TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: ZNFHBS820

Equipment Under Test	:	LG STEREO Headset
Model Name	:	HBS-820
Applicant	:	LG Electronics MobileComm USA. Inc.
Manufacturer	:	Bluecom Co,. Ltd.
Date of Receipt	:	2016.11.30
Date of Test(s)	:	2016.12.06 ~ 2016.12.12
Date of Issue	:	2016.12.15

In the configuration tested, the EUT complied with the standards specified above.

Tested By:	Haegyu Park	**Date:**	**2016.12.15**
Technical Manager:	Hyunchae You	**Date:**	**2016.12.15**

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1. General information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
-Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx.
Phone No. : +82 31 688 0901
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1.2. Details of Applicant

Applicant : LG Electronics MobileComm USA. Inc.
Address : 1000 Sylvan Avenue Englewood Cliffs, New Jersey, United States
Contact Person : Kim, Kyung-Jung
Phone No. : +201 816 2003

1.3. Description of EUT

Kind of Product	Bluetooth STEREO Headset
Model Name	HBS-820
Power Supply	DC 3.7 V
Frequency Range	2 402 ㎒ ~ 2 480 ㎒
Modulation Technique	GFSK, π/4DQPSK, 8DPSK
Number of Channels	79 channels
Antenna Type	FPCB antenna
Antenna Gain	4.64 dBi
H/W Version	1.0
S/W Version	1.0

1.4. Declaration by the manufacturer

- Adaptive Frequency Hopping is supported and use at least 20 channels.

1.5. Information about the FHSS characteristics:

1.5.1. Pseudorandom Frequency Hopping Sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

1.5.2. Equal Hopping Frequency Use

The channels of this system will be used equally over the long-term distribution of the hopsets.

1.5.3. Example of a 79 hopping sequence in data mode:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

1.5.4. System Receiver Input Bandwidth

Each channel bandwidth is 1 ㎒.
The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

1.5.5. Equipment Description

15.247(a)(1) that the rx input bandwidths shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate it channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	Agilent	E8257D	MY51501169	Jul. 07, 2016	Annual	Jul. 07, 2017
Signal Generator	R&S	SMBV100A	255834	Jun. 20, 2016	Annual	Jun. 20, 2017
Spectrum Analyzer	R&S	FSV30	103102	Jun. 08, 2016	Annual	Jun. 08, 2017
Spectrum Analyzer	Agilent	N9030A	MY53120526	Jun. 24, 2016	Annual	Jun. 24, 2017
Bluetooth Tester	TESCOM	TC-3000C	3000C000560	Sep. 22, 2016	Annual	Sep. 22, 2017
Directional Coupler	KRYTAR	152613	140973	Jun. 15, 2016	Annual	Jun. 15, 2017
High Pass Filter	Wainwright Instrument GmbH	WHK3.0/18G-6SS	4	Jun. 18, 2016	Annual	Jun. 18, 2017
High Pass Filter	Wainwright Instrument GmbH	WHNX7.5/26.5G-6SS	11	Jun. 03, 2016	Annual	Jun. 03, 2017
Low Pass Filter	Mini-Circuits	NLP-1200+	V 8979400903-2	Feb. 29, 2016	Annual	Feb. 28, 2017
Power Sensor	R&S	NRP-Z81	100418	Feb. 29, 2016	Annual	Feb. 29, 2017
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 21, 2016	Annual	Mar. 21, 2017
Preamplifier	H.P.	8447F	2944A03909	Aug. 11, 2016	Annual	Aug. 11, 2017
Preamplifier	R&S	SCU-18	10117	Apr. 07, 2016	Annual	Apr. 07, 2017
Preamplifier	MITEQ Inc.	JS44-18004000-35-8P	1546891	May 12, 2016	Annual	May 12, 2017
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 19, 2015	Biennial	Aug. 19, 2017
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	396	Jun. 18, 2015	Biennial	Jun. 18, 2017
Horn Antenna	R&S	HF906	100326	Feb. 01, 2016	Biennial	Feb. 01, 2018
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	BBHA9170431	Aug. 25, 2016	Biennial	Aug. 25, 2018
Antenna Master	INNCO systems	MA4640-XP-ET	N/A	N.C.R.	N/A	N.C.R.
Turn Table	INNCO systems	CONTROLLER CO3000	N/A	N.C.R.	N/A	N.C.R.
Test Receiver	R&S	ESU26	100109	Mar. 07, 2016	Annual	Mar. 07, 2017
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

1.7. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD:FCC Part15 subpart C		
Standard Section	**Test Item**	**Result**
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions Conducted Spurious Emission	Complied
15.247(a)(1)	20 dB Bandwidth	Complied
15.247(b)(1)	Maximum Peak Conducted Output Power	Complied
15.247(a)(1)	Carrier Frequency Separation	Complied
15.247(a)(1)(iii)	Number of Hopping Frequencies	Complied
15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Complied

1.8. Test Procedure(s)

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in DA 00-705 were used in the measurement of the DUT.

1.9. Sample calculation

Where relevant, the following sample calculation is provided:

1.9.1. Conducted test

Offset value (dB) = Directional Coupler (dB) + Cable loss (dB)

1.9.2. Radiation test

Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB) - Amplifier gain (dB)

1.10. Test report revision

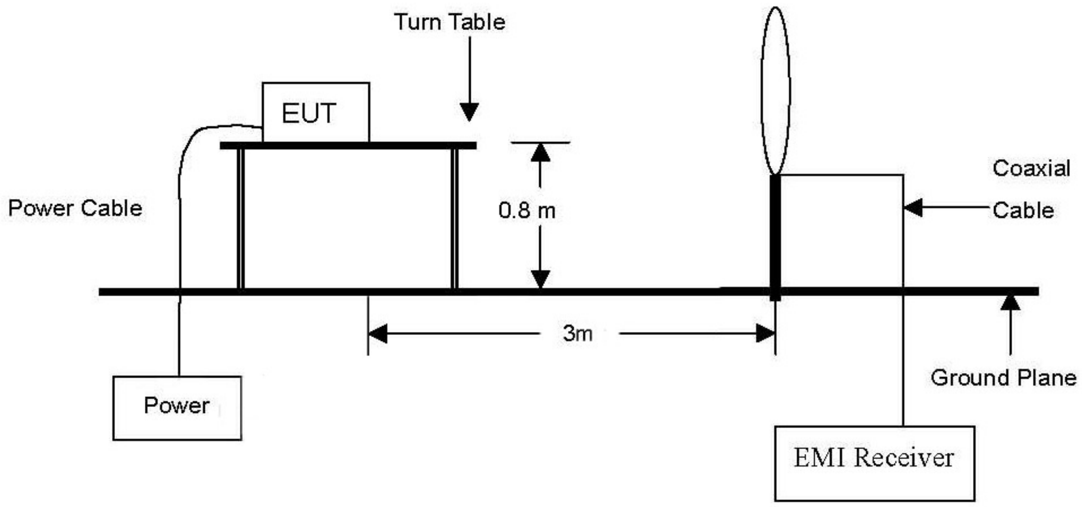
Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL010659	2016.12.15	Initial

2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

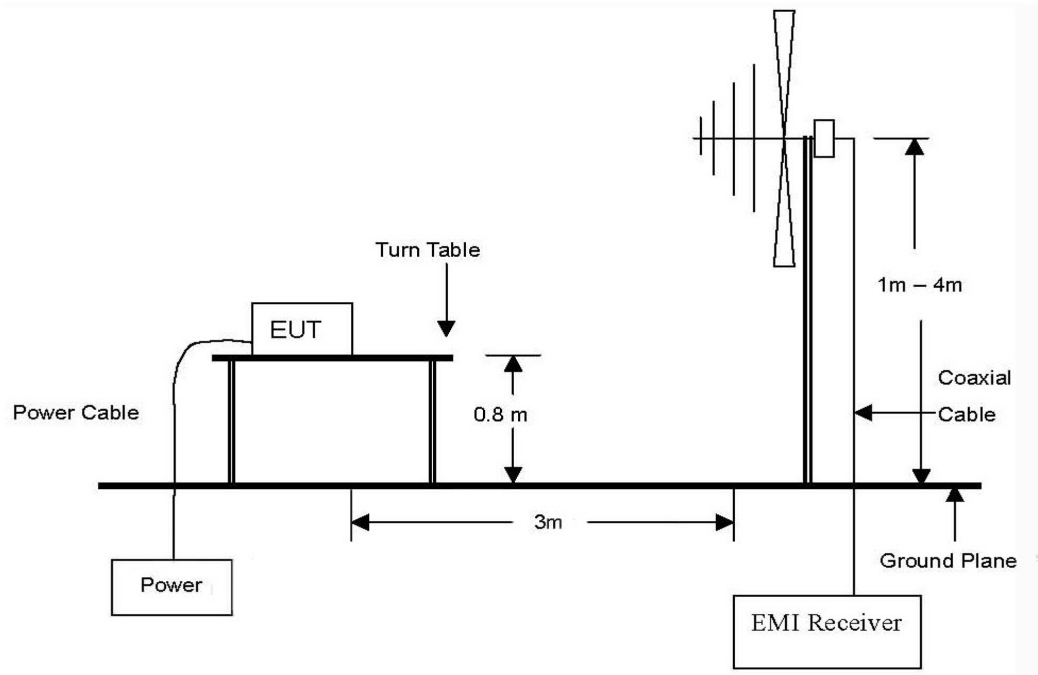
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

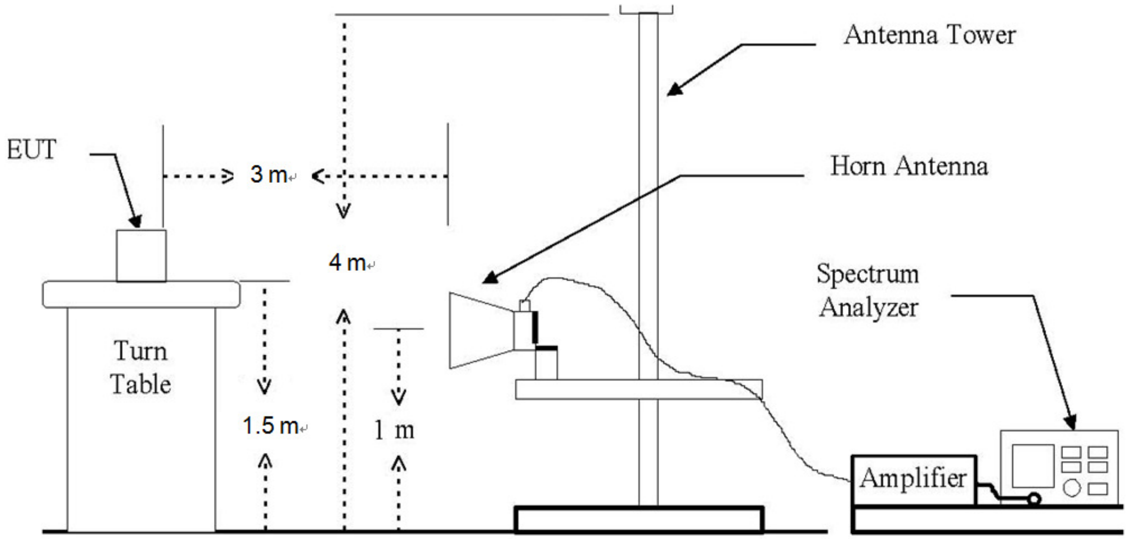
The diagram below shows the test setup that is utilized to make the measurements for emission from 32.768 ㎑ to 30 ㎒ Emissions.



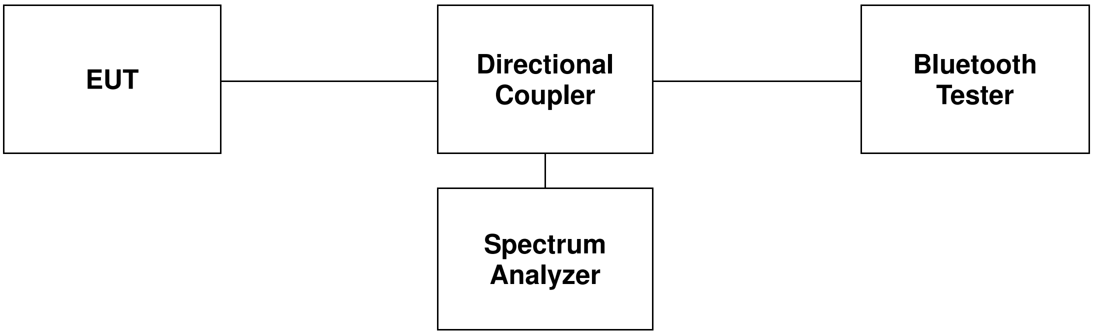
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.1.2. Conducted Spurious Emissions



2.2. 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 operating, 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 limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph(b)(3) of this section, the attenuation required under this paragraph shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in section §15.209(a) is not required. In addition, radiated emission which in the restricted band, as define in section §15.205(a), must also comply the radiated emission limits specified in section §15.209(a) (see section §15.205(c))

According to §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 (㎒)	**Distance (Meters)**	**Field Strength (㏈㎶/m)**	**Field Strength (㎶/m)**
0.009 – 0.490	300	20 log (2 400/F(㎑))	2 400/F(㎑)
0.490 – 1.705	30	20 log (24 000/F(㎑))	24 000/F(㎑)
1.705 – 30.0	30	29.54	30
30 – 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

2.3.1. Test Procedures for emission below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

Note;

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 meter open field test 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 937606.

2.3.2. Test Procedures for emission from above 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 ㎓ and 1.5 meter above the ground at a 3 meter anechoic chamber test site above 1 ㎓. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 ㏈ lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 ㏈ margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

NOTE;

All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection and frequency above 1 ㎓.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is $1/T_{on}$ ㎐ (T_{on} = On-time of the Pulsed emission) for Average detection (AV) at frequency above 1 ㎓.
   VBW = 360 ㎐ ≥ $1/T_{on}$ ㎐, pulse width in seconds (T_{on} = 2.91 ㎳). Refer to the DH5, 3DH5 of Time of Occupancy (Dwell Time) test item.
4. When Average result is different from peak result over 20 ㏈ (over-averaging), according to §15.35 (c), as a “duty cycle correction factor”, pulse averaging with 20 log(duty cycle) has to be used.
5. Definition of DUT Axis.
   Definition of the test orthogonal plan for EUT was described in the test setup photo.
   The test orthogonal plan of EUT is **X – axis** during radiation test.

2.3.3. Test Procedures for Conducted Spurious Emissions

2.3.3.1. Band-edge Compliance of RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.
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.
RBW ≥ 100 ㎑
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2.3.3.2. Spurious RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.
RBW = 100 ㎑
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2.3.3.3. TDF function

- For plots showing conducted spurious emissions from 9 ㎑ to 25 ㎓, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.
So, the reading values shown in plots were final result.

2.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

2.4.1. Radiated Spurious Emission below 1 000 ㎒

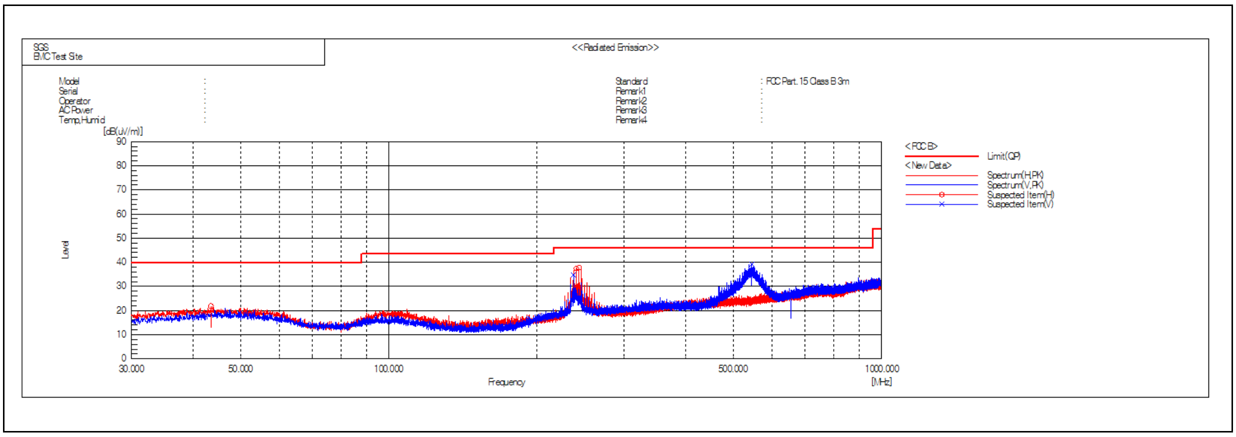
The frequency spectrum from 9 ㎑ to 1 000 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
43.50	32.90	Peak	H	16.07	-27.14	21.83	40.00	18.17
236.93	46.30	Peak	V	13.40	-25.49	34.21	46.00	11.79
240.01	49.70	Peak	H	13.02	-25.46	37.26	46.00	8.74
243.08	50.00	Peak	H	13.14	-25.47	37.67	46.00	8.33
545.07	46.60	Peak	V	18.57	-25.94	39.23	46.00	6.77
Above 600.00	Not detected	-	-	-	-	-	-	-

Remark:

1. Spurious emissions for all channels and modes were investigated and almost the same below 1 ㎓.
2. Reported spurious emissions are in **EDR / 3DH5 / Low channel** as worst case among other modes.
3. Radiated spurious emission measurement as below.
   (Actual = Reading + AF + AMP + CL)
4. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.

Test plot



2.4.2. Radiated Spurious Emission above 1 000 ㎒

The frequency spectrum above 1 000 ㎒ was investigated. All reading values are peak and average values.

Operating Mode: GFSK (1 Mbps)

A. Low Channel (2 402 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 310.00	22.45	Peak	H	28.07	5.31	-	55.83	74.00	18.17
*2 310.00	22.45	Average	H	28.07	5.31	-24.70	31.13	54.00	22.87
*2 363.65	26.75	Peak	H	28.12	5.60	-	60.47	74.00	13.53
*2 363.65	26.75	Average	H	28.12	5.60	-24.70	35.77	54.00	18.23
*2 390.00	23.81	Peak	H	28.15	5.80	-	57.76	74.00	16.24
*2 390.00	23.81	Average	H	28.15	5.80	-24.70	33.06	54.00	20.94

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

B. Middle Channel (2 441 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

C. High Channel (2 480 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	25.37	Peak	H	28.24	5.54	-	59.15	74.00	14.85
*2 483.50	25.37	Average	H	28.24	5.54	-24.70	34.45	54.00	19.55
*2 487.17	27.01	Peak	H	28.25	6.00	-	61.26	74.00	12.74
*2 487.17	27.01	Average	H	28.25	5.53	-24.70	36.09	54.00	17.91
*2 500.00	24.86	Peak	H	28.26	5.49	-	58.61	74.00	15.39
*2 500.00	24.86	Average	H	28.26	5.49	-24.70	33.91	54.00	20.09

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

Operating Mode: 8DPSK (3 Mbps)

A. Low Channel (2 402 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 310.00	22.16	Peak	H	28.07	5.31	-	55.54	74.00	18.46
*2 310.00	22.16	Average	H	28.07	5.31	-24.70	30.84	54.00	23.16
*2 322.25	24.80	Peak	H	28.08	5.37	-	58.25	74.00	15.75
*2 322.25	24.80	Average	H	28.08	5.37	-24.70	33.55	54.00	20.45
*2 390.00	22.08	Peak	H	28.15	5.80	-	56.03	74.00	17.97
*2 390.00	22.08	Average	H	28.15	5.80	-24.70	31.33	54.00	22.67

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

B. Middle Channel (2 441 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

C. High Channel (2 480 ㎒)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 483.50	24.73	Peak	H	28.24	5.54	-	58.51	74.00	15.49
*2 483.50	24.73	Average	H	28.24	5.54	-24.70	33.81	54.00	20.19
*2 499.05	26.54	Peak	H	28.26	5.49	-	60.29	74.00	13.71
*2 499.05	26.54	Average	H	28.26	5.49	-24.70	35.59	54.00	18.41
*2 500.00	24.33	Peak	H	28.26	5.49	-	58.08	74.00	15.92
*2 500.00	24.33	Average	H	28.26	5.49	-24.70	33.38	54.00	20.62

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Duty Factor	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

