

TEST REPORT



CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:
CTK-2019-05055
Page (1) / (69) Pages

1. Client

- Name : EVERINT Co.,Ltd.
- Address : (Yongtan-dong), 129, Chungjusandan1-ro, Chungju-si, Chungcheongbuk-do, Korea 27326
- Date of Receipt : 2019-11-19

2. Manufacturer

- Name : EVERINT Co.,Ltd.
- Address : (Yongtan-dong), 129, Chungjusandan1-ro, Chungju-si, Chungcheongbuk-do, Korea 27326

3. Use of Report : For FCC Certification

4. Test Sample / Model: Bluetooth Module / BT-MSOIII

5. Date of Test : 2019-11-29 to 2019-12-12

6. Test Standard(method) used : FCC 47 CFR Part 15 subpart C 15.247 ANSI C63.10-2013

7. Testing Environment: Temp.: (23 ± 1) °C, Humidity: (48 ± 5) % R.H.

8. Test Results : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by	Technical Manager
	Gwanyong Kim: (Signature) 	Young-taek Lee: (Signature) 

2019-12-19

Republic of KOREA **CTK Co., Ltd.**



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REPORT REVISION HISTORY

Date	Revision	Page No
2019-12-19	Issued (CTK-2019-05055)	all

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 CTK Co., Ltd. The Prime Leader of Global Regulatory Certification	CTK Co., Ltd. (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: +82-31-339-9970 Fax: +82-31-624-9501	Report No.: CTK-2019-05055 Page (4) / (69) Pages	
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1. General Product Description

1.1 Client Information

Company	EVERINT Co.,Ltd.
Contact Point	(Yongtan-dong), 129, Chungjusandan1-ro, Chungju-si, Chungcheongbuk-do, Korea 27326
Contact Person	Name : Ji-Sung Shin E-mail : jsshin@bixolon.com Tel : +82-31-218-5582

1.2 Product Information

FCC ID	2AKMF-BT-MSOIII
Product Description	Bluetooth Module
Model name	BT-MSOIII
Variant Model name	-
Operating Frequency	2 402 MHz – 2 480 MHz
RF Output Power	GSKS : 6.71 dBm (4.688 mW) - Peak Conducted $\pi/4$ DQPSK : 8.75 dBm (7.499 mW) - Peak Conducted 8-DPSK : 9.04 dBm (8.017 mW) - Peak Conducted
Antenna type	Chip Antenna
Antenna gain	3.36 dBi
Number of channels	79
Channel Spacing	1 MHz
Type of Modulation	GFSK(1Mbps), $\pi/4$ DQPSK(2Mbps), 8-DPSK(3Mbps)
Power Source	DC 3.3 V
Test Software(Version)	Airoha AB1122 (verC) Lab Test Tool – Version 2.0.9.10812
RF Power setting in Test SW	TX GC "49"

1.3 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	15-bs563TU	CND7253R6P
AC/DC Adapter	HP	HSTNN-LA40	7628011101

2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A-2
KOREA	NRRA	KR0025

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

3. Test Specifications

3.1 Standards

Section in FCC	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	Carrier Frequency Separation	C	Conducted
15.247(a)	Number of Hopping Frequencies	C	
15.247(a)	20 dB Bandwidth	C	
15.247(a)	Time of occupancy (Dwell Time)	C	
15.247(b)	Maximum peak conducted output power	C	
15.247(d)	Unwanted emission	C	
15.209	Transmitter emission	C	Radiated
15.207(a)	AC Conducted Emission	C	Line Conducted
<u>Note 1:</u> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
<u>Note 2:</u> This device is frequency hopping system(FHS), and complies frequency hopping system requirement.			
<u>Note 3:</u> The data in this test report are traceable to the national or international standards.			
<u>Note 4:</u> The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013			
<u>Note 5:</u> The tests were performed according to the method of measurements prescribed in KDB No.558074.			

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests.
The results are only attached worst cases.

Test Frequency

Lowest channel	Middle channel	Highest channel
2 402 MHz	2 441 MHz	2 480 MHz

Test mode

Modulation	Packet type	Data rate	Duty Cycle
GFSK	DH5	1 Mbps	78.14%
8-DPSK	3-DH5	3 Mbps	93.60%

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	± 0.19 dB
Conducted Unwanted Emission	± 3.0 dB
Radiated Emissions ($f \leq 1$ GHz)	± 4.38 dB
Radiated Emissions ($f > 1$ GHz)	± 5.12 dB
AC Conducted Emission	± 3.64 dB

4. Technical Characteristic Test

4.1 Carrier Frequency Separation

Test Procedures

ANSI C63.10-2013 7.8.2

The carrier frequency separation was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function enabled.
After the trace being stable, the reading value between the peaks of the adjacent channels using the marker-delta function was recorded as the measurement results.

The spectrum analyzer is set to:

- a) Span = 5 MHz (wide enough to capture the peaks of two adjacent channels)
- b) RBW = 30 kHz (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) VBW = 30 kHz ($\geq$ RBW)
- d) Sweep = auto
- e) Detector function = peak
- f) Trace = max hold

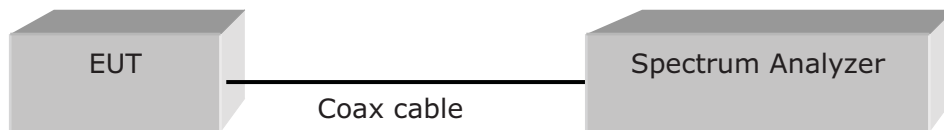


Figure 1 : Measurement setup for the carrier frequency separation

Limit

FHSS operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater.

Test Results

Test mode : GFSK

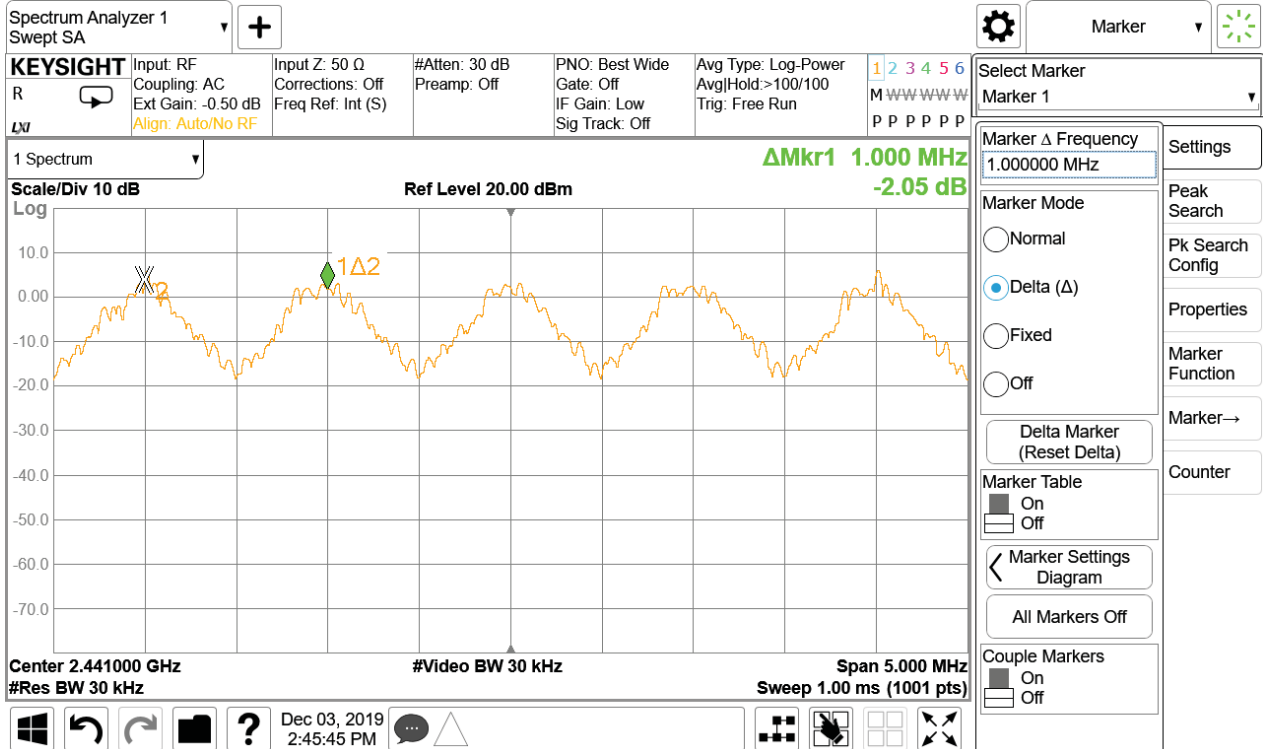
Channel	Adjacent Hopping Channel Separation [kHz]	Two-third of 20dB bandwidth [kHz]	Minimum Bandwidth [kHz]	Result
Middle	1000	618	25	Complies

Test mode : 8-DPSK

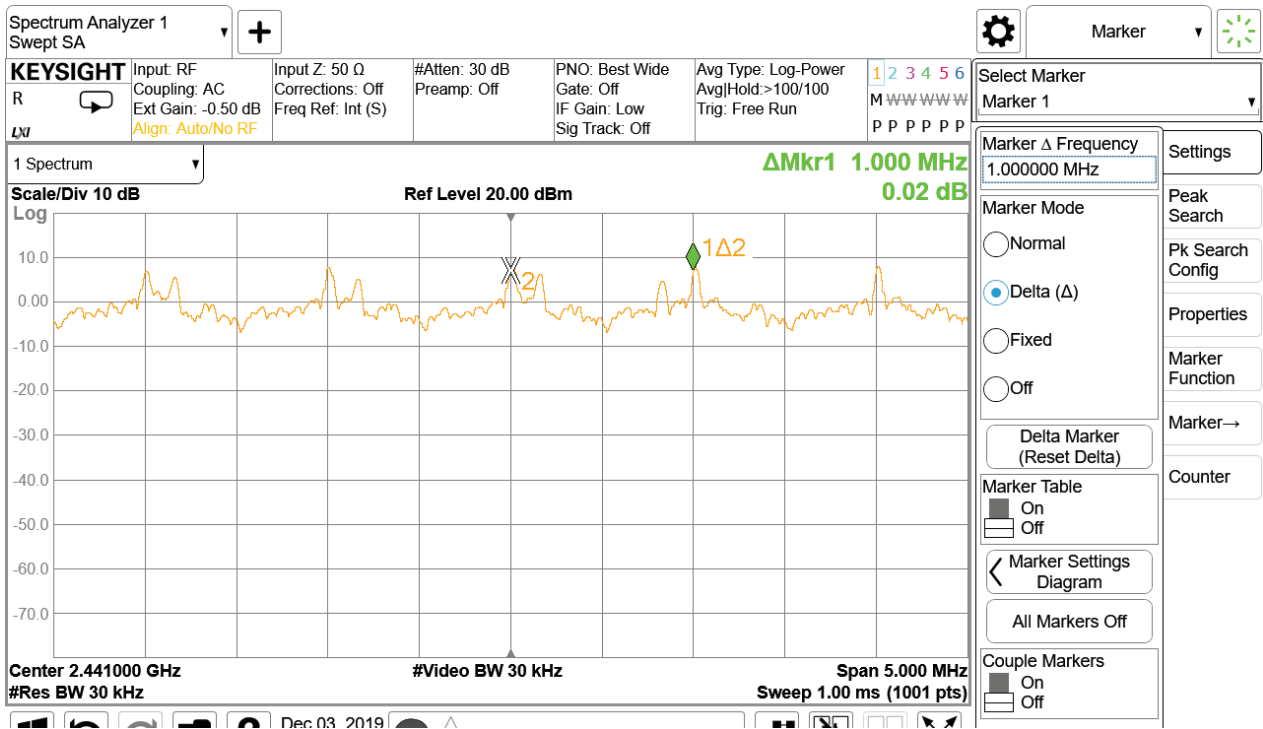
Channel	Adjacent Hopping Channel Separation [kHz]	Two-third of 20dB bandwidth [kHz]	Minimum Bandwidth [kHz]	Result
Middle	1000	840	25	Complies

See next pages for actual measured spectrum plots.

Test mode : GFSK



Test mode : 8-DPSK



4.2 Number of Hopping Frequencies

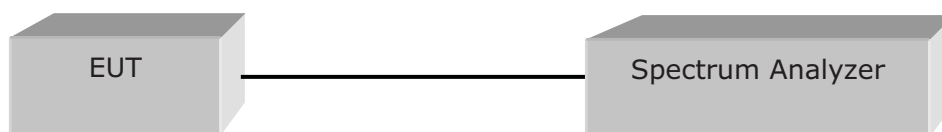
Test Procedures

ANSI C63.10-2013 7.8.3

The number of hopping frequencies was measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function enabled.

The spectrum analyzer is set to:

- a) Frequency range 1: Start = 2 390.0 MHz, Stop = 2 439.5 MHz
 2: Start = 2 439.5 MHz, Stop = 2 489.5 MHz
- b) RBW = 300 kHz (To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller)
- c) VBW = 300 kHz ($\geq$ RBW)
- d) Sweep = auto
- e) Detector function = peak
- f) Trace = max hold



Limit

FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels.

