FCC TEST REPORT

Application No:	ZR/2020/40013
Applicant:	Xiaomi Communications Co., Ltd.
Address of Applicant	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085
Manufacturer:	Xiaomi Communications Co., Ltd.
Address of Manufacturer	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085
EUT Description:	Mobile Phone
Model No.:	M2004J19AG
Trade Mark:	Redmi
FCC ID:	ZAFZZJ19AG
Standards:	47 CFR FCC Part 2, Subpart J 47 CFR Part 15, Subpart C
Test Method	KDB558074 D01 15.247 Meas Guidance v05r02 ANSI C63.10 (2013)
Date of Receipt:	2020/4/9
Date of Test:	2020/4/10 to 2020/5/6
Date of Issue:	2021/4/28
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**
01		2020/5/6		Original
02		2021/4/28	Sherlock Fang	1.Add test site Information 2. Modify data conversion error of antenna height 3.Update equipment list

*This report supersedes our previous report ZR/2020/4001302, issued on 2020-5-6, which is hereby deemed null and void.

Authorized for issue by:		
Prepared By		Sherlock Fang **(Sherlock Fang) / Engineer**
Checked By		Jim Huang **(Jim Huang) / Reviewer**

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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 4.2	PASS	B
Conducted Output Power	15.247 (b)(3)	ANSI C63.10 2013	Clause 4.3	PASS	A
DTS (6 dB) Bandwidth & 99% Occupied Bandwidth	15.247 (a)(2)	ANSI C63.10 2013	Clause 4.4	PASS	A
Power Spectral Density	15.247 (e)	ANSI C63.10 2013	Clause 4.5	PASS	A
Band-edge for RF Conducted Emissions	15.247(d)	ANSI C63.10 2013	Clause 4.6	PASS	A
RF Conducted Spurious Emissions	15.247(d)	ANSI C63.10 2013	Clause 4.7	PASS	A
Radiated Spurious Emissions	15.205/15.209	ANSI C63.10 2013	Clause 4.8	PASS	B
Restricted bands around fundamental frequency (Radiated Emission)	15.205/15.209	ANSI C63.10 2013	Clause 4.9	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.

通标标准技术服务有限公司深圳分公司
检验检测专用章
Inspection & Testing Services
SGS-CSTC Standards Technical Services Co.,Ltd. Shenzhen Branch Technical Services Co., Ltd. Laboratory

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3 General Information

3.1 Client Information

Applicant:	Xiaomi Communications Co., Ltd.
Address of Applicant:	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085
Manufacturer:	Xiaomi Communications Co., Ltd.
Address of Manufacturer:	#019, 9th Floor, Building 6, 33 Xi'erqi Middle Road, Haidian District, Beijing, China, 100085

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:	Dee Zheng,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, Leah Chen

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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:	Mobile Phone
Model No.:	M2004J19AG
Trade Mark:	Redmi
Hardware Version:	P2
Software Version:	MIUI 11
Operation Frequency:	2400MHz~2483.5MHz fc = 2402 MHz + N * 2 MHz, where: -fc = “Operating Frequency” in MHz, -N = “Channel Number” with the range from 0 to 39.
Bluetooth Version:	Bluetooth V5.0 LE
Modulation Type:	GFSK
Number of Channel:	40
Sample Type:	☒ Portable Device, ☐Module
Antenna Type:	☐ External, ☒ Integrated
Antenna Gain:	0.09dBi
Power Supply:	☐ AC/DC Adapter; ☒ Battery;☐ PoE:; ☐ Other:

Operation Frequency of each channel							
Channel	**Frequency**	**Channel**	**Frequency**	**Channel**	**Frequency**	**Channel**	**Frequency**
0	2402MHz	10	2422MHz	20	2442MHz	30	2462MHz
1	2404MHz	11	2424MHz	21	2444MHz	31	2464MHz
2	2406MHz	12	2426MHz	22	2446MHz	32	2466MHz
3	2408MHz	13	2428MHz	23	2448MHz	33	2468MHz
4	2410MHz	14	2430MHz	24	2450MHz	34	2470MHz
5	2412MHz	15	2432MHz	25	2452MHz	35	2472MHz
6	2414MHz	16	2434MHz	26	2454MHz	36	2474MHz
7	2416MHz	17	2436MHz	27	2456MHz	37	2476MHz
8	2418MHz	18	2438MHz	28	2458MHz	38	2478MHz
9	2420MHz	19	2440MHz	29	2460MHz	39	2480MHz

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 (CH0)	2402MHz
The middle channel (CH19)	2440MHz
The highest channel (CH39)	2480MHz

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3.5 Test Environment

Operating Environment	
Temperature:	25.0 °C
Humidity:	50 % RH
Atmospheric Pressure:	101.32 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 0.09dBi.	

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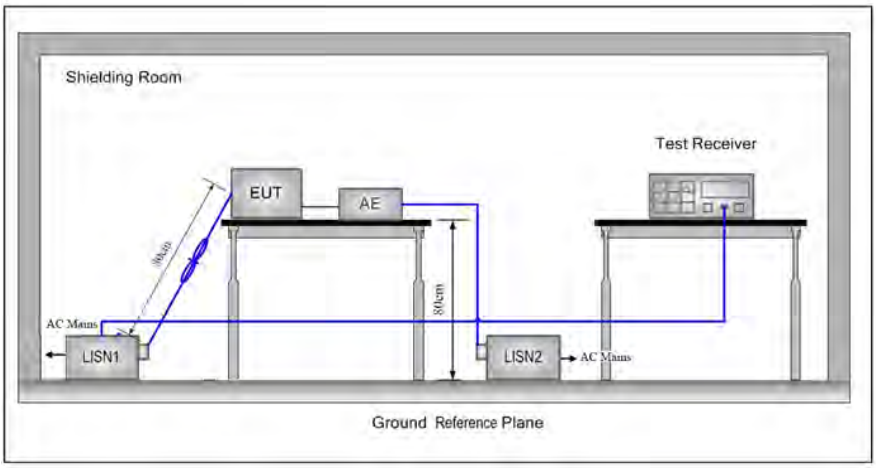
4.2 AC Power Line Conducted Emissions

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:			

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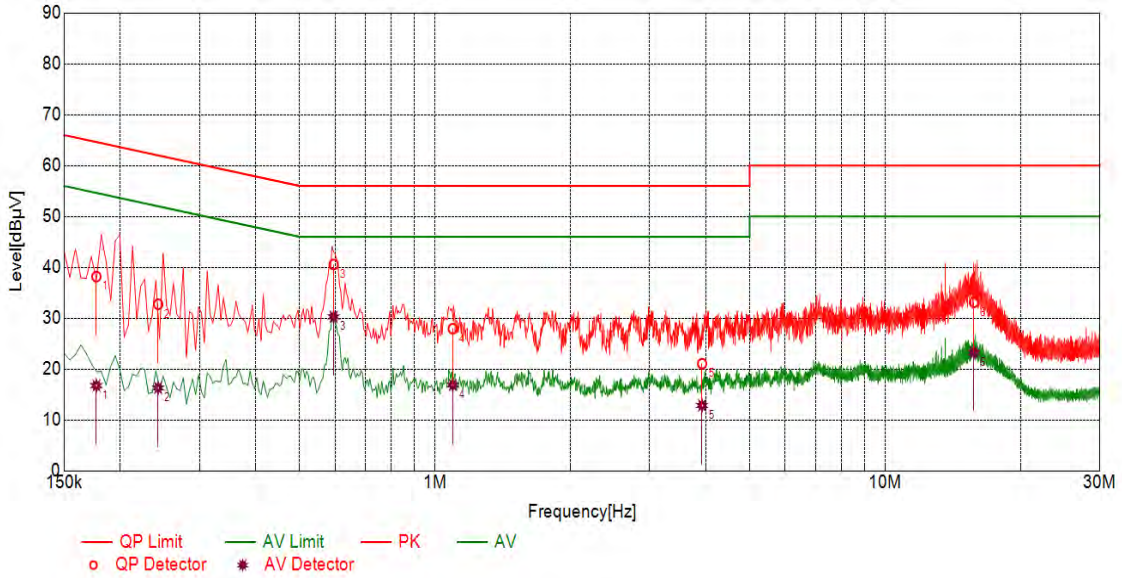
Test Mode:	Transmitting with GFSK modulation. Charge +Transmitting mode.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

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:



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	0.1770	10.10	38.19	64.63	26.44	16.75	54.63	37.88	L
2	0.2428	10.10	32.75	62.00	29.25	16.29	52.00	35.71	L
3	0.5956	10.10	40.57	56.00	15.43	30.27	46.00	15.73	L
4	1.0956	10.10	27.94	56.00	28.06	16.87	46.00	29.13	L
5	3.9220	10.10	21.06	56.00	34.94	12.85	46.00	33.15	L
6	15.7521	10.11	33.13	60.00	26.87	23.27	50.00	26.73	L

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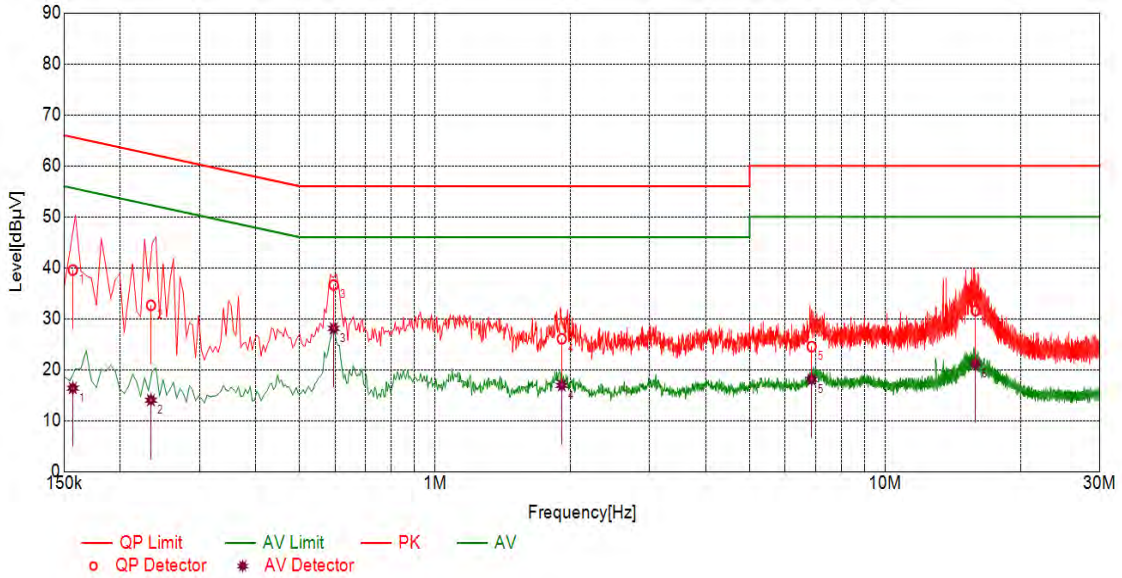
Neutral line:



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	0.1569	10.10	39.56	65.63	26.07	16.38	55.63	39.25	N
2	0.2340	10.10	32.63	62.31	29.68	14.02	52.31	38.29	N
3	0.5959	10.10	36.62	56.00	19.38	28.11	46.00	17.89	N
4	1.9133	10.10	26.07	56.00	29.93	16.91	46.00	29.09	N
5	6.8681	10.10	24.53	60.00	35.47	18.08	50.00	31.92	N
6	15.8870	10.11	31.60	60.00	28.40	21.16	50.00	28.84	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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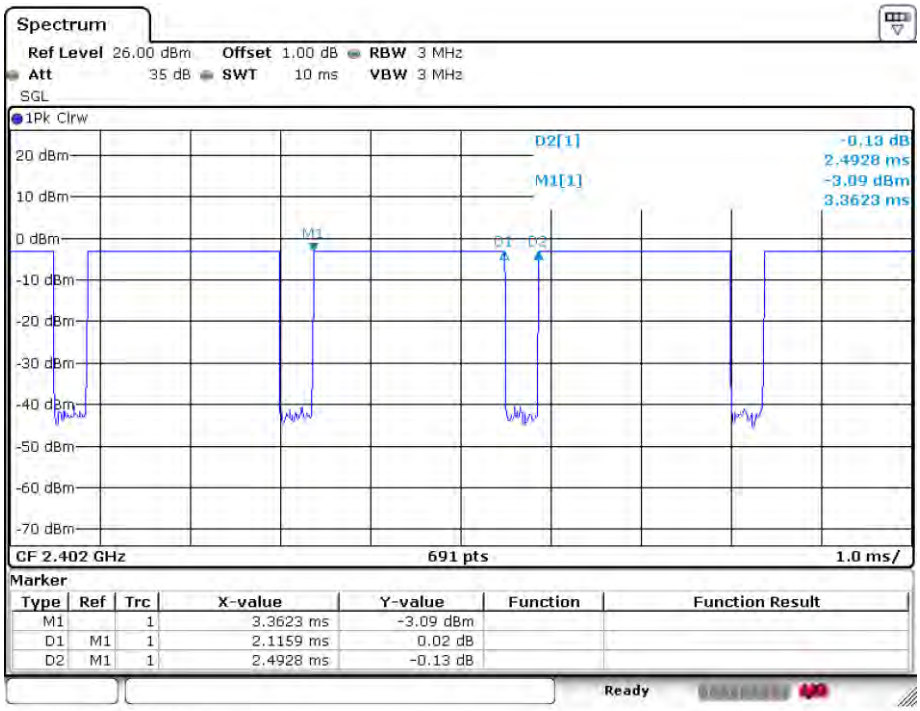
4.3 Duty Cycle

4.3.1 Test Results

Test Mode	TX Freq. [MHz]	Duty cycle [%]
BLE_1M	CH0, CH19, CH39	84.88
BLE_2M	CH0, CH19, CH39	56.92

4.3.1 Test Plots

4.3.1.1 BLE_1M



Date: 6.MAY.2020 10:14:24

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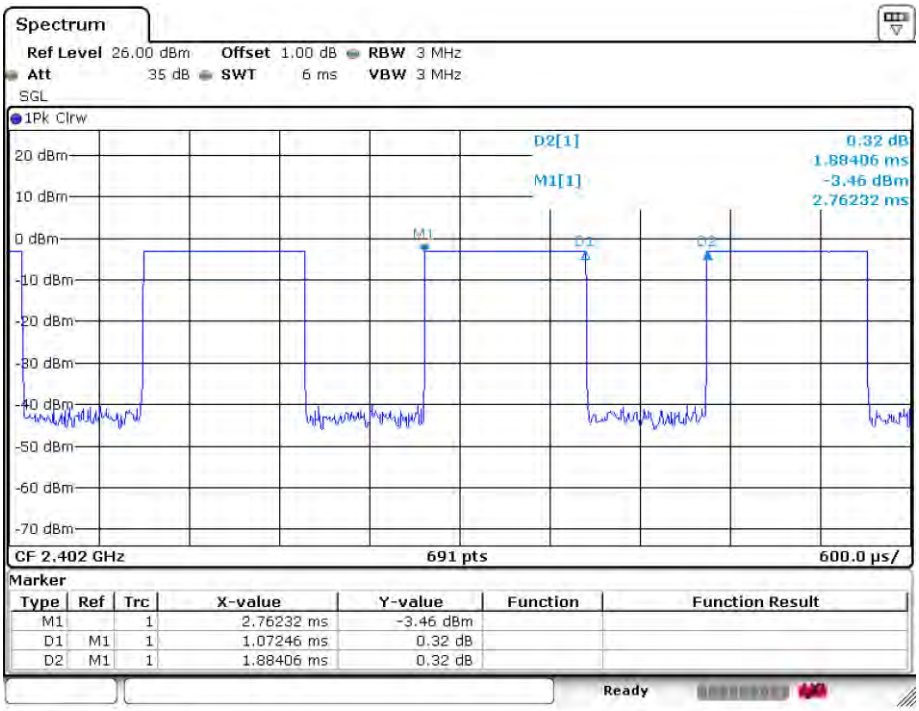
4.3.1.1 BLE_2M