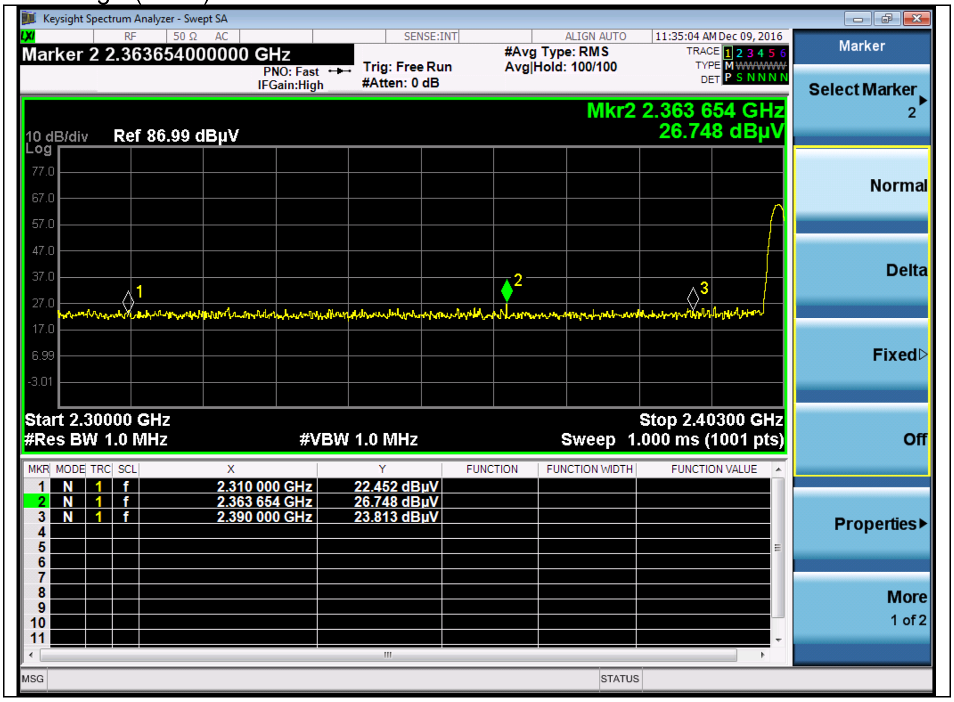
Remarks;

1. “*” means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + AMP + CL
5. According to §15.31(o), emission levels are not reported much lower than the limits by over 20 ㏈.
6. Duty Cycle Correction factor formula:
   - Time to cycle through all channels= Δ t = T [㎳] x 20 channels = 58.2 ㎳, where T = pulse width
   - 100 ㎳/ Δt [㎳] = *H* → Round up to next highest integer, *H ‘ = 2*
   - Worst Case Dwell Time = T[㎳] x *H ‘* = 5.82 ㎳
   - Duty Cycle Correction = 20log (Worst Case Dwell Time/ 100 ㎳) ㏈ = -24.70 ㏈

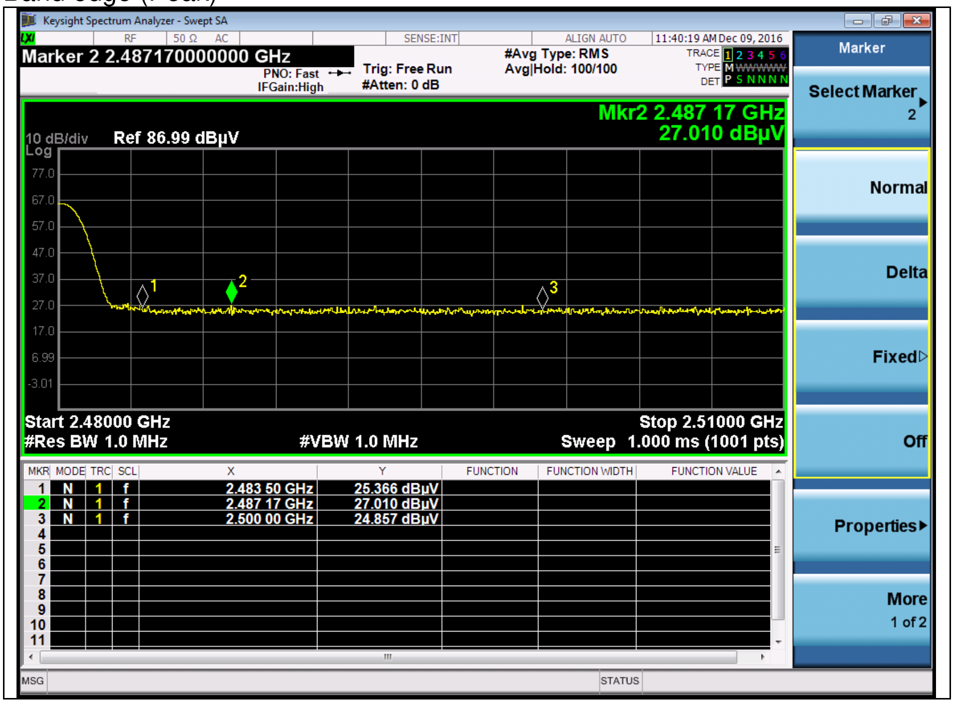
2.4.3. Plots of Transmitter Radiated Spurious Emissions

Operating Mode: GFSK (1 Mbps)

Low Channel Band edge (Peak)

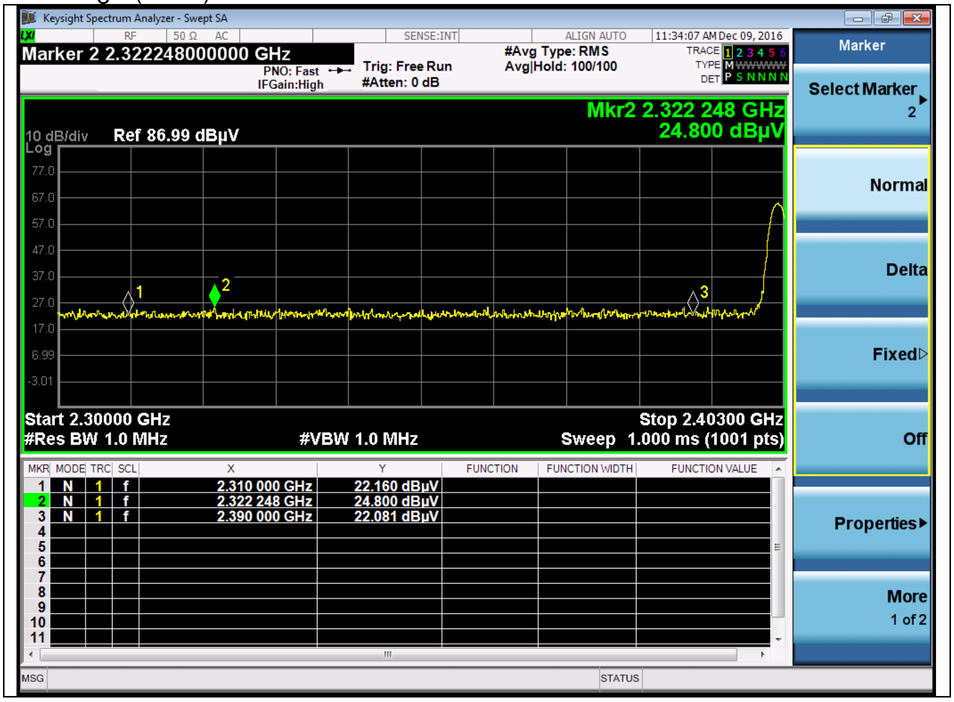


High Channel Band edge (Peak)

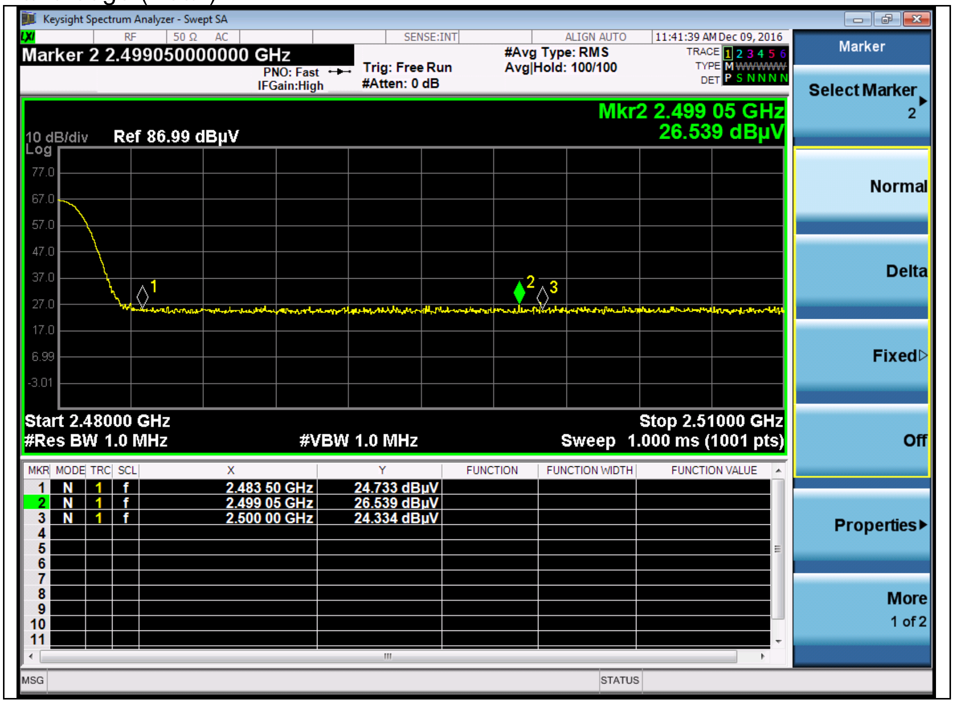


Operating Mode: 8DPSK (3 Mbps)

Low Channel Band edge (Peak)



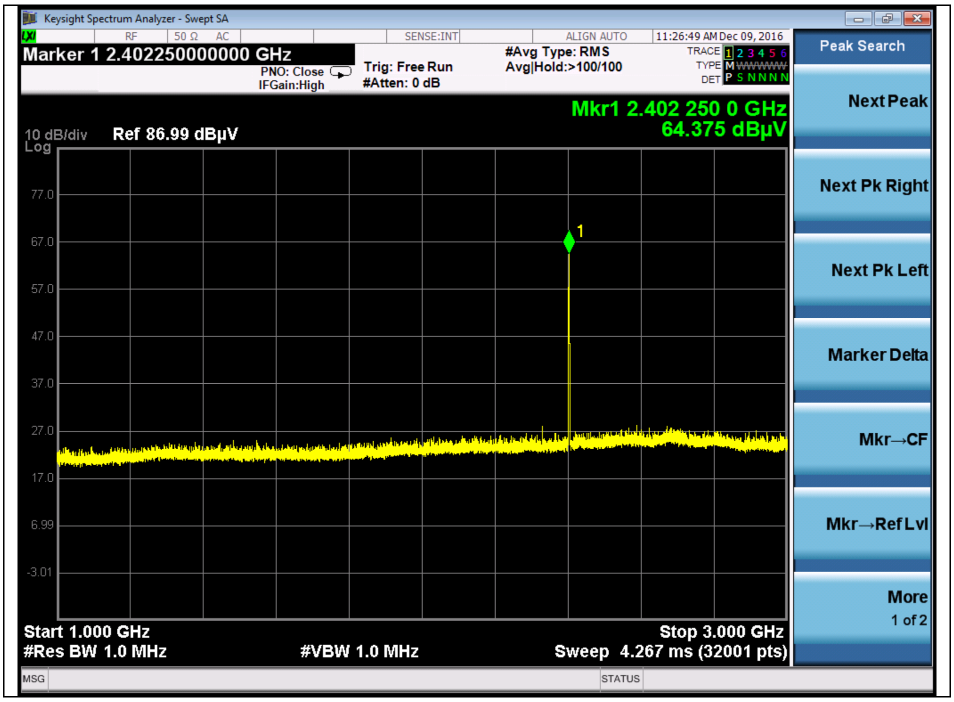
High Channel Band edge (Peak)



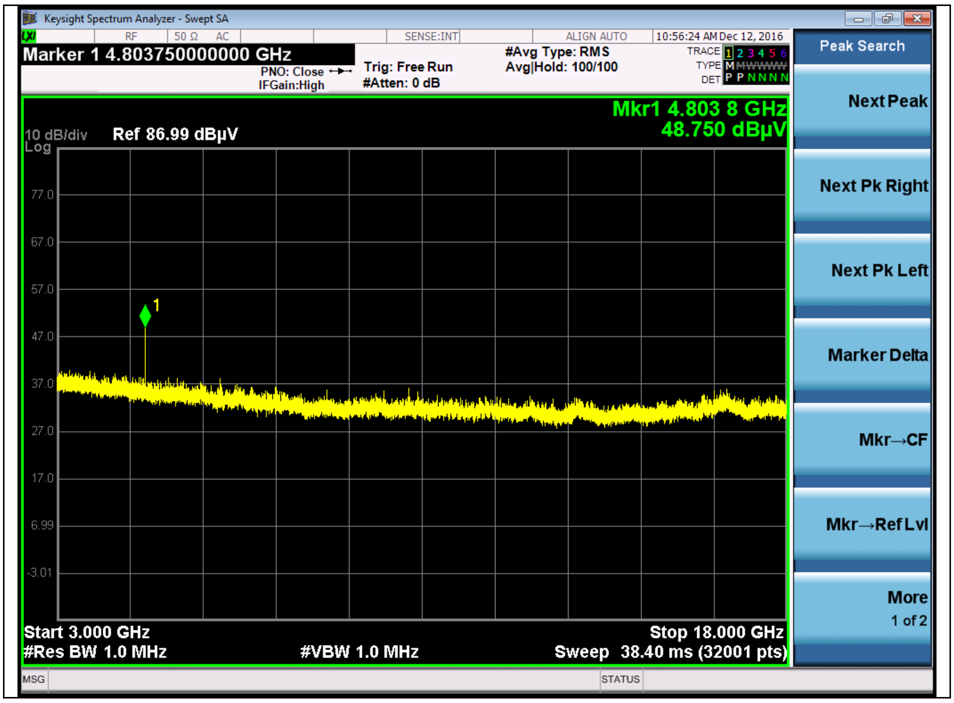
Pre-scan Test Plots

Operating Mode: GFSK (1 Mbps)

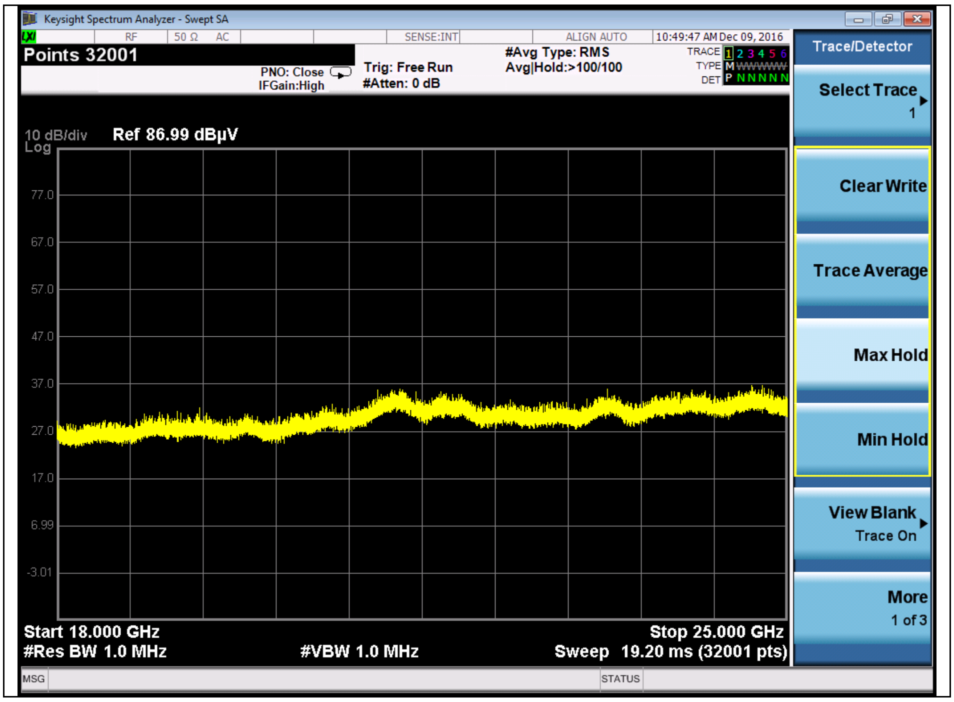
1 ㎓ ~ 3 ㎓



3 ㎓ ~ 18 ㎓

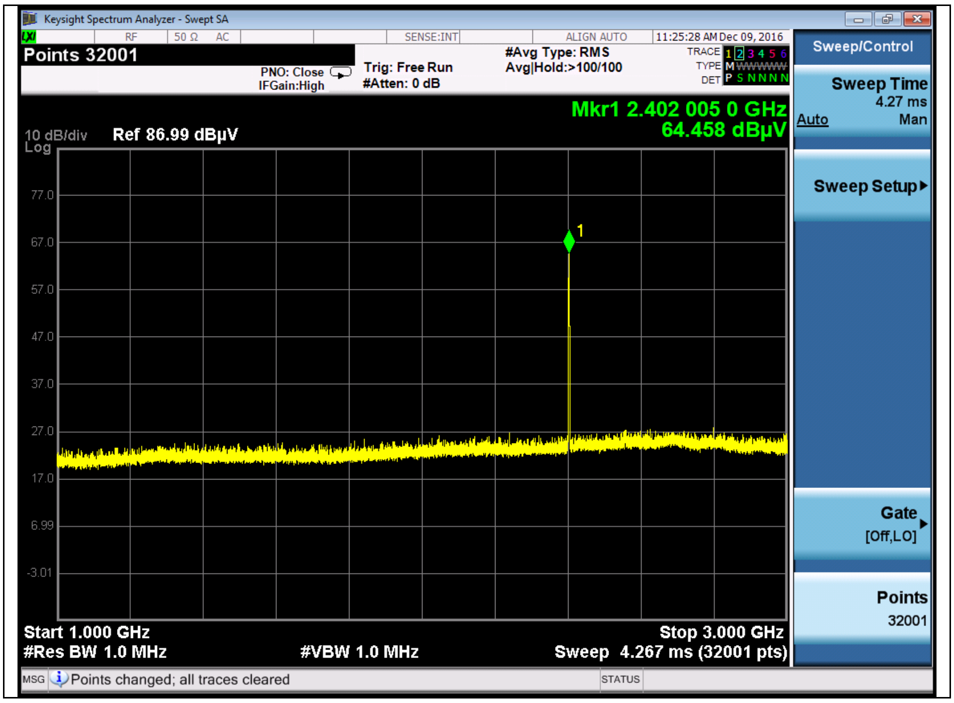


18 ㎓ ~ 25 ㎓

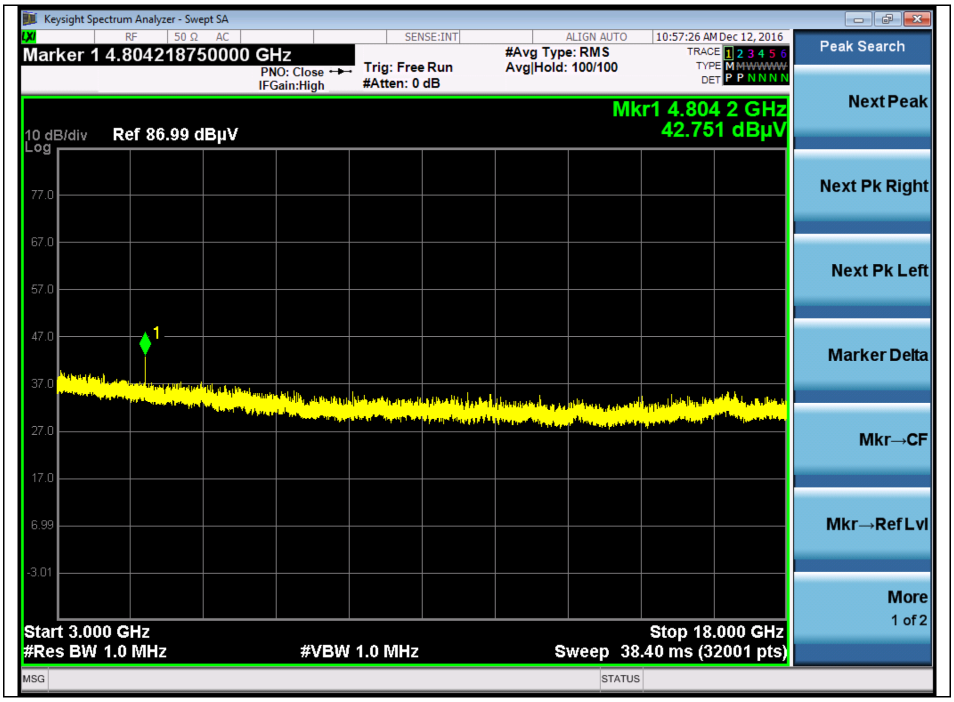


Operating Mode: 8DPSK (3 Mbps)

