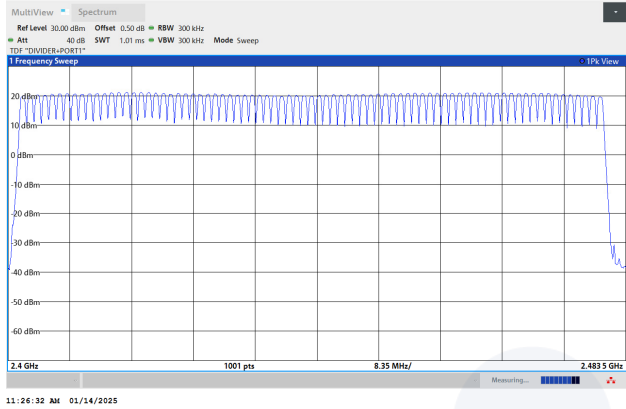


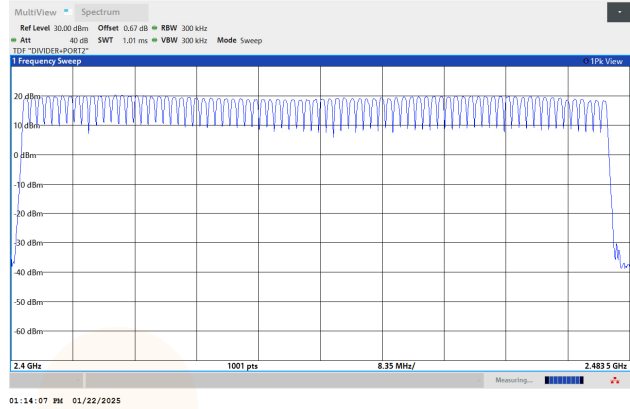
ANT1

GFSK

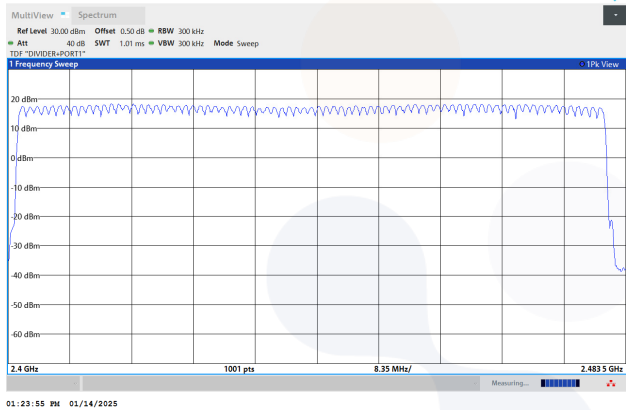


ANT2

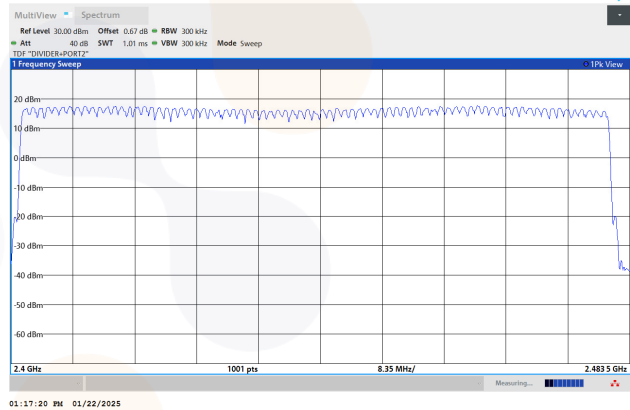
GFSK



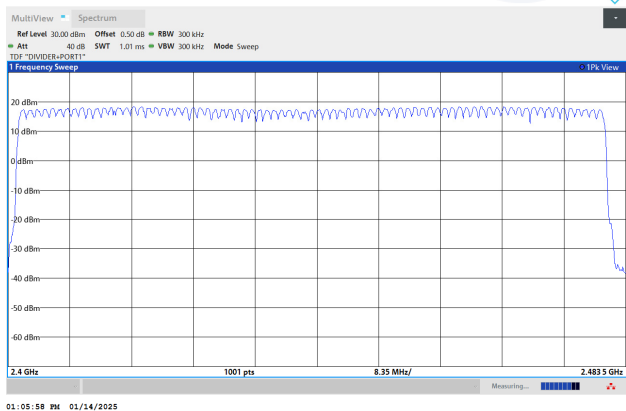
π /4DQPSK



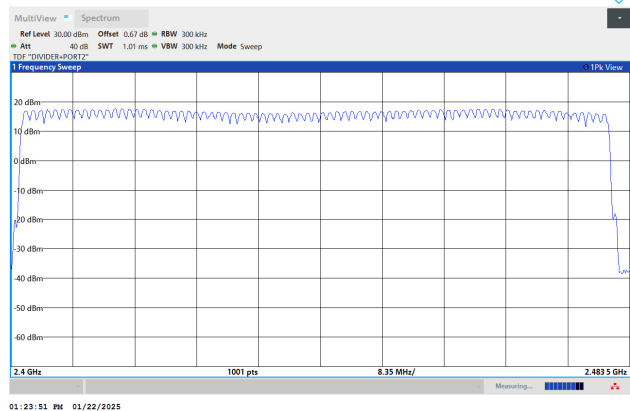
π /4DQPSK



8DPSK

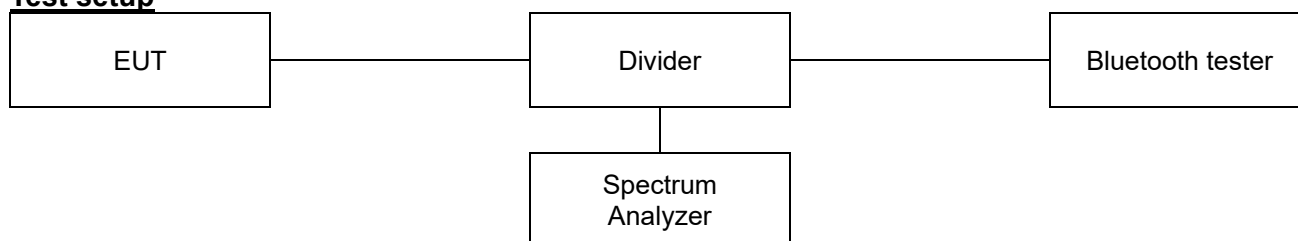


8DPSK



8.5. Time of occupancy(Dwell time)

Test setup



Limit

According to §15.247(a)(1)(iii),

Frequency hopping systems in the 2 400-2 483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test procedure

ANSI C63.10-2013 - Section 7.8.4

Test settings

- Span: Zero span, centered on a hopping channel.
- $RBW \leq \text{channel spacing}$ and $\gg 1 / T$, where T is the expected dwell time per channel.
- Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- Detector function: Peak.
- Trace: Max hold.
- Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Test results

ANT1

- Non-AFH

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.380	800.000	79	0.122	0.400
DH3		1.638	400.000		0.262	
DH5		2.888	266.667		0.308	
2-DH1		0.385	800.000		0.123	
2-DH3		1.636	400.000		0.262	
2-DH5		2.888	266.667		0.308	
3-DH1		0.384	800.000		0.123	
3-DH3		1.634	400.000		0.261	
3-DH5		2.888	266.667		0.308	

- AFH

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.380	400.000	20	0.061	0.400
DH3		1.638	200.000		0.131	
DH5		2.884	133.333		0.154	
2-DH1		0.385	400.000		0.062	
2-DH3		1.638	200.000		0.131	
2-DH5		2.888	133.333		0.154	
3-DH1		0.384	400.000		0.061	
3-DH3		1.634	200.000		0.131	
3-DH5		2.884	133.333		0.154	

Notes:

1. Non-AFH

- Period Time: 0.4 sec x 79 channels = 31.6 sec
- Result (s)= (Hopping rate (hop/s/slot) / 79 channels) x 31.6 sec x Pulse width (ms)

2. AFH

- Period Time: 0.4 sec x 20 channels = 8 sec
- Result (s)= (Hopping rate (hop/s/slot) / 20 channels) x 8 sec x Pulse width (ms)

