TEST REPORT

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1. Client

◦ Name : PARTRON CO., LTD.

◦ Address : 22,Samsung1-ro2-gil, Hwaseong-si, Gyeonggi-do, South Korea

◦ Date of Receipt : 2019-03-08

2. Use of Report : -

3. Name of Product and Model : Truly Wireless Earbuds / PWE-100

4. Manufacturer and Country of Origin : PARTRON VINA CO.,LTD / Vietnam

5. FCC ID : 2AD5K-PWE100

6. Date of Test : 2019-04-08 to 2019-04-10

7. Test Standards : FCC Part 15 Subpart C, 15.247

8. Test Results : Refer to the test result in the test report

Affirmation	Tested by Name : Seonjun Yun (Signature)	Technical Manager Name : Seungyong Kim (Signature)

2019-05-13

KCTL Inc.

Report revision history

Date	Revision	Page No
2019-04-15	Initial report	-
2019-05-13	Updated	5, 14, 42 ~ 43

CONTENTS

1. General information

Client : PARTRON CO., LTD.
Address : 22,Samsung1-ro2-gil, Hwaseong-si, Gyeonggi-do, South Korea
Manufacturer : PARTRON VINA CO.,LTD
Address : Plot 11-khai Quang IZ, Vinh Yen, Yinh Phuc, Vietnam
Laboratory : KCTL Inc.
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-3327, G-198, C-3706, T-1849
Industry Canada Registration No. : 8035A-2
KOLAS No.: KT231

2. Device information

Equipment under test : Truly Wireless Earbuds
Model : PWE-100
Frequency range : 2 402 ㎒ ~ 2 480 ㎒ (Bluetooth, Bluetooth low energy)
Modulation technique : GFSK, π/4DQPSK, 8DPSK (Bluetooth)
GFSK (Bluetooth low energy)
Number of channels : 79 ch (Bluetooth)
40 ch (Bluetooth low energy)
Power source : DC 3.7 V
Antenna specification : Fixed Type Antenna
Antenna gain : -0.22 dBi
Software version : 1.0
Hardware version : 1.0
Test device serial No. : N/A
Operation temperature : 23 ℃

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
--		-	-	-

2.2. Information about derivative model

N/A

2.3. Frequency/channel operations

This device contains the following capabilities:
Bluetooth(BDR/EDR), Bluetooth low energy

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

Table 2.3.1. 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 Fixed Type Antenna on the exterior by using glue epoxy.

4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.247(b)(1), (4)	Maximum peak output power	Pass
15.247(a)(1)	Carrier frequency separation	Pass
15.247(a)(1)	20dB channel bandwidth	Pass
-	Occupied 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
15.205(a), 15.209(a) 15.247(d),	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted emissions	N/A(Note1)

Notes:

1. This test is not applicable because the EUT uses battery and it's not to be connected to the public utility(AC) power line.
2. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
3. 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.
4. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that X orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in X orientation
5. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
6. The software and hardware of two earbuds is same. Two earbuds have been tested. However, the test result of left earbud is only listed, which is worst-case.

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	1.76 ㏈	
Conducted spurious emissions	4.03 ㏈	
Radiated spurious emissions	9 ㎑ ~ 30 ㎒:	2.28 ㏈
	30 ㎒ ~ 300 ㎒	4.98 ㏈
	300 ㎒ ~ 1 000 ㎒	5.14 ㏈
	1 ㎓ ~ 6 ㎓	6.70 ㏈
	Above 6 ㎓	6.60 ㏈
Conducted emissions	9 ㎑ ~ 150 ㎑	3.66 ㏈
	150 ㎑ ~ 30 ㎒	3.26 ㏈

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.

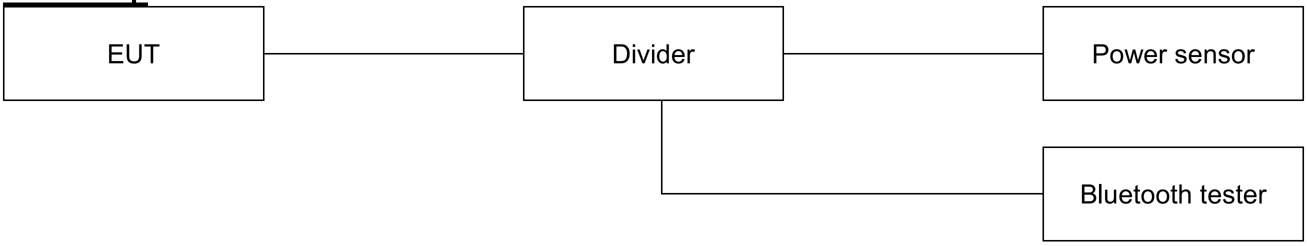
Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	0.62	9 000	2.72
100	0.57	10 000	2.86
200	0.64	11 000	2.80
300	0.57	12 000	3.08
400	0.80	13 000	3.23
500	0.84	14 000	3.33
600	0.83	15 000	3.53
700	0.91	16 000	3.82
800	1.03	17 000	3.74
900	1.10	18 000	3.89
1 000	1.03	19 000	4.17
2 000	1.41	20 000	4.38
3 000	1.86	21 000	4.67
4 000	2.25	22 000	4.73
5 000	2.15	23 000	4.87
6 000	2.31	24 000	4.64
7 000	2.32	25 000	4.77
8 000	2.42	26 000	4.73

Note.
Offset(㏈) = RF cable loss(㏈)

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 following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:
Use the following spectrum analyzer settings:

1) Span: Approximately five times the 20 ㏈ bandwidth, centered on a hopping channel.
2) RBW > 20 ㏈ bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
7) Allow trace to stabilize.

Notes:

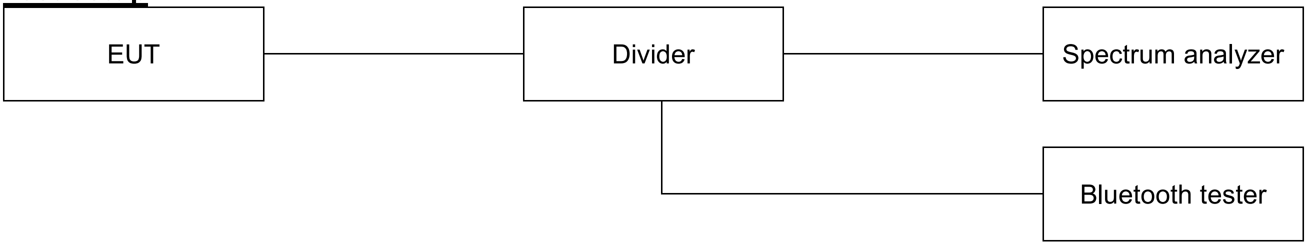
A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

Test results

Frequency(㎒)	Data rate(Mbps)	Measured output power(㎈m)		Limit(㎈m)
		Peak	Average	
2 402	1	4.15	2.79	20.97
2 441	1	4.15	2.77	
2 480	1	4.15	2.75	
2 402	2	7.05	2.80	20.97
2 441	2	7.05	2.80	
2 480	2	7.05	2.76	
2 402	3	7.75	2.80	20.97
2 441	3	7.65	2.80	
2 480	3	7.65	2.77	

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

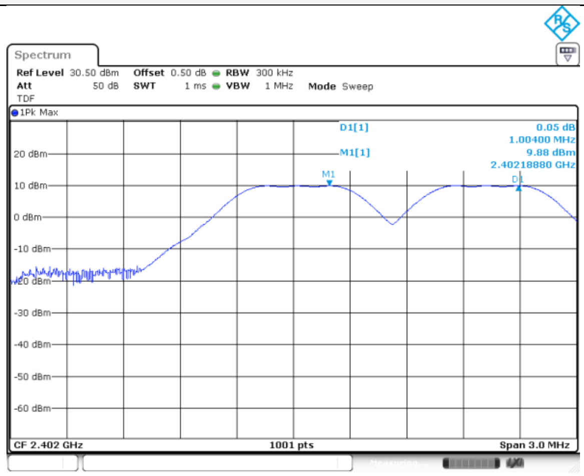
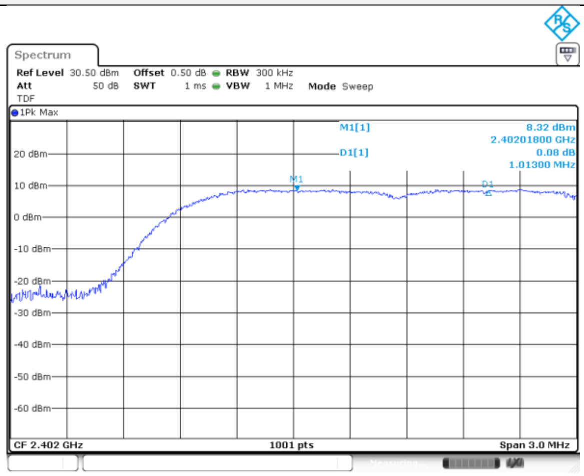
Test settings

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	1.004	0.427
2 441	1	1.001	0.431
2 480	1	0.995	0.427
2 402	3	1.013	0.867
2 441	3	1.007	0.869
2 480	3	1.148	0.853

GFSK	8DPSK
	
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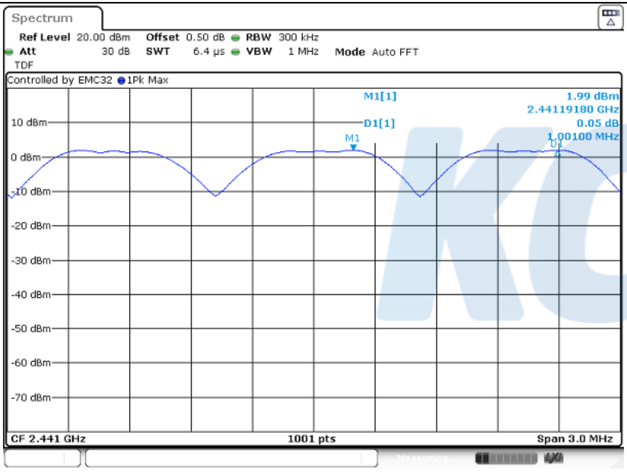	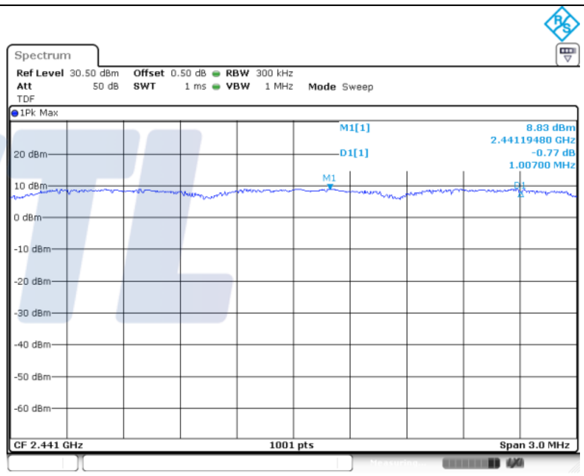
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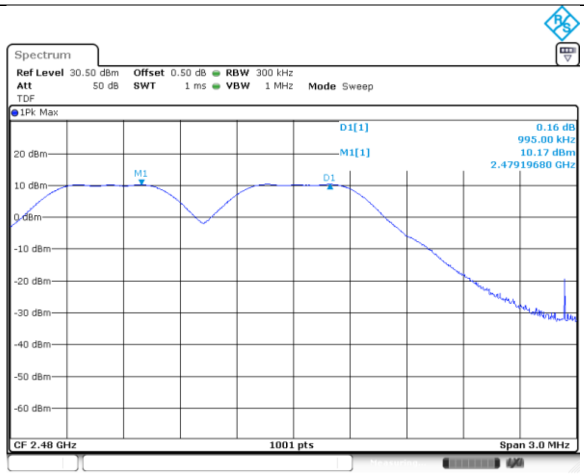
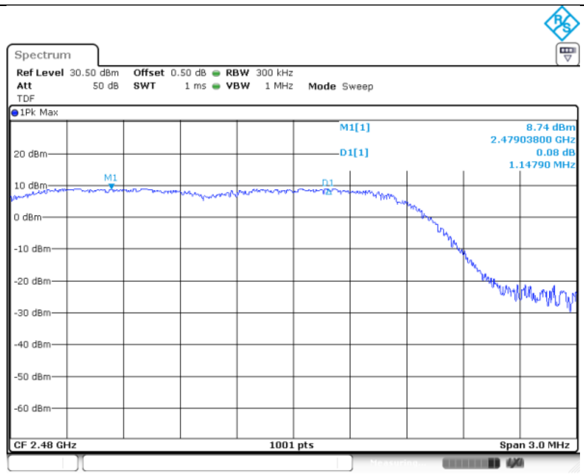
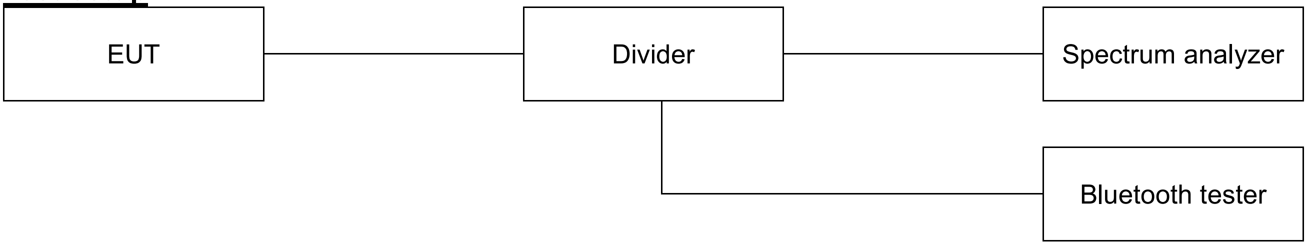
	
2 480 ㎒	2 480 ㎒

7.3. 20dB channel 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

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.