Test Results

Test mode : GFSK

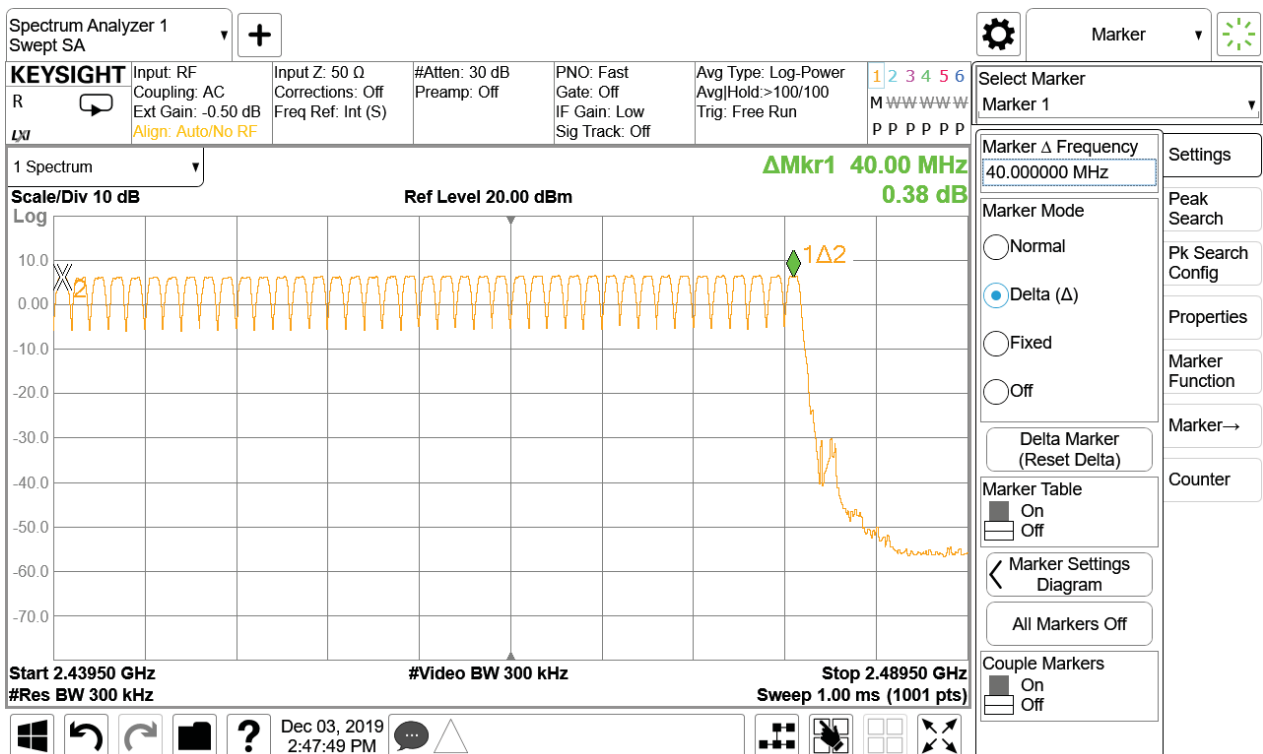
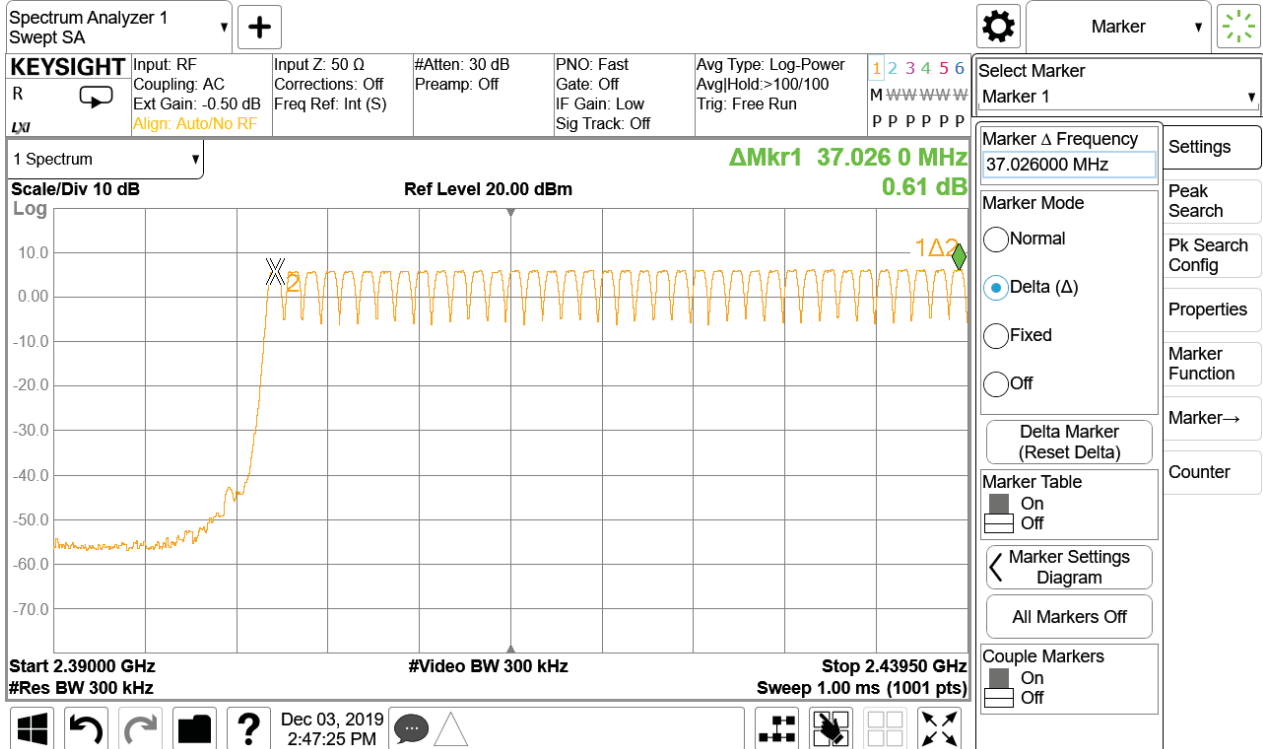
Total number of Hopping Channels	Result
79	Complies

Test mode : 8-DPSK

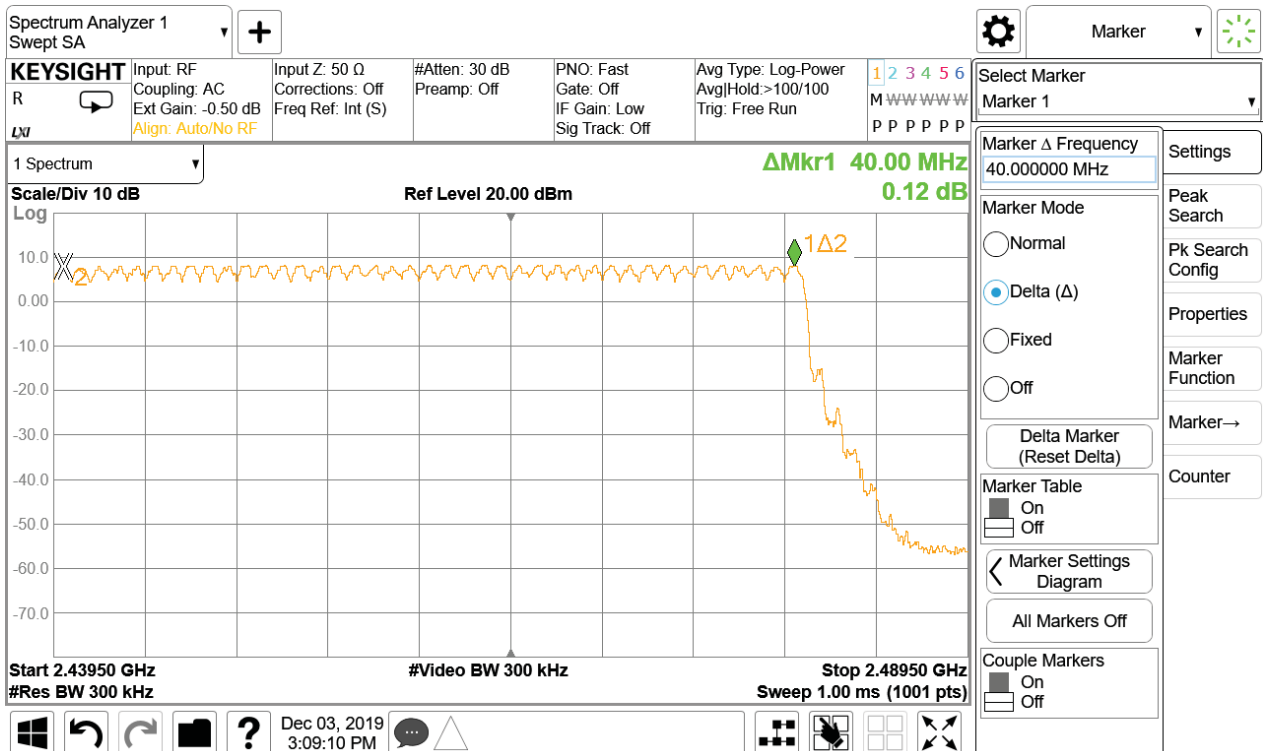
Total number of Hopping Channels	Result
79	Complies

See next pages for actual measured spectrum plots.

Test Mode : GFSK



Test Mode : 8-DPSK



4.3 20 dB bandwidth & 99% Bandwidth

Test Procedures

ANSI C63.10-2013 6.9.2

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

ANSI C63.10-2013 6.9.3

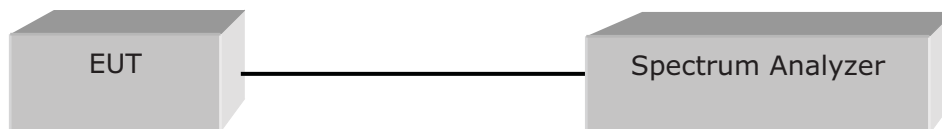
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

- a) Span = 3 MHz (between 2 times and 5 times the OBW)
- b) RBW = 30 kHz (1% to 5% of the OBW)
- c) VBW = 100 kHz (approximately 3 times RBW)
- d) Sweep = auto
- e) Detector function = peak
- f) Trace = max hold



Limit

Limit : N/A

Test Results

Test mode : GFSK

Channel	Frequency [MHz]	20 dB Bandwidth [MHz]	99% Bandwidth [MHz]
Low	2 402	0.927	0.885
Middle	2 441	0.927	0.883
High	2 480	0.924	0.881

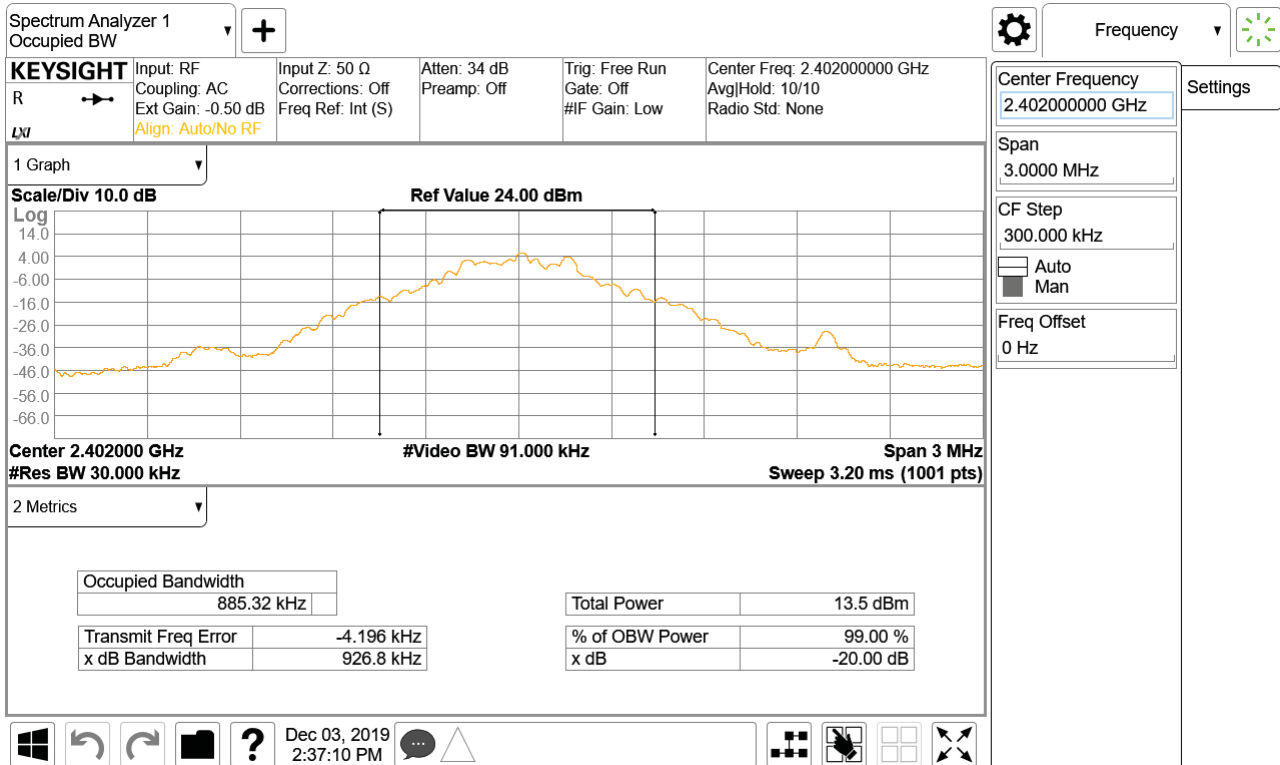
Test mode : 8-DPSK

Channel	Frequency [MHz]	20 dB Bandwidth [MHz]	99% Bandwidth [MHz]
Low	2 402	1.259	1.191
Middle	2 441	1.260	1.196
High	2 480	1.263	1.218

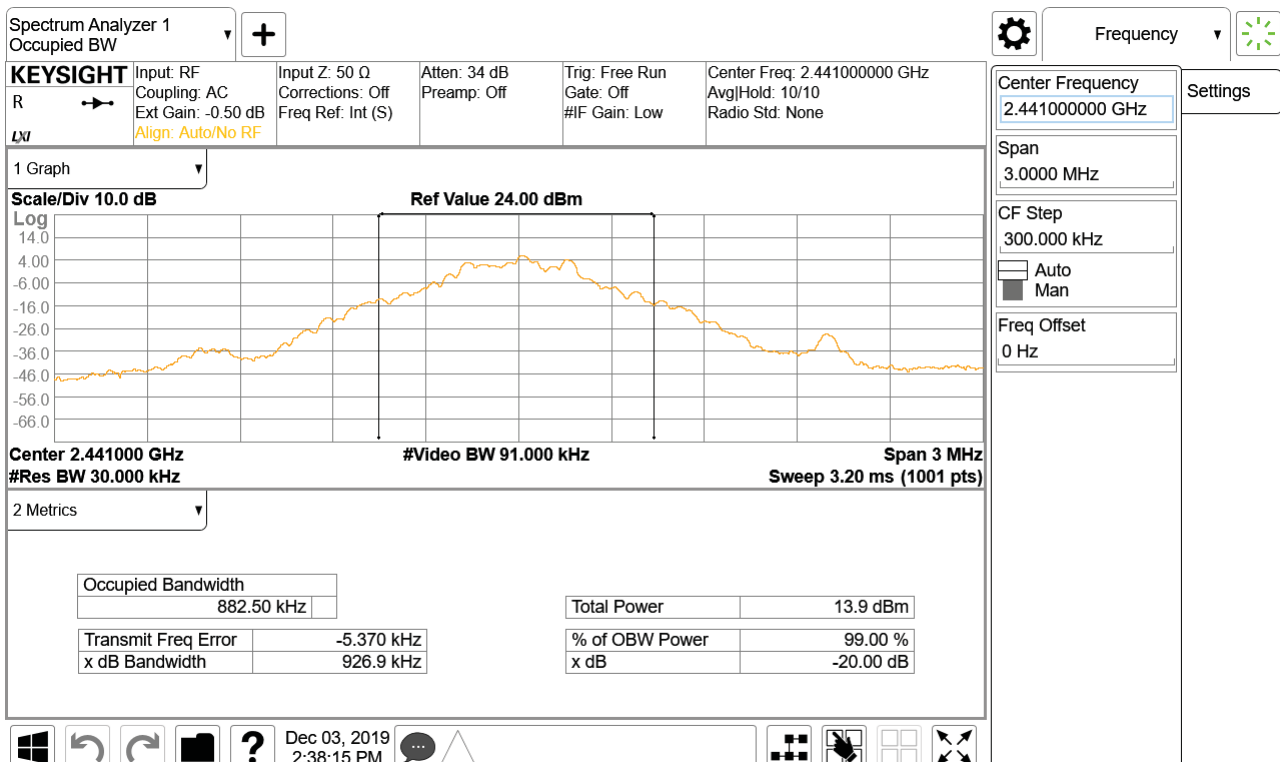
See next pages for actual measured spectrum plots.

