A.4 Radiated Emission

Measurement Limit:

Standard	Limit
FCC 47 CFR Part 15.247, 15.205, 15.209	20dB below peak output power

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)).

Limit in restricted band:

Frequency of emission (MHz)	Field strength (μV/m)	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

Test Condition:

The EUT was placed on a non-conductive table. The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and the EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. This maximization process was repeated with the EUT positioned in each of its three orthogonal orientations.

Frequency of emission (MHz)	RBW/VBW	Sweep Time (s)
30-1000	120kHz/300kHz	5
1000-4000	1MHz/3MHz	15
4000-18000	1MHz/3MHz	40
18000-26500	1MHz/3MHz	20

Note: According to the performance evaluation, the radiated emission margin of EUT is over 20dB in the band from 9kHz to 30MHz. Therefore, the measurement starts from 30MHz to tenth harmonic.

The measurement results include the horizontal polarization and vertical polarization measurements.

Measurement Results:

Mode	Channel	Frequency Range	Test Results	Conclusion
GFSK	0	3 GHz ~ 18 GHz	Fig.42	**P**
	39	3 GHz ~ 18 GHz	Fig.43	**P**
	78	3 GHz ~ 18 GHz	Fig.44	**P**
	Restricted Band(CH0)	2.38 GHz ~ 2.45 GHz	Fig.45	**P**
	Restricted Band (CH78)	2.45 GHz ~ 2.5 GHz	Fig.46	**P**
π /4 DQPSK	0	3 GHz ~ 18 GHz	Fig.47	**P**
	39	3 GHz ~ 18 GHz	Fig.48	**P**
	78	3 GHz ~ 18 GHz	Fig.49	**P**
	Restricted Band (CH0)	2.38 GHz ~ 2.45 GHz	Fig.50	**P**
	Restricted Band (CH78)	2.45 GHz ~ 2.5 GHz	Fig.51	**P**
8DPSK	0	3 GHz ~ 18 GHz	Fig.52	**P**
	39	3 GHz ~ 18 GHz	Fig.53	**P**
	78	3 GHz ~ 18 GHz	Fig.54	**P**
	Restricted Band (CH0)	2.38 GHz ~ 2.45 GHz	Fig.55	**P**
	Restricted Band (CH78)	2.45 GHz ~ 2.5 GHz	Fig.56	**P**
/	All channels	9 kHz ~ 30 MHz	Fig.57	**P**
		30 MHz ~ 1 GHz	Fig.58	**P**
		1 GHz ~ 3 GHz	Fig.59	**P**
		18 GHz ~ 26.5 GHz	Fig.60	**P**

Worst Case Result

GFSK CH0 (3-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
6629.000000	49.44	74.00	24.56	H	2.3
10975.500000	46.55	74.00	27.45	V	6.6
13097.500000	48.07	74.00	25.93	V	9.8
14496.500000	50.20	74.00	23.80	V	11.7
16579.000000	51.54	74.00	22.46	V	15.2
17962.000000	51.62	74.00	22.38	V	16.8

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
3603.000000	38.30	54.00	15.70	H	-2.2
10786.500000	34.67	54.00	19.33	V	6.4
13121.000000	36.40	54.00	17.60	V	9.7
14497.500000	37.29	54.00	16.71	V	11.7
16547.500000	39.39	54.00	14.61	V	15.3
17946.000000	40.00	54.00	14.00	H	17.3

π/4 DQPSK CH0 (3-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
6629.500000	49.81	74.00	24.19	H	2.3
11486.000000	46.86	74.00	27.14	V	6.9
12941.500000	48.66	74.00	25.34	H	9.5
15303.000000	49.29	74.00	24.71	H	12.3
16536.000000	51.30	74.00	22.70	V	15.2
17927.500000	52.22	74.00	21.78	H	16.7

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
3602.500000	37.64	54.00	16.36	H	-2.2
4641.000000	36.28	54.00	17.72	V	-0.5
12940.500000	36.48	54.00	17.52	V	9.4
14458.500000	37.30	54.00	16.70	V	11.7
16556.500000	39.51	54.00	14.49	V	15.3
17945.000000	40.09	54.00	13.91	H	17.3

8DPSK CH0 (3-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
6629.500000	49.84	74.00	24.16	H	2.3
10792.000000	46.68	74.00	27.32	H	6.4
12984.000000	48.35	74.00	25.66	V	9.1
15315.000000	49.45	74.00	24.55	H	12.3
16718.500000	52.13	74.00	21.87	H	15.4
17942.000000	51.45	74.00	22.55	H	17.2

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB)
3603.000000	37.89	54.00	16.11	H	-2.2
11007.500000	34.80	54.00	19.20	H	6.6
13124.500000	36.31	54.00	17.69	H	9.8
14508.000000	37.30	54.00	16.70	H	11.7
16543.000000	39.65	54.00	14.35	V	15.3
17951.500000	40.18	54.00	13.82	H	17.1

Note:
A "reference path loss" is established and the A_{Rpl} is the attenuation of “reference path loss”, and Antenna Factor, the gain of the preamplifier, the cable loss. P_{Mea} is the field strength recorded from the instrument.
The measurement results are obtained as described below:
Result = P_{Mea} + Cable Loss + Antenna Factor - Gain of the preamplifier

See below for test graphs.
Conclusion: Pass

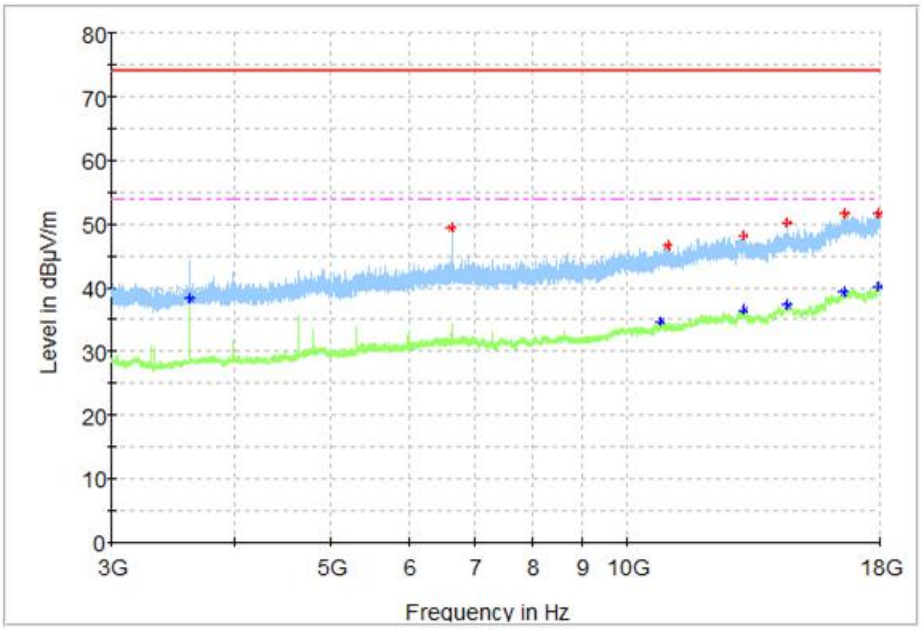

Fig. 42 Radiated Spurious Emission (GFSK, Ch0, 3GHz ~ 18GHz)

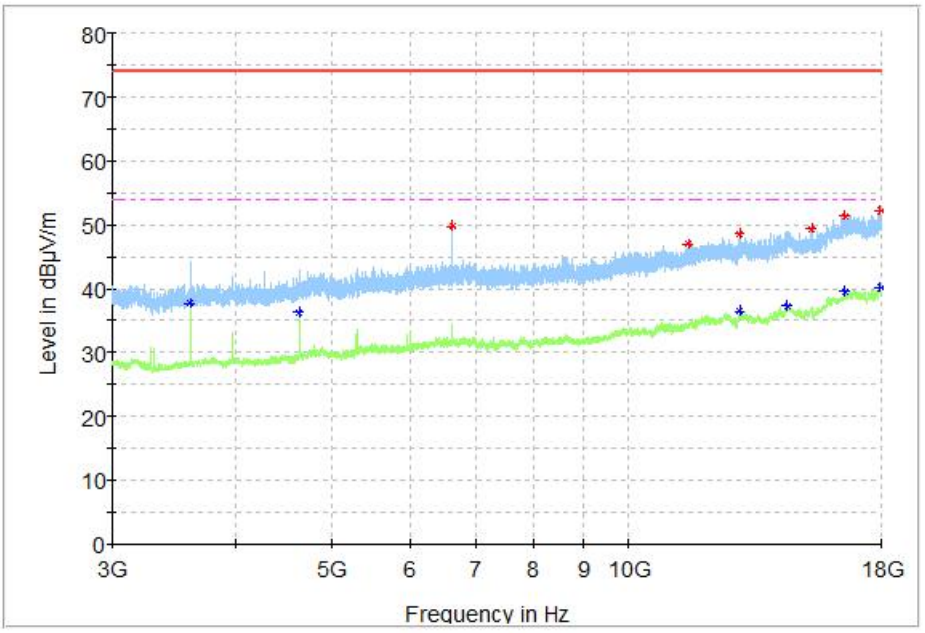

Fig. 43 Radiated Spurious Emission (GFSK, Ch39, 3GHz ~ 18GHz)

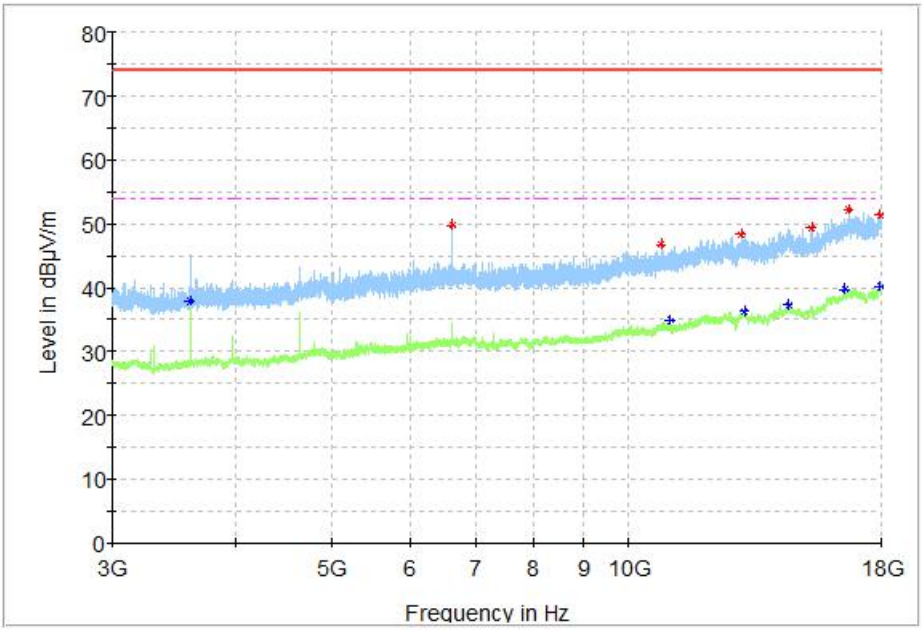

Fig. 44 Radiated Spurious Emission (GFSK, Ch78, 3GHz ~ 18GHz)

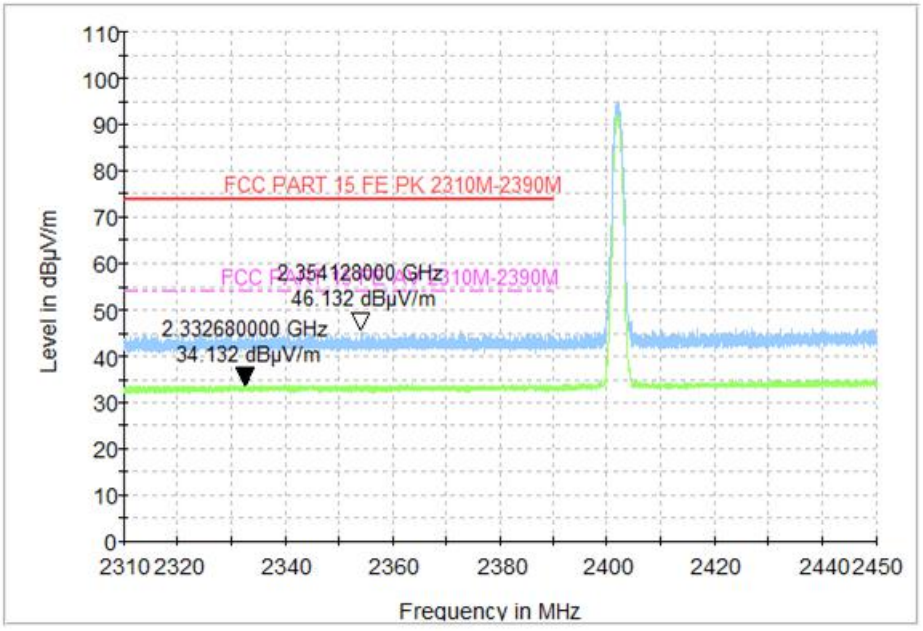

Fig. 45 Radiated Band Edges (GFSK, Ch0, 2380GHz ~ 2450GHz)

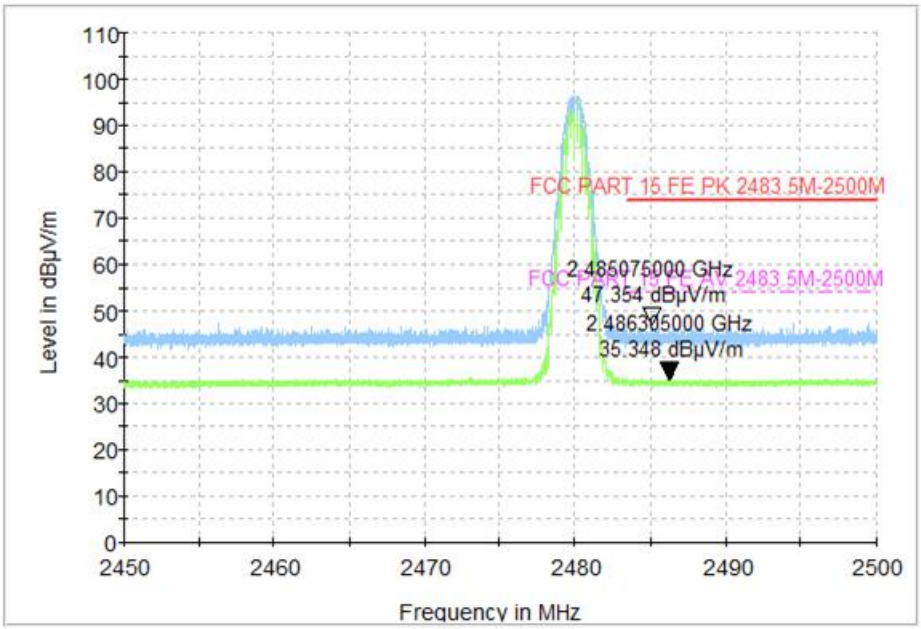

Fig. 46 Radiated Band Edges (GFSK, Ch78, 2450GHz ~ 2500GHz)

