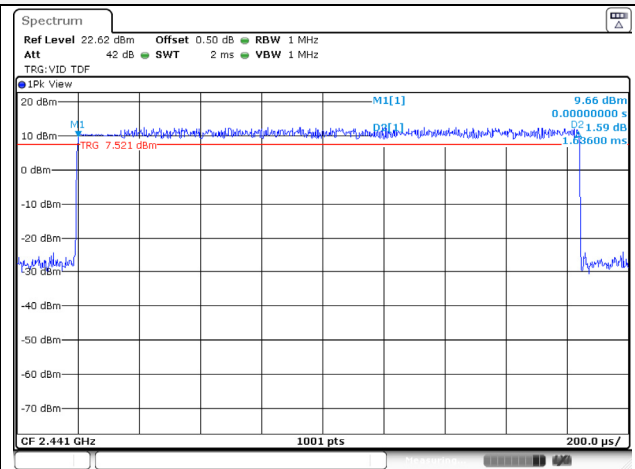
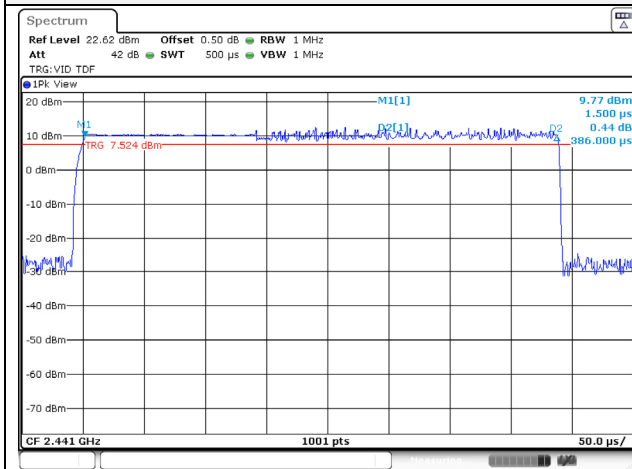
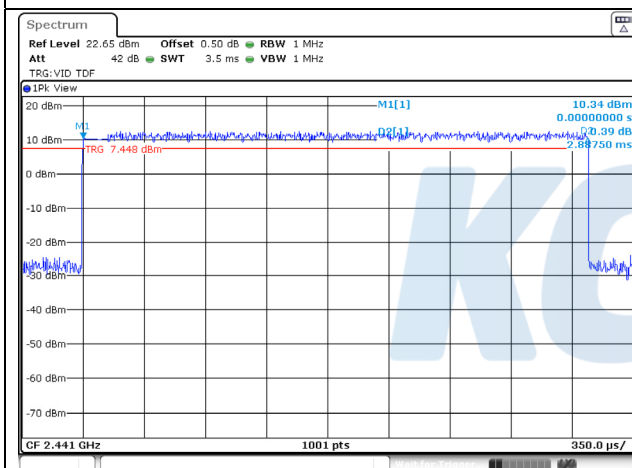


Non-AFH(8DPSK)



3-DH1

3-DH3



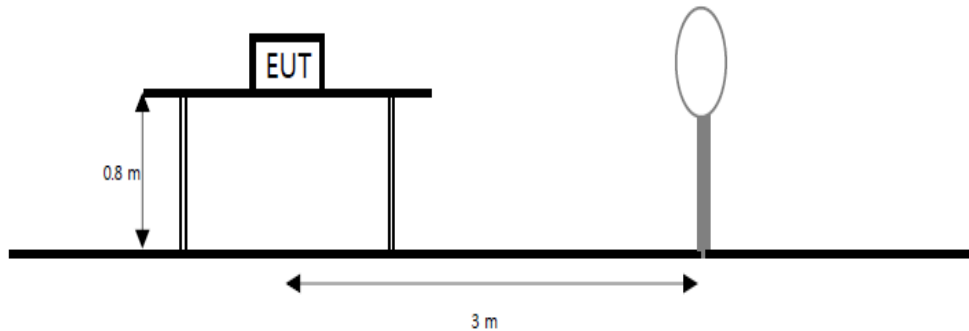
Blank

3-DH5

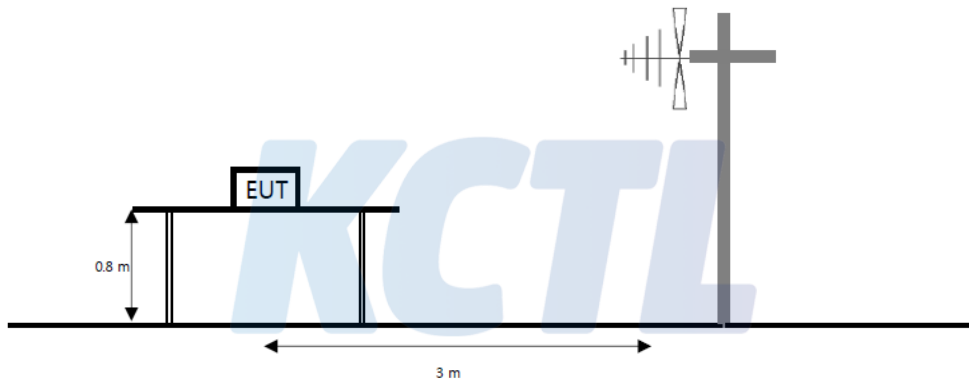
7.6. Radiated spurious emissions & band edge

Test setup

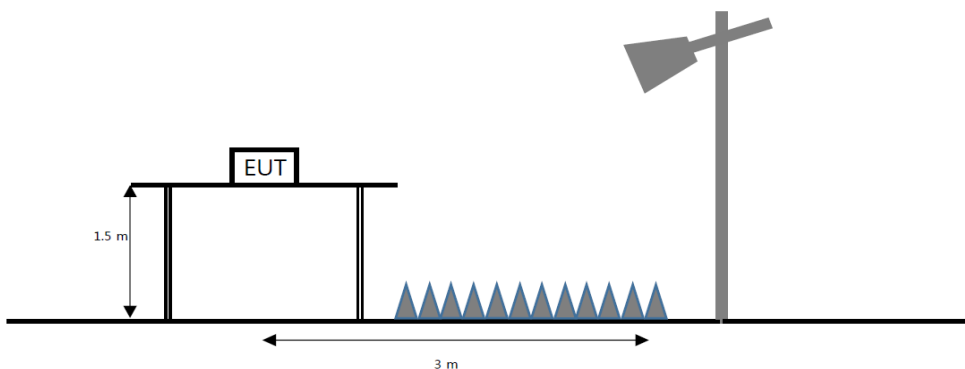
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



Limit

According to section 15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength ($\mu\text{V/m}$)	Measurement distance (m)
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section 15.231 and 15.241.

According to section 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	25	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	156.7 - 156.9	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	162.012 5 - 167.17	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	167.72 - 173.2	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	240 - 285	3 600 - 4 400	Above 38.6
13.36 - 13.41	322 - 335.4		

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in section 15.35 apply to these measurements.

Test procedure

ANSI C63.10-2013

Test settings**Peak field strength measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW $\geq (3 \times \text{RBW})$
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

Table. RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1 000 MHz	100 kHz to 120 kHz
> 1 000 MHz	1 MHz

Average field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 MHz
3. VBW = $1/T \geq 1$ Hz
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times(1/duty cycle) traces

Notes:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz ($\geq 1/T$) for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)
2. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40 \log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20 \log(D_m/D_s)$

Where:

 F_d = Distance factor in dB D_m = Measurement distance in meters D_s = Specification distance in meters

3. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d (dB)
4. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. ¹⁾ means restricted band.

7. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.

Duty cycle correction factor calculation:

According to 7.5 Procedure for determining the average value of pulsed emissions

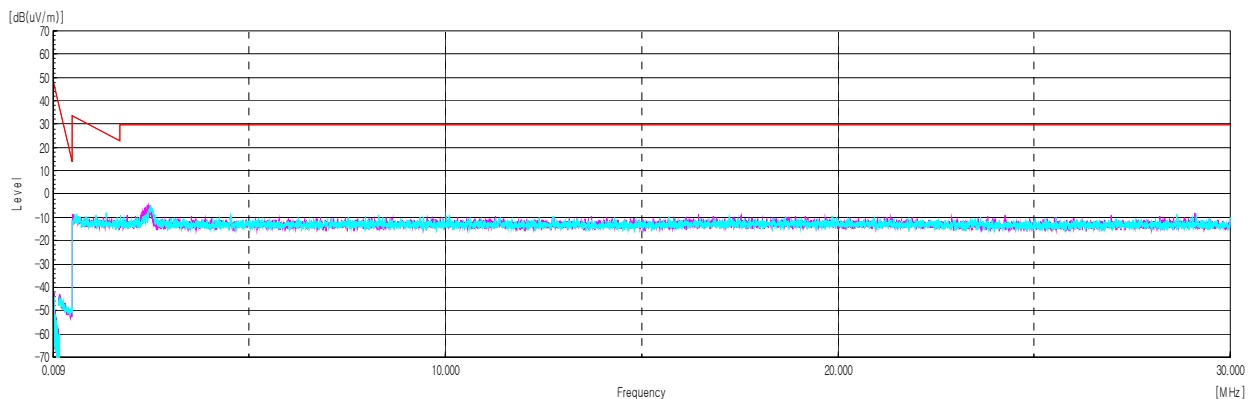
Duty Cycle Correction Factor Calculation

- Worst case : AFH mode
- Channel hop rate = 800 hops/second
- Hopping rate for DH5 mode = 800 hops/second / 6 (6 slots for DH5) = 133.33 hops/second
- Time per channel hop = $1 / 133.33 \text{ hops/second} = 7.50 \text{ ms}$
- Time to cycle through all channels = $7.50 \times 20 \text{ channels(AFH mode)} = 150 \text{ ms}$
- Number of times transmitter hits on one channel = $100 \text{ ms} / \text{Time to cycle through all channels (ms)}$
 $= 100 \text{ ms} / 150 \text{ ms} = 1 \text{ time}$
- Worst case Dwell time = 7.5 ms
- Duty Cycle Correction Factor = $20\log(7.5 \text{ ms}/100 \text{ ms}) = -22.5 \text{ dB}$

KCTL

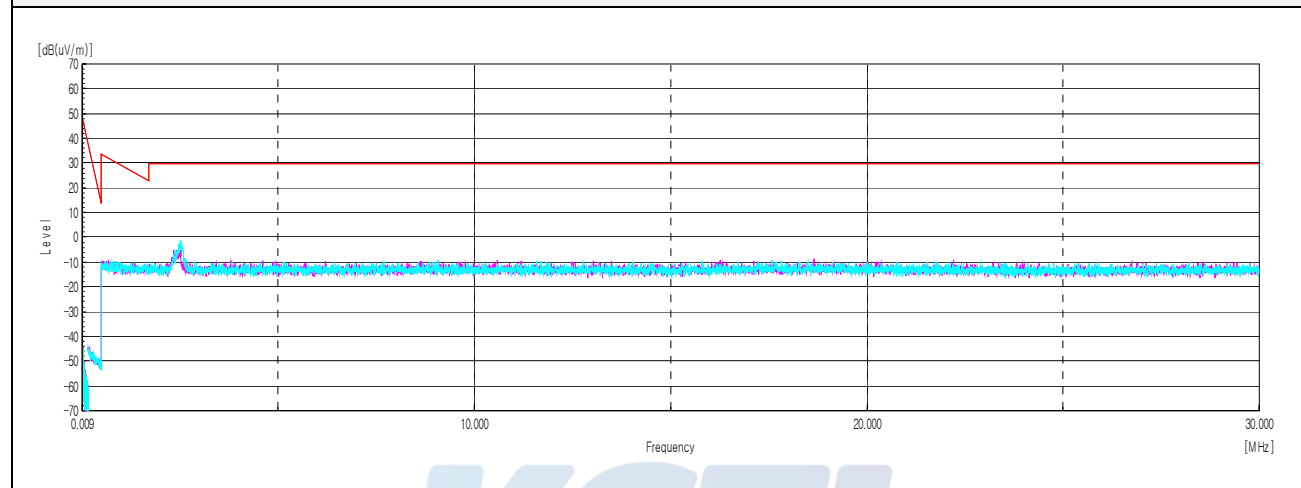
Test results (Below 30 MHz) – Worst case: 8DPSK High frequency Left

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
No spurious emissions were detected within 20 dB of the limit.									

Horizontal/Vertical**KCTL**

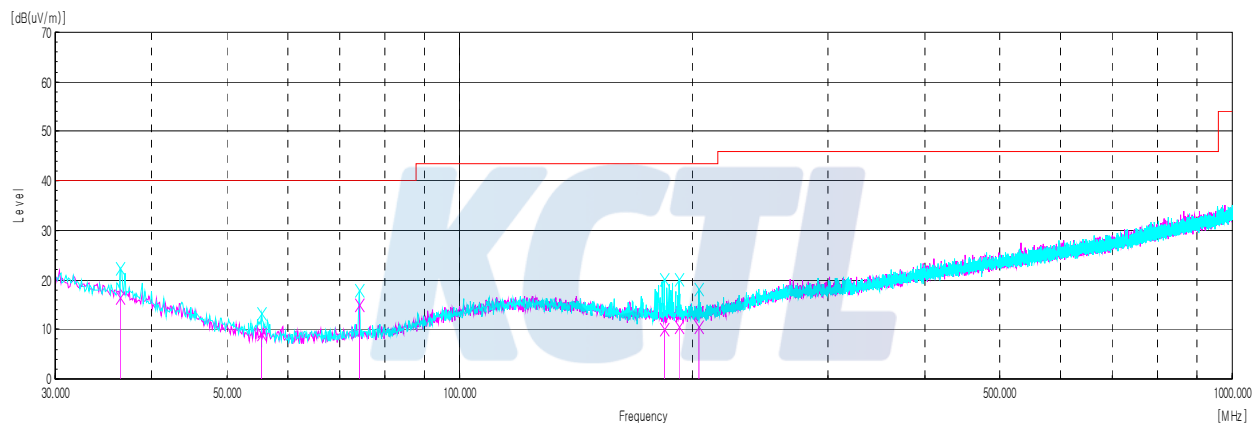
Test results (Below 30 MHz) – Worst case: 8DPSK High frequency Right

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
No spurious emissions were detected within 20 dB of the limit.									

