TEST REPORT

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.: KR23-SRF0171-B Page (1) of (46)	eurofins | KCTL

1. Client

- Name : Samsung Electronics Co., Ltd.
- Address : 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
- Date of Receipt : 2023-03-14

2. Use of Report : Certification

3. Name of Product / Model : Notebook PC / NP935QNA

4. Manufacturer / Country of Origin : Samsung Electronics Co., Ltd. / Vietnam

5. FCC ID : A3LNP935QNA

6. Date of Test : 2023-04-15 to 2023-05-25

7. Location of Test : ■ Permanent Testing Lab ☐ On Site Testing
(Address:65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea)

8. Test method used : FCC Part 15 Subpart C, 15.247

9. Test Result : Refer to the test result in the test report

Affirmation	Tested by	Technical Manager
	Name : Sunghyun Yoon (Signature)	Name : Seungyong Kim (Signature)

2023-06-05

Eurofins KCTL Co.,Ltd.

REPORT REVISION HISTORY

Date	Revision	Page No
2023-05-26	Originally issued	-
2023-06-01	Updated	4,6,27
2023-06-05	Updated	6

Note. The report No. KR23-SRF0171-A is superseded by the report No. KR23-SRF0171-B.

General remarks for test reports

Statement concerning the uncertainty of the measurement systems used for the tests

(may be required by the product standard or client)

☐ **Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:**

Procedure number, issue date and title:

Calculations leading to the reported values are on file with the testing laboratory that conducted the testing.

☒ **Statement not required by the standard or client used for type testing**

CONTENTS

1. General information

Client	:	Samsung Electronics Co., Ltd.
Address	:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
Manufacturer	:	Samsung Electronics Co., Ltd.
Address	:	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
Factory	:	SAMSUNG ELECTRONICS VIETNAM CO.,LTD.
Address	:	Khu Cong nghiep Ten Phong 1, Yen Trung, Yen Phong, Bac Ninh, Vietnam
Laboratory	:	Eurofins KCTL Co.,Ltd.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
Accreditations	:	FCC Site Designation No: KR0040, FCC Site Registration No: 687132
		VCCI Registration No. : R-20080, G-20078, C-20059, T-20056
		CAB Identifier: KR0040
		ISED Number: 8035A
		KOLAS No.: KT231

2. Device information

Equipment under test	:	Notebook PC		
Model	:	NP935QNA		
Modulation technique	:	Bluetooth(BDR/EDR)	:	GFSK, π/4DQPSK, 8DPSK
Number of channels	:	79 ch		
Power source	:	DC 11.58 V		
Antenna specification	:	Antenna 1 (Aux)	:	PIFA Antenna
Antenna gain	:	1.07 dBi		
Frequency range	:	2 402 ㎒ ~ 2 480 ㎒		(BDR/EDR)
Software version	:	NP930QNA.001		
Hardware version	:	REV0.1		
Test device serial No.	:	Conducted	:	KQZZ930W300149P
		Radiated	:	KQZZ930W300219W
Operation temperature	:	10 ℃ ~ 35 ℃		

2.1. Frequency/channel operations

This device contains the following capabilities:
WLAN (11a/b/g/n/ac/ax), Bluetooth (BDR/EDR/BLE)

Ch.	Frequency (㎒)
00	2 402
.	.
39	2 441
.	.
78	2 480

Table 2.1.1. Bluetooth(BDR/EDR) mode

15.247 Requirements for Bluetooth transmitter:

- This Bluetooth module has been tested by a Bluetooth Qualification Lab, and we confirm the following:
  1) This system is hopping pseudo-randomly.
  2) Each frequency is used equally on the average by each transmitter.
  3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
  4) The receiver shifts frequencies in synchronization with the transmitted signals.
- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

3. Antenna requirement

Requirement of FCC part section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- The transmitter has permanently attached PIFA Antenna (Internal antenna) on board.
- The EUT Complies with the requirement of §15.203, §15.247.

4. Summary of tests

FCC Part section(s)	Parameter	Test Condition	Test results
15.247(b)(1), (4)	Maximum peak output power	Conducted	Pass
15.247(a)(1)	Carrier frequency separation		Pass
15.247(a)(1)	20dB channel bandwidth & 99% bandwidth		Pass
15.247(a)(iii) 15.247(b)(1)	Number of hopping channel		Pass
15.247(a) (iii)	Time of occupancy(dwell time)		Pass
15.207(a)	AC Conducted Emissions		Pass
15.247(d)	Conducted Spurious Emissions		Pass
15.205(a), 15.209(a)	Spurious emission	Radiated	Pass
	Band-edge, restricted band		Pass

Notes:

1. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
3. All the radiated tests have been performed two modes (Notebook and Tablet mode) and the fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z.
   Worst case: Notebook mode, X axis
4. All configurations have been performed (stand-alone, stand-alone with TA, with accessories) and the worst case is Stand-alone with TA.
5. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
   - KDB 558074 D01 v05r02
6. The worst-case data rate were: BDR Packet type DH-3
   EDR Packet type 3DH-3

5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k=2 to indicated a 95 % level of confidence. The measurement data shown herein meets of exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty (±)	
Conducted RF power	0.9 dB	
Conducted spurious emissions	1.3 dB	
Radiated spurious emissions	Below 30 ㎒:	2.3 dB
	30 ㎒ ~ 1 000 ㎒	2.5 dB
	1 000 ㎒ ~ 18 000 ㎒	4.7 dB
	Above 18 000 ㎒	4.8 dB
Conducted emissions	9 ㎑ ~ 150 ㎑	2.7 dB
	150 ㎑ ~ 30 ㎒	2.7 dB

6. Measurement results explanation example

The offset level is set in the spectrum analyzer to compensate the RF cable loss factor between EUT conducted output port and spectrum analyzer.
With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

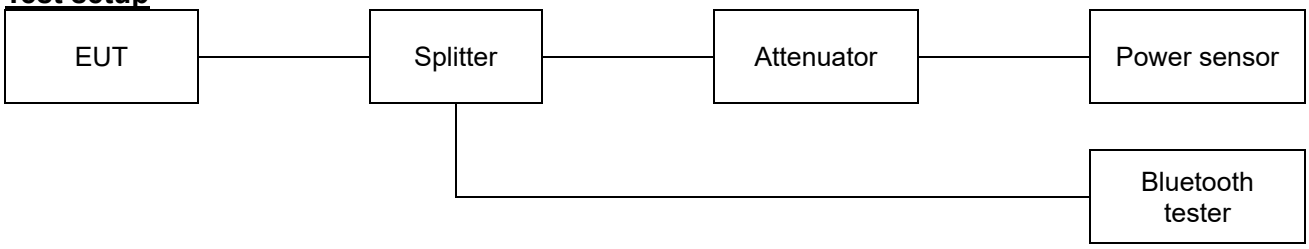
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	3.56	9 000	5.76
50	3.82	10 000	6.47
100	4.11	11 000	6.19
200	4.24	12 000	6.93
300	4.43	13 000	6.89
400	4.48	14 000	6.94
500	4.47	15 000	7.89
600	4.54	16 000	8.24
700	4.85	17 000	8.06
800	4.91	18 000	9.32
900	4.75	19 000	9.09
1 000	4.72	20 000	9.86
2 000	5.66	21 000	9.65
3 000	5.42	22 000	9.13
4 000	5.81	23 000	9.37
5 000	6.45	24 000	9.91
6 000	7.22	25 000	10.86
7 000	5.03	26 000	11.50
8 000	5.36	26 500	12.88

Note.
Offset(㏈) = RF cable loss(㏈) + Splitter(㏈)

7 Test results

7.1. Maximum peak output power

Test setup



Limit

According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

According to §15.247(b)(1), for frequency hopping systems operating in the 2 400-2 483.5 ㎒ band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725-5 850 ㎒ band: 1 watt. For all other frequency hopping systems in the 2 400-2 483.5 ㎒ band: 0.125 watts.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

Test procedure

ANSI C63.10-2013 - Section 7.8.5

Test settings

The test follows ANSI C63.10-2013 – Section 7.8.5. Using the power sensor instead of a spectrum analyzer.

Notes:

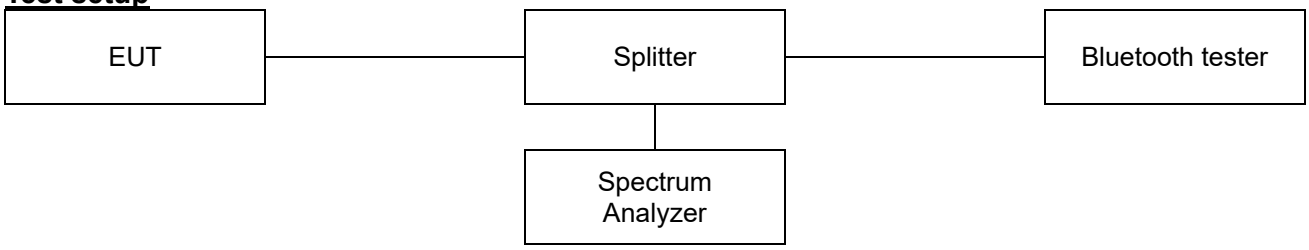
A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

Test results

Frequency(㎒)	Data rate(Mbps)	Measured output power(dBm)		Limit(dBm)
		Peak	Average	
2 402	1	12.75	12.34	20.97
2 441	1	13.62	13.24	
2 480	1	12.24	11.84	
2 402	2	12.02	9.20	
2 441	2	12.91	10.06	
2 480	2	11.51	8.72	
2 402	3	12.40	9.22	
2 441	3	13.23	10.09	
2 480	3	11.86	8.70	

7.2. Carrier frequency separation

Test setup



Limit

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

Test procedure

ANSI C63.10-2013 - Section 7.8.2

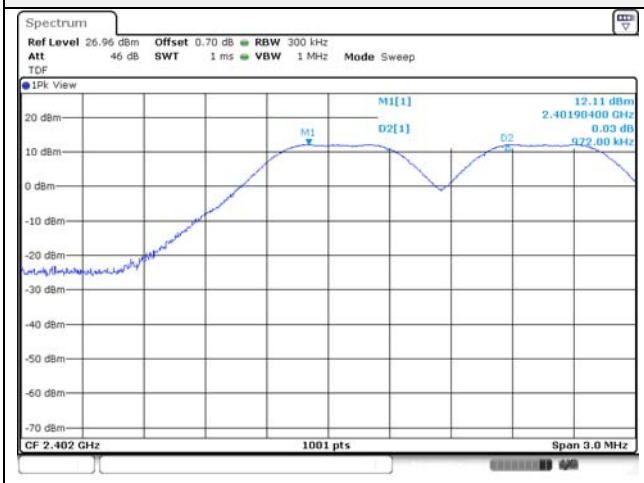
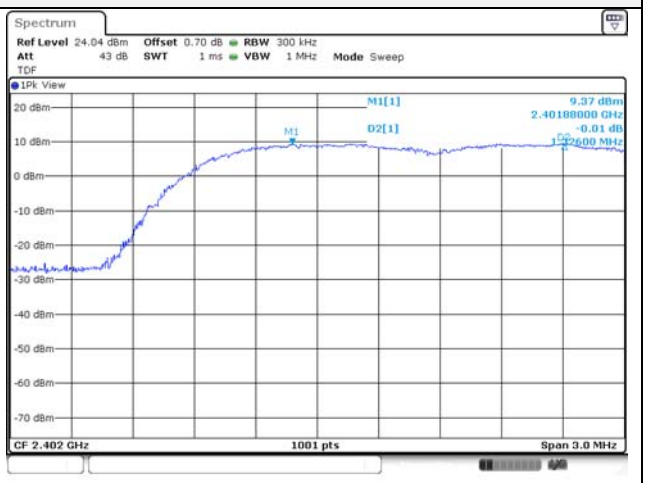
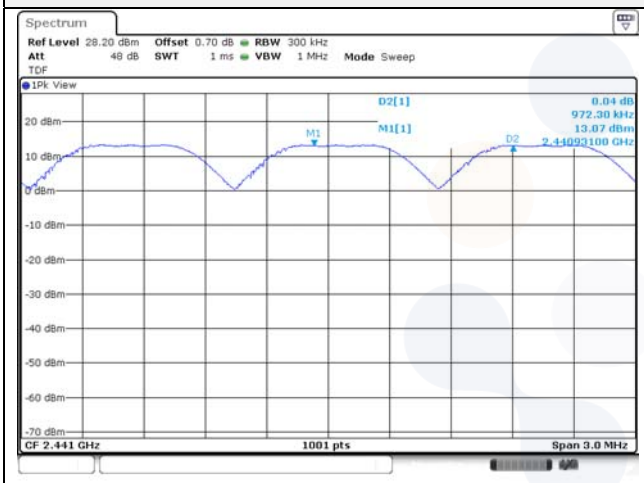
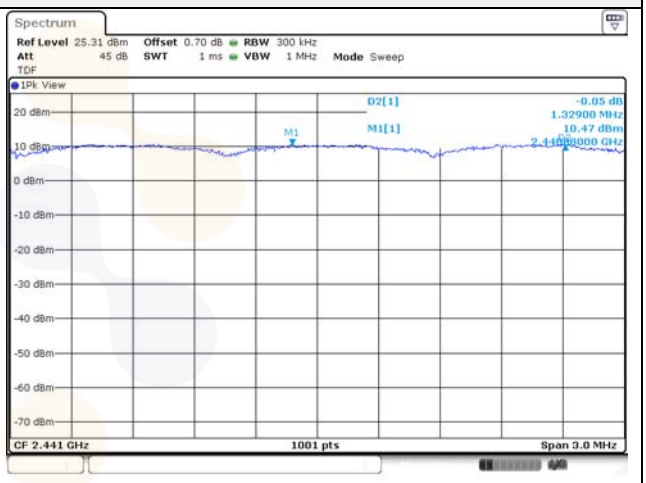
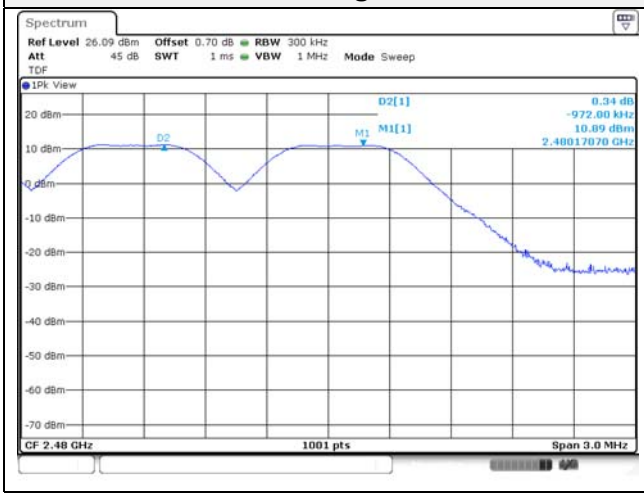
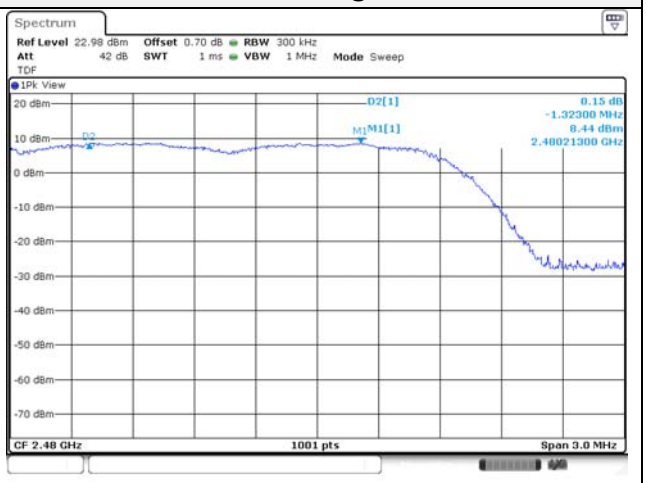
Test settings