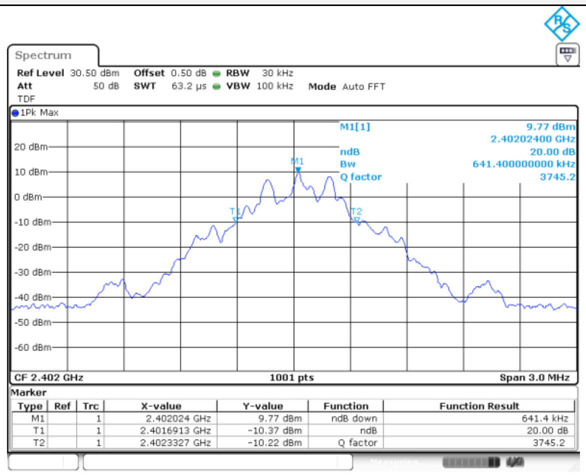
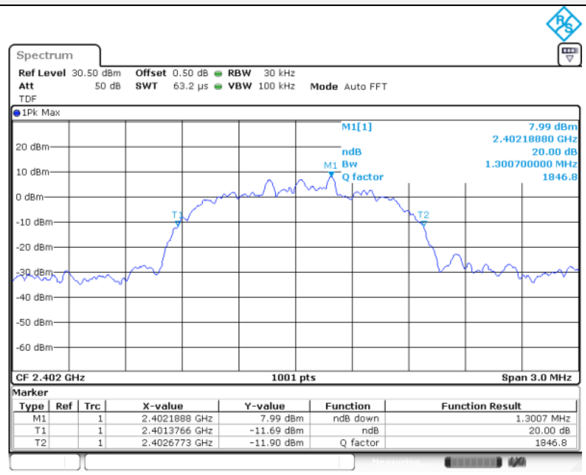
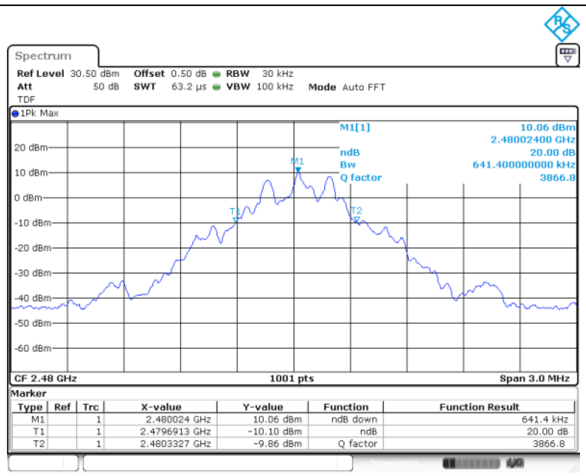
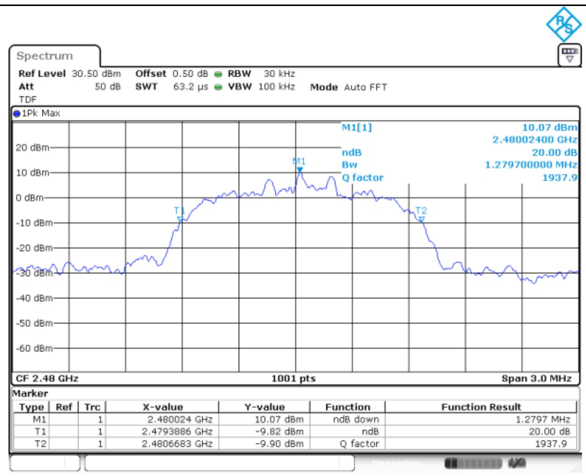
a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
Span: Two times and five times the OBW.
b) RBW = 1 % to 5 % of the OBW and VBW ≥ 3 x RBW
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
d) 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.
e) Detector: peak
f) Trace mode: max hold.
g) Allow the trace to stabilize.
h) Determine the “−xx ㏈ down amplitude” using ((reference value) − xx). Alternatively, this calculation may be made by using the marker-delta function of the instrument.
i) 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).

j) 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 ㏈ down amplitude” determined in step h). If a marker is below this “−xx ㏈ 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 ㏈ 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 ㏈ bandwidth(㎒)	99 % bandwidth(㎒)	Limit
2 402	1	0.641	0.869	0.427
2 441	1	0.647	0.773	0.432
2 480	1	0.641	0.767	0.428
2 402	3	1.301	1.190	0.867
2 441	3	1.304	1.178	0.869
2 480	3	1.280	1.181	0.853

20 ㏈ bandwidth(㎒)

GFSK	8DPSK
	
2 402 MHz	2 402 MHz
	
2 441 MHz	2 441 MHz
	
2 480 MHz	2 480 MHz

99 % bandwidth(㎒)

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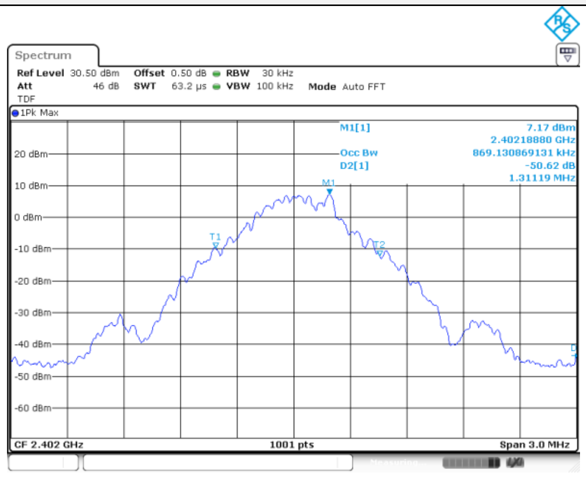
<tr><td>
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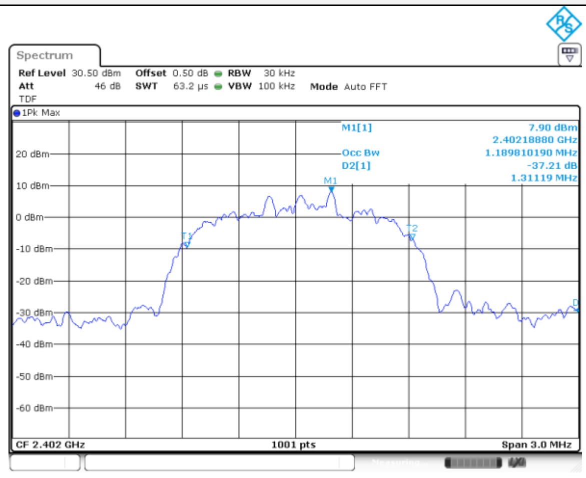
<td>
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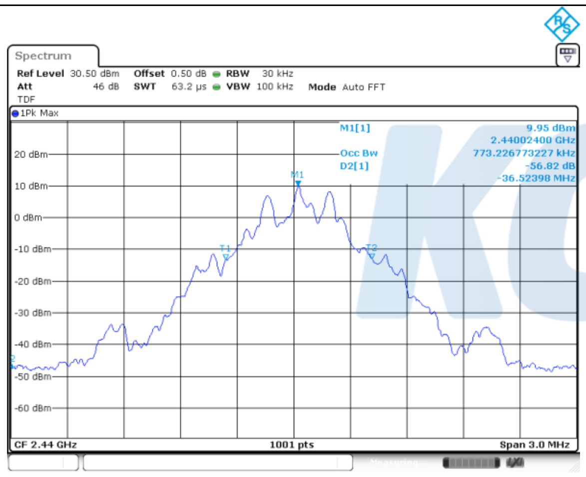
<tr><td>
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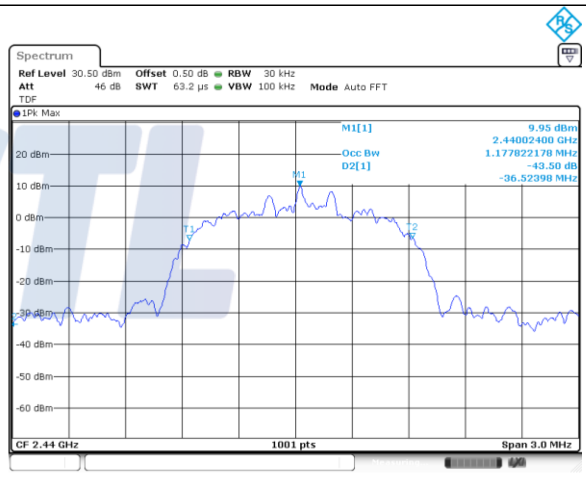
<td>
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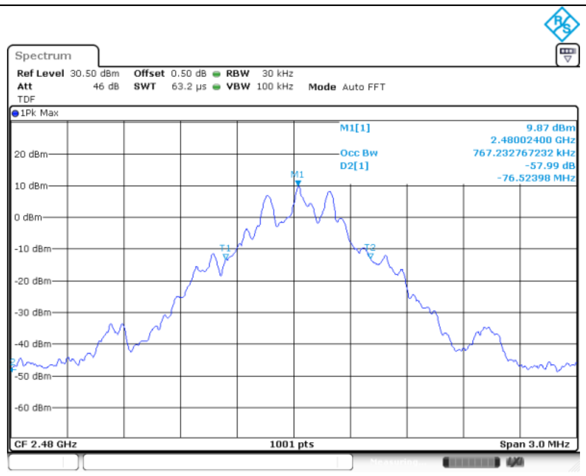
<tr><td>
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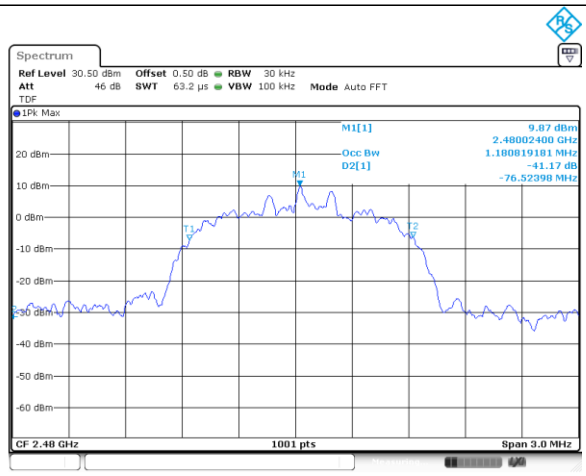
<td>
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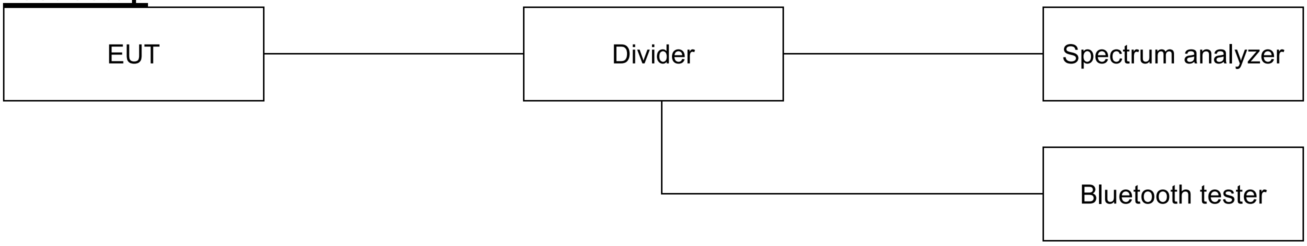
7.4. Number of hopping channels

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

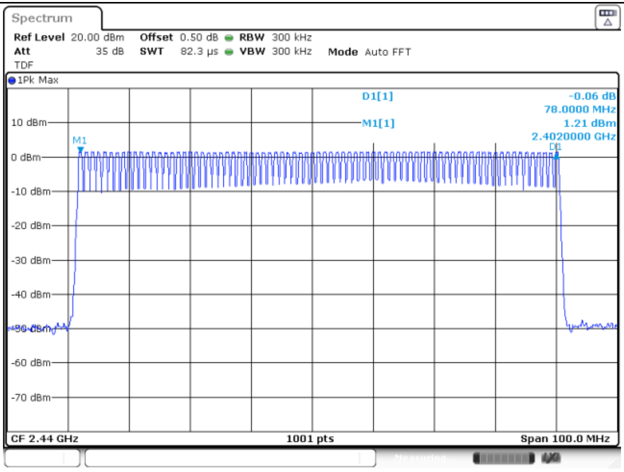
Test settings

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.

