



TESTING CERT #3478.01



TEST REPORT

EUT Description	1x1 802.11ac + BT 4.2 combo, PCIe M.2 2230 adapter card
Brand Name	Intel® Dual-Band Wireless-AC 3168
Model Name	3168NGW
Serial Number	TA#: H84692-006 WF MAC: 34:13:E8:4F:20:63 / 34:13:EB:4F:12:3A BT MAC: 34:13:E8:4F:20:67 / 34:13:E8:4F:12:3E (see section 4)
FCC/IC ID	FCC ID: PD93168NG / PD93168NGU IC ID: 1000M-3168NG
Antenna type	SkyCross WIMAX/WLAN Reference Antenna
Hardware/Software Version	HW: TF1 – cfg 51.12 Test SW: DRTU version 1.8.4-02432 Op SW: 99.0.17.7
Date of Sample Receipt	2016-01-17
Date of Test	2016-01-19 / 2016-01-27
Features	802.11 a/b/g/n/ac Wireless LAN + BDR/EDR 2.1 + BLE 4.2 (see section 5)

Applicant	Intel Mobile Communications
Address	100 Center Point Circle, Suite 200 Columbia, South Carolina 29210 USA
Contact Person	Steven Hackett
Telephone/Fax/ Email	steven.c.hackett@intel.com

Reference Standards	FCC CFR Title 47 Part 15C RSS-247 issue 1, RSS-Gen issue 4 (see section 1)
---------------------	--

Test Report number	160107-01.TR04
Revision Control	Rev. 00

The test results relate only to the samples tested.
The test report shall not be reproduced in full, without written approval of the laboratory.

Issued by

Reviewed by

Olivier FARGANT
(RF Test Lead)

Jose M. FORTES
(Technical Manager)

Intel Mobile Communications France S.A.S – WRF Lab
425 rue de Goa – Le Cargo B6 – 06600, Antibes, France
Tel. +33493001400 / Fax +33493001401

Table of Contents

1. Standards, reference documents and applicable test methods	3
2. General conditions, competences and guarantees	3
3. Environmental Conditions.....	3
4. Test samples.....	4
5. EUT features	4
6. Remarks and comments.....	4
7. Test Verdicts summary.....	5
7.1. BT Basic Data Rate / Enhanced Data Rate	5
8. Document Revision History	5
Annex A. Test & System Description	6
A.1 MEASUREMENT SYSTEM	6
A.2 TEST EQUIPMENT LIST.....	8
A.3 MEASUREMENT UNCERTAINTY EVALUATION.....	8
Annex B. Test Results.....	9
B.1 20DB BANDWIDTH AND CARRIER FREQUENCY SEPARATION	9
B.2 NUMBER OF HOPPING CHANNELS	16
B.3 TIME OF OCCUPANCY (D WELL TIME)	20
B.4 MAXIMUM PEAK OUTPUT POWER AND ANTENNA GAIN	27
B.5 OUT-OF-BAND EMISSIONS (CONDUCTED)	34
B.6 RADIATED SPURIOUS EMISSION	59
Annex C. Photographs.....	71

1. Standards, reference documents and applicable test methods

1. FCC 47 CFR part 15 - Subpart C – §15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
2. FCC 47 CFR part 15 - Subpart C – §15.209 Radiated emission limits; general requirements.
3. Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems - DA 00-705 Released March 30, 2000
4. RSS-247 Issue 1 - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
5. RSS-Gen Issue 4 - General Requirements for Compliance of Radio Apparatus.
6. ANSI C63.10-2009 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

2. General conditions, competences and guarantees

- ✓ Intel Mobile Communications Wireless RF Lab (Intel WRF Lab) is a testing laboratory accredited by the American Association for Laboratory Accreditation (A2LA).
- ✓ Intel Mobile Communications Wireless RF Lab (Intel WRF Lab) is an Accredited Test Firm listed by the FCC, with Designation Number FR0011.
- ✓ Intel Mobile Communications Wireless RF Lab (Intel WRF Lab) is a Registered Test Site listed by IC, with IC Assigned Code 1000Y.
- ✓ Intel WRF Lab only provides testing services and is committed to providing reliable, unbiased test results and interpretations.
- ✓ Intel WRF Lab is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.
- ✓ Intel WRF Lab has developed calibration and proficiency programs for its measurement equipment to ensure correlated and reliable results to its customers.
- ✓ This report is only referred to the item that has undergone the test.
- ✓ This report does not imply an approval of the product by the Certification Bodies or competent Authorities.
- ✓ Complete or partial reproduction of the report cannot be made without written permission of Intel WRF Lab.

3. Environmental Conditions

- ✓ At the site where the measurements were performed the following limits were not exceeded during the tests:

Temperature	22°C ± 2°C
Humidity	35% ± 5%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of reception	Note
#01	160107-01.S07	WiFi/BT Module	3168NGW	WF MAC: 34:13:E8:4F:20:63	2016-01-07	Used for conducted tests
	160107-01.S14	Extender board	PC00495	ASS0495-001, 4950414-064	2016-01-07	
	160107-01.S19	Switching power supply SINPRO 5V 6A	SPU60-102	08741187 1350	2016-01-07	
	15040201.S14	Laptop	Dell Latitude	27081704053	2015-04-15	
#02	160107-01.S03	WiFi/BT High End Module	3168NGW	WF MAC: 34:13:EB:4F:12:3A	2016-07-01	Used for radiated tests
	160107-01.S11	Extender board	PC00495	4955013-097	2016-07-01	
	160107-01.S27	USB Cable	E154336	NA	2015-05-12	
	150818-01.S14	PCI Cable	Blue cable 1 meter	NA	2015-05-12	
	160107-01.S28	Laptop	Dell E5440	BJSYN32	2016-01-15	
	160107-01.S26	AC/DC Adapter	SPU60-102	07990509 1249	2016-01-15	

NA: Not Applicable

5. EUT features

These are the detailed bands and modes supported by the Equipment Under Test:

802.11b/g/n	2.4GHz (2400.0 – 2483.5 MHz)
802.11a/n/ac	5.2GHz (5150.0 – 5250.0 MHz)
	5.3GHz (5250.0 – 5350.0 MHz)
	5.6GHz (5470.0 – 5725.0 MHz)
	5.8GHz (5725.0 – 5850.0 MHz)
BDR/EDR 2.1 BLE 4.2	2.4GHz (2400.0 – 2483.5 MHz)

6. Remarks and comments

N/A

7. Test Verdicts summary

7.1. BT Basic Data Rate / Enhanced Data Rate

FCC part	RSS part	Test name	Verdict
15.247 (a) (1)	RSS-247 Clause 5.1 (1) and (2)	20dB Bandwidth and Carrier frequency separation	P
15.247 (a) (1) (iii)	RSS-247 Clause 5.1 (4)	Number of hopping channels	P
15.247 (a) (1) (iii)	RSS-247 Clause 5.1 (4)	Time of Occupancy (Dwell Time)	P
15.247 (b) (1)	RSS-247 Clause 5.4 (2)	Maximum Peak Output Power and antenna gain	P
15.247 (d)	RSS-247 Clause 5.5	Out-of-band Emissions (conducted)	P
15.247 (d) 15.209	RSS-247 Clause 5.5	Out-of-band Emissions (radiated)	P

P: Pass
 F: Fail
 NM: Not Measured
 NA: Not Applicable

8. Document Revision History

Revision #	Date	Modified by	Details
Rev. 00	2016-02-19	O.Fargant	First Issue

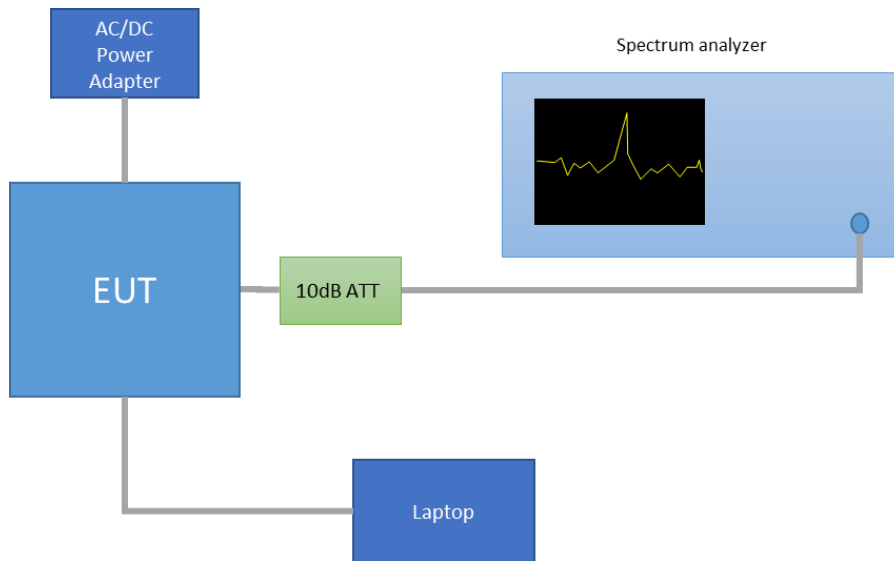
Annex A. Test & System Description

A.1 Measurement system

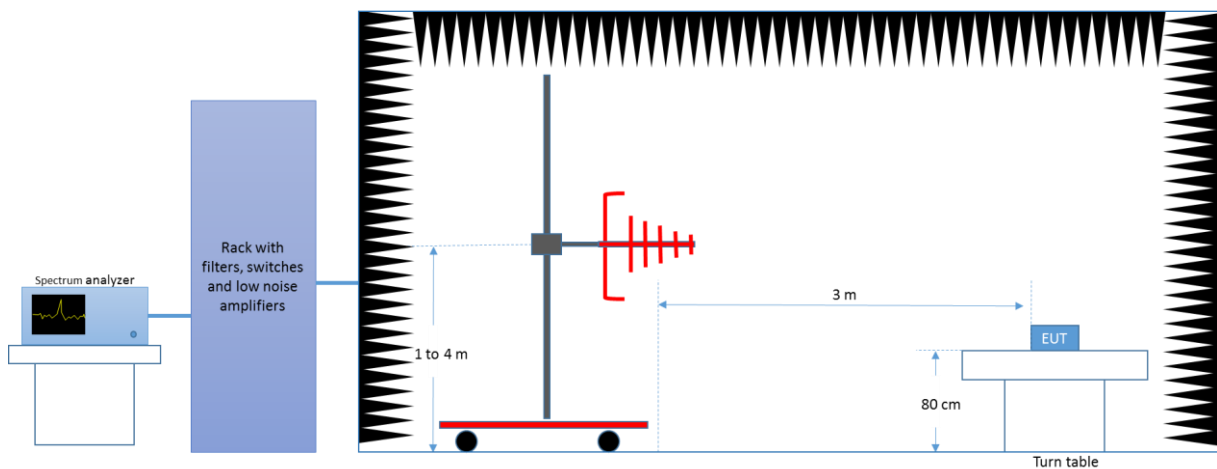
Measurements were performed using the following setups.

The DUT was installed in a test fixture and this test fixture is connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using all different modes and modulation schemes.

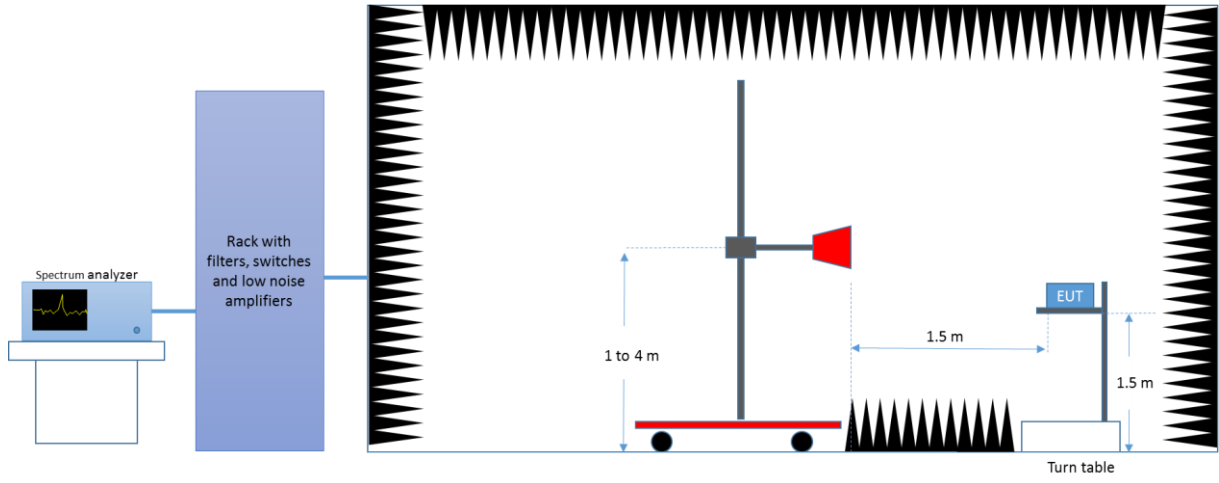
Conducted Setup



Radiated Setup < 1GHz



Radiated Setup > 1GHz



A.2 Test Equipment List

Conducted Setup

ID#	Device	Type/Model	Serial Number	Manufacturer	Cal. Date	Cal. Due Date
0316	Spectrum analyzer	FSV30	103309	Rohde & Schwarz	2015-03-20	2017-03-20

Radiated Setup

ID#	Device	Type/Model	Serial Number	Manufacturer	Cal. Date	Cal. Due Date
0133	Spectrum analyzer	FSV40	101358	Rohde & Schwarz	2014-05-09	2016-05-09
0137	Log antenna 30 MHz – 1 GHz	3142E	00156946	ETS Lindgren	2014-03-05	2016-03-05
0138	Horn antenna 1 GHz – 6.4 GHz	3117	00152266	ETS Lindgren	2014-03-04	2016-03-04
0141	Horn Antenna 6.4 GHz – 18 GHz	3117-PA	00157736	ETS Lindgren	2014-06-03	2016-06-03
0248	Horn Antenna 1 GHz – 18 GHz	3117-PA	00167062	ETS Lindgren	2014-08-13	2016-08-13
0139	Horn Antenna 18GHz – 26GHz	114514	00167100	ETS Lindgren	2014-04-25	2016-04-25
0140	Horn Antenna 26GHz – 40GHz	120722	00169638	ETS Lindgren	2014-08-14	2016-08-14
0135	Anechoic chamber	FACT 3	RFD_FA_100	ETS Lindgren	2014-05-06	2016-05-06
0329	Measurement Software	EMC32	1300.7027.00 (100401)	Rohde & Schwarz	N/A	N/A
0133	Spectrum analyzer	FSV40	101358	Rohde & Schwarz	2014-05-09	2016-05-09
0296	DC Power Supply	6673A	MY41000318	Agilent	N/A	N/A

A.3 Measurement Uncertainty Evaluation

The system uncertainty evaluation is shown in the below table:

Measurement type	Uncertainty [±dB]
Conducted Power (power meter)	± 1.0
Conducted spurious emission	± 2.9
Radiated test < 1GHz	± 3.8
Radiated test 1GHz -26 GHz	± 4.7

Annex B. Test Results

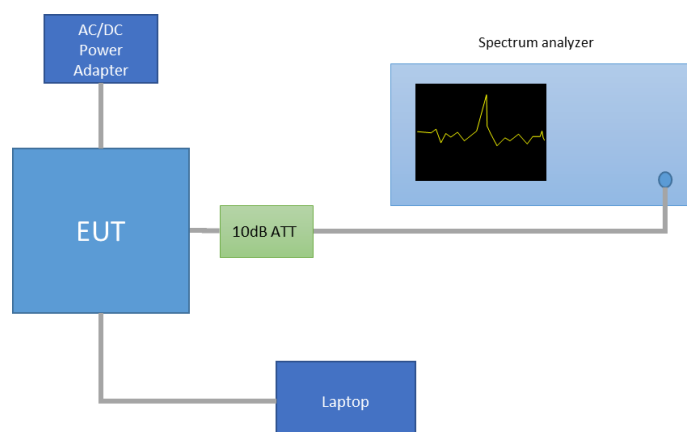
B.1 20dB Bandwidth and Carrier frequency separation

Test limits:

FCC part	RSS part	Limits
15.247 (a) (1)	RSS-247 Clause 5.1 (1) and (2)	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.

Test procedure:

The setup below was used to measure the 20dB Bandwidth and Carrier frequency separation. The antenna terminal of the EUT is connected to the spectrum analyzer through an attenuator, and the spectrum analyzer reading is compensated to include the RF path loss.



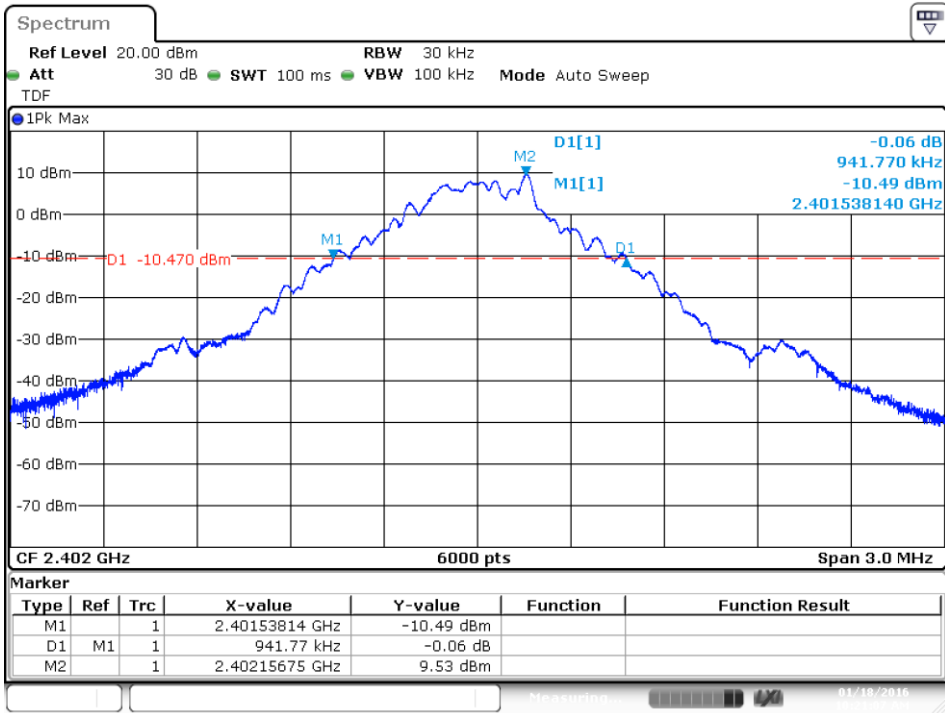
Results tables:

Mode	Channel Number	Frequency [MHz]	20dB BW [MHz]	Freq. Separation [kHz]
Basic Rate GFSK	0	2402	0.942	1000.0
	39	2441	0.939	
	78	2480	0.941	
EDR $\pi/4$ -DQPSK	0	2402	1.482	1000.0
	39	2441	1.476	
	78	2480	1.480	
EDR 8-DPSK	0	2402	1.423	1000.0
	39	2441	1.431	
	78	2480	1.435	

Results screenshot:

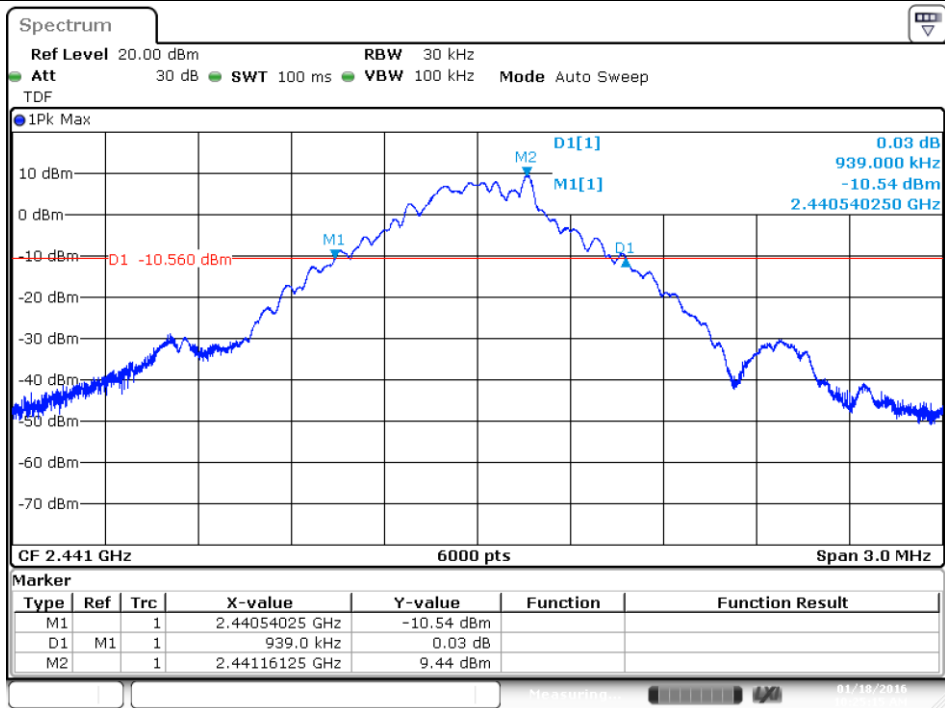
Basic Rate - GFSK

20dB BW - CH0

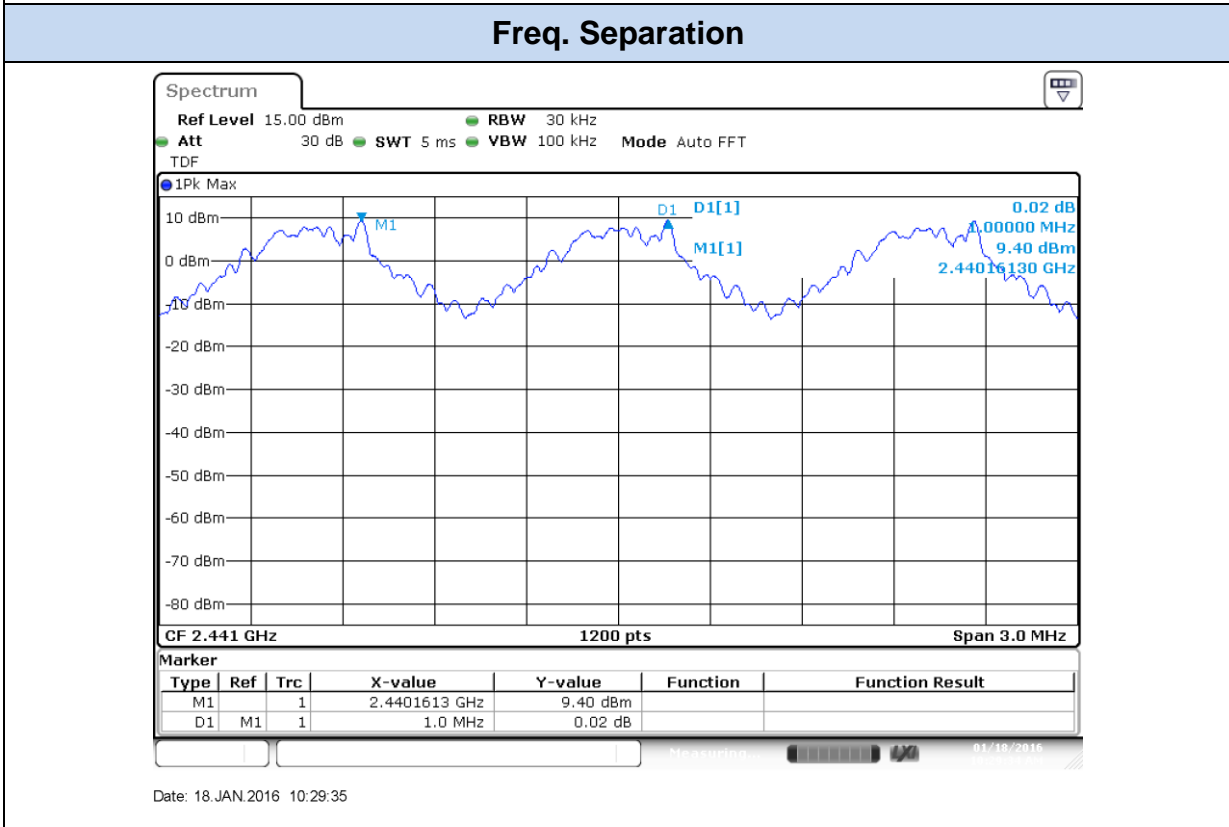
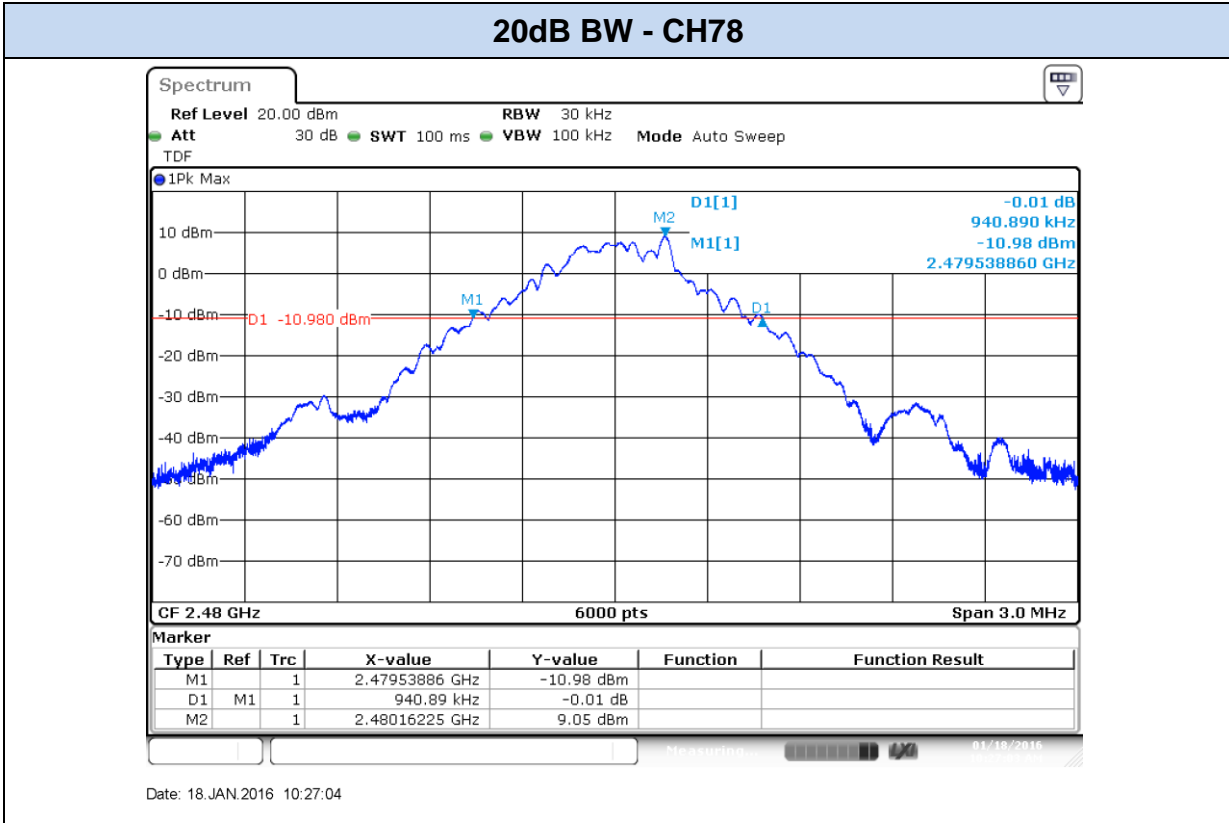


Date: 18.JAN.2016 10:21:08

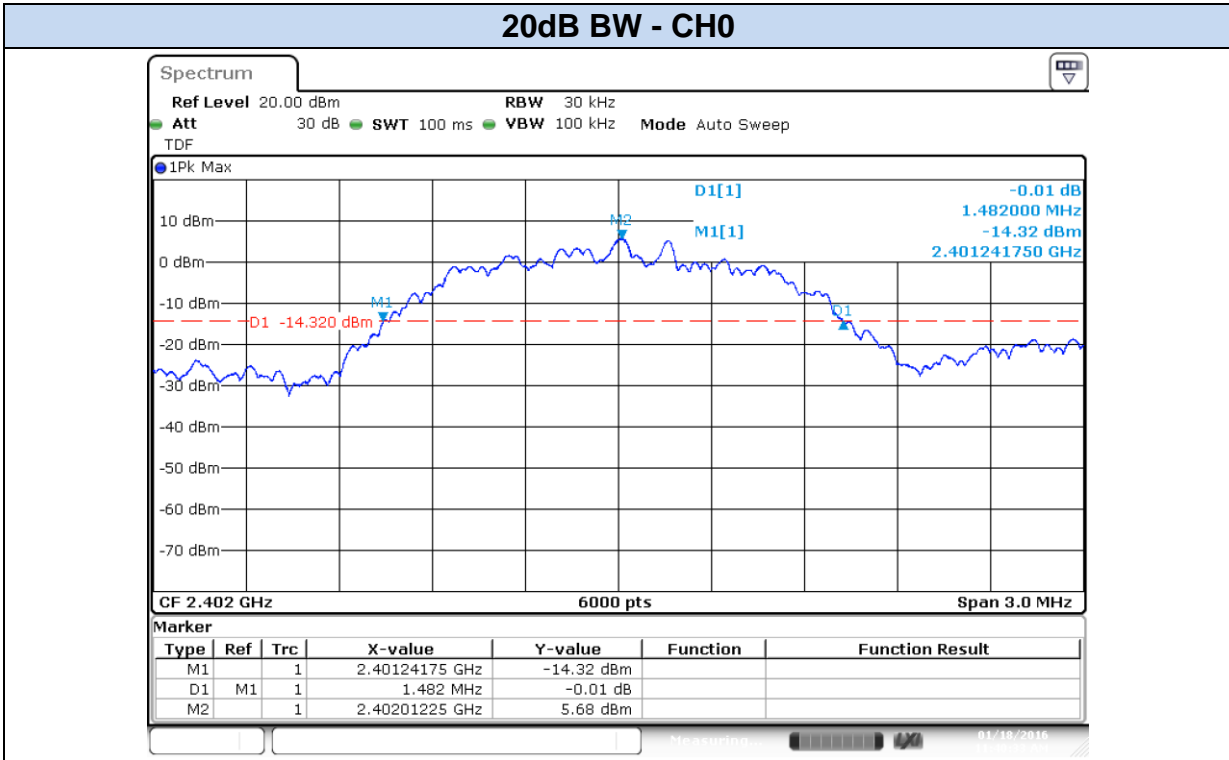
20dB BW - CH39



Date: 18.JAN.2016 10:25:15

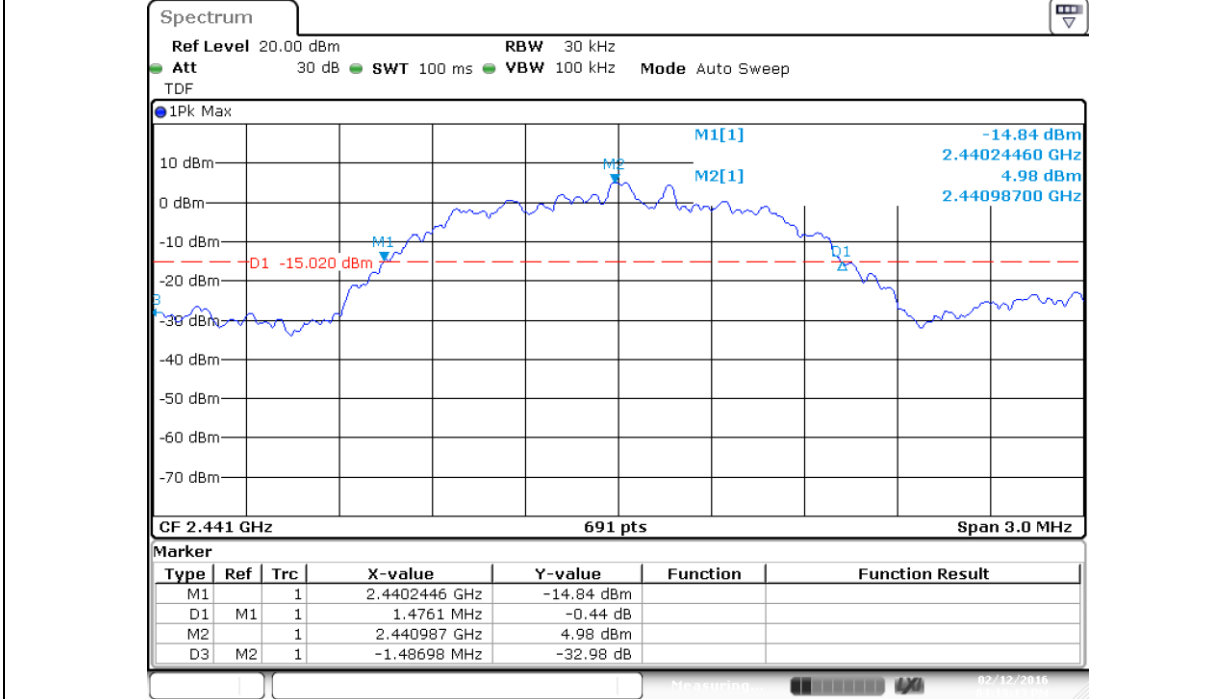


EDR – $\pi/4$ -DQPSK

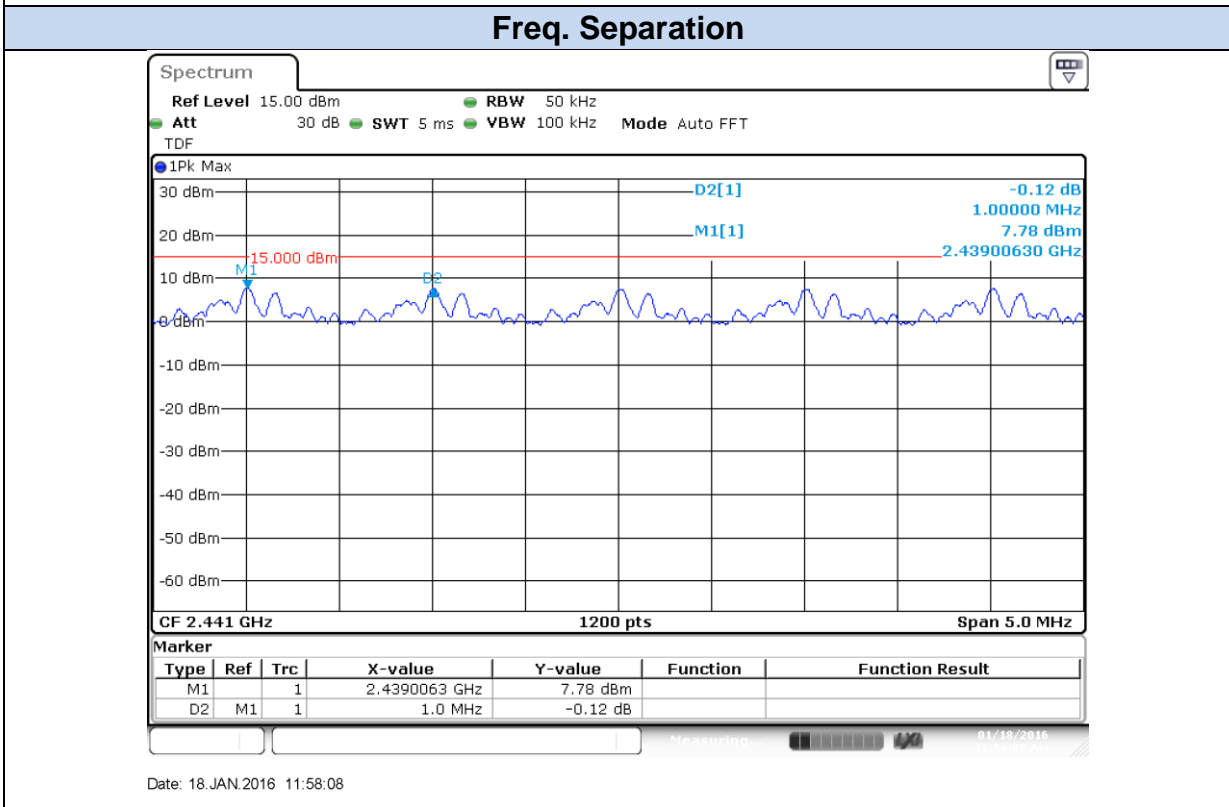
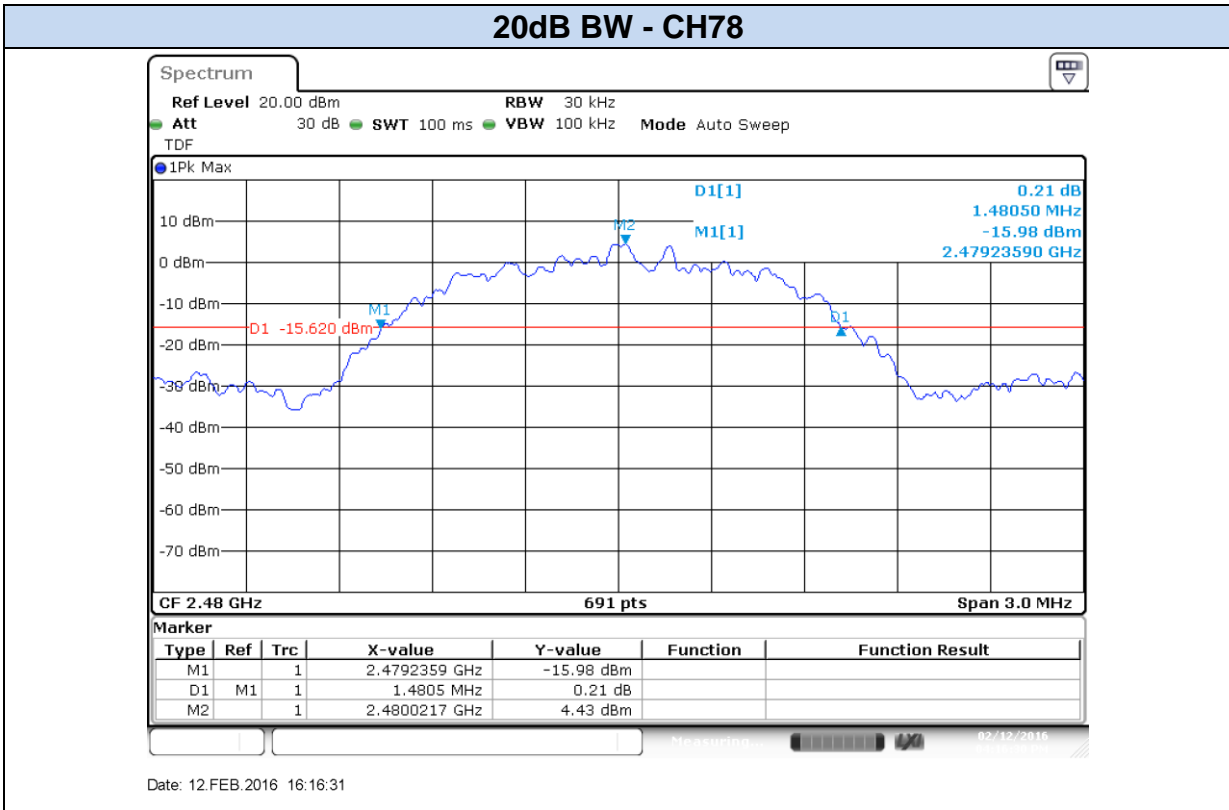