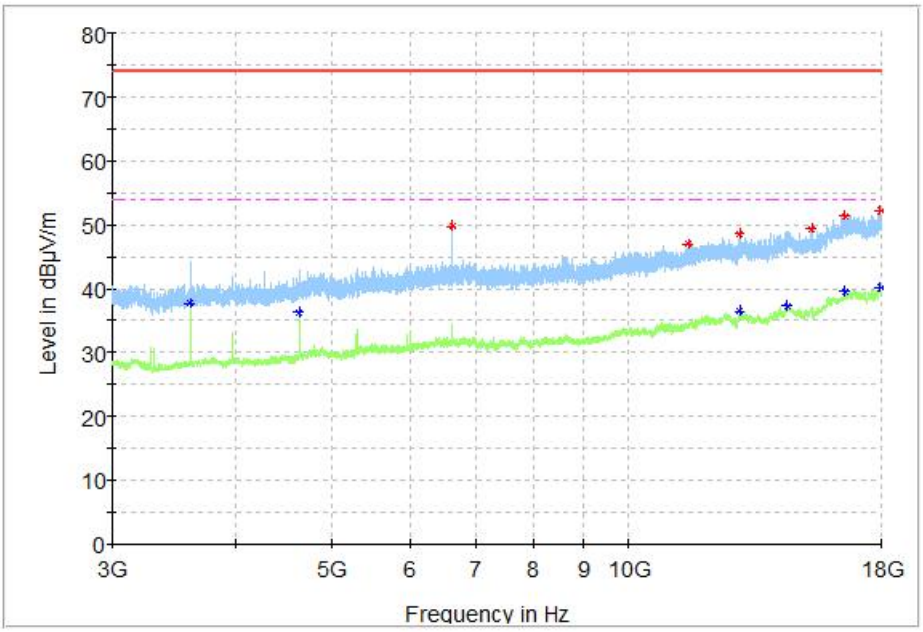

Fig. 47 Radiated Spurious Emission (π /4 DQPSK, Ch0, 3GHz ~ 18GHz)

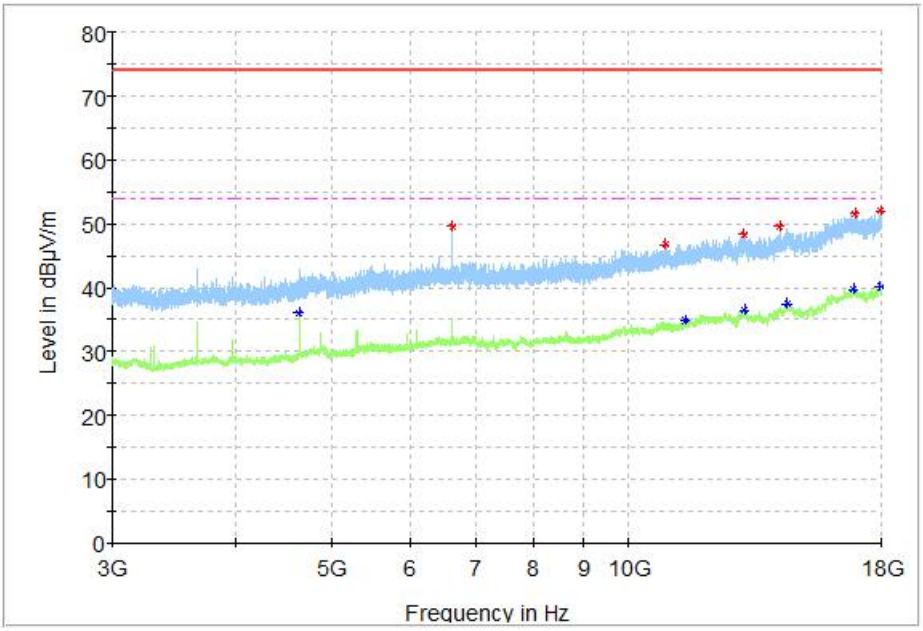

Fig. 48 Radiated Spurious Emission (π /4 DQPSK, Ch39, 3GHz ~ 18GHz)

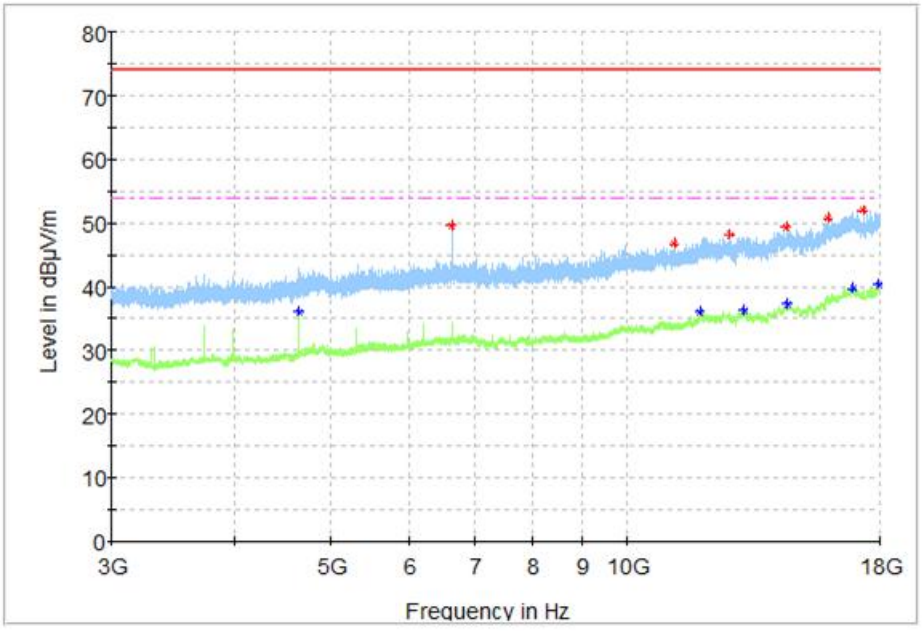

Fig. 49 Radiated Spurious Emission (π /4 DQPSK, Ch78, 3GHz ~ 18GHz)

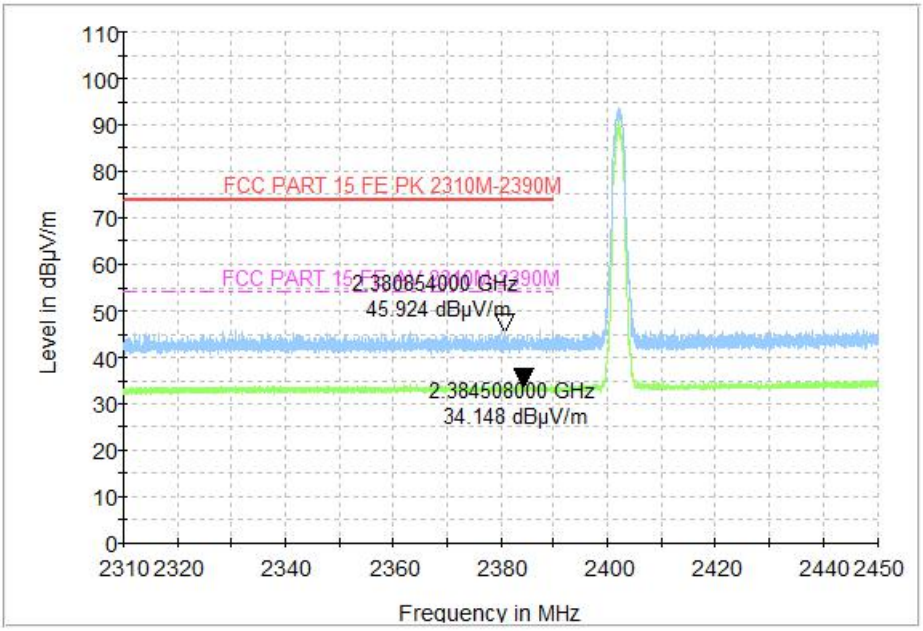

Fig. 50 Radiated Band Edges (π /4 DQPSK, Ch0, 2380GHz ~ 2450GHz)

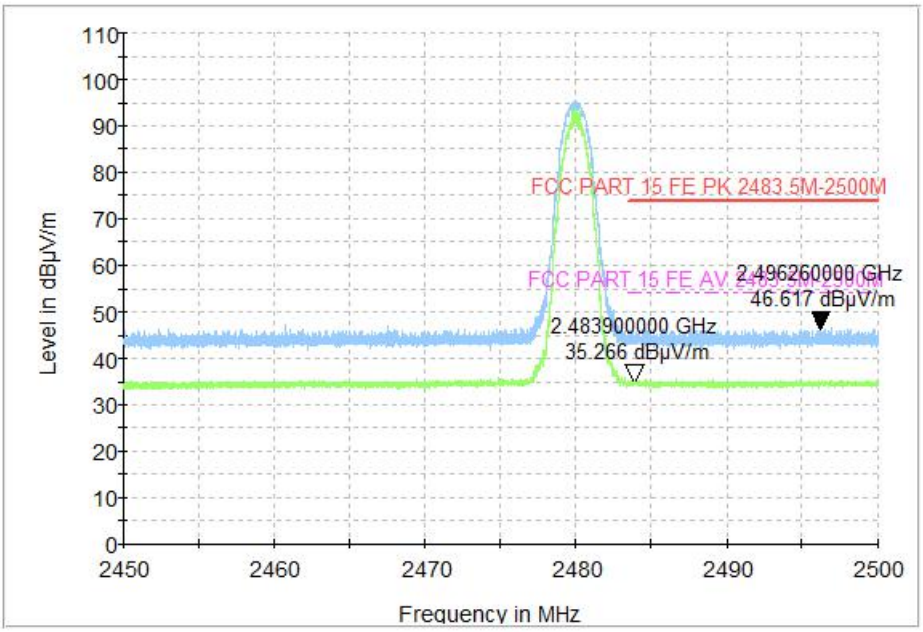

Fig. 51 Radiated Band Edges (π /4 DQPSK, Ch78, 2450GHz ~ 2500GHz)

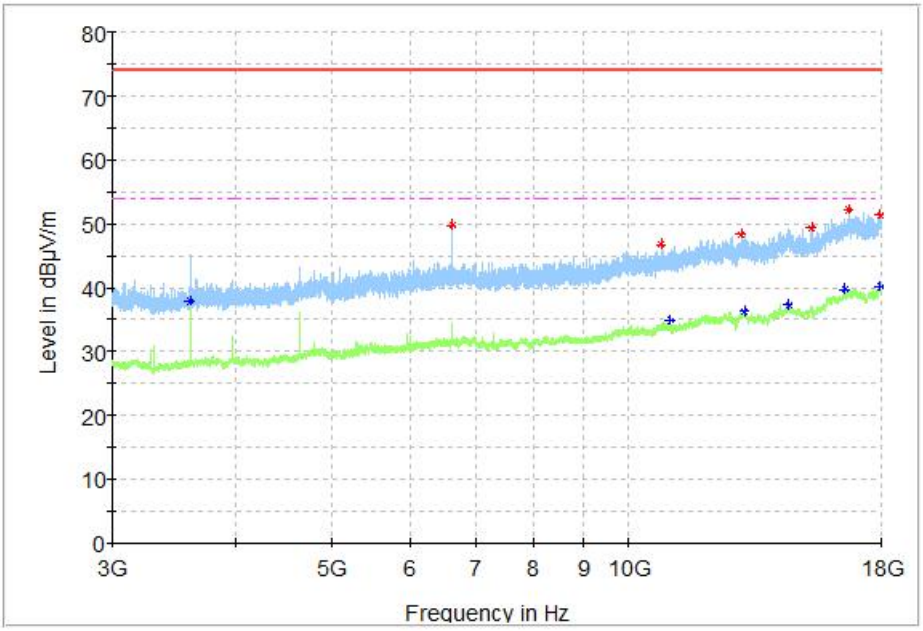

Fig. 52 Radiated Spurious Emission (8DPSK, Ch0, 3GHz ~ 18GHz)

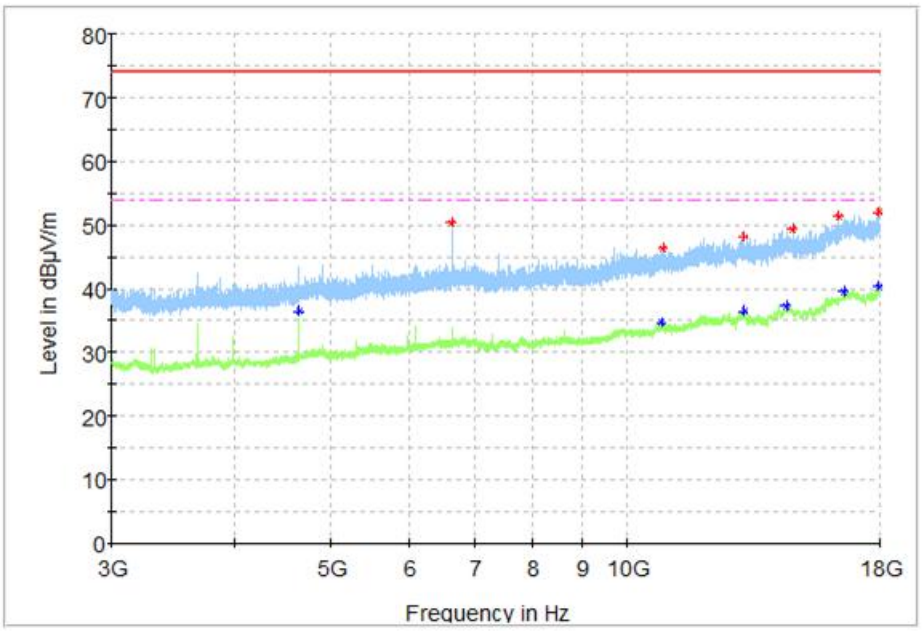

Fig. 53 Radiated Spurious Emission (8DPSK, Ch39, 3GHz ~ 18GHz)

