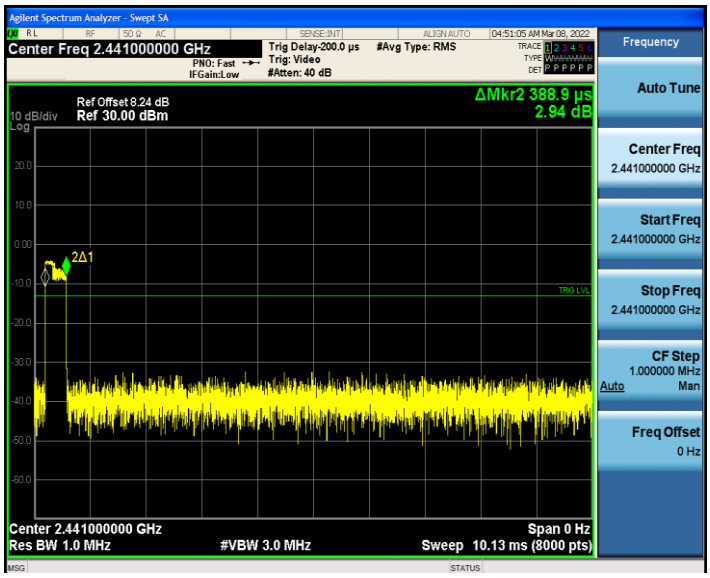
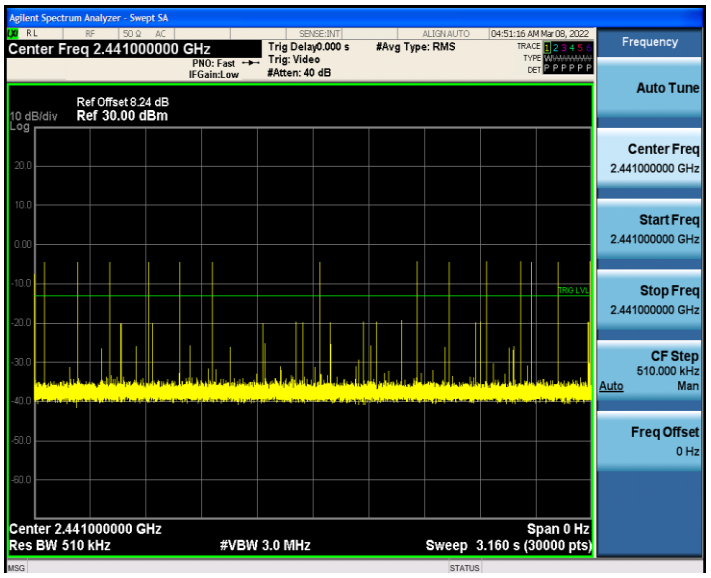
π/4-DQPSK - Average time of occupancy