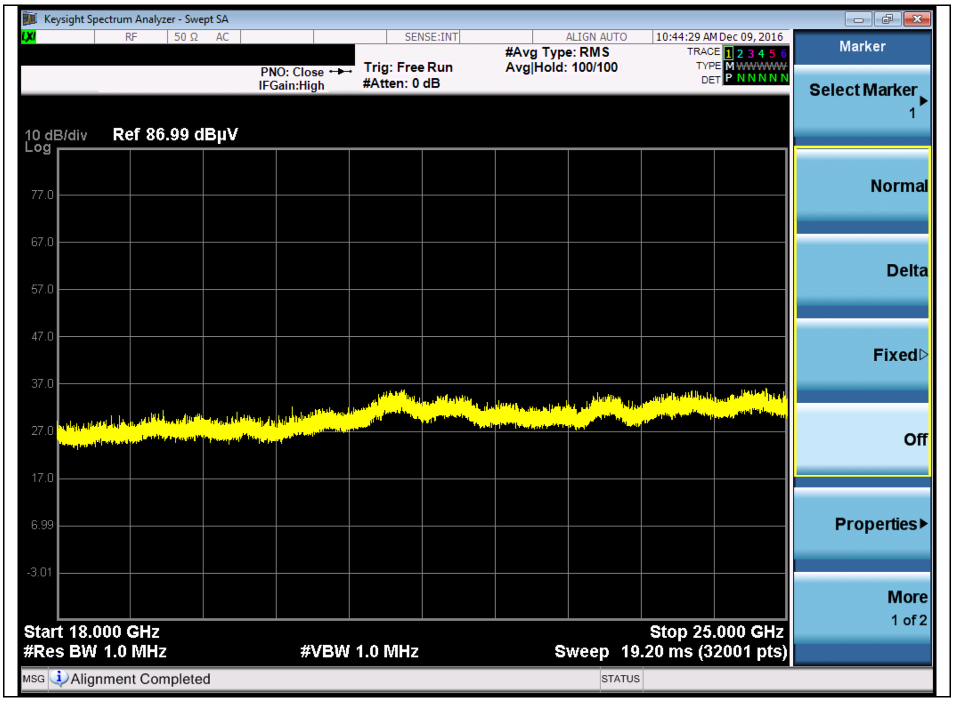
1 ㎓ ~ 3 ㎓



3 ㎓ ~ 18 ㎓



18 ㎓ ~ 25 ㎓

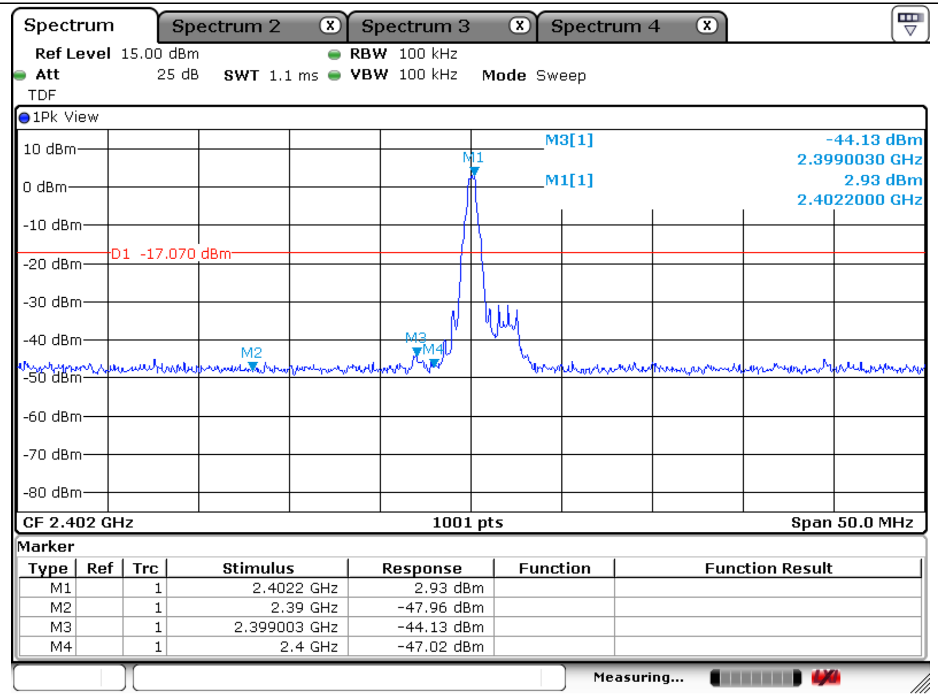


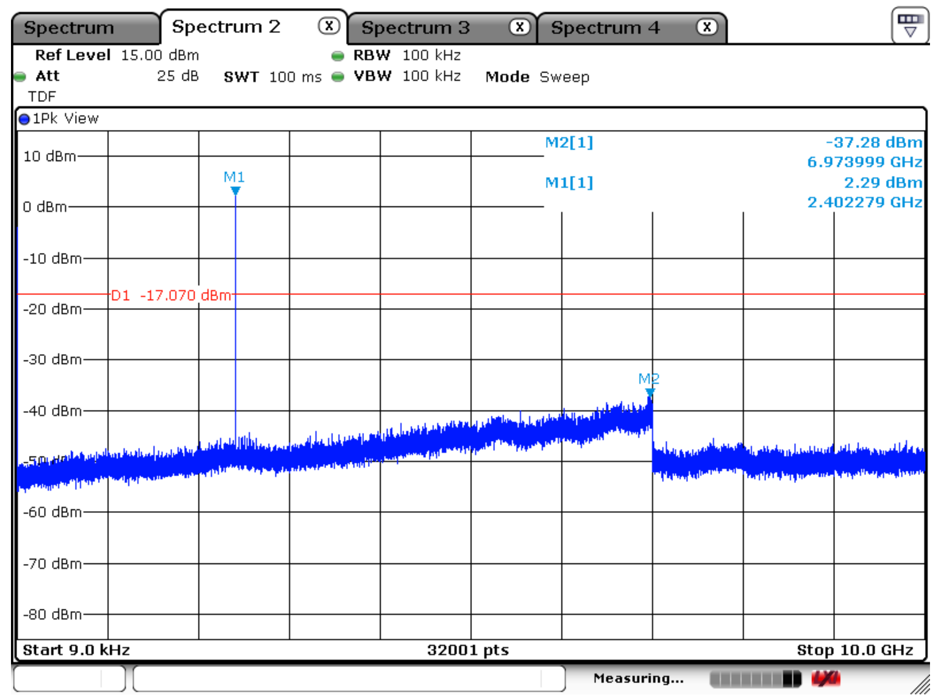
Note: Emission was scanned up to 25 ㎓.
No emissions were detected above the noise floor which was at least 20 ㏈ below the specification limit.

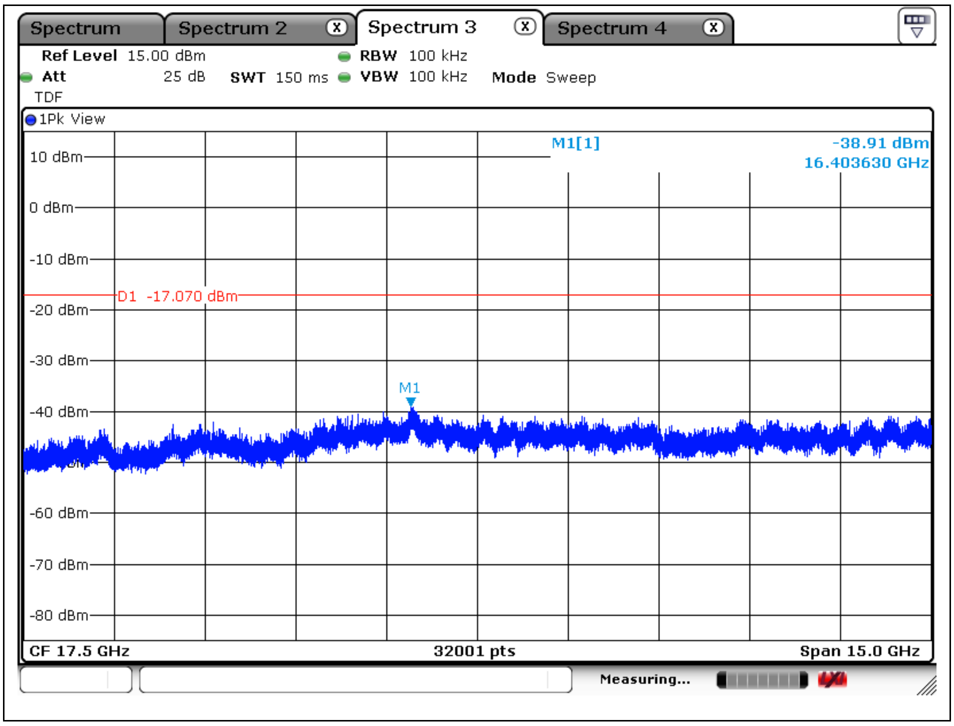
2.4.4. Spurious RF Conducted Emissions: Plot of Spurious RF Conducted Emission

Operating Mode: GFSK (1 Mbps)

Low Channel

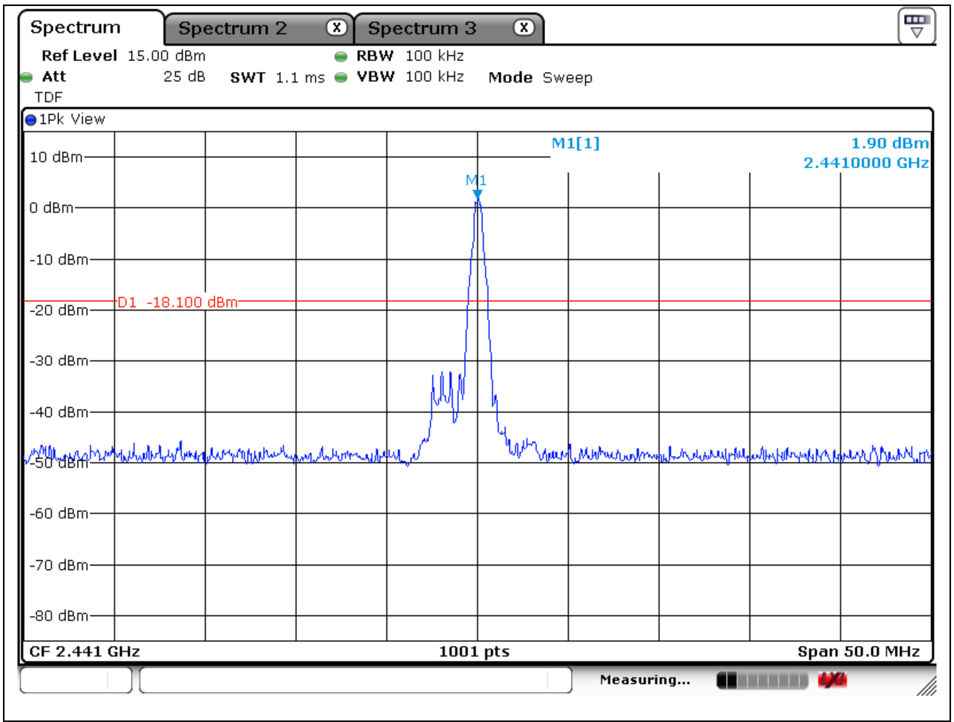


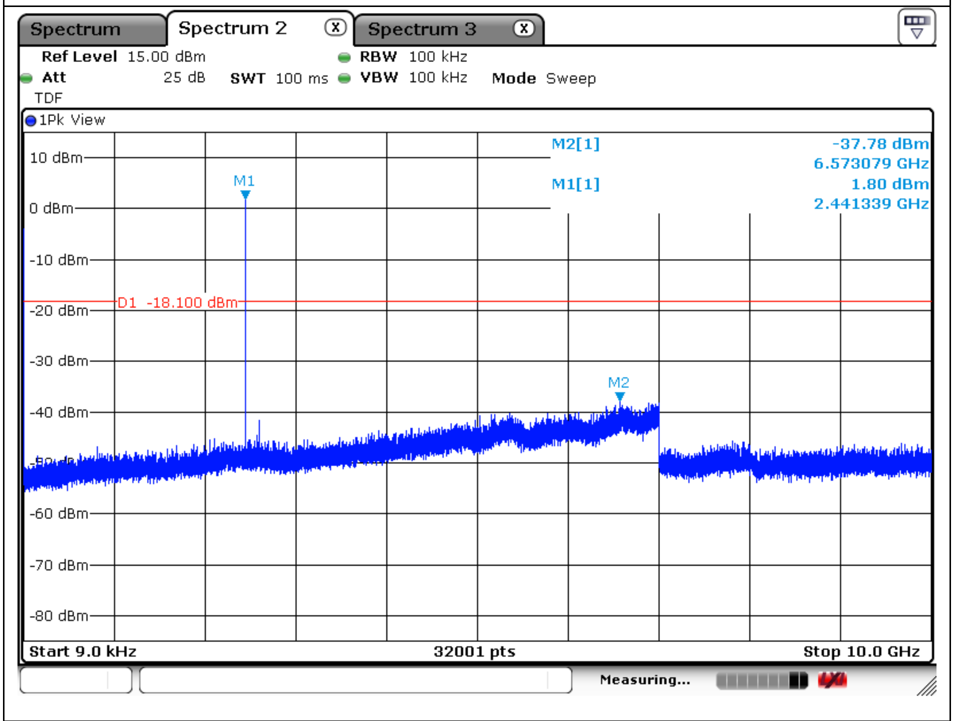


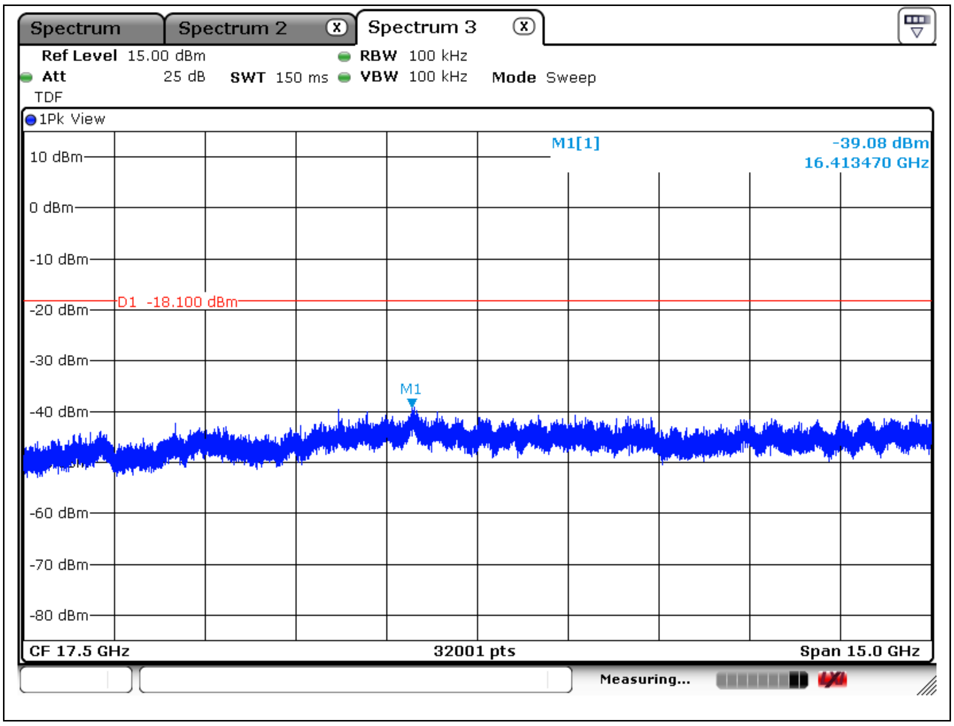


Spectrum
Spectrum 2
Spectrum 3
Spectrum 4
Ref Level 15.00 dBm
Att 25 dB
SWT 150 ms
RBW 100 kHz
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-38.91 dBm
16.403630 GHz
10 dBm
0 dBm
-10 dBm
D1 -17.070 dBm
-20 dBm
-30 dBm
-40 dBm
M1
-60 dBm
-70 dBm
-80 dBm
CF 17.5 GHz
32001 pts
Span 15.0 GHz
Measuring...

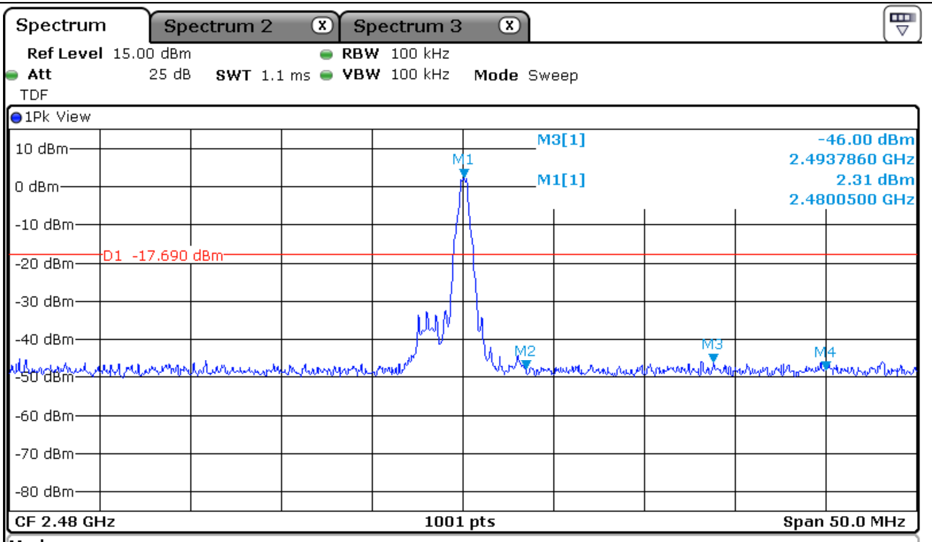
Middle Channel



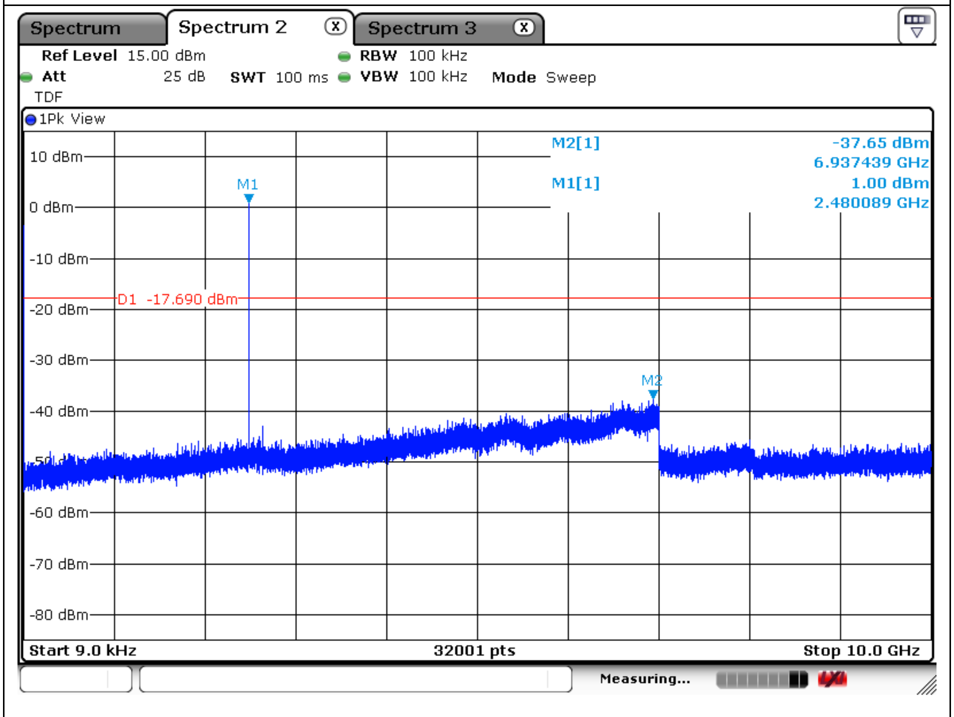


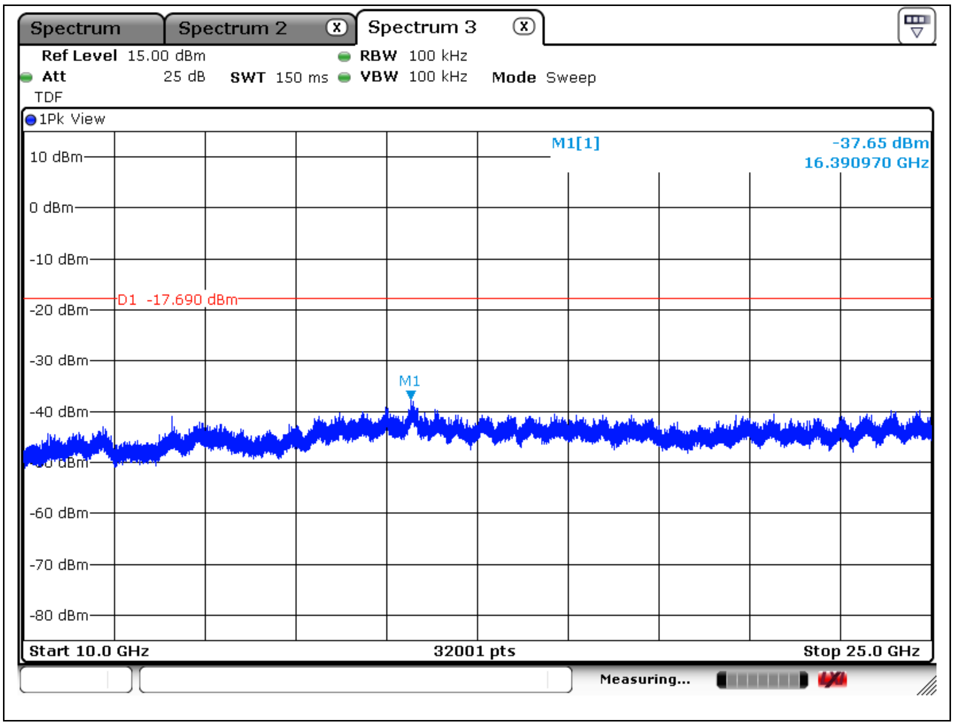

Spectrum
Spectrum 2
Spectrum 3
Ref Level 15.00 dBm
RBW 100 kHz
Att 25 dB SWT 150 ms
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-39.08 dBm
16.413470 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
D1 -18.100 dBm
-30 dBm
-40 dBm
M1
-60 dBm
-70 dBm
-80 dBm
CF 17.5 GHz
32001 pts
Span 15.0 GHz
Measuring...