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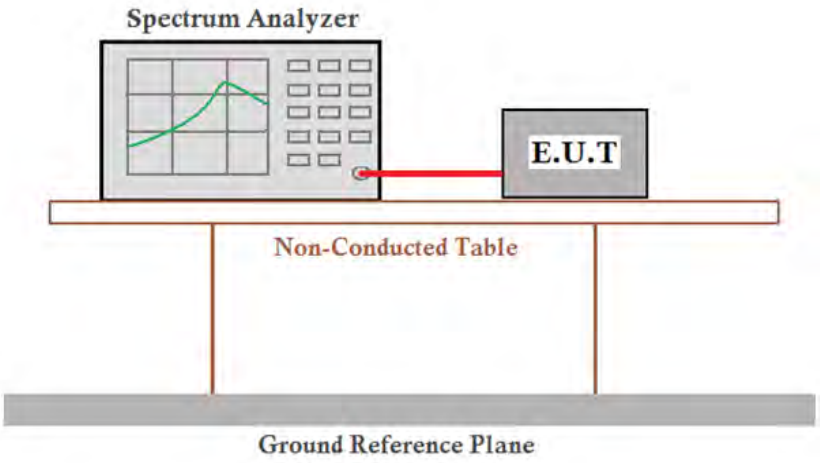
4.4 Conducted Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(3)
Test Method:	ANSI C63.10 :2013 Section 11.9.1.1
Test Setup:	
Limit:	30dBm
Test Mode:	Transmitting with GFSK modulation.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

4.4.1 Test Results

Measurement Data of Peak Power:

GFSK_1M mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-3.08	30.00	Pass
Middle	-1.91	30.00	Pass
Highest	-3.08	30.00	Pass

GFSK_2M mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-3.05	30.00	Pass
Middle	-1.88	30.00	Pass
Highest	-3.00	30.00	Pass

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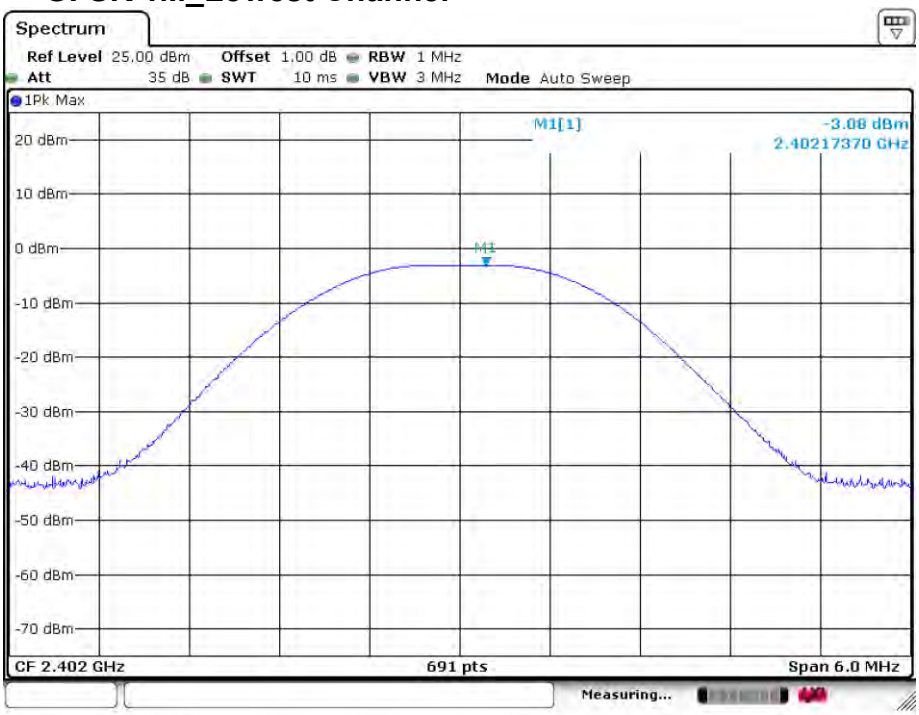
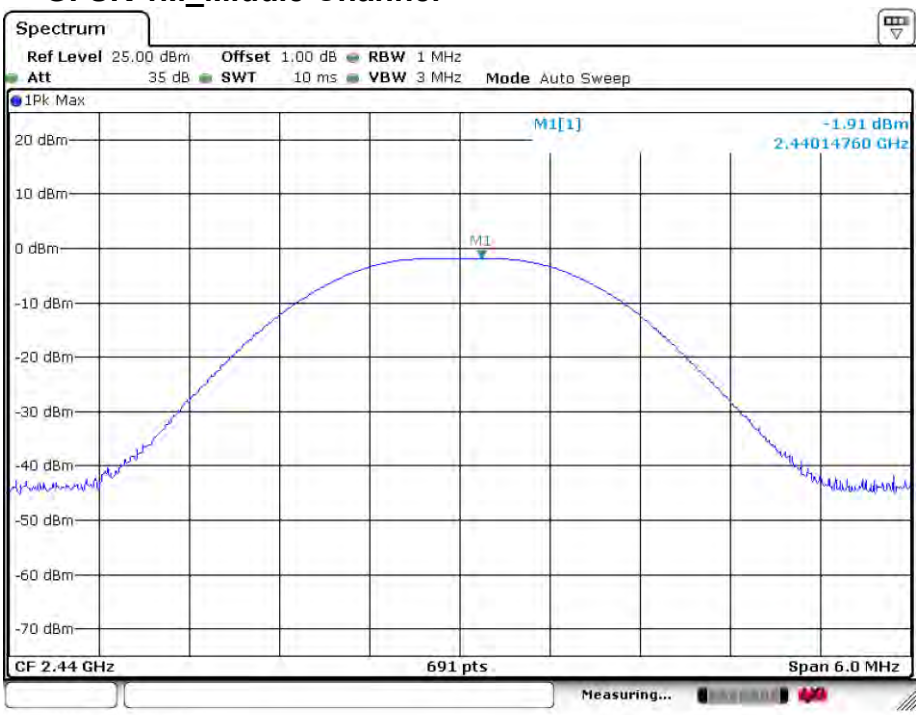
4.4.2 Test plots:

4.4.2.1 GFSK 1M_Lowest Channel



Date: 6.MAY.2020 09:57:49

4.4.2.2 GFSK 1M_Middle Channel



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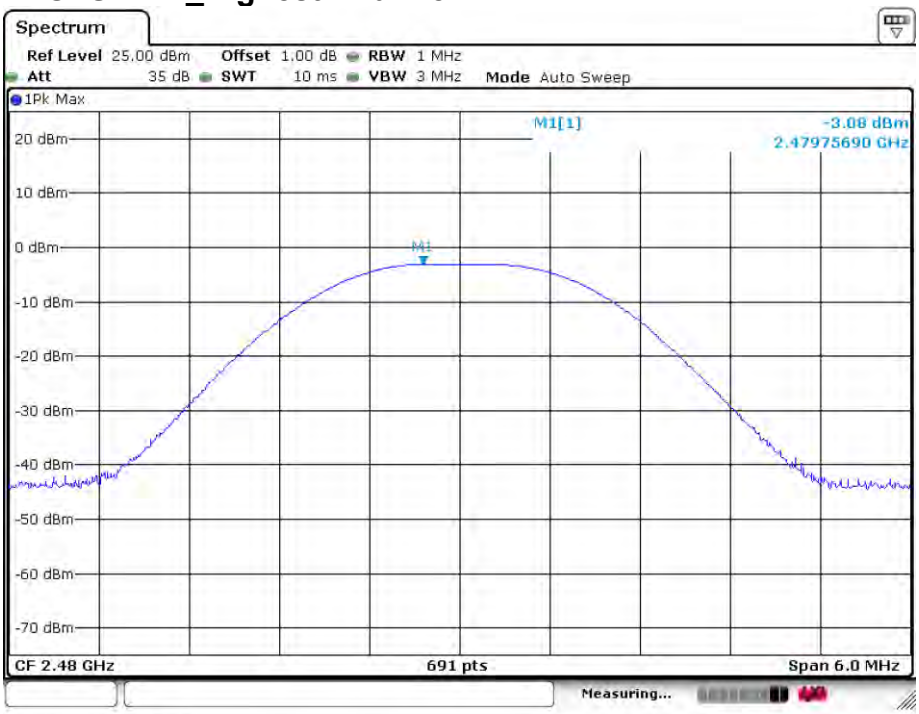
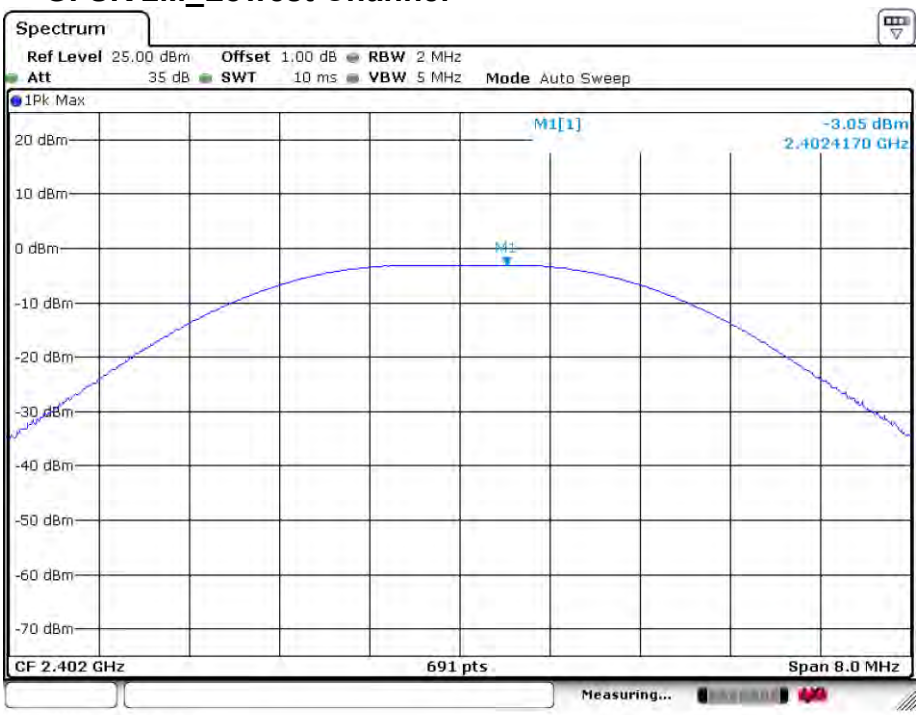
4.4.2.3 GFSK 1M_Highest Channel



Date: 6.MAY.2020 09:58:56

4.4.2.4 GFSK 2M_Lowest Channel



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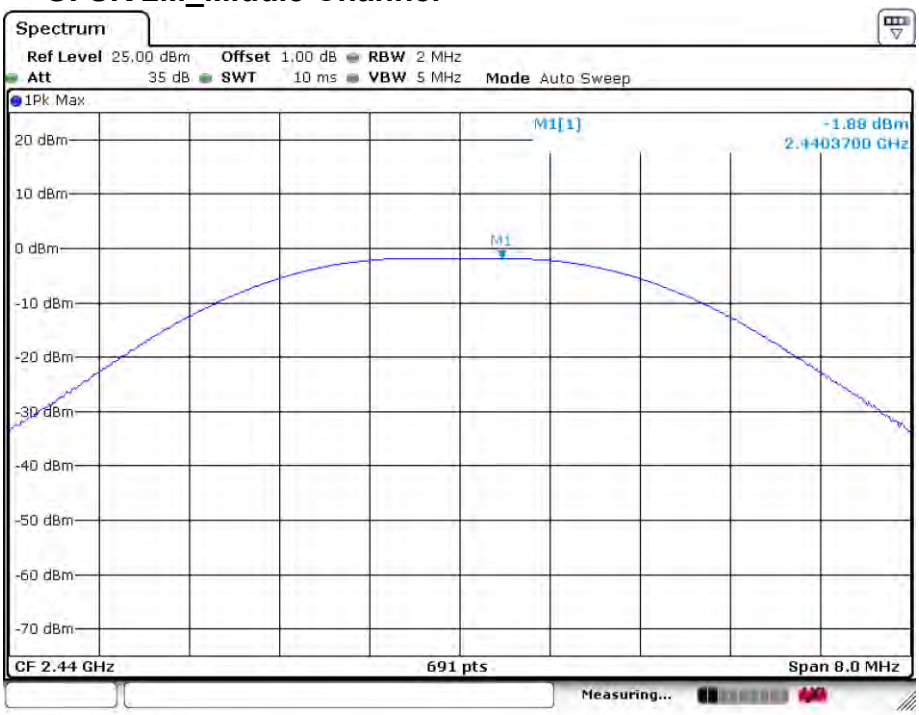
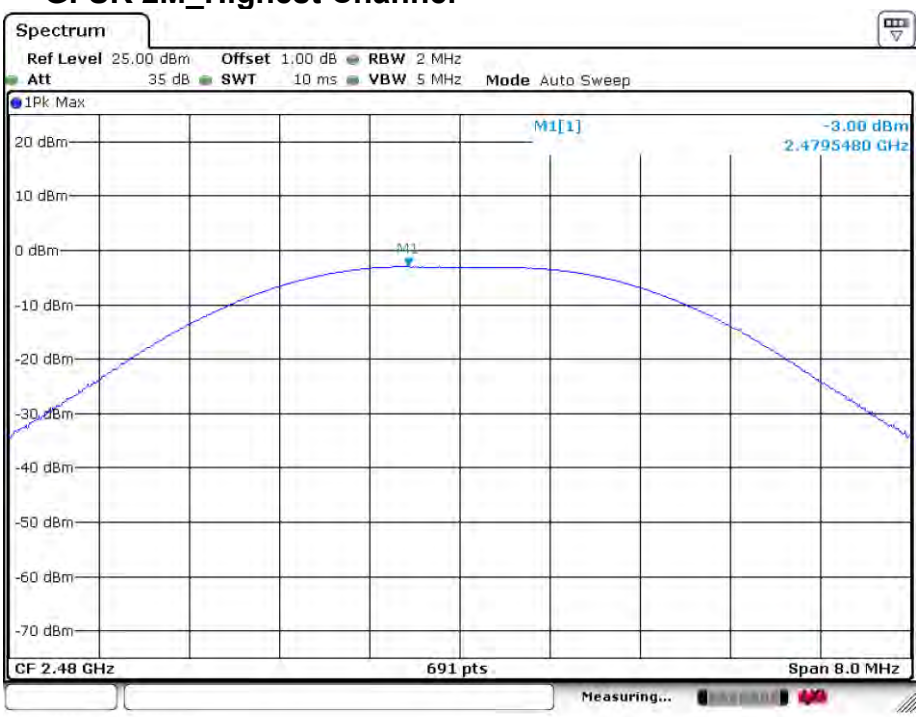
4.4.2.5 GFSK 2M_Middle Channel