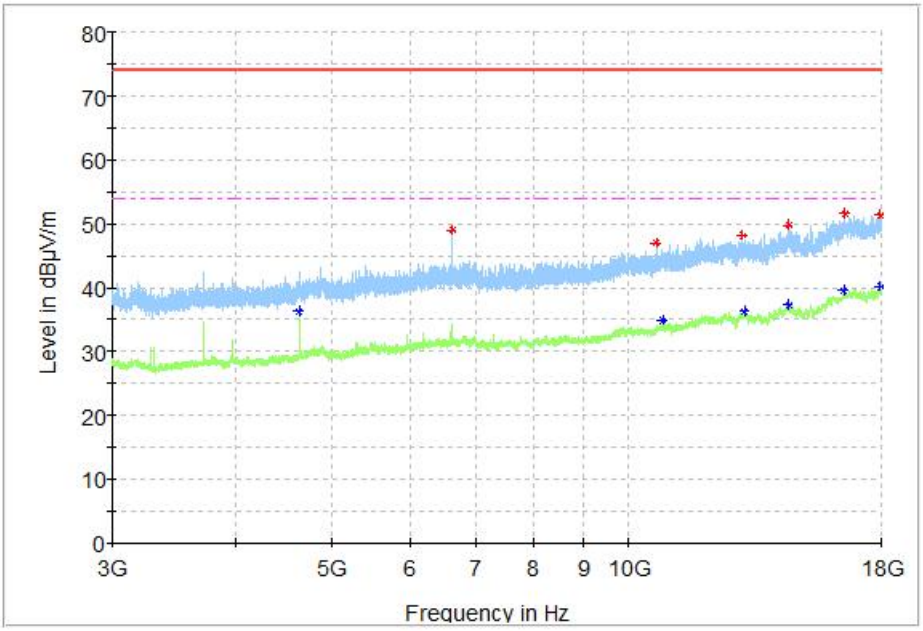

Fig. 54 Radiated Spurious Emission (8DPSK, Ch78, 3GHz ~ 18GHz)

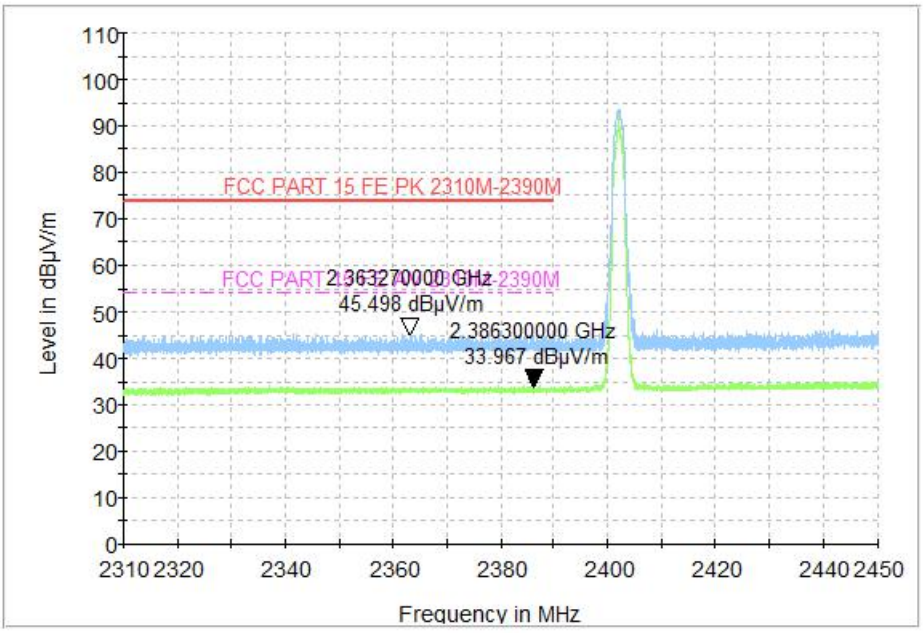

Fig. 55 Radiated Band Edges (8DPSK, Ch0, 2380GHz ~ 2450GHz)

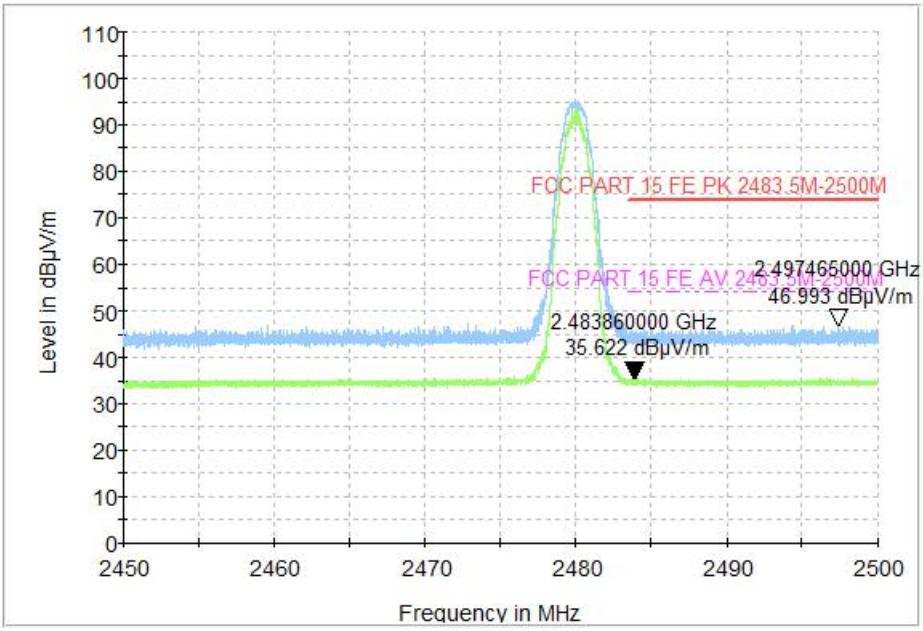

Fig. 56 Radiated Band Edges (8DPSK, Ch78, 2450GHz ~ 2500GHz)

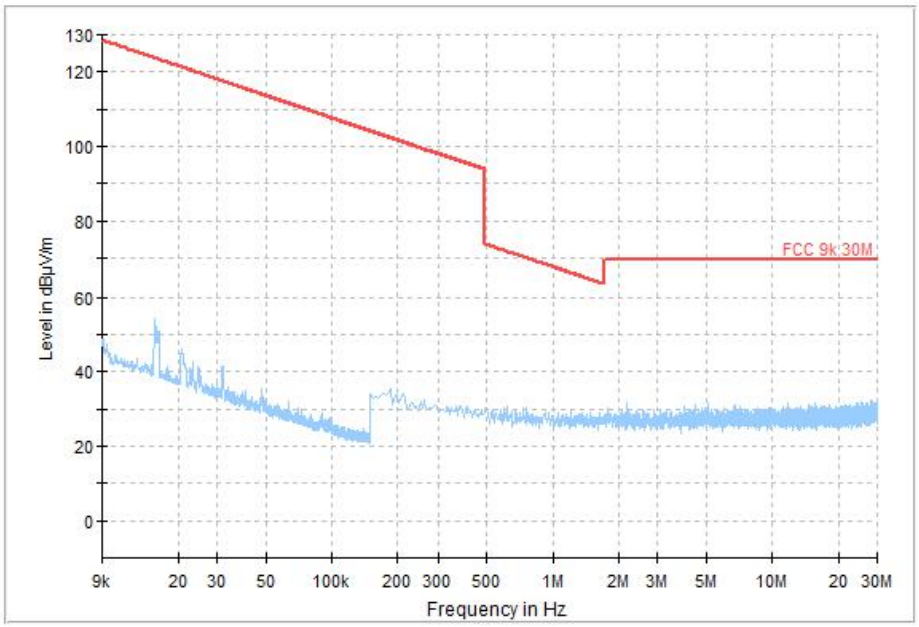

Fig. 57 Radiated Spurious Emission (All Channels, 9kHz ~ 30MHz)

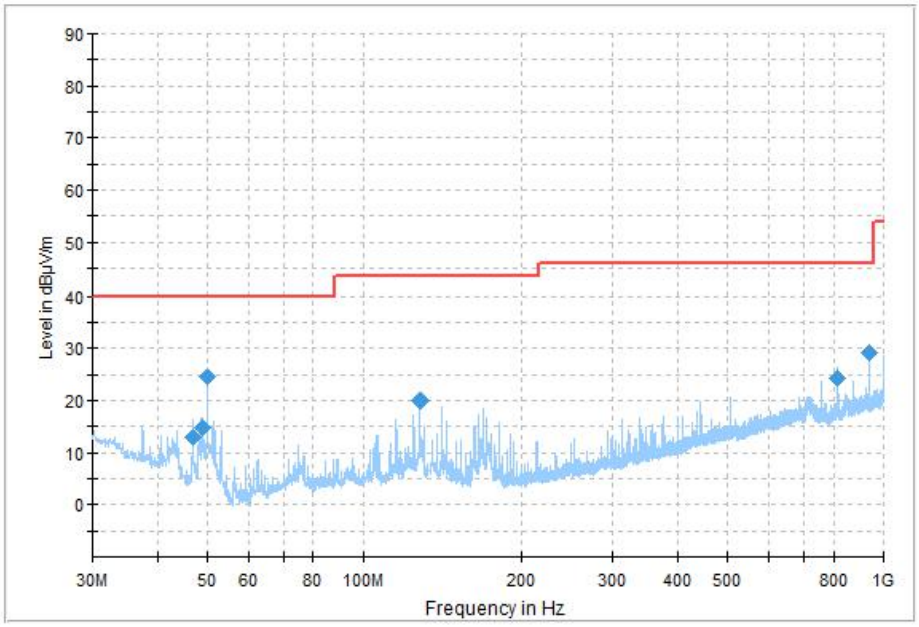

Fig. 58 Radiated Spurious Emission (All Channels, 30MHz ~ 1GHz)

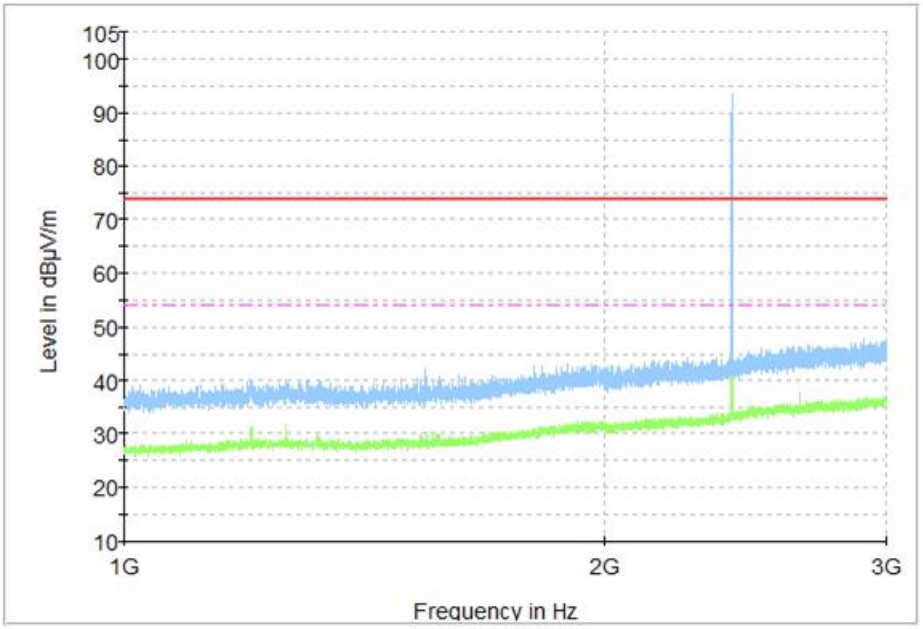

Fig. 59 Radiated Spurious Emission (All Channels, 1GHz ~ 3GHz)

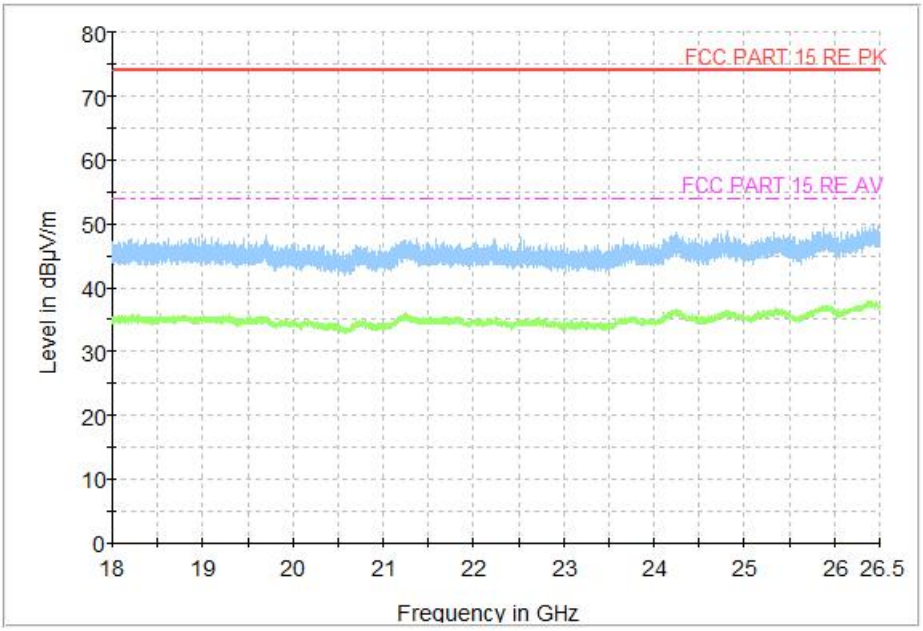

Fig. 60 Radiated Spurious Emission (All Channels, 18GHz ~ 26.5GHz)

A.5 20dB Bandwidth

Measurement Limit:

Standard	Limit (kHz)
FCC 47 CFR Part 15.247 (a)	/

Measurement Result:

Mode	Channel	20dB Bandwidth (kHz)		conclusion
GFSK	0	Fig.61	948.00	/
	39	Fig.62	950.25	
	78	Fig.63	1023.00	
π /4 DQPSK	0	Fig.64	1287.75	/
	39	Fig.65	1265.25	
	78	Fig.66	1263.00	
8DPSK	0	Fig.67	1284.00	/
	39	Fig.68	1282.50	
	78	Fig.69	1285.50	

See below for test graphs.