Horizontal/Vertical**KCTL**

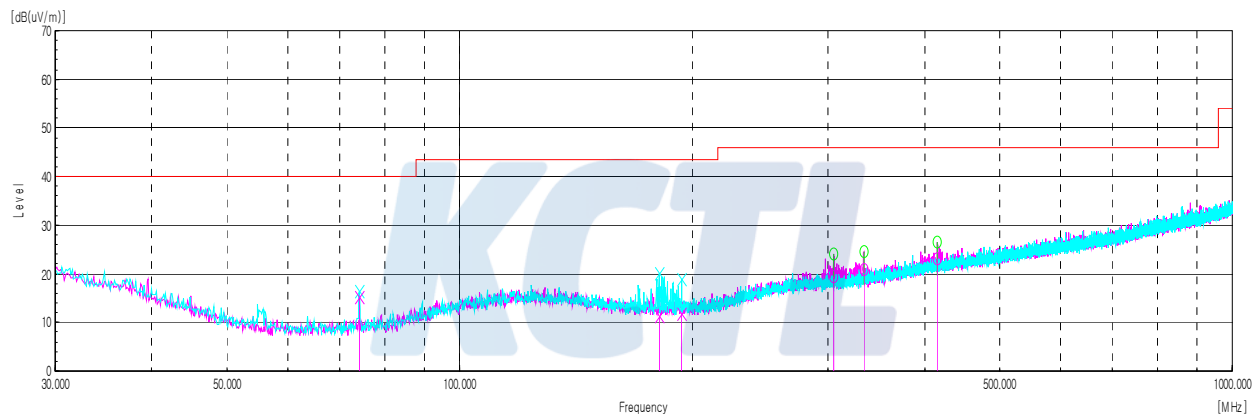
Test results (Below 1 000 MHz) – Worst case: 8DPSK High frequency Left

Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Quasi peak data								
36.43	V	25.20	21.63	-30.45	-	16.38	40.00	23.62
55.46	V	26.30	12.67	-29.99	-	8.98	40.00	31.02
74.26	V	31.80	12.77	-29.63	-	14.94	40.00	25.06
184.23	V	22.60	15.43	-28.02	-	10.01	43.50	33.49
192.35	V	23.00	15.35	-27.89	-	10.46	43.50	33.04
203.99	V	22.70	15.50	-27.74	-	10.46	43.50	33.04

Horizontal/Vertical

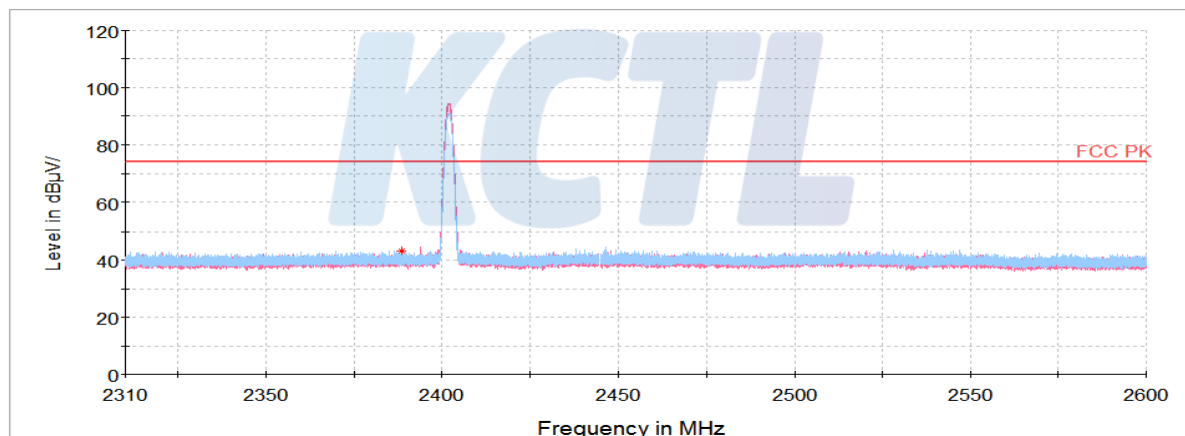
Test results (Below 1 000 MHz) – Worst case: 8DPSK High frequency Right

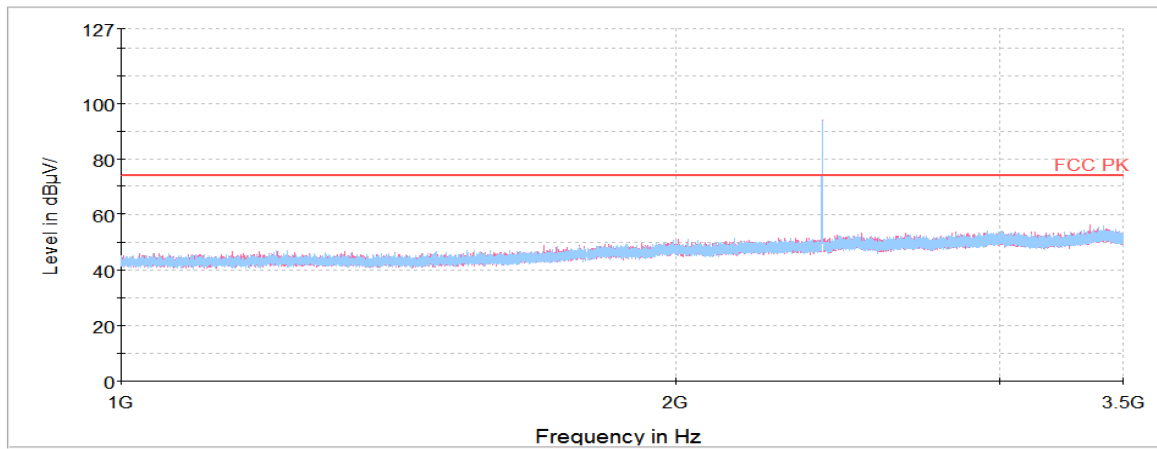
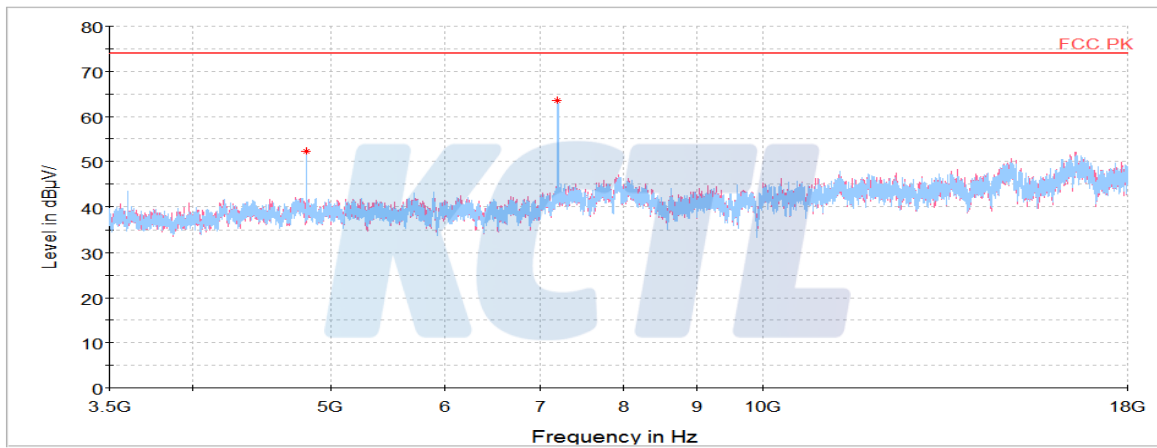
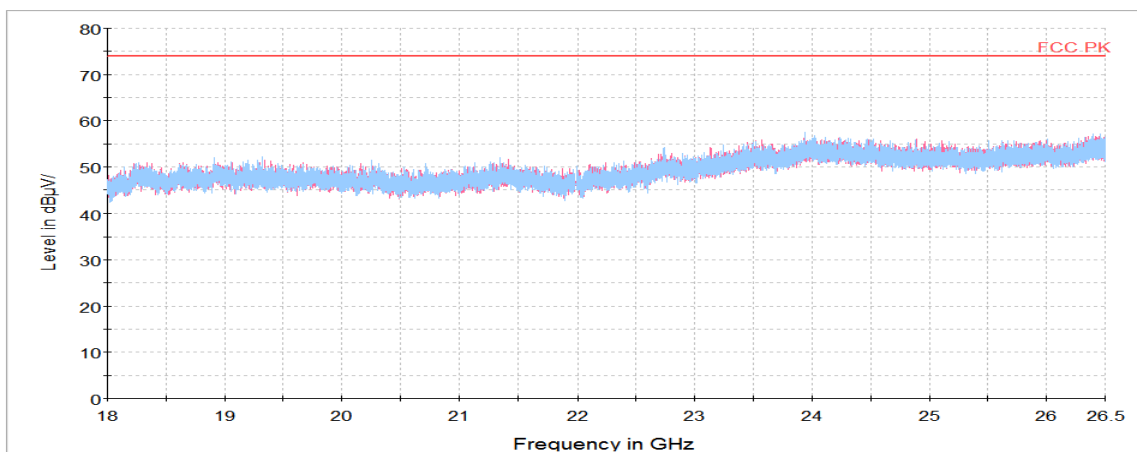
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Quasi peak data								
74.26	V	32.00	12.77	-29.63	-	15.14	40.00	24.86
181.32	V	23.80	15.55	-28.06	-	11.29	43.50	32.21
193.93	V	24.10	15.38	-27.87	-	11.61	43.50	31.89
304.63	H	26.30	19.75	-26.66	-	19.39	46.00	26.61
333.49	H	26.90	20.00	-26.42	-	20.48	46.00	25.52
414.97	H	26.40	22.55	-25.73	-	23.22	46.00	22.78

Horizontal/Vertical

Test results (Above 1 000 MHz)**-Left****GFSK****Low Channel**

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 388.50 ¹⁾	H	40.45	31.88	-29.05	-	43.28	74.00	30.72
4 803.64 ¹⁾	H	71.43	33.92	-53.00	-	52.35	74.00	21.65
7 205.66	H	81.16	35.40	-53.08	-	63.48	74.00	10.52
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

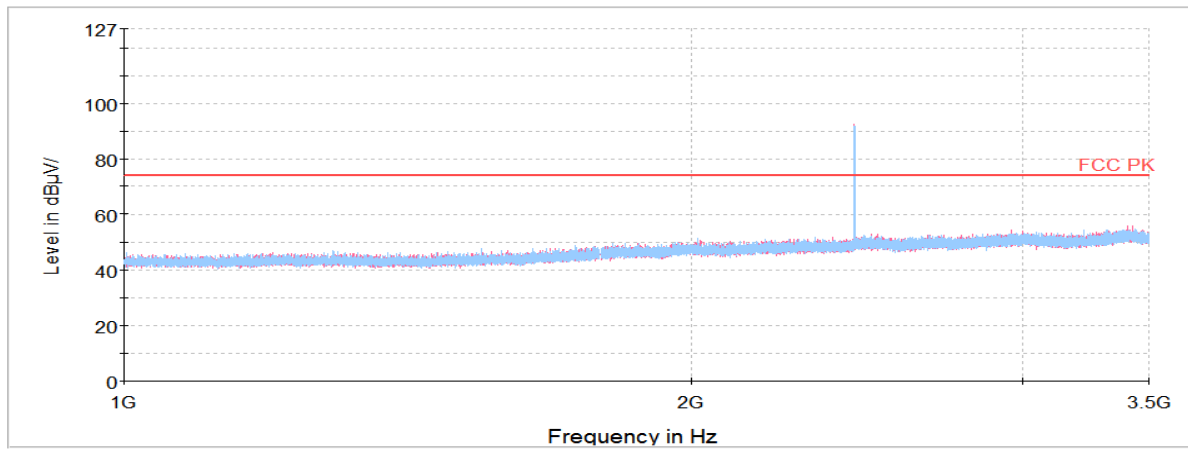
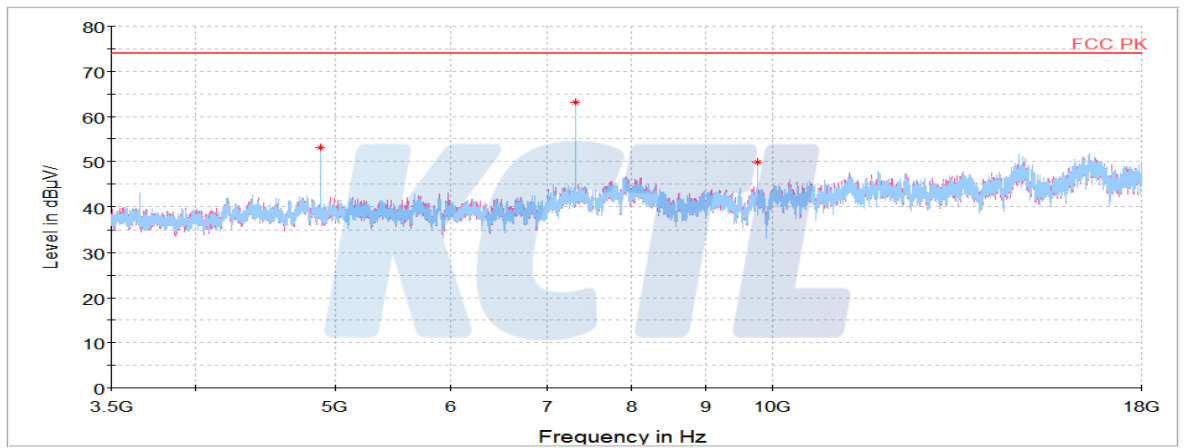
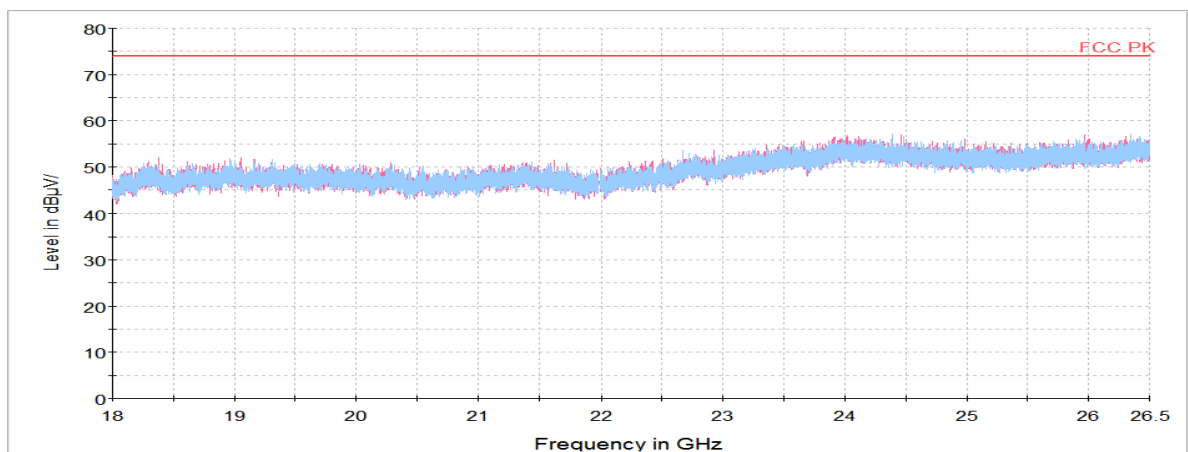
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