Date: 18.JAN.2016 11:40:34

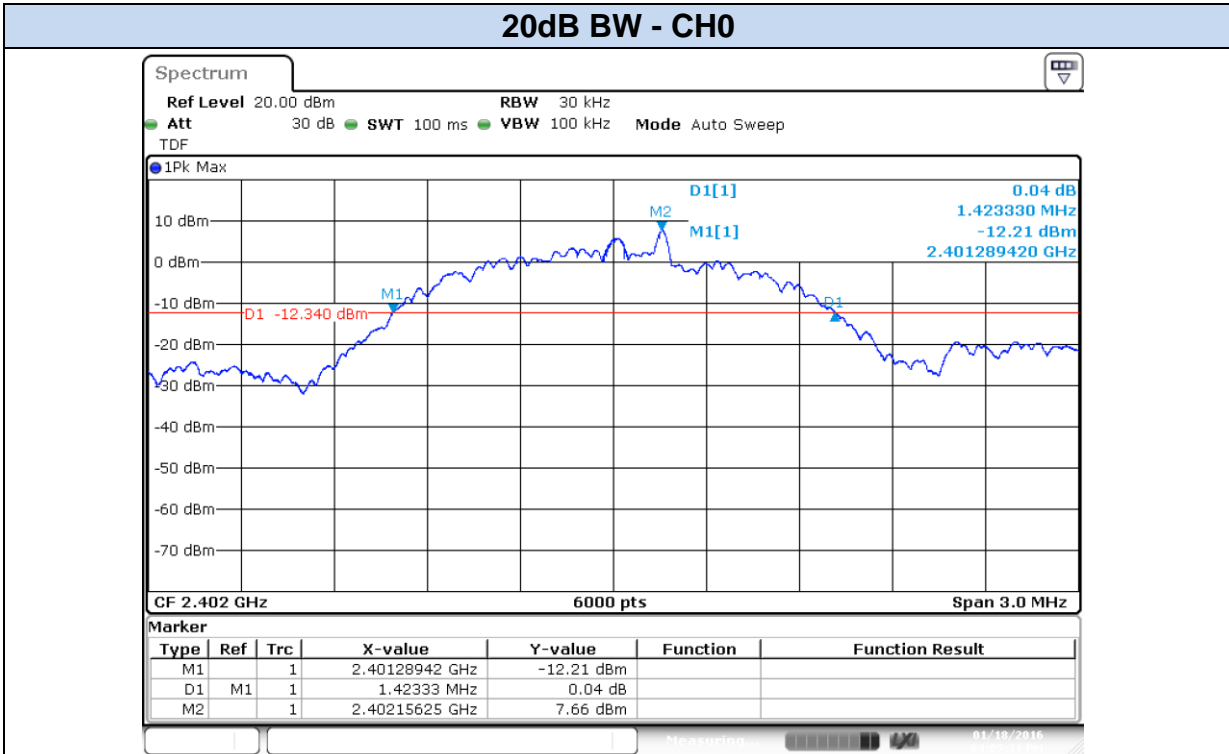
20dB BW - CH39



Date: 12.FEB.2016 16:13:12

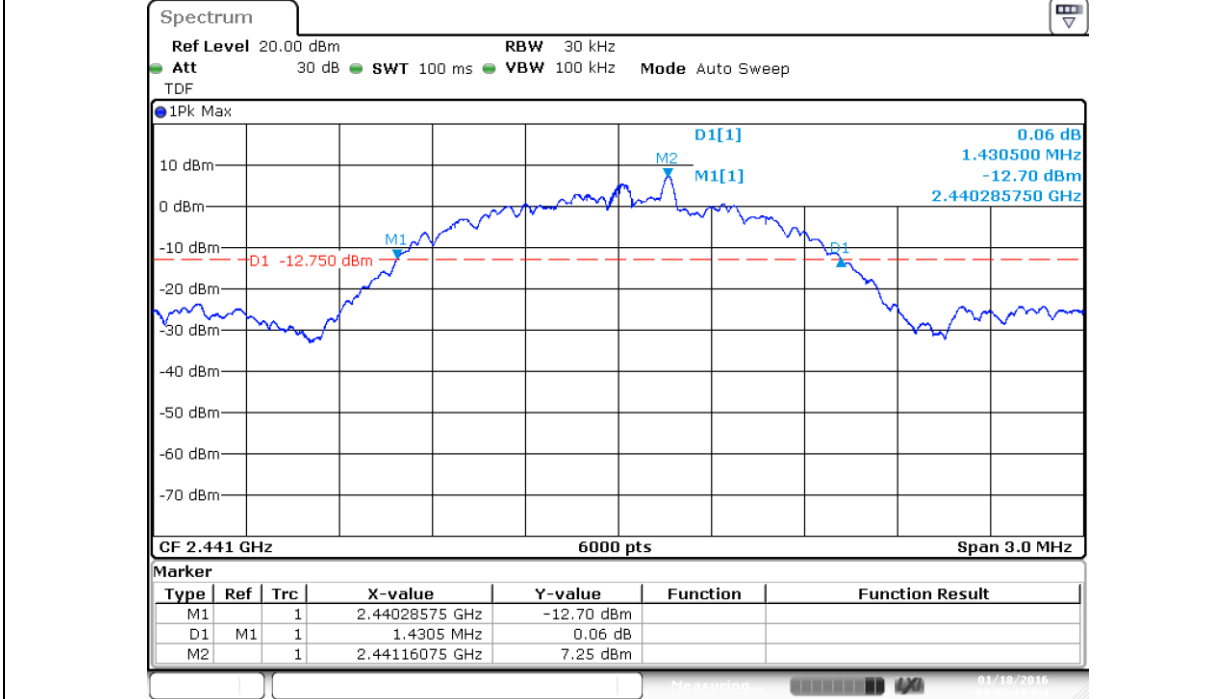


EDR – 8-DPSK

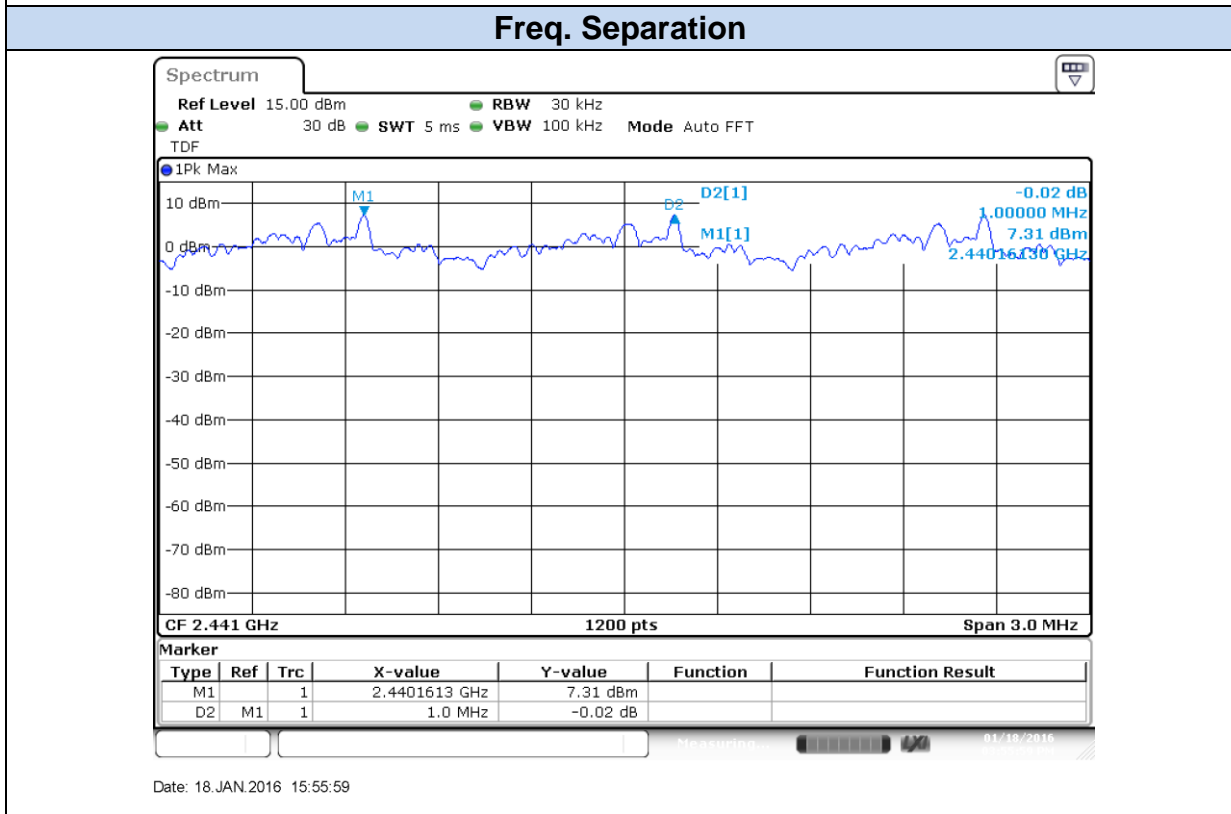
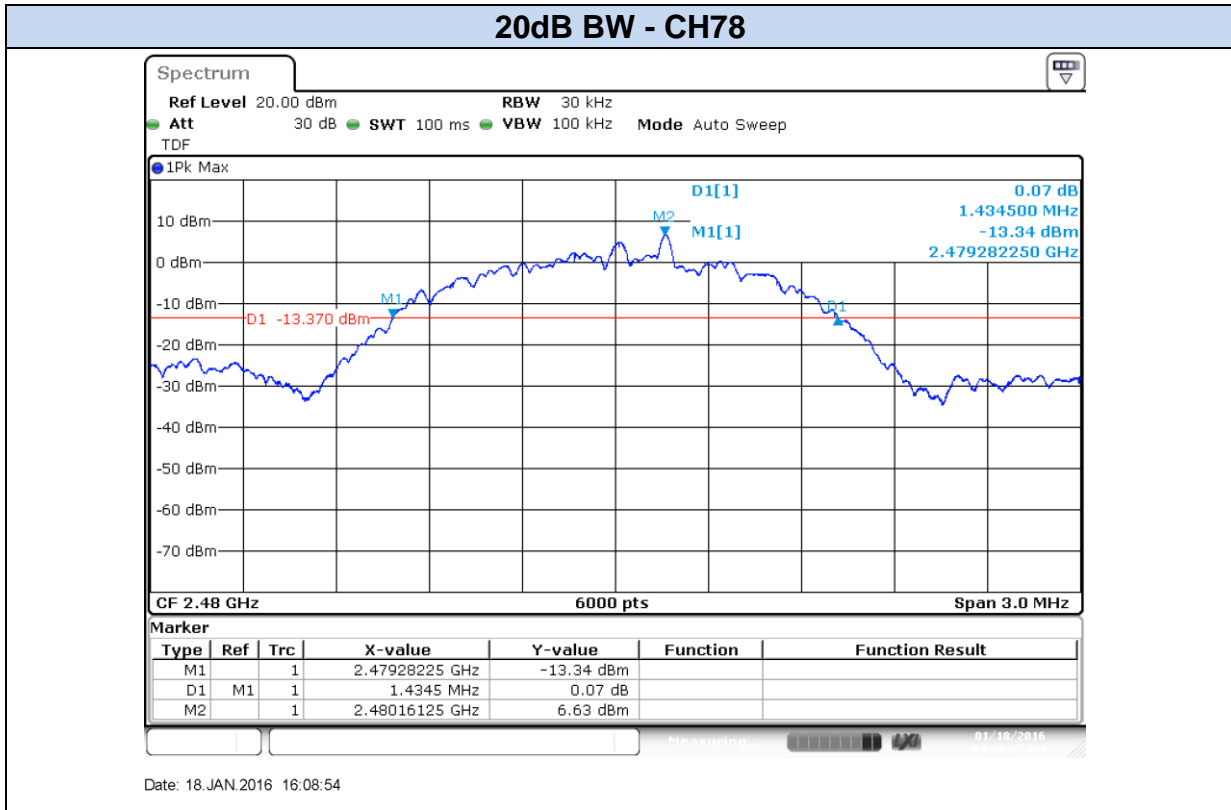


Date: 18.JAN.2016 16:05:31

20dB BW - CH39



Date: 18.JAN.2016 16:07:19



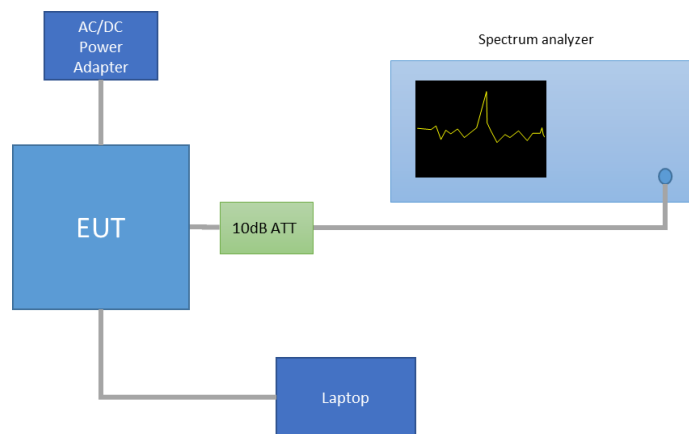
B.2 Number of hopping channels

Test limits:

FCC part	RSS part	Limits
15.247 (a) (1) (iii)	RSS-247 Clause 5.1 (4)	Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test procedure:

The setup below was used to measure the number of hopping channels. The antenna terminal of the EUT is connected to the spectrum through an attenuator, and the spectrum analyzer reading is compensated to include the RF path loss.



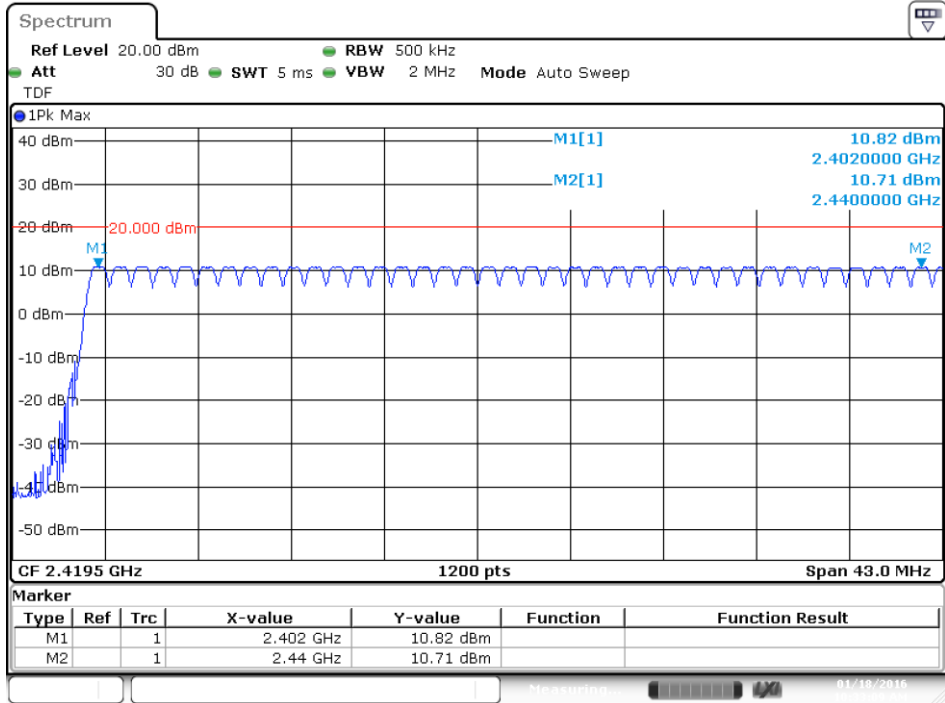
Results tables:

Mode	Number of hopping channels
Basic Rate GFSK	79
EDR $\pi/4$ -DQPSK	79
EDR 8-DPSK	79

Results screenshot:

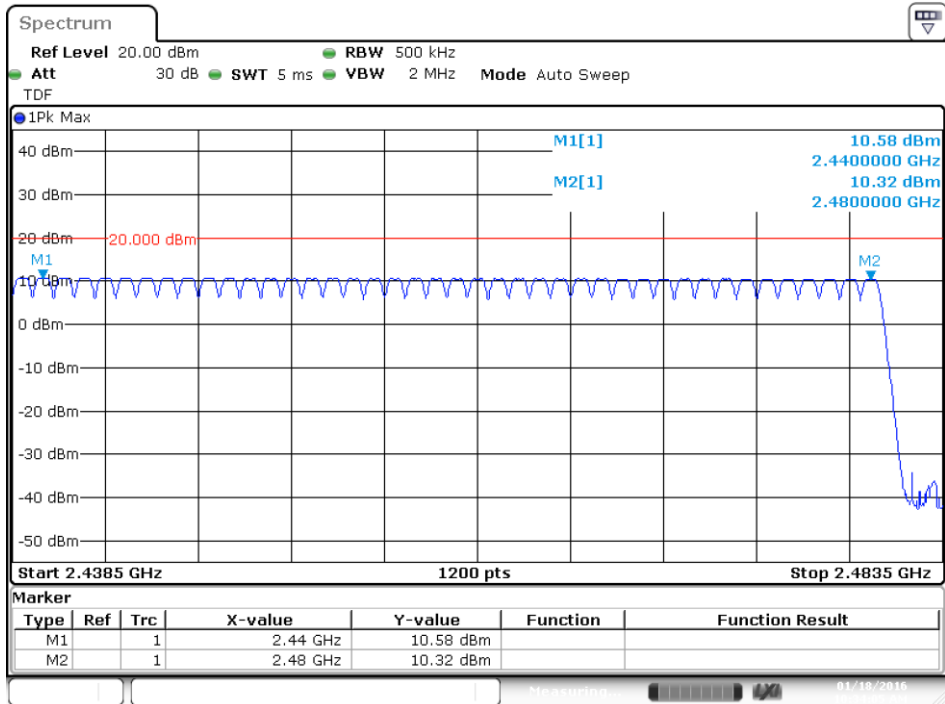
Number of hopping channels

Basic Rate - GFSK

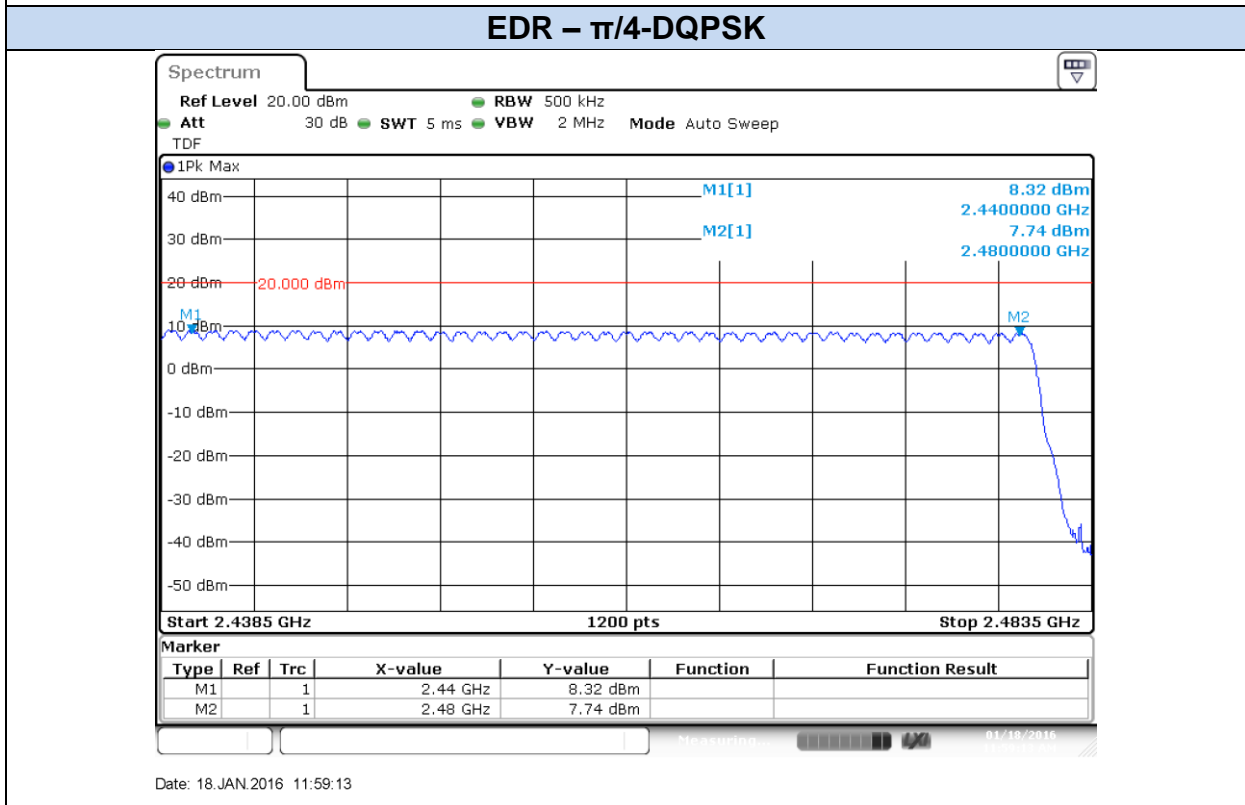
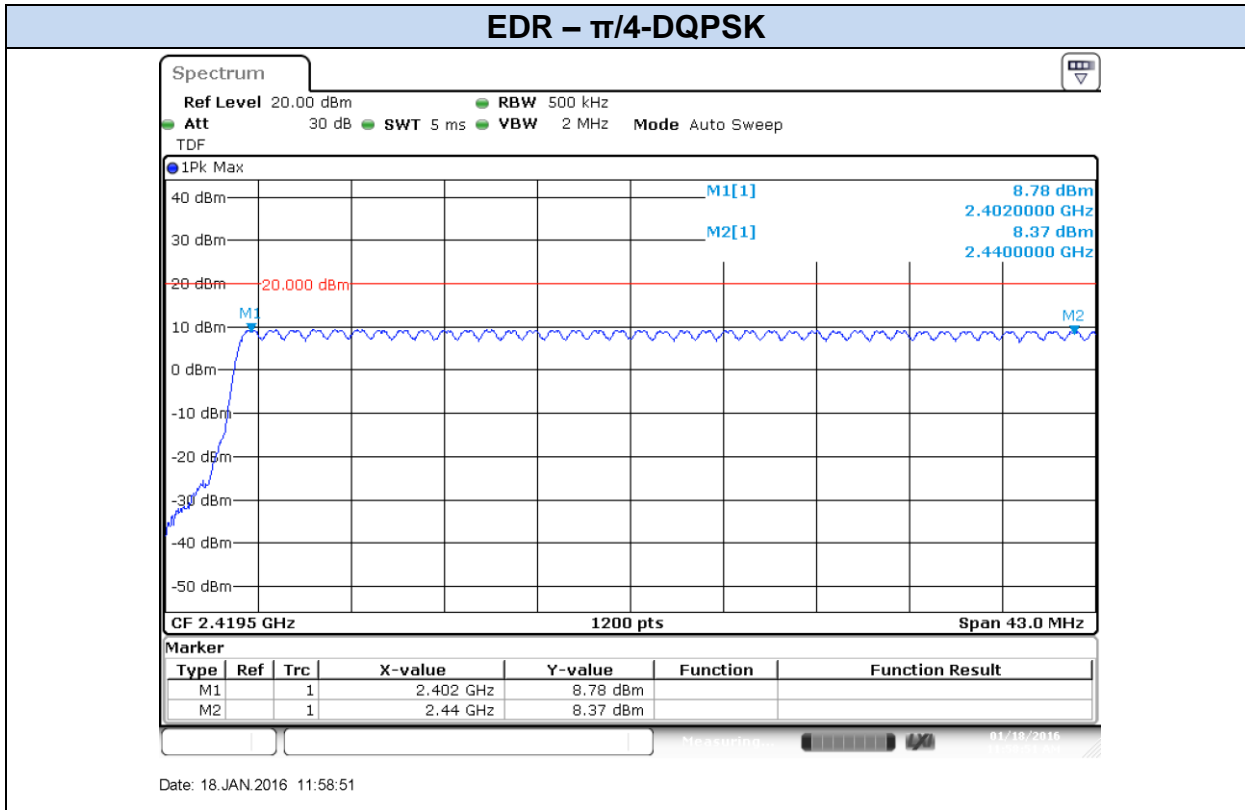


