FCC TEST REPORT

Application No:	ZR/2020/50001
Applicant:	Lenovo(Shanghai) Electronics Technology Co., Ltd.
Address of Applicant	Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone
Manufacturer:	Lenovo PC HK Limited
Address of Manufacturer	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong P.R.China
EUT Description:	Portable Tablet Computer
Model No.:	Lenovo TB-X306F
Trade Mark:	Lenovo
FCC ID:	O57TBX306F
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:	2020/5/7
Date of Test:	2020/5/10 to 2020/5/20
Date of Issue:	2020/5/22
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		2020/5/22		Original

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

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Inspection & Testing Services
SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch Testing Center-EEC Laboratory.

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2 Test Summary

Test Item	Test Requirement	Test method	Test Result	Result
AC Power Line Conducted Emission	15.207	ANSI C63.10 2013	Clause 4.2	PASS
Conducted Output Power	15.247 (b)(3)	ANSI C63.10 2013	Clause 4.3	PASS
DTS (6 dB) Bandwidth	15.247 (a)(2)	ANSI C63.10 2013	Clause 4.4	PASS
Power Spectral Density	15.247 (e)	ANSI C63.10 2013	Clause 4.5	PASS
Band-edge for RF Conducted Emissions	15.247(d)	ANSI C63.10 2013	Clause 4.6	PASS
RF Conducted Spurious Emissions	15.247(d)	ANSI C63.10 2013	Clause 4.7	PASS
Radiated Spurious Emissions	15.205/15.209	ANSI C63.10 2013	Clause 4.8	PASS
Restricted bands around fundamental frequency (Radiated Emission)	15.205/15.209	ANSI C63.10 2013	Clause 4.9	PASS

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Contents

1 VERSION 2
2 TEST SUMMARY 3
3 GENERAL INFORMATION 5
3.1 CLIENT INFORMATION 5
3.2 TEST LOCATION 5
3.3 TEST FACILITY 5
3.4 GENERAL DESCRIPTION OF EUT 6
3.5 TEST ENVIRONMENT 7
3.6 DESCRIPTION OF SUPPORT UNITS 7
4 TEST RESULTS AND MEASUREMENT DATA 8
4.1 ANTENNA REQUIREMENT 8
4.2 AC POWER LINE CONDUCTED EMISSIONS 9
4.3 DUTY CYCLE 13
4.3.1 Test Results 13
4.3.1 Test Plots 13
4.4 CONDUCTED OUTPUT POWER 15
4.4.1 Test Results 15
4.4.2 Test plots: 17
4.5 DTS (6 DB) BANDWIDTH & 99% OCCUPIED BANDWIDTH 20
4.5.1 Test Results 20
4.5.2 Test plots 21
4.6 POWER SPECTRAL DENSITY 27
4.6.1 Test Results 27
4.6.2 Test plots 28
4.7 BAND-EDGE FOR RF CONDUCTED EMISSIONS 31
4.7.1 Test plots 32
4.8 SPURIOUS RF CONDUCTED EMISSIONS 35
4.8.1 Test plots: 36
4.9 RADIATED SPURIOUS EMISSION 40
4.9.1 Radiated Emission below 1GHz 43
4.9.2 Transmitter Emission above 1GHz 45
4.10 RESTRICTED BANDS AROUND FUNDAMENTAL FREQUENCY 51
4.10.1 Test plots 52
5 MEASUREMENT UNCERTAINTY (95% CONFIDENCE LEVELS, K=2) 56
6 EQUIPMENT LIST 57
7 PHOTOGRAPHS - EUT CONSTRUCTIONAL DETAILS 59

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3 General Information

3.1 Client Information

Applicant:	Lenovo(Shanghai) Electronics Technology Co., Ltd.
Address of Applicant:	Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone
Manufacturer:	Lenovo PC HK Limited
Address of Manufacturer:	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong P.R.China

3.2 Test Location

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

3.3 Test Facility

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

• CNAS (No. CNAS L2929)

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

• A2LA (Certificate No. 3816.01)

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

• VCCI

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

• FCC –Designation Number: CN1178

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

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

• Industry Canada (IC)

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

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3.4 General Description of EUT

EUT Description::	Portable Tablet Computer
Model No.:	Lenovo TB-X306F
Trade Mark:	Lenovo
Hardware Version:	Lenovo TB-X306F
Software Version:	TB-X306F_RF01_200529
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:	-3.5dBi
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 -3.5dBi.	

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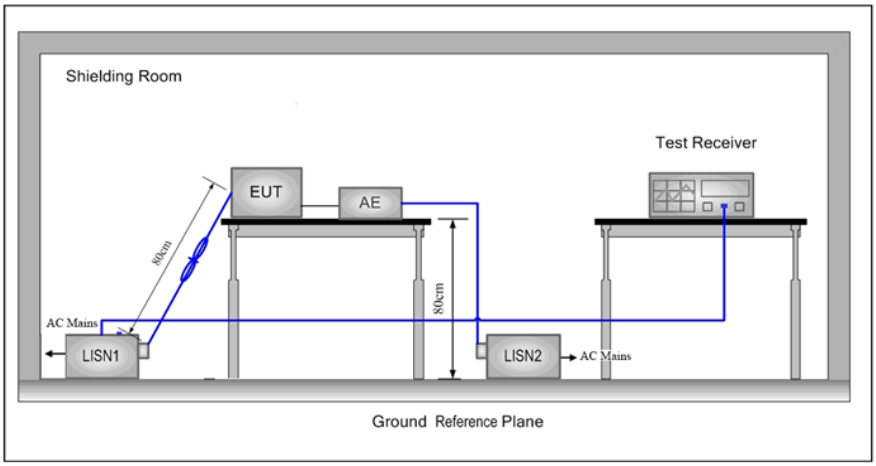
4.2 AC Power Line Conducted Emissions

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

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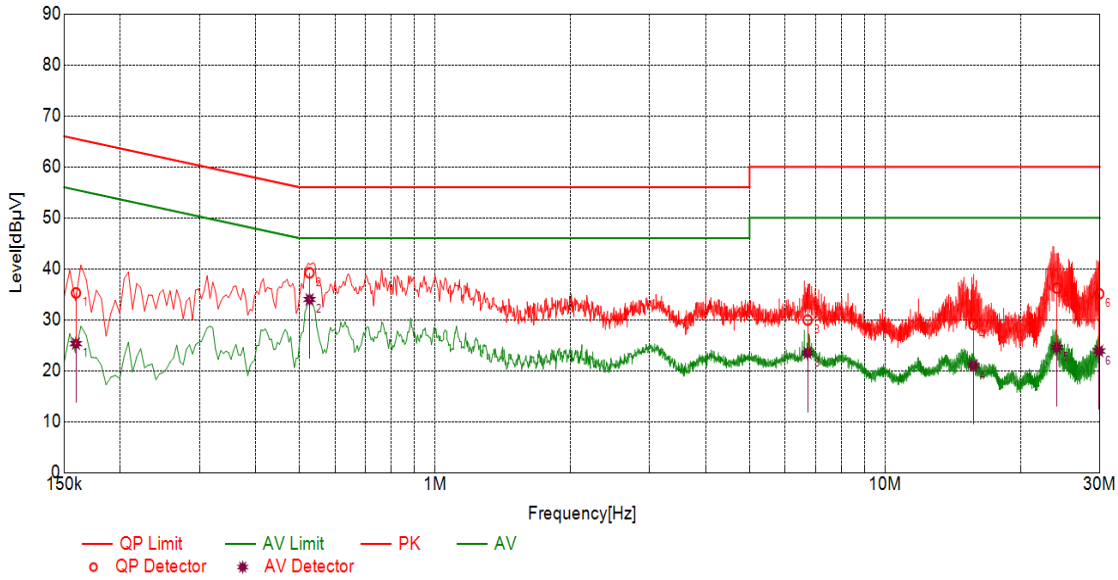
Measurement Data

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:



Test Graph

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	0.1594	10.10	35.27	65.49	30.22	25.32	55.49	30.17	L
2	0.5267	10.10	39.21	56.00	16.79	33.98	46.00	12.02	L
3	6.7288	10.10	29.95	60.00	30.05	23.46	50.00	26.54	L
4	15.7030	10.11	29.05	60.00	30.95	21.00	50.00	29.00	L
5	24.0885	10.11	36.23	60.00	23.77	24.57	50.00	25.43	L
6	29.9025	10.11	35.10	60.00	24.90	23.87	50.00	26.13	L

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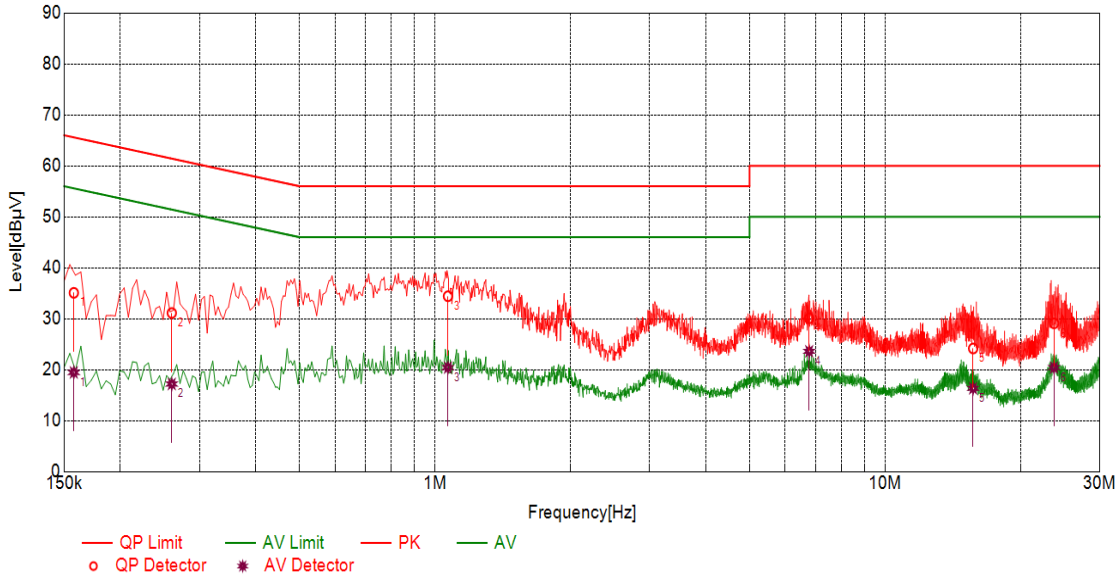
Neutral line:



Test Graph

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	0.1577	10.10	35.09	65.58	30.49	19.45	55.58	36.13	N
2	0.2603	10.10	31.13	61.42	30.29	17.19	51.42	34.23	N
3	1.0689	10.10	34.42	56.00	21.58	20.42	46.00	25.58	N
4	6.7828	10.10	30.09	60.00	29.91	23.61	50.00	26.39	N
5	15.6866	10.11	24.17	60.00	35.83	16.35	50.00	33.65	N
6	23.7298	10.11	29.10	60.00	30.90	20.42	50.00	29.58	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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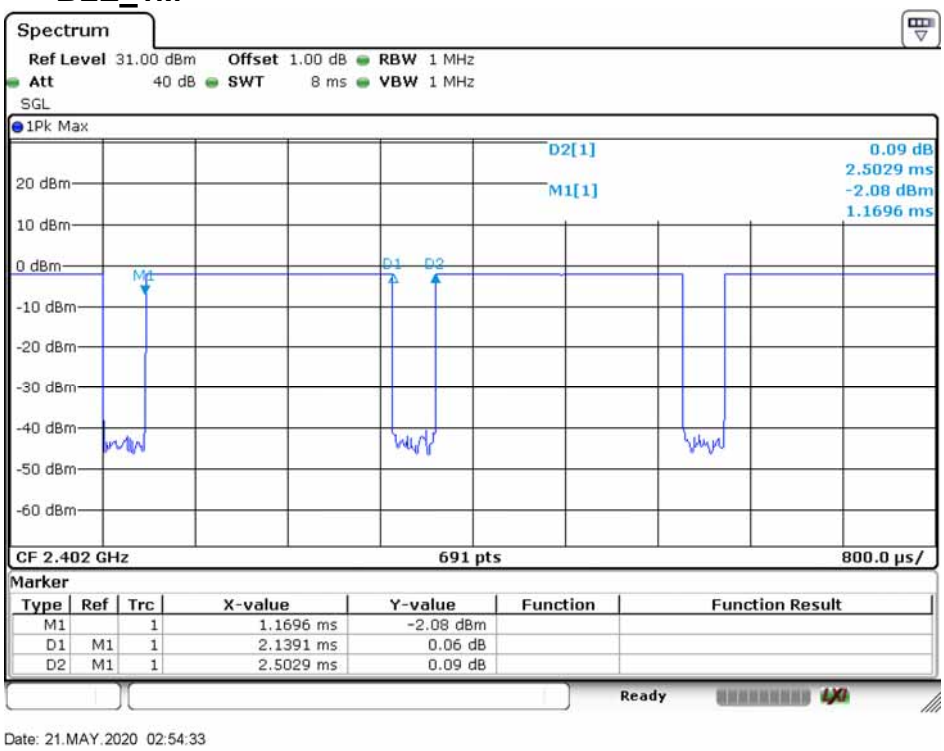
4.3 Duty Cycle

4.3.1 Test Results

Test Mode	TX Freq. [MHz]	Duty cycle [%]
BLE_1M	CH0, CH19, CH39	85.46
BLE_2M	CH0, CH19, CH39	57.14

