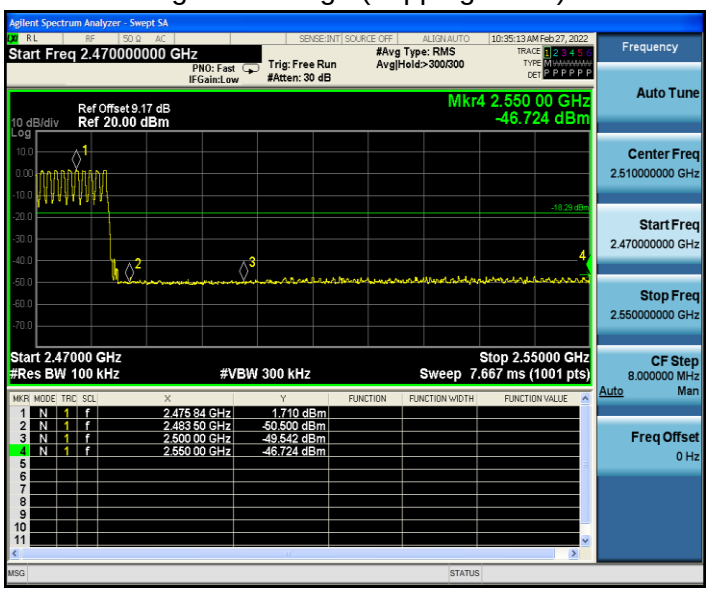
High band-edge (non-hopping mode)



Low band-edge (hopping mode)

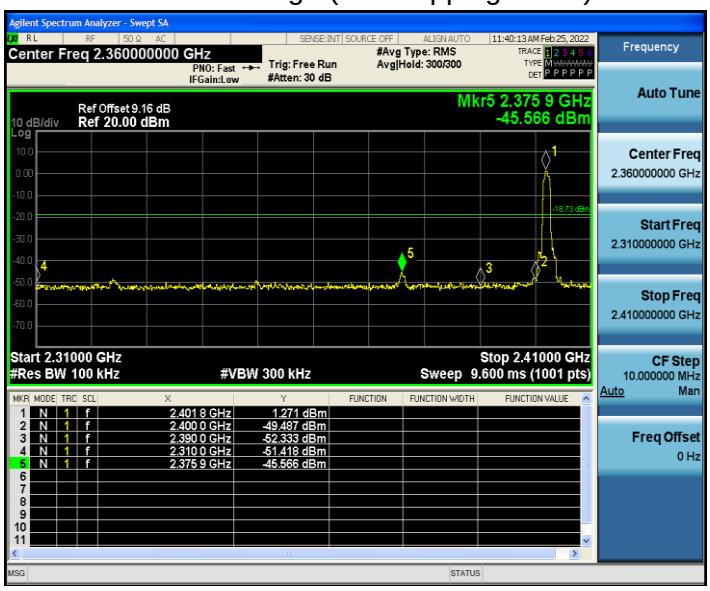


High band-edge (hopping mode)

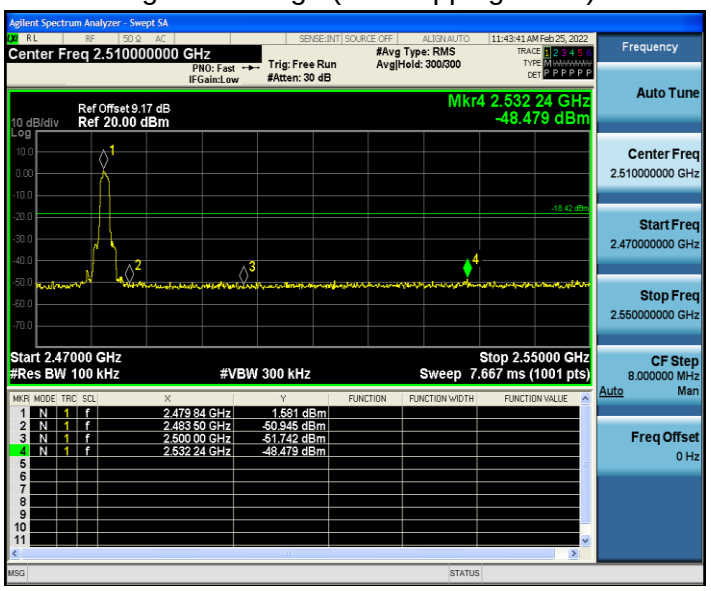


π/4-DQPSK mode - conducted emissions at the band edge

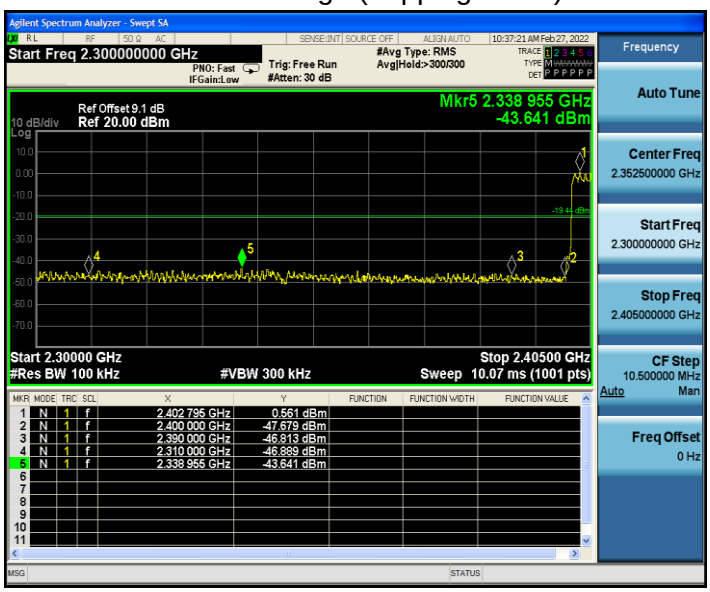
Low band-edge (non-hopping mode)



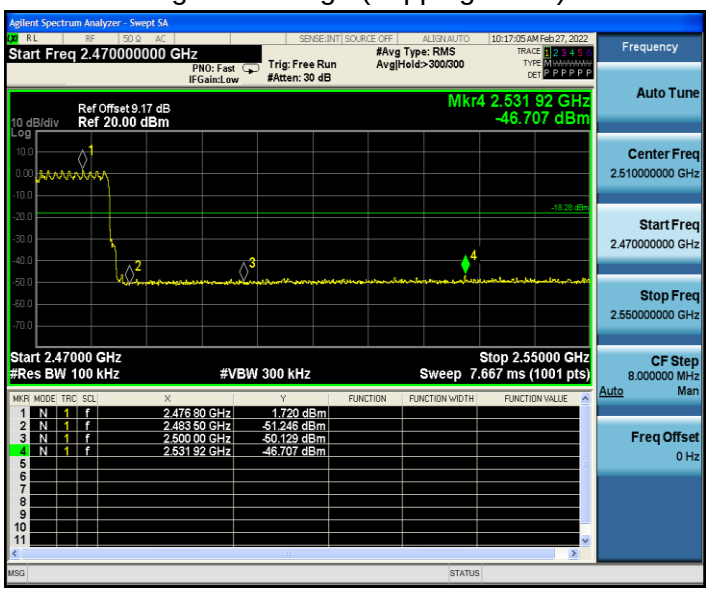
High band-edge (non-hopping mode)



Low band-edge (hopping mode)

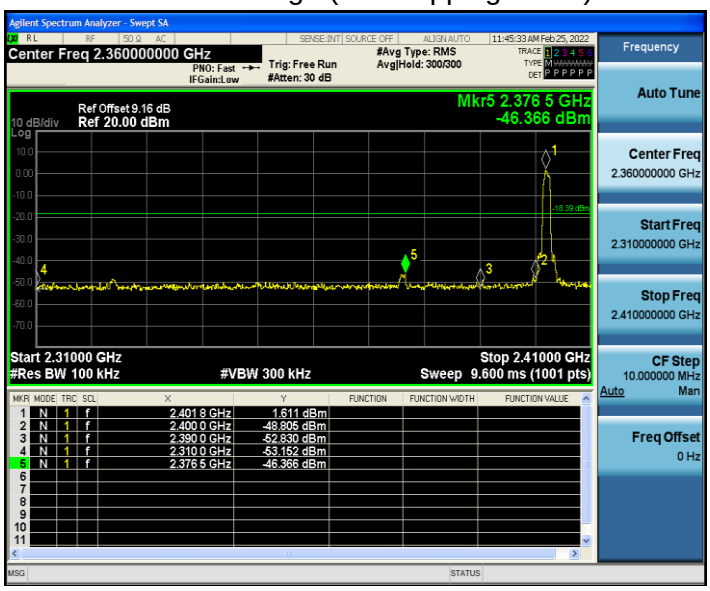


High band-edge (hopping mode)

