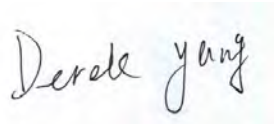
FCC TEST REPORT

Application No.:	HR/2019/50006
Applicant:	Quectel Wireless Solutions Co., Ltd.
Address of Applicant	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
Manufacturer:	Quectel Wireless Solutions Co., Ltd.
Address of Manufacturer	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
Factory:	Quectel Wireless Solutions Co., Ltd.
Address of Factory	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
EUT Description:	LTE Module
Model No.:	SC600Y-NA, SC600T-NA
Trade Mark:	Quectel
FCC ID:	XMR2019SC600NA
Standards:	47 CFR FCC Part 2, Subpart J 47 CFR Part 15, Subpart C
Test Method	ANSI C63.10 (2013)
Date of Receipt:	2019/5/29
Date of Test:	2019/5/30 to 2019/7/3
Date of Issue:	2019/7/3
Test Result:	**PASS ***

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

Authorized Signature:



Derek Yang
Wireless Laboratory Manager

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1 Version

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
00		2019/7/3		Original

Authorized for issue by:				
Tested By		Mike Hu **(Mike Hu) /Project Engineer**		2019/7/3 **Date**
Checked By		David Chen **(David Chen) /Reviewer**		2019/7/3 **Date**

Remark:
The difference between SC600Y-NA and SC600T-NA showed as following:
SC600Y-NA and SC600T-NA are all LTE modules. They share the same software & hardware design（the chip component is pin-for-pin compatible；have the same basic function；no change in radio parameters has occurred.）. The difference is on chipset with different CPU frequency. The Chipset SDM450 is a de-rated version of the MSM8953. We hereby state that two models are identical in interior structure and components.

The detail is shown as following table.

Module	Chipset	frequency
SC600T-NA	Qualcomm MSM8953	2.0GHz
SC600Y-NA	Qualcomm SDM450	1.8GHz

According to the difference above, all the test were performed on SC600T-NA, and spot check the worst case Conducted power and RSE on SC600Y-NA, the conducted and RSE data shown in the report is the worst data.. and other data of SC600Y-NA can refer to SC600T-NA.

2 Test Summary

Test Item	Test Requirement	Test method	Test Result	Result
AC Power Line Conducted Emission	15.207	ANSI C63.10 (2013)	Clause 4.3	PASS
Conducted Peak Output Power	15.247 (a)(1)	ANSI C63.10 (2013)	Clause 4.4	PASS
20dB Emission Bandwidth & 99% Occupied Bandwidth	15.247 (a)(1)	ANSI C63.10 (2013)	Clause 4.5	PASS
Carrier Frequencies Separation	15.247 (a)(1)	ANSI C63.10 (2013)	Clause 4.6	PASS
Hopping Channel Number	15.247 (a)(1)	ANSI C63.10 (2013)	Clause 4.7	PASS
Dwell Time	15.247 (a)(1)	ANSI C63.10 (2013)	Clause 4.8	PASS
Band-edge for RF Conducted Emissions	15.247(d)	ANSI C63.10 (2013)	Clause 4.9	PASS
RF Conducted Spurious Emissions	15.247(d)	ANSI C63.10 (2013)	Clause 4.10	PASS
Radiated Spurious emissions	15.247(d);15.205/15.209	ANSI C63.10 (2013)	Clause 4.11	PASS
Restricted bands around fundamental frequency (Radiated Emission)	15.247(d);15.205/15.209	ANSI C63.10 (2013)	Clause 4.12	PASS

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中国·深圳·科技园中区M-10栋一号厂房 邮编: 518057 t (86-755) 26012053 f (86-755) 26710594 sgs.china@sgs.com

Contents

3 General Information

3.1 Client Information

Applicant:	Quectel Wireless Solutions Co., Ltd.
Address of Applicant:	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
Manufacturer:	Quectel Wireless Solutions Co., Ltd.
Address of Manufacturer:	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
Factory:	Quectel Wireless Solutions Co., Ltd.
Address of Factory:	7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China

3.2 Test Location

Company:	SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch
Address:	No. 1 Workshop, M-10, Middle section, Science & Technology Park, Shenzhen, Guangdong, China
Post code:	518057
Telephone:	+86 (0) 755 2601 2053
Fax:	+86 (0) 755 2671 0594
E-mail:	ee.shenzhen@sgs.com

3.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• CNAS (No. CNAS L2929)

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

• A2LA (Certificate No. 3816.01)

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

• VCCI

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

• FCC –Designation Number: CN1178

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

• Industry Canada (IC)

Two 3m Semi-anechoic chambers and the 10m Semi-anechoic chamber of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab have been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 4620C-1, 4620C-2, 4620C-3.

3.4 General Description of EUT

EUT Description::	LTE Module
Model No.:	SC600Y-NA, SC600T-NA
Trade Mark:	Quectel
Hardware Version:	R1.0
Software Version:	SC600YNAPAR05A02
Operation Frequency:	2400MHz~2483.5MHz fc = 2402 MHz + N * 1 MHz, where: -fc = “Operating Frequency” in MHz, -N = “Channel Number” with the range from 0 to 78.
Bluetooth Version:	Bluetooth V3.0 +EDR
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, π/4DQPSK, 8DPSK
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Sample Type:	☐ Portable Device, ☒Module
Antenna Type:	☐ External, ☒ Integrated
Antenna Gain:	5.0dBi
Power Supply	☒ AC/DC Adapter; ☐ Battery ☐ PoE:; ☐ Other:

Operation Frequency each of channel							
Channel	**Frequency**	**Channel**	**Frequency**	**Channel**	**Frequency**	**Channel**	**Frequency**
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
2	2404MHz	22	2424MHz	42	2444MHz	62	2464MHz
3	2405MHz	23	2425MHz	43	2445MHz	63	2465MHz
4	2406MHz	24	2426MHz	44	2446MHz	64	2466MHz
5	2407MHz	25	2427MHz	45	2447MHz	65	2467MHz
6	2408MHz	26	2428MHz	46	2448MHz	66	2468MHz
7	2409MHz	27	2429MHz	47	2449MHz	67	2469MHz
8	2410MHz	28	2430MHz	48	2450MHz	68	2470MHz
9	2411MHz	29	2431MHz	49	2451MHz	69	2471MHz
10	2412MHz	30	2432MHz	50	2452MHz	70	2472MHz
11	2413MHz	31	2433MHz	51	2453MHz	71	2473MHz
12	2414MHz	32	2434MHz	52	2454MHz	72	2474MHz
13	2415MHz	33	2435MHz	53	2455MHz	73	2475MHz
14	2416MHz	34	2436MHz	54	2456MHz	74	2476MHz
15	2417MHz	35	2437MHz	55	2457MHz	75	2477MHz
16	2418MHz	36	2438MHz	56	2458MHz	76	2478MHz

17	2419MHz	37	2439MHz	57	2459MHz	77	2479MHz
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz		

Remark:
In section 15.31(m), regards to the operating frequency range over 10 MHz, the Lowest frequency, the middle
frequency, and the highest frequency of channel were selected to perform the test, and the selected channel see below:

Channel	Frequency
The Lowest channel	2402MHz
The Middle channel	2441MHz
The Highest channel	2480MHz

3.5 Test Environment

Operating Environment	
Temperature:	24.0 °C
Humidity:	55 % RH
Atmospheric Pressure:	101.30 KPa

3.6 Description of Support Units

The EUT has been tested independent unit.

4 Test results and Measurement Data

4.1 Antenna Requirement

Standard requirement:	47 CFR Part 15C Section 15.203 /247(c)
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(b) (4) requirement: 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. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	
The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 5.0dBi.	

4.2 Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence

4.2.1 Test Requirement:

47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)

4.2.2 Conclusion

Standard Requirement:
The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.
The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.
Compliance for section 15.247(a)(1):
According to Technical Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

> Number of shift register stages: 9
> Length of pseudo-random sequence: 29 -1 = 511 bits
> Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:

Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

Compliance for section 15.247(g):

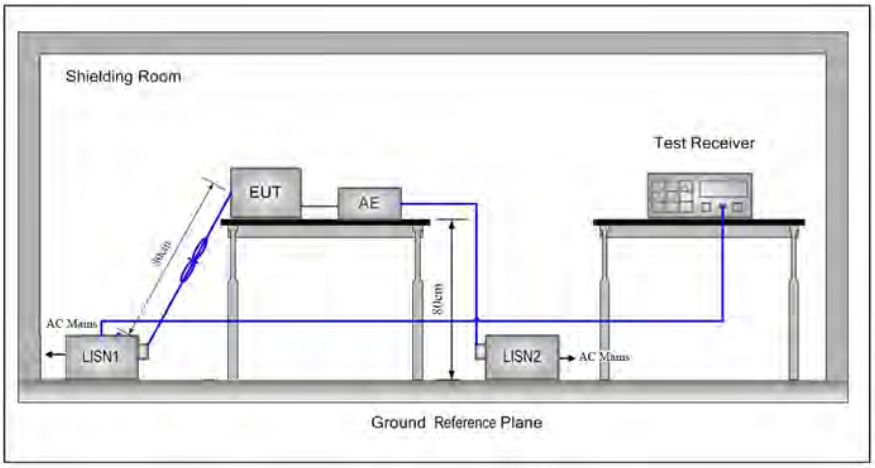
According to Technical Specification, the system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the RF system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h):

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels. The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

4.3 AC Power Line Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2013		
Test Frequency Range:	150kHz to 30MHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		Quasi-peak	Average
	0.15-0.5	66 to 56*	56 to 46*
	0.5-5	56	46
	5-30	60	50
	* Decreases with the logarithm of the frequency.		
Test Procedure:	1) The mains terminal disturbance voltage test was conducted in a shielded room. 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded. 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane, 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2. 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.		

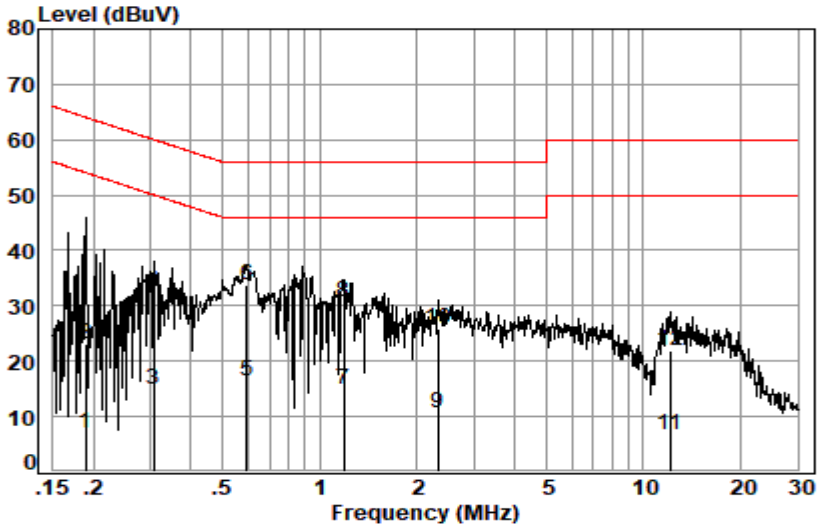
Test Setup:	
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type at the lowest, middle, high channel. Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation at the lowest channel is the worst case. Charge + Transmitting mode Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

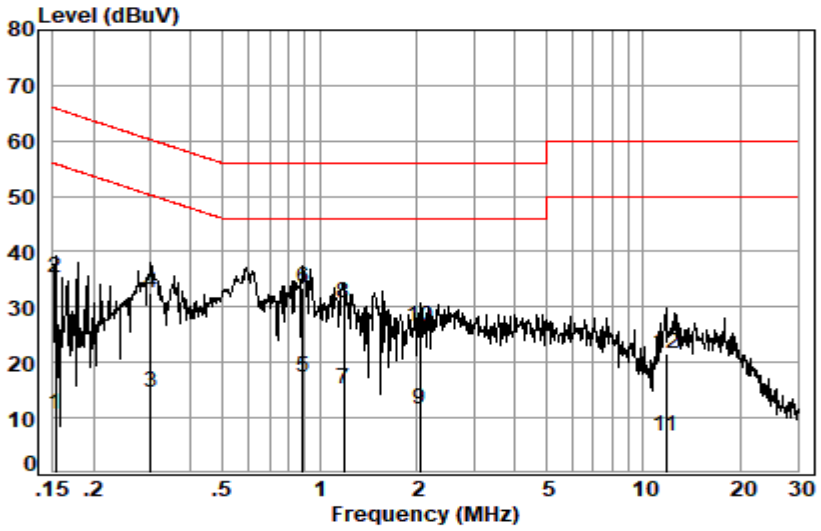
Live line:



Site : Shielding Room
Condition: Line
Job No. : 15593CR
Test mode: b

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1894	0.02	9.66	-2.66	7.02	54.06	-47.04	Average
2	0.1894	0.02	9.66	13.56	23.24	64.06	-40.82	QP
3	0.3067	0.04	9.67	5.18	14.89	50.06	-35.17	Average
4	0.3067	0.04	9.67	22.88	32.59	60.06	-27.47	QP
5	0.5948	0.07	9.67	6.65	16.39	46.00	-29.61	Average
6	0.5948	0.07	9.67	23.98	33.72	56.00	-22.28	QP
7	1.1844	0.11	9.73	5.18	15.02	46.00	-30.98	Average
8	1.1844	0.11	9.73	20.95	30.79	56.00	-25.21	QP
9	2.3213	0.16	9.71	0.88	10.75	46.00	-35.25	Average
10	2.3213	0.16	9.71	16.01	25.88	56.00	-30.12	QP
11	12.0599	0.19	10.08	-3.46	6.81	50.00	-43.19	Average
12	12.0599	0.19	10.08	11.63	21.90	60.00	-38.10	QP

Neutral line:



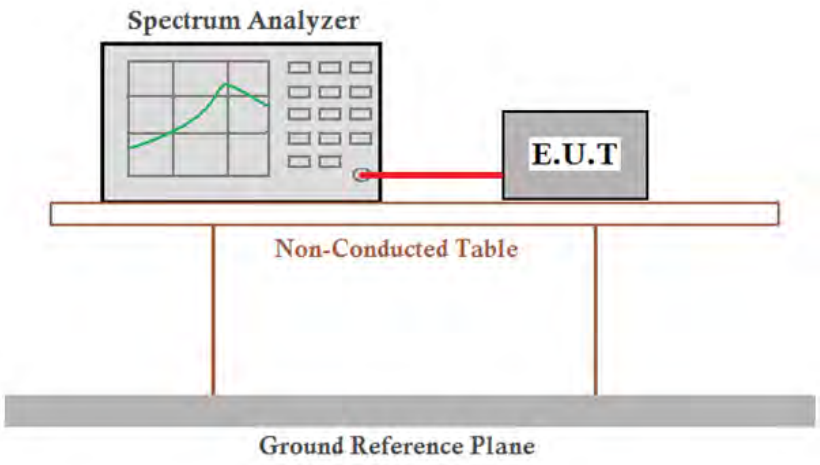
Site : Shielding Room
Condition: Neutral
Job No. : 15593CR
Test mode: b

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1532	0.01	9.63	1.15	10.79	55.82	-45.03	Average
2	0.1532	0.01	9.63	25.74	35.38	65.82	-30.44	QP
3	0.3003	0.04	9.64	4.78	14.46	50.24	-35.78	Average
4	0.3003	0.04	9.64	22.98	32.66	60.24	-27.58	QP
5	0.8897	0.08	9.71	7.55	17.34	46.00	-28.66	Average
6	0.8897	0.08	9.71	23.68	33.47	56.00	-22.53	QP
7	1.1844	0.11	9.70	5.43	15.24	46.00	-30.76	Average
8	1.1844	0.11	9.70	20.94	30.75	56.00	-25.25	QP
9	2.0441	0.16	9.69	1.74	11.59	46.00	-34.41	Average
10	2.0441	0.16	9.69	16.54	26.39	56.00	-29.61	QP
11	11.7446	0.19	10.05	-3.57	6.67	50.00	-43.33	Average
12	11.7446	0.19	10.05	11.39	21.63	60.00	-38.37	QP

Remarks:

1. *The following Quasi-Peak and Average measurements were performed on the EUT:*
2. *Final Test Level =Receiver Reading + LISN Factor + Cable Loss.*

4.4 Conducted Peak Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013 Section 7.8.5
Test Setup:	
Limit:	(20.97dBm) 125mW
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type.
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

4.4.1 Test Results

Measurement Data of Average power:

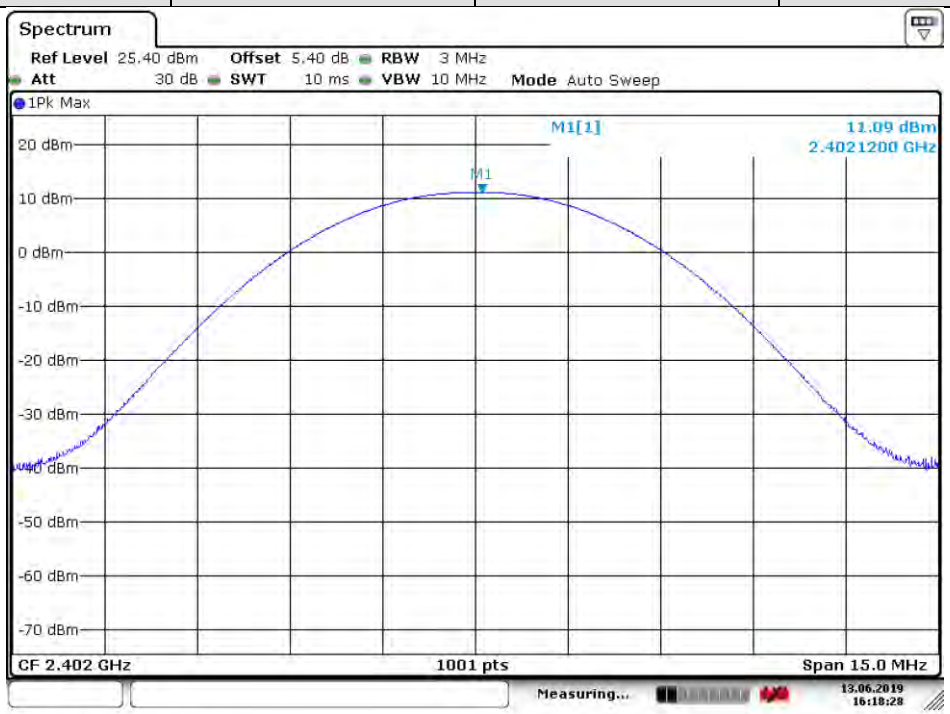
GFSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	9.80	Report purpose only
Middle	10.44	Report purpose only
Highest	9.28	Report purpose only
π/4DQPSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	8.10	Report purpose only
Middle	8.78	Report purpose only
Highest	7.6	Report purpose only
8DPSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	8.10	Report purpose only
Middle	8.76	Report purpose only
Highest	7.58	Report purpose only

Measurement Data of Peak power:

GFSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	11.09	20.97	Pass
Middle	11.56	20.97	Pass
Highest	9.74	20.97	Pass
π/4DQPSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	11.21	20.97	Pass
Middle	11.68	20.97	Pass
Highest	9.84	20.97	Pass
8DPSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	11.51	20.97	Pass
Middle	12.00	20.97	Pass
Highest	10.16	20.97	Pass