Conclusion: PASS

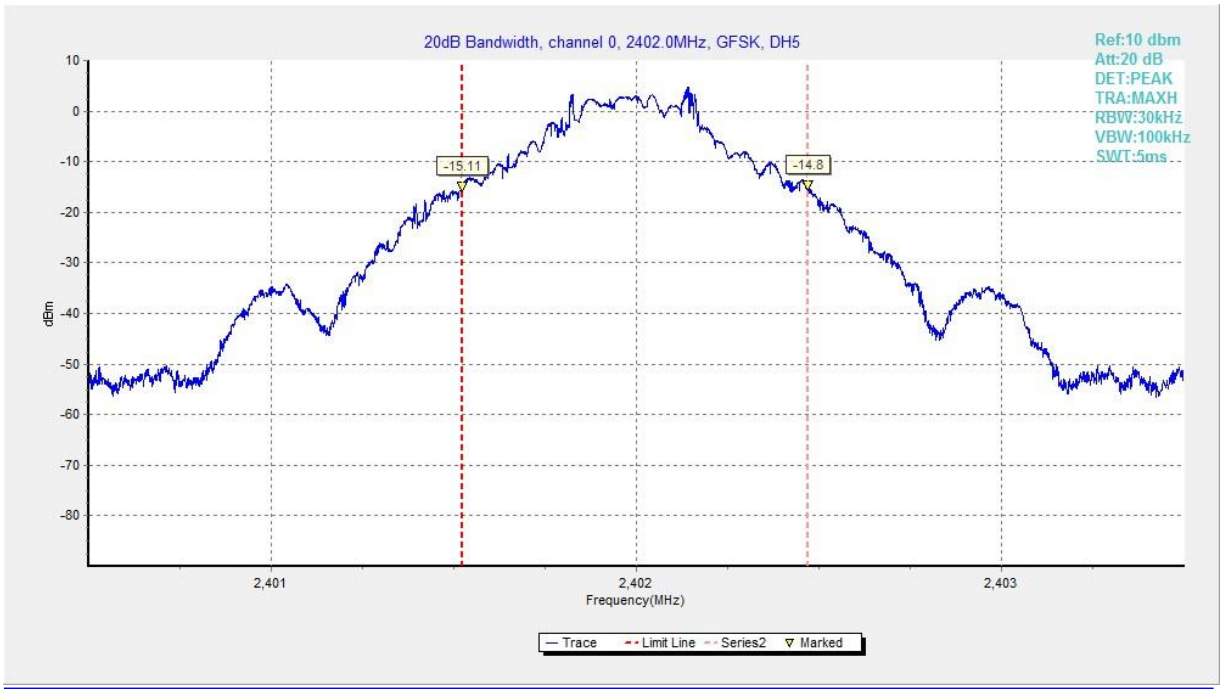

Fig. 61 20dB Bandwidth (GFSK, Ch 0)

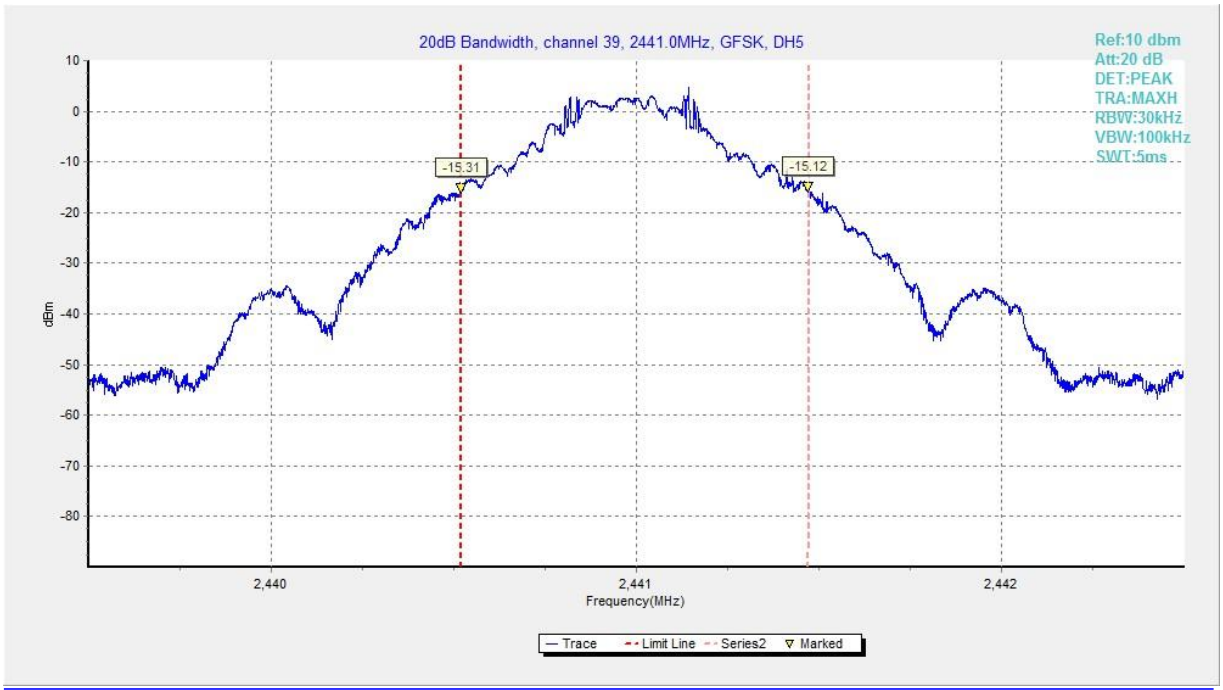

Fig. 62 20dB Bandwidth (GFSK, Ch 39)

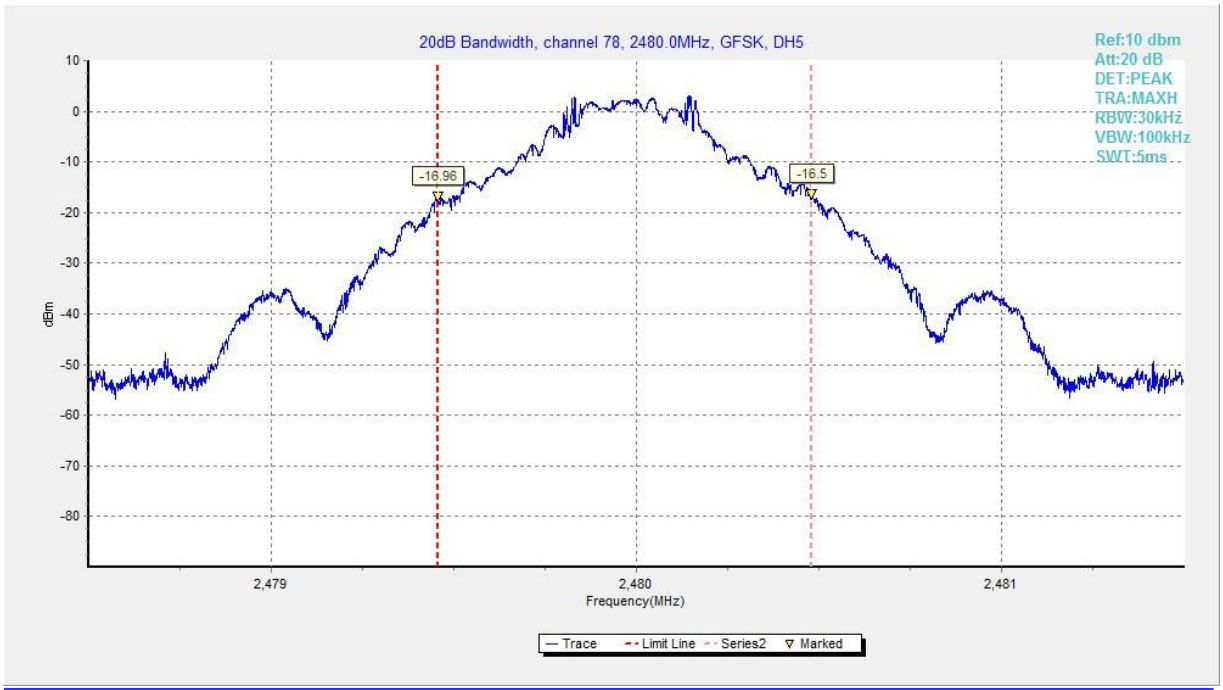

Fig. 63 20dB Bandwidth (GFSK, Ch 78)

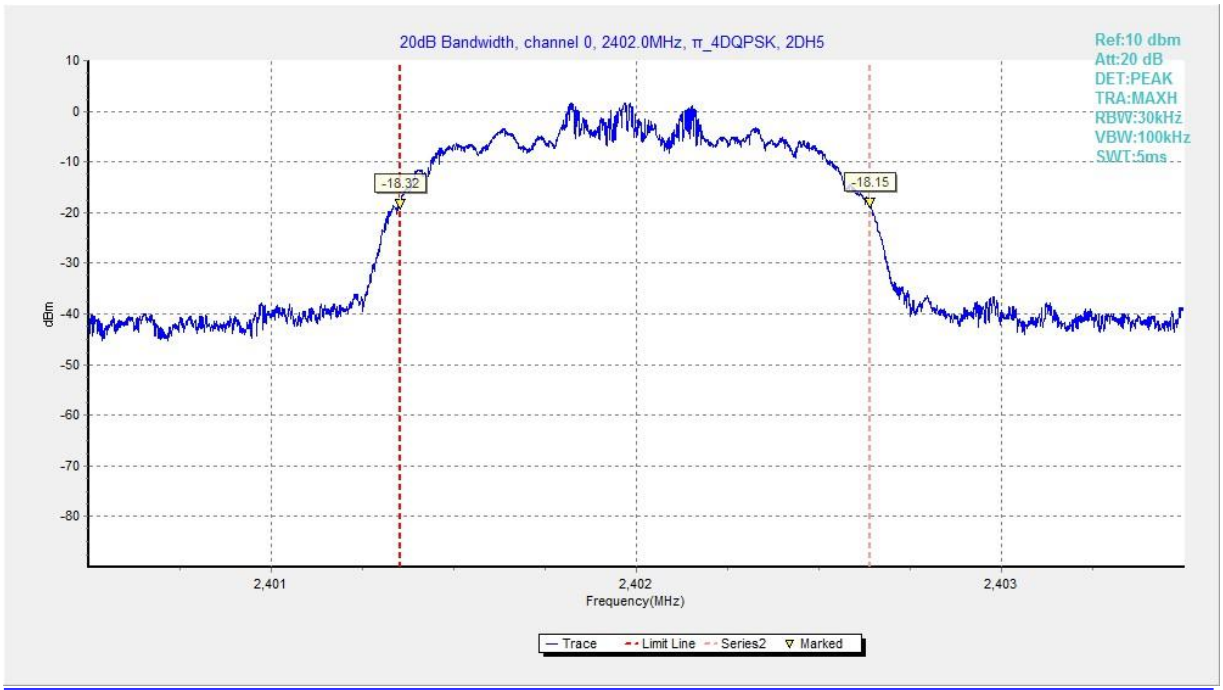

Fig. 64 20dB Bandwidth (π /4 DQPSK, Ch 0)

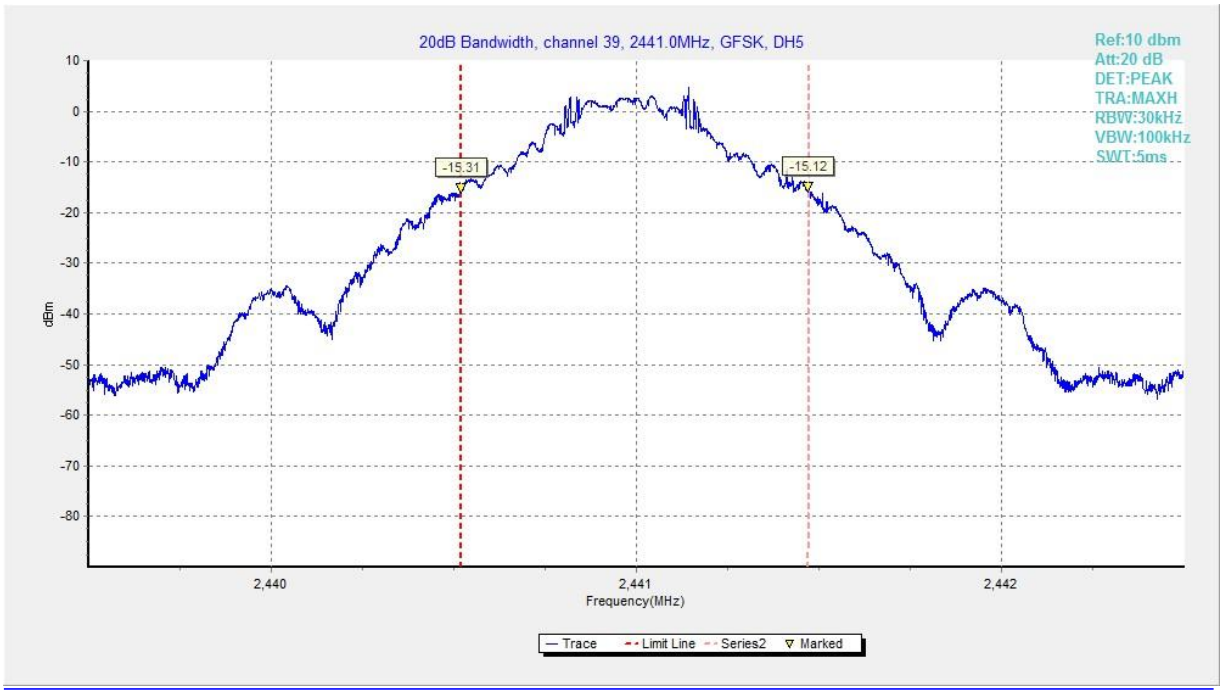

Fig. 65 20dB Bandwidth (π /4 DQPSK, Ch 39)

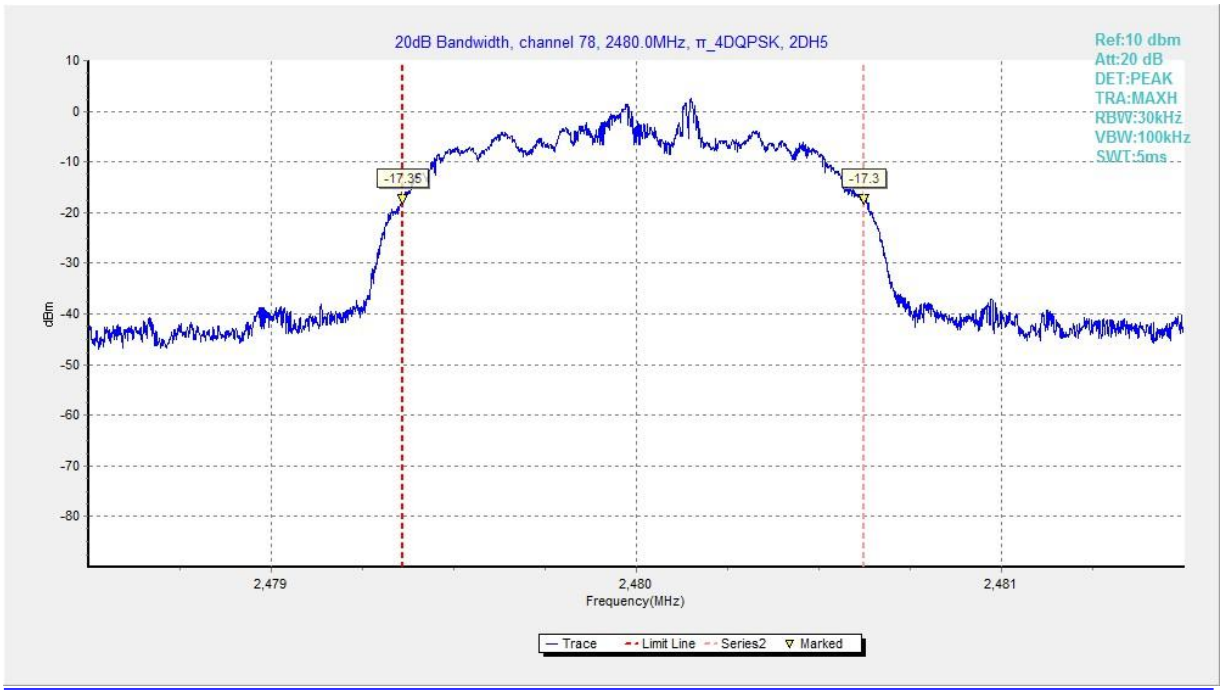

Fig. 66 20dB Bandwidth (π /4 DQPSK, Ch 78)