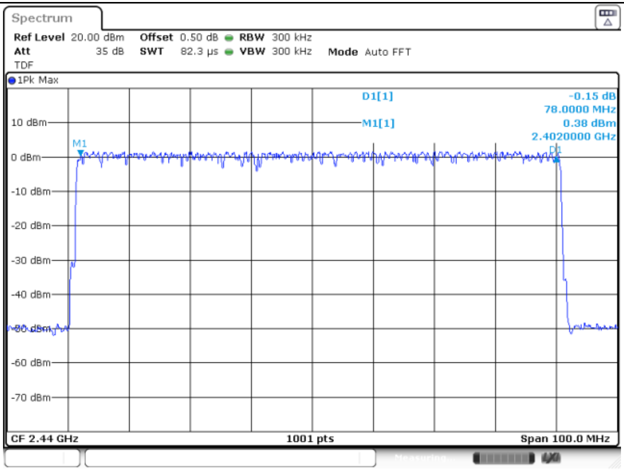
It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

Test results

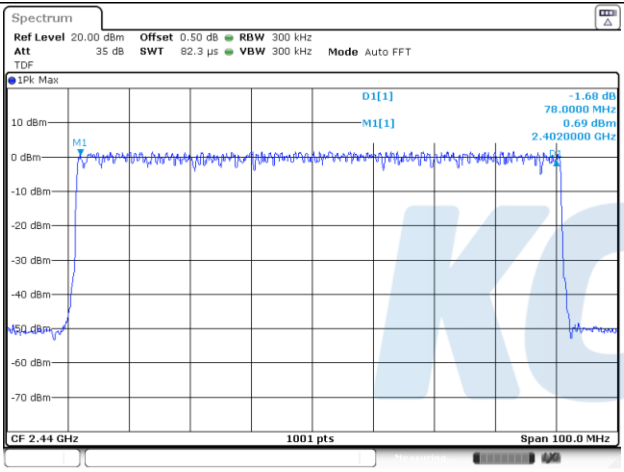
Mode	Number of hopping channel	Limit
GFSK	79	≥15
π/4DQPSK	79	≥15
8DPSK	79	≥15



GFSK



π/4DQPSK

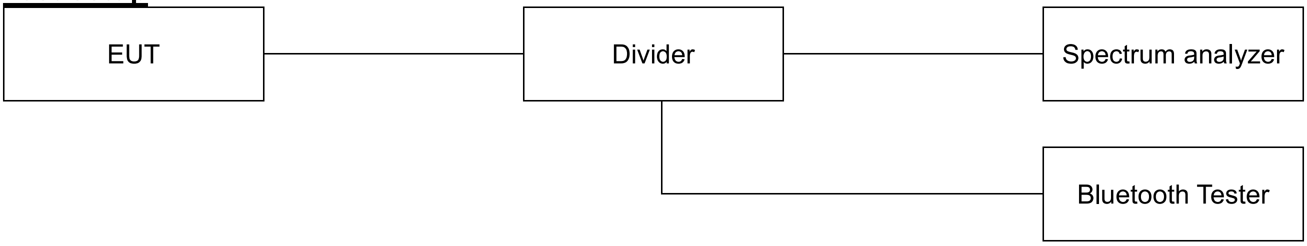


8DPSK

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	0.375	800.000	79	0.120	0.400
DH3	2 441	1.633	400.000	79	0.261	0.400
DH5	2 441	2.881	266.667	79	0.307	0.400
2-DH1	2 441	0.385	800.000	79	0.123	0.400
2-DH3	2 441	1.638	400.000	79	0.262	0.400
2-DH5	2 441	2.881	266.667	79	0.307	0.400
3-DH1	2 441	0.386	800.000	79	0.124	0.400
3-DH3	2 441	1.638	400.000	79	0.262	0.400
3-DH5	2 441	2.881	266.667	79	0.307	0.400

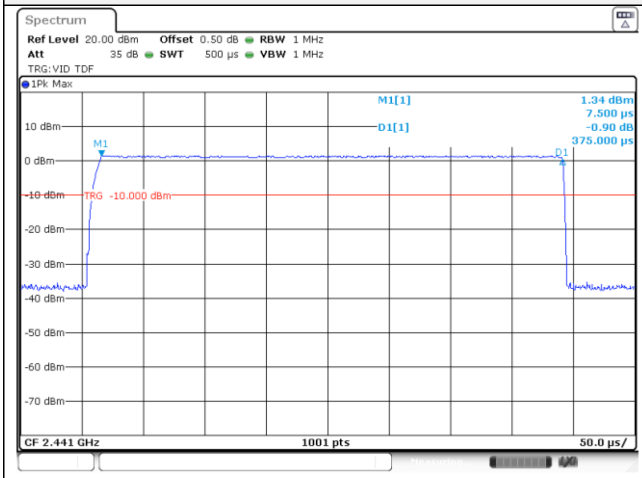
- AFH

Modulation	Frequency (㎒)	Pulse Width (㎳)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
DH1	2 441	0.375	400.000	20	0.060	0.400
DH3	2 441	1.630	200.000	20	0.130	0.400
DH5	2 441	2.881	133.333	20	0.154	0.400
2-DH1	2 441	0.386	400.000	20	0.062	0.400
2-DH3	2 441	1.630	200.000	20	0.130	0.400
2-DH5	2 441	2.881	133.333	20	0.154	0.400
3-DH1	2 441	0.386	400.000	20	0.062	0.400
3-DH3	2 441	1.630	200.000	20	0.130	0.400
3-DH5	2 441	2.881	133.333	20	0.154	0.400

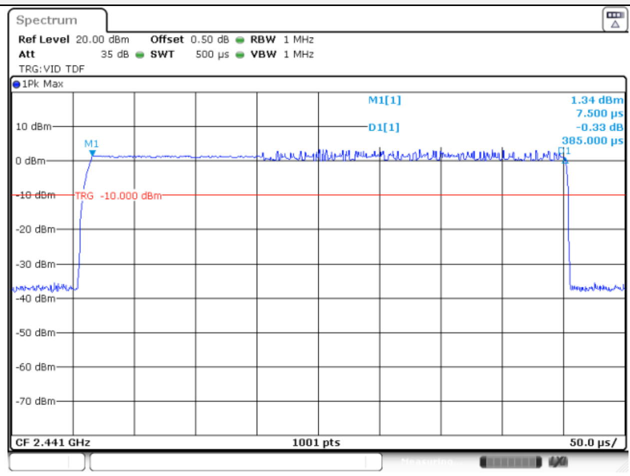
Notes:

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)

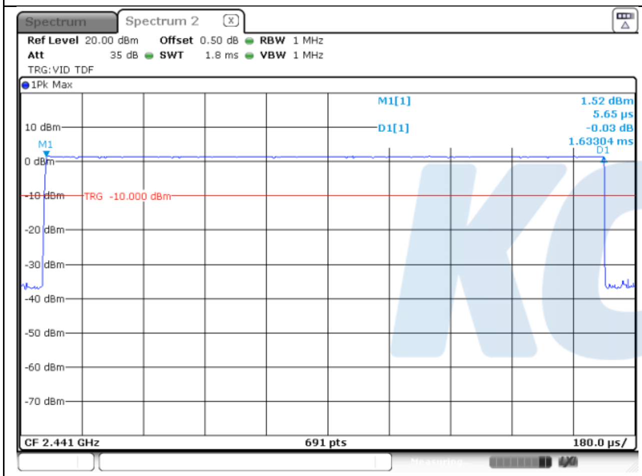
Non-AFH(GFSK)	Non-AFH(π/4DQPSK)



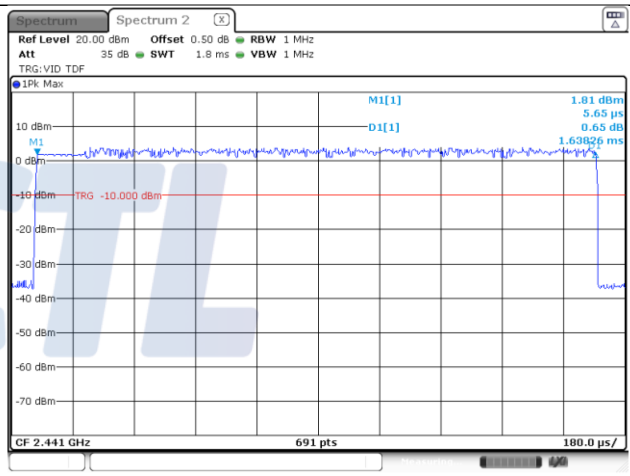
DH1



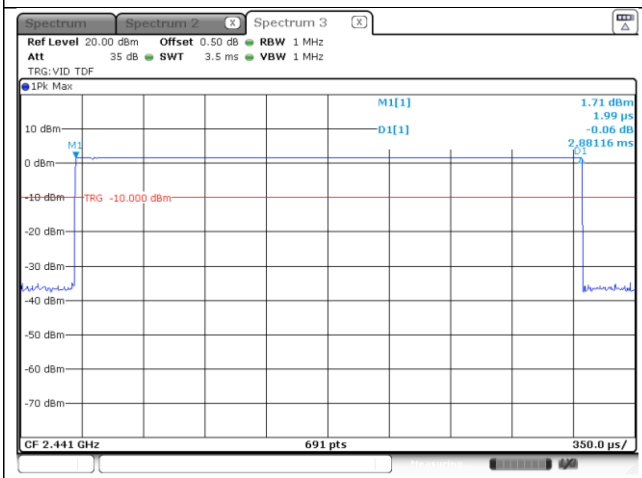
2-DH1



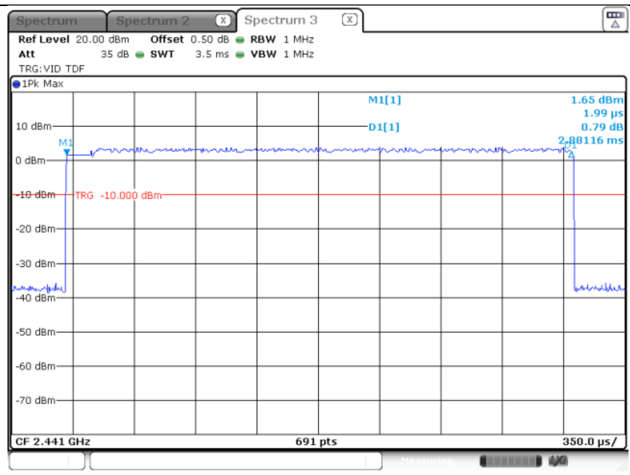
DH3



2-DH3

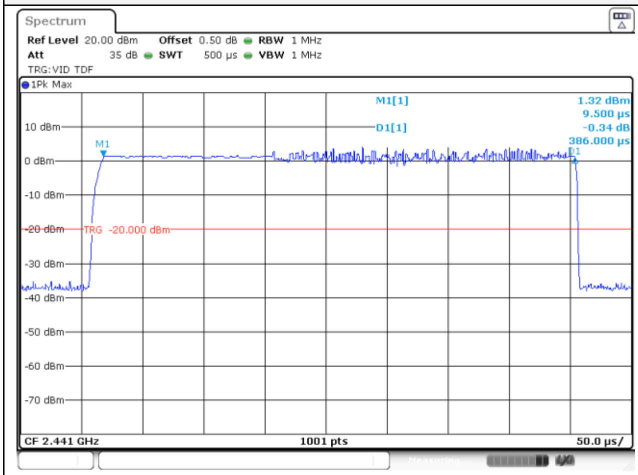


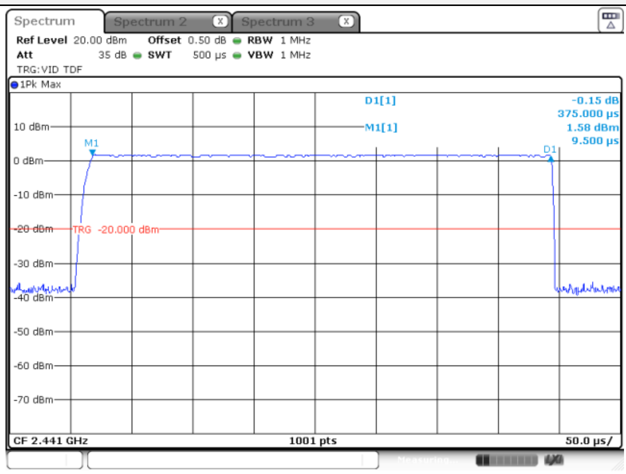
DH5



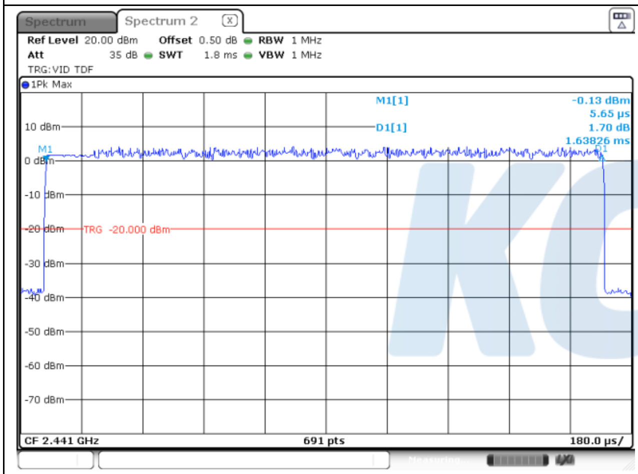
2-DH5

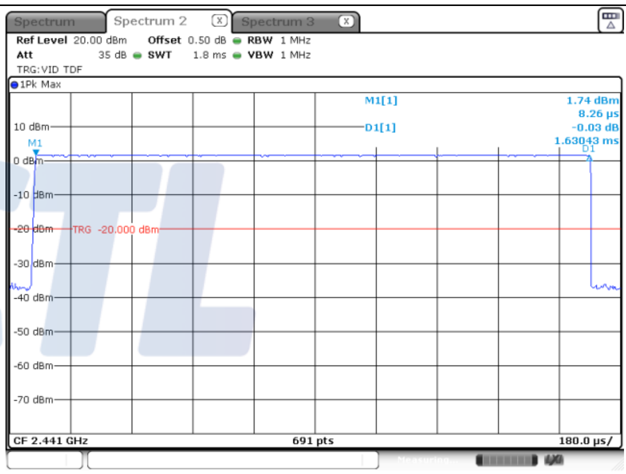
Non-AFH(8DPSK)	AFH(GFSK)