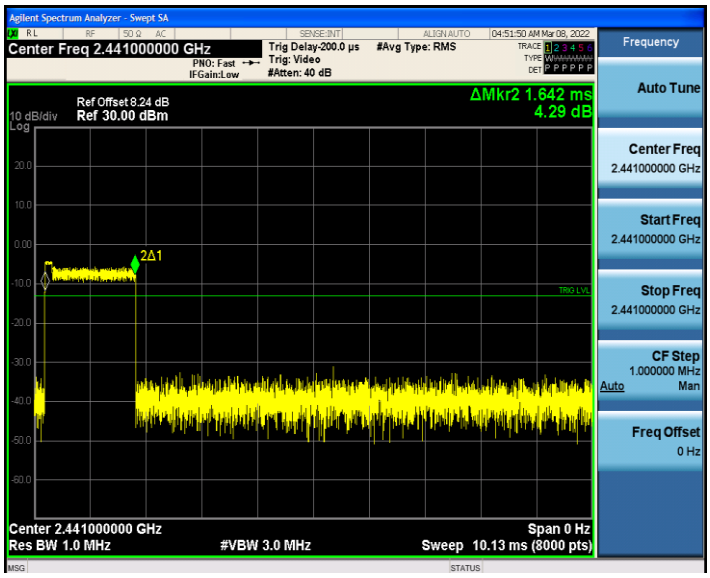
Pulse width – 2DH1



Number of pulses in 3.16 s – 2DH1

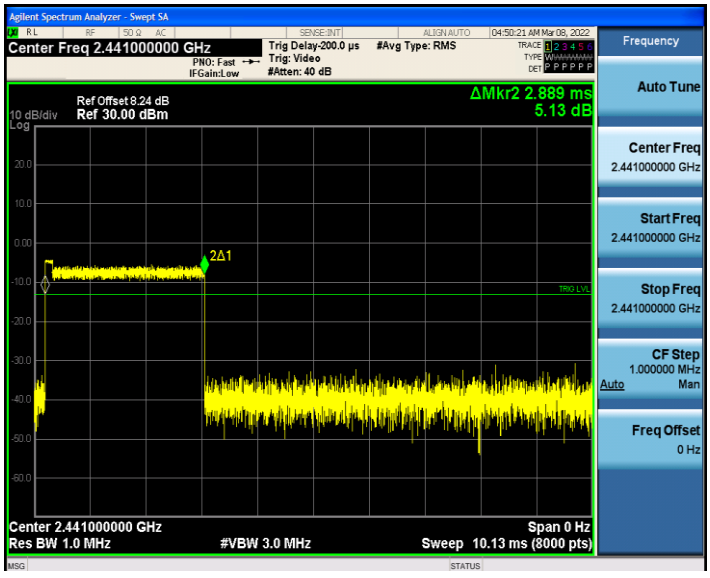


Pulse width – 2DH3

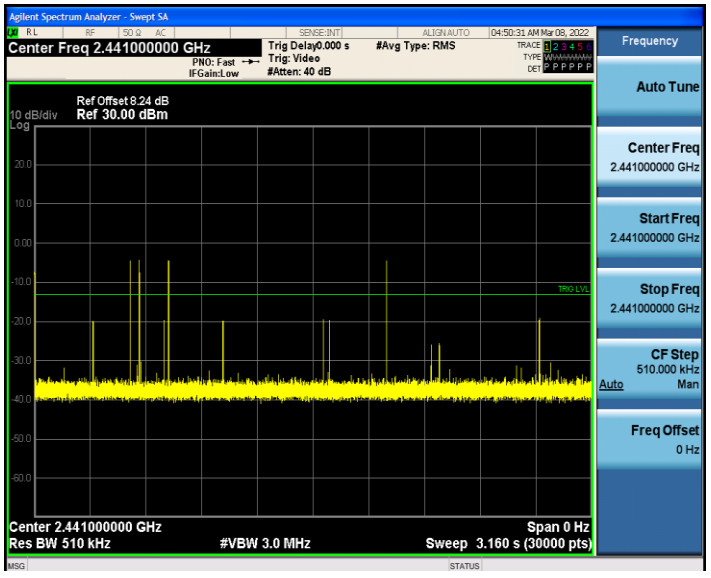


Number of pulses in 3.16 s – 2DH3

Pulse width – 2DH5

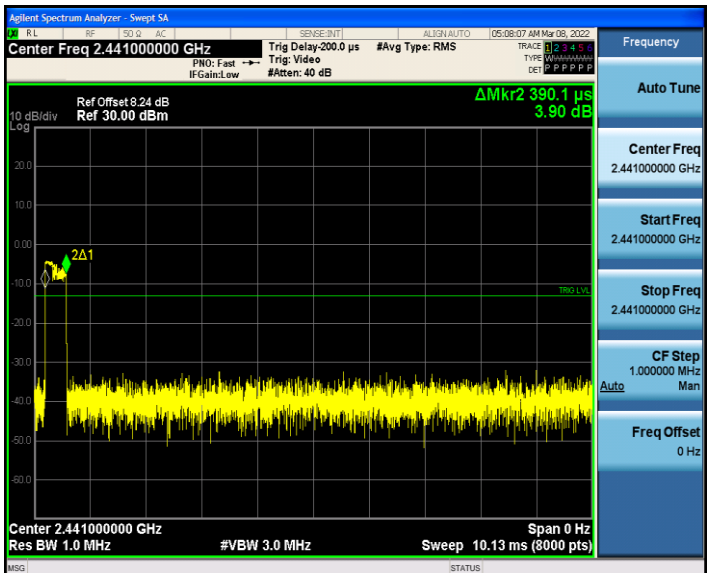


Number of pulses in 3.16 s – 2DH5



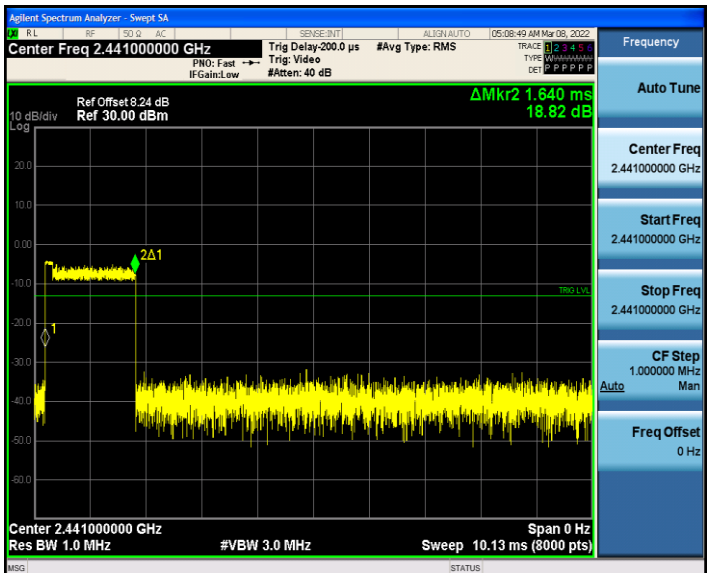
8DPSK - Average time of occupancy

Pulse width – 3DH1

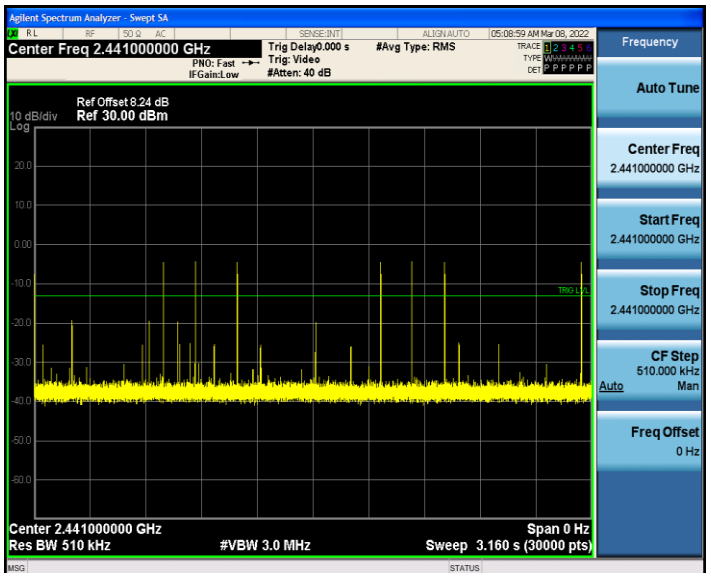


Number of pulses in 3.16 s – 3DH1

Pulse width – 3DH3

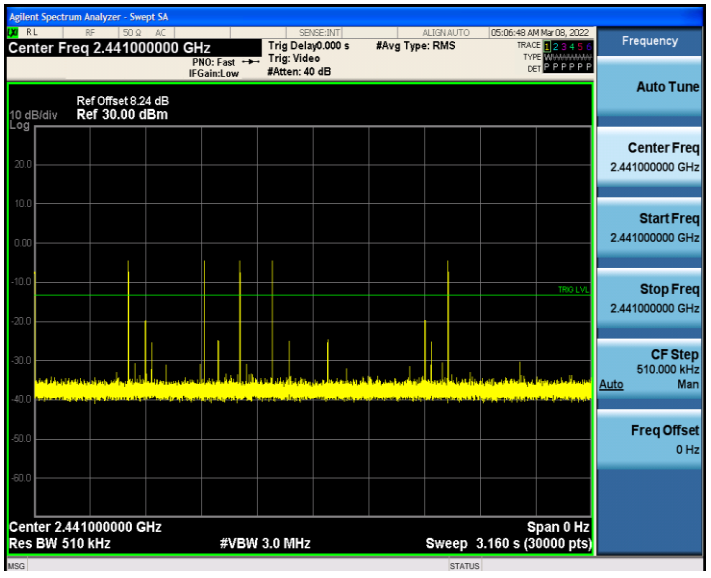


Number of pulses in 3.16 s – 3DH3



Pulse width – 3DH5

Number of pulses in 3.16 s – 3DH5

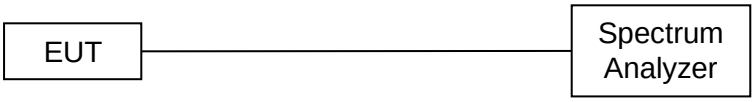


5.7 Number of hopping channels

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

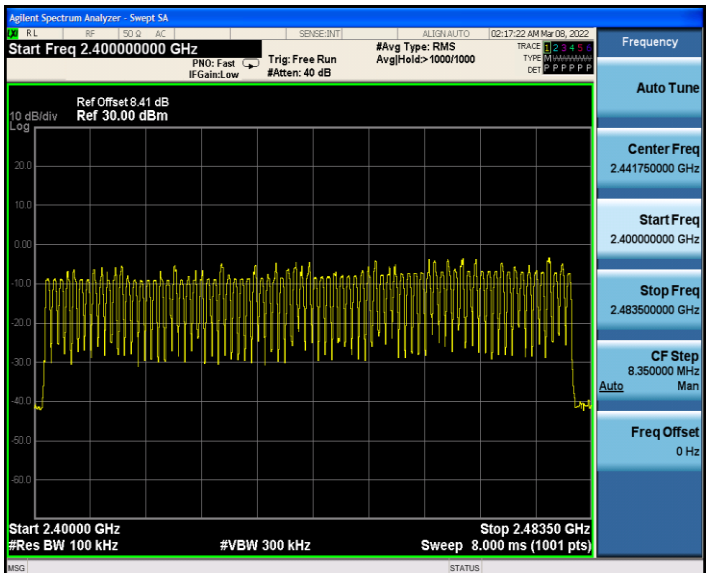
a) Test method: ANSI C63.10-2013 Section 7.8.3
b) The EUT was set to hopping mode during the test.
c) The tranistter output of EUT is connneted to the specturm analyzer.
d) Spectrum analyzer setting: RBW = 100 kHz, VBW = 300 klHz, Detector = Peak.