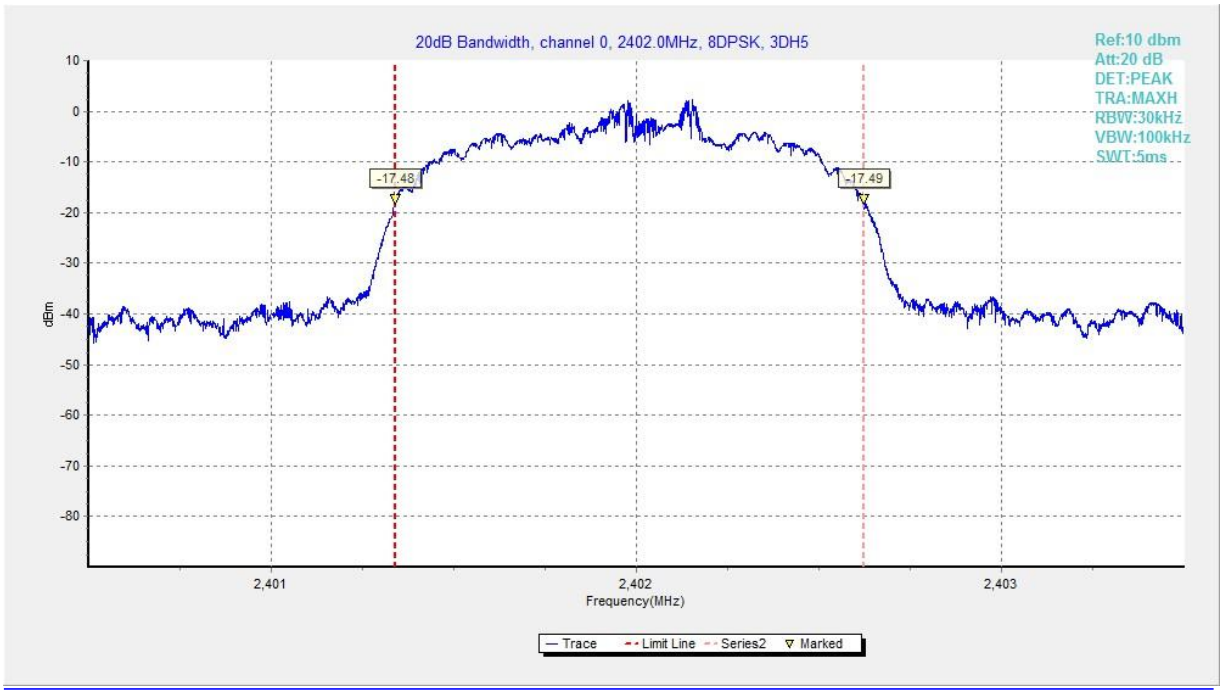

Fig. 67 20dB Bandwidth (8DPSK, Ch 0)

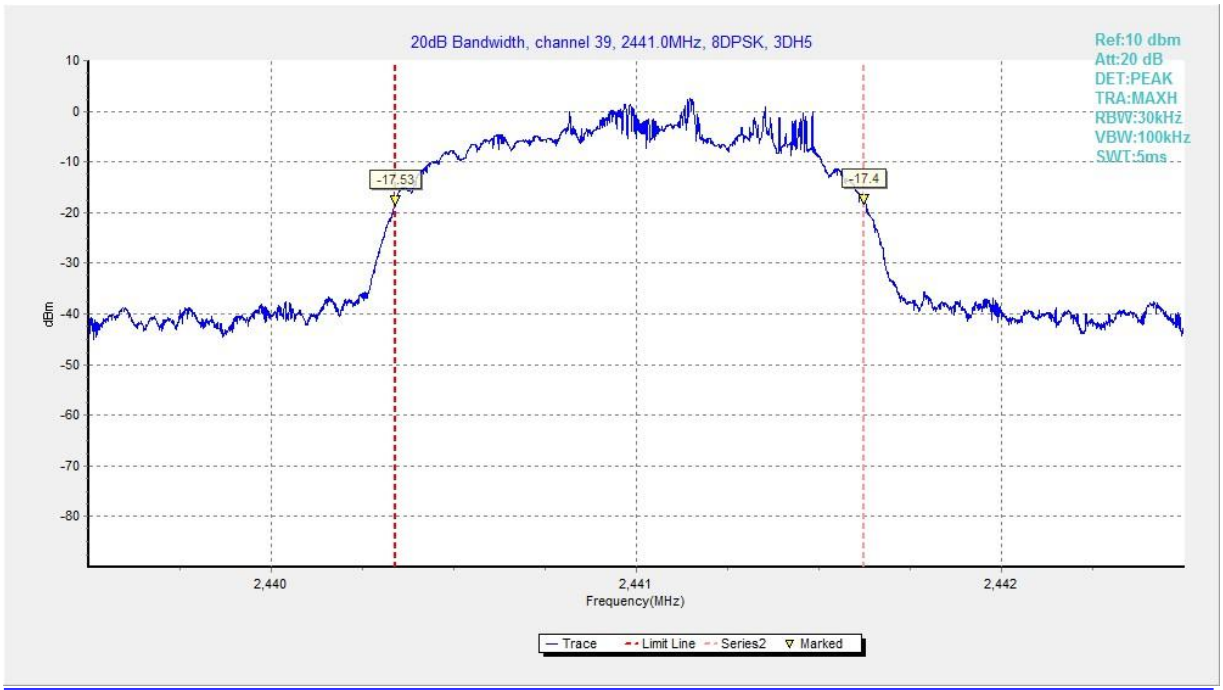

Fig. 68 20dB Bandwidth (8DPSK, Ch 39)

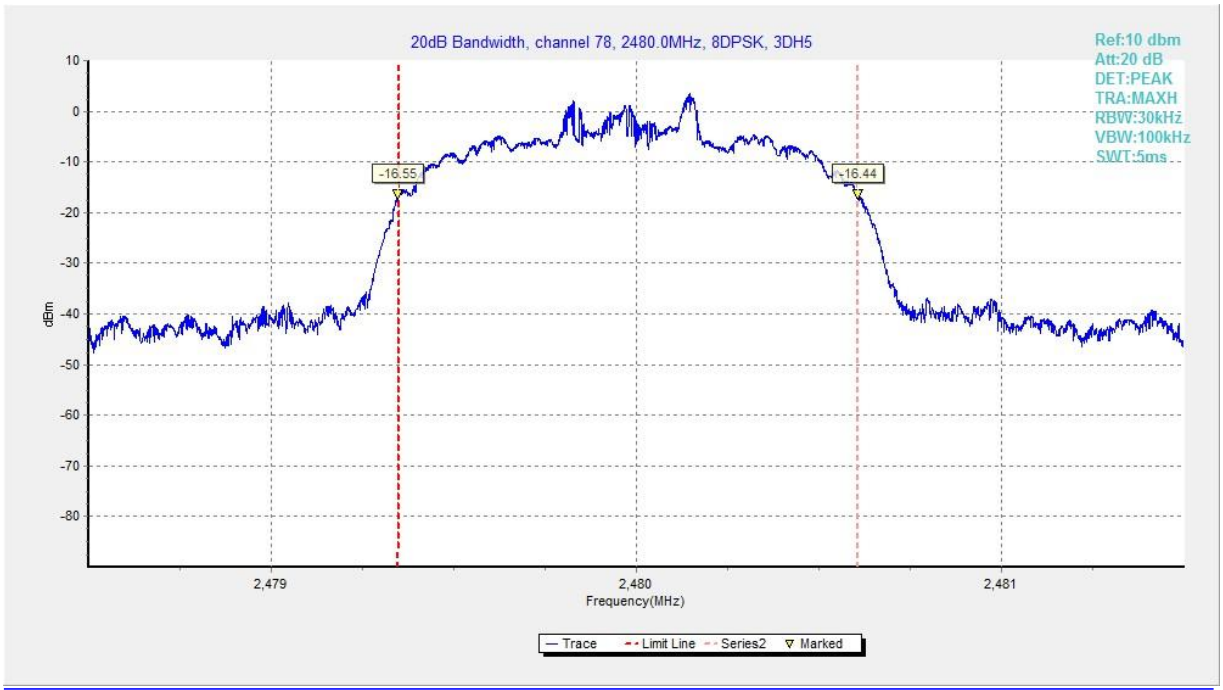

Fig. 69 20dB Bandwidth (8DPSK, Ch 78)

A.6 Time of Occupancy (Dwell Time)

Measurement Limit:

Standard	Limit
FCC 47 CFR Part 15.247 (a)	< 400 ms

Measurement Results:

Mode	Channel	Packet	Dwell Time(ms)		Conclusion
GFSK	39	DH5	Fig.70	135.44	**P**
			Fig.71		
π /4 DQPSK	39	2-DH5	Fig.72	147.14	**P**
			Fig.73		
8DPSK	39	3-DH5	Fig.74	169.88	**P**
			Fig.75		

See below for test graphs.

Conclusion: Pass

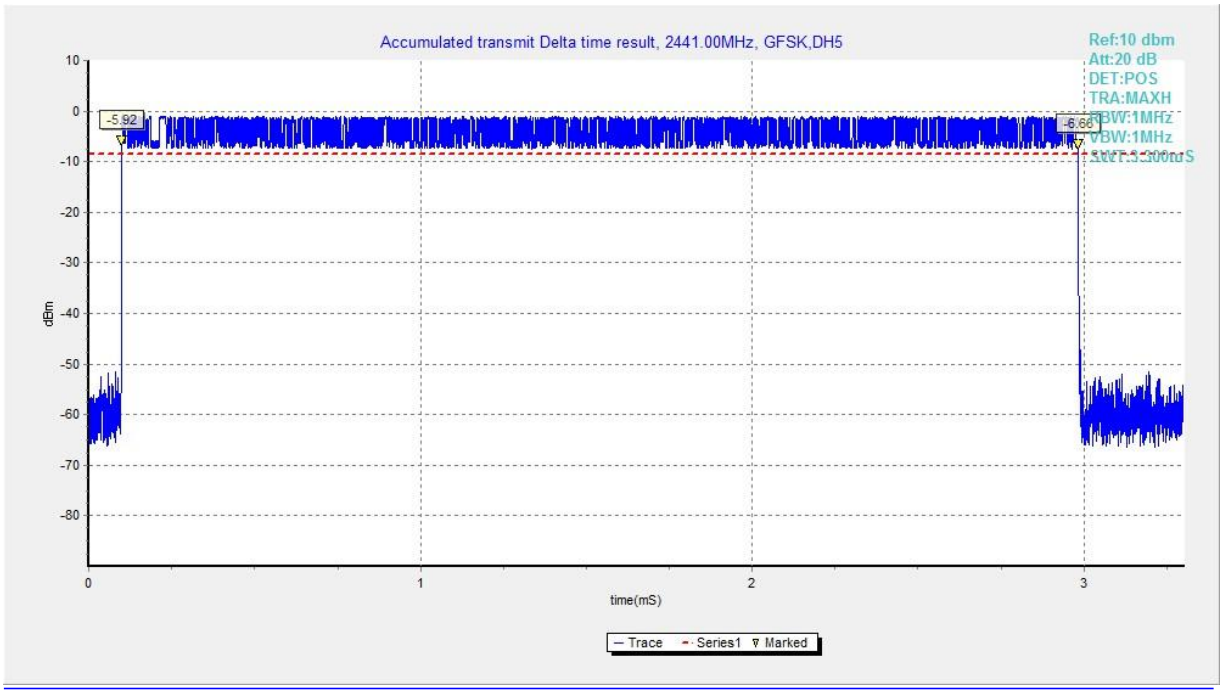

Fig. 70 Time of Occupancy (Dwell Time) (GFSK, Ch39)

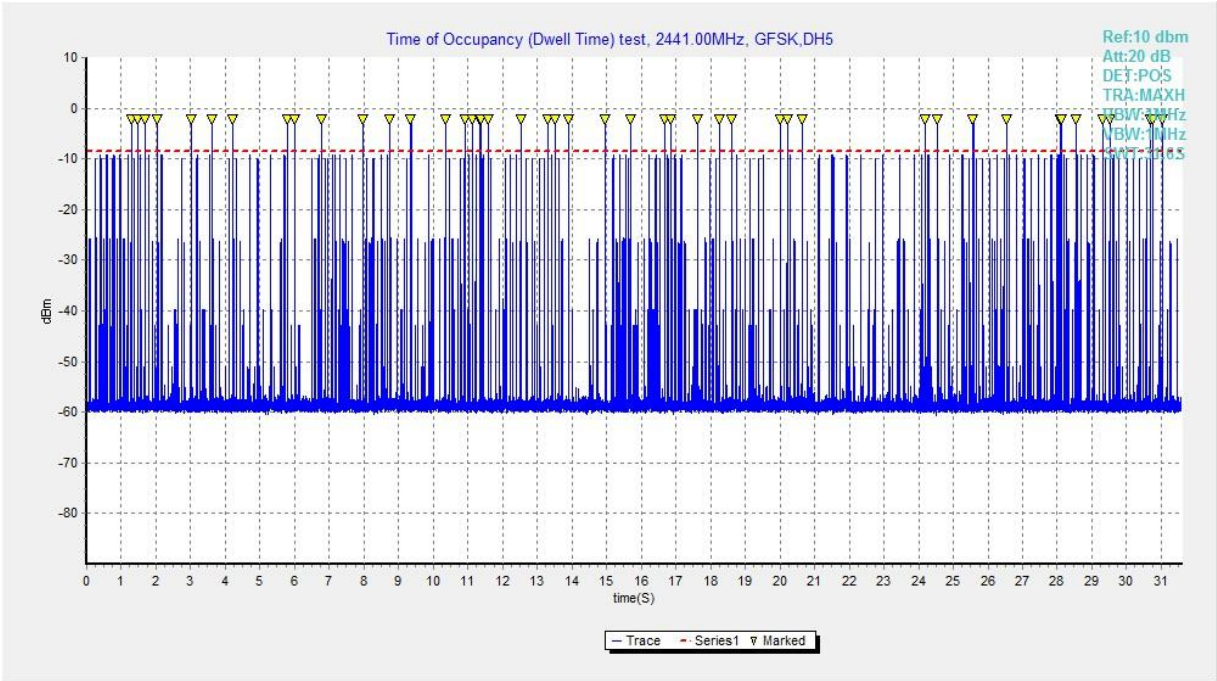

Fig. 71 Time of Occupancy (Dwell Time) (GFSK, Ch39)

