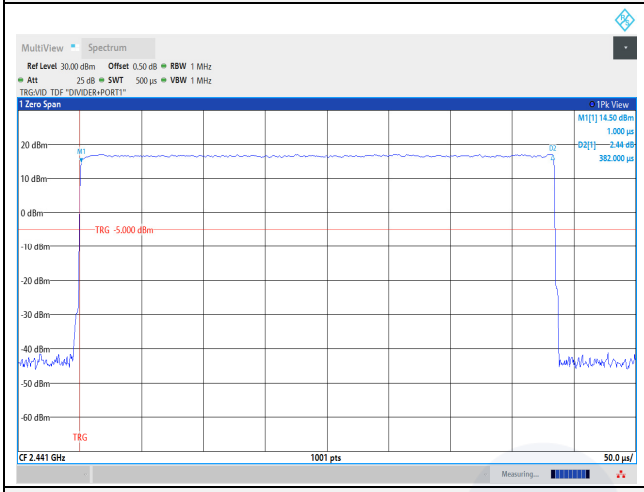
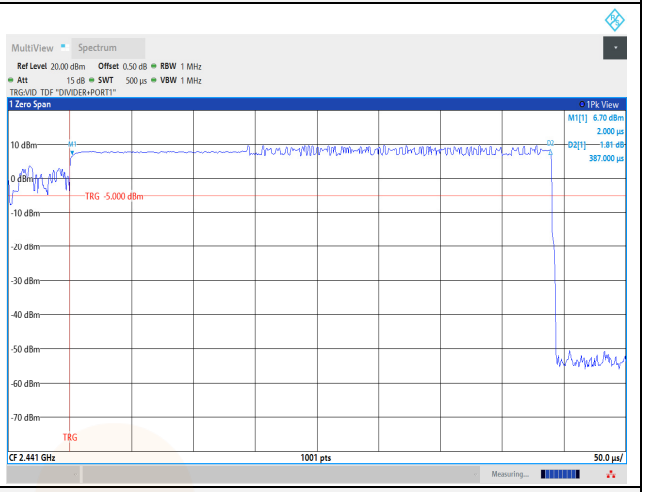
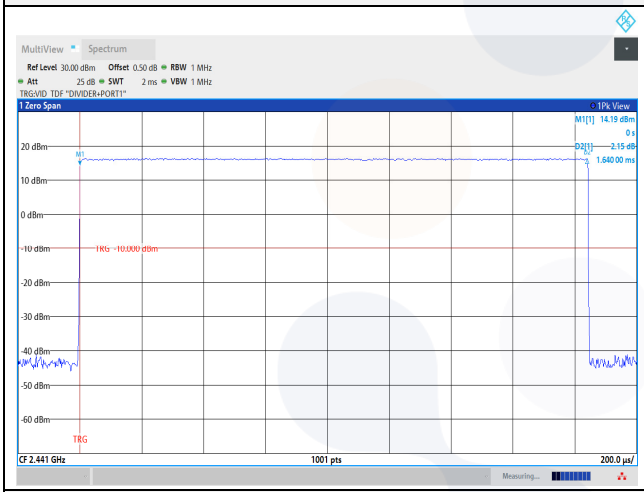
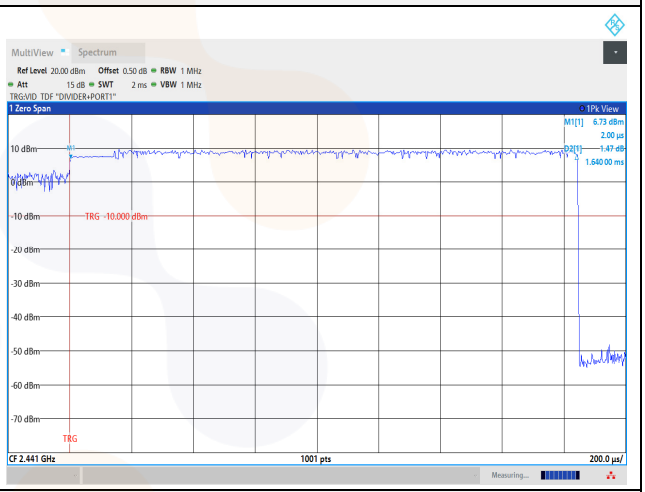
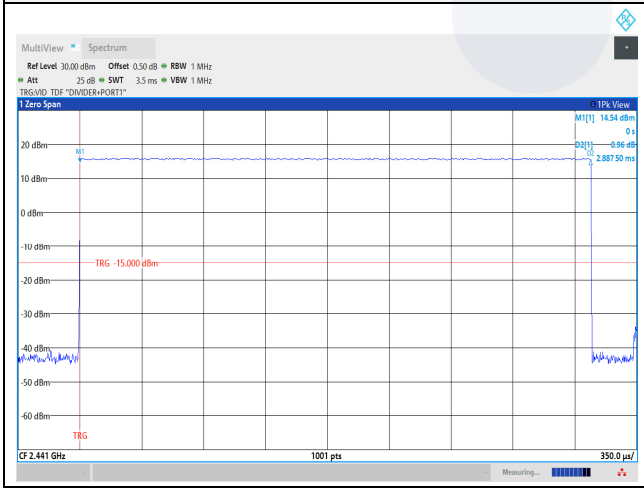
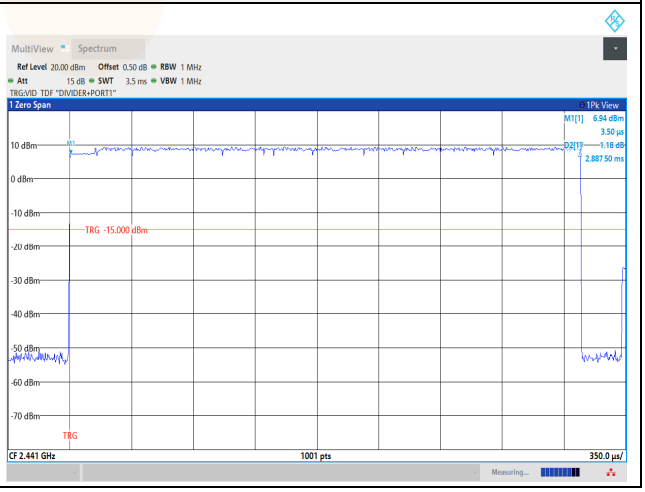
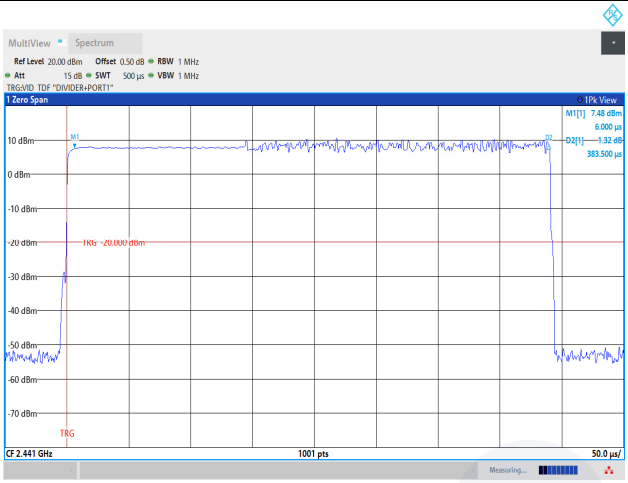
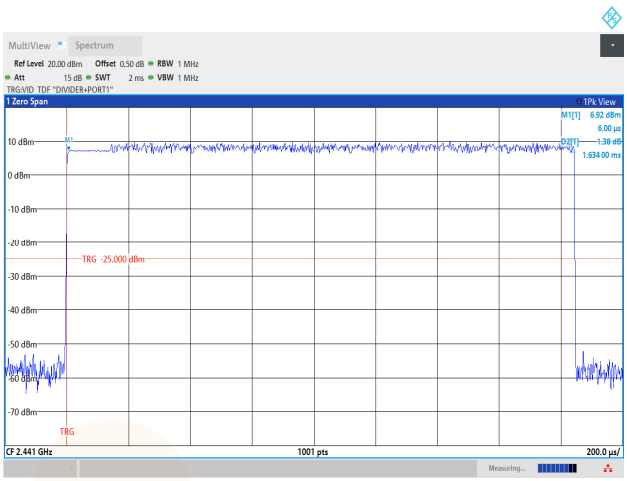
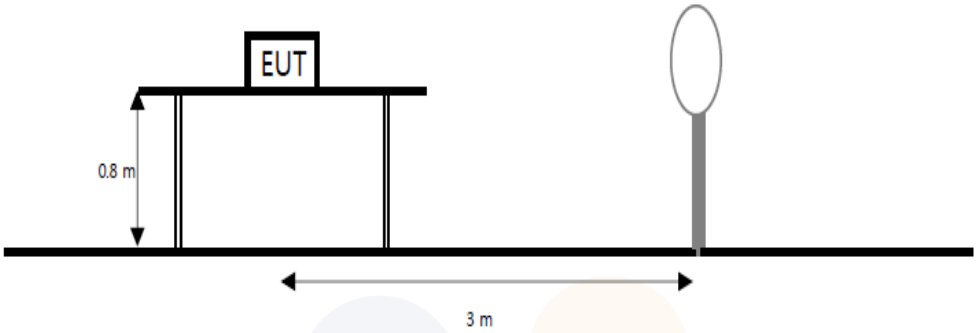
GFSK / DH1	π/4DQPSK / 2-DH1
	