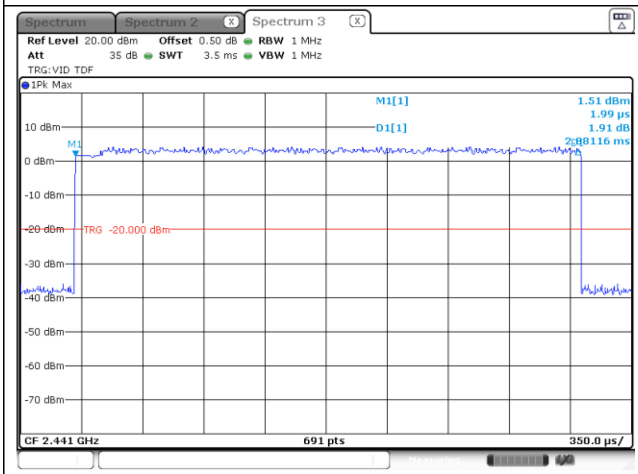


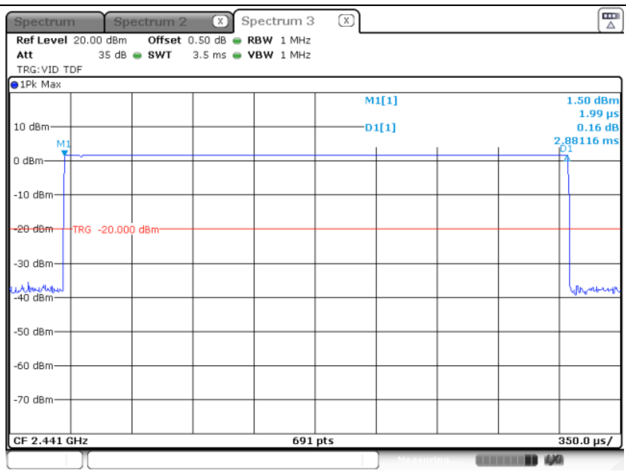
3-DH1	DH1





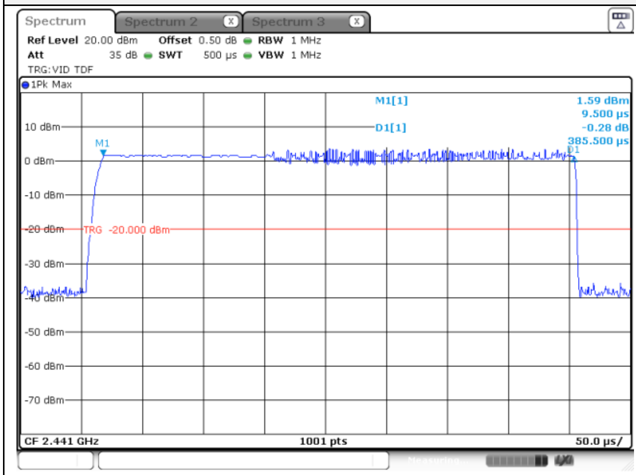
3-DH3	DH3



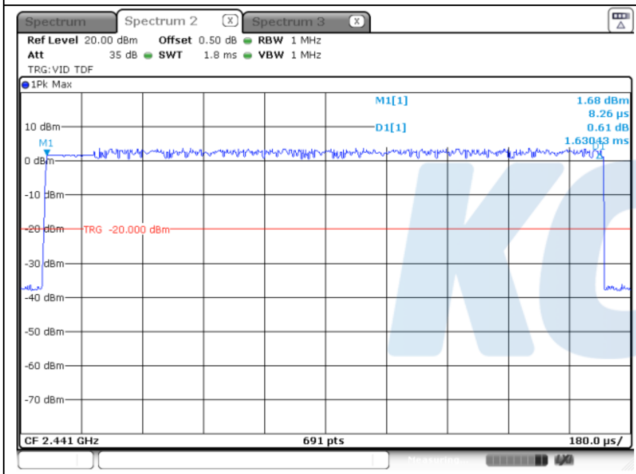


3-DH5	DH5

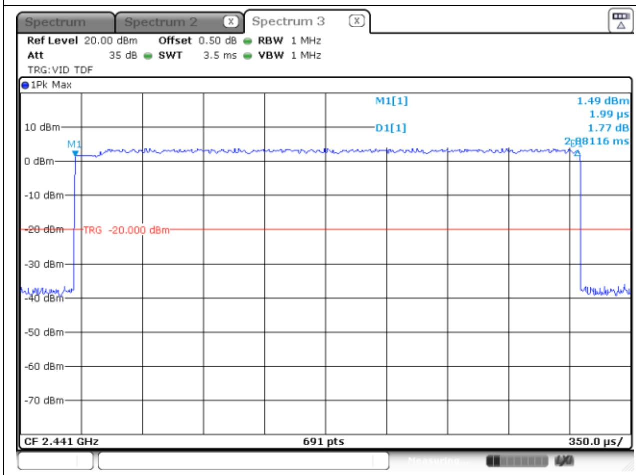
AFH(π/4DQPSK)



2-DH1

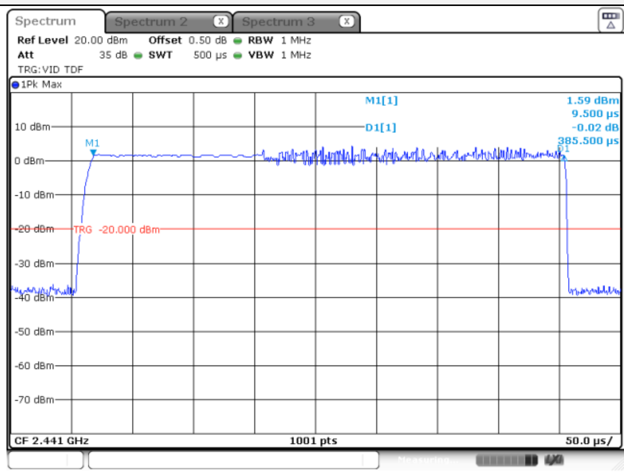


2-DH3

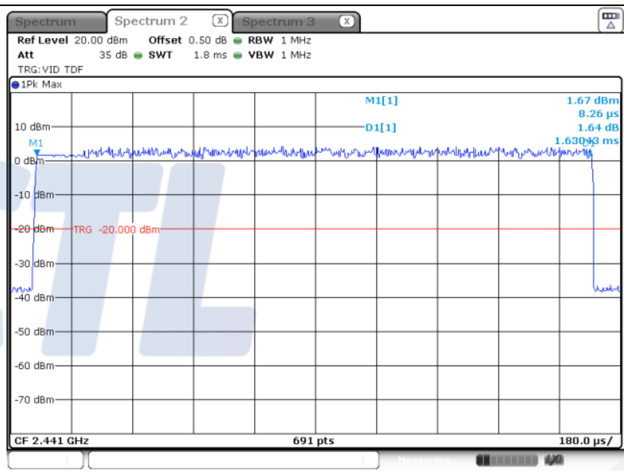


2-DH5

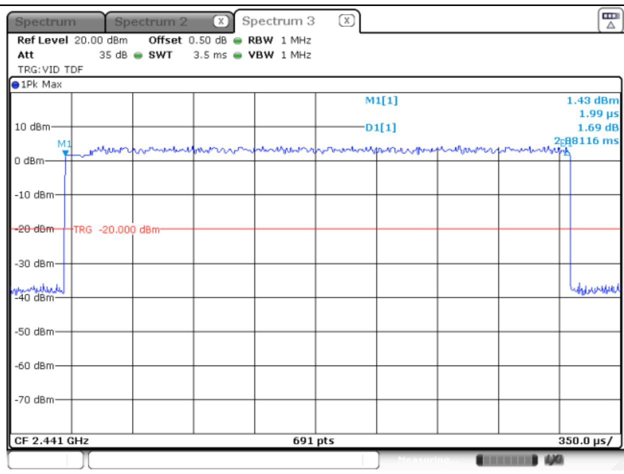
AFH(8DPSK)



3-DH1



3-DH3

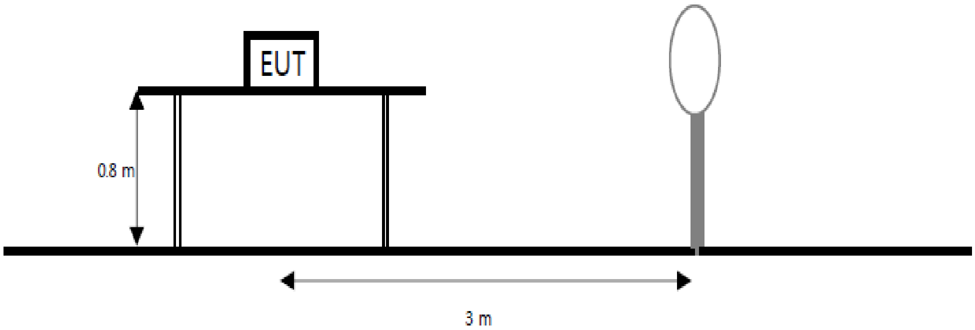


3-DH5

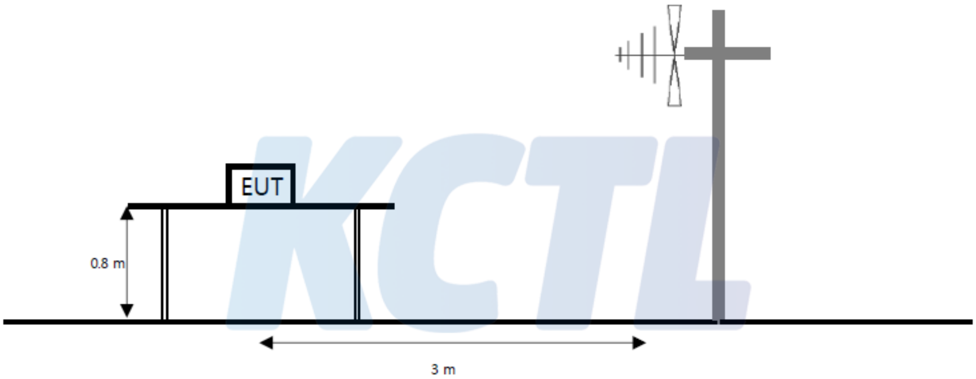
7.6. Radiated spurious emissions & band edge

Test setup

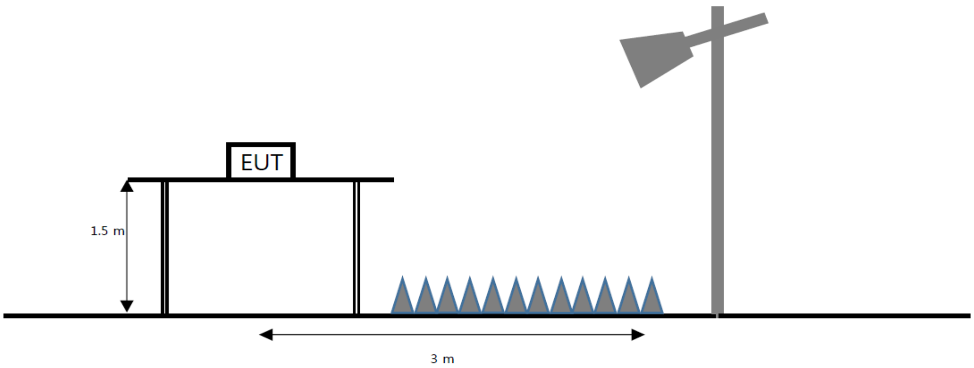
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



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 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 ≥ 1 Hz
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times(1/duty cycle) traces

Notes:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1 kHz(≥1/T) for Average detection (AV) at frequency above 1 GHz. (where T = pulse width)
2. f <30 MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d= Distance factor in dB
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
3. Factors(dB) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d(dB)
4. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
5. Average test would be performed if the peak result were greater than the average limit.
6. [1)] means restricted band.
7. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.

Duty cycle correction factor calculation:

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

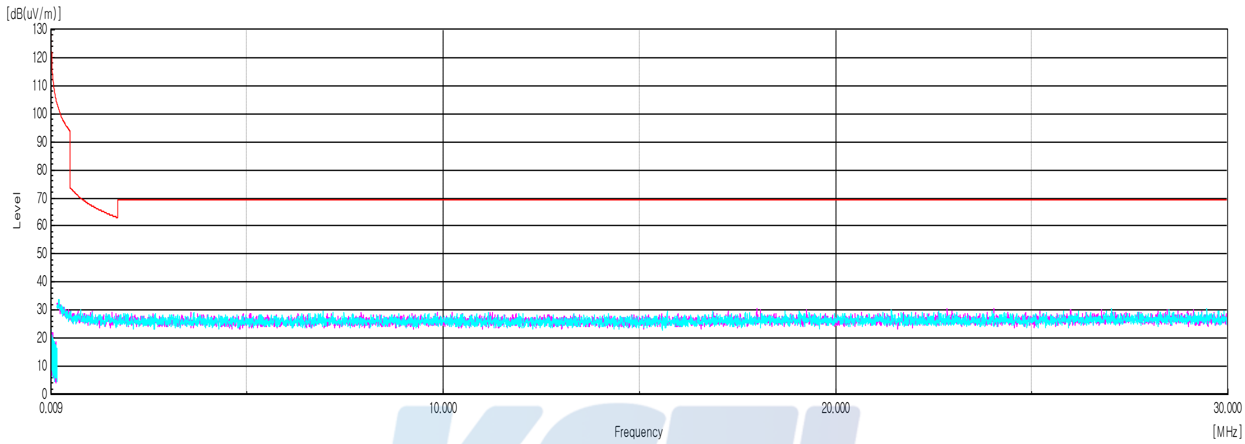
Duty Cycle Correction Factor Calculation

- Worst case : AFH mode
- Channel hop rate = 800 hops/second
- Hopping rate for DH5 mode = 800 hops/second / 5 (6 slots for DH5) = 133.33 hops/second
- Time per channel hop = 1 / 133.33 hops/second = 7.50 ㎳
- Time to cycle through all channels = 7.50 x 20 channels(AFH mode) = 150 ㎳
- Number of times transmitter hits on one channel = 100 ㎳ / Time to cycle through all channels (㎳)
  = 100 ㎳ / 150 ㎳ = 1 time
- Worst case Dwell time = 7.5 ㎳
- Duty Cycle Correction Factor = 20log(7.5 ㎳/100 ㎳) = -22.5 ㏈