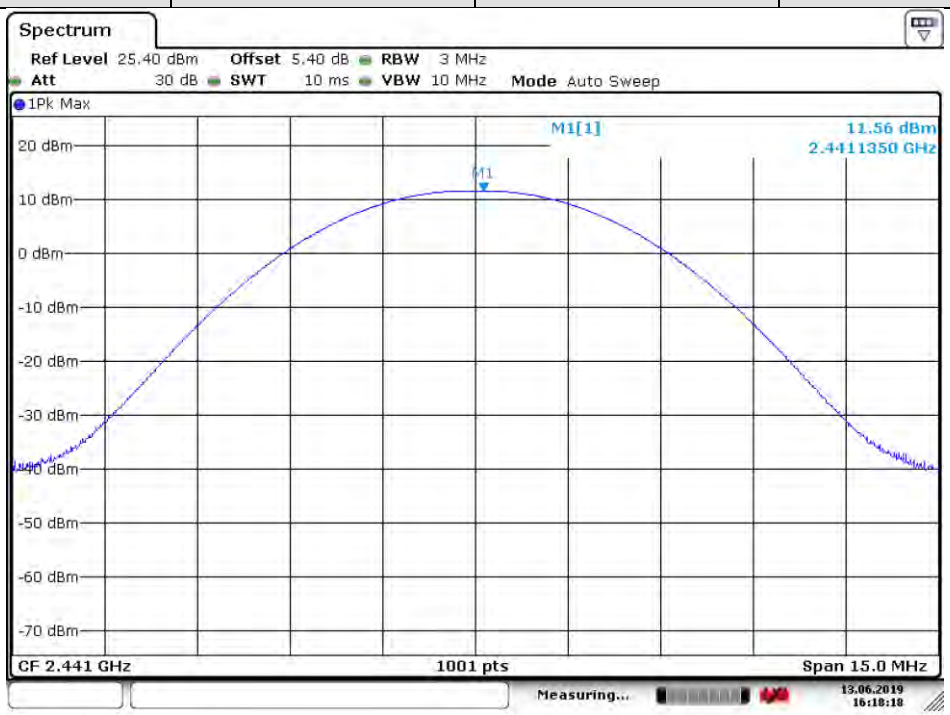
4.4.2 Test plots

Test mode:	GFSK	Test channel:	Lowest



Date: 13.JUN.2019 16:18:29

Test mode:	GFSK	Test channel:	Middle

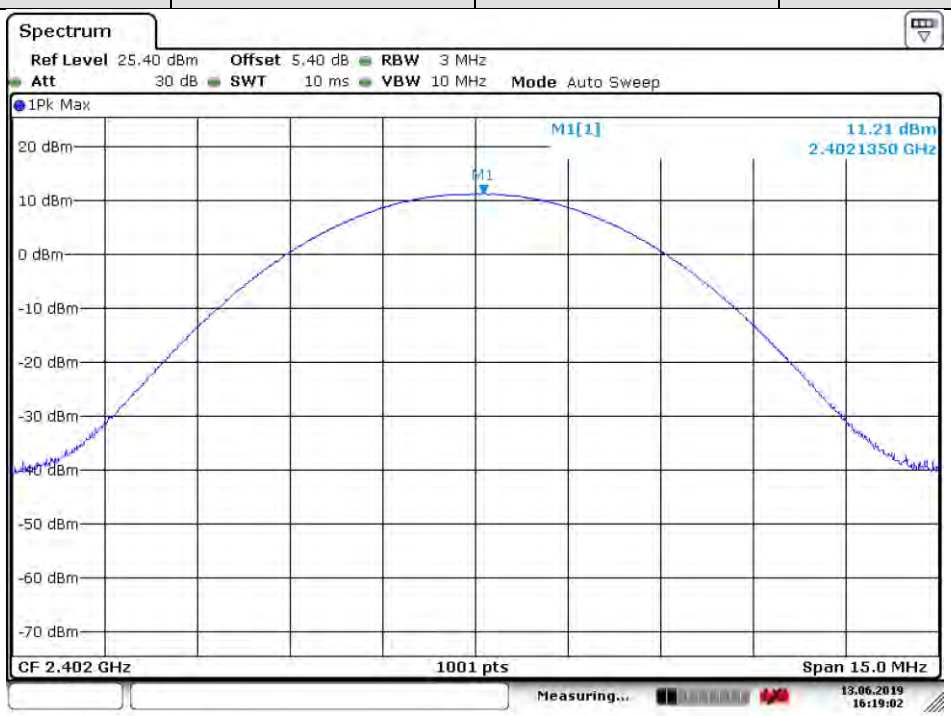


Date: 13.JUN.2019 16:18:18

Test mode:	GFSK	Test channel:	Highest

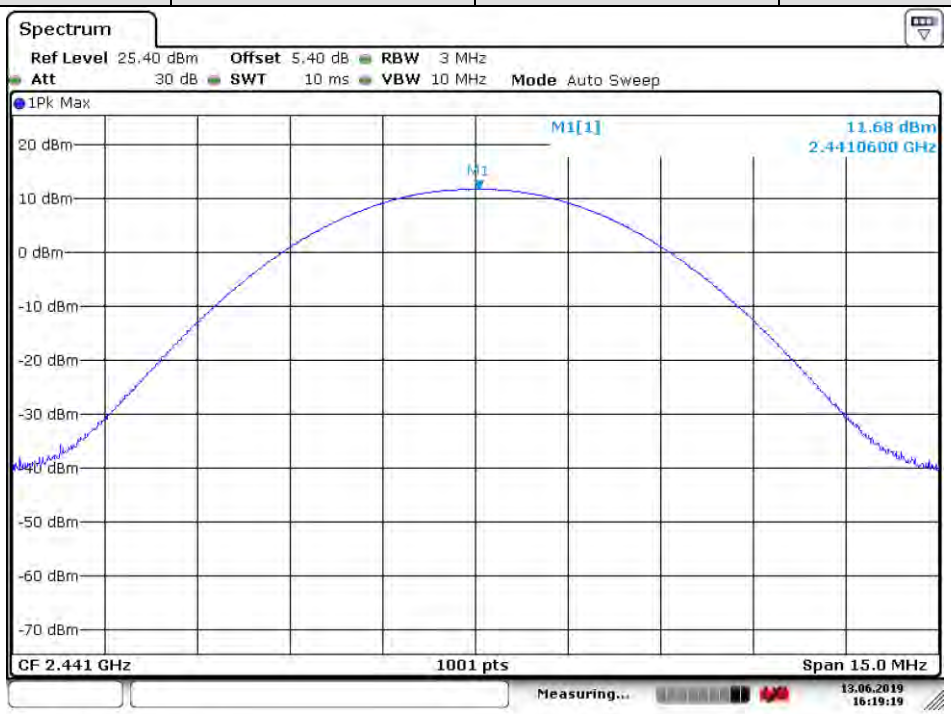
Date: 13.JUN.2019 16:17:57

Test mode:	π/4DQPSK	Test channel:	Lowest



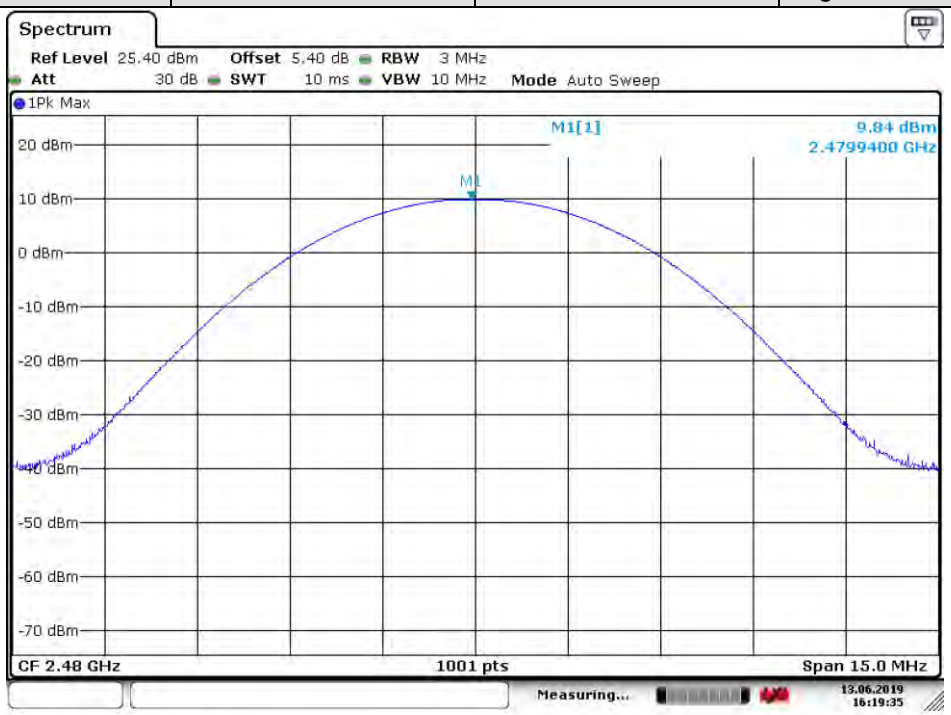
Date: 13.JUN.2019 16:19:03

Test mode:	π/4DQPSK	Test channel:	Middle



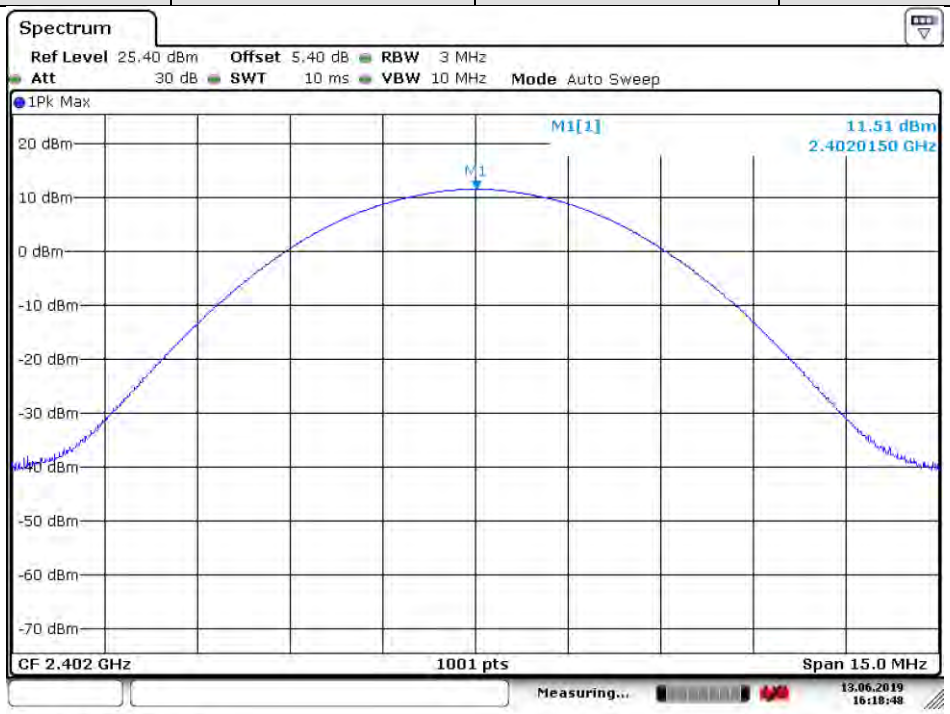
Date: 13.JUN.2019 16:19:19

Test mode:	π/4DQPSK	Test channel:	Highest



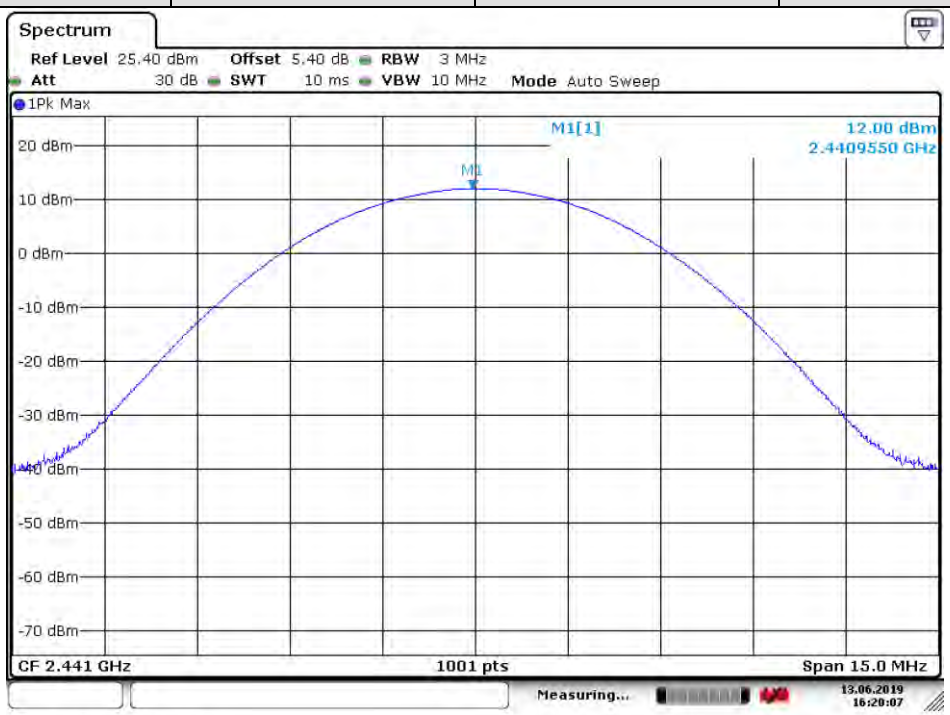
Date: 13.JUN.2019 16:19:35

Test mode:	8DPSK	Test channel:	Lowest



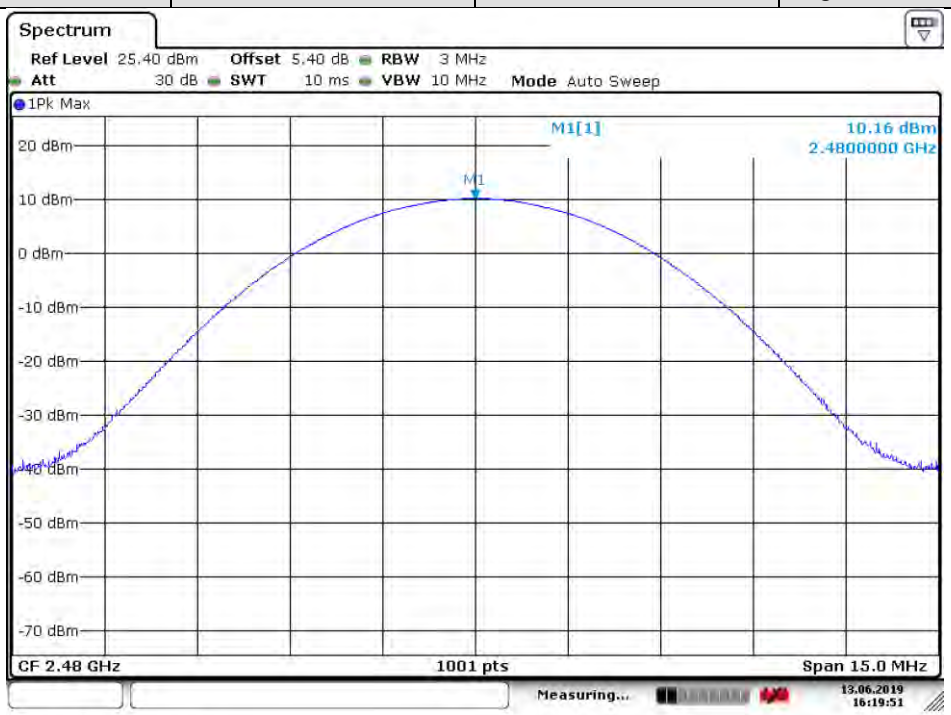
Date: 13.JUN.2019 16:18:48

Test mode:	8DPSK	Test channel:	Middle



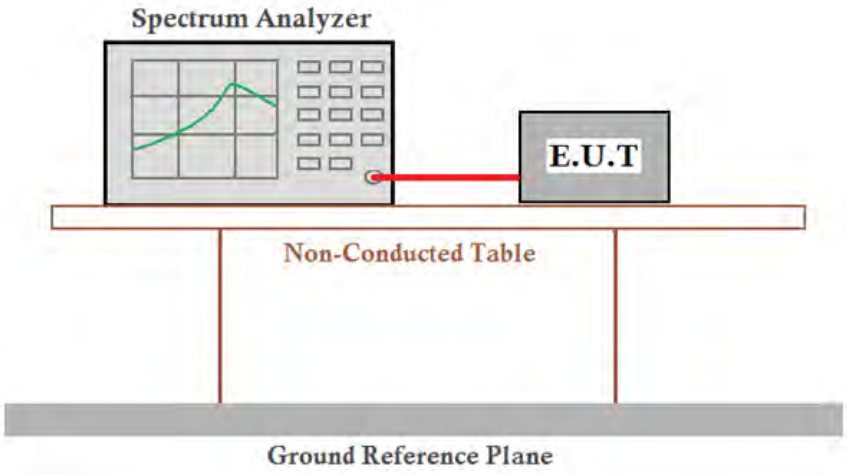
Date: 13.JUN.2019 16:20:08

Test mode:	8DPSK	Test channel:	Highest



Date: 13.JUN.2019 16:19:52

4.5 20dB Emission Bandwidth & 99% Occupied Bandwidth

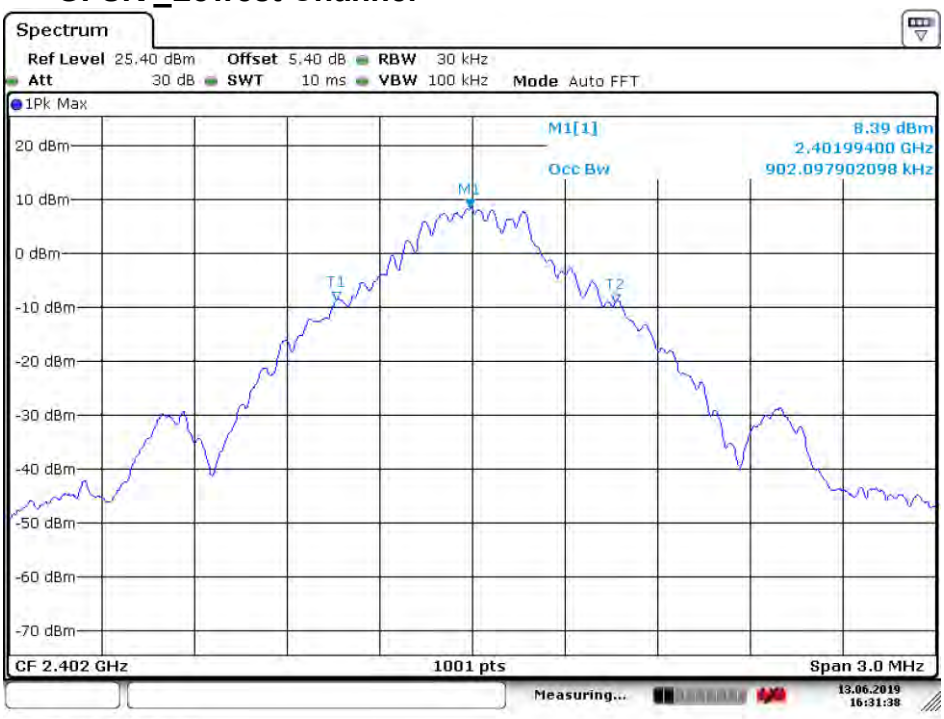
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013 Section 7.8.7
Test Setup:	
Limit:	NA
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type.
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

4.5.1 Test Results

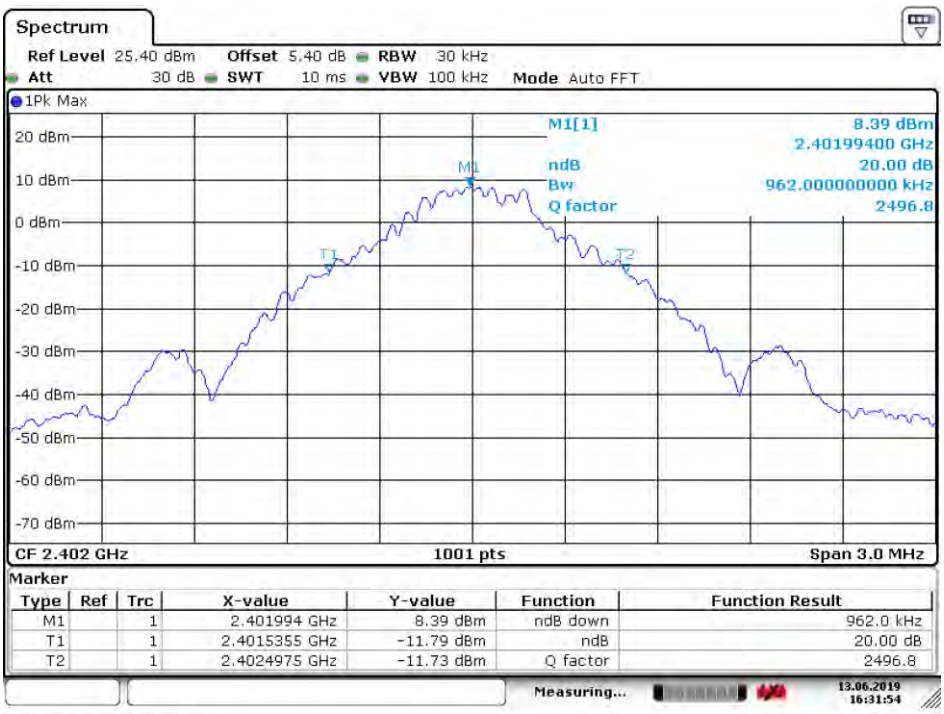
Mode	Test Channel	99% Occupied Bandwidth (KHz)	20dB Emission Bandwidth (KHz)	Result
GFSK	Lowest	902.1	962.0	Pass
	Middle	905.1	959.0	Pass
	Highest	905.1	977.0	Pass
π/4DQPSK	Lowest	1168.8	1285.7	Pass
	Middle	1168.8	1288.7	Pass
	Highest	1168.8	1291.7	Pass
8DPSK	Lowest	1171.8	1294.7	Pass
	Middle	1174.8	1294.7	Pass
	Highest	1171.8	1294.7	Pass

4.5.2 Test plots

4.5.2.1 GFSK _Lowest Channel



Date: 13.JUN.2019 16:31:39

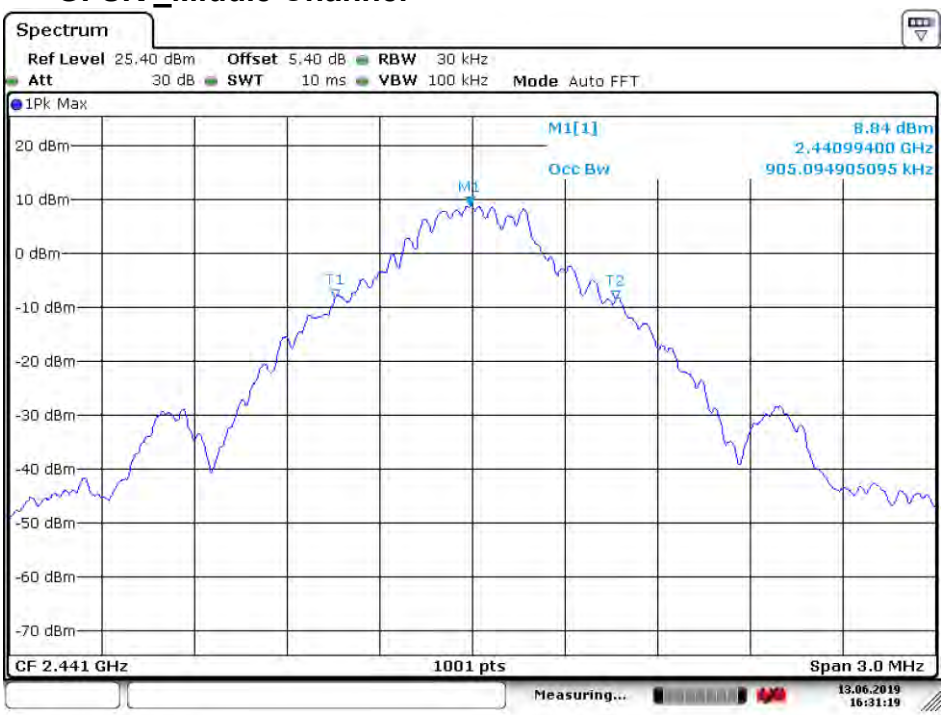


Marker

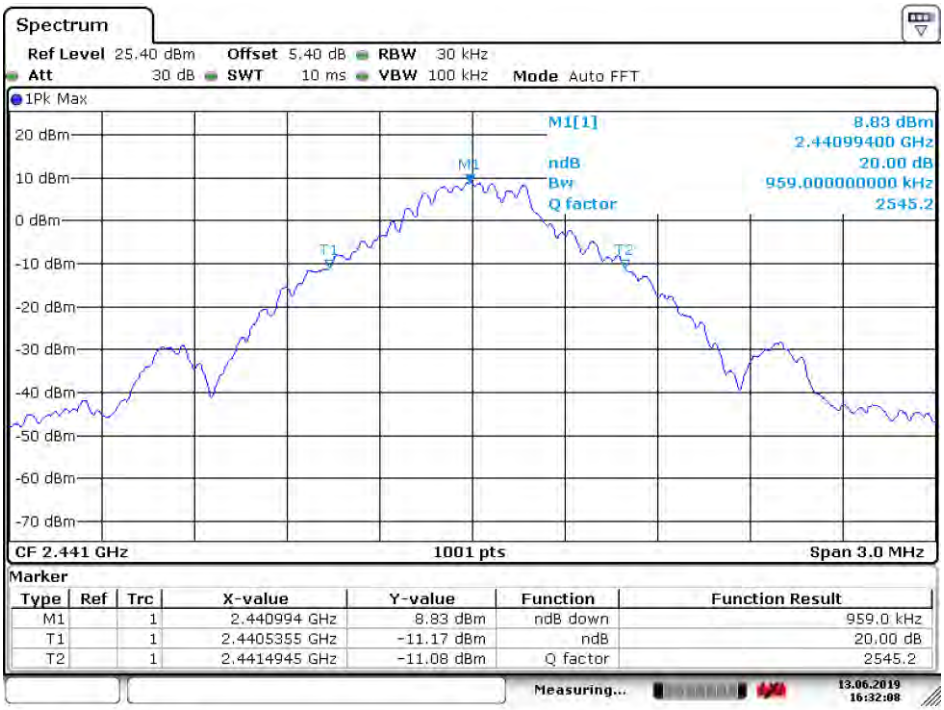
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401994 GHz	8.39 dBm	ndB down	962.0 kHz
T1		1	2.4015355 GHz	-11.79 dBm	ndB	20.00 dB
T2		1	2.4024975 GHz	-11.73 dBm	Q factor	2496.8

Date: 13.JUN.2019 16:31:55

4.5.2.2 GFSK _Middle Channel



Date: 13.JUN.2019 16:31:19

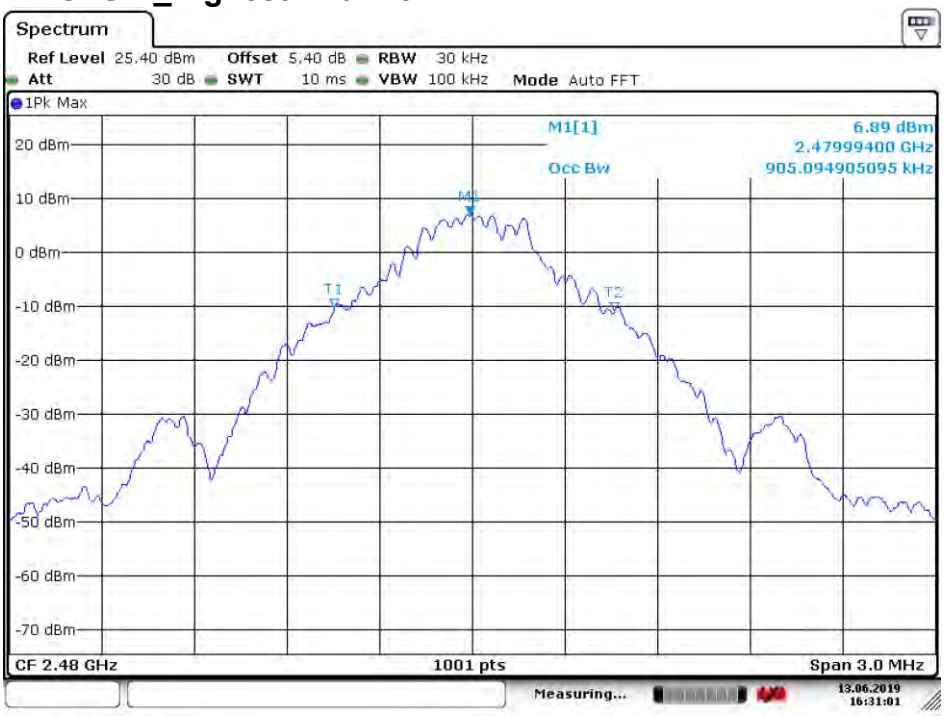


Marker

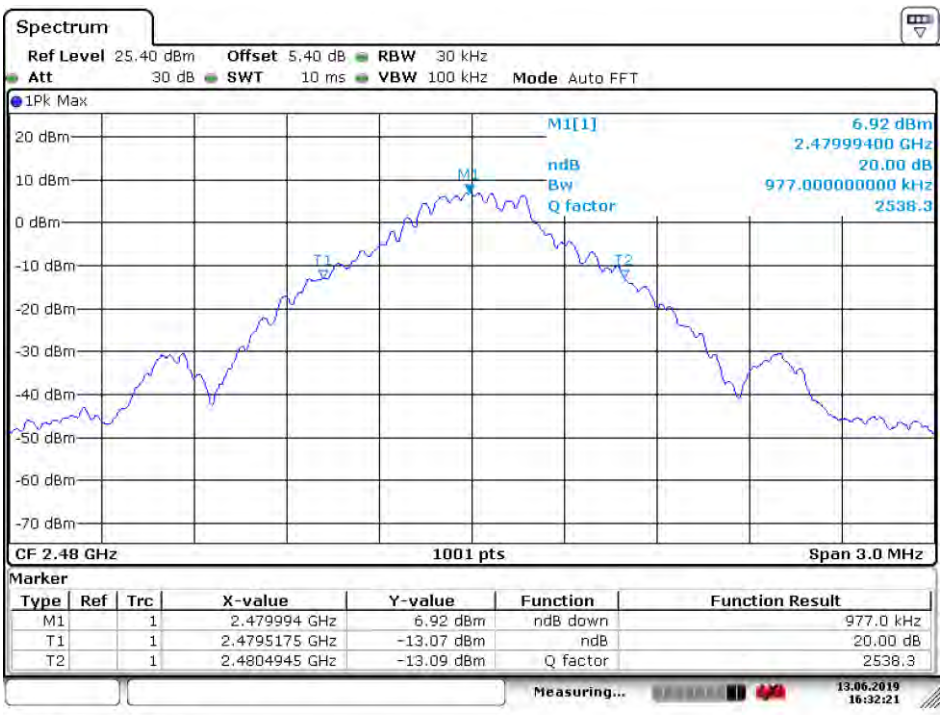
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.440994 GHz	8.83 dBm	ndB down	959.0 kHz
T1		1	2.4405355 GHz	-11.17 dBm	ndB	20.00 dB
T2		1	2.4414945 GHz	-11.08 dBm	Q factor	2545.2