Middle Channel

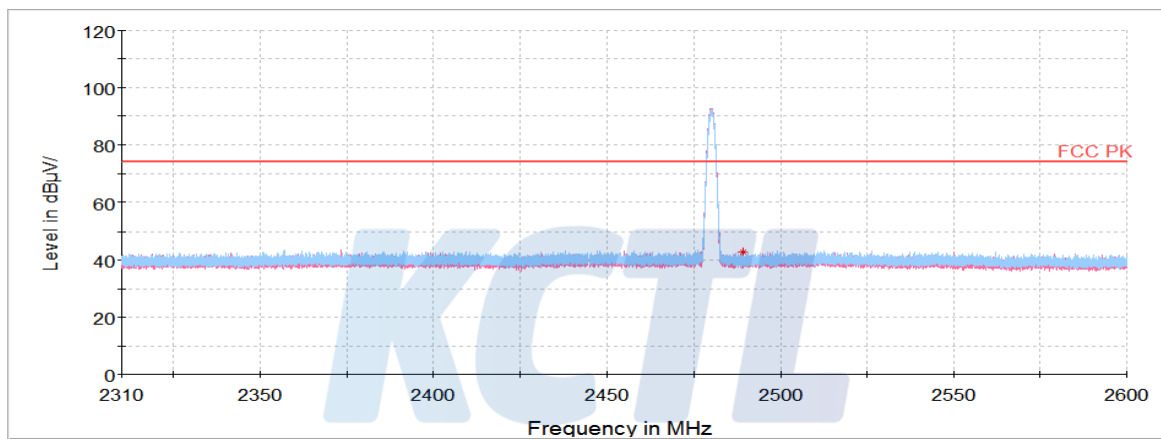
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 881.58 ¹⁾	H	74.24	33.95	-55.21	-	52.98	74.00	21.02
7 323.02 ¹⁾	H	80.27	35.40	-52.64	-	63.03	74.00	10.97
9 764.91	H	66.43	36.71	-53.37	-	49.77	74.00	24.23
Average Data								
7 323.02 ¹⁾	H	80.27	35.40	-52.64	-22.50	40.53	54.00	13.47

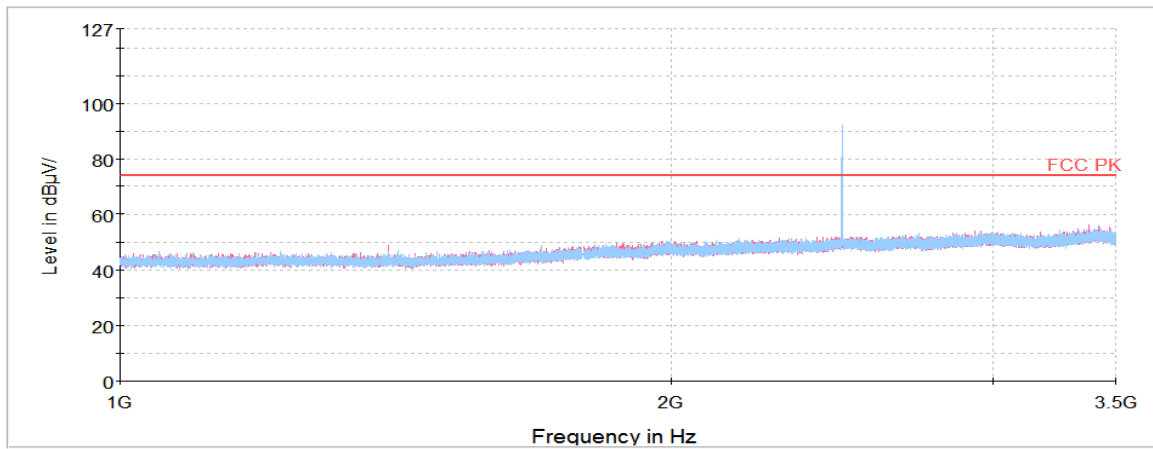
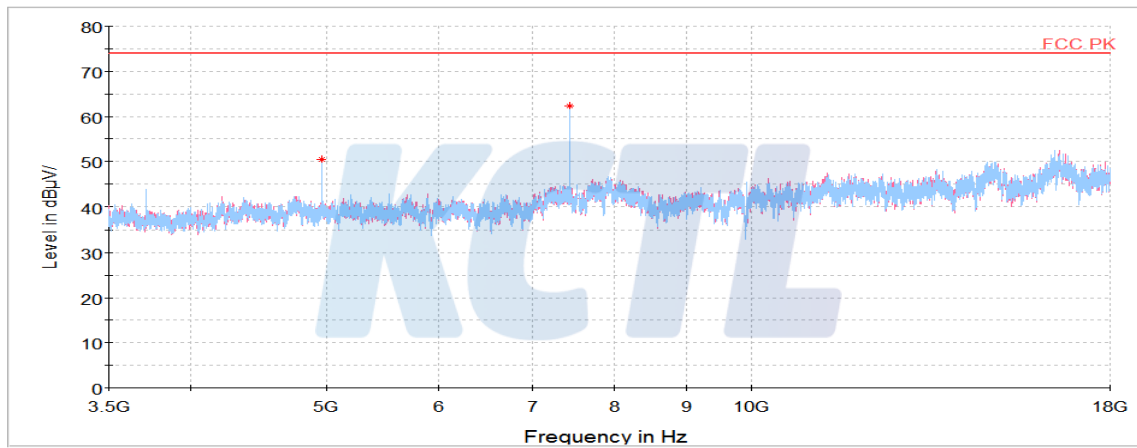
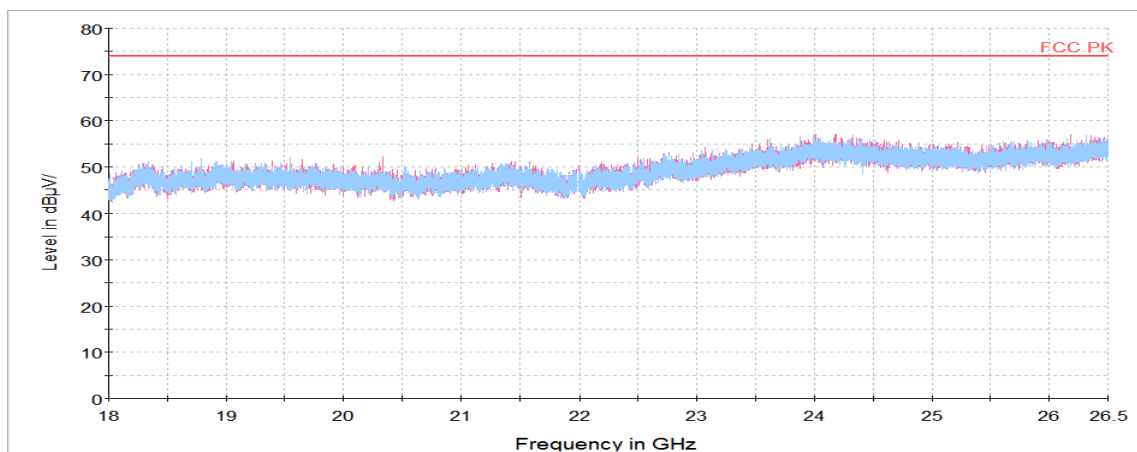


Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

High Channel

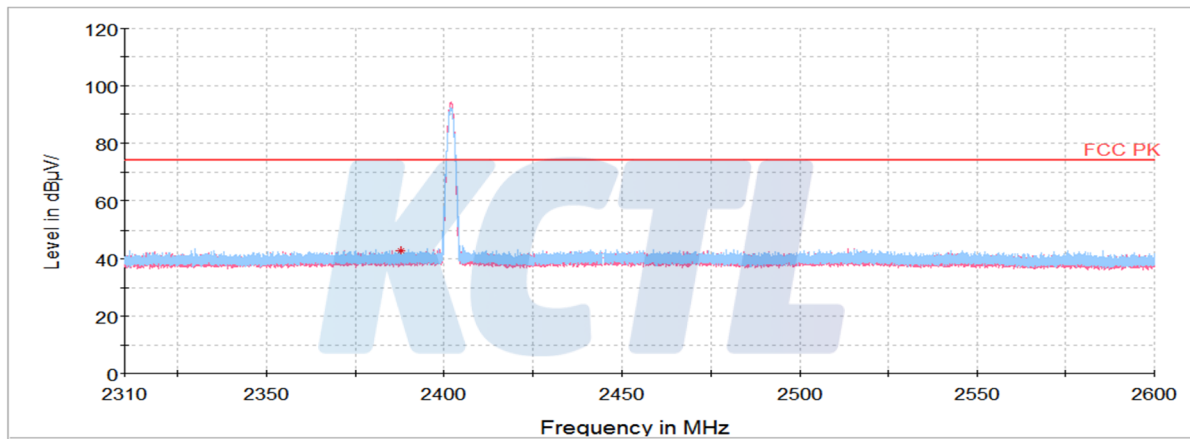
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 489.01 ¹⁾	H	39.83	32.08	-29.23	-	42.68	74.00	31.32
4 959.97 ¹⁾	H	71.21	33.98	-54.66	-	50.53	74.00	23.47
7 439.47 ¹⁾	H	79.16	35.40	-52.21	-	62.35	74.00	11.65
Average Data								
7 439.47 ¹⁾	H	79.16	35.40	-52.21	-22.50	39.85	54.00	14.15