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

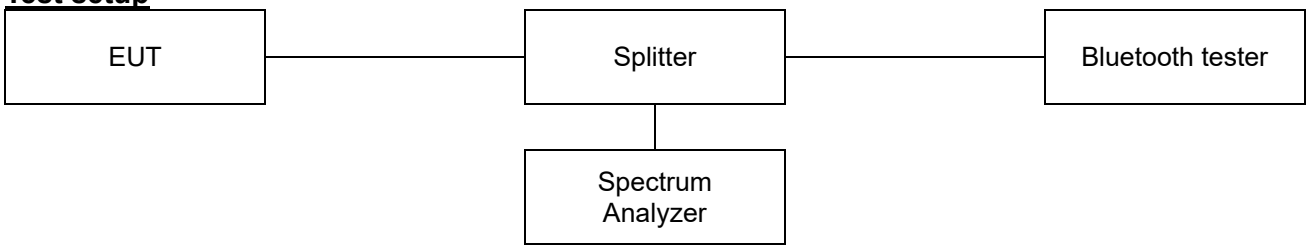
Test results

Frequency(㎒)	Data rate(Mbps)	Carrier frequency separation(㎒)	Limit(㎒)
2 402	1	0.972	0.647
2 441	1	0.972	0.631
2 480	1	0.972	0.651
2 402	3	1.326	0.865
2 441	3	1.329	0.865
2 480	3	1.323	0.863

GFSK / Low ch.	8DPSK / Low ch.
	
GFSK / Mid ch.	**8DPSK / Mid ch.**
	
GFSK / High ch.	**8DPSK / High ch.**
	

7.3. 20dB Channel Bandwidth & 99% Bandwidth

Test setup



Limit

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

Test procedure

ANSI C63.10-2013 - Section 6.9.2

Test settings

20dB channel bandwidth and Occupied bandwidth

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of ㏈ down from the reference value). Typical ratios, expressed in dB, are −6 ㏈, −20 ㏈, and −26 ㏈, corresponding to 6 ㏈ BW, 20 ㏈ BW, and 26 ㏈ BW, respectively. In this subclause, the ratio is designated by "−xx ㏈." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "−xx ㏈" bandwidth; other requirements might specify that the "−xx ㏈" bandwidth be entirely contained within the authorized or designated frequency band.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
b) Span: Two times and five times the OBW.
c) RBW = 1 % to 5 % of the OBW and VBW ≥ 3 x RBW
d) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 ㏈ below the target "−xx ㏈ down" requirement; that is, if the requirement calls for measuring the −20 ㏈ OBW, the instrument noise floor at the selected RBW shall be at least 30 ㏈ below the reference value.
f) Detector: peak
g) Trace mode: max hold.
h) Allow the trace to stabilize.
i) Determine the "−xx ㏈ down amplitude" using ((reference value) − xx). Alternatively, this calculation may be made by using the marker-delta function of the instrument.
j) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
k) Place two markers, one at the lowest frequency and the other at the highest frequency of the

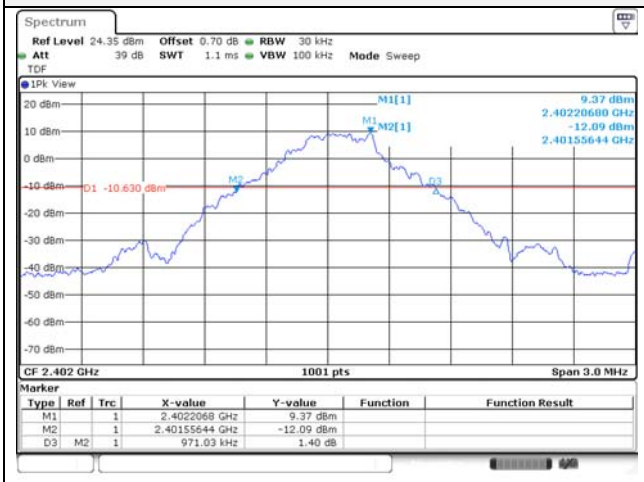
envelope of the spectral display, such that each marker is at or slightly below the "−xx dB down amplitude" determined in step h). If a marker is below this "−xx dB down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "−xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

Test results

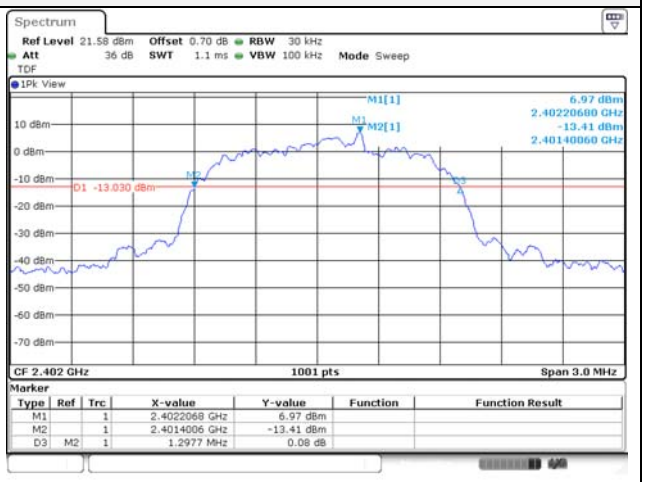
Frequency(㎒)	Data rate (Mbps)	20 dB Bandwidth (㎒)	99% Bandwidth (㎒)
2 402	1	0.971	0.839
2 441	1	0.947	0.842
2 480	1	0.977	0.839
2 402	3	1.298	1.172
2 441	3	1.298	1.172
2 480	3	1.295	1.187

20 dB Bandwidth

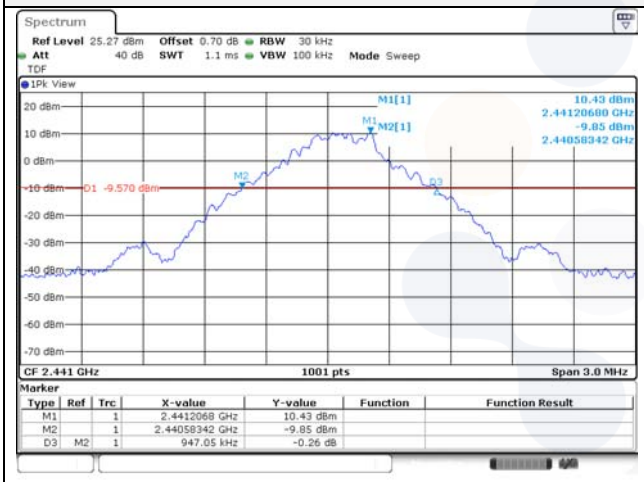
GFSK / Low ch.



8DPSK / Low ch.

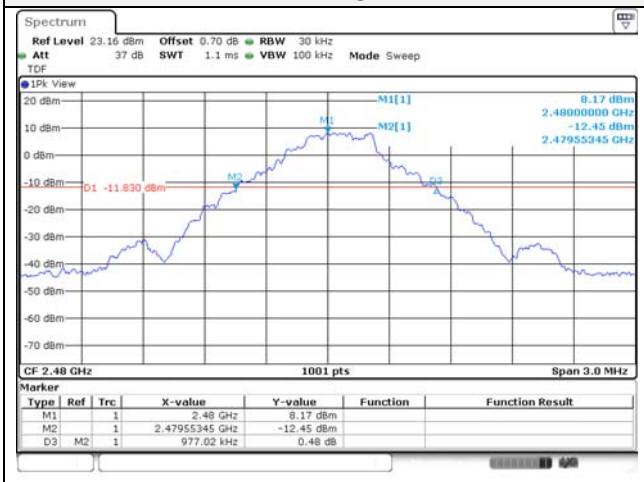


GFSK / Mid ch.

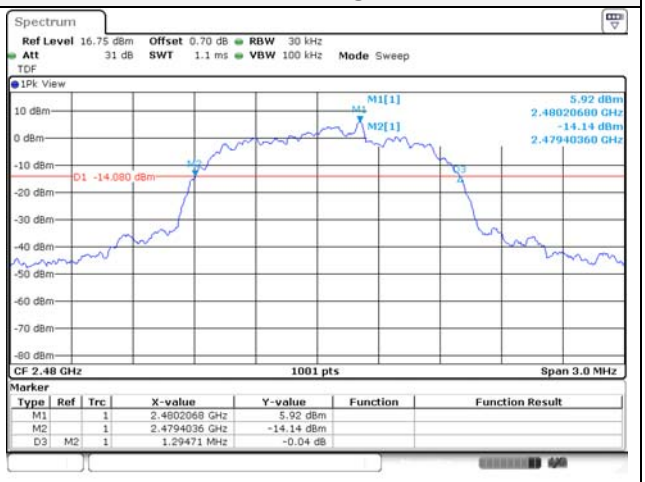


8DPSK / Mid ch.

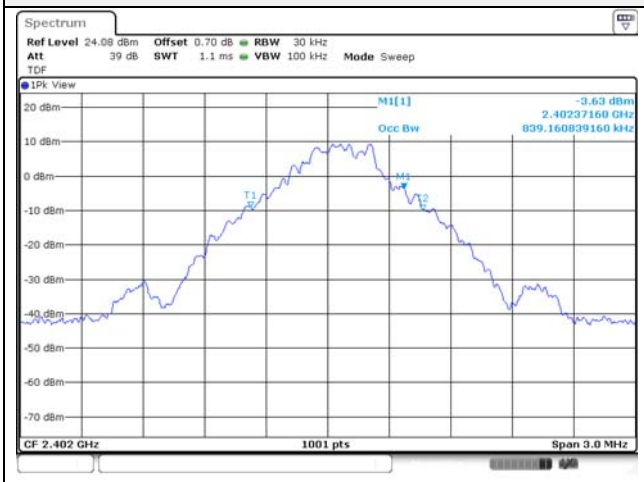
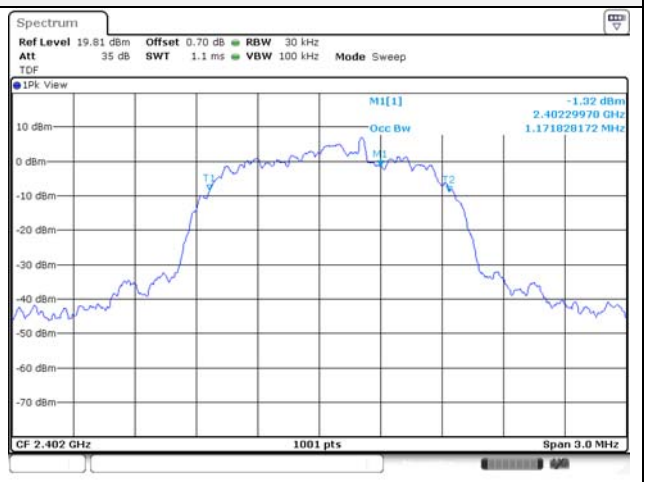
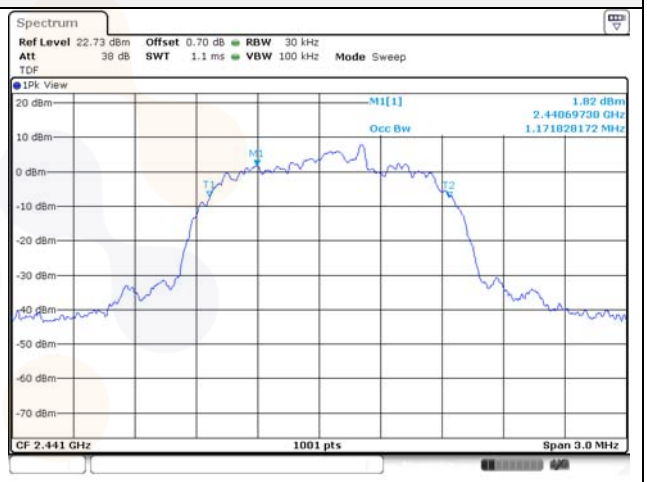
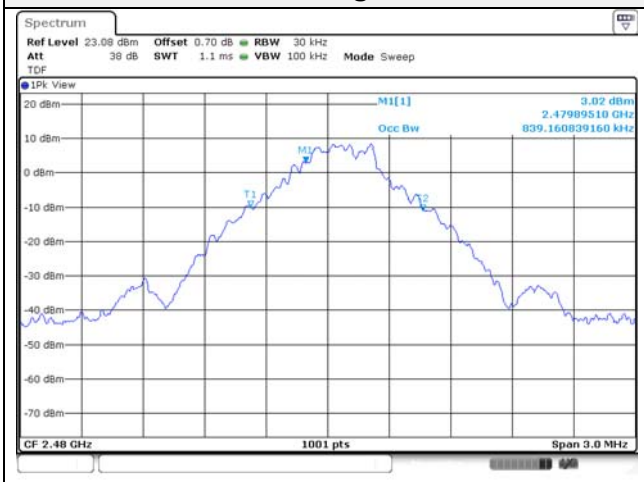
GFSK / High ch.