Test results (Below 30 ㎒) – Worst case: GFSK Highest frequency

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

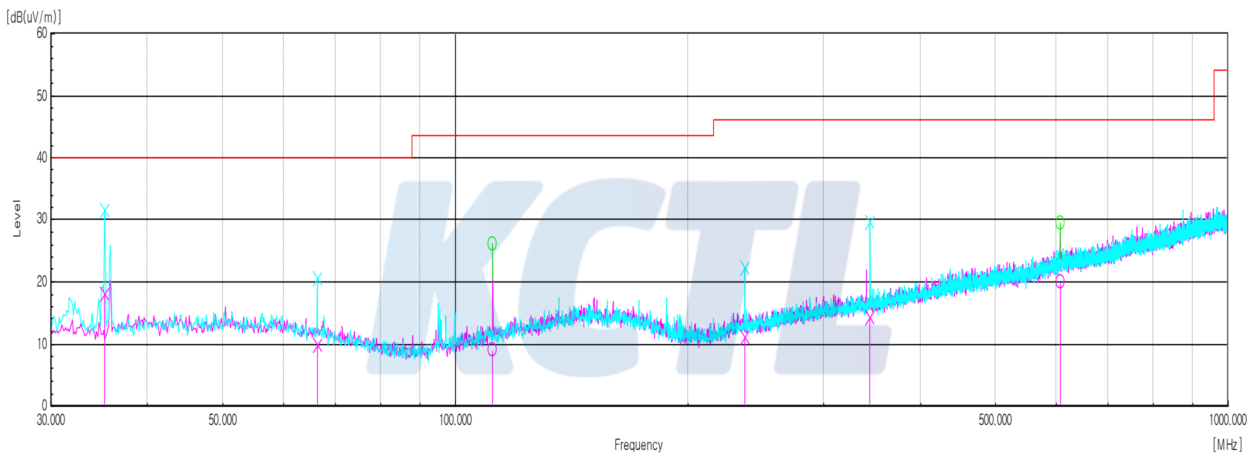
Horizontal/Vertical



Test results (Below 1 000 ㎒) – Worst case: GFSK Highest frequency

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data									
35.21	V	31.70	1.18	-36.76	22.08	-	18.20	40.00	21.80
66.25	V	23.20	1.69	-27.52	12.43	-	9.80	40.00	30.20
111.84	H	22.40	2.27	-33.18	17.61	-	9.10	43.50	34.40
236.85	V	22.70	3.41	-32.35	17.44	-	11.20	46.00	34.80
344.16	V	21.90	4.18	-32.08	20.30	-	14.30	46.00	31.70
606.18	H	20.50	5.75	-30.97	24.62	-	19.90	46.00	26.10

Horizontal/Vertical



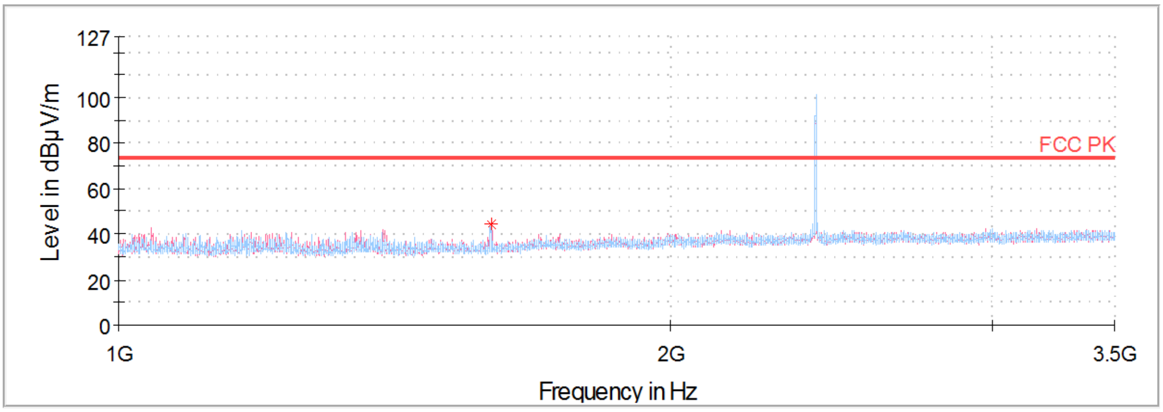
Test results (Above 1 000 ㎒)

GFSK

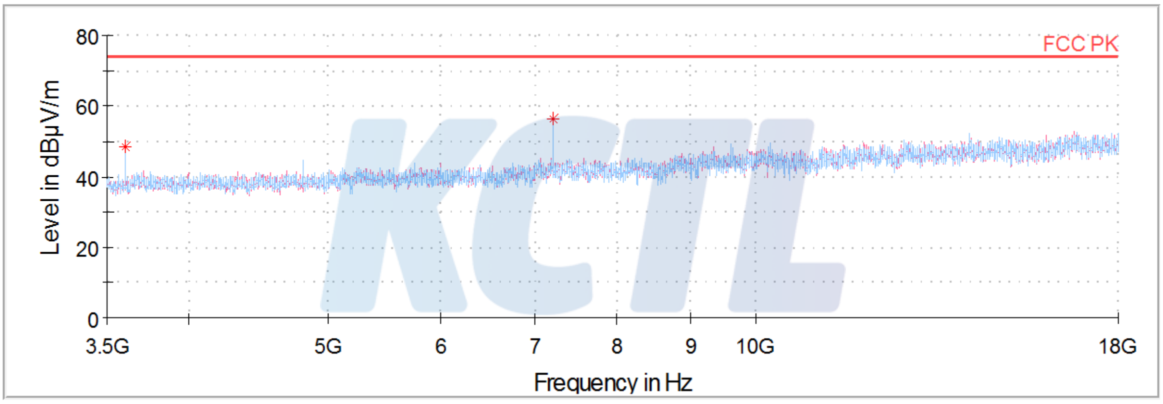
Low Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 596.95[1)]	V	52.61	3.04	-37.42	26.19	-	44.42	74.00	29.58
3 603.31[1)]	V	73.32	4.53	-60.82	31.33	-	48.36	74.00	25.64
7 206.56	H	75.21	6.71	-61.37	35.91	-	56.46	74.00	17.54
Average Data									
7 206.56	H	75.21	6.71	-61.37	35.91	-22.50	33.96	54.00	20.04

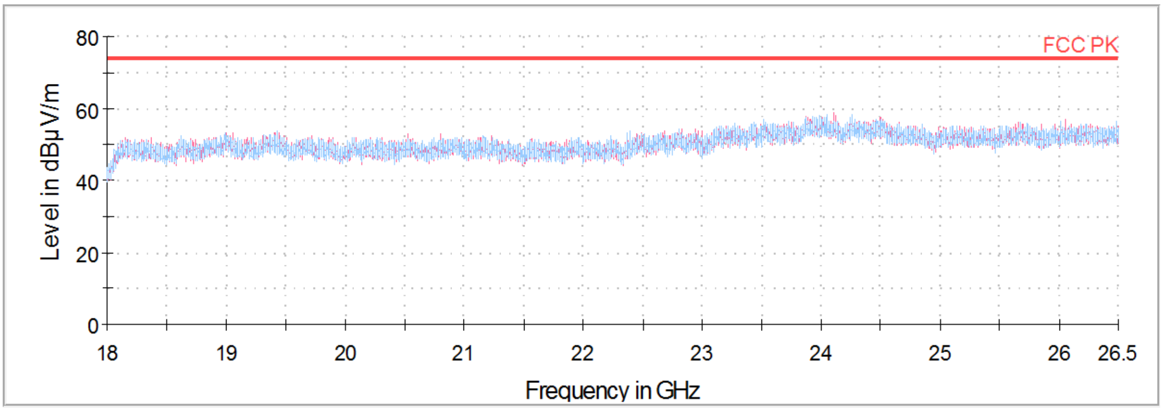
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



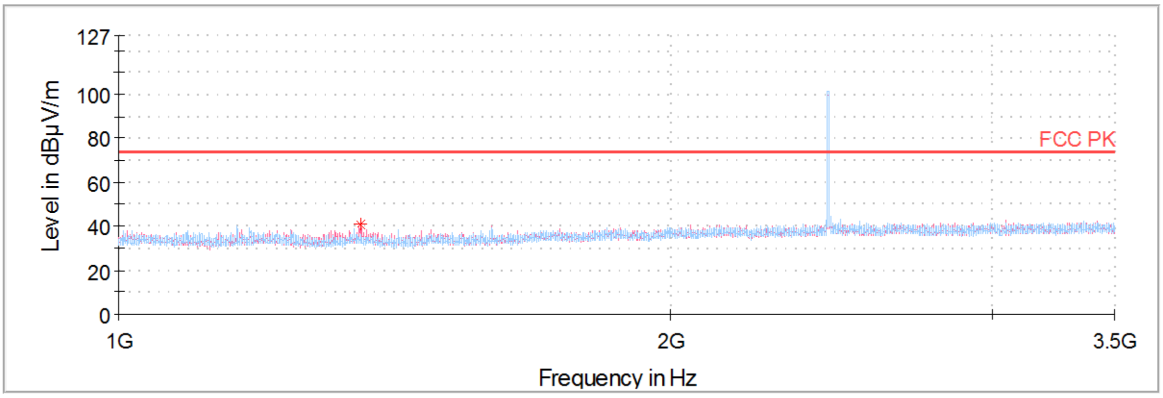
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



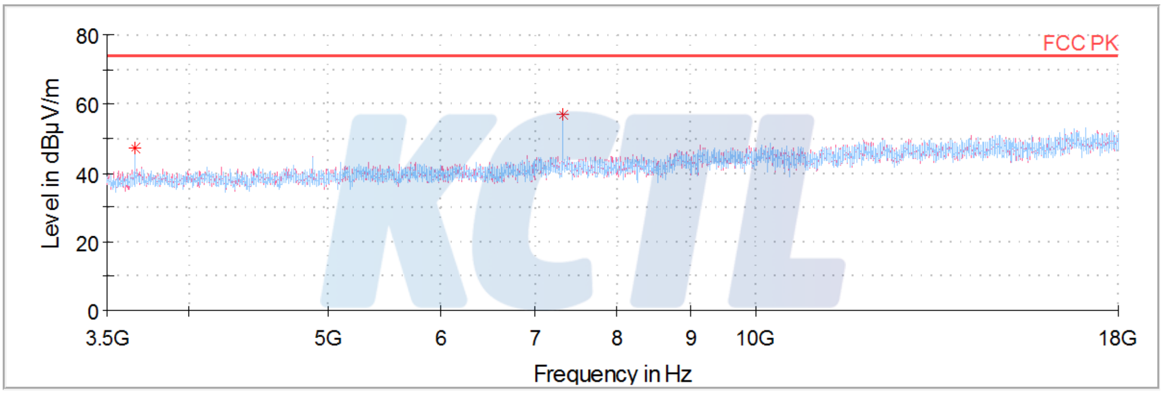
Middle Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 354.14 1)	V	49.42	2.81	-36.76	25.22	-	40.69	74.00	33.31
3 661.31 1)	H	71.37	4.56	-60.10	31.49	-	47.31	74.00	26.69
7 322.95 1)	H	75.88	6.76	-61.58	36.02	-	57.08	74.00	16.92
Average Data									
7 322.95 1)	H	75.88	6.76	-61.58	36.02	-22.50	34.58	54.00	19.42

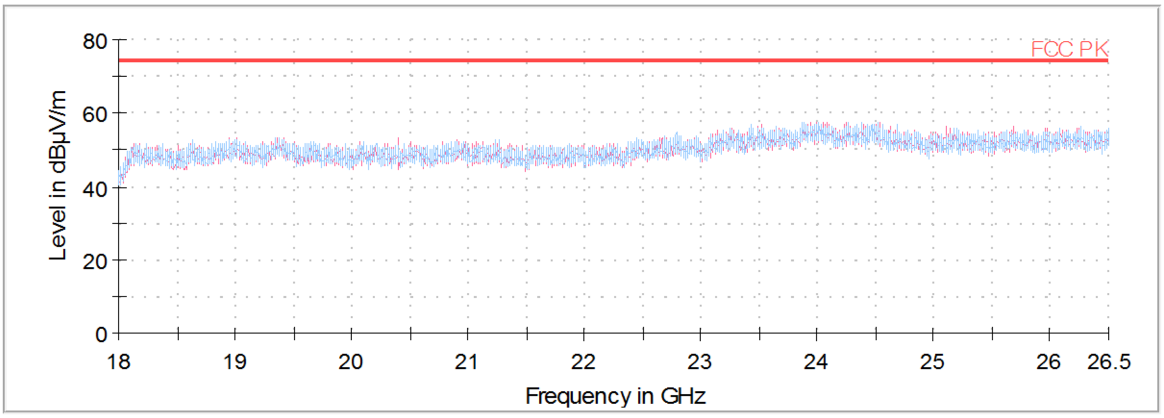
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



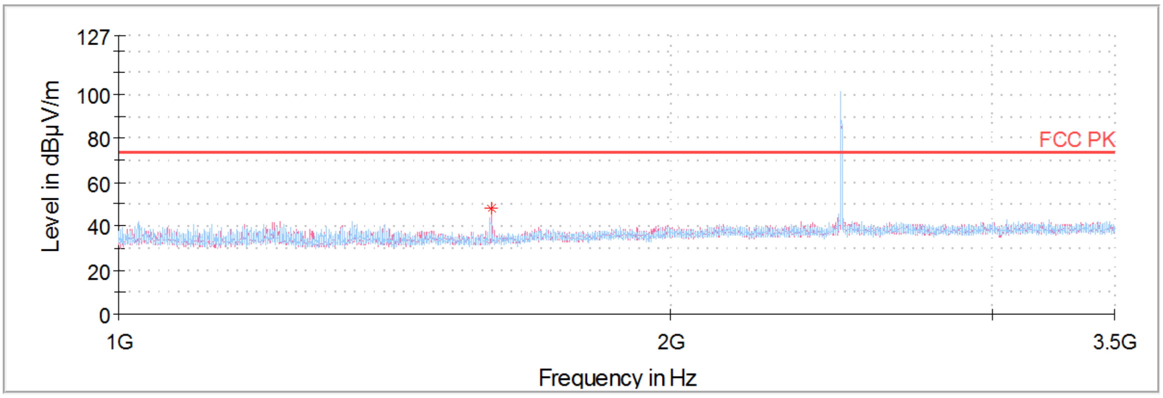
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