Date: 6.MAY.2020 09:59:52

4.4.2.6 GFSK 2M_Highest Channel



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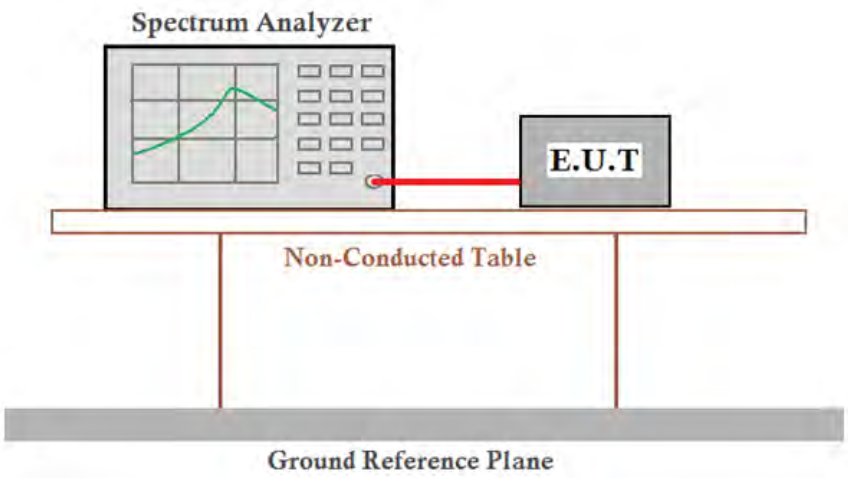
4.5 DTS (6 dB) Bandwidth & 99% Occupied Bandwidth

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(2)
Test Method:	ANSI C63.10: 2013 Section 11.8 Option 2
Test Setup:	
Limit:	≥ 500 kHz
Test Mode:	Transmitting with GFSK modulation.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

4.5.1 Test Results

Mode	Test Channel	99% Occupied Bandwidth (MHz)	6dB Emission Bandwidth (MHz)	Limit (kHz)	Result
GFSK_1M	Lowest	1.05	0.66	≥500	Pass
	Middle	1.05	0.67	≥500	Pass
	Highest	1.05	0.66	≥500	Pass

Mode	Test Channel	99% Occupied Bandwidth (MHz)	6dB Emission Bandwidth (MHz)	Limit (kHz)	Result
GFSK_2M	Lowest	2.07	1.16	≥500	Pass
	Middle	2.08	1.17	≥500	Pass
	Highest	2.08	1.17	≥500	Pass

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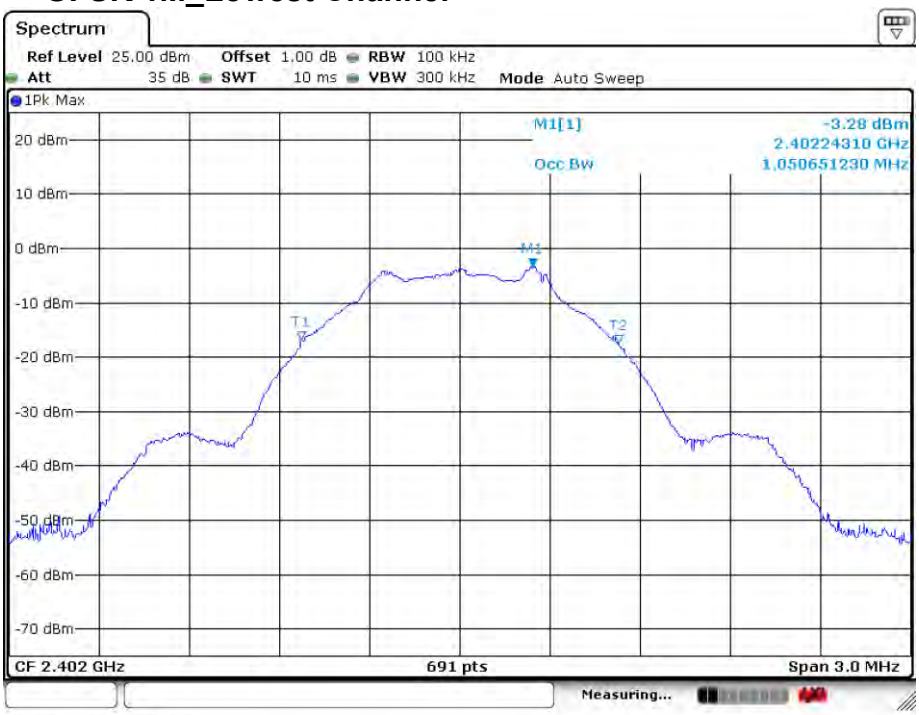
4.5.2 Test plots

4.5.2.1 GFSK 1M_Lowest Channel



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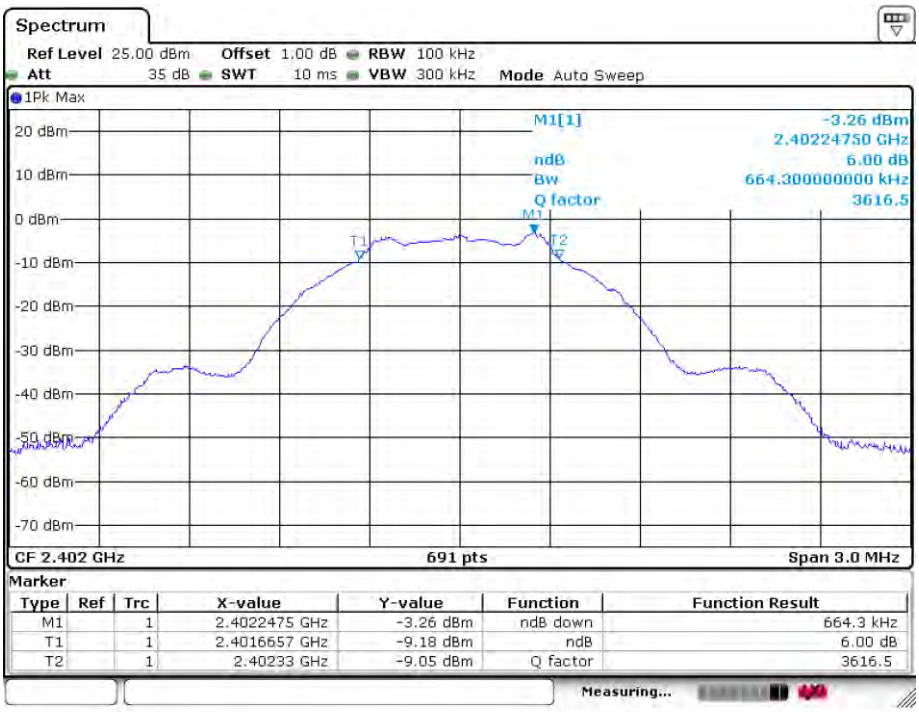

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4022475 GHz	-3.26 dBm	ndB down	664.3 kHz
T1		1	2.4016657 GHz	-9.18 dBm	ndB	6.00 dB
T2		1	2.40233 GHz	-9.05 dBm	Q factor	3616.5

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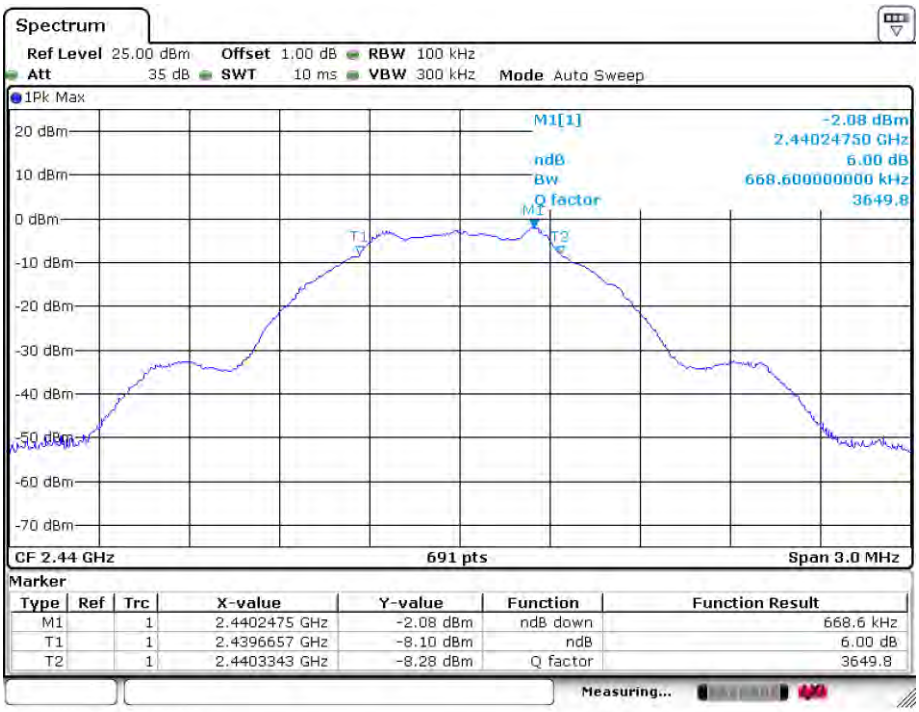
4.5.2.2 GFSK 1M_Middle Channel

Date: 6.MAY.2020 10:07:23



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4402475 GHz	-2.08 dBm	ndB down	668.6 kHz
T1		1	2.4396657 GHz	-8.10 dBm	ndB	6.00 dB
T2		1	2.4403343 GHz	-8.28 dBm	Q factor	3649.8

Date: 6.MAY.2020 10:07:34

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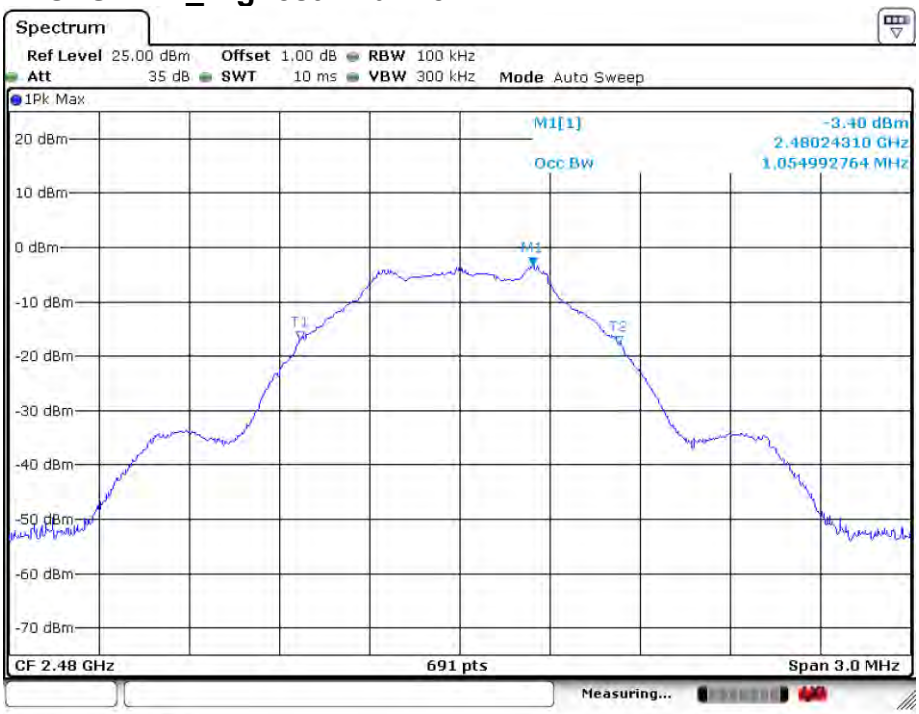
4.5.2.3 GFSK 1M_Highest Channel



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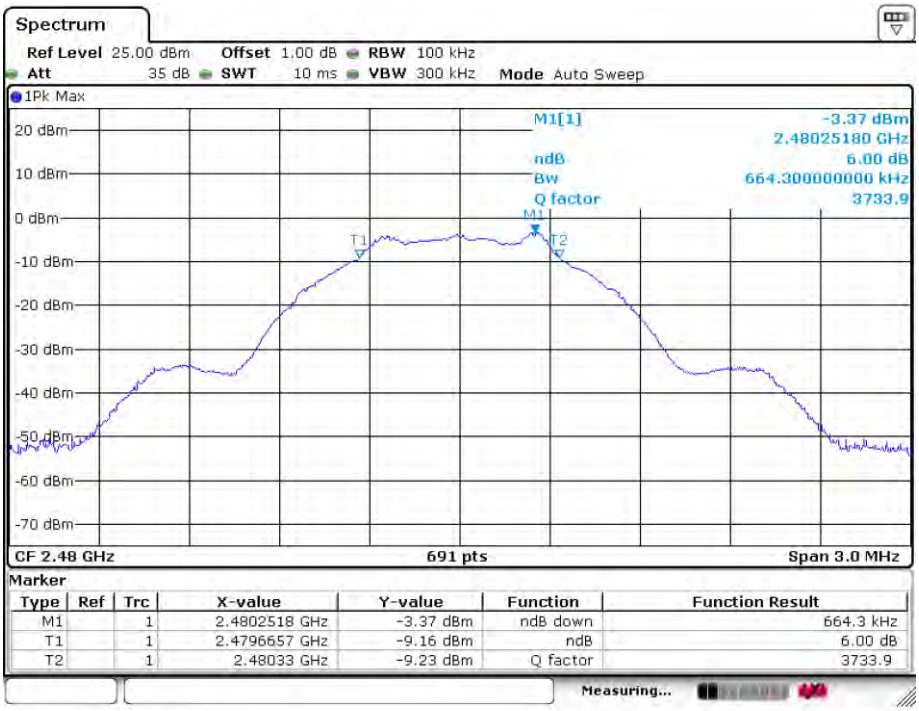

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4802518 GHz	-3.37 dBm	ndB down	664.3 kHz
T1		1	2.4796657 GHz	-9.16 dBm	ndB	6.00 dB
T2		1	2.48033 GHz	-9.23 dBm	Q factor	3733.9