GFSK / DH3	**π/4DQPSK / 2-DH3**
	
GFSK / DH5	**π/4DQPSK / 2-DH5**
	

8DPSK / 3-DH1	8DPSK / 3-DH3
	
8DPSK / 3-DH5	
	Blank

7.6. Radiated spurious emissions & band edge

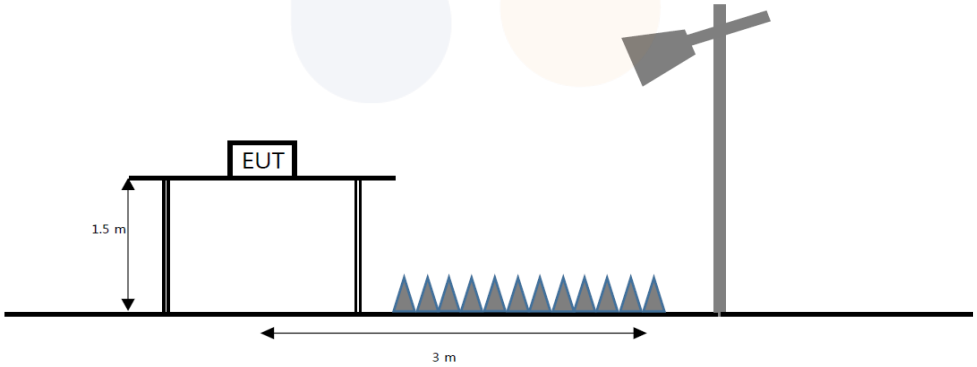
Test setup

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



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

The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ 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 (㎒)	Field strength (㎶/m)	Measurement distance (m)
0.009 - 0.490	2 400/F(㎑)	300
0.490 - 1.705	24 000/F(㎑)	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 ㎒, 76–88 ㎒, 174–216 ㎒ or 470–806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section15.231 and 15.241.

According to section 15.205(a) and (b),

Only spurious emissions are permitted in any of the frequency bands listed below:

㎒	㎒	㎒	㎓
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	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6
13.36 - 13.41			

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 ㎒, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 ㎒, 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 ≥ (3×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 ㎑ to 150 ㎑	200 ㎐ to 300 ㎐
0.15 ㎒ to 30 ㎒	9 ㎑ to 10 ㎑
30 ㎒ to 1 000 ㎒	100 ㎑ to 120 ㎑
> 1 000 ㎒	1 ㎒

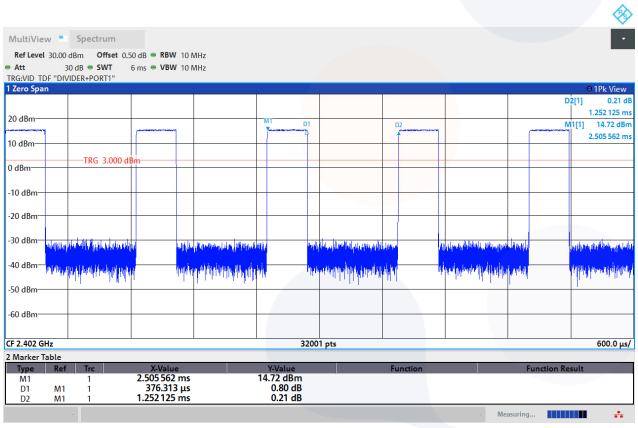
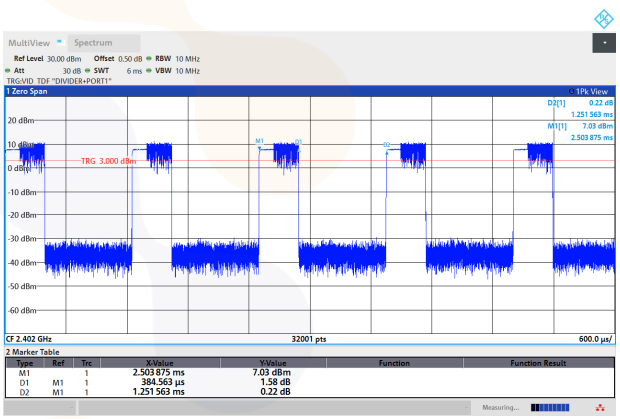
Average field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 ㎒
3. VBW = 1/T ≥ 1 ㎐
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 ㎒ for Peak detection and frequency above 1 ㎓. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is 3 ㎑(≥1/T) for Average detection (AV) at frequency above 1 ㎓.
   According to ANSI C63.10-2013, for average measurement during radiation test, Reduced VBW shall be greater than [1/(minimum transmitter on time)] and no less than 1 ㎐.

Test mode	Period (㎳)	On time (㎳)	Reduced VBW (㎐)
GFSK	1.252 125	0.376 313	2 657.36
8DPSK	1.251 563	0.384 563	2 600.35

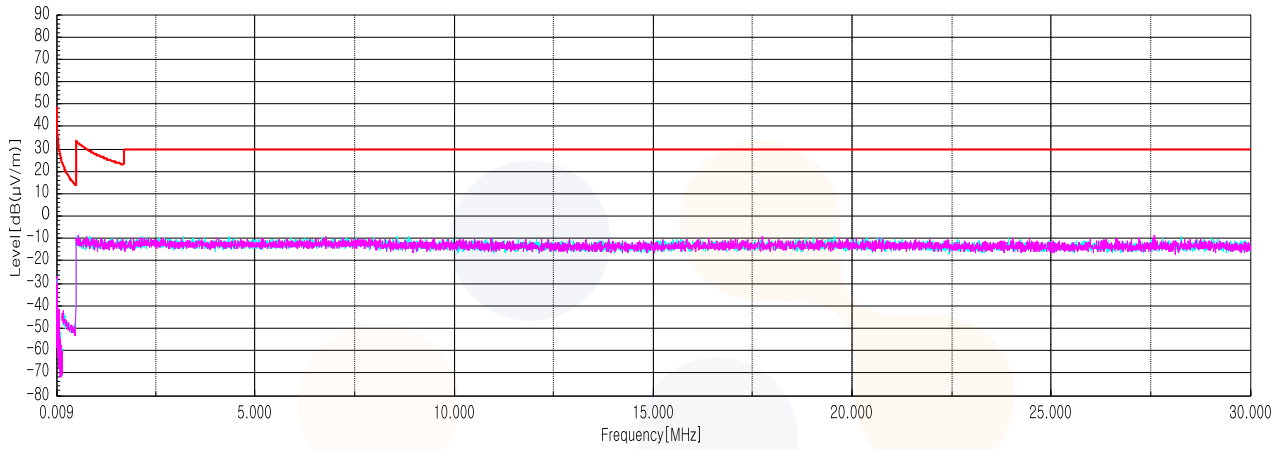
GFSK (DH-1)	8DPSK (3DH-1)
	

2. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. F_d = 40log(D_m/Ds)
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. F_d = 20log(D_m/Ds)
   Where:
   F_d= Distance factor in ㏈
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
3. Factors(㏈) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
4. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ 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 ㎓ the worst results between two antenna polarizations (H and V) were documented in the test report.
8. Below 30 ㎒ 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 ㏈ of the limit, then the following statement shall be made: “No spurious emissions were detected within 20 ㏈ of the limit.”

Test results (Below 30 ㎒) – Worst case: GFSK 2 480 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
No spurious emissions were detected within 20 ㏈ of the limit.								