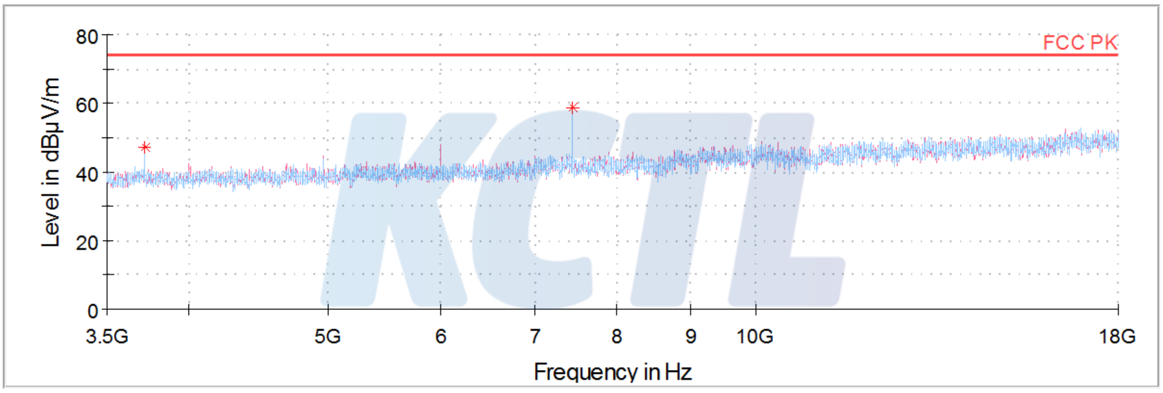
High Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(MHz)	(V/H)	(dB(μV))	(dB)	(dB)	(dB)	(dB)	(dB(μV/m))	(dB(μV/m))	(dB)
Peak data									
1 598.44[1)]	V	56.30	3.04	-37.41	26.19	-	48.12	74.00	25.88
3 720.22[1)]	H	70.86	4.60	-59.90	31.64	-	47.20	74.00	26.80
7 439.87[1)]	H	77.72	6.81	-61.80	36.14	-	58.87	74.00	15.13
Average Data									
7 439.87[1)]	H	77.72	6.81	-61.80	36.14	-22.50	36.37	54.00	17.63

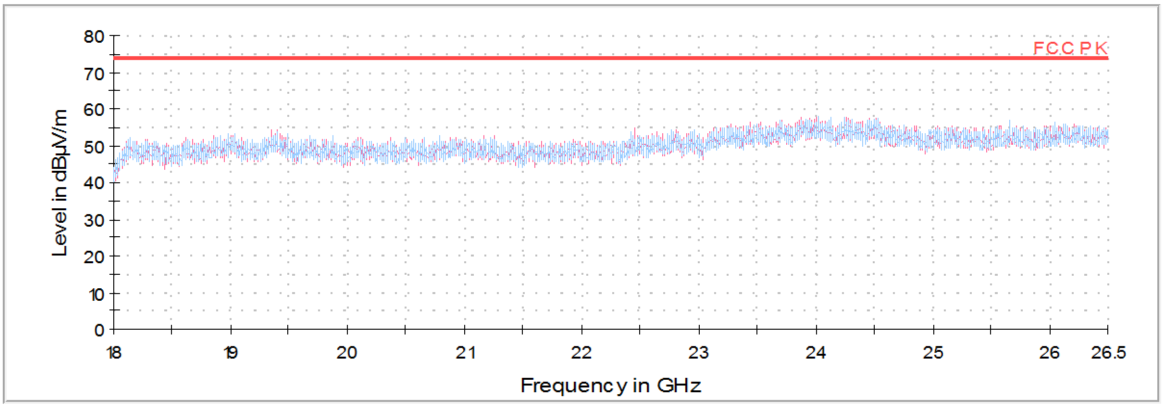
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓

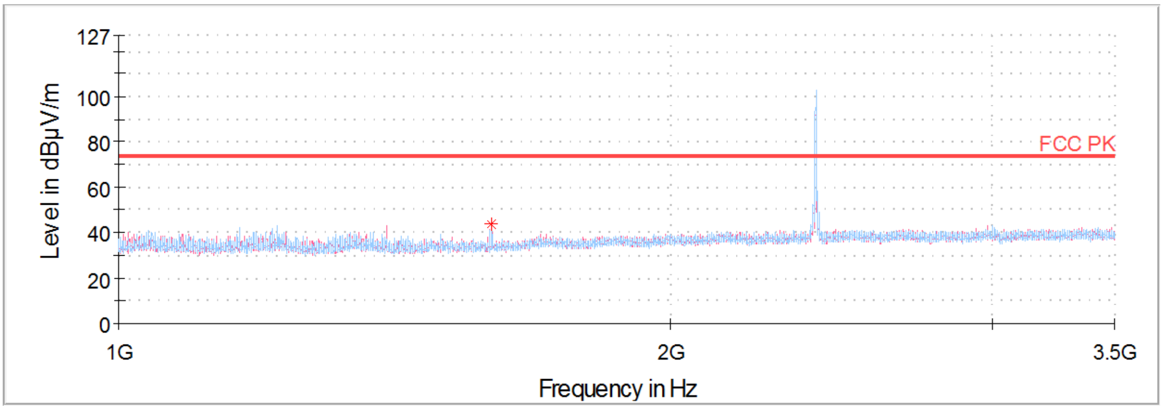


8DPSK

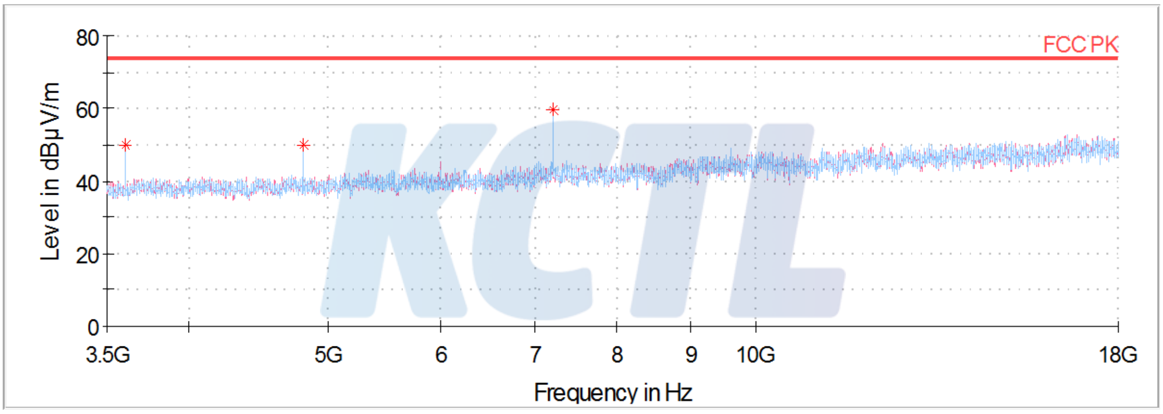
Low Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 597.58[1)]	H	51.88	3.04	-37.42	26.19	-	43.69	74.00	30.31
3 602.86[1)]	H	74.92	3.82	-59.55	28.84	-	48.98	74.00	25.02
4 803.64[1)]	H	72.48	5.34	-60.83	32.80	-	56.53	74.00	17.47
7 205.81	H	78.57	6.71	-61.37	35.91	-	54.10	74.00	19.90
Average Data									
4 803.64[1)]	H	72.48	5.34	-60.83	32.80	-22.50	27.29	54.00	26.71
7 205.81	H	78.57	6.73	-61.47	35.99	-22.50	37.32	54.00	16.68

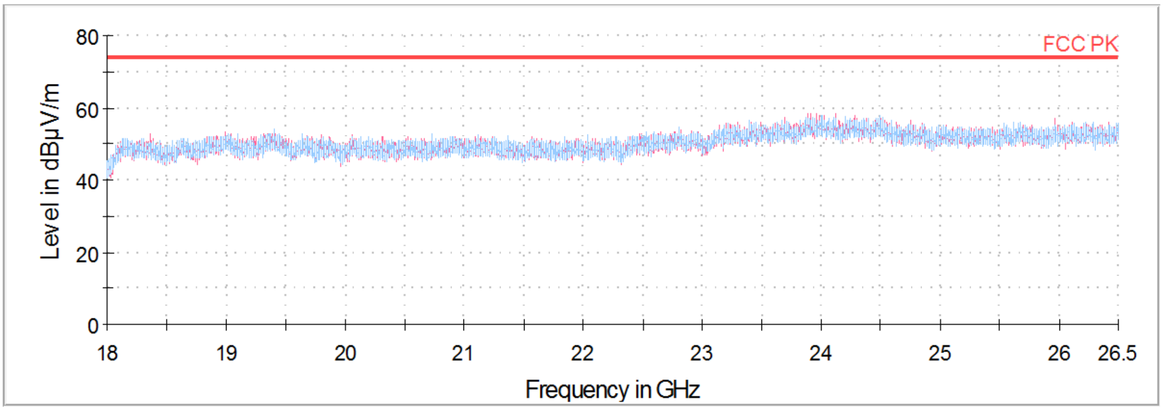
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



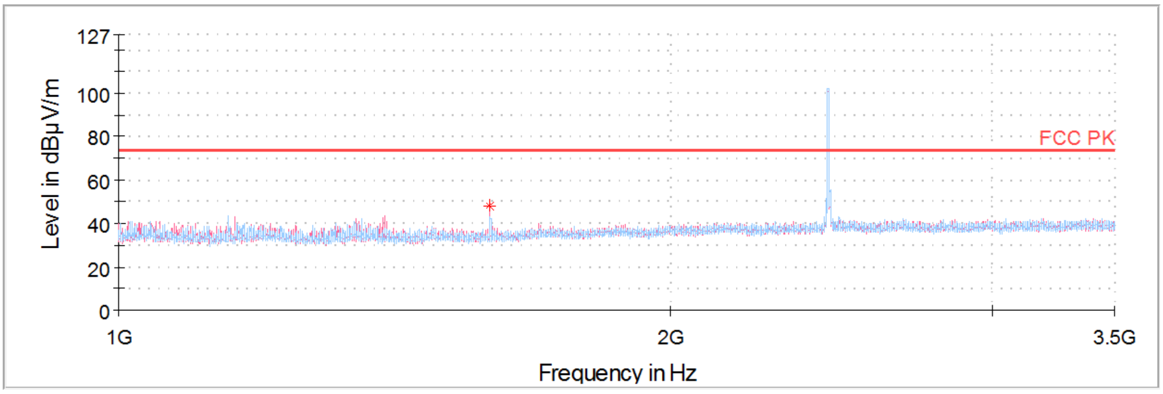
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



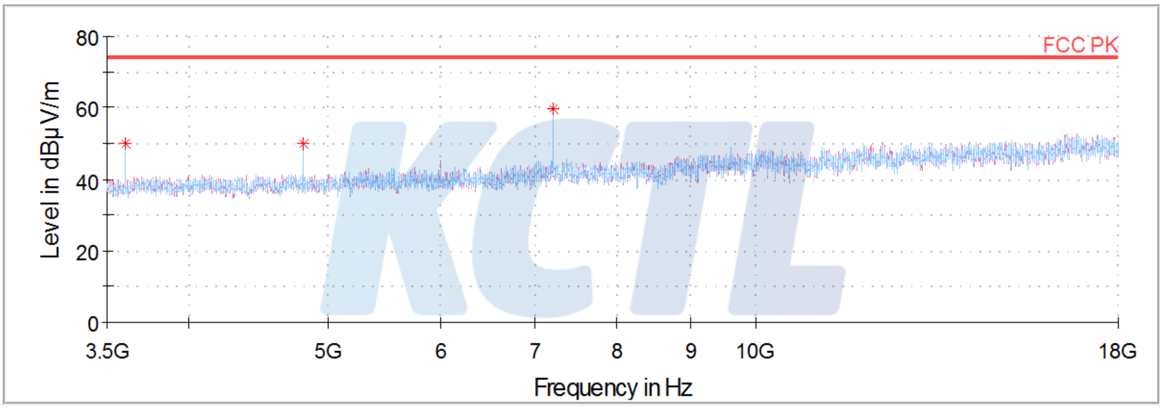
Middle Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 592.81 1)	V	56.17	3.04	-37.42	26.17	-	47.96	74.00	26.04
3 660.86 1)	H	73.19	4.56	-60.10	31.48	-	49.13	74.00	24.87
7 322.78 1)	H	76.61	6.76	-61.58	36.02	-	57.81	74.00	16.19
Average Data									
7 322.78 1)	H	76.61	6.76	-61.58	36.02	-22.50	35.31	54.00	18.69

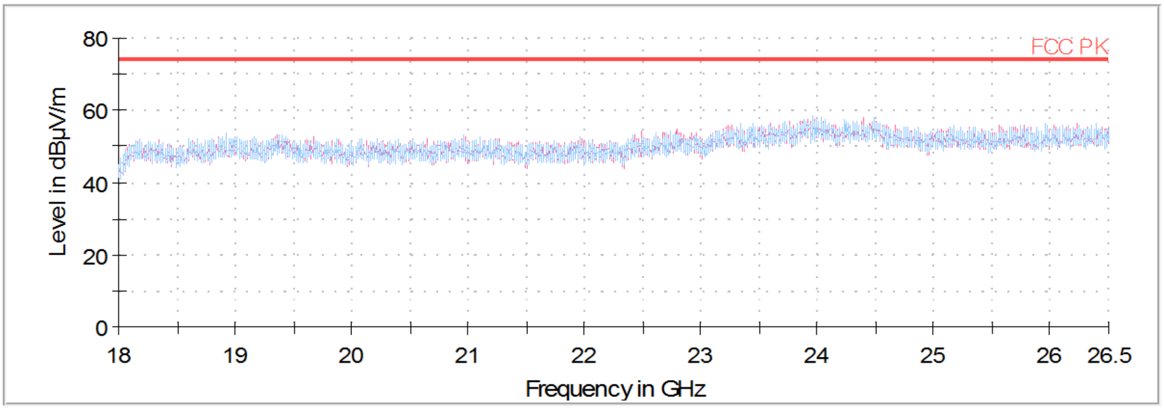
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