5.7.4 Test results

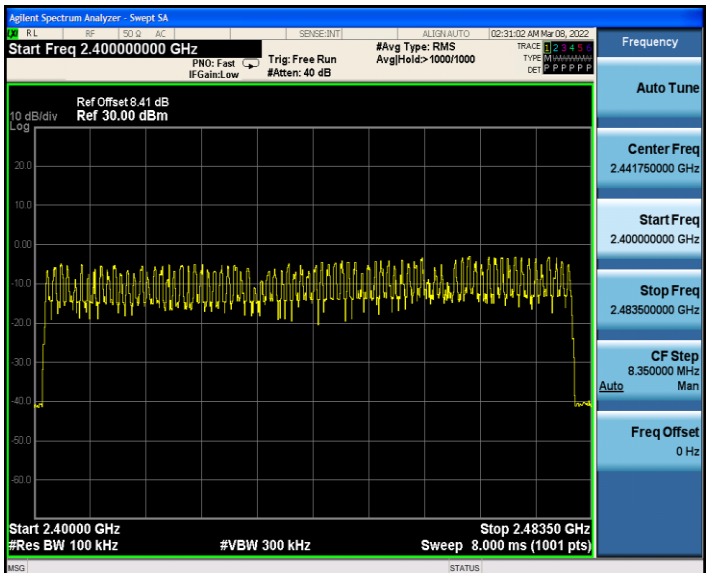
Mode	Quantity of Hopping Channel	Limit	Results
GFSK	79	≥15	Pass
π/4-DQPSK	79	≥15	Pass
8DPSK	79	≥15	Pass

Number of hopping channels

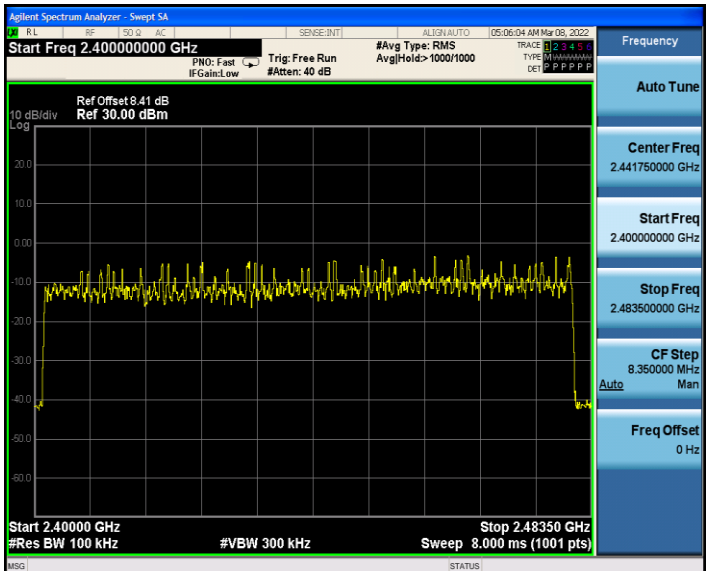
GFSK



π/4-DQPSK



8DPSK

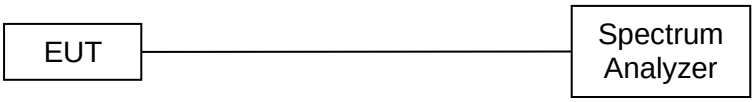


5.8 Conducted emissions at the band edge

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



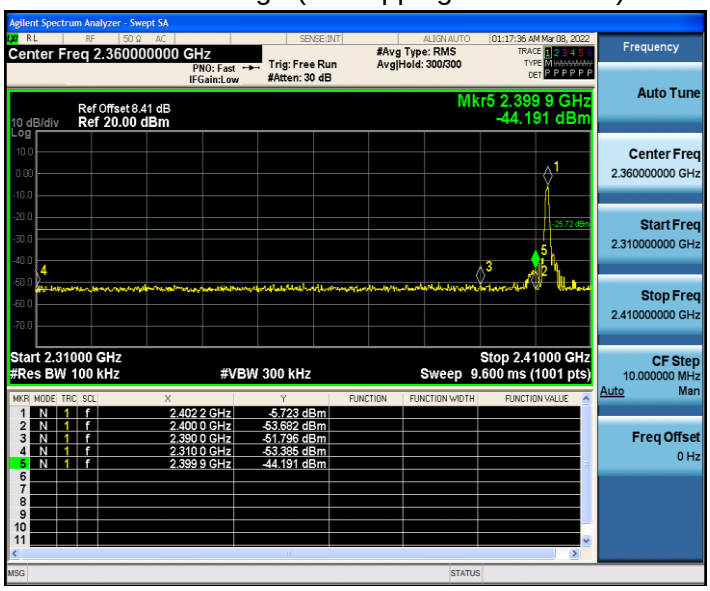
5.8.3 Test procedure

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.