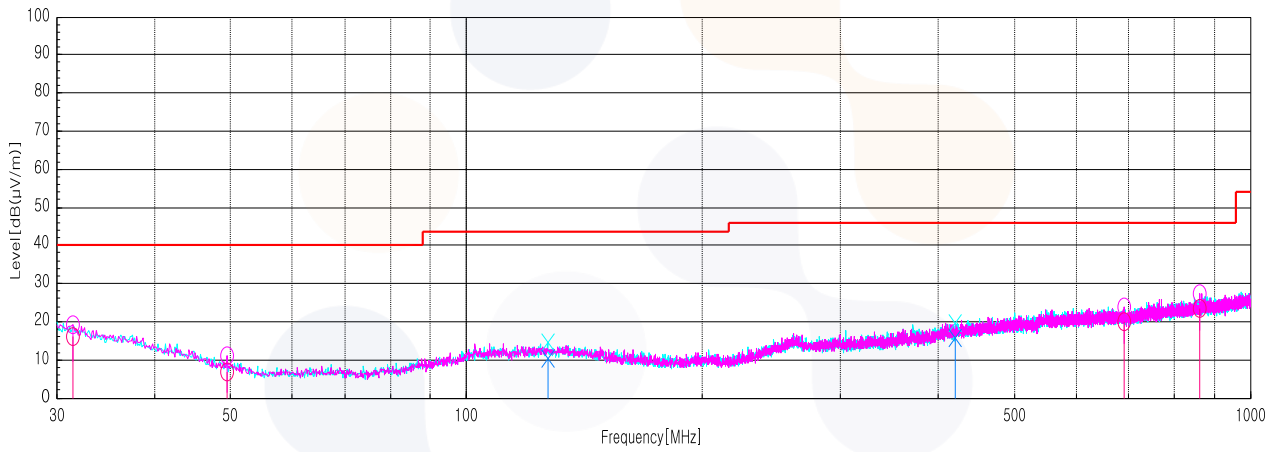
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: GFSK 2 480 ㎒

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
31.46	H	23.00	24.03	-30.91	-	16.12	40.00	23.88
49.52	H	23.30	14.10	-30.46	-	6.94	40.00	33.06
127.00[1)]	V	21.50	17.80	-29.02	-	10.28	43.50	33.22
420.43	V	19.00	22.10	-25.54	-	15.56	46.00	30.44
690.57	H	18.50	24.50	-23.24	-	19.76	46.00	26.24
862.50	H	19.00	25.80	-21.42	-	23.38	46.00	22.62

Horizontal/Vertical

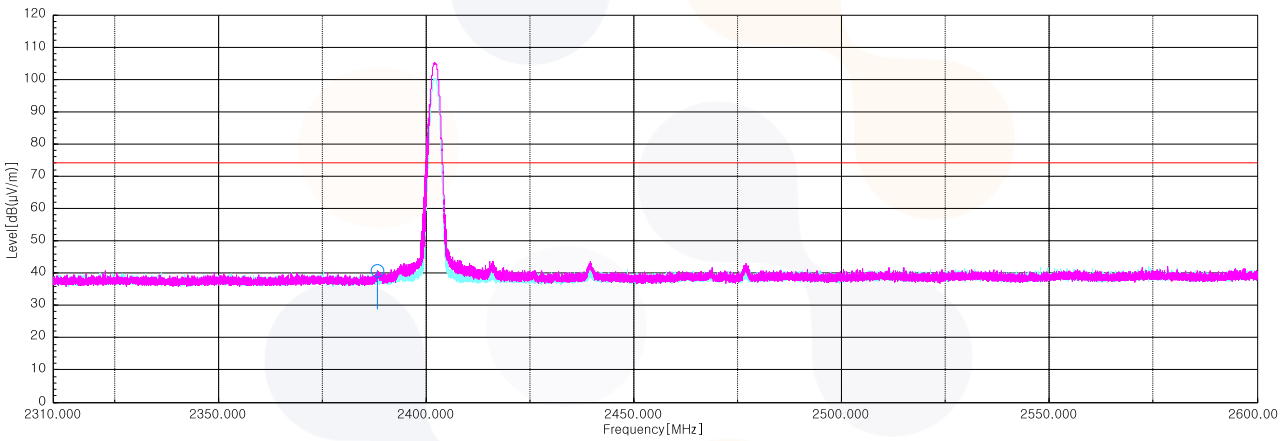


Test results (Above 1 000 ㎒)

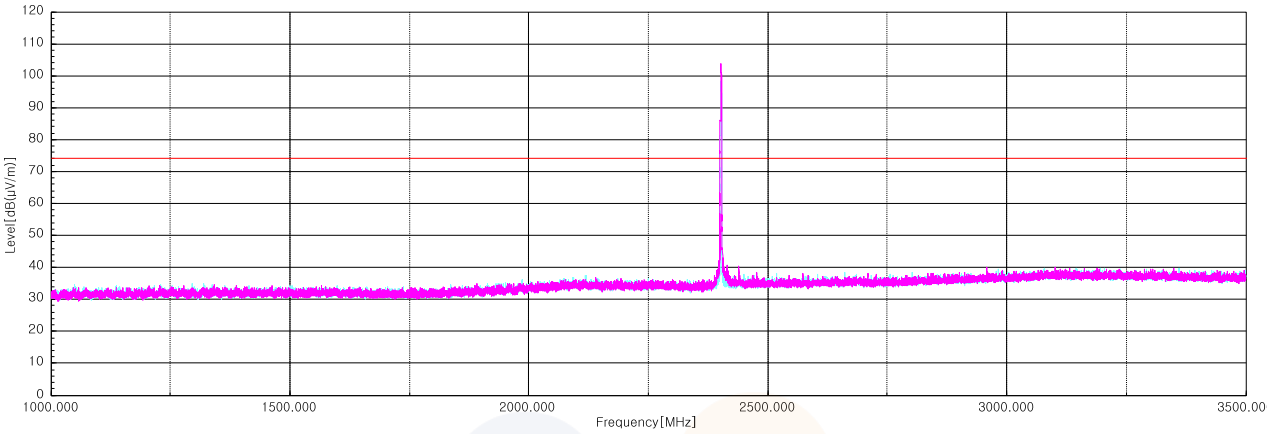
GFSK_Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 388.15[1)]	H	43.90	27.10	-30.39	-	40.61	74.00	33.39
4 800.17[1)]	V	54.50	32.30	-46.15	-	40.65	74.00	33.35
7 223.60	V	53.60	37.15	-44.35	-	46.40	74.00	27.60
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

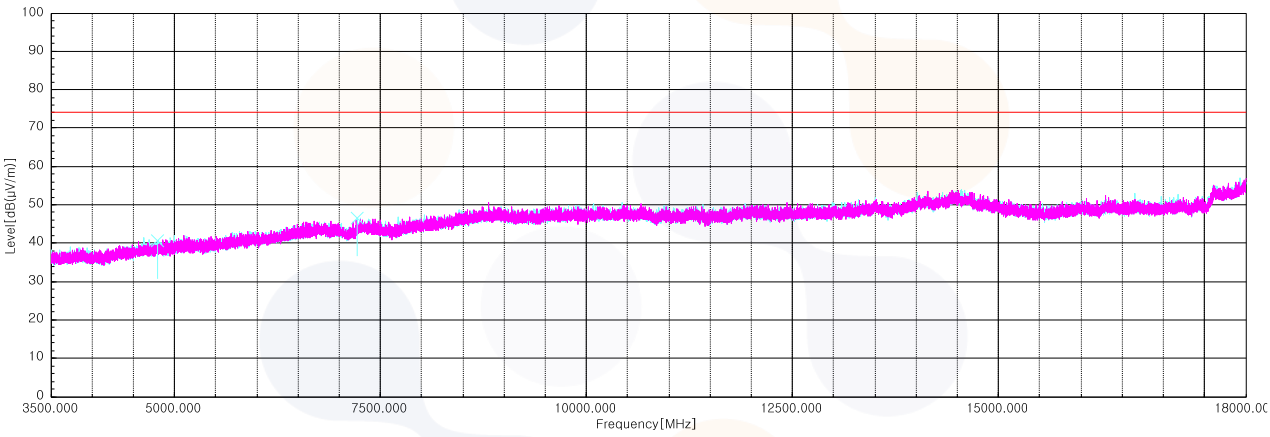
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