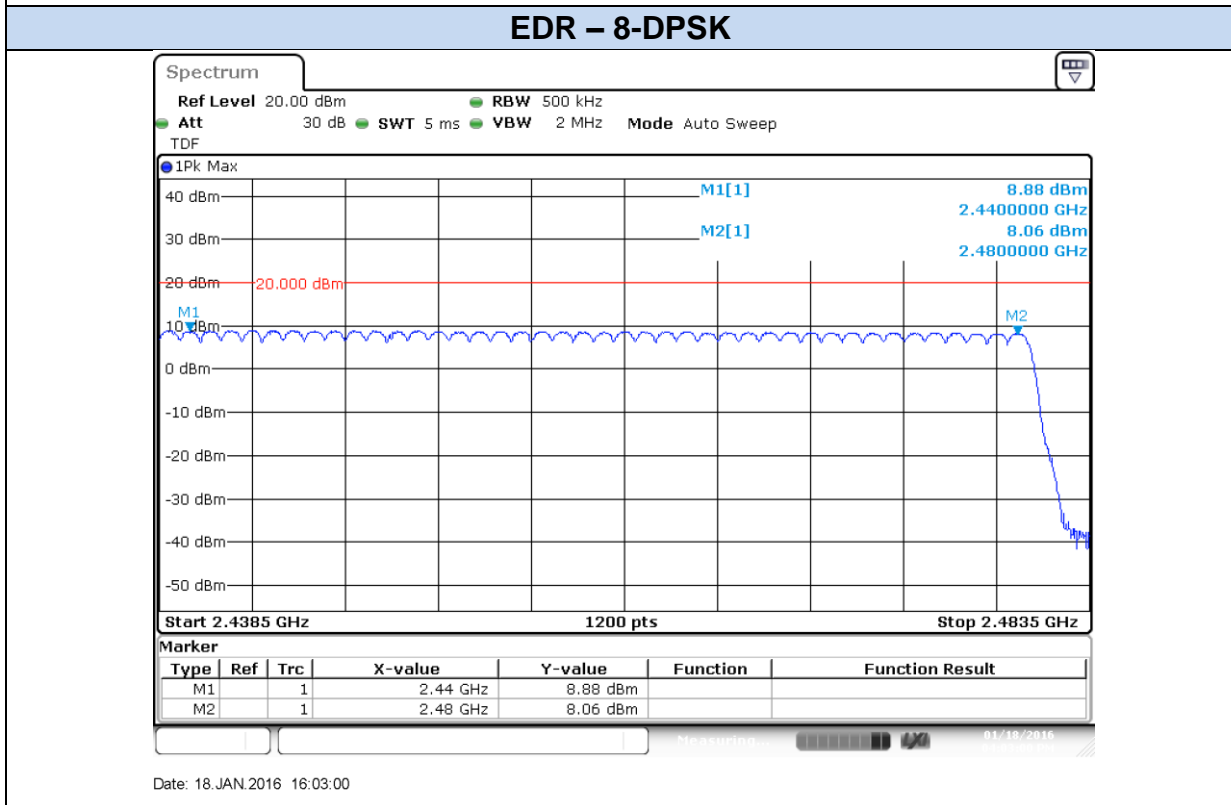
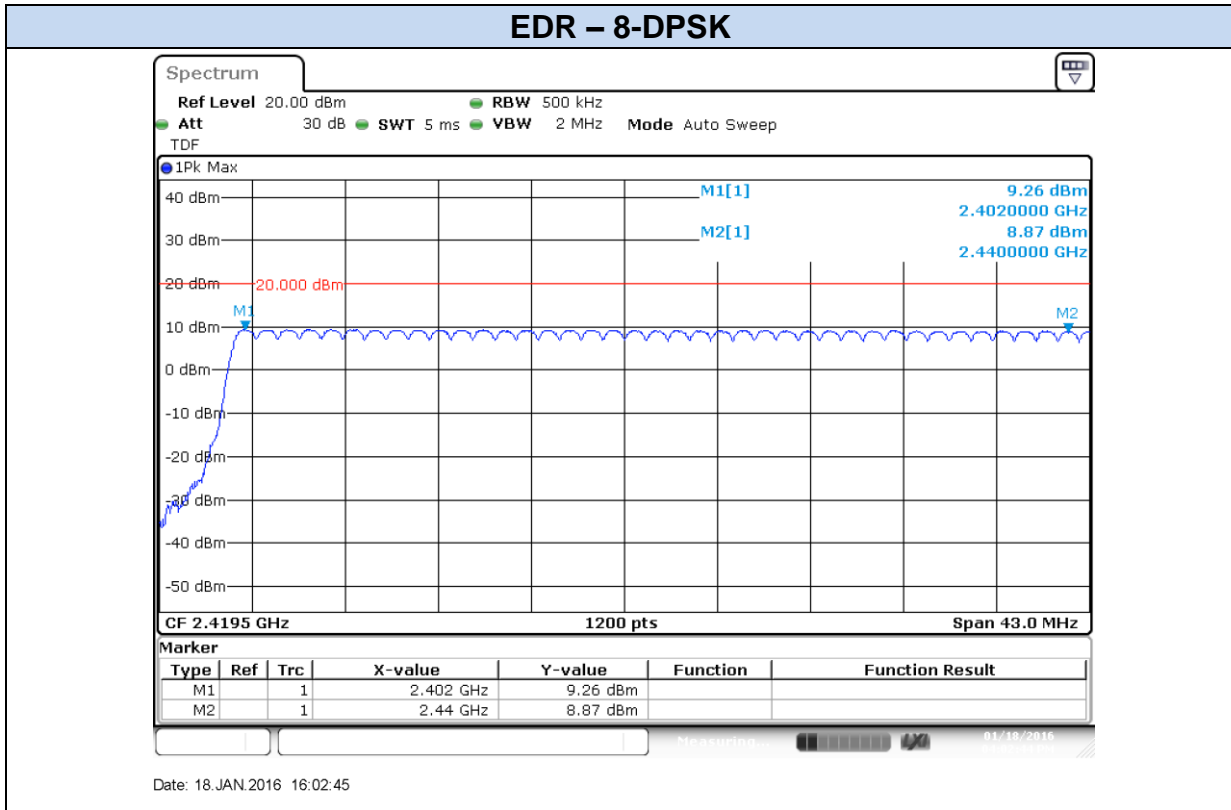
Date: 18.JAN.2016 10:33:09

Basic Rate - GFSK



Date: 18.JAN.2016 10:34:05





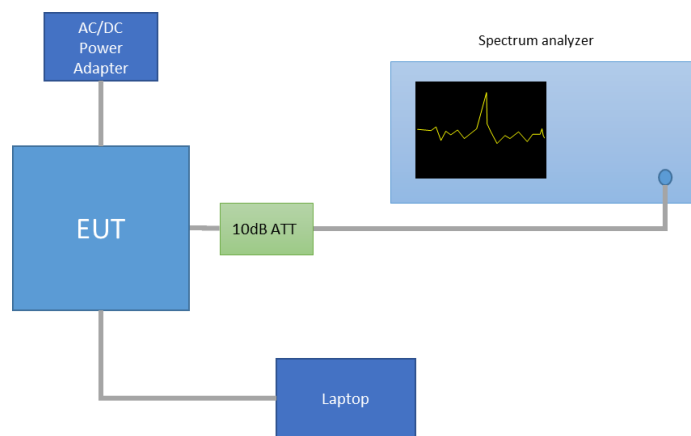
B.3 Time of Occupancy (Dwell Time)

Test limits:

FCC part	RSS part	Limits
15.247 (a) (1) (iii)	RSS-247 Clause 5.1 (4)	The average time of occupancy (Dwell Time) 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 procedure:

The setup below was used to measure the dwell time. The antenna terminal of the EUT is connected to the spectrum analyzer through an attenuator, and the spectrum analyzer reading is compensated to include the RF path loss.



In the worst case, the system makes 1600 hops per second with 79 channels, providing a 1 timeslot length of 625µs.

A DH1 packet, with independence of the modulation, needs 1 time slot for transmitting and 1 time slot for receiving. Then, the system makes in the worst case $1600/2 = 800$ hops per second with 79 channels. So each channel appears $800/79 = 10.13$ times per second and, for a period of $0.4 \times 79 = 31.6$ seconds, each channel appears $10.13 \times 31.6 = 320.11$ times.

A DH3 packet, with independence of the modulation, needs 3 time slots for transmitting and 1 time slot for receiving. Then, the system makes in the worst case $1600/4 = 400$ hops per second with 79 channels. So each channel appears $400/79 = 5.1$ times per second and, for a period of $0.4 \times 79 = 31.6$ seconds, each channel appears $5.1 \times 31.6 = 161.16$ times.

A DH5 packet, with independence of the modulation, needs 5 time slots for transmitting and 1 time slot for receiving. Then, the system makes in the worst case $1600/6 = 266.67$ hops per second with 79 channels. So each channel appears $266.67/79 = 3.37$ times per second and, for a period of $0.4 \times 79 = 31.6$ seconds, each channel appears $3.37 \times 31.6 = 106.49$ times.

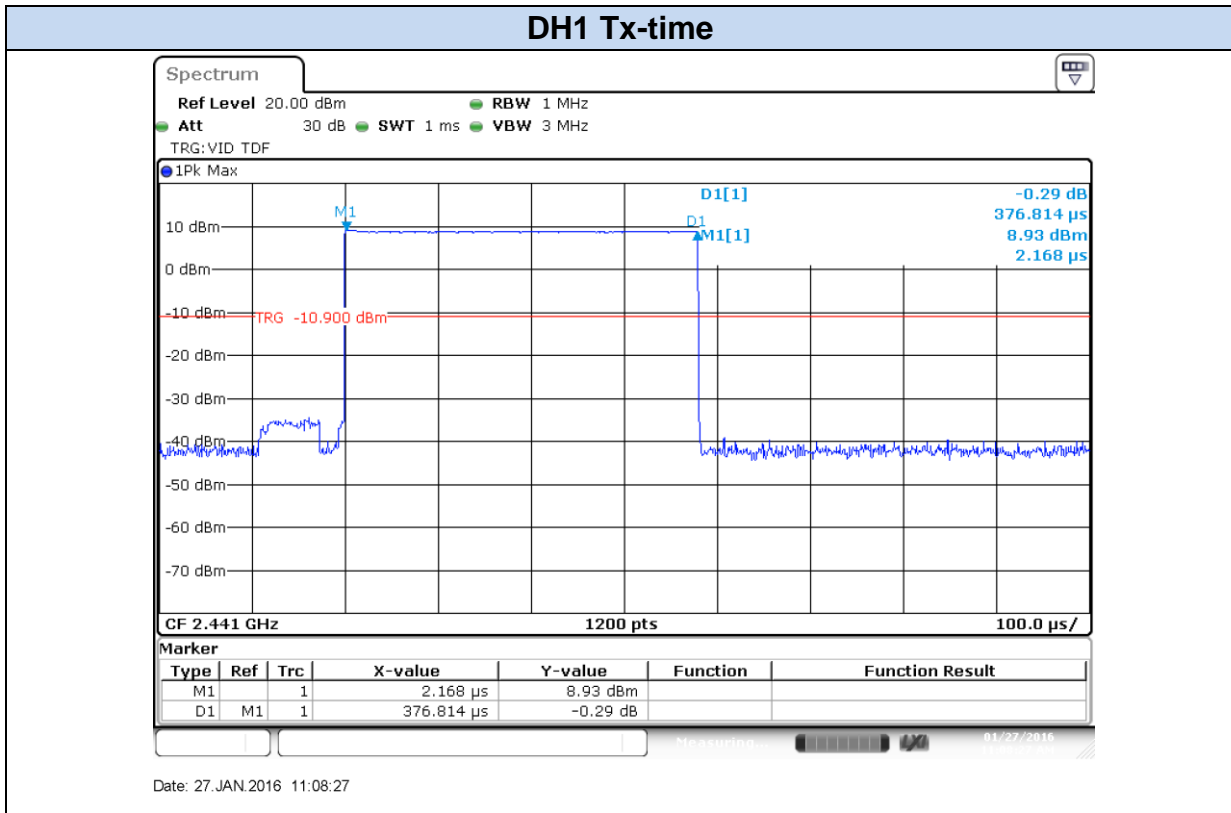
Thus, the total time of occupancy is obtained by multiplying the calculated maximum number of appearances per packet type and the measured Tx-time, as shown in the results screenshots.

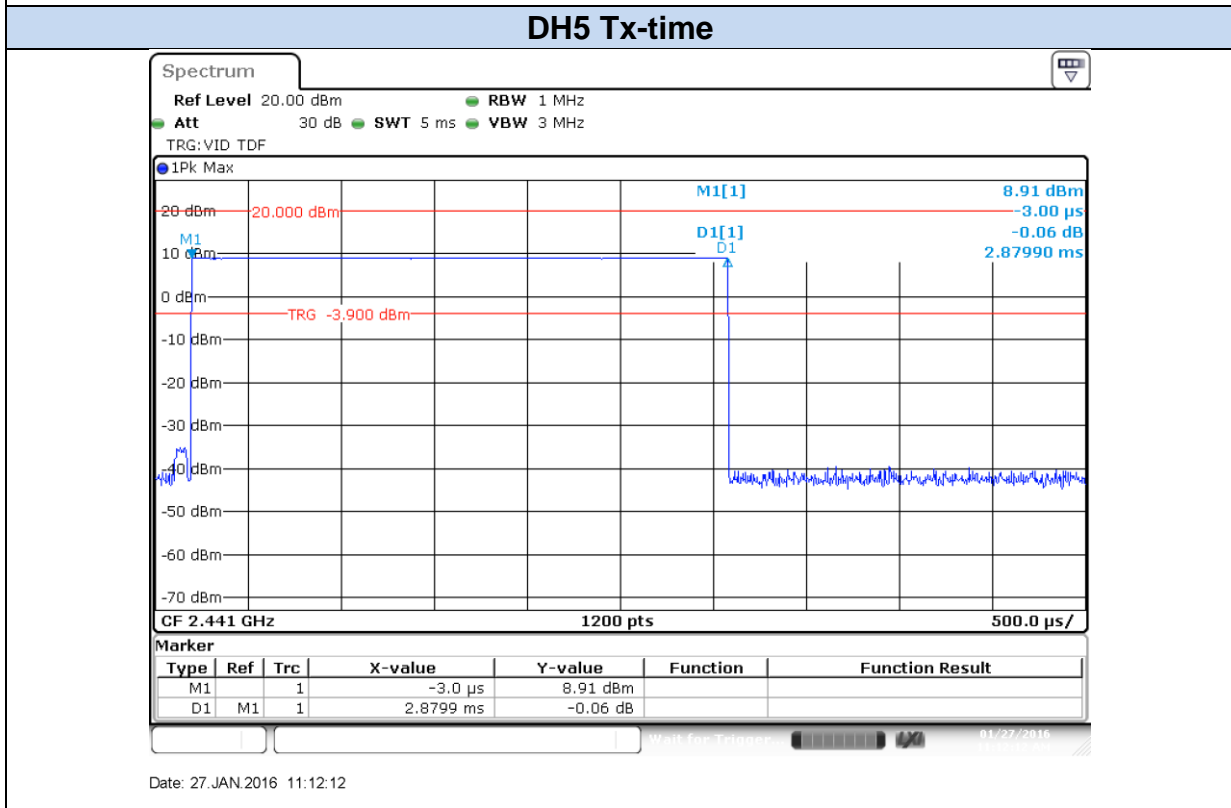
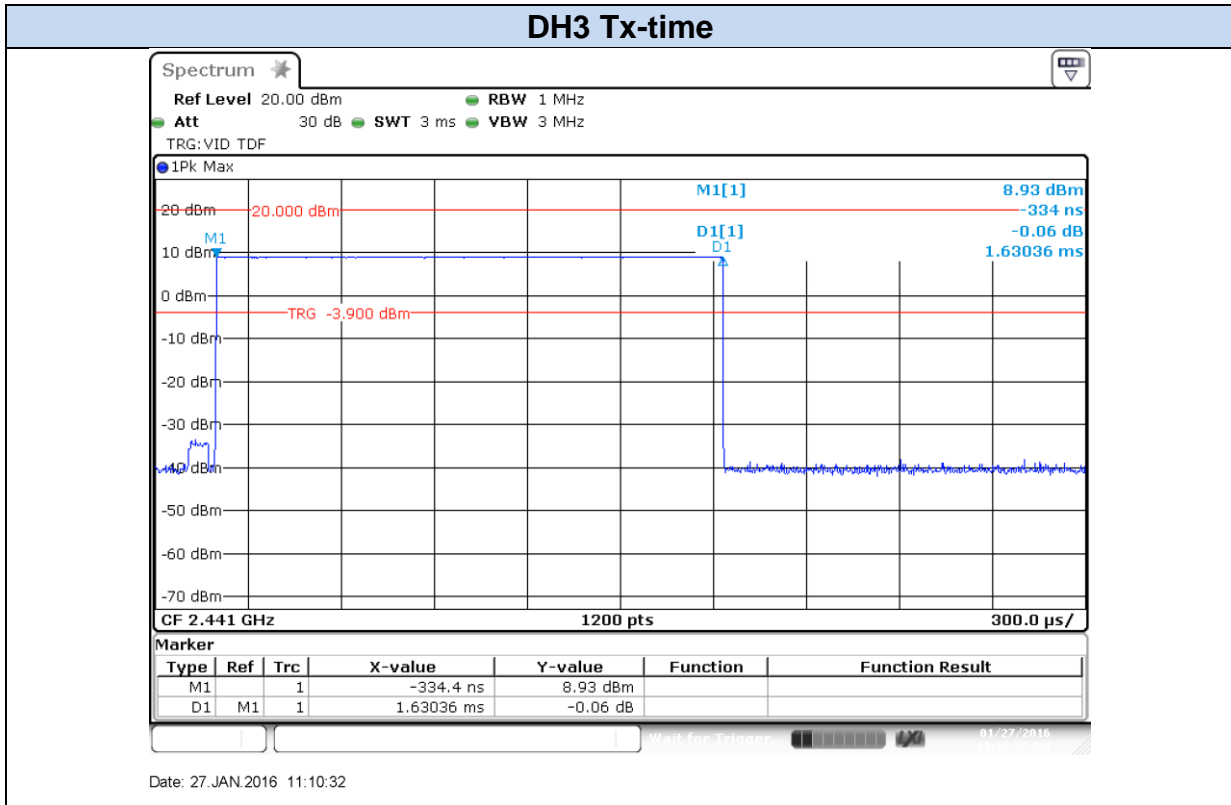
Results tables:

Mode	Packet Type	Times of appearance	Tx-time [ms]	Dwell Time [ms]
Basic Rate GFSK	DH1	320.11	0.377	120.68
	DH3	161.16	1.630	262.69
	DH5	106.49	2.880	306.69
EDR $\pi/4$ -DQPSK	2-DH1	320.11	0.389	124.52
	2-DH3	161.16	1.635	263.50
	2-DH5	106.49	2.882	306.80
EDR 8-DPSK	3-DH1	320.11	0.389	124.52
	3-DH3	161.16	1.635	263.50
	3-DH5	106.49	2.886	307.33

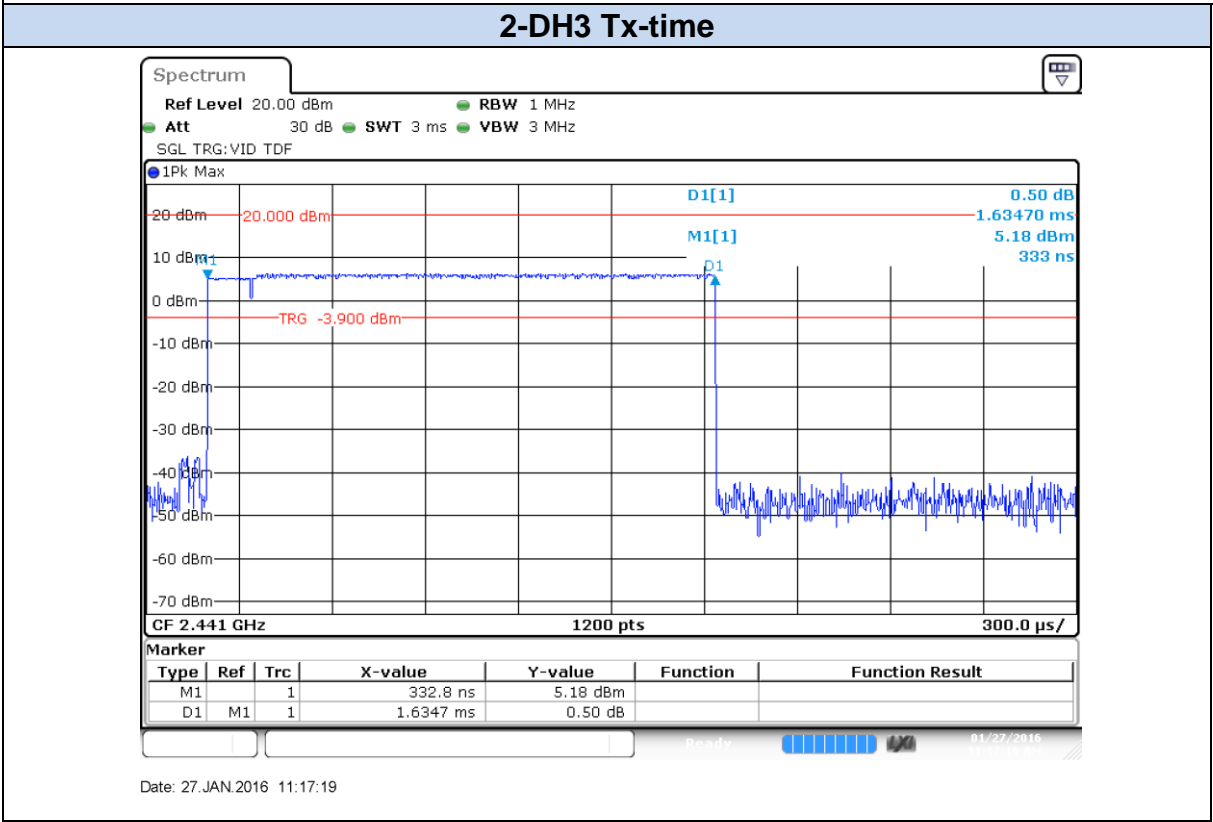
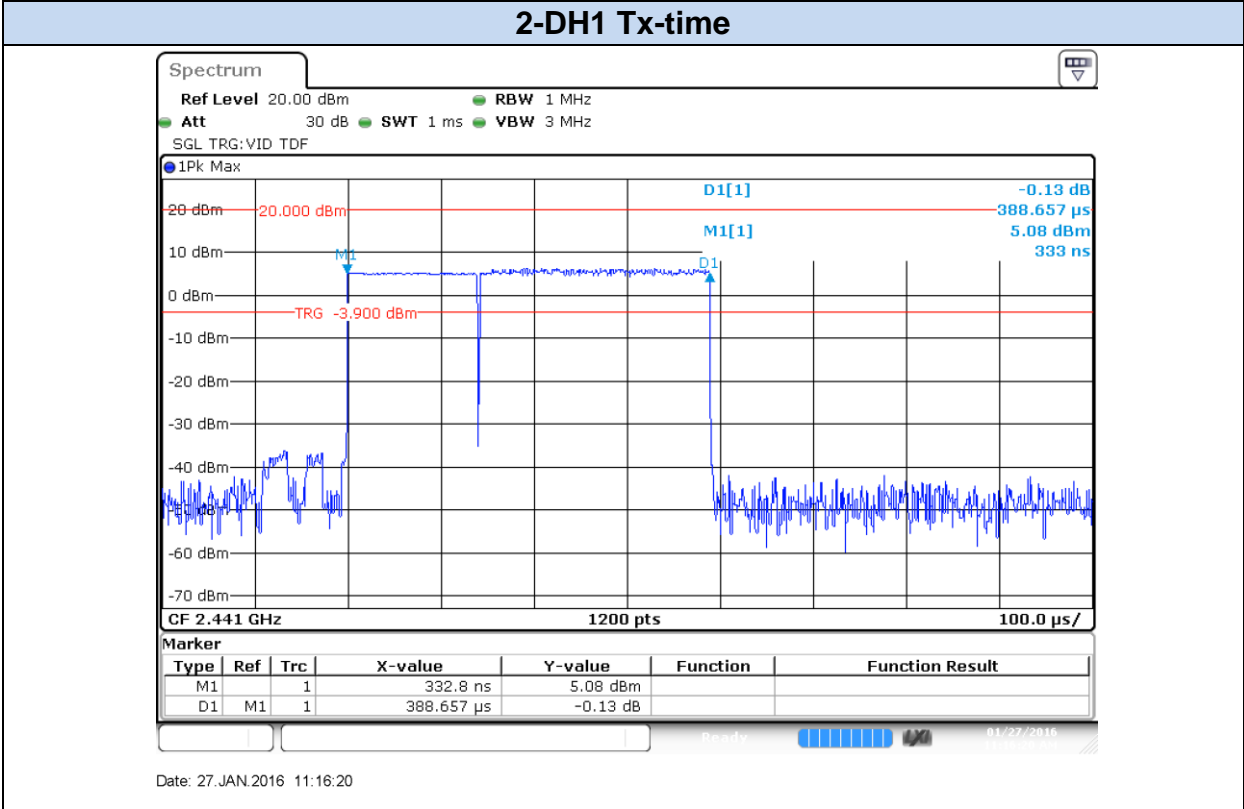
Results Screenshot:

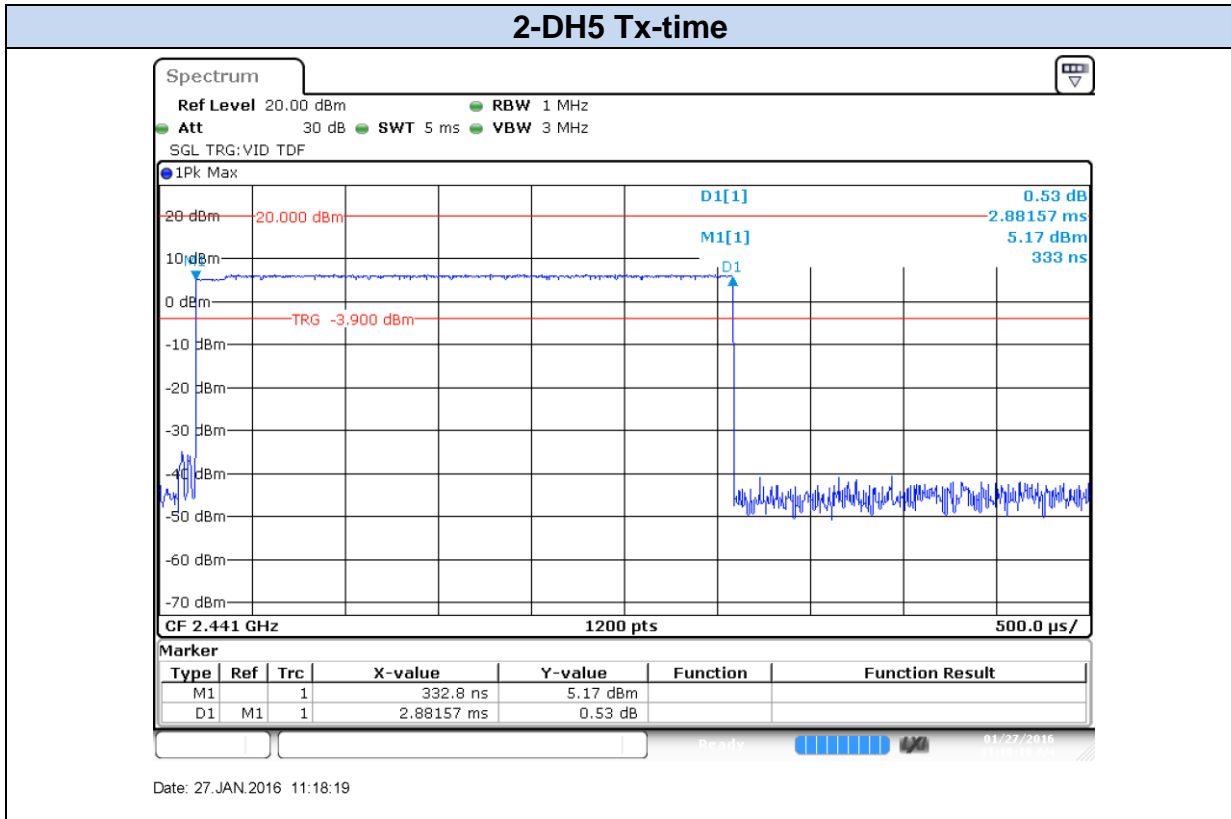
BDR – GFSK





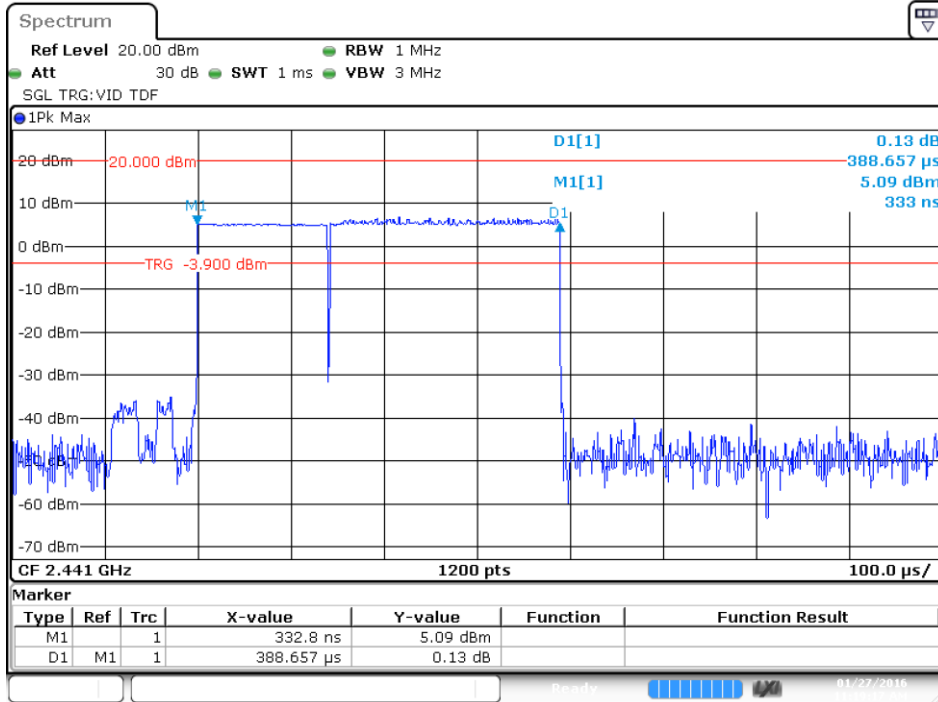
EDR – $\pi/4$ -DQPSK





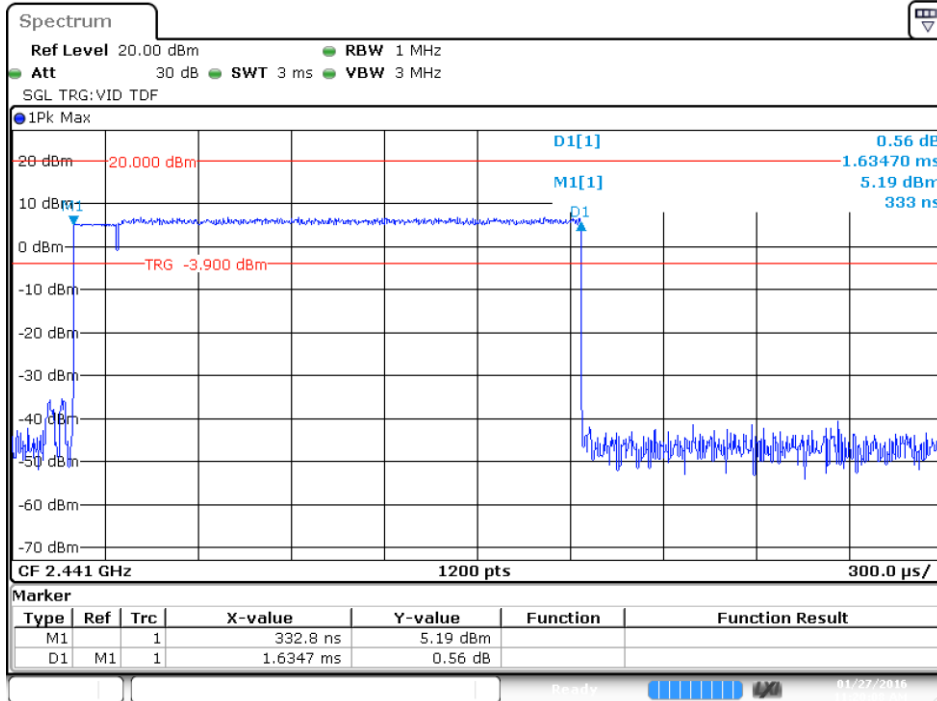
EDR – 8-DPSK

3-DH1 Tx-time

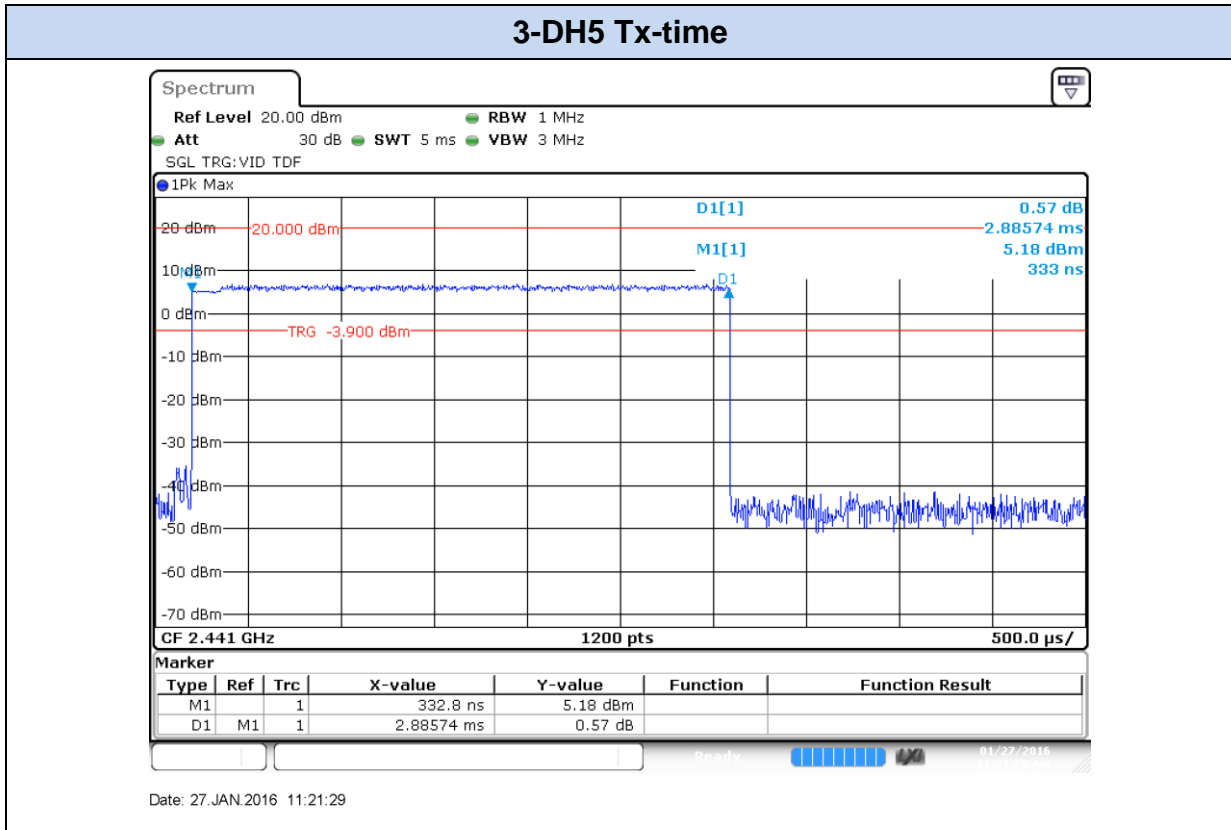


Date: 27.JAN.2016 11:19:17

3-DH3 Tx-time



Date: 27.JAN.2016 11:20:08



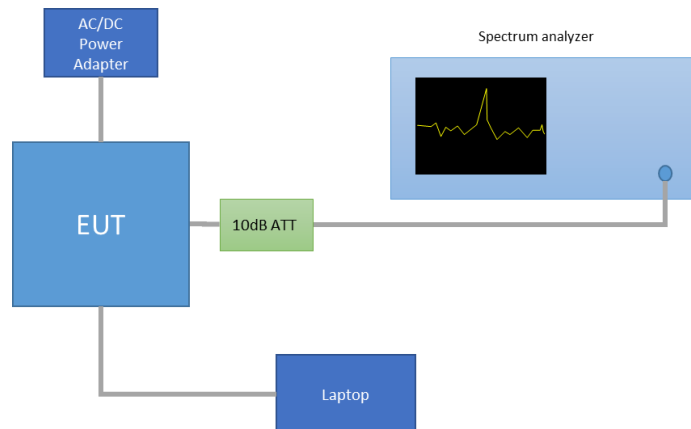
B.4 Maximum Peak Output Power and antenna gain

Test limits:

FCC part	RSS part	Limits
15.247 (b) (1)	RSS-247 Clause 5.4 (2)	<p>(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:</p> <p>(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. (...)</p> <p>(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 dBi.</p>

Test procedure:

The setup below was used to measure the maximum peak output power. The antenna terminal of the EUT is connected to the spectrum analyzer through an attenuator, and the spectrum analyzer reading is compensated to include the RF path loss.



The declared maximum antenna gain is 3dBi.

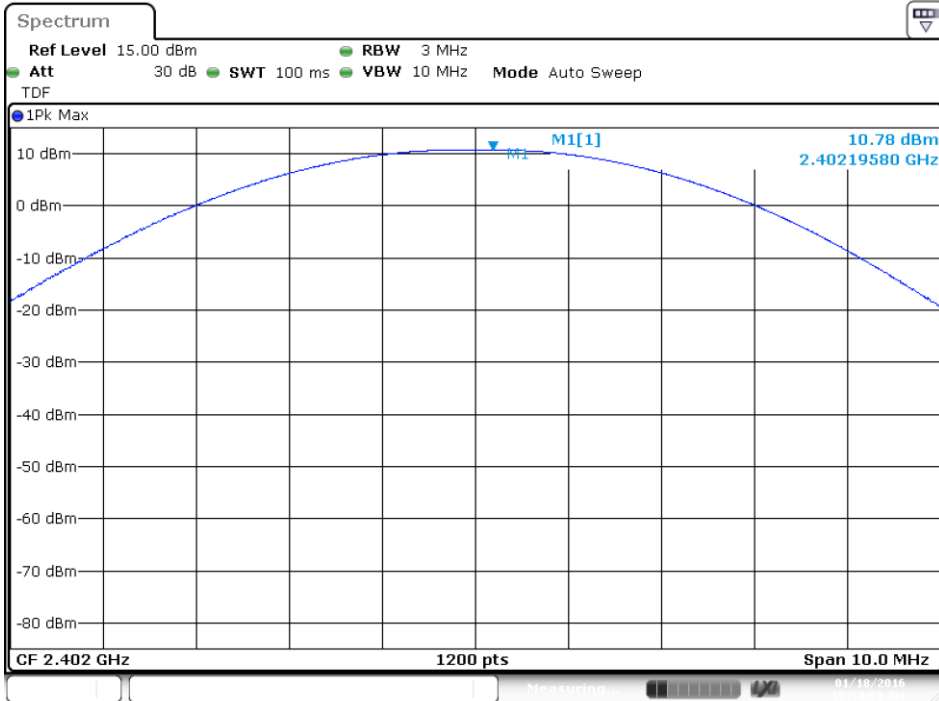
Results tables:

Mode	Channel Number	Frequency [MHz]	Peak Power [dBm]
Basic Rate GFSK	0	2402	10.78
	39	2441	10.69
	78	2480	10.43
EDR π/4-DQPSK	0	2402	10.22
	39	2441	9.98
	78	2480	9.58
EDR 8-DPSK	0	2402	10.36
	39	2441	10.14
	78	2480	9.75

Results Screenshot:

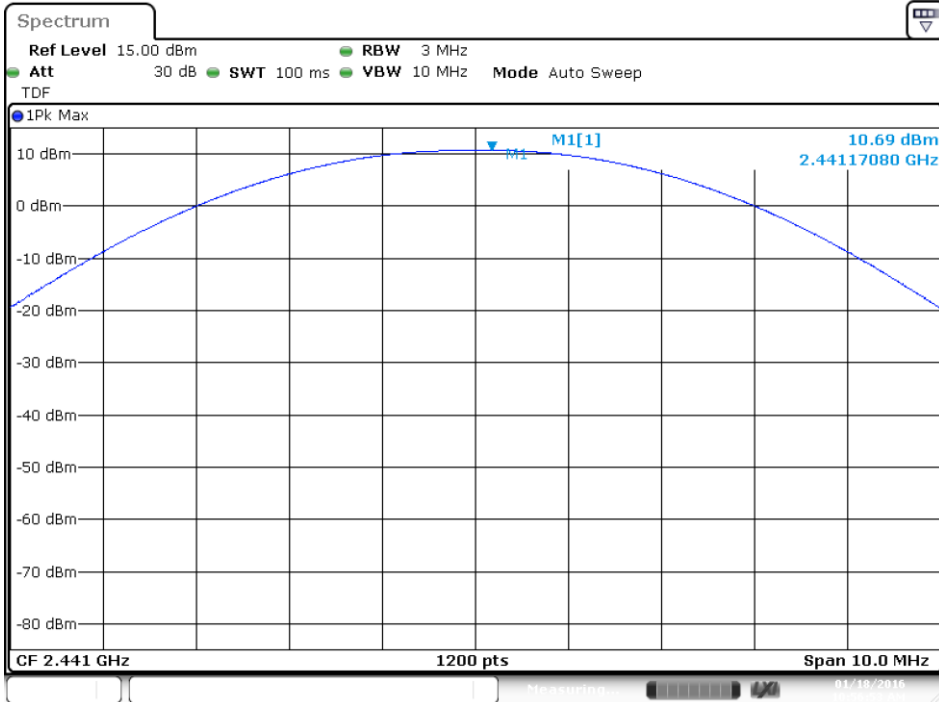
Basic Rate - GFSK

Peak Power - CH0

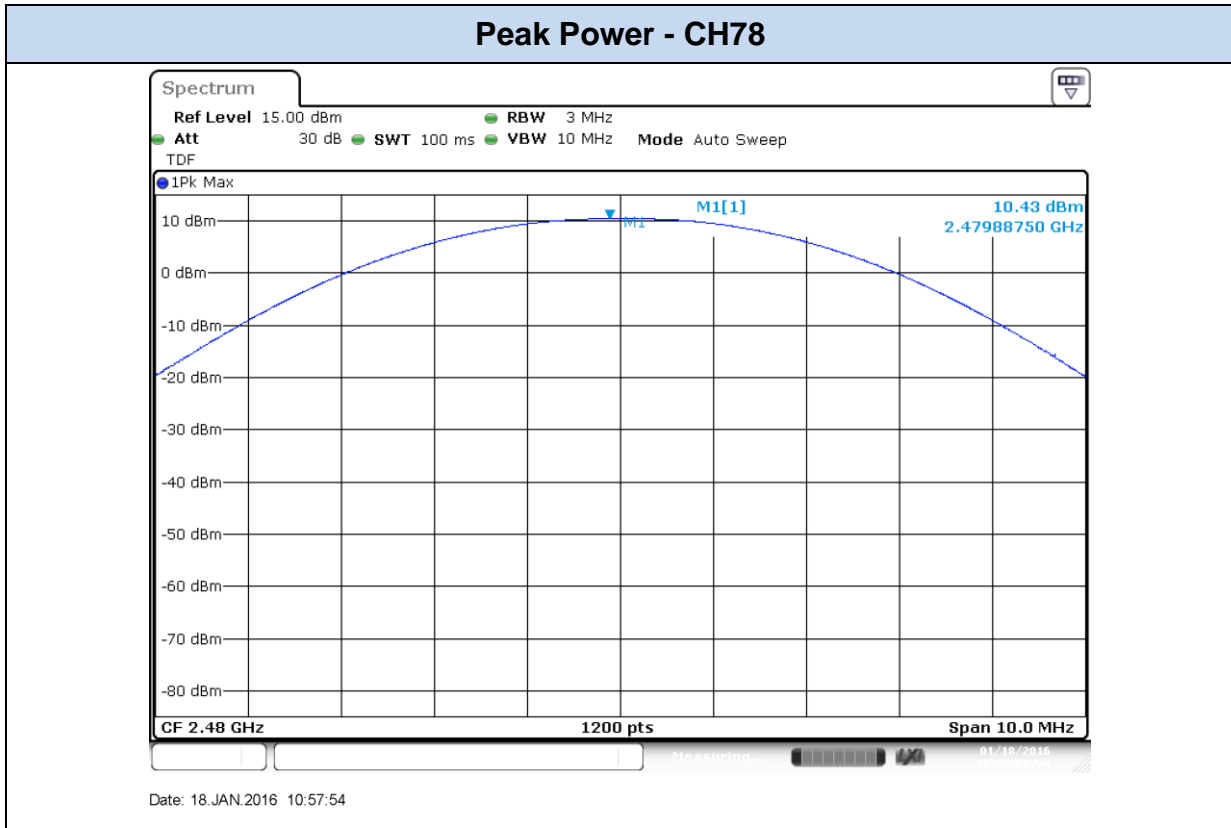


Date: 18. JAN 2016 10:55:00

Peak Power - CH39

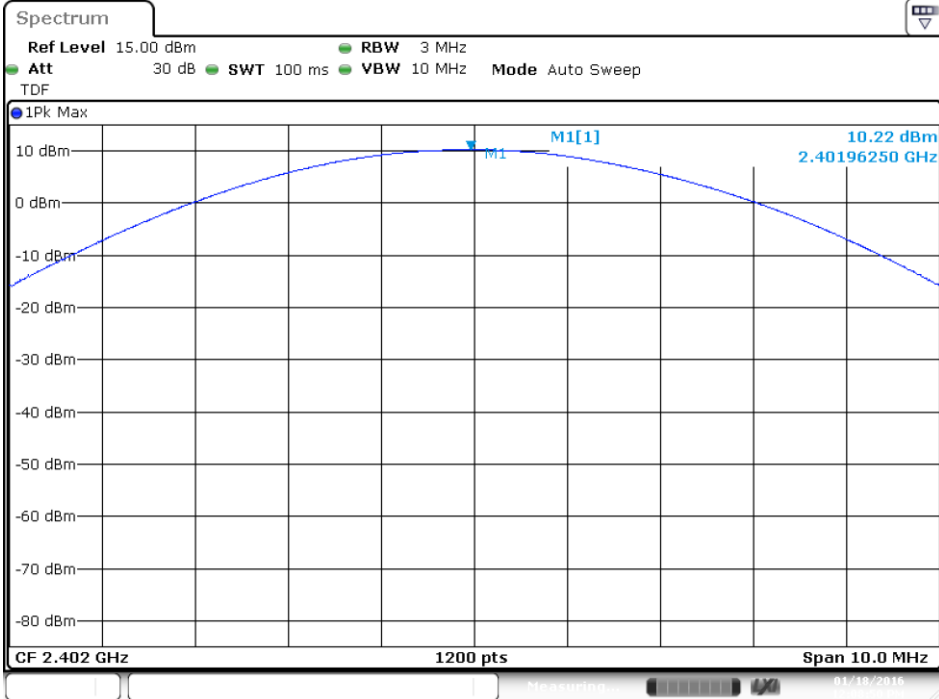


Date: 18. JAN 2016 10:56:53



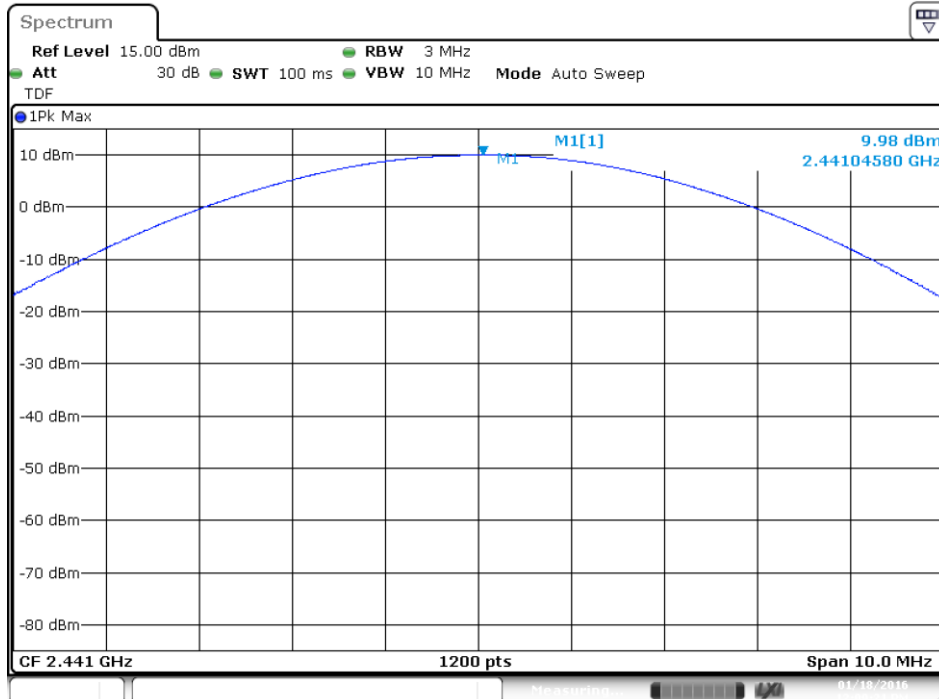
EDR – $\pi/4$ -DQPSK

Peak Power - CH0

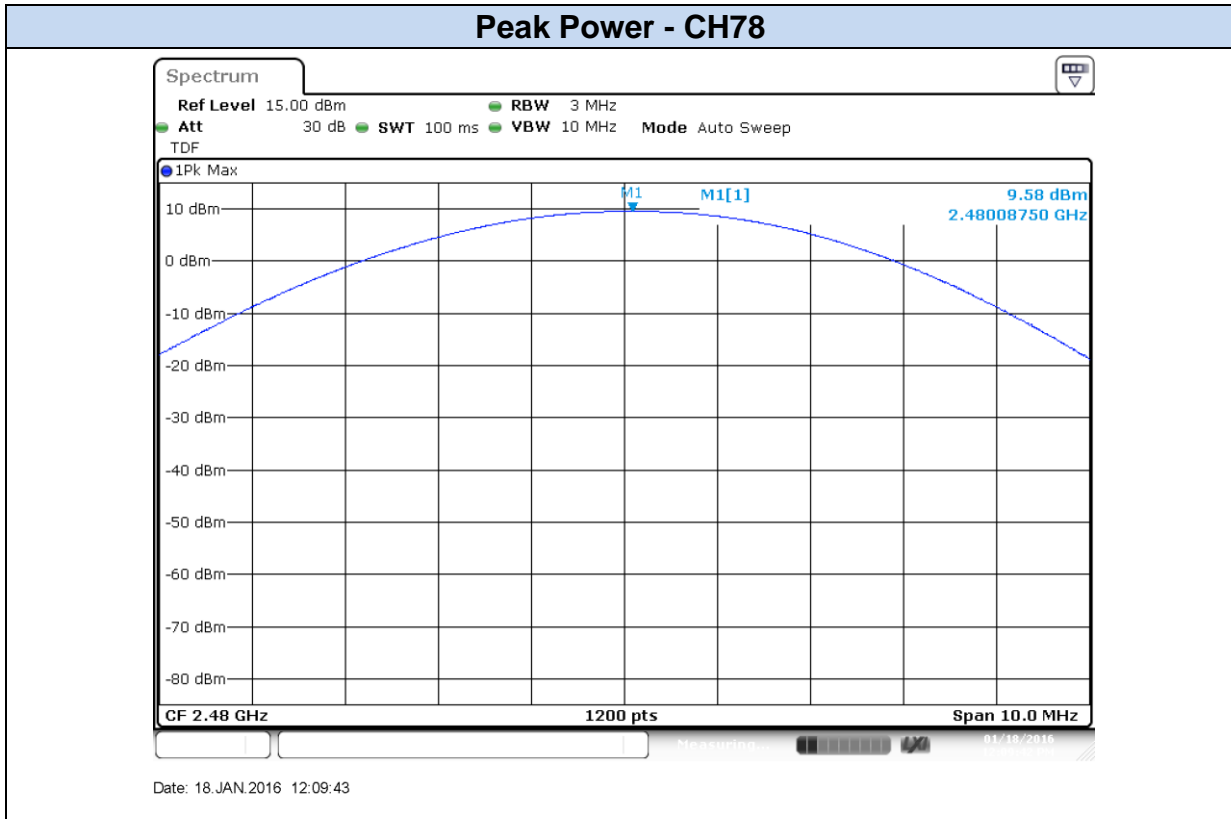


Date: 18.JAN.2016 12:08:50

Peak Power - CH39

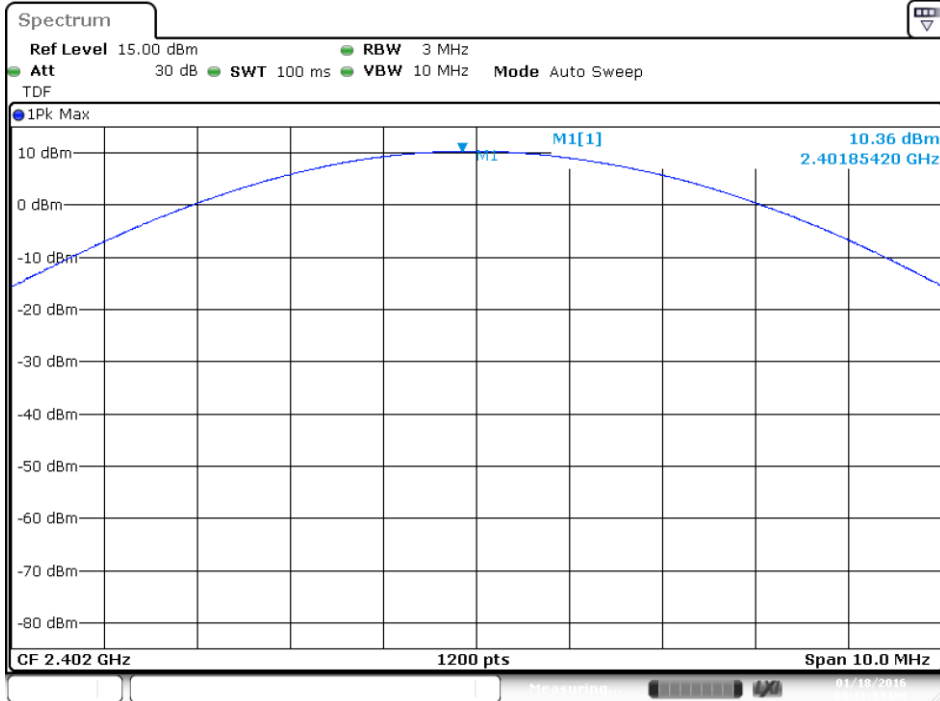


Date: 18.JAN.2016 12:09:22



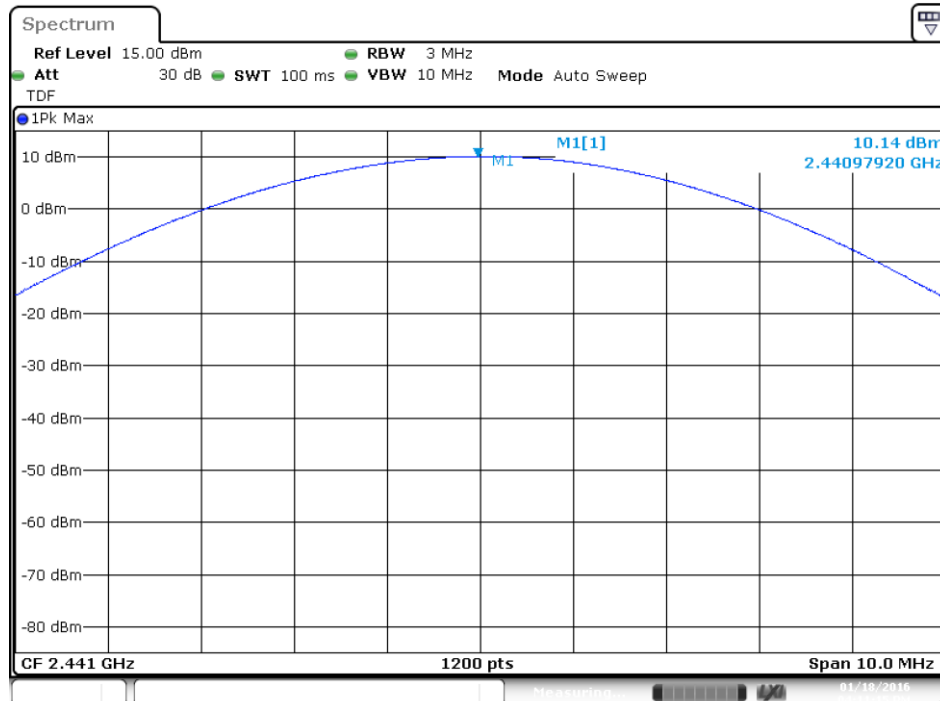
EDR – 8-DPSK

Peak Power - CH0

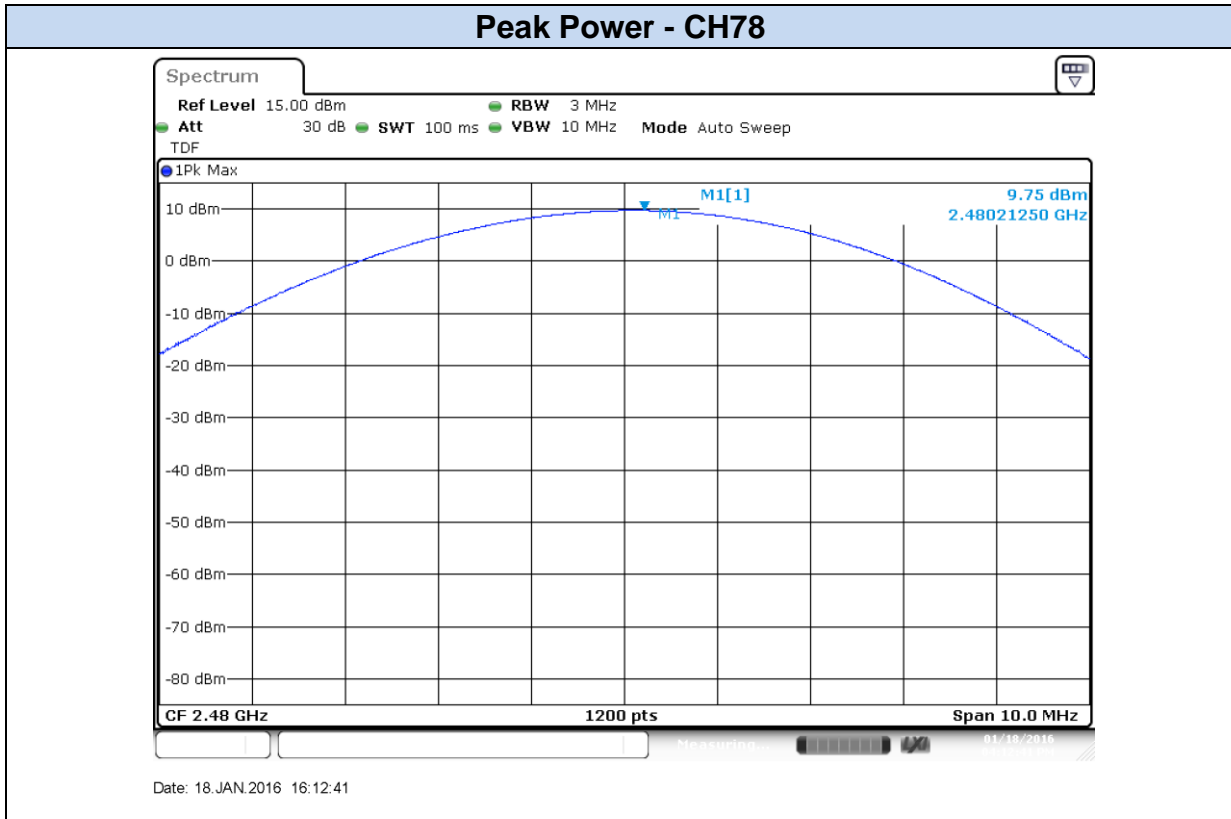


Date: 18.JAN.2016 16:12:15

Peak Power - CH39



Date: 18.JAN.2016 16:11:16



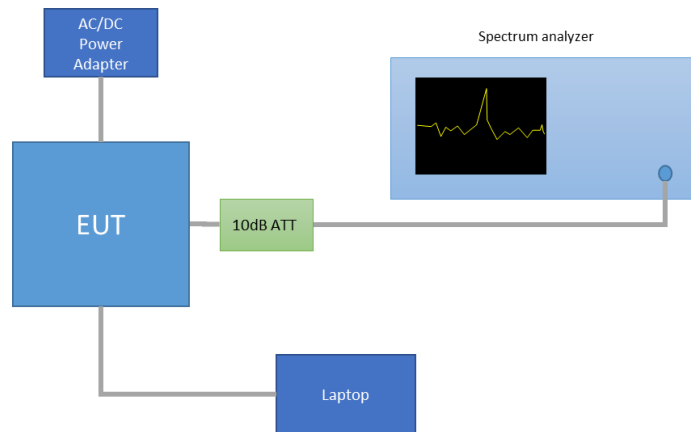
B.5 Out-of-band emissions (conducted)

Test limits:

FCC part	RSS part	Limits
15.247 (d)	RSS-247 Clause 5.5	In any 100 kHz 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 dB below that in the 100 kHz 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.

Test procedure:

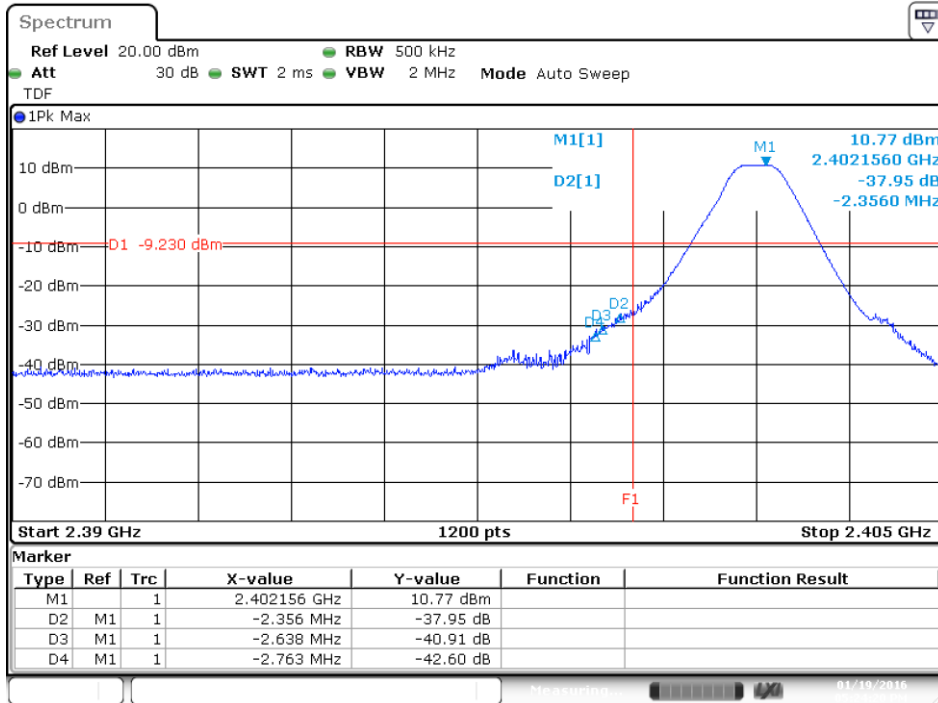
The setup below was used to measure the out-of-band emissions (conducted). The antenna terminal of the EUT is connected to the spectrum analyzer through an attenuator, and the spectrum analyzer reading is compensated to include the RF path loss.