ANT2

- Non-AFH

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.380	800.000	79	0.122	0.400
DH3		1.638	400.000		0.262	
DH5		2.888	266.667		0.308	
2-DH1		0.385	800.000		0.123	
2-DH3		1.638	400.000		0.262	
2-DH5		2.888	266.667		0.308	
3-DH1		0.385	800.000		0.123	
3-DH3		1.634	400.000		0.261	
3-DH5		2.888	266.667		0.308	

- AFH

Modulation	Frequency (MHz)	Pulse Width (ms)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.380	400.000	20	0.061	0.400
DH3		1.638	200.000		0.131	
DH5		2.888	133.333		0.154	
2-DH1		0.385	400.000		0.062	
2-DH3		1.636	200.000		0.131	
2-DH5		2.884	133.333		0.154	
3-DH1		0.385	400.000		0.062	
3-DH3		1.636	200.000		0.131	
3-DH5		2.888	133.333		0.154	

Notes:

1. Non-AFH

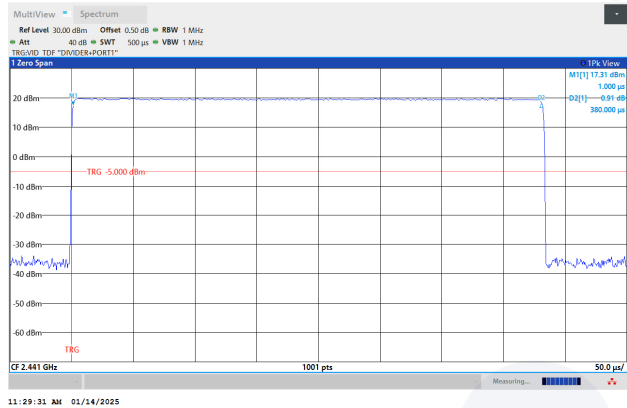
- Period Time: 0.4 sec x 79 channels = 31.6 sec
- Result (s)= (Hopping rate (hop/s/slot) / 79 channels) x 31.6 sec x Pulse width (ms)

2. AFH

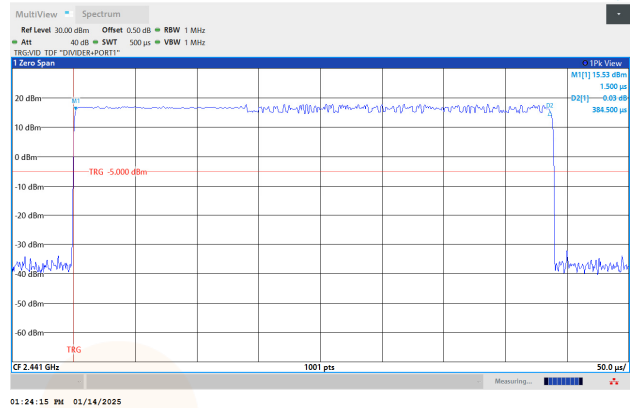
- Period Time: 0.4 sec x 20 channels = 8 sec
- Result (s)= (Hopping rate (hop/s/slot) / 20 channels) x 8 sec x Pulse width (ms)