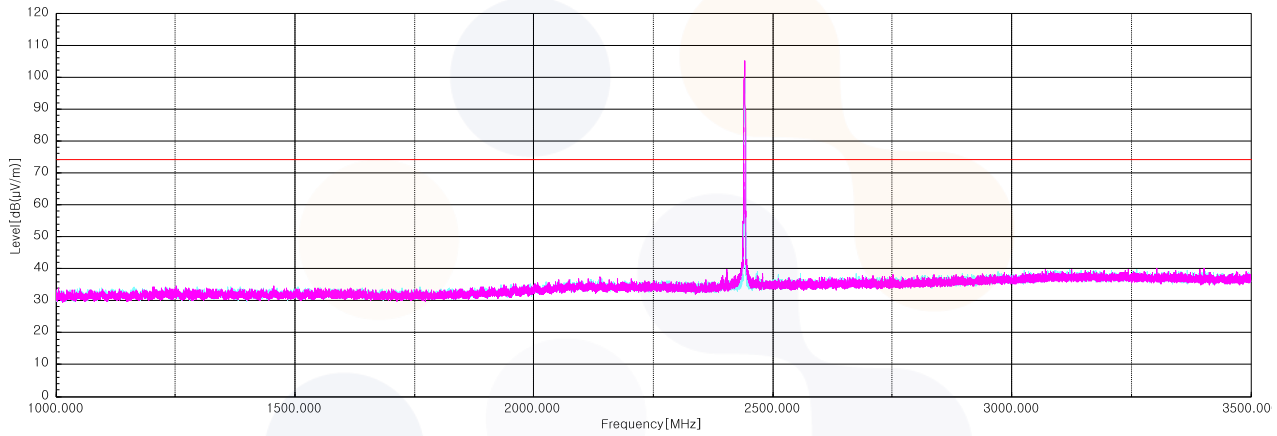
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



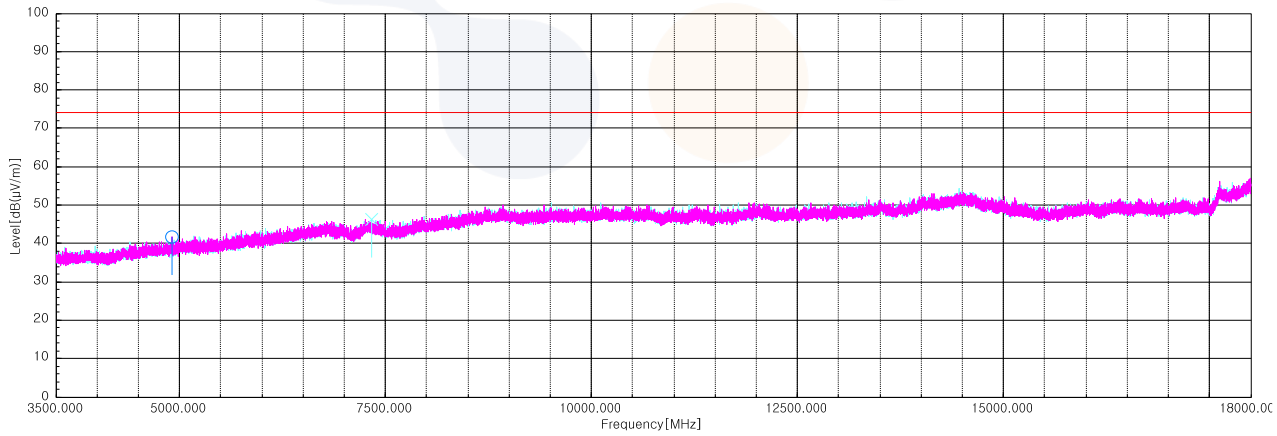
GFSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
4 908.92[1)]	H	54.50	32.72	-45.66	-	41.56	74.00	32.44
7 336.22[1)]	V	53.30	36.96	-44.27	-	45.99	74.00	28.01
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



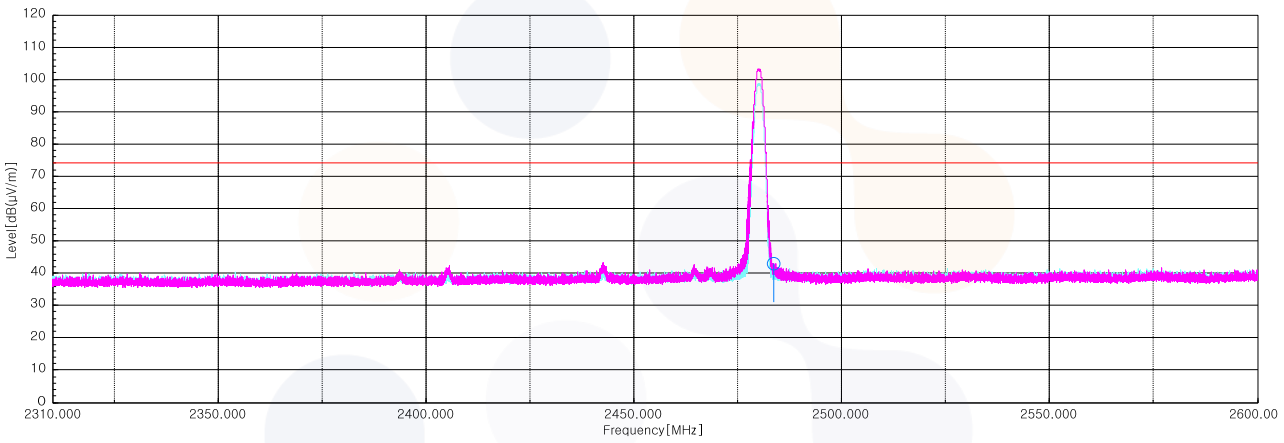
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



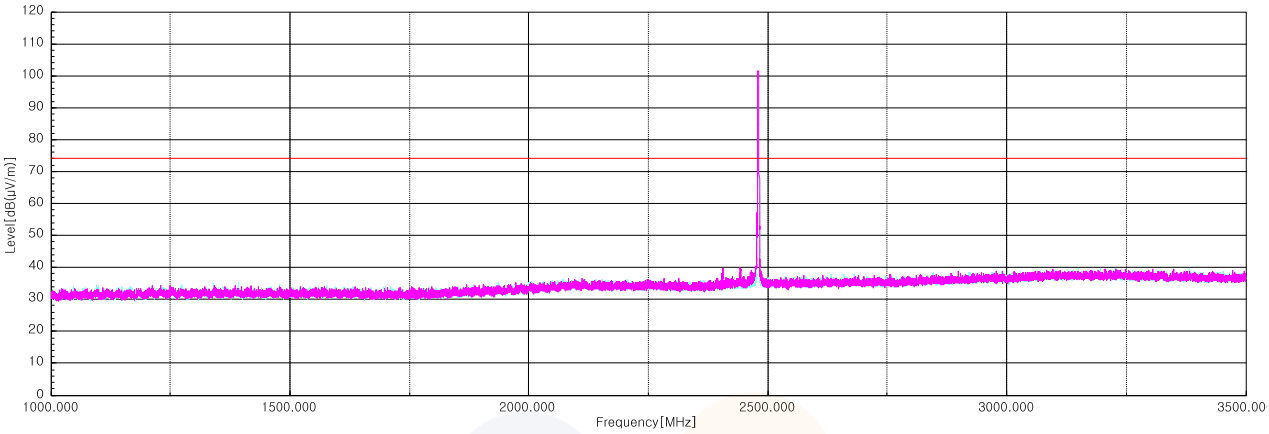
GFSK_High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 483.56[1)]	H	45.60	27.70	-30.24	-	43.06	74.00	30.94
5 003.65[1)]	H	54.10	33.01	-45.25	-	41.86	74.00	32.14
7 448.83[1)]	H	52.10	36.80	-44.08	-	44.82	74.00	29.18
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

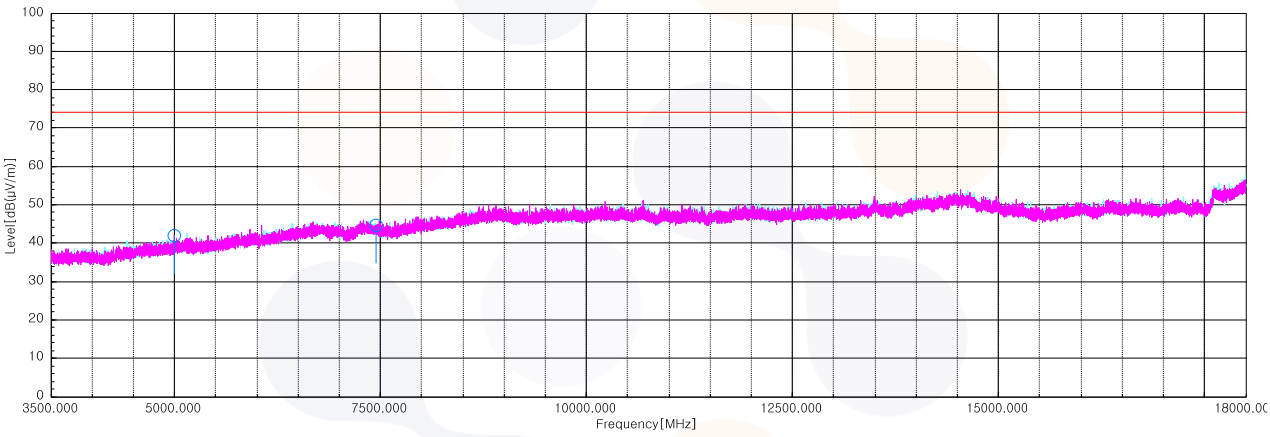
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