High Channel

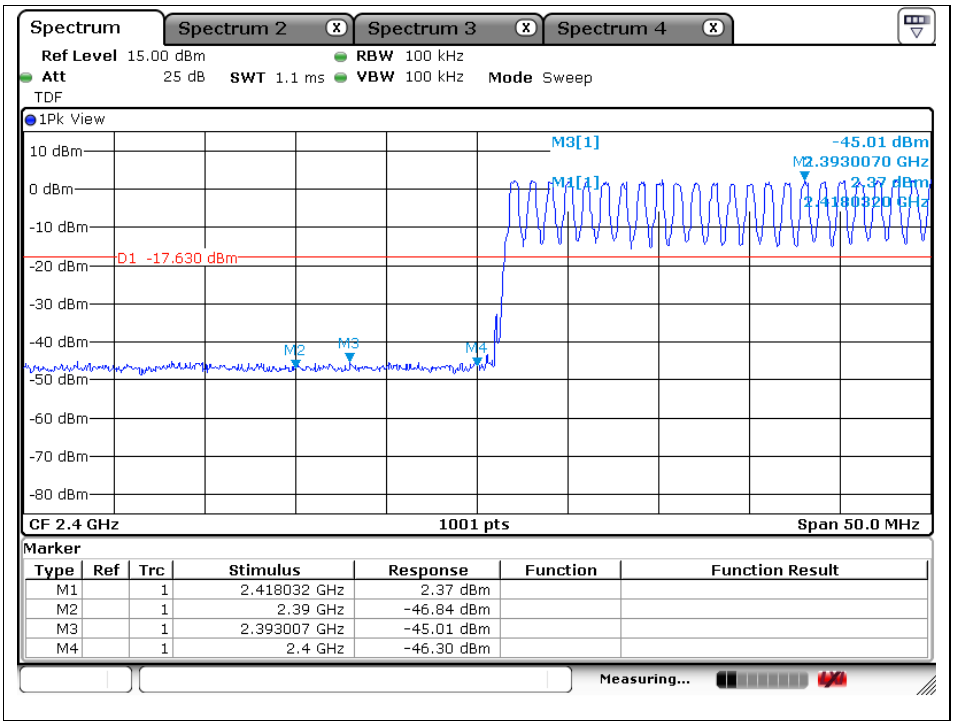


Type	Ref	Trc	Stimulus	Response	Function	Function Result
M1		1	2.48005 GHz	2.31 dBm		
M2		1	2.4835 GHz	-47.82 dBm		
M3		1	2.493786 GHz	-46.00 dBm		
M4		1	2.5 GHz	-47.99 dBm		

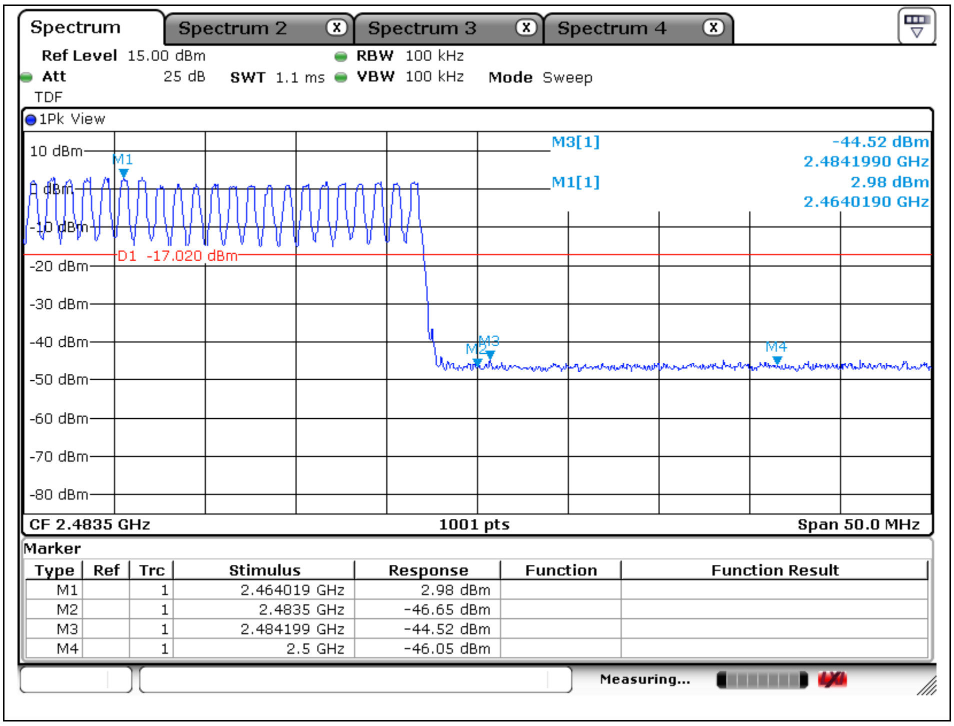



Spectrum
Spectrum 2
Spectrum 3
Ref Level 15.00 dBm
RBW 100 kHz
Att 25 dB
SWT 150 ms
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-37.65 dBm
16.390970 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
D1 -17.690 dBm
-30 dBm
M1
-40 dBm
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Measuring...

Band edge Compliance with Hopping Enabled
Low channel

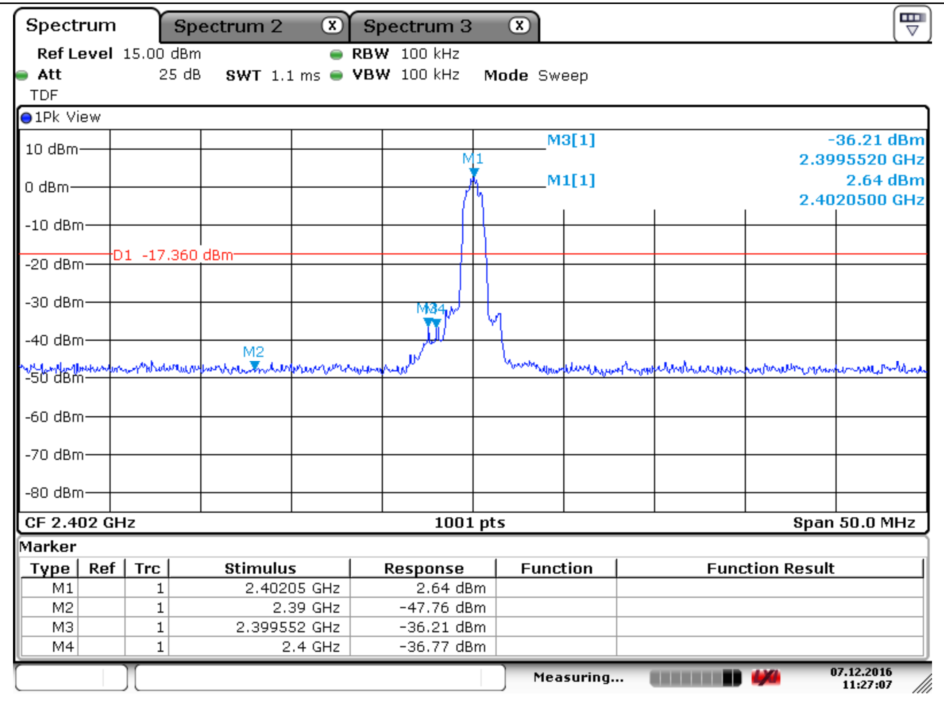


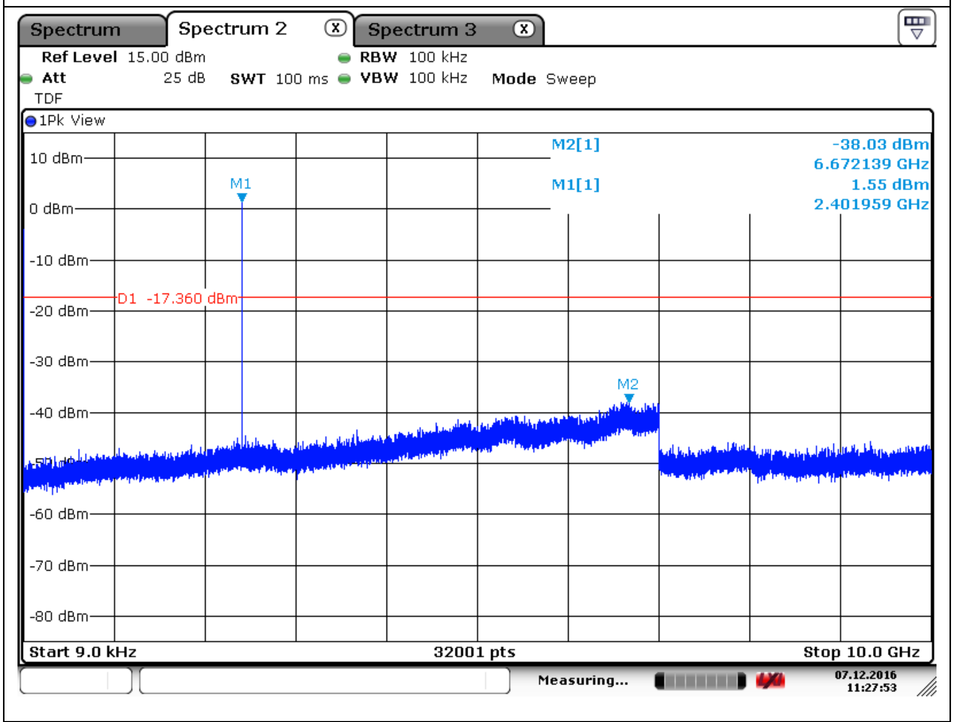
High channel

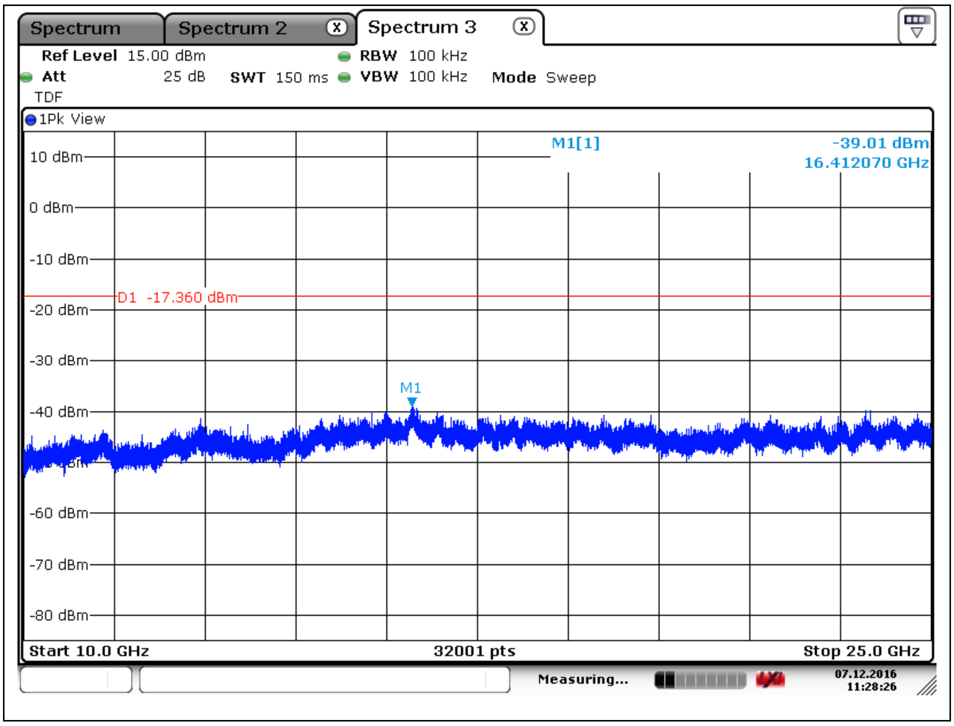


Operating Mode: 8DPSK (3 Mbps)

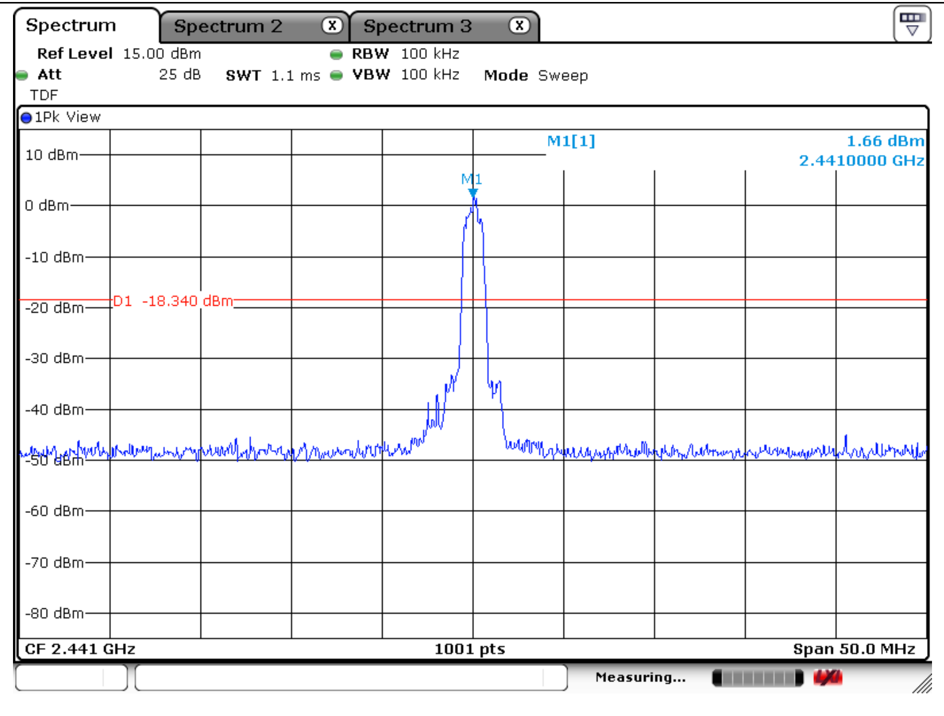
Low Channel

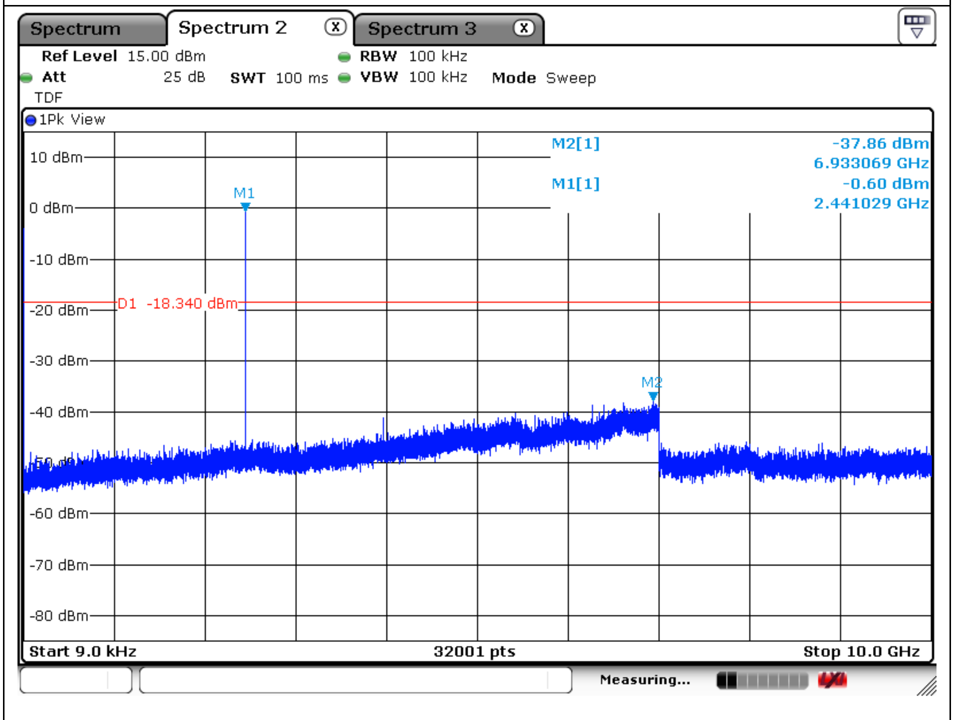


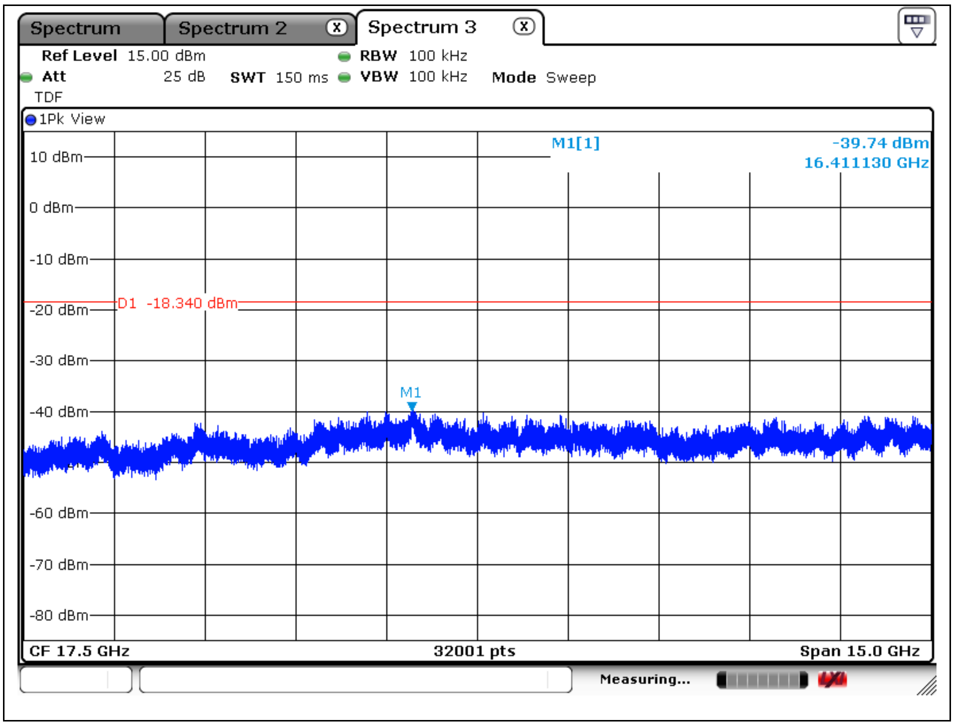



Spectrum
Spectrum 2
Spectrum 3
Ref Level 15.00 dBm
Att 25 dB
SWT 150 ms
RBW 100 kHz
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-39.01 dBm
16.412070 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
D1 -17.360 dBm
-30 dBm
-40 dBm
M1
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Measuring...
07.12.2016
11:28:26