Date: 6.MAY.2020 10:07:50

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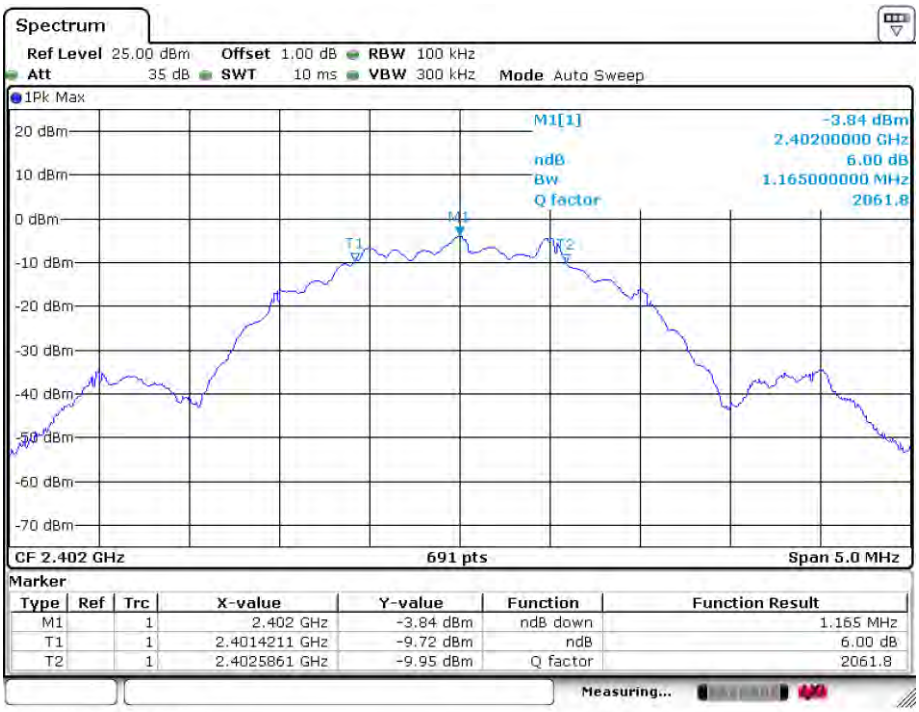
4.5.2.4 GFSK 2M_Lowest Channel

Date: 6.MAY.2020 10:06:34



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Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402 GHz	-3.84 dBm	ndB down	1.165 MHz
T1		1	2.4014211 GHz	-9.72 dBm	ndB	6.00 dB
T2		1	2.4025861 GHz	-9.95 dBm	Q factor	2061.8

Date: 6.MAY.2020 10:06:44

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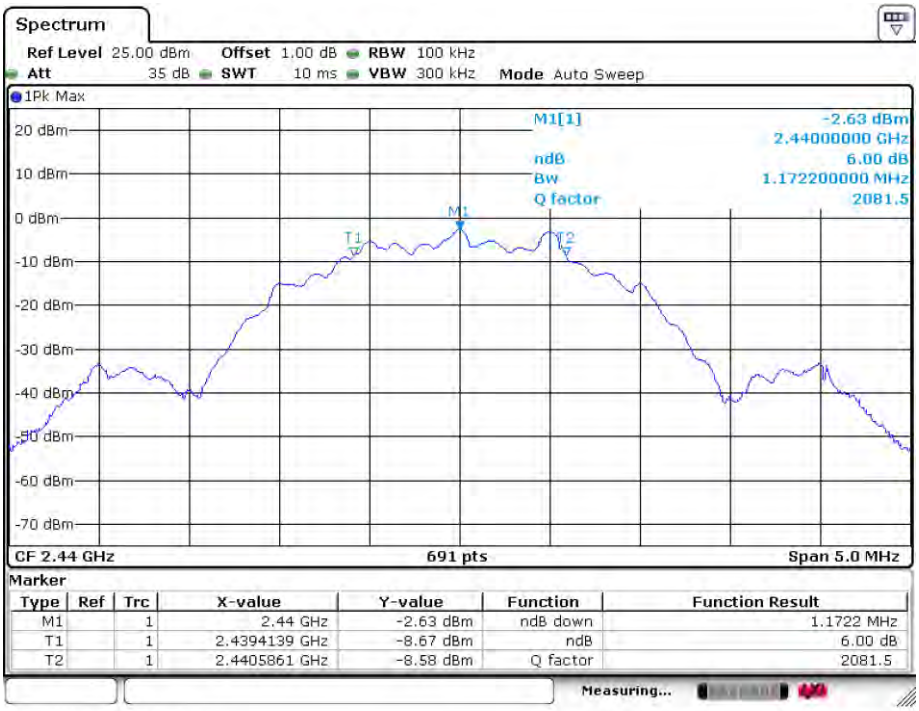
4.5.2.5 GFSK 2M_Middle Channel

Date: 6.MAY.2020 10:06:18



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44 GHz	-2.63 dBm	ndB down	1.1722 MHz
T1		1	2.4394139 GHz	-8.67 dBm	ndB	6.00 dB
T2		1	2.4405861 GHz	-8.58 dBm	Q factor	2081.5

Date: 6.MAY.2020 10:05:56

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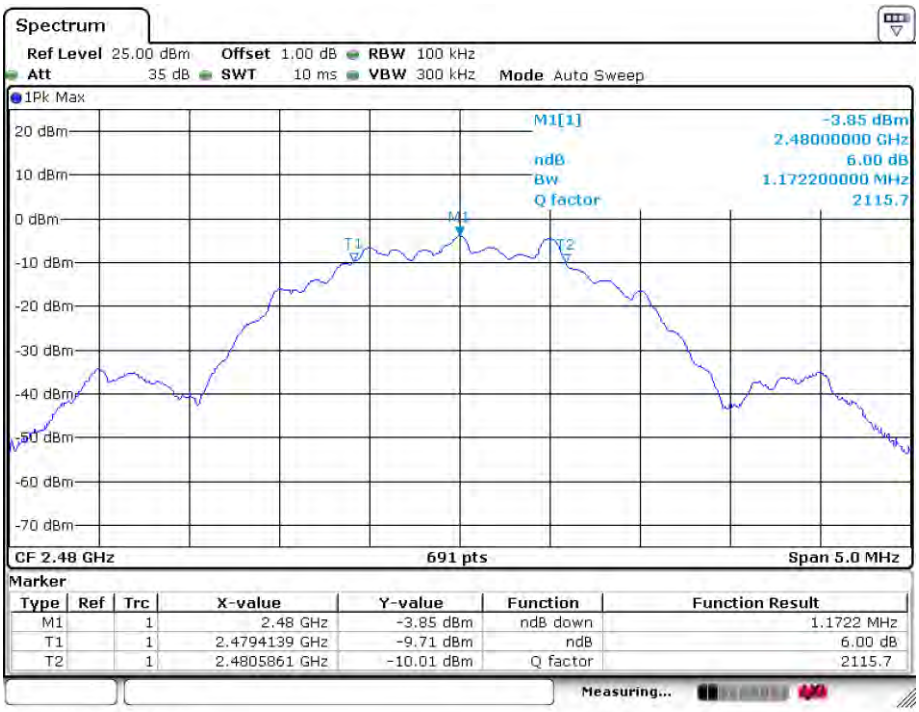
4.5.2.6 GFSK 2M_Highest Channel

Date: 6.MAY.2020 10:04:51



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48 GHz	-3.85 dBm	ndB down	1.1722 MHz
T1		1	2.4794139 GHz	-9.71 dBm	ndB	6.00 dB
T2		1	2.4805861 GHz	-10.01 dBm	Q factor	2115.7

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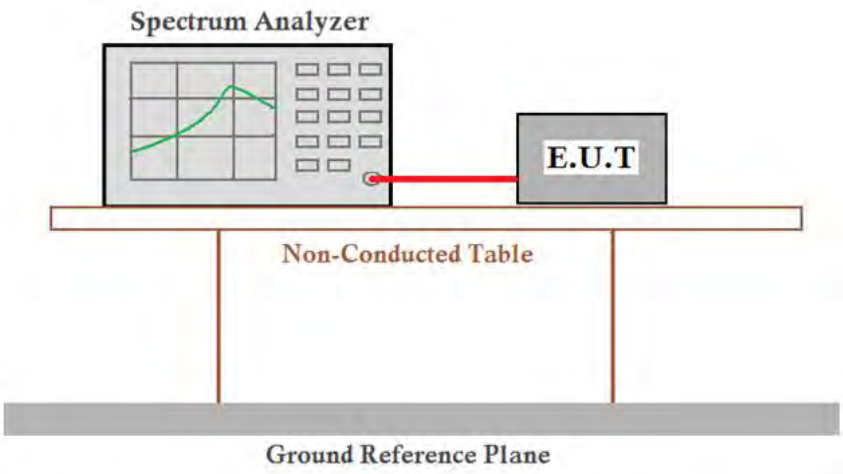
4.6 Power Spectral Density

Test Requirement:	47 CFR Part 15C Section 15.247 (e)
Test Method:	ANSI C63.10 :2013 Section 11.10.2
Test Setup:	
Limit:	≤8.00dBm/3kHz
Test Mode:	Transmitting with GFSK modulation.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

4.6.1 Test Results

Mode	Test Channel	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
GFSK_1M	Lowest	-19.84	≤8.00	Pass
	Middle	-18.63	≤8.00	Pass
	Highest	-19.78	≤8.00	Pass

Mode	Test Channel	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
GFSK_2M	Lowest	-21.99	≤8.00	Pass
	Middle	-20.78	≤8.00	Pass
	Highest	-21.99	≤8.00	Pass

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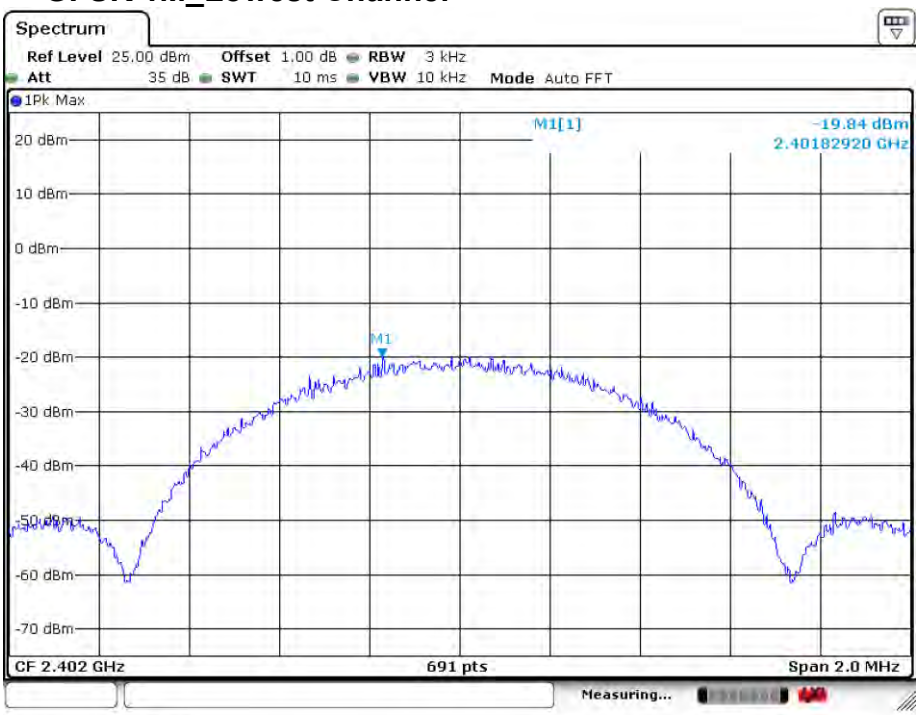
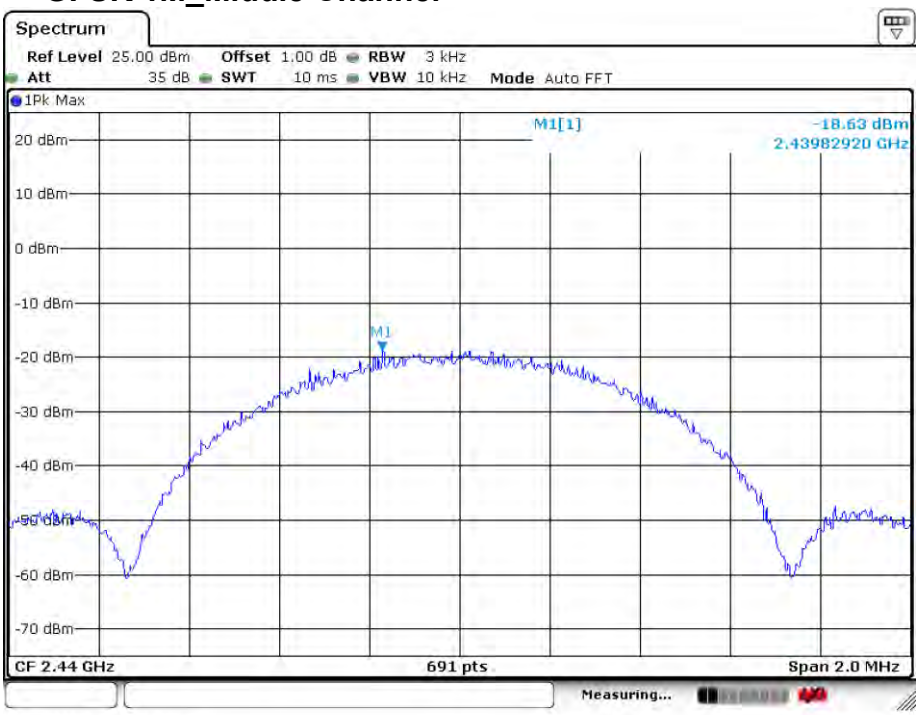
4.6.2 Test plots

4.6.2.1 GFSK 1M_Lowest Channel



Date: 6.MAY.2020 10:02:35

4.6.2.2 GFSK 1M_Middle Channel



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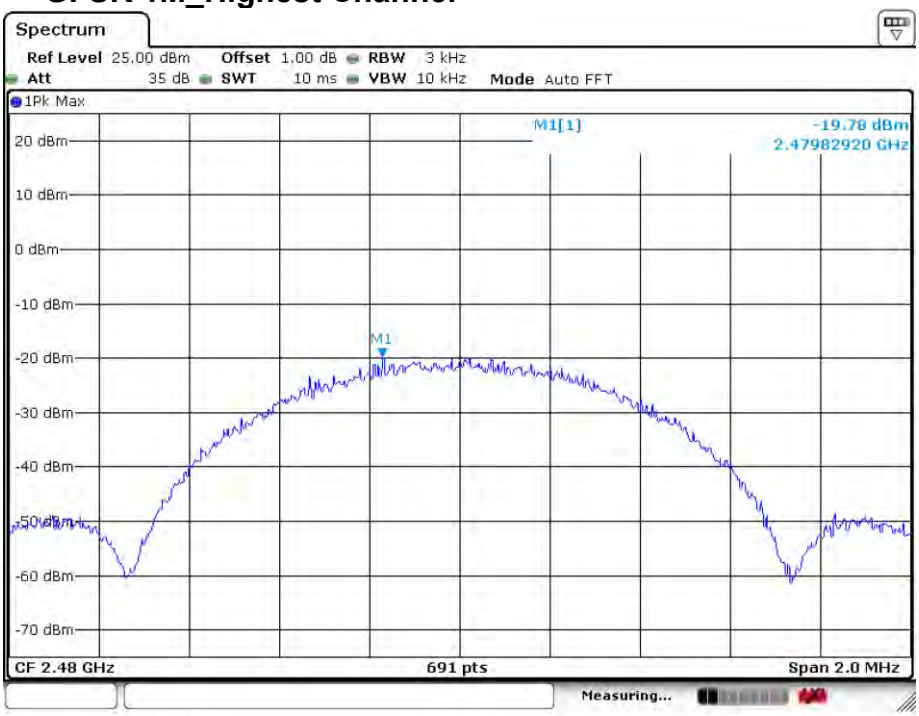
4.6.2.3 GFSK 1M_Highest Channel