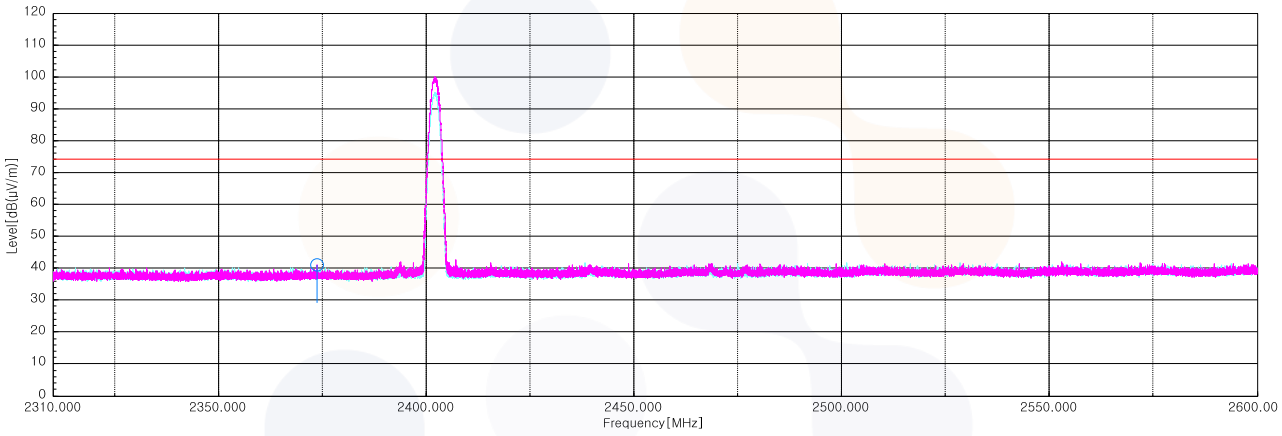
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



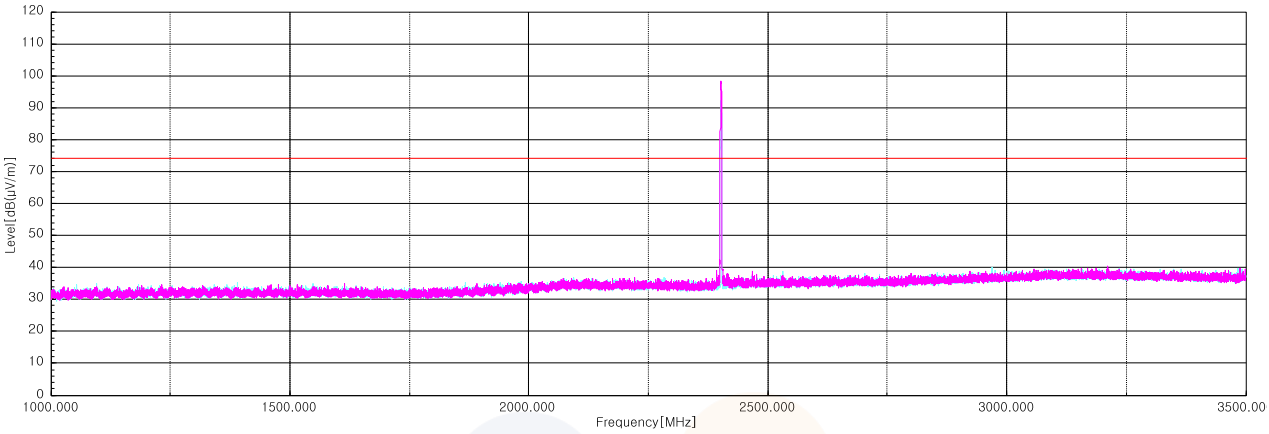
8DPSK_Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 373.74[1)]	H	44.20	27.14	-30.41	-	40.93	74.00	33.07
4 803.07[1)]	H	53.70	32.32	-46.13	-	39.89	74.00	34.11
7 209.58	V	52.30	37.12	-44.32	-	45.10	74.00	28.90
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

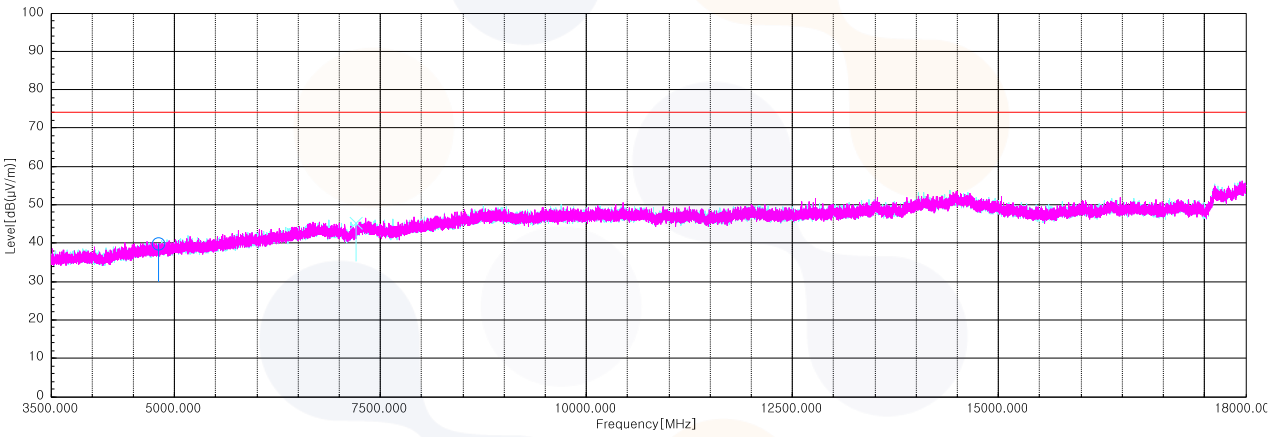
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



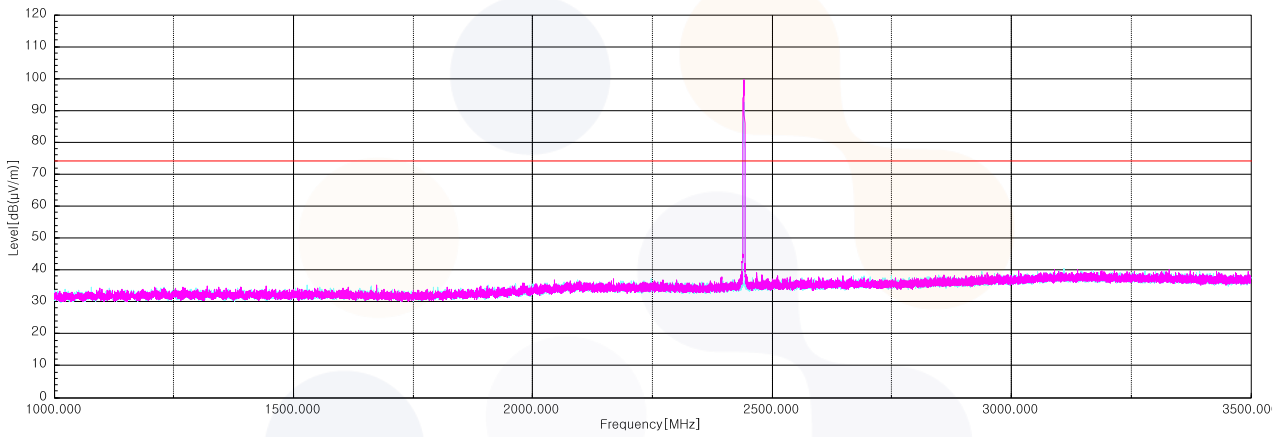
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



