FCC TEST REPORT

Application No.:	ZR/2019/30027
Applicant:	TCL Communication Ltd.
Address of Applicant	5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT, Hong Kong
Manufacturer:	TCL Communication Ltd.
Address of Manufacturer	5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT, Hong Kong
EUT Description:	LTE/UMTS/GSM mobile phone
Model No.:	5029A
Trade Mark:	alcatel
FCC ID:	2ACCJH119
Standards:	47 CFR FCC Part 2, Subpart J 47 CFR Part 15, Subpart C
Test Method	ANSI C63.10 (2013) KDB558074 D01 15.247 Meas Guidance v05r02
Date of Receipt:	2019/12/27
Date of Test:	2019/12/27 to 2020/1/16
Date of Issue:	2021/4/20
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		2020/4/17		Original
01		2021/4/20	Eason Wang	1. Add test site Information 2.Modify data conversion error of antenna height 3.Update equipment list

Authorized for issue by:		
Prepared By		Eason Wang **(Eason Wang) /Engineer**
Checked By		David Chen **(David Chen) /Reviewer**

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Remark:
The difference between 5029E to 5029A showed as below

- SOFTWARE MODIFICATIONS:
  - Protocol Stack changes: No
  - MMS/STK/USAT/USIM changes: No
  - DM/SUPL/VT/FUMO/SWP/HCI: No
  - Other changes detailed:
- HARDWARE MODIFICATIONS:
  - Band changes: No
  - PCB Layout changes: No
  - Main components changes:

	Antenna	Base Band	Transceiver	ASM	Power Amplifier	Tx SAW Filter	Rx SAW Filter	Duplexer
GSM850	NO	NO	NO	NO	NO	NO	NO	NO
GSM900	NO	NO	NO	NO	NO	NO	NO	NO
GSM1800	NO	NO	NO	NO	NO	NO	NO	NO
GSM1900	NO	NO	NO	NO	NO	NO	NO	NO
UMTS2100	NO	NO	NO	NO	NO	NO	NO	NO
UMTS1900	NO	NO	NO	NO	NO	NO	NO	NO
UMTS1700	NO	NO	NO	NO	NO	NO	NO	NO
UMTS900	NO	NO	NO	NO	NO	NO	NO	NO
UMTS850	NO	NO	NO	NO	NO	NO	NO	NO
LTE 1	NO	NO	NO	NO	NO	NO	NO	NO
LTE 2	NO	NO	NO	NO	NO	NO	NO	NO
LTE 3	NO	NO	NO	NO	NO	NO	NO	NO
LTE 4	NO	NO	NO	NO	NO	NO	NO	NO
LTE 5	NO	NO	NO	NO	NO	NO	NO	NO
LTE 7	NO	NO	NO	NO	NO	NO	NO	NO
LTE 8	NO	NO	NO	NO	NO	NO	NO	NO
LTE 13	NO	NO	NO	NO	NO	NO	NO	NO
LTE 17	NO	NO	NO	NO	NO	NO	NO	NO
LTE 28	NO	NO	NO	NO	NO	NO	NO	NO
LTE 66	NO	NO	NO	NO	NO	NO	NO	NO
Bluetooth	NA	NA	NA	NA	NA	NA	NA	NA
WiFi	NA	NA	NA	NA	NA	NA	NA	NA
GPS	NA	NA	NA	NA	NA	NA	NA	NA
NFC	NA	NA	NA	NA	NA	NA	NA	NA

  - FM changes: No
  - Other components changes:
    LCD/ Speaker/ Camera/ Vibrator changes: Camera is Changed
  - Other changes detailed:
- MECHANICAL MODIFICATIONS:
  - Use new metal front/back cover or keypad: No
  - Mechanical shell changes:
    Whole size of EUT: No
    Distance of Ear reference point to bottom of handset: No
    Other trinkets to change the surface of handset: No
  - Other changes detailed: the hole for camera is changed.

According to the difference above, there were no test on 5029A, all the data of 5029A were copied from the report of 5029E (Report No.: ZR/2019/C003503-01).

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2 Test Summary

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

Remark：All test were performed by Lab A and B.
Parts of test items above were subcontracted to Lab B.
Lab A SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch
Lab B SGS-CSTC STANDARDS TECHNICAL SERVICES (XI 'AN) CO., LTD.

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3 General Information

3.1 Client Information

Applicant:	TCL Communication Ltd.
Address of Applicant:	5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT, Hong Kong
Manufacturer:	TCL Communication Ltd.
Address of Manufacturer:	5/F, Building 22E, 22 Science Park East Avenue, Hong Kong Science Park, Shatin, NT, Hong Kong

3.2 Test Location

Lab A:

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
Test engineer:	Adam Liang, Mike Hu

Lab B:

Company:	SGS-CSTC STANDARDS TECHNICAL SERVICES (XI 'AN) CO., LTD.
Address:	1/F, Unit D, Building 1, Kanghong Orange Technology Park, No.137, Keyuan 3rd Road, Fengdong New City, Xi'an, Shaanxi China
Post code:	710086
Test engineer:	Ben Huang

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3.3 Test Facility

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

Lab A:

• 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.

• Innovation, Science and Economic Development Canada

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

CAB identifier: CN0006.

IC#: 4620C.

Lab B:

• A2LA (Certificate No. 4854.01)

SGS-CSTC STANDARDS TECHNICAL SERVICES (XI 'AN) CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 4854.01.

• FCC –Designation Number: CN1271.

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3.4 General Description of EUT

EUT Description:	LTE/UMTS/GSM mobile phone
Model No.:	5029A
Trade Mark:	alcatel
Hardware Version:	PIO
Software Version:	v4F5E
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:	0.36dBi
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

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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.

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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 0.36dBi.	

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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:

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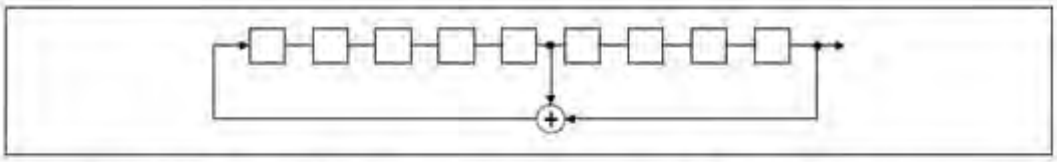
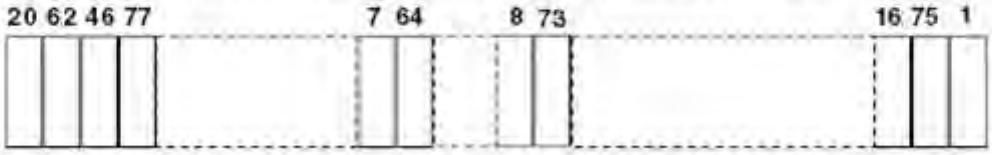


Linear Feedback Shift Register for Generation of the PRBS sequence

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.

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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.		

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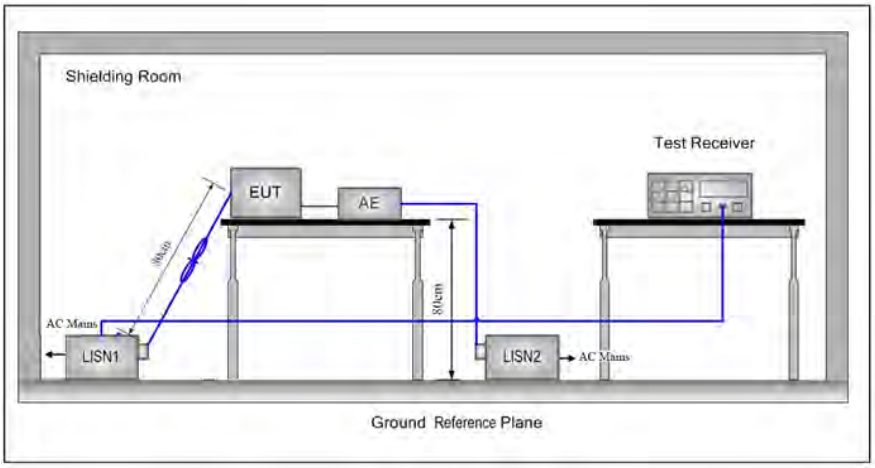
Test Setup:	
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type at the lowest, middle, high channel. Charge + Transmitting mode.
Final Test Mode:	Through Pre-scan, find the DH5 of data type and GFSK modulation at the lowest channel is the worst 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

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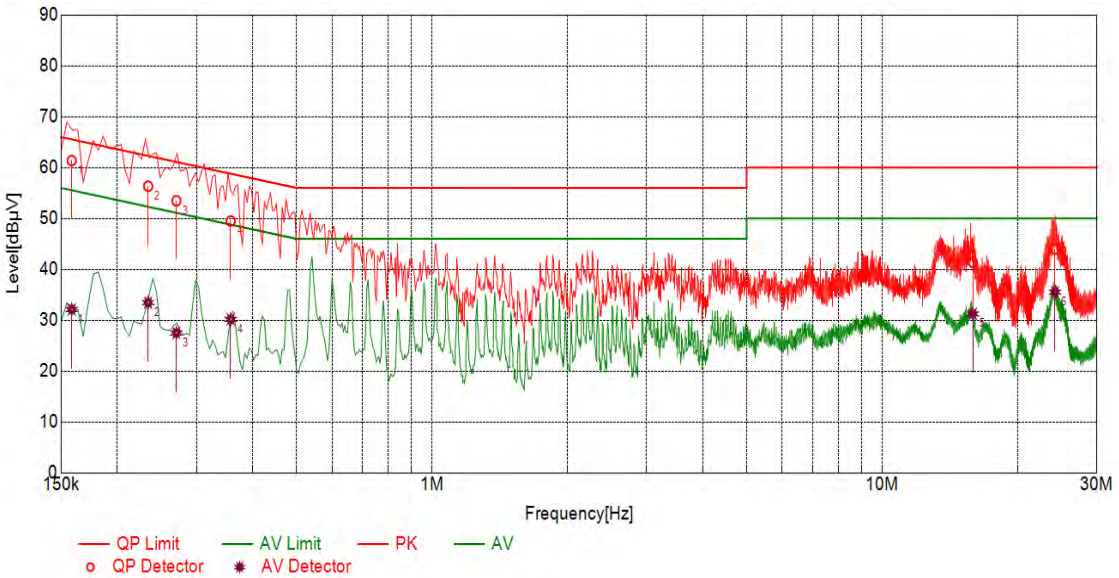
Measurement Data

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:



Final Data List									
NO.	Freq. [MHz]	Factor [dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Type
1	0.1584	10.10	61.38	65.55	4.17	32.09	55.55	23.46	L
2	0.2342	10.10	56.33	62.30	5.97	33.45	52.30	18.85	L
3	0.2706	10.10	53.47	61.10	7.63	27.48	51.10	23.62	L
4	0.3573	10.10	49.49	58.79	9.30	30.16	48.79	18.63	L
5	15.9133	10.11	41.37	60.00	18.63	31.24	50.00	18.76	L
6	24.2235	10.11	43.98	60.00	16.02	35.52	50.00	14.48	L

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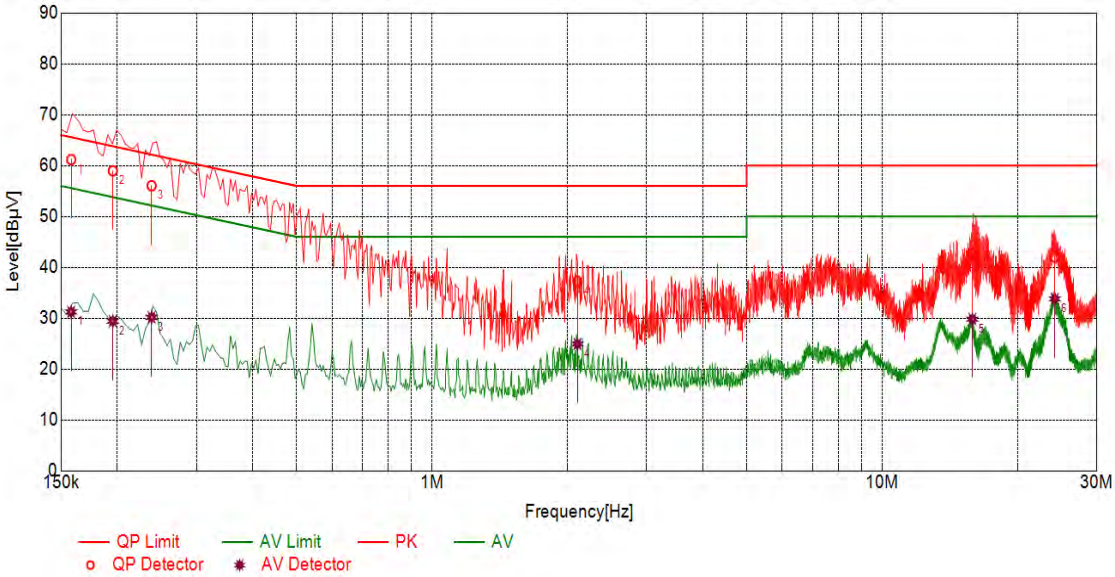
Neutral line:



Final Data List									
NO.	Freq. [MHz]	Factor [dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Type
1	0.1580	10.10	61.18	65.57	4.39	31.22	55.57	24.35	N
2	0.1955	10.10	58.97	63.80	4.83	29.41	53.80	24.39	N
3	0.2384	10.10	56.04	62.15	6.11	30.17	52.15	21.98	N
4	2.1051	10.10	37.25	56.00	18.75	24.93	46.00	21.07	N
5	15.8690	10.11	42.59	60.00	17.41	29.82	50.00	20.18	N
6	24.1928	10.11	42.03	60.00	17.97	33.79	50.00	16.21	N

Remarks:

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

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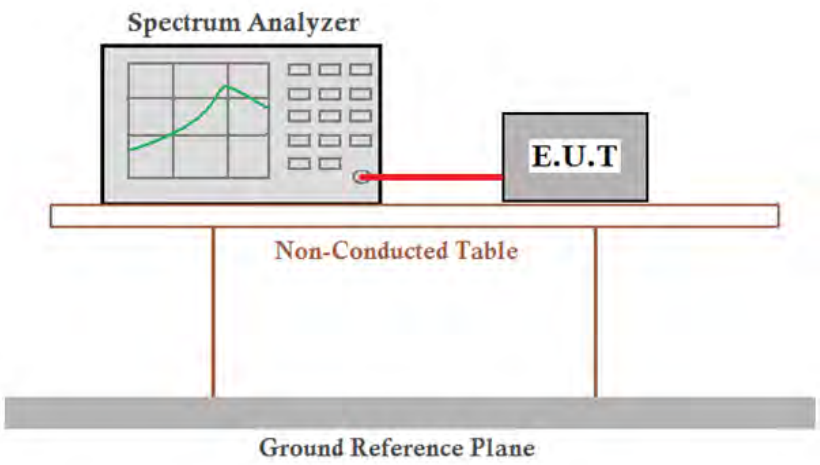
4.4 Conducted Peak Output Power

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

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4.4.1 Test Results

Measurement Data of Average power:

GFSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	9.59	Report purpose only
Middle	9.91	Report purpose only
Highest	9.89	Report purpose only
π/4DQPSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	7.09	Report purpose only
Middle	7.51	Report purpose only
Highest	7.28	Report purpose only
8DPSK mode		
Test channel	**Average Output Power (dBm)**	**Result**
Lowest	7.06	Report purpose only
Middle	7.48	Report purpose only
Highest	7.32	Report purpose only

Measurement Data of Peak power:

GFSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	10.92	20.97	Pass
Middle	9.76	20.97	Pass
Highest	10.62	20.97	Pass
π/4DQPSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	9.93	20.97	Pass
Middle	9.82	20.97	Pass
Highest	9.97	20.97	Pass
8DPSK mode			
Test channel	**Peak Output Power (dBm)**	**Limit (dBm)**	**Result**
Lowest	9.93	20.97	Pass
Middle	9.84	20.97	Pass
Highest	9.99	20.97	Pass

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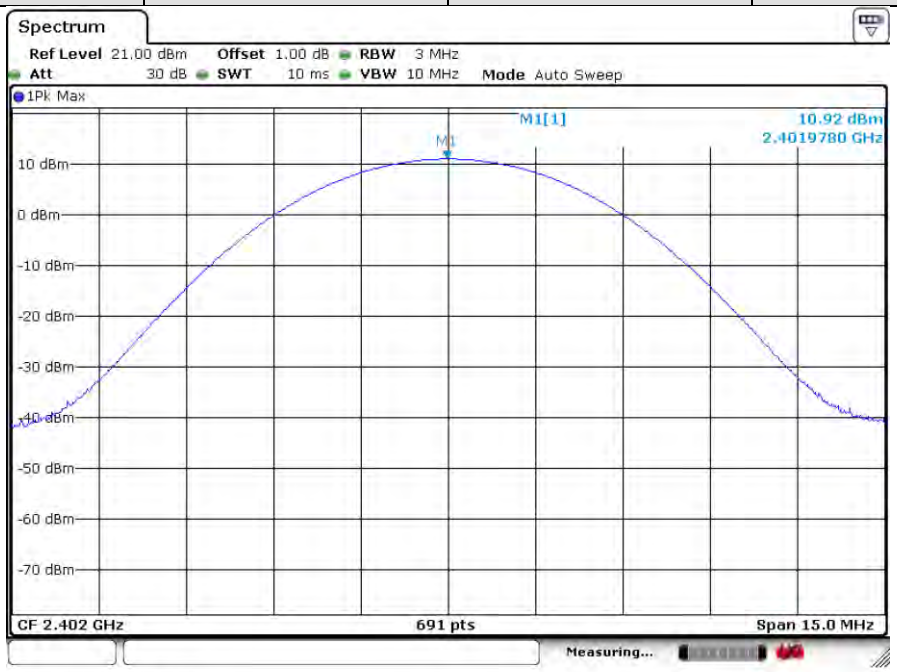
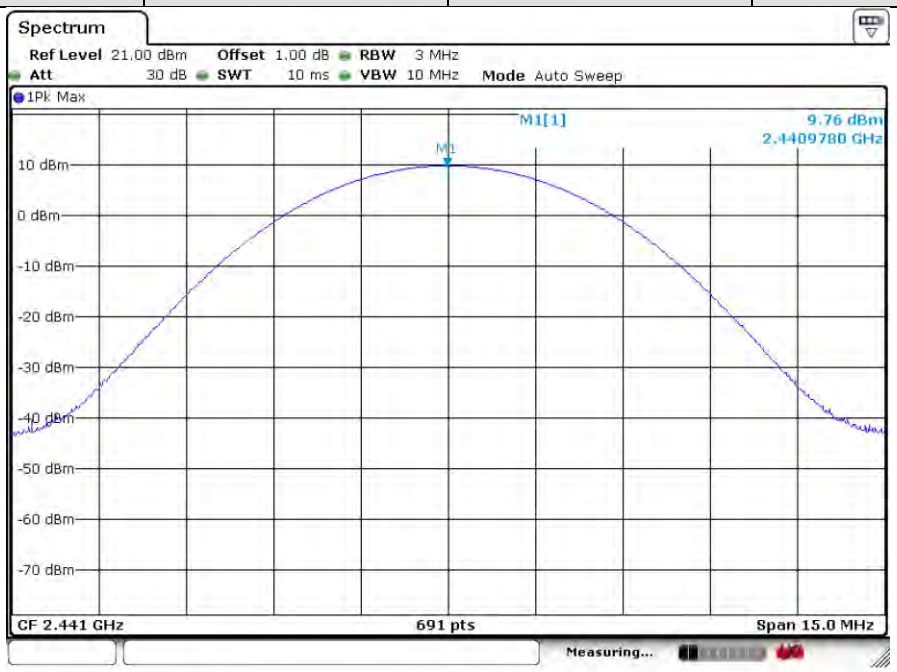
4.4.2 Test plots

Test mode:	GFSK	Test channel:	Lowest



Date: 30.DEC.2019 03:40:30

Test mode:	GFSK	Test channel:	Middle



Date: 30.DEC.2019 03:41:09

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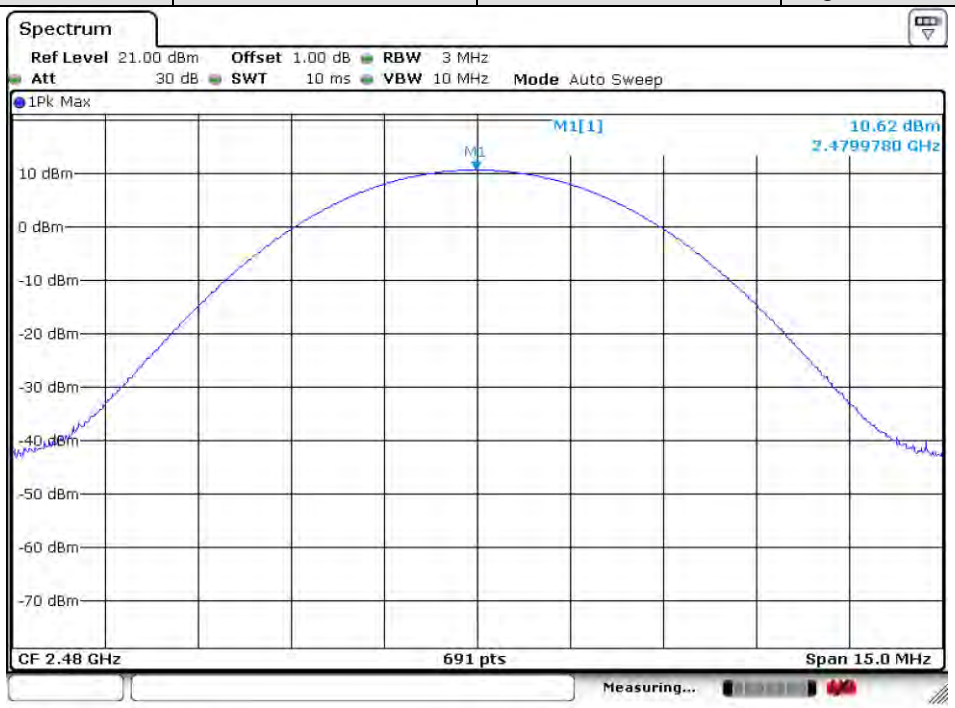
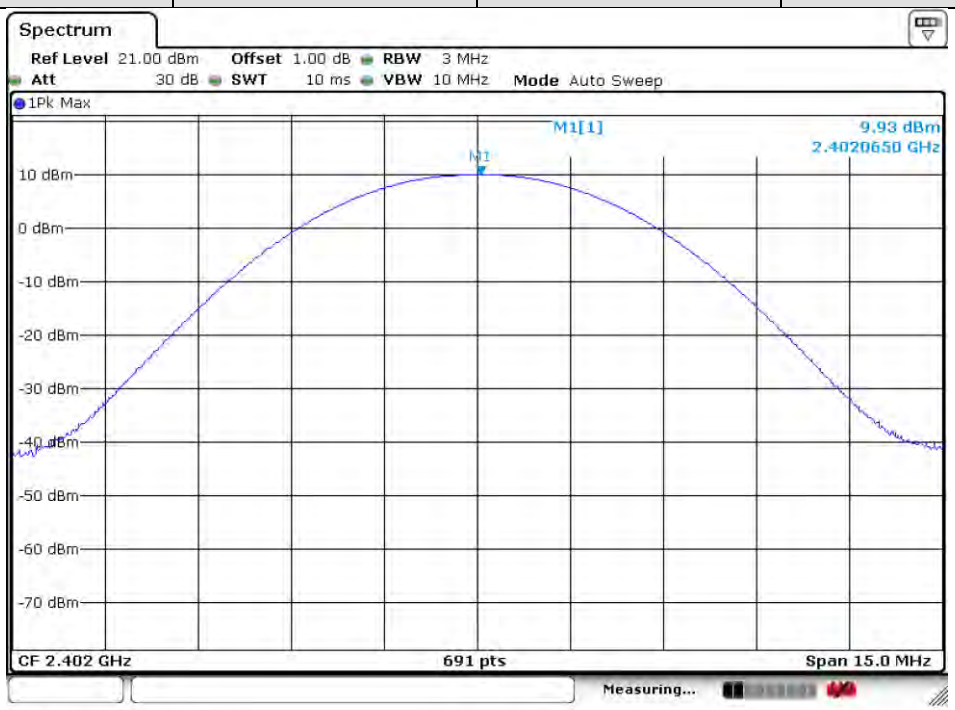
Test mode:	GFSK	Test channel:	Highest