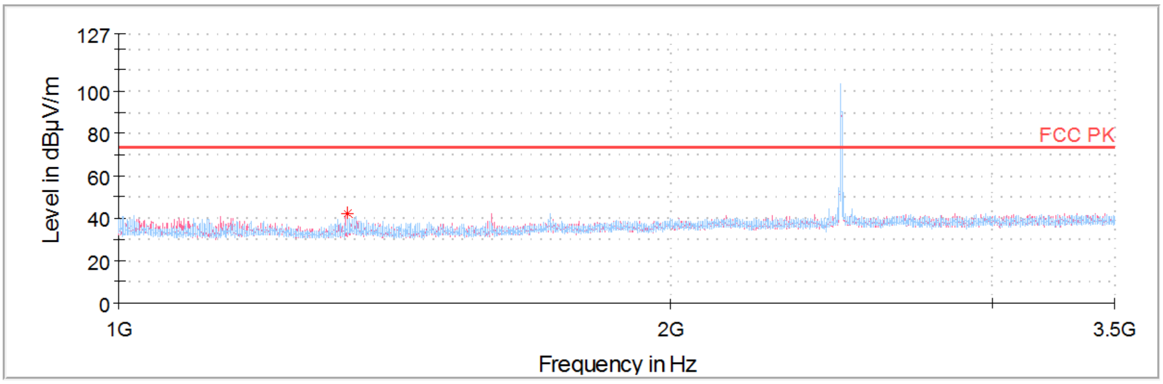
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



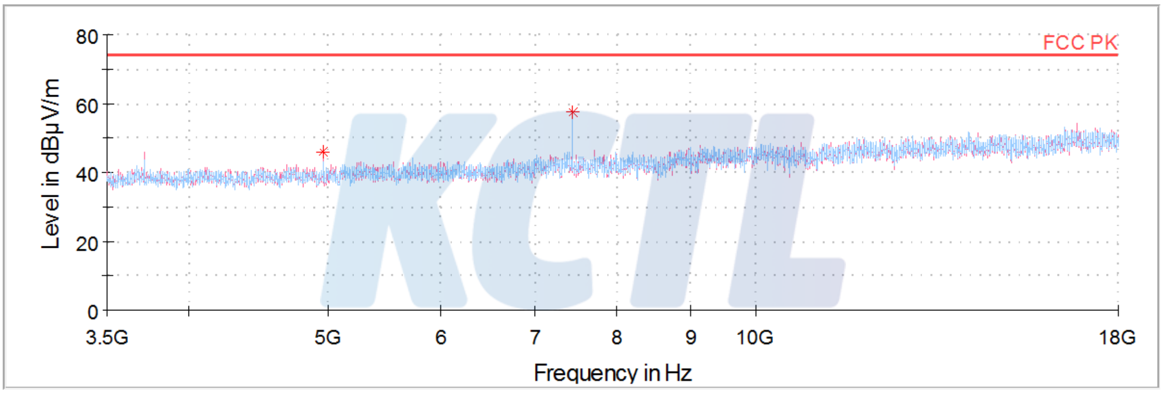
High Channel

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 332.66[1)]	H	51.11	2.79	-36.66	25.13	-	42.37	74.00	31.63
4 959.97[1)]	V	68.36	5.44	-60.71	32.88	-	45.97	74.00	28.03
7 439.92[1)]	H	76.54	6.81	-61.80	36.14	-	57.68	74.00	16.32
Average Data									
7 439.92[1)]	H	76.54	6.81	-61.80	36.14	-22.50	35.18	54.00	18.82

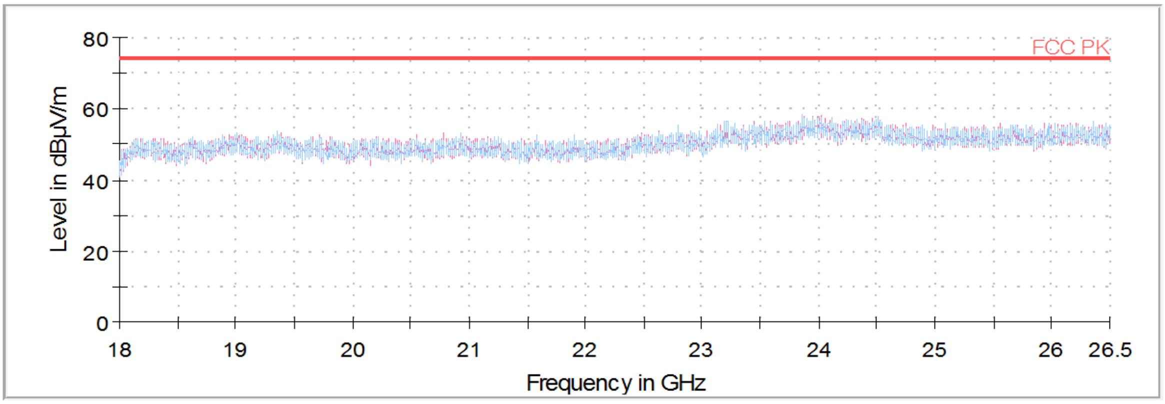
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓

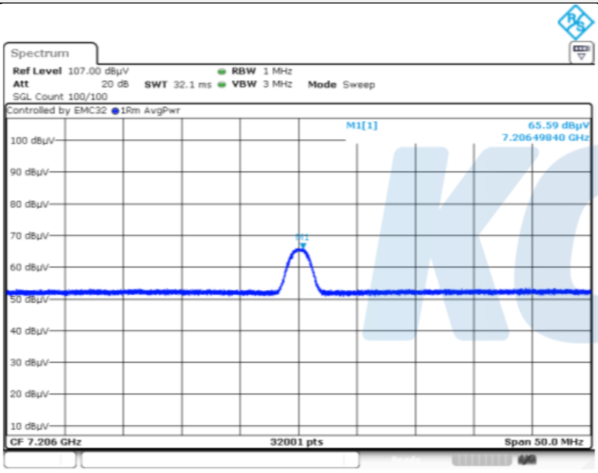


Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓

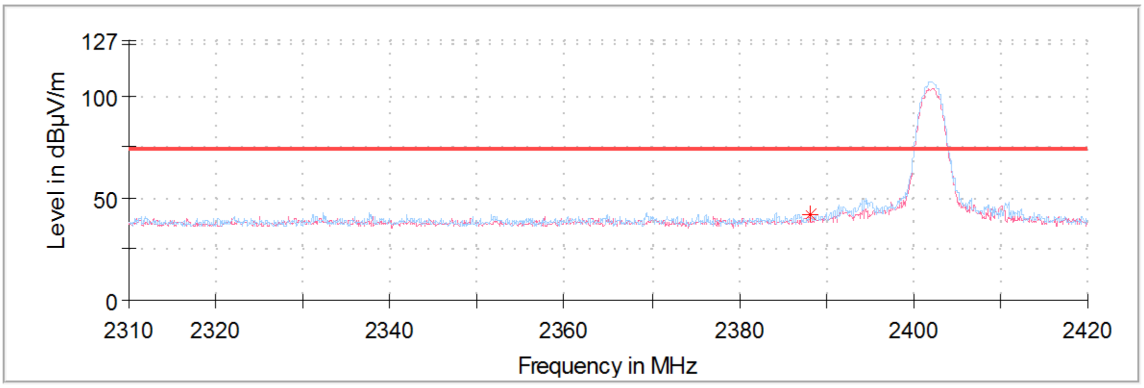


BLE(2 402 ㎒) + BT, BDR (2 402 ㎒)

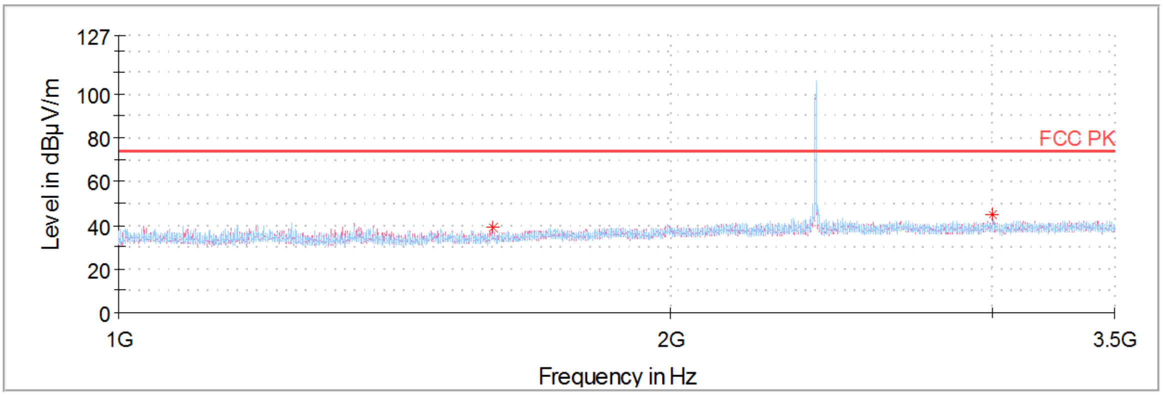
Frequency	Pol.	Reading	Cable Loss	Amp Gain	Antenna Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data									
1 188.59[1)]	H	47.10	3.04	-37.42	26.20	-	38.92	74.00	35.08
2 365.92[1)]	H	47.43	4.14	-36.37	29.71	-	44.91	74.00	29.09
2 388.20[1)]	H	46.21	3.70	-36.23	28.54	-	42.22	74.00	31.78
3 602.86[1)]	V	72.78	4.53	-60.83	31.33	-	47.81	74.00	26.19
7 206.50	H	75.04	6.71	-61.37	35.91	-	56.29	74.00	17.71
Average Data									
7 206.50	H	65.59	6.71	-61.37	35.91	-	46.84	54.00	7.16