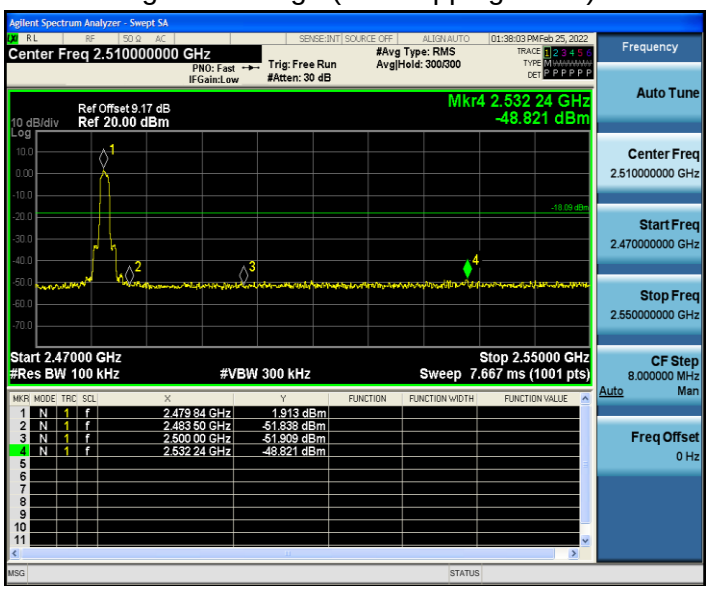


8DPSK mode - conducted emissions at the band edge

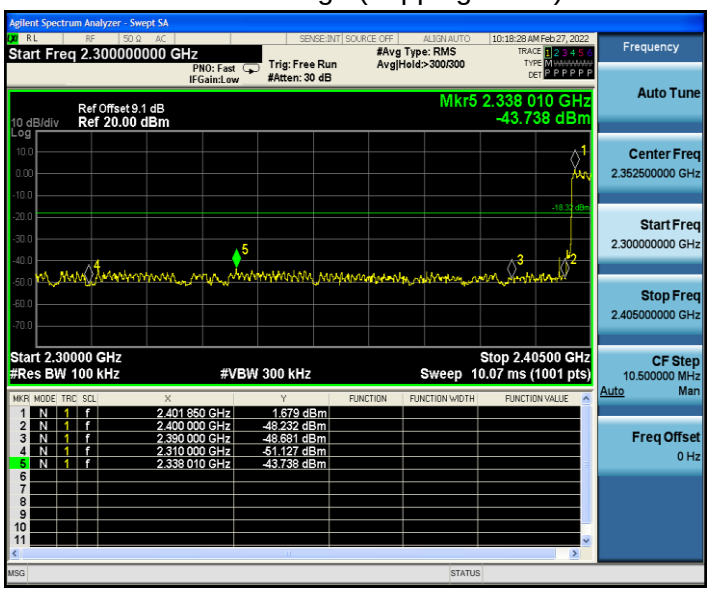
Low band-edge (non-hopping mode)



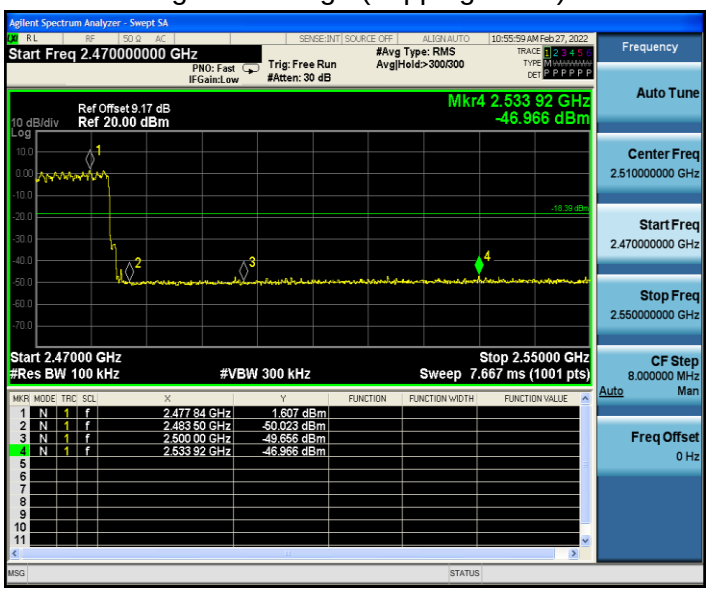
High band-edge (non-hopping mode)



Low band-edge (hopping mode)



High band-edge (hopping mode)

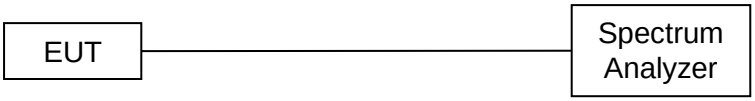


5.9 Conducted spurious emissions

5.9.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

5.9.2 Test setup



5.9.3 Test procedure

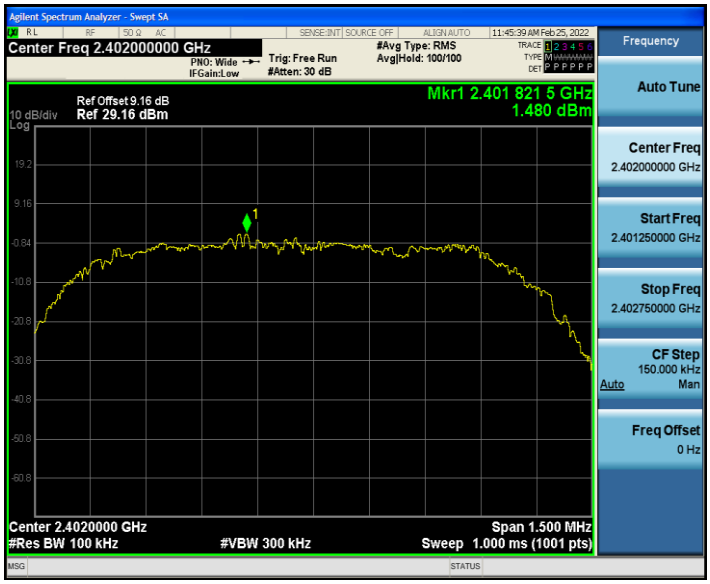
a) Test method: ANSI C63.10-2013 Section 6.10.4
b) The EUT was set to non-hopping mode & hopping mode during the test.
c) The transmitter output of EUT is connected to the spectrum analyzer.
d) Spectrum analyzer setting: RBW = 100 kHz, VBW = 300 kHz, Detector = Peak.

5.9.4 Test results

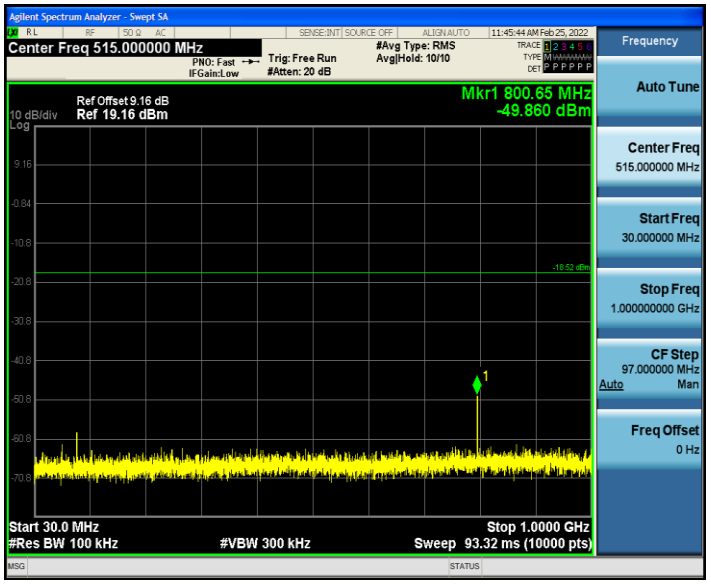
Notes:
All modes of operation of the EUT were investigated, and only the worst-case results are reported.
The worst-case mode: TX mode (8DPSK).