ANT1

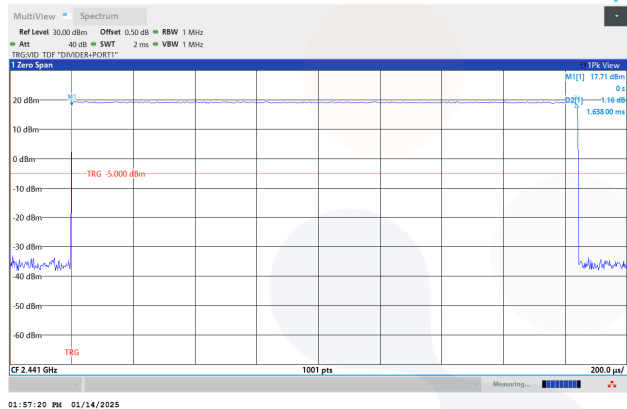
GFSK / DH1



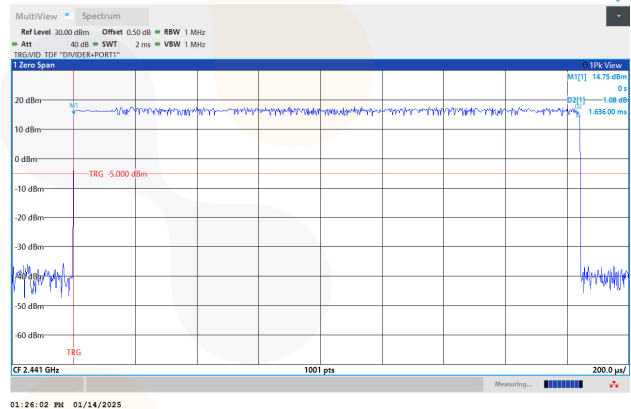
π /4DQPSK / 2-DH1



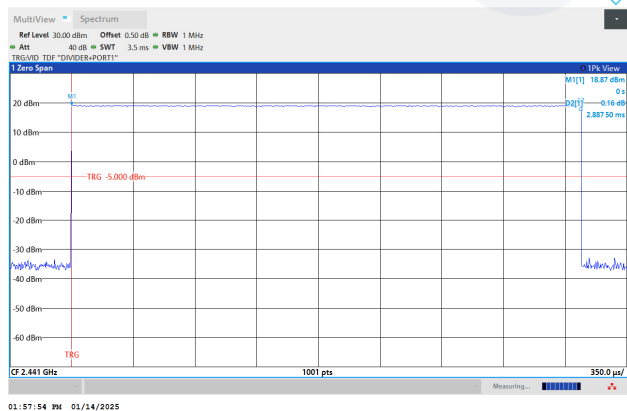
GFSK / DH3



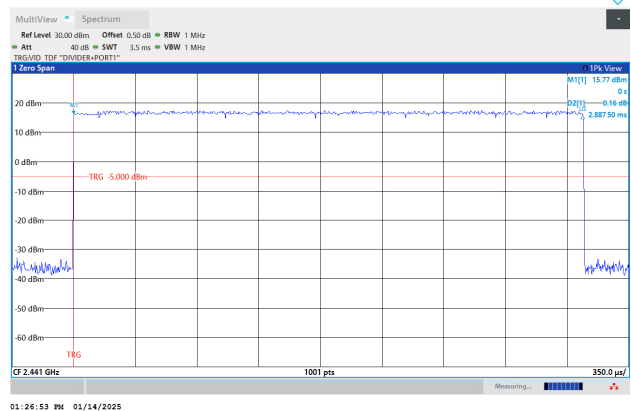
π /4DQPSK / 2-DH3



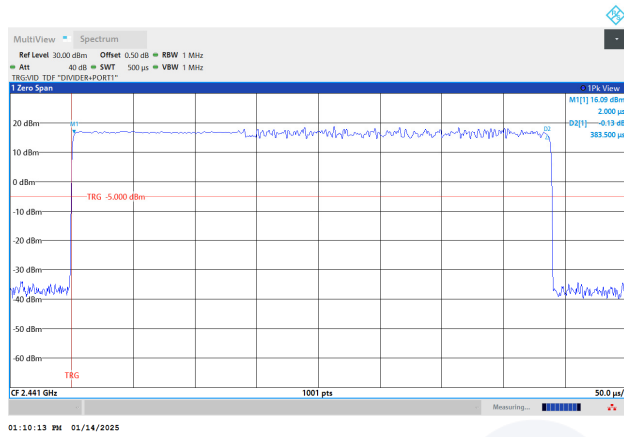
GFSK / DH5



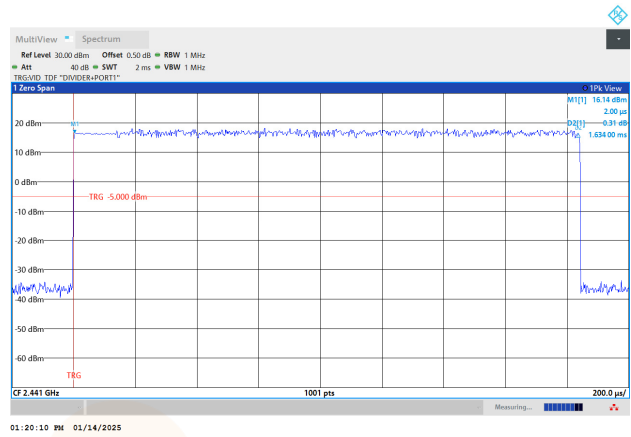
π /4DQPSK / 2-DH5



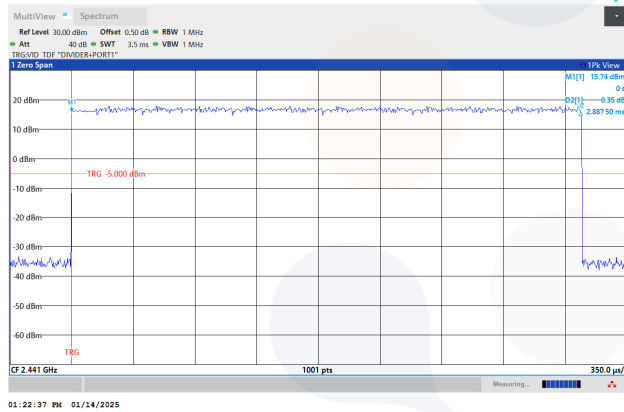
8DPSK / 3-DH1



8DPSK / 3-DH3



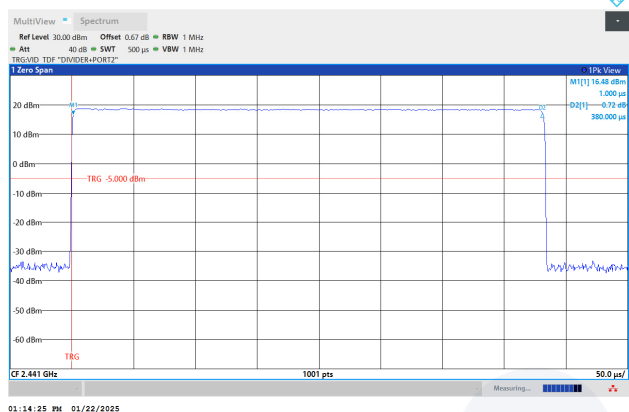
8DPSK / 3-DH5



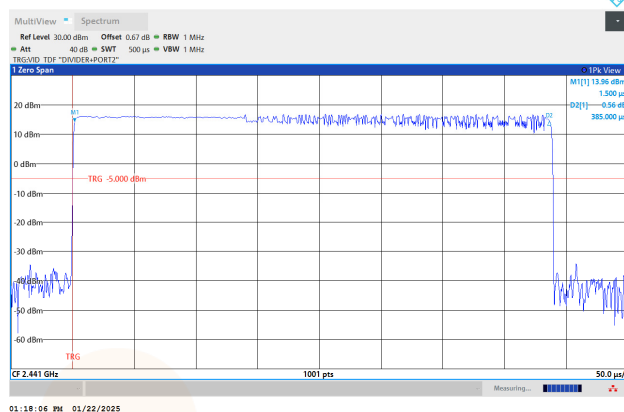
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ANT2