4.3.1 Test Plots

4.3.1.1 BLE_1M



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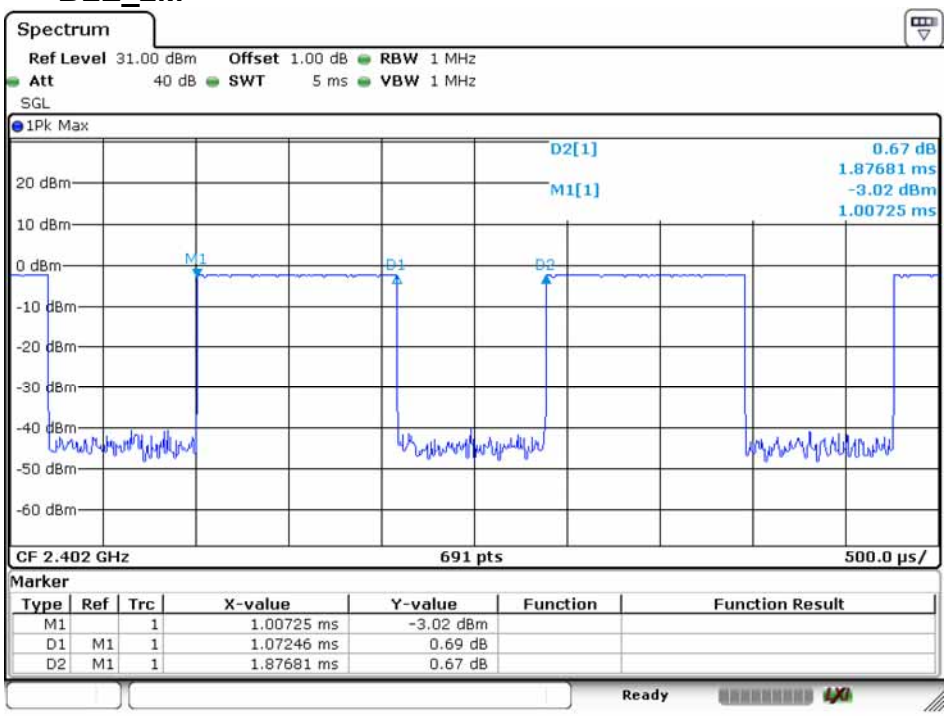
4.3.1.2 **BLE_2M**



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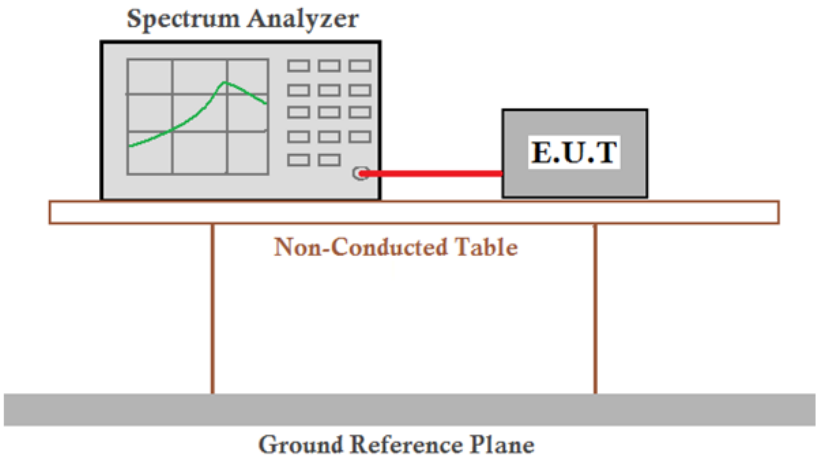
4.4 Conducted Output Power

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 Average Power

GFSK_1M mode		
Test channel	Average Output Power (dBm)	Result
Lowest	-3.45	Report purpose only
Middle	-2.46	Report purpose only
Highest	-3.79	Report purpose only

GFSK_2M mode		
Test channel	Average Output Power (dBm)	Result
Lowest	-5.15	Report purpose only
Middle	-4.14	Report purpose only
Highest	-5.52	Report purpose only

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Measurement Data of Peak Power:

GFSK_1M mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-1.72	30.00	Pass
Middle	-0.75	30.00	Pass
Highest	-2.13	30.00	Pass

GFSK_2M mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	-1.80	30.00	Pass
Middle	-0.77	30.00	Pass
Highest	-2.11	30.00	Pass

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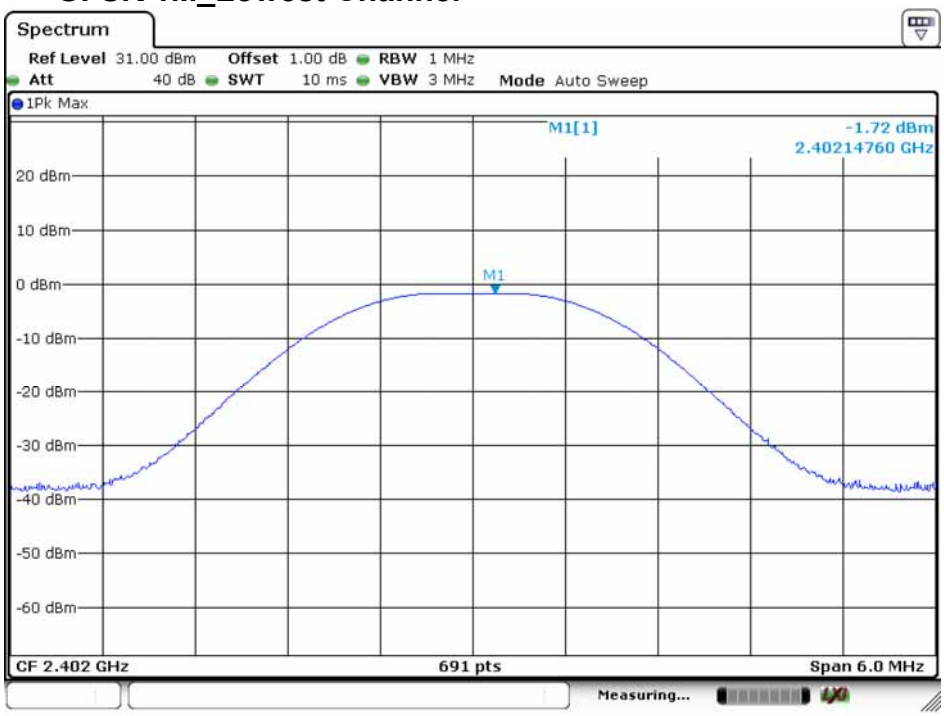
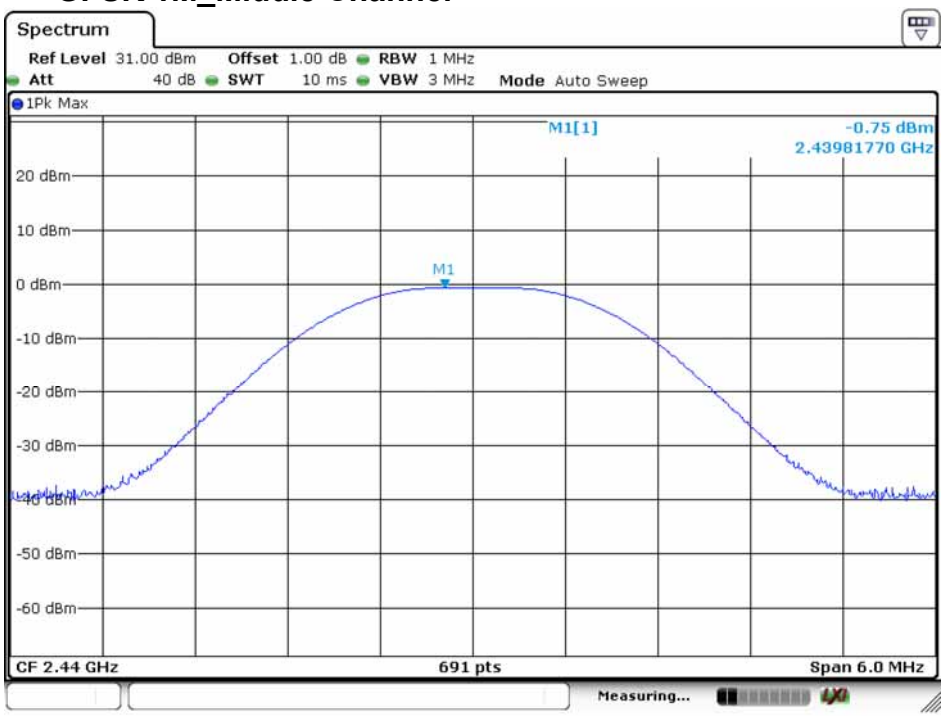
4.4.2 Test plots:

4.4.2.1 GFSK 1M_Lowest Channel



Date: 21.MAY.2020 02:39:35

4.4.2.2 GFSK 1M_Middle Channel



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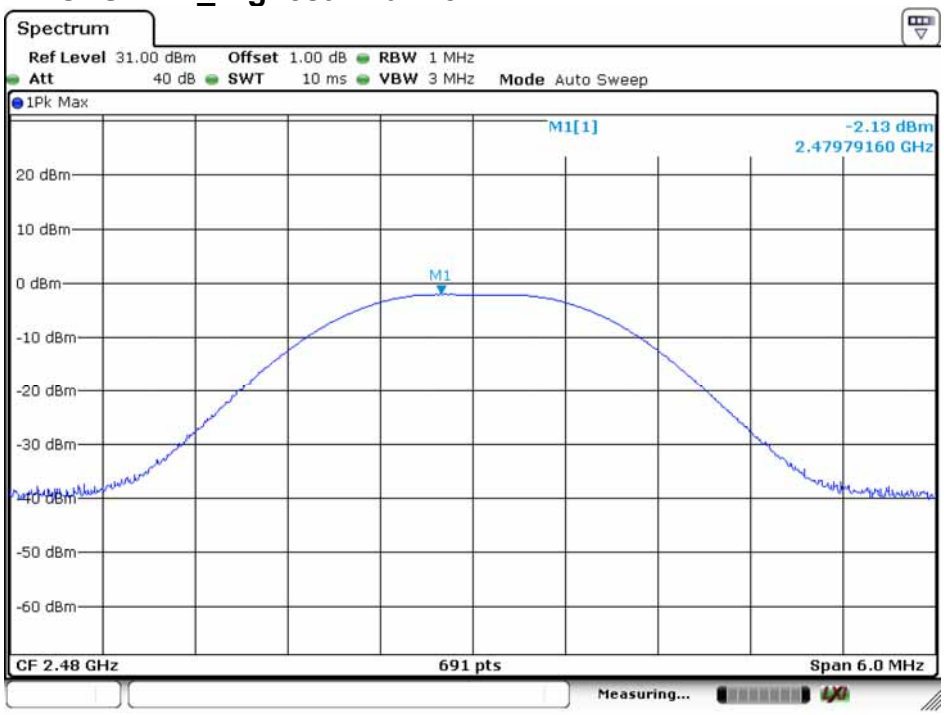
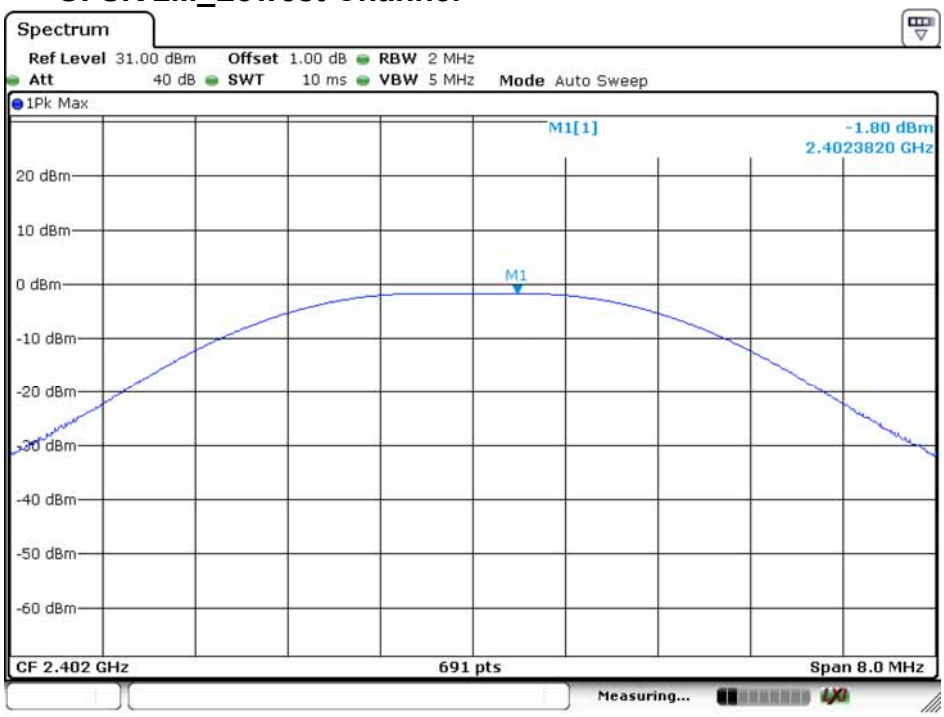
4.4.2.3 GFSK 1M_Highest Channel