20 dB bandwidth & 99% Bandwidth - GFSK

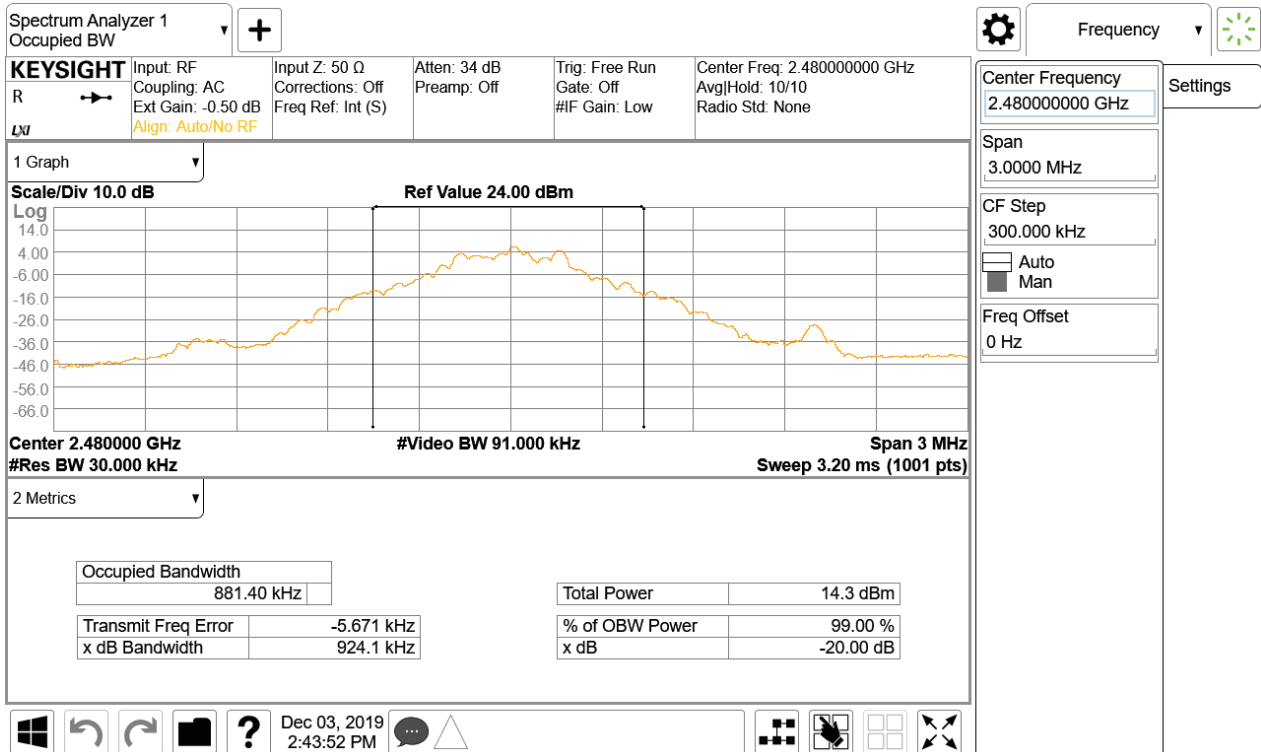
[Low channel]



[Middle channel]

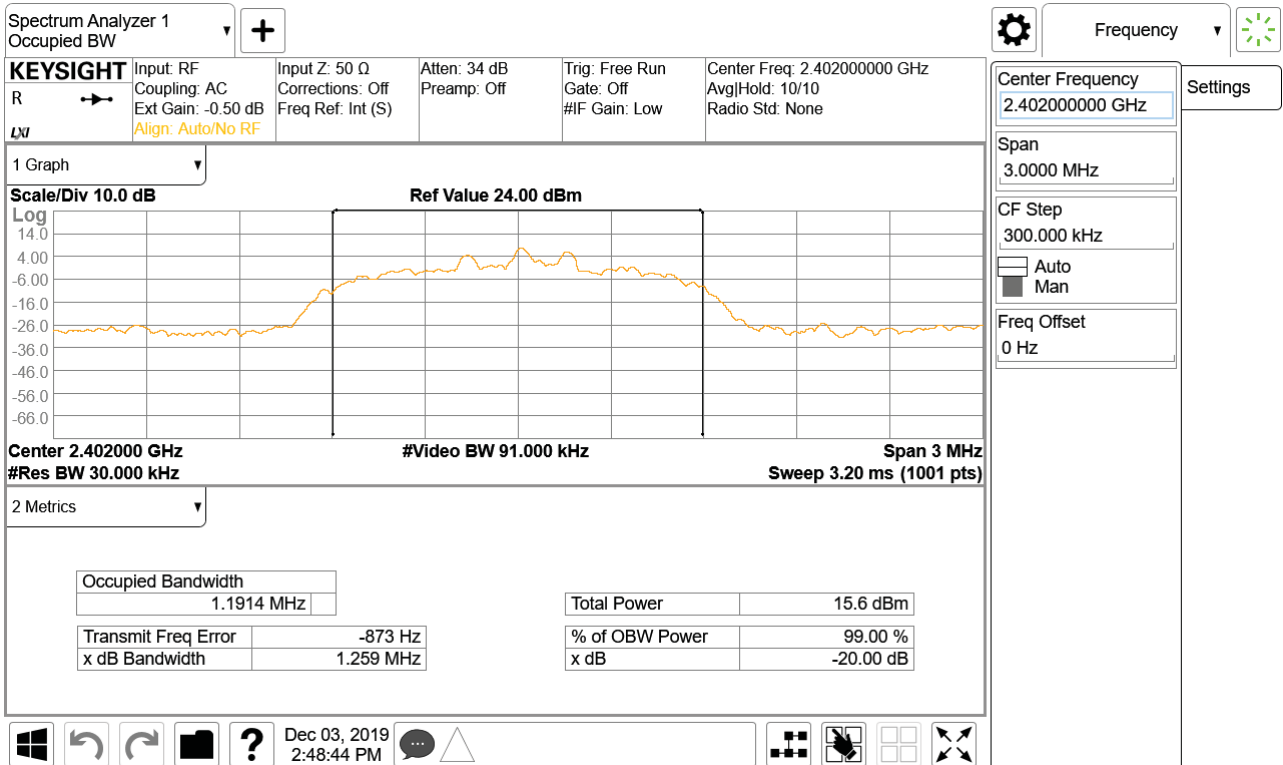


[High channel]

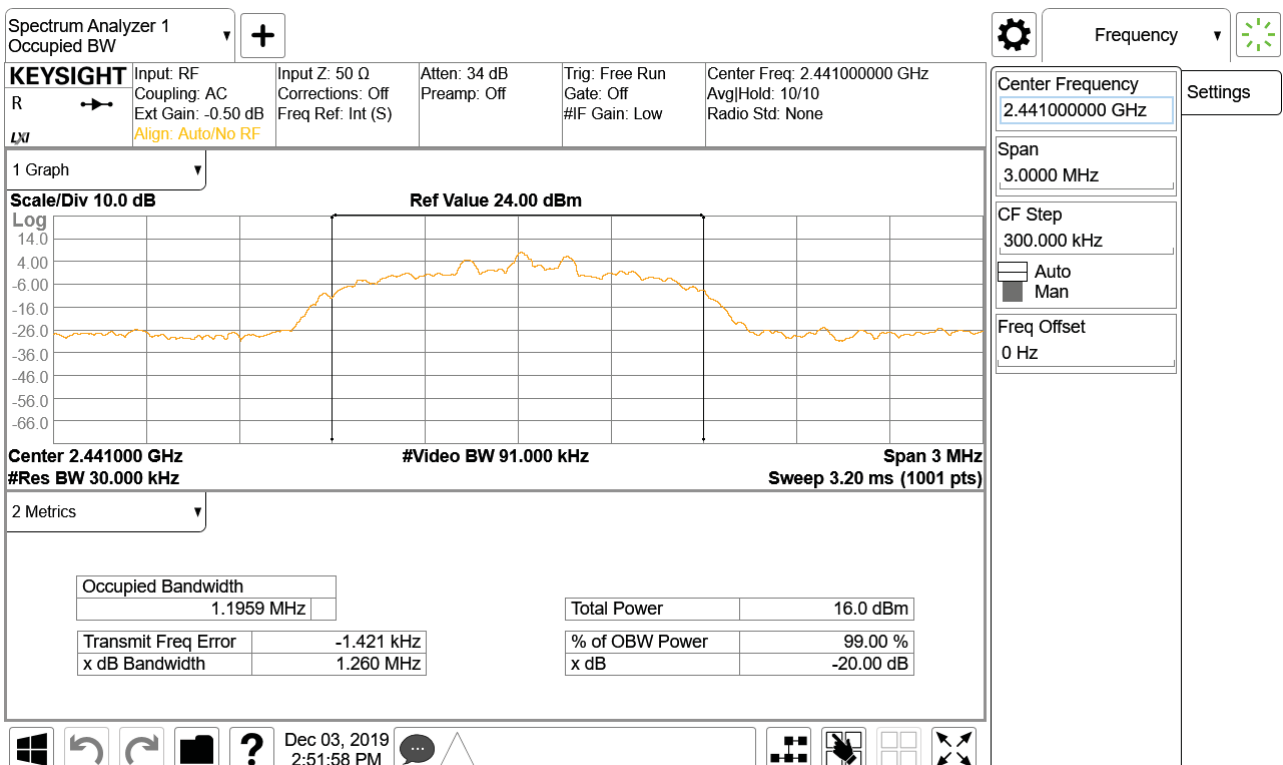


20 dB bandwidth & 99% Bandwidth - 8-DPSK

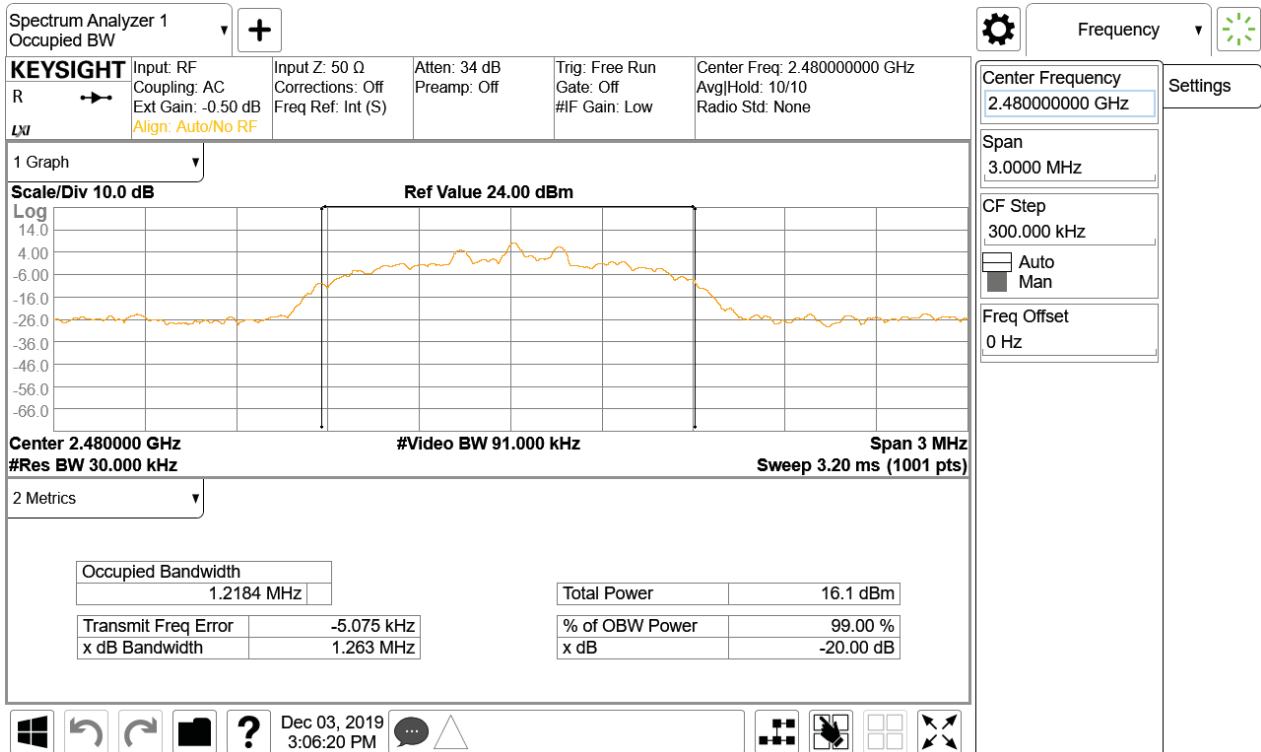
[Low channel]



[Middle channel]



[High channel]



4.4 Time of Occupancy (Dwell Time)

Test Procedures

ANSI C63.10-2013 7.8.4

The dwell time was measured with a spectrum analyzer connected to the antenna terminal, while EUT has its hopping function enabled.