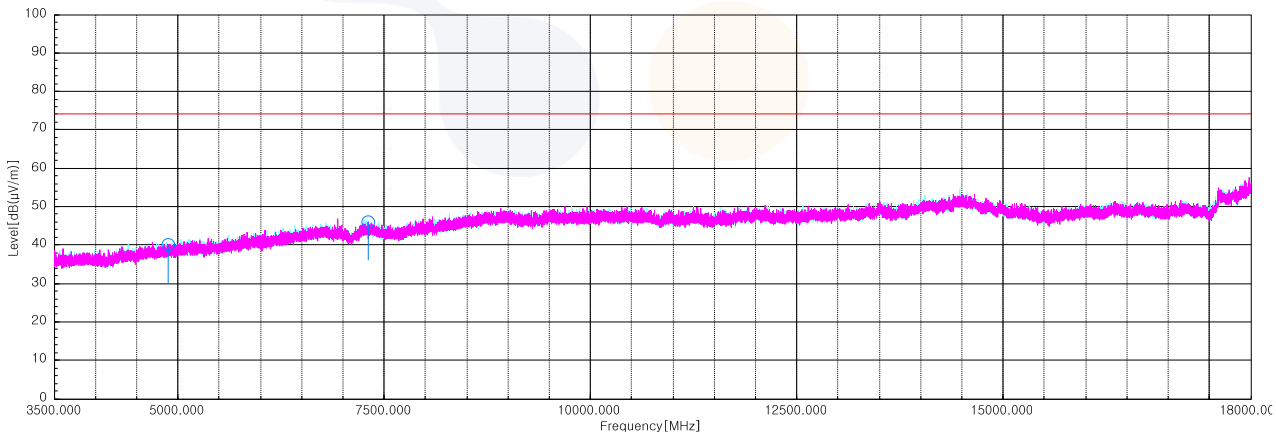
8DPSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
4 881.37[1)]	H	53.10	32.79	-45.78	-	40.11	74.00	33.89
7 313.02[1)]	H	53.30	37.05	-44.31	-	46.04	74.00	27.96
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



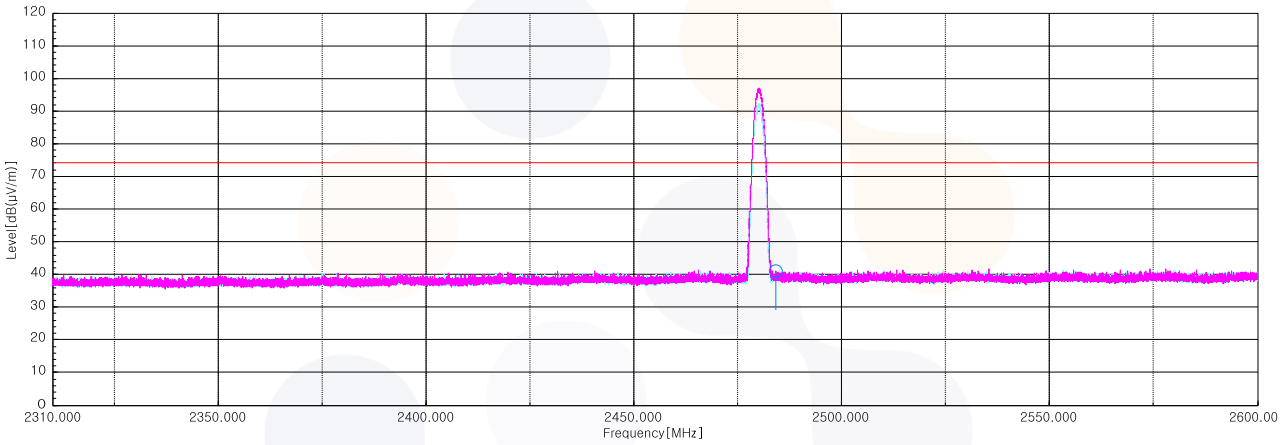
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



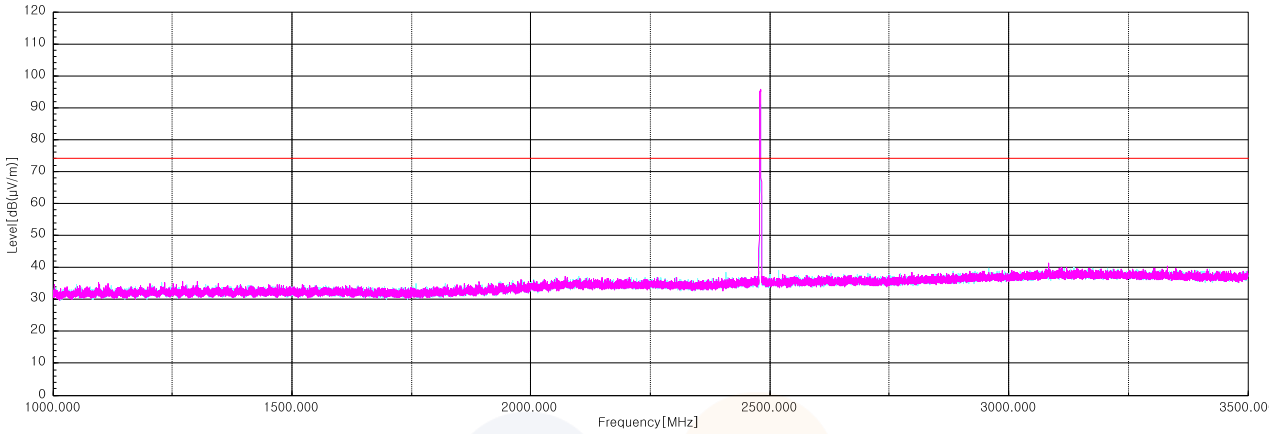
8DPSK_High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
2 484.05[1)]	H	43.40	27.70	-30.24	-	40.86	74.00	33.14
4 951.45[1)]	V	53.70	32.80	-45.47	-	41.03	74.00	32.97
7 427.08[1)]	V	52.50	36.85	-44.12	-	45.23	74.00	28.77
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

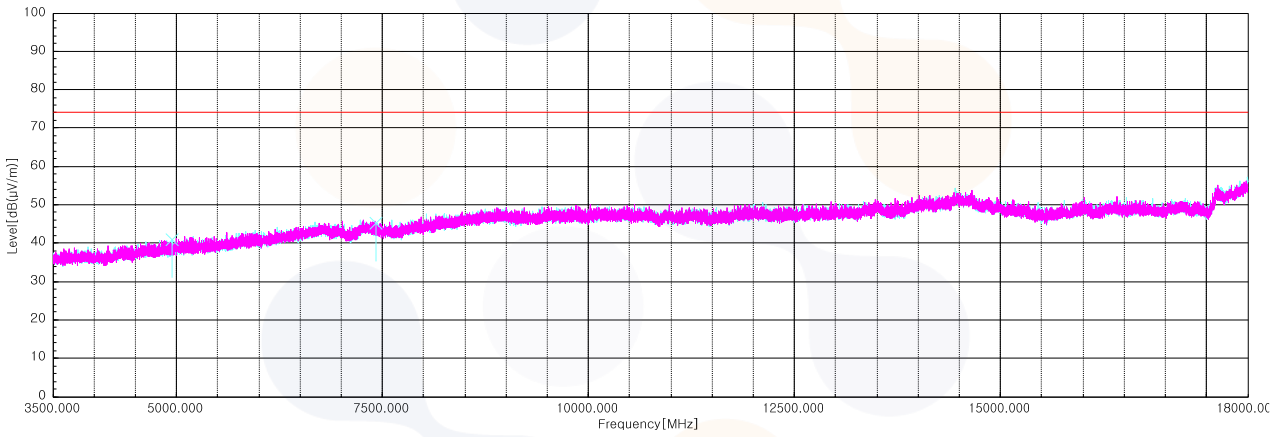
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓

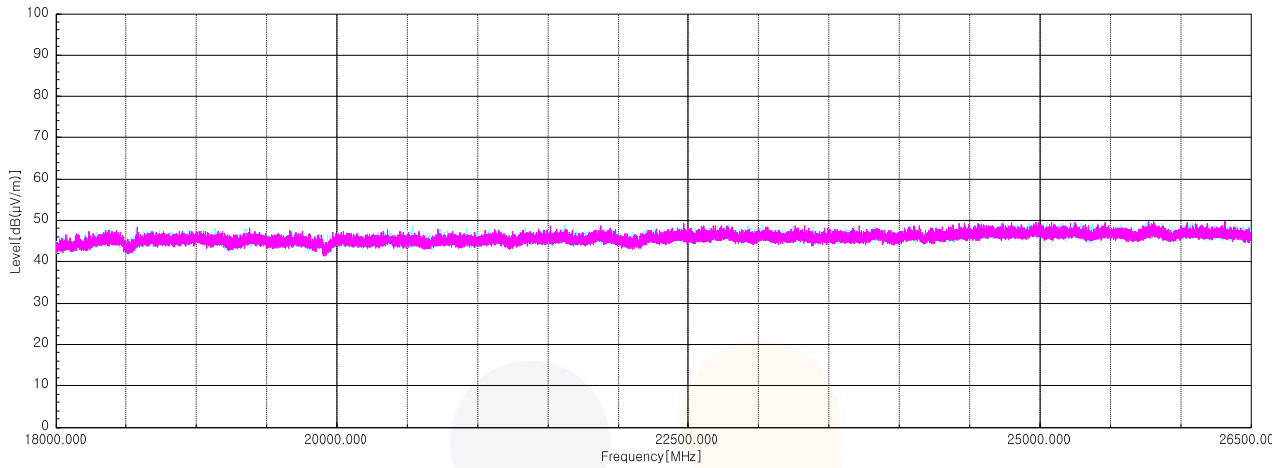


Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Test results (Above 18 ㎓) – Worst case: GFSK 2 402 ㎒

