

8. 20dB Bandwidth Measurement Data

8.1 Test Limit

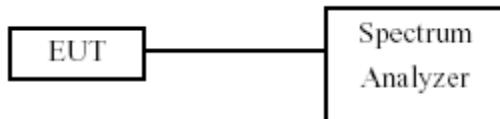
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band 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, provided the systems operate with an output power no greater than 125 mW.

8.2 Test Procedures

- a. The transmitter output was connected to the spectrum analyzer.
- b. Set RBW of spectrum analyzer to 30 KHz and VBW to 100 KHz.
- c. The 20 dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20 dB.

8.3 Test Setup Layout





8.4 Test Result and Data

Test Date: Dec. 17, 2015

Temperature: 20 °C

Atmospheric pressure: 1010 hPa

Humidity: 60 %

Modulation Type	Channel	Frequency (MHz)	20dB Bandwidth (KHz)	2/3 20dB Bandwidth (KHz)
GFSK (1Mbps)	00	2402	920.00	613.33
	39	2441	928.00	618.67
	78	2480	852.00	568.00
$\pi/4$ -DQPSK (2 Mbps)	00	2402	1232.00	821.33
	39	2441	1226.00	817.33
	78	2480	1224.00	816.00
8DPSK (3Mbps)	00	2402	1278.00	852.00
	39	2441	1244.00	829.33
	78	2480	1268.00	845.33



Modulation Standard: GFSK (1Mbps)

Channel: 00



Modulation Standard: GFSK (1Mbps)