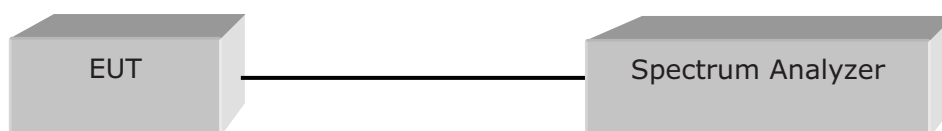
- a) Span: Zero span, centered on a hopping channel.
- b) RBW shall be $\leq$ channel spacing and where possible RBW should be set $\gg 1 / T$, where T is the expected dwell time per channel.
- c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger 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.

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.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

Number of hops in the period specified in the requirements =
 (number of hops on spectrum analyzer) $\times$ (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.



Limit

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.

Test Results

The requirements are:

☒ Complies

Test Data

Test mode : GFSK

Mode	Number of hops on spectrum analyzer	period specified in the requirement (sec)	analyzer sweep time (sec)	Number of transmission in a period (channel number*0.4 sec)	Transmission time per hop (msec)	average time of occupancy (msec)	Limit (msec)
1-DH1	81	31.6	5.0	511.92	0.419	214.494	400
1-DH3	25	31.6	5.0	158.00	1.674	264.492	400
1-DH5	17	31.6	5.0	107.44	2.924	314.154	400

Test mode : $\pi/4$ DQPSK

Mode	Number of hops on spectrum analyzer	period specified in the requirement (sec)	analyzer sweep time (sec)	Number of transmission in a period (channel number*0.4 sec)	Transmission time per hop (msec)	average time of occupancy (msec)	Limit (msec)
2-DH1	102	31.6	5.0	644.64	0.429	276.551	400
2-DH3	32	31.6	5.0	202.24	1.680	339.763	400
2-DH5	20	31.6	5.0	126.40	2.931	370.478	400

Test mode : 8-DPSK

Mode	Number of hops on spectrum analyzer	period specified in the requirement (sec)	analyzer sweep time (sec)	Number of transmission in a period (channel number*0.4 sec)	Transmission time per hop (msec)	average time of occupancy (msec)	Limit (msec)
3-DH1	102	31.6	5.0	644.64	0.429	276.551	400
3-DH3	33	31.6	5.0	208.56	1.679	350.172	400
3-DH5	21	31.6	5.0	132.72	2.924	388.073	400

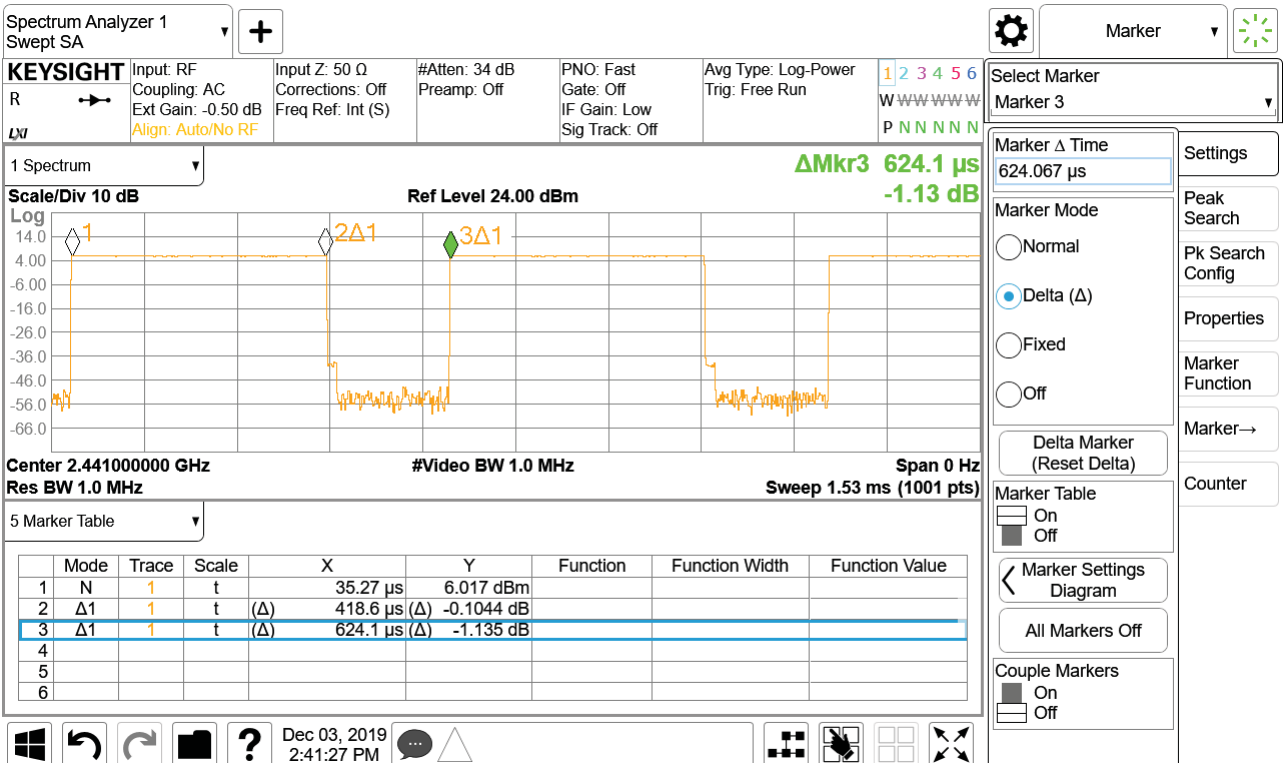
Remark:

Number of transmission in a period(Channel number * 0.4)
= Number of hops on spectrum analyzer × (period specified in the requirement / analyzer sweep time)

Average time of occupancy = Number of transmission in a period × Transmission time per hop

See next pages for actual measured spectrum plots.

Time of Occupancy for Packet Type 1-DH1(GFSK)

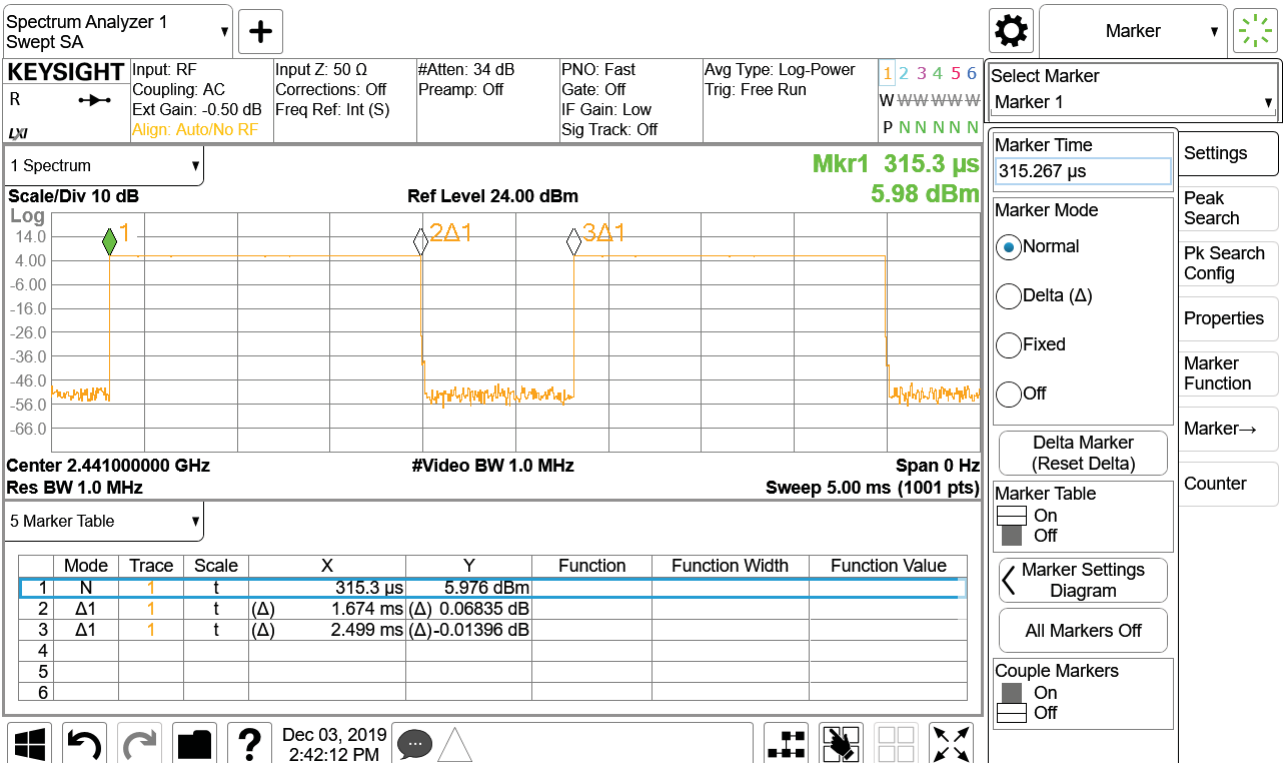




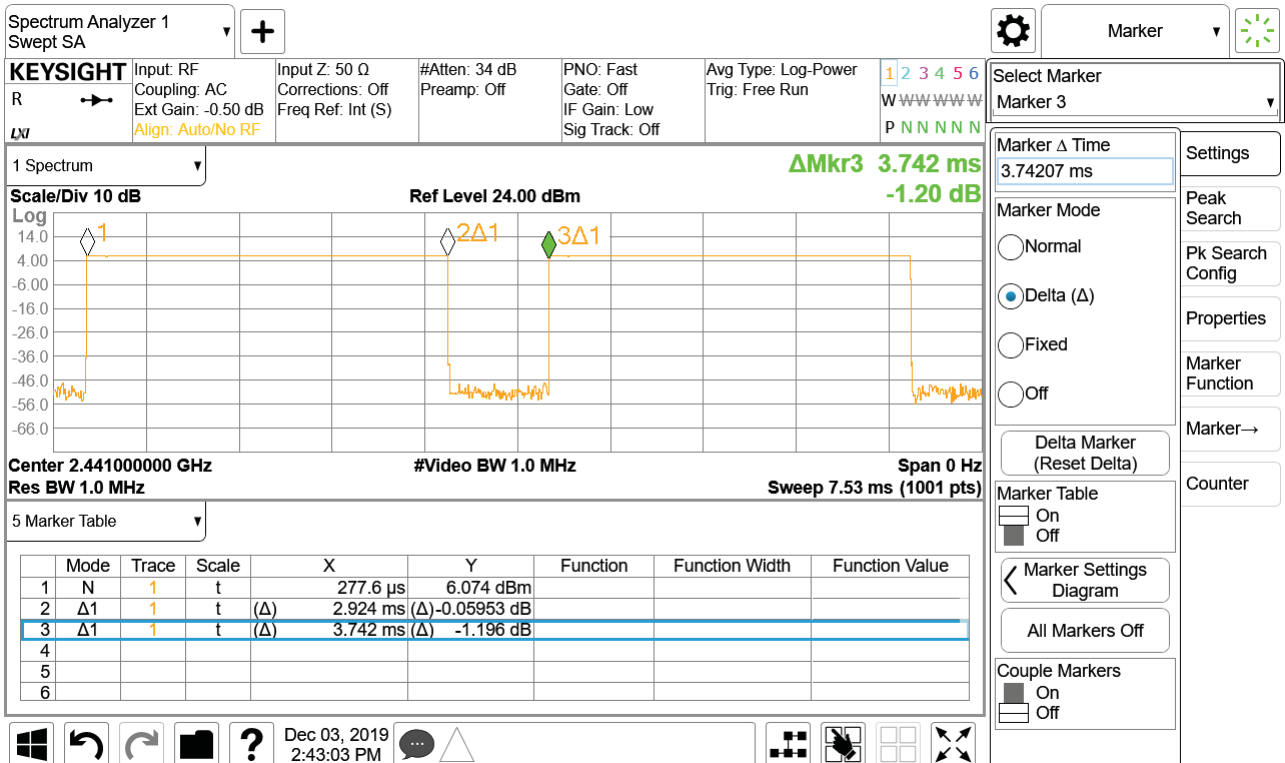
CTK Co., Ltd.
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Tel: +82-31-339-9970
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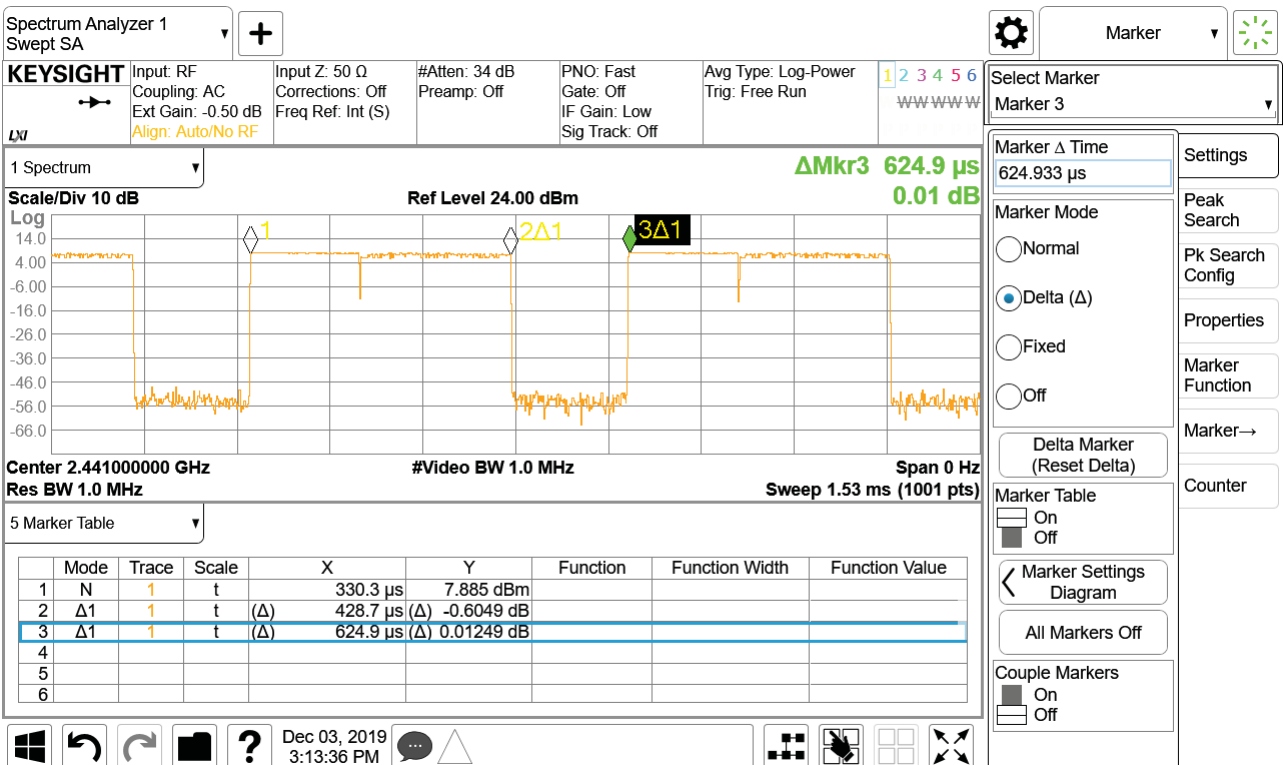
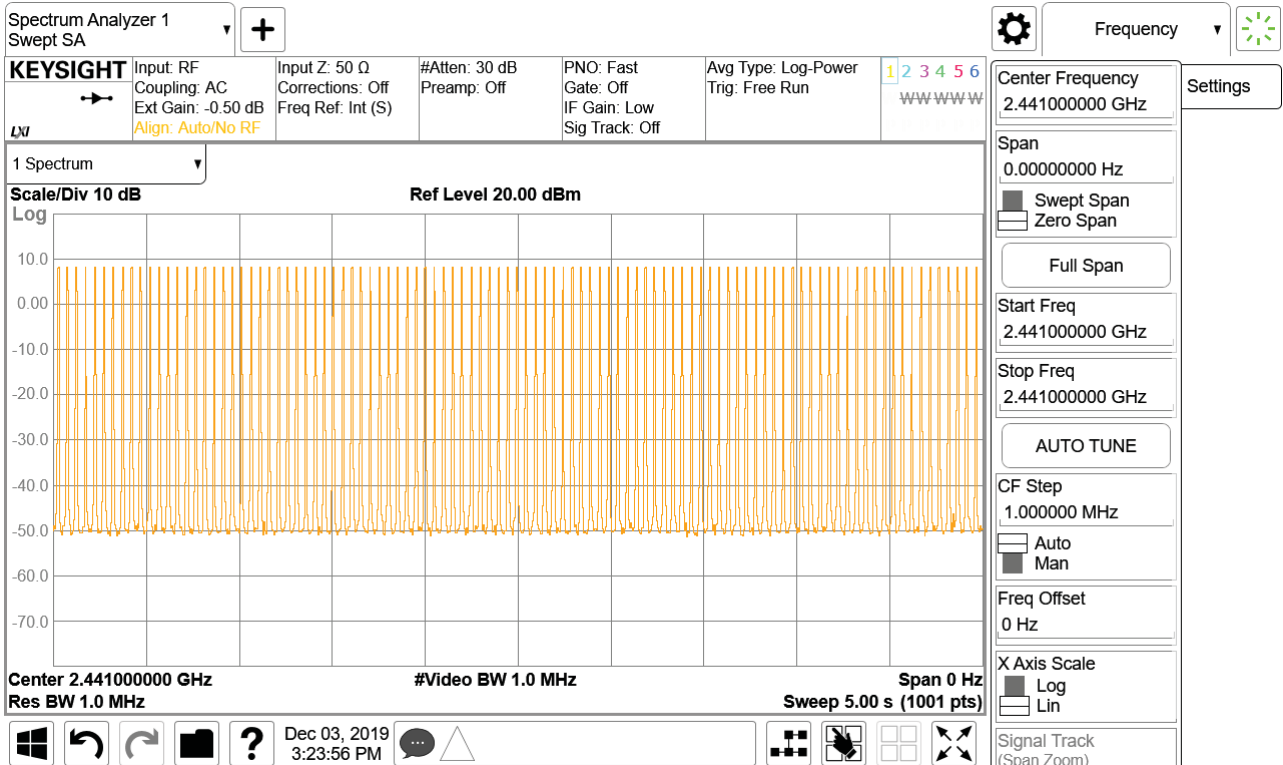
Time of Occupancy for Packet Type 1-DH3(GFSK)