Date: 21.MAY.2020 02:40:26

4.4.2.4 GFSK 2M_Lowest Channel



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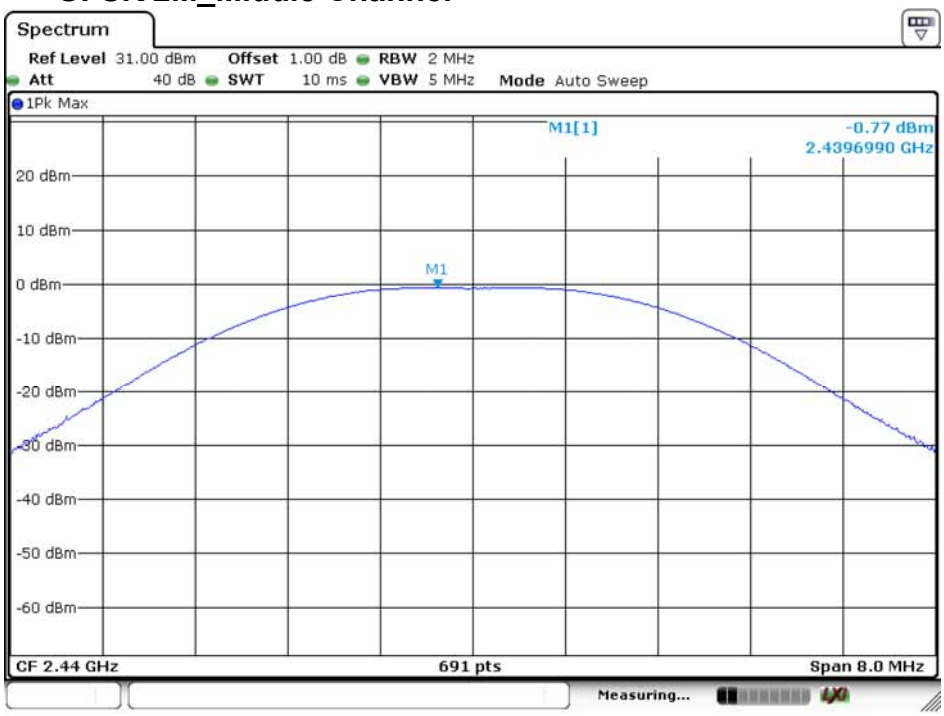
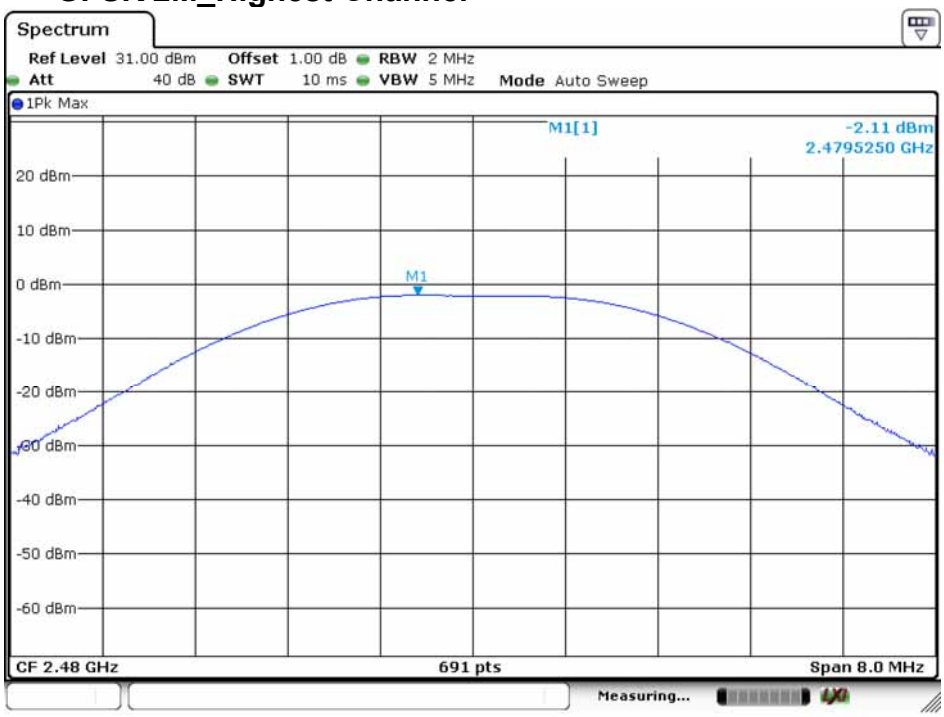
4.4.2.5 GFSK 2M_Middle Channel



Date: 21.MAY.2020 02:52:49

4.4.2.6 GFSK 2M_Highest Channel



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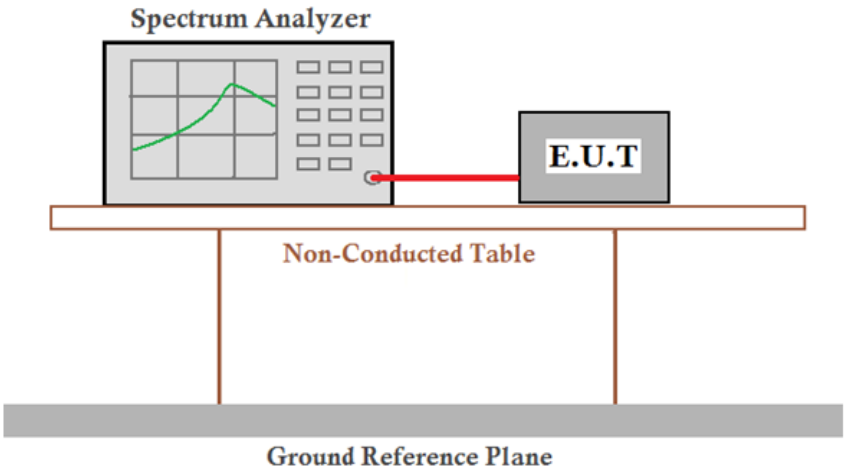
4.5 DTS (6 dB) Bandwidth

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	6dB Emission Bandwidth (MHz)	Limit (kHz)	Result
GFSK_1M	Lowest	0.67	≥500	Pass
	Middle	0.67	≥500	Pass
	Highest	0.67	≥500	Pass

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

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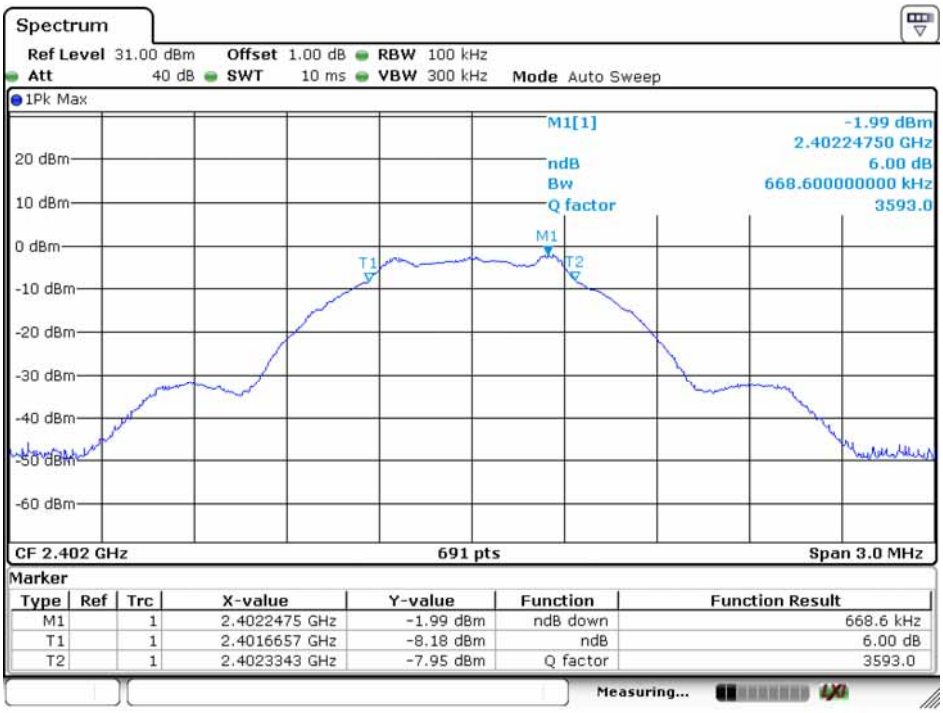
4.5.2 Test plots

4.5.2.1 GFSK 1M_Lowest Channel

Date: 21.MAY.2020 02:45:41



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4022475 GHz	-1.99 dBm	ndB down	668.6 kHz
T1		1	2.4016657 GHz	-8.18 dBm	ndB	6.00 dB
T2		1	2.4023343 GHz	-7.95 dBm	Q factor	3593.0

Date: 21.MAY.2020 02:45:25

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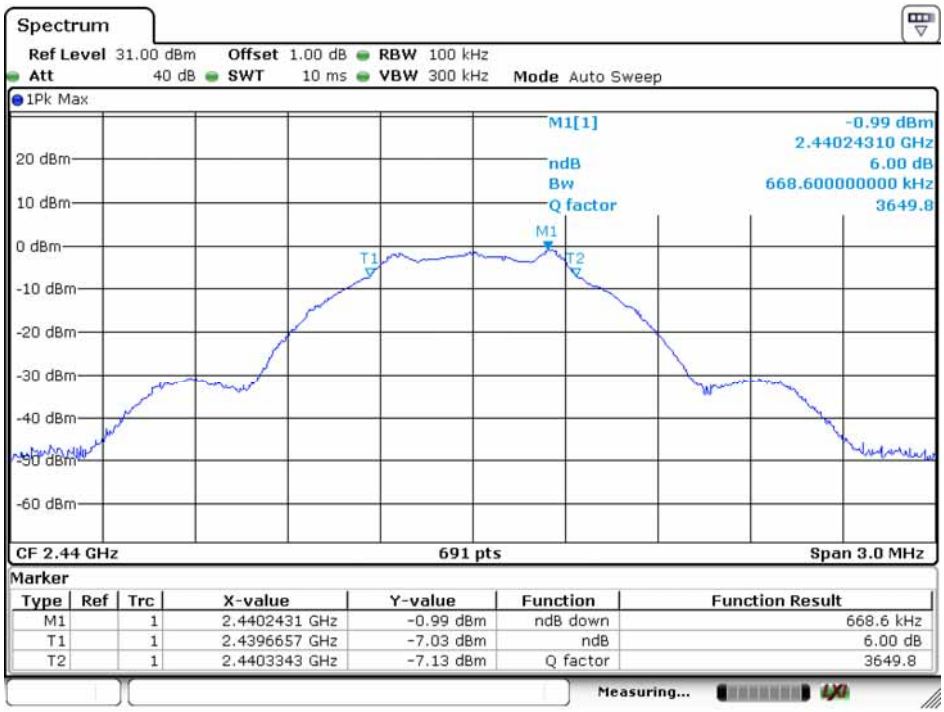
4.5.2.2 GFSK 1M_Middle Channel

Date: 21.MAY.2020 02:45:55



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4402431 GHz	-0.99 dBm	ndB down	668.6 kHz
T1		1	2.4396657 GHz	-7.03 dBm	ndB	6.00 dB
T2		1	2.4403343 GHz	-7.13 dBm	Q factor	3649.8

Date: 21.MAY.2020 02:45:06

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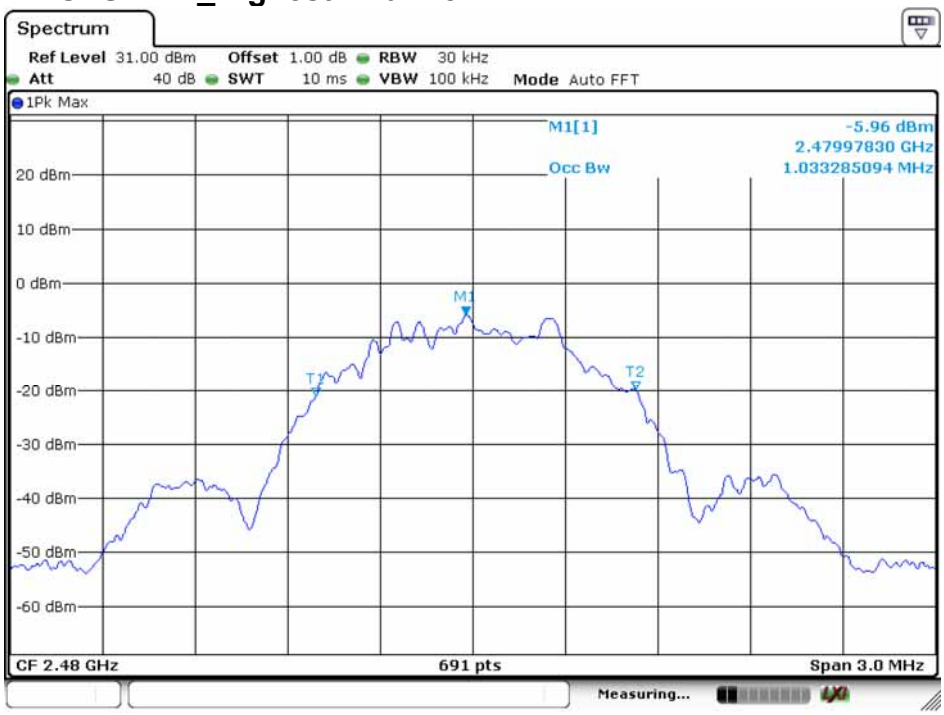
4.5.2.3 GFSK 1M_Highest Channel