Channel: 39

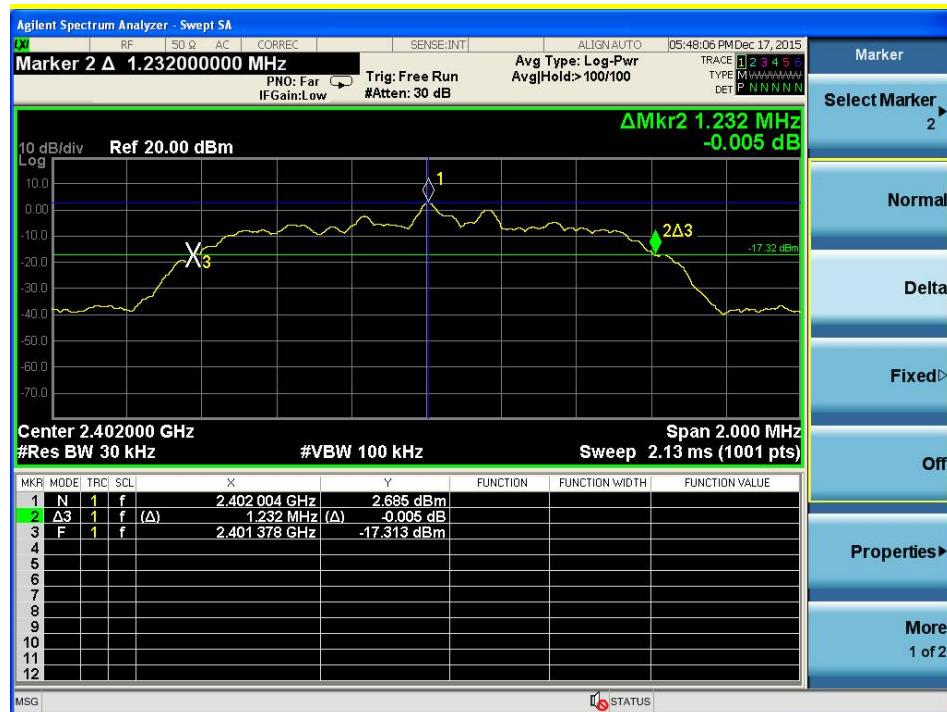




Modulation Standard: GFSK (1Mbps)
Channel: 78



Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
Channel: 00



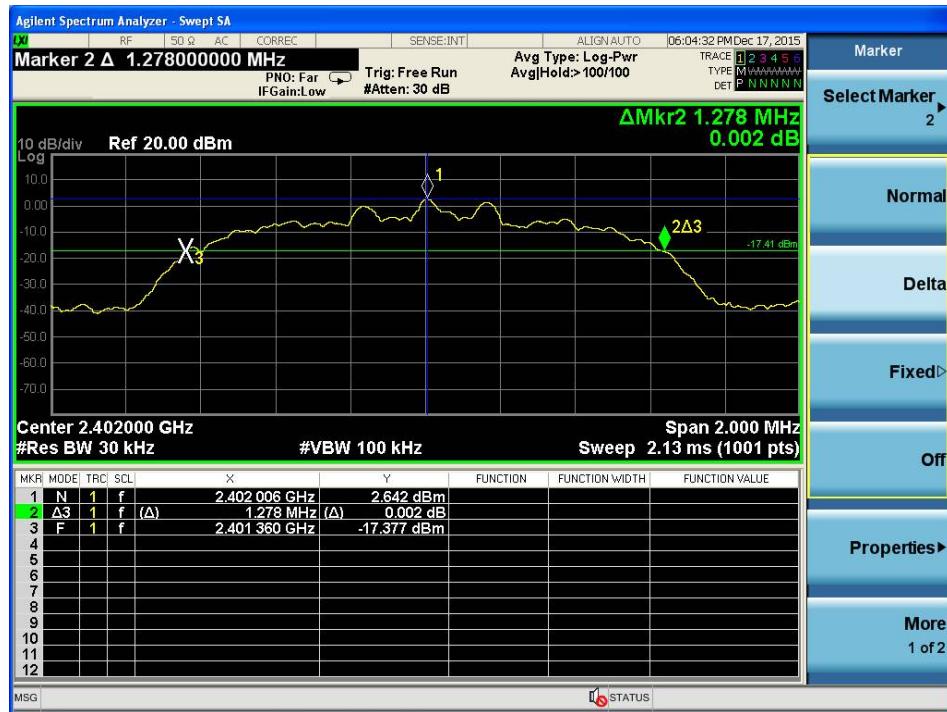
Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
 Channel: 39



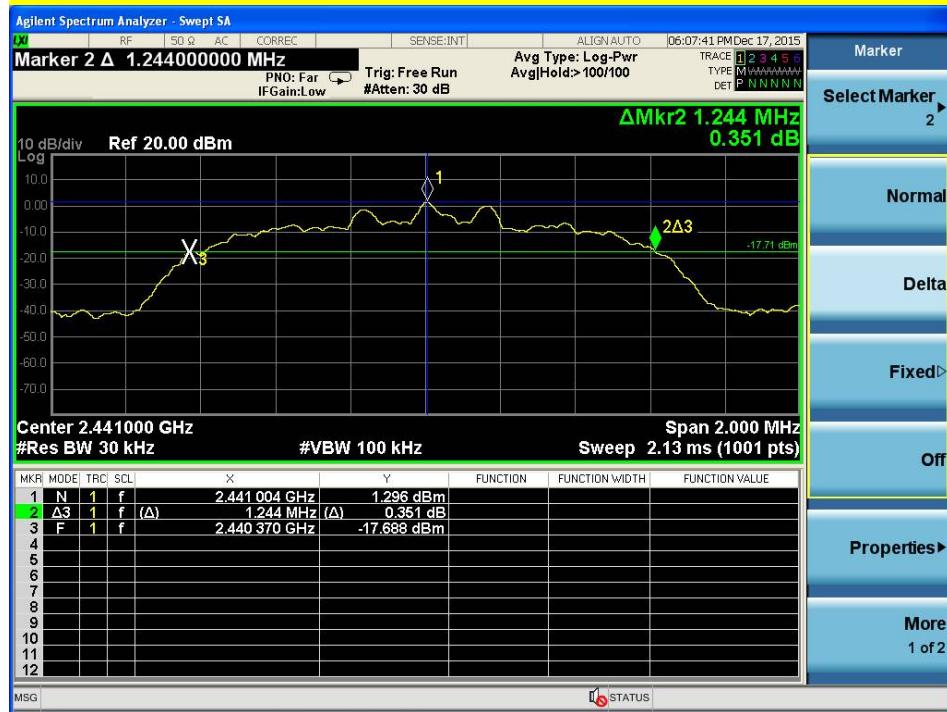
Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
 Channel: 78