Time of Occupancy for Packet Type 1-DH5(GFSK)



Time of Occupancy for Packet Type 2-DH1($\pi/4$ DQPSK)

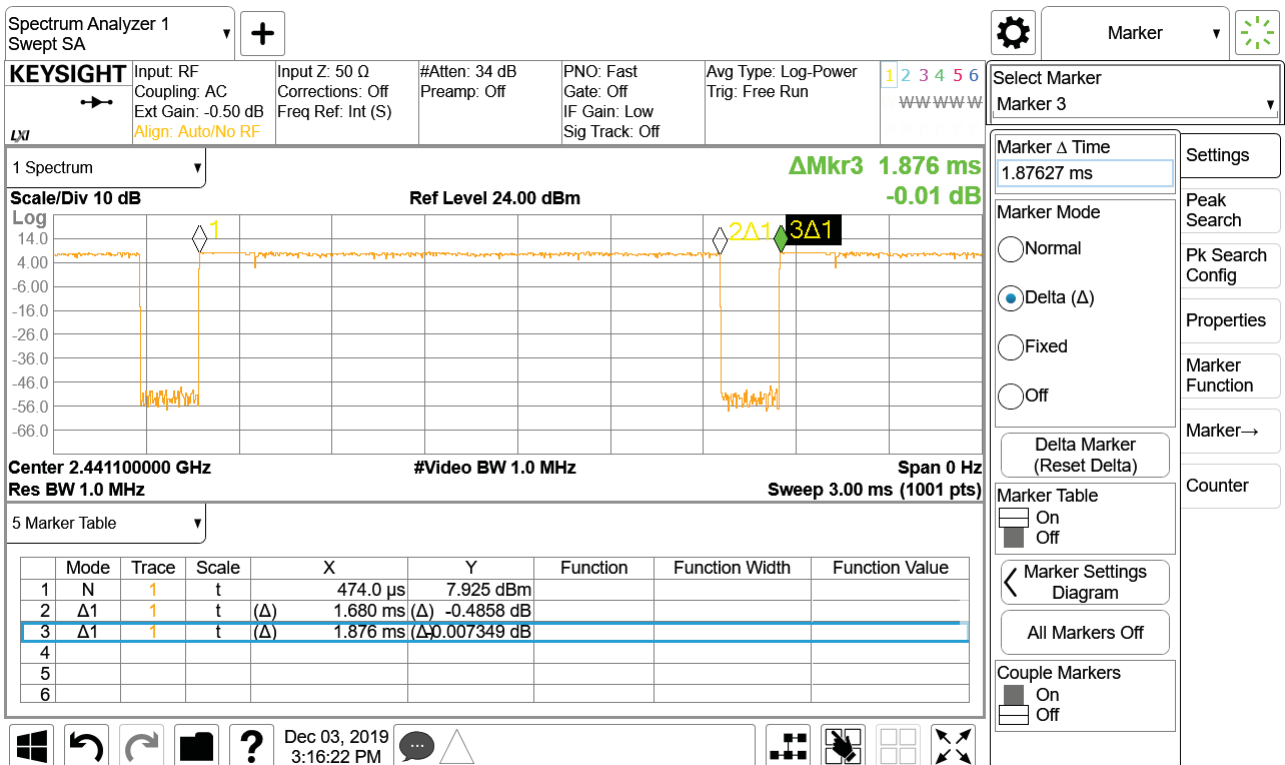




CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
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Time of Occupancy for Packet Type 2-DH3($\pi/4$ DQPSK)

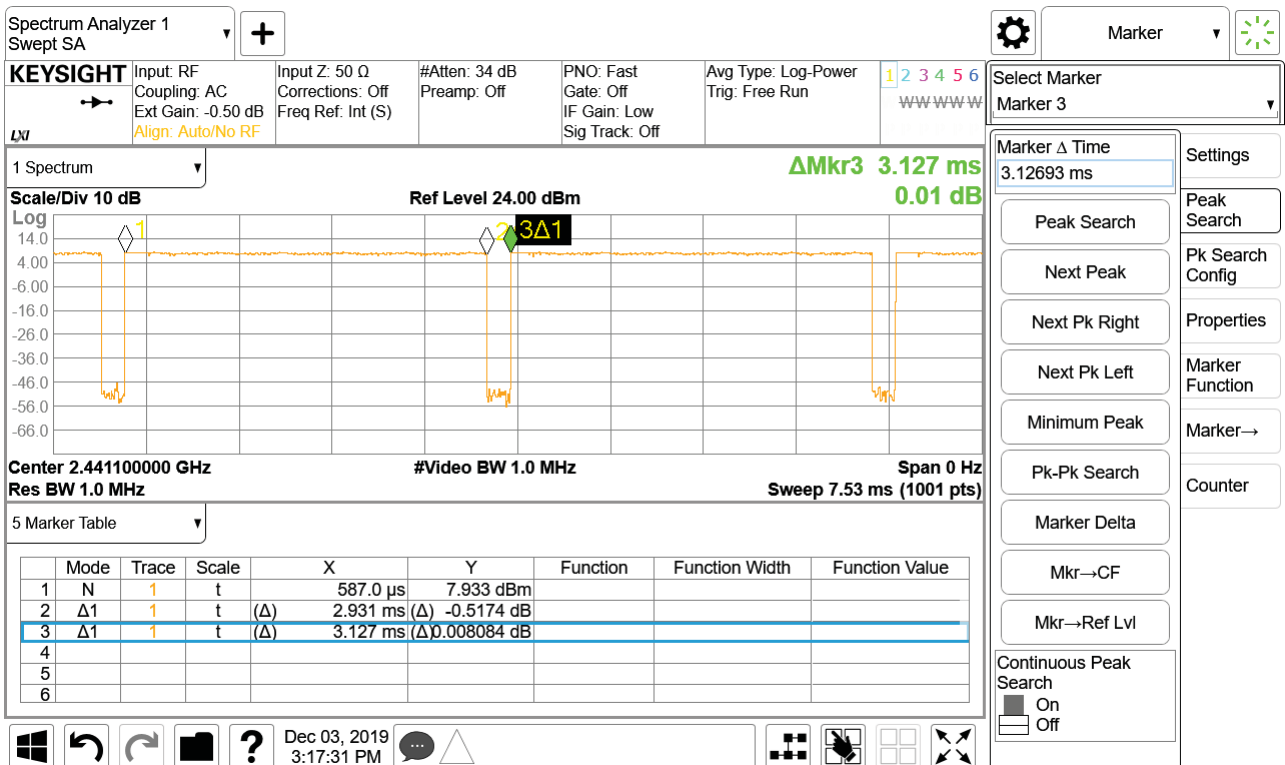
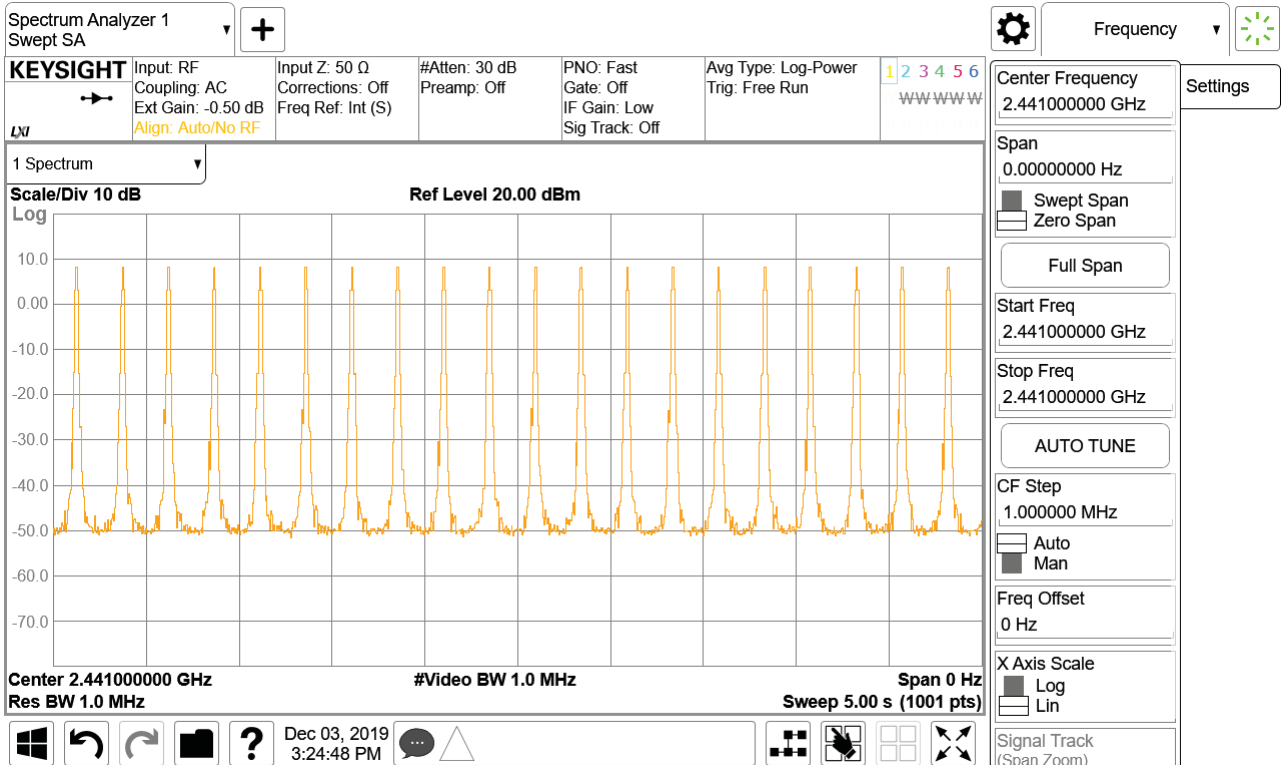