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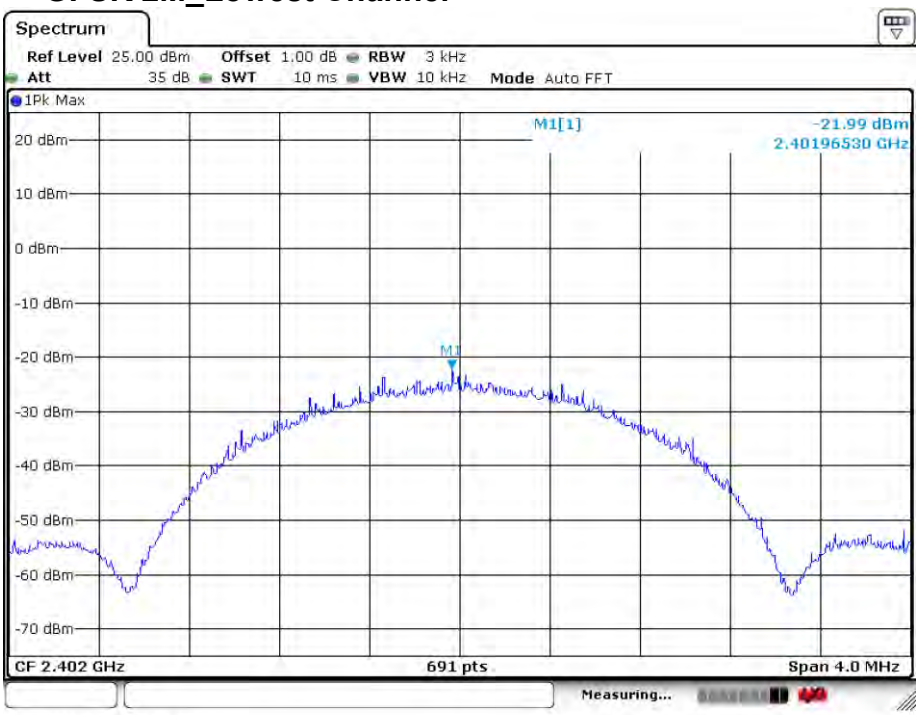
4.6.2.4 GFSK 2M_Lowest Channel



Date: 6.MAY.2020 10:02:50

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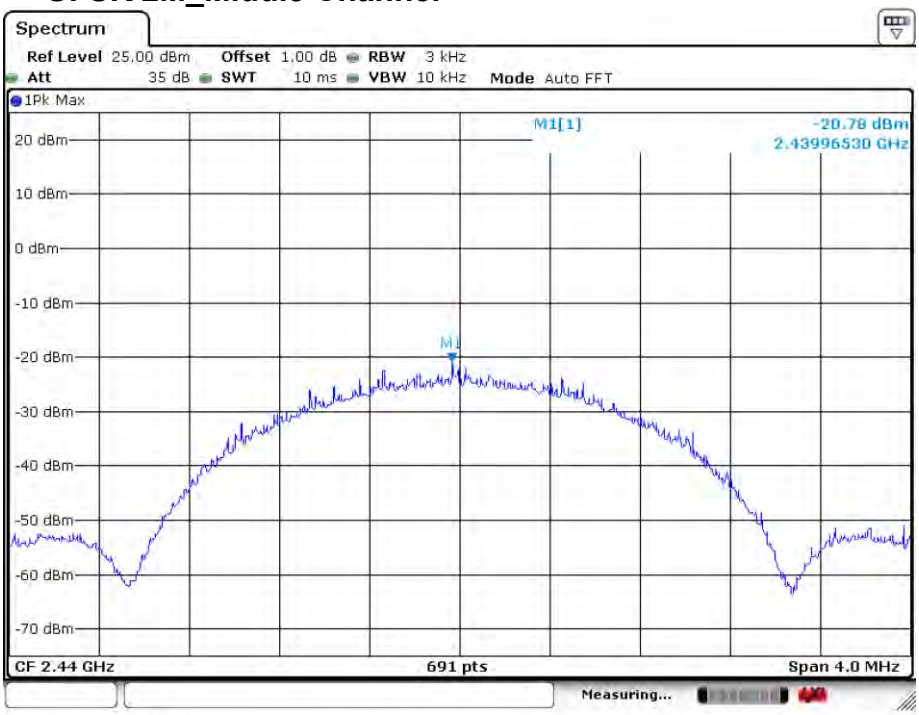
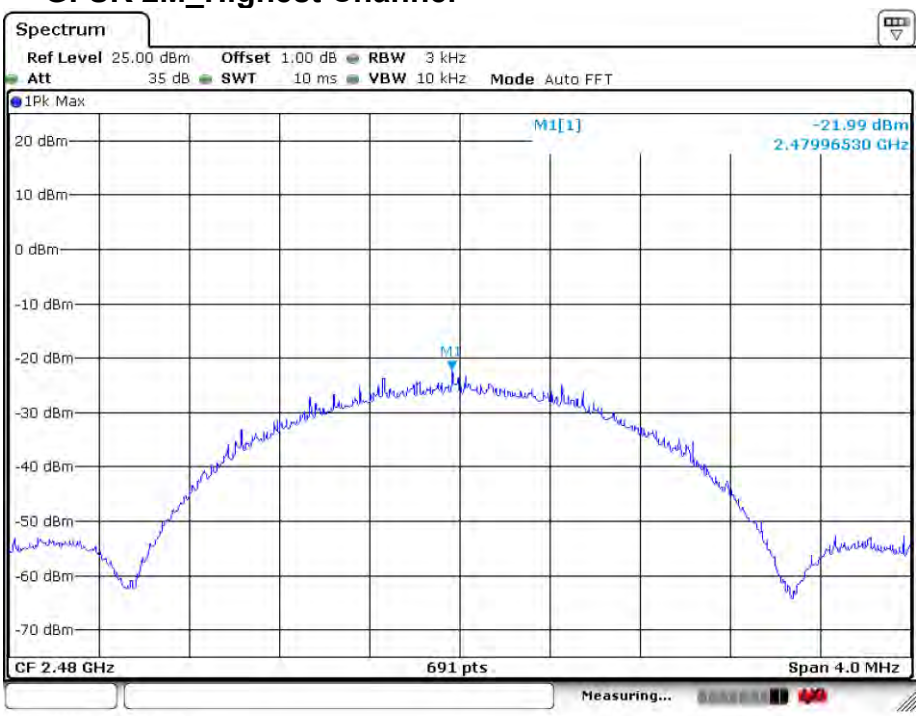
4.6.2.5 GFSK 2M_Middle Channel



Date: 6.MAY.2020 10:03:06

4.6.2.6 GFSK 2M_Highest Channel



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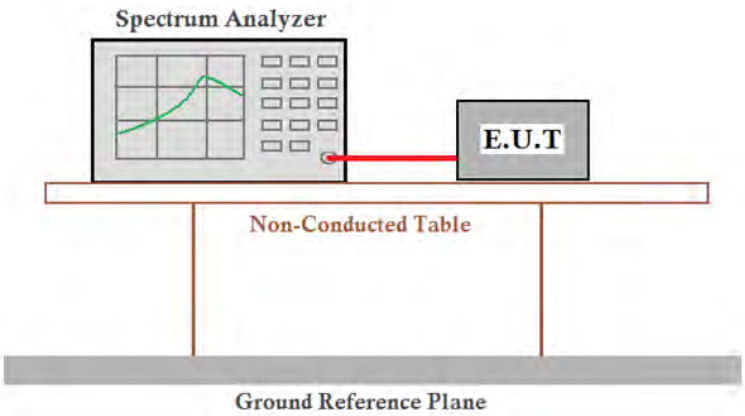
4.7 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 11.13
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.
Test Mode:	Transmitting with GFSK modulation.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

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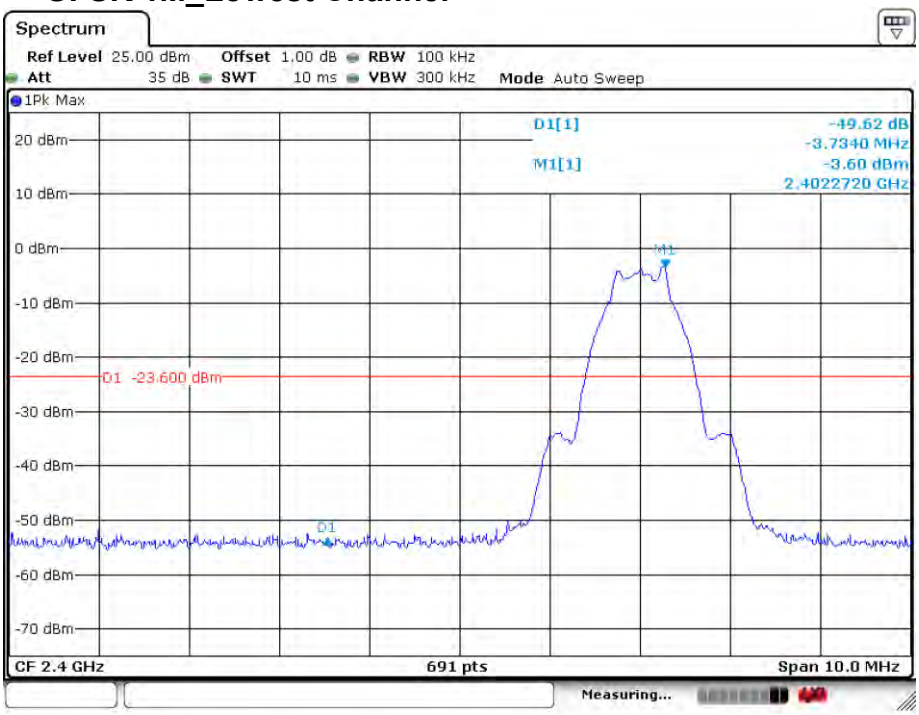
4.7.1 Test plots

4.7.1.1 GFSK 1M_Lowest Channel



Date: 6.MAY.2020 10:08:53

4.7.1.2 GFSK 1M_Highest Channel

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4.7.1.3 GFSK 2M_Lowest Channel

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4.7.1.4 GFSK 2M_Highest Channel

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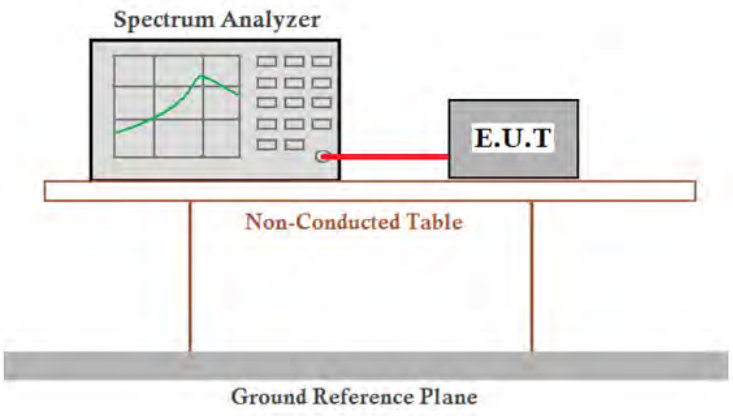
4.8 Spurious RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 11.11
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.
Test Mode:	Transmitting with GFSK modulation.
Instruments Used:	Refer to section 5.10 for details.
Test Results:	Pass

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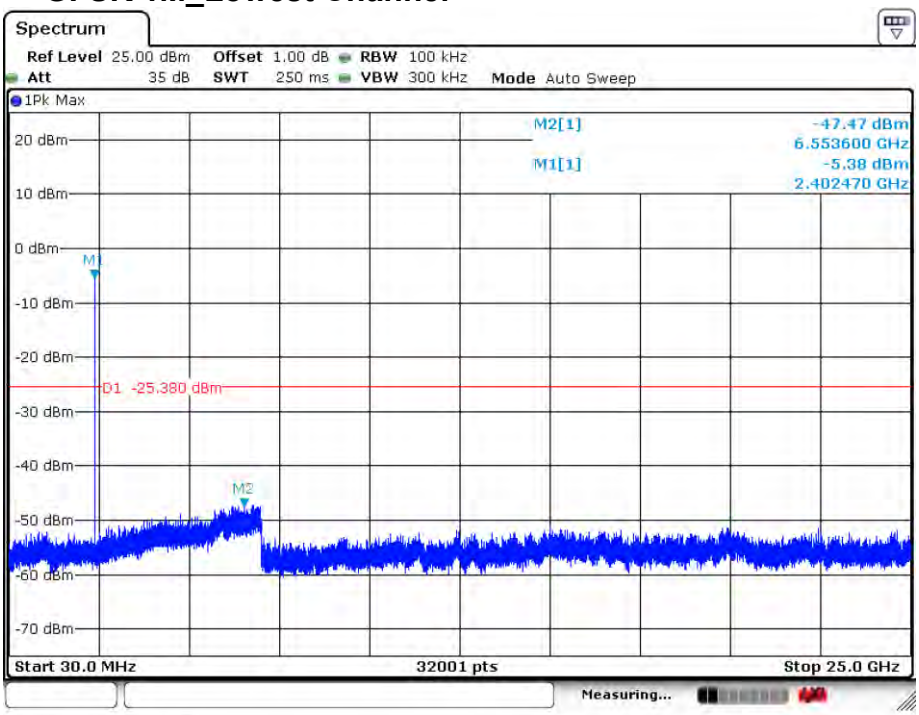
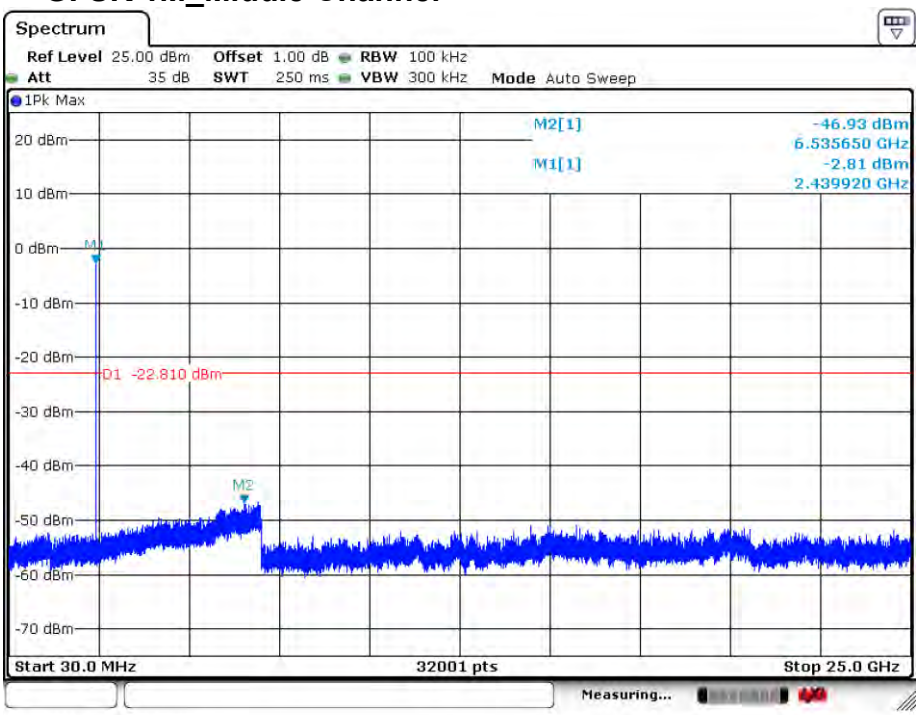
4.8.1 Test plots:

4.8.1.1 GFSK 1M_Lowest Channel



Date: 6.MAY.2020 10:12:15

4.8.1.2 GFSK 1M_Middle Channel



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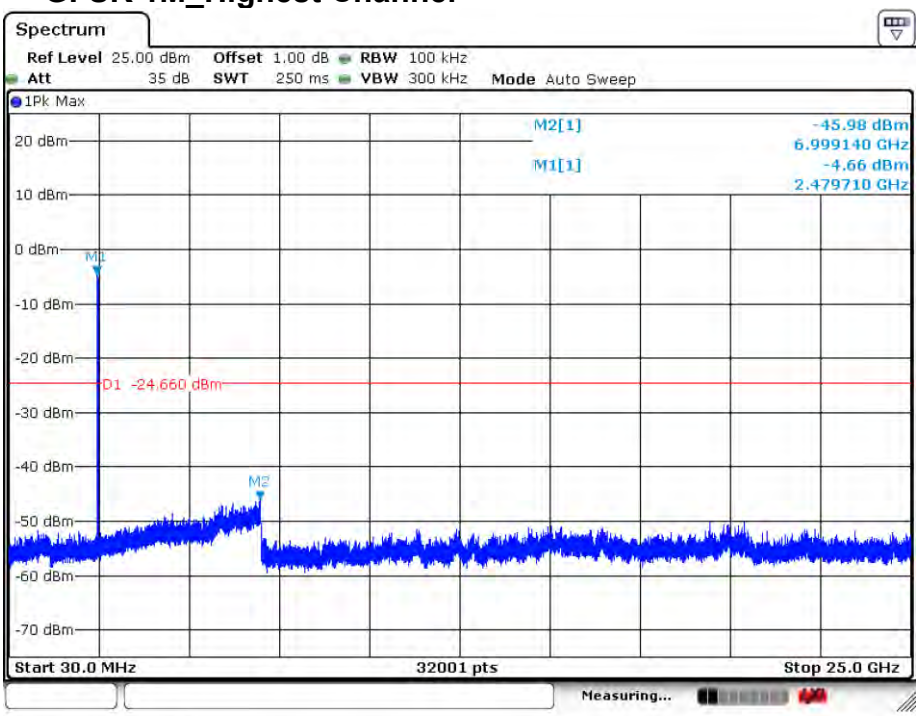
4.8.1.3 GFSK 1M_Highest Channel



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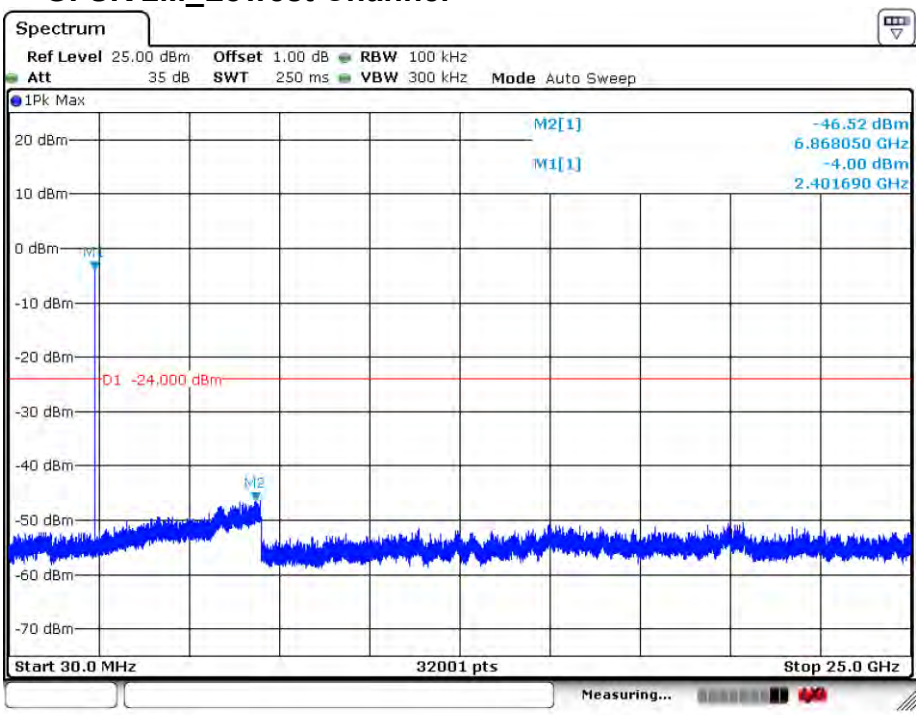
4.8.1.4 GFSK 2M_Lowest Channel



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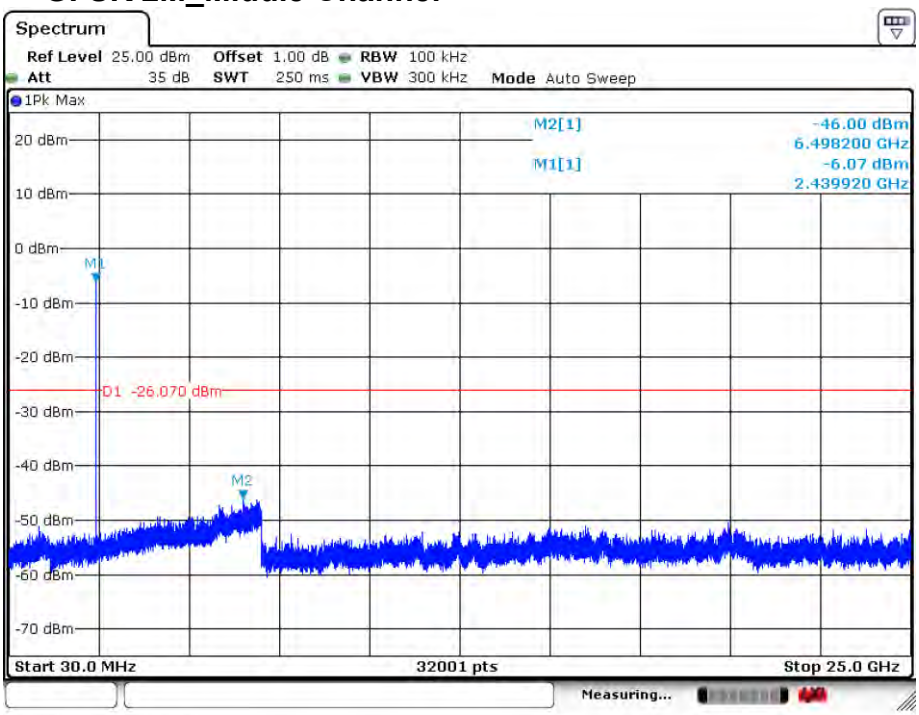
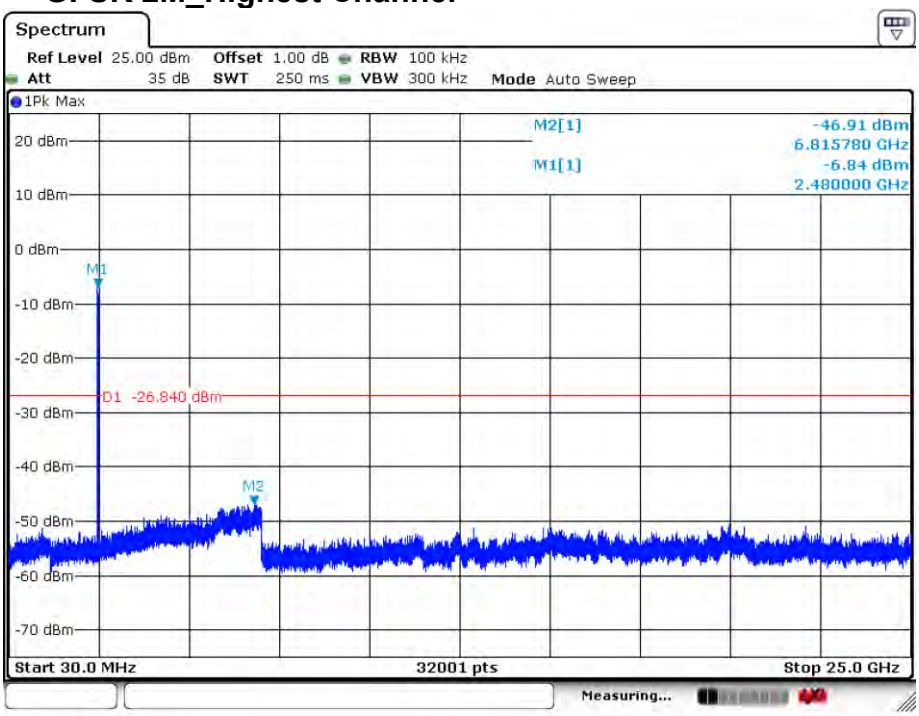
4.8.1.5 GFSK 2M_Middle Channel



Date: 6.MAY.2020 10:11:08

4.8.1.6 GFSK 2M_Highest Channel



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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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4.9 Radiated Spurious Emission

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10 :2013 Section 11.12				
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:

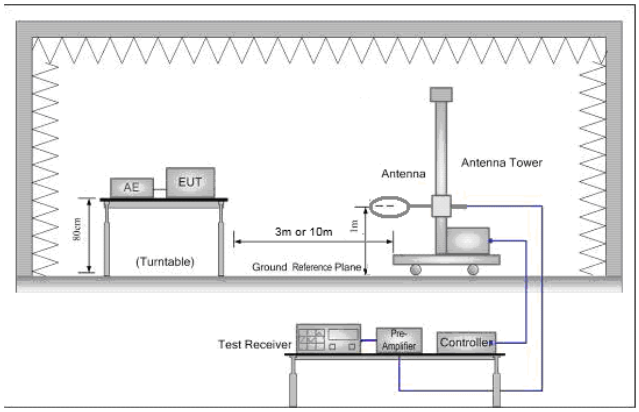

Figure 1. Below 30MHz

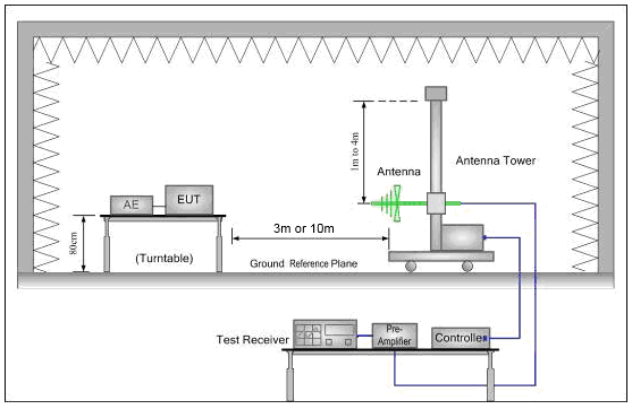

Figure 2. 30MHz to 1GHz

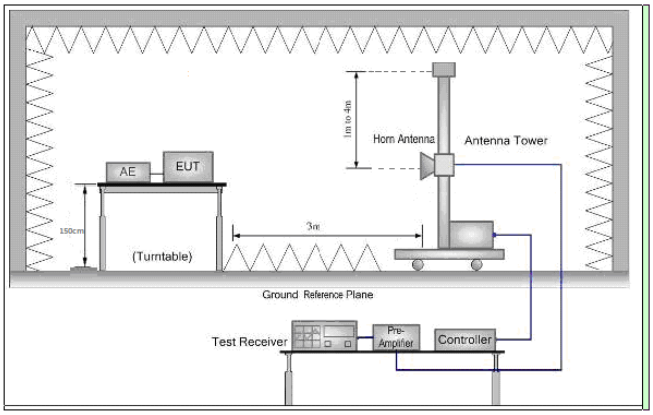

Figure 3. Above 1 GHz

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. Use the following spectrum analyzer settings:

(1) Span shall wide enough to fully capture the emission being measured;

(2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ;
VBW≥ RBW; Sweep = auto;
Detector function = peak; Trace = max hold for peak

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	(3) For average measurement: use duty cycle correction factor method per 15.35(c). Duty cycle = On time/100 milliseconds On time = N 1 *L 1 +N 2 *L 2 +...+N n-1 *LN n-1 +N n *L n Where N 1 is number of type 1 pulses, L 1 is length of type 1 pulses, etc. Average Emission Level = Peak Emission Level + 20*log(Duty cycle) f. 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. g. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. h. 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. i. Test the EUT in the lowest channel (2402MHz),the middle channel (2440MHz),the Highest channel (2480MHz) j. 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. k. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with GFSK modulation. Charge + Transmitting mode.
Final Test Mode:	Transmitting with GFSK modulation. 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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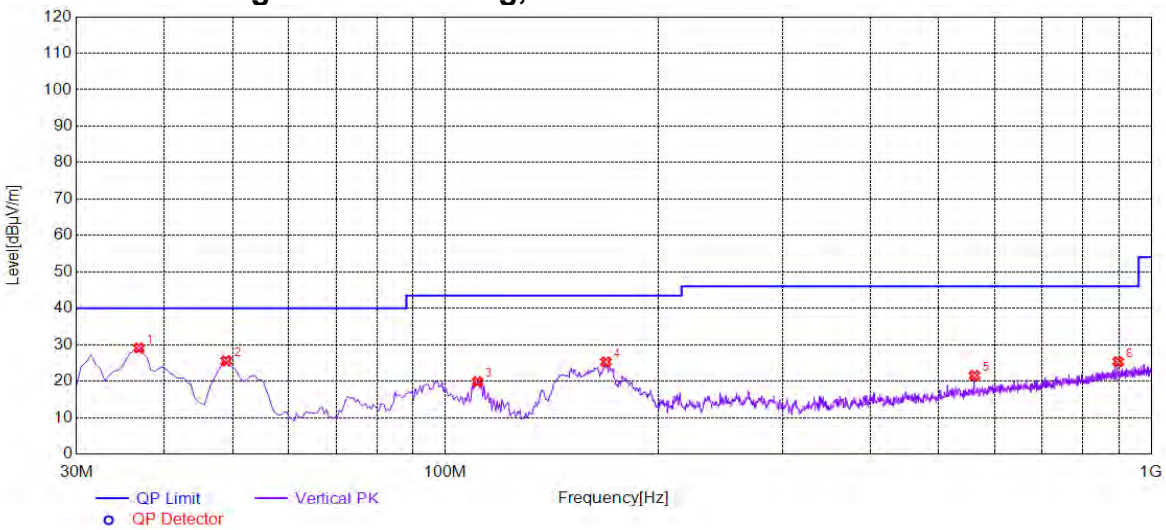
4.9.1 Radiated Emission below 1GHz

4.9.1.1 Charge + Transmitting, Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	36.7934	29.09	-32.19	40.00	10.91	152	344	Vertical
2	48.9245	25.56	-30.19	40.00	14.44	167	267	Vertical
3	111.0355	19.86	-31.85	43.50	23.64	153	101	Vertical
4	168.7794	25.28	-33.69	43.50	18.22	268	344	Vertical
5	561.8259	21.52	-21.13	46.00	24.48	270	142	Vertical
6	897.6138	25.36	-15.27	46.00	20.64	195	344	Vertical