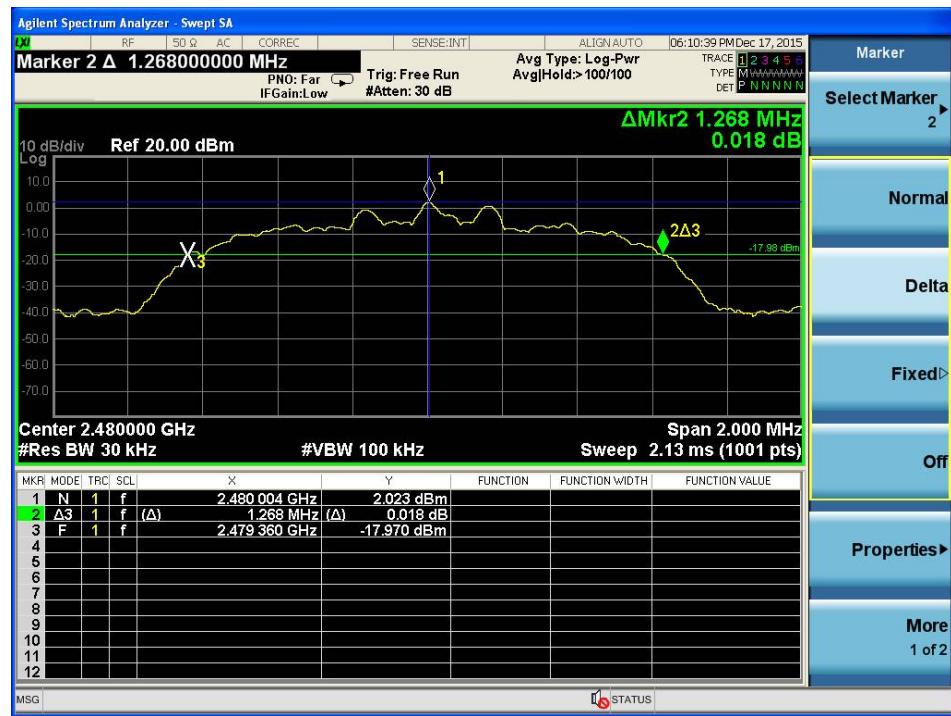
Modulation Standard: 8DPSK (3Mbps)
 Channel: 00



Modulation Standard: 8DPSK (3Mbps)
 Channel: 39



Modulation Standard: 8DPSK (3Mbps)
 Channel: 78



9. Frequencies Separation

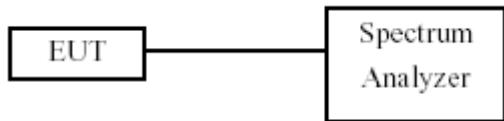
9.1 Test Limit

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

9.2 Test Procedures

- a. The transmitter output was connected to the spectrum analyzer.
- b. Set RBW of spectrum analyzer to 30 KHz and VBW to 100 KHz.
- c. By using the Max Hold function record the separation of two adjacent channels.
- d. Measure the frequency difference of these two adjacent channels.

9.3 Test Setup Layout





9.4 Test Result and Data

Test Date: Dec. 18, 2015

Temperature: 20 °C

Atmospheric pressure: 1010 hPa

Humidity: 60 %

Modulation Type	Channel	Frequency (MHz)	Frequency Separation (MHz)
GFSK (1Mbps)	00	2402	1.000
	39	2441	1.000
	78	2480	1.002
$\pi/4$ -DQPSK (2 Mbps)	00	2402	1.000
	39	2441	1.000
	78	2480	1.000
8DPSK (3Mbps)	00	2402	1.000
	39	2441	1.002
	78	2480	1.000