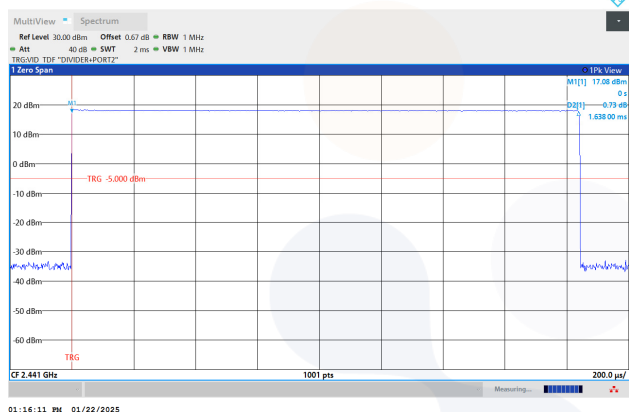
GFSK / DH1



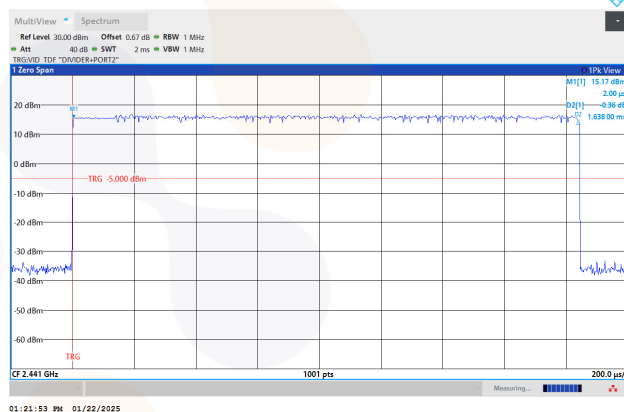
$\pi/4$ DQPSK / 2-DH1



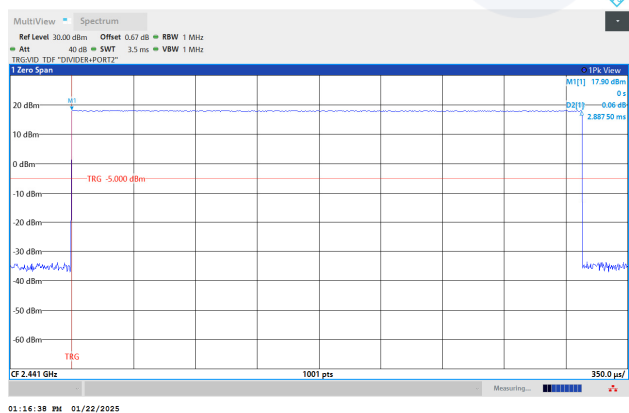
GFSK / DH3



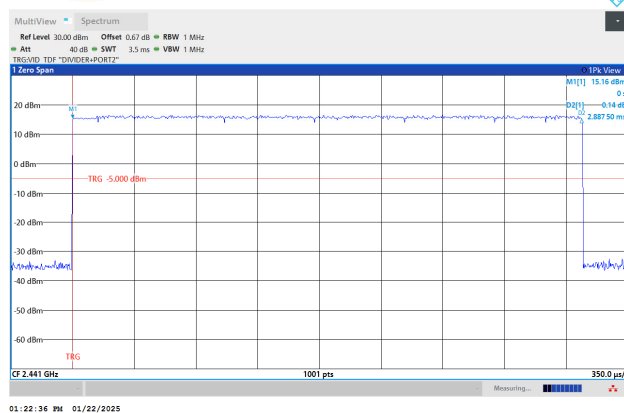
$\pi/4$ DQPSK / 2-DH3



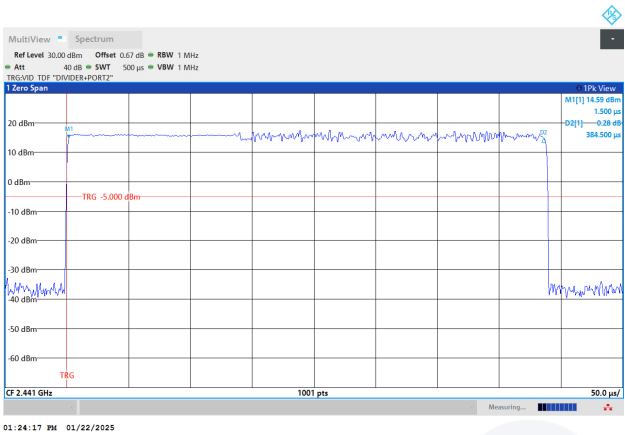
GFSK / DH5



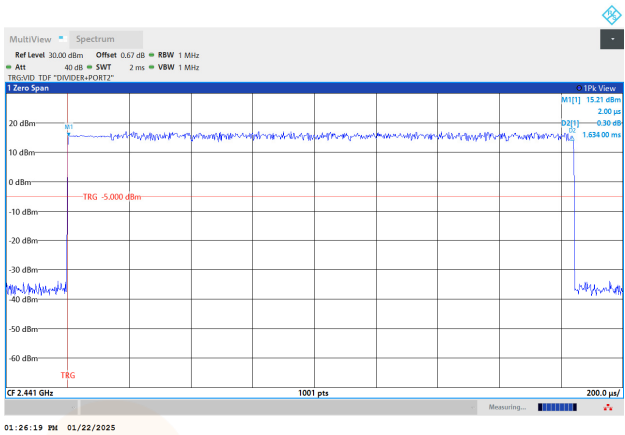
$\pi/4$ DQPSK / 2-DH5



8DPSK / 3-DH1



8DPSK / 3-DH3



8DPSK / 3-DH5

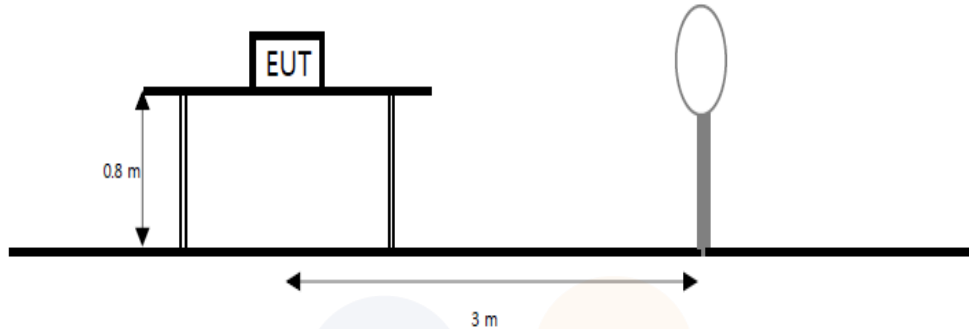


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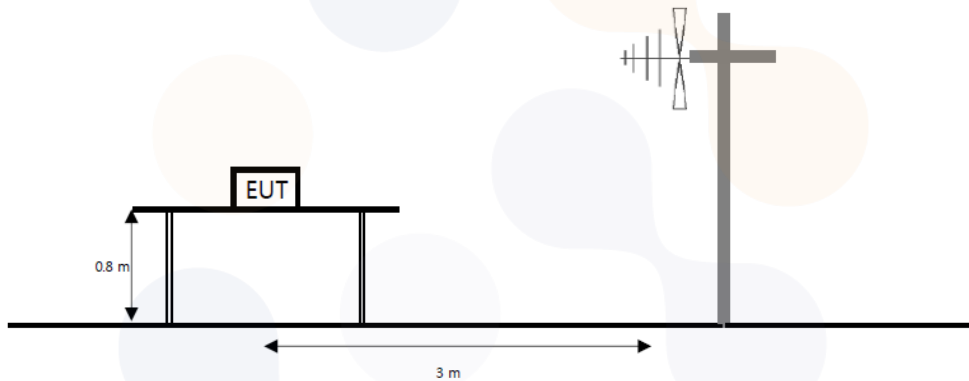
8.6. Radiated spurious emissions & band edge

Test setup

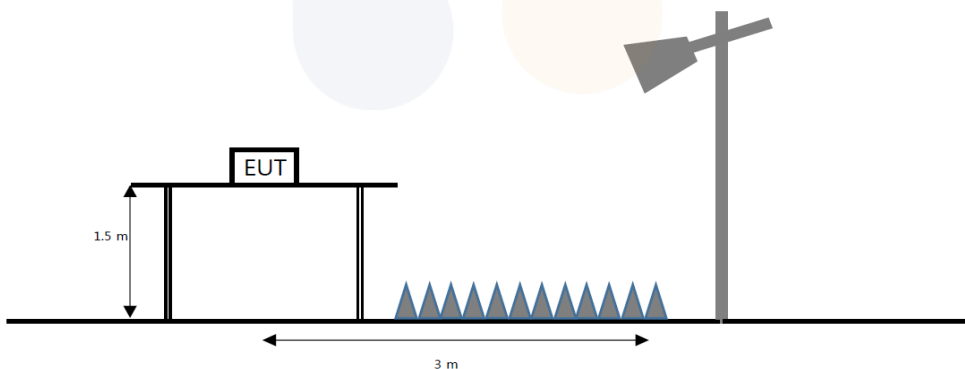
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions



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 ($\mu V/m$)	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 25	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 $\times$ 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

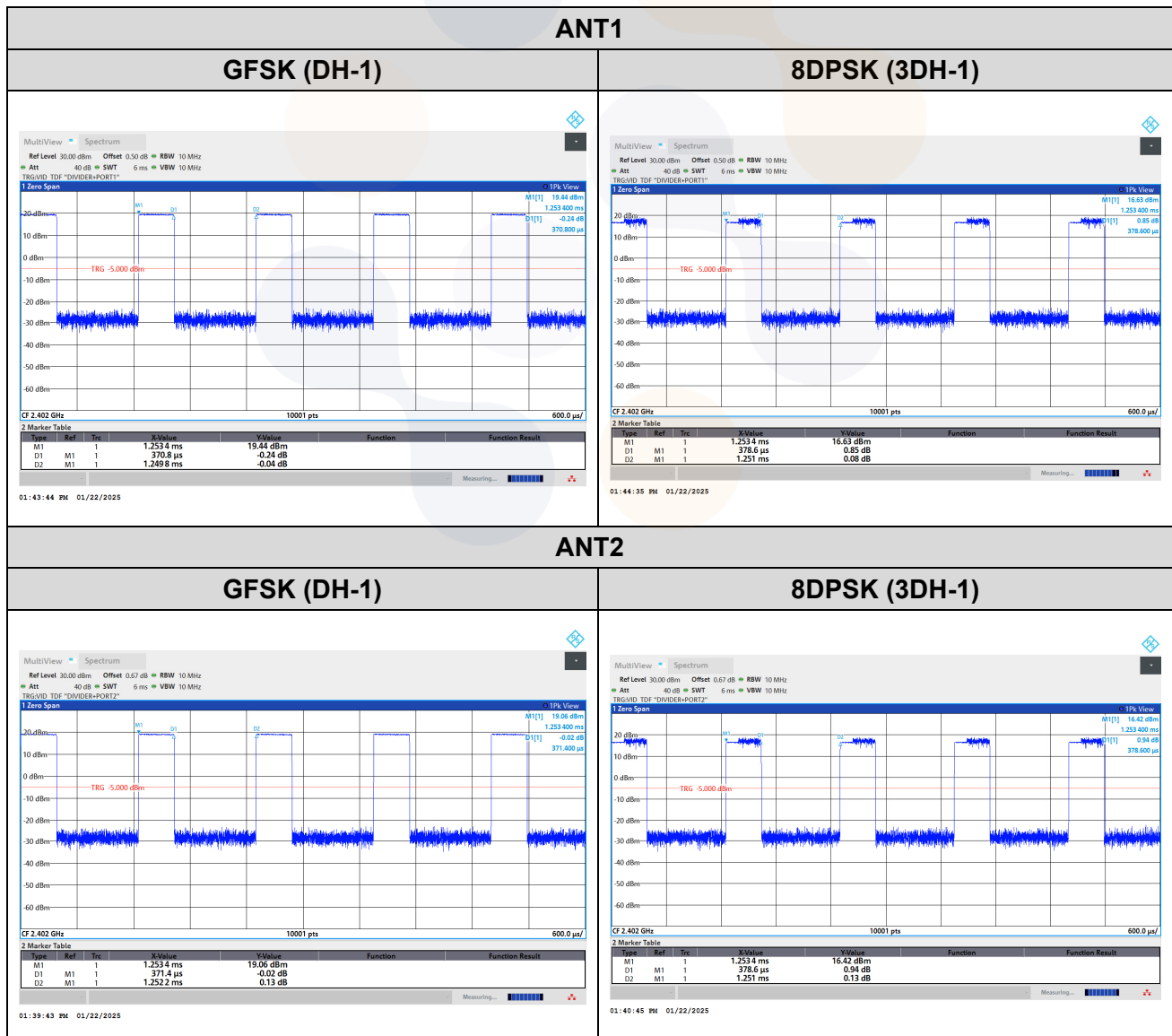
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 MHz
3. VBW = $1/T \geq 1$ Hz
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold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

Notes:

- 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 3 kHz ($\geq 1/T$) for Average detection (AV) at frequency above 1 GHz.