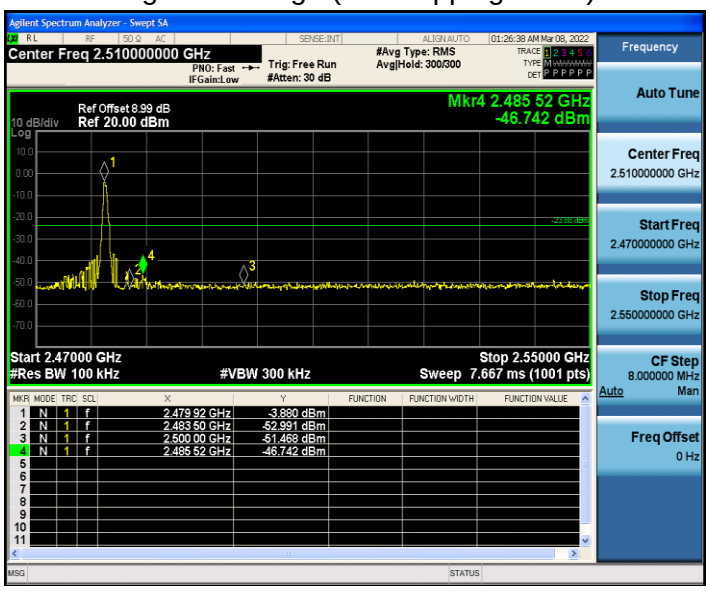
5.8.4 Test results

GFSK mode - conducted emissions at the band edge

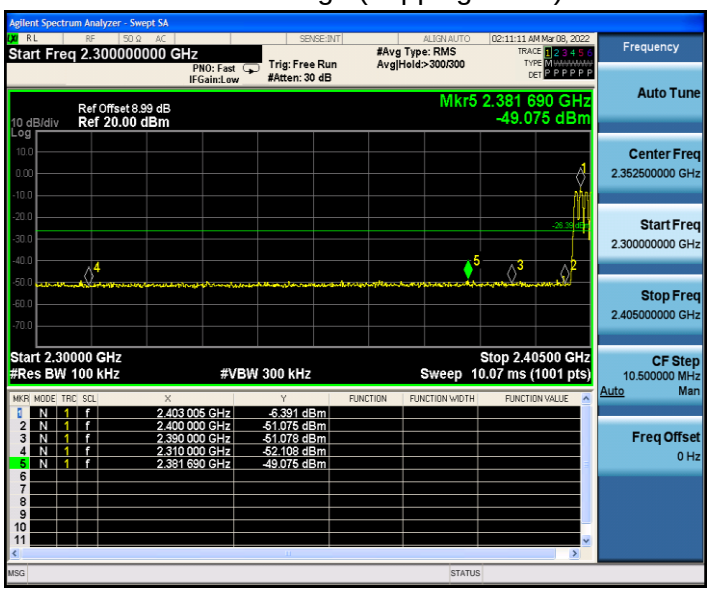
Low band-edge (no-hopping mode mode)



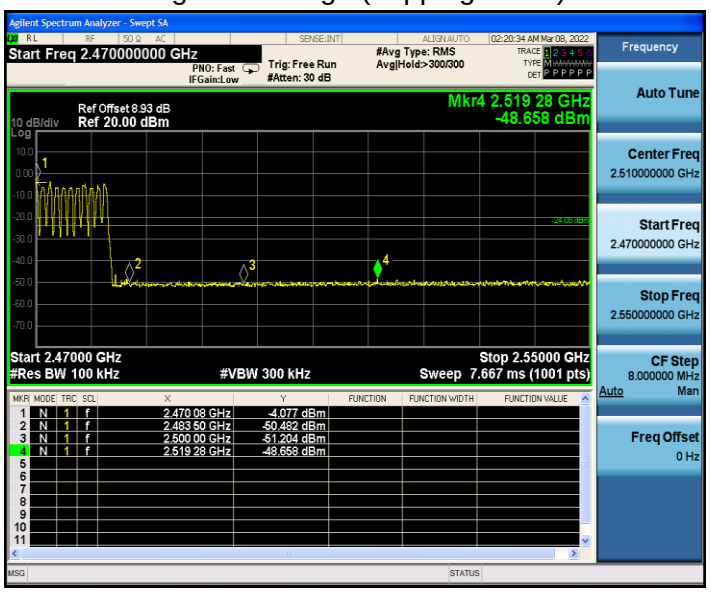
High band-edge (non-hopping mode)



Low band-edge (hopping mode)

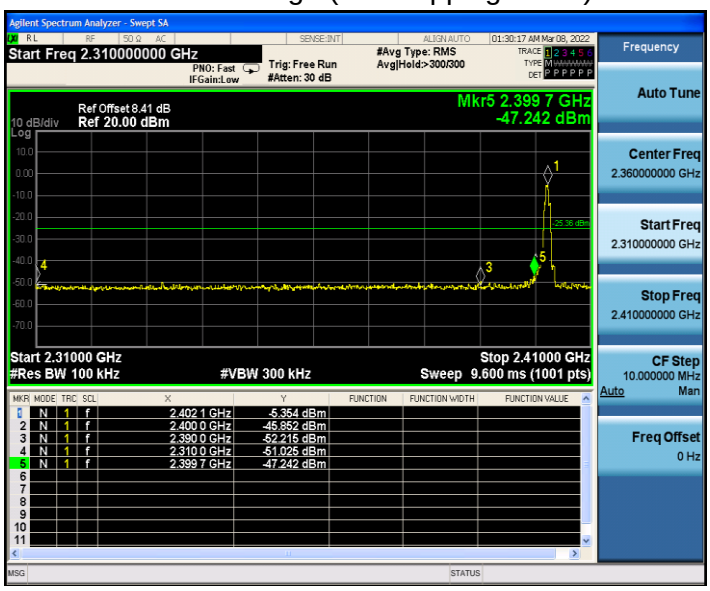


High band-edge (hopping mode)

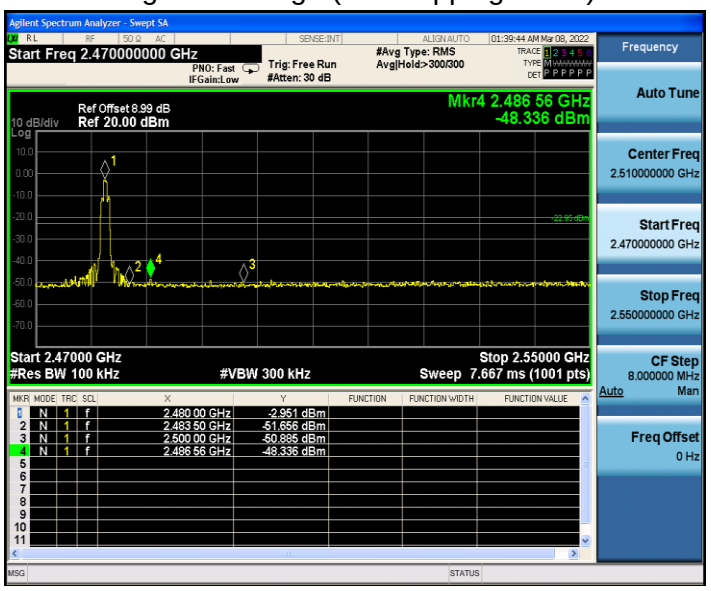


π/4-DQPSK mode - conducted emissions at the band edge

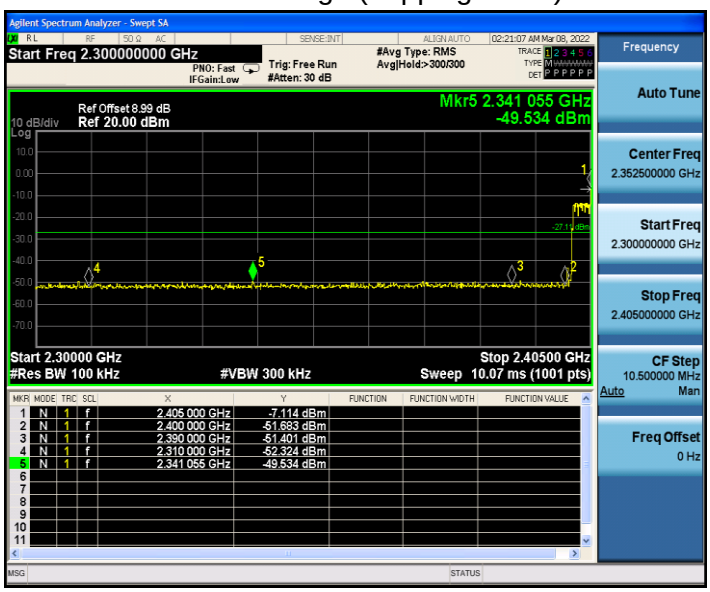
Low band-edge (non-hopping mode)