Date: 13.JUN.2019 16:32:09

4.5.2.3 GFSK _Highest Channel

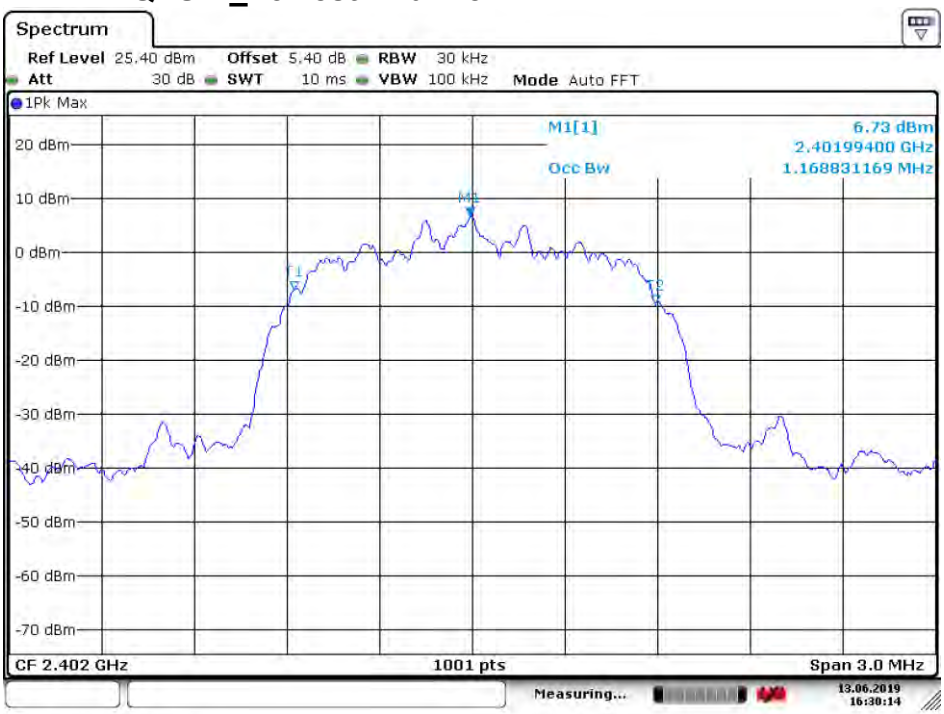


Date: 13.JUN.2019 16:31:02

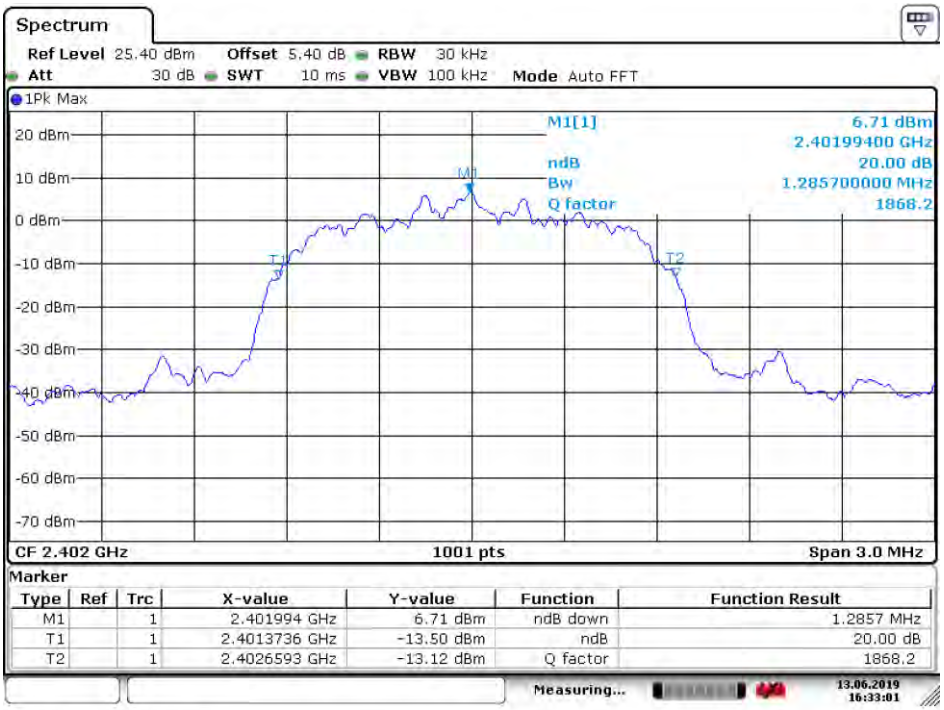


Date: 13.JUN.2019 16:32:22

4.5.2.4 π/4DQPSK _Lowest Channel



Date: 13.JUN.2019 16:30:14

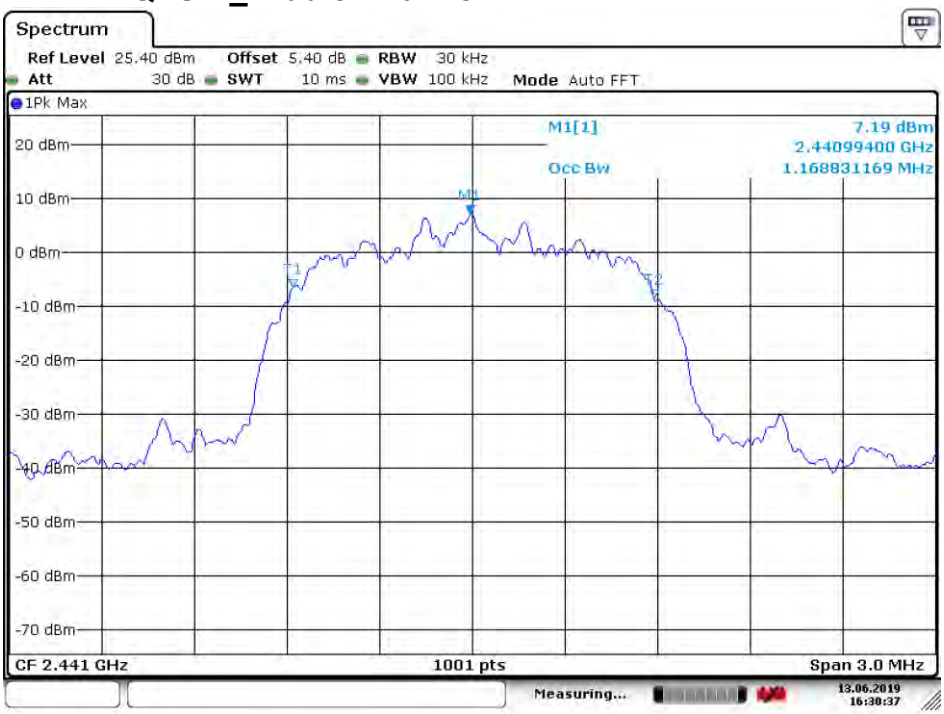


Marker

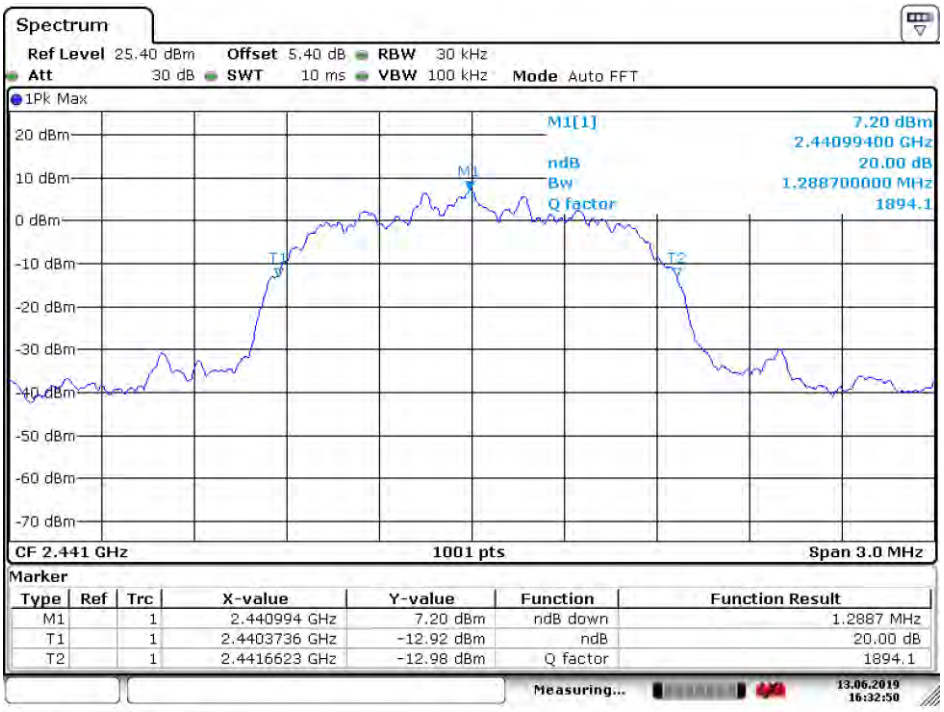
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401994 GHz	6.71 dBm	ndB down	1.2857 MHz
T1		1	2.4013736 GHz	-13.50 dBm	ndB	20.00 dB
T2		1	2.4026593 GHz	-13.12 dBm	Q factor	1868.2

Date: 13.JUN.2019 16:33:01

4.5.2.5 π/4DQPSK _Middle Channel



Date: 13.JUN.2019 16:30:37

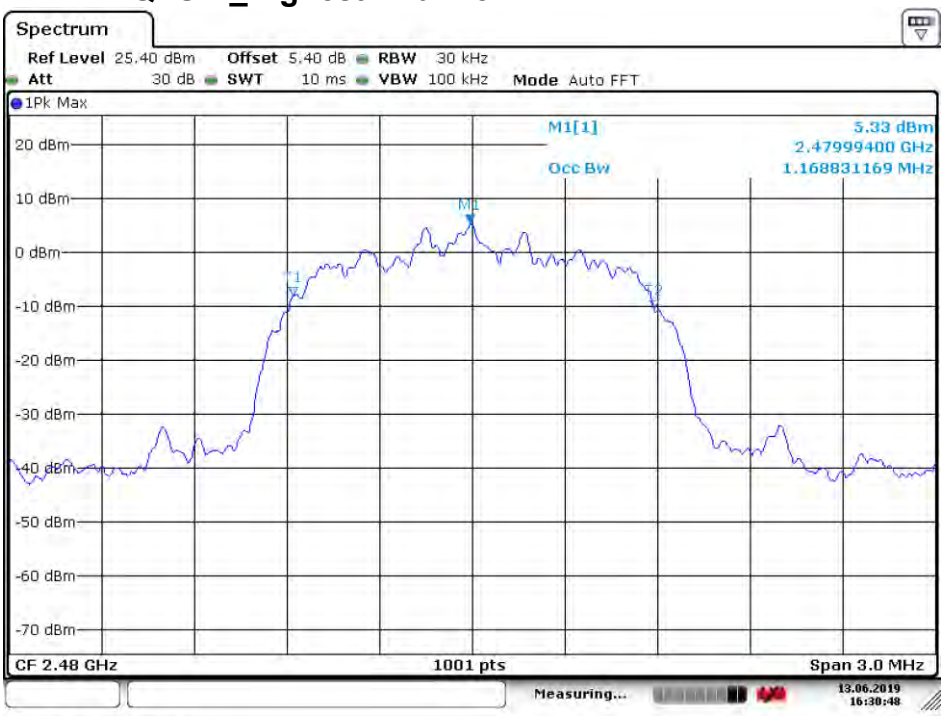


Marker

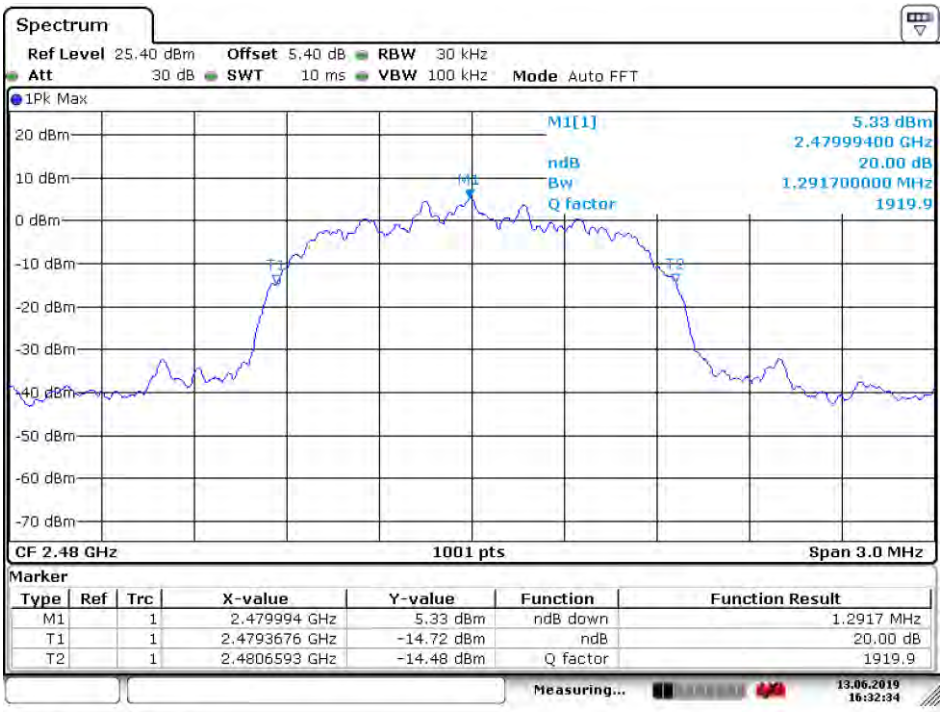
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.440994 GHz	7.20 dBm	ndB down	1.2887 MHz
T1		1	2.4403736 GHz	-12.92 dBm	ndB	20.00 dB
T2		1	2.4416623 GHz	-12.98 dBm	Q factor	1894.1

Date: 13.JUN.2019 16:32:50

4.5.2.6 π/4DQPSK _Highest Channel



Date: 13.JUN.2019 16:30:49

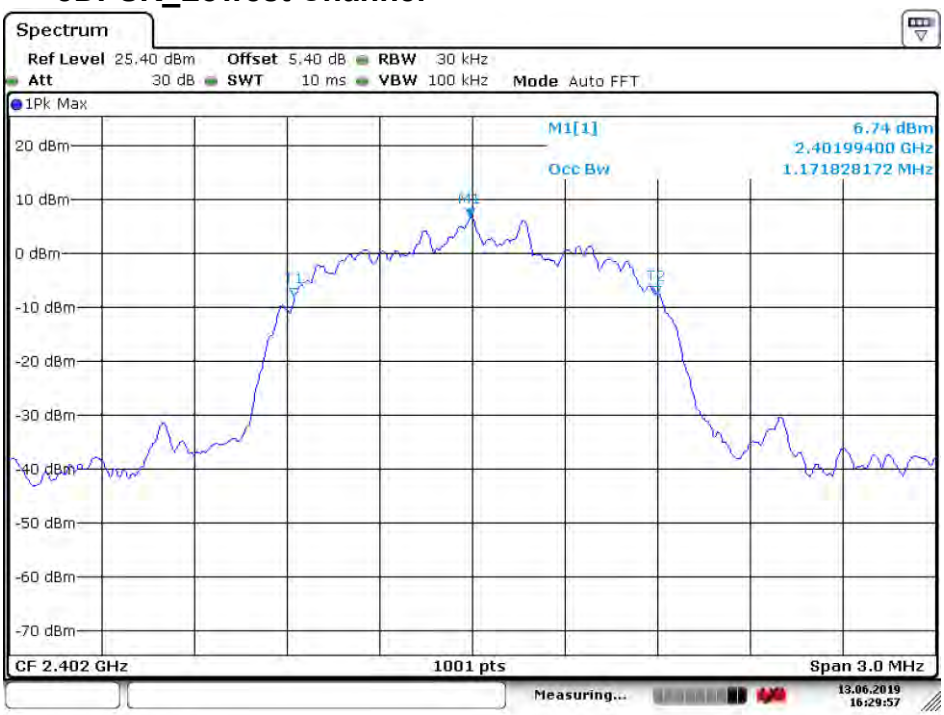


Marker

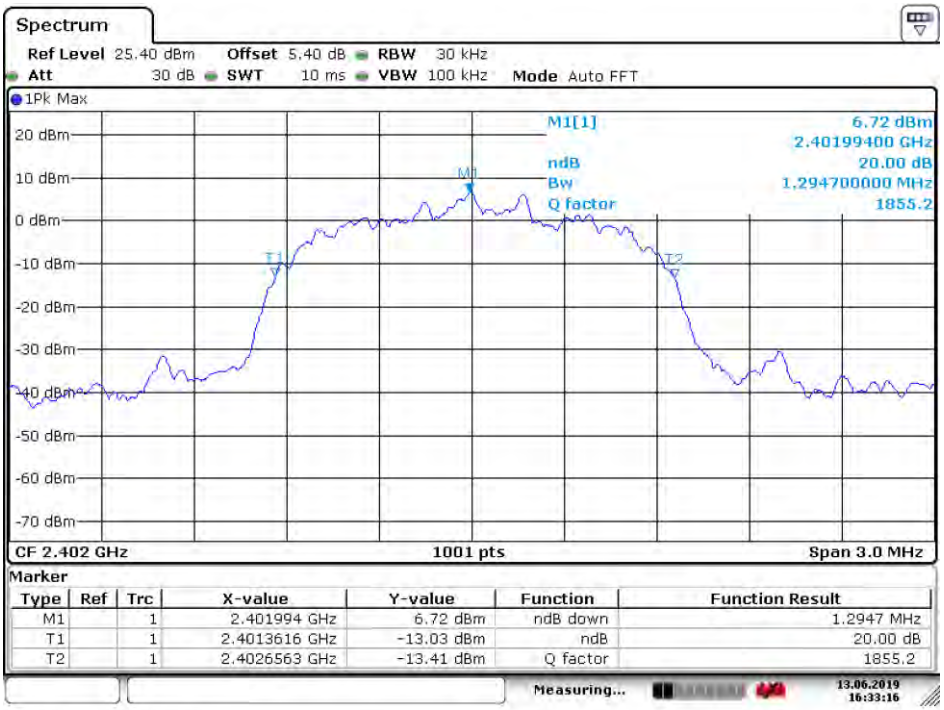
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.479994 GHz	5.33 dBm	ndB down	1.2917 MHz
T1		1	2.4793676 GHz	-14.72 dBm	ndB	20.00 dB
T2		1	2.4806593 GHz	-14.48 dBm	Q factor	1919.9

Date: 13.JUN.2019 16:32:34

4.5.2.7 8DPSK_Lowest Channel

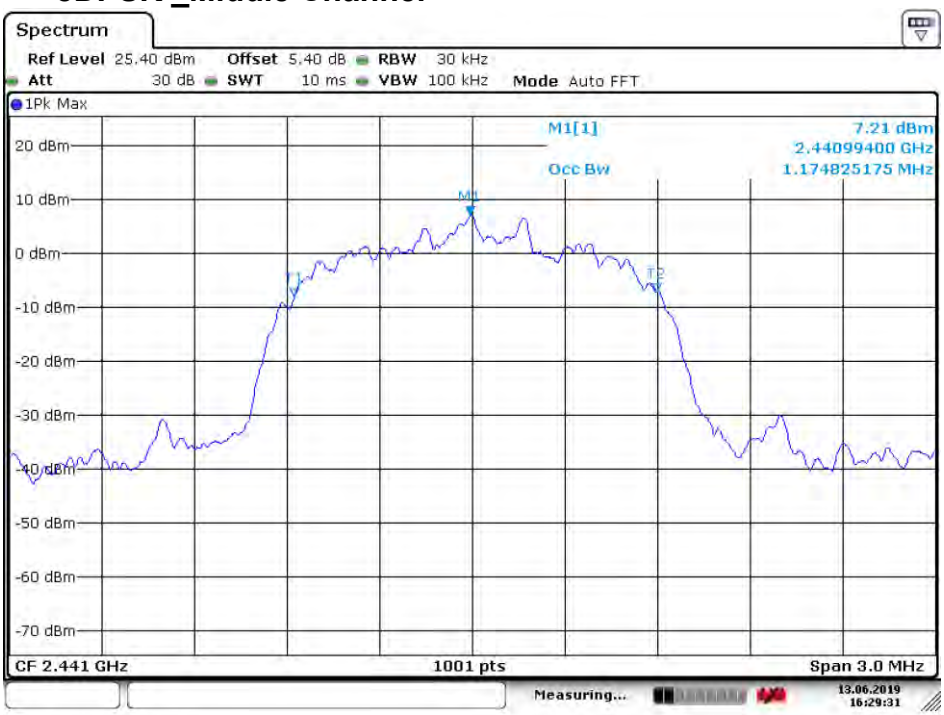


Date: 13.JUN.2019 16:29:58

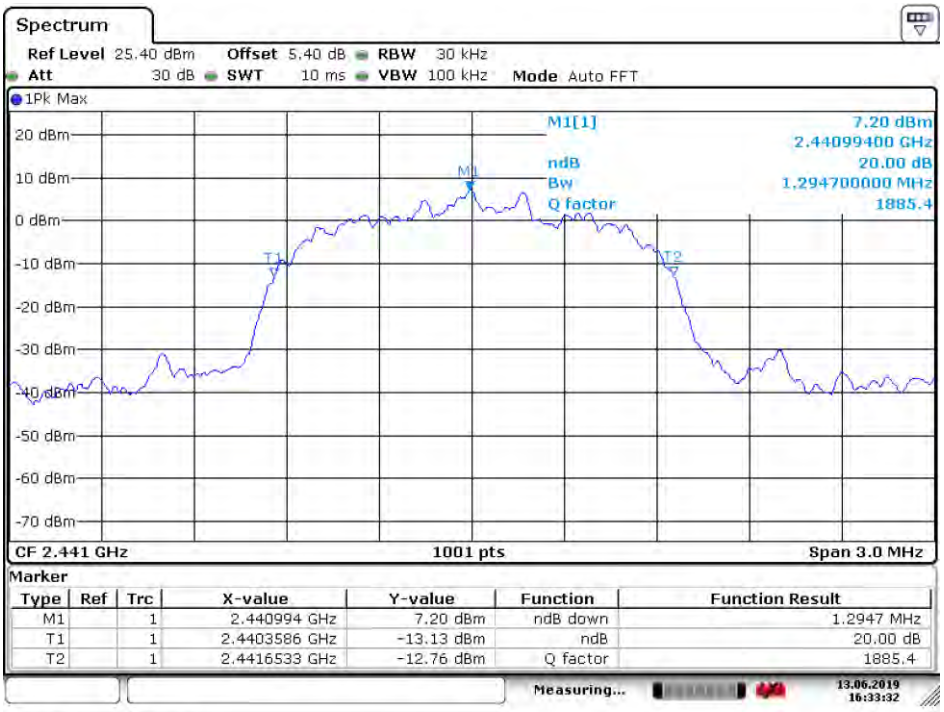


Date: 13.JUN.2019 16:33:16

4.5.2.8 8DPSK _Middle Channel



Date: 13.JUN.2019 16:29:32

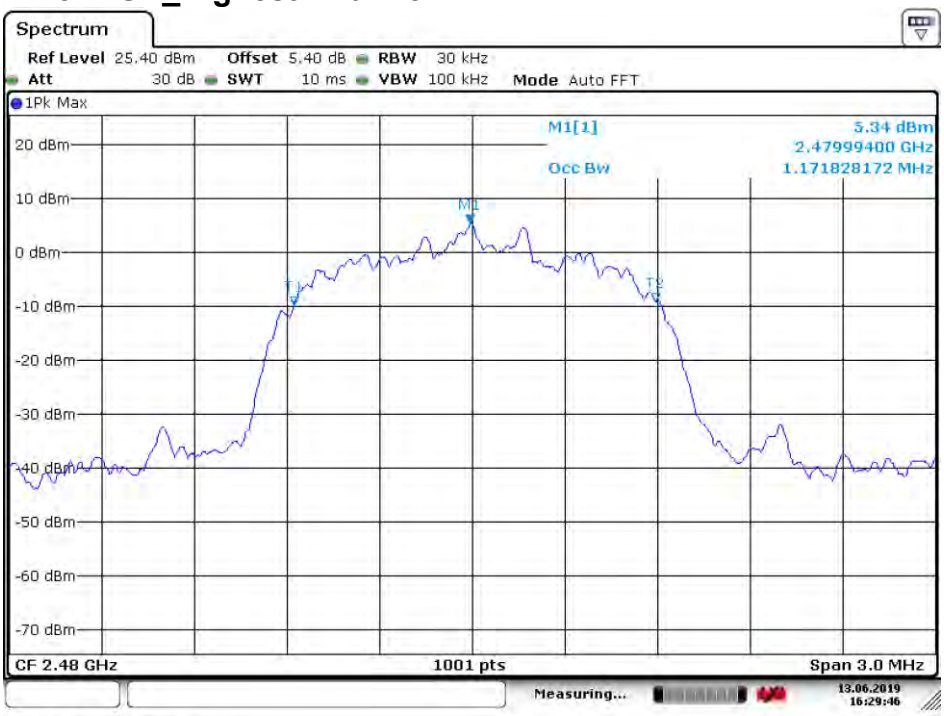


Marker

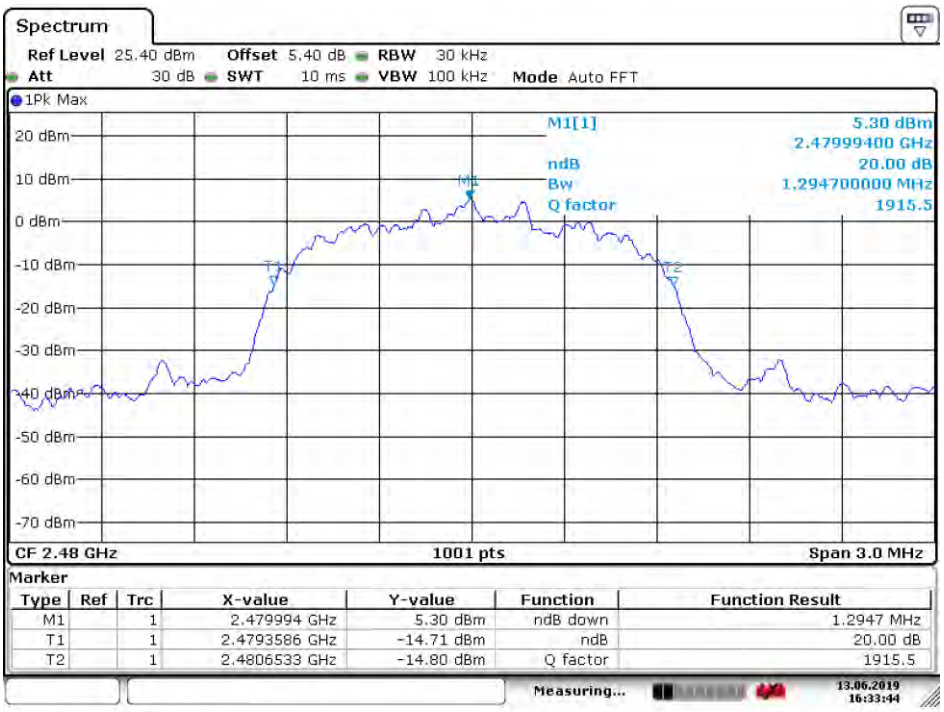
Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.440994 GHz	7.20 dBm	ndB down	1.2947 MHz
T1		1	2.4403586 GHz	-13.13 dBm	ndB	20.00 dB
T2		1	2.4416533 GHz	-12.76 dBm	Q factor	1885.4