According to ANSI C63.10-2013, for average measurement during radiation test, Reduced VBW shall be greater than $[1/(\text{minimum transmitter on time})]$ and no less than 1 Hz.

Test mode		Period (ms)	On time (ms)	Reduced VBW (Hz)
ANT1	GFSK	1.249 8	0.370 8	2 696.872
	8DPSK	1.251 0	0.378 6	2 641.310
ANT2	GFSK	1.252 2	0.371 4	2 692.515
	8DPSK	1.251 0	0.378 6	2 641.310



Eurofins KCTL Co.,Ltd. 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea TEL: 82-70-5008-1021 FAX: 82-505-299-8311 www.kctl.co.kr	Report No.: KR25-SRF0029-A Page (35) of (68)	
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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.

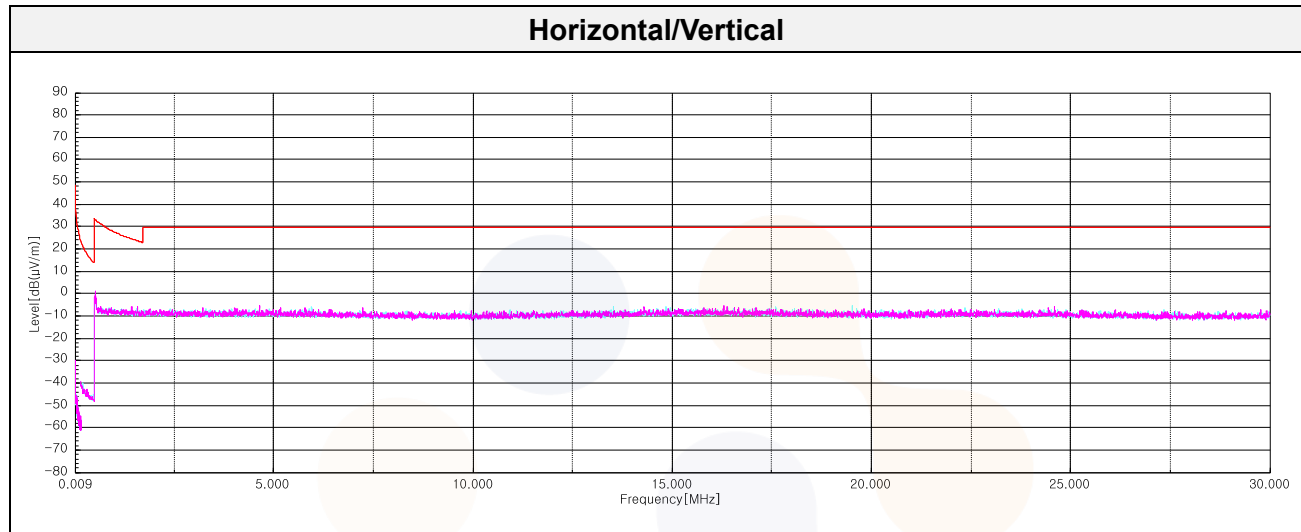
6. ¹⁾ means restricted band.

7. Above 1 GHz the worst results between two antenna polarizations (H and V) were documented in the test report.

8. Below 30 MHz frequency range, In order to search for the worst result, all orientations about parallel, perpendicular, and ground-parallel were investigated then reported. when the emission level was higher than 20 dB of the limit, then the following statement shall be made: "No spurious emissions were detected within 20 dB of the limit."

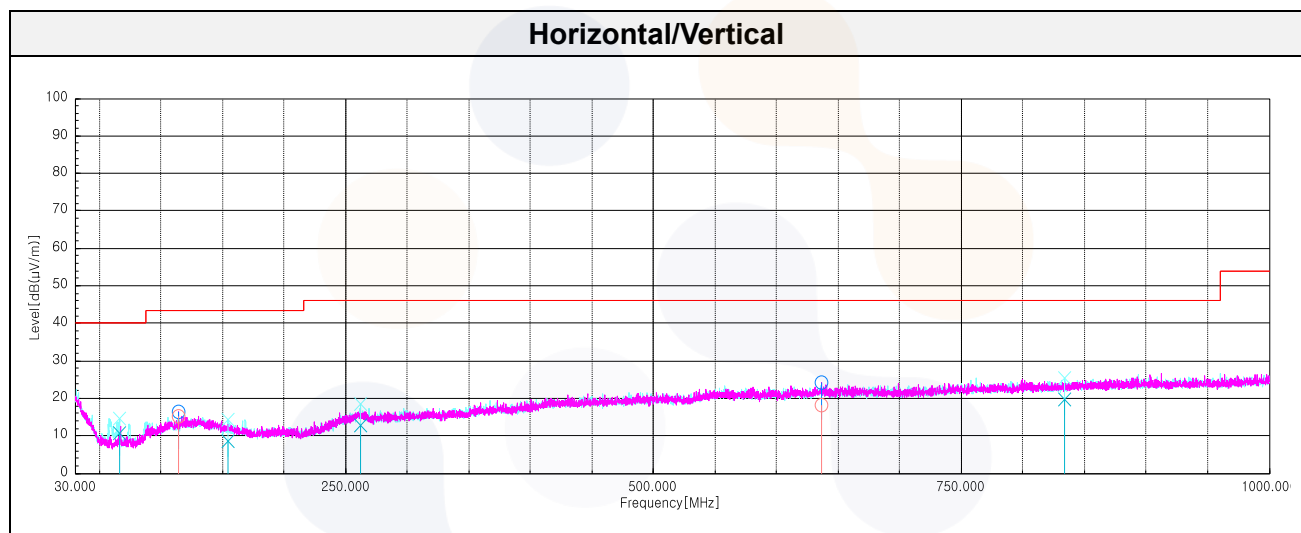
Test results (Below 30 MHz) – Worst case: ANT1_GFSK 2 402 MHz

Frequency	Pol.	Reading	Ant. 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								
No spurious emissions were detected within 20 dB of the limit.								



Test results (Below 1 000 MHz) – Worst case: ANT1_GFSK 2 402 MHz

Frequency	Pol.	Reading	Ant. 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								
66.38	V	30.10	12.38	-31.72	-	10.76	40.00	29.24
114.03 ¹⁾	H	29.00	17.51	-31.35	-	15.16	43.52	28.36
154.16	V	23.50	16.38	-31.22	-	8.66	43.52	34.86
261.95 ¹⁾	V	23.90	19.70	-30.93	-	12.67	46.02	33.35
636.37	H	23.40	25.00	-30.13	-	18.27	46.02	27.75
834.13	V	23.30	25.81	-29.53	-	19.58	46.02	26.44

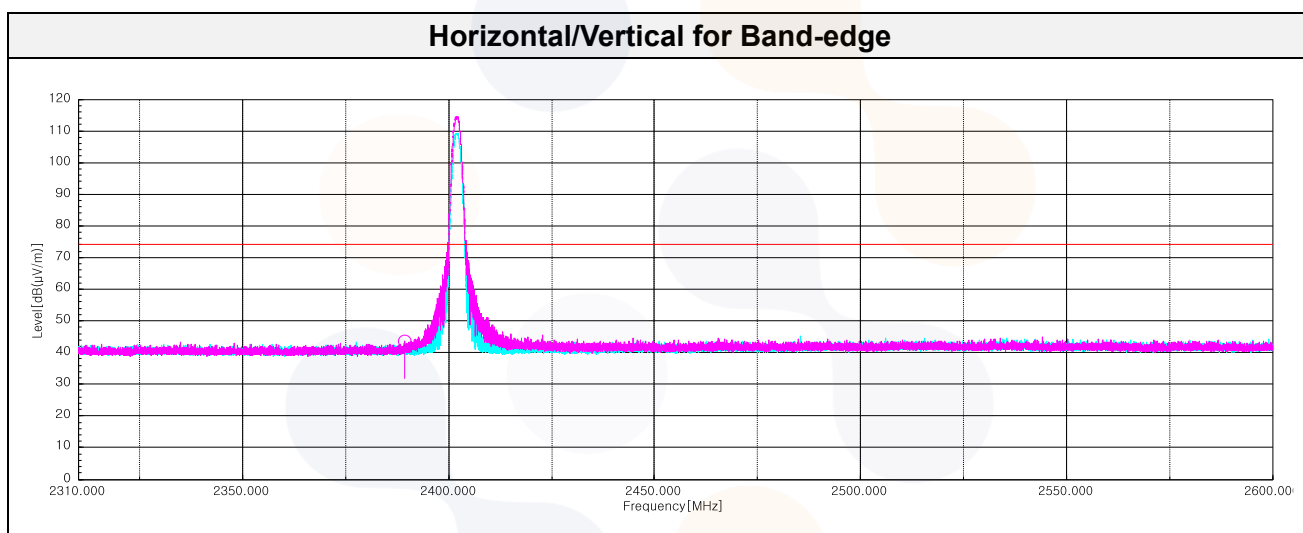


Test results (Above 1 000 MHz)