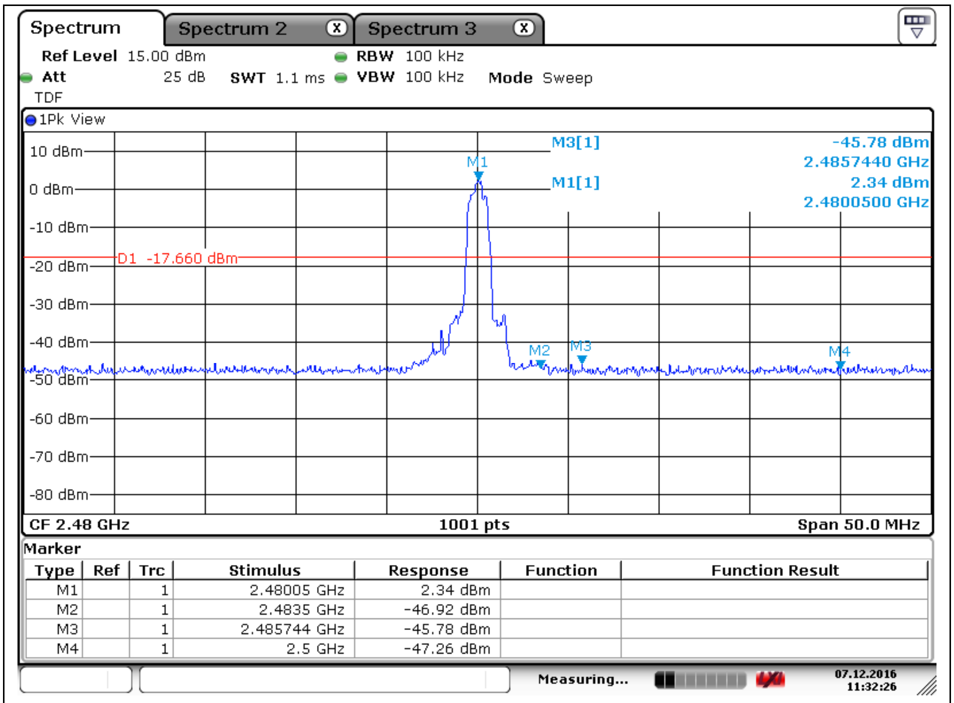
Middle Channel

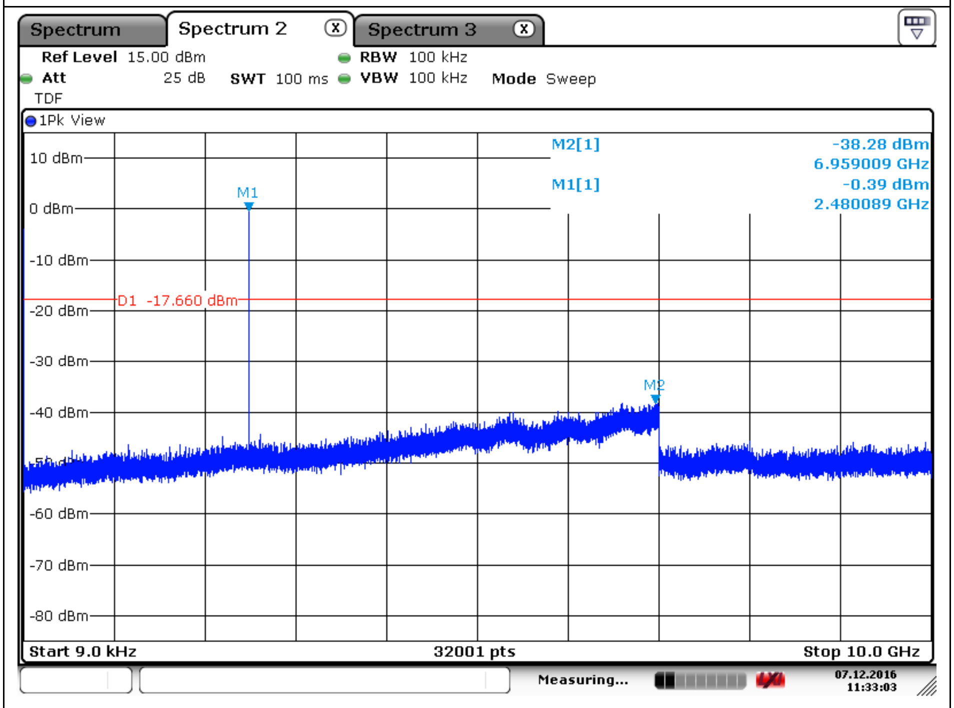


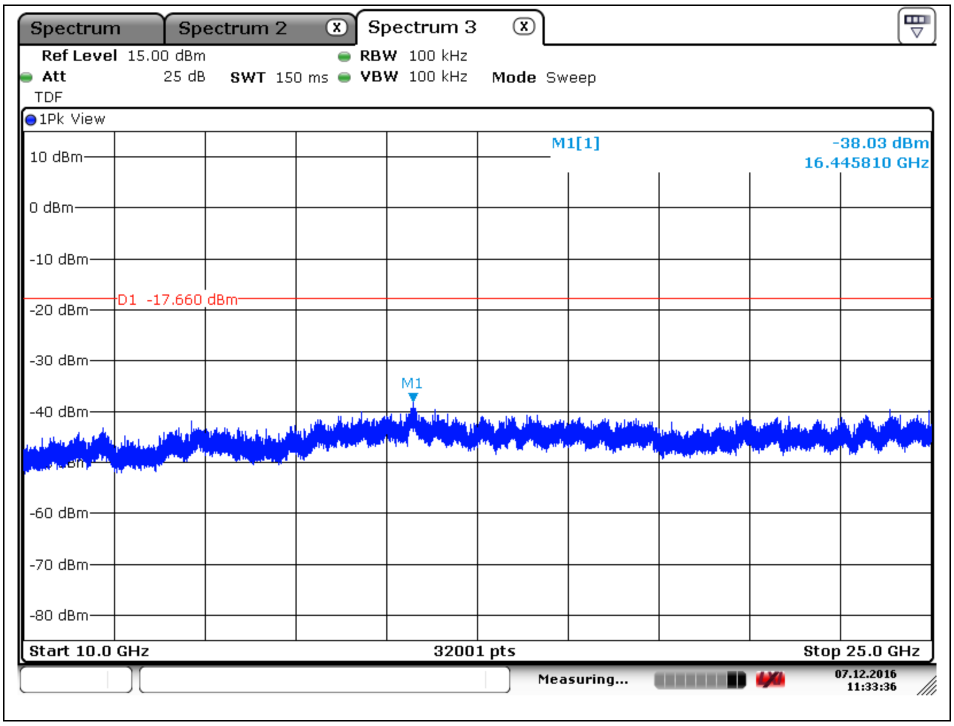



Spectrum
Spectrum 2
Spectrum 3
Ref Level 15.00 dBm
RBW 100 kHz
Att 25 dB
SWT 150 ms
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-39.74 dBm
16.411130 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
D1 -18.340 dBm
-30 dBm
-40 dBm
M1
-60 dBm
-70 dBm
-80 dBm
CF 17.5 GHz
32001 pts
Span 15.0 GHz
Measuring...

High Channel

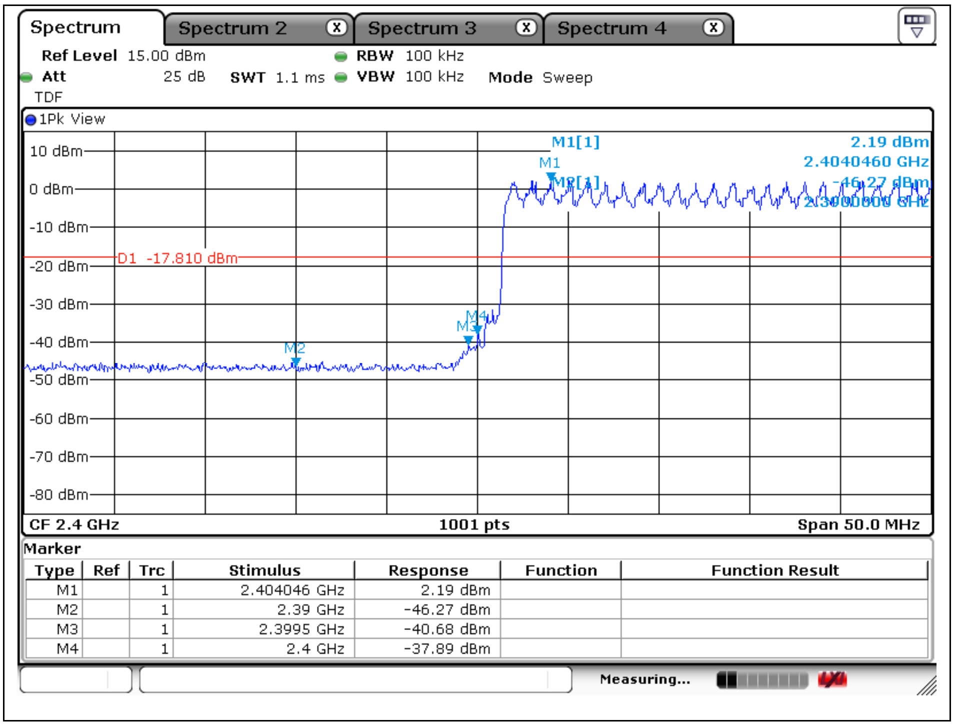




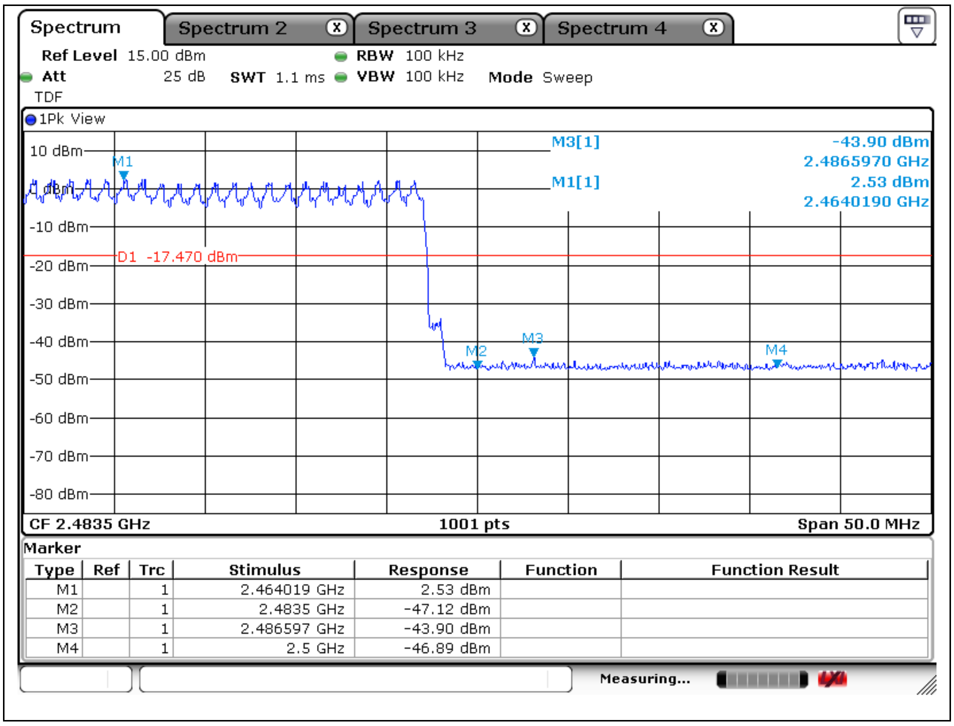

Spectrum
Spectrum 2
Spectrum 3
Ref Level 15.00 dBm
Att 25 dB
SWT 150 ms
RBW 100 kHz
VBW 100 kHz
Mode Sweep
TDF
1Pk View
M1[1]
-38.03 dBm
16.445810 GHz
10 dBm
0 dBm
-10 dBm
-20 dBm
D1 -17.660 dBm
-30 dBm
M1
-40 dBm
-60 dBm
-70 dBm
-80 dBm
Start 10.0 GHz
32001 pts
Stop 25.0 GHz
Measuring...
07.12.2016
11:33:36

Band edge Compliance with Hopping Enabled

Low channel

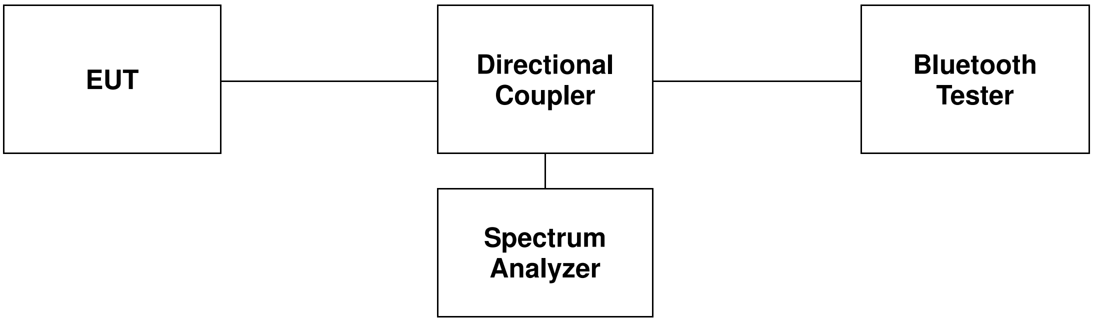


High channel



3. 20 dB Bandwidth

3.1. Test Setup



3.2. Limit

Limit: Not Applicable

3.3. Test Procedure

The test follows DA 00-705.
The 20 dB bandwidth was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency.

Use the following spectrum analyzer setting :

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1 % of the 20 dB bandwidth
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

Use the marker-to-peak function to set the mark to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.

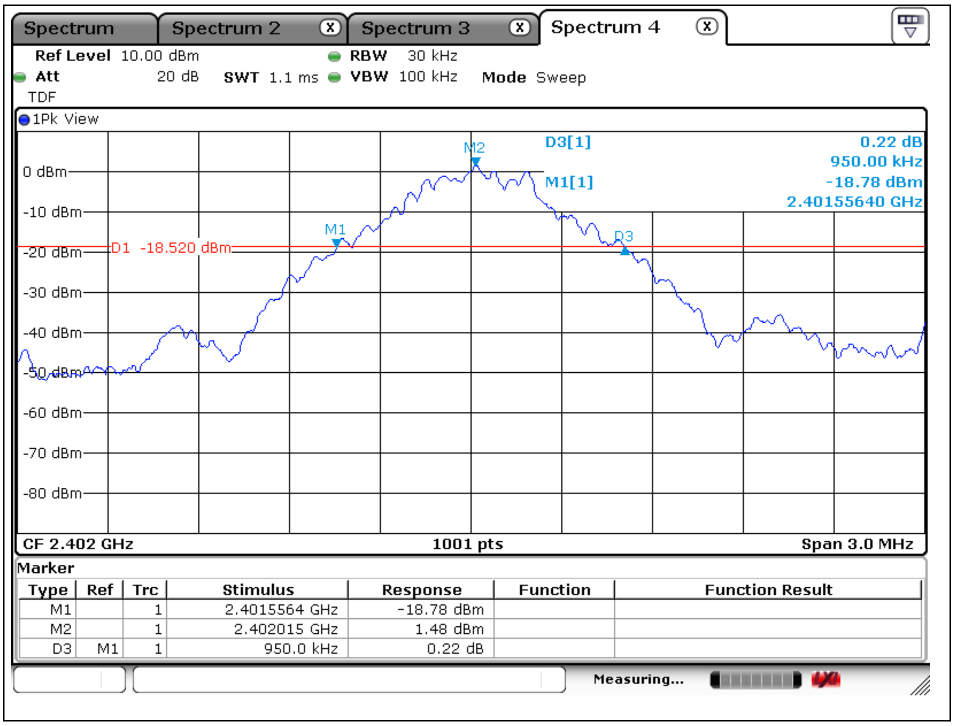
3.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

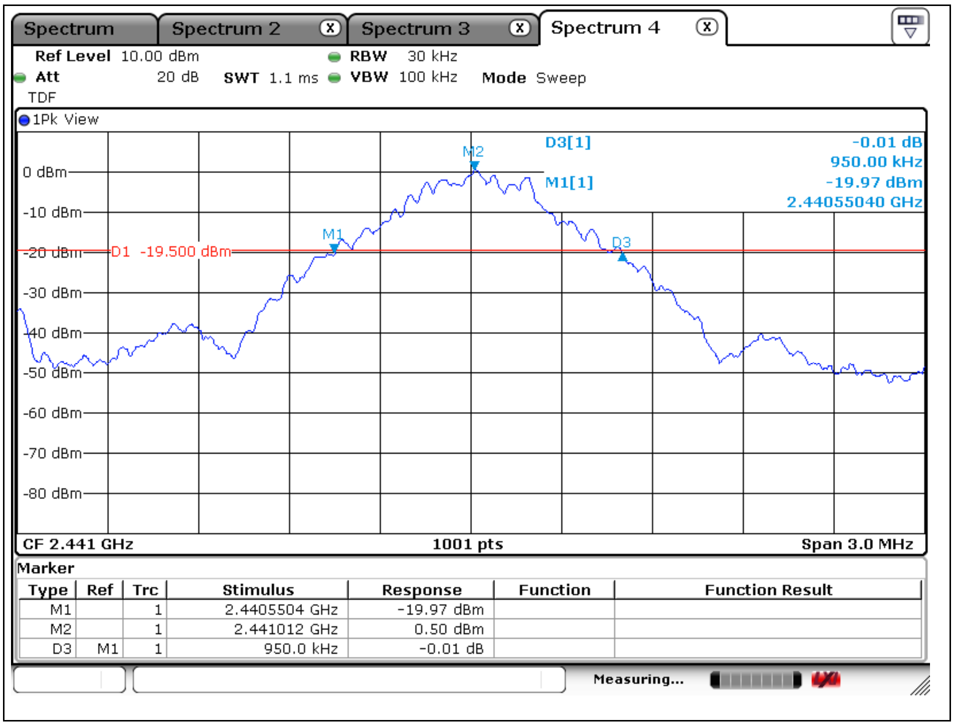
Operation Mode	Data Rate	Channel	Frequency (㎒)	20 ㏈ Bandwidth (㎒)
GFSK	1 Mbps	Low	2 402	0.950
		Middle	2 441	0.950
		High	2 480	0.944
π/4DQPSK	2 Mbps	Low	2 402	1.250
		Middle	2 441	1.247
		High	2 480	1.247
8DPSK	3 Mbps	Low	2 402	1.259
		Middle	2 441	1.259
		High	2 480	1.259