Date: 30.DEC.2019 03:41:29

Test mode:	π/4DQPSK	Test channel:	Lowest



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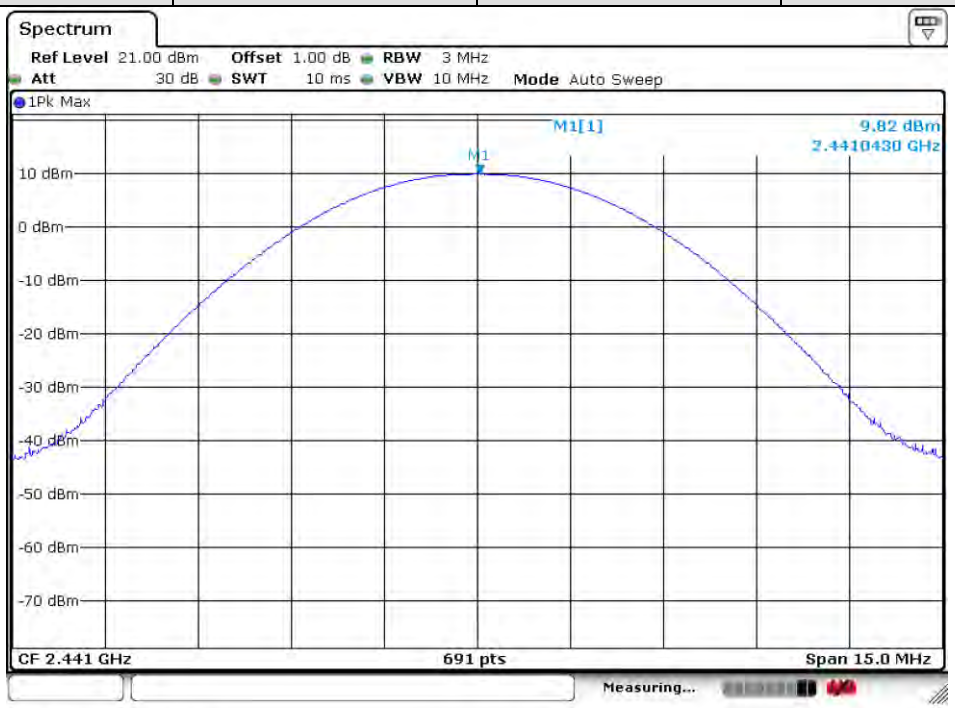
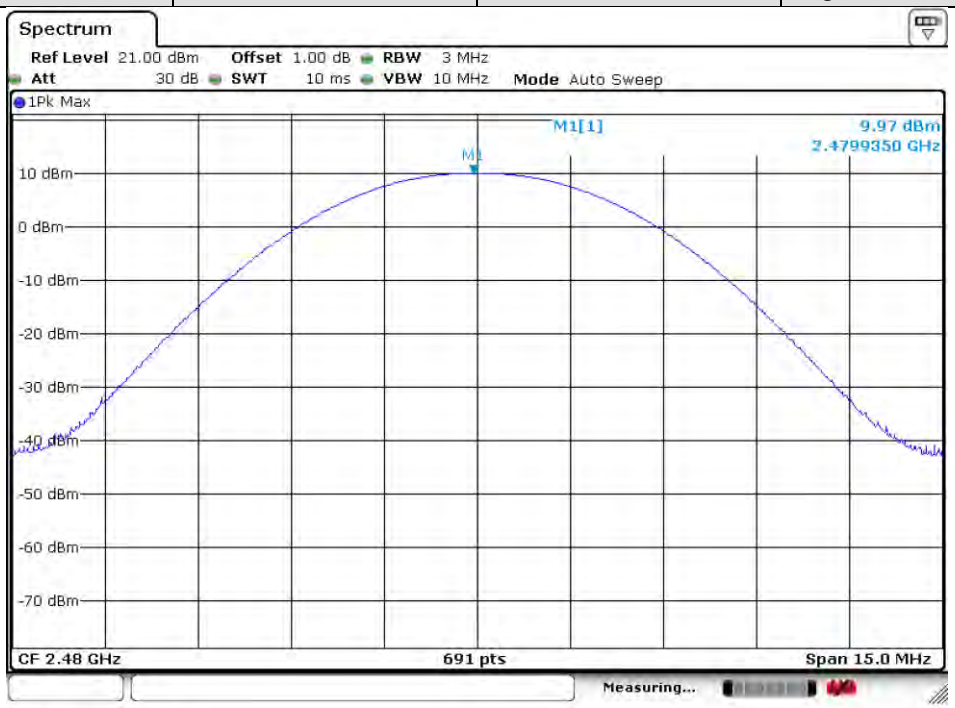
Test mode:	π/4DQPSK	Test channel:	Middle



Date: 30.DEC.2019 03:42:12

Test mode:	π/4DQPSK	Test channel:	Highest



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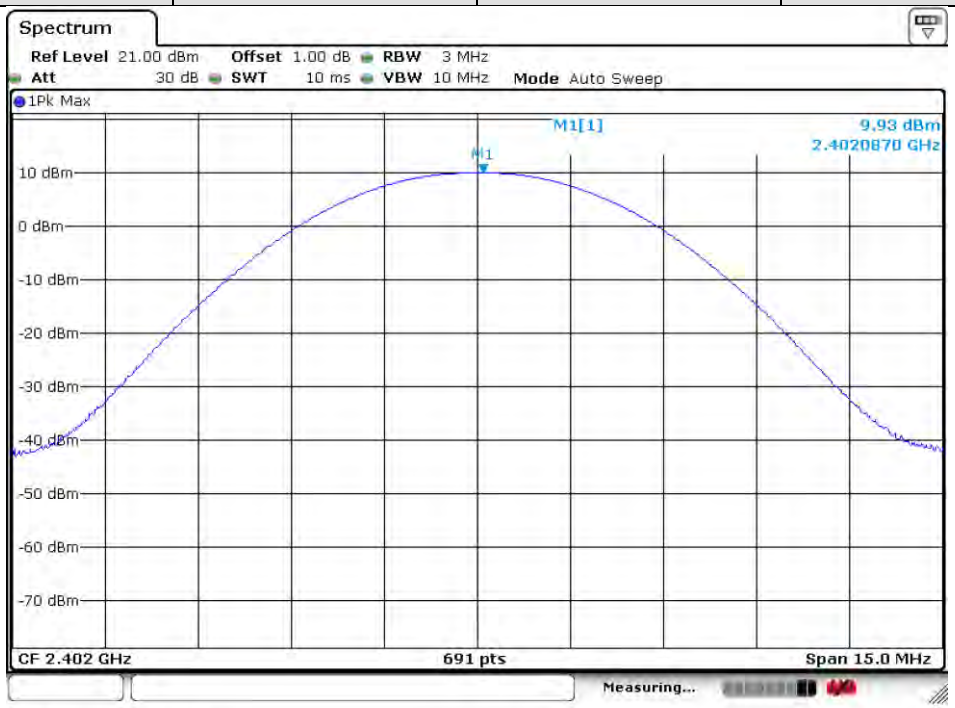
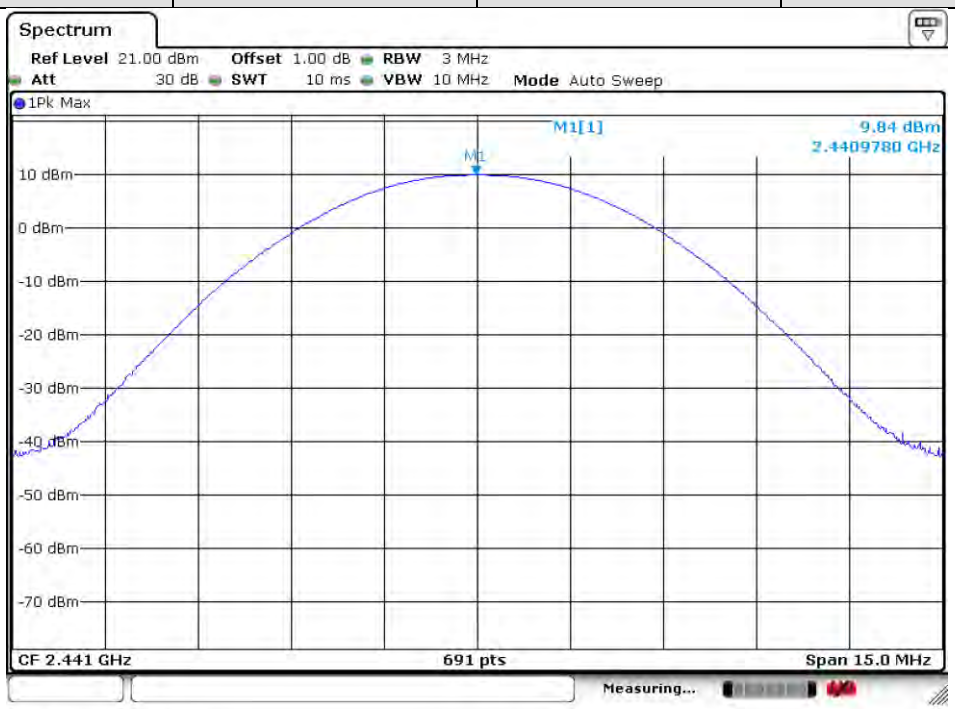
Test mode:	8DPSK	Test channel:	Lowest



Date: 30.DEC.2019 03:43:34

Test mode:	8DPSK	Test channel:	Middle



Date: 30.DEC.2019 03:44:03

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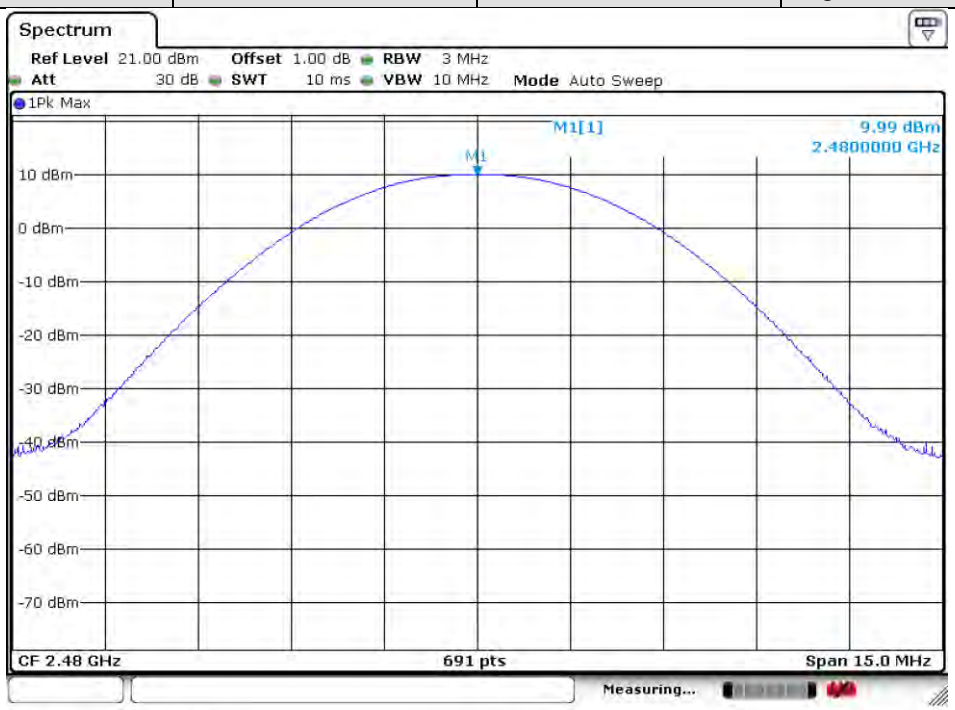
Test mode:	8DPSK	Test channel:	Highest



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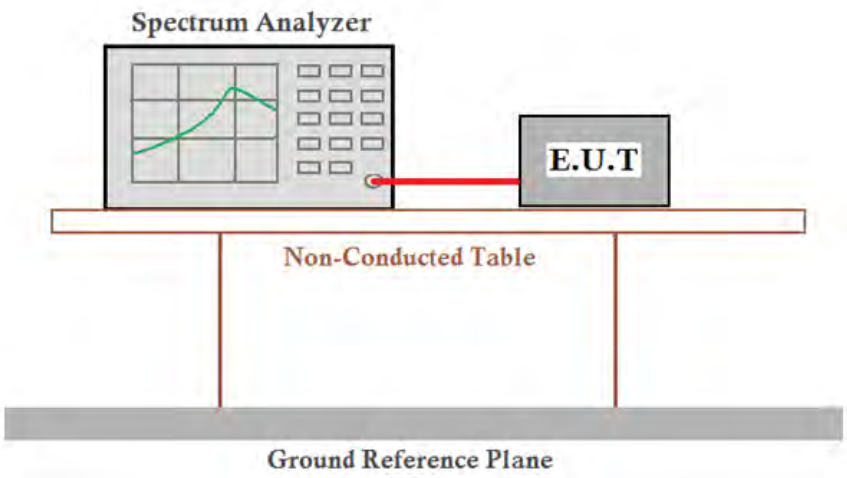
4.5 20dB Emission Bandwidth & 99% Occupied Bandwidth

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	759.8	816.2	Pass
	Middle	764.1	816.2	Pass
	Highest	755.4	816.2	Pass
π/4DQPSK	Lowest	1146.2	1263.4	Pass
	Middle	1150.5	1267.7	Pass
	Highest	1141.8	1259.0	Pass
8DPSK	Lowest	1146.2	1220.0	Pass
	Middle	1146.2	1220.0	Pass
	Highest	1141.8	1220.0	Pass

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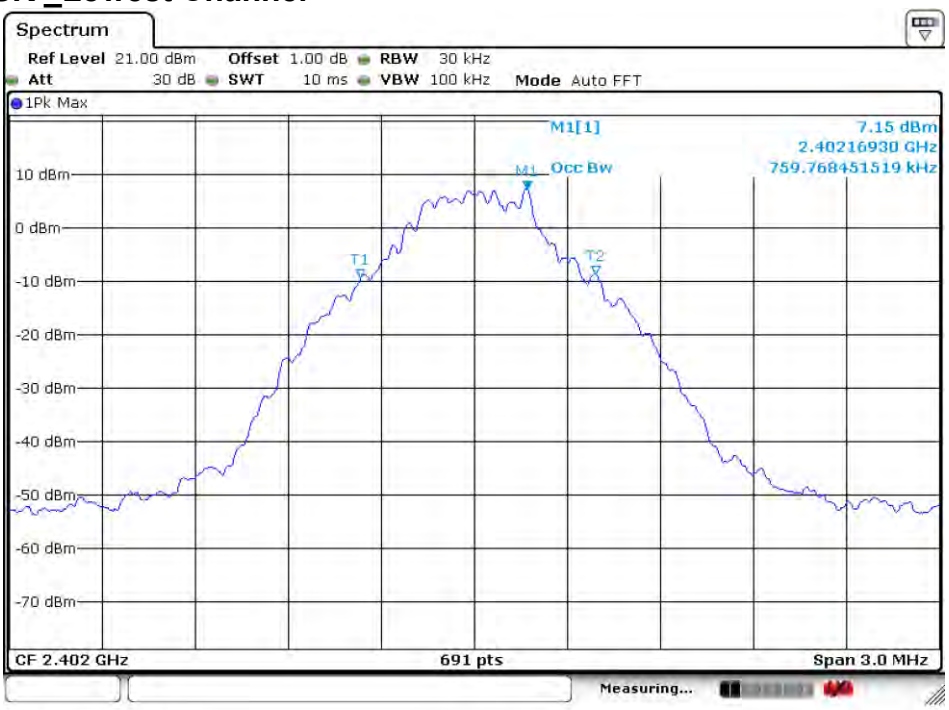
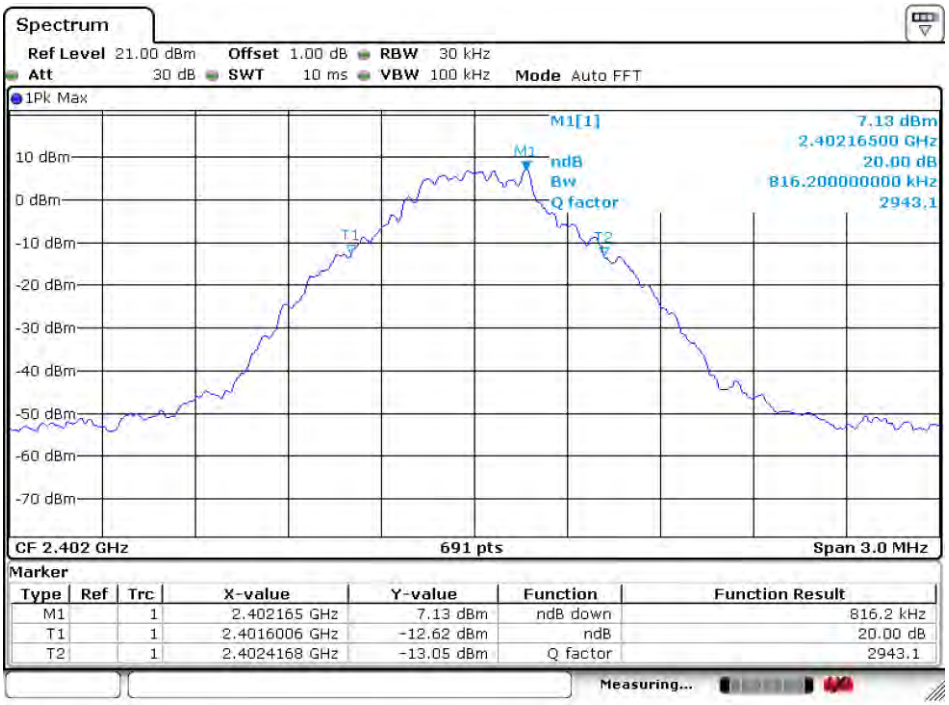
4.5.2 Test plots

4.5.2.1 GFSK _Lowest Channel



Date: 30.DEC.2019 05:36:57



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402165 GHz	7.13 dBm	ndB down	816.2 kHz
T1		1	2.4016006 GHz	-12.62 dBm	ndB	20.00 dB
T2		1	2.4024168 GHz	-13.05 dBm	Q factor	2943.1

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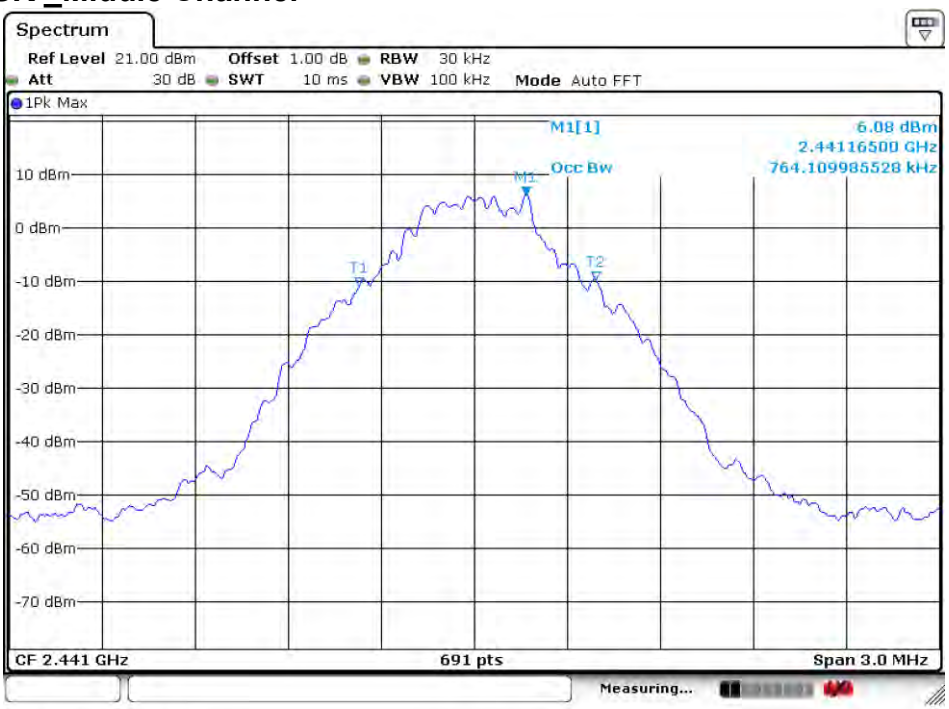
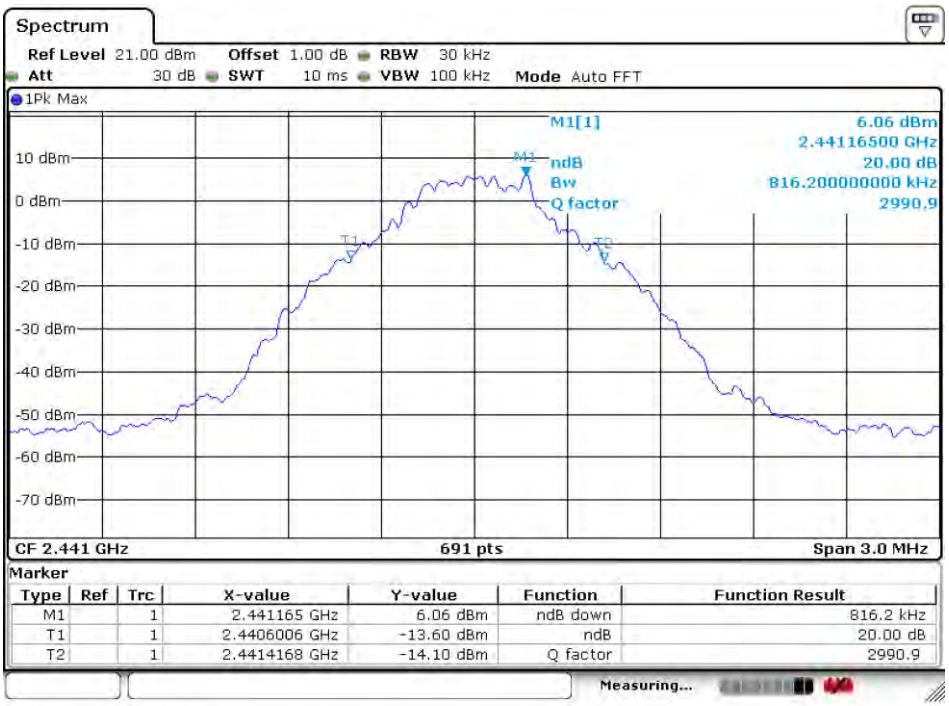
4.5.2.2 GFSK _Middle Channel