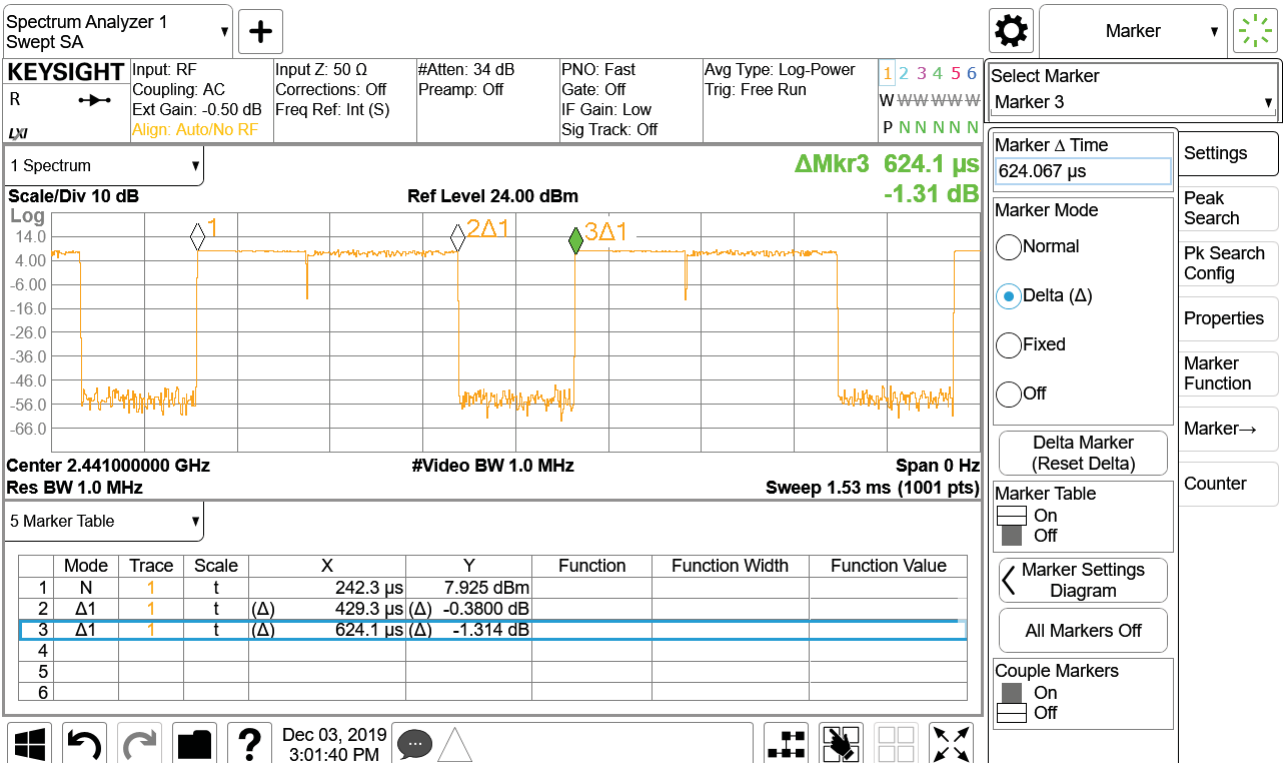
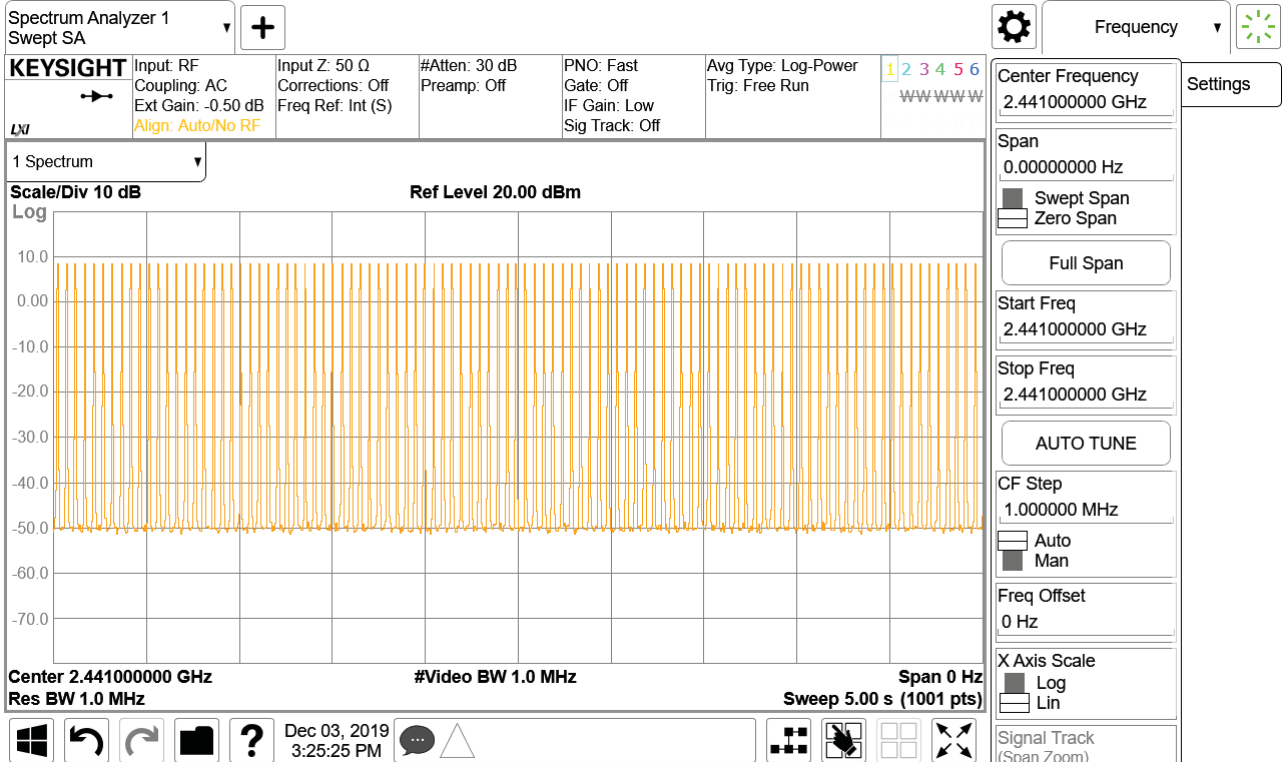
CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

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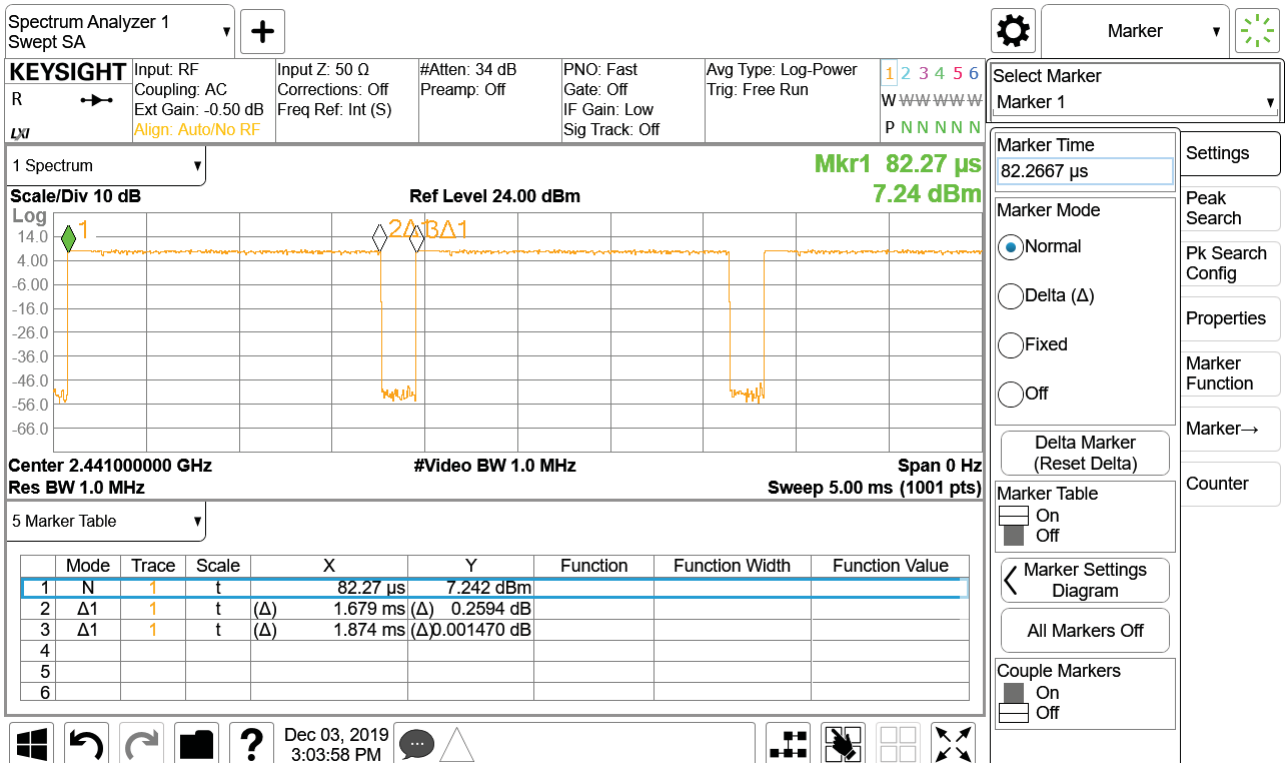
Time of Occupancy for Packet Type 2-DH5($\pi/4$ DQPSK)



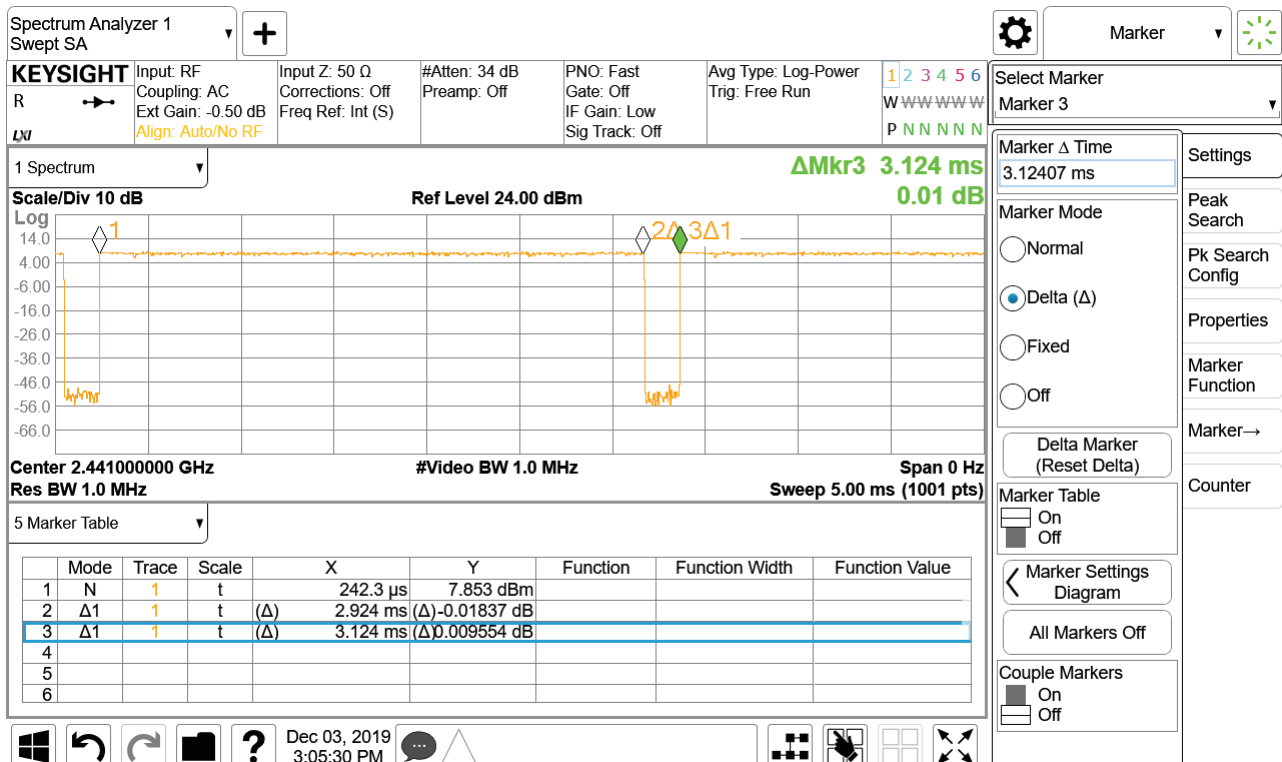
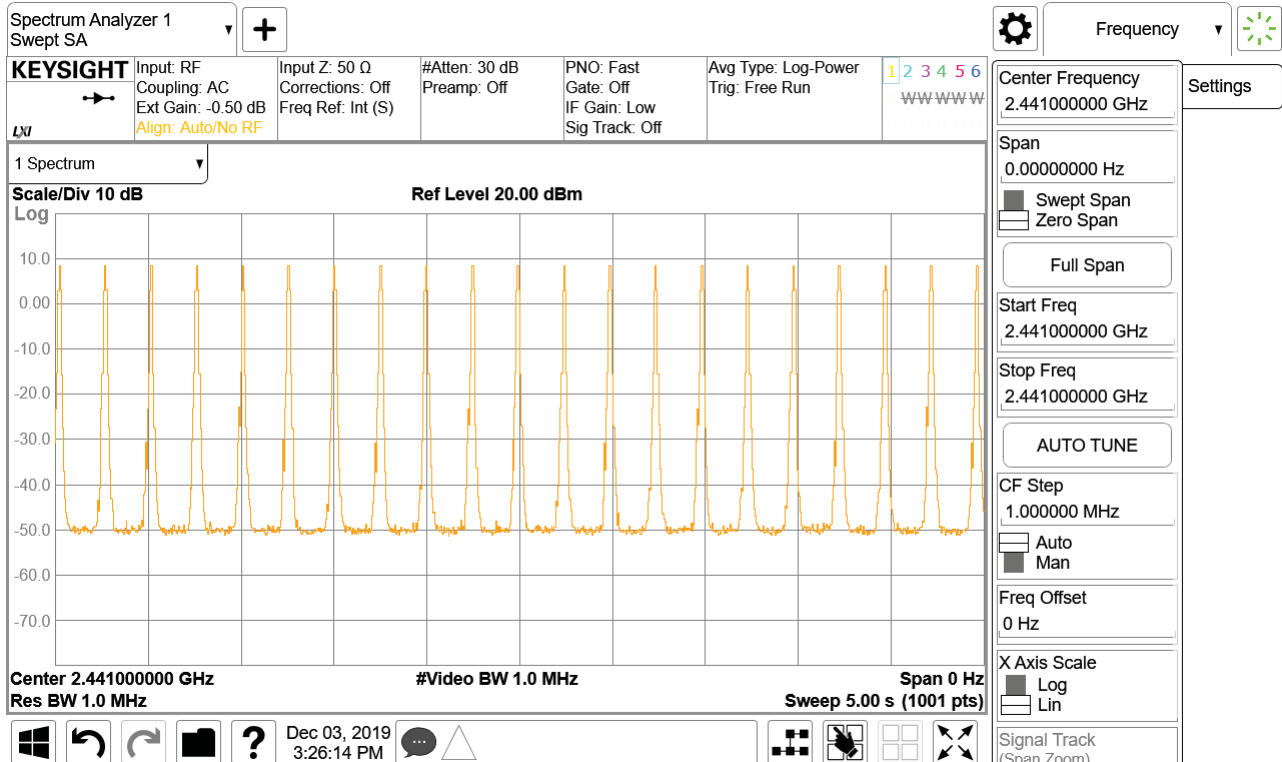
Time of Occupancy for Packet Type 3-DH1(8-DPSK)



Time of Occupancy for Packet Type 3-DH3(8-DPSK)



Time of Occupancy for Packet Type 3-DH5(8-DPSK)



4.5 Maximum peak Conducted Output Power

Test Procedures

ANSI C63.10-2013 7.8.5

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

a) Span = 5 MHz (approximately 5 times of the 20 dB bandwidth)

b) RBW = 3 MHz (greater than the 20 dB bandwidth of the emission being measured)

c) VBW = 3 MHz ($\geq$ RBW)

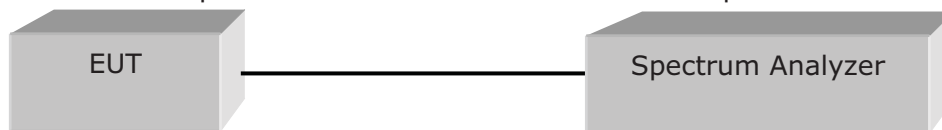
d) Detector = peak

e) Trace = max hold

f) Sweep = auto

Allow trace to stabilize.