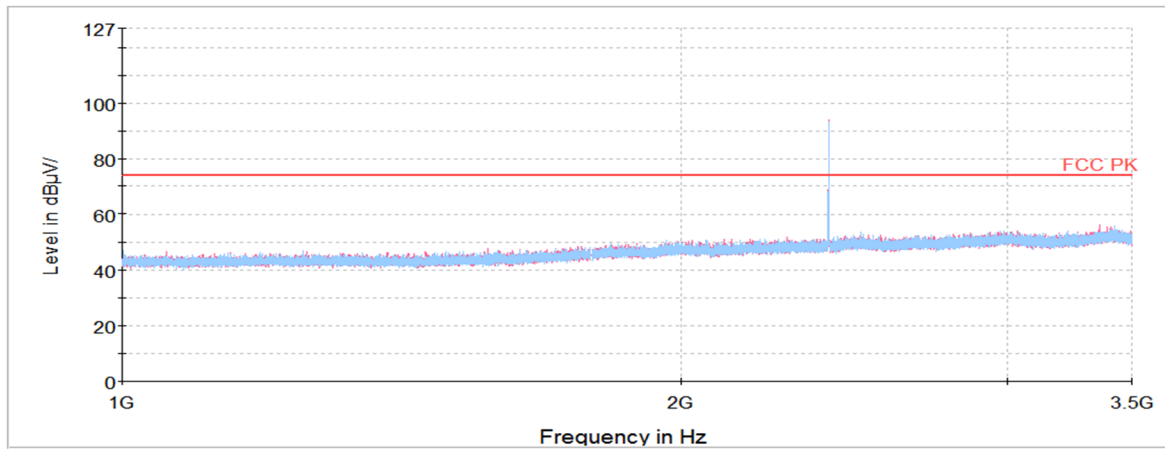
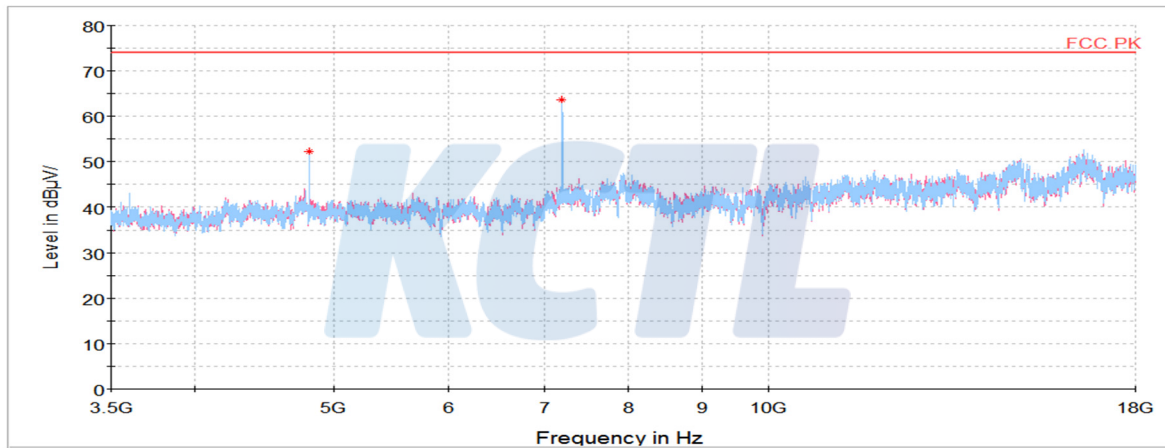
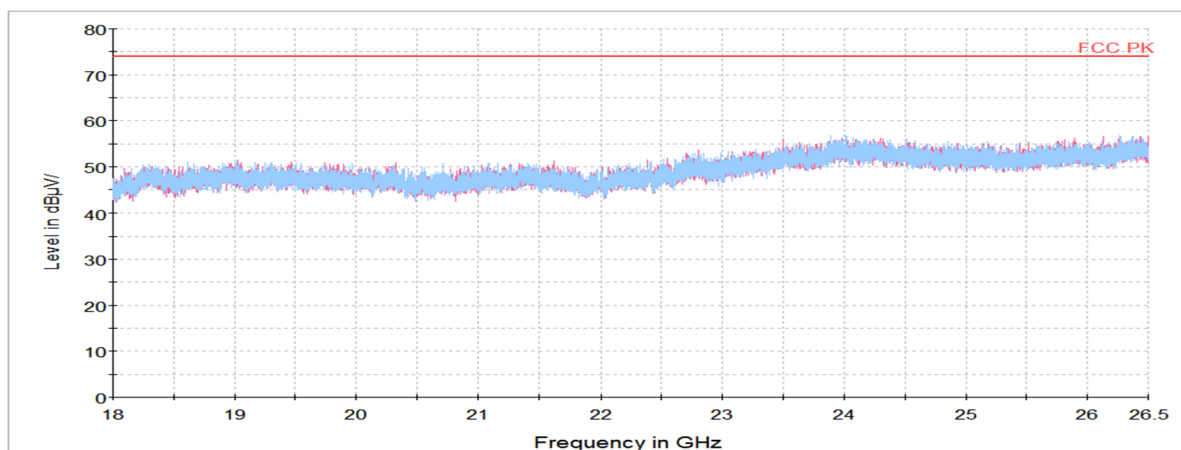
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

8DPSK**Low Channel**

Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 388.05 ¹⁾	H	40.09	31.88	-29.05	-	42.92	74.00	31.08
4 804.09 ¹⁾	H	71.23	33.92	-53.02	-	52.13	74.00	21.87
7 206.11	H	81.33	35.40	-53.08	-	63.65	74.00	10.35
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

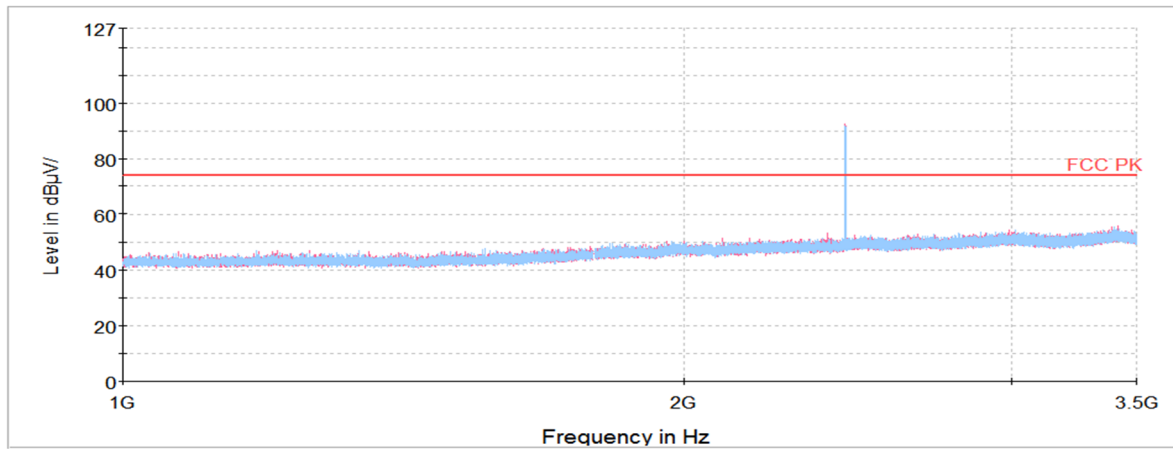
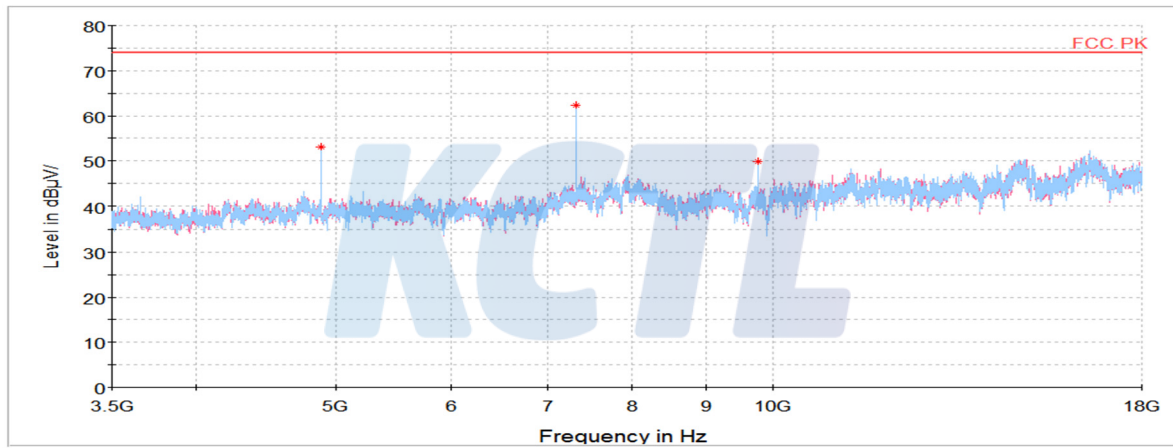
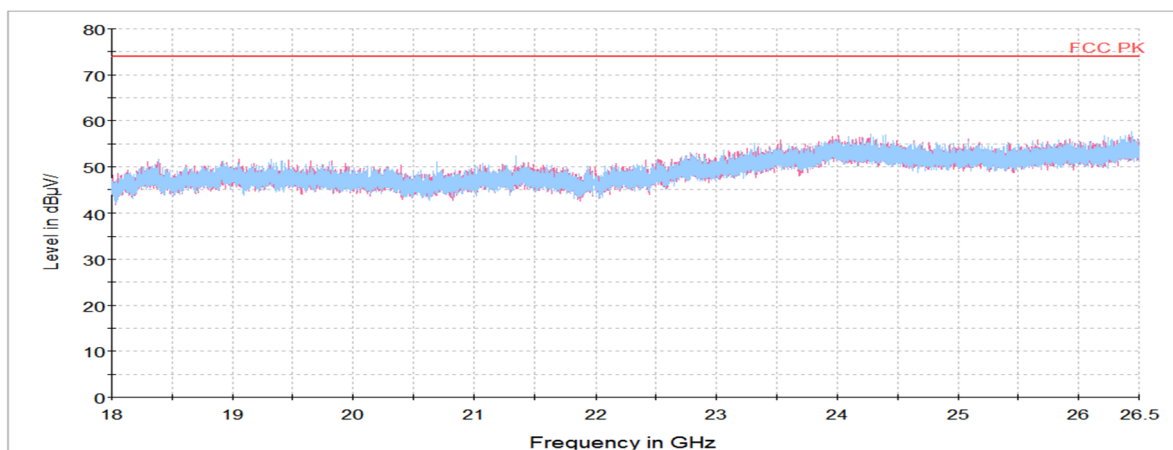
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

Middle Channel

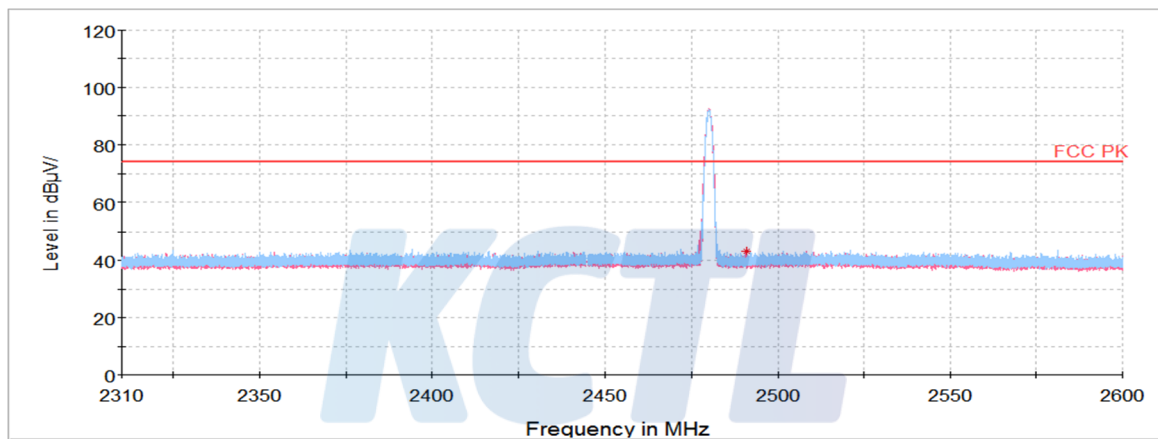
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 882.03 ¹⁾	H	74.43	33.95	-55.23	-	53.15	74.00	20.85
7 323.02 ¹⁾	H	79.65	35.40	-52.64	-	62.41	74.00	11.59
9 764.00	H	66.46	36.71	-53.38	-	49.79	74.00	24.21
Average Data								
7 323.02 ¹⁾	H	79.65	35.40	-52.64	-22.50	39.91	54.00	14.09

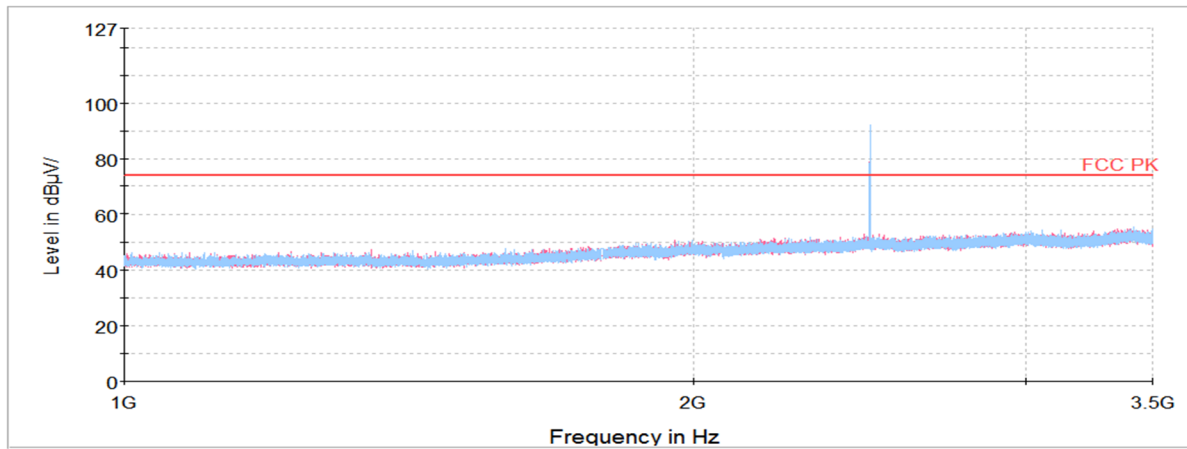
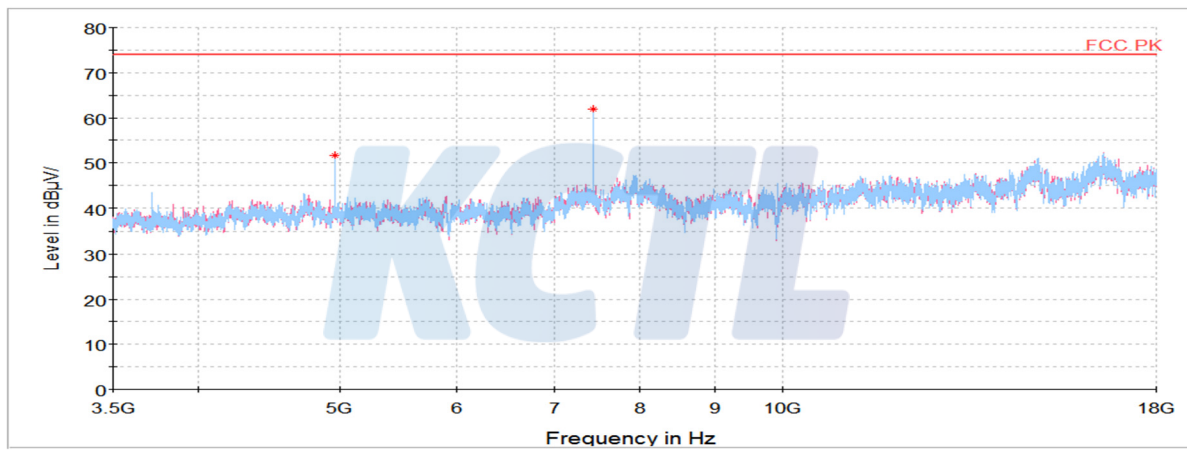
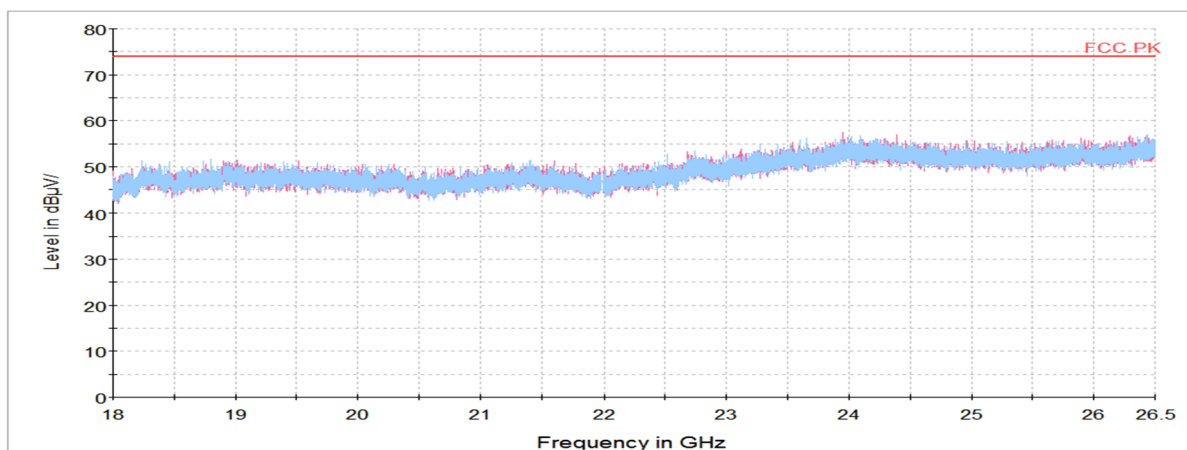


Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

High Channel

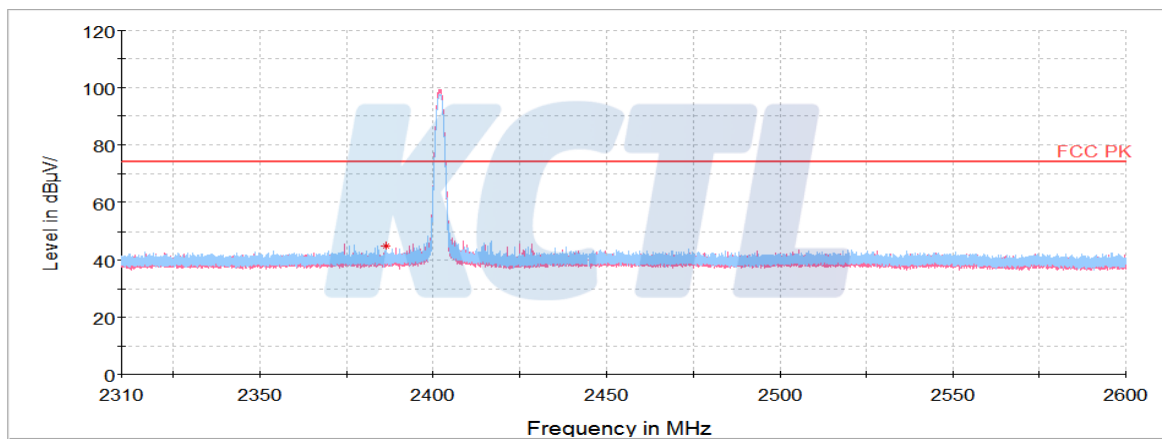
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 490.93 ¹⁾	V	40.19	32.08	-29.23	-	43.04	74.00	30.96
4 959.97 ¹⁾	H	72.37	33.98	-54.66	-	51.69	74.00	22.31
7 439.92 ¹⁾	H	78.71	35.40	-52.20	-	61.91	74.00	12.09
Average Data								
7 439.92 ¹⁾	H	78.71	35.40	-52.20	-22.50	39.41	54.00	14.59

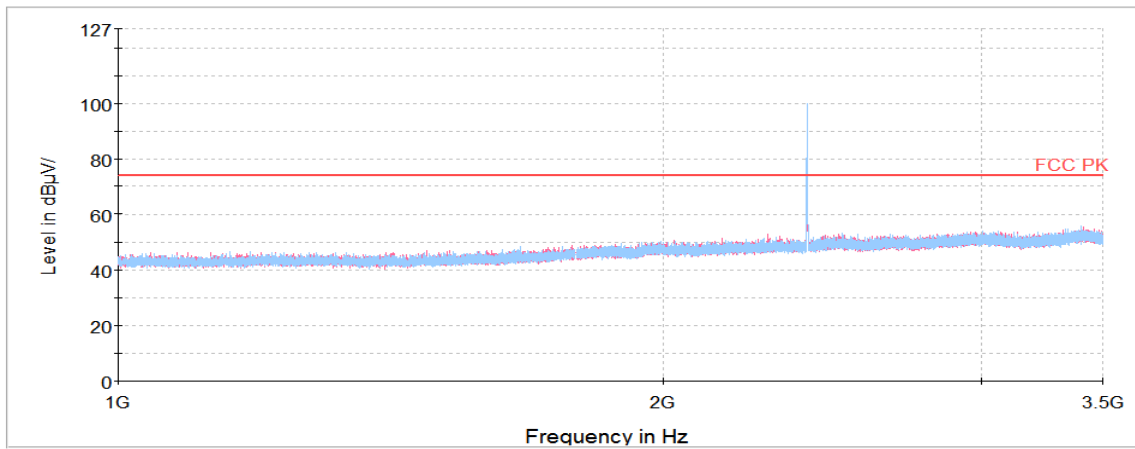
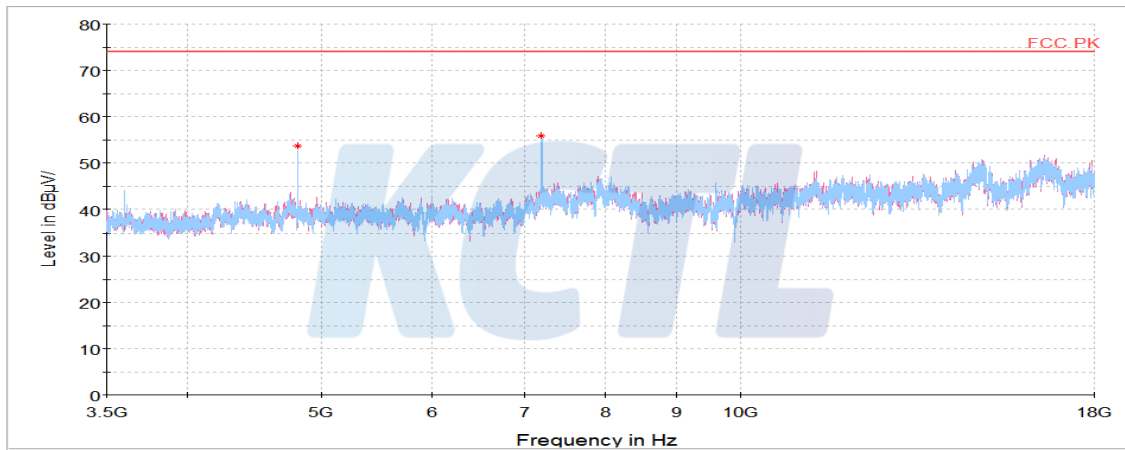
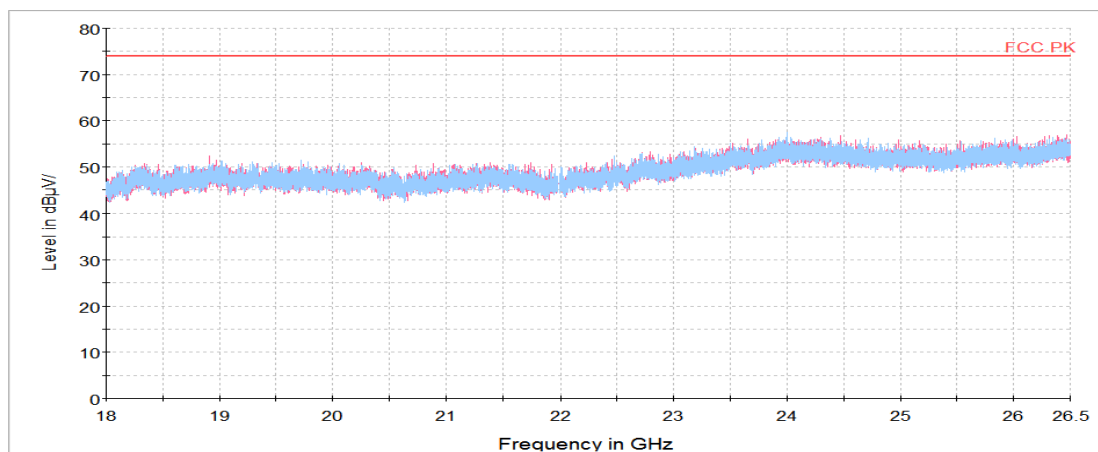
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

-Right**GFSK****Low Channel**

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 386.62 ¹⁾	H	42.21	31.87	-29.06	-	45.02	74.00	28.98
4 803.64 ¹⁾	H	72.68	33.92	-53.00	-	53.60	74.00	20.40
7 206.56	H	73.54	35.40	-53.08	-	55.86	74.00	18.14
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

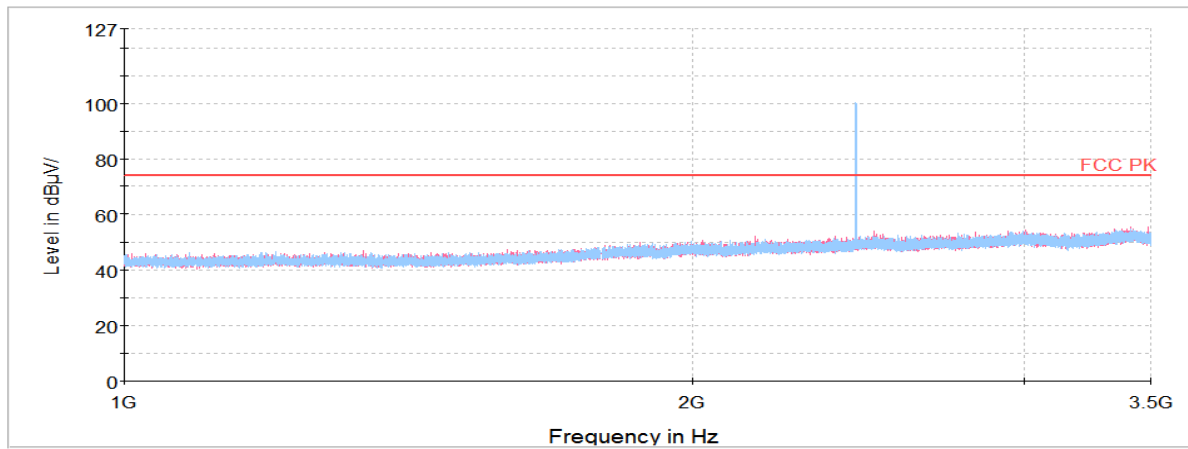
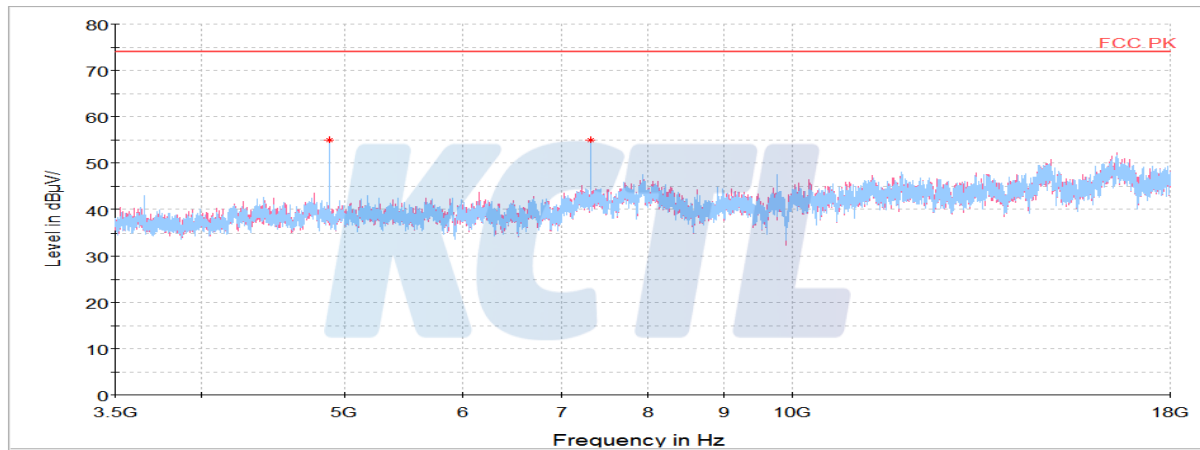
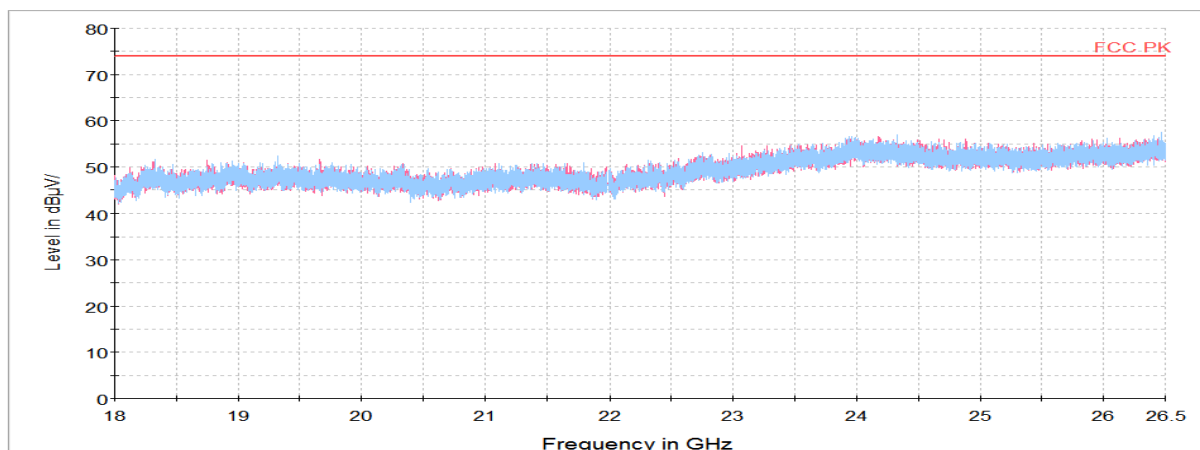
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