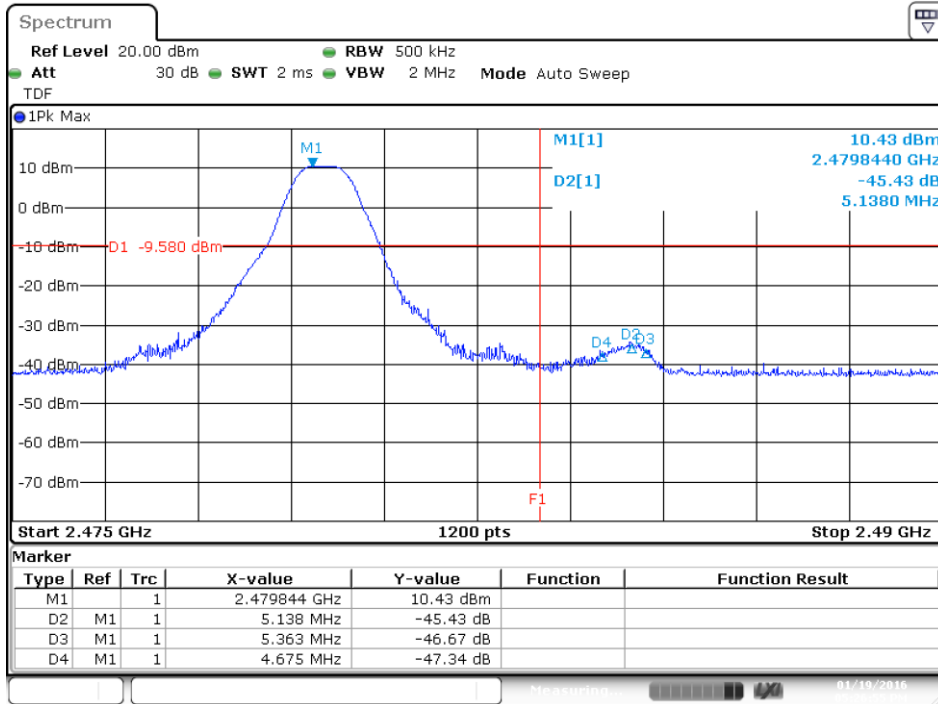
Band Edge results Screenshot:

Basic Rate - GFSK

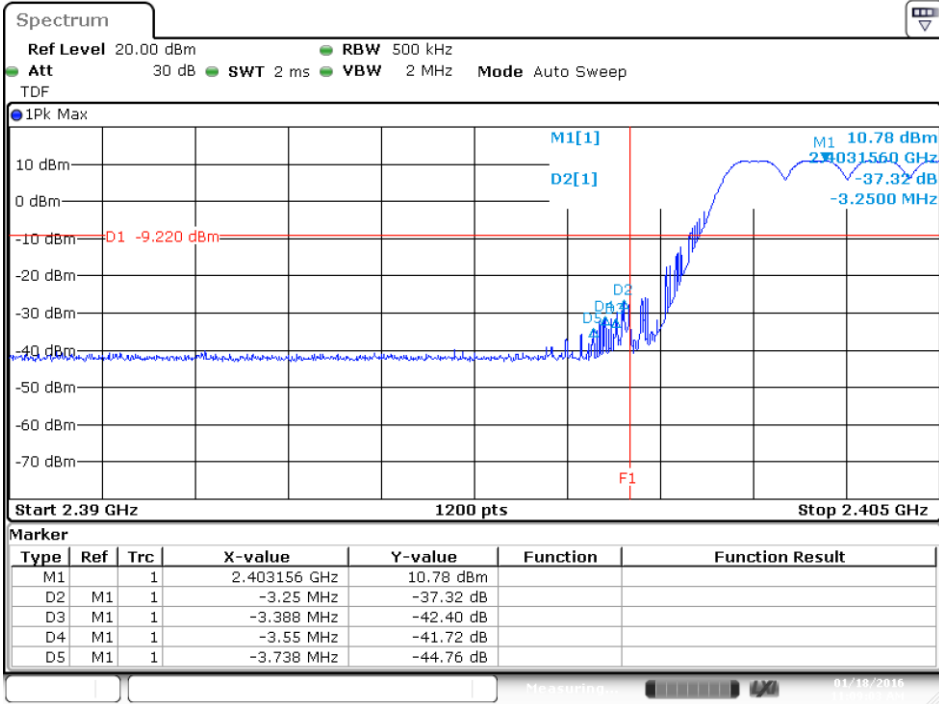
BE Low Freq Section - CH0



BE High Freq Section - CH78

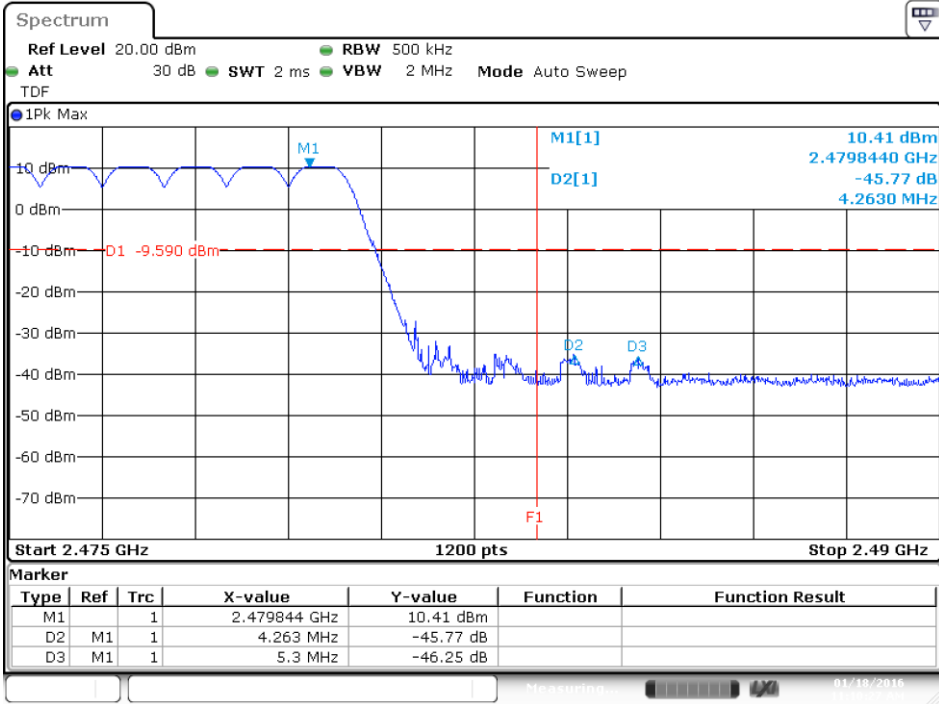


BE Low Freq Section - Hopping



Date: 18.JAN.2016 11:09:03

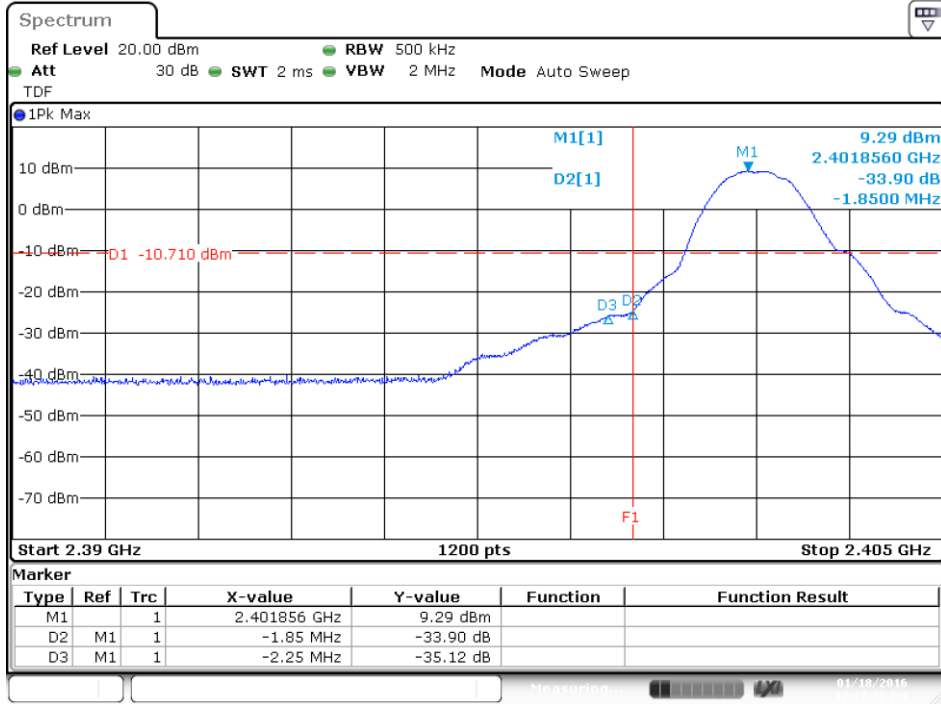
BE High Freq Section - Hopping



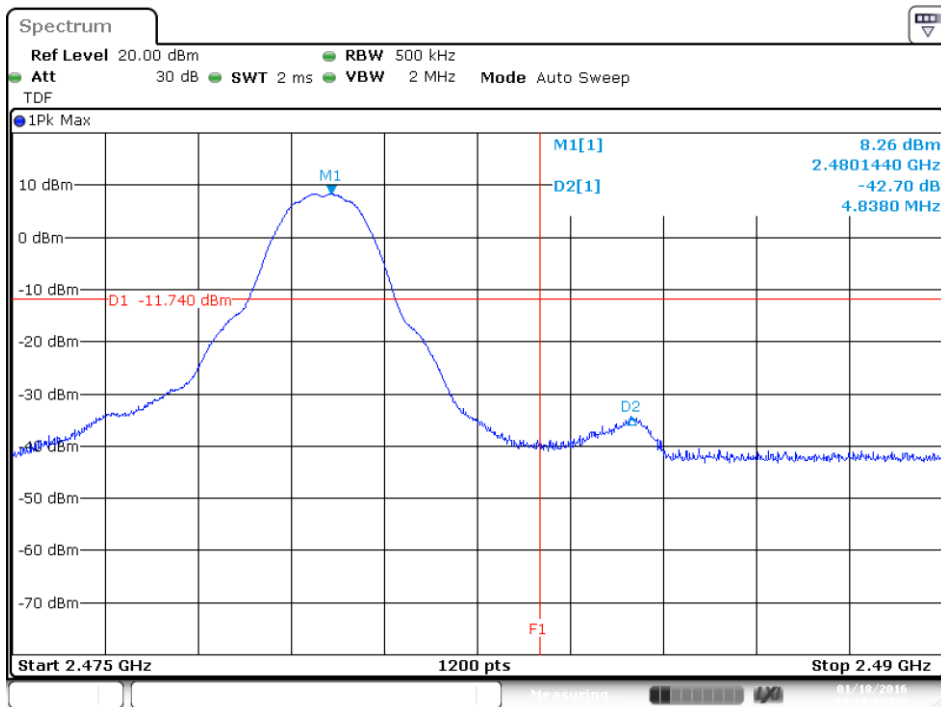
Date: 18.JAN.2016 11:10:27

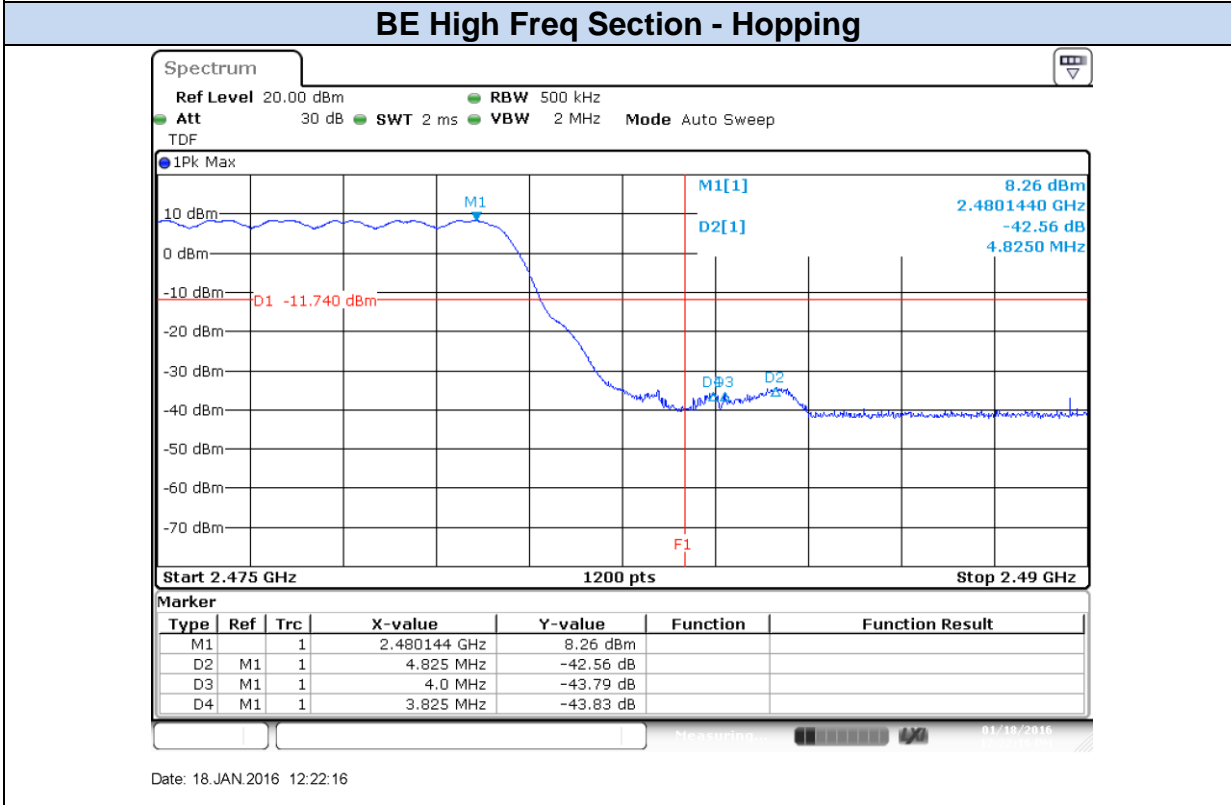
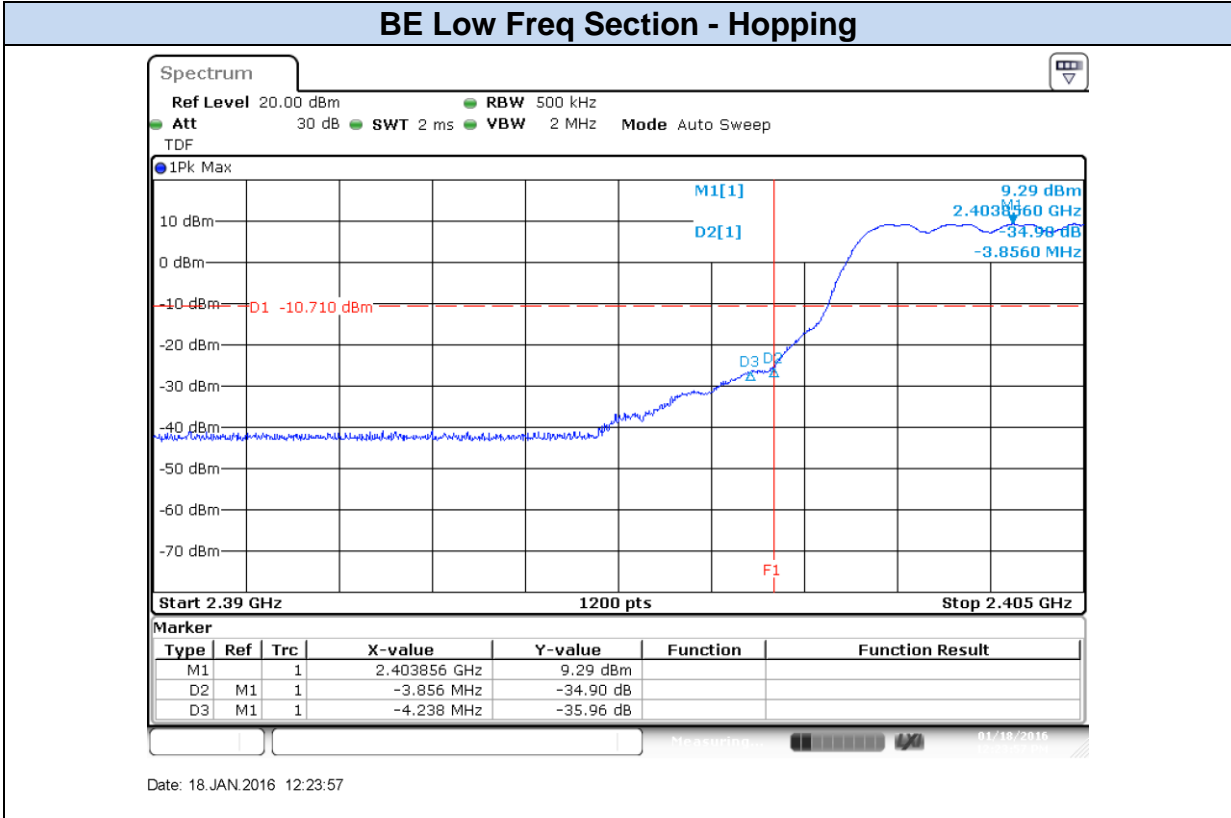
EDR – $\pi/4$ -DQPSK

BE Low Freq Section - CH0

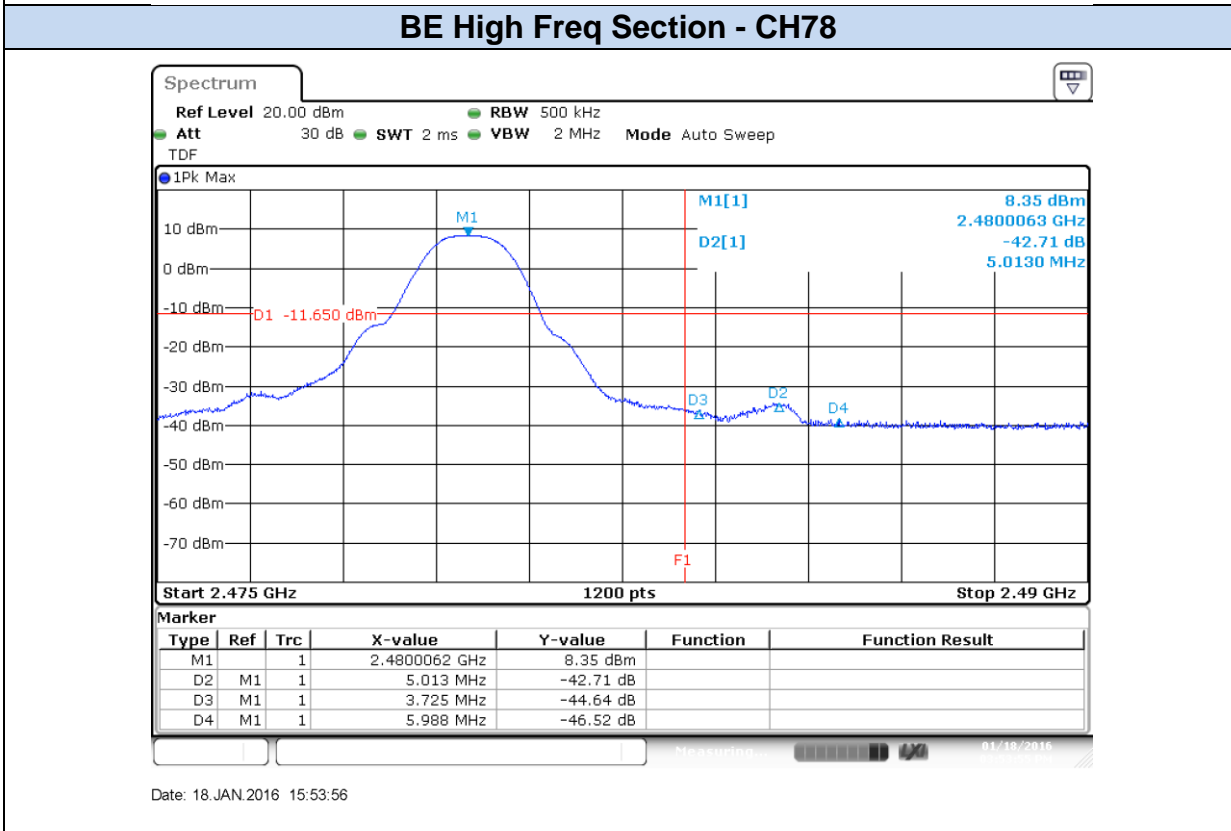
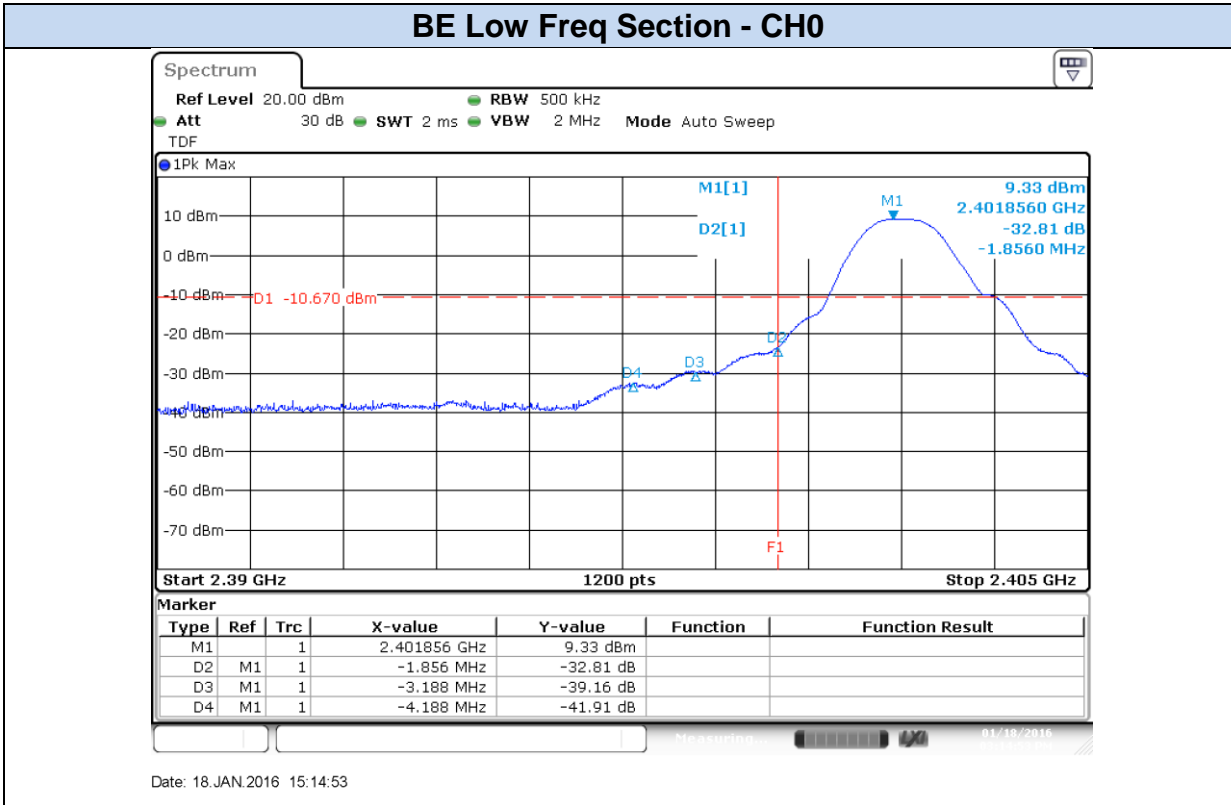