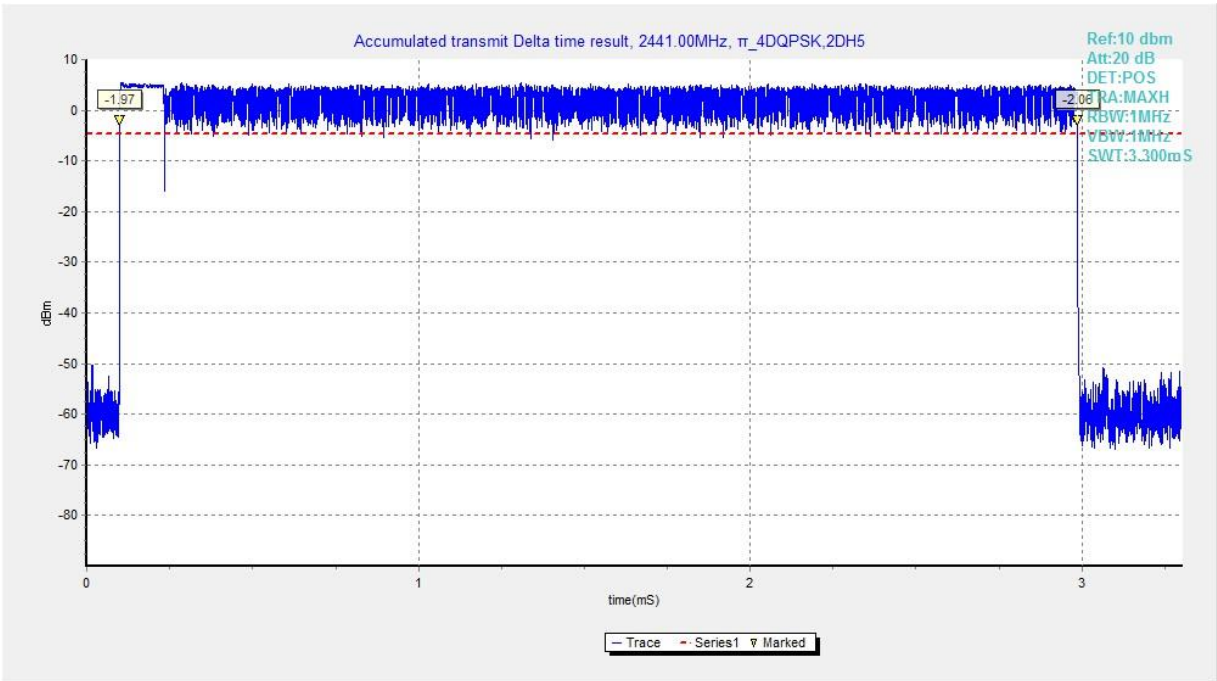

Fig. 72 Time of Occupancy (Dwell Time) (π /4 DQPSK, Ch39)

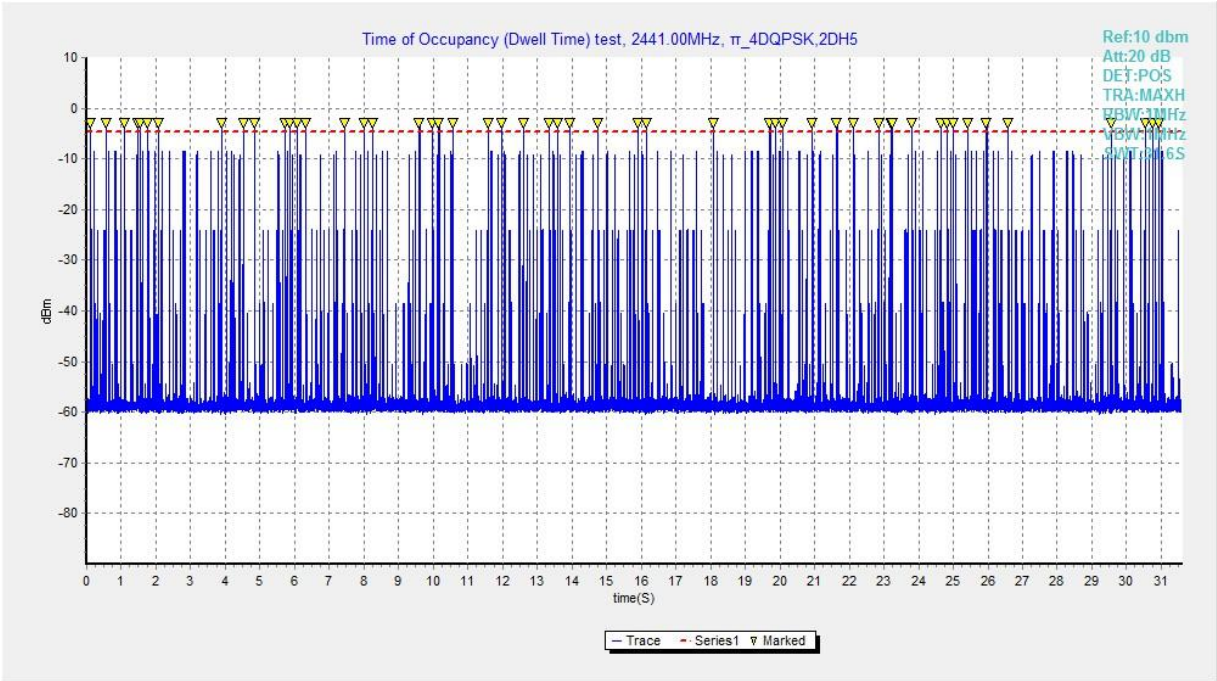

Fig. 73 Time of Occupancy (Dwell Time) (π /4 DQPSK, Ch39)

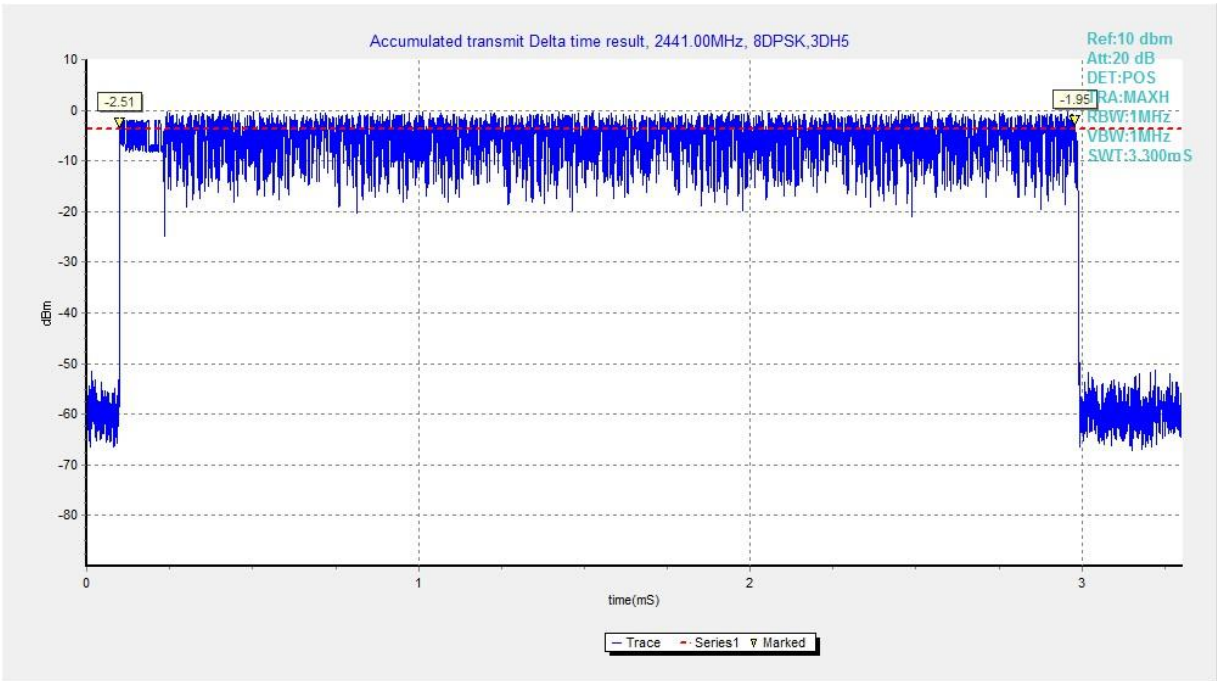

Fig. 74 Time of Occupancy (Dwell Time) (8DPSK, Ch39)

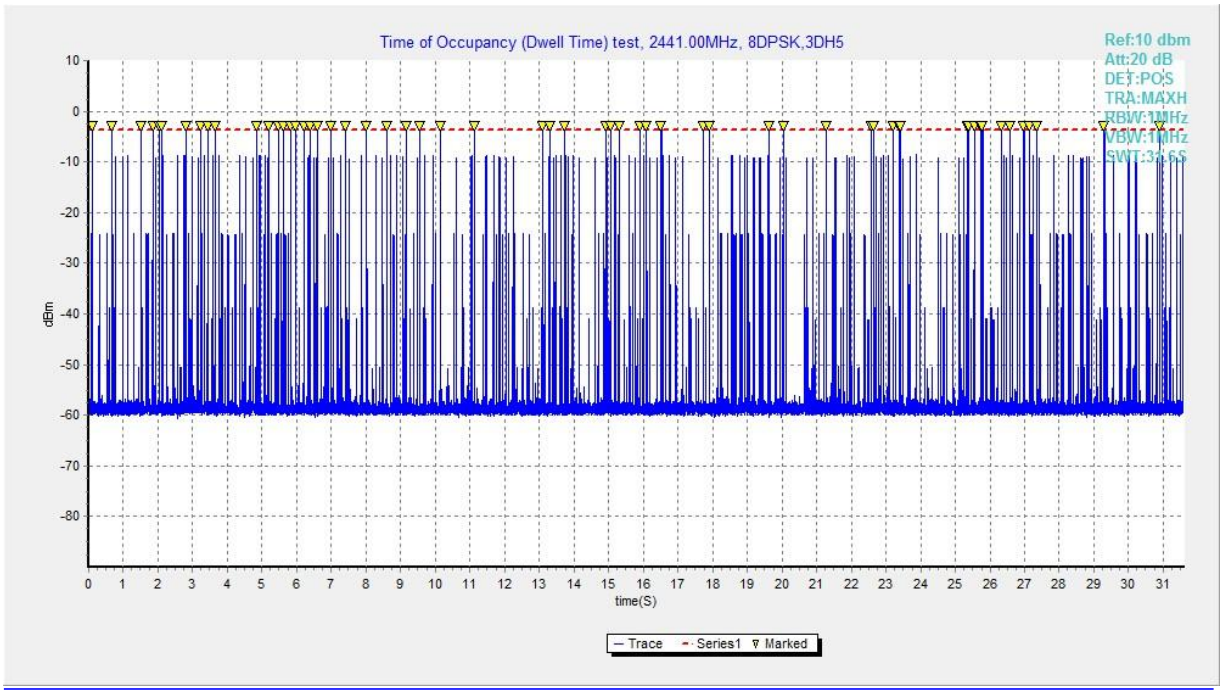

Fig. 75 Time of Occupancy (Dwell Time) (8DPSK, Ch39)

A.7 Number of Hopping Channels

Measurement Limit:

Standard	Limit
FCC 47 CFR Part 15.247(a)	At least 15 non-overlapping channels

Measurement Results:

Mode	Packet	Number of hopping channels		Test result	Conclusion
GFSK	DH5	Fig.76	Fig.77	79	**P**
π /4 DQPSK	2-DH5	Fig.78	Fig.79	79	**P**
8DPSK	3-DH5	Fig.80	Fig.81	79	**P**

See below for test graphs.

Conclusion: Pass

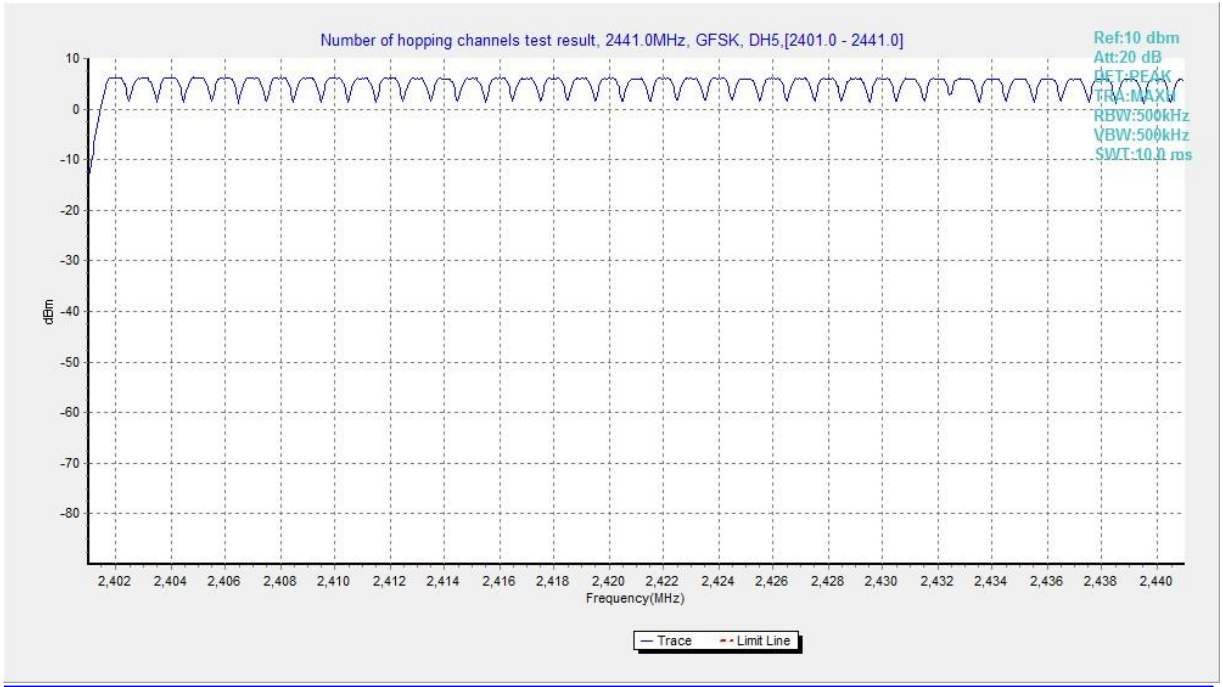

Fig. 76 Hopping channel ch0~39 (GFSK, Ch39)