Middle Channel

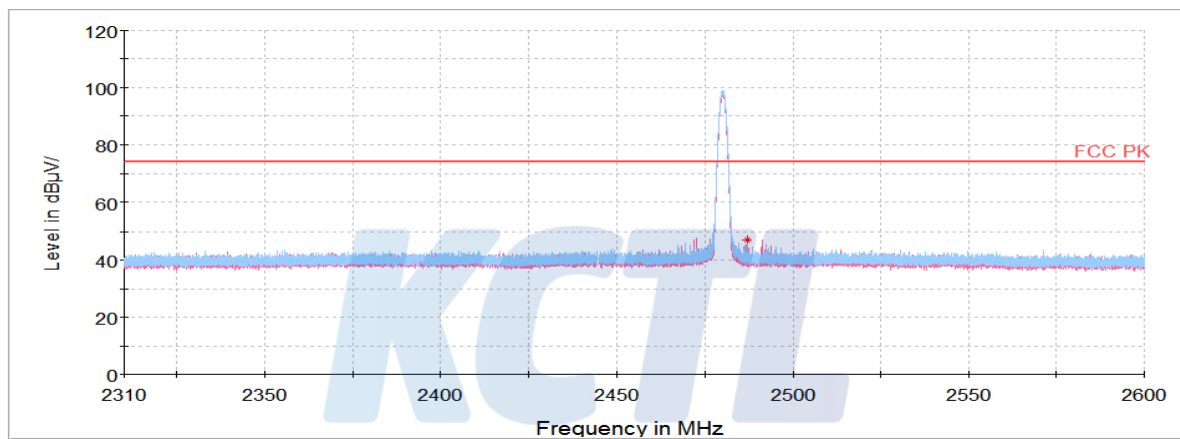
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 882.48 ¹⁾	H	76.15	33.95	-55.24	-	54.86	74.00	19.14
7 323.47 ¹⁾	H	72.18	35.40	-52.64	-	54.94	74.00	19.06
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

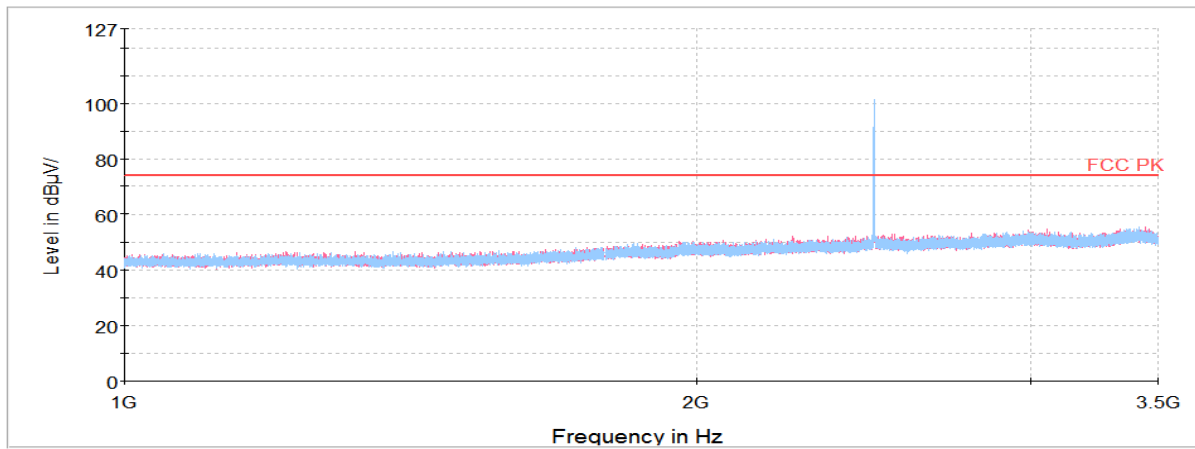
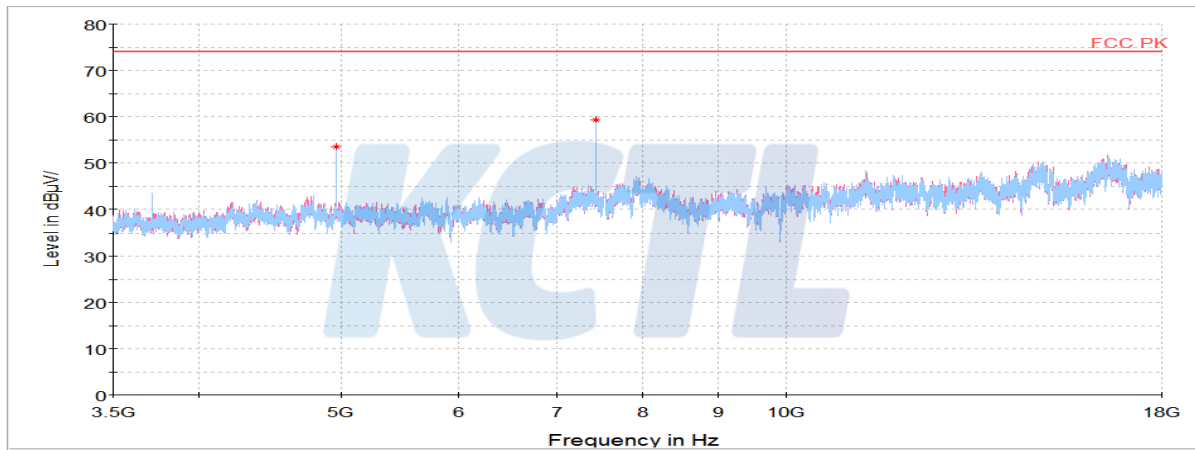
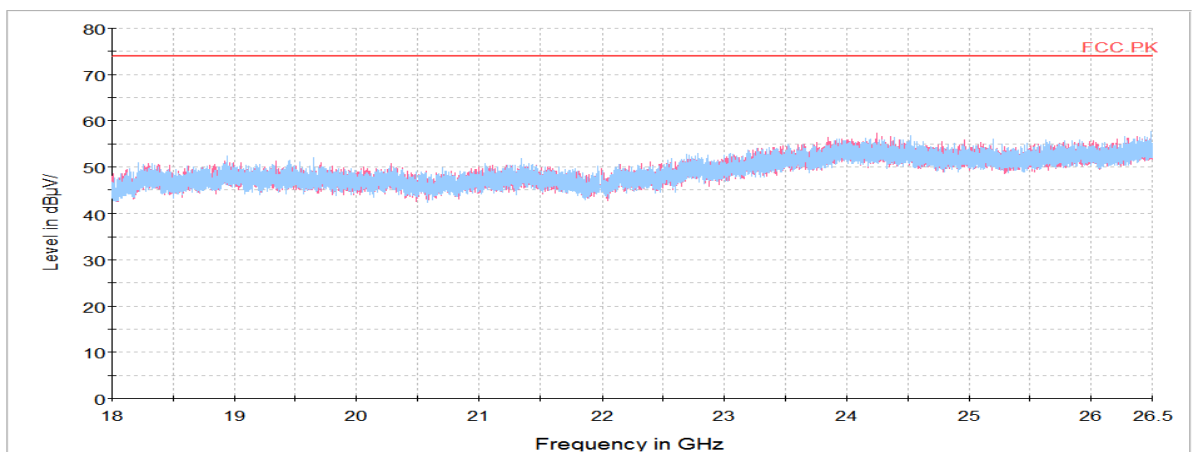


Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

High Channel

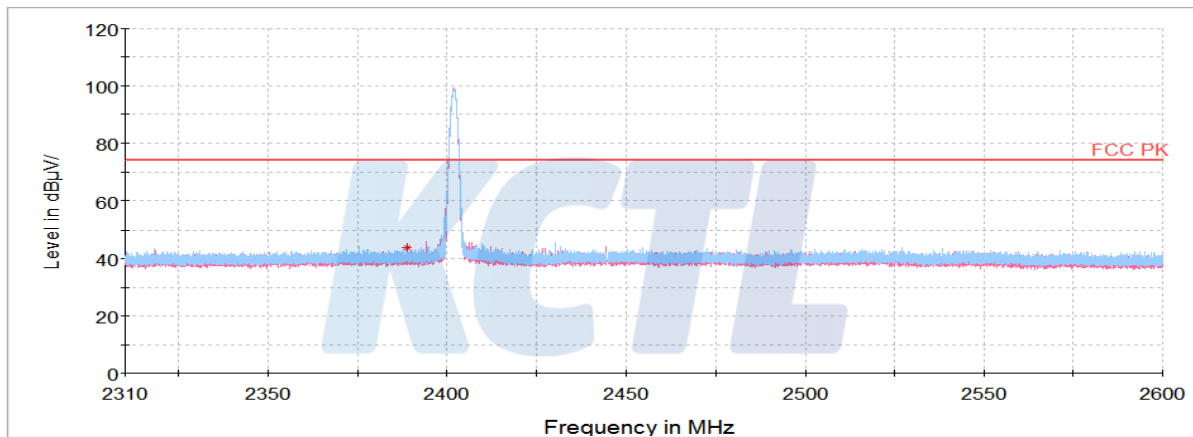
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 486.95 ¹⁾	H	44.03	32.07	-29.22	-	46.88	74.00	27.12
4 959.97 ¹⁾	H	74.17	33.98	-54.66	-	53.49	74.00	20.51
7 440.38 ¹⁾	H	76.07	35.40	-52.20	-	59.27	74.00	14.73
Average Data								
7 440.38 ¹⁾	H	76.07	35.40	-52.20	-22.50	36.77	54.00	17.23

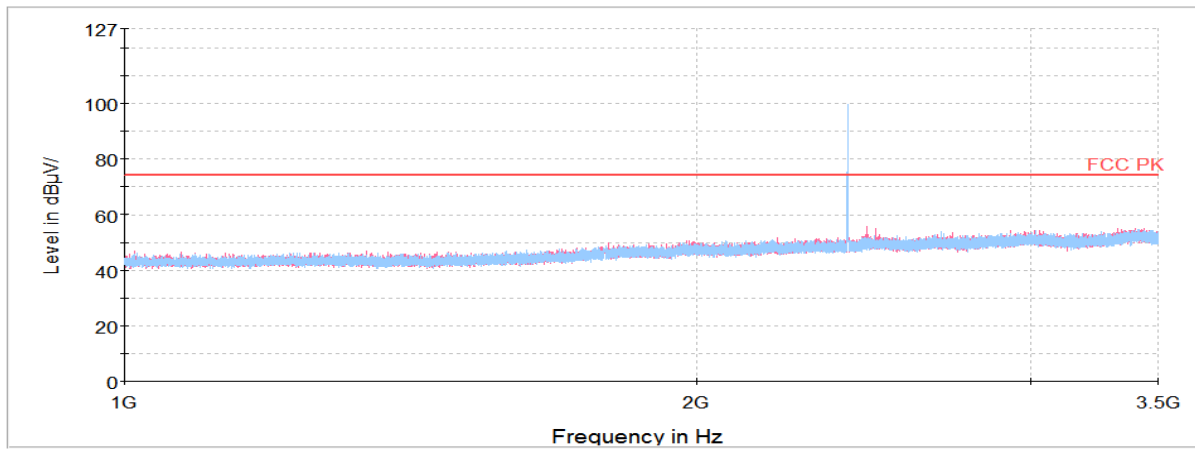
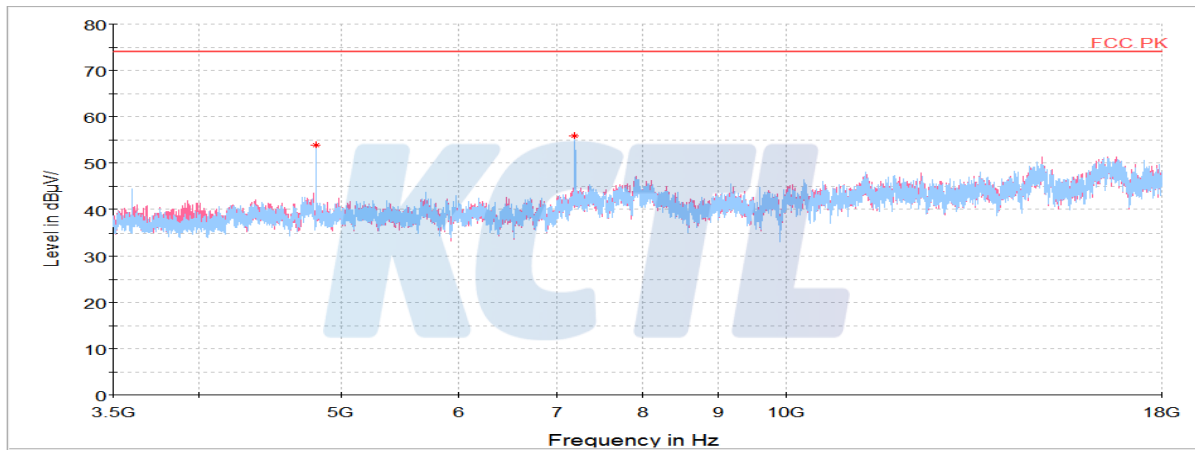
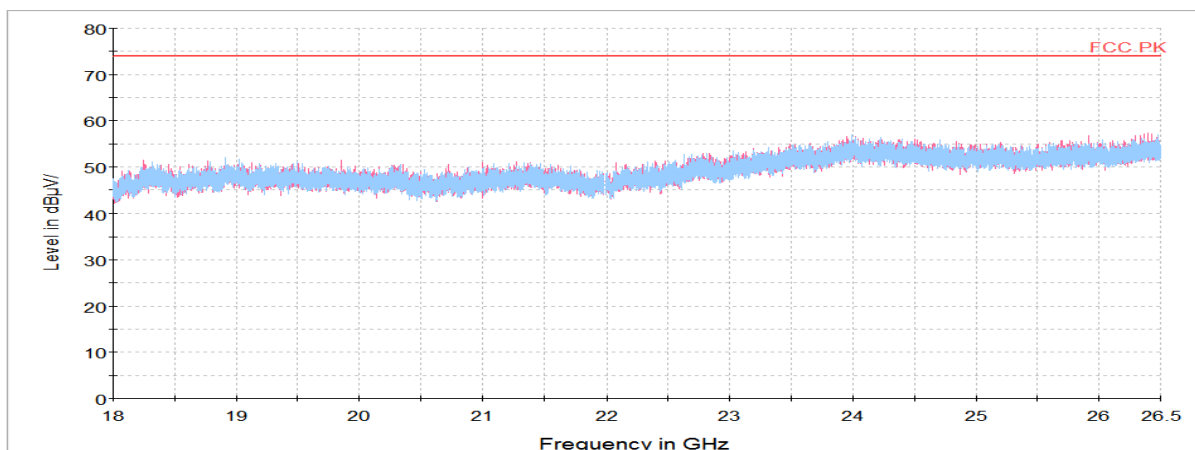
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