Date: 30.DEC.2019 05:39:35



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.441165 GHz	6.06 dBm	ndB down	816.2 kHz
T1		1	2.4406006 GHz	-13.60 dBm	ndB	20.00 dB
T2		1	2.4414168 GHz	-14.10 dBm	Q factor	2990.9

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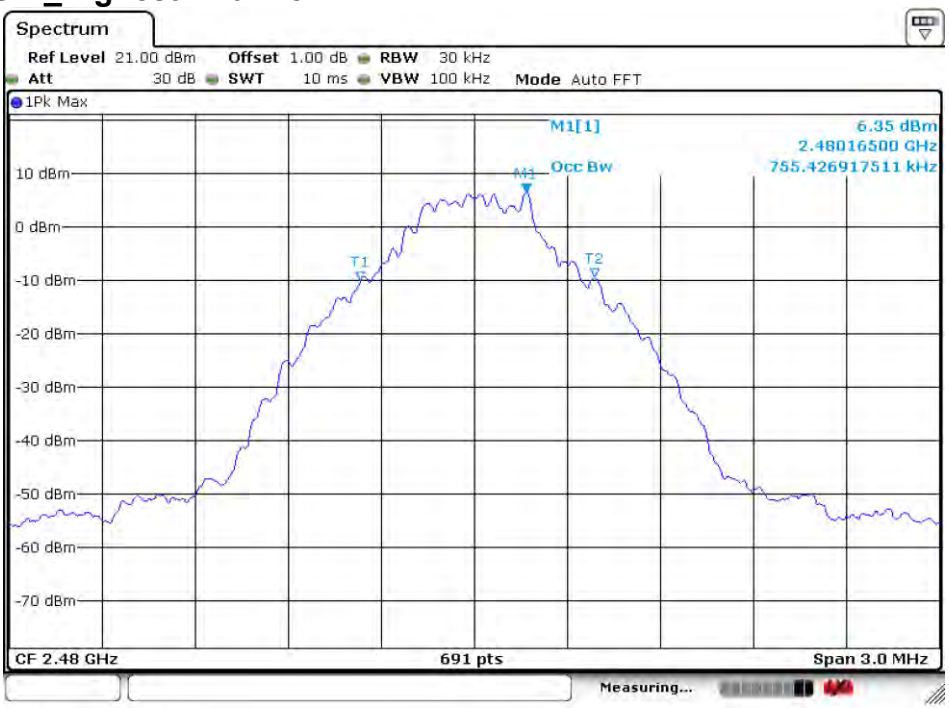
4.5.2.3 GFSK _Highest Channel



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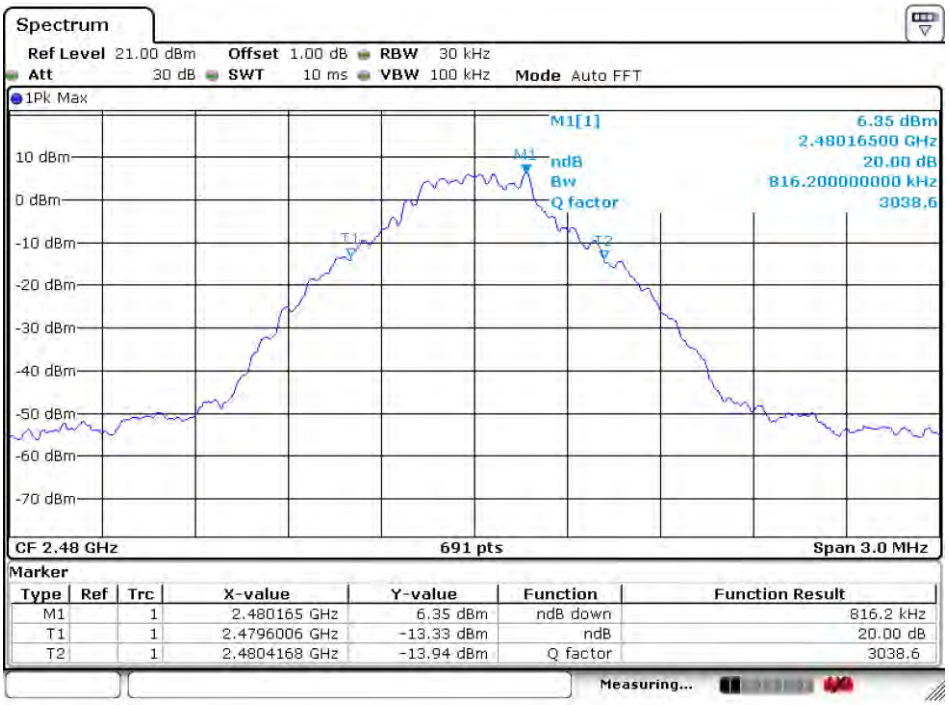

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.480165 GHz	6.35 dBm	ndB down	816.2 kHz
T1		1	2.4796006 GHz	-13.33 dBm	ndB	20.00 dB
T2		1	2.4804168 GHz	-13.94 dBm	Q factor	3038.6

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4.5.2.4 π/4DQPSK _Lowest Channel

Date: 30.DEC.2019 05:37:25

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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4021693 GHz	6.06 dBm	ndB down	1.2634 MHz
T1		1	2.4013792 GHz	-13.46 dBm	ndB	20.00 dB
T2		1	2.4026425 GHz	-13.89 dBm	Q factor	1901.4

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4.5.2.5 π/4DQPSK _Middle Channel

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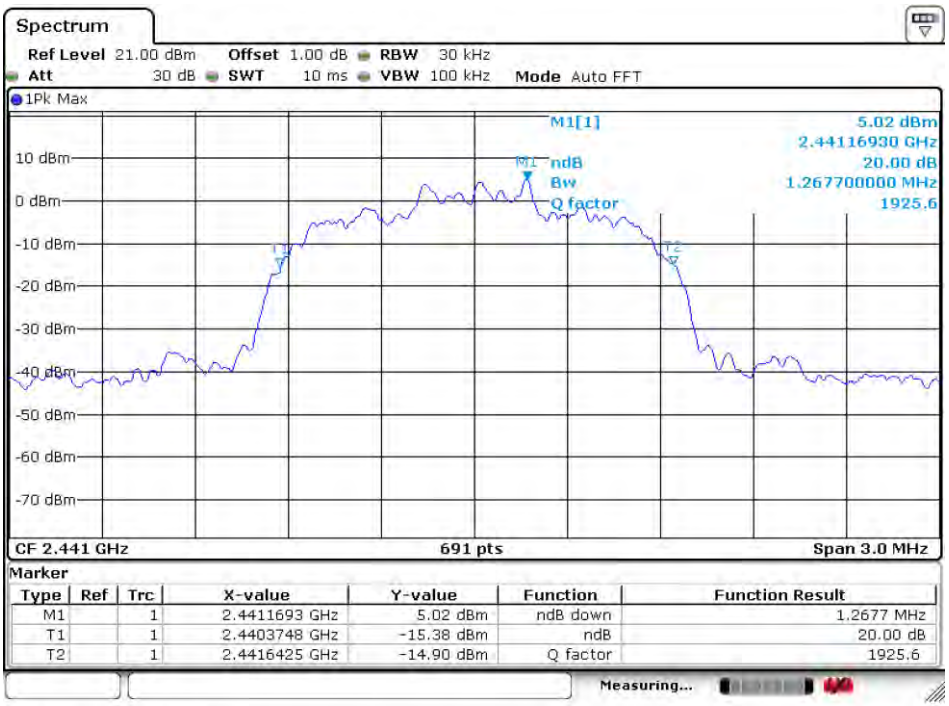

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4411693 GHz	5.02 dBm	ndB down	1.2677 MHz
T1		1	2.4403748 GHz	-15.38 dBm	ndB	20.00 dB
T2		1	2.4416425 GHz	-14.90 dBm	Q factor	1925.6

Date: 30.DEC.2019 05:43:24

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4.5.2.6 π/4DQPSK _Highest Channel

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Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4801693 GHz	5.26 dBm	ndB down	1.259 MHz
T1		1	2.4793748 GHz	-15.24 dBm	ndB	20.00 dB
T2		1	2.4806339 GHz	-14.73 dBm	Q factor	1969.9

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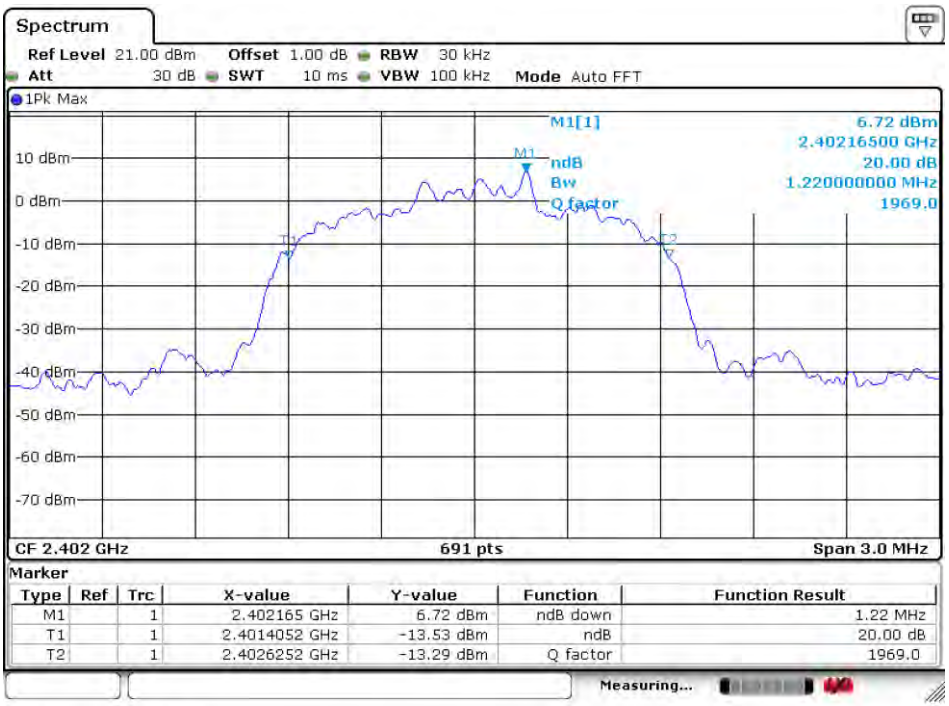
4.5.2.7 8DPSK_Lowest Channel

Date: 30.DEC.2019 05:37:44



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402165 GHz	6.72 dBm	ndB down	1.22 MHz
T1		1	2.4014052 GHz	-13.53 dBm	ndB	20.00 dB
T2		1	2.4026252 GHz	-13.29 dBm	Q factor	1969.0

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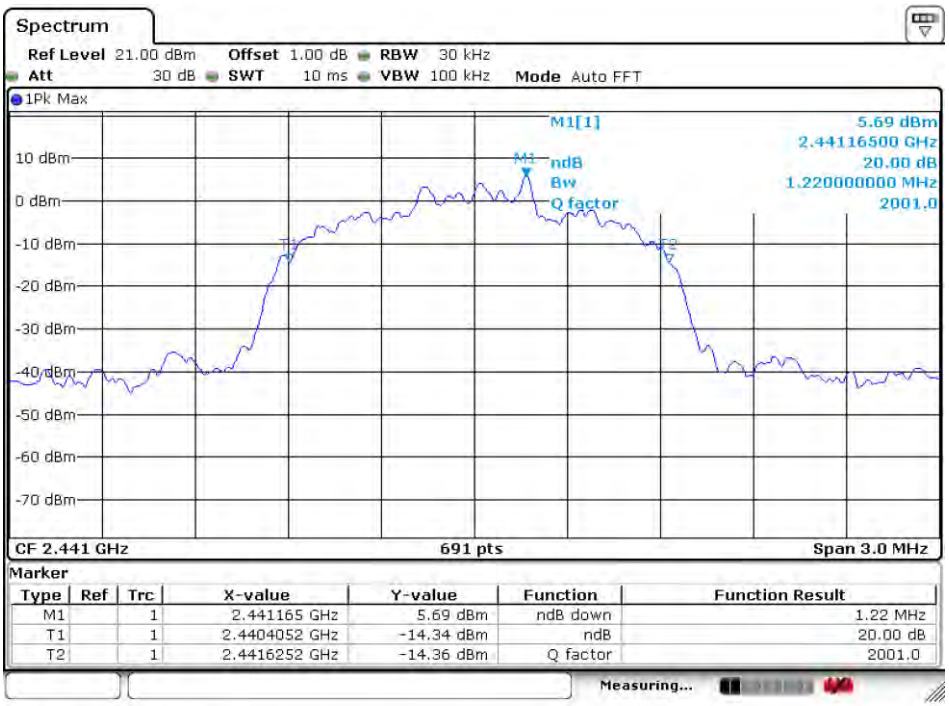
4.5.2.8 8DPSK _Middle Channel

Date: 30.DEC.2019 05:38:03



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.441165 GHz	5.69 dBm	ndB down	1.22 MHz
T1		1	2.4404052 GHz	-14.34 dBm	ndB	20.00 dB
T2		1	2.4416252 GHz	-14.36 dBm	Q factor	2001.0

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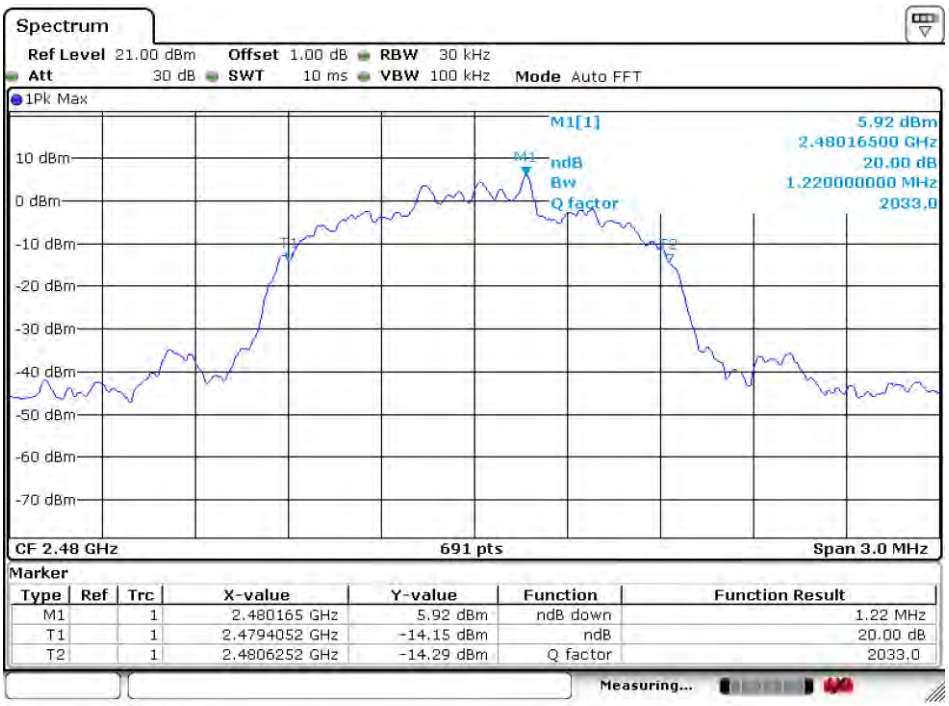
4.5.2.9 8DPSK_Highest Channel

Date: 30.DEC.2019 05:41:03



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.480165 GHz	5.92 dBm	ndB down	1.22 MHz
T1		1	2.4794052 GHz	-14.15 dBm	ndB	20.00 dB
T2		1	2.4806252 GHz	-14.29 dBm	Q factor	2033.0

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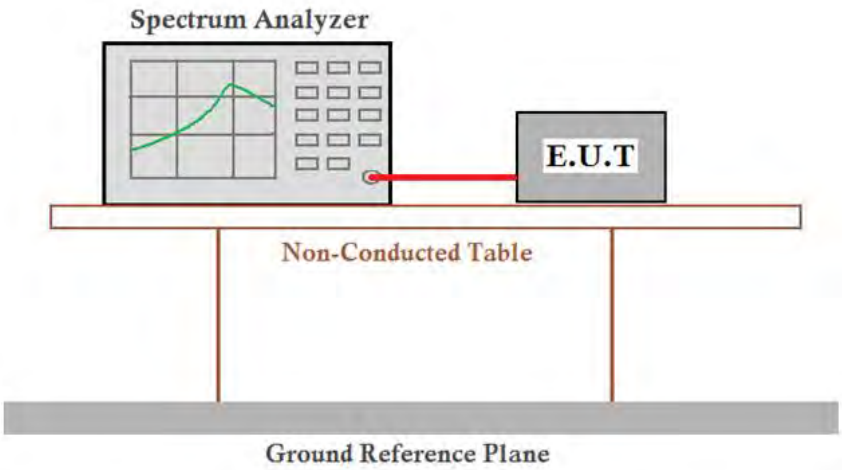
4.6 Carrier Frequencies Separation

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

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4.6.1 Test Results

GFSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	999	544.1	Pass
π/4DQPSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	1003	845.1	Pass
8DPSK mode			
Test channel	**Carrier Frequencies Separation (kHz)**	**Limit (kHz)**	**Result**
Middle	1003	813.3	Pass

Remark: According to section 6.4,

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	816.2	544.1
π/4DQPSK	1267.7	845.1
8DPSK	1220.0	813.3

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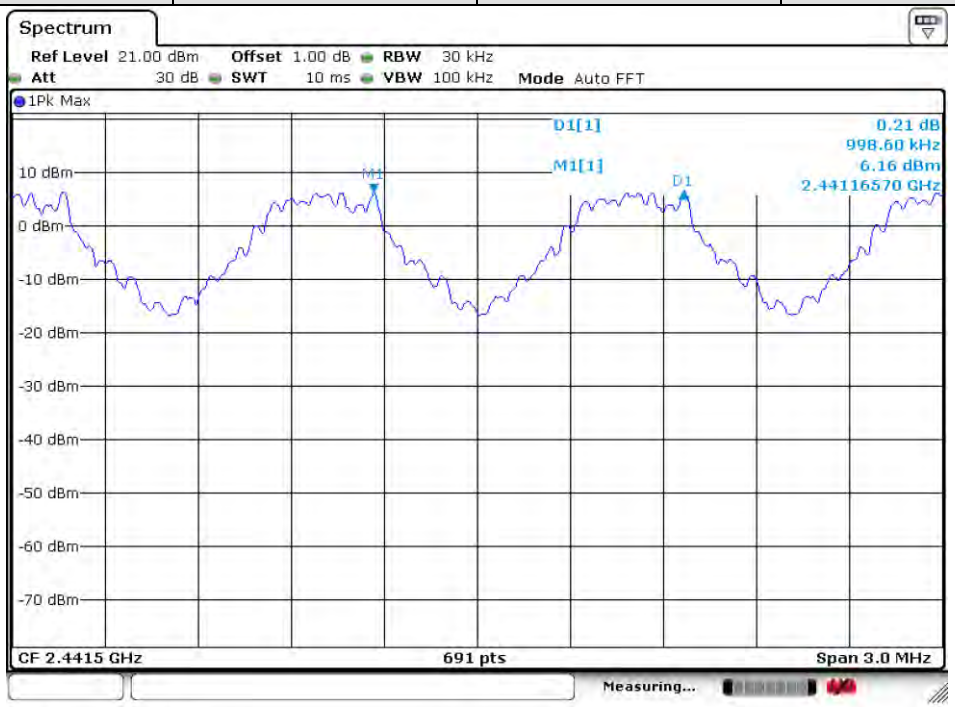
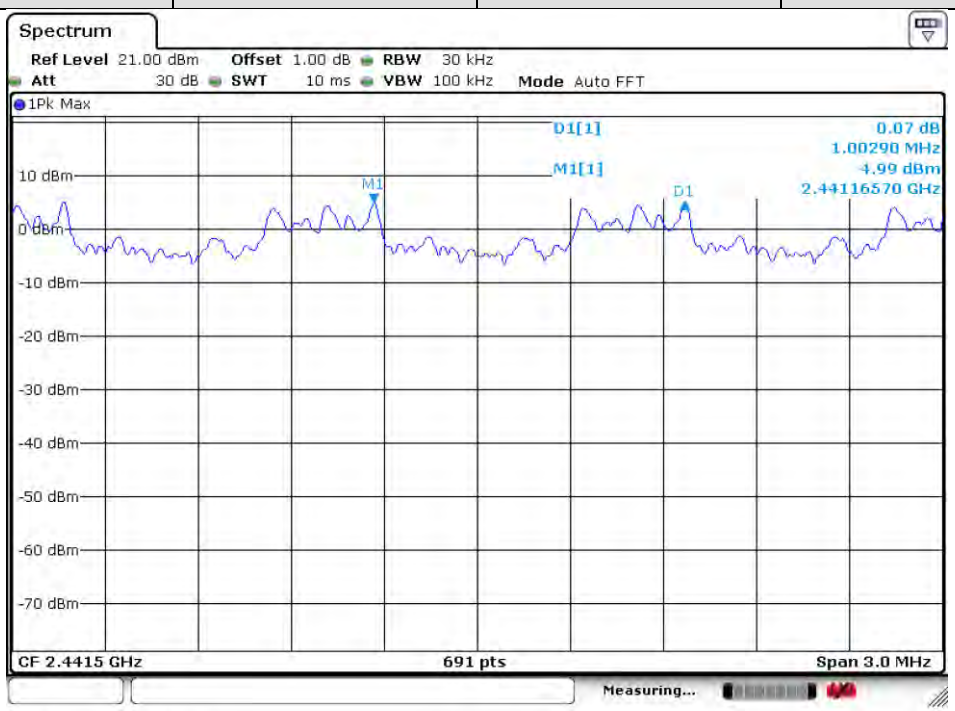
4.6.2 Test plots:

Test mode:	GFSK	Test channel:	Middle



Date: 30.DEC.2019 05:45:55

Test mode:	π/4DQPSK	Test channel:	Middle



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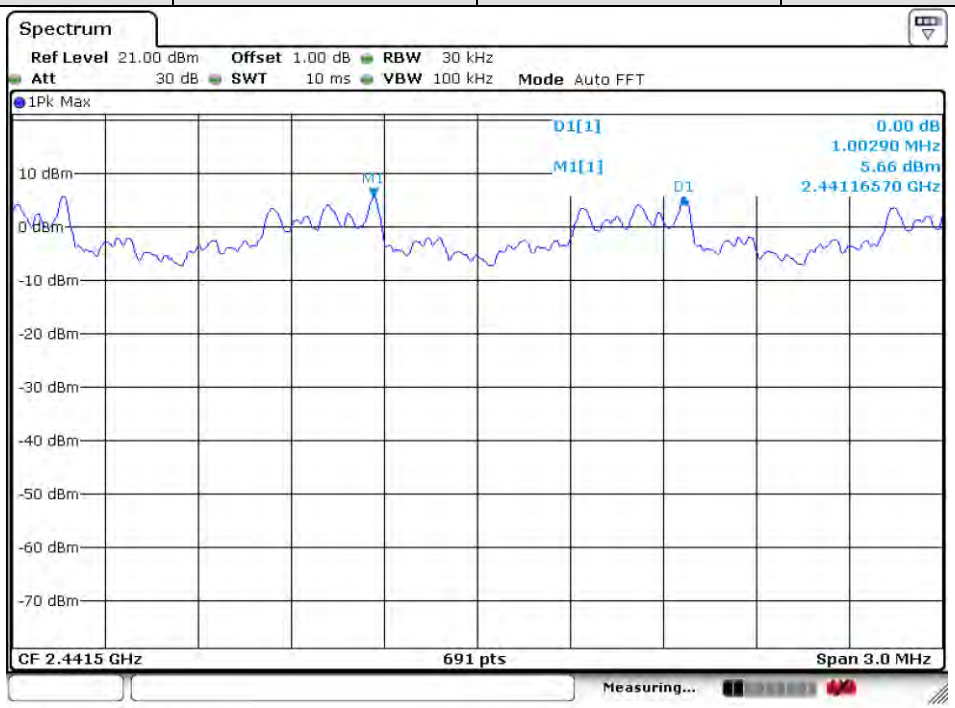
Test mode:	8DPSK	Test channel:	Middle