Average data	Average data
	Blank

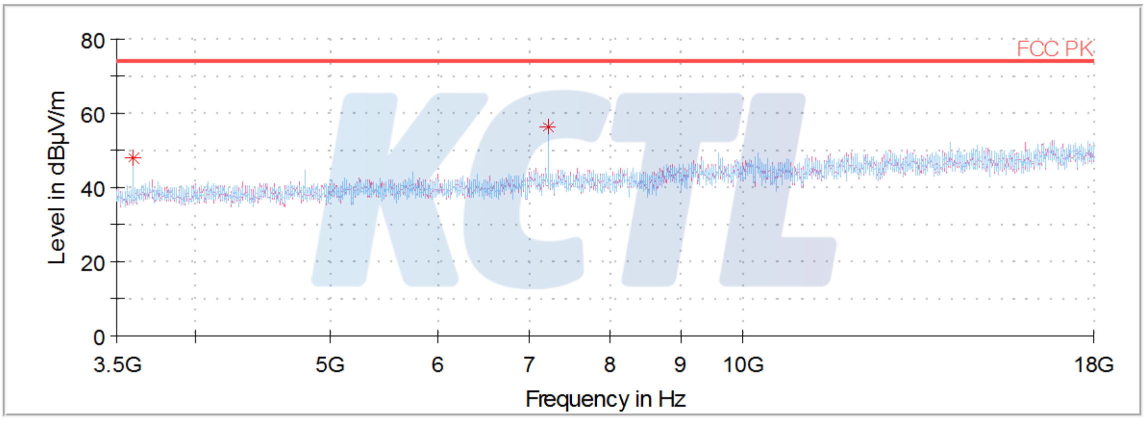
Horizontal/Vertical for Band-edge



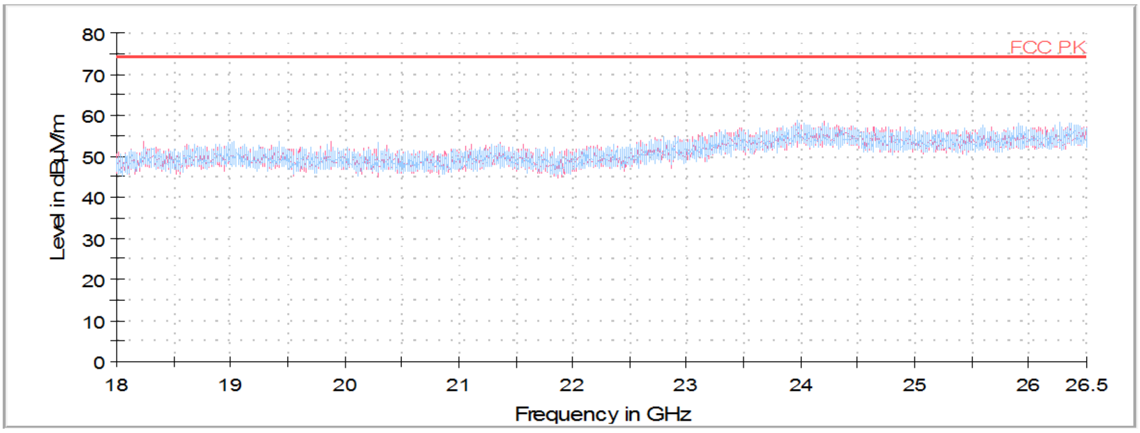
Horizontal/Vertical for 1 ㎓ ~ 3.5 ㎓



Horizontal/Vertical for 3.5 ㎓ ~ 18 ㎓



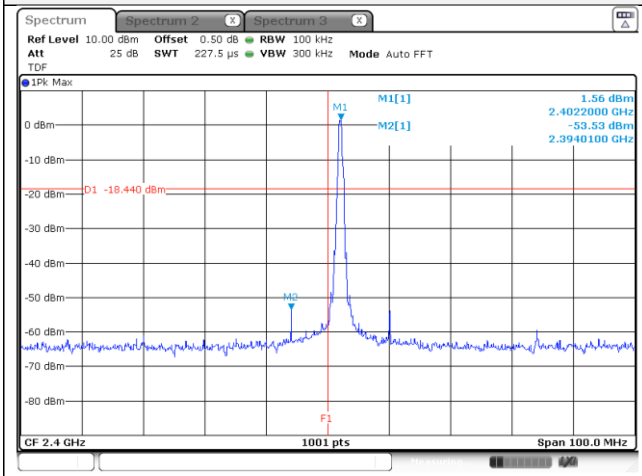
Horizontal/Vertical for 18 ㎓ ~ 26.5 ㎓



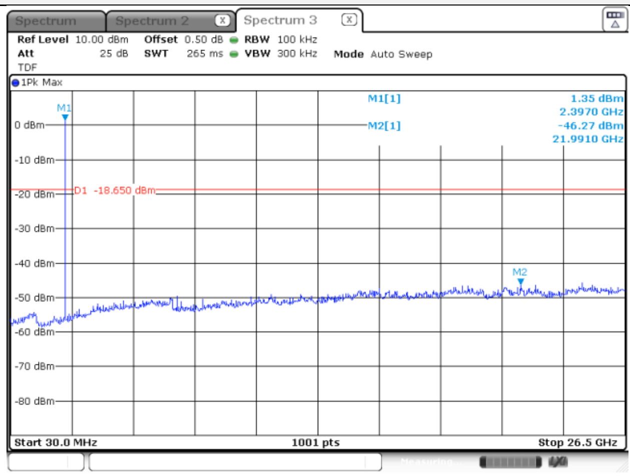
Test results

GFSK

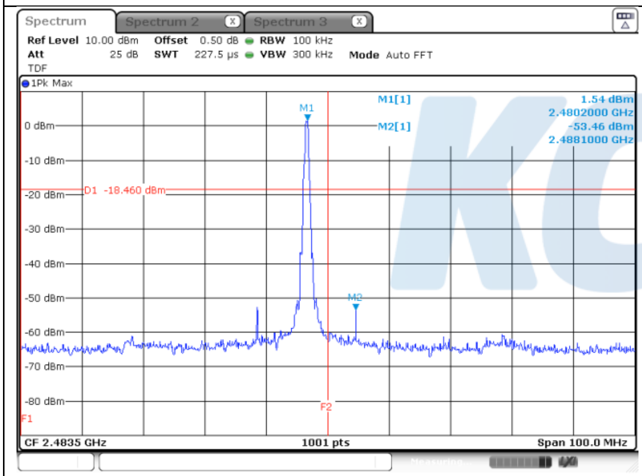
Conducted band-edge	Conducted spurious



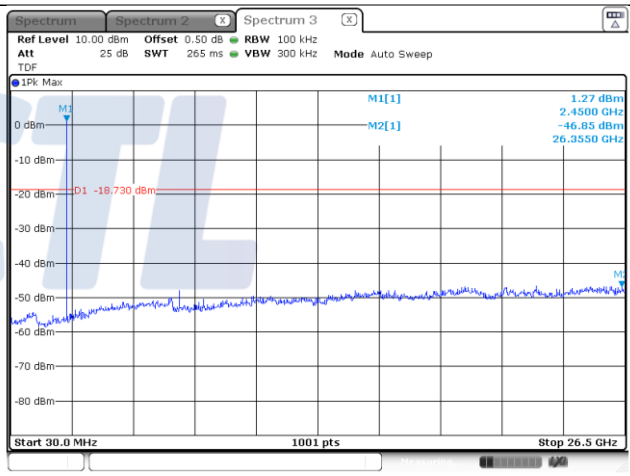
Lowest



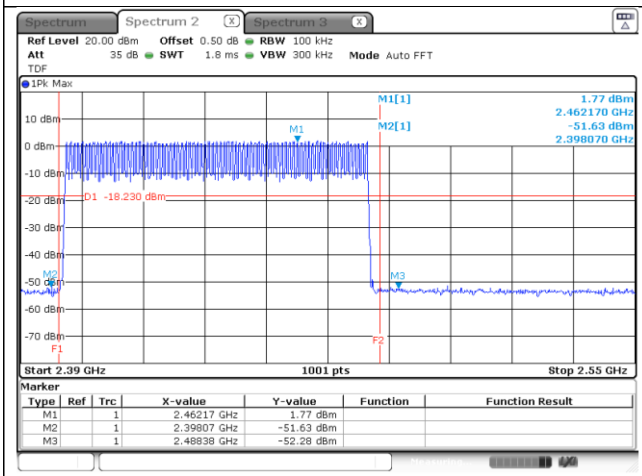
Lowest



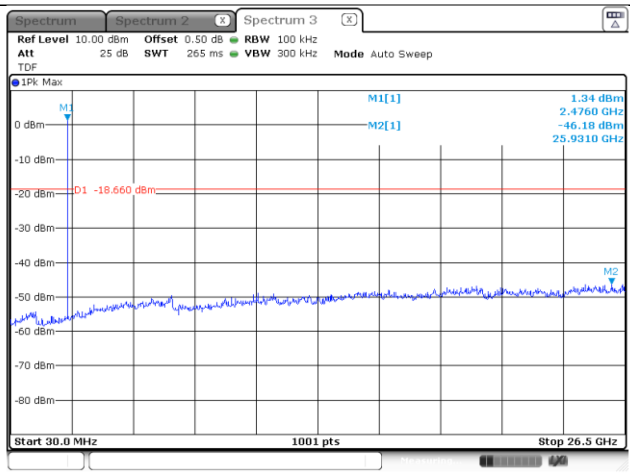
Highest



Middle



With Hopping Band-edge

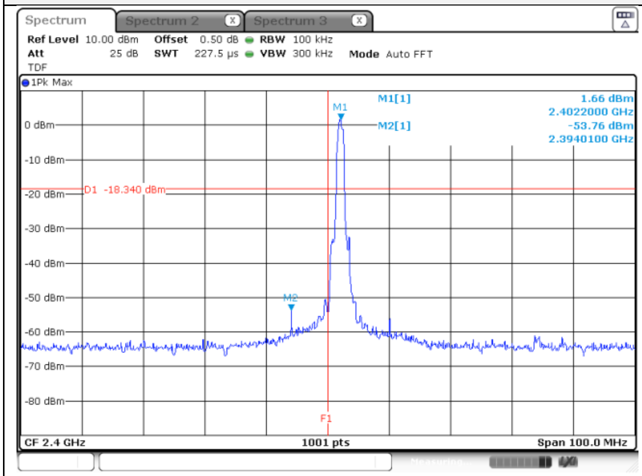


Highest

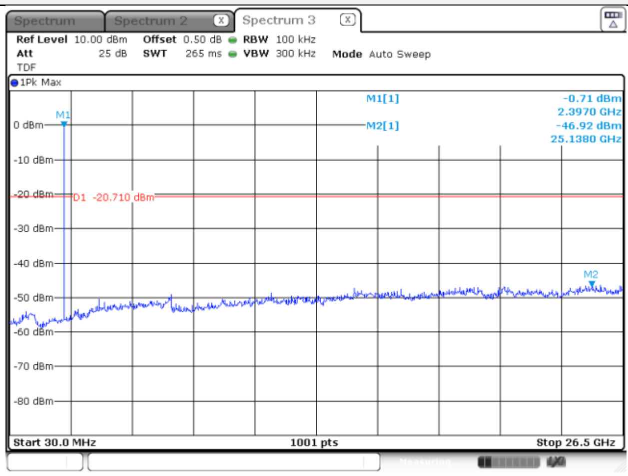
Test results

8DPSK

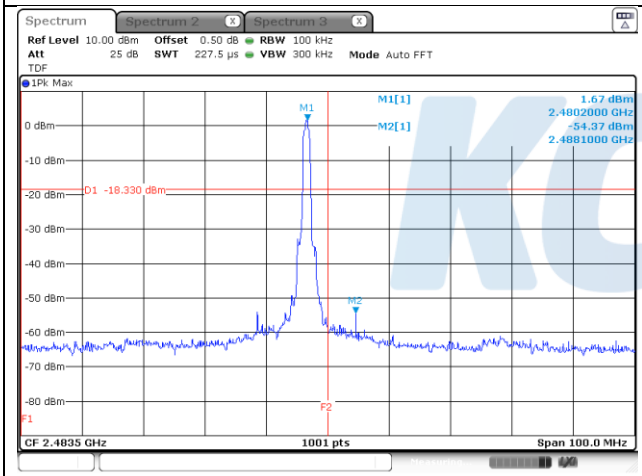
Conducted band-edge	Conducted spurious



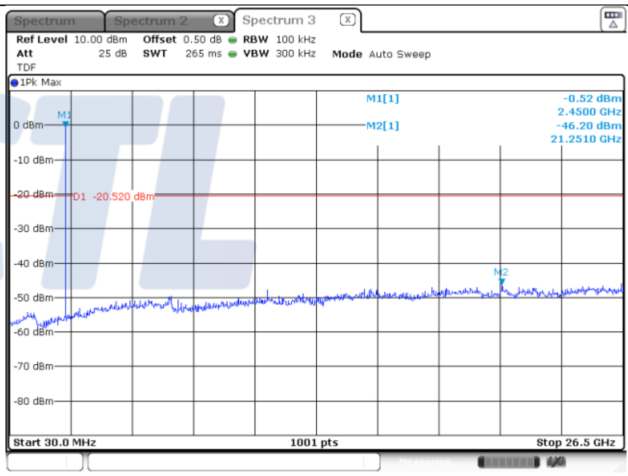
Lowest



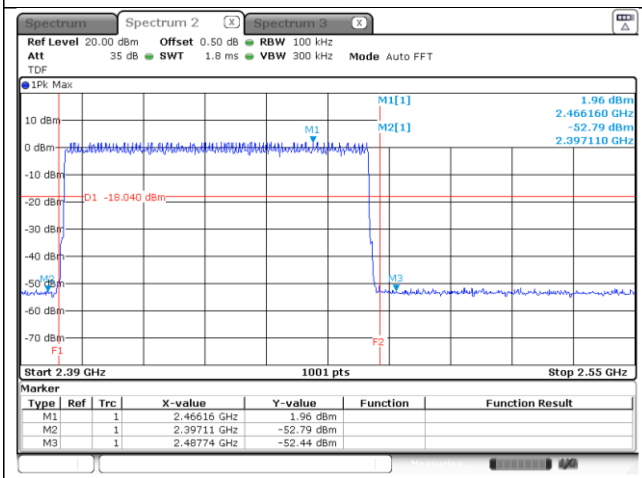
Lowest



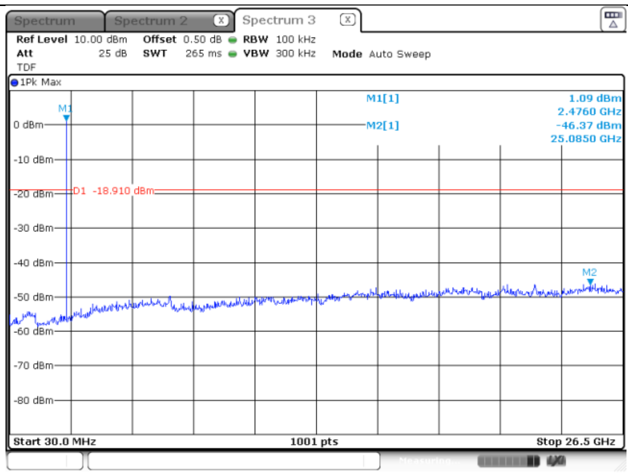
Highest



Middle



With Hopping Band-edge



Highest

8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R & S	FSV40	100988	20.01.25
Spectrum Analyzer	R & S	FSV30	100732	20.01.25
Wideband Power Sensor	R & S	NRP-Z81	102398	20.01.25
ATTENUATOR	R & S	DNF Dämpfungsglied 10 dB in N-50 Ohm	31212	19.05.14
EMI TEST RECEIVER	R & S	ESCI	100732	19.08.23
Bi-Log Antenna	SCHWARZBECK	VULB 9168	583	20.05.04
Amplifier	SONOMA INSTRUMENT	310N	284608	19.08.23
COAXIAL FIXED ATTENUATOR	Agilent	8491B-003	2708A18758	20.05.04
Horn antenna	ETS.lindgren	3116	00086632	19.04.20
Horn antenna	ETS.lindgren	3117	161225	19.05.18
AMPLIFIER	L-3 Narda-MITEQ	AMF-7D-01001800-22-10P	2003683	19.05.15
AMPLIFIER	L-3 Narda-MITEQ	JS44-18004000-33-8P	2000997	19.08.02
LOOP Antenna	R & S	HFH2-Z2	100355	20.08.24
Antenna Mast	Innco Systems	MA4640-XP-ET	-	-
Turn Table	Innco Systems	DT2000	79	-
Antenna Mast	Innco Systems	MA4000-EP	303	-
Turn Table	Innco Systems	DT2000	79	-
Highpass Filter	WT	WT-A1698-HS	WT160411001	19.05.14
Vector Signal Generator	R & S	SMBV100A	257566	20.01.04
Signal Generator	R & S	SMR40	100007	19.05.15
Cable Assembly	RadiAll	2301761768000PJ	1724.659	-
Cable Assembly	gigalane	RG-400	-	-
Cable Assembly	HUER+SUHNER	SUCOFLEX 104	MY4342/4	-

End of test report