Modulation Standard: GFSK (1Mbps)
 Channel: 00



Modulation Standard: GFSK (1Mbps)
 Channel: 39



Modulation Standard: GFSK (1Mbps)
 Channel: 78



Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
 Channel: 00



Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
 Channel: 39



Modulation Standard: $\pi/4$ -DQPSK (2Mbps)
 Channel: 78



Modulation Standard: 8DPSK (3Mbps)

Channel: 00



Modulation Standard: 8DPSK (3Mbps)

Channel: 39



Modulation Standard: 8DPSK (3Mbps)

Channel: 78



10. Dwell Time on each channel

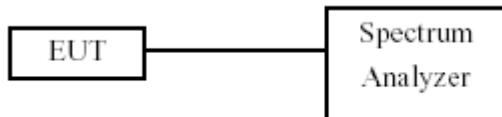
10.1 Test Limit

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.

10.2 Test Procedures

- a. The transmitter output was connected to the spectrum analyzer.
- b. Adjust the center frequency to measure frequency, then set zero span mode.
- c. Set RBW of spectrum analyzer to 1 MHz and VBW to 1 MHz.
- d. Measure the time duration of one transmission on the measured frequency.

10.3 Test Setup Layout





10.4 Test Result and Data

Test Date: Dec. 21, 2015

Temperature: 22 °C

Atmospheric pressure: 1010 hPa

Humidity: 60 %

Modulation Type	Channel	Frequency (MHz)	Normal mode Dwell Time (ms)
GFSK DH1	00	2402	127.68
	39	2441	128.00
	78	2480	128.00
GFSK DH3	00	2402	264.96
	39	2441	265.44
	78	2480	264.96
GFSK DH5	00	2402	309.67
	39	2441	309.67
	78	2480	309.67
$\pi/4$ -DQPSK 2DH5	00	2402	312.34
	39	2441	312.87
	78	2480	312.34
8DPSK 3DH5	00	2402	312.34
	39	2441	312.34
	78	2480	312.34

Normal mode test period: 0.4(second/ channel) x 79 channel= 31.6 second

The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 1/1600 seconds, or 0.625ms. DH1 Packet permit maximum $1600 / 79 / 2 = 10.12$ hops per second in each channel (1 time slot RX, 1 time slot TX). So, the dwell time is the time duration of the pulse times $10.12 \times 31.6 = 320$ within 31.6 seconds.

The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 3/1600 seconds, or 1.875ms. DH3 Packet permit maximum $1600 / 79 / 4 = 5.06$ hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $5.06 \times 31.6 = 160$ within 31.6 seconds.

The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and



maximum duty cycle. A maximum length packet has duration of 5 time slots. The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms. DH5 Packet permit maximum $1600 / 79 / 6 = 3.37$ hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $3.37 \times 31.6 = 106.6$ within 31.6 seconds

Example:

CH0,DH1 mode = $0.399 \text{ (ms)} \times (1600/79/2) \times 31.6 = 127.68 \text{ (ms)}$

CH0,DH3 mode = $1.656 \text{ (ms)} \times (1600/79/4) \times 31.6 = 264.96 \text{ (ms)}$

CH0,DH5 mode = $2.905 \text{ (ms)} \times (1600/79/6) \times 31.6 = 309.67 \text{ (ms)}$

Modulation Type	Channel	Frequency (MHz)	AFH mode Dwell Time (ms)
GFSK DH1	00	2402	64.16
	09	2411	64.00
	19	2421	64.16
GFSK DH3	00	2402	132.48
	09	2411	132.48
	19	2421	132.48
GFSK DH5	00	2402	155.01
	09	2411	155.01
	19	2421	155.01
$\pi/4$ -DQPSK 2DH5	00	2402	156.34
	09	2411	156.34
	19	2421	156.61
8DPSK 3DH5	00	2402	156.61
	09	2411	156.61
	19	2421	156.34

AFH mode test period: $0.4(\text{second}/\text{channel}) \times 20 \text{ channel} = 8 \text{ second}$

The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots. The hopping rate is 800 hops/second so the maximum dwell time is 1/800 seconds, or 1.25ms. DH1 Packet permit maximum $800 / 20 / 2 = 20$ hops per second in each channel (1 time slot RX, 1 time slot TX). So, the dwell time is the time duration of the pulse times $20 \times 8 = 160$ within 8 seconds.