8DPSK / High ch.

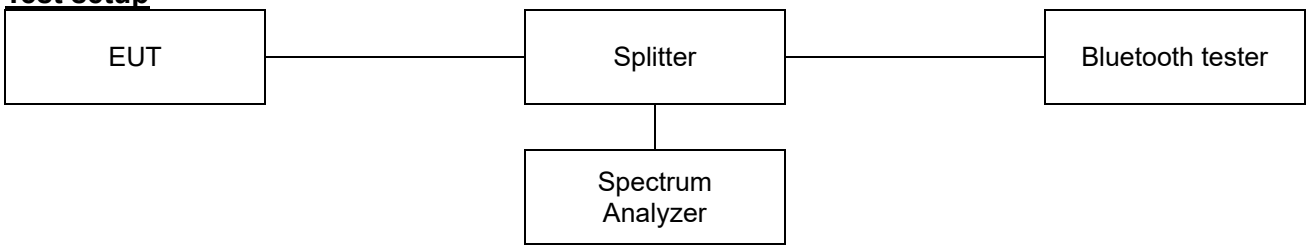


99% Bandwidth

GFSK / Low ch.	8DPSK / Low ch.
	
GFSK / Mid ch.	**8DPSK / Mid ch.**
	
GFSK / High ch.	**8DPSK / High ch.**
	

7.4. Number of hopping channels

Test setup



Limit

According to §15.247(a)(1)(iii), frequency hopping systems in the 2 400-2 483.5 ㎒ band shall use at least 15 channels.

Test procedure

ANSI C63.10-2013 - Section 7.8.3

Test settings

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 ㏈ bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

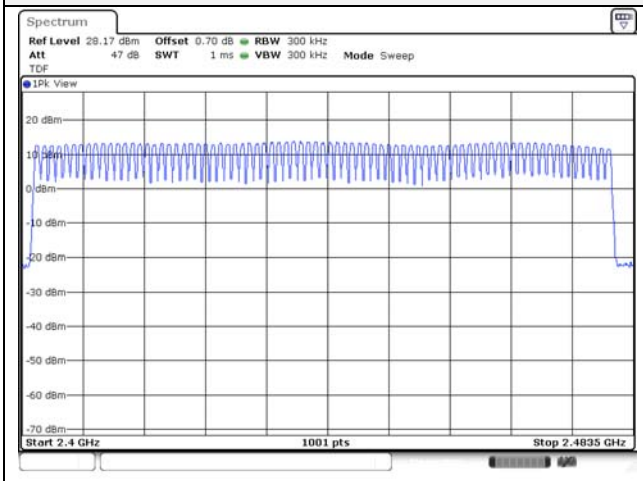
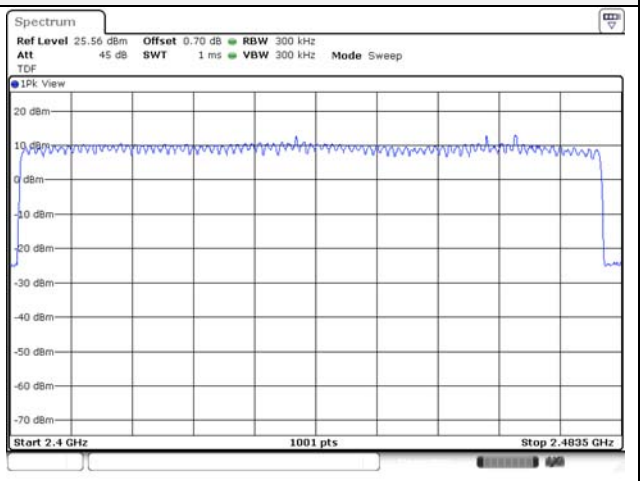
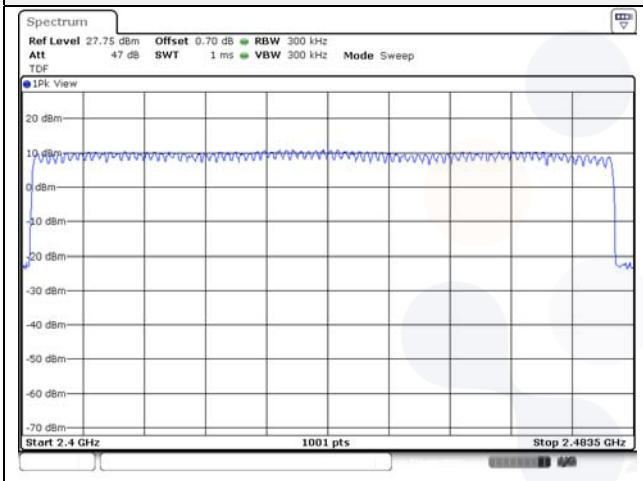
It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

Test results

Mode	Number of hopping channel	Limit
GFSK	79	≥15
π/4DQPSK	79	≥15
8DPSK	79	≥15

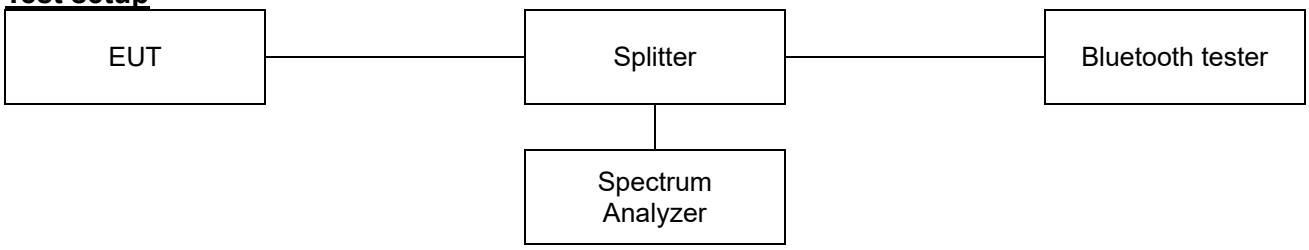
Notes:

In case of AFH mode, minimum number of hopping channels is 20.

GFSK	π/4DQPSK
	
8DPSK	
	Blank

7.5. 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 ㎒ 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

a) Span: Zero span, centered on a hopping channel.
b) RBW ≤ channel spacing and >> 1 / T, where T is the expected dwell time per channel.
c) 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.
d) Detector function: Peak.
e) Trace: Max hold.
f) 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

- Non-AFH

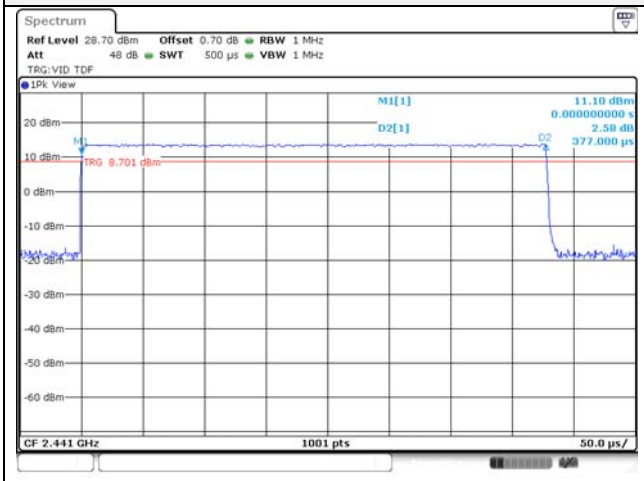
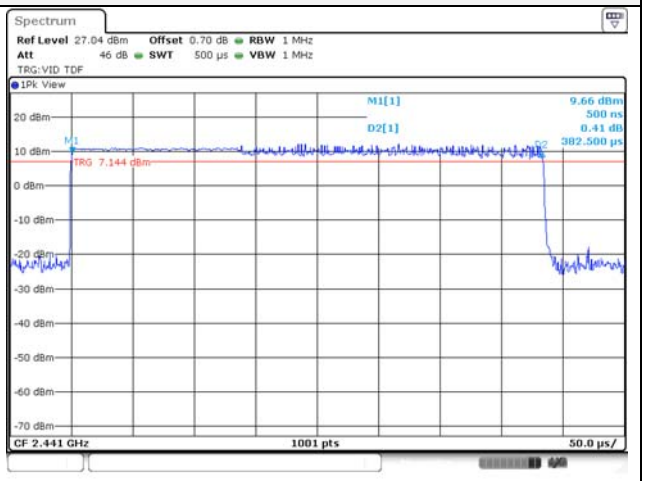
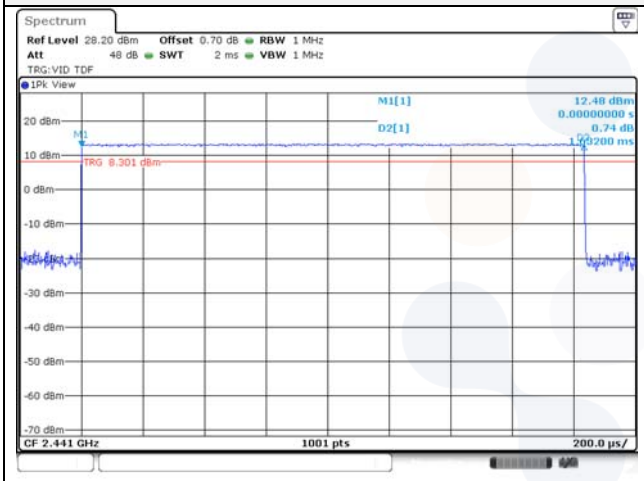
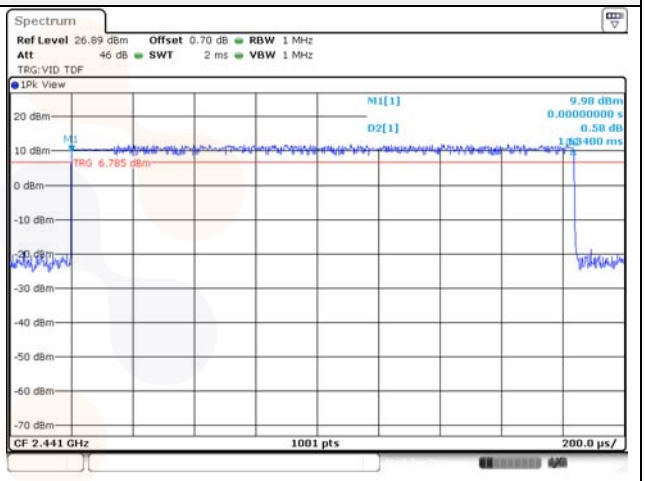
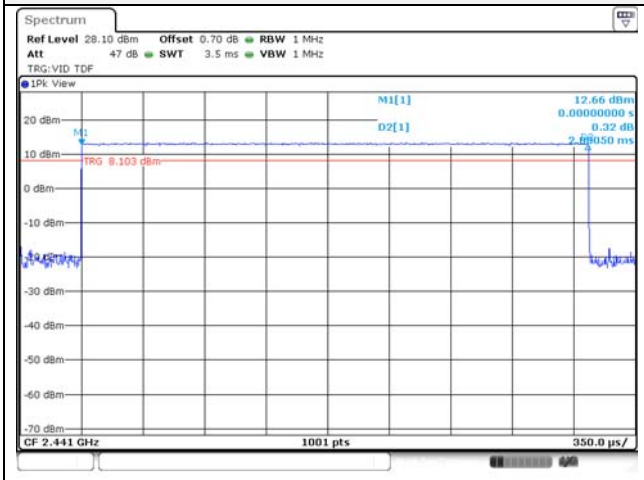
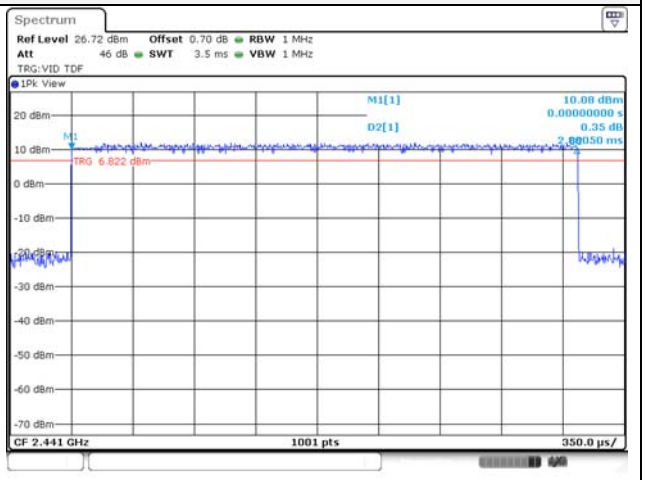
Modulation	Frequency (㎒)	Pulse Width (㎳)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.377	800.000	79	0.121	0.400
DH3		1.632	400.000		0.261	
DH5		2.881	266.667		0.307	
2-DH1		0.383	800.000		0.122	
2-DH3		1.634	400.000		0.261	
2-DH5		2.881	266.667		0.307	
3-DH1		0.382	800.000		0.122	
3-DH3		1.632	400.000		0.261	
3-DH5		2.884	266.667		0.308	