Date: 13.JUN.2019 16:33:33

4.5.2.9 8DPSK_Highest Channel



Date: 13.JUN.2019 16:29:46

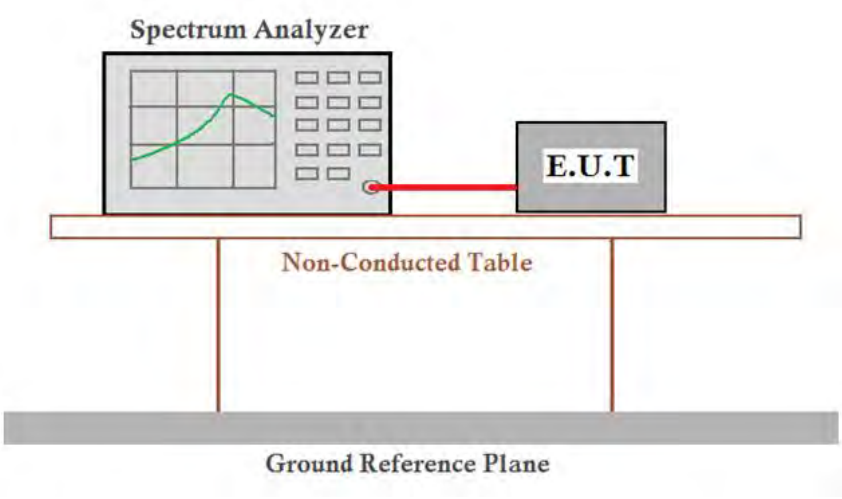


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.479994 GHz	5.30 dBm	ndB down	1.2947 MHz
T1		1	2.4793586 GHz	-14.71 dBm	ndB	20.00 dB
T2		1	2.4806533 GHz	-14.80 dBm	Q factor	1915.5

Date: 13.JUN.2019 16:33:44

4.6 Carrier Frequencies Separation

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013 Section 7.8.2
Test Setup:	
Limit:	2/3 of the 20dB bandwidth
	Remark: the transmission power is less than 0.125W.
Exploratory Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

4.6.1 Test Results

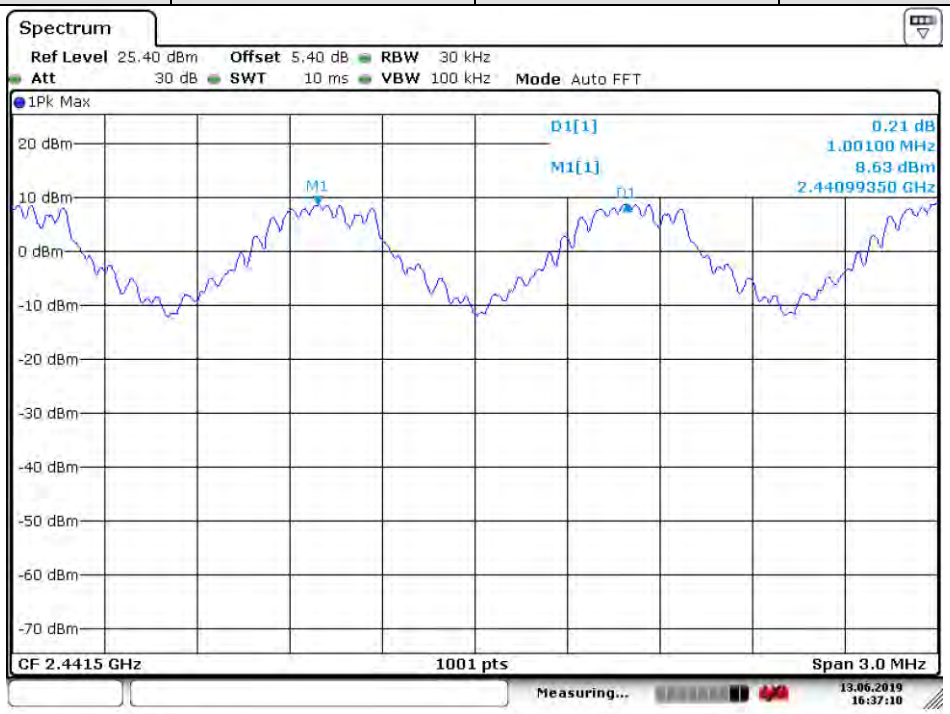
GFSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	1001	651.3	Pass
π/4DQPSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	1001	861.1	Pass
8DPSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	1001	863.1	Pass

Remark: According to section 6.4,

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	977.0	651.3
π/4DQPSK	1291.7	861.1
8DPSK	1294.7	863.1

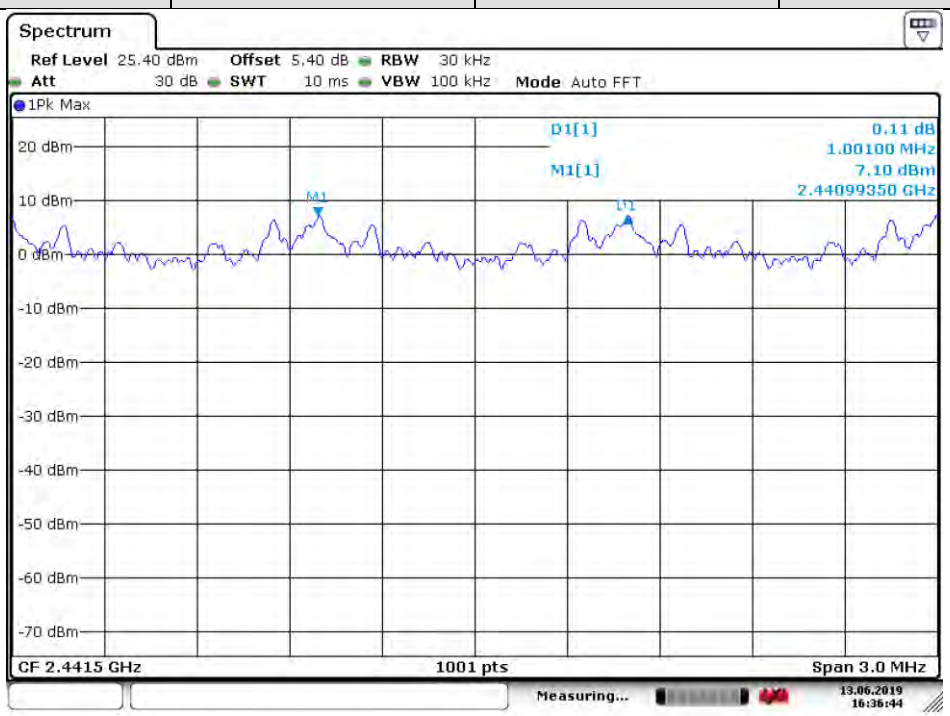
4.6.2 Test plots:

Test mode:	GFSK	Test channel:	Middle



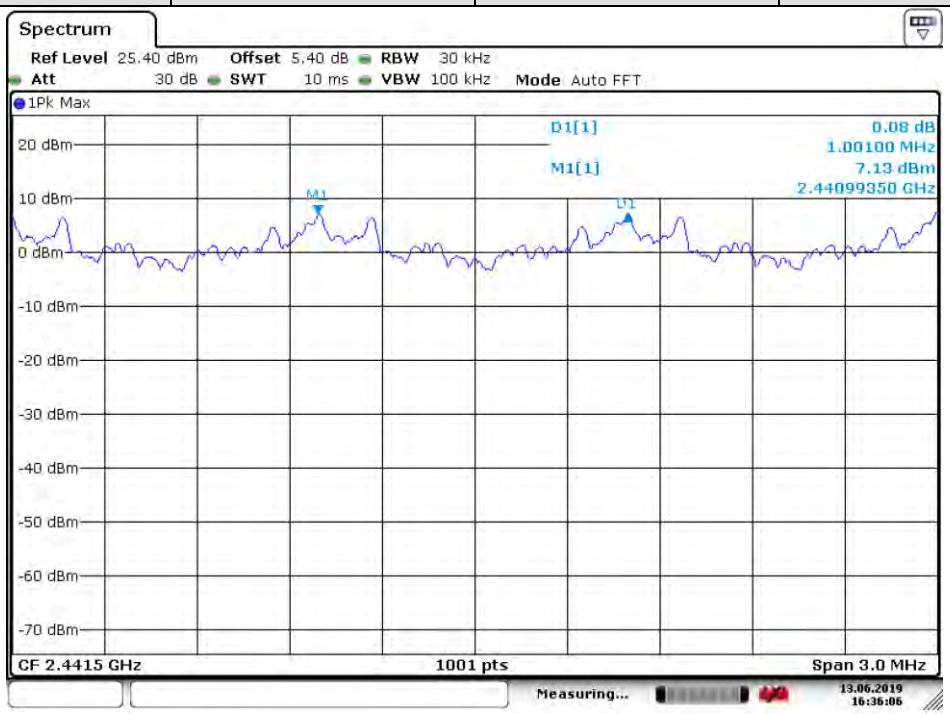
Date: 13.JUN.2019 16:37:11

Test mode:	π/4DQPSK	Test channel:	Middle



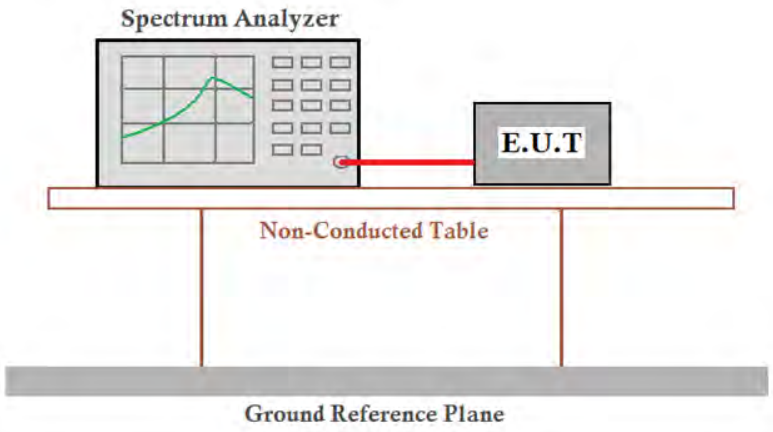
Date: 13.JUN.2019 16:36:44

Test mode:	8DPSK	Test channel:	Middle



Date: 13.JUN.2019 16:36:06

4.7 Hopping Channel Number

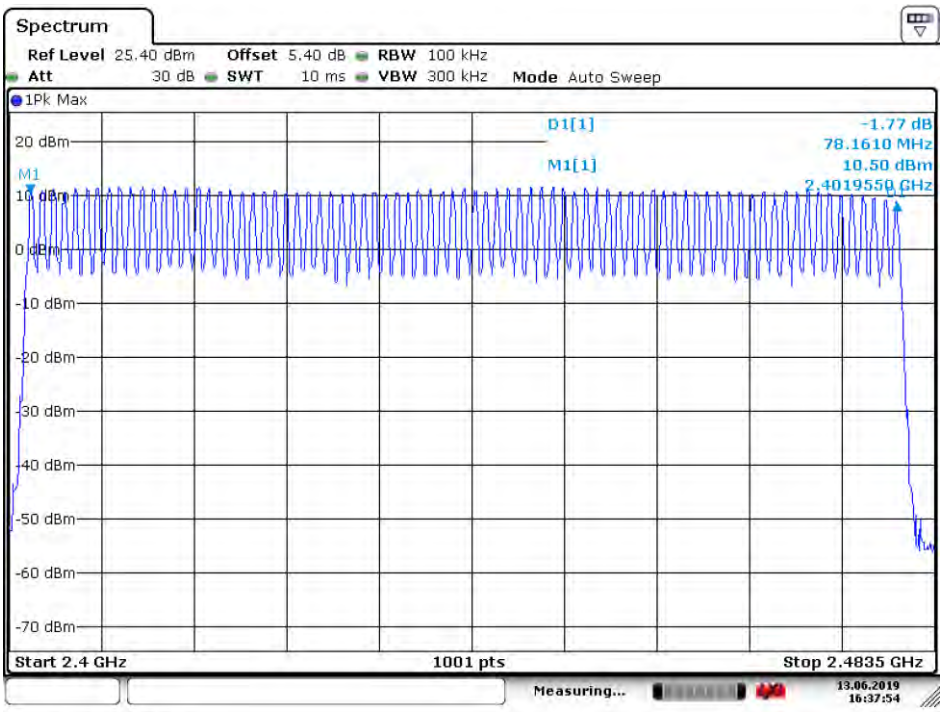
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013 Section 7.8.3
Test Setup:	
Limit:	At least 15 channels
Test Mode:	Hopping transmitting with all kind of modulation
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

4.7.1 Test Results

Mode	Hopping channel numbers	Limit
GFSK	79	≥15
π/4DQPSK	79	≥15
8DPSK	79	≥15

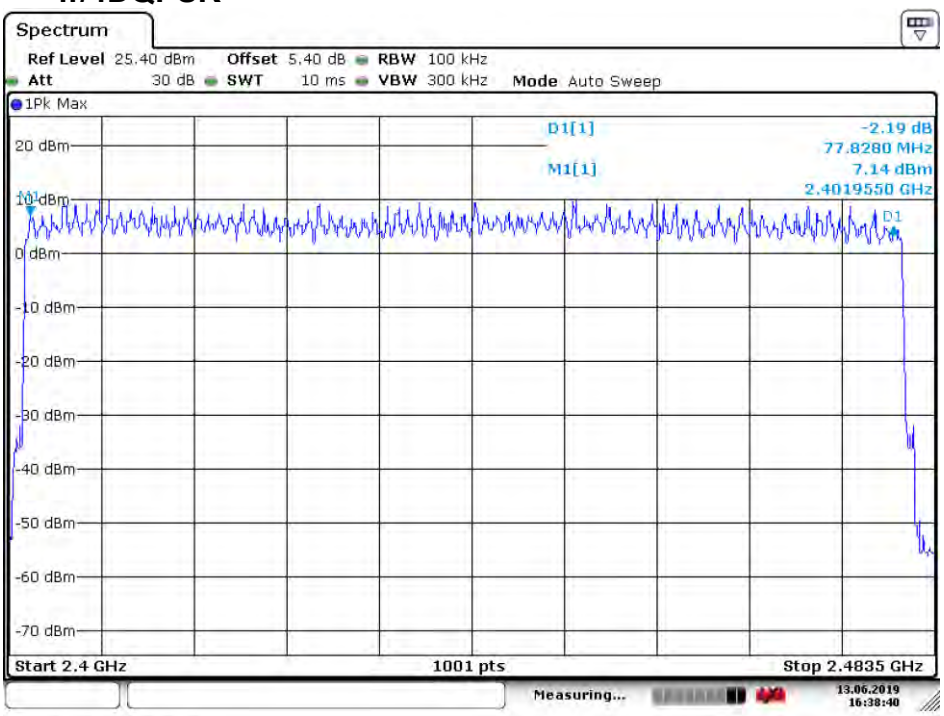
4.7.2 Test plots

4.7.2.1 GFSK



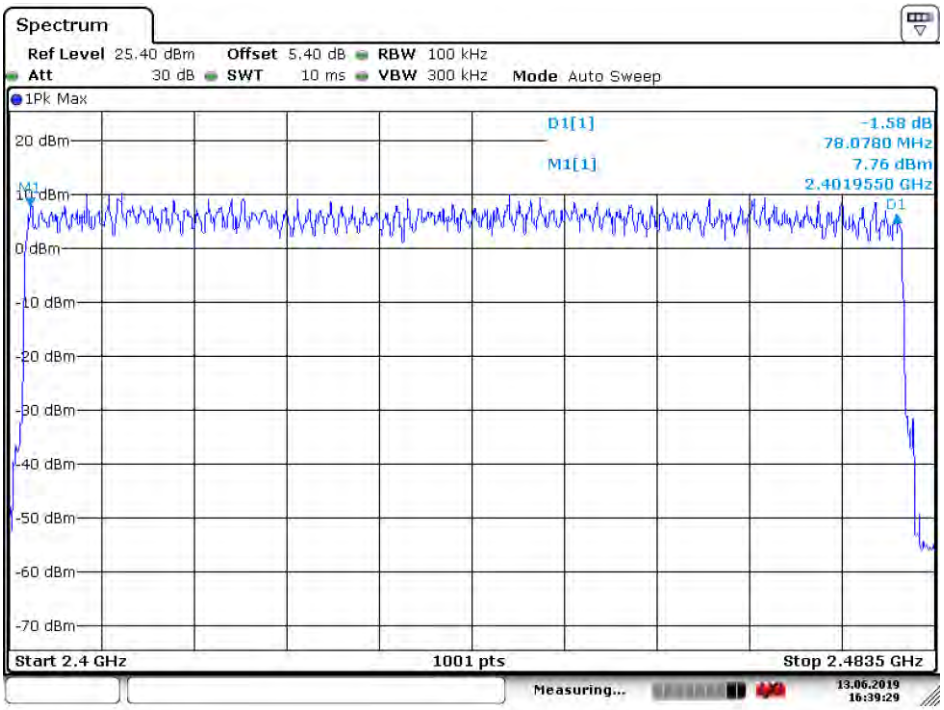
Date: 13.JUN.2019 16:37:55

4.7.2.2 π/4DQPSK



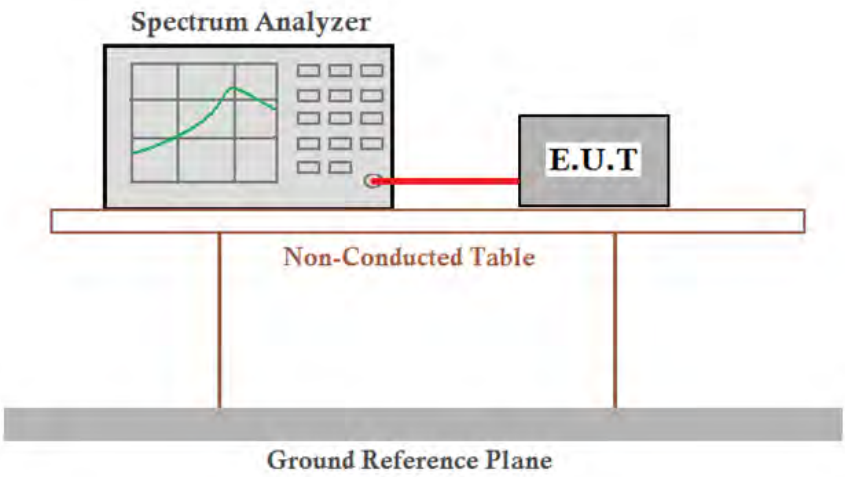
Date: 13.JUN.2019 16:38:40

4.7.2.3 8DPSK



Date: 13.JUN.2019 16:39:29

4.8 Dwell Time

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013 Section 7.8.4
Test Setup:	
Instruments Used:	Refer to section 5.10 for details
Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Limit:	0.4 Second
Test Results:	Pass

4.8.1 Test Results

Operation Modes	On time（ms）on one channel
DH1	0.403
DH3	1.664
DH5	2.914
2-DH1	0.408
2-DH3	1.667
2-DH5	2.914
3-DH1	0.407
3-DH3	1.664
3-DH5	2.919

Bluetooth Time of Occupancy Calculation

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s, since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of 1600/6=266.67 hops/slot

400ms x 79 Channel = 31.6 s (Time of Occupancy Limit)

Worst case BT has 266.67 hops/second（for 1x/EDR modes with 3-DH5 operation）

266.67 hops/second/79 channels=3.38 hops/second (# of hops/second on one channel)

3.38 hops/second/channel*31.6seconds=106.67 hops (#hops over a 31.6 second period)

106.67 hops *2.919 ms/channel =311.37 ms(worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800hops/s, AFH mode also uses 6 slots so the Bluetooth transmitter hops at a rate of 800/6=133.3 hops/s/slot

400ms x 20 Channel = 8 s (Time of Occupancy Limit)

Worst case BT has 133.3 hops/second/slot (for AFH mode with 3-DH5 operation)

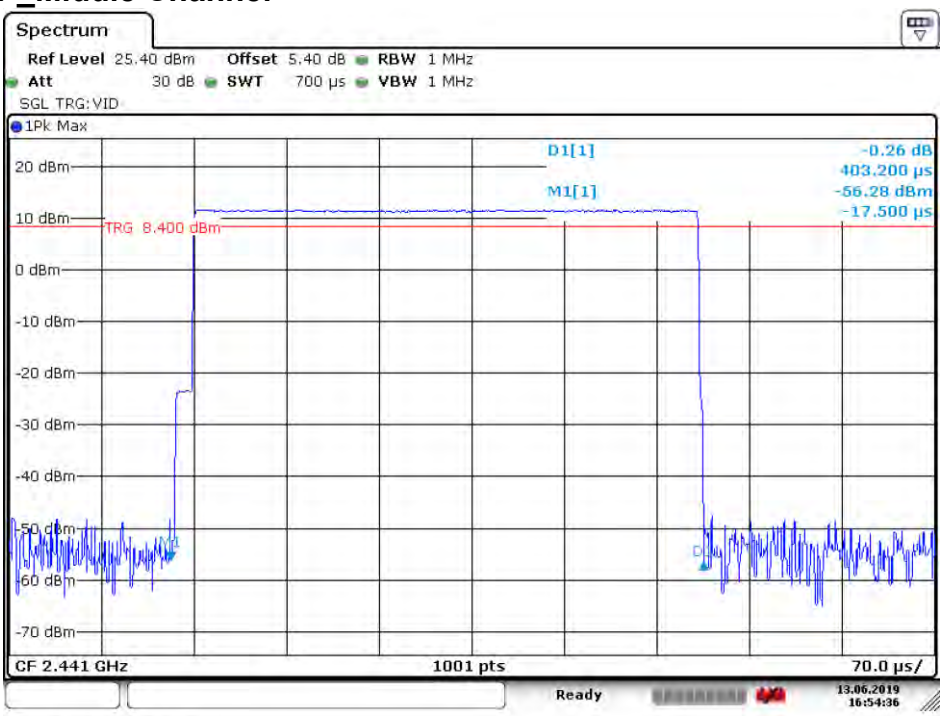
133.3 hops/second/20 channels=6.67 hops/second (#hops/second on one channel)

6.67 hops/second *8seconds=53.34 hops (#hops over a 8 seconds period)

53.34 hops x2.919 ms/channel=155.70 ms(worst case dwell time for one channel in AFH mode)