Use the marker-to-peak function to set the marker to the peak of the emission.



Limit

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W

Test Results

Test mode : GFSK

Frequency [MHz]	Conducted Power [dBm]	Conducted power [mW]	e.i.r.p. [dBm]	e.i.r.p. [W]	Result
2 402	5.97	3.954	9.33	0.008 6	Complies
2 441	6.36	4.325	9.72	0.009 4	Complies
2 480	6.71	4.688	10.07	0.010 2	Complies

Test mode : $\pi/4$ DQPSK

Frequency [MHz]	Conducted Power [dBm]	Conducted power [mW]	e.i.r.p. [dBm]	e.i.r.p. [W]	Result
2 402	8.47	7.031	11.83	0.015 2	Complies
2 441	8.75	7.499	12.11	0.016 3	Complies
2 480	8.74	7.482	12.10	0.016 2	Complies

Test mode : 8-DPSK

Frequency [MHz]	Conducted Power [dBm]	Conducted power [mW]	e.i.r.p. [dBm]	e.i.r.p. [W]	Result
2 402	8.80	7.586	12.16	0.016 4	Complies
2 441	9.04	8.017	12.40	0.017 4	Complies
2 480	8.96	7.870	12.32	0.017 1	Complies

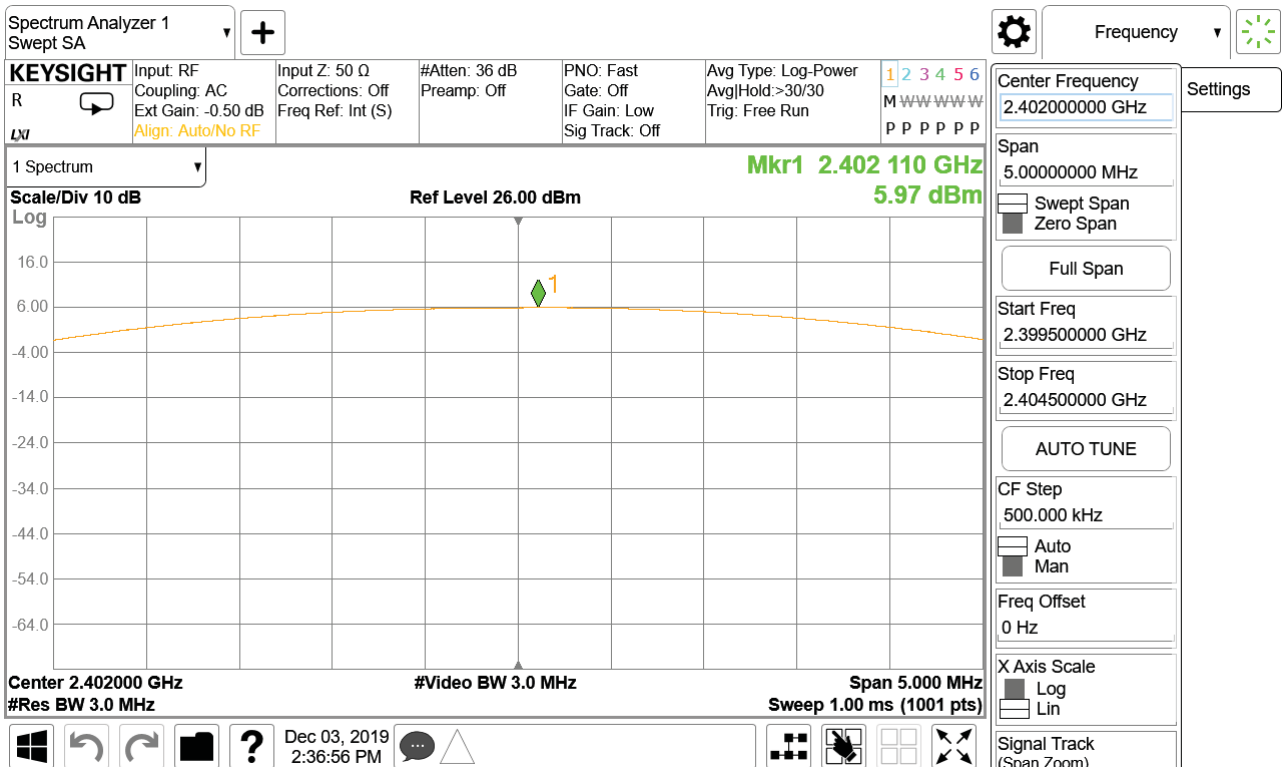
Remark

1. e.i.r.p.[dBm] = Conducted Power[dBm] + Antenna Gain[dBi]

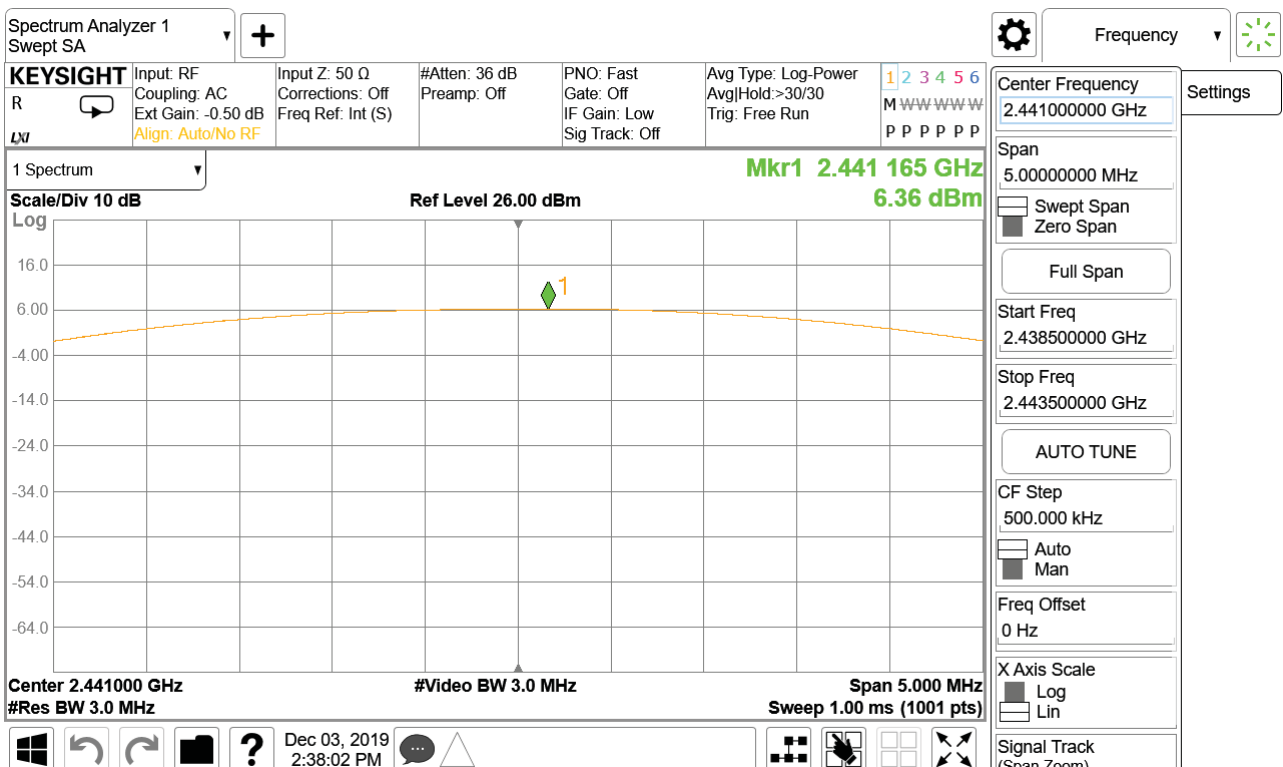
See next pages for actual measured spectrum plots.

Test Mode : GFSK

[Low channel]



[Middle channel]

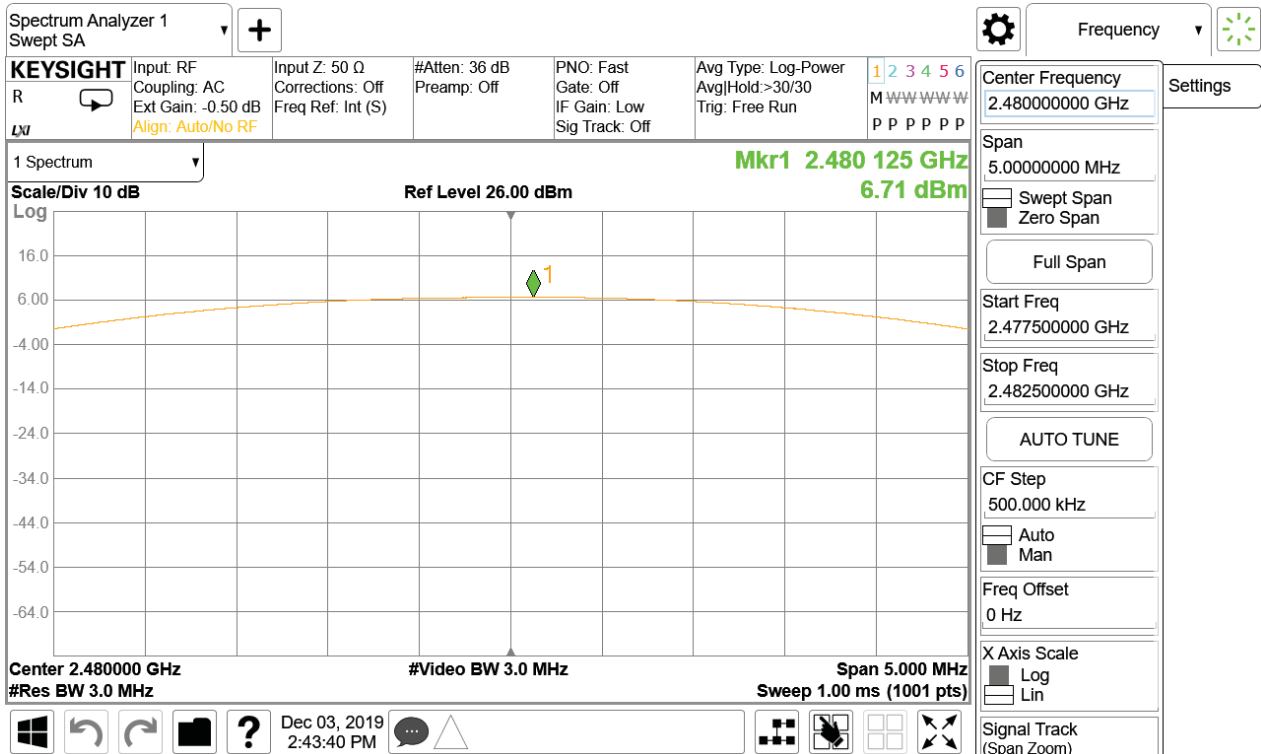




CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

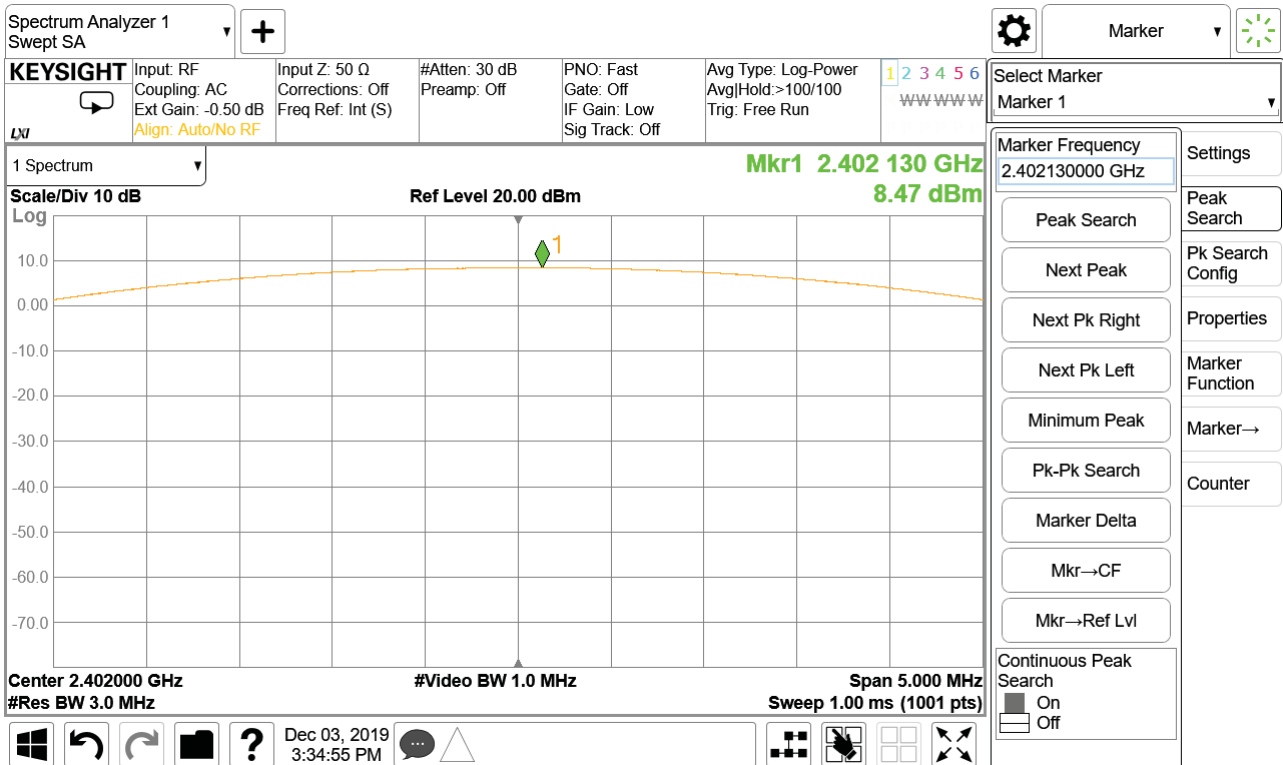
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[High channel]