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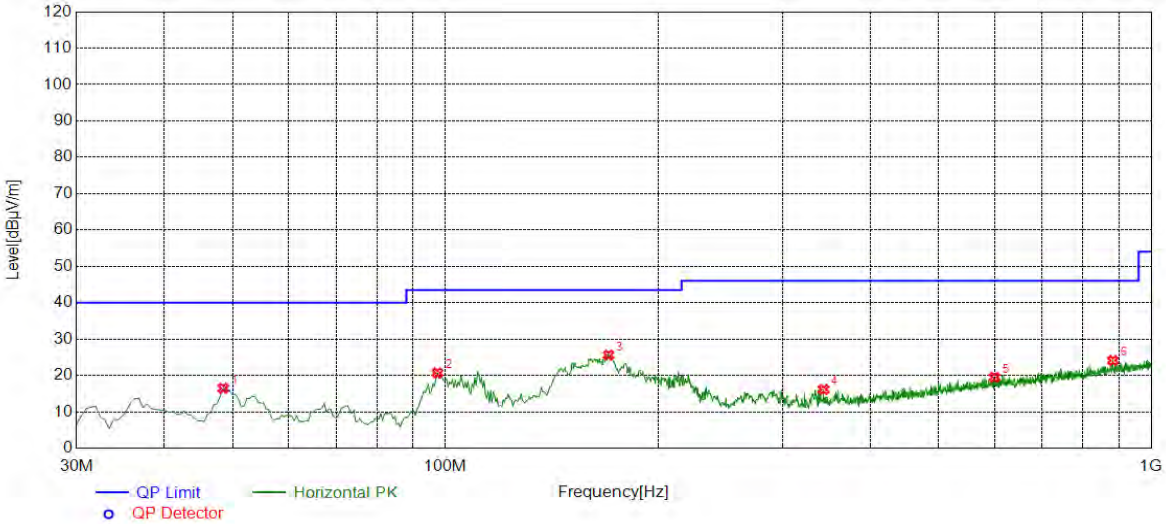
4.9.1.2 Charge + Transmitting, Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	48.4392	16.49	-30.19	40.00	23.51	210	254	Horizontal
2	97.4487	20.71	-32.13	43.50	22.79	118	254	Horizontal
3	170.2351	25.61	-33.59	43.50	17.89	138	129	Horizontal
4	343.4667	16.14	-26.60	46.00	29.86	144	241	Horizontal
5	599.6748	19.49	-20.09	46.00	26.51	153	56	Horizontal
6	882.5713	24.10	-15.51	46.00	21.90	230	326	Horizontal

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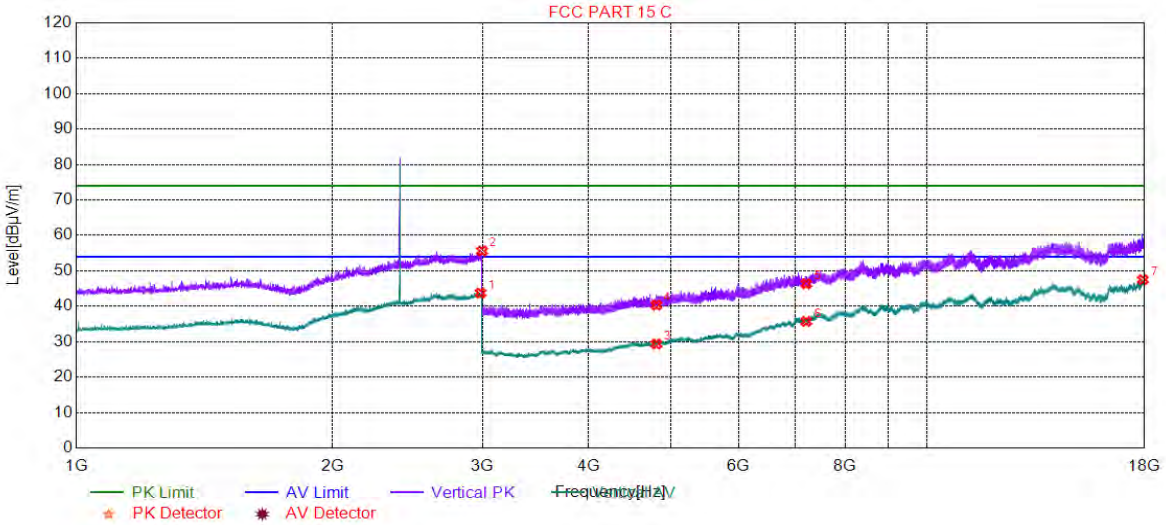
4.9.2 Transmitter Emission above 1GHz

4.9.2.1 GFSK _Lowest Channel_ Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2985.4964	43.74	9.52	54.00	10.26	235	306	Vertical
2	2997.9995	55.60	9.46	74.00	18.40	198	73	Vertical
3	4804.0000	29.36	-18.30	54.00	24.64	163	155	Vertical
4	4804.0000	40.32	-18.30	74.00	33.68	208	128	Vertical
5	7206.0000	46.34	-10.09	74.00	27.66	270	291	Vertical
6	7206.0000	35.73	-10.09	54.00	18.27	226	0	Vertical
7	17914.1957	47.52	0.69	54.00	6.48	274	0	Vertical

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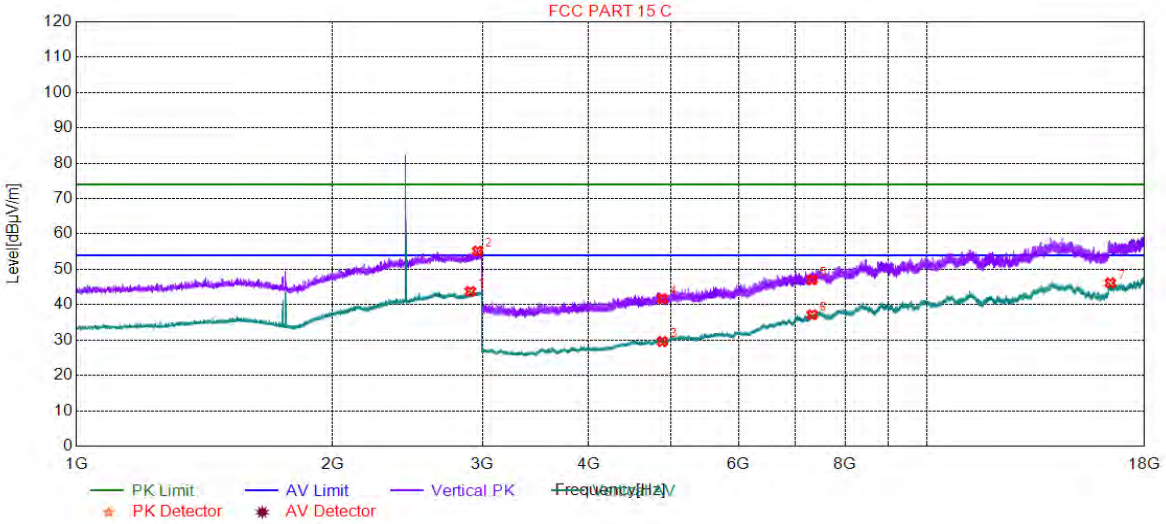
4.9.2.2 GFSK _Middle Channel_ Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2904.4761	43.76	9.19	54.00	10.24	165	18	Vertical
2	2961.4904	55.20	9.63	74.00	18.80	153	72	Vertical
3	4882.0000	29.58	-17.96	54.00	24.42	212	101	Vertical
4	4882.0000	41.74	-17.96	74.00	32.26	176	128	Vertical
5	7323.0000	47.01	-9.71	74.00	26.99	162	191	Vertical
6	7323.0000	37.16	-9.71	54.00	16.84	269	0	Vertical
7	16401.6201	46.15	-0.11	54.00	7.85	294	342	Vertical

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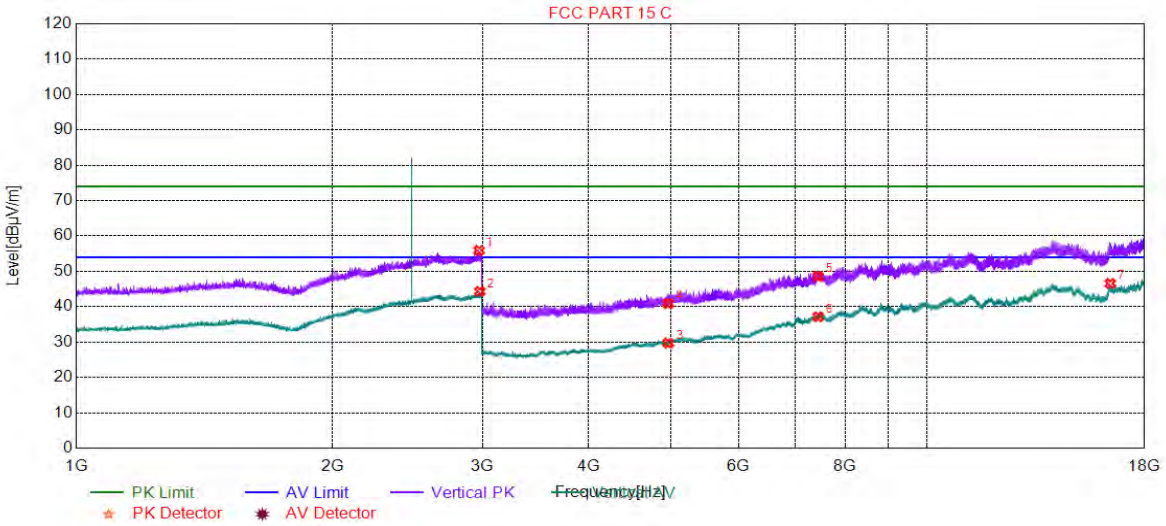
4.9.2.3 GFSK _High Channel_ Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2972.9932	55.93	9.57	74.00	18.07	224	32	Vertical
2	2979.9950	44.32	9.54	54.00	9.68	208	347	Vertical
3	4960.0000	29.69	-17.47	54.00	24.31	260	317	Vertical
4	4960.0000	40.86	-17.47	74.00	33.14	257	360	Vertical
5	7440.0000	48.58	-9.35	74.00	25.42	247	142	Vertical
6	7440.0000	37.17	-9.35	54.00	16.83	165	242	Vertical
7	16398.8699	46.56	-0.12	54.00	7.44	159	342	Vertical

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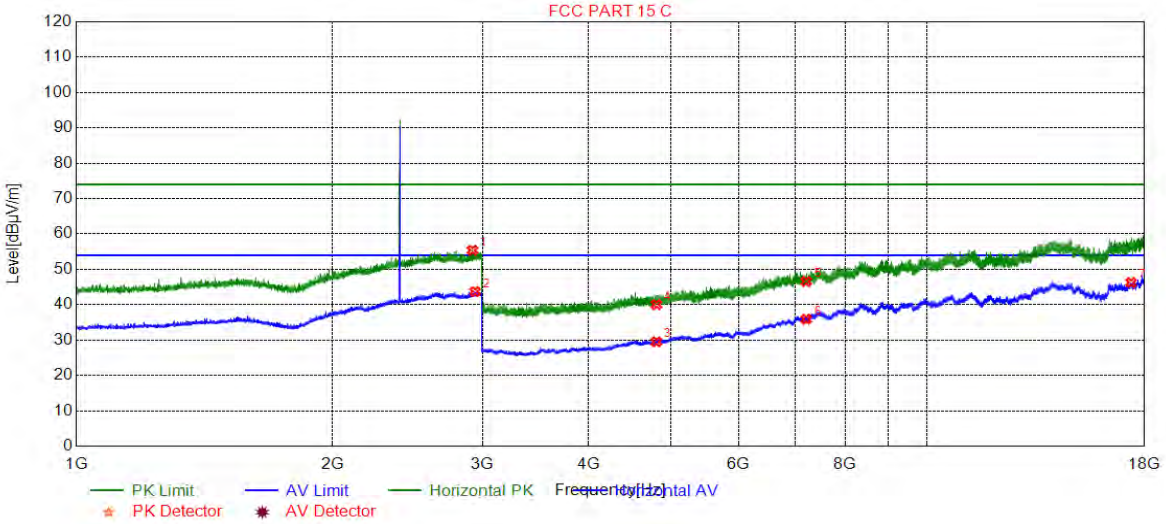
4.9.2.4 GFSK _Lowest Channel_ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2920.4801	55.42	9.36	74.00	18.58	179	94	Horizontal
2	2940.4851	43.70	9.58	54.00	10.30	192	342	Horizontal
3	4804.0000	29.52	-18.30	54.00	24.48	112	128	Horizontal
4	4804.0000	40.04	-18.30	74.00	33.96	159	320	Horizontal
5	7206.0000	46.58	-10.09	74.00	27.42	188	191	Horizontal
6	7206.0000	35.92	-10.09	54.00	18.08	117	242	Horizontal
7	17352.6176	46.28	0.05	54.00	7.72	182	342	Horizontal

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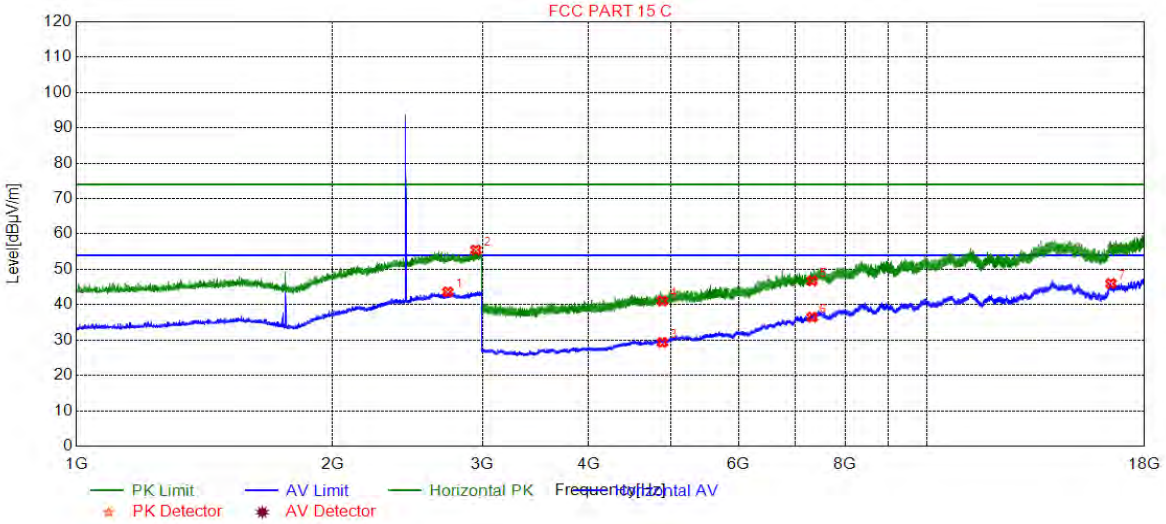
4.9.2.5 GFSK _Middle Channel_ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2731.4329	43.62	8.92	54.00	10.38	111	152	Horizontal
2	2947.9870	55.48	9.66	74.00	18.52	159	15	Horizontal
3	4882.0000	29.35	-17.96	54.00	24.65	159	128	Horizontal
4	4882.0000	41.07	-17.96	74.00	32.93	177	321	Horizontal
5	7323.0000	46.73	-9.71	74.00	27.27	168	191	Horizontal
6	7323.0000	36.49	-9.71	54.00	17.51	188	342	Horizontal
7	16432.9716	45.99	0.03	54.00	8.01	186	141	Horizontal