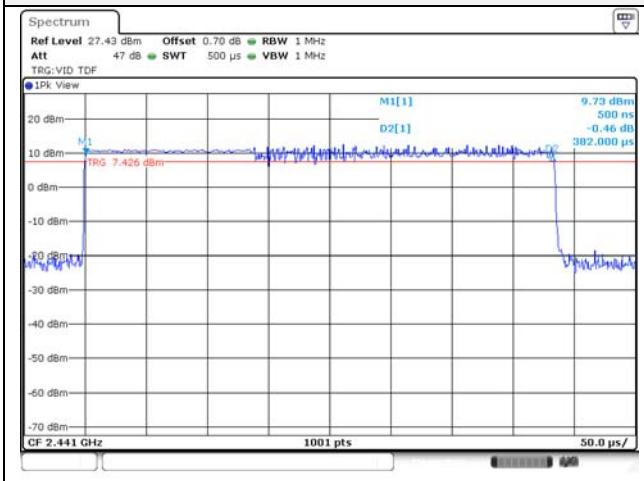
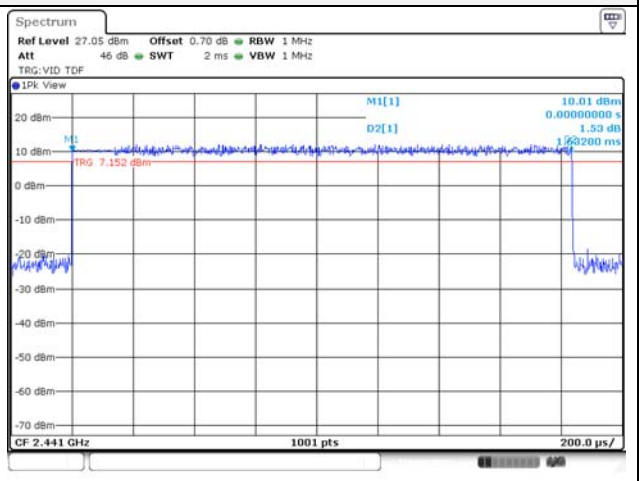
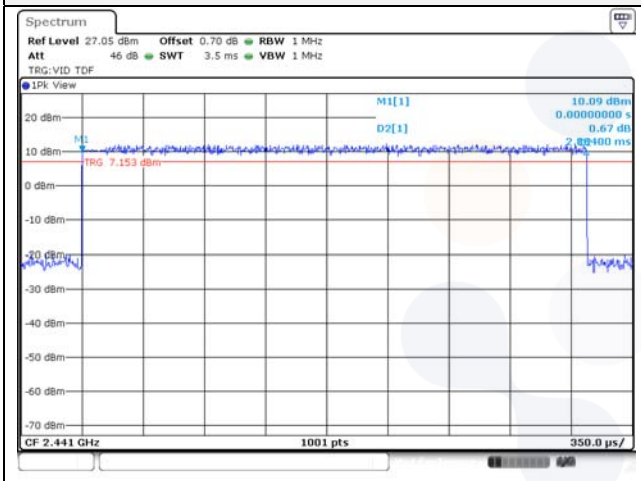
- AFH

Modulation	Frequency (㎒)	Pulse Width (㎳)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.377	400.000	20	0.060	0.400
DH3		1.632	200.000		0.131	
DH5		2.881	133.333		0.154	
2-DH1		0.383	400.000		0.061	
2-DH3		1.634	200.000		0.131	
2-DH5		2.881	133.333		0.154	
3-DH1		0.382	400.000		0.061	
3-DH3		1.632	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)

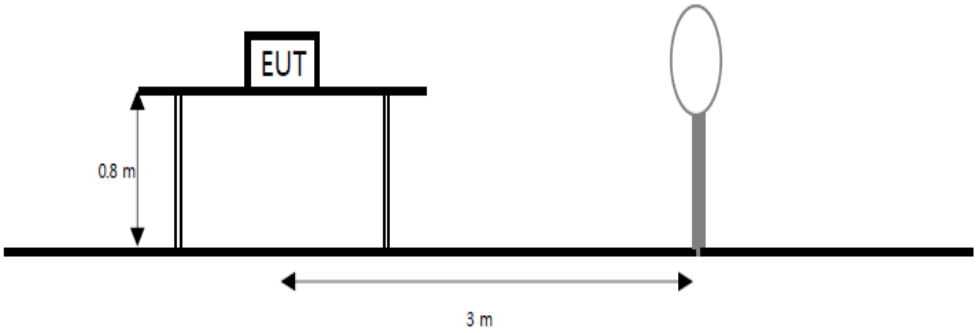
GFSK / DH1	π/4DQPSK / 2-DH1
	
GFSK / DH3	**π/4DQPSK / 2-DH3**
	
GFSK / DH5	**π/4DQPSK / 2-DH5**
	

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

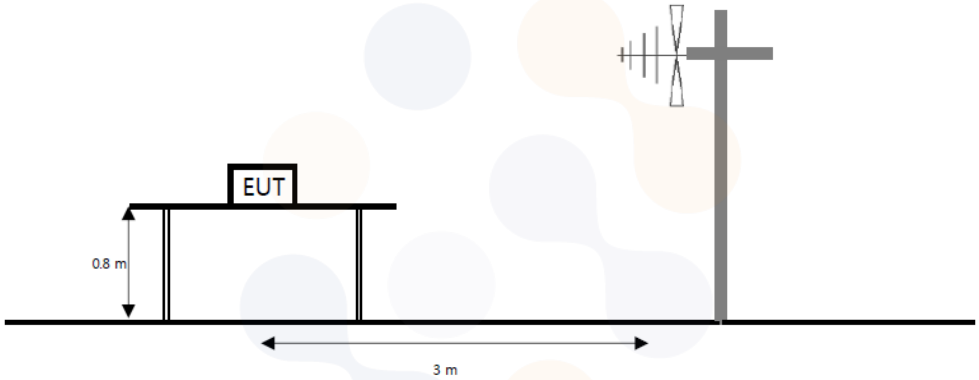
7.6. Radiated spurious emissions & band edge

Test setup

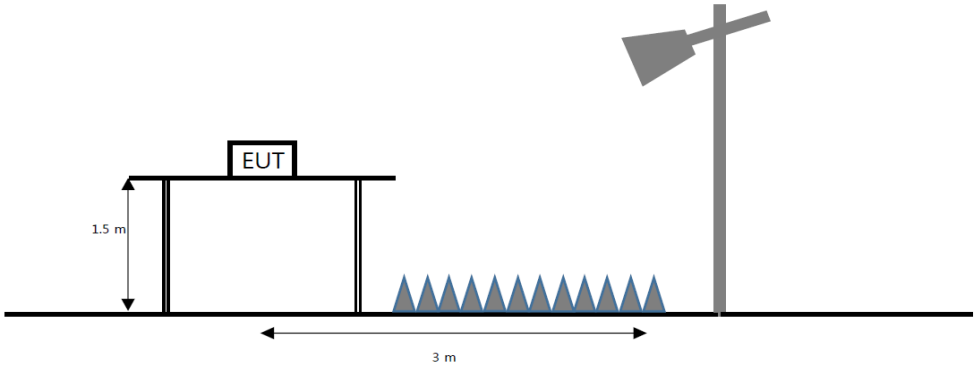
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



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

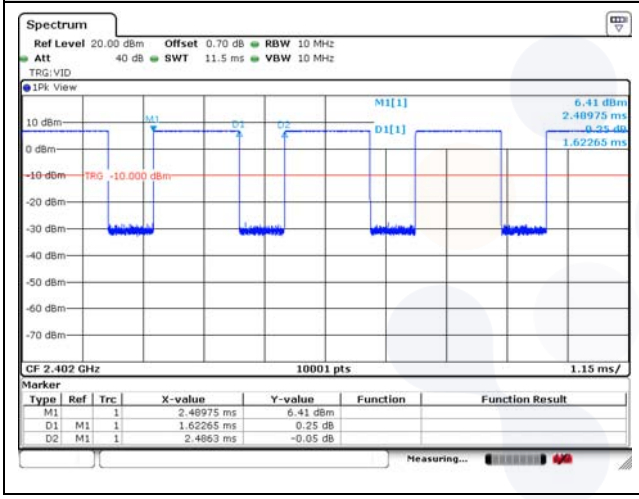
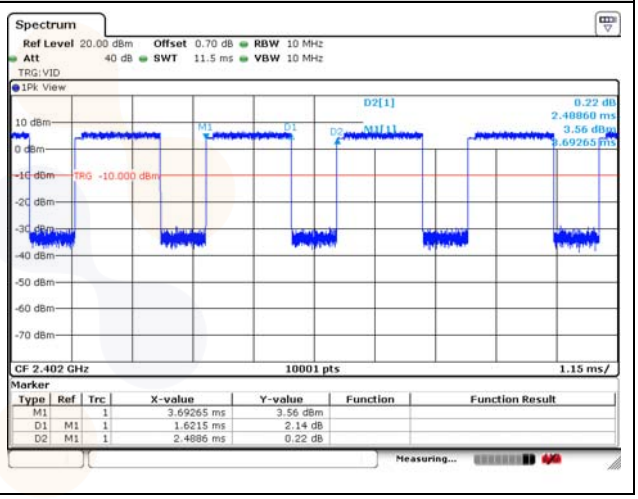
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 ㎒
3. VBW = 1/T ≥ 1 ㎐
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace 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 1 ㎑(≥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	2.486 3	1.622 7	616.257
π/4DQPSK	2.488 6	1.621 5	616.713

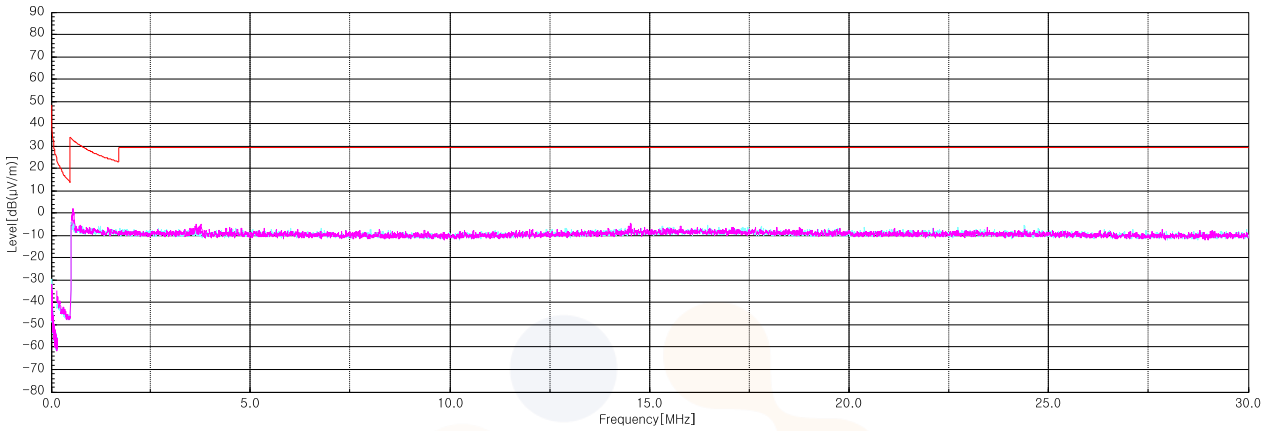
GFSK (DH-3)	8DPSK (3-DH3)
	

2. f <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   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. 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.”
8. Above 1 ㎓ the worst results between two antenna polarizations (H and V) were documented in the test report.