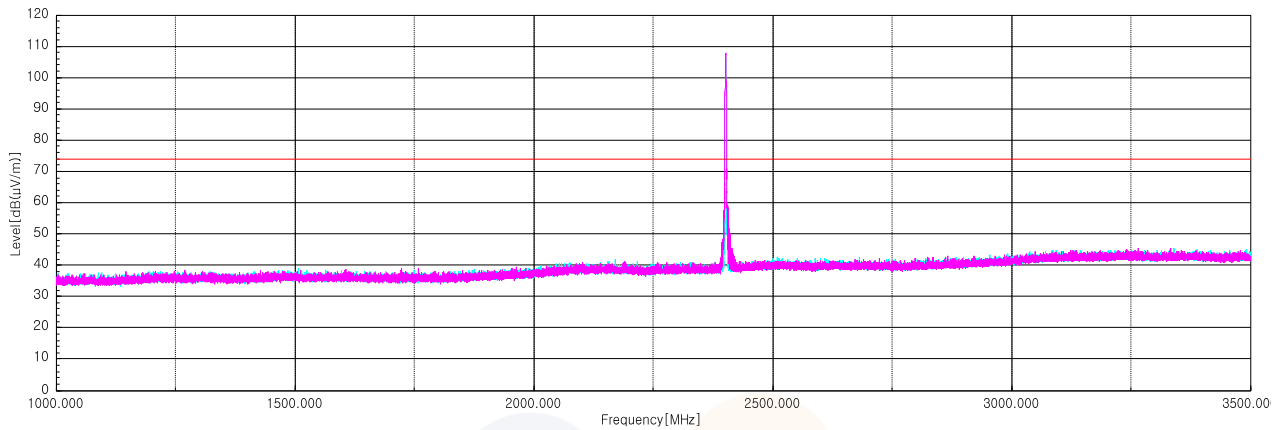
ANT1

GFSK Low Channel

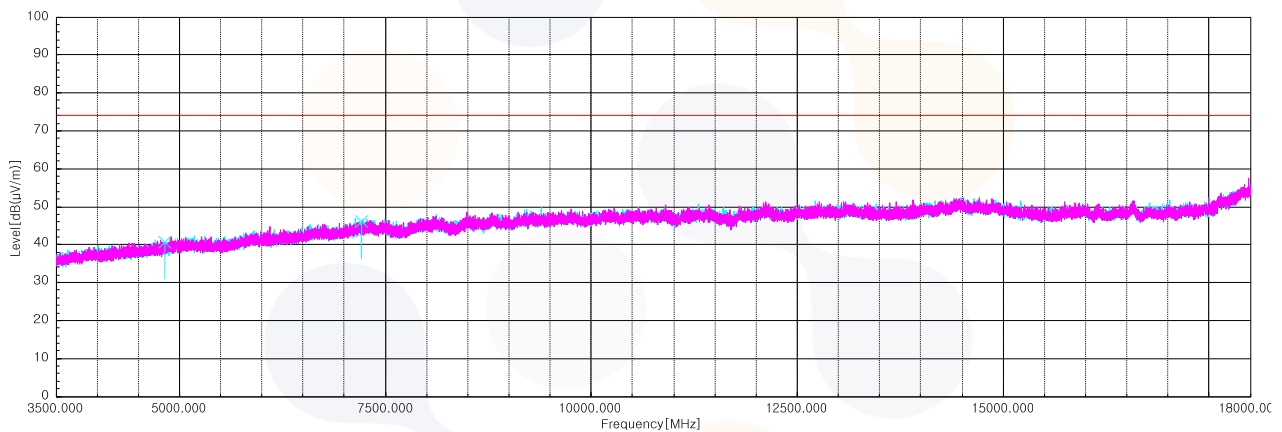
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 389.36 ¹⁾	H	46.80	27.20	-30.36	-	43.64	74.00	30.36
4 819.50 ¹⁾	V	52.10	32.42	-43.76	-	40.76	74.00	33.24
7 216.83	V	50.50	36.87	-41.33	-	46.04	74.00	27.96
Average Data								
No spurious emissions were detected within 20 dB of the limit.								



Horizontal/Vertical for 1 GHz ~ 3.5 GHz



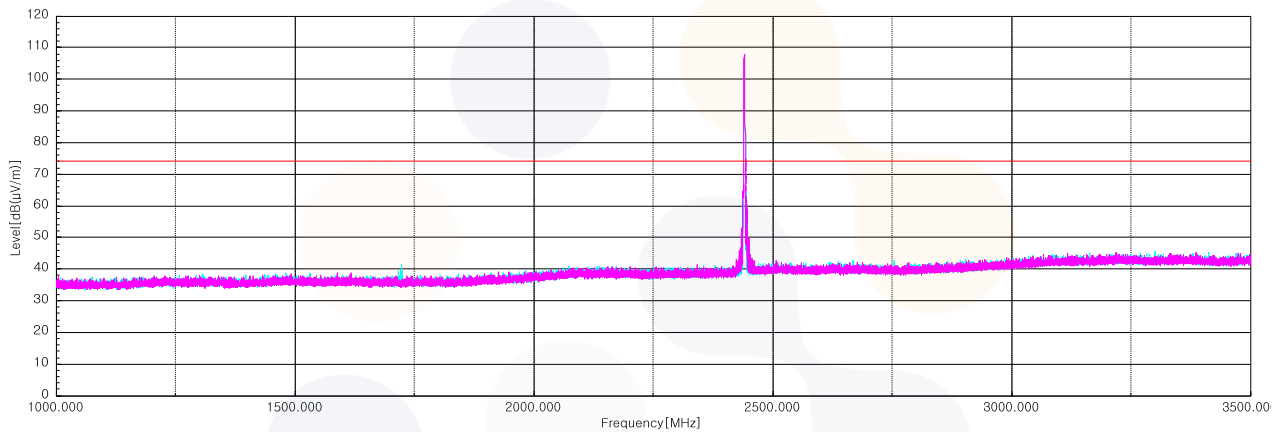
Horizontal/Vertical for 3.5 GHz ~ 18 GHz



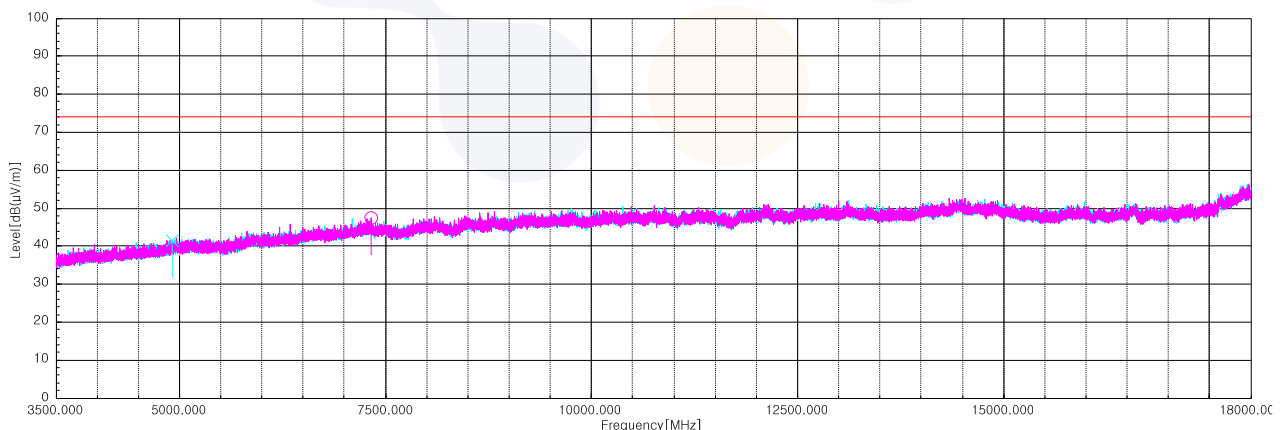
GFSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 907.47 ¹⁾	V	51.90	32.83	-43.37	-	41.36	74.00	32.64
7 325.58 ¹⁾	H	51.90	36.60	-41.28	-	47.22	74.00	26.78
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