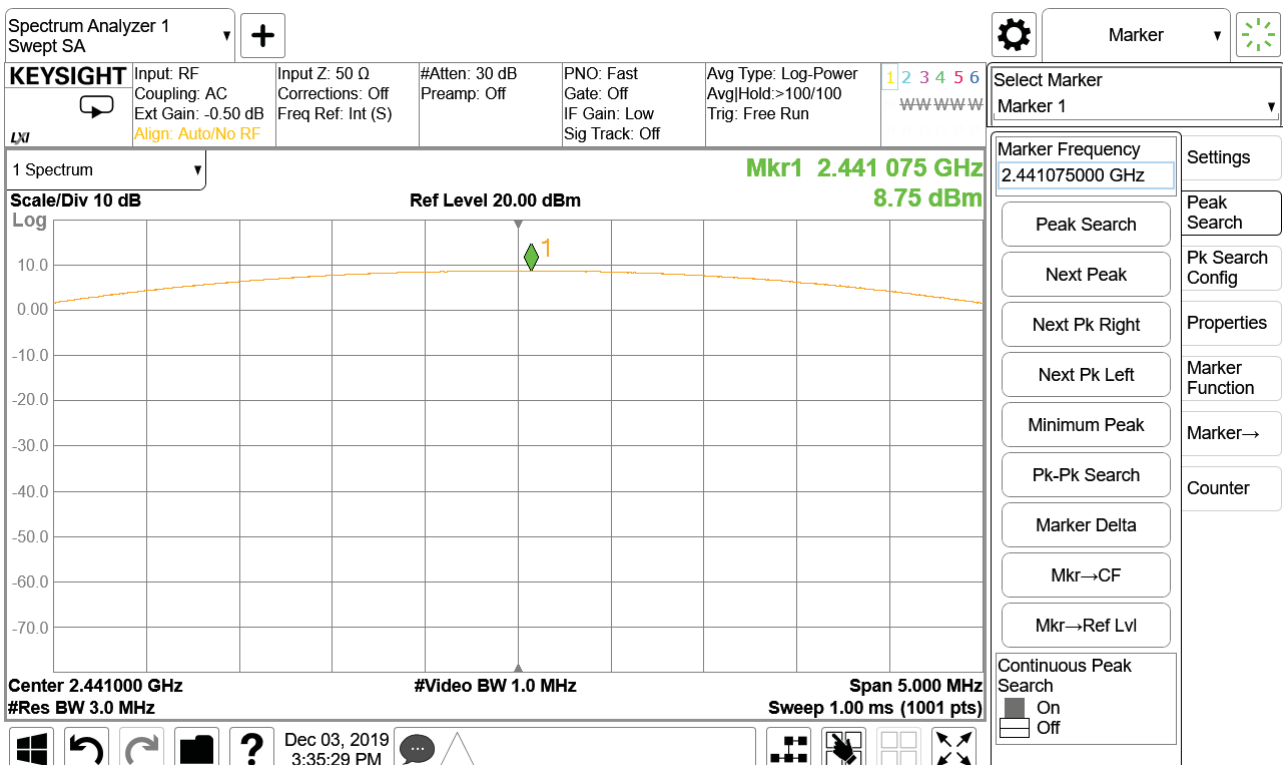


Test Mode : $\pi/4$ DQPSK

[Low channel]



[Middle channel]

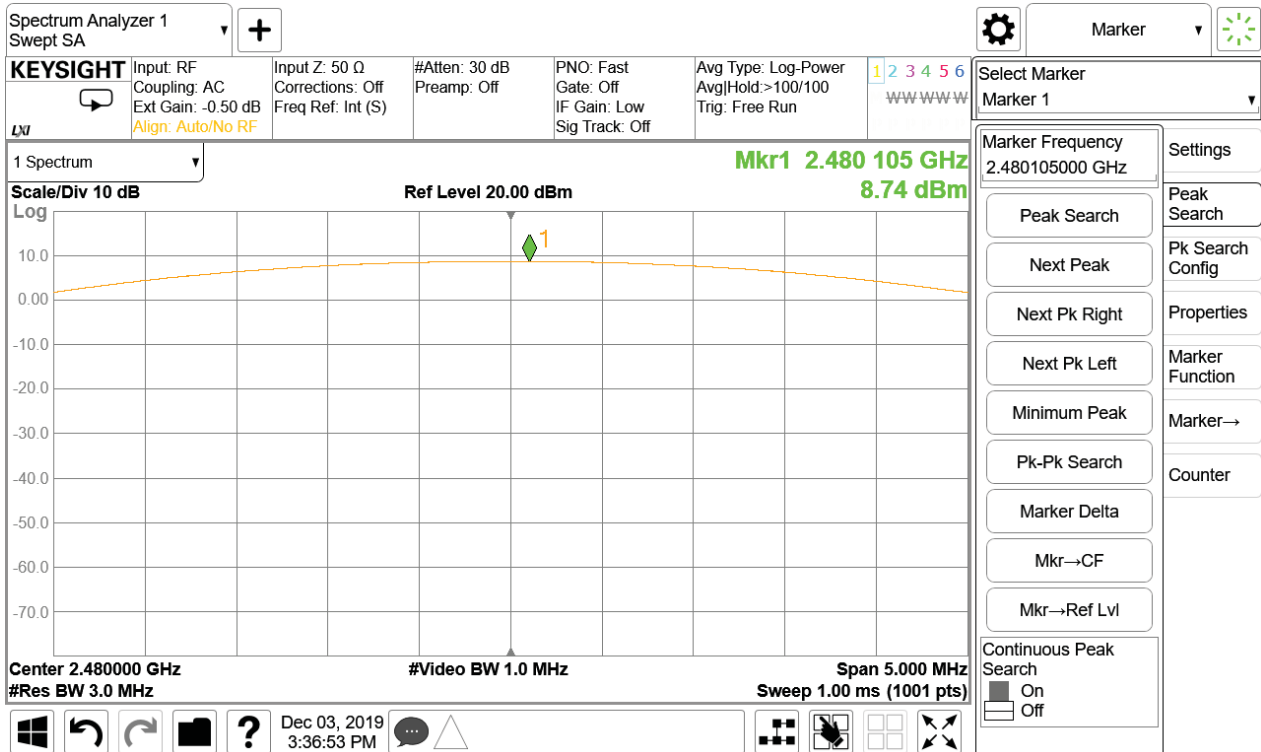




CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

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[High channel]



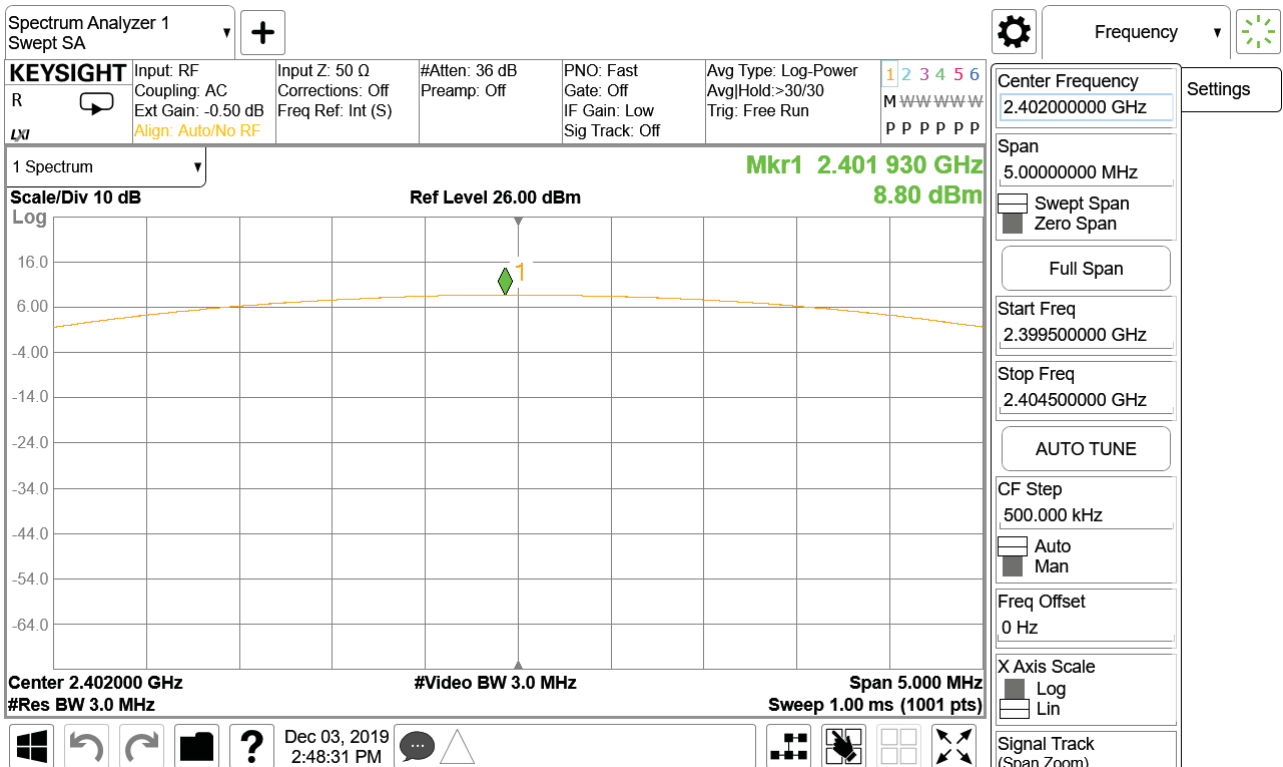


CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

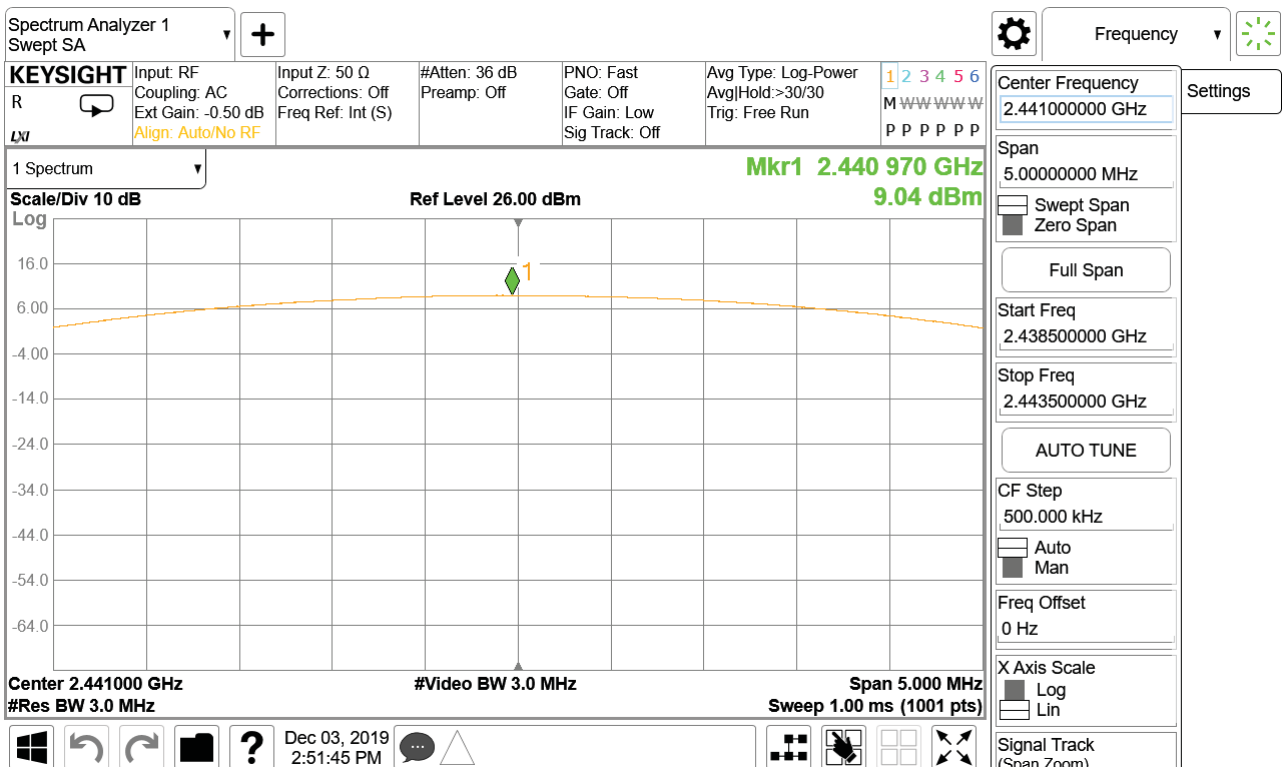
Report No.:
CTK-2019-05055
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Test Mode : 8-DPSK

[Low channel]



[Middle channel]



[High channel]