Test results (Below 30 ㎒) – Worst case: GFSK 2 441 ㎒

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

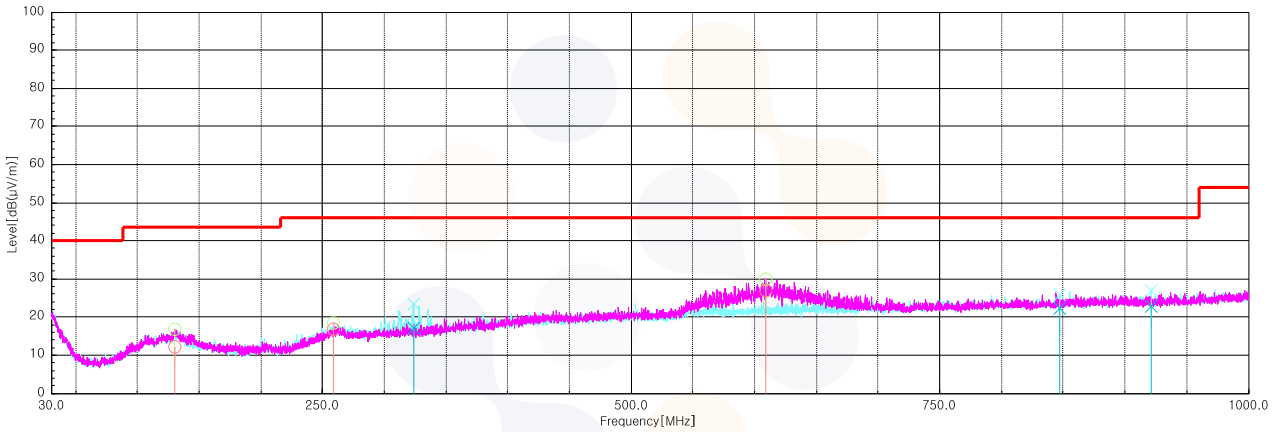
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: GFSK 2 441 ㎒

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								
130.52[1)]	H	24.60	18.00	-30.52	-	12.08	43.50	31.42
259.04[1)]	H	27.20	19.81	-30.26	-	16.75	46.00	29.25
323.55[1)]	V	27.90	19.50	-30.17	-	17.23	46.00	28.77
609.09[1)]	H	32.10	24.70	-29.88	-	26.92	46.00	19.08
847.47	V	25.10	26.00	-28.75	-	22.35	46.00	23.65
921.43	V	24.80	26.40	-28.30	-	22.90	46.00	23.10

Horizontal/Vertical

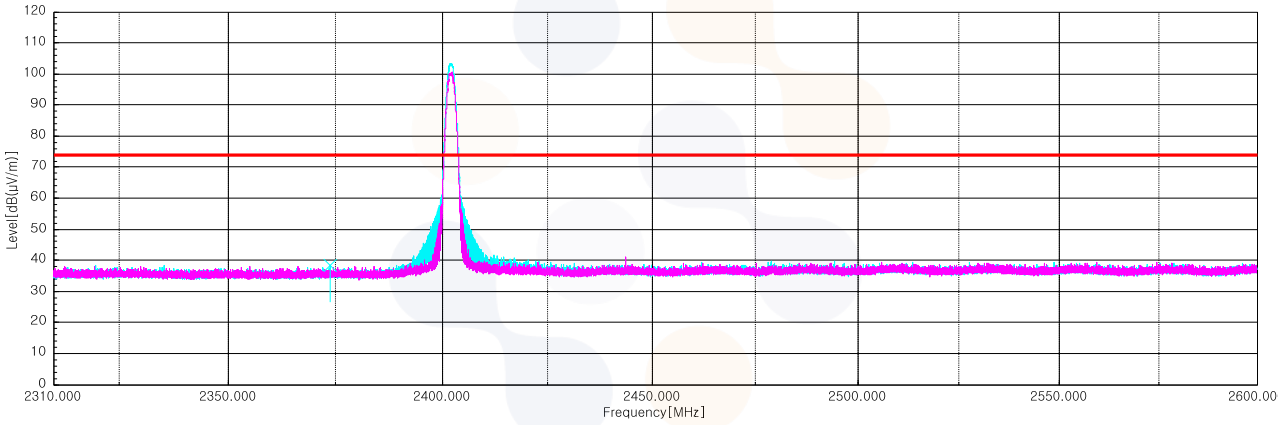


Test results (Above 1 000 ㎒)

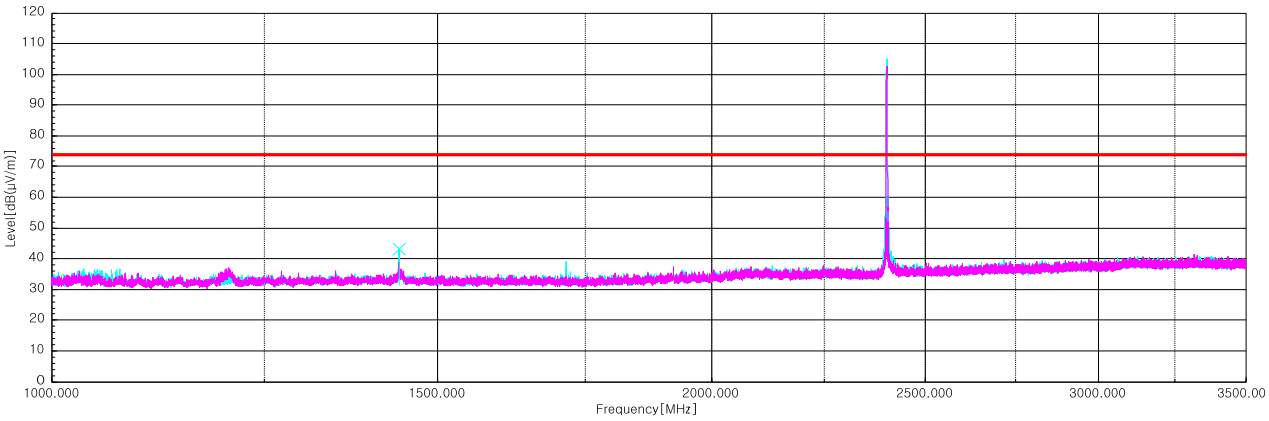
GFSK_Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.33[1)]	V	64.50	25.50	-46.81	-	43.19	74.00	30.81
2 373.61[1)]	V	44.10	27.14	-32.85	-	38.39	74.00	35.61
4 847.05[1)]	H	53.40	32.29	-42.34	-	43.35	74.00	30.65
7 151.58	H	52.10	36.71	-41.05	-	47.76	74.00	26.24
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

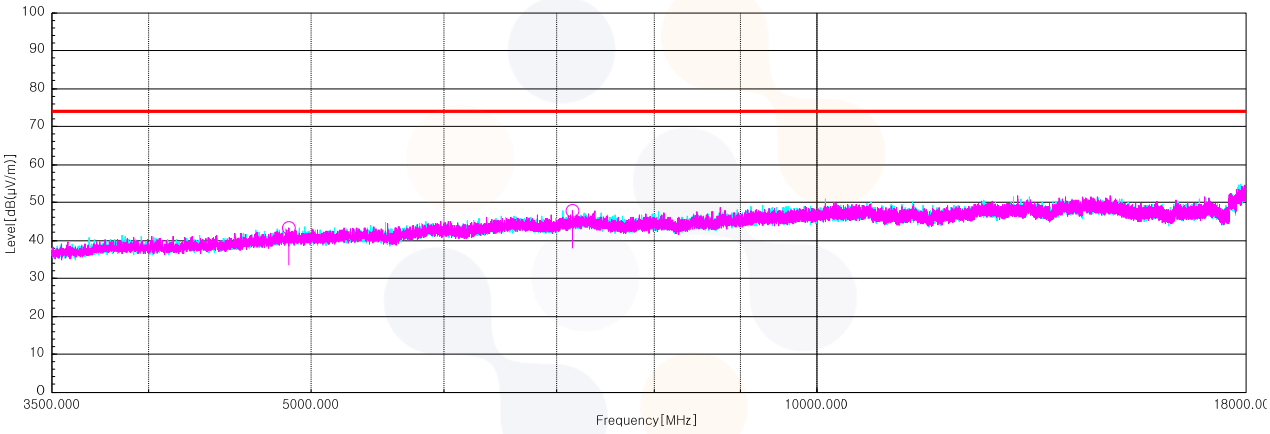
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



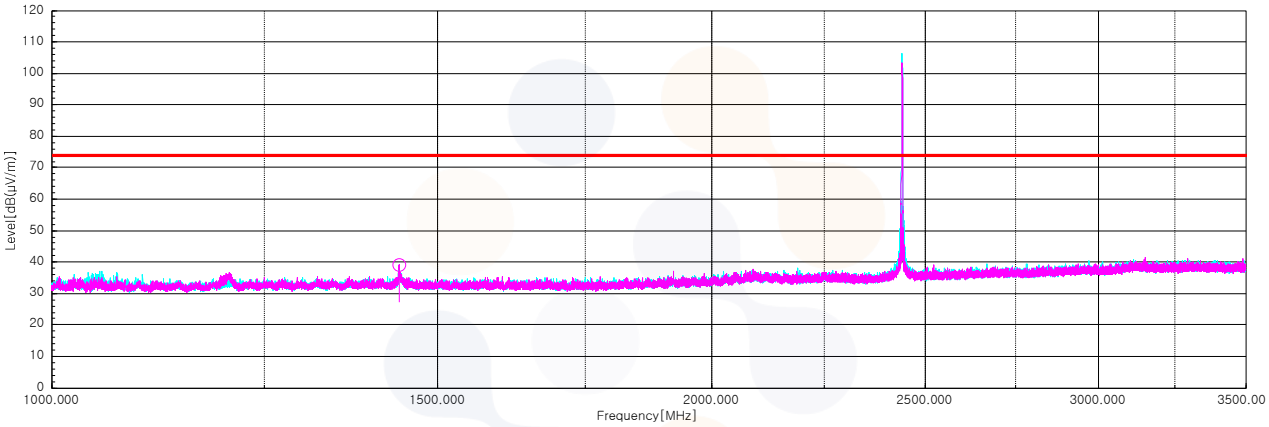
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



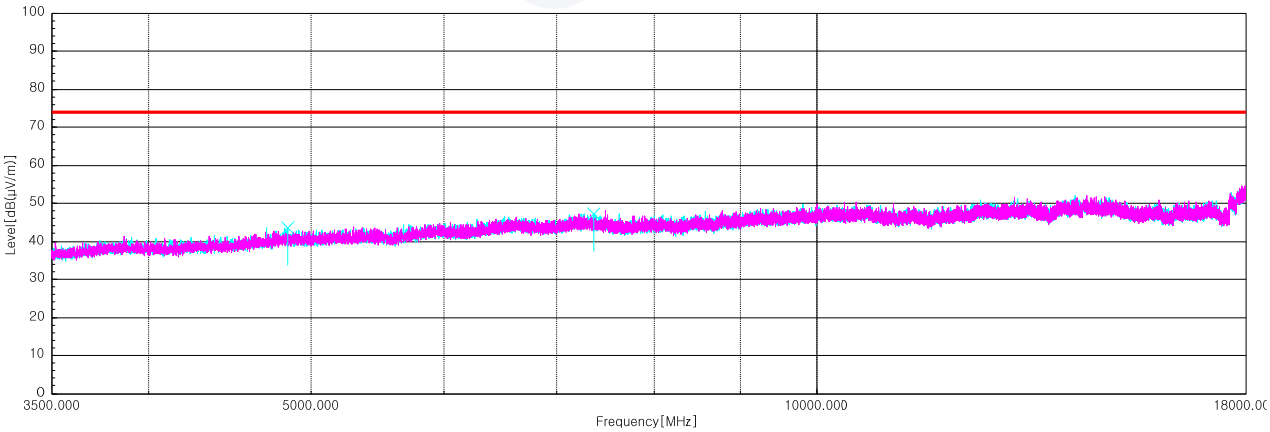
GFSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.50[1)]	H	60.40	25.50	-46.81	-	39.09	74.00	34.91
4 841.25[1)]	V	53.50	32.28	-42.34	-	43.44	74.00	30.56
7 364.25[1)]	V	51.90	36.54	-41.24	-	47.20	74.00	26.80
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



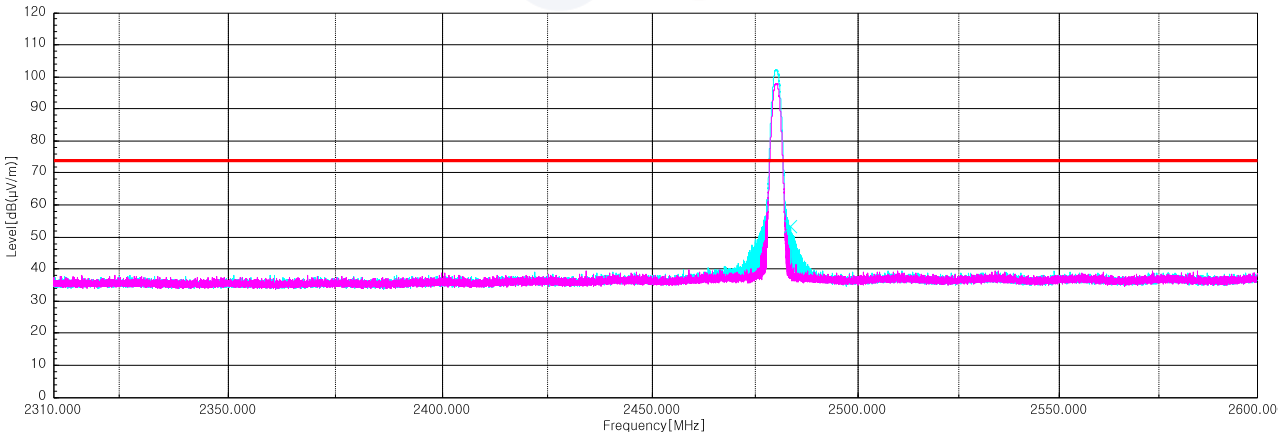
GFSK_High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.25[1)]	V	60.50	25.50	-46.81	-	39.19	74.00	34.81
2 483.51[1)]	V	57.90	27.84	-32.59	-	53.15	74.00	20.85
4 914.72[1)]	H	52.10	32.79	-42.40	-	42.49	74.00	31.51
7 263.72[1)]	V	51.60	36.93	-41.15	-	47.38	74.00	26.62
Average Data								
2 483.51[1)]	V	35.33	27.84	-32.59	-	30.58	54.00	23.42