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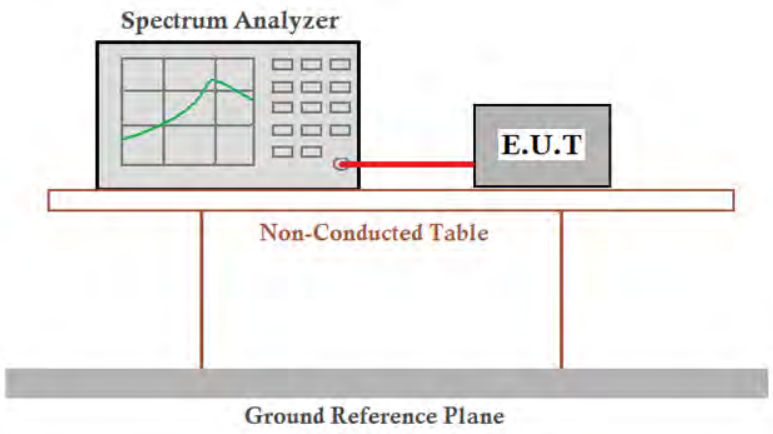
4.7 Hopping Channel Number

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

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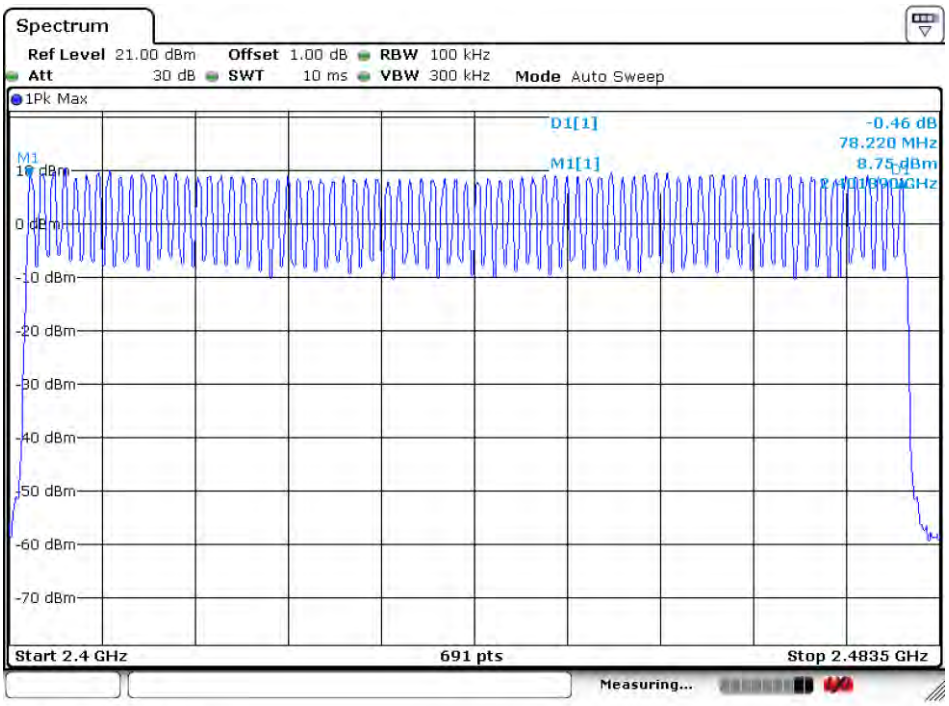
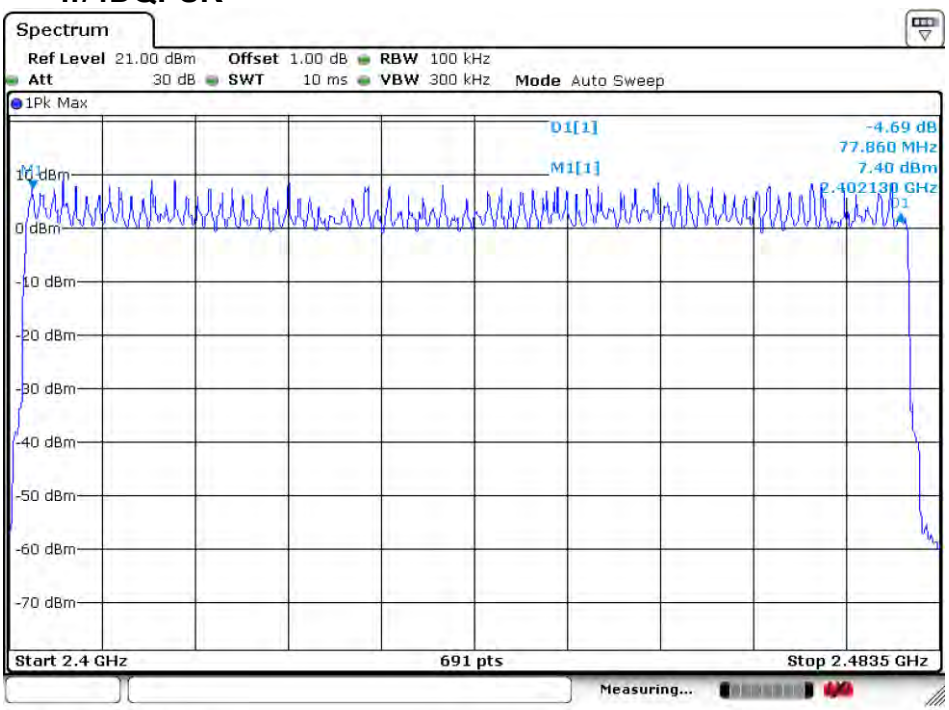
4.7.2 Test plots

4.7.2.1 GFSK



Date: 30.DEC.2019 05:50:45

4.7.2.2 π/4DQPSK



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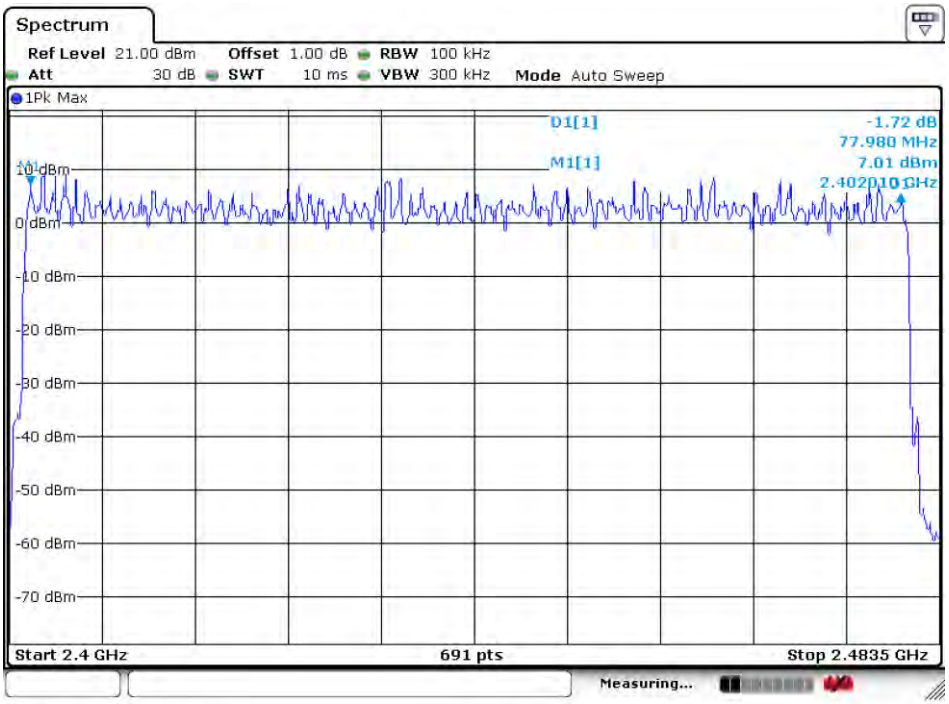
4.7.2.3 8DPSK



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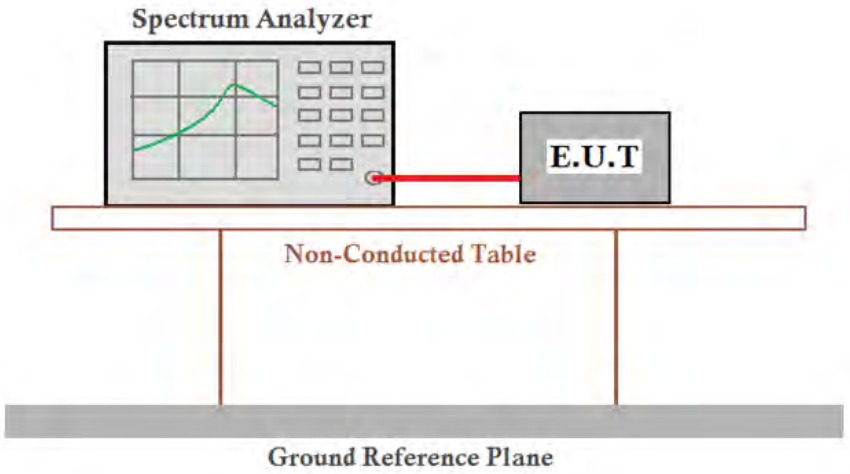
4.8 Dwell Time

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

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4.8.1 Test Results

Operation Modes	On time（ms）on one channel
DH1	0.391
DH3	1.655
DH5	2.900
2-DH1	0.397
2-DH3	1.655
2-DH5	2.910
3-DH1	0.398
3-DH3	1.655
3-DH5	2.920

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 *2.920 ms/channel =311.48 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 x2.920 ms/channel=155.75 ms(worst case dwell time for one channel in AFH mode)

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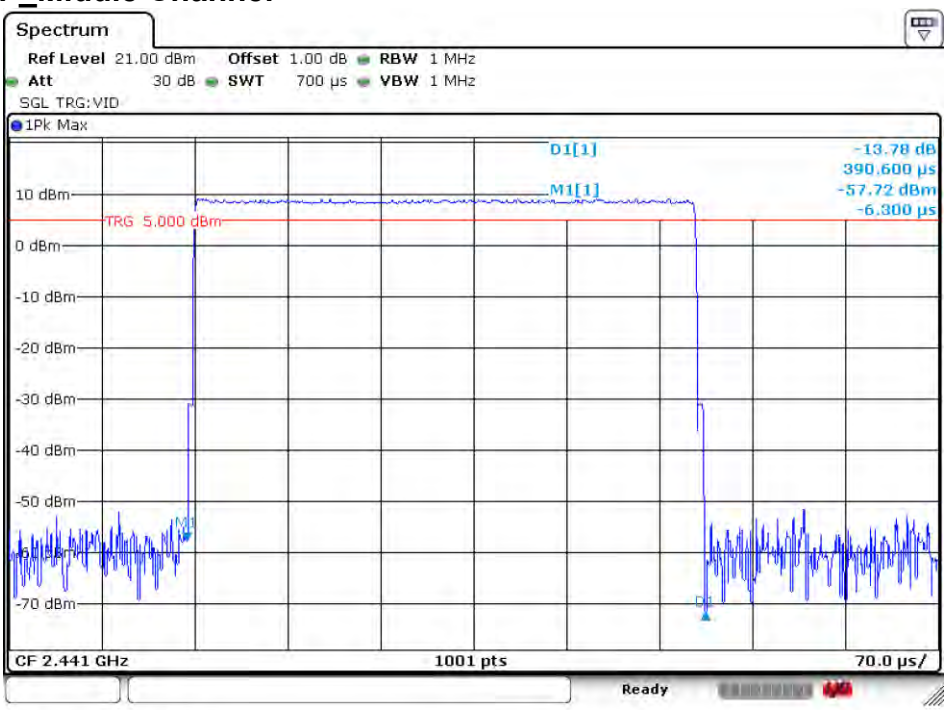
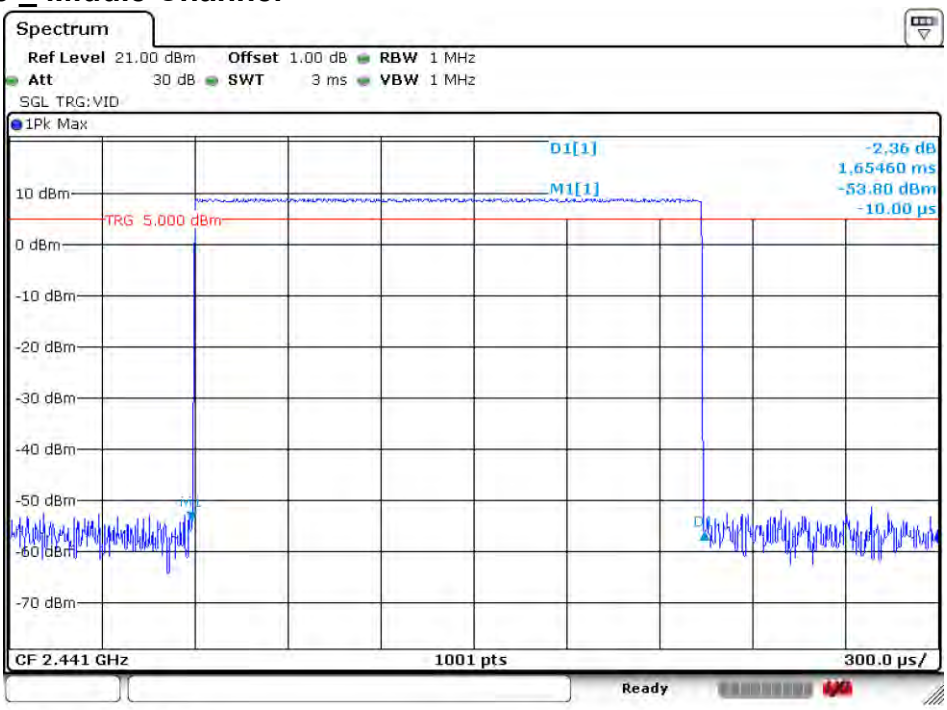
4.8.2 Test plots

4.8.2.1 DH1 _Middle Channel



Date: 30.DEC.2019 06:18:23

4.8.2.2 DH3 _ Middle Channel



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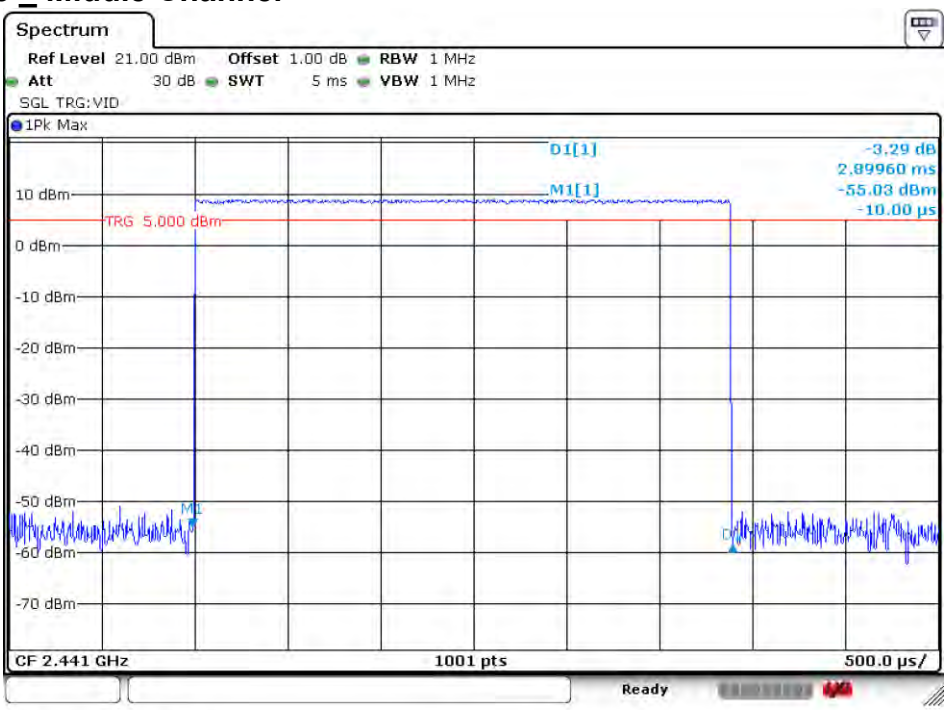
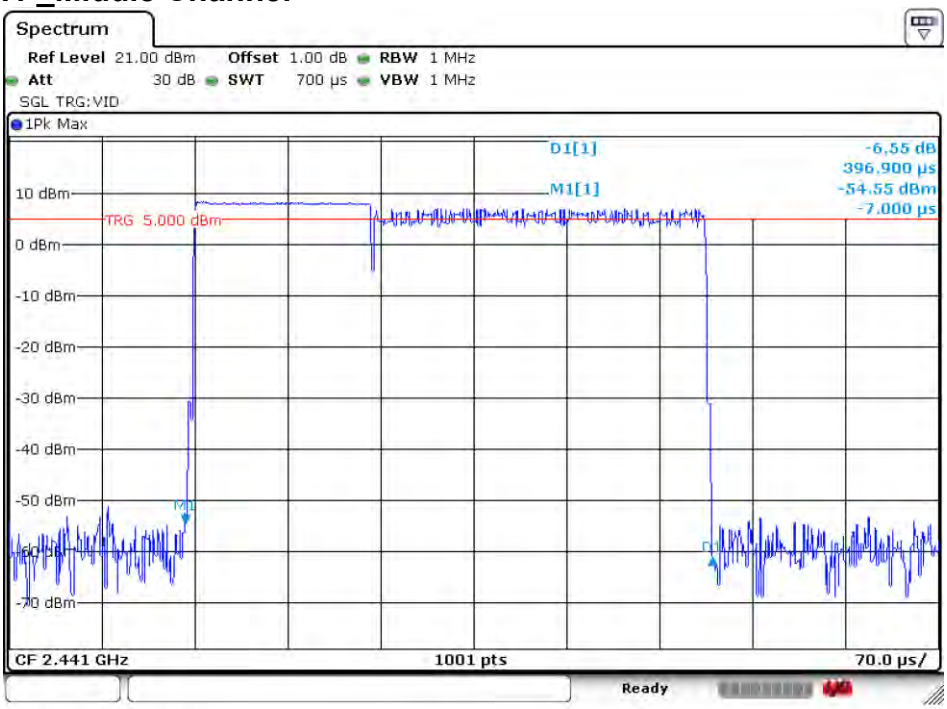
4.8.2.3 DH5 _ Middle Channel



Date: 30.DEC.2019 06:22:24

4.8.2.4 2DH1 _Middle Channel



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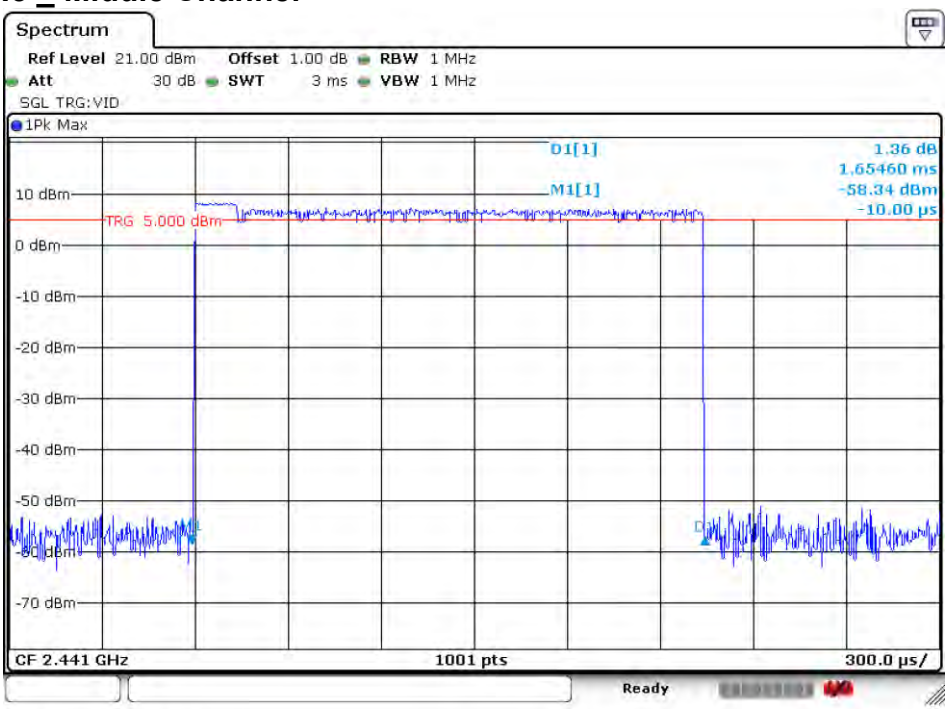
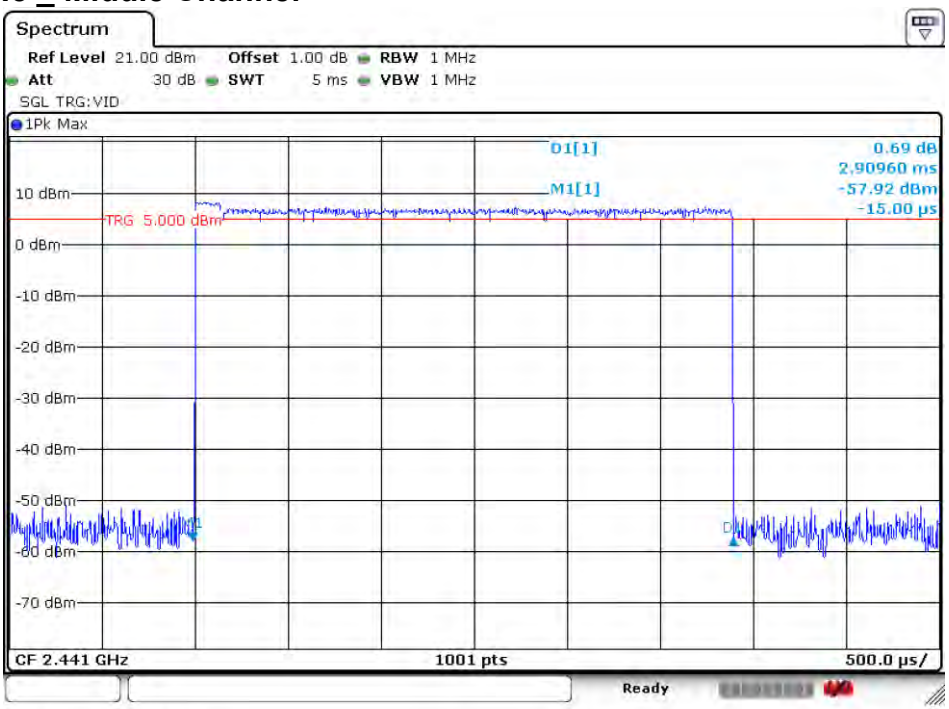
4.8.2.5 2DH3 _ Middle Channel