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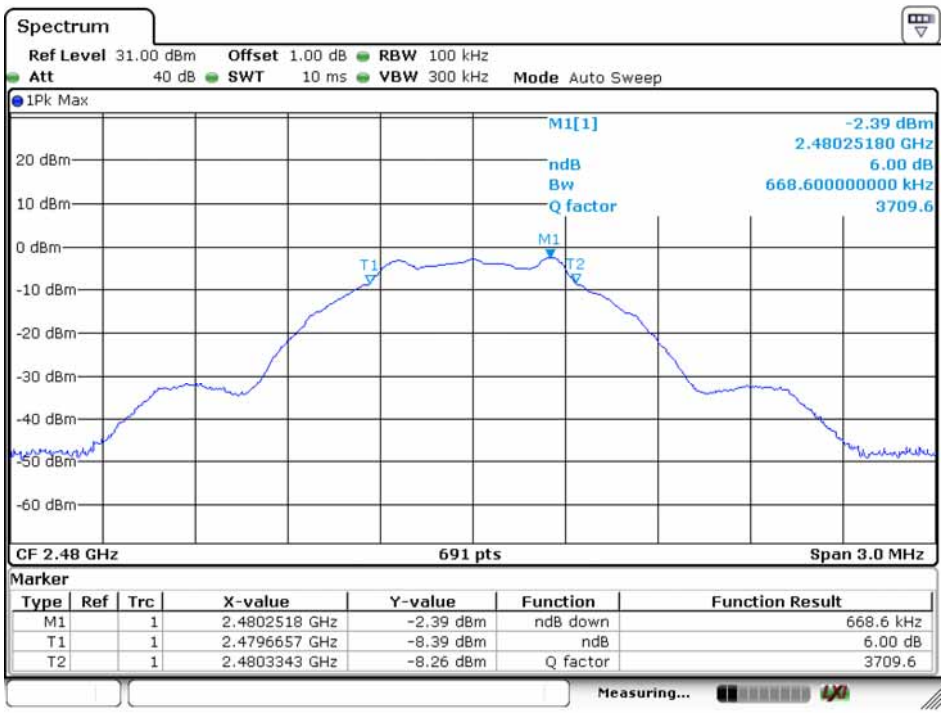

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4802518 GHz	-2.39 dBm	ndB down	668.6 kHz
T1		1	2.4796657 GHz	-8.39 dBm	ndB	6.00 dB
T2		1	2.4803343 GHz	-8.26 dBm	Q factor	3709.6

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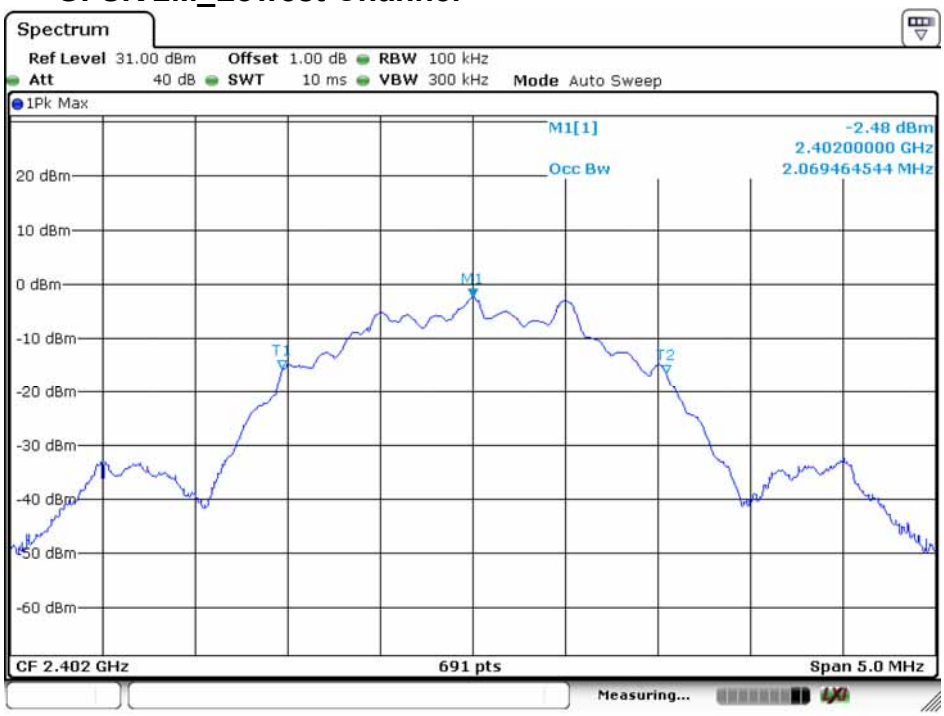
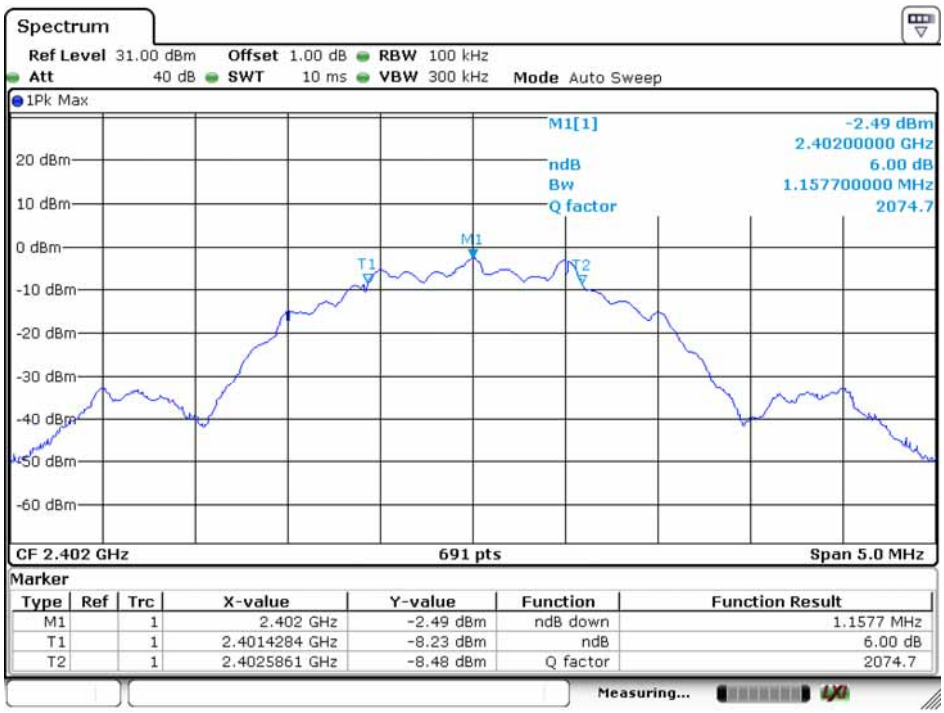
4.5.2.4 GFSK 2M_Lowest Channel



Date: 21.MAY.2020 02:51:22



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.402 GHz	-2.49 dBm	ndB down	1.1577 MHz
T1		1	2.4014284 GHz	-8.23 dBm	ndB	6.00 dB
T2		1	2.4025861 GHz	-8.48 dBm	Q factor	2074.7

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4.5.2.5 GFSK 2M_Middle Channel

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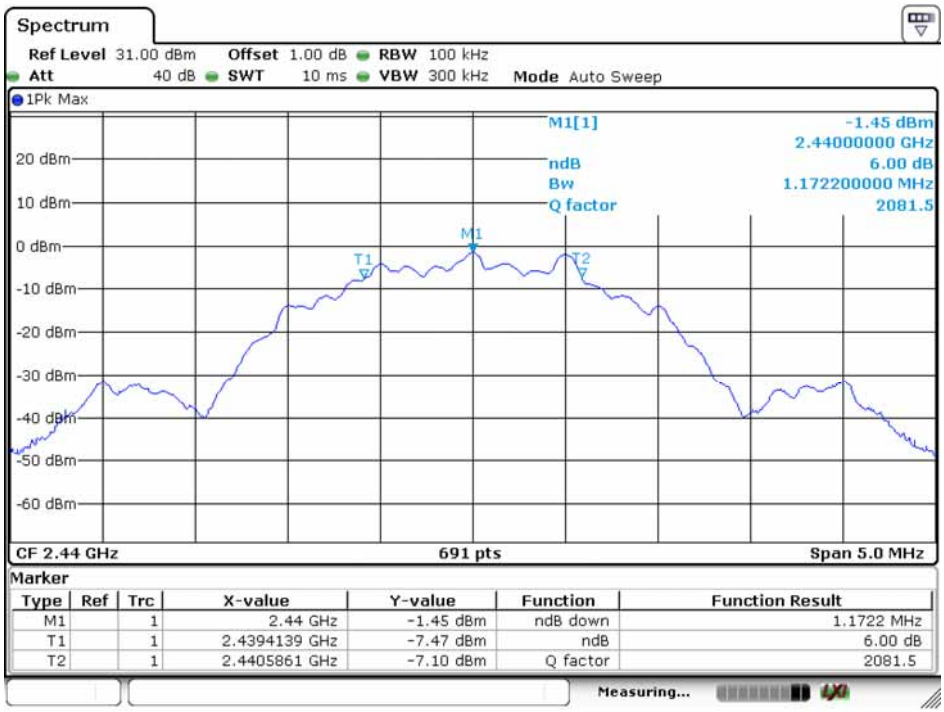

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.44 GHz	-1.45 dBm	ndB down	1.1722 MHz
T1		1	2.4394139 GHz	-7.47 dBm	ndB	6.00 dB
T2		1	2.4405861 GHz	-7.10 dBm	Q factor	2081.5

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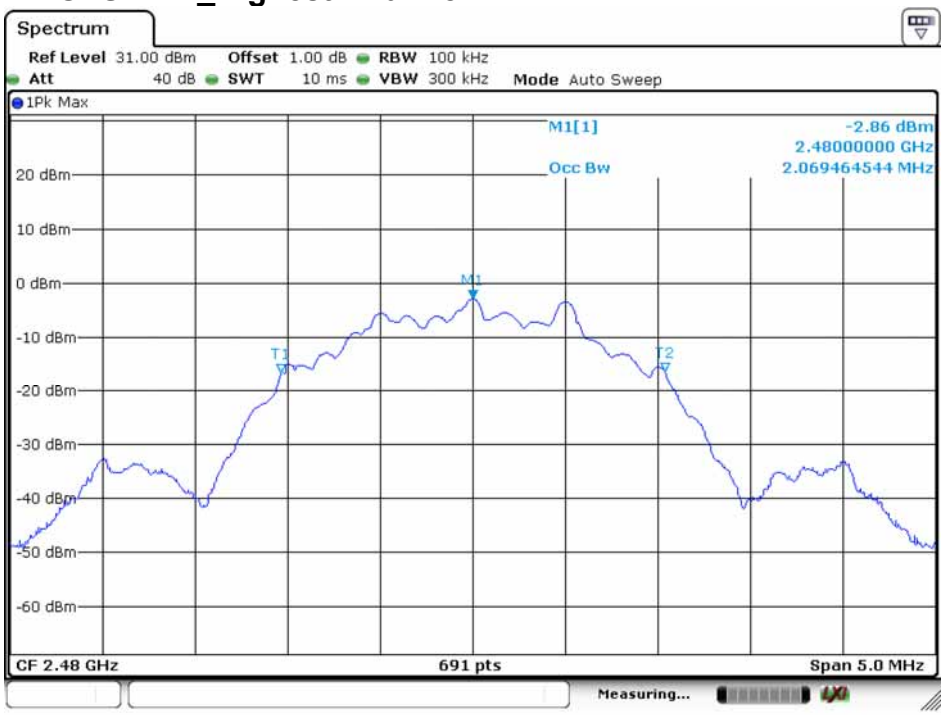
4.5.2.6 GFSK 2M_Highest Channel



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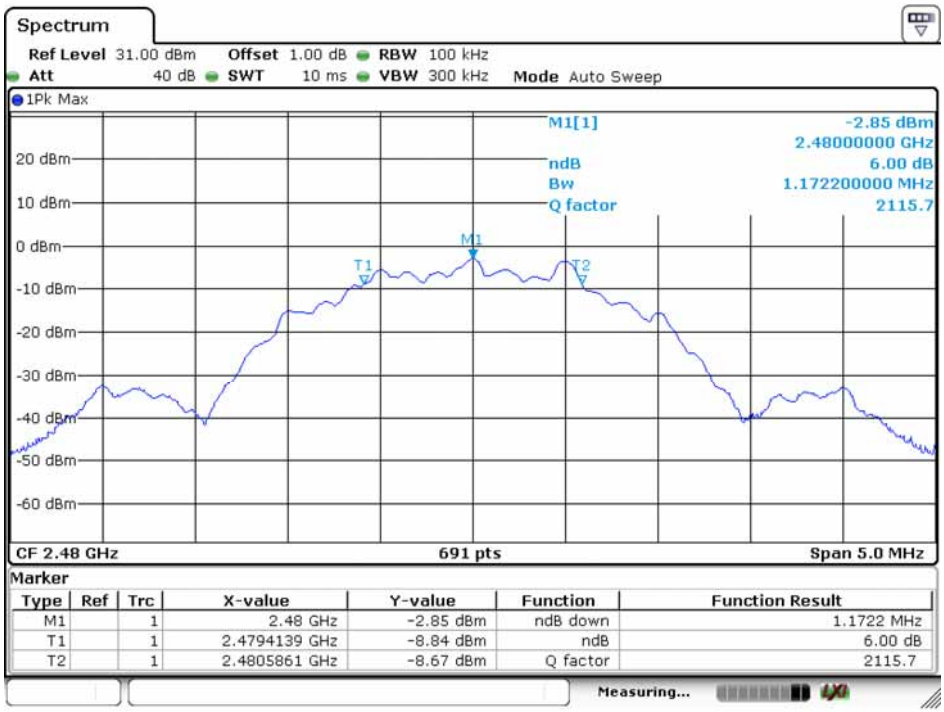

Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.48 GHz	-2.85 dBm	ndB down	1.1722 MHz
T1		1	2.4794139 GHz	-8.84 dBm	ndB	6.00 dB
T2		1	2.4805861 GHz	-8.67 dBm	Q factor	2115.7