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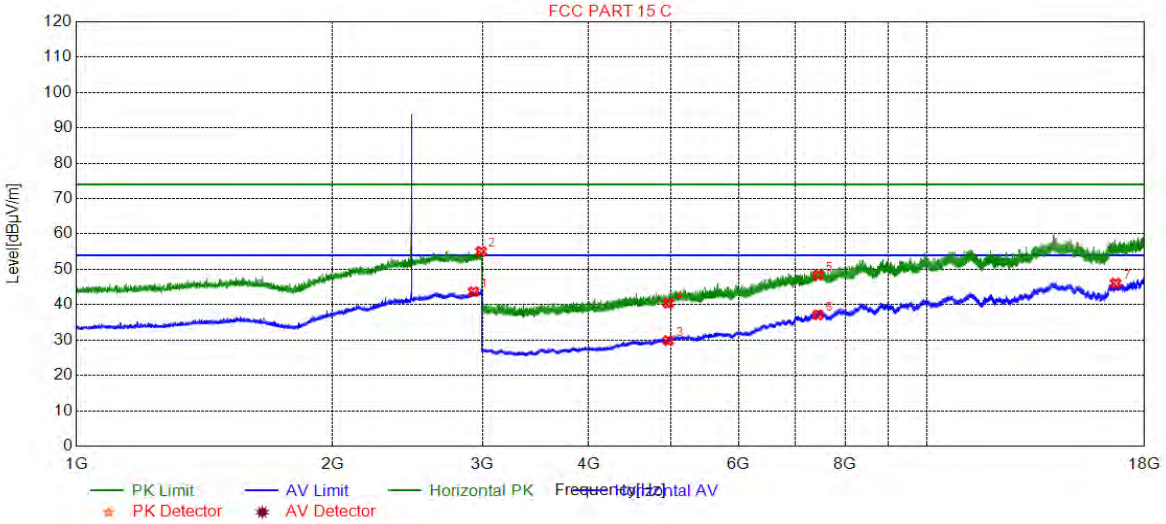
4.9.2.6 GFSK _High Channel_ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2928.9822	43.69	9.45	54.00	10.31	205	314	Horizontal
2	2989.4974	55.09	9.50	74.00	18.91	228	342	Horizontal
3	4960.0000	29.86	-17.47	54.00	24.14	134	100	Horizontal
4	4960.0000	40.41	-17.47	74.00	33.59	216	73	Horizontal
5	7440.0000	48.42	-9.35	74.00	25.58	109	242	Horizontal
6	7440.0000	37.14	-9.35	54.00	16.86	243	141	Horizontal
7	16645.8323	46.07	0.38	54.00	7.93	186	141	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 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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4.10 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2013 Section 11.12		
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:			

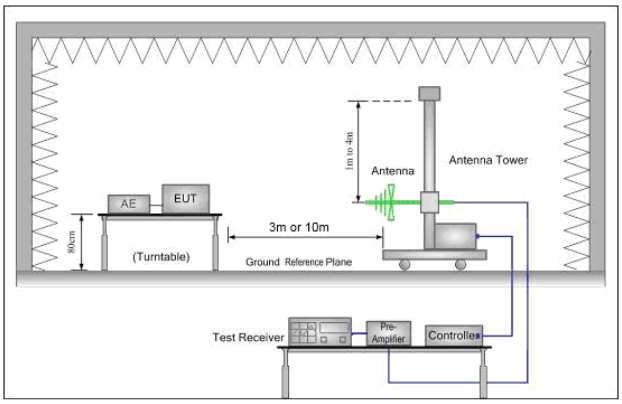

Figure 1. 30MHz to 1GHz

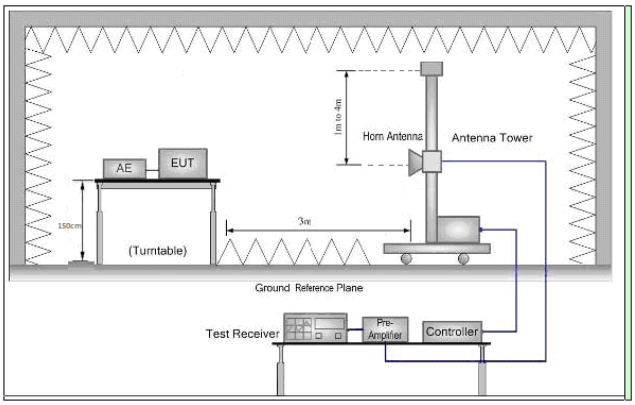

Figure 2. Above 1 GHz

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

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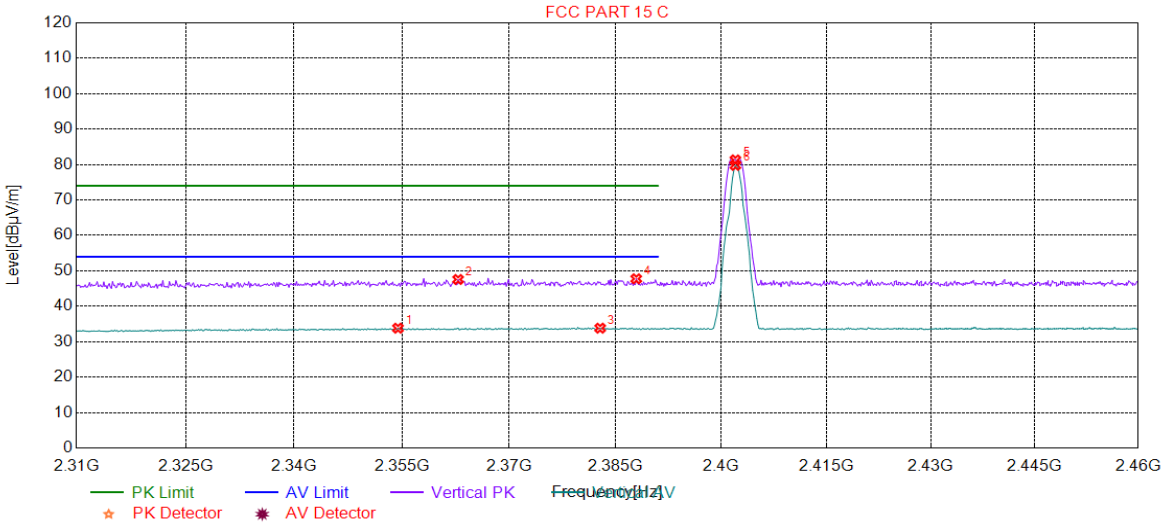
	i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with GFSK modulation. Charge + Transmitting mode.
Final Test Mode:	Transmitting with GFSK modulation. 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

4.10.1 Test plots

4.10.1.1 Worst Case Mode (GFSK) Lowest Channel_ Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2354.4444	33.83	7.81	54.00	20.17	221	319	Vertical
2	2362.8529	47.57	7.80	74.00	26.43	260	236	Vertical
3	2382.8228	33.83	7.78	54.00	20.17	231	348	Vertical
4	2387.9279	47.76	7.77	74.00	26.24	285	58	Vertical
5	2402.0000	81.32	7.77	0.00	-81.32	257	332	Vertical
6	2402.0000	79.77	7.77	0.00	-79.77	161	332	Vertical

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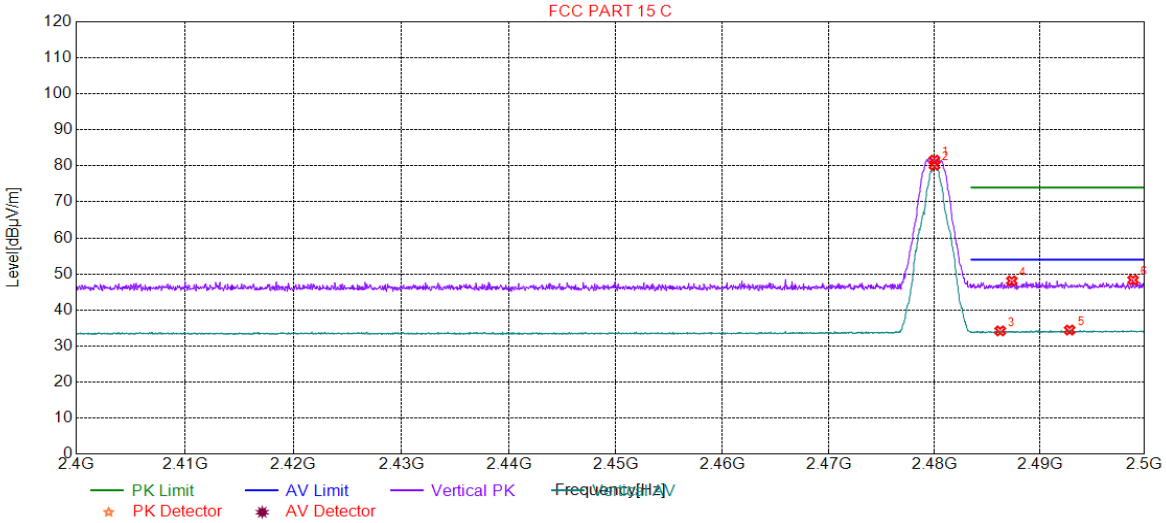
4.10.1.2 Worst Case Mode (GFSK) Highest Channel_ Vertical



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.0000	81.60	8.01	0.00	-81.60	265	336	Vertical
2	2480.0000	80.20	8.01	0.00	-80.20	243	336	Vertical
3	2486.2431	34.20	8.01	54.00	19.80	232	162	Vertical
4	2487.3437	48.09	8.01	74.00	25.91	222	118	Vertical
5	2492.8464	34.44	8.02	54.00	19.56	248	308	Vertical
6	2498.8995	48.33	8.03	74.00	25.67	229	254	Vertical

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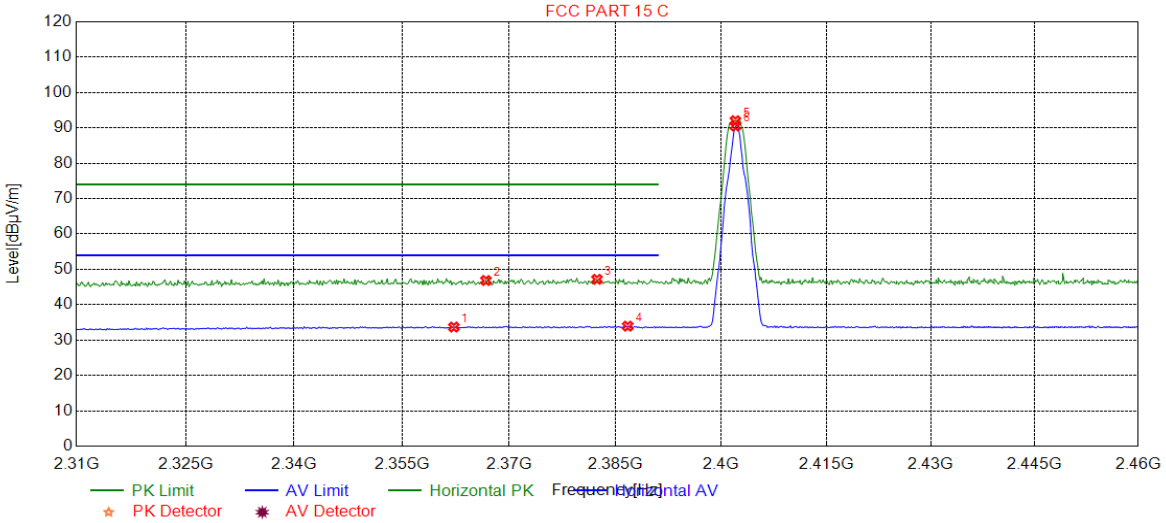
4.10.1.3 Worst Case Mode (GFSK) Lowest Channel_ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2362.2523	33.69	7.80	54.00	20.31	124	68	Horizontal
2	2366.7568	46.85	7.79	74.00	27.15	190	241	Horizontal
3	2382.3724	47.19	7.78	74.00	26.81	139	84	Horizontal
4	2386.7267	33.94	7.77	54.00	20.06	197	315	Horizontal
5	2402.0000	92.03	7.77	0.00	-92.03	171	211	Horizontal
6	2402.0000	90.52	7.77	0.00	-90.52	170	215	Horizontal

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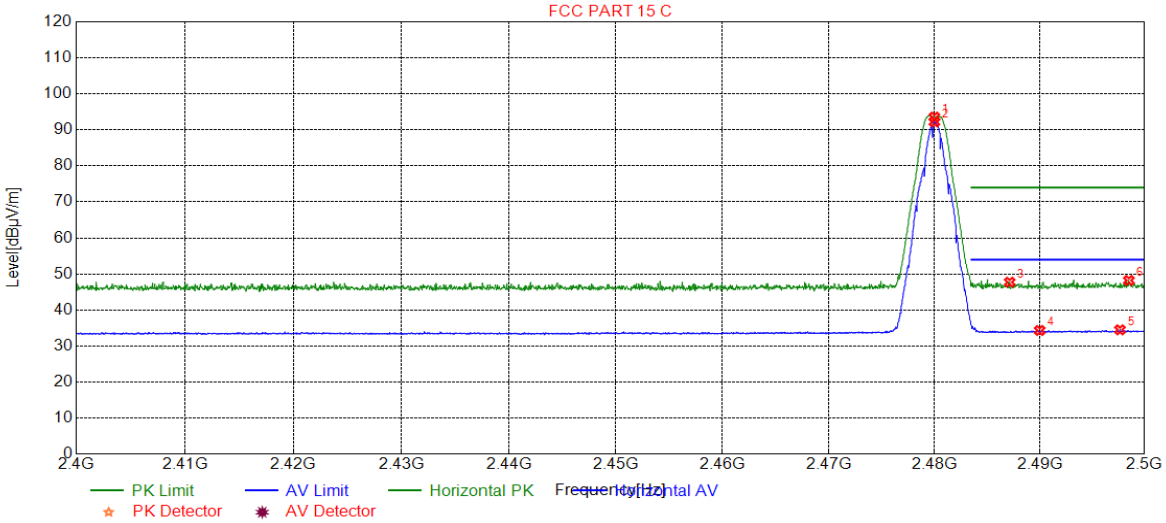
4.10.1.4 Worst Case Mode (GFSK) Highest Channel_ Horizontal



Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.0000	93.56	8.01	0.00	-93.56	142	216	Horizontal
2	2480.0000	92.21	8.01	0.00	-92.21	174	221	Horizontal
3	2487.1436	47.73	8.01	74.00	26.27	215	167	Horizontal
4	2489.9950	34.32	8.02	54.00	19.68	158	287	Horizontal
5	2497.6488	34.50	8.03	54.00	19.50	193	13	Horizontal
6	2498.4993	48.21	8.03	74.00	25.79	249	2	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	2020/1/3	2021/1/2
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	2020-04-02	2021-04-01
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 ZR/2020/40013.

The End

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