Date: 30.DEC.2019 06:20:31

4.8.2.6 2DH5 _ Middle Channel



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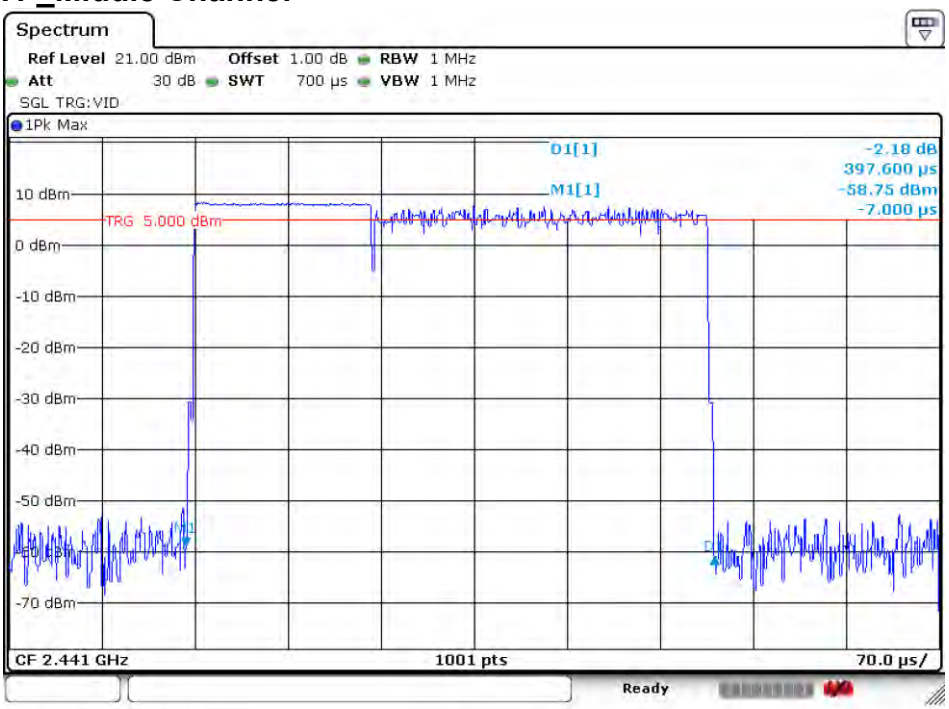
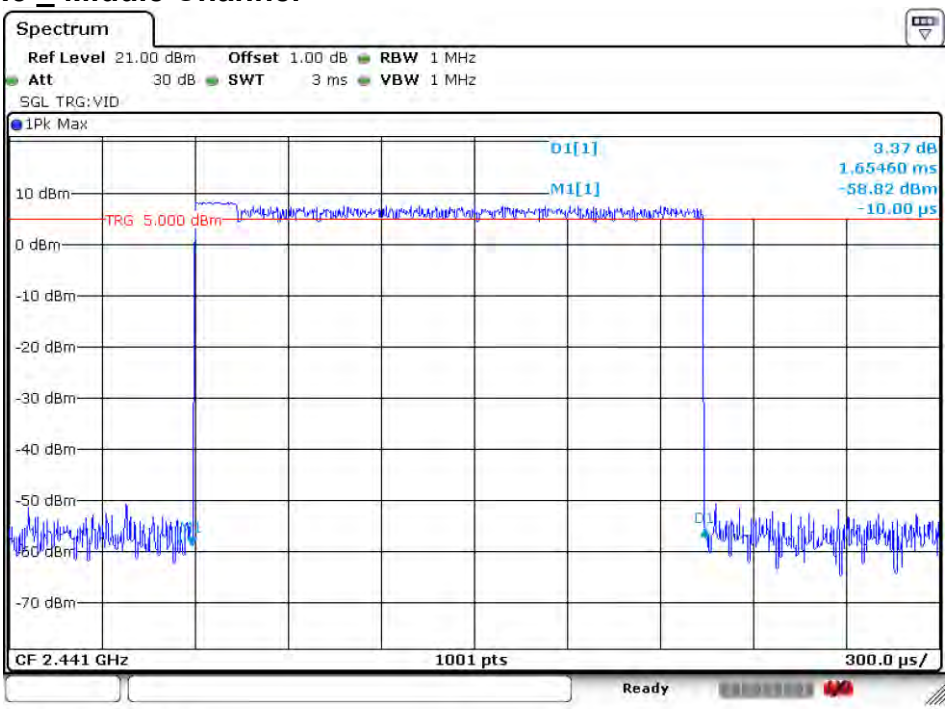
4.8.2.7 3DH1 _Middle Channel



Date: 30.DEC.2019 06:19:29

4.8.2.8 3DH3 _ Middle Channel



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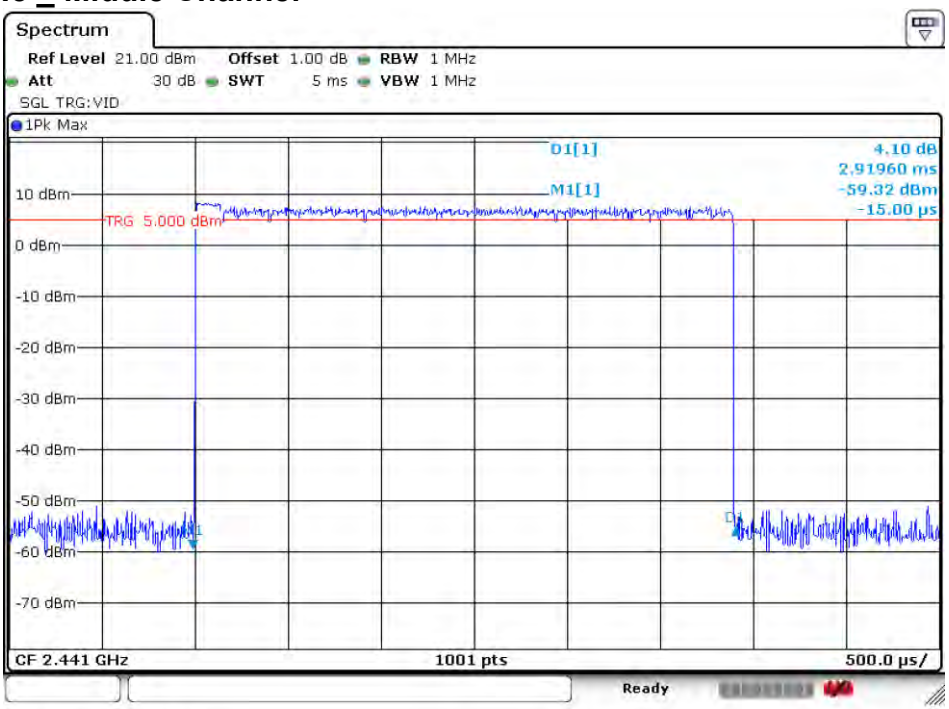
4.8.2.9 3DH5 _ Middle Channel



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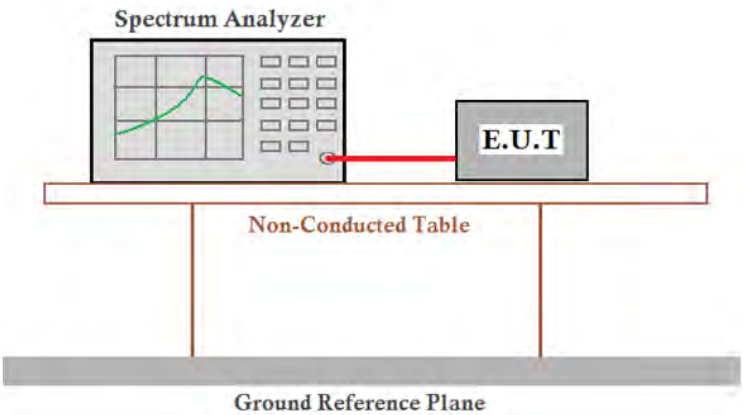
4.9 Band-edge for RF Conducted Emissions

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

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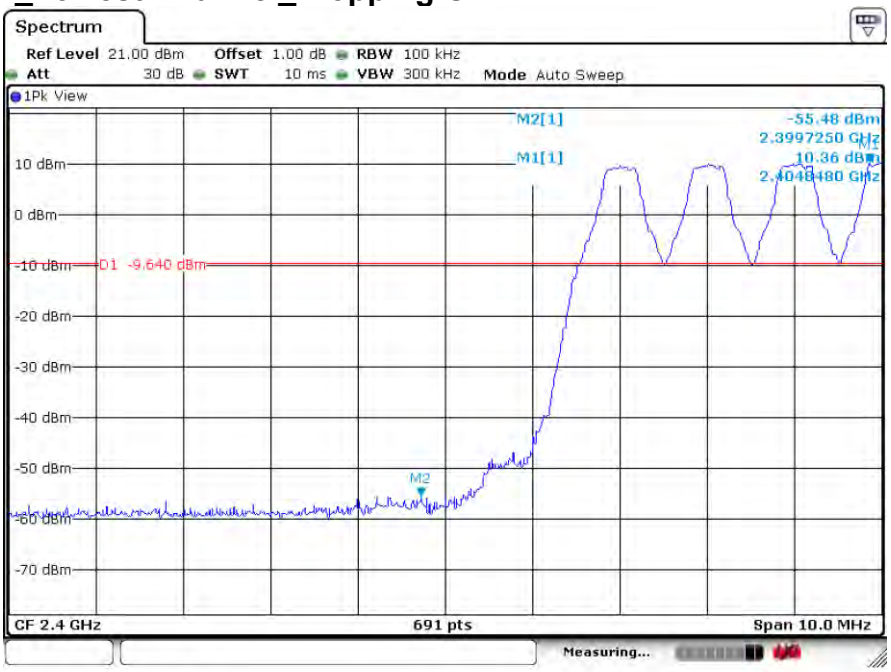
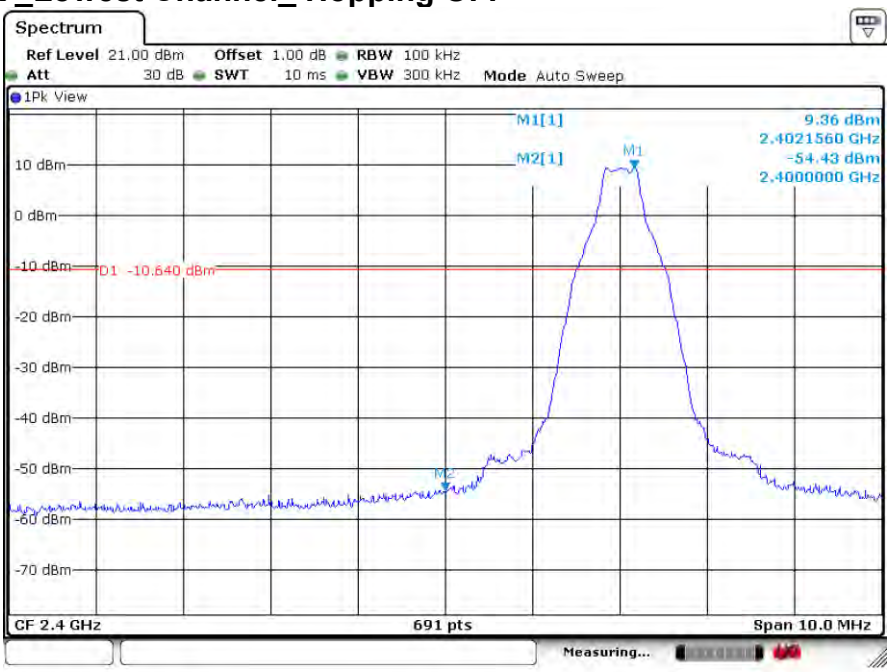
4.9.1 Test plots

4.9.1.1 GFSK _Lowest Channel_ Hopping ON



Date: 30.DEC.2019 05:53:10

4.9.1.2 GFSK _Lowest Channel_ Hopping OFF



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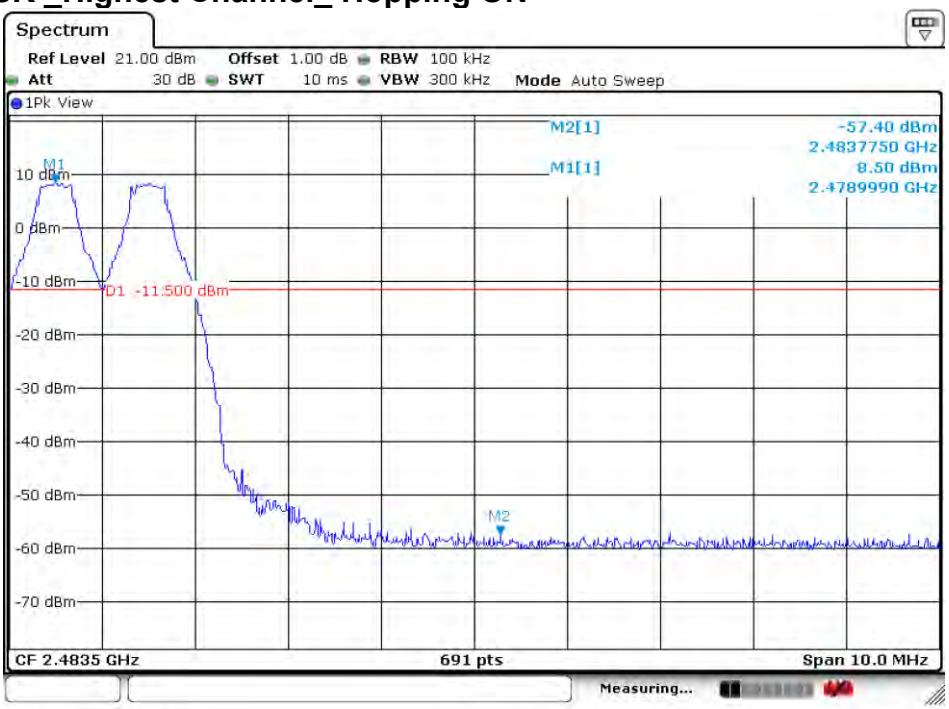
4.9.1.3 GFSK _Highest Channel_ Hopping ON



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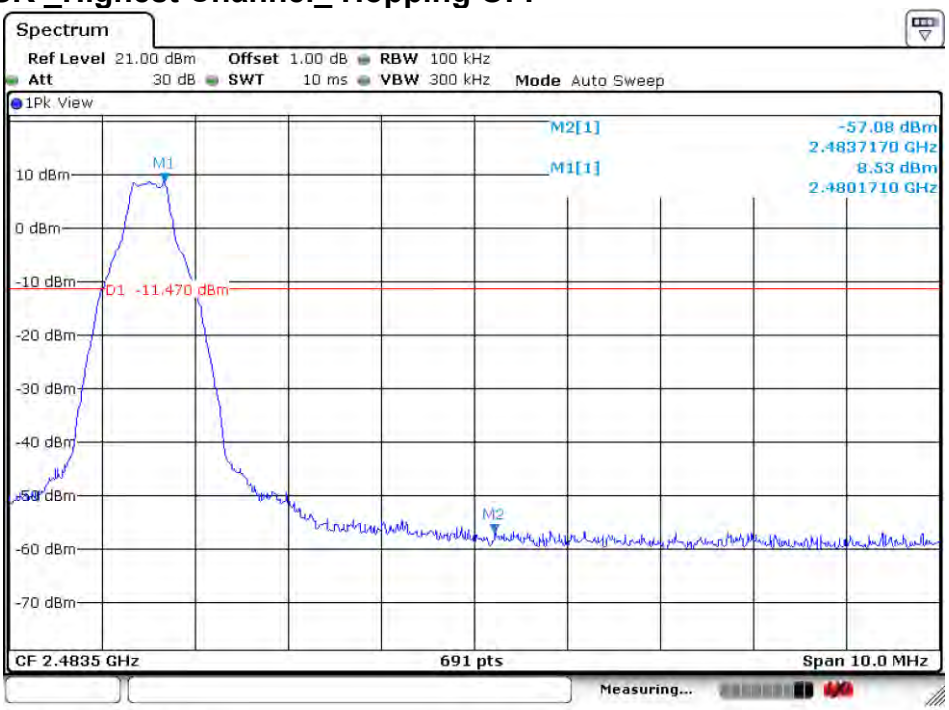
4.9.1.4 GFSK _Highest Channel_ Hopping OFF



Date: 30.DEC.2019 06:05:59

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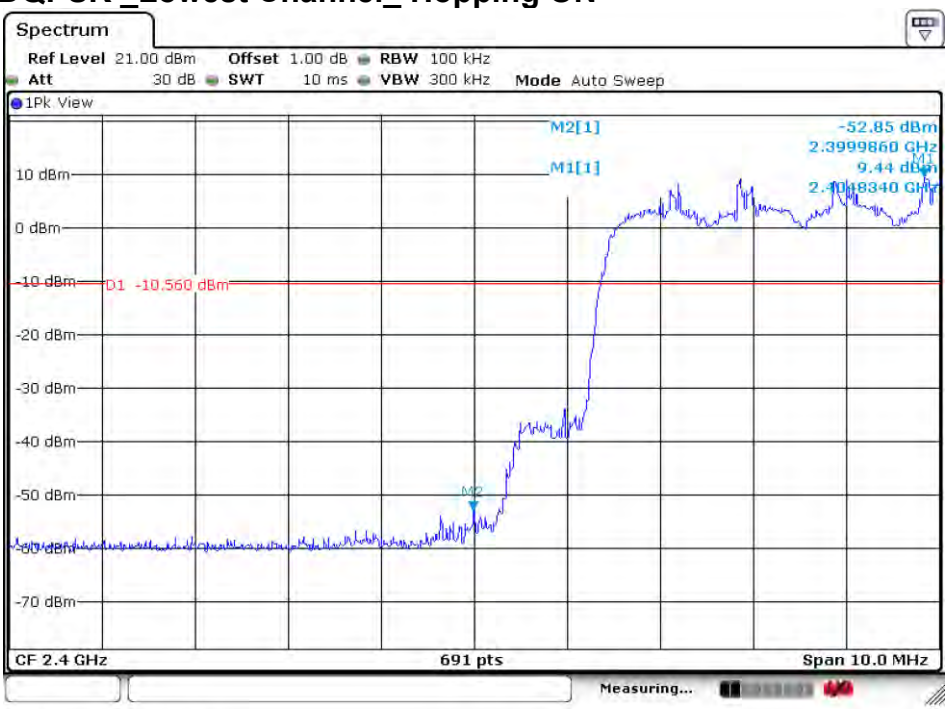
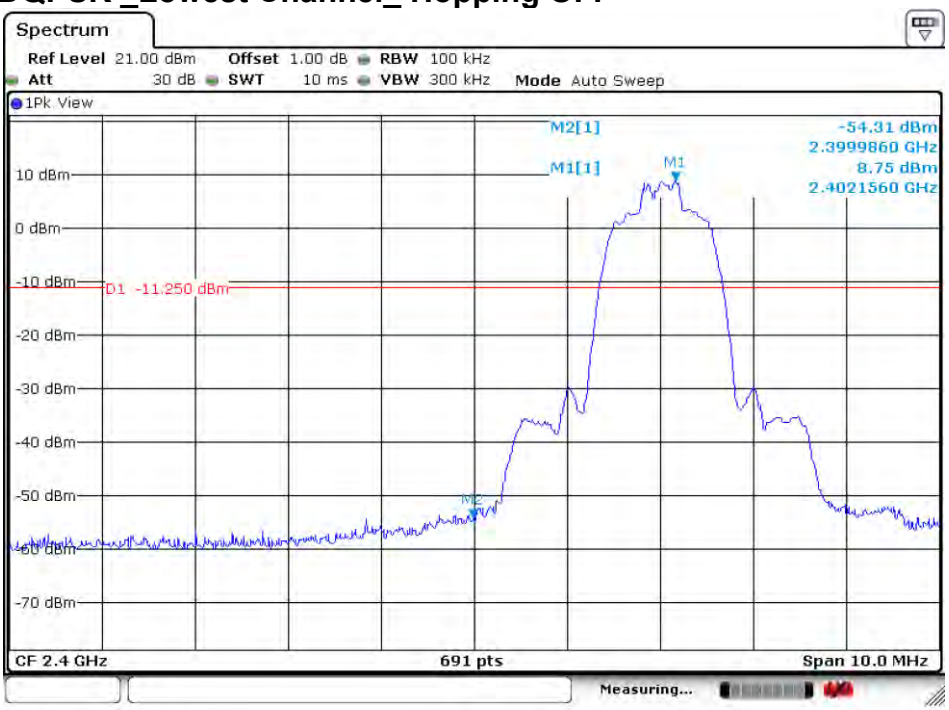
4.9.1.5 π/4DQPSK _Lowest Channel_ Hopping ON



Date: 30.DEC.2019 05:57:18

4.9.1.6 π/4DQPSK _Lowest Channel_ Hopping OFF



Date: 30.DEC.2019 05:56:25

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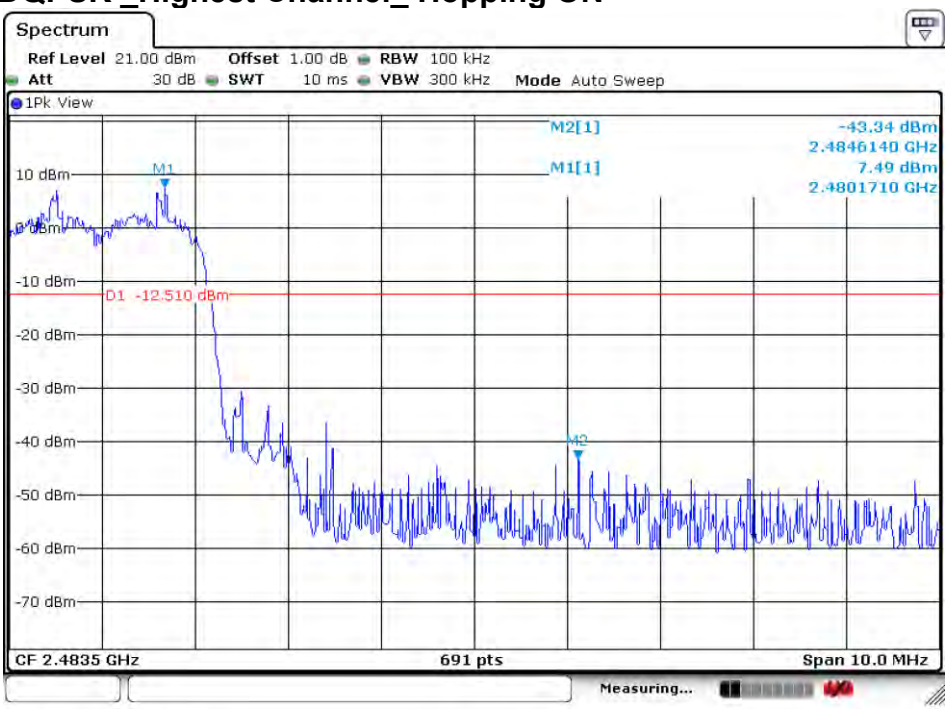
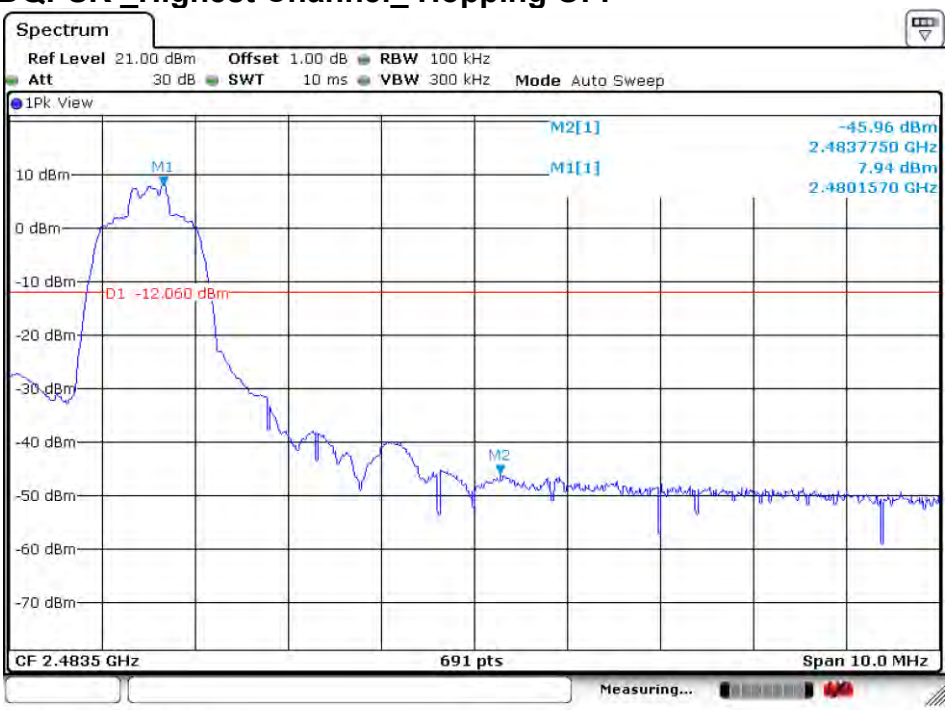
4.9.1.7 π/4DQPSK _Highest Channel_ Hopping ON