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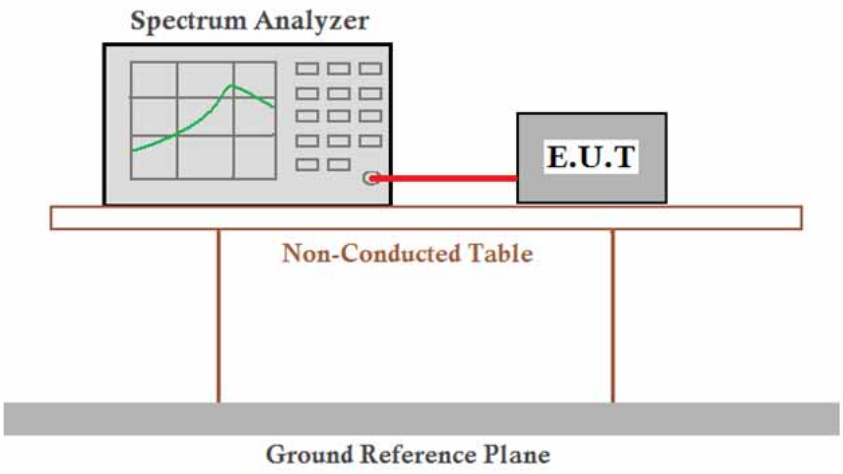
4.6 Power Spectral Density

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	-18.42	≤8.00	Pass
	Middle	-17.37	≤8.00	Pass
	Highest	-17.78	≤8.00	Pass

Mode	Test Channel	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Result
GFSK_2M	Lowest	-20.62	≤8.00	Pass
	Middle	-19.58	≤8.00	Pass
	Highest	-20.99	≤8.00	Pass

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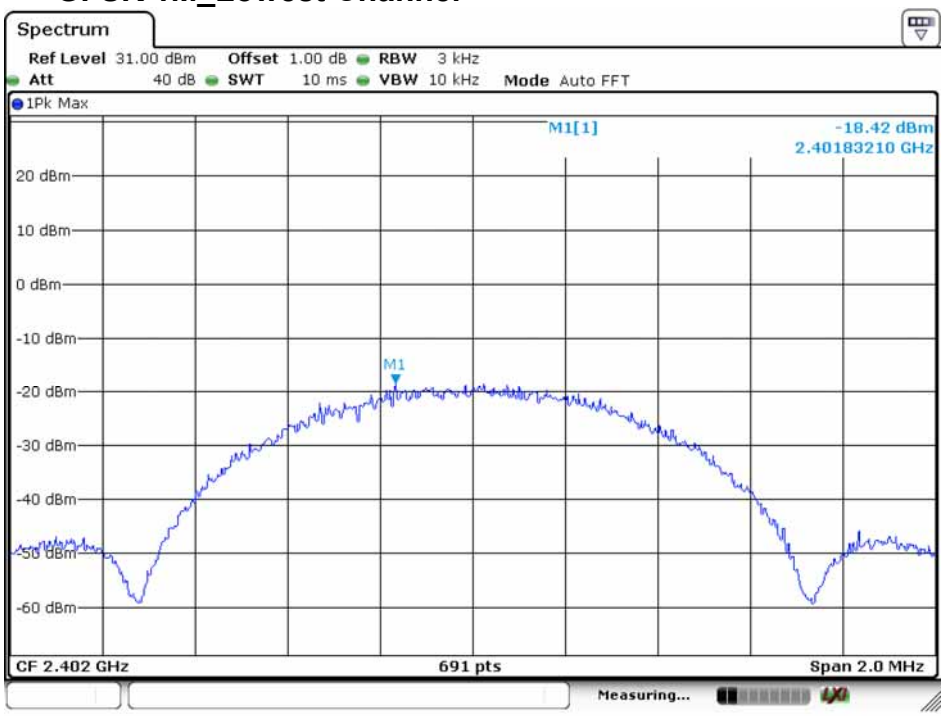
4.6.2 Test plots

4.6.2.1 GFSK 1M_Lowest Channel



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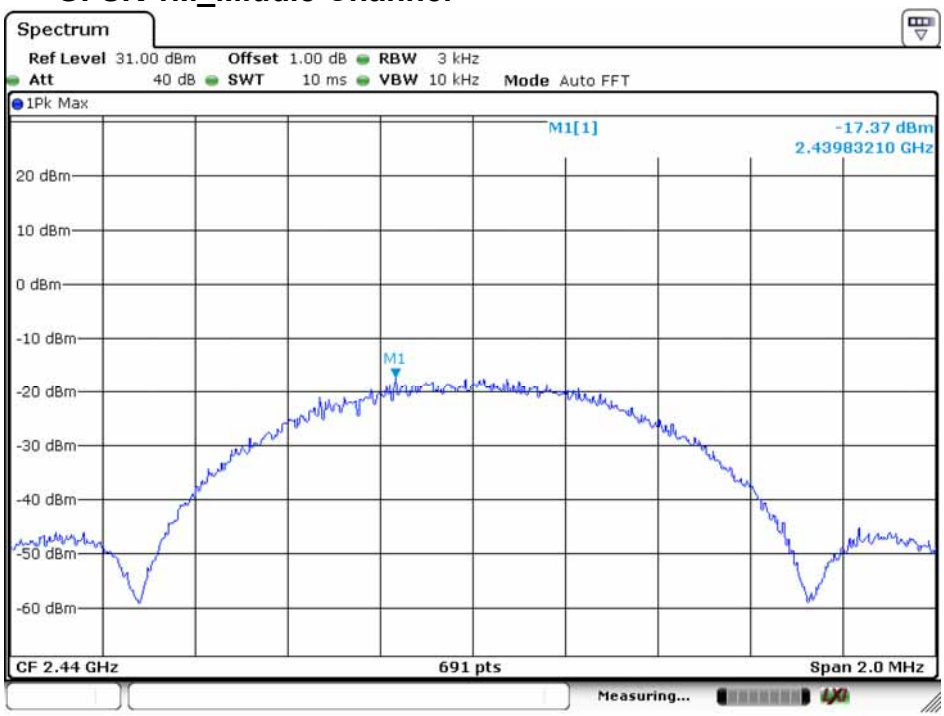
4.6.2.2 GFSK 1M_Middle Channel



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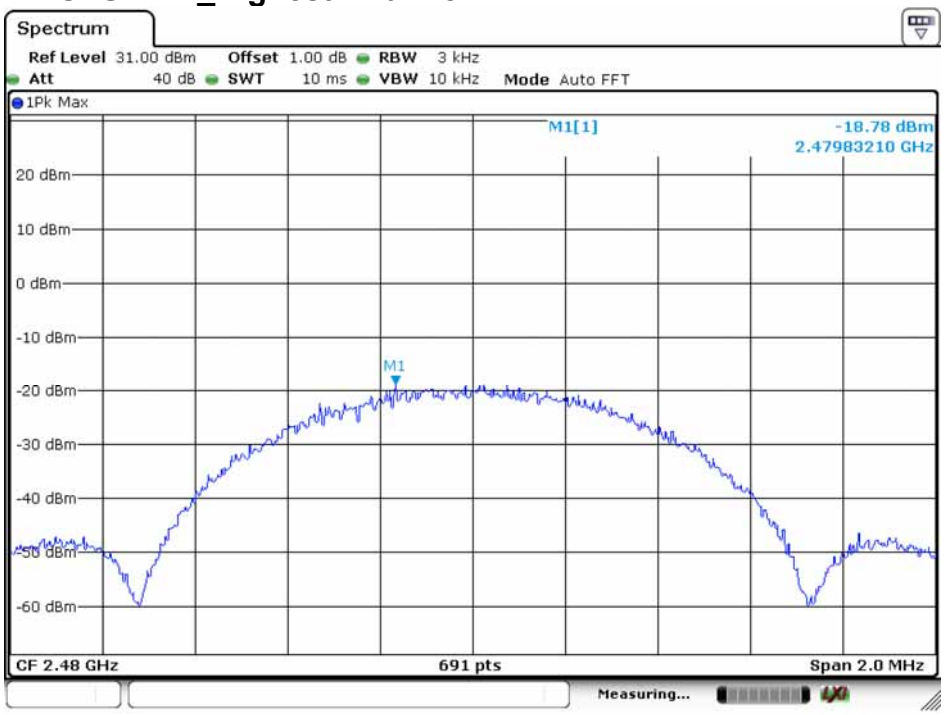
4.6.2.3 GFSK 1M_Highest Channel



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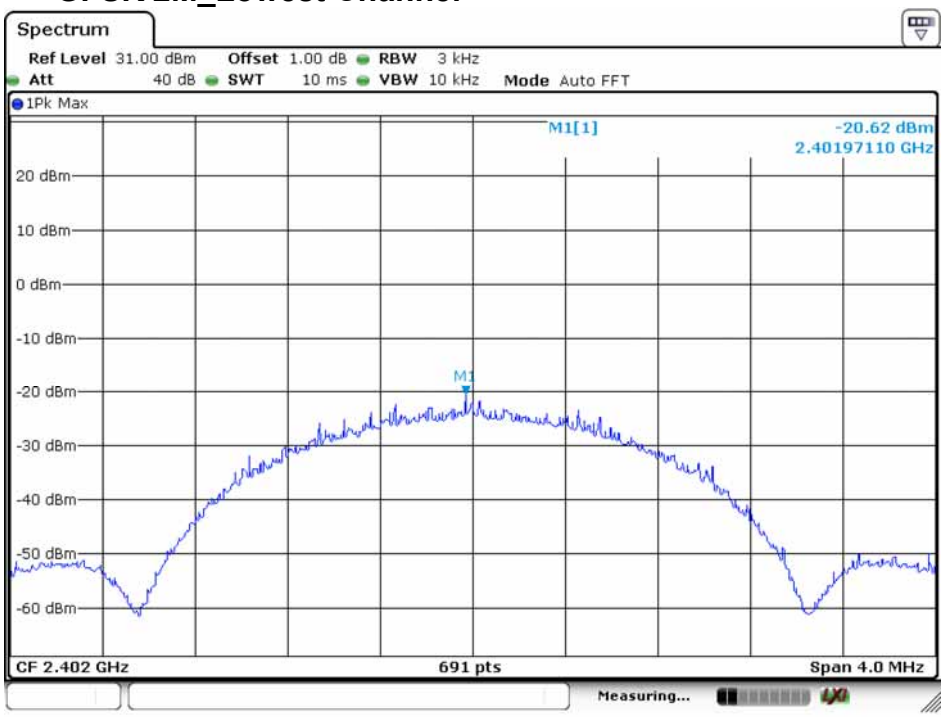
4.6.2.4 GFSK 2M_Lowest Channel



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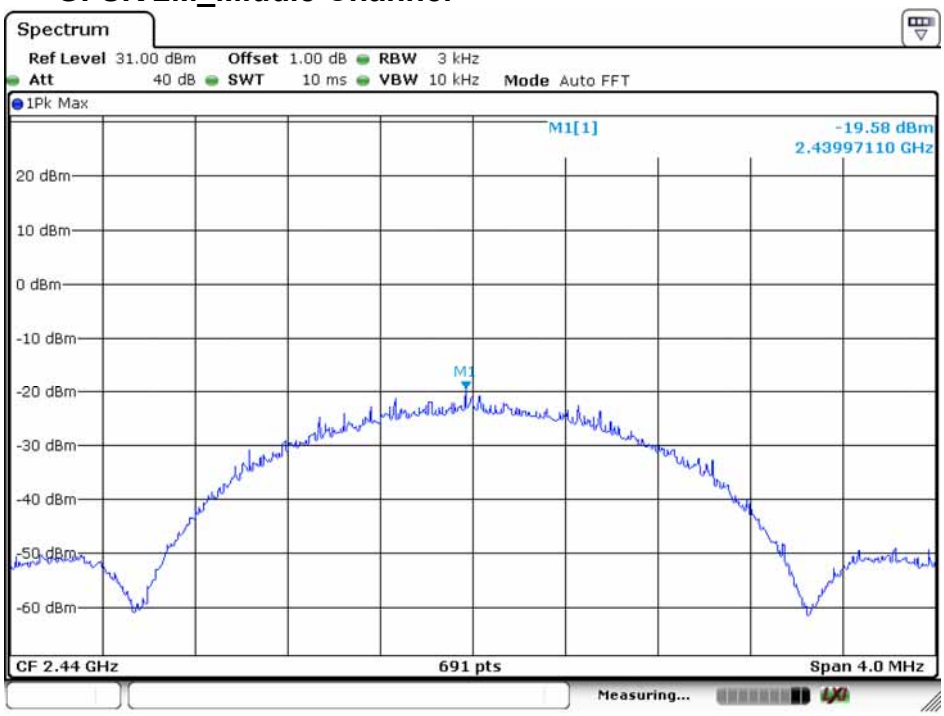
4.6.2.5 GFSK 2M_Middle Channel



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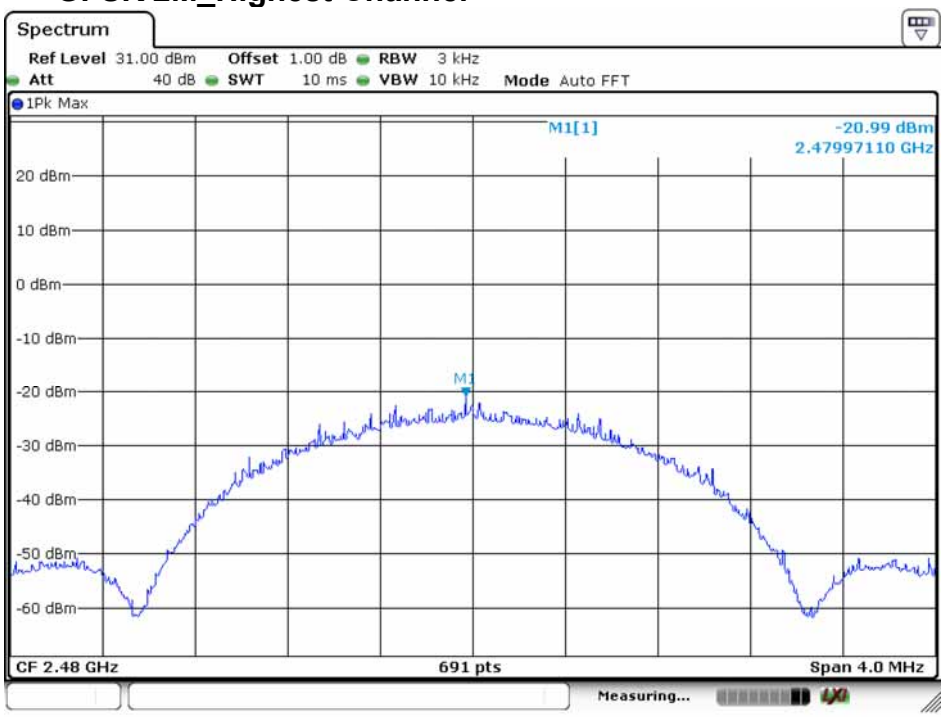
4.6.2.6 GFSK 2M_Highest Channel