Horizontal/Vertical for 1 GHz ~ 3.5 GHz

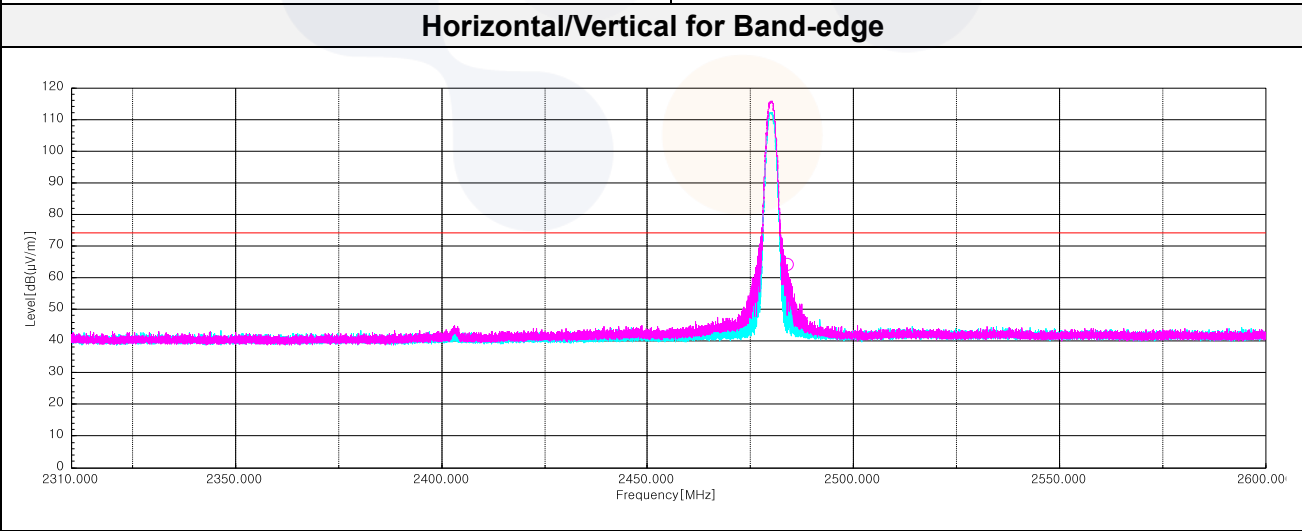
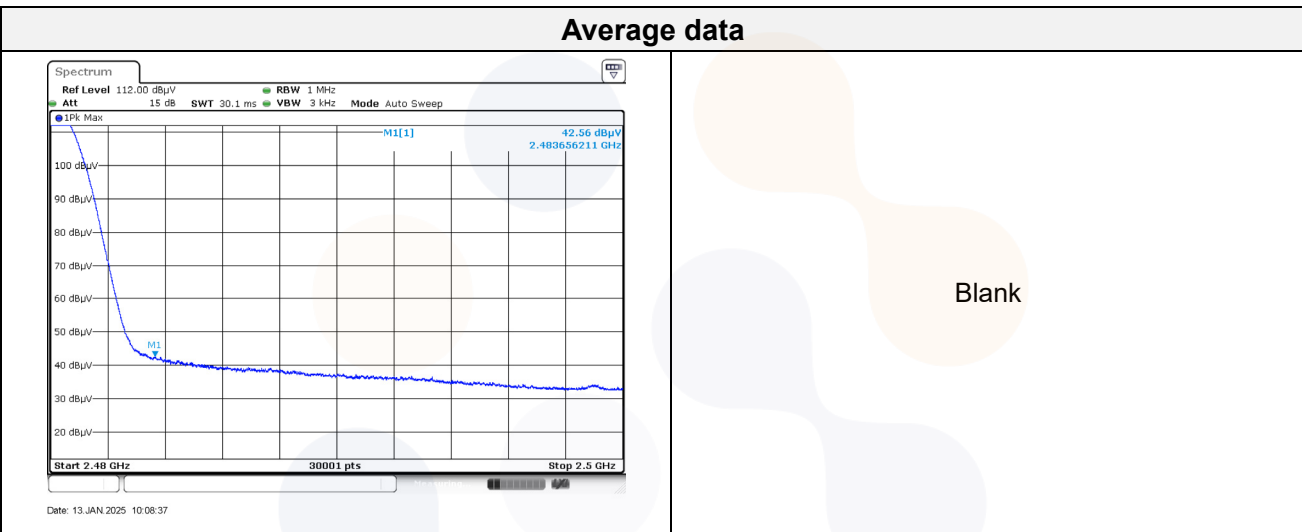