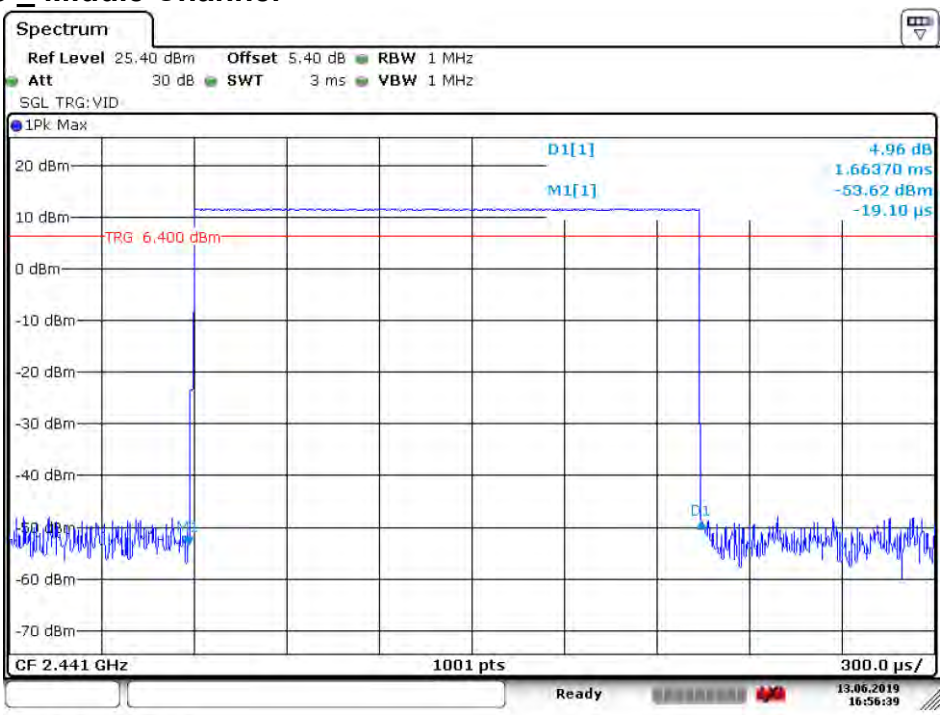
4.8.2 Test plots

4.8.2.1 DH1 _Middle Channel



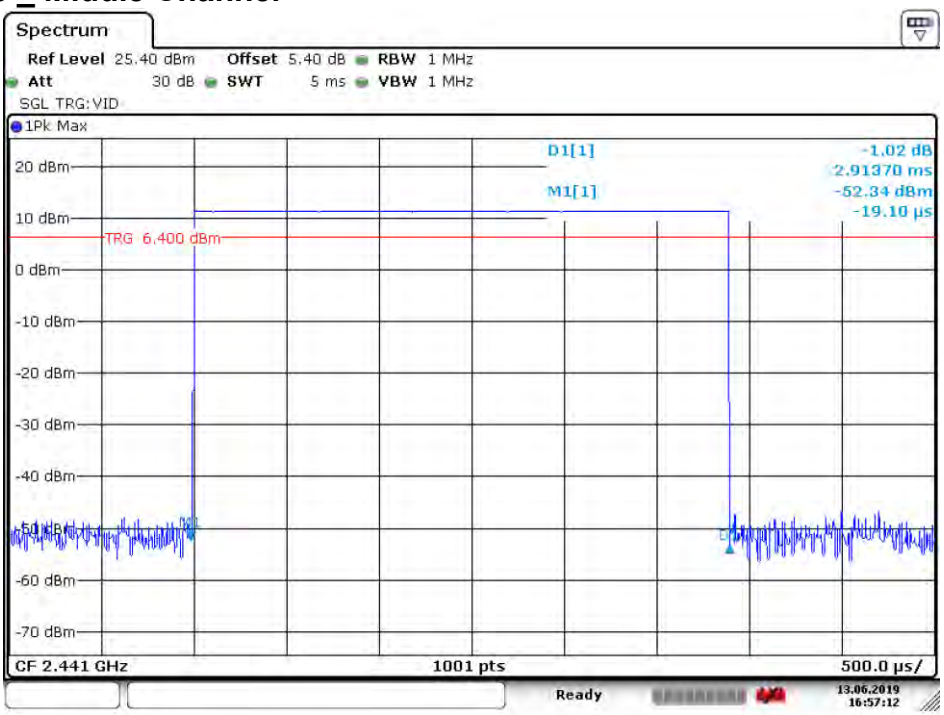
Date: 13.JUN.2019 16:54:36

4.8.2.2 DH3 _ Middle Channel



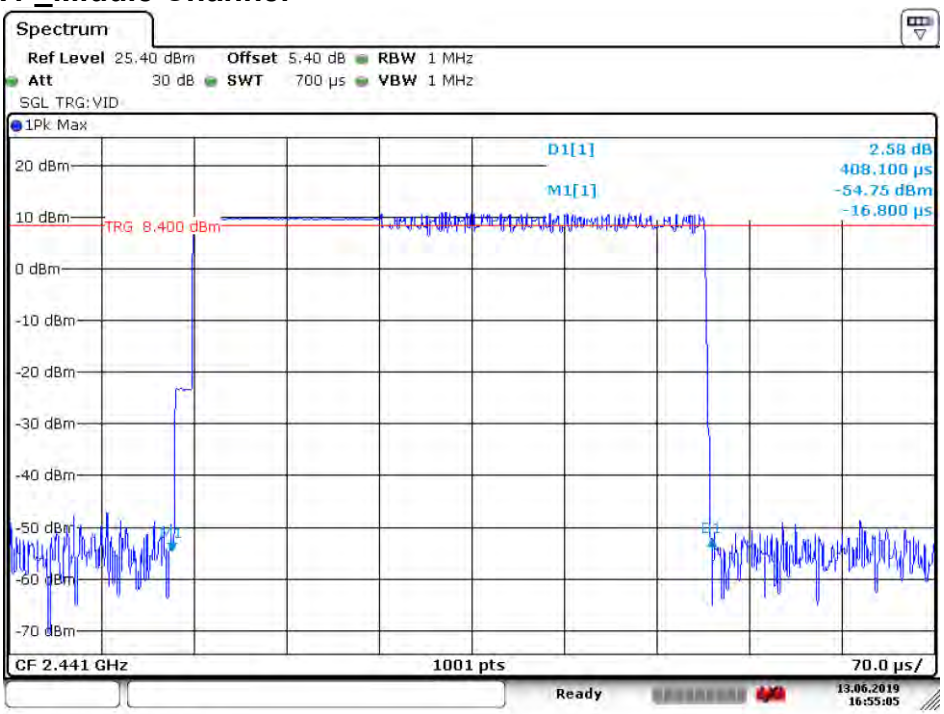
Date: 13.JUN.2019 16:56:39

4.8.2.3 DH5 _ Middle Channel



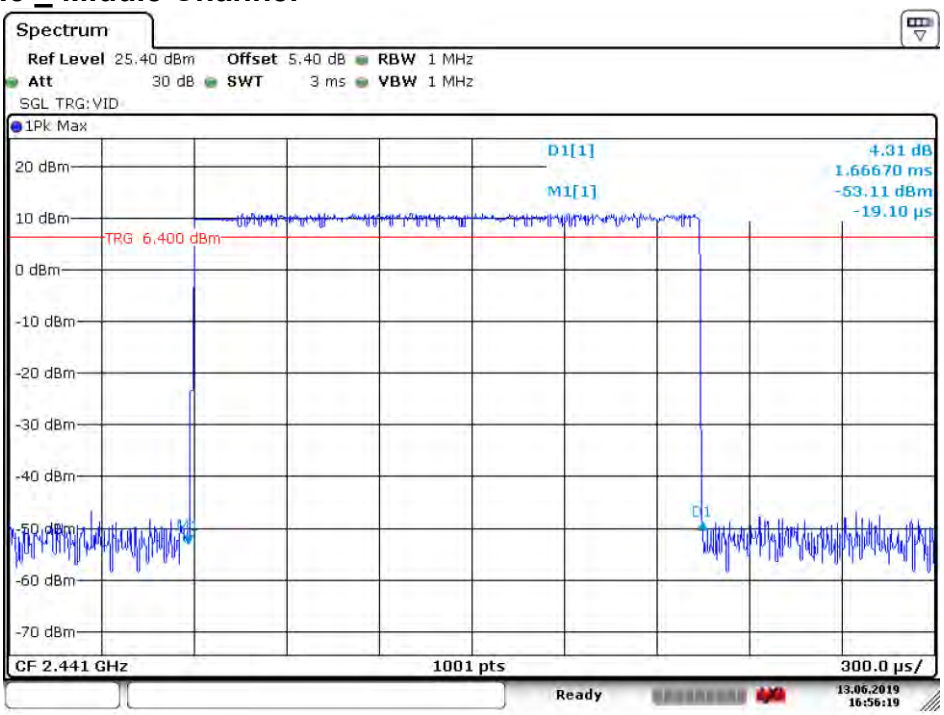
Date: 13.JUN.2019 16:57:12

4.8.2.4 2DH1 _Middle Channel



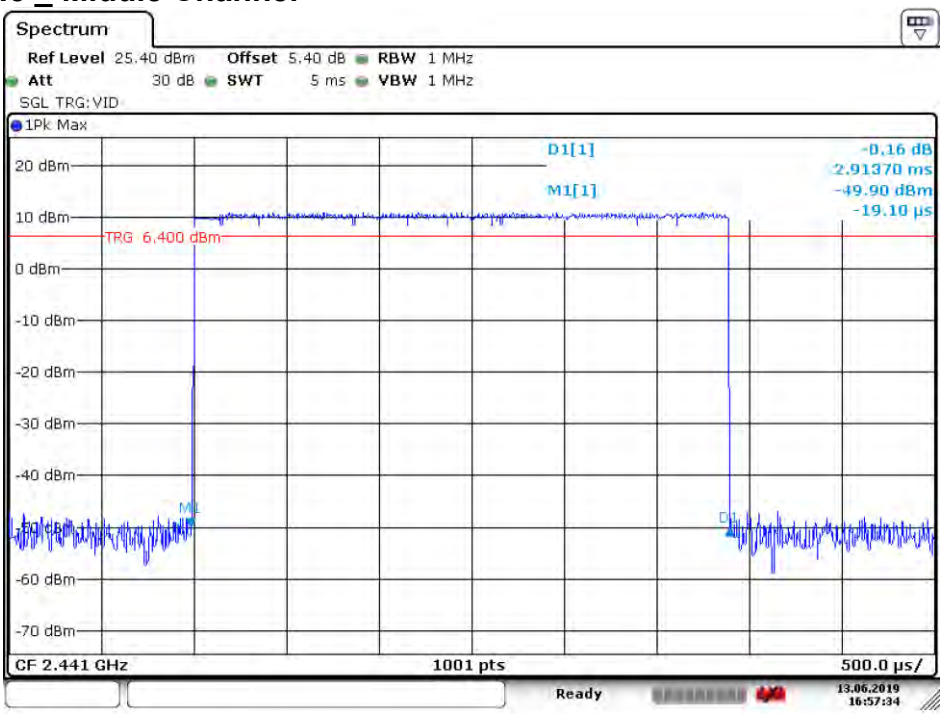
Date: 13.JUN.2019 16:55:05

4.8.2.5 2DH3 _ Middle Channel



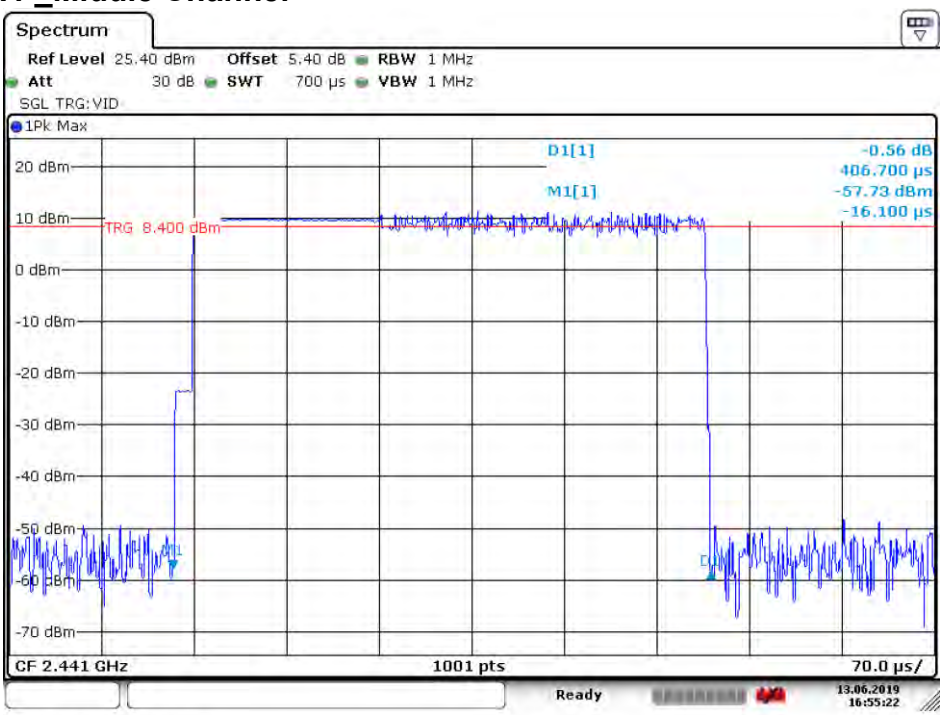
Date: 13.JUN.2019 16:56:19

4.8.2.6 2DH5 _ Middle Channel



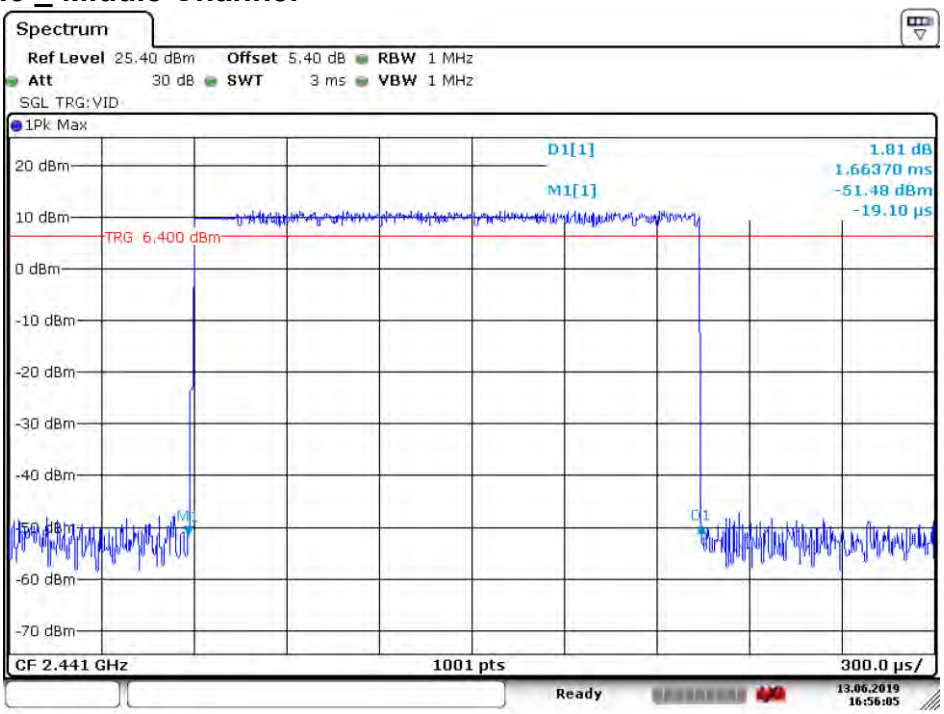
Date: 13.JUN.2019 16:57:34

4.8.2.7 3DH1 _Middle Channel



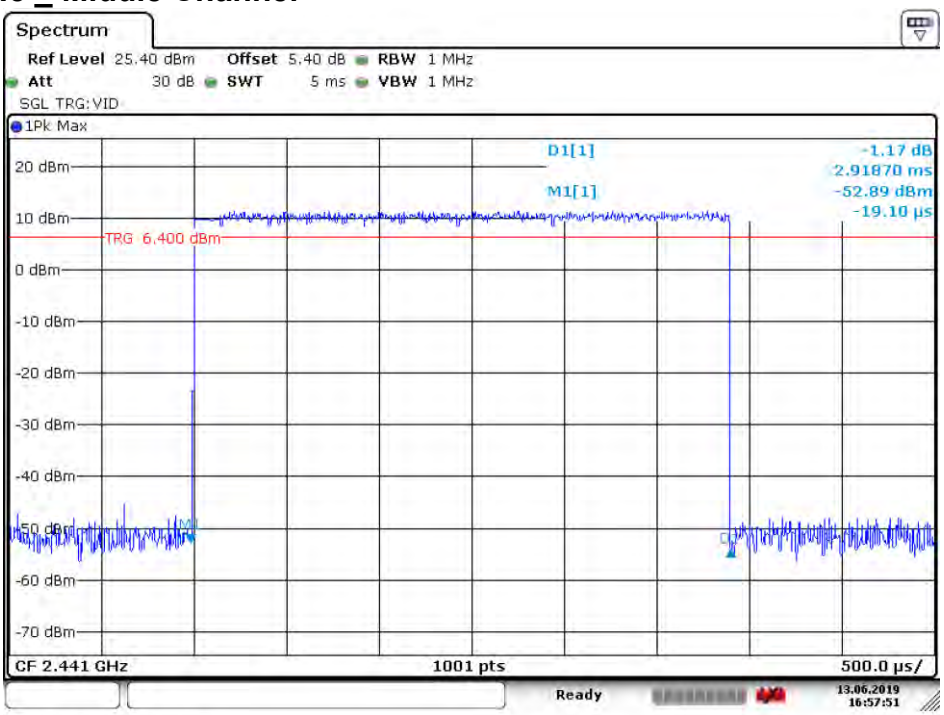
Date: 13.JUN.2019 16:55:21

4.8.2.8 3DH3 _ Middle Channel



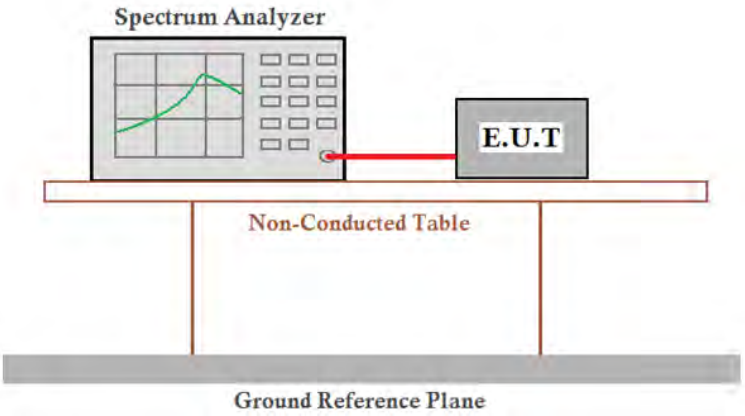
Date: 13.JUN.2019 16:56:06

4.8.2.9 3DH5 _ Middle Channel



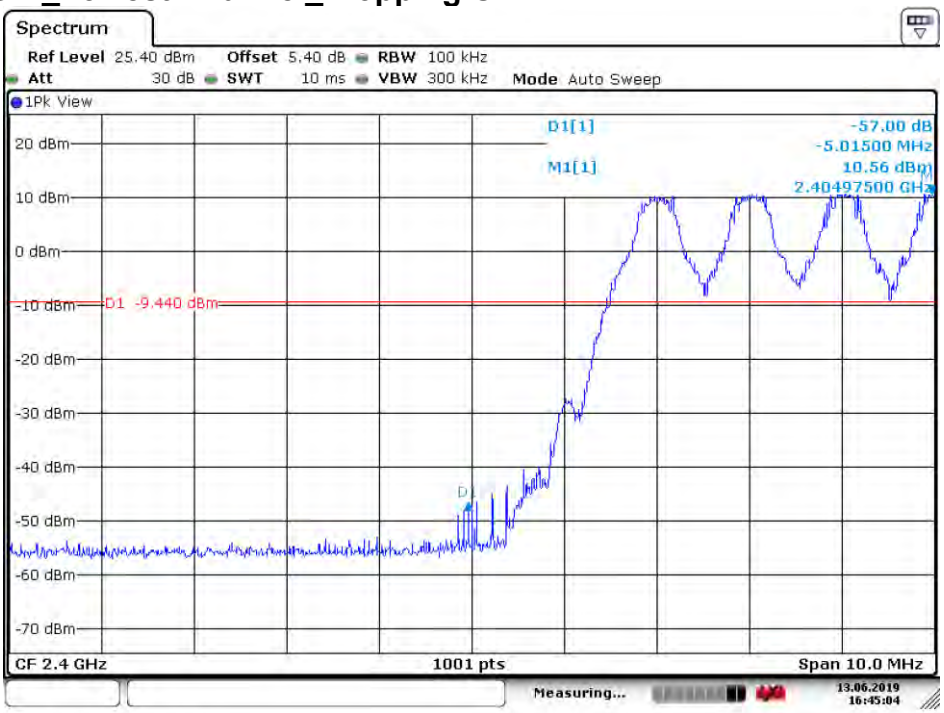
Date: 13.JUN.2019 16:57:51

4.9 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013 Section 7.8.6
Test Setup:	
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