Operating Mode: GFSK

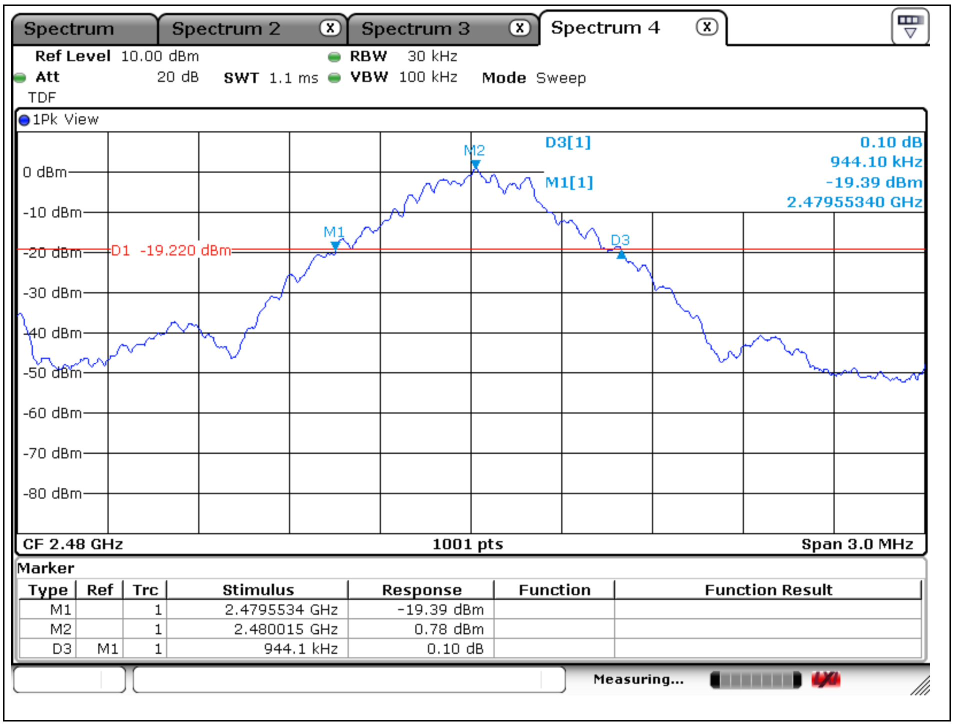
Low Channel



Middle Channel

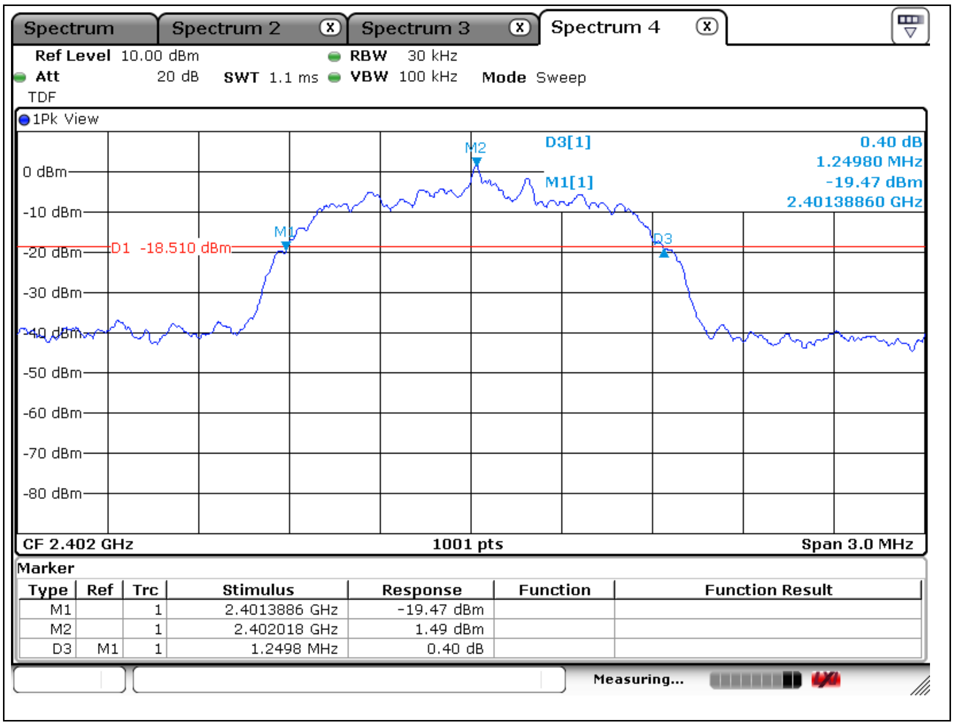


High Channel



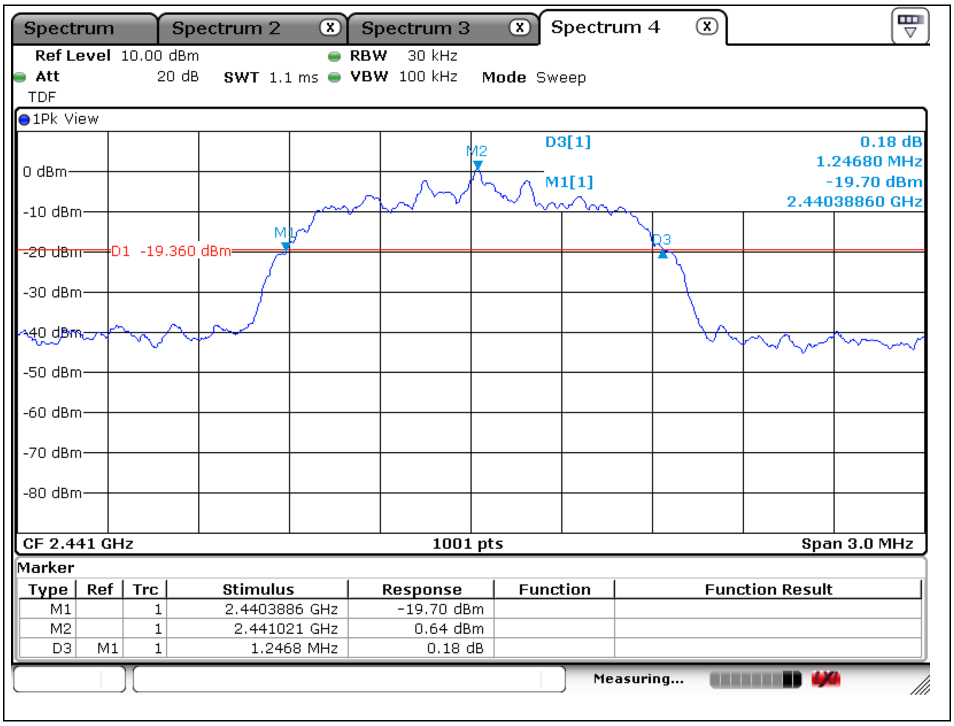
Operating Mode: π/4DQPSK

Low Channel



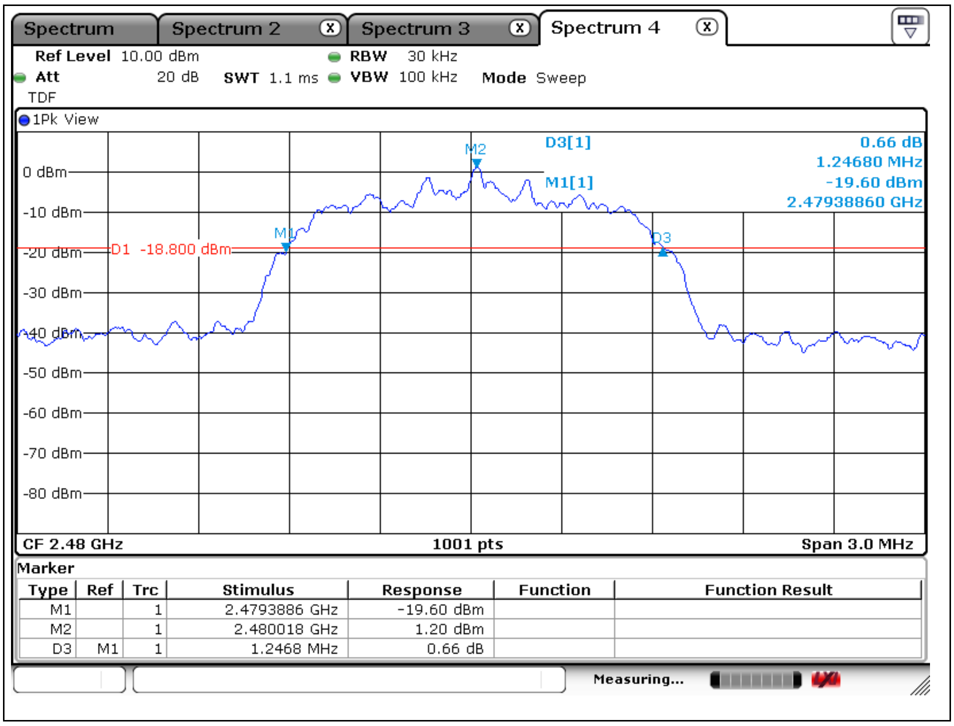
Type	Ref	Trc	Stimulus	Response	Function	Function Result
M1		1	2.4013886 GHz	-19.47 dBm		
M2		1	2.402018 GHz	1.49 dBm		
D3	M1	1	1.2498 MHz	0.40 dB		

Middle Channel



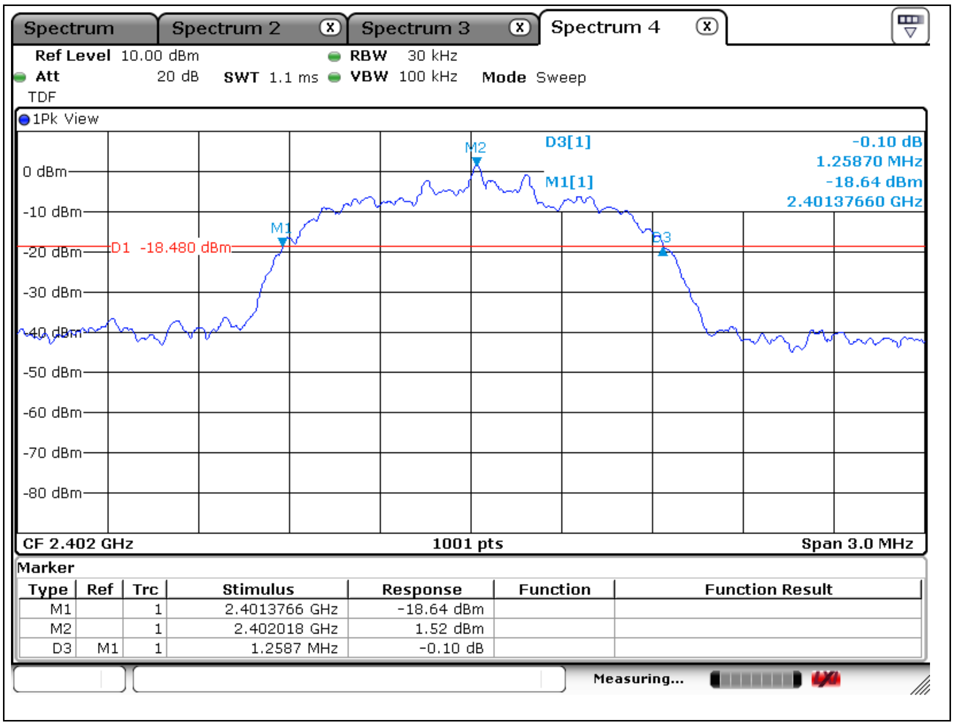
Type	Ref	Trc	Stimulus	Response	Function	Function Result
M1		1	2.4403886 GHz	-19.70 dBm		
M2		1	2.441021 GHz	0.64 dBm		
D3	M1	1	1.2468 MHz	0.18 dB		

High Channel

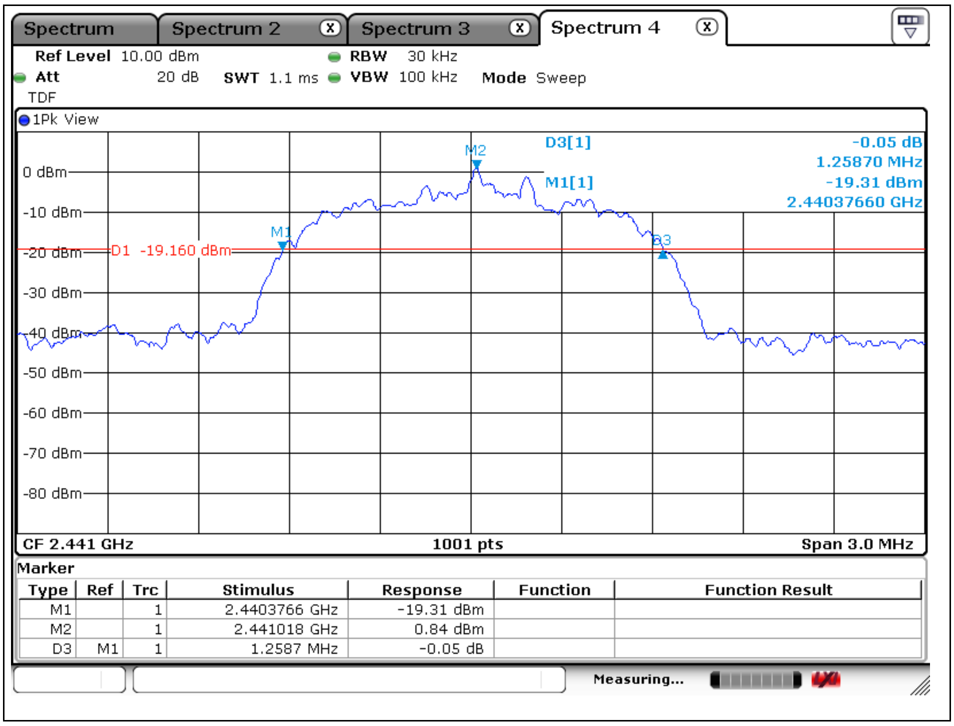


Operating Mode: 8DPSK

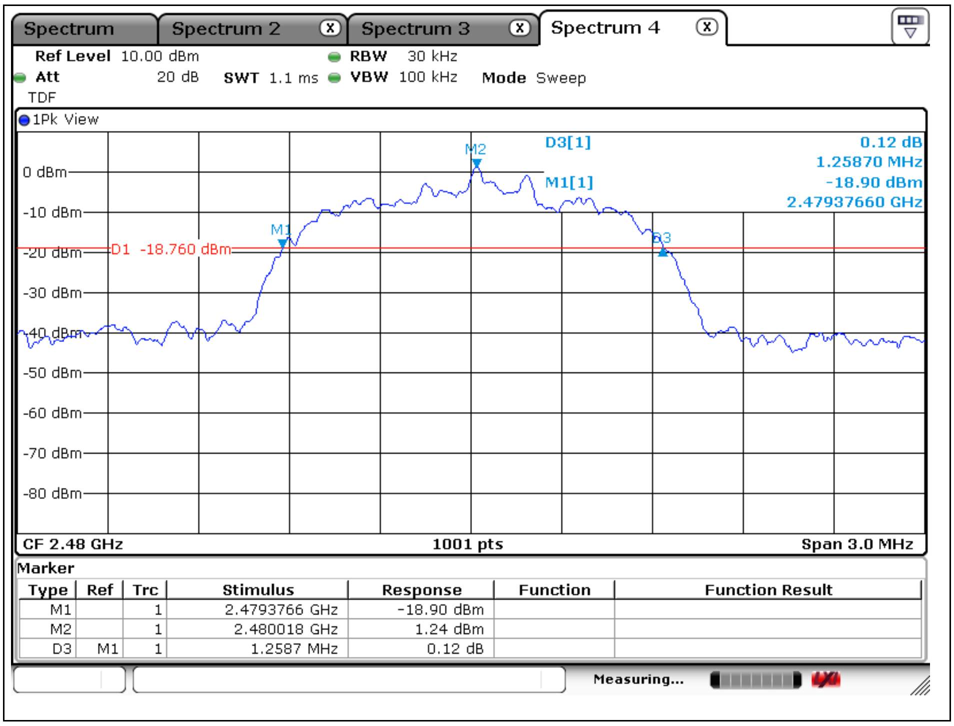
Low Channel



Middle Channel

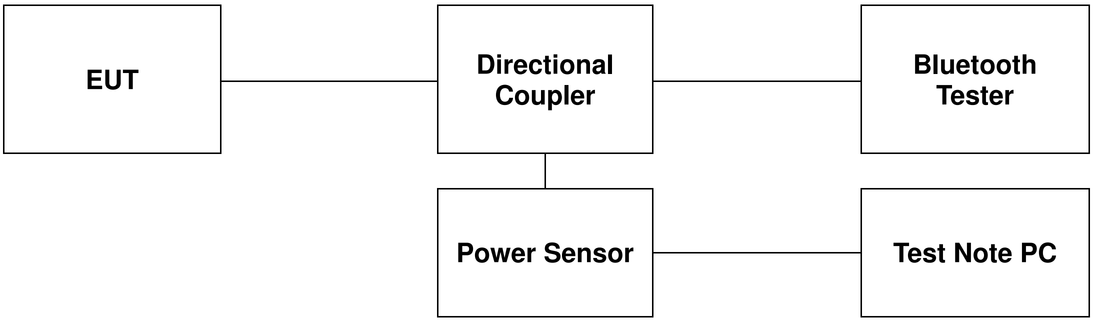


High Channel



4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following :

1. §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, provided the systems operate with an output power no greater than 125 ㎽.
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 850 ㎒ band : 1 Watt.

4.3. Test Procedure

The test follows DA 00-705. Using the power sensor instead of a spectrum analyzer.

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the Power sensor.
3. Test program : (S/W name : R&S Power Viewer, Version : 3.2.0)
4. Measure peak power each channel.

4.4. Test Results

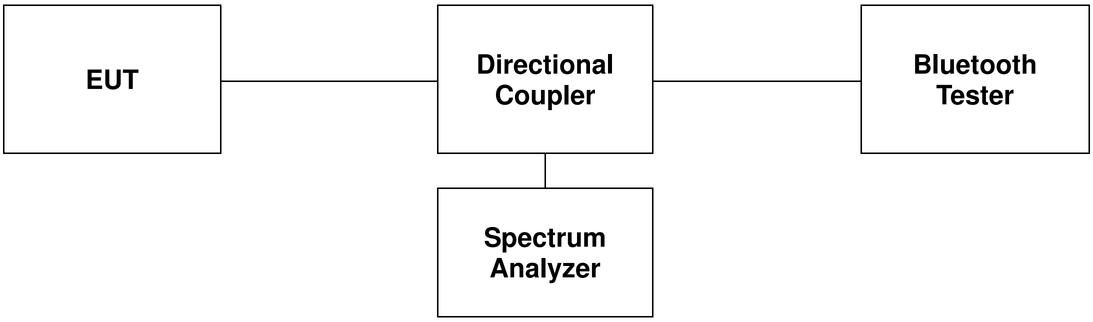
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Operation Mode	Data Rate	Channel	Frequency (㎒)	Directional Coupler + Cable offset (dB)	Peak Power Result (dB m)	Peak Power Limit (dB m)
GFSK	1 Mbps	Low	2 402	16.21	**4.01**	30.00
		Middle	2 441	16.11	3.26	
		High	2 480	16.06	3.36	
π/4DQPSK	2 Mbps	Low	2 402	16.21	**4.59**	20.97
		Middle	2 441	16.11	3.88	
		High	2 480	16.06	4.24	
8DPSK	3 Mbps	Low	2 402	16.21	**5.01**	20.97
		Middle	2 441	16.11	4.35	
		High	2 480	16.06	4.67	

Remark:
In the case of AFH, the limit for peak power is 0.125 W.
Directional coupler and cable offset compensate for test program (R&S Power Viewer) before measuring.

5. Carrier Frequency Separation

5.1. Test Setup



5.2. Limit

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

5.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA 00-705.

The device is operating in hopping mode between 79 channels and also supporting Adaptive Frequency Hopping with hopping between 20 channels. As compared with each operating mode, 79 channels are chosen as a representative for test.
Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels
RBW ≥ 1 % of the span
VBW ≥ RBW
Sweep = auto
Detector = peak
Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the between the peaks of the adjacent channels.

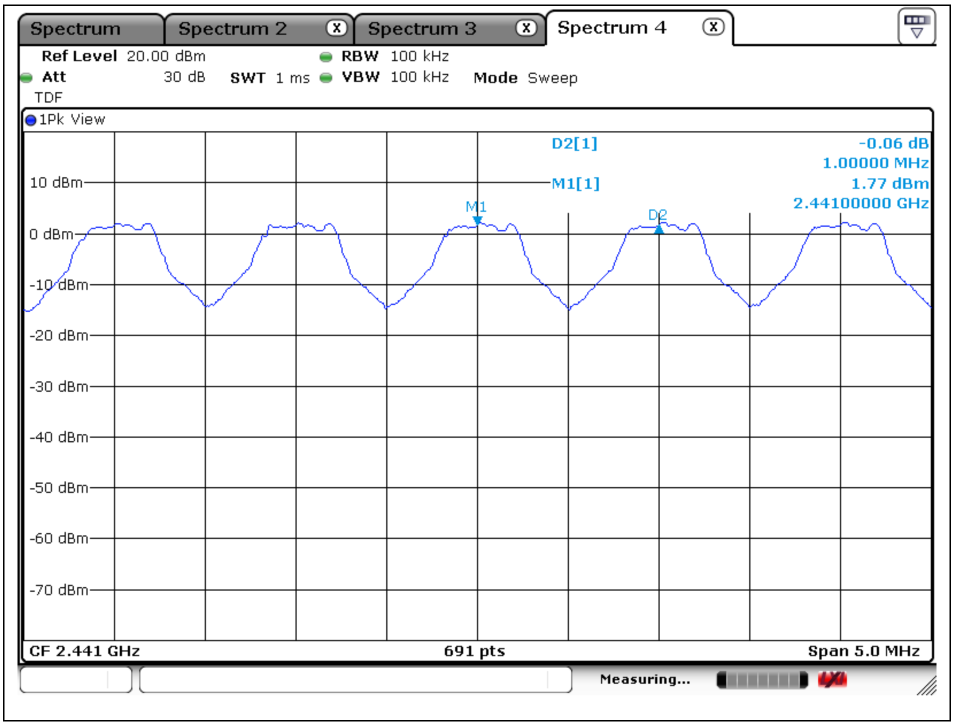
5.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

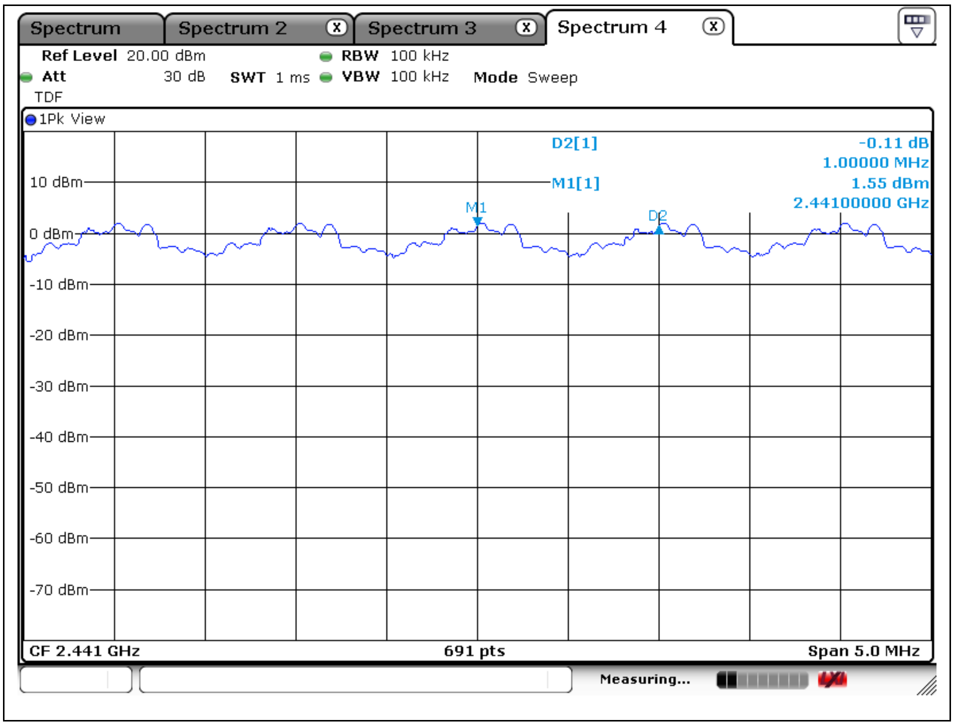
Operation Mode	Channel (Middle)	Adjacent Hopping Channel Separation (㎑)	Two-third of 20 ㏈ Bandwidth (㎑)	Minimum Bandwidth (㎑)
GFSK	2 441 ㎒	1 000	633	25
8DPSK	2 441 ㎒	1 000	839	25

Note;
Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

Operating Mode: GFSK

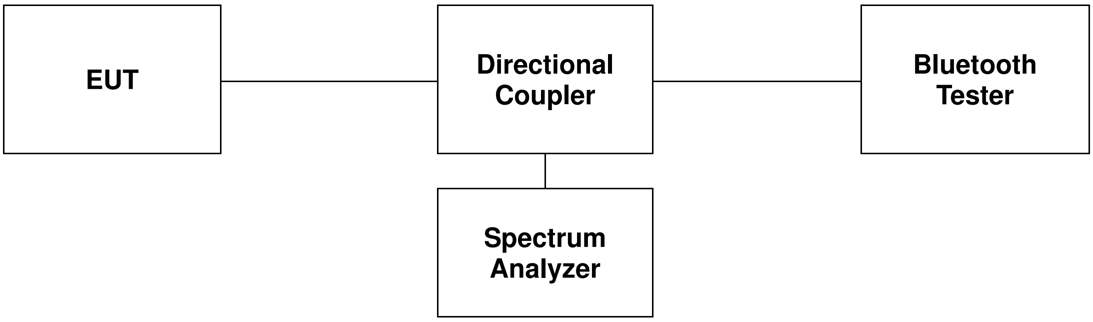


Operating Mode: 8DPSK



6. Number of Hopping Frequencies

6.1. Test Setup



6.2. Limit

§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.