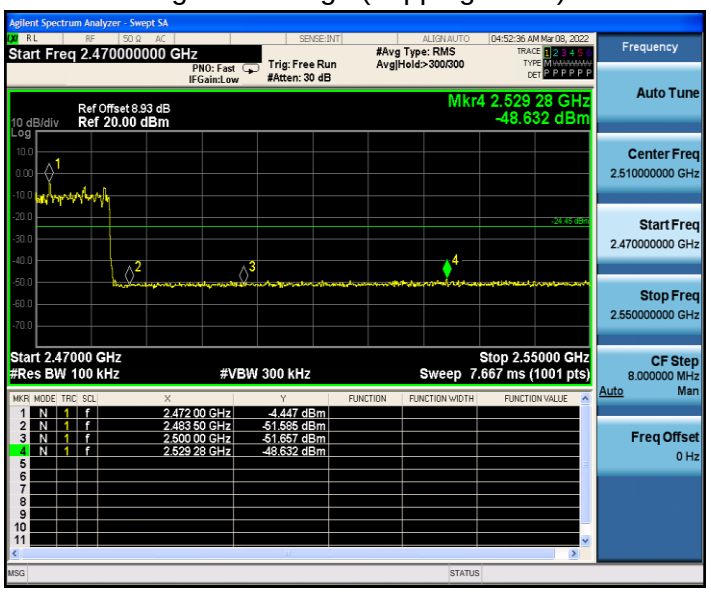
High band-edge (non-hopping mode)



Low band-edge (hopping mode)

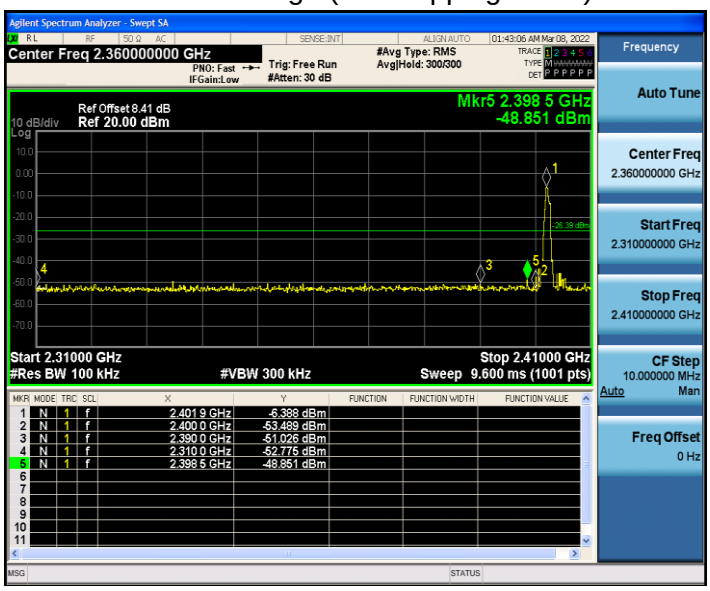


High band-edge (hopping mode)

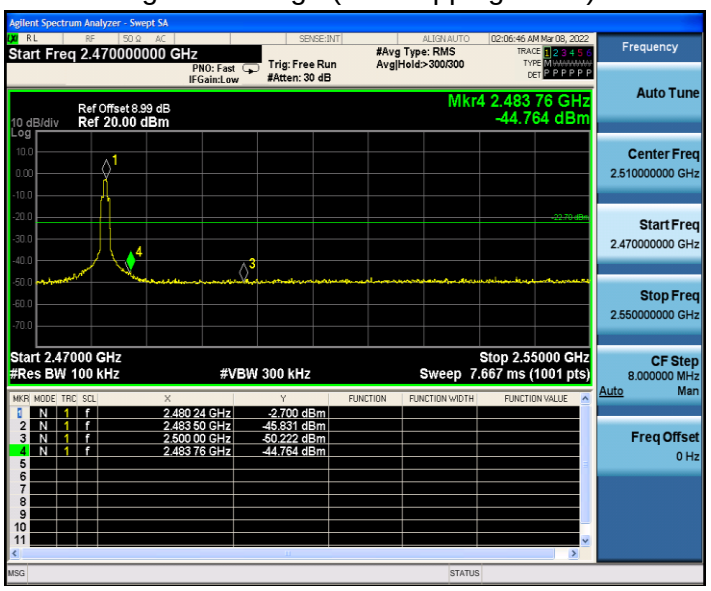


8DPSK mode - conducted emissions at the band edge

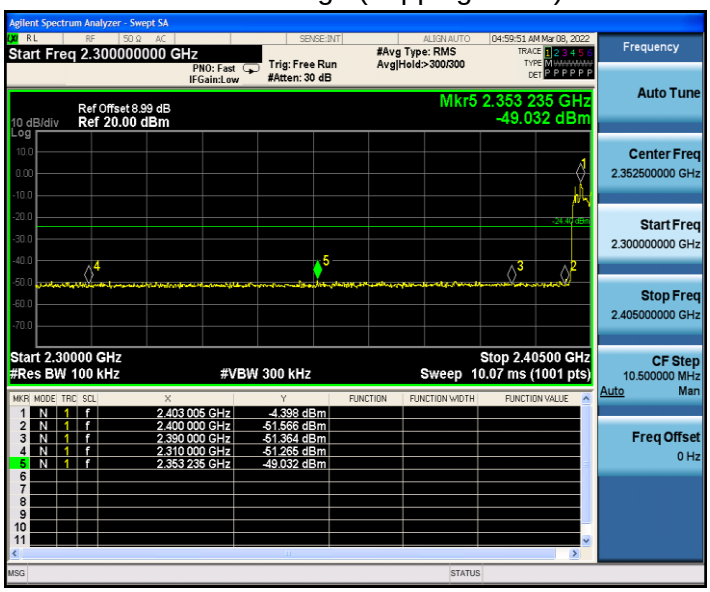
Low band-edge (non-hopping mode)



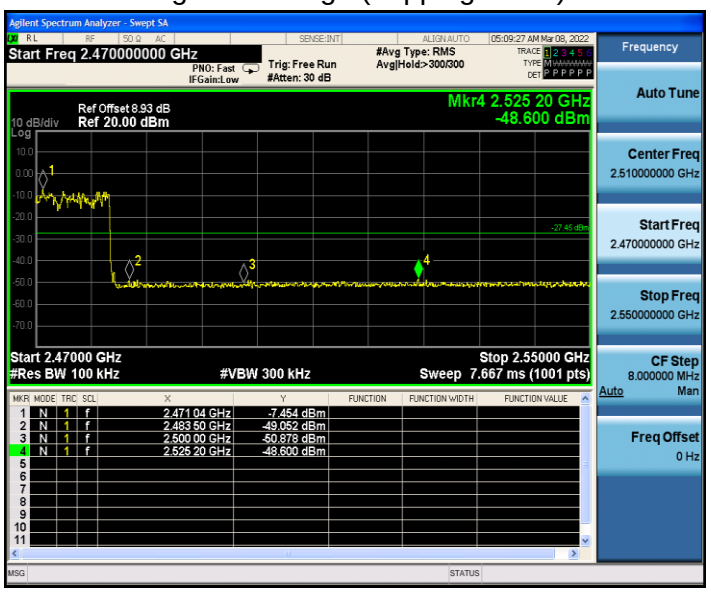
High band-edge (non-hopping mode)



Low band-edge (hopping mode)



High band-edge (hopping mode)

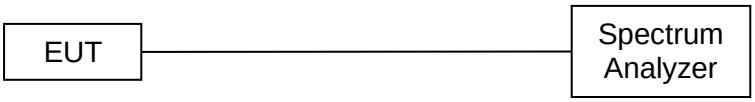


5.9 Conducted spurious emissions

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.