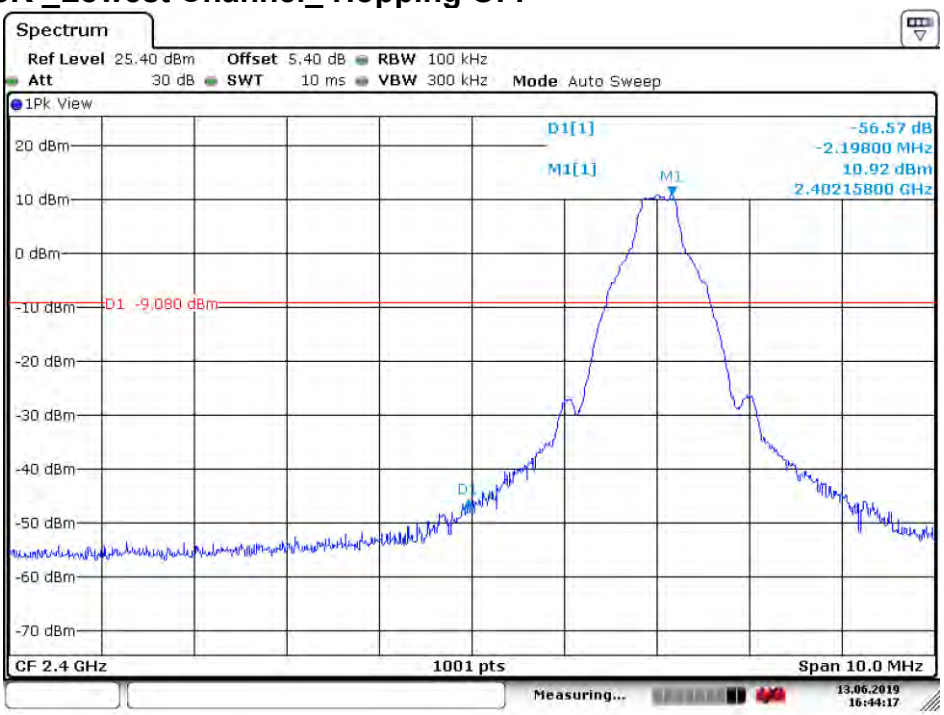
4.9.1 Test plots

4.9.1.1 GFSK _Lowest Channel_ Hopping ON



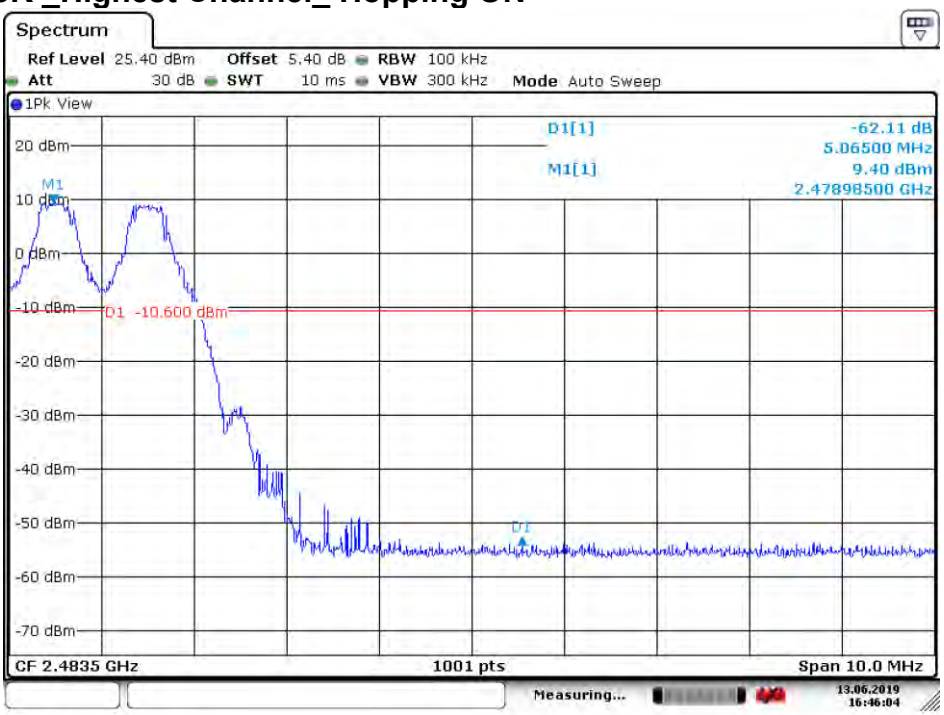
Date: 13.JUN.2019 16:45:04

4.9.1.2 GFSK _Lowest Channel_ Hopping OFF



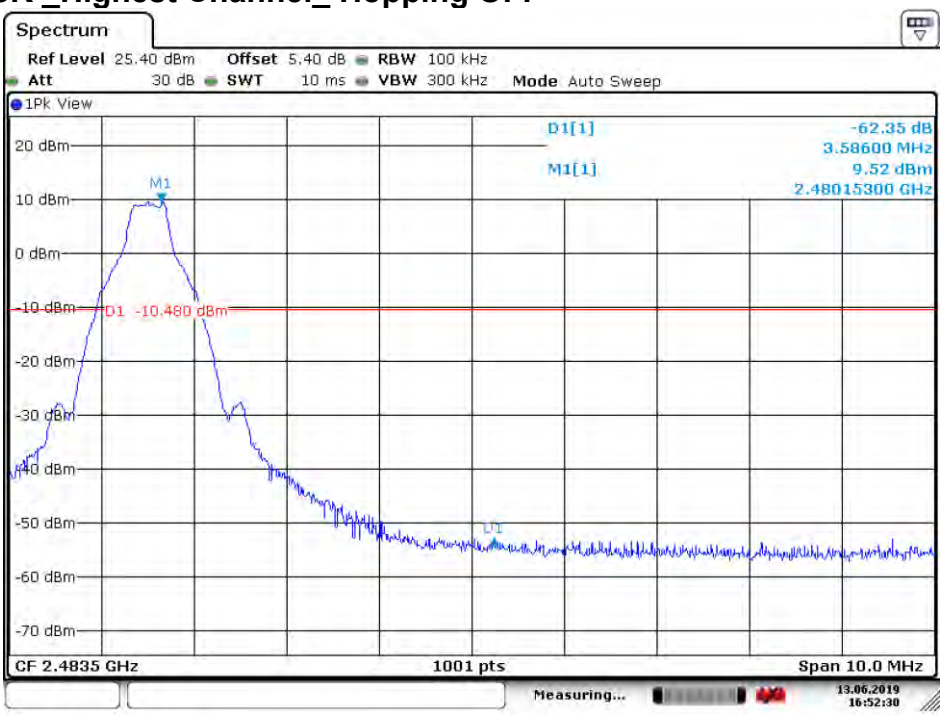
Date: 13.JUN.2019 16:44:17

4.9.1.3 GFSK _Highest Channel_ Hopping ON



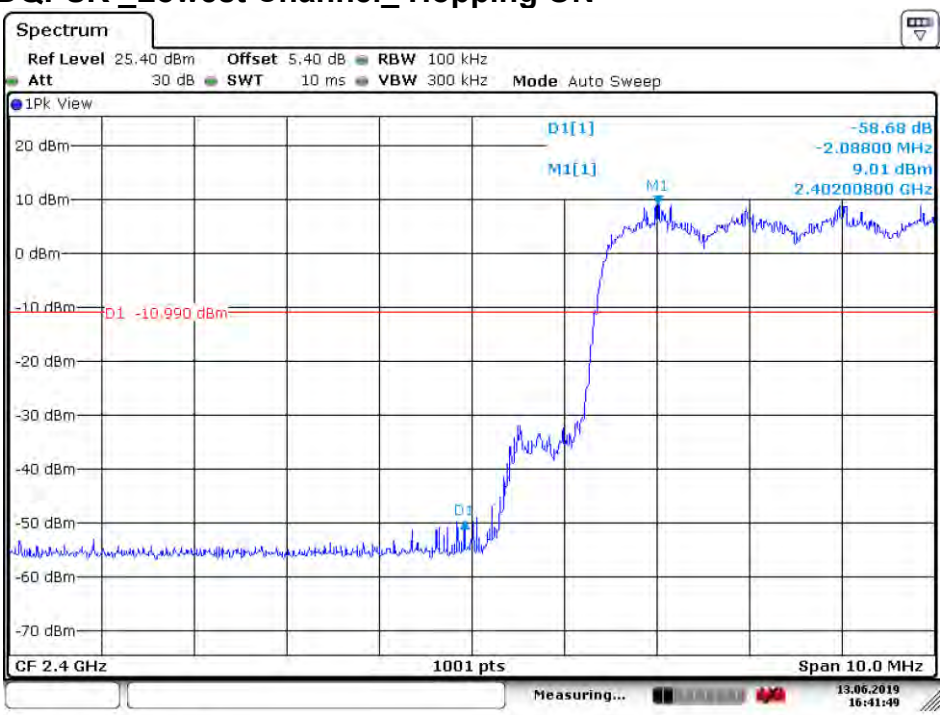
Date: 13.JUN.2019 16:46:04

4.9.1.4 GFSK _Highest Channel_ Hopping OFF



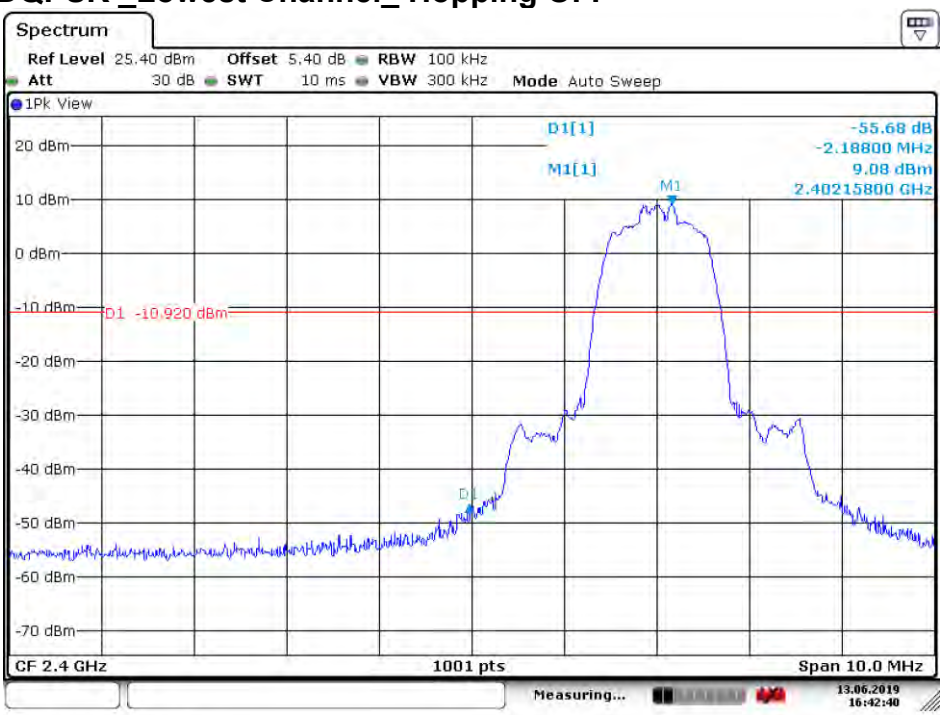
Date: 13.JUN.2019 16:52:31

4.9.1.5 π/4DQPSK _Lowest Channel_ Hopping ON



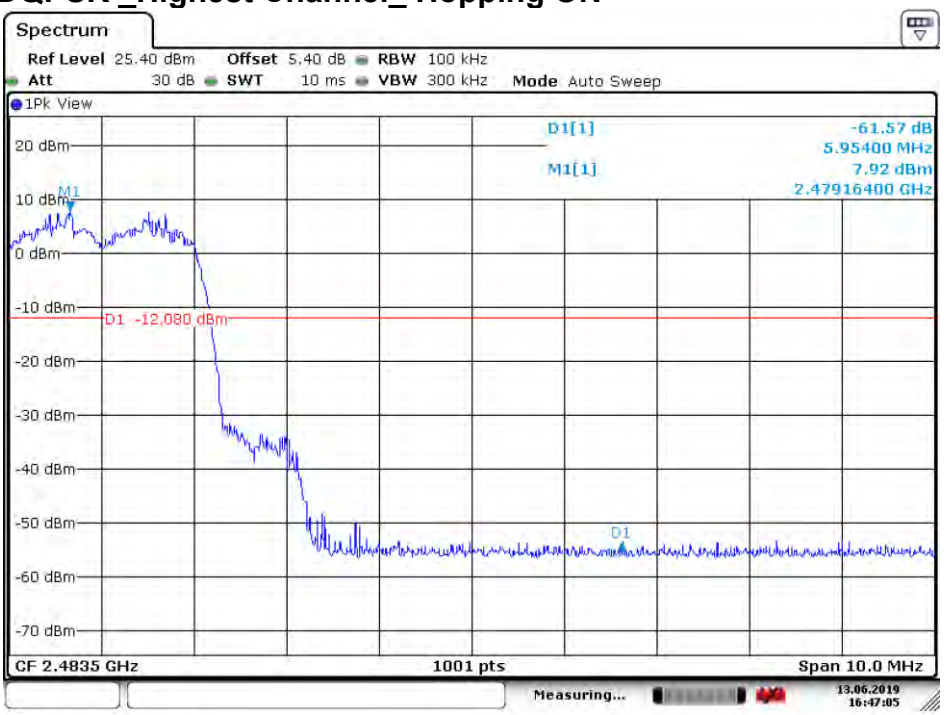
Date: 13.JUN.2019 16:41:50

4.9.1.6 π/4DQPSK _Lowest Channel_ Hopping OFF



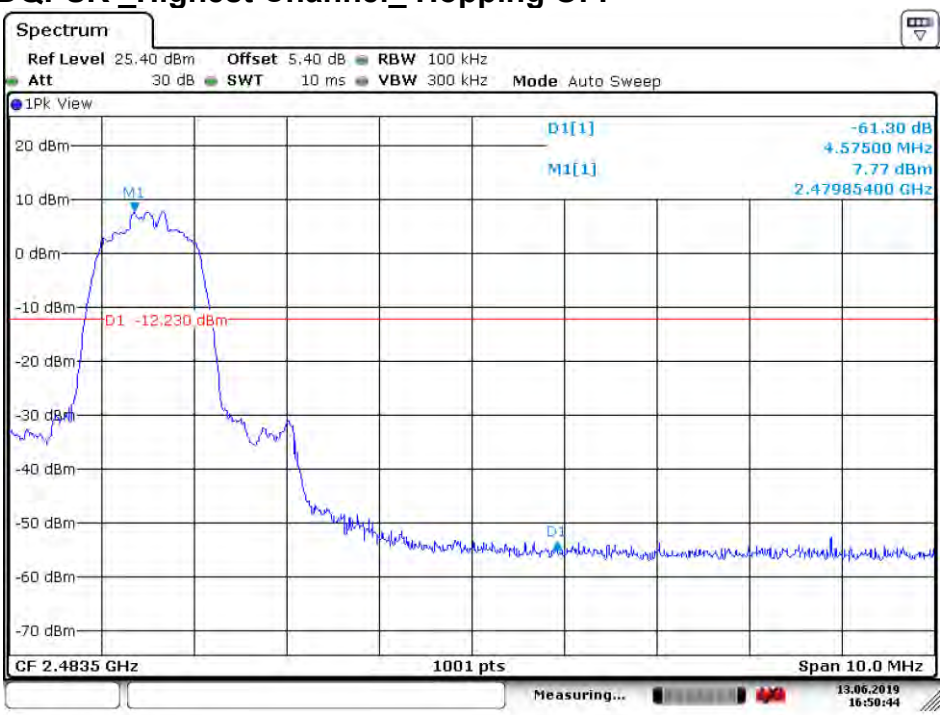
Date: 13.JUN.2019 16:42:40

4.9.1.7 π/4DQPSK _Highest Channel_ Hopping ON



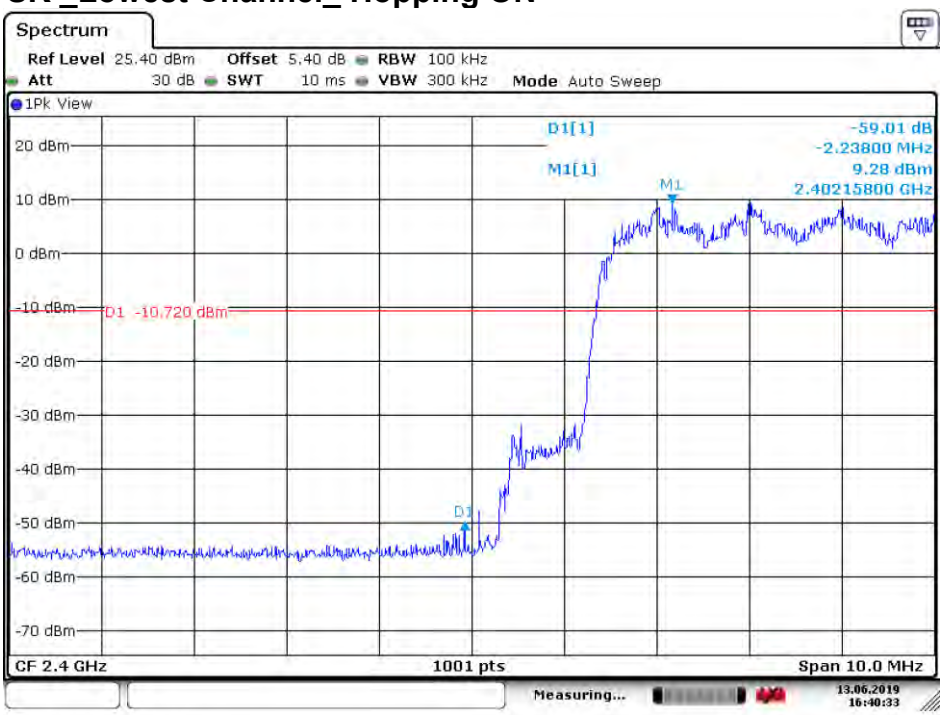
Date: 13.JUN.2019 16:47:05

4.9.1.8 π/4DQPSK _Highest Channel_ Hopping OFF



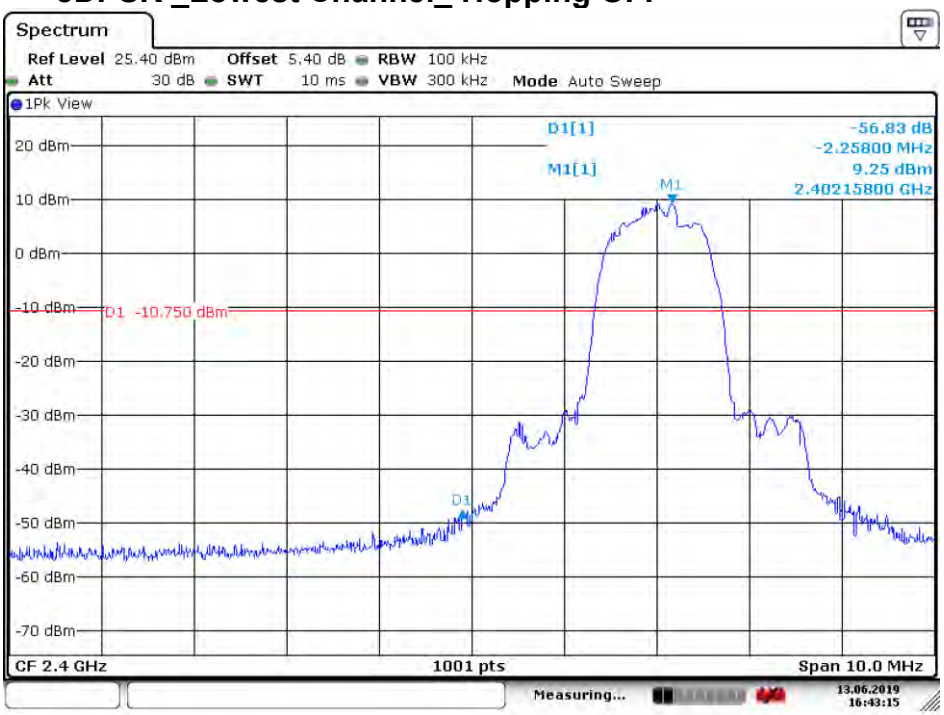
Date: 13.JUN.2019 16:50:44

4.9.1.9 8DPSK _Lowest Channel_ Hopping ON



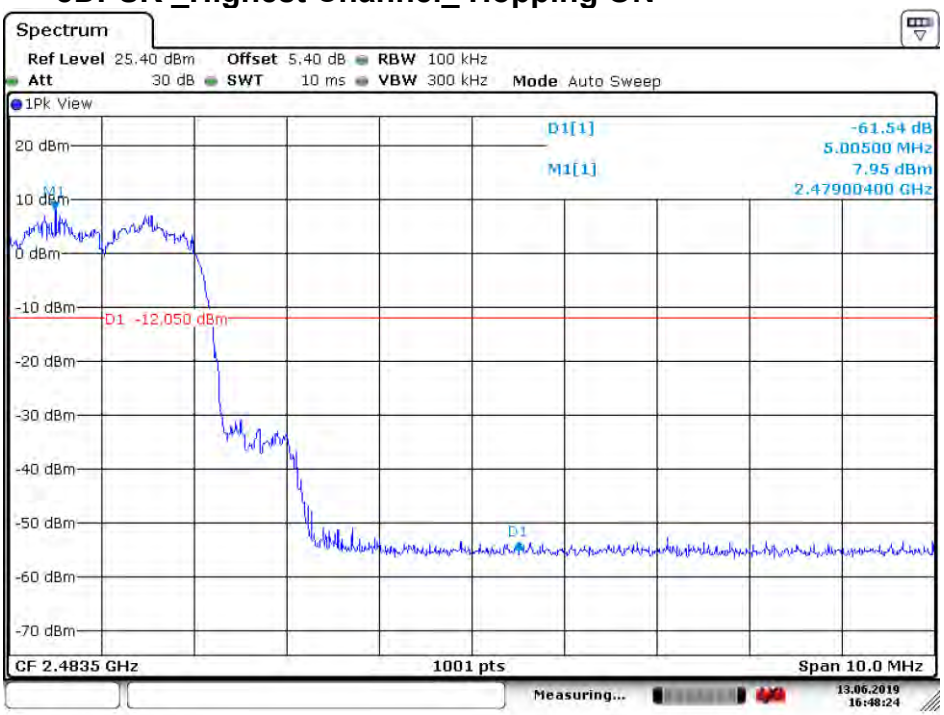
Date: 13.JUN.2019 16:40:34

4.9.1.10 8DPSK _Lowest Channel_ Hopping OFF



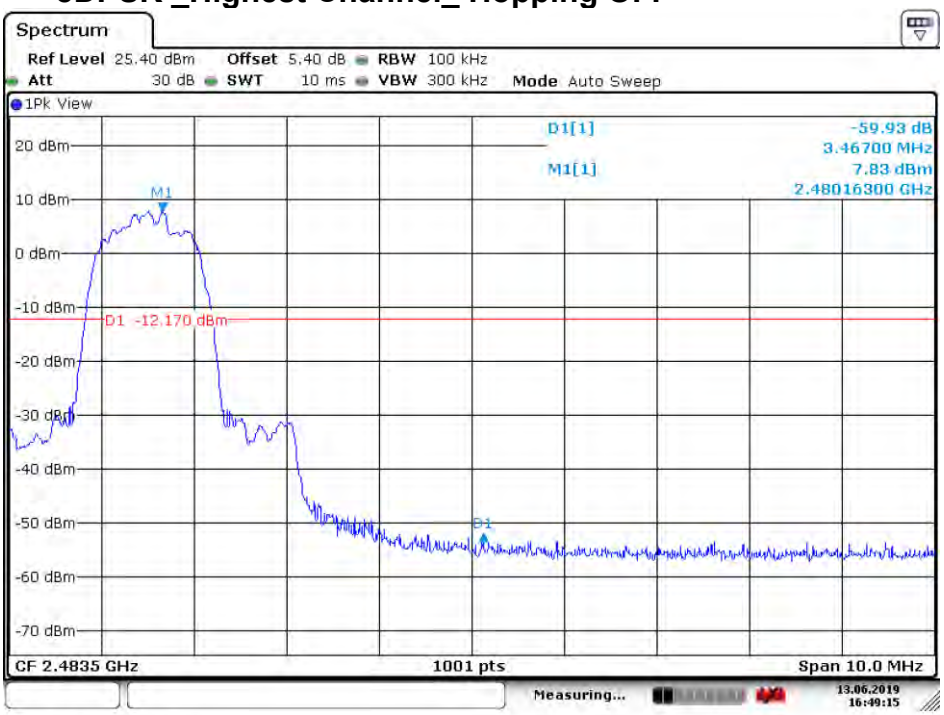
Date: 13.JUN.2019 16:43:16

4.9.1.11 8DPSK _Highest Channel_ Hopping ON

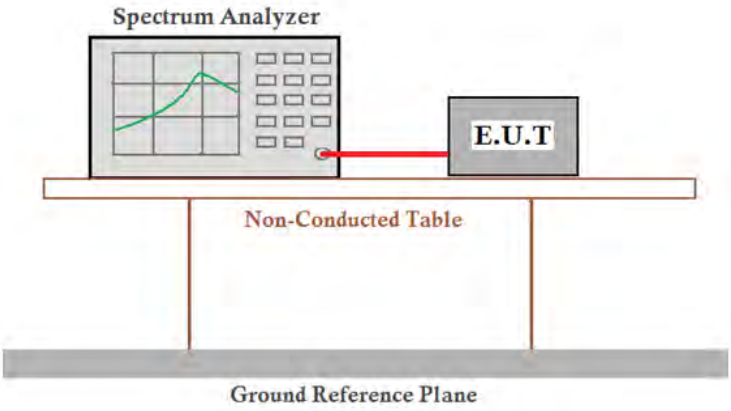


Date: 13.JUN.2019 16:48:24

4.9.1.12 8DPSK _Highest Channel_ Hopping OFF

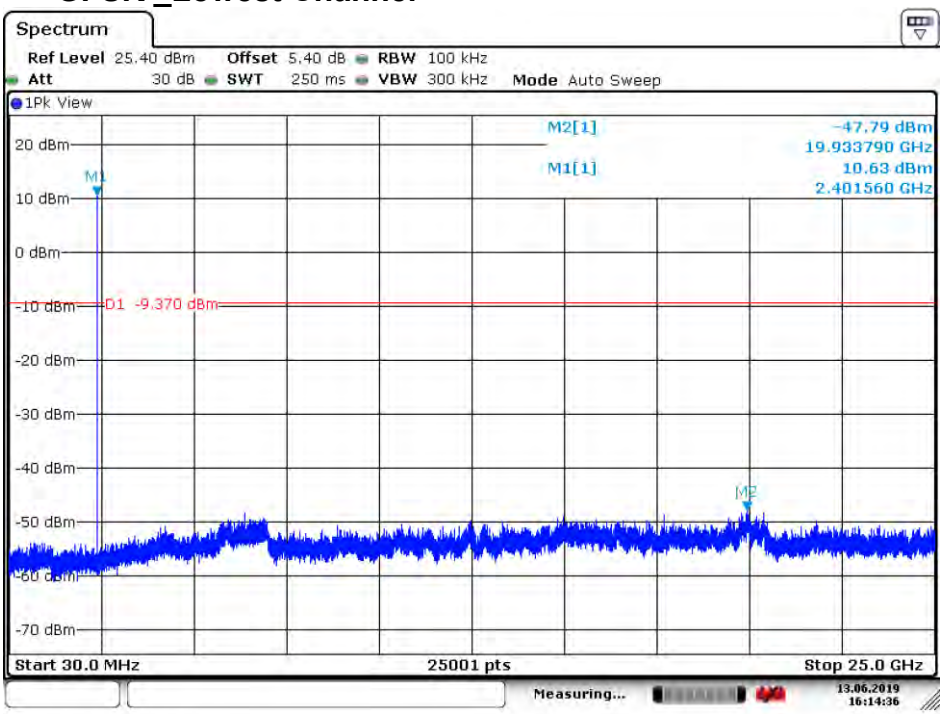


4.10 Spurious RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013 Section 7.8.8
Test Setup:	
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