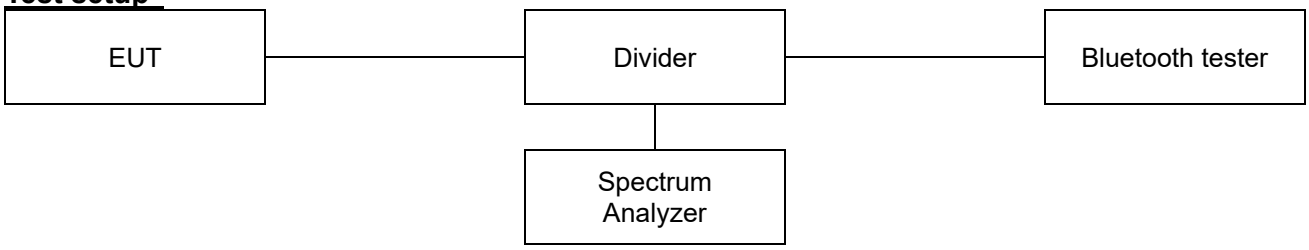
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



Note: The Worst case was based on the lowest margin condition considering Harmonic and Spurious Emission

7.7. Conducted Spurious Emission

Test setup



Limit

According to §15.247(d),

In any 100 ㎑ 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 ㏈ below that in the 100 ㎑ 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 ㏈c

Test procedure

ANSI C63.10-2013 - Section 6.10.4, 7.8.8

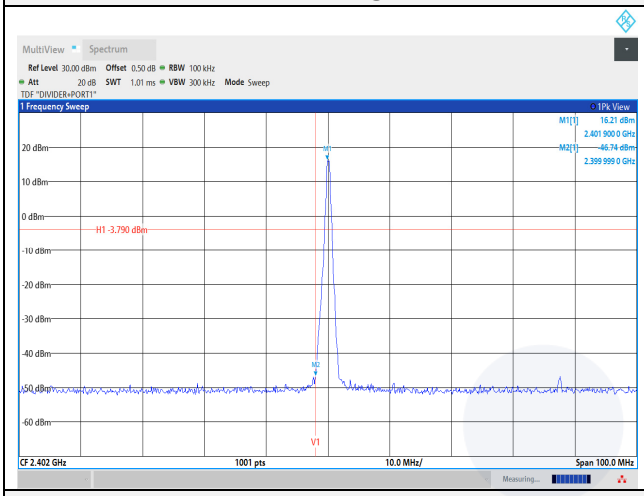
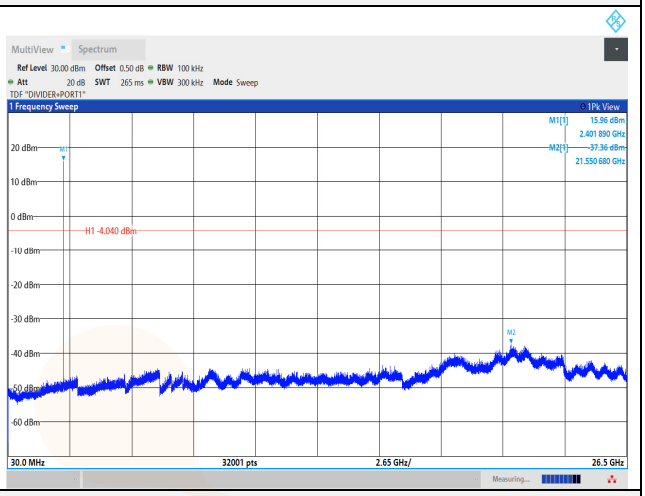
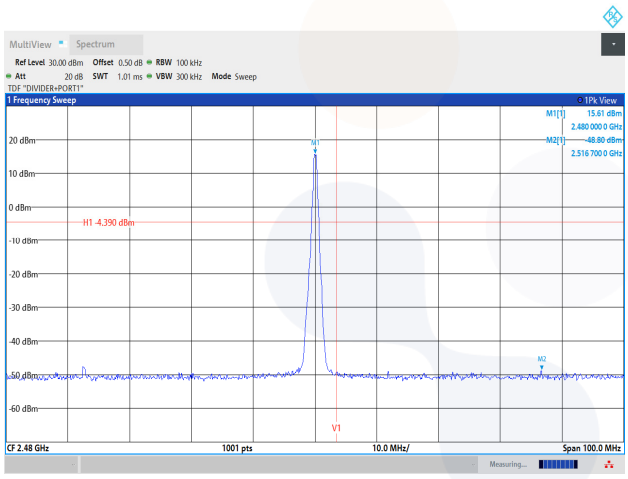
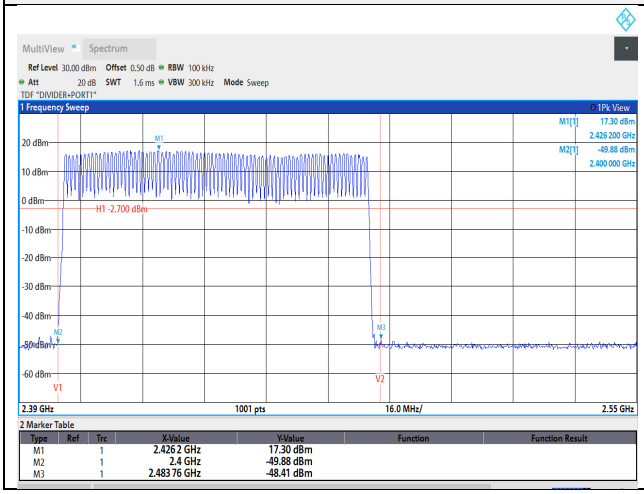
Test settings

- **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(OBW/RBW)] below the reference level.
  3) Attenuation: Auto (at least 10 ㏈ preferred)
  4) Sweep time = Coupled
  5) RBW : 100 ㎑
  6) VBW : 300 ㎑
  7) Detector : Peak
  8) Trace : Max hold

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

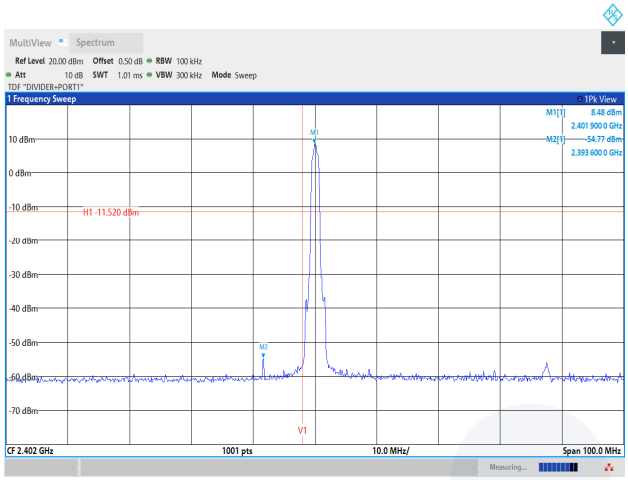
Test results

GFSK

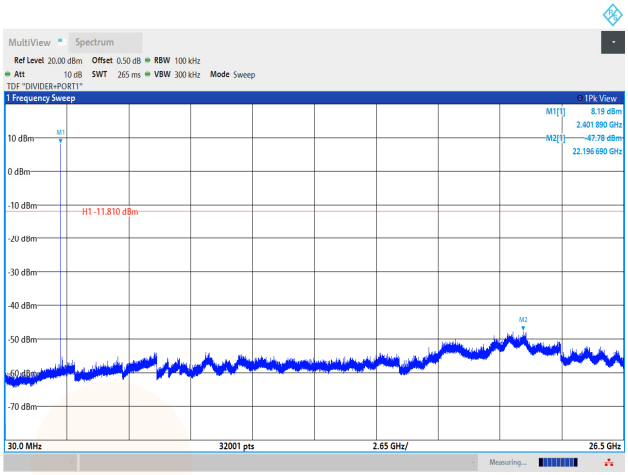
Conducted band-edge / Low ch.	Conducted spurious / Low ch.
	