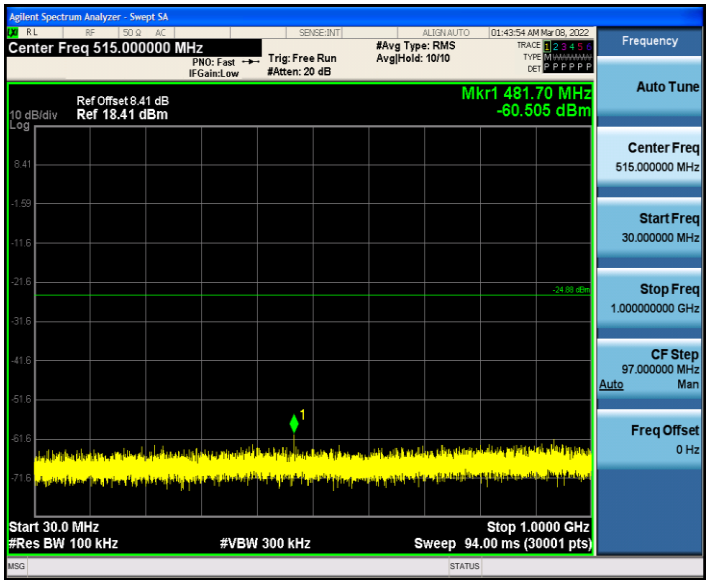
5.9.4 Test results

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

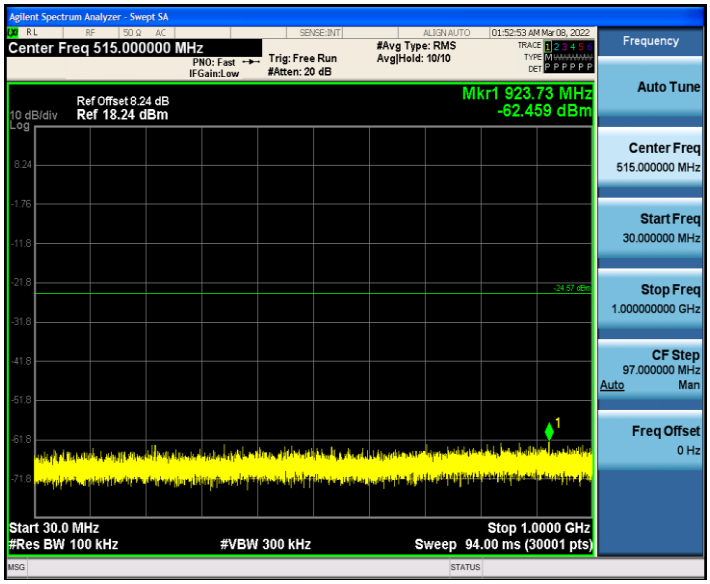
CH0



CH0

CH39

CH39

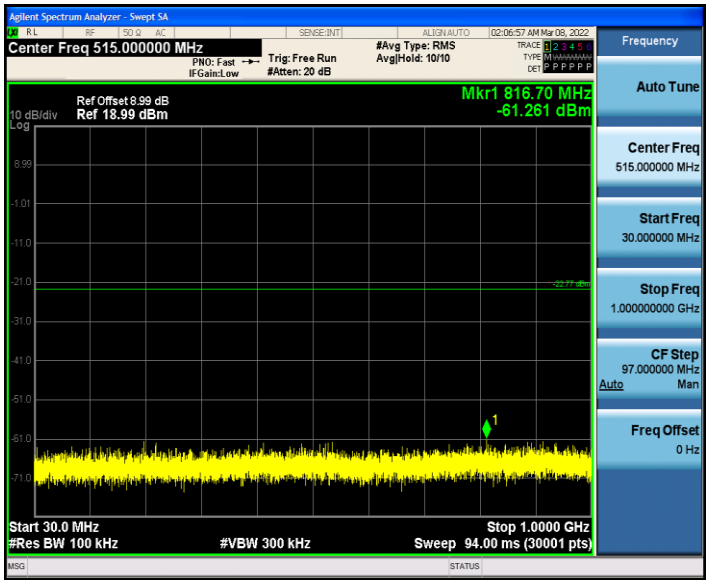


CH39

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

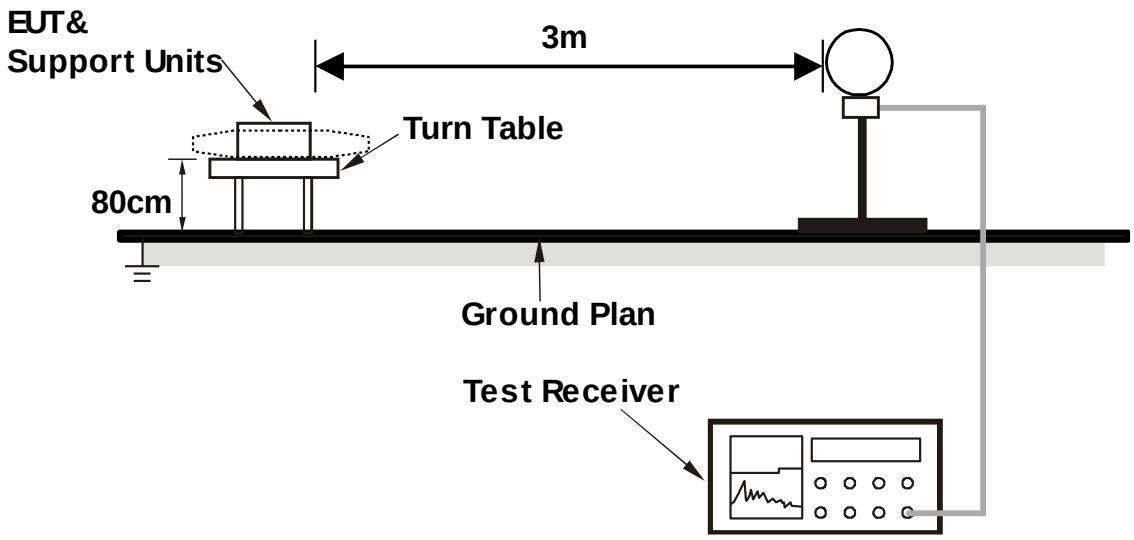
Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or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