Conducted spurious emissions –8DPSK mode

CH0



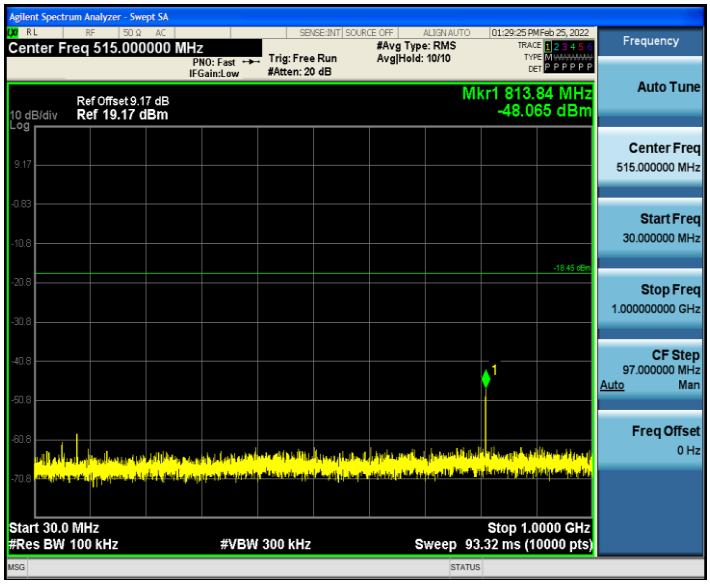
CH0



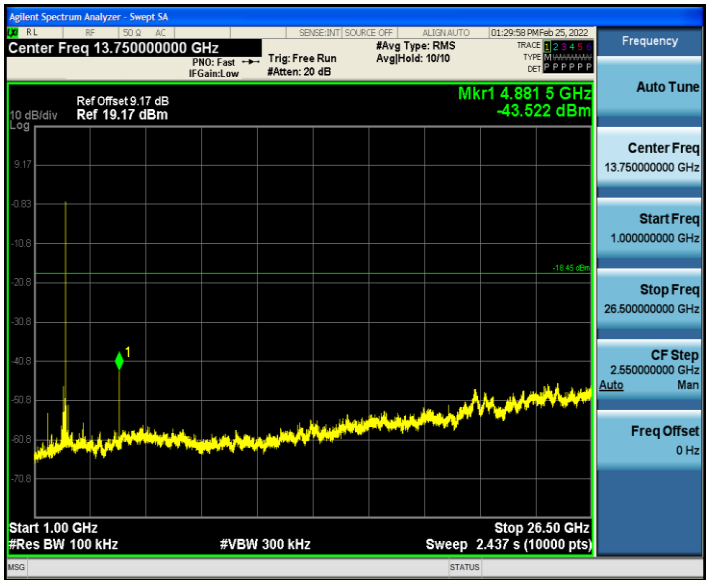
CH0

CH39

CH39



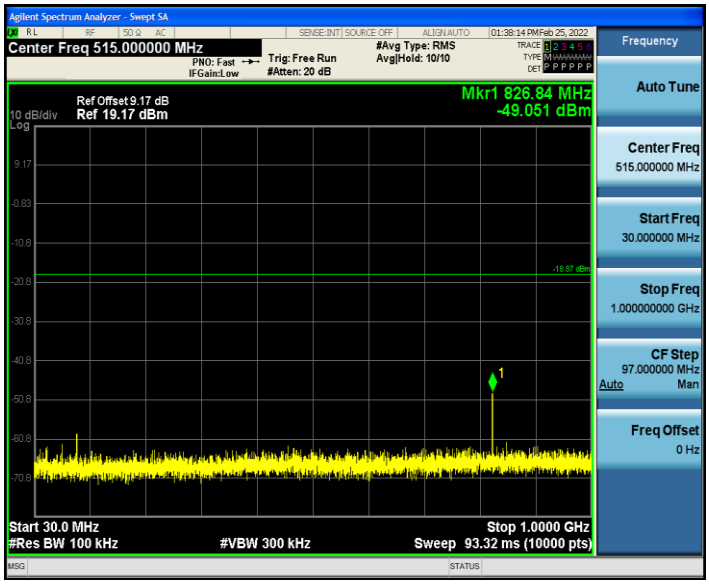
CH39



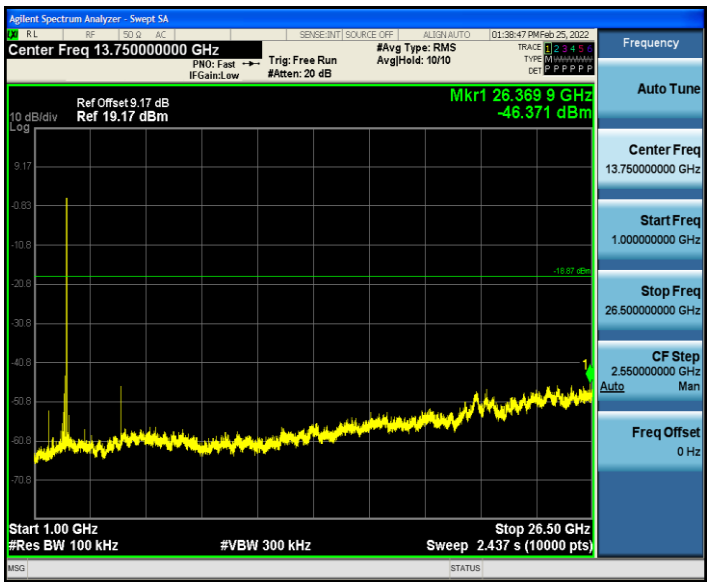
Conducted spurious emissions –8DPSK mode

CH78

CH78



CH78



5.10 Radiated spurious emission

5.10.1 Limits

§ 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

§ 15.209 Radiated emission limits; general requirements.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note 1: the tighter limit applies at the band edges.
Note 2: the emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector

§ 15.35 (b) requirements:
When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to ANSI C63.10-2013, the tests shall be performed in the frequency range shown in the following table:

Frequency range of measurements for unlicensed wireless device

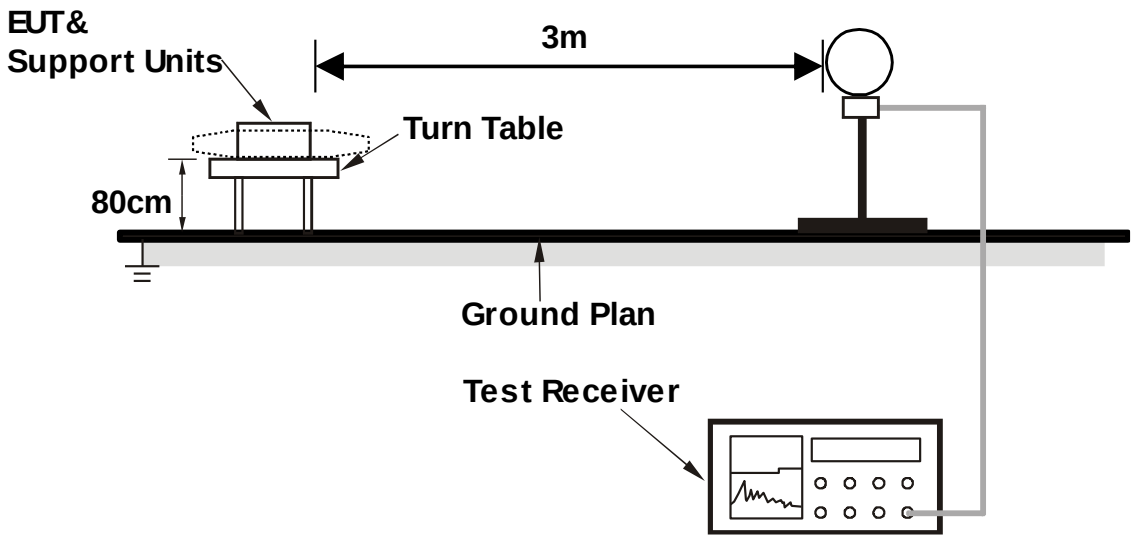
Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified

Frequency range of measurements for unlicensed wireless device with digital device

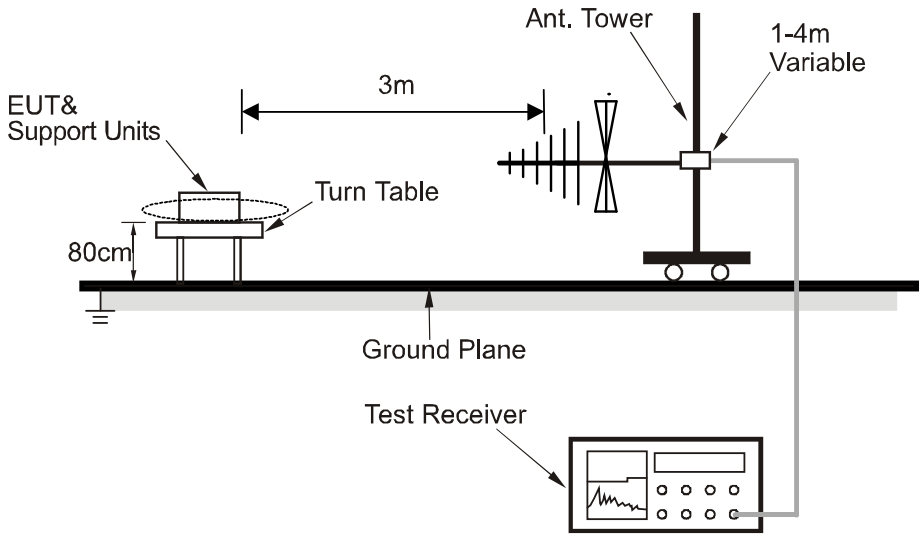
Highest frequency generated or used in the device or on which the device operates or tunes	Upper frequency range of measurement
Below 1.705 MHz	30 MHz
1.705 MHz to 108 MHz	1000 MHz
108 MHz to 500 MHz	2000 MHz
500 MHz to 1000 MHz	5000 MHz
Above 1000 MHz	5th harmonic of the highest frequency or 40 GHz, whichever is lower

5.10.2 Test setup

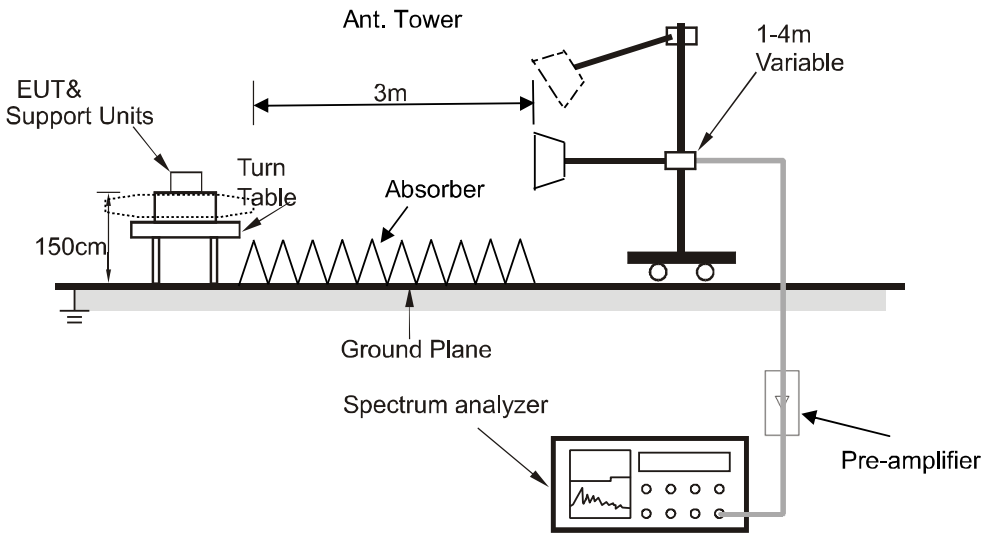
Below 30MHz



30MHz~1GHz



Above 1GHz



For the actual test configuration, please refer to the related item – Photographs of the test setup.