The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time



slots. The hopping rate is 800 hops/second so the maximum dwell time is 3/800 seconds, or 3.75ms. DH3 Packet permit maximum $800 / 20 / 4 = 10$ hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $10 \times 8 = 80$ within 8 seconds.

The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slots. The hopping rate is 800 hops/second so the maximum dwell time is 5/800 seconds, or 6.25ms. DH5 Packet permit maximum $800 / 20 / 6 = 6.67$ hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $6.67 \times 8 = 53.36$ within 8 seconds

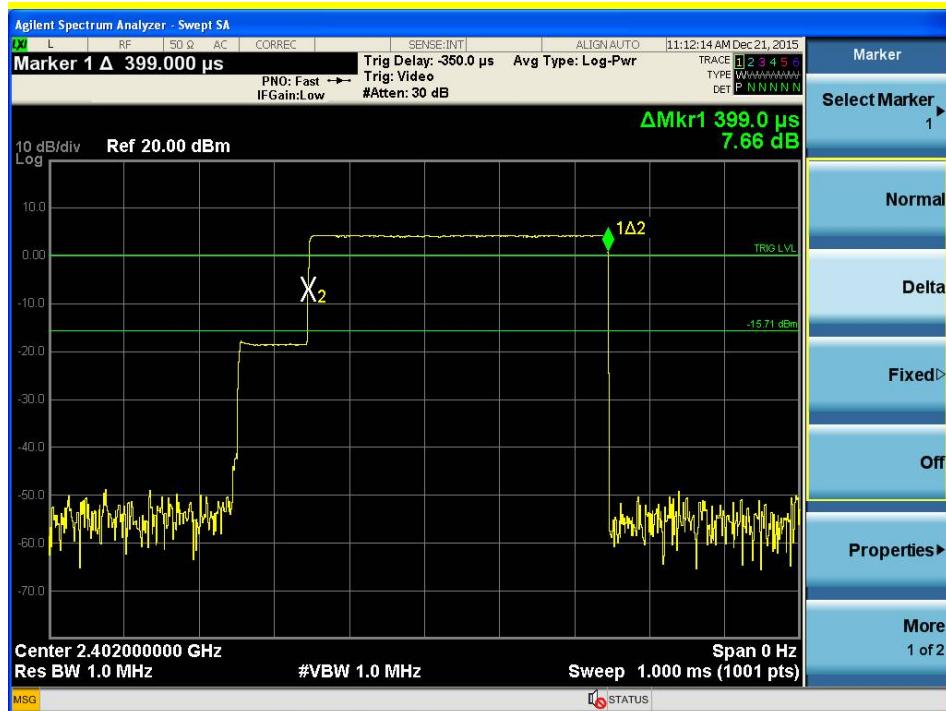
Example:

$$\text{CH0,DH1 mode} = 0.401 \text{ (ms)} * (800 / 20 / 2) * 8 = 64.16 \text{ (ms)}$$