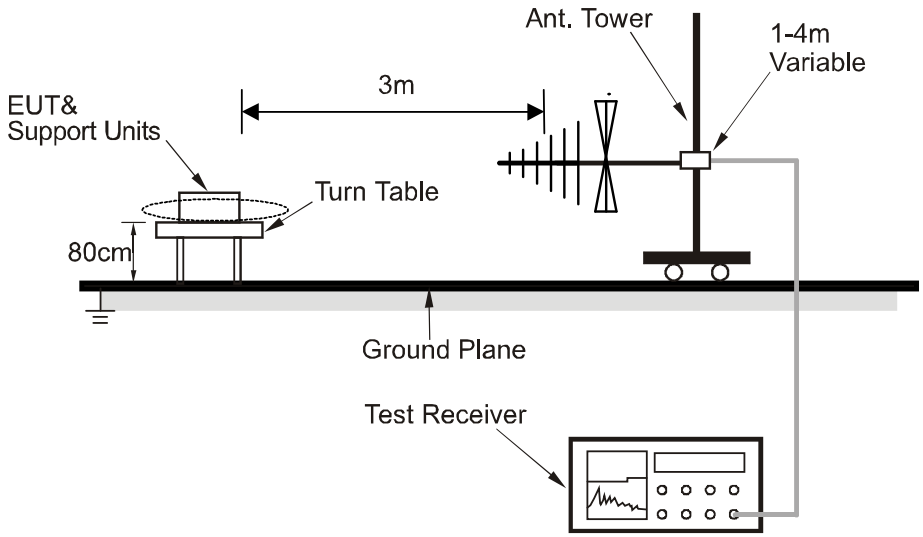
Highest frequency generated or used in the device or on which the device operates or tunes	Upper frequency range of measurement
Below 1.705 MHz	30 MHz
1.705 MHz to 108 MHz	1000 MHz
108 MHz to 500 MHz	2000 MHz
500 MHz to 1000 MHz	5000 MHz
Above 1000 MHz	5th harmonic of the highest frequency or 40 GHz,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

5.10.2 Test setup

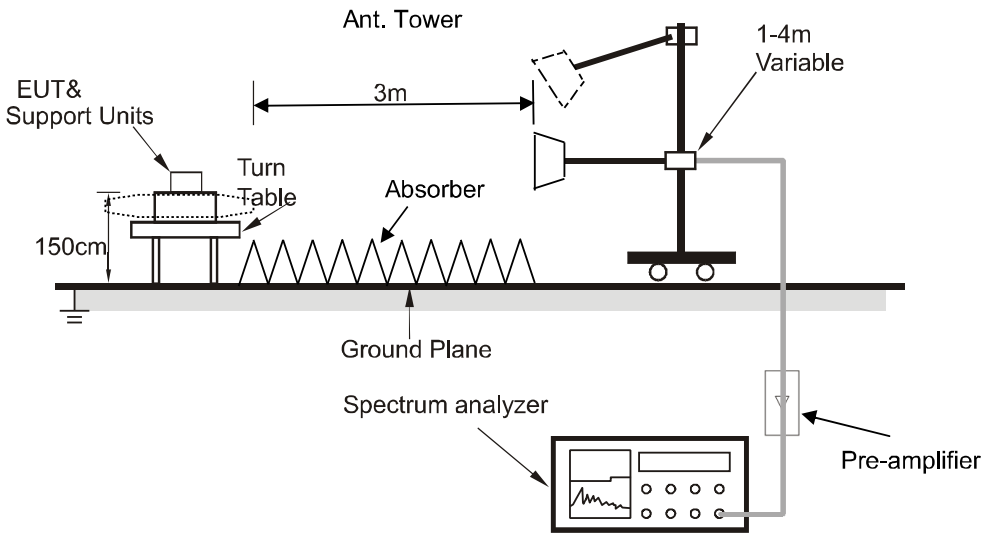
Below 30MHz



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 1.5-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.

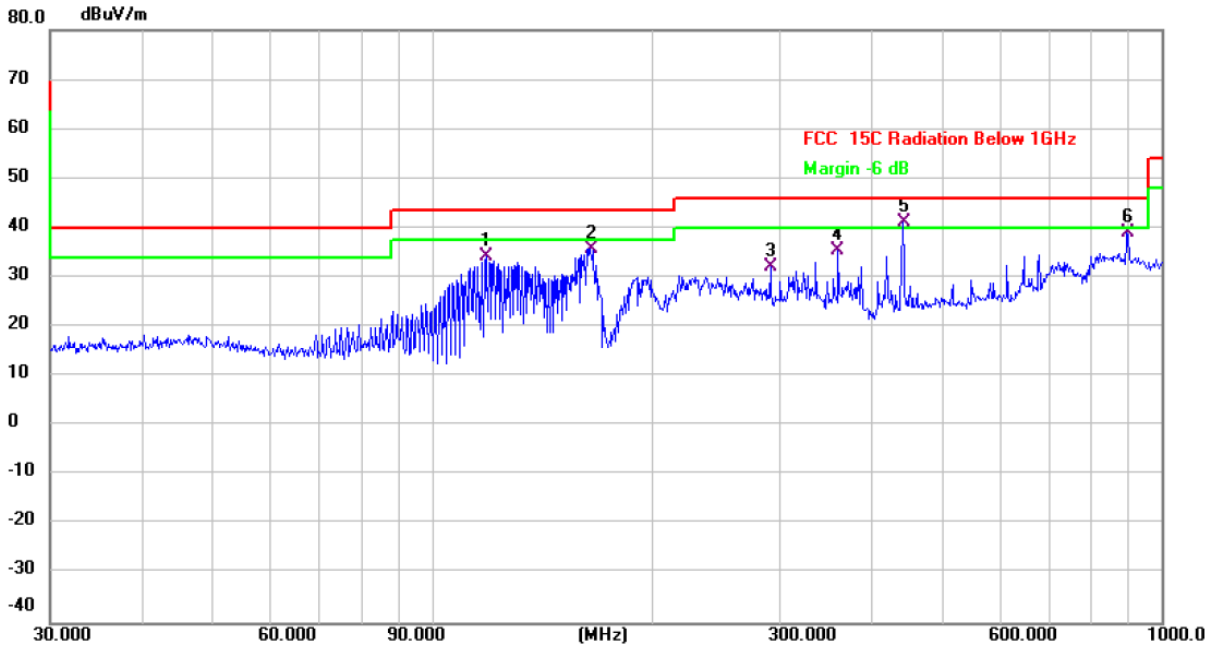
All modes of operation of the EUT were investigated, and only the worst-case results are reported, the worst mode is 8DPSK TX CH78.