Conducted band-edge / High ch.	**Conducted spurious / Mid ch.**
	
Conducted band-edge / Hopping ch.	**Conducted spurious / High ch.**
	

8DPSK

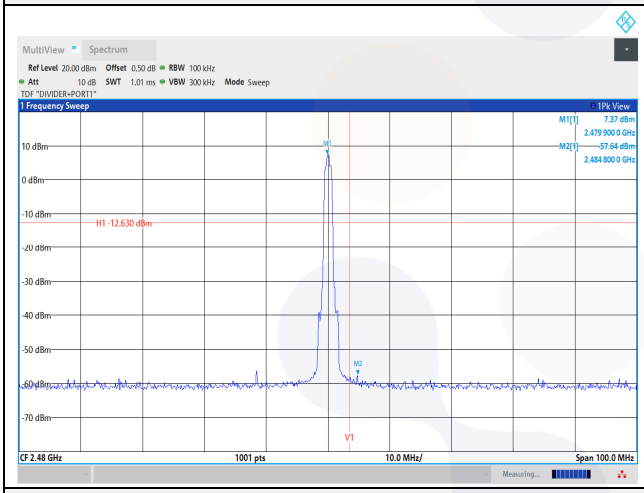
Conducted band-edge / Low ch.



Conducted spurious / Low ch.



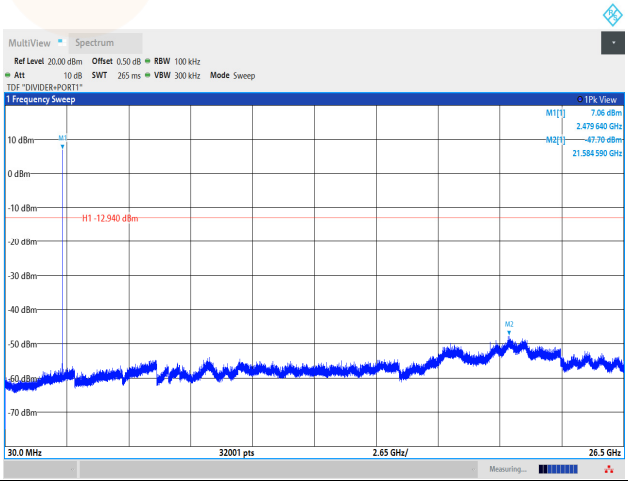
Conducted band-edge / High ch.



Conducted spurious / Mid ch.

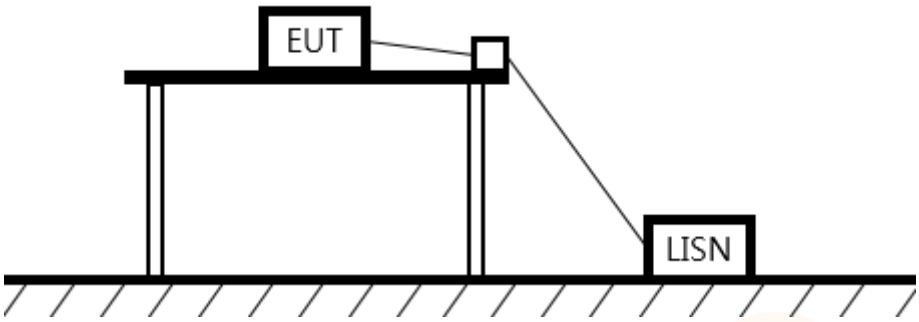
Conducted band-edge / Hopping ch.

Conducted spurious / High ch.



7.8. AC Conducted emission

Test setup



Limit

According to 15.207(a),

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

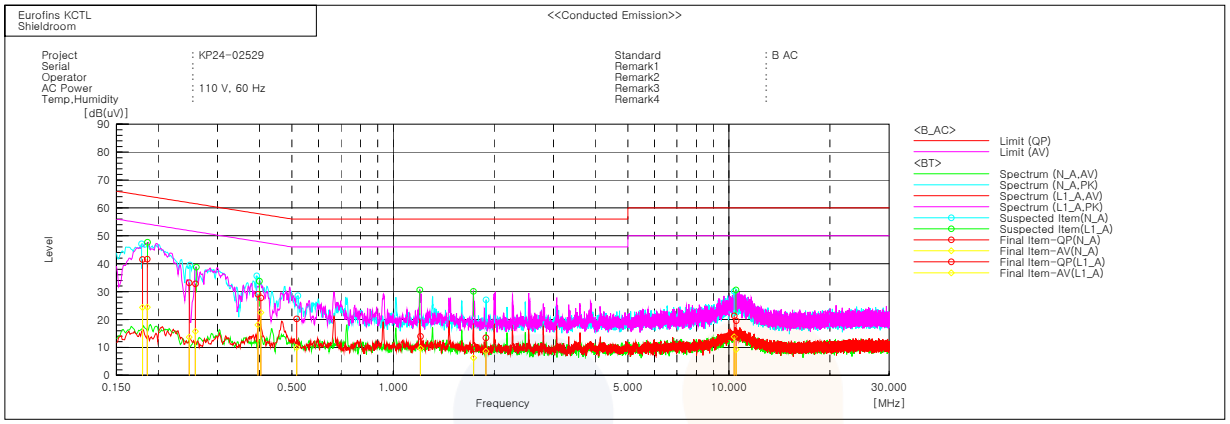
Frequency of Emission (㎒)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Measurement procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a spectrum analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 ㎒ to 30 ㎒.
5. The measurements were made with the detector set to peak amplitude within a bandwidth of 10 ㎑ or to quasi-peak and average within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

Test results

Worst case: GFSK 2 480 ㎒



Final Result

--- N_A Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.17948	31.1	13.9	10.4	41.5	24.3	64.5	54.5	23.0	30.2
2	0.24727	23.1	3.7	10.0	33.1	13.7	61.8	51.8	28.7	38.1
3	0.39611	18.8	7.8	10.2	29.0	18.0	57.9	47.9	28.9	29.9
4	0.51653	10.0	-0.3	10.2	20.2	9.9	56.0	46.0	35.8	36.1
5	1.89031	3.5	-1.3	9.9	13.4	8.6	56.0	46.0	42.6	37.4
6	10.36781	10.6	3.1	10.7	21.3	13.8	60.0	50.0	38.7	36.2

--- L1_A Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.18552	31.2	14.0	10.4	41.6	24.4	64.2	54.2	22.6	29.8
2	0.25789	22.8	5.7	10.0	32.8	15.7	61.5	51.5	28.7	35.8
3	0.4036	17.5	12.3	10.2	27.7	22.5	57.8	47.8	30.1	25.3
4	1.20638	4.0	-0.2	9.9	13.9	9.7	56.0	46.0	42.1	36.3
5	1.73645	-0.5	-3.6	9.9	9.4	6.3	56.0	46.0	46.6	39.7
6	10.5075	8.9	-1.5	10.7	19.6	9.2	60.0	50.0	40.4	40.8

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Bluetooth Tester	TESCOM	TC-3000B	3000B640056	25.01.19
Spectrum Analyzer	R&S	FSV3044	101427	25.03.28
Signal Generator	R&S	SMB100A	176206	25.01.18
DC Power Supply	AGILENT	E3632A	MY51220373	24.07.03
Power Divider	Marki Microwave, Inc.	PD-0040	D0002	24.07.04
Power Sensor	R&S	NRP-Z81	1137.9009.02-106224-tg	24.09.12
Spectrum Analyzer	R&S	FSVA40	101575	25.04.24*
Bluetooth Tester	TESCOM	TC-3000C	3000C000270	24.07.04
Broadband PreAmplifier	SCHWARZBECK	BBV9718D	57	25.01.19
Low Noise Amplifier	TESTEK	TK-PA18H	220124-L	24.10.12
Low Noise Amplifier	TESTEK	TK-PA1840H	220133-L	24.10.17
Horn Antenna	SCHWARZBECK	BBHA9120D	2763	24.10.18
Horn Antenna	SCHWARZBECK	BBHA9170	1267	24.10.16
High Pass Filter	Wainwright Instruments GmbH	WHKX12-2805-3000-18000-40SS	SN58	24.10.16
High Pass Filter	QOTANA TECHNOLOGIES	DBHF0508004000A	23041800061	24.07.10
TWO-LINE V - NETWORK	R&S	ENV216	101358	24.09.27
EMI TEST RECEIVER	R&S	ESCI3	100001	24.08.18
EMI TEST RECEIVER	R&S	ESCI7	100732	25.02.28
Bi-Log Antenna	TESEQ	CBL 6112D	62438	25.05.25
Amplifier	SONOMA INSTRUMENT	310N	284608	24.08.18
LOOP Antenna	R&S	HFH2-Z2	100355	24.08.10
ISOLATION TRANSFORMER	ONETECH CO.,LTD	OT-IT500VA	OTR1-16026	25.03.21

*This equipment was calibrated during the test period, and was used after calibration.

End of test report