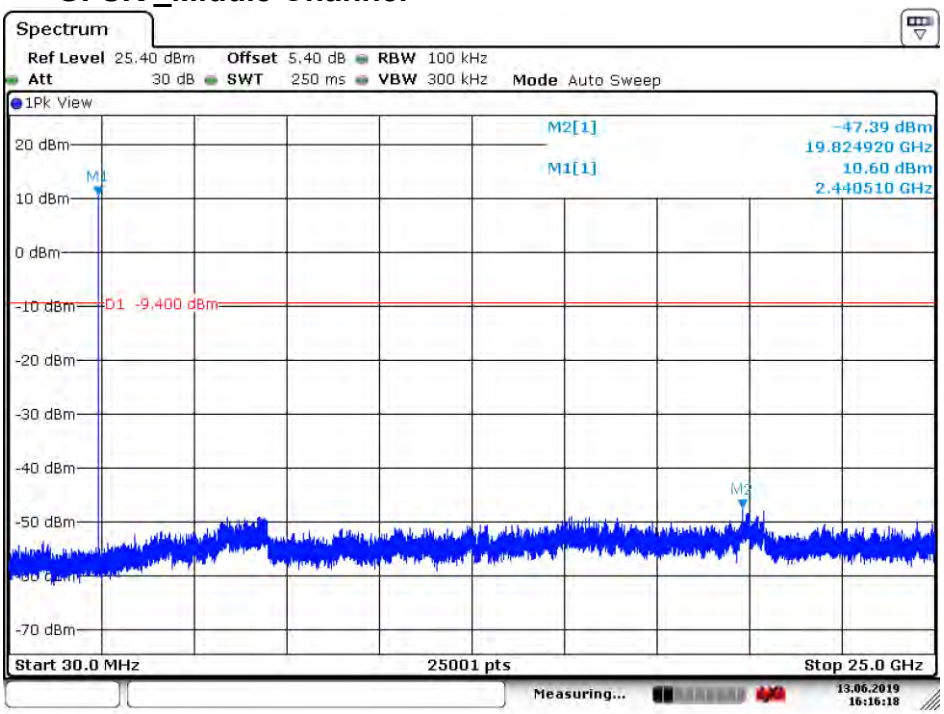
4.10.1 Test plots

4.10.1.1 GFSK _Lowest Channel



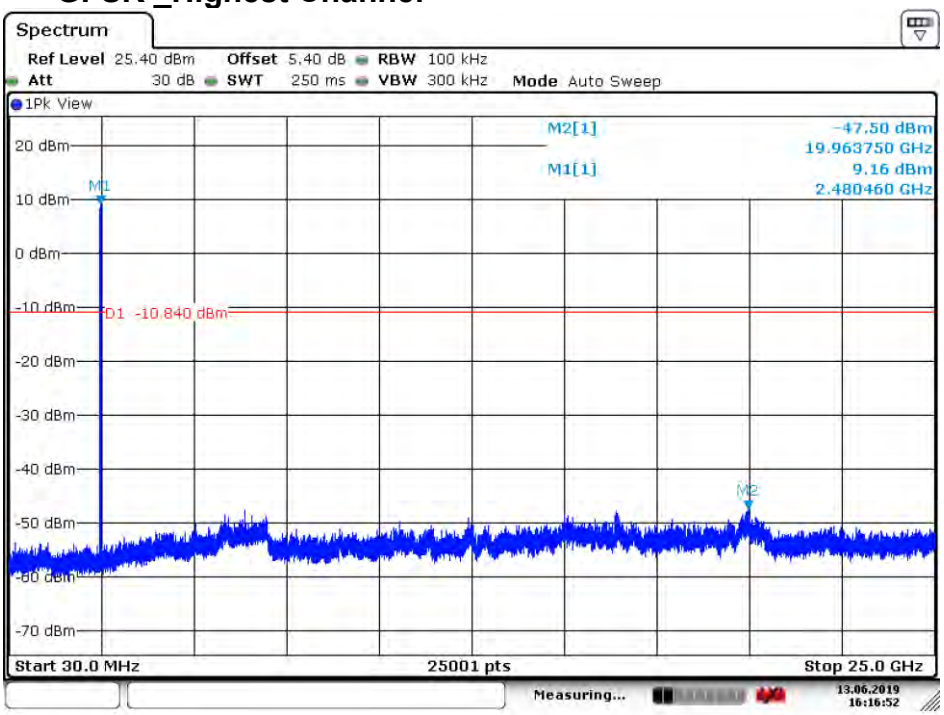
Date: 13.JUN.2019 16:14:37

4.10.1.2 GFSK _Middle Channel



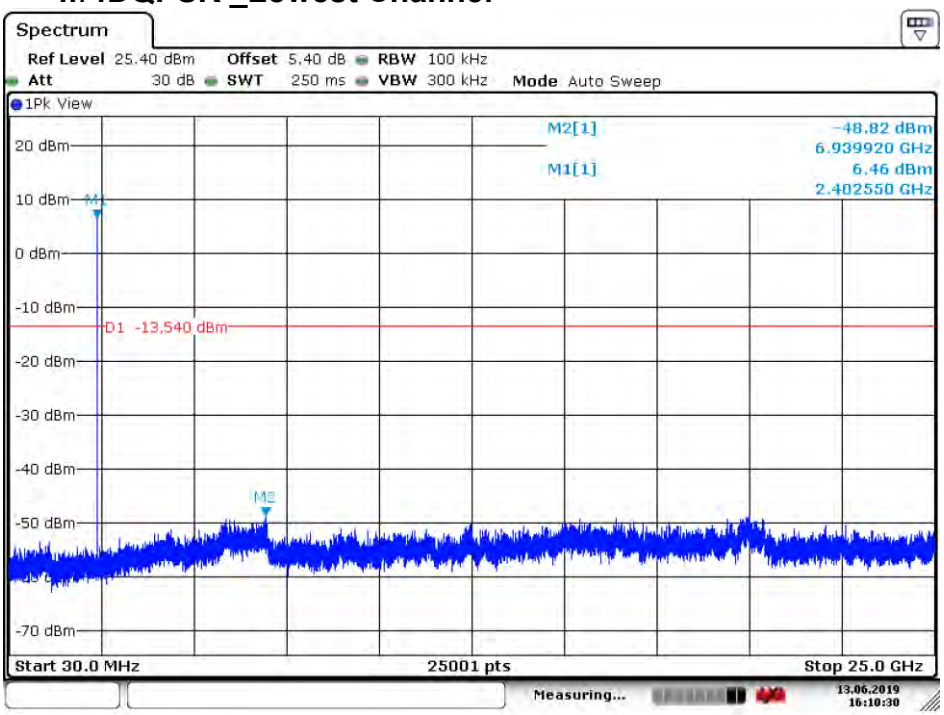
Date: 13.JUN.2019 16:16:19

4.10.1.3 GFSK _Highest Channel



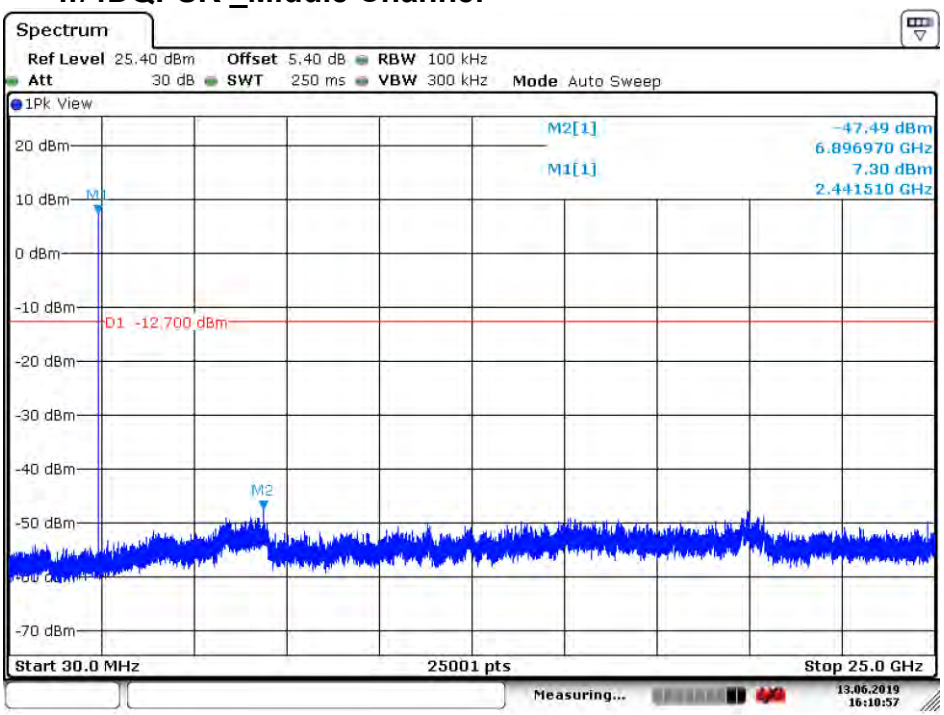
Date: 13.JUN.2019 16:16:52

4.10.1.4 π/4DQPSK _Lowest Channel



Date: 13.JUN.2019 16:10:30

4.10.1.5 π/4DQPSK _Middle Channel



Date: 13.JUN.2019 16:10:57

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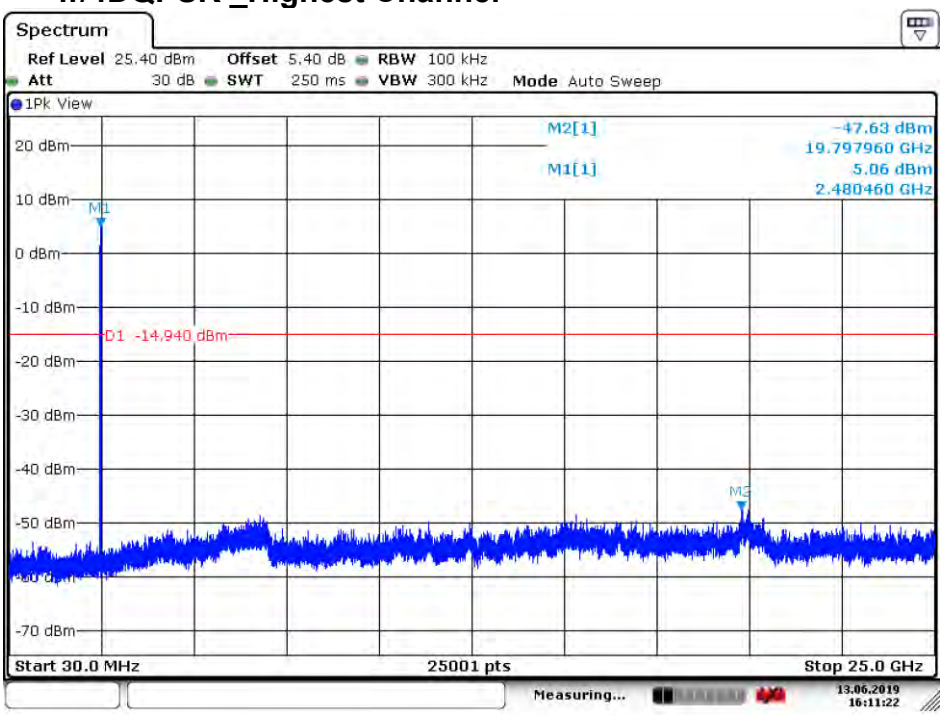
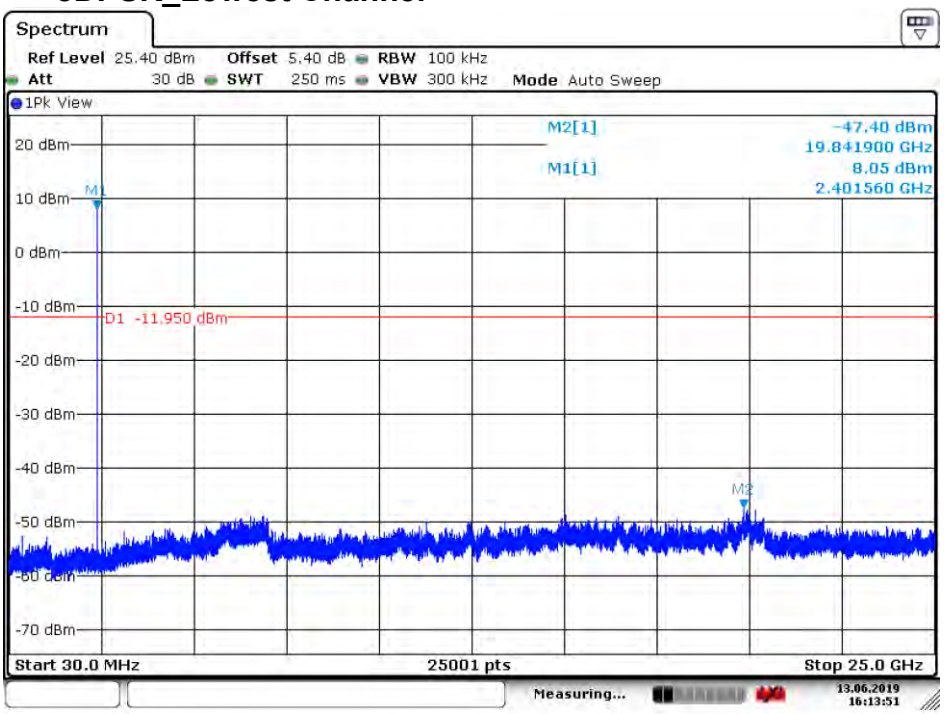
4.10.1.6 π/4DQPSK _Highest Channel



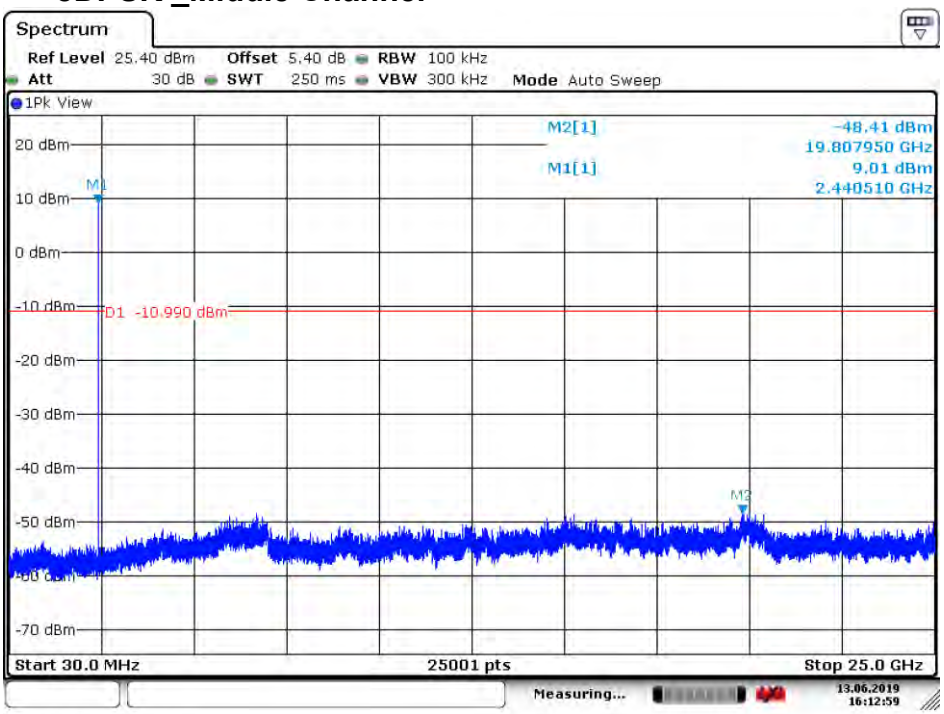
Date: 13.JUN.2019 16:11:23

4.10.1.7 8DPSK_Lowest Channel



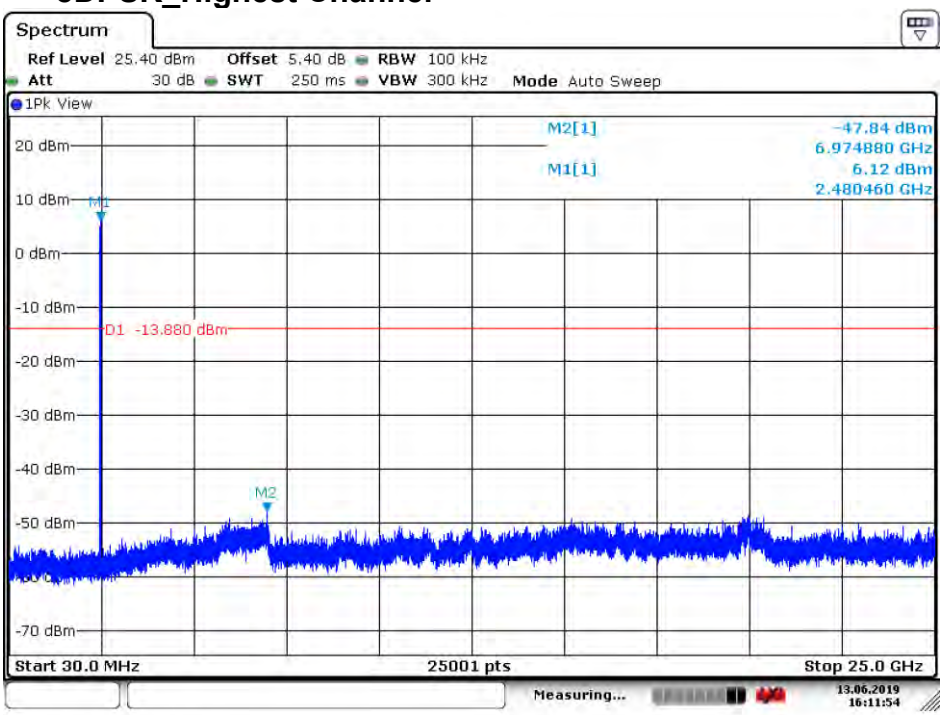
Date: 13.JUN.2019 16:13:51

4.10.1.8 8DPSK _Middle Channel



Date: 13.JUN.2019 16:12:59

4.10.1.9 8DPSK_Highest Channel



Date: 13.JUN.2019 16:11:55

Remark:

Scan from 9kHz to 25GHz, the disturbance between 9KHz to 30MHz was very low, and the above harmonics were the highest point could be found when testing, The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4.11 Radiated Spurious Emission

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10: 2013				
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	100 kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	10Hz	Average
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Remark: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				

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Test Setup:	

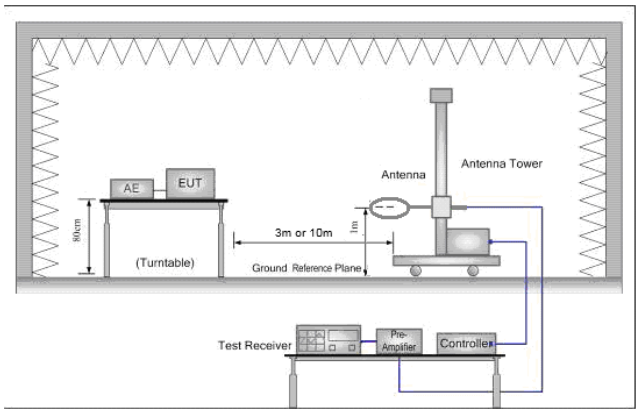

Figure 1. Below 30MHz

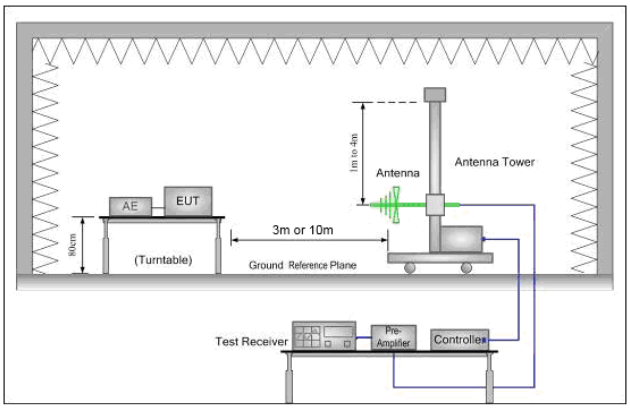

Figure 2. 30MHz to 1GHz

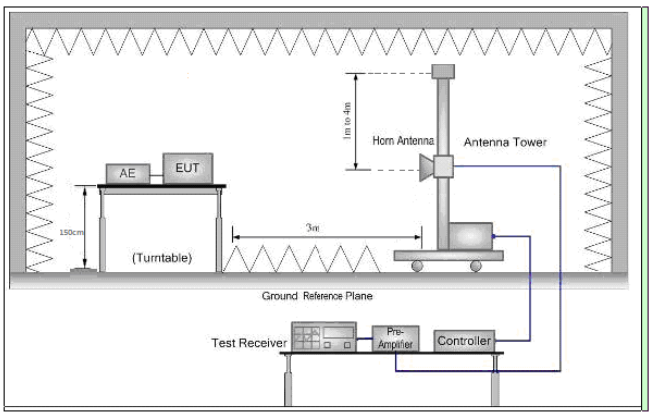

Figure 3. Above 1 GHz

Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna 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. e. 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. If the emission level of the EUT in peak mode was 10dB 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 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet. h. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Pretest the EUT at Charge + Transmitting mode For below 1GHz part, through pre-scan, the worst case is the lowest channel. Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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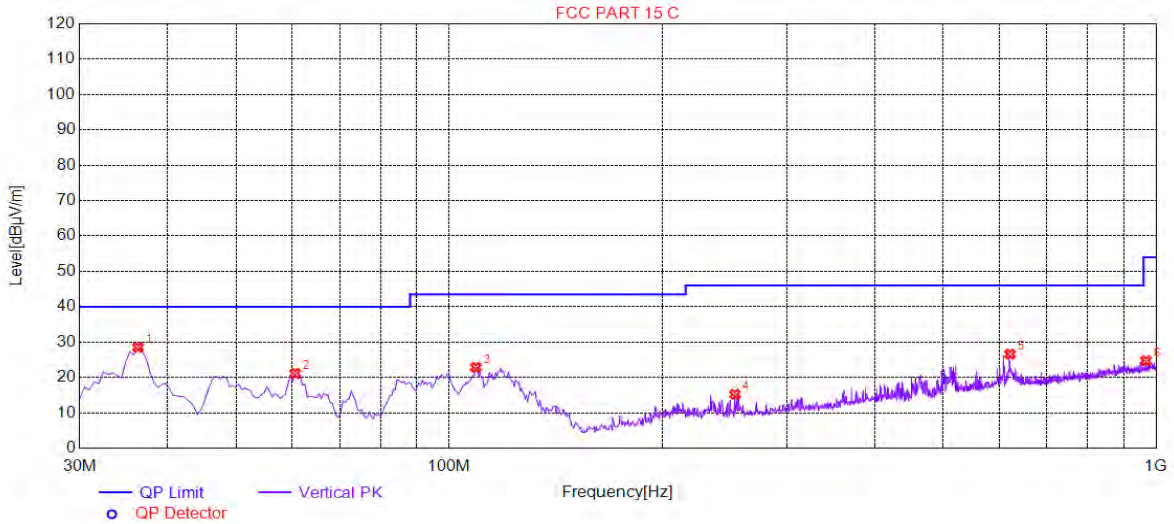
4.11.1 Radiated Emission below 1GHz

4.11.1.1 Charge + Transmitting, Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	36.3082	28.52	-32.34	40.00	11.48	100	174	Vertical
2	60.5703	21.15	-31.79	40.00	18.85	100	286	Vertical
3	109.094	22.87	-31.69	43.50	20.63	200	344	Vertical
4	253.696	15.25	-29.14	46.00	30.75	100	317	Vertical
5	621.510	26.58	-19.78	46.00	19.42	100	317	Vertical
6	967.488	24.76	-14.26	54.00	29.24	100	351	Vertical

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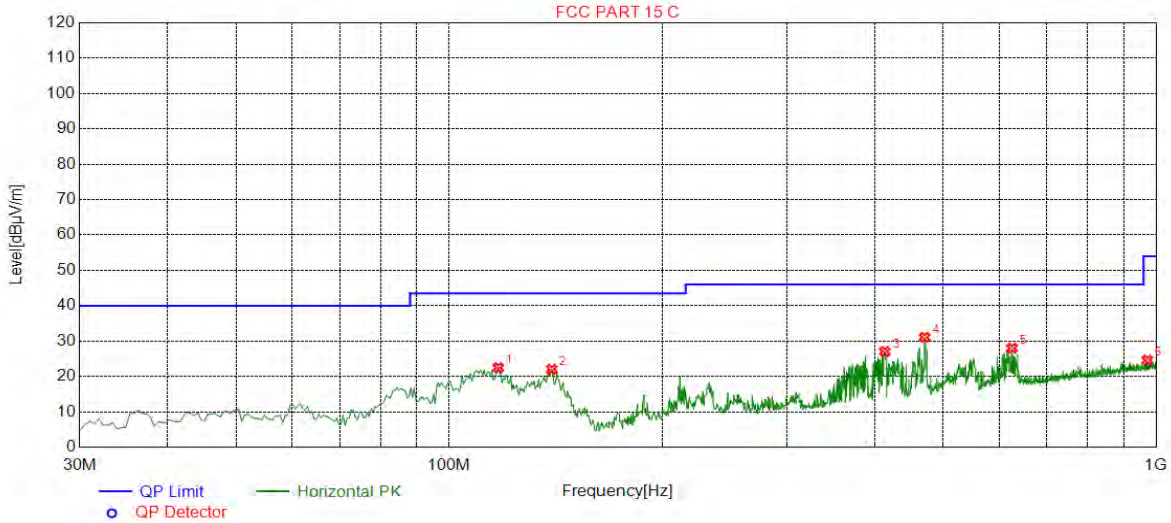
4.11.1.2 Charge + Transmitting, Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	117.343	22.47	-32.84	43.50	21.03	200	37	Horizontal
2	139.664	22.02	-35.20	43.50	21.48	200	239	Horizontal
3	413.341	27.04	-24.61	46.00	18.96	100	202	Horizontal
4	470.600	31.07	-23.41	46.00	14.93	100	202	Horizontal
5	625.392	28.02	-19.72	46.00	17.98	100	205	Horizontal
6	971.855	24.63	-14.21	54.00	29.37	200	15	Horizontal

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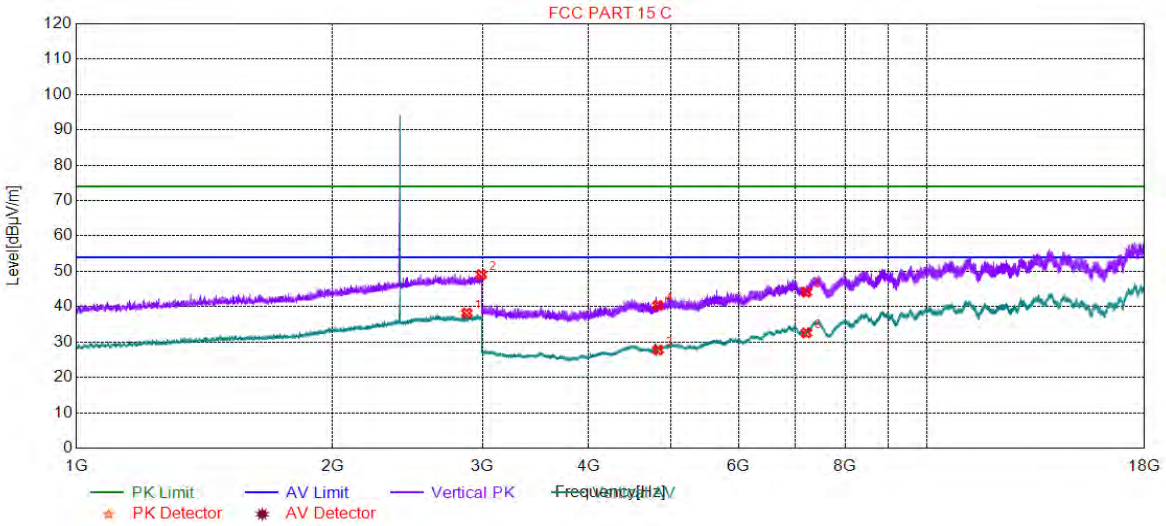
4.11.2 Transmitter Emission above 1GHz

4.11.2.1 GFSK(DH5) _Lowest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2875.96	38.20	2.23	54.00	15.80	150	49	Vertical
2	2990.49	49.08	2.32	74.00	24.92	150	56	Vertical
3	4824.00	27.76	-20.09	54.00	26.24	150	293	Vertical
4	4824.00	40.35	-20.09	74.00	33.65	150	325	Vertical
5	7206.00	44.11	-12.76	74.00	29.89	150	245	Vertical
6	7206.00	32.60	-12.76	54.00	21.40	150	89	Vertical

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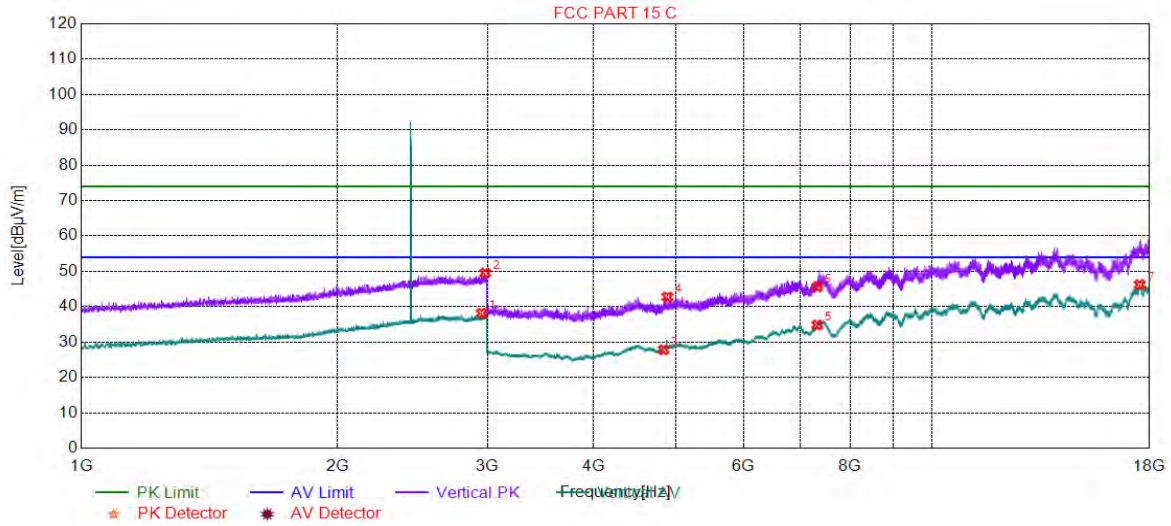
4.11.2.2 GFSK(DH5) _Middle Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2953.98	38.18	2.30	54.00	15.82	150	326	Vertical
2	2982.49	49.51	2.32	74.00	24.49	150	111	Vertical
3	4832.00	27.82	-19.98	54.00	26.18	150	278	Vertical
4	4882.00	42.74	-19.26	74.00	31.26	150	116	Vertical
5	7323.00	34.82	-11.38	54.00	19.18	150	132	Vertical
6	7323.00	45.61	-11.38	74.00	28.39	150	84	Vertical
7	17523.4	46.23	0.65	54.00	7.77	150	46	Vertical