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

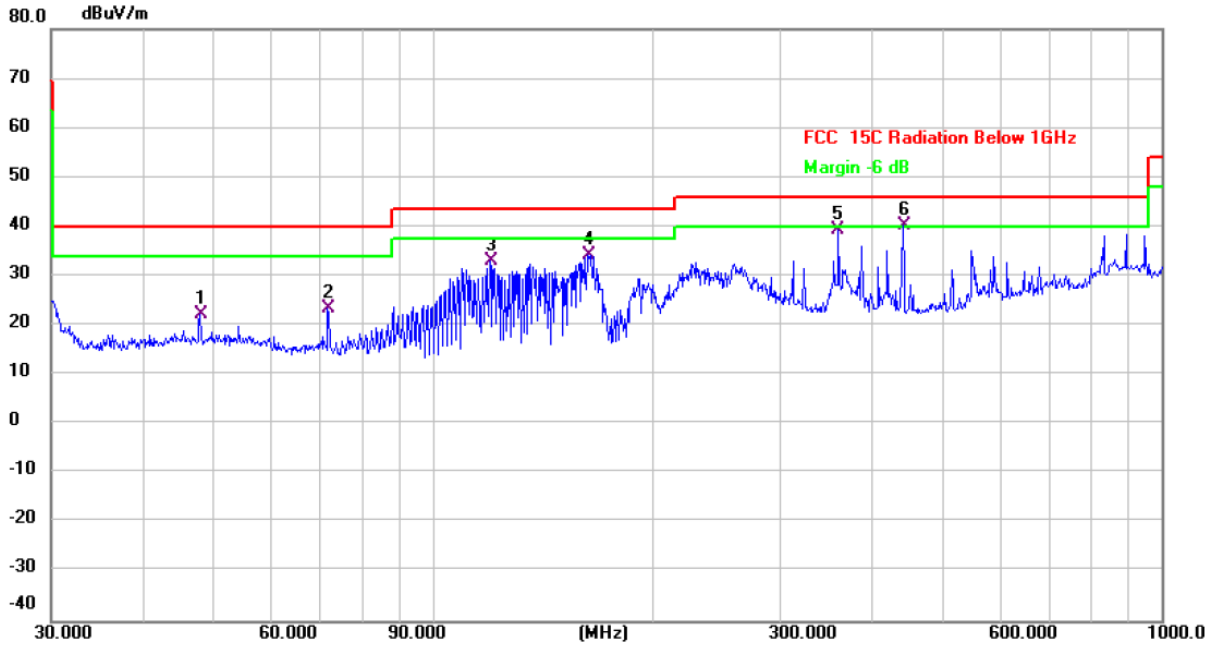
Test mode:	8DPSK-TX-2480MHz	Polarization:	Horizontal
Power supply:	DC 3.7V from battery	Test site:	RE chamber 1



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		118.6014	44.33	-10.02	34.31	43.50	-9.19	QP
2		164.9075	45.42	-9.73	35.69	43.50	-7.81	QP
3		291.0360	37.82	-5.78	32.04	46.00	-13.96	QP
4		360.4476	40.15	-4.58	35.57	46.00	-10.43	QP
5	*	441.7426	44.42	-3.41	41.01	46.00	-4.99	QP
6		896.9965	35.55	3.53	39.08	46.00	-6.92	QP

Radiated emissions between 30MHz – 1GHz

Test mode:	8DPSK-TX-2480MHz	Polarization:	Vertical
Power supply:	DC 3.7V from battery	Test site:	RE chamber 1



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		47.9940	29.88	-7.54	22.34	40.00	-17.66	QP
2		71.8320	33.36	-10.03	23.33	40.00	-16.67	QP
3		119.8556	43.36	-10.21	33.15	43.50	-10.35	QP
4		163.1818	43.98	-9.77	34.21	43.50	-9.29	QP
5		360.4476	44.03	-4.58	39.45	46.00	-6.55	QP
6	*	441.7426	43.72	-3.41	40.31	46.00	-5.69	QP

Radiated emissions 1 GHz ~ 25 GHz

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
8DPSK - 2402 MHz TX mode							
4804	41.89	1.52	43.41	74	-30.59	Peak	V
4804	31.93	1.52	33.45	54	-20.55	AVG	V
7206	39.75	5.46	45.21	74	-28.79	Peak	V
7206	30.41	5.46	35.87	54	-18.13	AVG	V
9608	42.35	6.33	48.68	74	-25.32	Peak	V
9608	32.63	6.33	38.96	54	-15.04	AVG	V
4804	41.19	1.52	42.71	74	-31.29	Peak	H
4804	31.17	1.52	32.69	54	-21.31	AVG	H
7206	40.16	5.46	45.62	74	-28.38	Peak	H
7206	30.32	5.46	35.78	54	-18.22	AVG	H
9608	41.94	6.33	48.27	74	-25.73	Peak	H
9608	32.23	6.33	38.56	54	-15.44	AVG	H
8DPSK - 2441 MHz TX mode							
4882	41.43	1.68	43.11	74	-30.89	Peak	V
4882	32.01	1.68	33.69	54	-20.31	AVG	V
7323	40.82	5.45	46.27	74	-27.73	Peak	V
7323	31	5.45	36.45	54	-17.55	AVG	V
9764	41.5	6.37	47.87	74	-26.13	Peak	V
9764	31.61	6.37	37.98	54	-16.02	AVG	V
4882	41.22	1.68	42.9	74	-31.1	Peak	H
4882	30.97	1.68	32.65	54	-21.35	AVG	H
7323	40.98	5.45	46.43	74	-27.57	Peak	H
7323	31.53	5.45	36.98	54	-17.02	AVG	H
9764	42.23	6.37	48.6	74	-25.4	Peak	H
9764	32.08	6.37	38.45	54	-15.55	AVG	H

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
8DPSK - 2480 MHz TX mode							
4960	42.48	1.83	44.31	74	-29.69	Peak	V
4960	32.86	1.83	34.69	54	-19.31	AVG	V
7440	40.3	5.43	45.73	74	-28.27	Peak	V
7440	30.35	5.43	35.78	54	-18.22	AVG	V
9920	41.43	6.41	47.84	74	-26.16	Peak	V
9920	31.44	6.41	37.85	54	-16.15	AVG	V
4960	42.16	1.83	43.99	74	-30.01	Peak	H
4960	32.06	1.83	33.89	54	-20.11	AVG	H
7440	39.99	5.43	45.42	74	-28.58	Peak	H
7440	30.03	5.43	35.46	54	-18.54	AVG	H
9920	41.22	6.41	47.63	74	-26.37	Peak	H
9920	31.44	6.41	37.85	54	-16.15	AVG	H

Radiated emissions at band edge

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
8DPSK – Low band-edge							
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
2310	48.63	-6.6	42.03	74	-31.97	Peak	V
2310	38.44	-6.6	31.84	54	-22.16	AVG	V
2390	52.63	-6.23	46.4	74	-27.6	Peak	V
2390	38.6	-6.23	32.37	54	-21.63	AVG	V
2310	49.36	-6.6	42.76	74	-31.24	Peak	H
2310	38.52	-6.6	31.92	54	-22.08	AVG	H
2390	55.83	-6.23	49.6	74	-24.4	Peak	H
2390	38.86	-6.23	32.63	54	-21.37	AVG	H
8DPSK – High band-edge							
2483.5	62.15	-5.79	56.36	74	-17.64	Peak	V
2483.5	40.2	-5.79	34.41	54	-19.59	AVG	V
2500	48.82	-5.72	43.1	74	-30.9	Peak	V
2500	38.77	-5.72	33.05	54	-20.95	AVG	V
2483.5	66.86	-5.79	61.07	74	-12.93	Peak	H
2483.5	41.54	-5.79	35.75	54	-18.25	AVG	H
2500	51.58	-5.72	45.86	74	-28.14	Peak	H
2500	38.69	-5.72	32.97	54	-21.03	AVG	H

Photographs of the Test Setup

See the appendix – Test Setup Photos.

Photographs of the EUT

See the appendix - EUT Photos.

----End of Report----