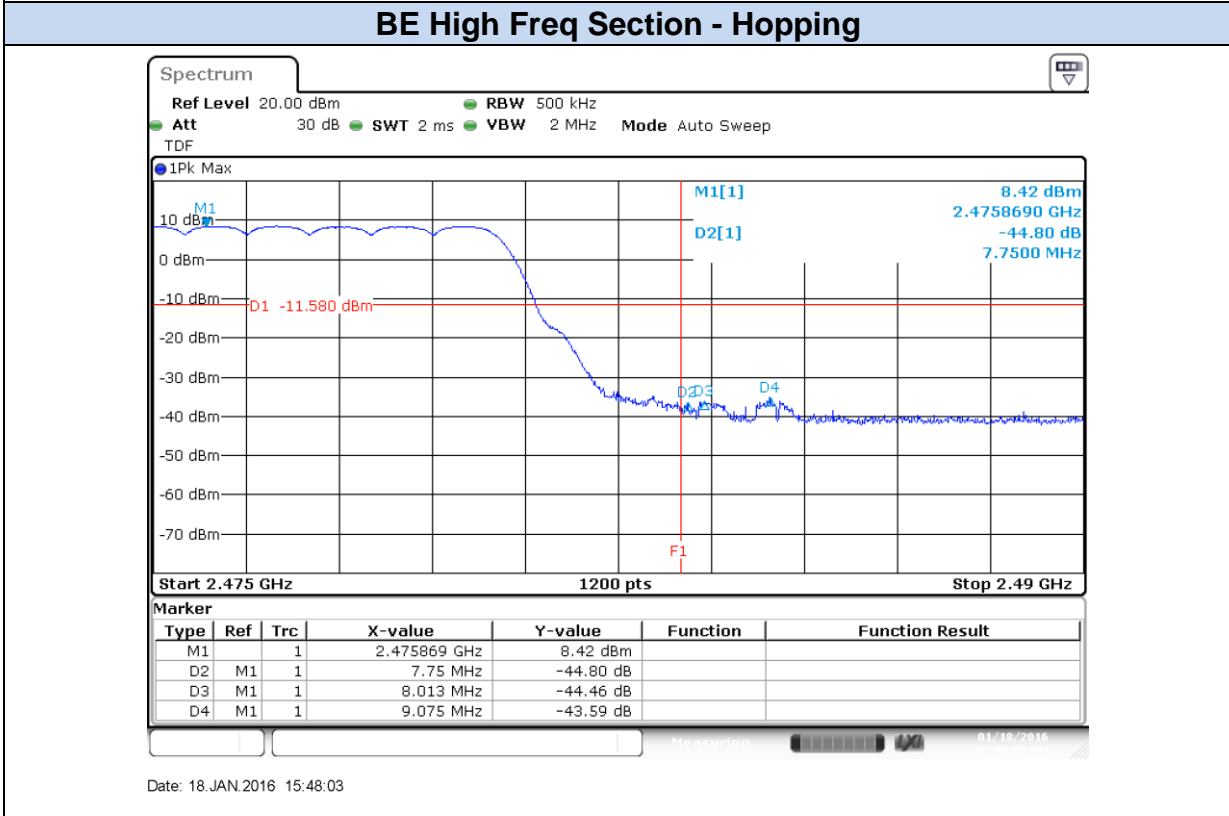
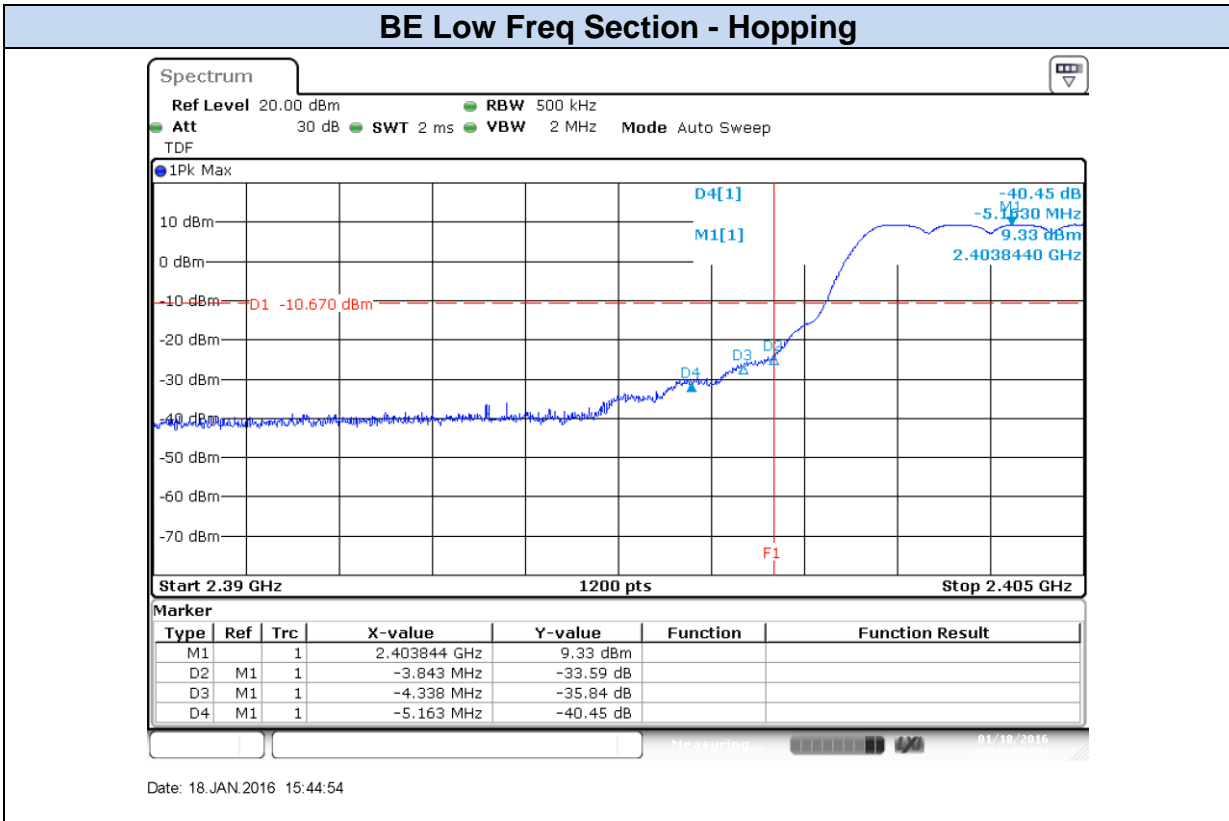
BE High Freq Section - CH78





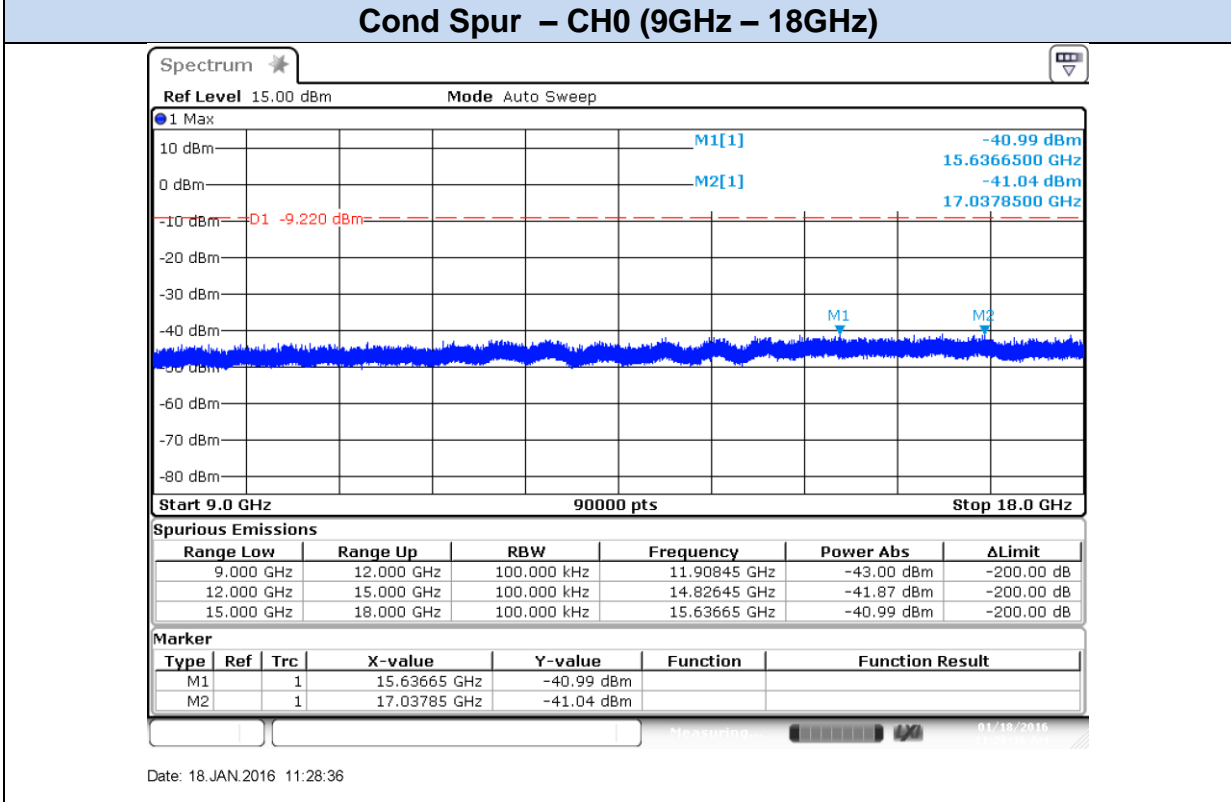
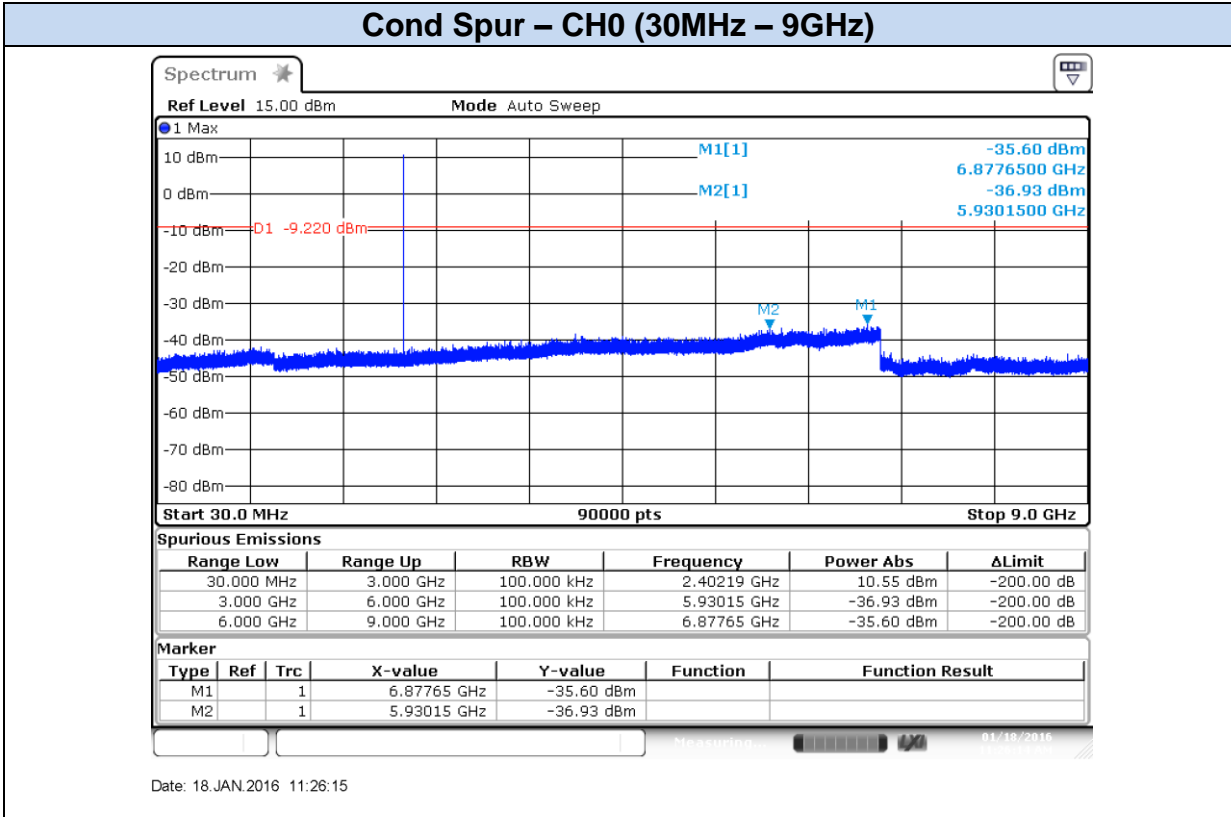
EDR – 8-DPSK

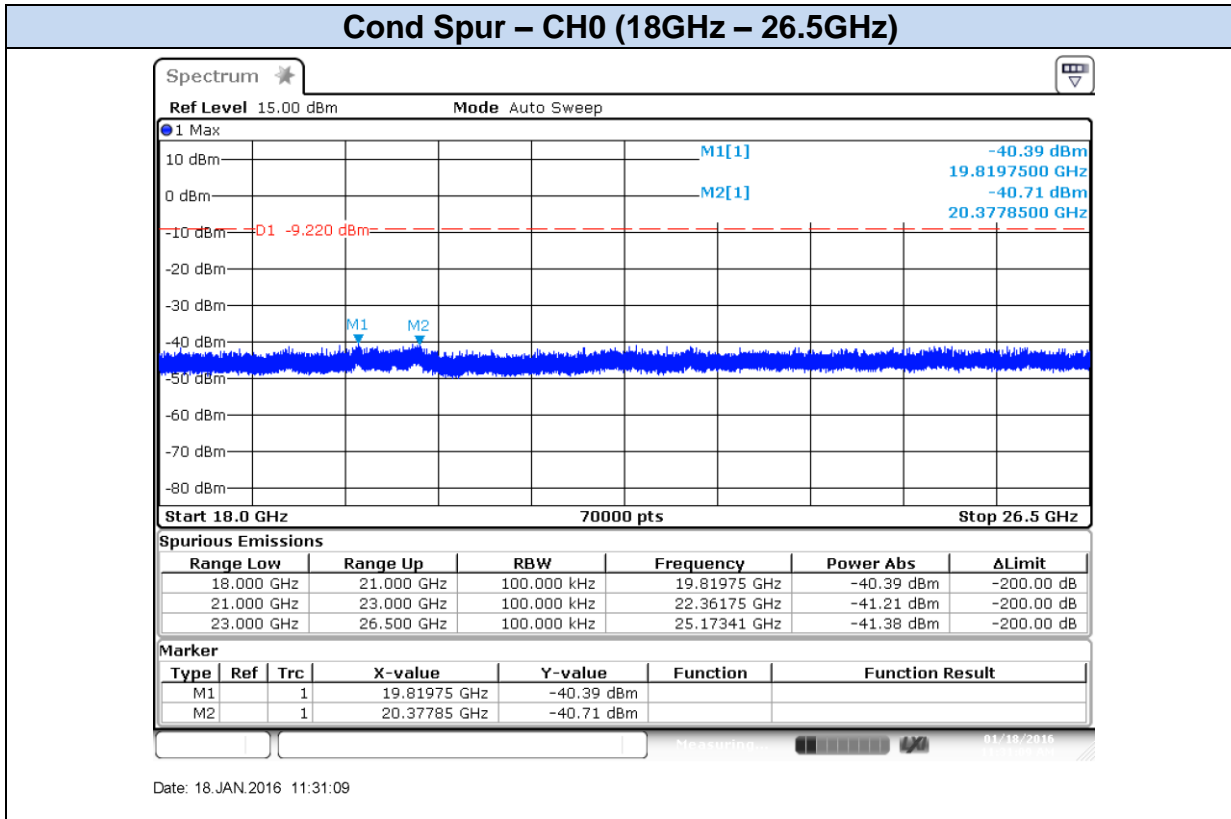




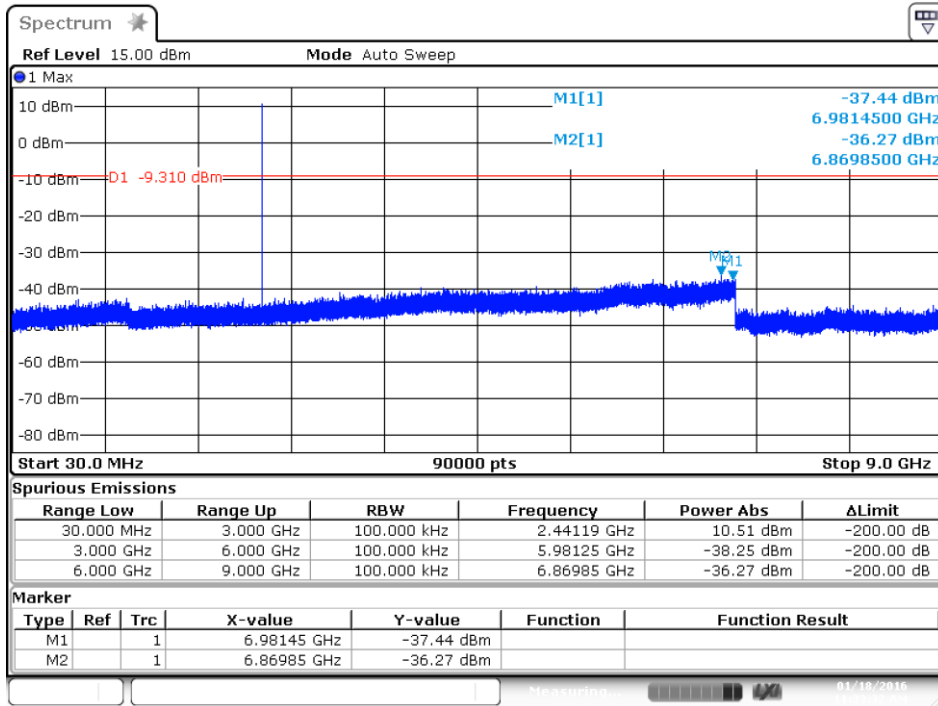
Conducted Spurious results Screenshot:

Basic Rate - GFSK



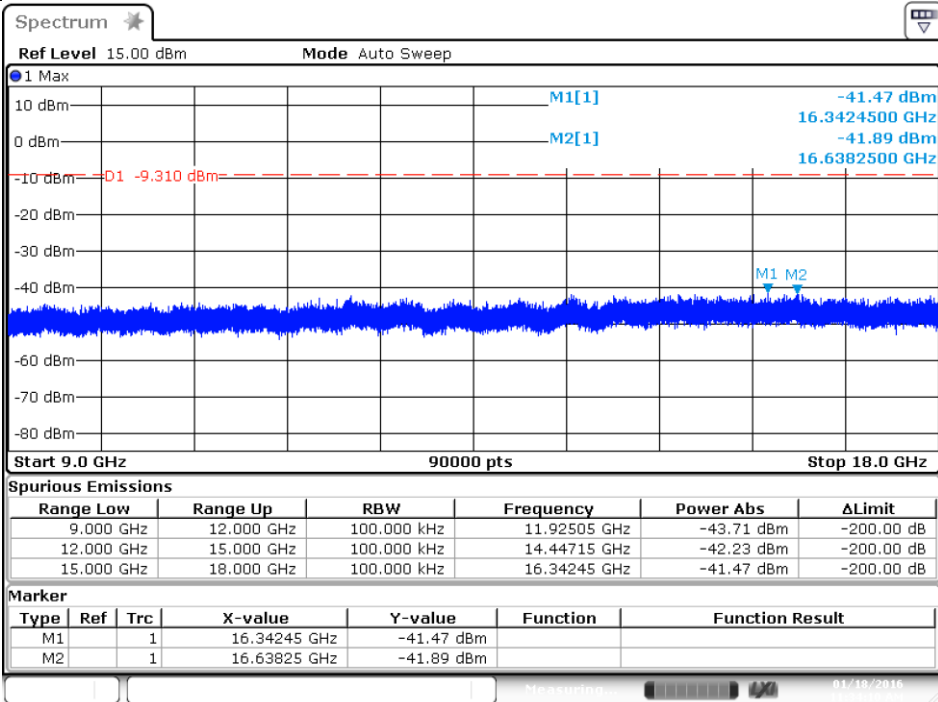


Cond Spur – CH39 (30MHz – 9GHz)



Date: 18.JAN.2016 11:33:32

Cond Spur - CH39 (9GHz – 18GHz)



Date: 18.JAN.2016 11:34:10