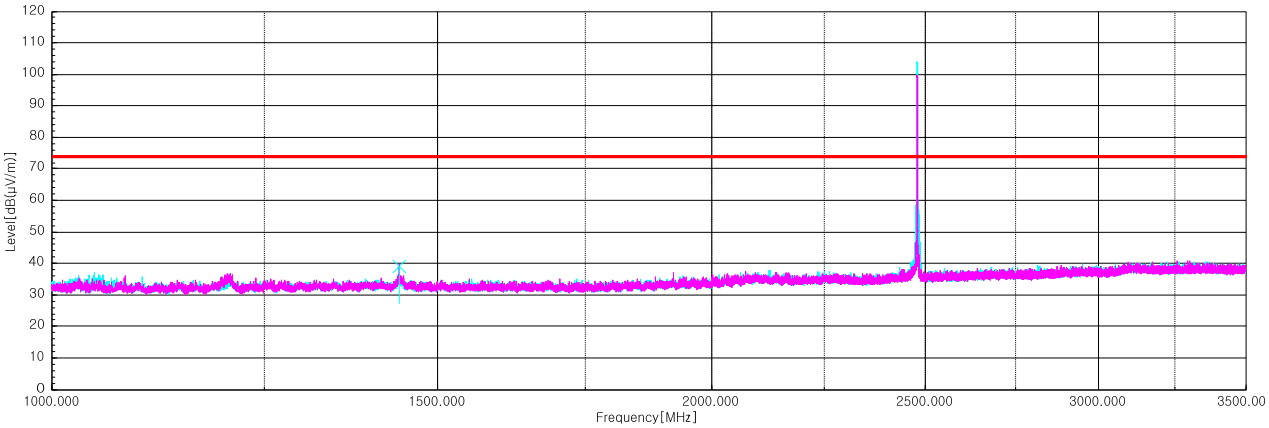
Average data

Blank

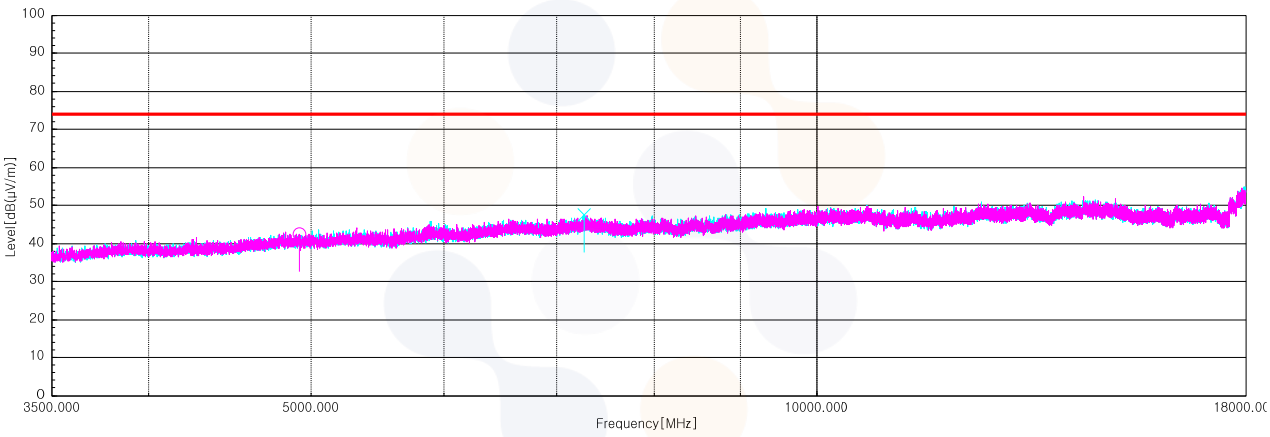
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



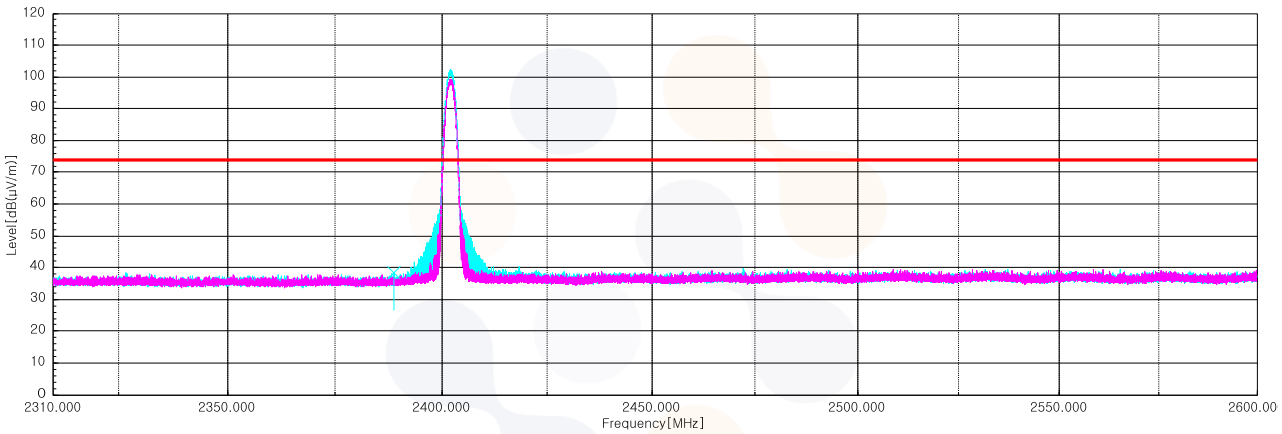
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



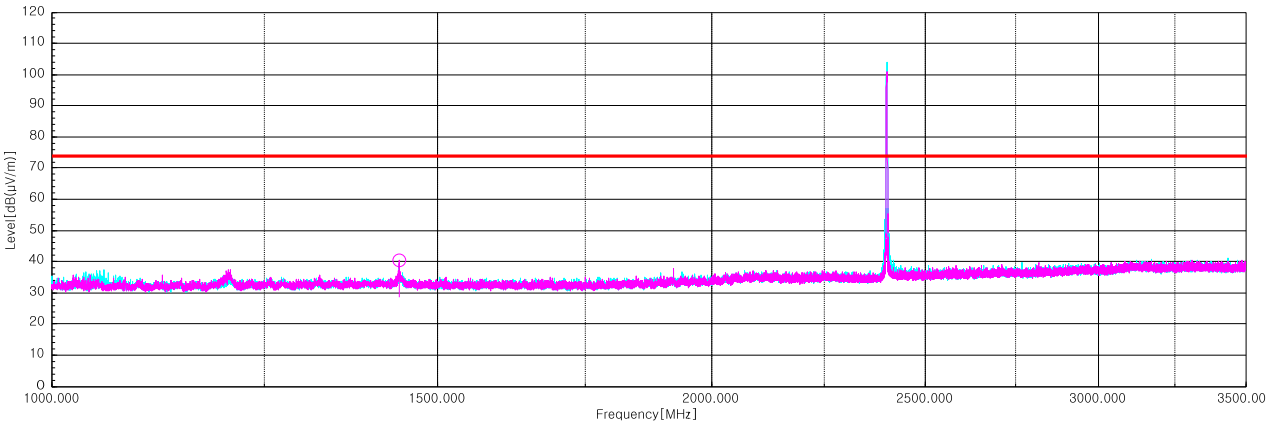
8DPSK_Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.50[1)]	H	61.50	25.50	-46.81	-	40.19	74.00	33.81
2 388.64[1)]	V	44.00	27.10	-32.87	-	38.23	74.00	35.77
4 794.85[1)]	H	54.20	32.28	-42.34	-	44.14	74.00	29.86
7 245.35	H	51.30	36.89	-41.13	-	47.06	74.00	26.94
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

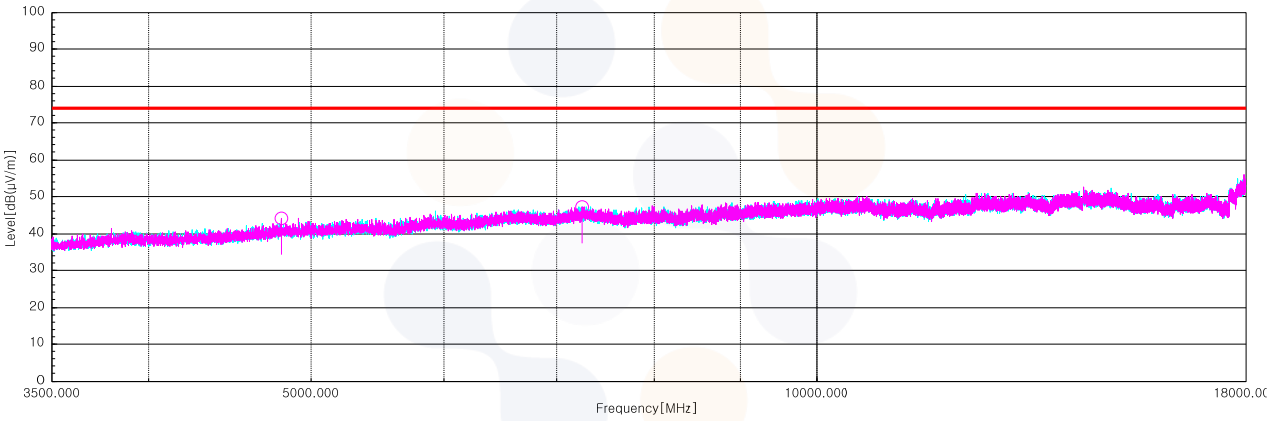
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



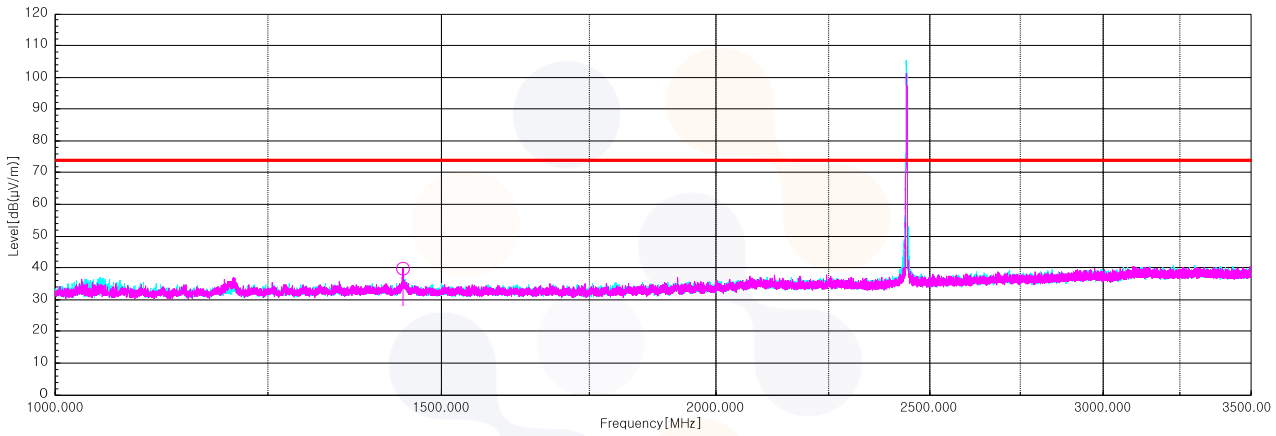
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



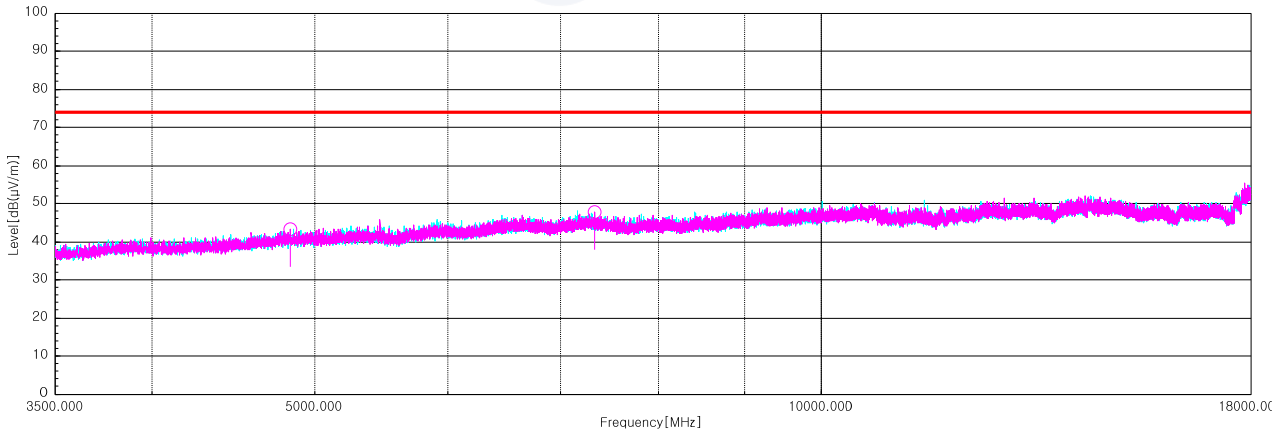
8DPSK_Mid Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.33[1)]	H	61.00	25.50	-46.81	-	39.69	74.00	34.31
4 831.10[1)]	H	53.20	32.26	-42.33	-	43.13	74.00	30.87
7 330.90[1)]	H	52.30	36.74	-41.21	-	47.83	74.00	26.17
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



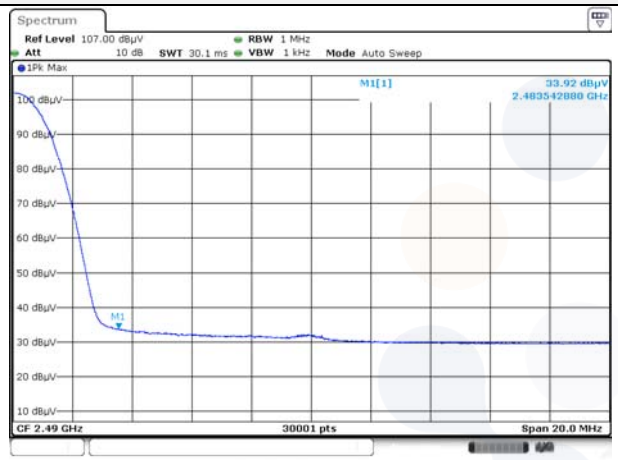
Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