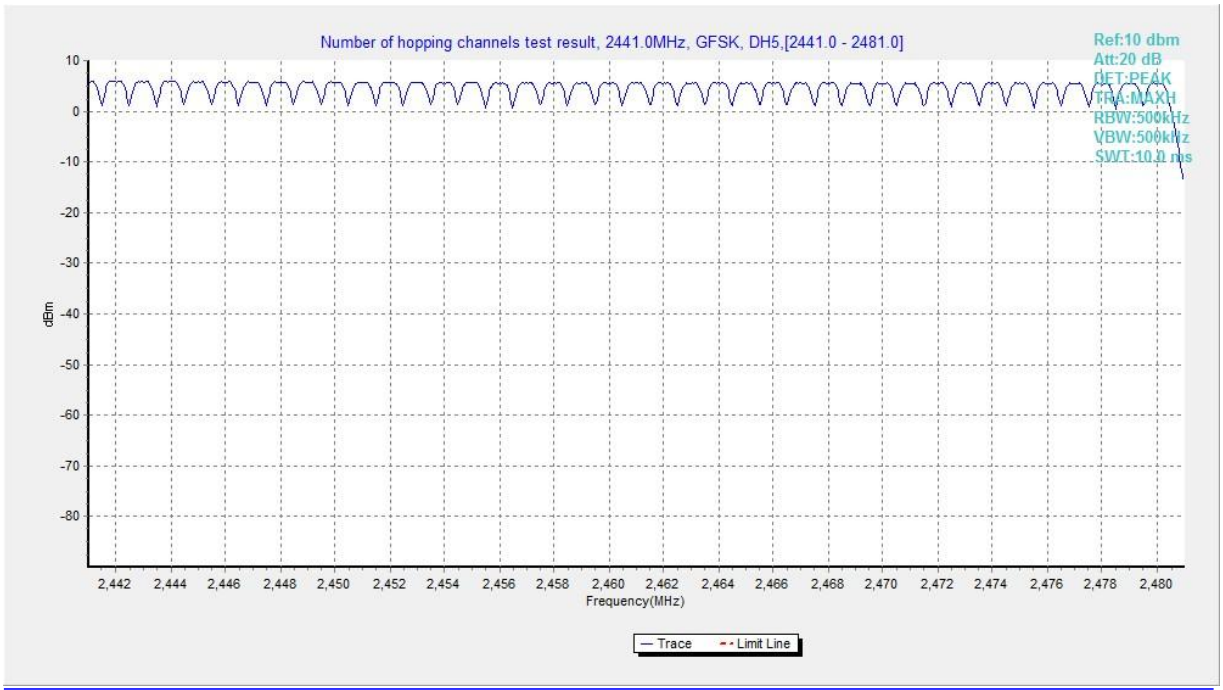

Fig. 77 Hopping channel ch40~78 (GFSK, Ch39)

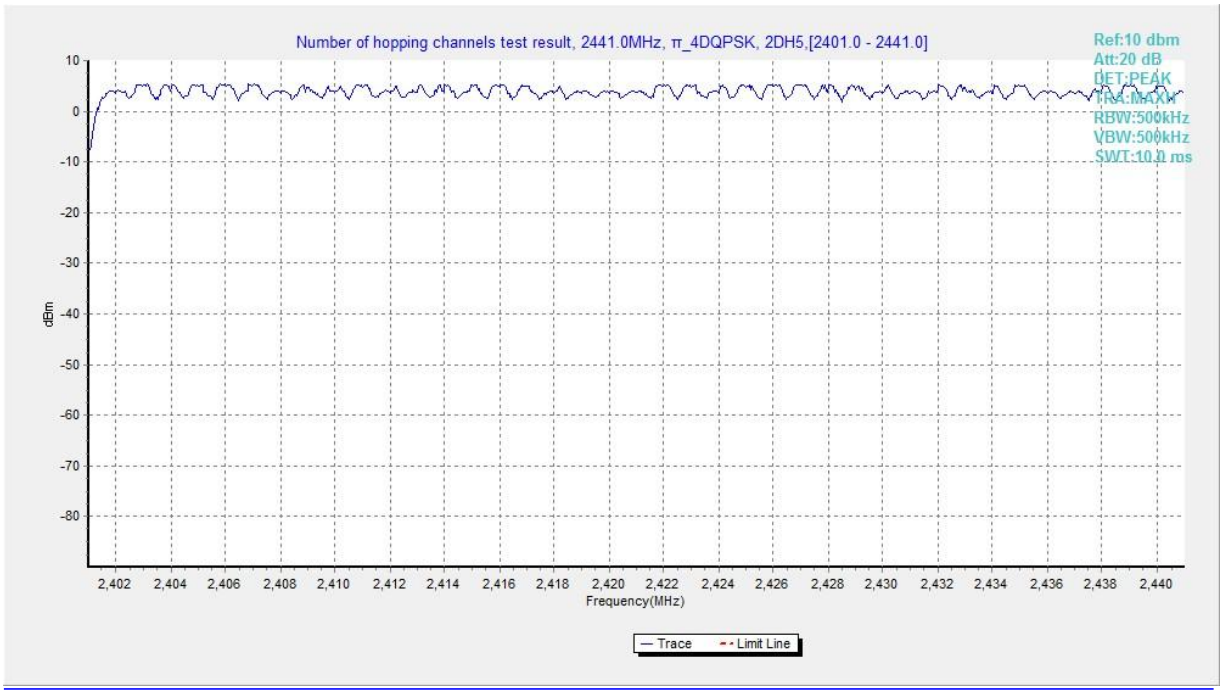

Fig. 78 Hopping channel ch0~39 (π /4 DQPSK, Ch39)

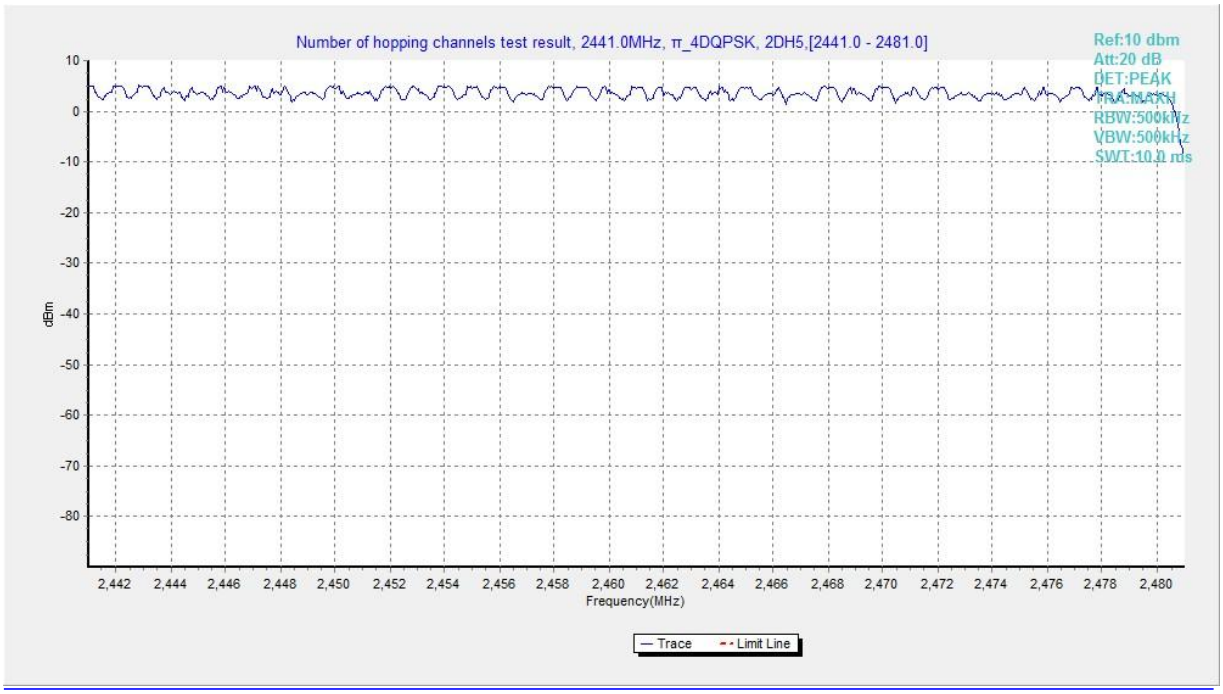

Fig. 79 Hopping channel ch40~78 (π /4 DQPSK, Ch39)

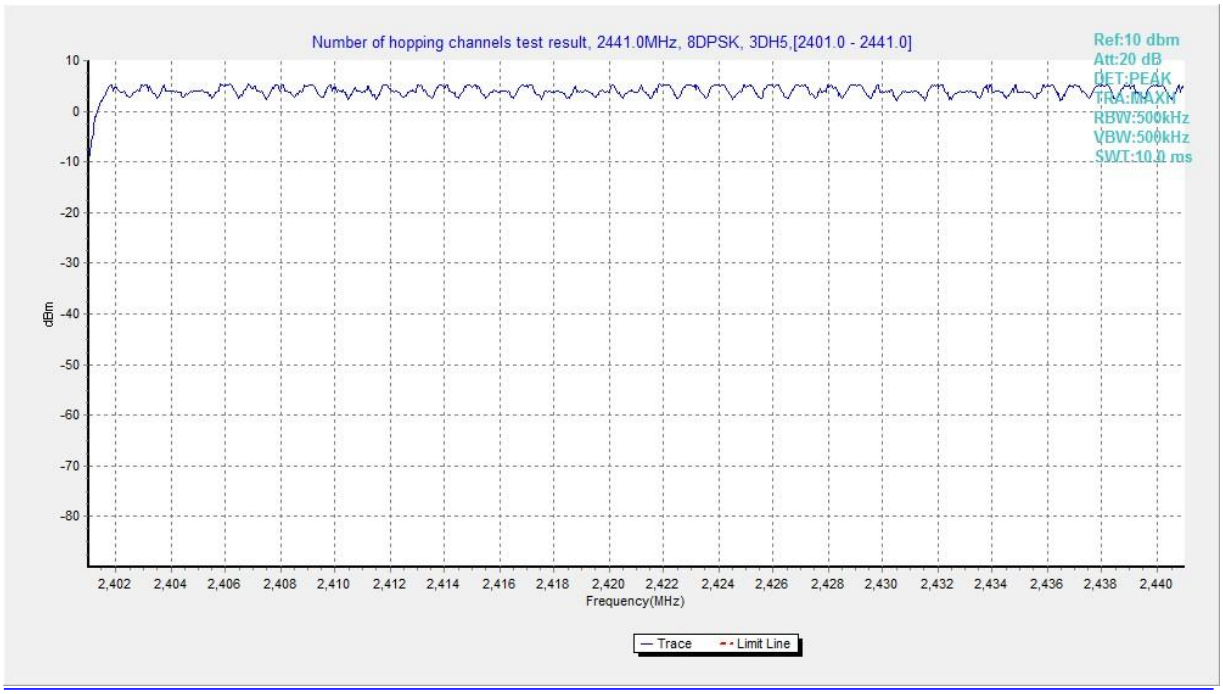

Fig. 80 Hopping channel ch0~39 (8DPSK, Ch39)

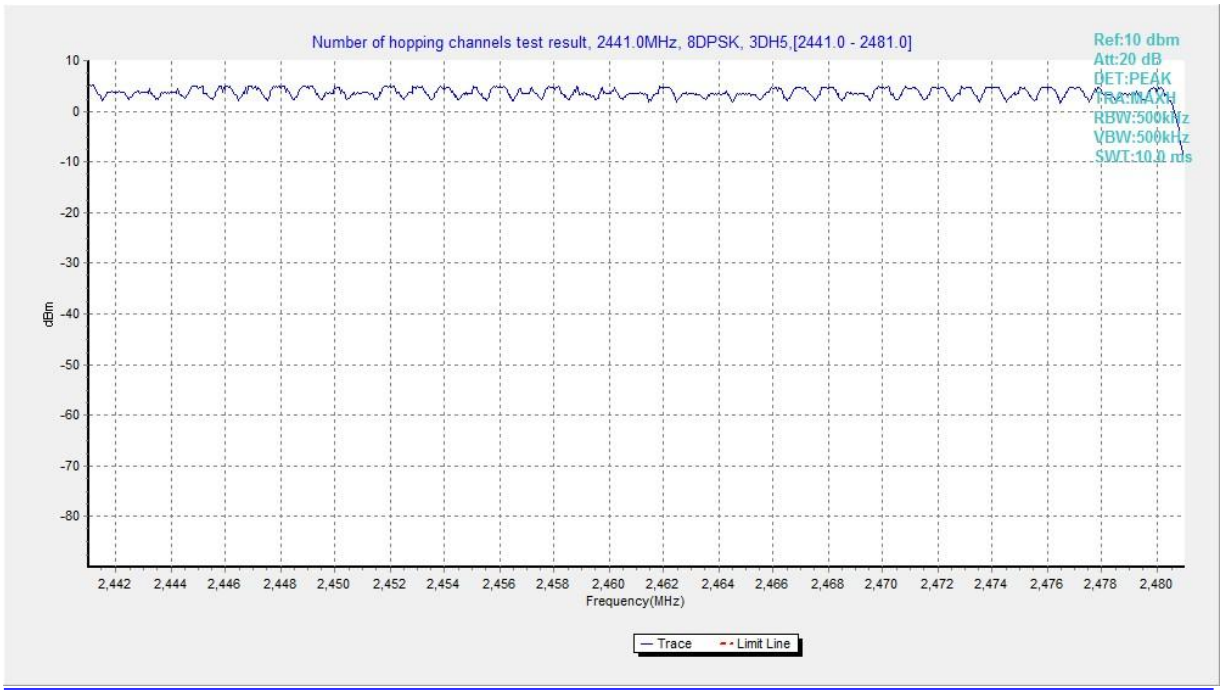

Fig. 81 Hopping channel ch40~78 (8DPSK, Ch39)

A.8 Carrier Frequency Separation

Measurement Limit:

Standard	Limit
FCC 47 CFR Part 15.247(a)	By a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater

Measurement Results:

Mode	Channel	Packet	Separation of hopping channels	Test result (MHz)	Conclusion
GFSK	39	DH5	Fig.82	1.00	**P**
π /4 DQPSK	39	2-DH5	Fig.83	1.00	**P**
8DPSK	39	3-DH5	Fig.84	1.00	**P**

See below for test graphs.