5.10.3 Test procedure

a) Test method: ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6, 6.10.
b) The EUT is placed on an on-conducting table 0.8 meters above the ground plane for measurement below 1GHz, 1.5 meters above the ground plane for measurement above 1GHz.
c) Emission blew 18 GHz were measured at a 3 meters test distance, above 18 GHz were measured at 1-meter test distance with the application of a distance correction factor
d) The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

KDB 558074 D01 15.247 Meas Guidance v05r02
The use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the unwanted emission limit is subject to an average field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period.

Test instrument setup

Frequency	Test receiver / Spectrum analyzer setting
9 kHz ~ 150 kHz	Quasi Peak / RBW: 200 Hz
150 kHz ~ 30 MHz	Quasi Peak / RBW: 9 kHz
30 MHz ~ 1 GHz	Quasi Peak / RBW: 120 kHz
Above 1 GHz	Peak / RBW: 1 MHz, VBW: 3MHz, Peak detector AVG / RBW: 1 MHz, VBW: 1/T, Peak detector

5.10.4 Test results

Notes:

The amplitude of spurious emissions which are attenuated more than 20 dB below the limits are not reported.

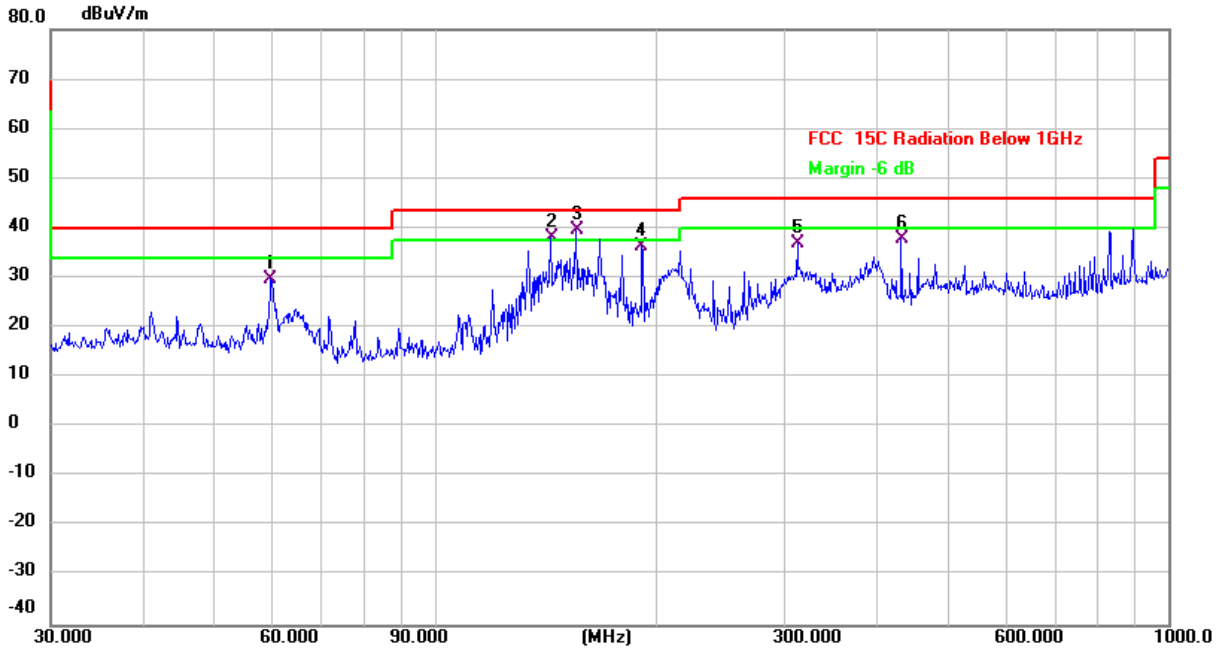
All modes of operation of the EUT were investigated, and only the worst-case results are reported.

There were no emissions found below 30MHz within 20dB of the limit.

Calculation formula:
Measurement (dBμV/m) = Reading Level (dBμV) + Correct Factor (dB/m)
Over (dB) = Measurement (dBμV/m) – Limit (dBμV/m)

Radiated emissions between 30MHz – 1GHz

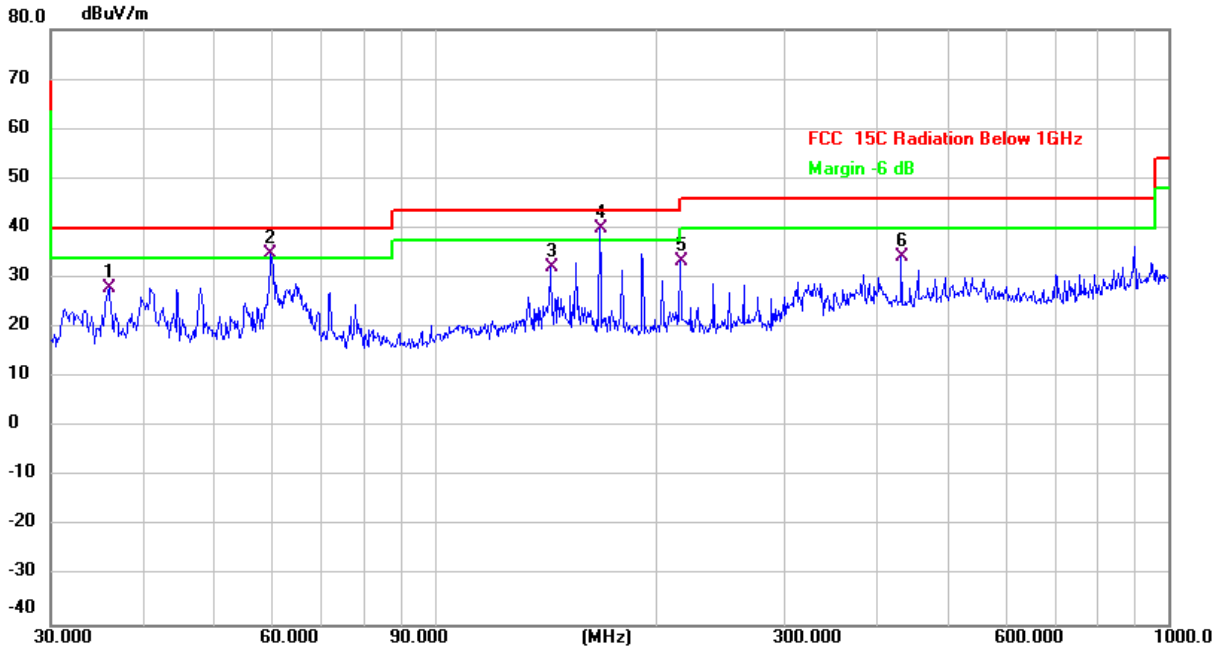
Test mode:	TX - 8DPSK-2441MHz	Polarization:	Horizontal
Power supply:	120 VAC 60Hz	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		59.8588	39.31	-9.48	29.83	40.00	-10.17	QP
2	!	143.8295	48.98	-10.69	38.29	43.50	-5.21	QP
3	*	155.9101	49.72	-10.05	39.67	43.50	-3.83	QP
4		191.7450	44.62	-8.40	36.22	43.50	-7.28	QP
5		312.1794	42.23	-5.22	37.01	46.00	-8.99	QP
6		432.5457	41.04	-3.27	37.77	46.00	-8.23	QP