Horizontal/Vertical for 3.5 GHz ~ 18 GHz

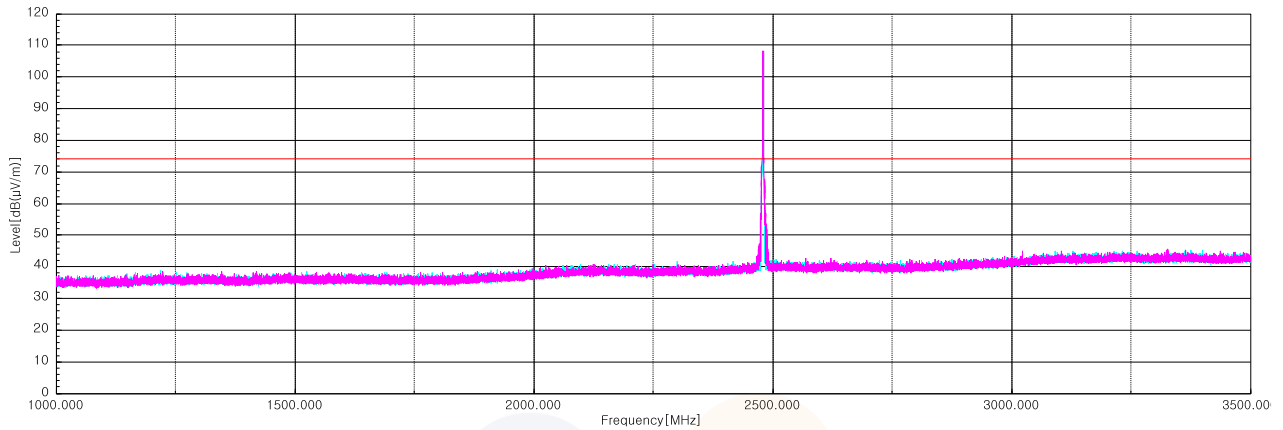


GFSK_High Channel

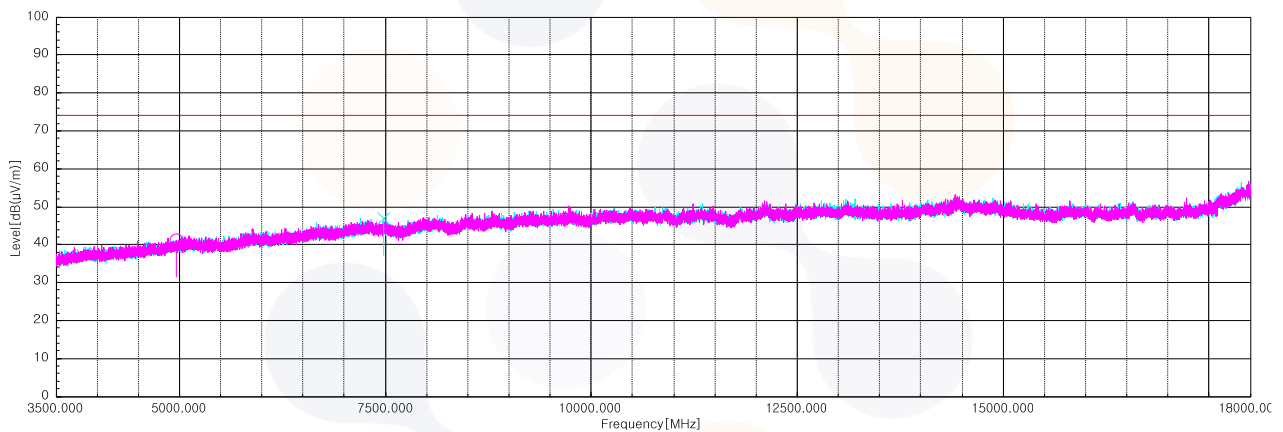
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
2 483.66 ¹⁾	H	66.50	27.84	-30.26	-	64.08	74.00	9.92
4 956.77 ¹⁾	H	51.50	33.03	-43.20	-	41.33	74.00	32.67
7 479.28 ¹⁾	V	51.90	36.34	-41.22	-	47.02	74.00	26.98
Average Data								
2 483.66 ¹⁾	H	42.56	27.84	-30.26	-	40.14	54.00	13.86



Horizontal/Vertical for 1 GHz ~ 3.5 GHz

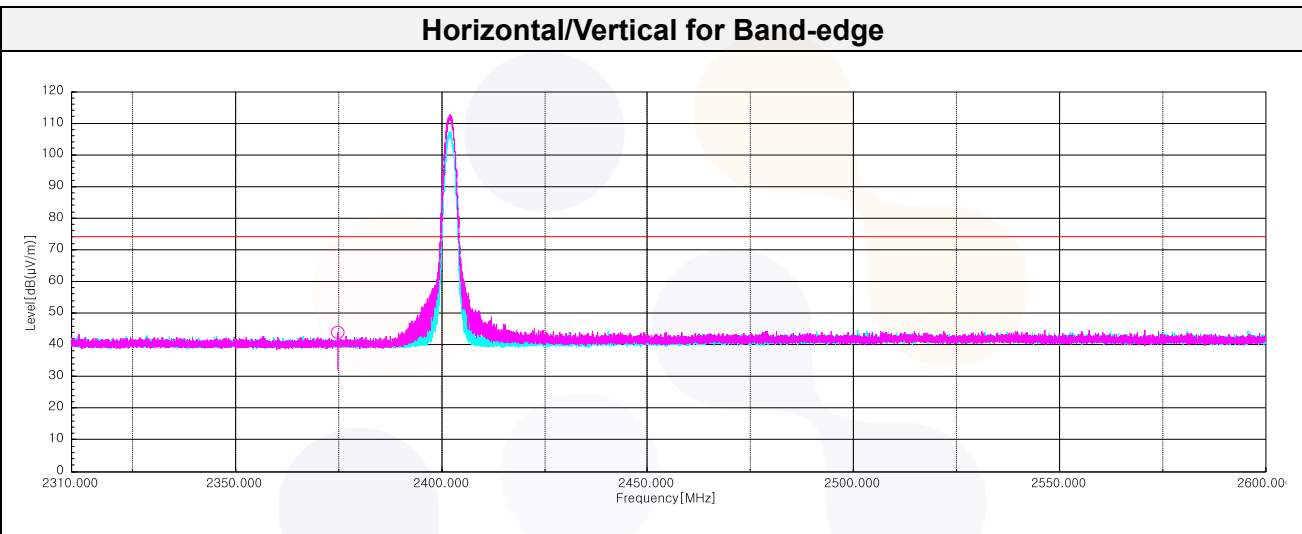


Horizontal/Vertical for 3.5 GHz ~ 18 GHz

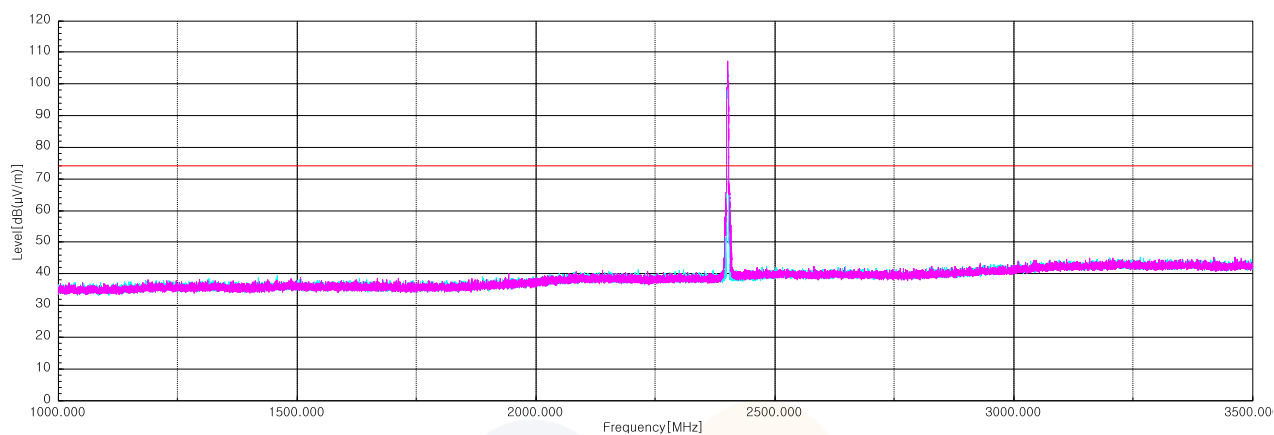


8DPSK Low Channel

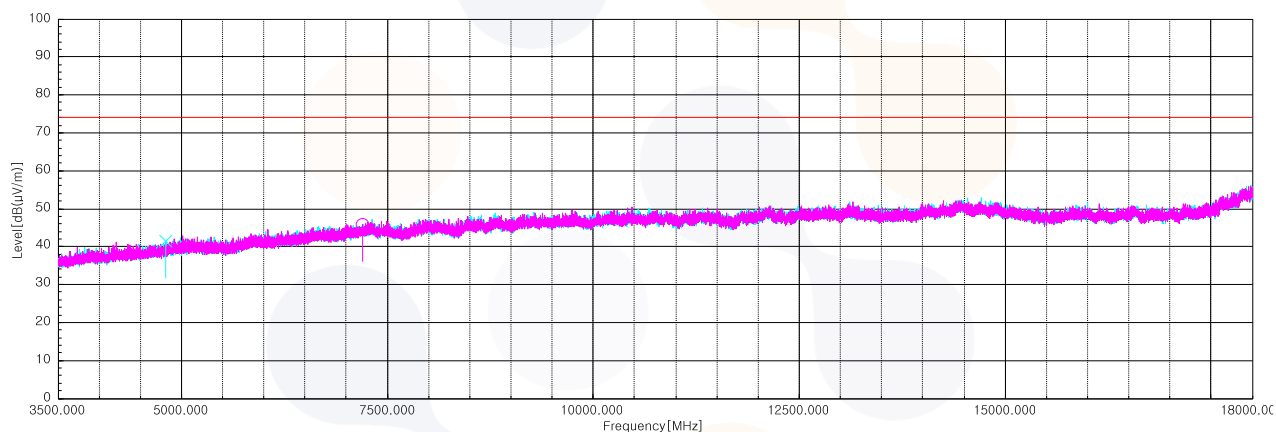
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μ V))	(dB)	(dB)	(dB)	(dB(μ V/m))	(dB(μ V/m))	(dB)
Peak data								
2 374.85 ¹⁾	H	47.10	27.25	-30.36	-	43.99	74.00	30.01
4 814.67 ¹⁾	V	52.70	32.39	-43.79	-	41.30	74.00	32.70
7 201.85	H	50.30	36.81	-41.31	-	45.80	74.00	28.20
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



8DPSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data								
4 851.88 ¹⁾	H	51.90	32.61	-43.62	-	40.89	74.00	33.11
7 300.45 ¹⁾	H	51.30	36.70	-41.25	-	46.75	74.00	27.25
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