Date: 30.DEC.2019 06:04:24

4.9.1.8 π/4DQPSK _Highest Channel_ Hopping OFF



Date: 30.DEC.2019 06:05:10

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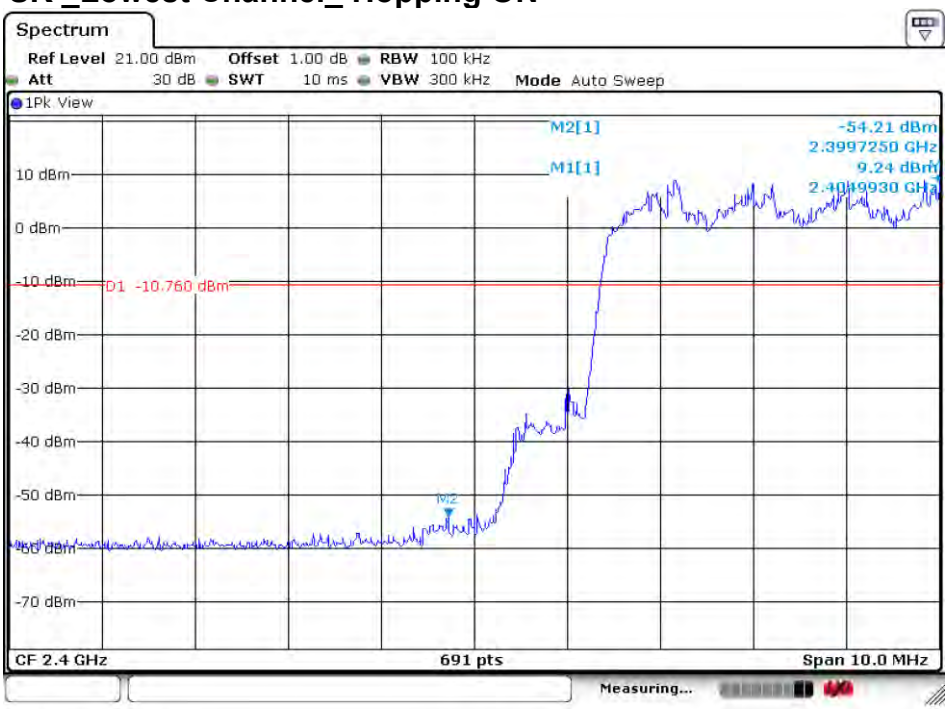
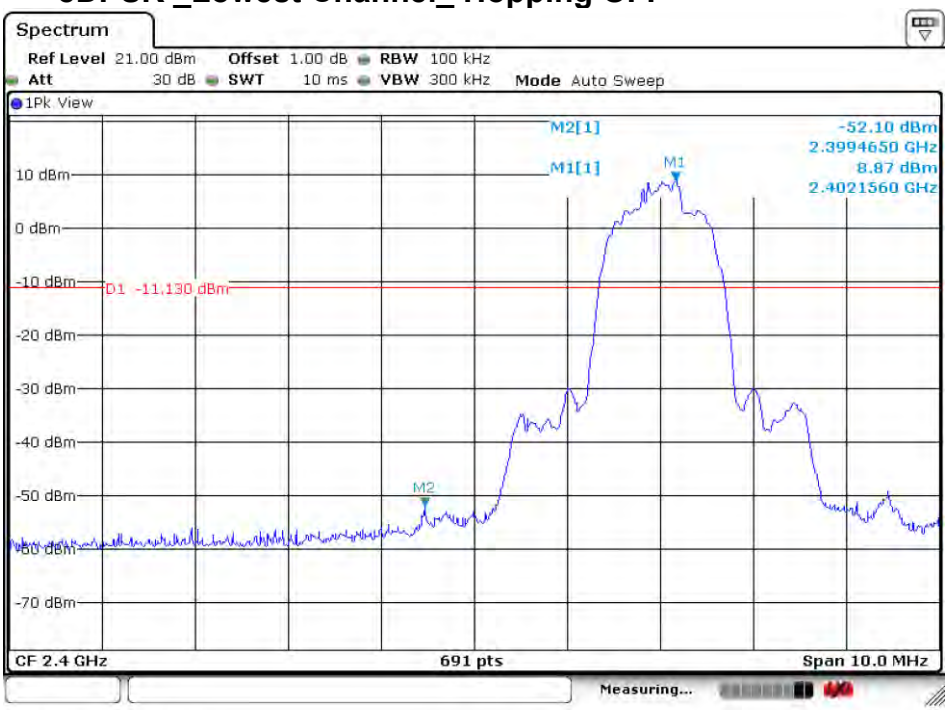
4.9.1.9 8DPSK _Lowest Channel_ Hopping ON



Date: 30.DEC.2019 05:58:51

4.9.1.10 8DPSK _Lowest Channel_ Hopping OFF



Date: 30.DEC.2019 05:59:37

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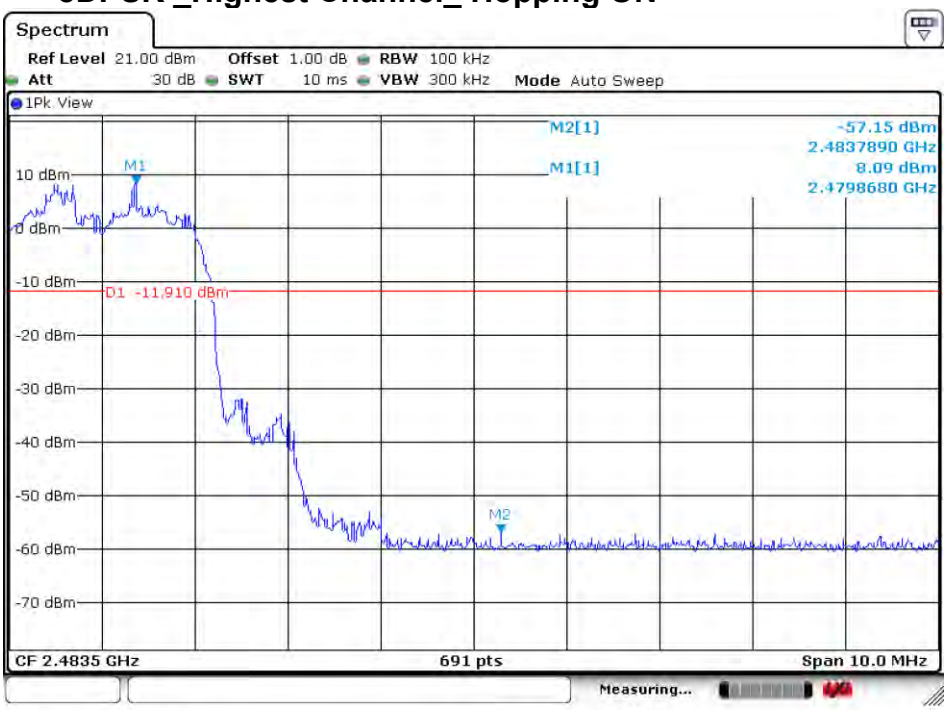
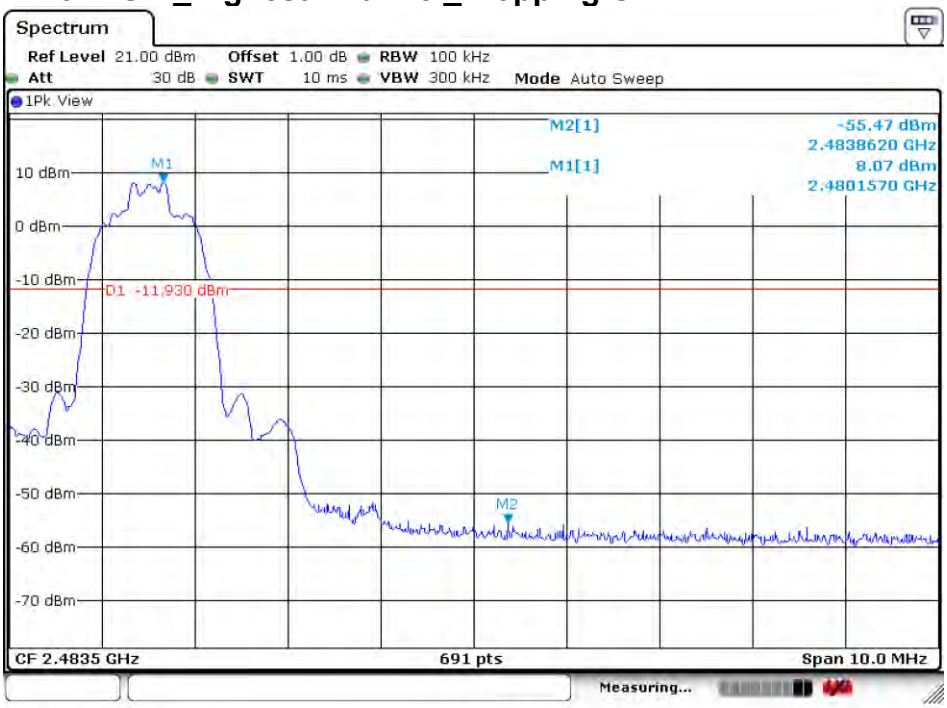
4.9.1.11 8DPSK _Highest Channel_ Hopping ON



Date: 30.DEC.2019 06:02:08

4.9.1.12 8DPSK _Highest Channel_ Hopping OFF



Date: 30.DEC.2019 06:01:13

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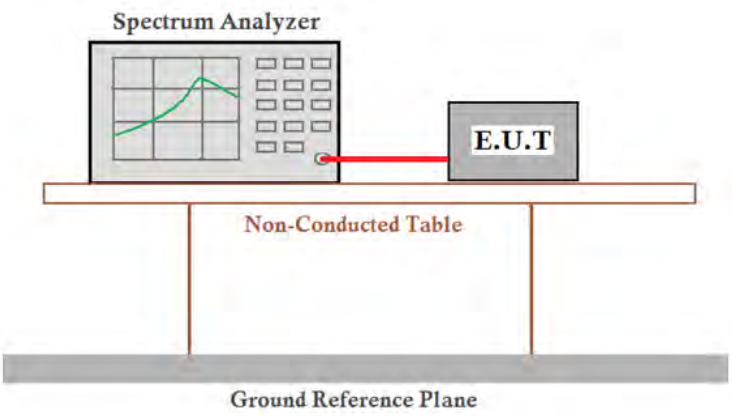
4.10 Spurious RF Conducted Emissions

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

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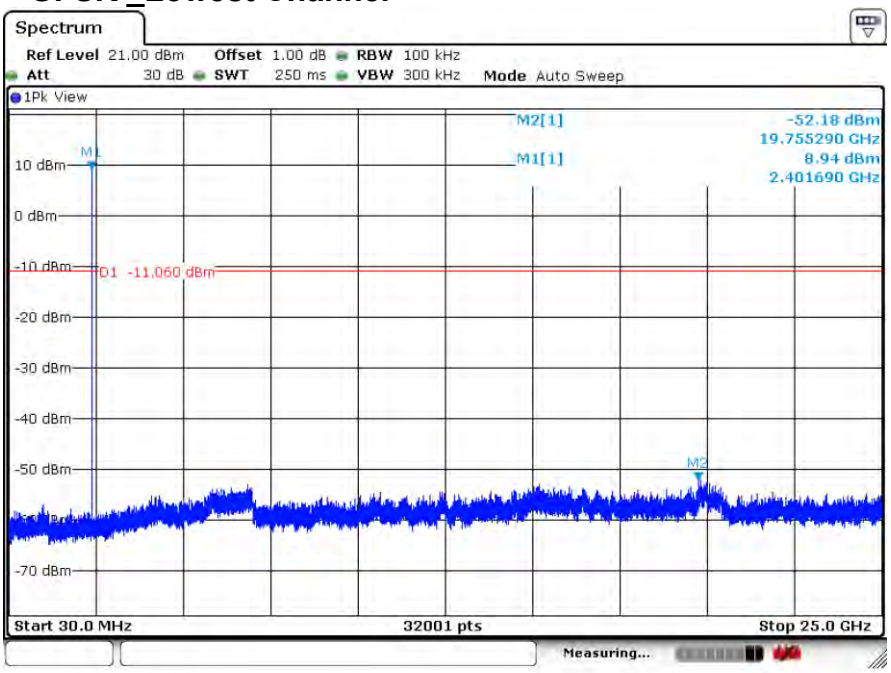
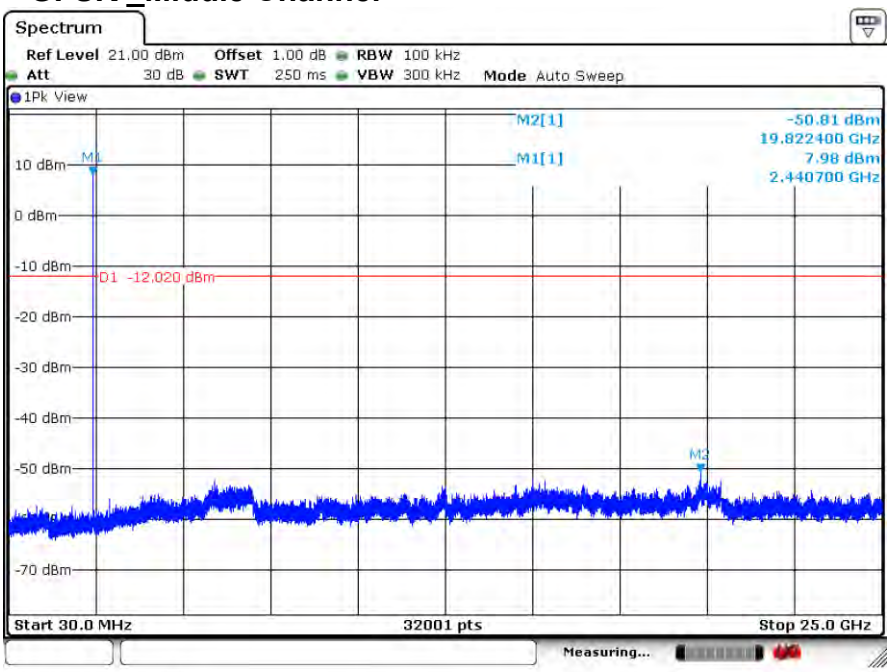
4.10.1 Test plots

4.10.1.1 GFSK _Lowest Channel



Date: 30.DEC.2019 06:12:35

4.10.1.2 GFSK _Middle Channel



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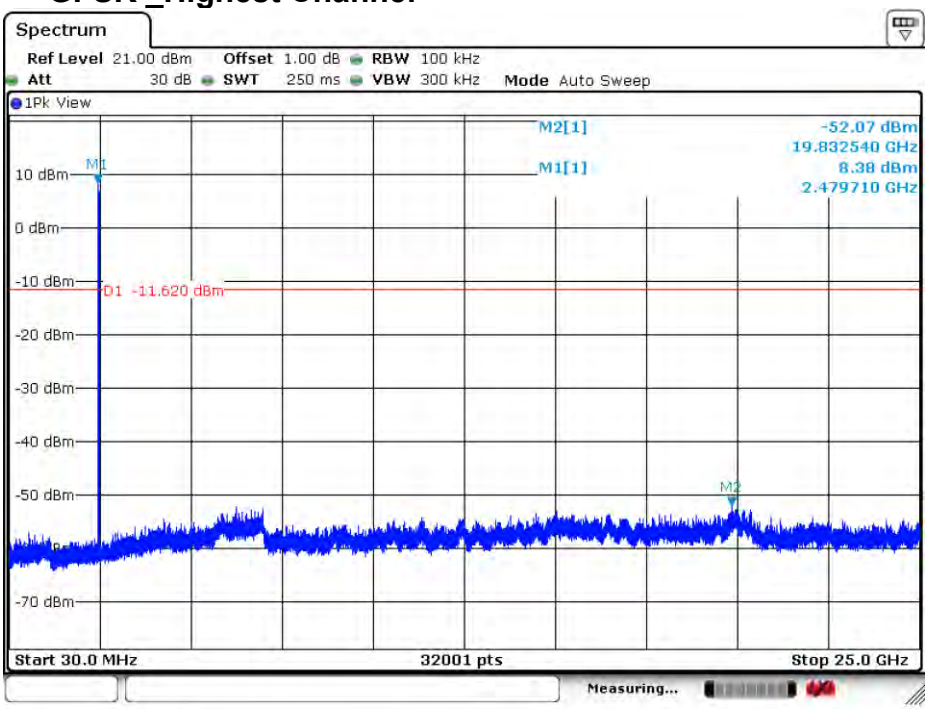
4.10.1.3 GFSK _Highest Channel



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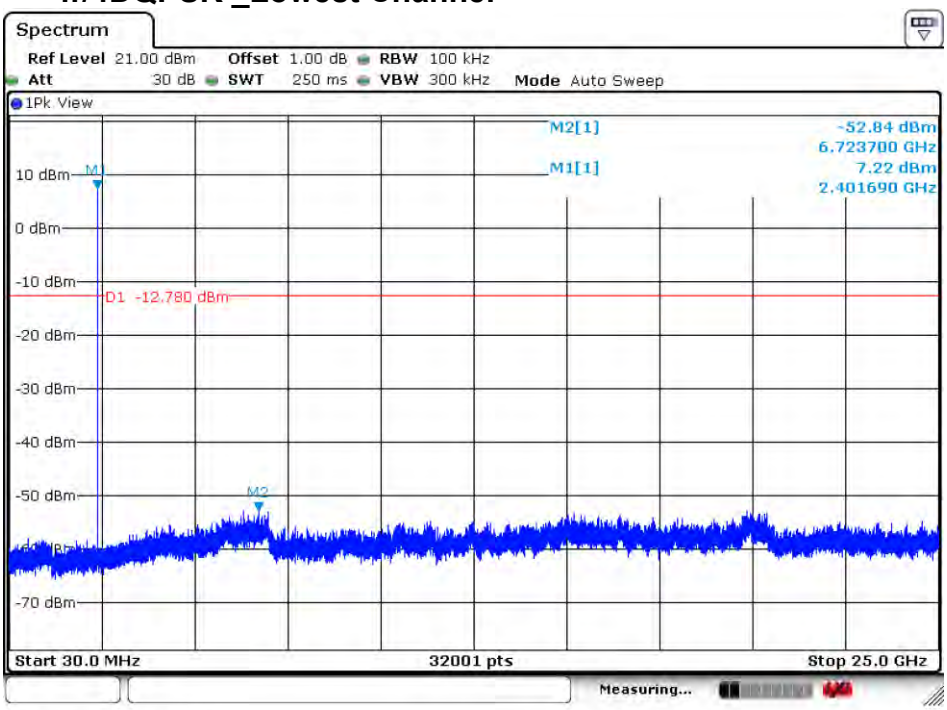
4.10.1.4 π/4DQPSK _Lowest Channel



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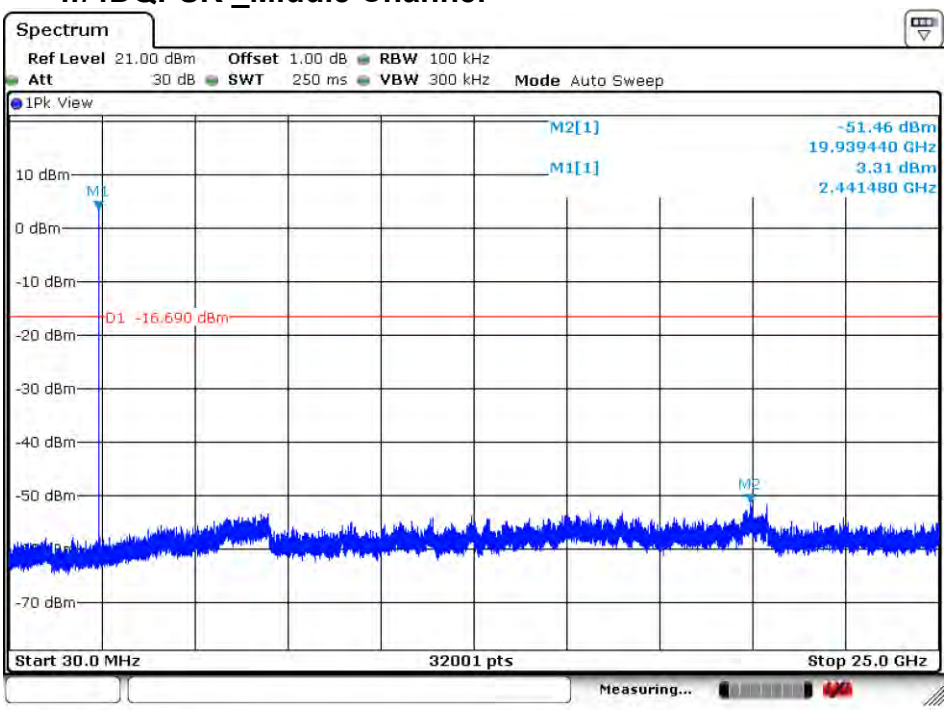
4.10.1.5 π/4DQPSK _Middle Channel