Radiated emissions between 30MHz – 1GHz

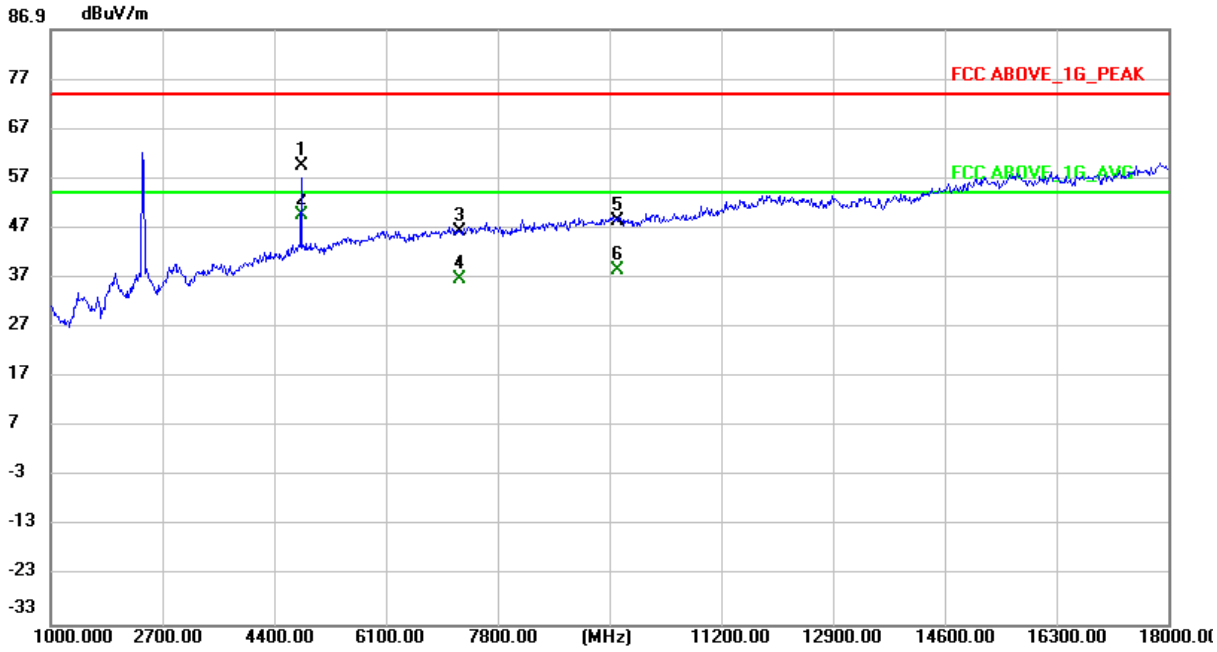
Test mode:	TX - 8DPSK-2441MHz	Polarization:	Vertical
Power supply:	120 VAC 60Hz	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		36.0007	36.14	-8.12	28.02	40.00	-11.98	QP
2	!	59.8588	44.21	-9.48	34.73	40.00	-5.27	QP
3		143.8295	42.89	-10.69	32.20	43.50	-11.30	QP
4	*	167.8243	49.76	-9.66	40.10	43.50	-3.40	QP
5		216.0240	40.69	-7.24	33.45	46.00	-12.55	QP
6		432.5457	37.59	-3.27	34.32	46.00	-11.68	QP

Radiated emissions 1 GHz ~ 18 GHz

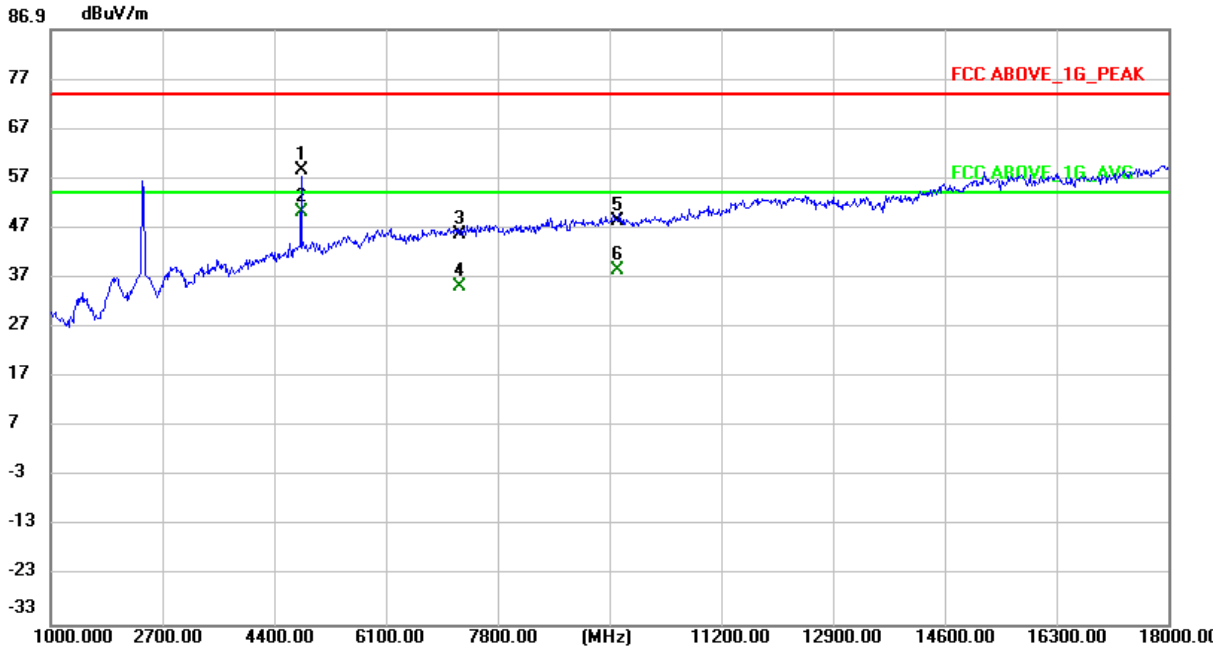
Test mode:	TX 8DPSK – 2402 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4804.000	57.92	1.52	59.44	74.00	-14.56	peak
2	*	4804.000	48.13	1.52	49.65	54.00	-4.35	AVG
3		7206.000	40.67	5.46	46.13	74.00	-27.87	peak
4		7206.000	31.12	5.46	36.58	54.00	-17.42	AVG
5		9608.000	41.89	6.33	48.22	74.00	-25.78	peak
6		9608.000	32.21	6.33	38.54	54.00	-15.46	AVG

Radiated emissions 1 GHz ~ 18 GHz

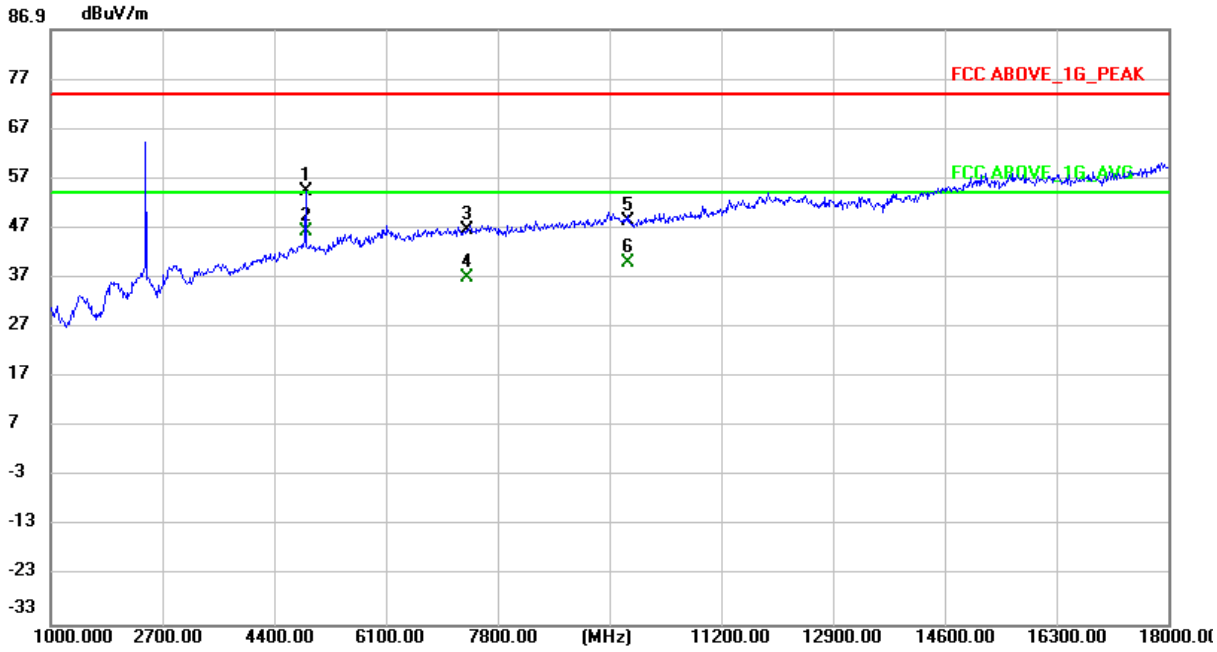
Test mode:	TX 8DPSK – 2402 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4804.000	56.95	1.52	58.47	74.00	-15.53	peak
2	*	4804.000	48.65	1.52	50.17	54.00	-3.83	AVG
3		7206.000	40.18	5.46	45.64	74.00	-28.36	peak
4		7206.000	29.68	5.46	35.14	54.00	-18.86	AVG
5		9608.000	42.02	6.33	48.35	74.00	-25.65	peak
6		9608.000	32.16	6.33	38.49	54.00	-15.51	AVG