8DPSK_High Channel

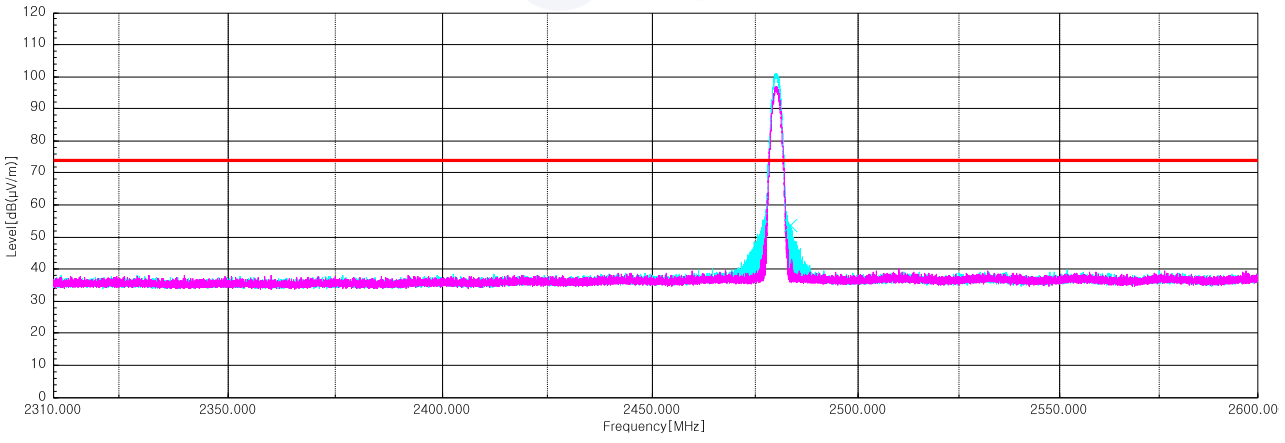
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 440.25[1)]	V	61.50	25.50	-46.81	-	40.19	74.00	33.81
2 483.54[1)]	V	58.40	27.84	-32.59	-	53.65	74.00	20.35
4 959.18[1)]	H	53.40	32.94	-42.47	-	43.87	74.00	30.13
7 390.83[1)]	V	52.40	36.44	-41.26	-	47.58	74.00	26.42
Average Data								
2 483.54[1)]	V	33.92	27.84	-32.59	-	29.17	54.00	24.83

Average data

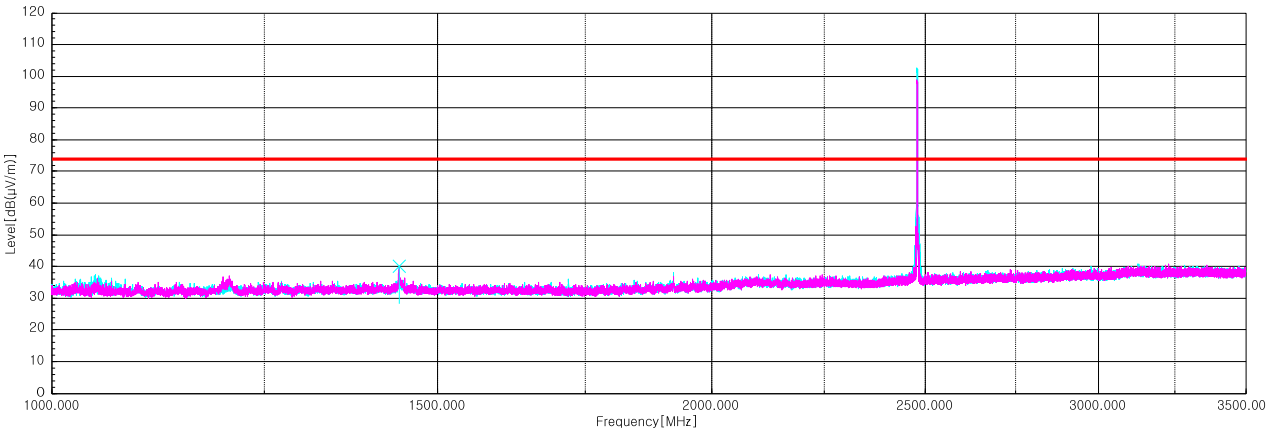


Blank

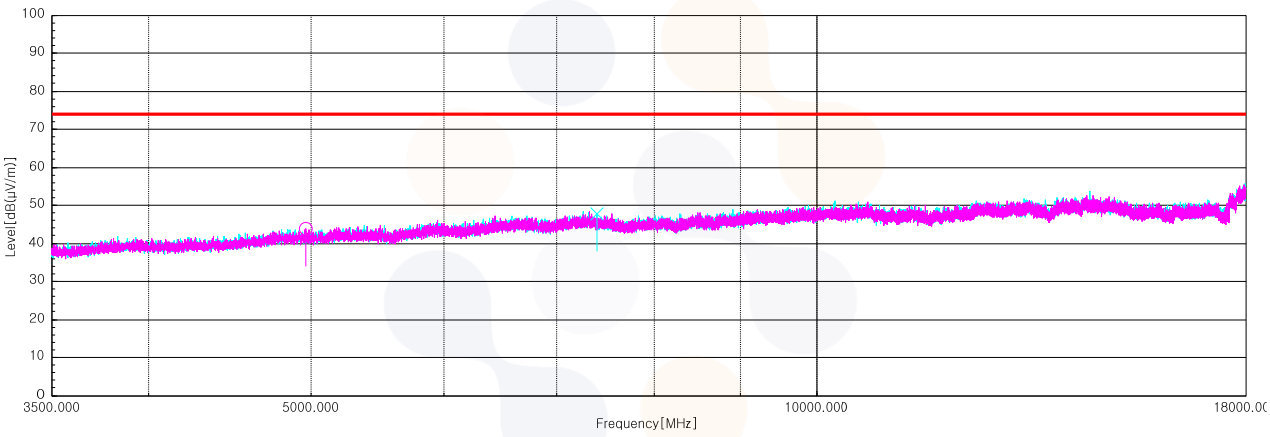
Horizontal/Vertical for Band-edge



Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓

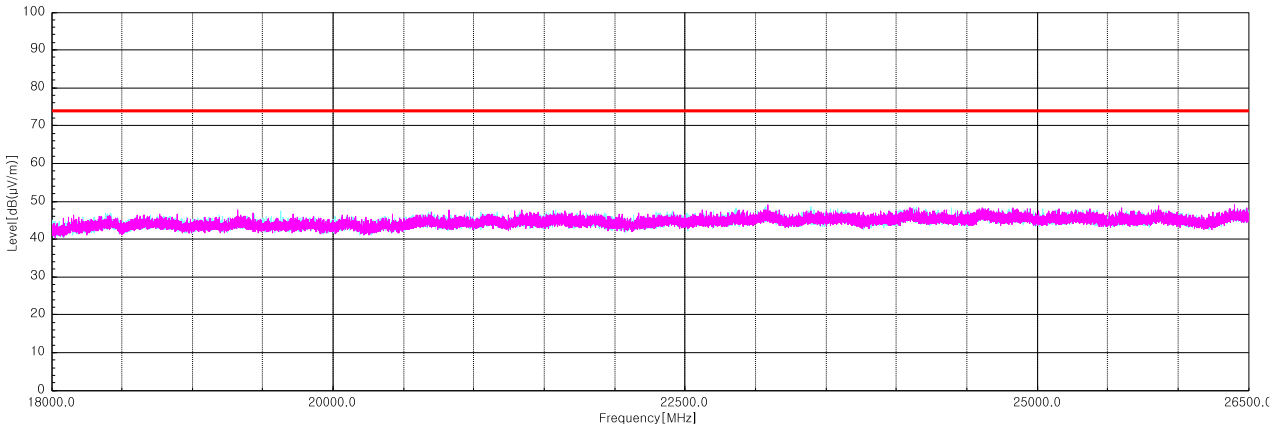


Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Test results (Above 18 ㎓) – Worst case: 8DPSK 2 480 ㎒

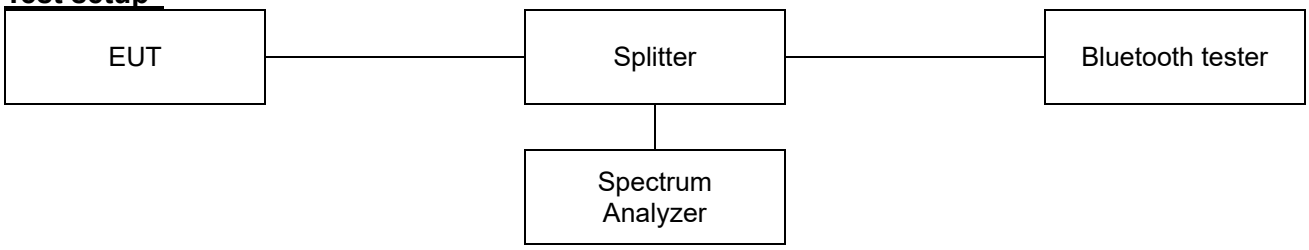
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



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

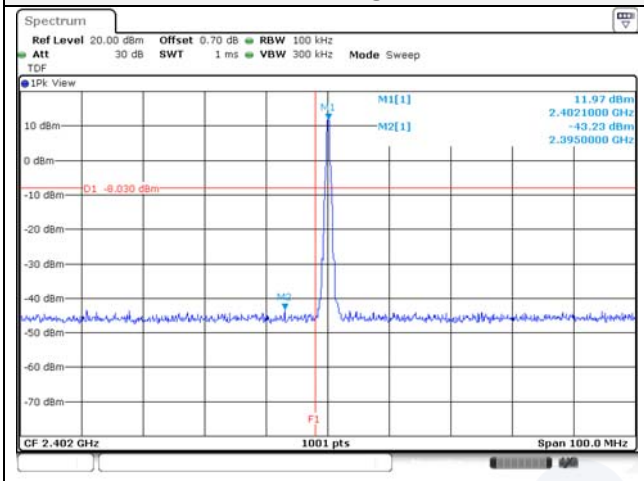
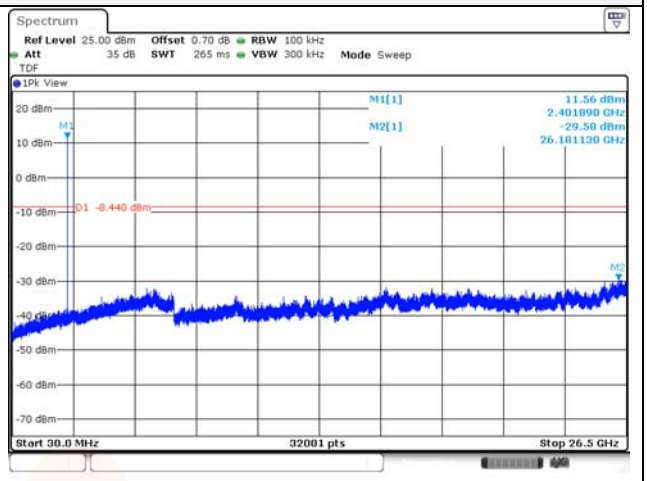
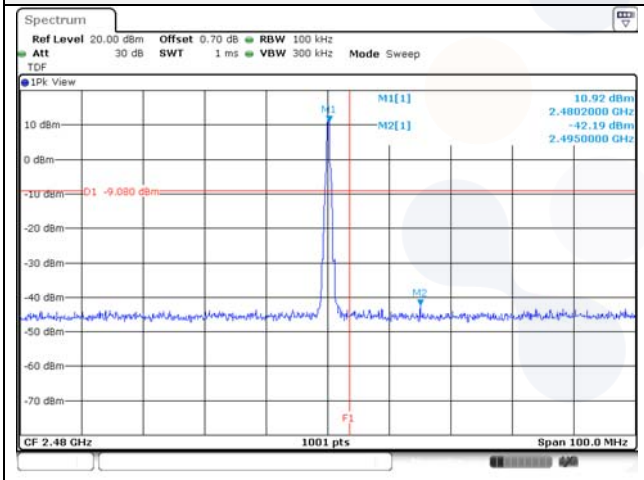
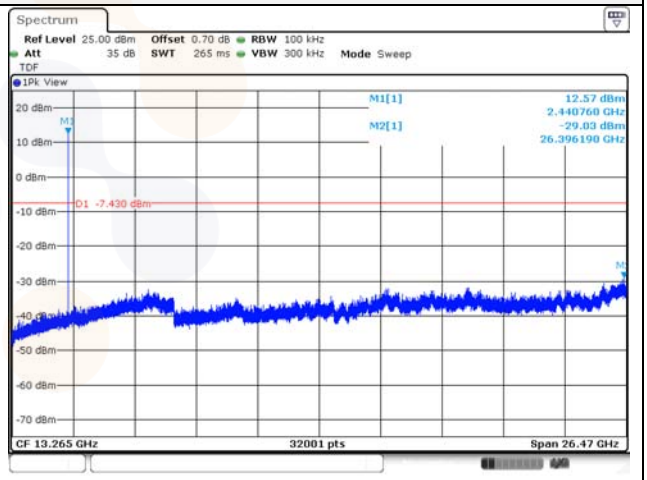
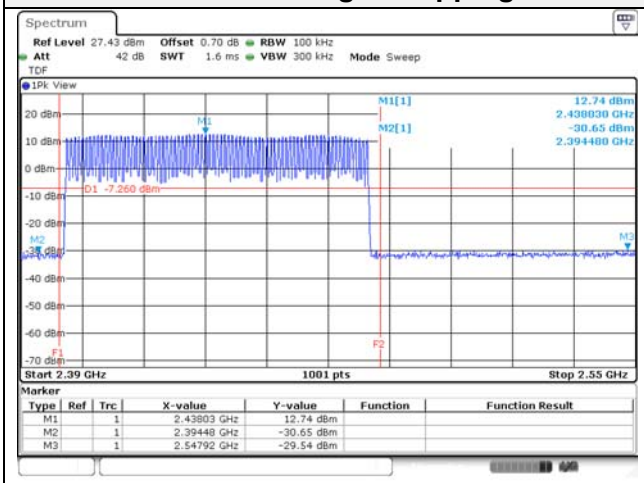
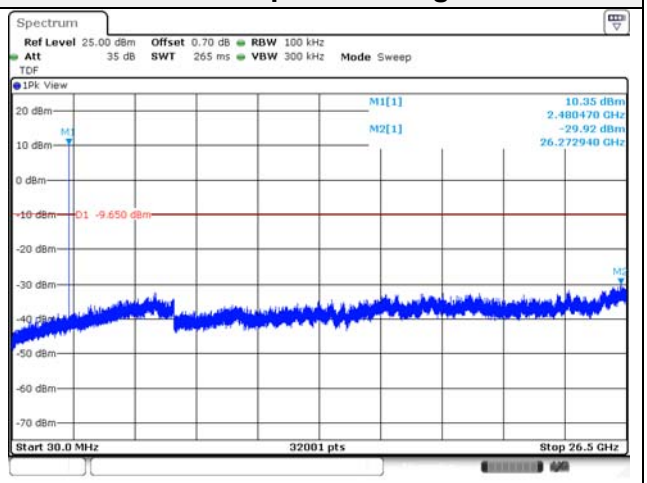
Test settings