8DPSK**Low Channel**

Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 388.80 ¹⁾	V	41.02	31.88	-29.04	-	43.86	74.00	30.14
4 804.09 ¹⁾	H	73.01	33.92	-53.02	-	53.91	74.00	20.09
7 206.11	H	73.47	35.40	-53.08	-	55.79	74.00	18.21
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

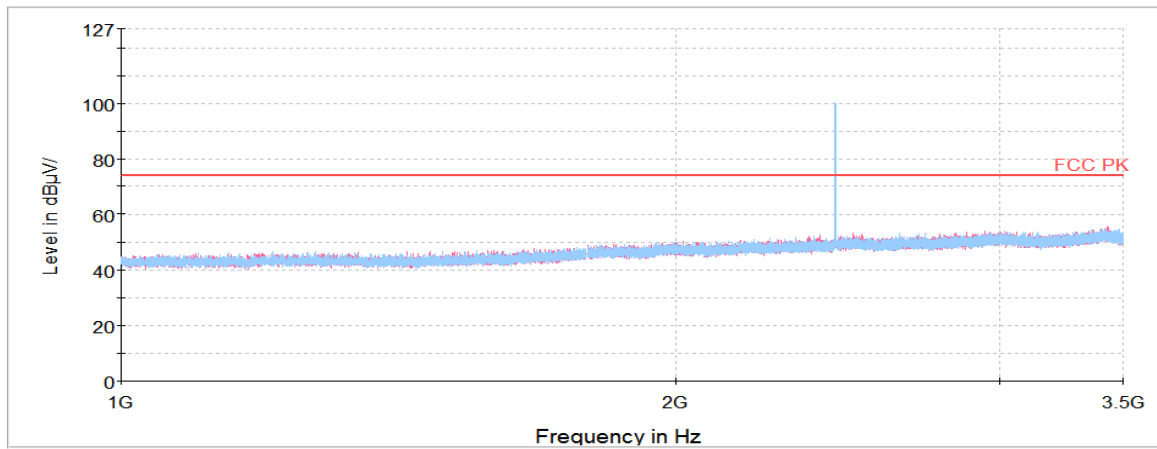
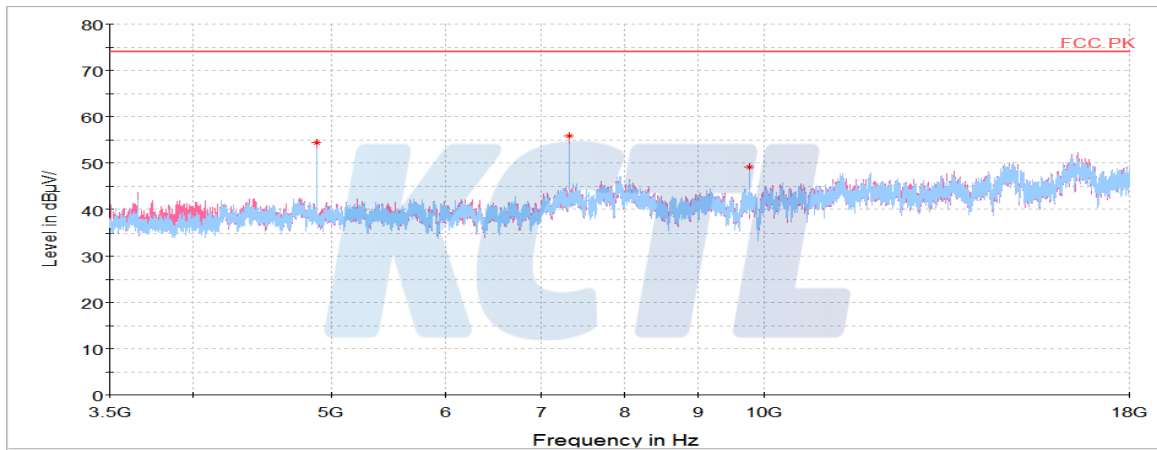
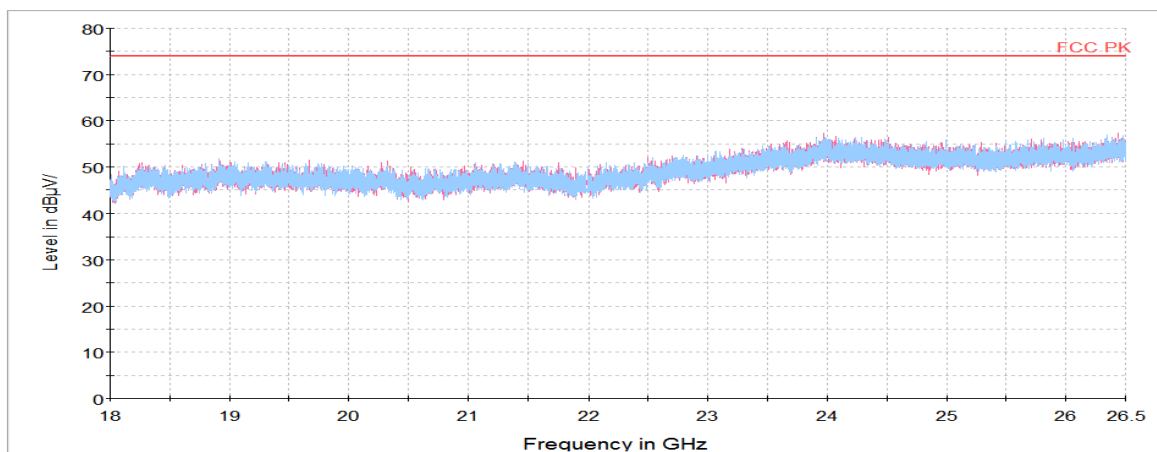
Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

Middle Channel

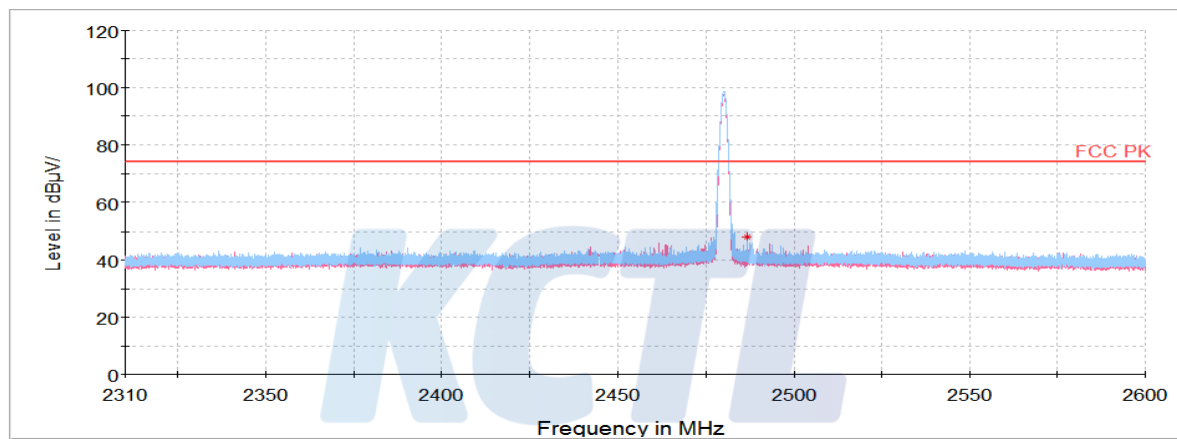
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 882.03 ¹⁾	V	75.63	33.95	-55.23	-	54.35	74.00	19.65
7 323.02 ¹⁾	V	73.11	35.40	-52.64	-	55.87	74.00	18.13
9 764.00	V	65.71	36.71	-53.38	-	49.04	74.00	24.96
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

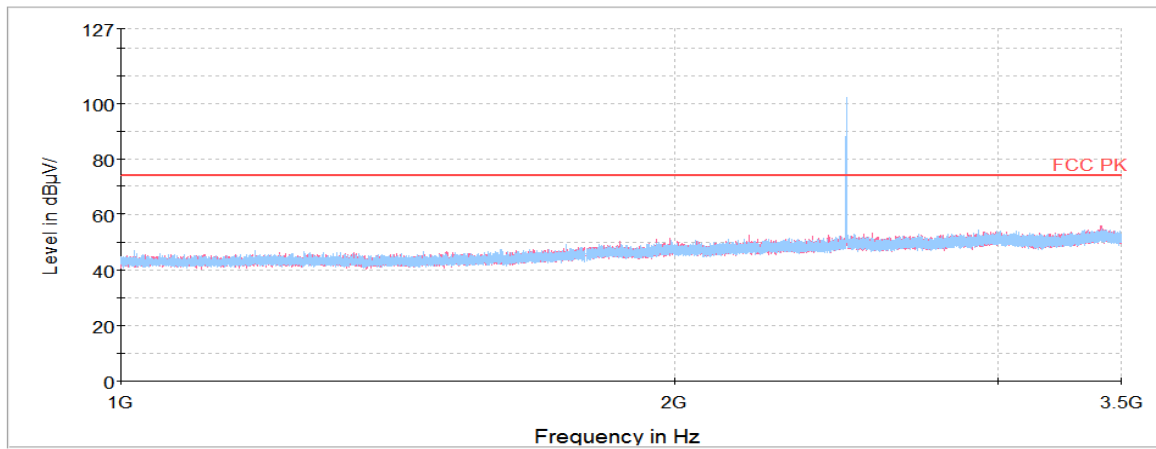
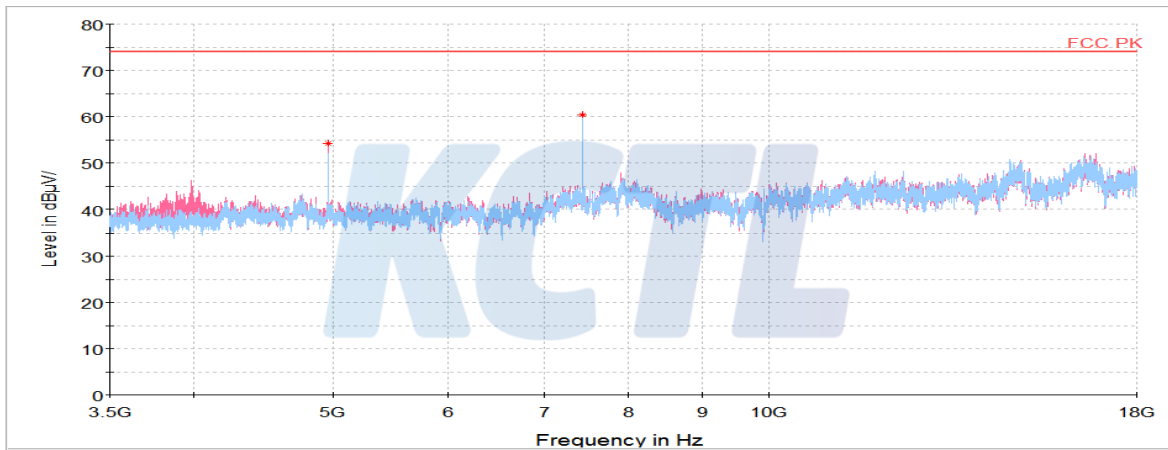
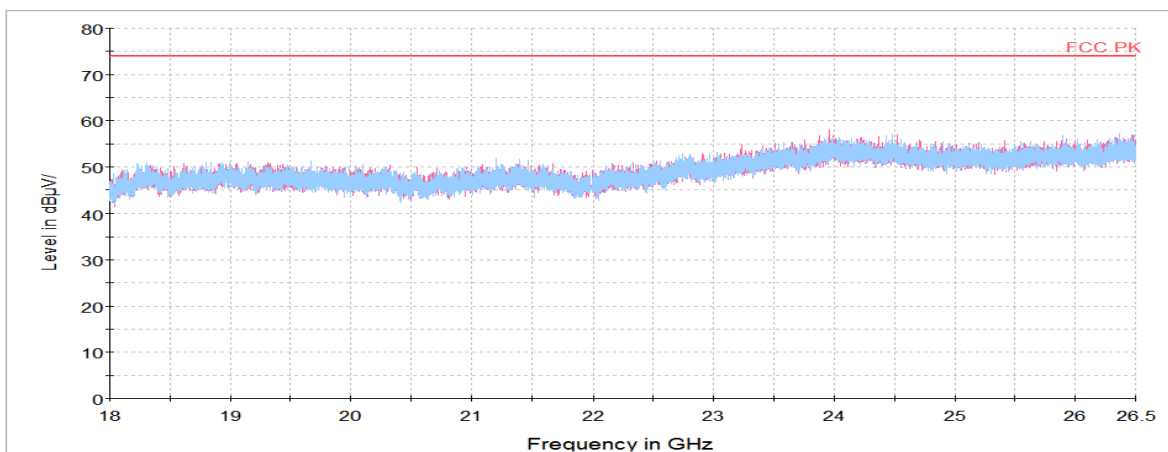
KCTL