Radiated emissions 1 GHz ~ 18 GHz

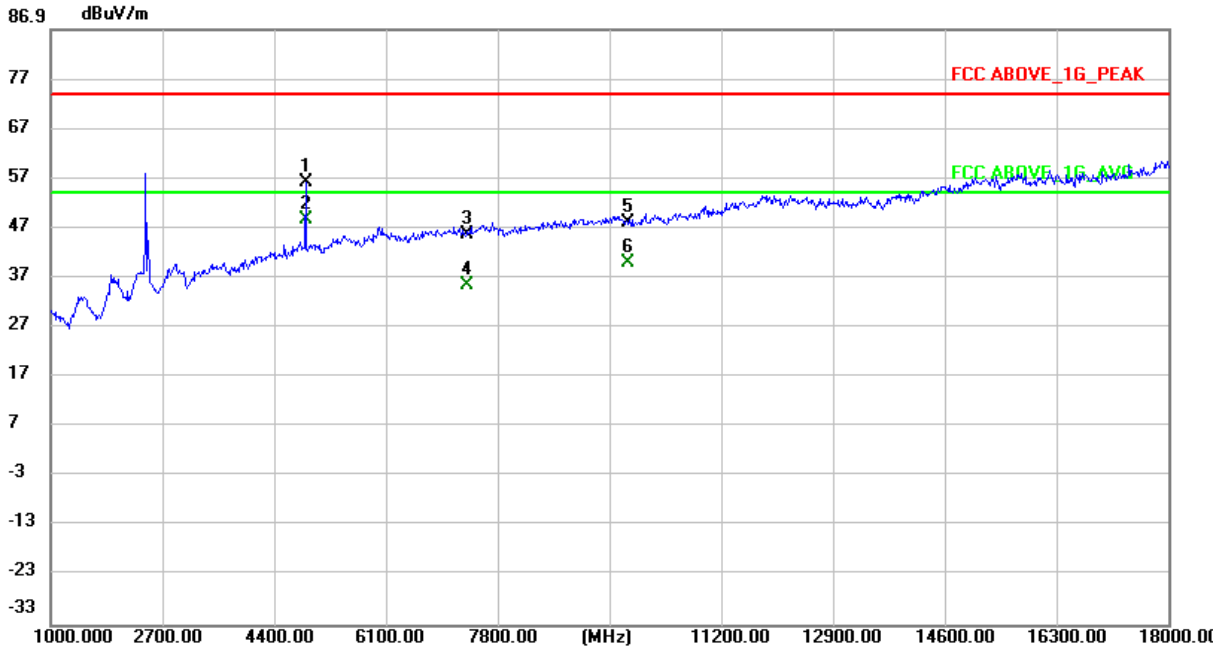
Test mode:	TX 8DPSK - 2441 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4882.000	52.76	1.68	54.44	74.00	-19.56	peak
2	*	4882.000	44.56	1.68	46.24	54.00	-7.76	AVG
3		7323.000	41.21	5.45	46.66	74.00	-27.34	peak
4		7323.000	31.40	5.45	36.85	54.00	-17.15	AVG
5		9764.000	42.08	6.37	48.45	74.00	-25.55	peak
6		9764.000	33.50	6.37	39.87	54.00	-14.13	AVG

Radiated emissions 1 GHz ~ 18 GHz

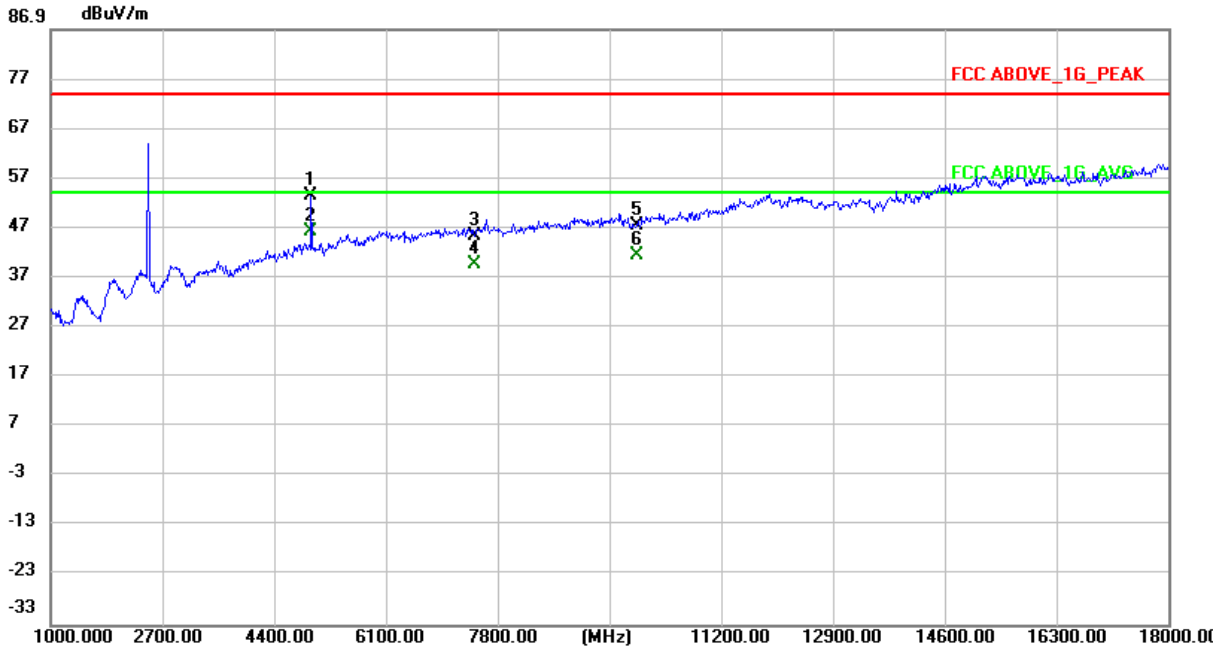
Test mode:	TX 8DPSK - 2441 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4882.000	54.41	1.68	56.09	74.00	-17.91	peak
2	*	4882.000	47.02	1.68	48.70	54.00	-5.30	AVG
3		7323.000	40.32	5.45	45.77	74.00	-28.23	peak
4		7323.000	30.03	5.45	35.48	54.00	-18.52	AVG
5		9764.000	41.75	6.37	48.12	74.00	-25.88	peak
6		9764.000	33.48	6.37	39.85	54.00	-14.15	AVG

Radiated emissions 1 GHz ~ 18 GHz

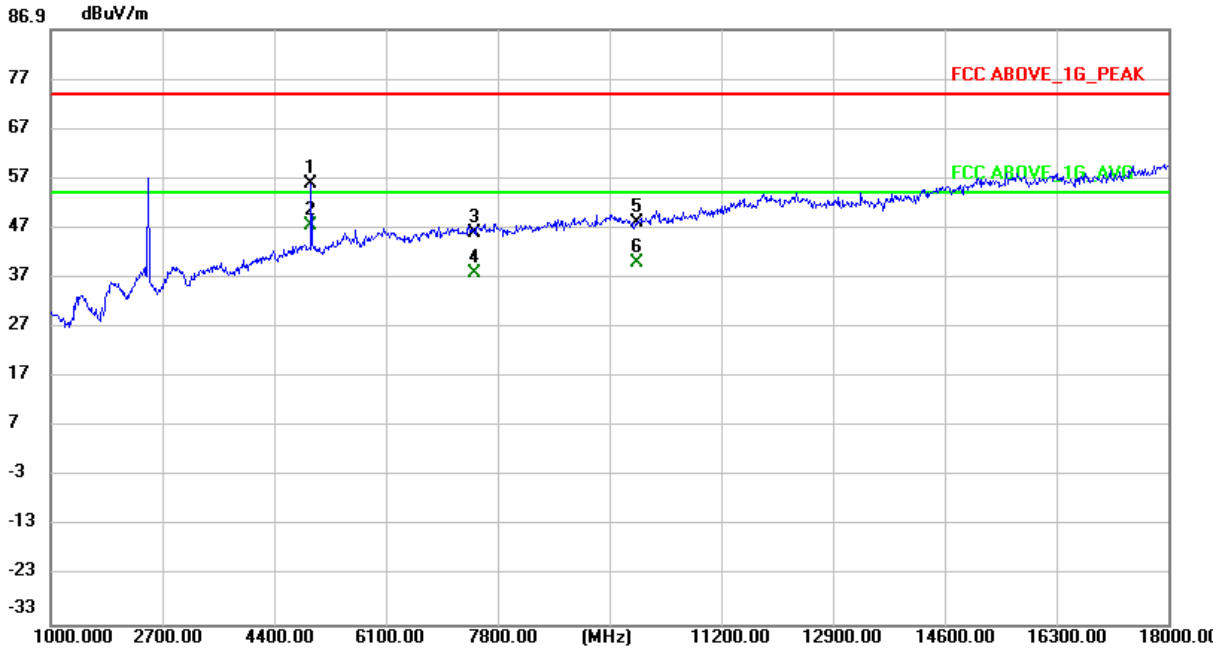
Test mode:	TX 8DPSK – 2480 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4960.000	51.69	1.83	53.52	74.00	-20.48	peak
2	*	4960.000	44.49	1.83	46.32	54.00	-7.68	AVG
3		7440.000	39.95	5.43	45.38	74.00	-28.62	peak
4		7440.000	34.15	5.43	39.58	54.00	-14.42	AVG
5		9920.000	41.04	6.41	47.45	74.00	-26.55	peak
6		9920.000	34.91	6.41	41.32	54.00	-12.68	AVG