6.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA 00-705.

The device supports Adaptive Frequency Hopping and will use a minimum of 20 channels of the 79 available channels.

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer.
2. Set spectrum analyzer Start = 2 400 ㎒, Stop = 2 441.5 ㎒, Sweep = auto and Start = 2 441.5 ㎒, Stop = 2 483.5 ㎒, Sweep = auto. Detector = peak.
3. Set the spectrum analyzer as RBW, VBW = 500 ㎑.
4. Max hold, allow the trace to stabilize and count how many channel in the band.

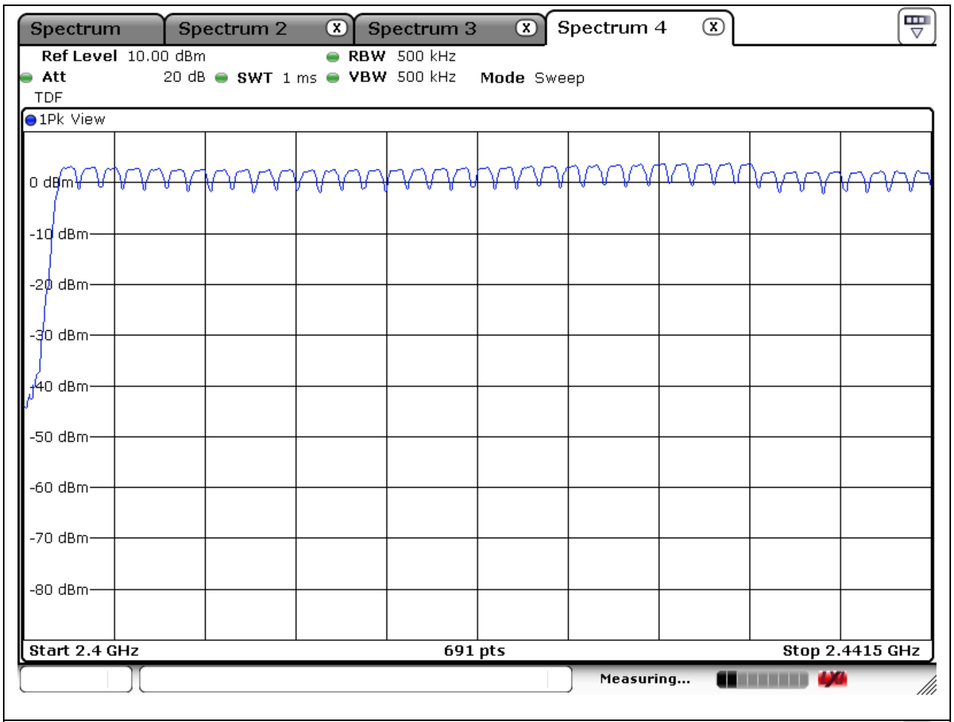
6.4. Test Results

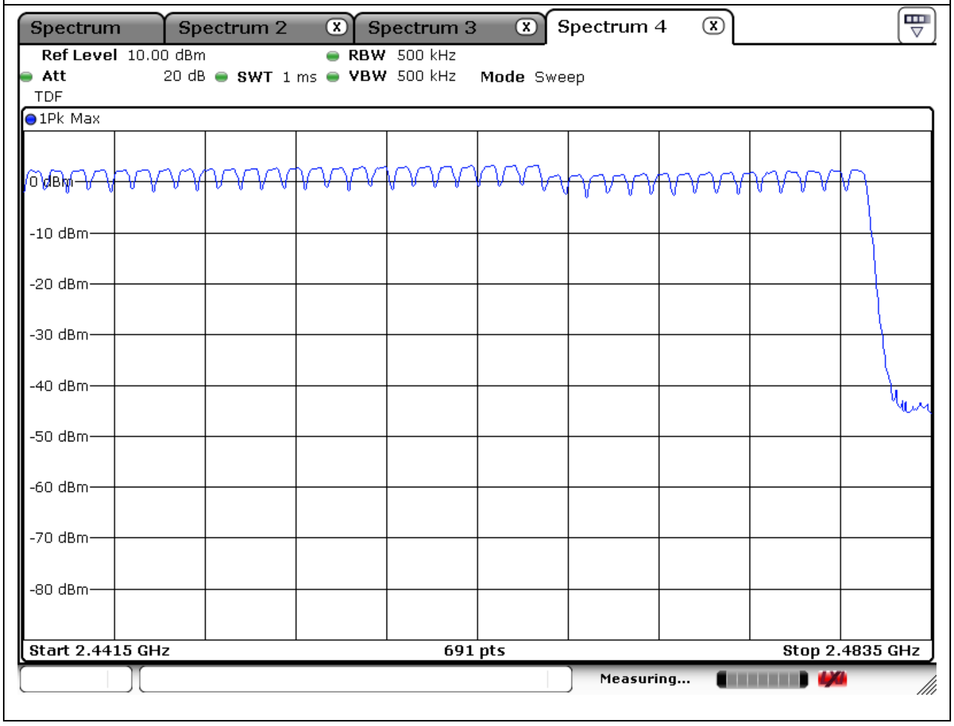
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Operation Mode	Number of Hopping Frequency	Limit
GFSK	79	≥ 15
8DPSK	79	≥ 15

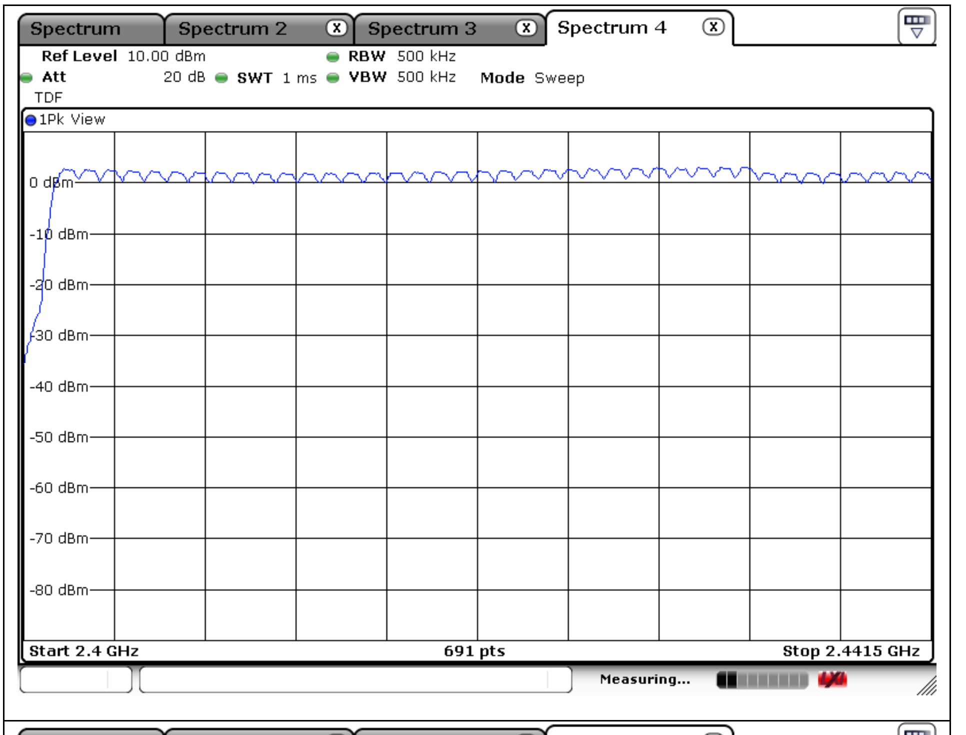
Remark:
Measurement is made with EUT operating in hopping mode between 79 channels providing a worse case scenario as compared to AFH mode hopping between 20 channels.

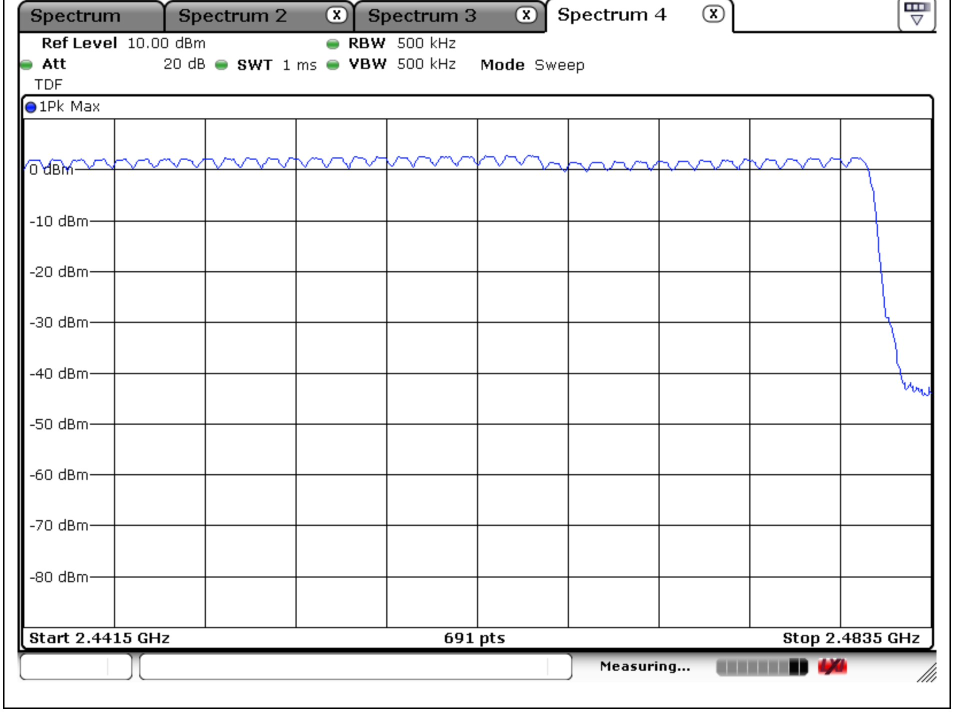
Operating Mode: GFSK





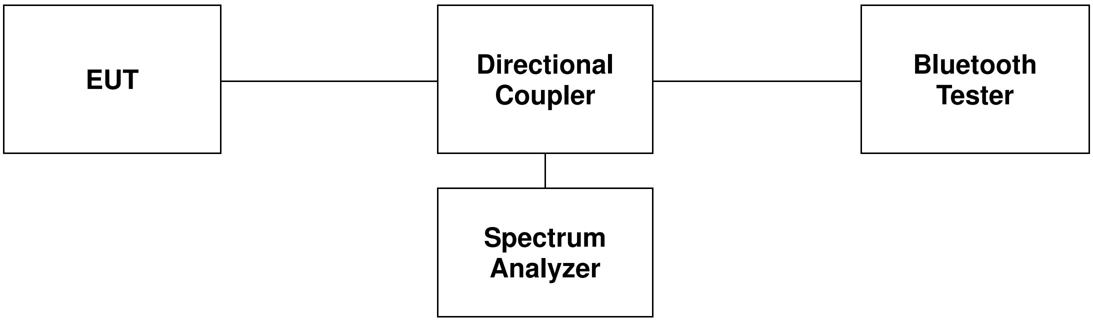
Operating Mode: 8DPSK





7. Time of Occupancy (Dwell Time)

7.1. Test Set up



7.2. Limit

§15.247(a)(1)(iii), For frequency hopping system operating in the 2 400 – 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4 (s) * 79 = 31.6 (s)

***Adaptive Frequency Hopping**

A period time = 0.4 (s) * 20 = 8 (s)

7.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section. The test follows DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.
3. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
4. The Bluetooth has 3 type of payload, DH1, DH3, DH5 and 3DH1, 3DH3, 3DH5.The hopping rate is insisted of 1 600 per second.

The EUT must have its hopping function enabled. Use the following spectrum analyzer setting:

Span = zero span, centered on a hopping channel
RBW = 1 ㎒
VBW ≥ RBW
Sweep = as necessary to capture the entire dwell time per hopping channel
Detector = peak
Trace = max hold
Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation, repeat this test for each variation.

7.4. Test Results

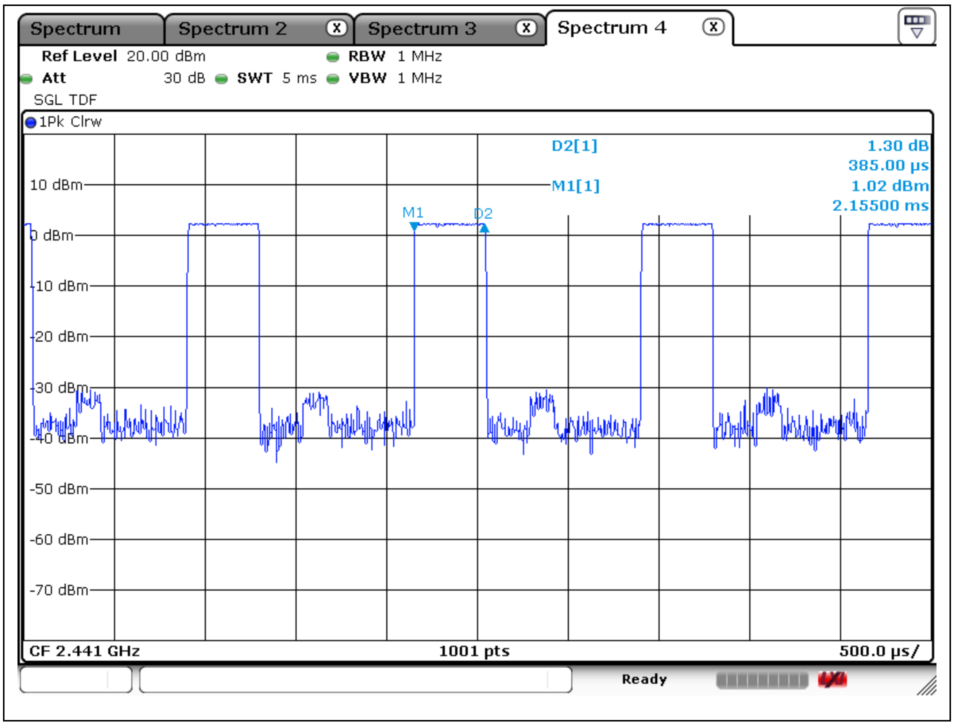
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

7.4.1. Packet Type: DH1, 3DH1

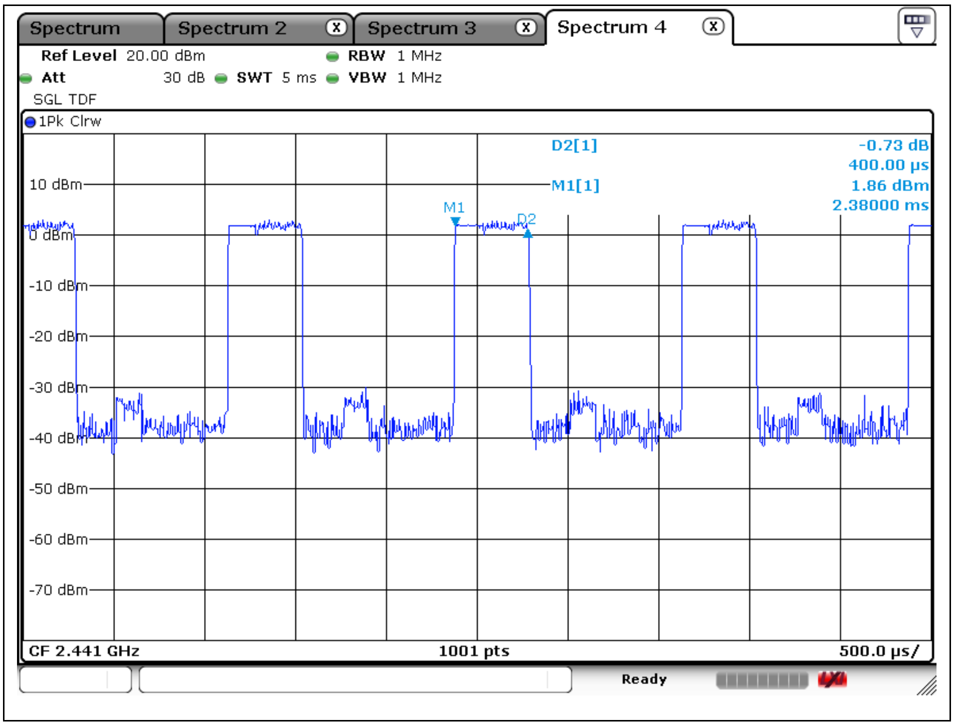
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441 ㎒	0.39	124.80	400
8DPSK	2 441 ㎒	0.40	128.00	400

Note:
Time of occupancy on the TX channel in 31.6 sec
In case of GFSK, 0.39 × {(1 600 ÷ 2) / 79} × 31.6 = 124.80 ㎳
In case of 8DPSK, 0.40 × {(1 600 ÷ 2) / 79} × 31.6 = 128.00 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK

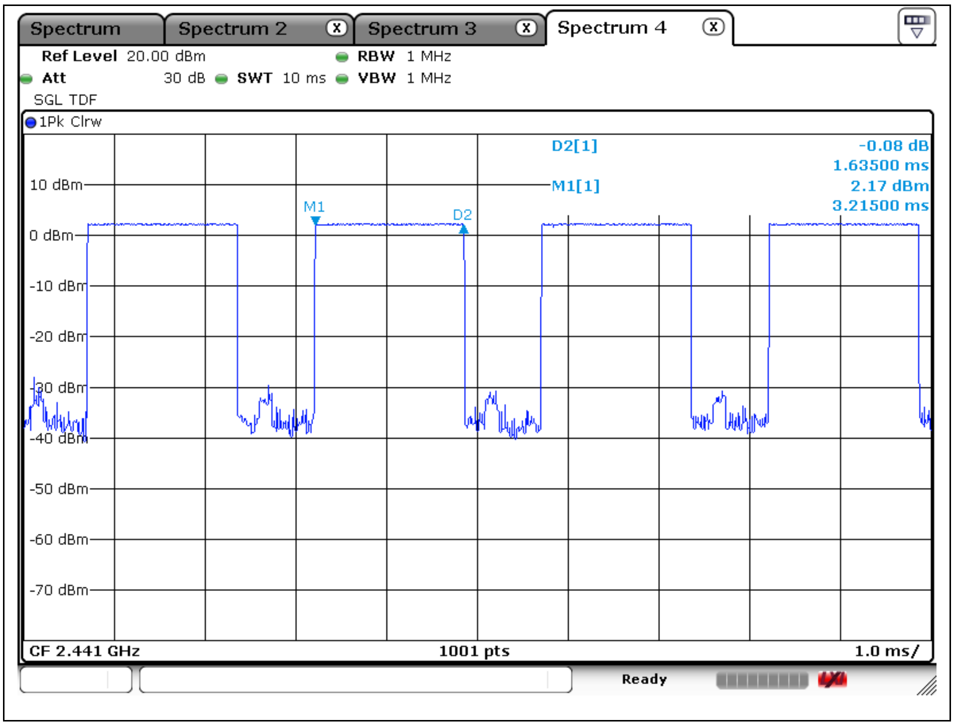


7.4.2. Packet Type: DH3, 3DH3

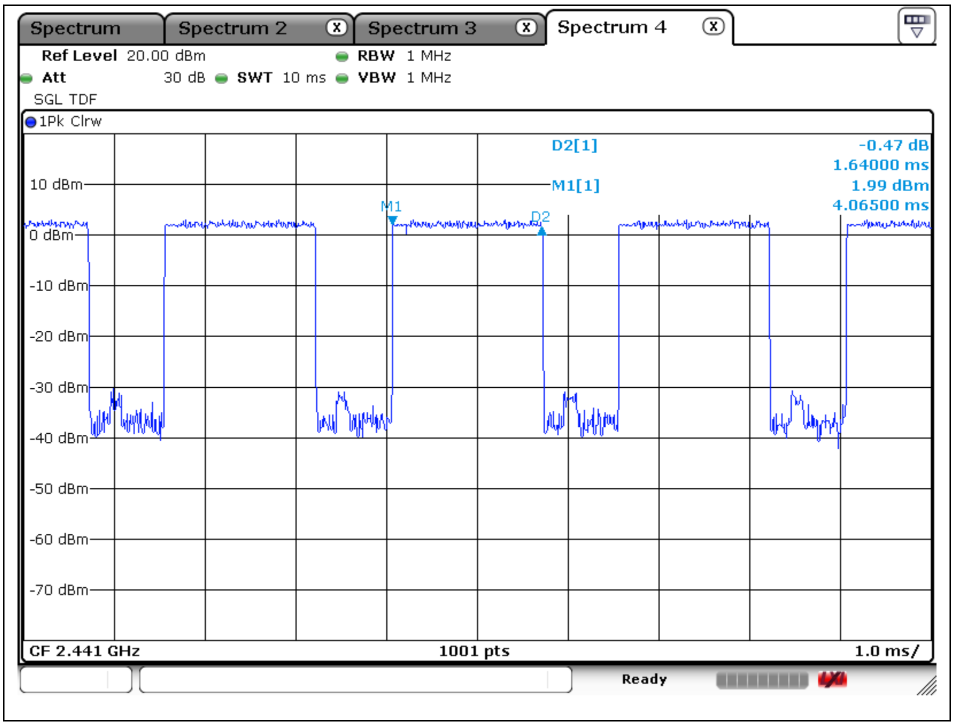
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441 ㎒	1.64	262.40	400
8DPSK	2 441 ㎒	1.64	262.40	400