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

High Channel

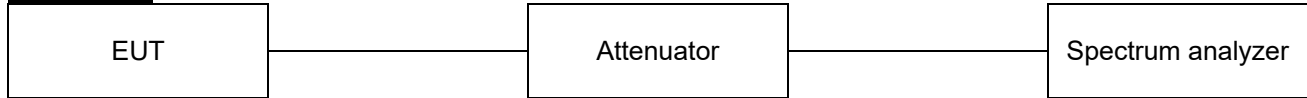
Frequency	Pol.	Reading	Antenna Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 486.60 ¹⁾	H	45.07	32.07	-29.22	-	47.92	74.00	26.08
4 959.97 ¹⁾	V	74.84	33.98	-54.66	-	54.16	74.00	19.84
7 440.38 ¹⁾	H	77.10	35.40	-52.20	-	60.30	74.00	13.70
Average Data								
7 440.38 ¹⁾	H	77.10	35.40	-52.20	-22.50	37.80	54.00	16.20

Horizontal/Vertical for Band-edge

Horizontal/Vertical for 1 GHz ~ 3.5 GHz**Horizontal/Vertical for 3.5 GHz ~ 18 GHz****Horizontal/Vertical for 18 GHz ~ 26.5 GHz**

7.7. Conducted Spurious Emission

Test setup



Limit

According to §15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operation, 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 averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation specified in §15.209(a) is not required. In addition, radiated emission limits specified in §15.209(a) (see §15.205(c)).

Limit : 20 dBc

Test procedure

ANSI C63.10-2013 - Section 6.10.4, 7.8.8

Test settings

▪ Band-edge

- 1) Span : Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
- 2) Reference level : As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log(\text{OBW}/\text{RBW})]$ below the reference level.
- 3) Attenuation: Auto (at least 10 dB preferred)
- 4) Sweep time = Coupled
- 5) RBW : 100 kHz
- 6) VBW : 300 kHz
- 7) Detector : Peak
- 8) Trace : Max hold

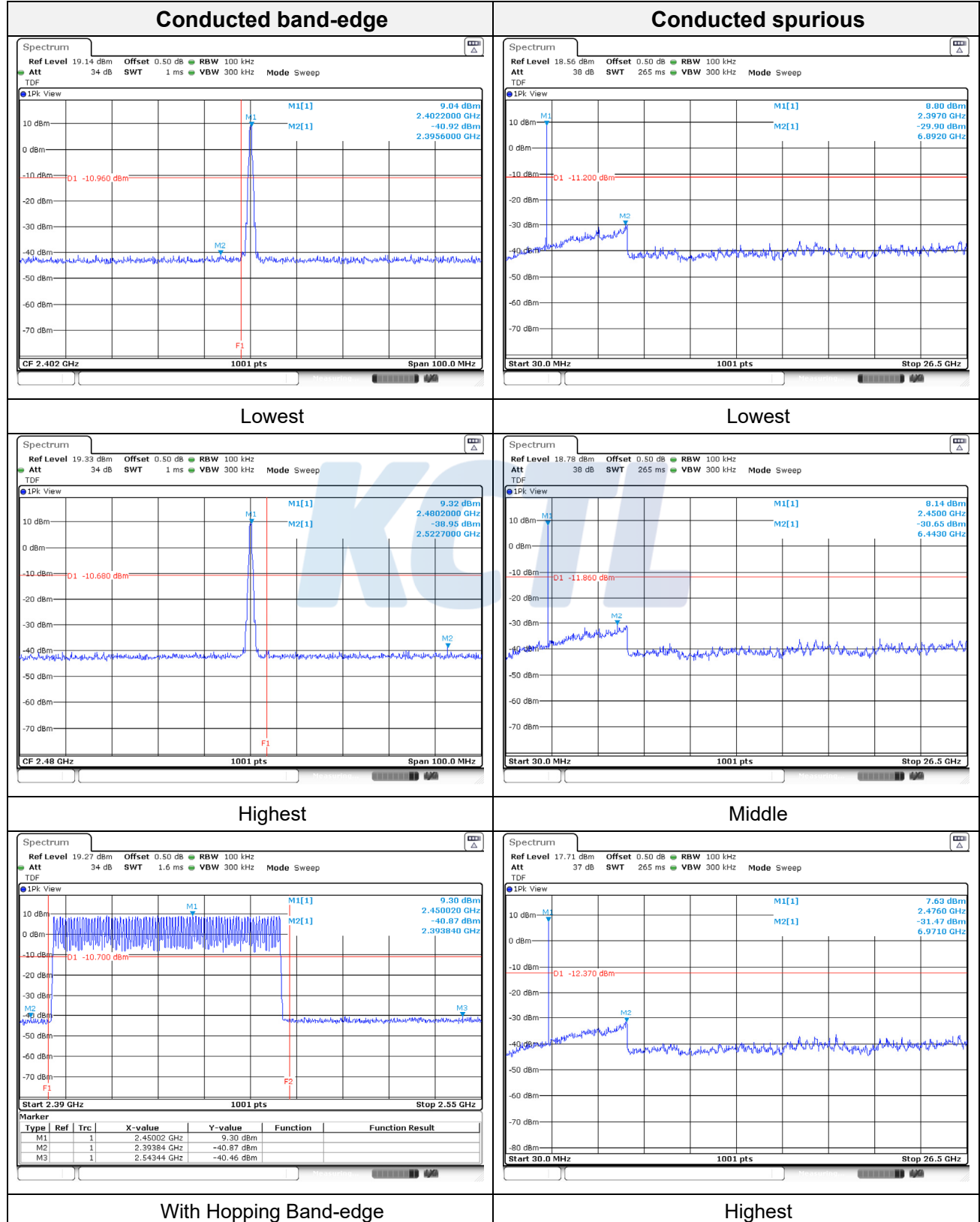
▪ Spurious emissions

- 1) Span : 30 MHz to 10 times the operating frequency in GHz
- 2) RBW : 100 kHz
- 3) VBW : 300 kHz
- 4) Sweep time : Coupled
- 5) Detector : Peak

Test results

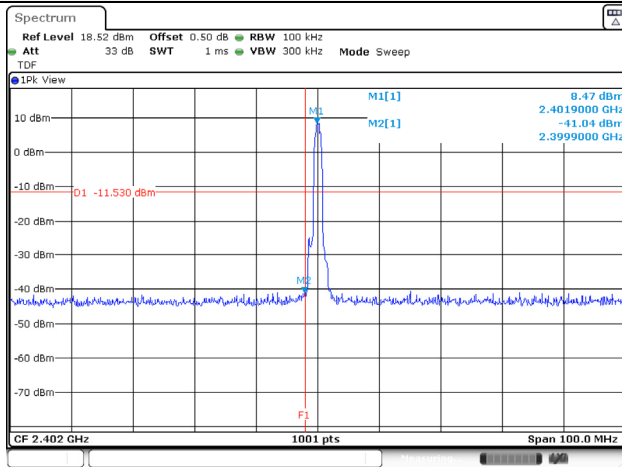
-Left

GFSK

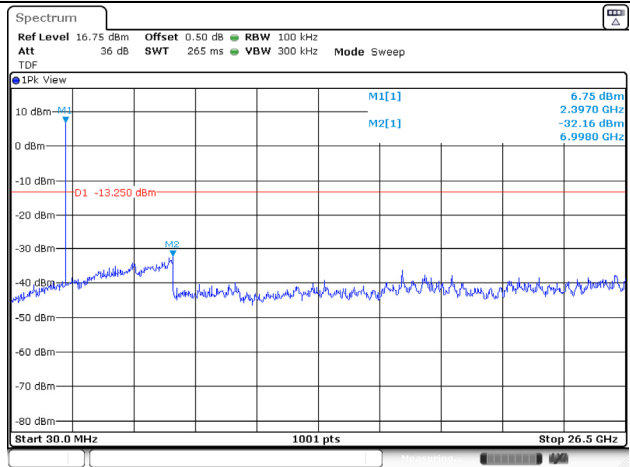


8DPSK

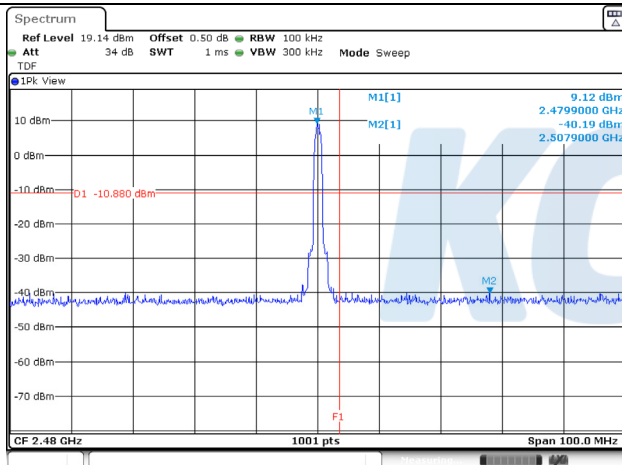
Conducted band-edge



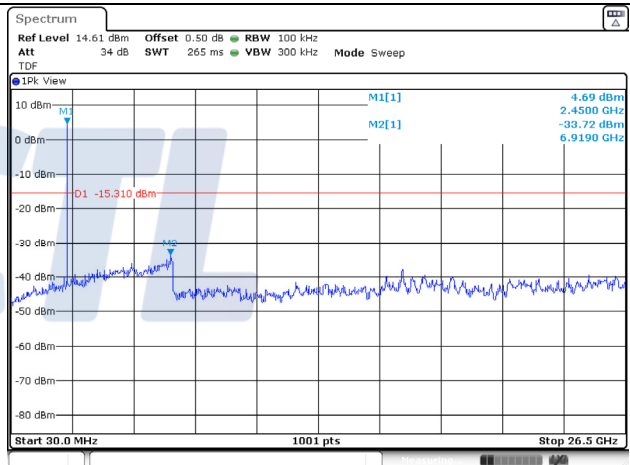
Conducted spurious



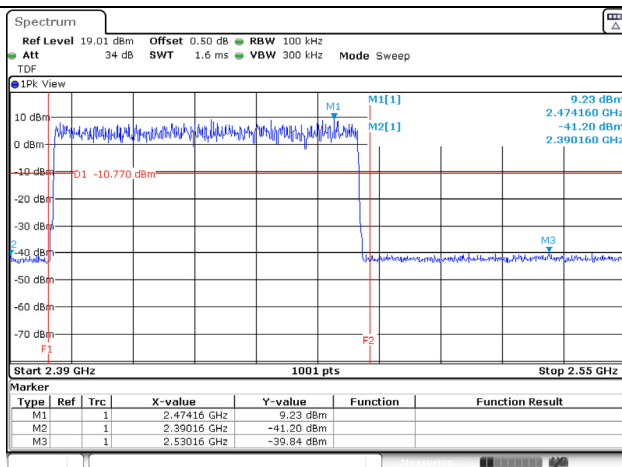
Lowest



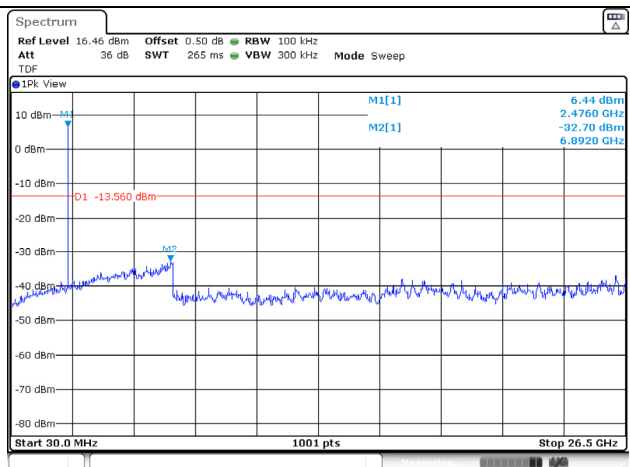
Lowest



Highest



Middle



With Hopping Band-edge

Highest