Radiated emissions 1 GHz ~ 18 GHz

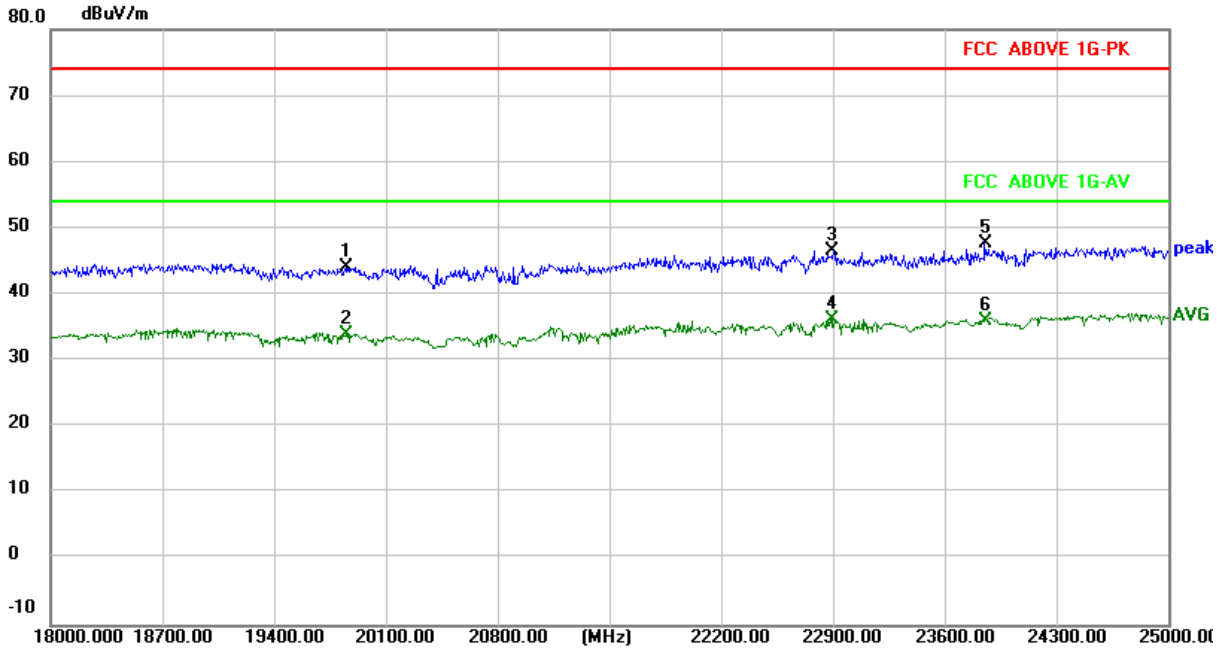
Test mode:	TX 8DPSK – 2480 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		4960.000	54.12	1.83	55.95	74.00	-18.05	peak
2	*	4960.000	45.75	1.83	47.58	54.00	-6.42	AVG
3		7440.000	40.49	5.43	45.92	74.00	-28.08	peak
4		7440.000	32.53	5.43	37.96	54.00	-16.04	AVG
5		9920.000	41.60	6.41	48.01	74.00	-25.99	peak
6		9920.000	33.46	6.41	39.87	54.00	-14.13	AVG

Radiated emissions above 18 GHz

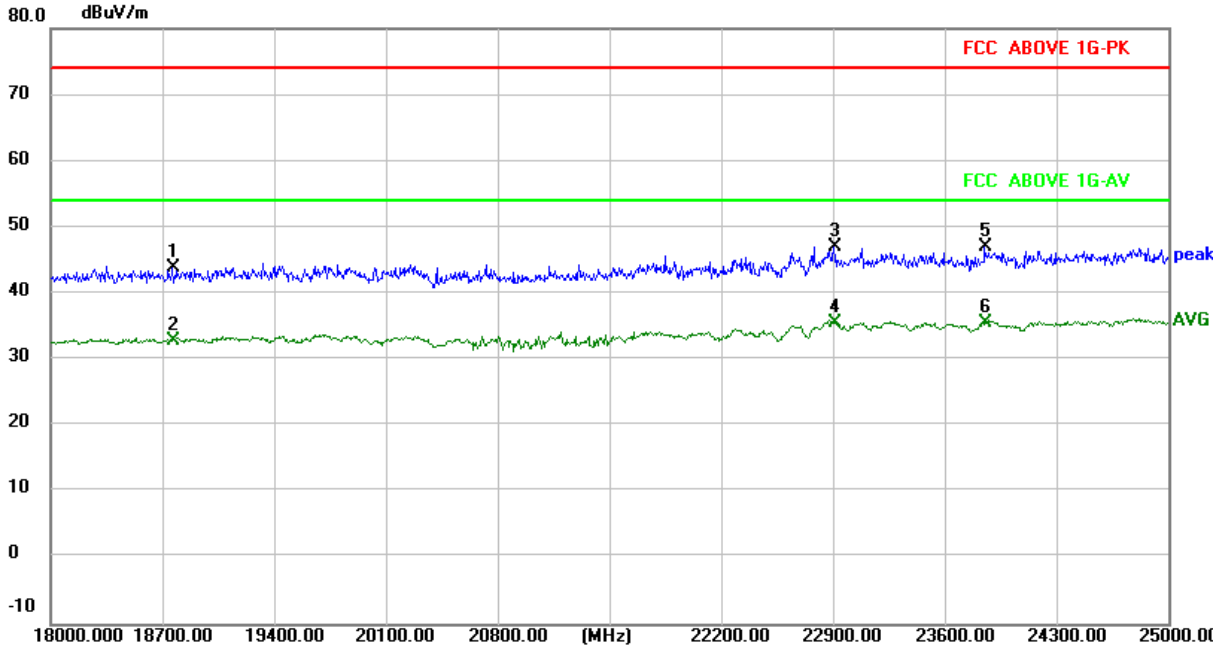
Test mode:	TX 8DPSK – 2441 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		19849.850	61.66	-17.59	44.07	74.00	-29.93	peak
2		19849.850	51.56	-17.59	33.97	54.00	-20.03	AVG
3		22883.884	61.44	-14.87	46.57	74.00	-27.43	peak
4	*	22883.884	51.15	-14.87	36.28	54.00	-17.72	AVG
5		23850.851	62.47	-14.86	47.61	74.00	-26.39	peak
6		23850.851	50.84	-14.86	35.98	54.00	-18.02	AVG

Notes:
The test distance is 1m.
The distance factor is -9.5dB, which has been in compensation during the testing.

Test mode:	TX 8DPSK – 2441 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2

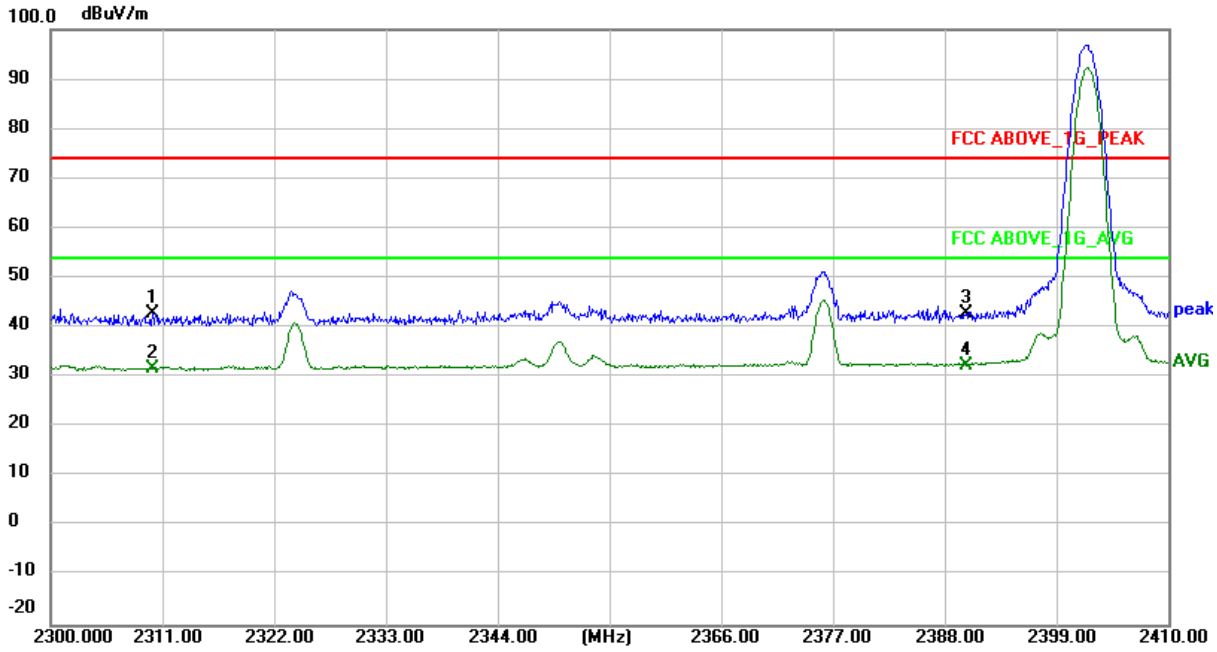


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		18763.764	61.74	-17.89	43.85	74.00	-30.15	peak
2		18763.764	50.82	-17.89	32.93	54.00	-21.07	AVG
3		22904.905	61.90	-14.83	47.07	74.00	-26.93	peak
4	*	22904.905	50.44	-14.83	35.61	54.00	-18.39	AVG
5		23850.851	61.97	-14.86	47.11	74.00	-26.89	peak
6		23850.851	50.34	-14.86	35.48	54.00	-18.52	AVG

Notes:
The test distance is 1m.
The distance factor is -9.5dB, which has been in compensation during the testing.