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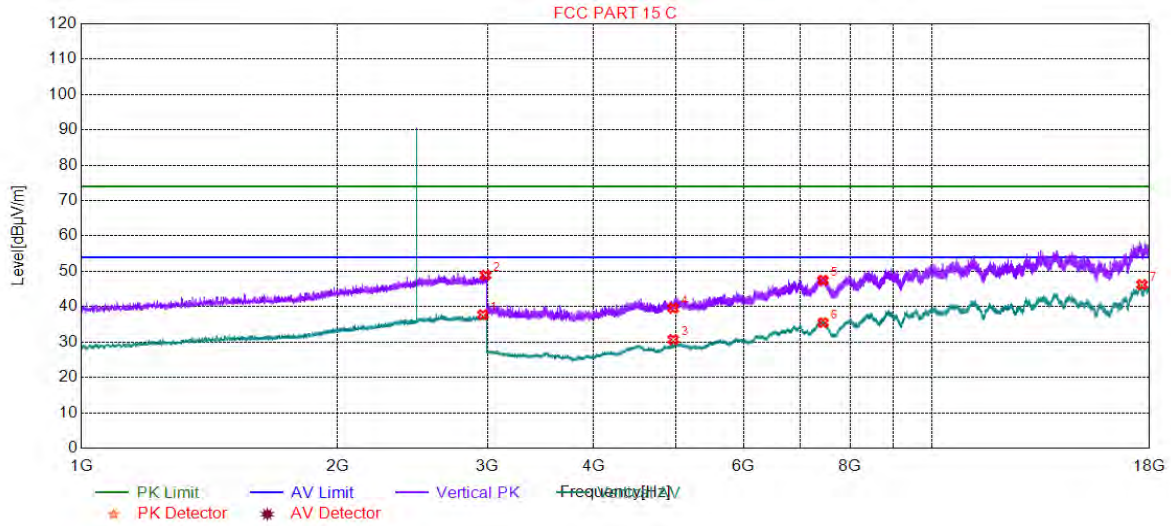
4.11.2.3 GFSK(DH5) _Highest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2963.99	37.74	2.30	54.00	16.26	150	95	Vertical
2	2985.99	48.91	2.32	74.00	25.09	150	72	Vertical
3	4960.00	30.71	-18.67	54.00	23.29	150	82	Vertical
4	4960.00	39.58	-18.67	74.00	34.42	150	82	Vertical
5	7440.00	47.47	-10.72	74.00	26.53	150	245	Vertical
6	7440.00	35.48	-10.72	54.00	18.52	150	33	Vertical
7	17631.4	46.23	0.81	54.00	7.77	150	162	Vertical

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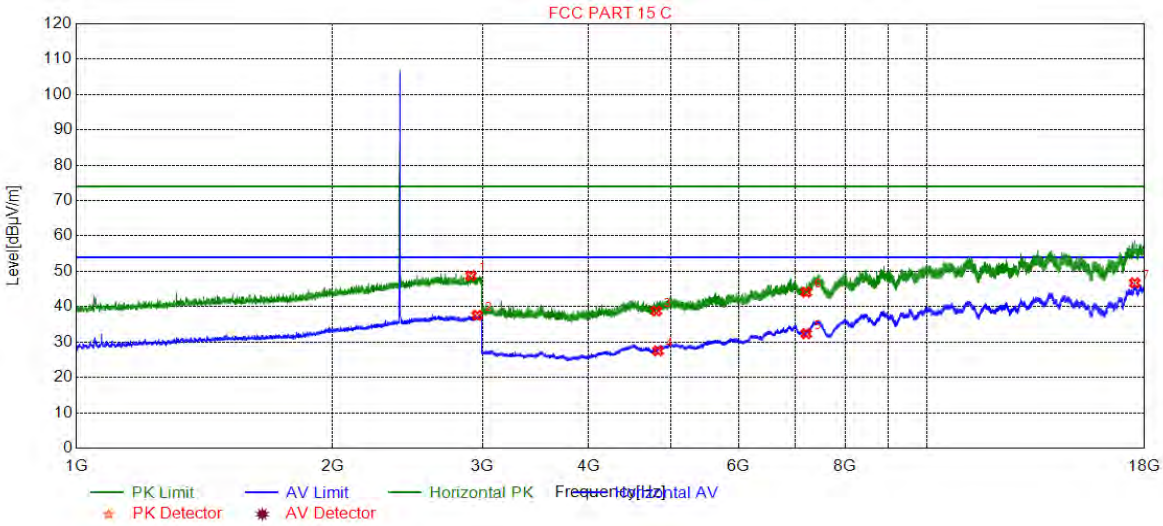
4.11.2.4 GFSK(DH5) _Lowest Channel _Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2907.97	48.77	2.27	74.00	25.23	150	7	Horizontal
2	2957.98	37.56	2.30	54.00	16.44	150	116	Horizontal
3	4804.00	38.78	-20.38	74.00	35.22	150	62	Horizontal
4	4824.00	27.53	-20.09	54.00	26.47	150	342	Horizontal
5	7206.00	32.37	-12.76	54.00	21.63	150	227	Horizontal
6	7206.00	44.08	-12.76	74.00	29.92	150	244	Horizontal
7	17529.9	46.72	0.73	54.00	7.28	150	106	Horizontal

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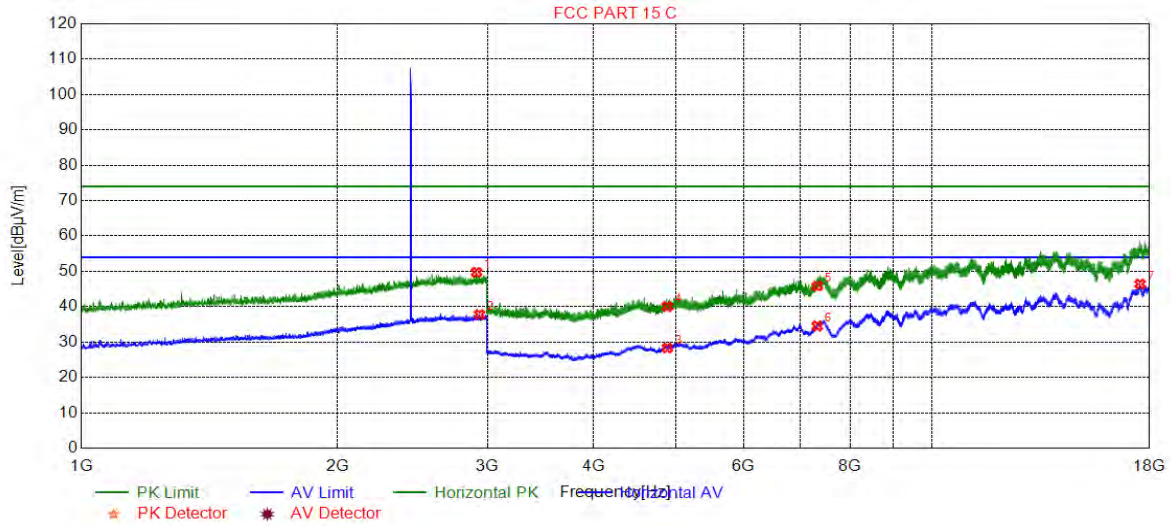
4.11.2.5 GFSK(DH5) _Middle Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2913.47	49.72	2.27	74.00	24.28	150	146	Horizontal
2	2936.98	37.78	2.29	54.00	16.22	150	162	Horizontal
3	4882.00	28.34	-19.26	54.00	25.66	150	17	Horizontal
4	4882.00	40.06	-19.26	74.00	33.94	150	99	Horizontal
5	7323.00	45.86	-11.38	74.00	28.14	150	213	Horizontal
6	7323.00	34.55	-11.38	54.00	19.45	150	245	Horizontal
7	17539.9	46.42	0.86	54.00	7.58	150	218	Horizontal

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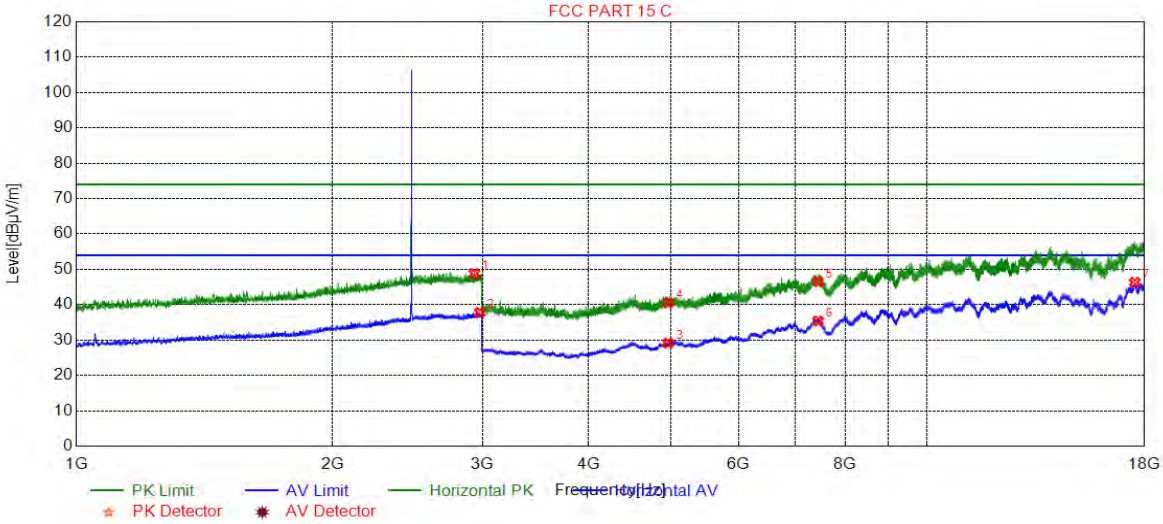
4.11.2.6 GFSK(DH5) _Highest Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2935.98	48.80	2.29	74.00	25.20	150	335	Horizontal
2	2979.49	37.79	2.32	54.00	16.21	150	14	Horizontal
3	4960.00	29.14	-18.67	54.00	24.86	150	244	Horizontal
4	4960.00	40.51	-18.67	74.00	33.49	150	244	Horizontal
5	7440.00	46.50	-10.72	74.00	27.50	150	3	Horizontal
6	7440.00	35.39	-10.72	54.00	18.61	150	293	Horizontal
7	17528.9	46.31	0.72	54.00	7.69	150	132	Horizontal

Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

2) Scan from 9kHz to 25GHz, the disturbance between 9KHz to 30MHz and 18GHz to 25GHz was very low, and the above harmonics were the highest point could be found when testing, The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

4）All Modes have been tested, but only the worst case data displayed in this report.

4.12 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2013		
Test Site:	Measurement Distance: 3m or 10m (Semi-Anechoic Chamber)		
Limit:	Frequency	Limit (dBuV/m @3m)	Remark
	30MHz-88MHz	40.0	Quasi-peak Value
	88MHz-216MHz	43.5	Quasi-peak Value
	216MHz-960MHz	46.0	Quasi-peak Value
	960MHz-1GHz	54.0	Quasi-peak Value
	Above 1GHz	54.0	Average Value
		74.0	Peak Value
Test Setup:			

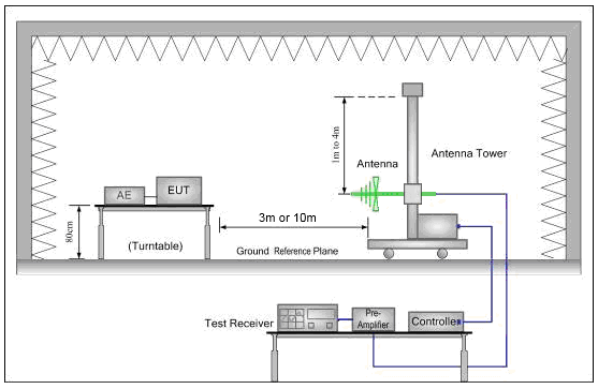


Figure 1. 30MHz to 1GHz

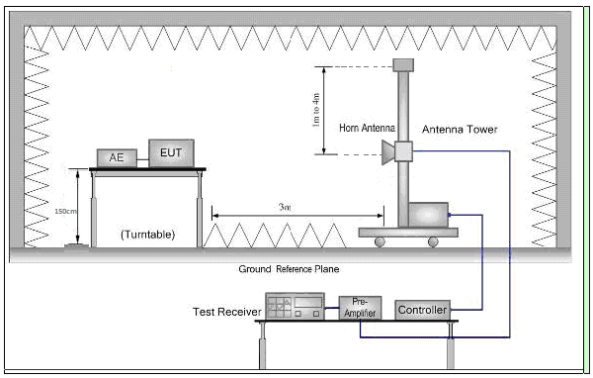


Figure 2. Above 1 GHz

Test Procedure:	a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation. c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. d. The antenna 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. e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. g. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel h. Test the EUT in the lowest channel , the Highest channel i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation is the worst case. Pretest the EUT at Charge + Transmitting mode, Only the worst case is recorded in the report.
Instruments Used:	Refer to section 5.10 for details
Test Results:	Pass

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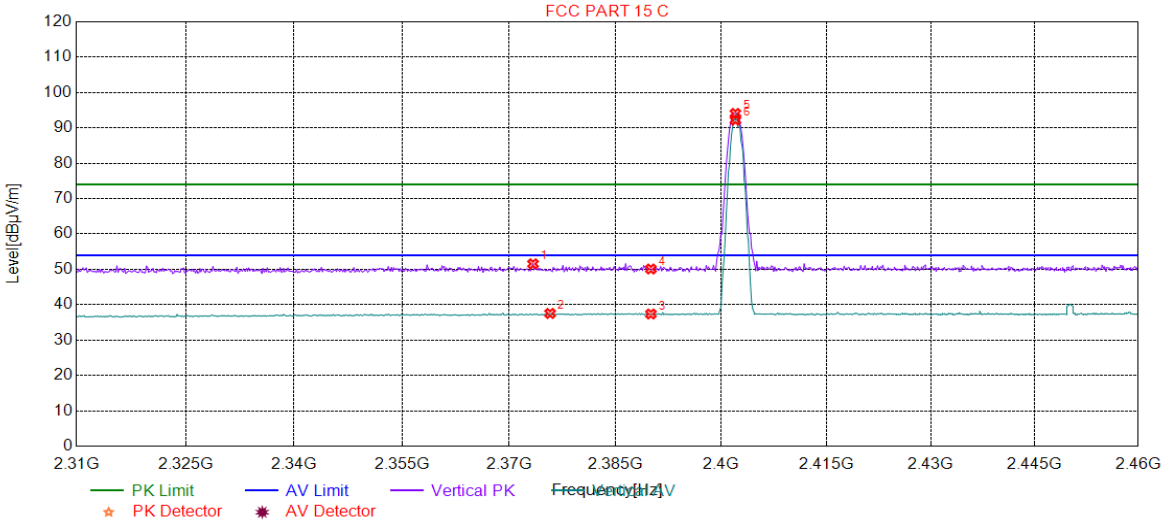
4.12.1 Test plots

4.12.1.1 Worst Case Mode (GFSK(DH5)) _Lowest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2373.36	51.56	1.17	74.00	22.44	150	42	Vertical
2	2375.76	37.54	1.18	54.00	16.46	150	331	Vertical
3	2390.00	37.38	1.25	54.00	16.62	150	26	Vertical
4	2390.00	50.10	1.25	74.00	23.90	150	324	Vertical
5	2402.00	94.09	1.30	74.00	-20.09	150	130	Vertical
6	2402.00	92.19	1.30	54.00	-38.19	150	124	Vertical

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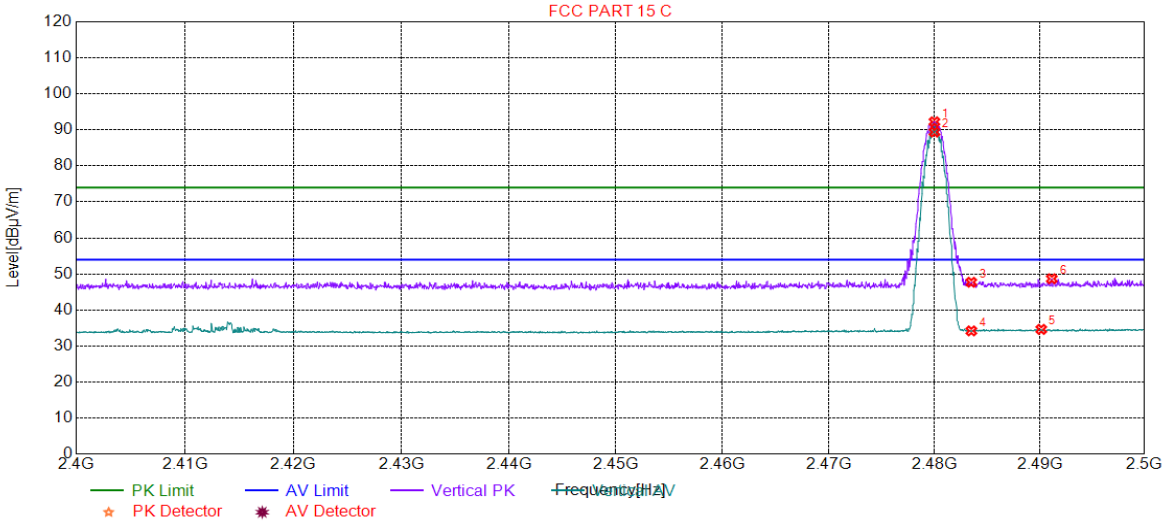
4.12.1.2 Worst Case Mode (GFSK(DH5)) _Highest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	92.24	1.51	74.00	-18.24	150	124	Vertical
2	2480.00	89.39	1.51	54.00	-35.39	150	132	Vertical
3	2483.50	47.70	1.52	74.00	26.30	150	11	Vertical
4	2483.50	34.20	1.52	54.00	19.80	150	81	Vertical
5	2490.14	34.62	1.54	54.00	19.38	150	300	Vertical
6	2491.14	48.67	1.55	74.00	25.33	150	38	Vertical

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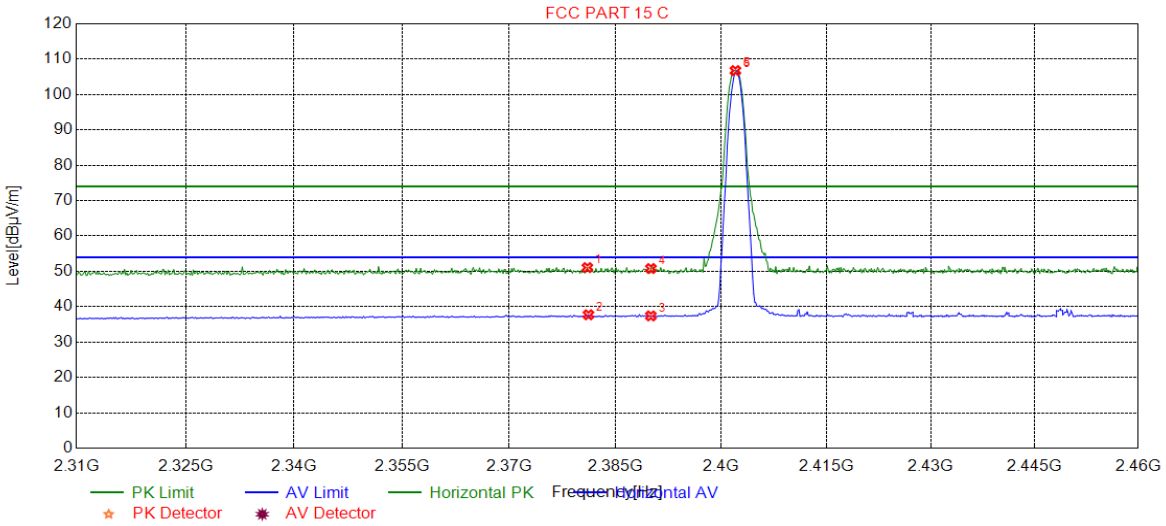
4.12.1.3 Worst Case Mode (GFSK(DH5)) _Lowest Channel _Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2381.02	51.07	1.21	74.00	22.93	150	248	Horizontal
2	2381.17	37.72	1.21	54.00	16.28	150	32	Horizontal
3	2390.00	37.40	1.25	54.00	16.60	150	192	Horizontal
4	2390.00	50.80	1.25	74.00	23.20	150	336	Horizontal
5	2402.00	106.77	1.30	74.00	-32.77	150	308	Horizontal
6	2402.00	106.40	1.30	54.00	-52.40	150	113	Horizontal

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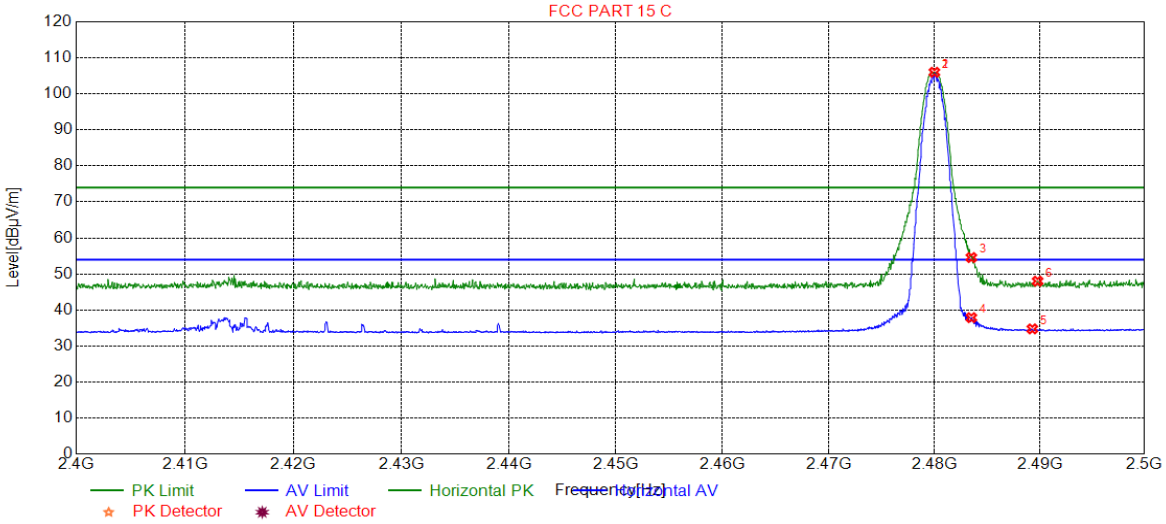
4.12.1.4 Worst Case Mode (GFSK(DH5)) _Highest Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	105.99	1.51	74.00	-31.99	150	310	Horizontal
2	2480.00	105.82	1.51	54.00	-51.82	150	310	Horizontal
3	2483.50	54.56	1.52	74.00	19.44	150	111	Horizontal
4	2483.50	37.88	1.52	54.00	16.12	150	310	Horizontal
5	2489.29	34.75	1.54	54.00	19.25	150	107	Horizontal
6	2489.79	48.00	1.54	74.00	26.00	150	216	Horizontal

Remark:
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor
All Modes have been tested, but only the worst case data displayed in this report.

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5 Measurement Uncertainty (95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	Total RF power, conducted	±0.75dB
2	RF power density, conducted	±2.84dB
3	Spurious emissions, conducted	±0.75dB
4	Radiated Spurious emission test	±4.5dB (30MHz-1GHz)
		±4.8dB (1GHz-25GHz)
5	Conduct emission test	±3.12 dB(9KHz- 30MHz)
6	Temperature test	±1°C
7	Humidity test	±3%
8	DC and low frequency voltages	±0.5%

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6 Equipment List

Conducted Emission					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Duedate (yyyy-mm-dd)
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2017/5/10	2020/5/9
LISN	Rohde & Schwarz	ENV216	SEM007-01	2018/9/2	2019/9/2
LISN	ETS-LINDGREN	Feb-16	SEM007-02	2019/3/2	2020/3/1
Measurement Software	AUDIX	e3 V5.4.1221d	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2018/7/12	2019/7/11
2 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T2-02	EMC0122	2019/2/11	2020/2/10
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2019/3/2	2020/3/1

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Duedate (yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2019/1/13	2020/1/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Due date (yyyy-mm-dd)
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2017/8/5	2020/8/4
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2018/7/12	2019/7/11
MXE EMI Receiver (20Hz-8.4GHz)	Agilent Technologies	N9038A	SEM004-05	2018/9/2	2019/9/2
BiConiLog Antenna (26-3000MHz)	ETS-LINDGREN	3142C	SEM003-01	2017/6/27	2020/6/26
Pre-amplifier (0.1-1.3GHz)	Agilent Technologies	8447D	SEM005-01	2019/3/2	2020/3/1

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Due date (yyyy-mm-dd)
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018/3/13	2021/3/12
Measurement Software	AUDIX	e3V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2018/7/12	2019/7/11
EXA Signal Analyzer (10Hz-26.5GHz)	Agilent Technologies Inc	N9010A	SEM004-09	2019/4/12	2020/4/11
BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-01	2017/6/27	2020/6/26
Horn Antenna (0.8-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018/4/13	2021/4/12
Pre-amplifier(0.1-1.3GHz)	HP	8447D	SEM005-02	2018/9/2	2019/9/2
Low Noise Amplifier(100MHz-18GHz)	Black Diamond Series	BDLNA-0118-352810	SEM005-05	2018/9/27	2019/9/27
Horn Antenna (15-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017/10/17	2020/10/16
Pre-amplifier(18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2019/3/2	2020/3/1
Band filter	N/A	N/A	SEM023-01	N/A	N/A

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RE in Chamber					
Test Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal. Date (yyyy-mm-dd)**	**Cal. Due date (yyyy-mm-dd)**
10m Semi-Anechoic Chamber	SAEMC	FSAC1018	SEM001-03	2018/3/31	2021/3/30
EMI Test Receiver (9k-7GHz)	Rohde & Schwarz	ESR	SEM004-03	2019/3/2	2020/3/1
Trilog-Broadband Antenna(25M-2GHz)	Schwarzbeck	VULB9168	SEM003-18	2016/6/29	2019/6/28
Pre-amplifier (9k-1GHz)	Sonoma	310N	SEM005-03	2019/4/12	2020/4/11
Loop Antenna (9kHz-30MHz)	ETS-Lindgren	6502	SEM003-08	2017/8/22	2020/8/21
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM029-01	2018/7/12	2019/7/11

7 Photographs - EUT Constructional Details

Refer to Appendix A - Photographs of EUT Constructional Details for HR/2019/50006.

The End

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