Note:
Time of occupancy on the TX channel in 31.6 sec
In case of GFSK and 8DPSK, 1.64 × {(1 600 ÷ 4) / 79} × 31.6 = 262.40 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK

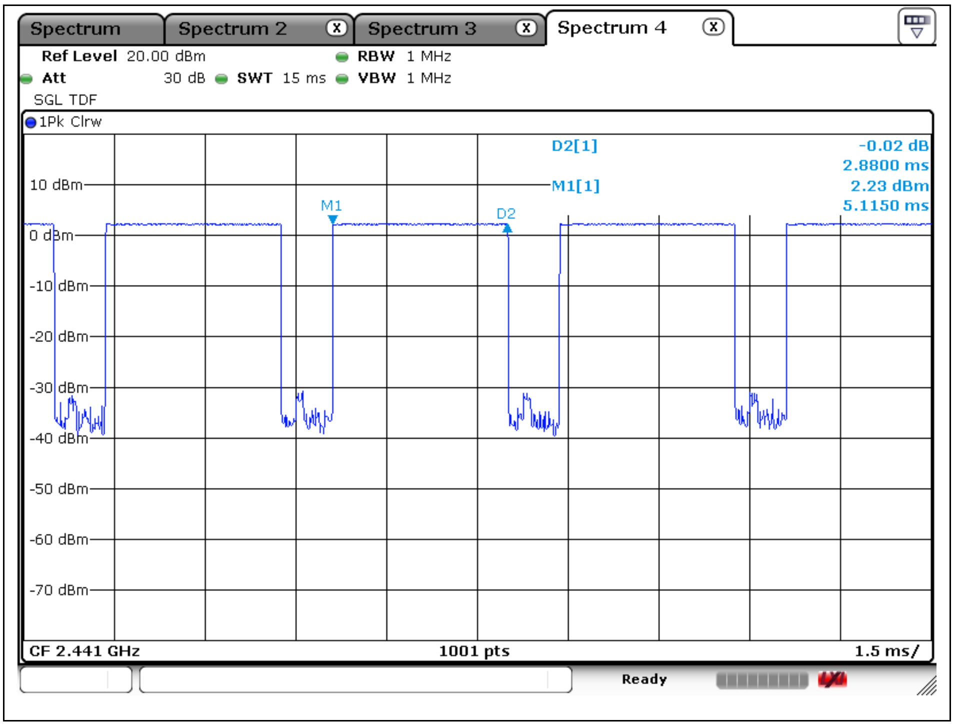


7.4.3. Packet Type: DH5, 3DH5

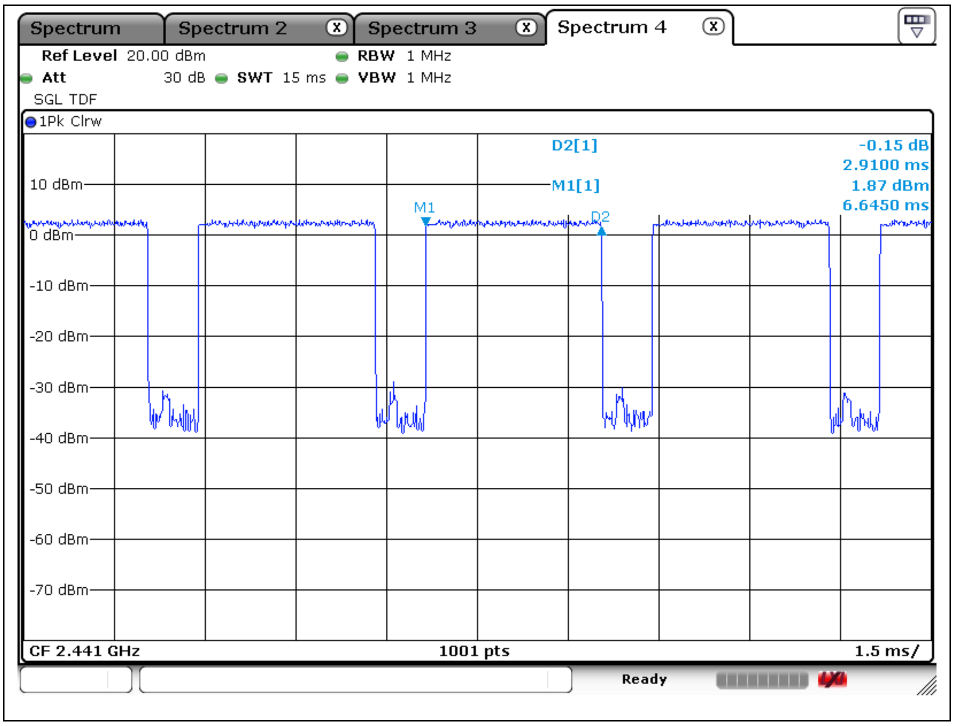
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 31.6 sec (㎳)	Limit for time of occupancy on the Tx Channel in 31.6 sec (㎳)
GFSK	2 441 ㎒	2.88	307.20	400
8DPSK	2 441 ㎒	2.91	310.40	400

Note:
Time of occupancy on the TX channel in 31.6 sec
In case of GFSK, 2.88 × {(1 600 ÷ 6) / 79} × 31.6 = 307.20 ㎳
In case of 8DPSK, 2.91 × {(1 600 ÷ 6) / 79} × 31.6 = 310.40 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK

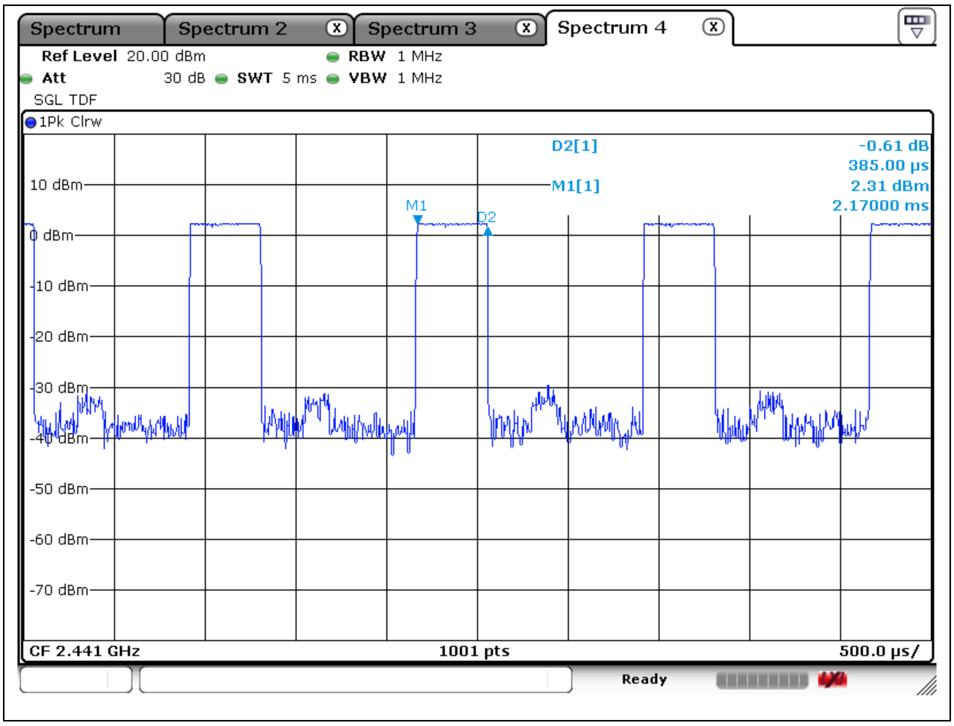


7.4.4. Packet Type: DH1, 3DH1 (Adaptive Frequency Hopping)

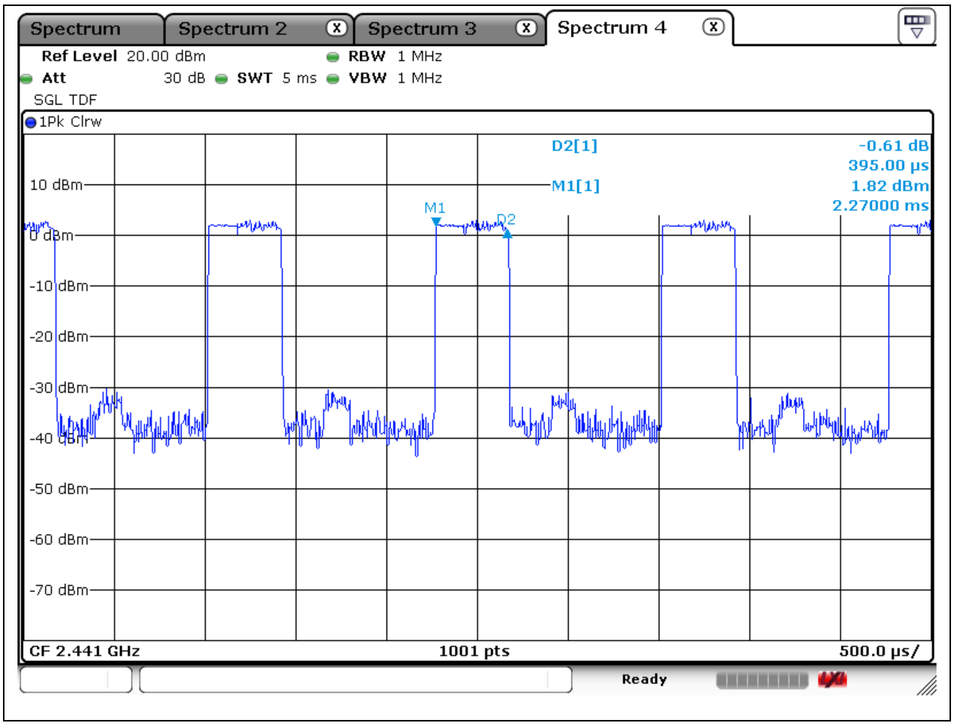
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 8 sec (㎳)	Limit for time of occupancy on the Tx Channel in 8 sec (㎳)
GFSK	2 441 ㎒	0.39	62.40	400
8DPSK	2 441 ㎒	0.40	64.00	400

Note:
Time of occupancy on the TX channel in 8 sec
In case of GFSK, 0.39 × {(800 ÷ 2) / 20} × 8 = 62.40 ㎳
In case of 8DPSK, 0.40 × {(800 ÷ 2) / 20} × 8 = 64.00 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK

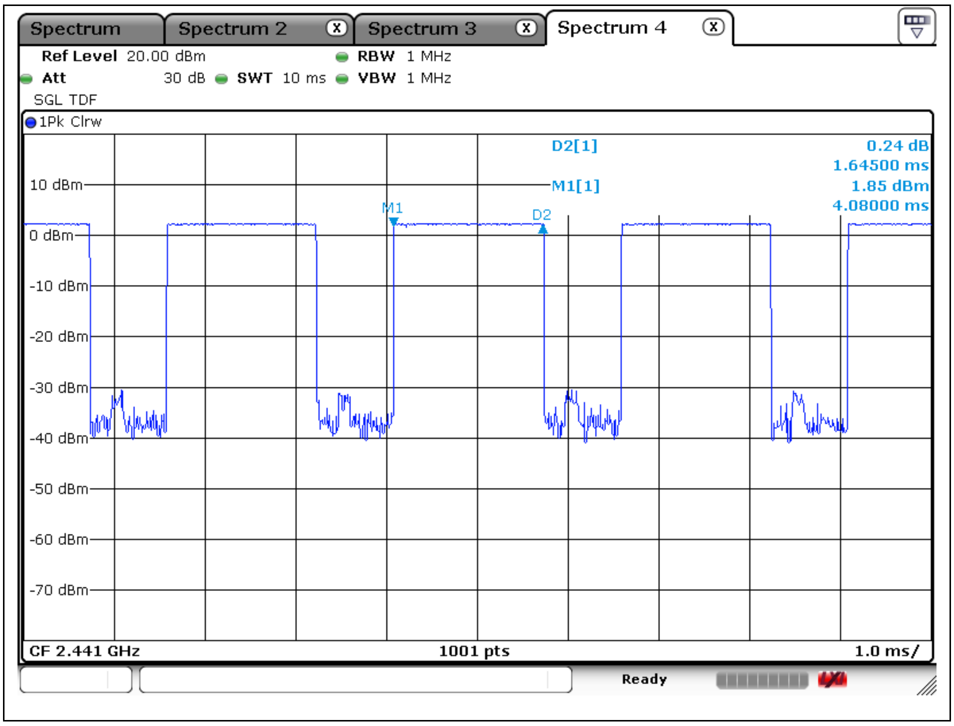


7.4.5. Packet Type: DH3, 3DH3 (Adaptive Frequency Hopping)

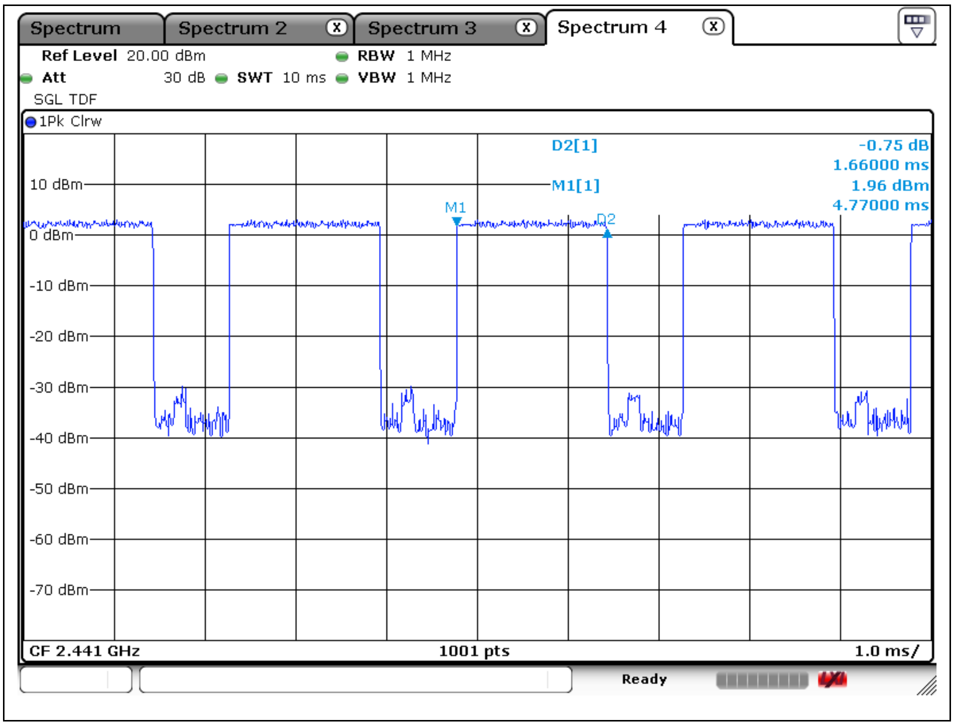
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 8 sec (㎳)	Limit for time of occupancy on the Tx Channel in 8 sec (㎳)
GFSK	2 441 ㎒	1.65	132.00	400
8DPSK	2 441 ㎒	1.66	132.80	400

Note:
Time of occupancy on the TX channel in 8 sec
In case of GFSK, 1.65 × {(800 ÷ 4) / 20} × 8 = 132.00 ㎳
In case of 8DPSK, 1.66 × {(800 ÷ 4) / 20} × 8 = 132.80 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK

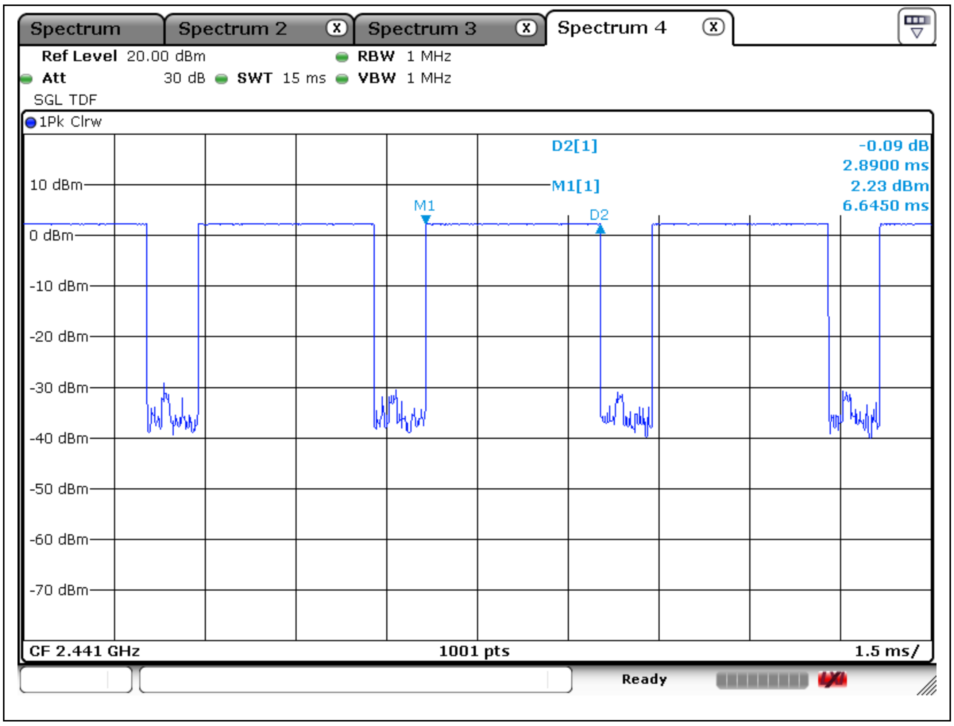


7.4.6. Packet Type: DH5, 3DH5 (Adaptive Frequency Hopping)

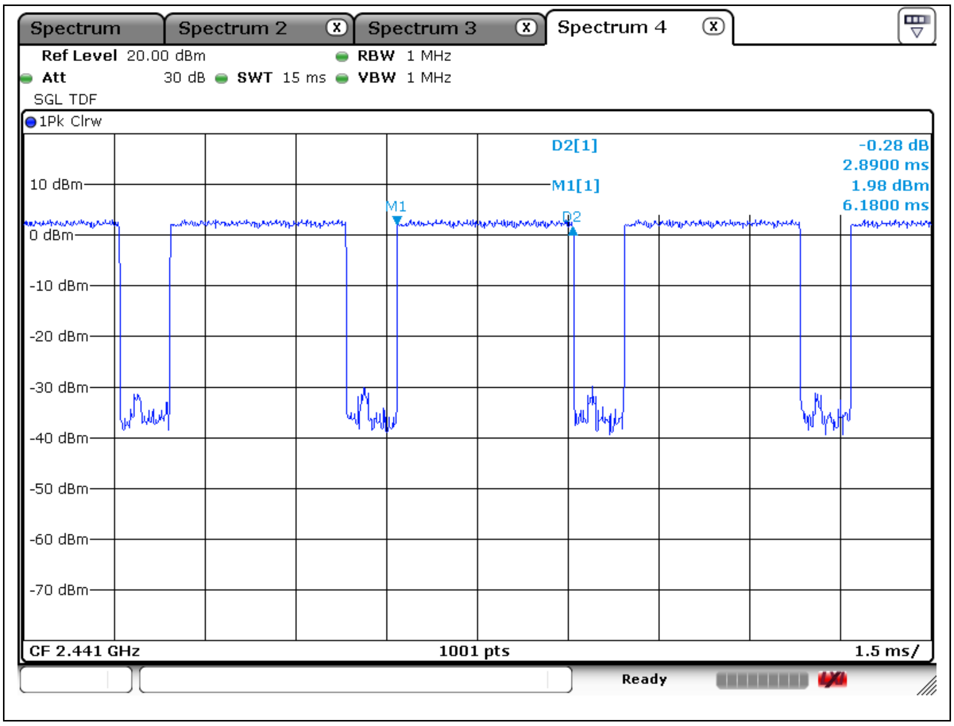
Operation Mode	Frequency	Dwell Time (㎳)	Time of occupancy on the Tx Channel in 8 sec (㎳)	Limit for time of occupancy on the Tx Channel in 8 sec (㎳)
GFSK	2 441 ㎒	2.89	154.13	400
8DPSK	2 441 ㎒	2.89	154.13	400

Note:
Time of occupancy on the TX channel in 8 sec
In case of GFSK and 8DPSK, 2.89 × {(800 ÷ 6) / 20} × 8 = 154.13 ㎳

Operating Mode: GFSK



Operating Mode: 8DPSK



8. Antenna Requirement

8.1. Standard Applicable

For intentional device, according to FCC 47 CFR 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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 ㏈i are used, the power shall be reduced by the amount in ㏈ that the gain of the antenna exceeds 6 ㏈i.

8.2. Antenna Connected Construction

Antenna used in this product is FPCB Antenna with gain of 4.64 ㏈i.

- End of the Test Report -