- **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

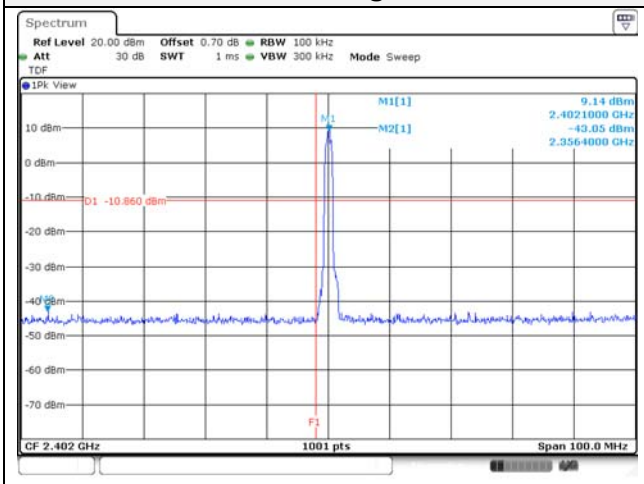
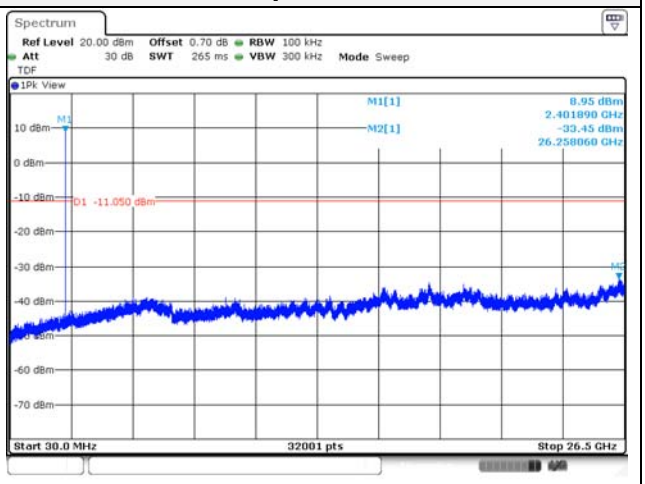
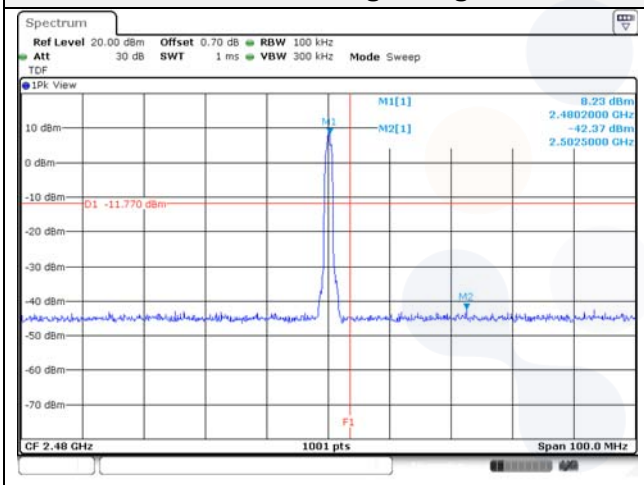
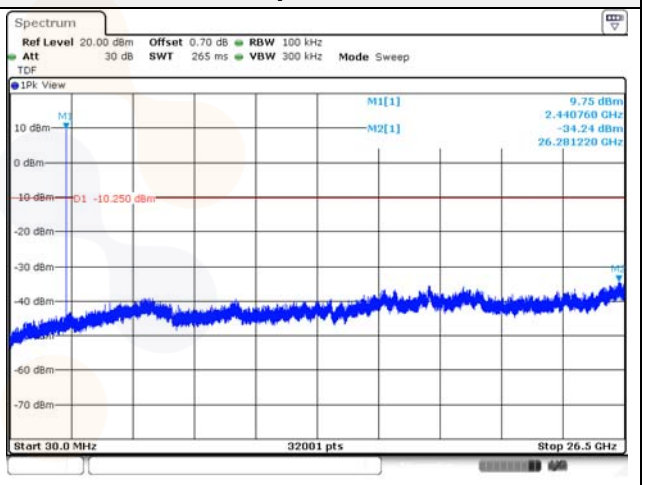
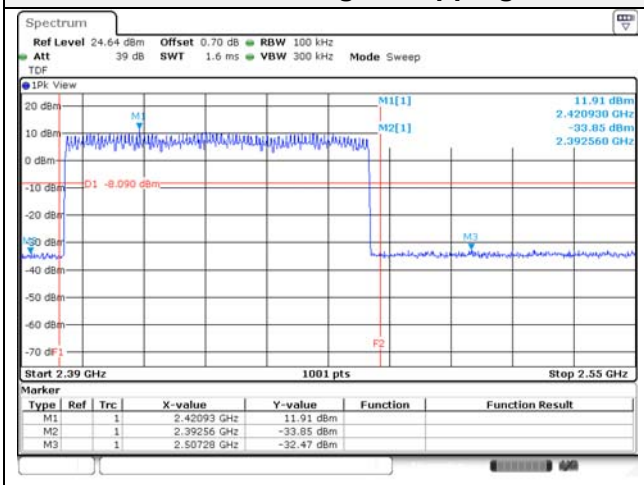
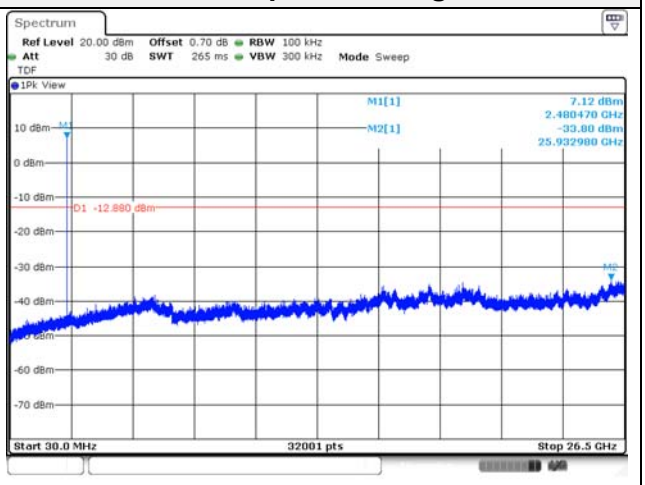
- **Spurious emissions**
  1) Span : 30 ㎒ to 10 times the operating frequency in ㎓
  2) RBW : 100 ㎑
  3) VBW : 300 ㎑
  4) Sweep time : Coupled
  5) Detector : Peak

Test results

GFSK

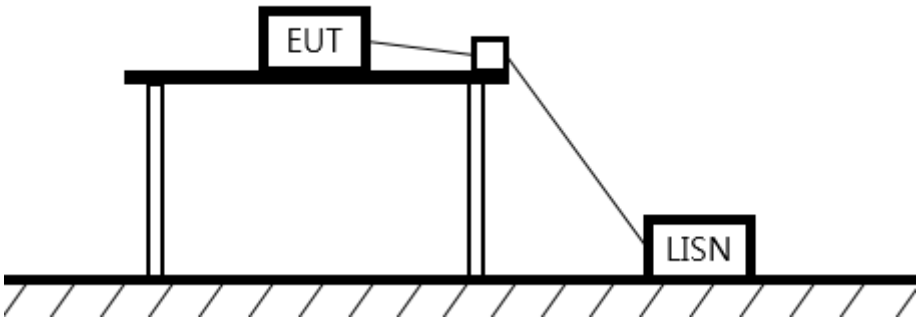
Conducted band-edge / Low ch.	Conducted spurious / Low ch.
	
Conducted band-edge / High ch.	**Conducted spurious / Mid ch.**
	
Conducted band-edge / Hopping ch.	**Conducted spurious / High ch.**
	

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.

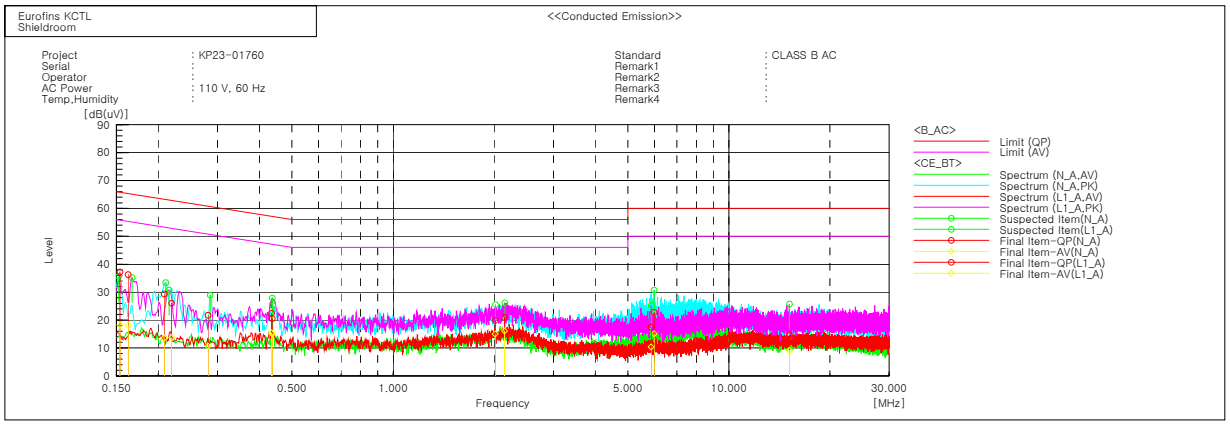
Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

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 2 441 ㎒



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	0.15377	27.3	8.4	9.9	37.2	18.3	65.8	55.8	28.6	37.5
2	0.20803	19.3	3.5	10.0	29.3	13.5	63.3	53.3	34.0	39.8
3	0.28127	11.9	0.9	9.8	21.7	10.7	60.8	50.8	39.1	40.1
4	0.43649	10.5	5.0	10.0	20.5	15.0	57.1	47.1	36.6	32.1
5	2.01395	10.1	5.2	9.8	19.9	15.0	56.0	46.0	36.1	31.0
6	5.99143	12.8	5.1	10.0	22.8	15.1	60.0	50.0	37.2	34.9

--- 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	0.16246	26.2	8.0	10.1	36.3	18.1	65.3	55.3	29.0	37.2
2	0.21902	16.1	3.8	9.9	26.0	13.7	62.9	52.9	36.9	39.2
3	0.43506	12.5	5.5	9.9	22.4	15.4	57.2	47.2	34.8	31.8
4	2.14738	11.1	6.3	9.8	20.9	16.1	56.0	46.0	35.1	29.9
5	5.86831	7.5	0.4	10.0	17.5	10.4	60.0	50.0	42.5	39.6
6	15.14479	4.1	-1.4	10.5	14.6	9.1	60.0	50.0	45.4	40.9

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R&S	FSV30	100807	23.07.12
Vector Signal Generator	R&S	SMBV100A	257566	23.07.04
Signal Generator	R&S	SMB100A	176206	24.01.19
Splitter	Mini-Circuits	ZX10-2-1252-S+	1633-1	24.01.19
Power Sensor	R&S	NRP-Z81	1137.9009.02-106224-tg	24.04.25*
Attenuator	R&S	DNF Dämpfungsglied 10 dB in N-50 Ohm	0006	24.01.19
Bluetooth Tester	TESCOM	TC-3000C	3000C000270	23.07.11
DC Power Supply	AGILENT	E3632A	MY40008800	23.07.11
Controller	INNCO SYSTEMS	CO3000	1441/54370322/P	-
Antenna Mast	INNCO SYSTEMS	MA4640-XP-ET	-	-
Turn Device	INNCO SYSTEMS	DS1200-S-1t	-	-
Spectrum Analyzer	R&S	FSVA40	101575	23.07.22
PSA Spectrum Analyzer	Agilent	E4440A	MY46186407	24.03.22
Bluetooth Tester	TESCOM	TC-3000C	3000C000427	24.04.24*
Broadband Pre-Amplifier	SCHWARZBECK	BBV9718D	57	24.03.17
Low Noise Amplifier	TESTEK	TK-PA18H	220124-L	23.12.02
Low Noise Amplifier	TESTEK	TK-PA1840H	220133-L	23.12.02
Amplifier	SONOMA INSTRUMENT	310N	421821	23.12.14
Horn Antenna	SCHWARZBECK	BBHA9120D	2763	23.12.06
Horn Antenna	SCHWARZBECK	BBHA9170	1267	23.12.05
Bi-log Antenna	Teseq GmbH	CBL 6112D	63756	24.11.17
Loop Antenna	R&S	HFH2-Z2	100355	24.08.10
High Pass Filter	Wainwright Instruments GmbH	WHKX12-2805-3000-18000-40SS	SN58	23.12.14
TWO-LINE V - Network	R&S	ENV216	101358	23.09.29
EMI Test Receiver	R&S	ESCI3	100001	23.08.18

* Tests related to this equipment were progressed after the calibration was completed.

End of test report