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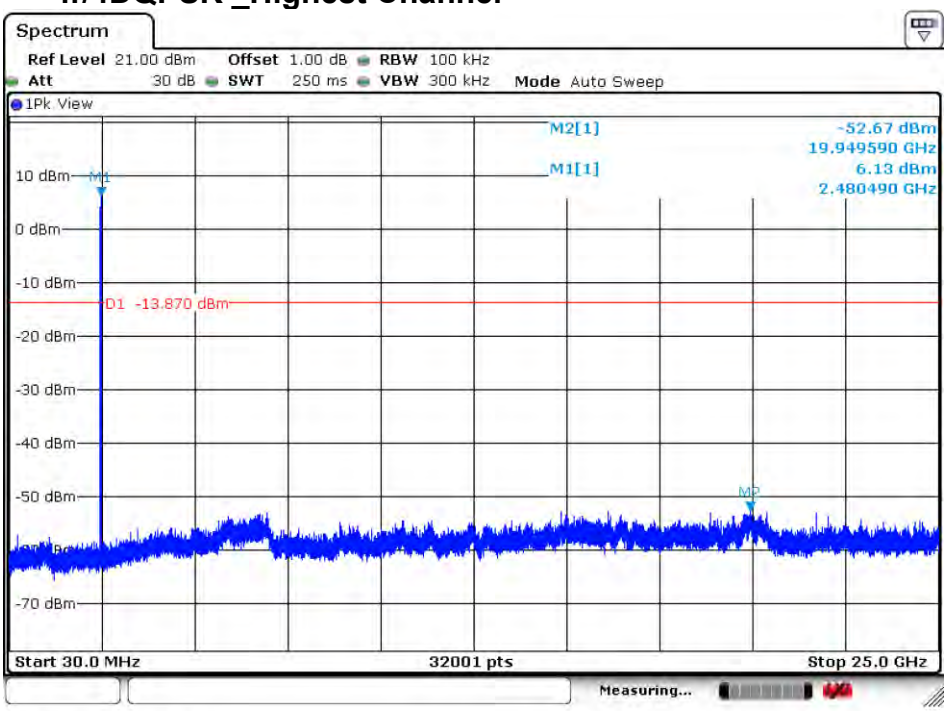
4.10.1.6 π/4DQPSK _Highest Channel



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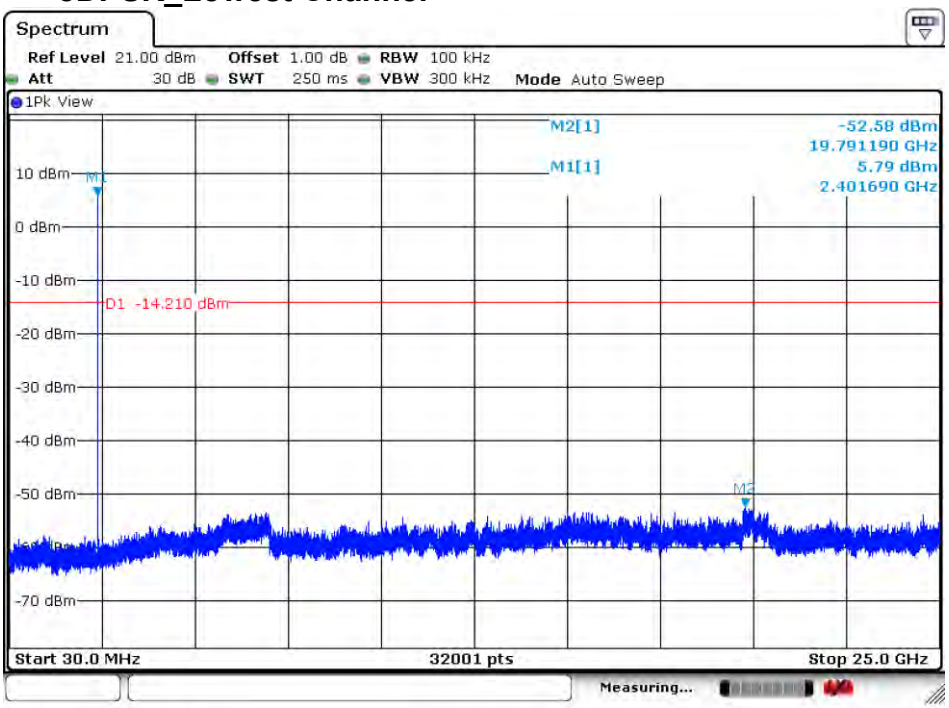
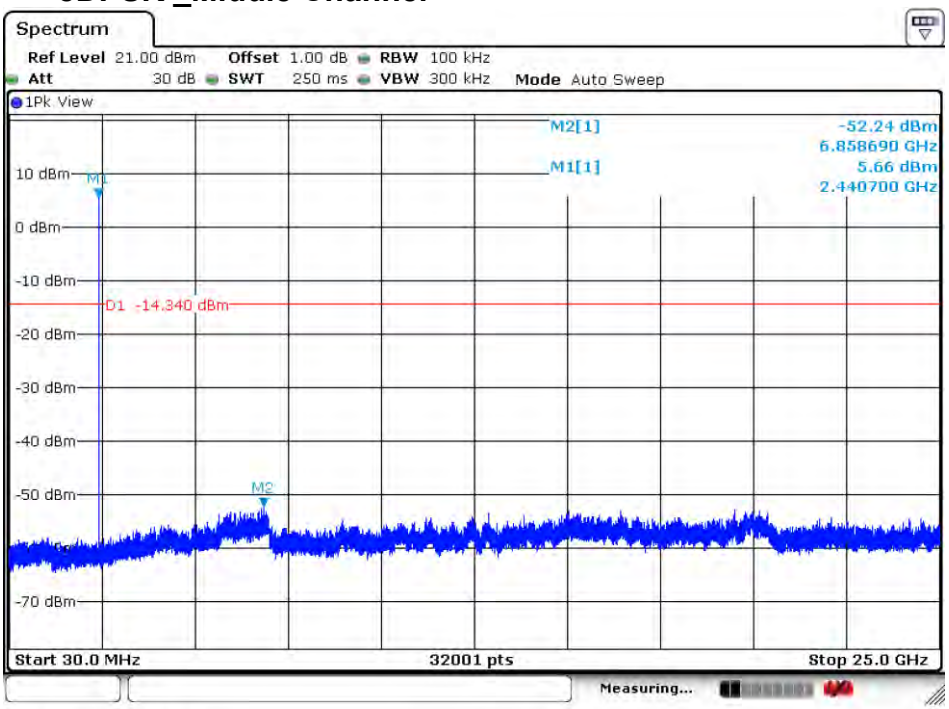
4.10.1.7 8DPSK_Lowest Channel



Date: 30.DEC.2019 06:16:38

4.10.1.8 8DPSK _Middle Channel



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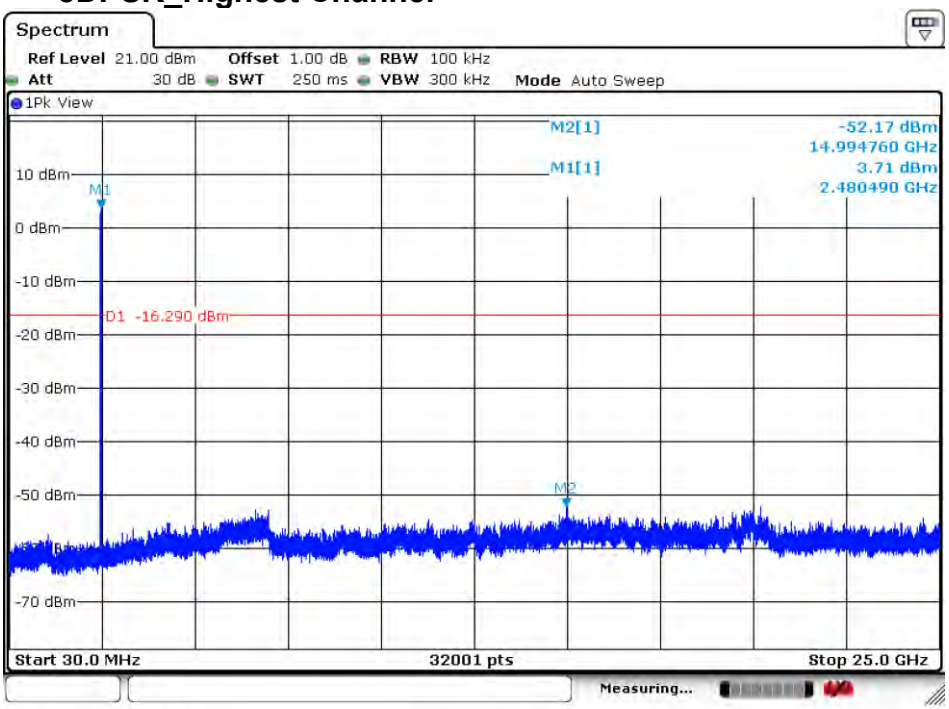
4.10.1.9 8DPSK_Highest Channel



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.

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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 (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:

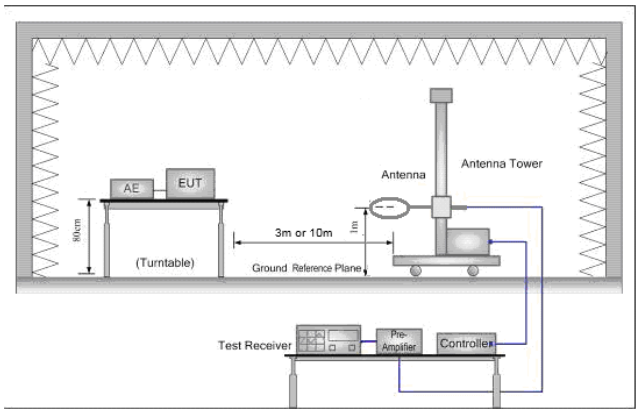

Figure 1. Below 30MHz

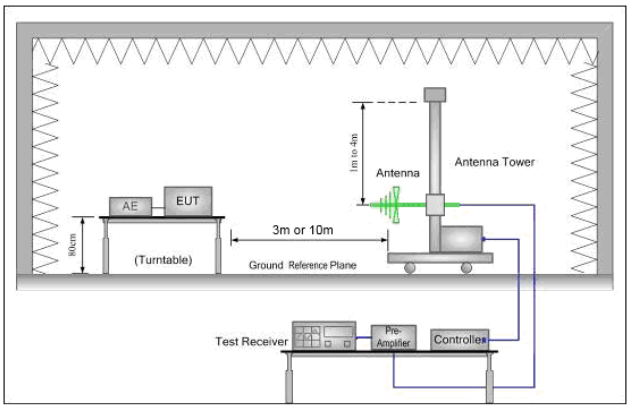

Figure 2. 30MHz to 1GHz

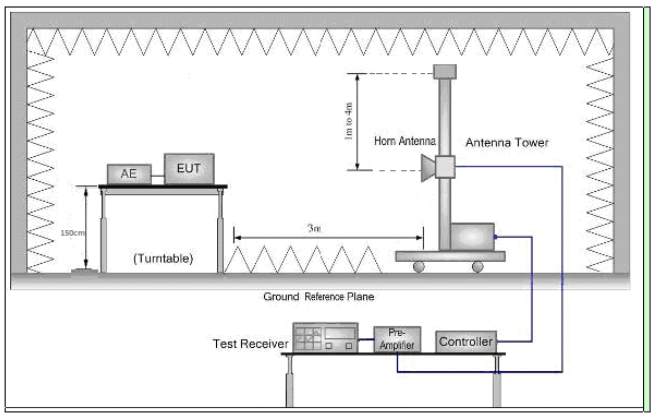

Figure 3. Above 1 GHz

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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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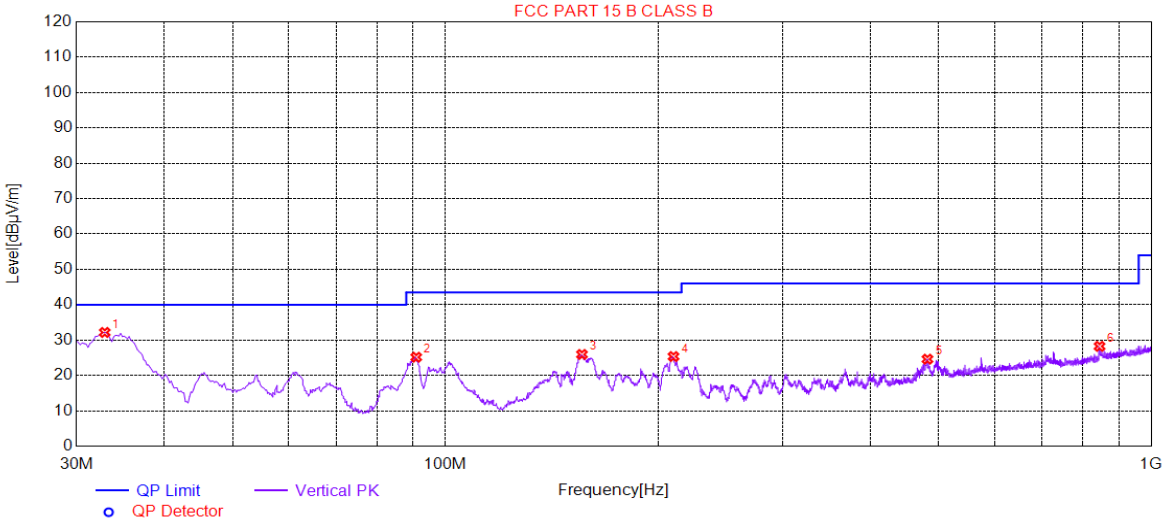
4.11.1 Radiated Emission below 1GHz

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	32.9106	32.17	-30.01	40.00	7.83	168	16	Vertical
2	90.9282	25.16	-33.56	43.50	18.34	282	272	Vertical
3	156.1252	25.95	-34.80	43.50	17.55	202	358	Vertical
4	210.4561	25.35	-30.97	43.50	18.15	266	343	Vertical
5	481.9164	24.61	-23.77	46.00	21.39	176	349	Vertical
6	844.9630	28.24	-16.97	46.00	17.76	180	82	Vertical

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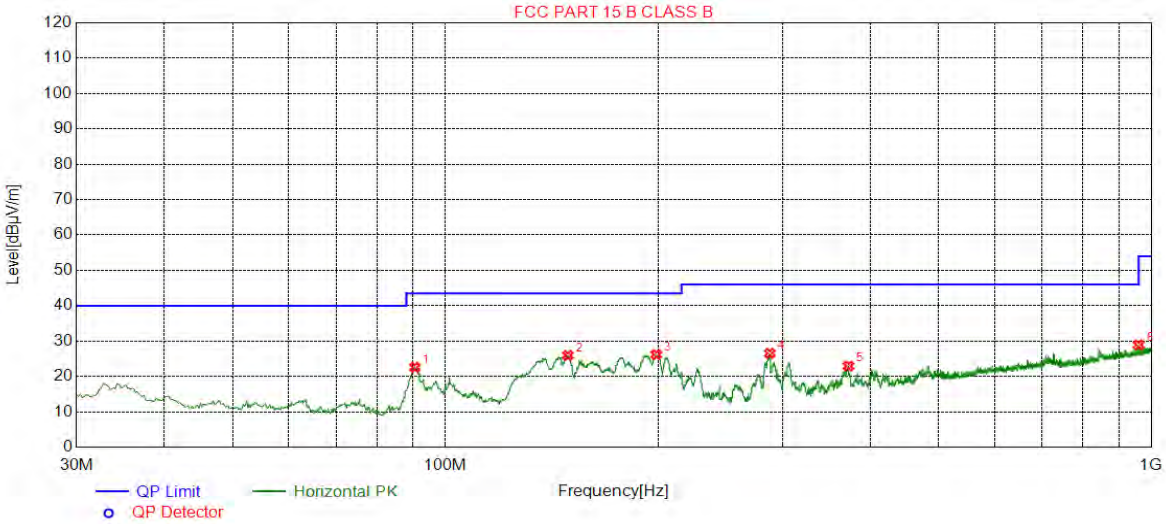
4.11.1.2 Charge + Transmitting, Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	90.5401	22.58	-33.62	43.50	20.92	174	22	Horizontal
2	149.1398	25.94	-35.12	43.50	17.56	228	225	Horizontal
3	199.0078	26.20	-31.29	43.50	17.30	185	248	Horizontal
4	288.0716	26.56	-28.72	46.00	19.44	155	55	Horizontal
5	372.4785	22.96	-26.27	46.00	23.04	107	58	Horizontal
6	960.0280	28.95	-15.34	54.00	25.05	106	104	Horizontal

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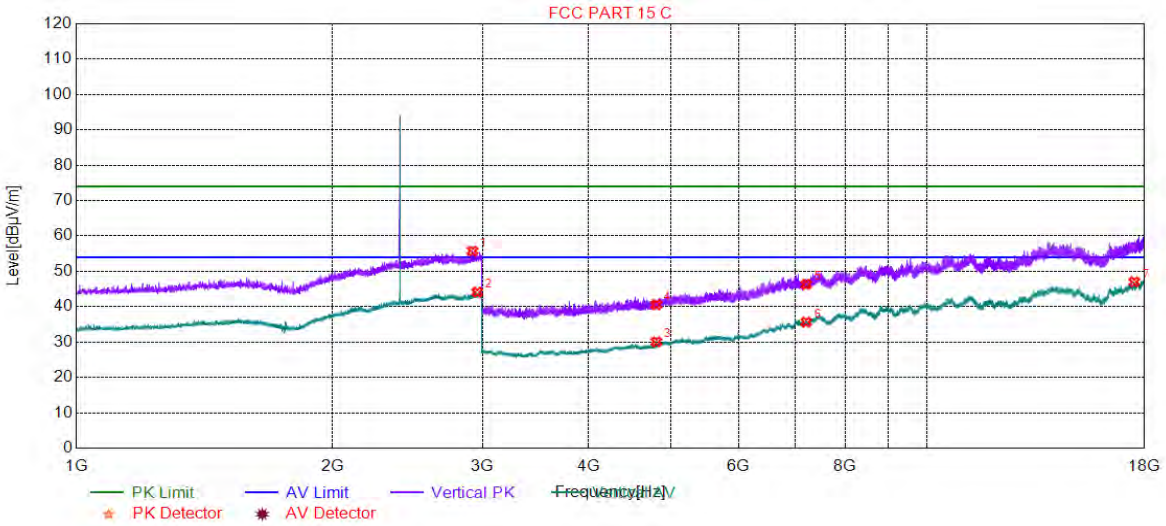
4.11.2 Transmitter Emission above 1GHz

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	2921.4804	55.78	9.37	74.00	18.22	225	360	Vertical
2	2958.4896	44.11	9.64	54.00	9.89	295	18	Vertical
3	4804.0000	30.07	-18.30	54.00	23.93	205	207	Vertical
4	4804.0000	40.59	-18.30	74.00	33.41	190	207	Vertical
5	7206.0000	46.31	-10.09	74.00	27.69	242	217	Vertical
6	7206.0000	35.65	-10.09	54.00	18.35	295	267	Vertical
7	17503.8752	47.03	1.94	54.00	6.97	297	267	Vertical

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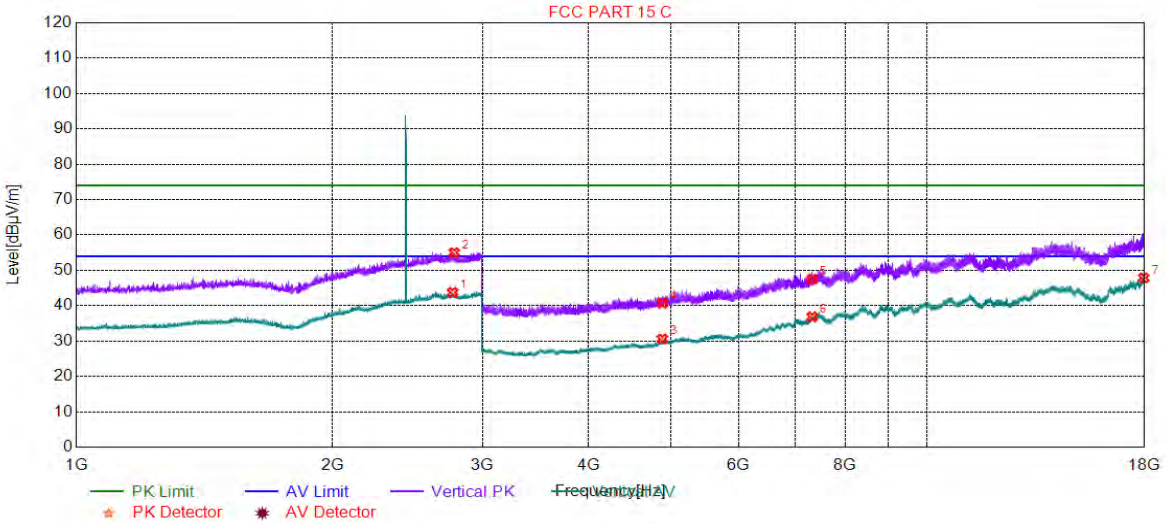
4.11.2.2 GFSK(DH5) _Middle Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2768.4421	43.77	9.06	54.00	10.23	182	126	Vertical
2	2779.4449	55.03	9.03	74.00	18.97	158	85	Vertical
3	4882.0000	30.62	-17.96	54.00	23.38	162	206	Vertical
4	4882.0000	40.72	-17.96	74.00	33.28	183	178	Vertical
5	7323.0000	47.53	-9.71	74.00	26.47	279	268	Vertical
6	7323.0000	36.86	-9.71	54.00	17.14	180	268	Vertical
7	17957.0979	47.87	1.71	54.00	6.13	230	68	Vertical

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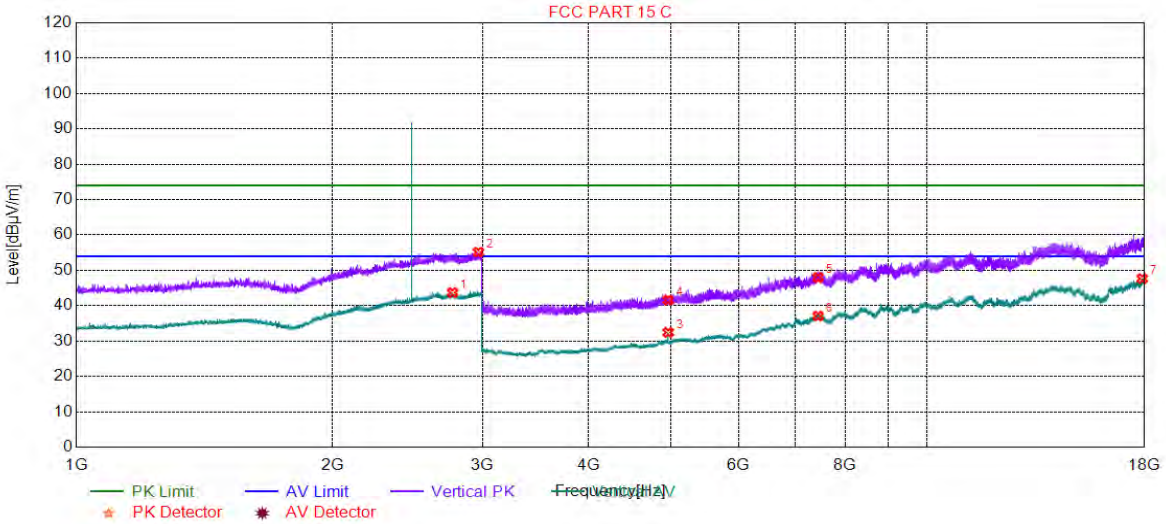
4.11.2.3 GFSK(DH5) _Highest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2767.4419	43.73	9.06	54.00	10.27	174	360	Vertical
2	2967.4919	55.17	9.60	74.00	18.83	198	180	Vertical
3	4960.0000	32.45	-17.47	54.00	21.55	223	98	Vertical
4	4960.0000	41.61	-17.47	74.00	32.39	218	71	Vertical
5	7440.0000	47.96	-9.35	74.00	26.04	151	217	Vertical
6	7440.0000	37.08	-9.35	54.00	16.92	165	317	Vertical
7	17884.4942	47.66	1.49	54.00	6.34	164	217	Vertical