Conclusion: Pass

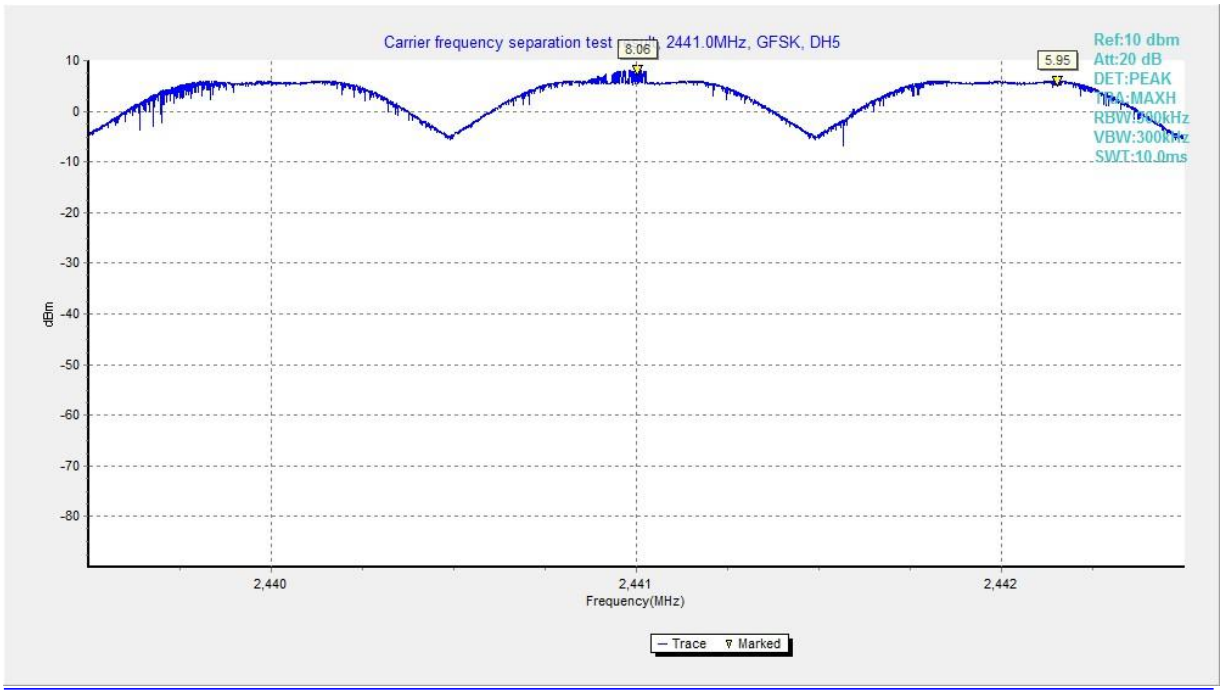

Fig. 82 Carrier Frequency Separation (GFSK, Ch39)

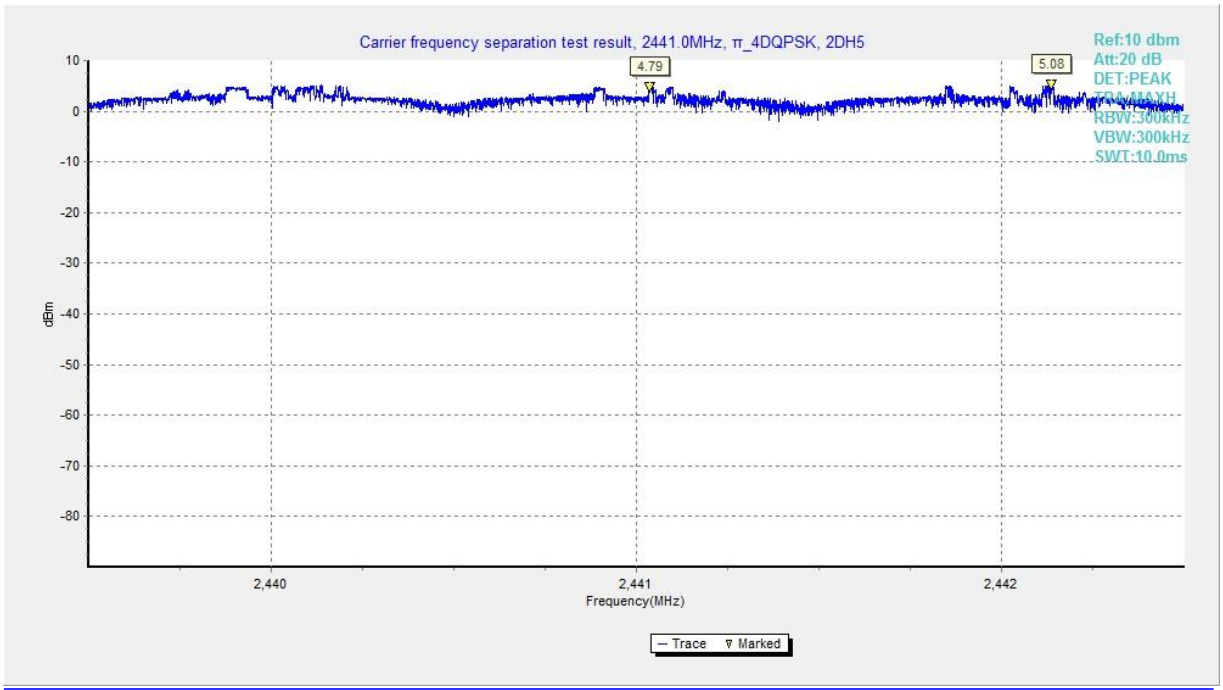

Fig. 83 Carrier Frequency Separation (π /4 DQPSK, Ch39)

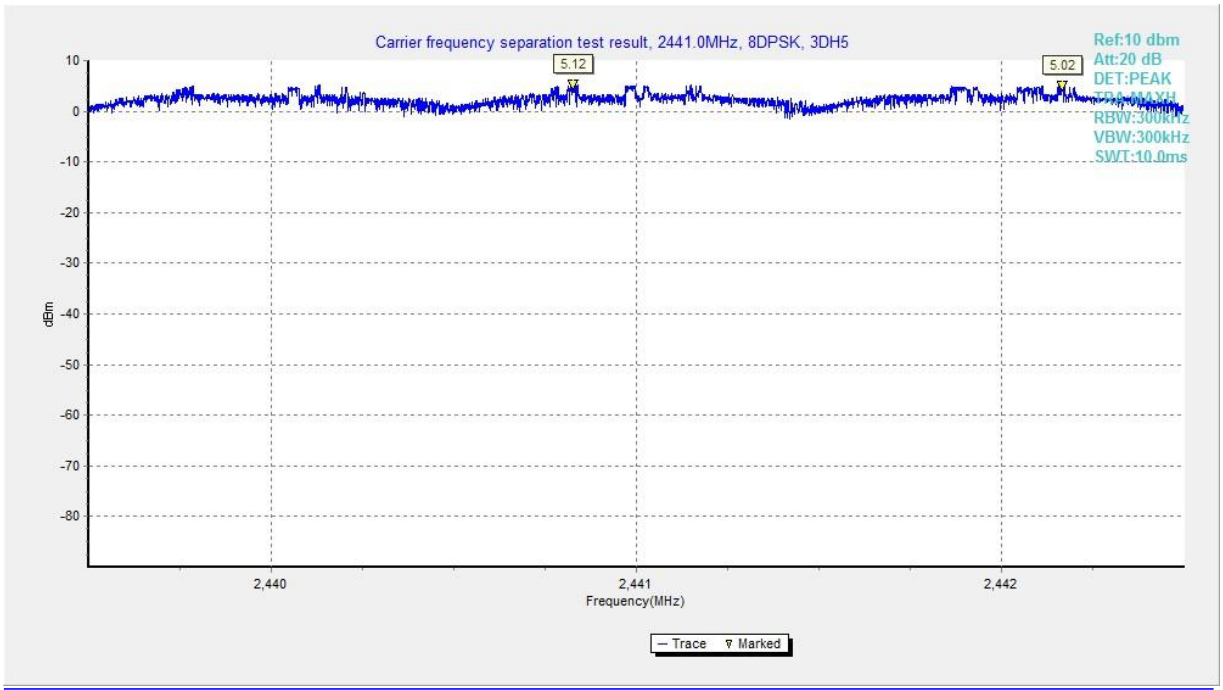

Fig. 84 Carrier Frequency Separation (8DPSK, Ch39)

A.9 AC Power line Conducted Emission

Test Condition:

Voltage (V)	Frequency (Hz)
120	60

Measurement Result and limit:

BT (Quasi-peak Limit) - AE2

Frequency range (MHz)	Quasi-peak Limit (dBμV)	Result (dBμV)		Conclusion
		Traffic	Idle	
0.15 to 0.5	66 to 56	Fig.85	Fig.86	P
0.5 to 5	56			
5 to 30	60			
Note: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz.				

BT (Average Limit) - AE2

Frequency range (MHz)	Average-peak Limit (dBμV)	Result (dBμV)		Conclusion
		Traffic	Idle	
0.15 to 0.5	56 to 46	Fig.85	Fig.86	P
0.5 to 5	46			
5 to 30	50			
Note: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz.				

Note: The measurement results include the L1 and N measurements.

See below for test graphs.

Conclusion: Pass

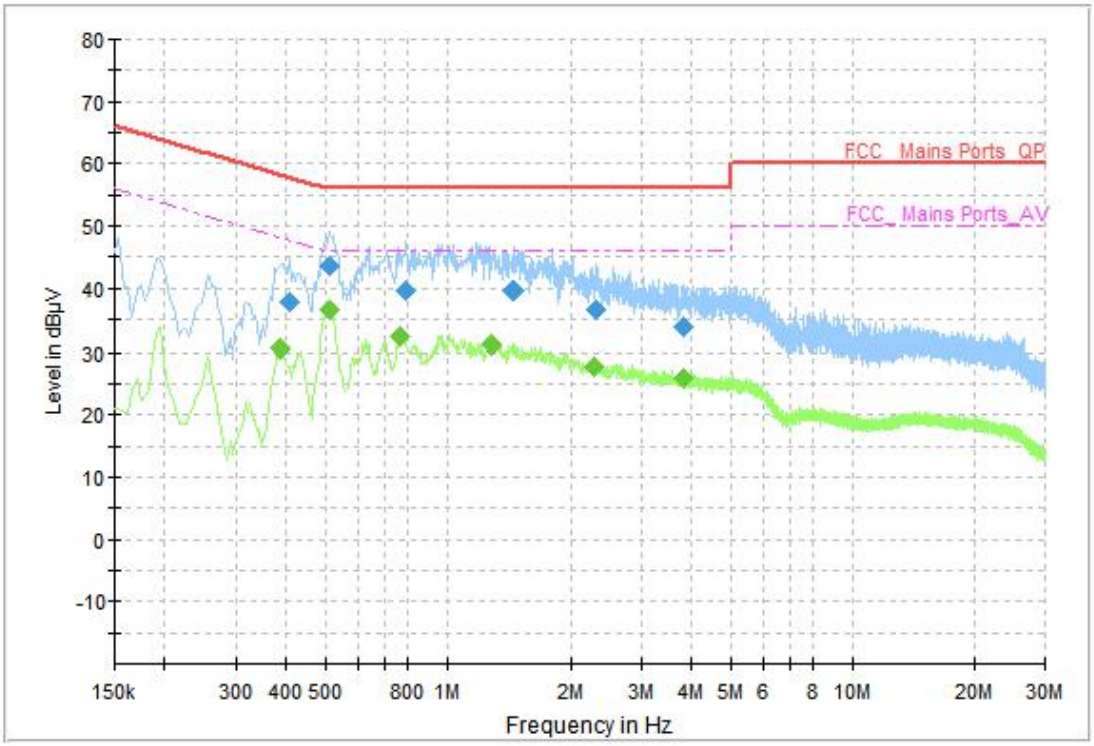

Fig. 85 AC Powerline Conducted Emission (Traffic, AE2, 120V)

Measurement Results: Quasi Peak

Frequency (MHz)	Quasi Peak (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.406000	37.85	57.73	19.88	N	ON	10
0.510000	43.56	56.00	12.44	N	ON	10
0.790000	39.56	56.00	16.44	L1	ON	10
1.446000	39.69	56.00	16.31	N	ON	10
2.302000	36.68	56.00	19.32	N	ON	10
3.818000	33.69	56.00	22.31	N	ON	10

Measurement Results: Average

Frequency (MHz)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.386000	30.56	48.15	17.59	N	ON	10
0.510000	36.53	46.00	9.47	N	ON	10
0.766000	32.44	46.00	13.56	N	ON	10
1.286000	31.09	46.00	14.91	N	ON	10
2.282000	27.82	46.00	18.18	N	ON	10
3.814000	25.72	46.00	20.28	N	ON	10

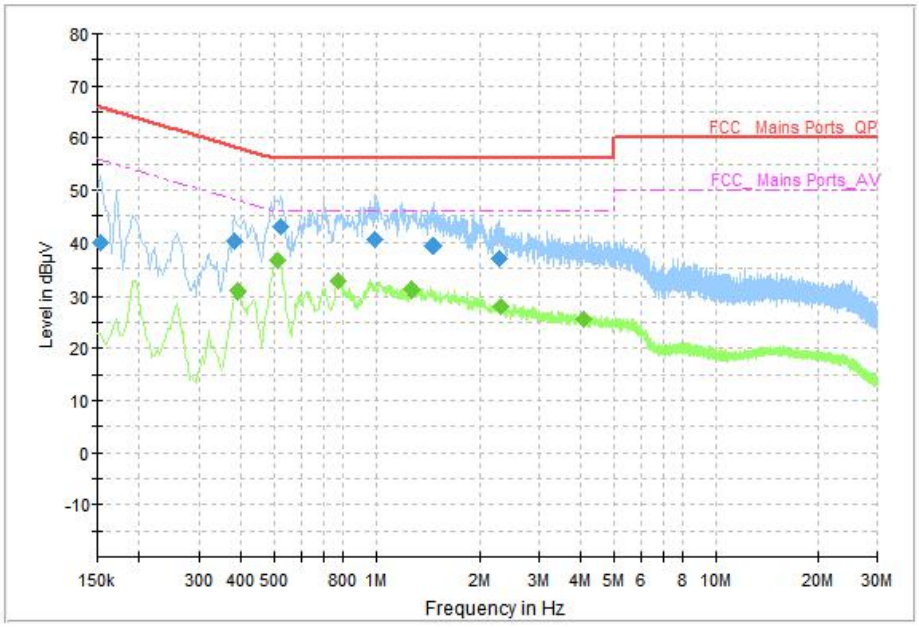

Fig. 86 AC Power line Conducted Emission (Idle, AE2, 120V)

Measurement Results: Quasi Peak

Frequency (MHz)	Quasi Peak (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.154000	39.81	65.78	25.97	N	ON	10
0.382000	40.11	58.24	18.13	N	ON	10
0.522000	43.04	56.00	12.96	L1	ON	10
0.994000	40.43	56.00	15.57	N	ON	10
1.466000	39.42	56.00	16.58	N	ON	10
2.294000	36.78	56.00	19.22	N	ON	10

Measurement Results: Average

Frequency (MHz)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.390000	30.75	48.06	17.32	N	ON	10
0.514000	36.49	46.00	9.51	N	ON	10
0.770000	32.75	46.00	13.25	N	ON	10
1.274000	30.96	46.00	15.04	N	ON	10
2.302000	27.89	46.00	18.11	N	ON	10
4.062000	25.65	46.00	20.35	N	ON	10

*****END OF REPORT*****