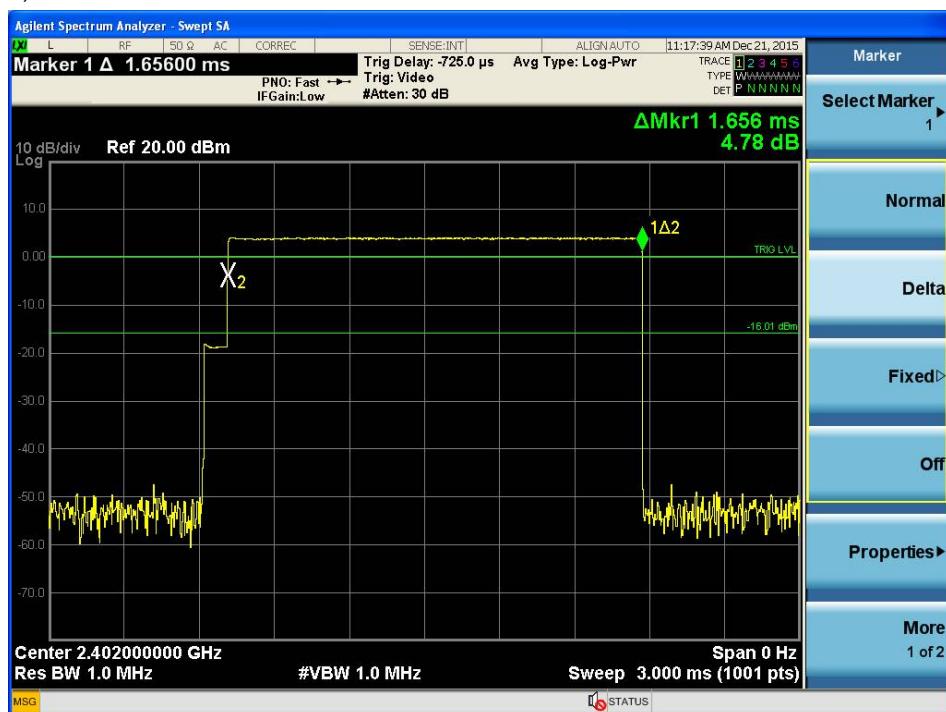
$$\text{CH0,DH3 mode} = 1.656 \text{ (ms)} * (800 / 20 / 4) * 8 = 132.48 \text{ (ms)}$$

$$\text{CH0,DH5 mode} = 2.905 \text{ (ms)} * (800 / 20 / 6) * 8 = 155.01 \text{ (ms)}$$

Modulation Standard: GFSK (1Mbps)
 Channel: 00, Rate: DH1

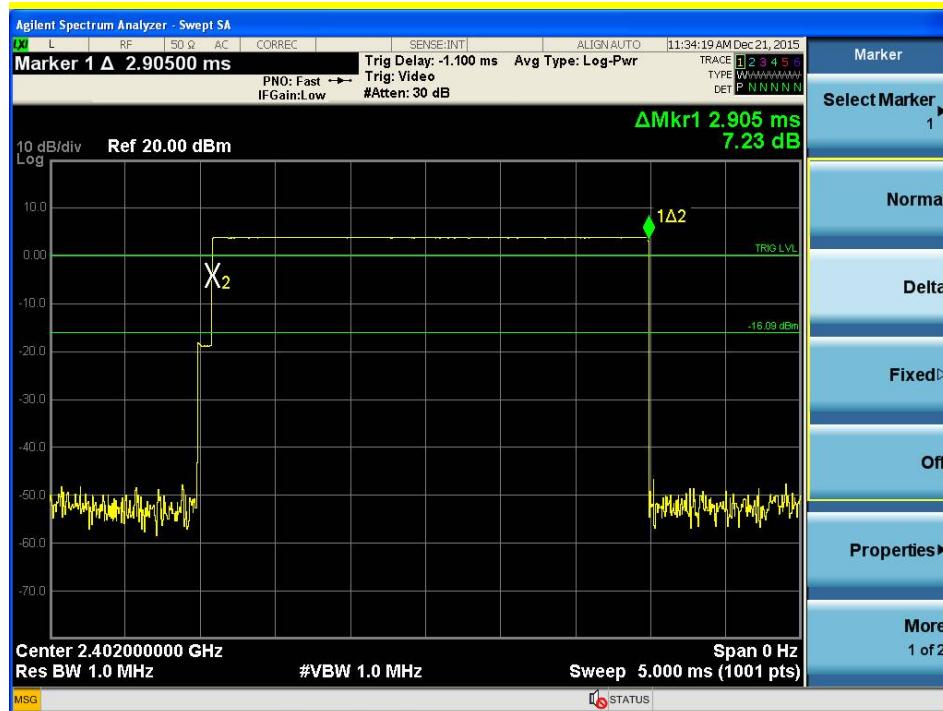


Modulation Standard: GFSK (1Mbps)
 Channel: 00, Rate: DH3



Modulation Standard: GFSK (1Mbps)

Channel: 00, Rate: DH5



Modulation Standard: GFSK (1Mbps)

Channel: 39, Rate: DH1