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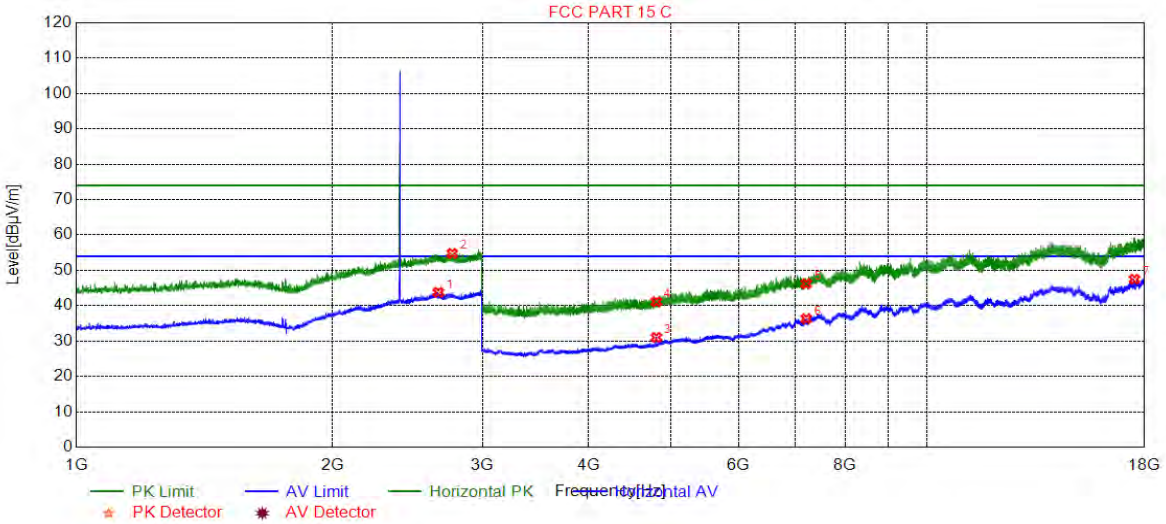
4.11.2.4 GFSK(DH5) _Lowest Channel _Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2663.4159	43.77	8.68	54.00	10.23	189	260	Horizontal
2	2764.9412	54.78	9.07	74.00	19.22	235	342	Horizontal
3	4804.0000	31.03	-18.30	54.00	22.97	227	44	Horizontal
4	4804.0000	41.12	-18.30	74.00	32.88	205	206	Horizontal
5	7206.0000	46.22	-10.09	74.00	27.78	197	317	Horizontal
6	7206.0000	36.31	-10.09	54.00	17.69	109	217	Horizontal
7	17512.1256	47.48	1.97	54.00	6.52	180	18	Horizontal

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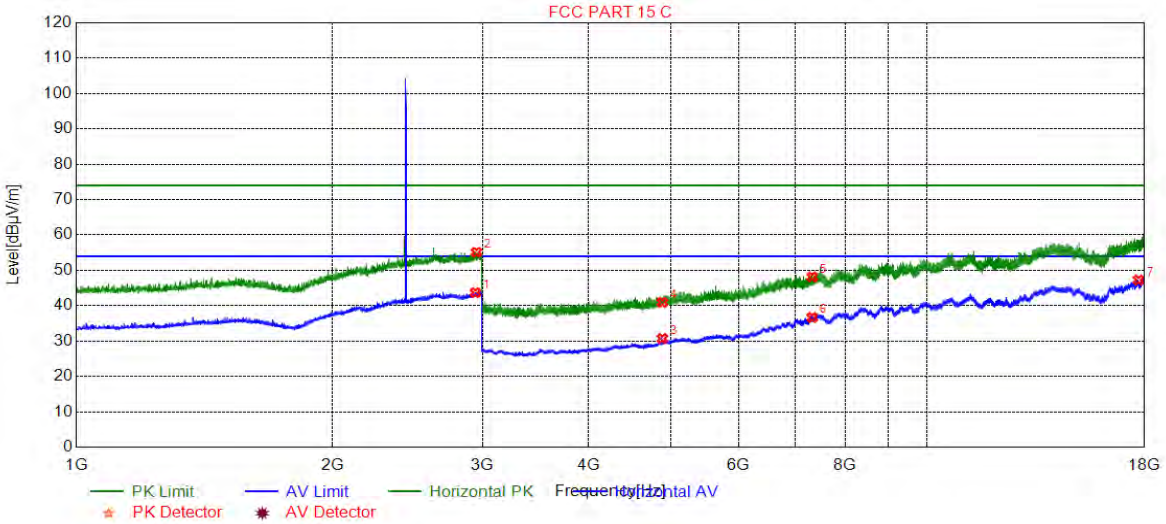
4.11.2.5 GFSK(DH5) _Middle Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2944.4861	43.70	9.62	54.00	10.30	241	315	Horizontal
2	2952.4881	55.14	9.67	74.00	18.86	149	234	Horizontal
3	4882.0000	30.73	-17.96	54.00	23.27	227	233	Horizontal
4	4882.0000	40.95	-17.96	74.00	33.05	157	206	Horizontal
5	7323.0000	48.15	-9.71	74.00	25.85	199	217	Horizontal
6	7323.0000	36.69	-9.71	54.00	17.31	156	217	Horizontal
7	17707.9354	47.27	2.20	54.00	6.73	150	267	Horizontal

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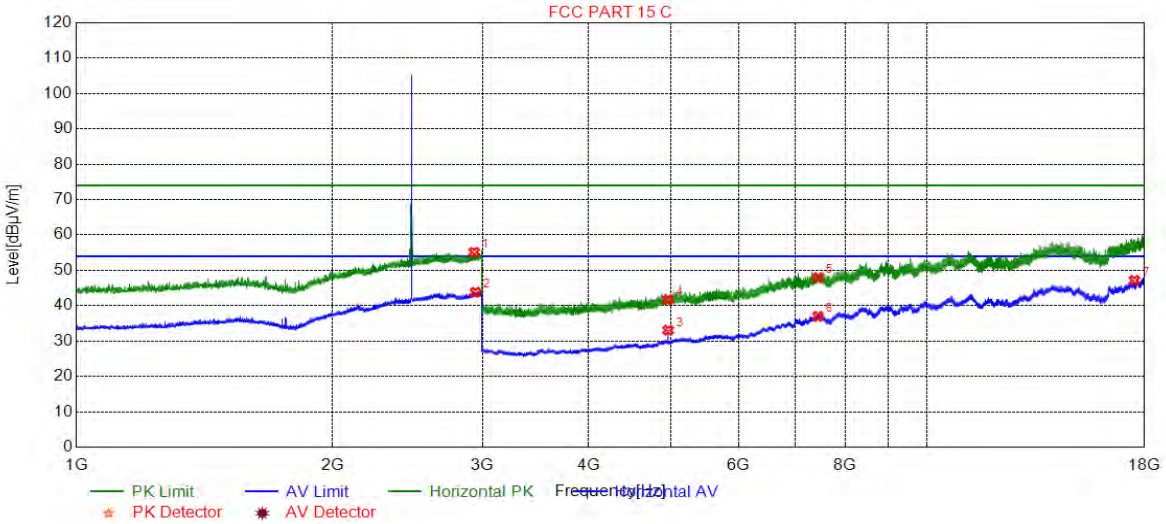
4.11.2.6 GFSK(DH5) _Highest Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2933.9835	55.16	9.51	74.00	18.84	229	96	Horizontal
2	2943.9860	43.81	9.62	54.00	10.19	214	288	Horizontal
3	4960.0000	33.07	-17.47	54.00	20.93	171	179	Horizontal
4	4960.0000	41.76	-17.47	74.00	32.24	104	179	Horizontal
5	7440.0000	47.93	-9.35	74.00	26.07	108	318	Horizontal
6	7440.0000	36.96	-9.35	54.00	17.04	181	267	Horizontal
7	17509.9255	47.17	1.96	54.00	6.83	226	217	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.

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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:			

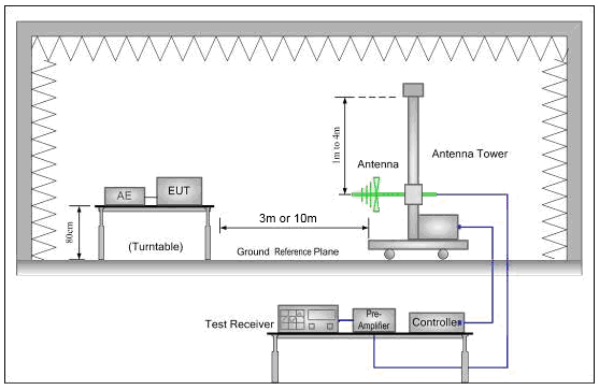

Figure 1. 30MHz to 1GHz

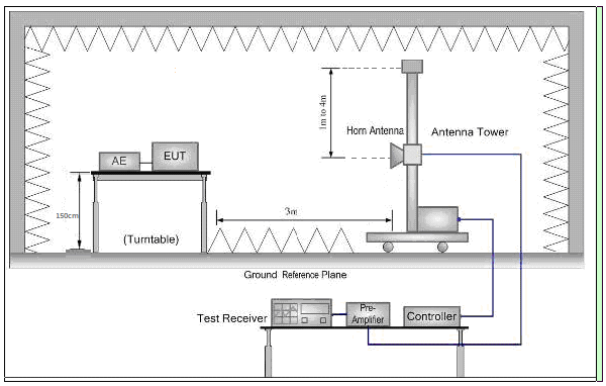

Figure 2. Above 1 GHz

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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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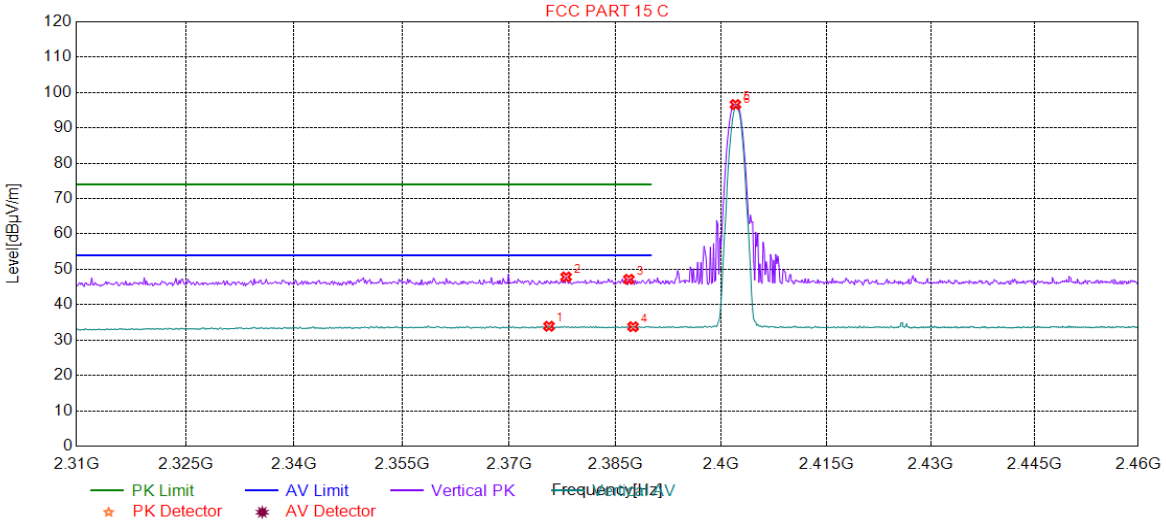
4.12.1 Test plots

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	2375.6156	33.92	7.78	54.00	20.08	217	99	Vertical
2	2378.0180	47.86	7.78	74.00	26.14	187	349	Vertical
3	2386.8769	47.19	7.77	74.00	26.81	208	149	Vertical
4	2387.4775	33.78	7.77	54.00	20.22	255	83	Vertical
5	2402.0000	96.60	7.77	0.00	-96.60	271	87	Vertical
6	2402.0000	95.73	7.77	0.00	-95.73	153	95	Vertical

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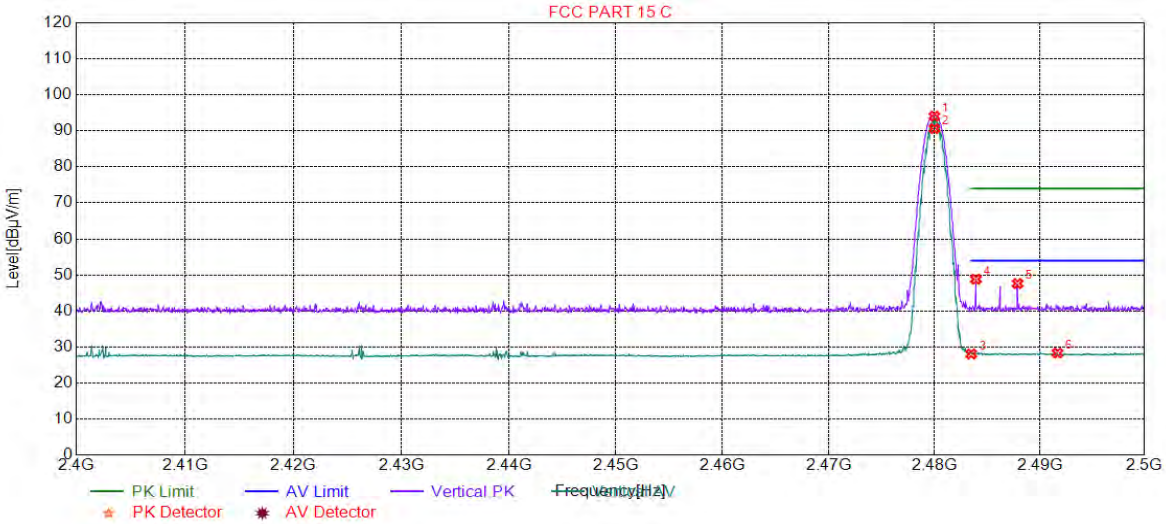
4.12.1.2 Worst Case Mode (GFSK(DH5)) _Highest Channel _Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.0000	94.06	8.01	0.00	-94.06	235	79	Vertical
2	2480.0000	90.60	8.01	0.00	-90.60	160	29	Vertical
3	2483.5000	28.08	8.01	54.00	25.92	190	85	Vertical
4	2483.9420	48.83	8.01	74.00	25.17	242	14	Vertical
5	2487.8939	47.62	8.02	74.00	26.38	291	14	Vertical
6	2491.6958	28.32	8.02	54.00	25.68	193	63	Vertical

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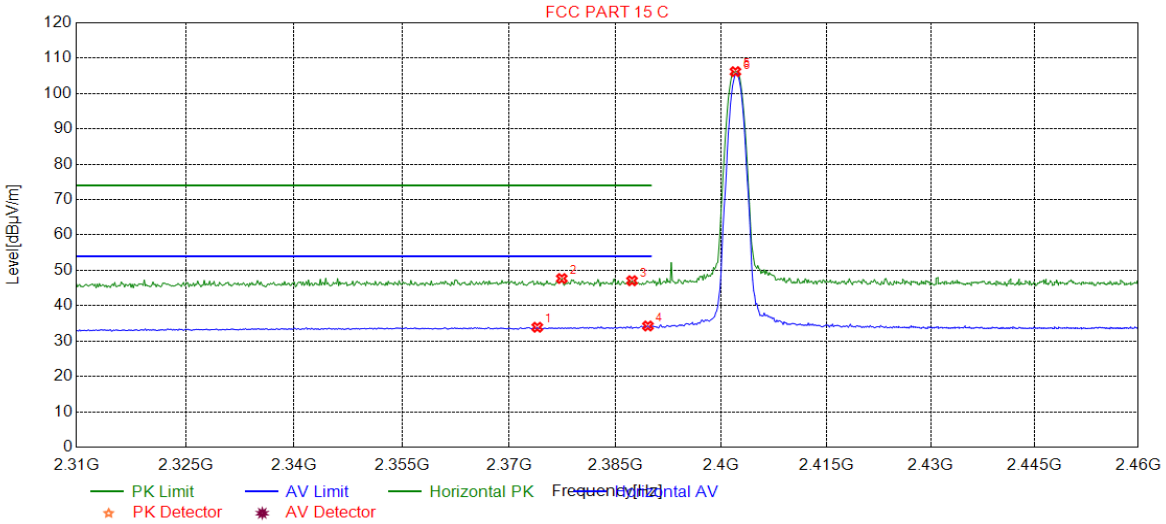
4.12.1.3 Worst Case Mode (GFSK(DH5)) _Lowest Channel _Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2373.9640	33.91	7.79	54.00	20.09	212	346	Horizontal
2	2377.4174	47.69	7.78	74.00	26.31	228	324	Horizontal
3	2387.3273	47.07	7.77	74.00	26.93	214	1	Horizontal
4	2389.5796	34.27	7.77	54.00	19.73	137	346	Horizontal
5	2402.0000	106.19	7.77	0.00	-106.19	172	346	Horizontal
6	2402.0000	105.65	7.77	0.00	-105.65	204	346	Horizontal

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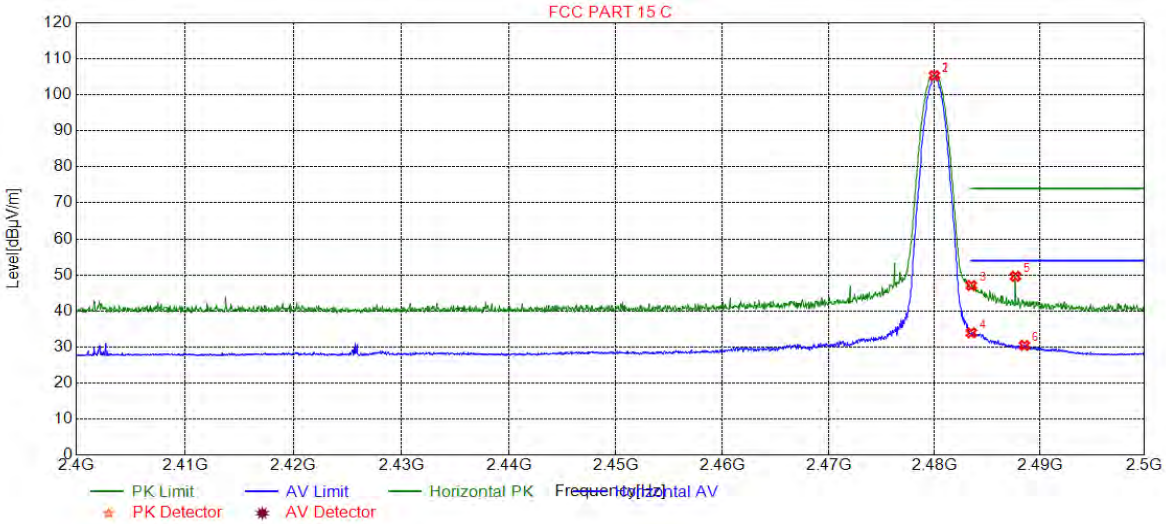
4.12.1.4 Worst Case Mode (GFSK(DH5)) _Highest Channel _ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.0000	105.34	8.01	0.00	-105.34	216	346	Horizontal
2	2480.0000	104.98	8.01	0.00	-104.98	200	346	Horizontal
3	2483.5000	47.06	8.01	74.00	26.94	239	199	Horizontal
4	2483.5000	33.93	8.01	54.00	20.07	138	346	Horizontal
5	2487.6938	49.62	8.02	74.00	24.38	134	172	Horizontal
6	2488.5443	30.45	8.02	54.00	23.55	132	346	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)

Lab A:

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	Temperature test	±1°C
5	Humidity test	±3%
6	DC and low frequency voltages	±0.5%

Lab B:

No.	Item	Measurement Uncertainty
1	Conduction Emission	± 3.0dB (150kHz to 30MHz)
2	Radiated Emission	± 4.8dB (Below 1GHz)
		± 4.8dB (1GHz to 6GHz)
		± 4.5dB (6GHz to 18GHz)
		± 5.02dB (Above 18GHz)

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6 Equipment List

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	2019/7/15	2020/7/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2019/4/9	2020/4/8
Coaxial Cable	SGS	N/A	SEM031-01	2019/6/12	2020/6/11
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2019/7/14	2020/7/14
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2019/10/27	2020/10/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2019/7/14	2020/7/14

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CE Test System					
Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal Date**	**Cal Due Date**
Shielding Room	Brilliant-emc	N/A	XAW03-35-01	2019-09-11	2022-09-10
Test receiver	ROHDE&SCHWARZ	ESR	XAW01-08-01	2019-09-07	2020-09-06
Artificial network	ROHDE&SCHWARZ	ENV216	XAW01-04-01	2019-07-16	2020-07-15
Temperature and humidity meter	MingGao	TH101B	XAW01-01-01	2019-12-06	2020-12-05
Measurement Software	Tonscend	TS+ CE V2.5	XAW02-05-02	NCR	NCR

RSE Test System					
Equipment	**Manufacturer**	**Model No.**	**Inventory No.**	**Cal Date**	**Cal Due Date**
Semi-Anechoic Chamber	Brilliant-emc	N/A	XAW03-35-01	2019-09-11	2022-09-10
MXA signal analyzer	Keysight	N9020A	XAW01-06-01	2019-06-27	2020-06-26
Test receiver	ROHDE&SCHWARZ	ESR	XAW01-08-01	2019-09-07	2020-09-06
Receiving antenna (30MHz-3GHz)	Schwarzbeck	VULB 9163	XAW01-09-01	2019-10-13	2021-10-12
Receiving antenna (1GHz~18GHz)	Schwarzbeck	BBHA 9120D	XAW01-09-02	2019-10-13	2021-10-12
Receiving antenna (15GHz~40GHz)	Schwarzbeck	BBHA 9170	XAW01-09-03	2019-10-13	2021-10-12
Directional antenna rack controller	Max-Full	MF-7802BS	XAW03-03-01	NCR	NCR
High-speed antenna rack controller	Max-Full	MF-7802	XAW03-04-01	NCR	NCR
Filter bank	Tonscend	JS0806-F	XAW03-05-01	NCR	NCR
Filter bank	Tonscend	JS0806s	XAW03-05-02	NCR	NCR
Amplifier	Tonscend	TAP00903040	XAW01-41-01	2019-11-18	2020-11-17
Amplifier	Tonscend	TAP01018048	XAW01-41-02	2019-11-18	2020-11-17
Amplifier	Tonscend	TAP18040048	XAW01-41-03	2019-12-03	2020-12-02
Amplifier	Shanghai Steed	YX28980930	XAW01-41-06	2019-11-18	2020-11-17
Temperature and humidity meter	MingGao	TH101B	XAW01-01-01	2019-12-06	2020-12-05
Measurement Software	Tonscend	TS+ RSE V3.0.0.2	XAW02-05-01	NCR	NCR

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7 Photographs - EUT Constructional Details

Refer to Appendix A - Photographs of Set-Up for ZR202030027.

The End

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