Radiated emissions at band edge

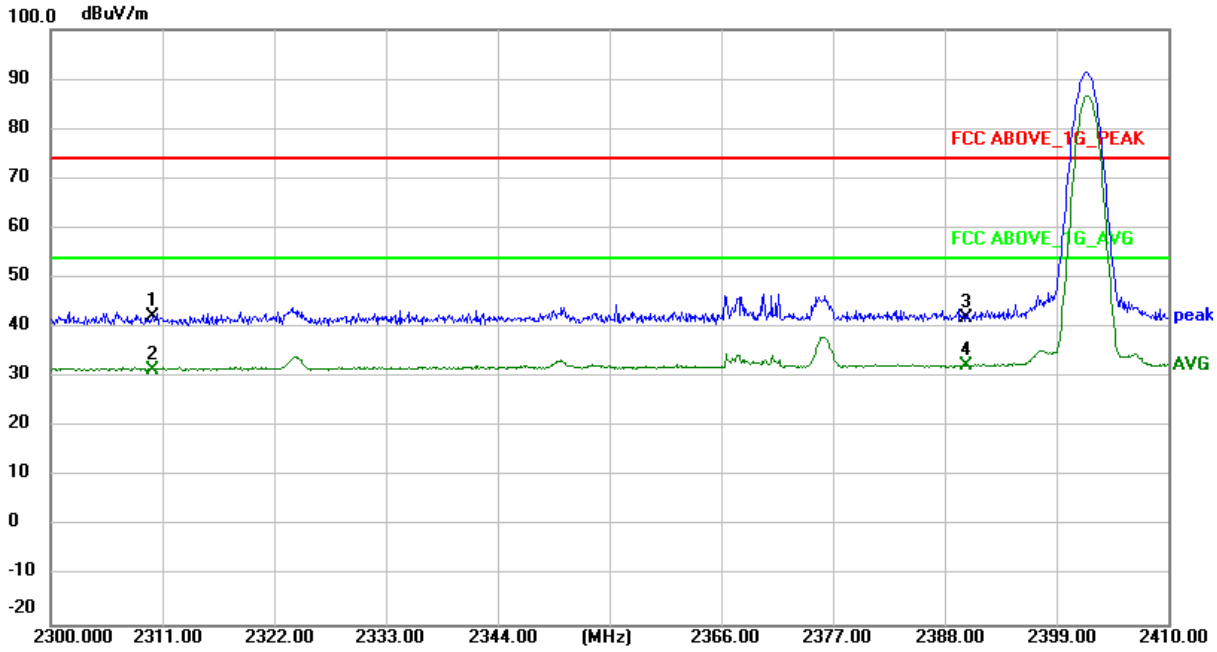
Test mode:	TX 8DPSK - 2402 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2310.000	49.30	-6.60	42.70	74.00	-31.30	peak
2		2310.000	38.33	-6.60	31.73	54.00	-22.27	AVG
3		2390.000	48.95	-6.23	42.72	74.00	-31.28	peak
4	*	2390.000	38.71	-6.23	32.48	54.00	-21.52	AVG

Radiated emissions at band edge

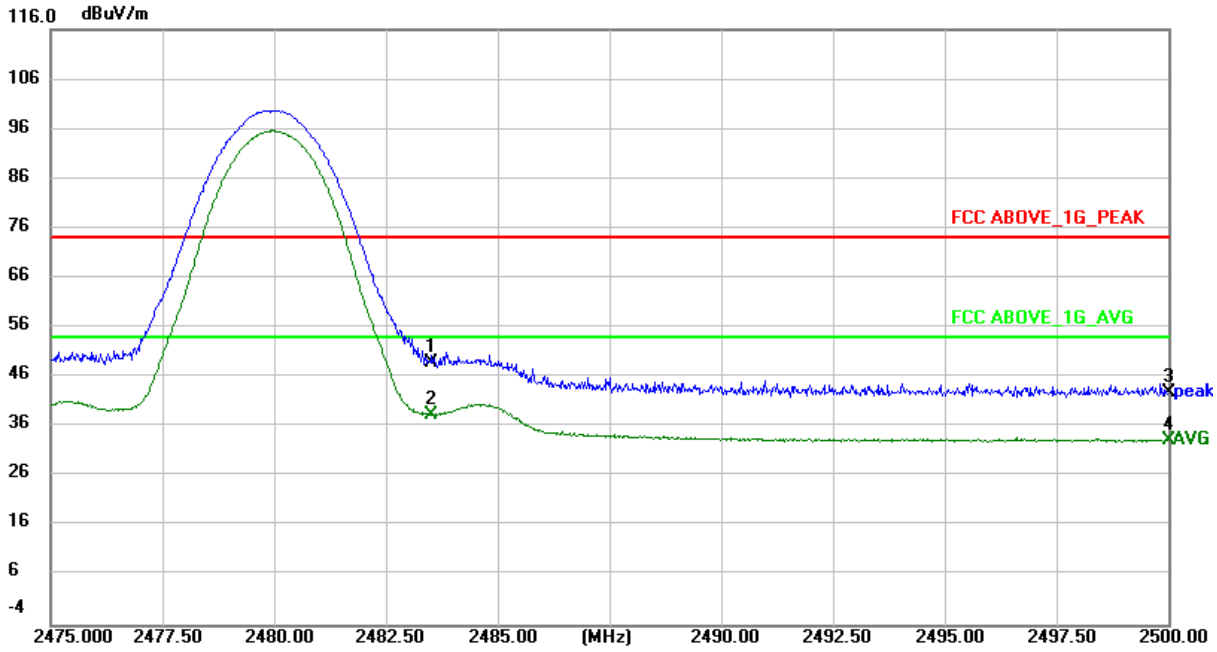
Test mode:	TX 8DPSK - 2402 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2310.000	48.83	-6.60	42.23	74.00	-31.77	peak
2		2310.000	38.16	-6.60	31.56	54.00	-22.44	AVG
3		2390.000	48.11	-6.23	41.88	74.00	-32.12	peak
4	*	2390.000	38.47	-6.23	32.24	54.00	-21.76	AVG

Radiated emissions at band edge

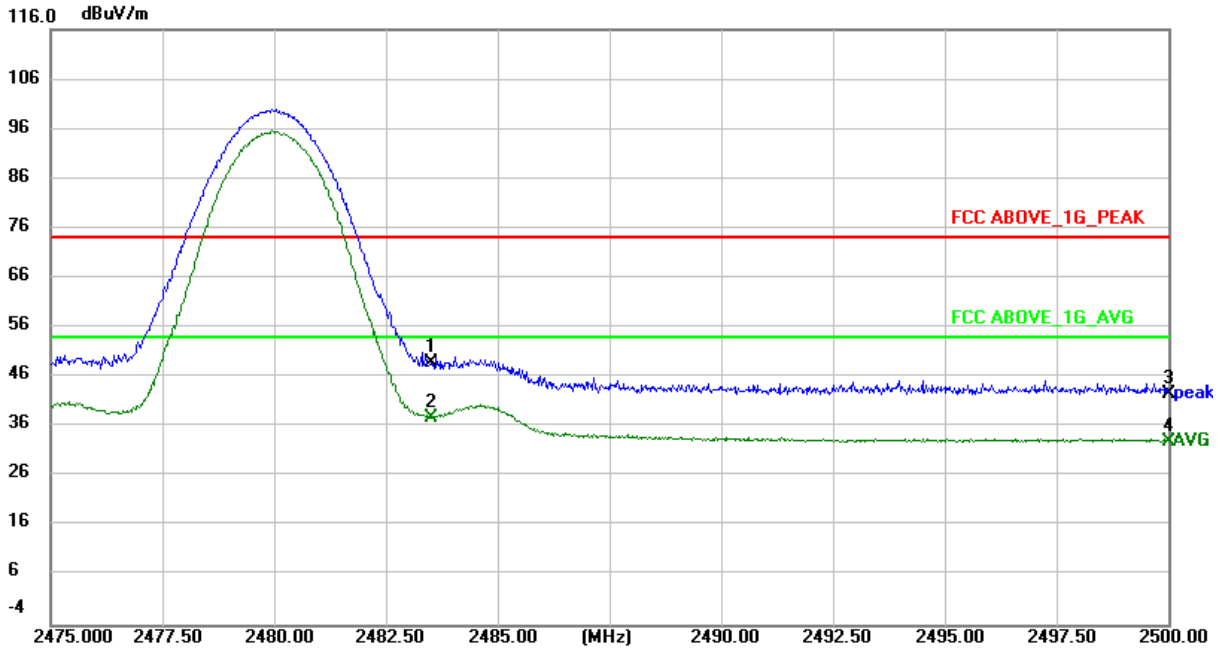
Test mode:	TX 8DPSK – 2480 MHz	Polarization:	Horizontal
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2483.500	54.67	-5.79	48.88	74.00	-25.12	peak
2	*	2483.500	44.39	-5.79	38.60	54.00	-15.40	AVG
3		2500.000	48.57	-5.72	42.85	74.00	-31.15	peak
4		2500.000	39.02	-5.72	33.30	54.00	-20.70	AVG

Radiated emissions at band edge

Test mode:	TX 8DPSK – 2480 MHz	Polarization:	Vertical
Power supply:	DC 7.4V	Test site:	RE chamber 2



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		2483.500	54.88	-5.79	49.09	74.00	-24.91	peak
2	*	2483.500	43.77	-5.79	37.98	54.00	-16.02	AVG
3		2500.000	48.24	-5.72	42.52	74.00	-31.48	peak
4		2500.000	38.89	-5.72	33.17	54.00	-20.83	AVG

Photographs of the Test Setup

See the appendix – Test Setup Photos.

Photographs of the EUT

See the appendix - EUT Photos.

----End of Report----