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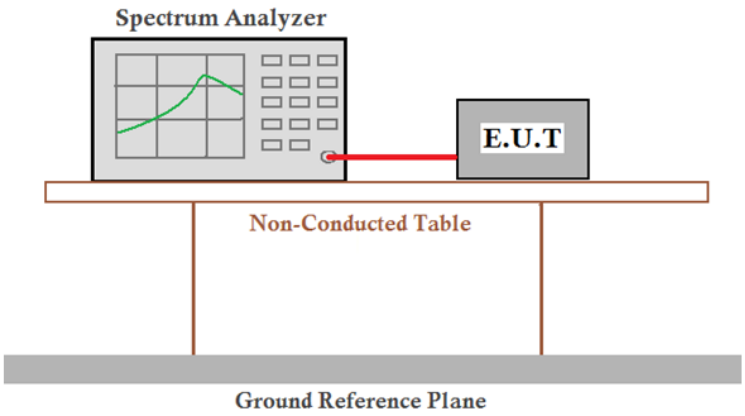
4.7 Band-edge for RF Conducted Emissions

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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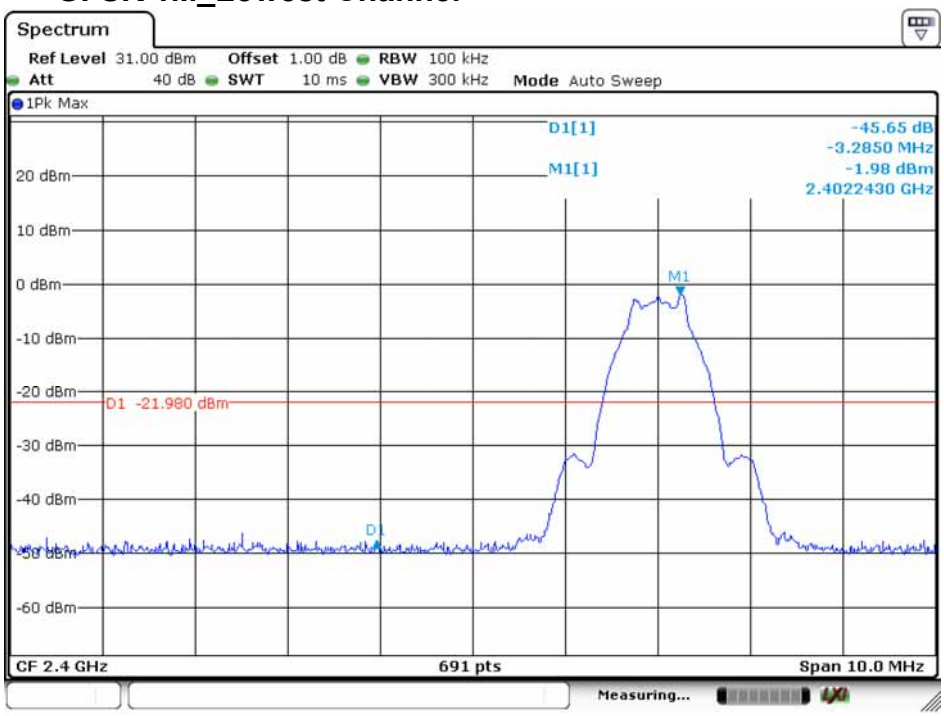
4.7.1 Test plots

4.7.1.1 GFSK 1M_Lowest Channel



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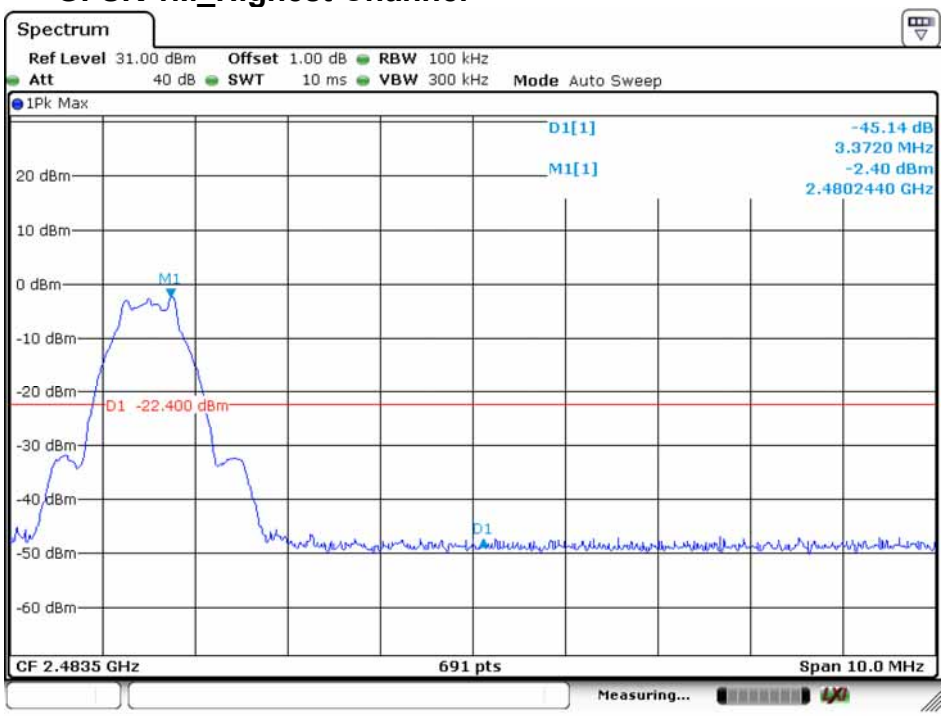
4.7.1.2 GFSK 1M_Highest Channel



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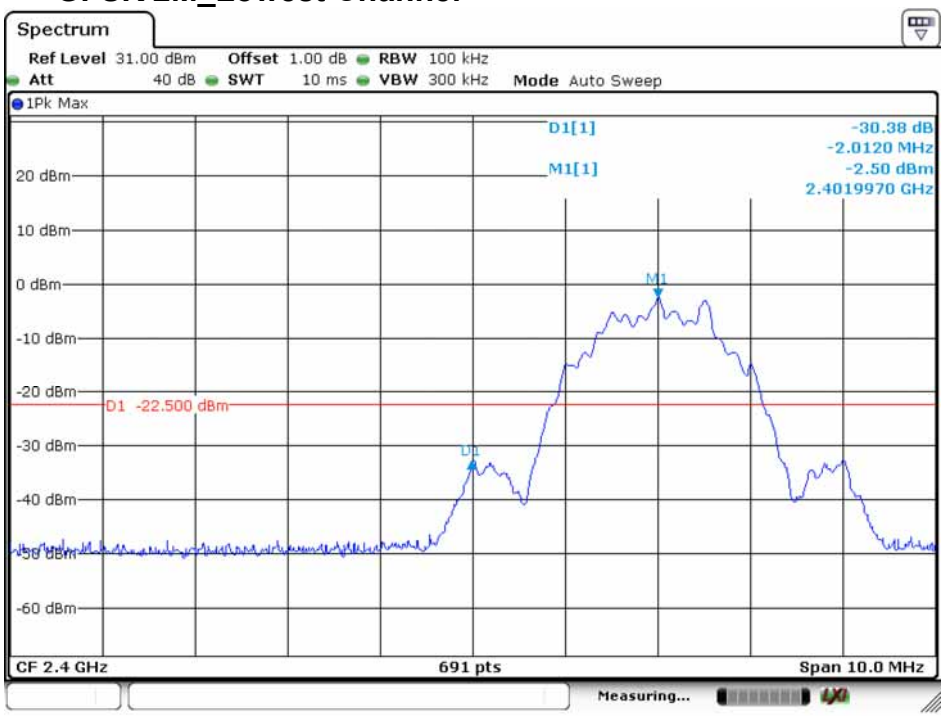
4.7.1.3 GFSK 2M_Lowest Channel



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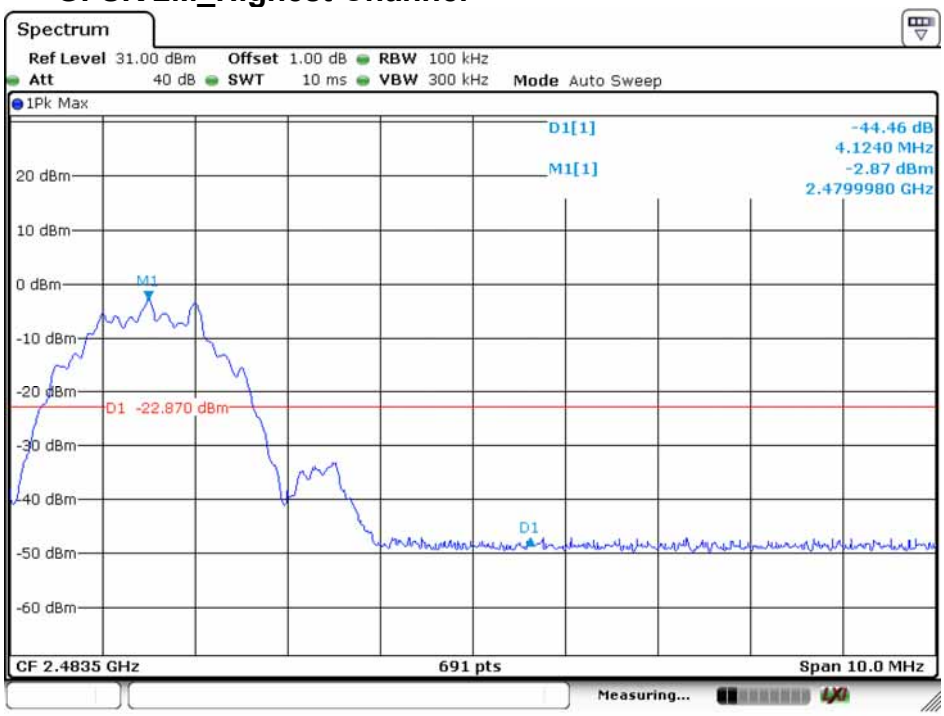
4.7.1.4 GFSK 2M_Highest Channel



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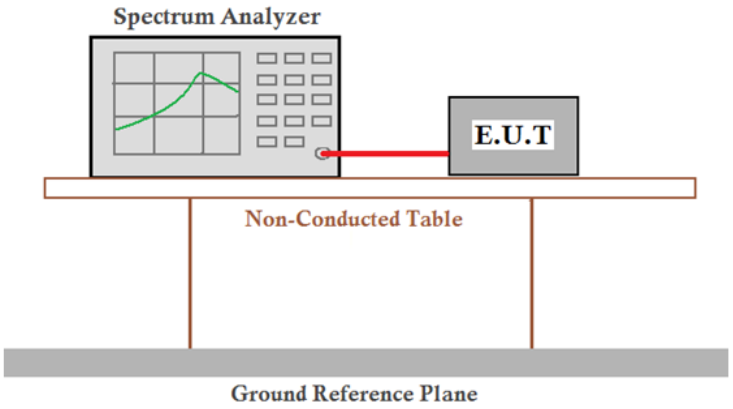
4.8 Spurious RF Conducted Emissions

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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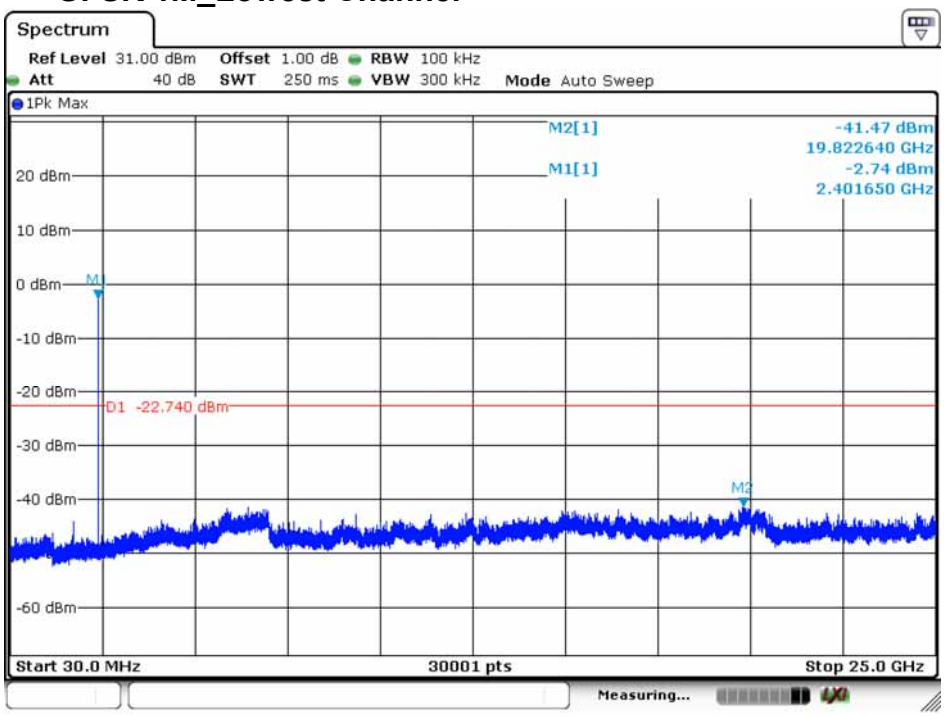
4.8.1 Test plots:

4.8.1.1 GFSK 1M_Lowest Channel



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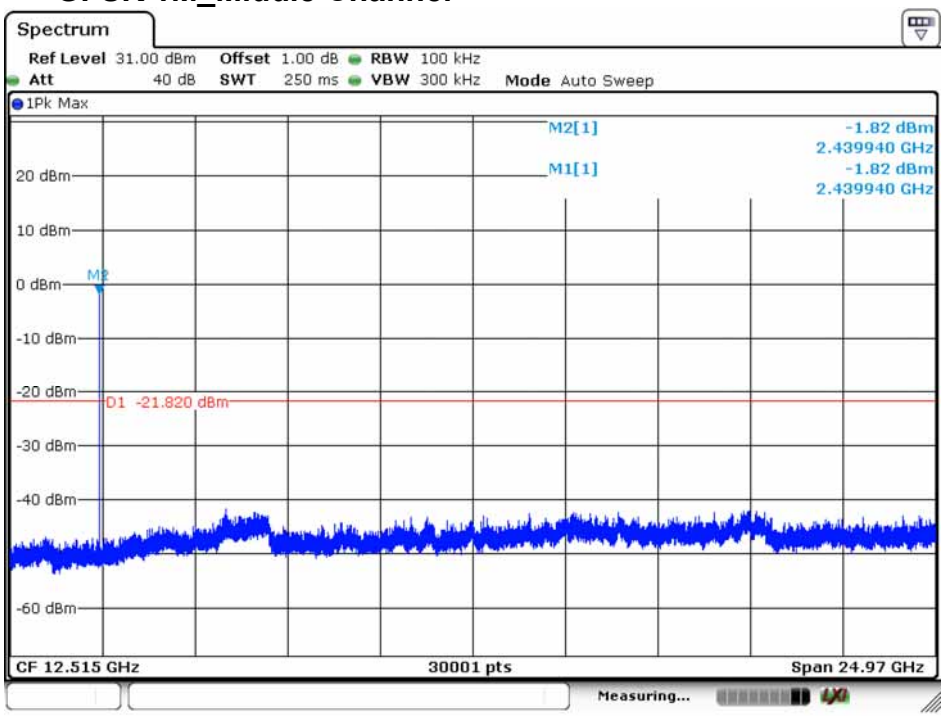
4.8.1.2 GFSK 1M_Middle Channel



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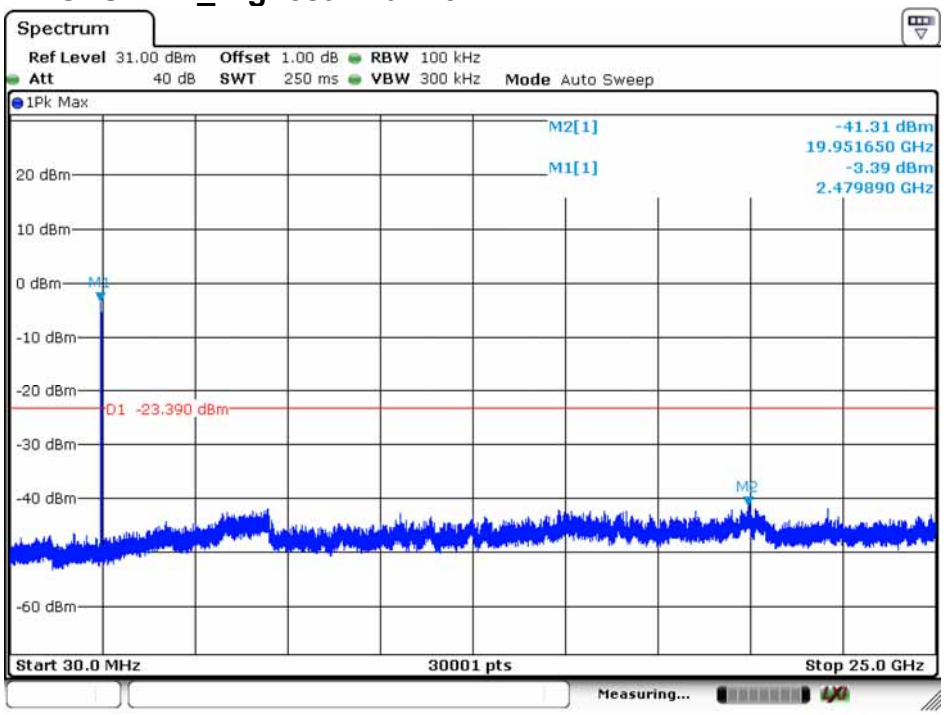
4.8.1.3 GFSK 1M_Highest Channel



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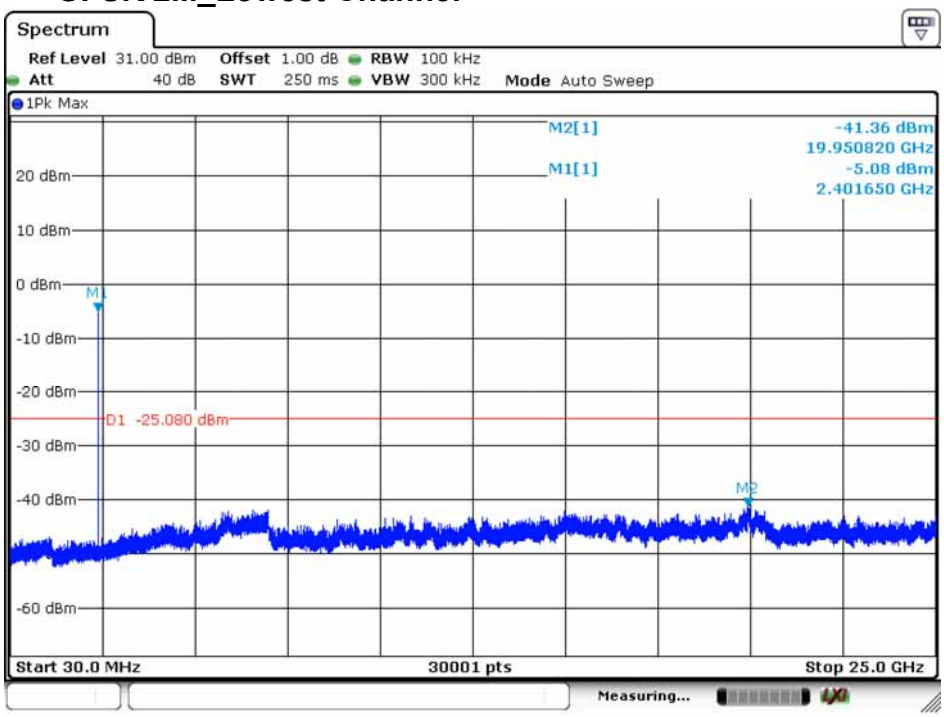
4.8.1.4 GFSK 2M_Lowest Channel



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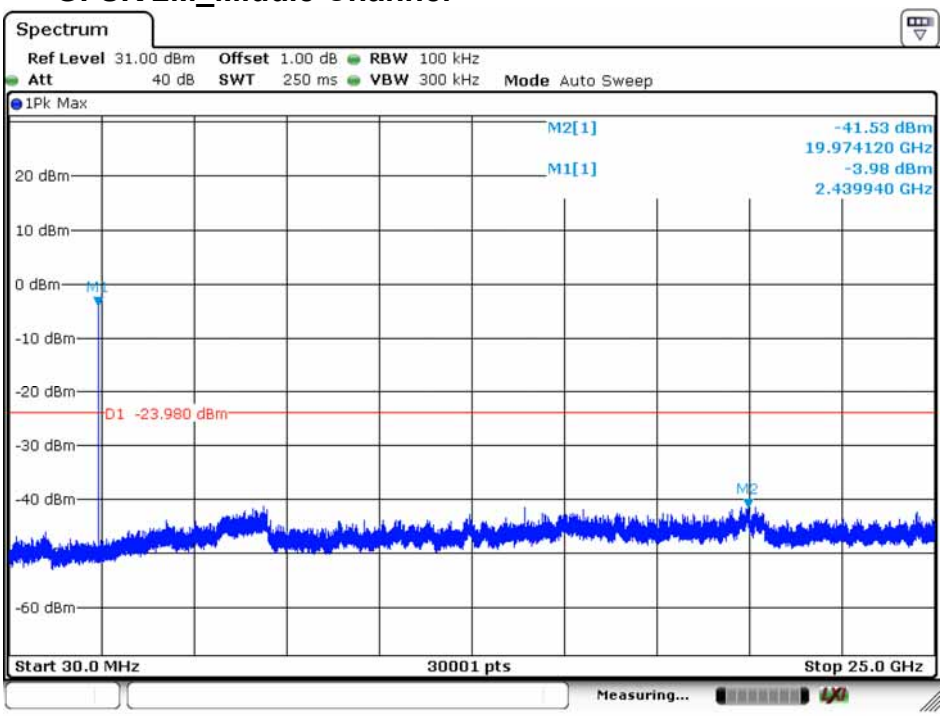
4.8.1.5 GFSK 2M_Middle Channel



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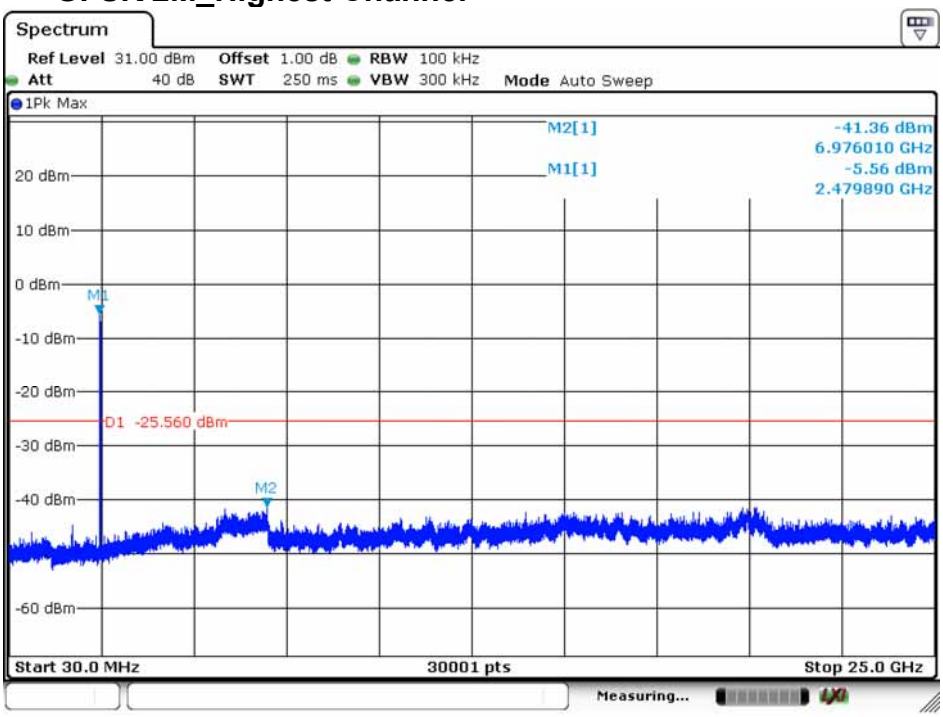
4.8.1.6 GFSK 2M_Highest Channel



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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 (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:

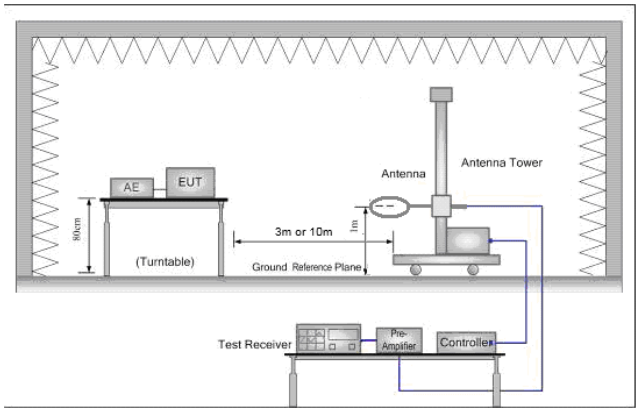

Figure 1. Below 30MHz

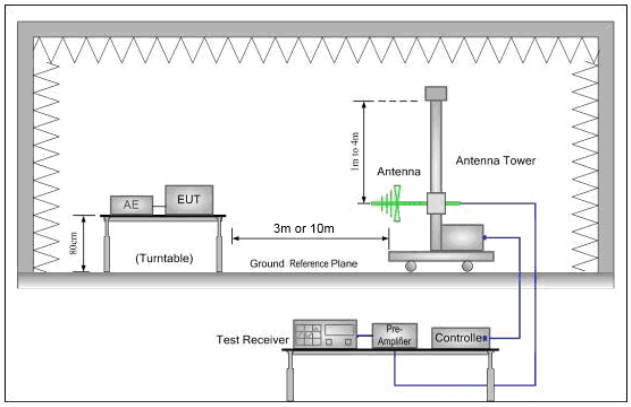

Figure 2. 30MHz to 1GHz

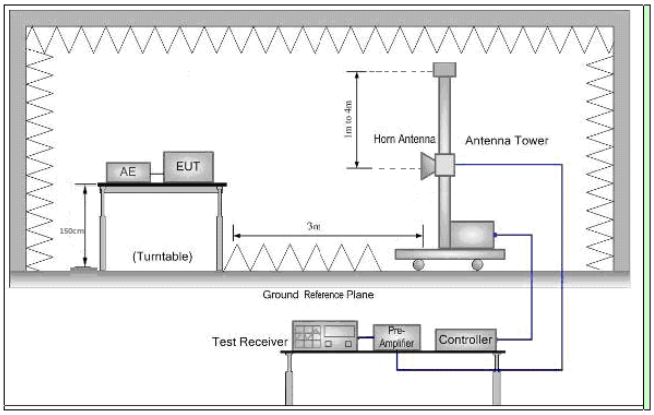

Figure 3. Above 1 GHz

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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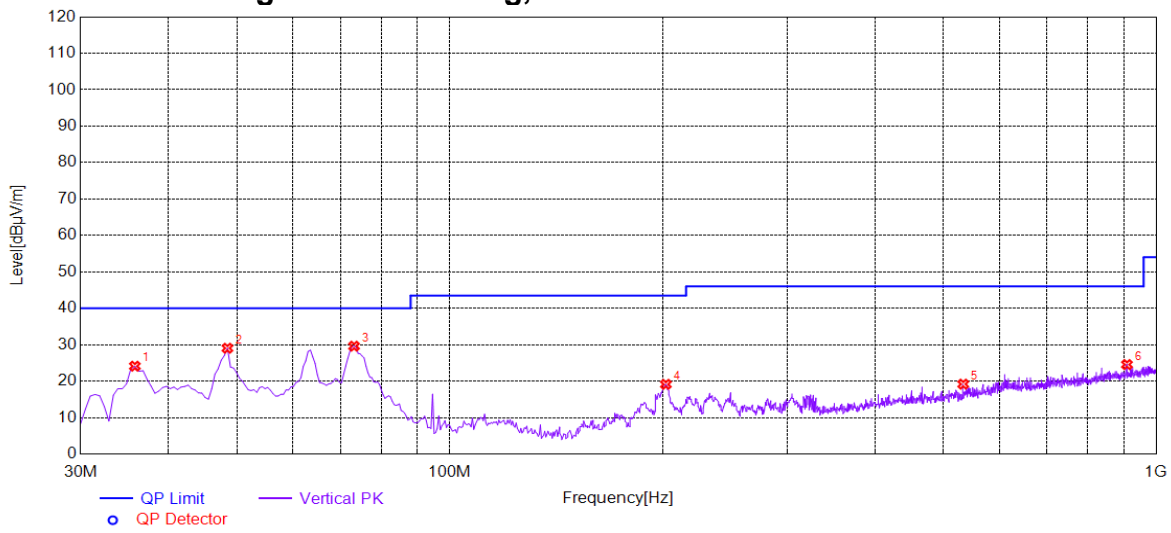
4.9.1 Radiated Emission below 1GHz

4.9.1.1 Charge + Transmitting, Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	35.8229	24.12	-32.50	40.00	15.88	150	164	Vertical
2	48.4392	29.05	-30.19	40.00	10.95	150	328	Vertical
3	73.1866	29.61	-34.71	40.00	10.39	150	292	Vertical
4	202.261	19.13	-30.77	43.50	24.37	150	314	Vertical
5	533.196	19.19	-21.86	46.00	26.81	150	164	Vertical
6	909.259	24.56	-15.09	46.00	21.44	150	176	Vertical

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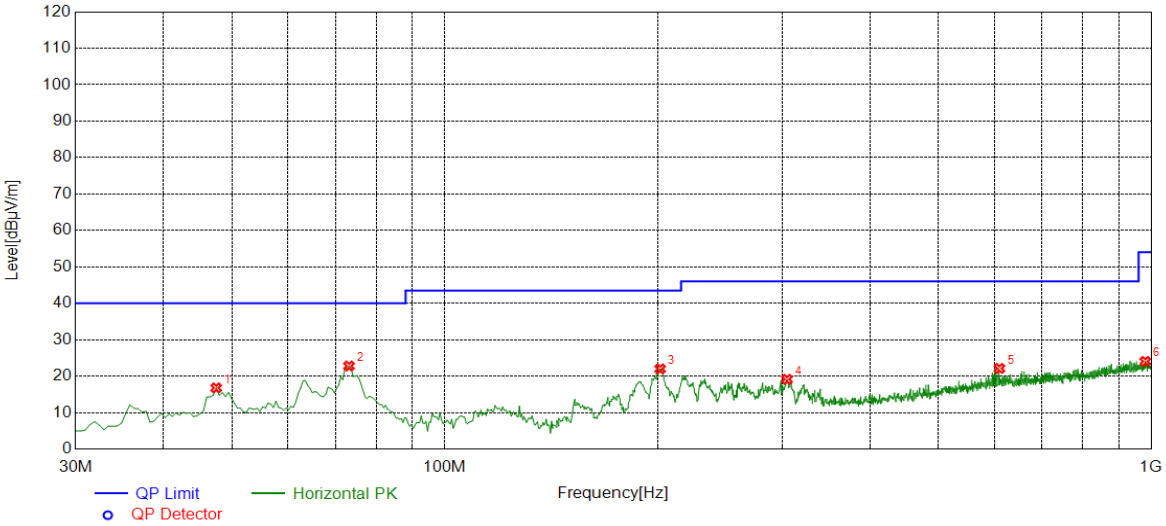
4.9.1.2 Charge + Transmitting, Horizontal



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	47.4687	16.79	-30.20	40.00	23.21	150	75	Horizontal
2	73.1866	22.79	-34.71	40.00	17.21	150	16	Horizontal
3	201.775	22.00	-30.78	43.50	21.50	150	236	Horizontal
4	305.132	19.14	-27.71	46.00	26.86	150	75	Horizontal
5	609.864	22.12	-19.94	46.00	23.88	150	82	Horizontal
6	981.075	24.05	-14.10	54.00	29.95	150	100	Horizontal

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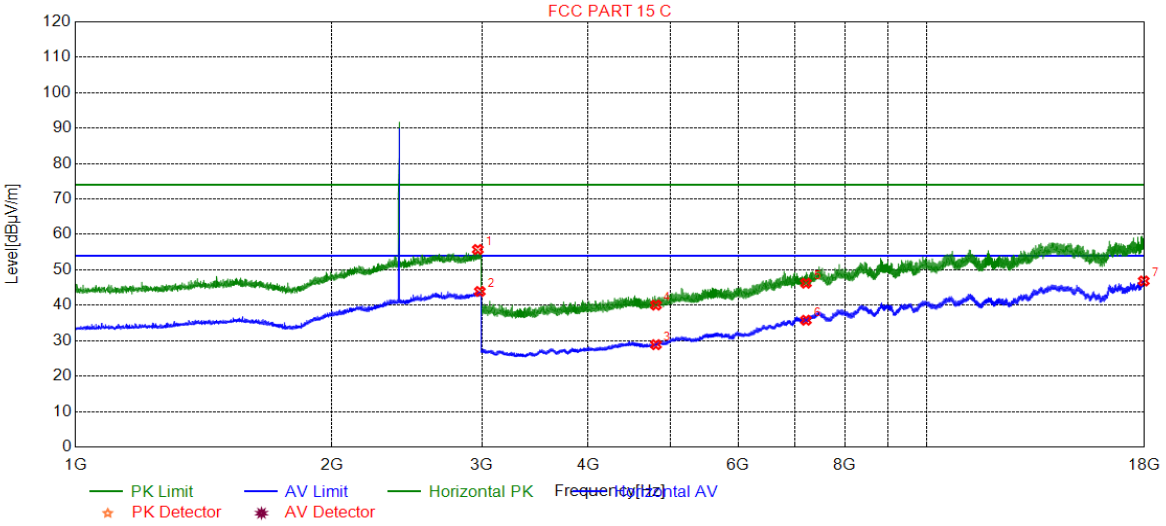
4.9.2 Transmitter Emission above 1GHz

4.9.2.1 GFSK _Lowest Channel_ Horizontal



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2967.49	55.74	9.60	74.00	18.26	150	315	Horizontal
2	2983.99	43.90	9.52	54.00	10.10	150	54	Horizontal
3	4804.00	28.89	-18.30	54.00	25.11	150	204	Horizontal
4	4804.00	40.05	-18.30	74.00	33.95	150	67	Horizontal
5	7206.00	46.23	-10.09	74.00	27.77	150	320	Horizontal
6	7206.00	35.79	-10.09	54.00	18.21	150	360	Horizontal
7	17959.8	46.86	0.71	54.00	7.14	150	360	Horizontal

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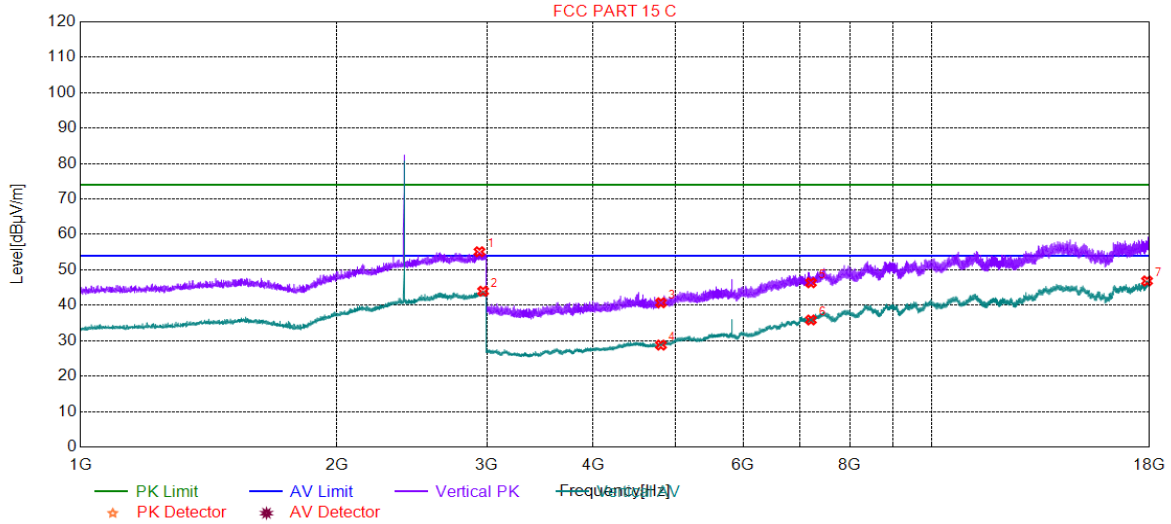
4.9.2.2 GFSK _Lowest Channel_ Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2940.98	55.12	9.58	74.00	18.88	150	333	Vertical
2	2969.99	43.97	9.59	54.00	10.03	150	73	Vertical
3	4804.00	40.71	-18.30	74.00	33.29	150	14	Vertical
4	4804.00	28.77	-18.30	54.00	25.23	150	123	Vertical
5	7206.00	46.36	-10.09	74.00	27.64	150	360	Vertical
6	7206.00	35.86	-10.09	54.00	18.14	150	360	Vertical
7	17876.7	46.87	0.38	54.00	7.13	150	322	Vertical

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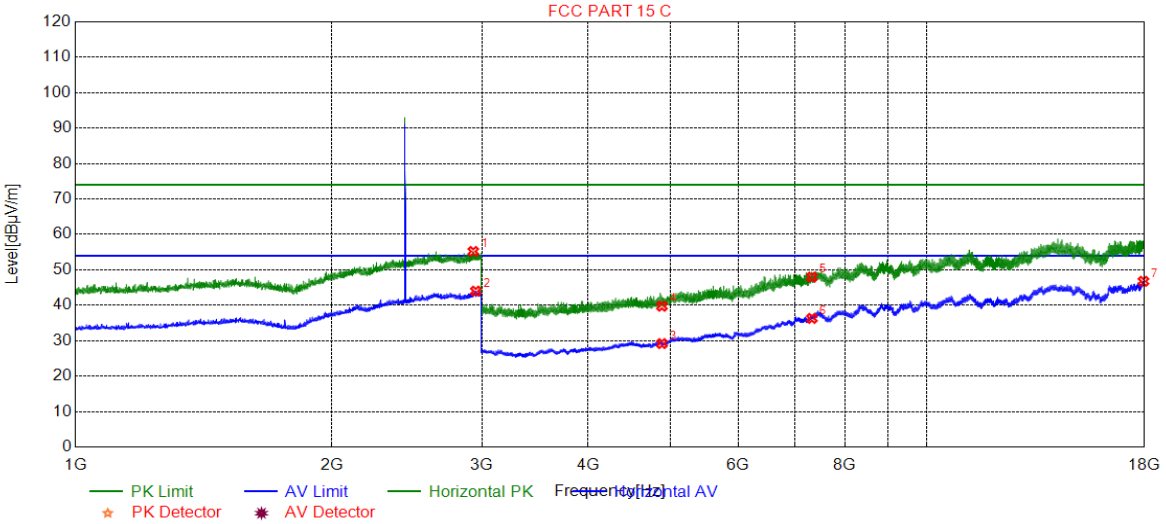
4.9.2.3 GFSK _Middle Channel_ Horizontal



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2931.48	55.20	9.48	74.00	18.80	150	274	Horizontal
2	2951.48	44.01	9.67	54.00	9.99	150	301	Horizontal
3	4882.00	29.20	-17.96	54.00	24.80	150	120	Horizontal
4	4882.00	39.74	-17.96	74.00	34.26	150	120	Horizontal
5	7323.00	47.96	-9.71	74.00	26.04	150	220	Horizontal
6	7323.00	36.30	-9.71	54.00	17.70	150	321	Horizontal
7	17946.6	46.77	0.70	54.00	7.23	150	69	Horizontal

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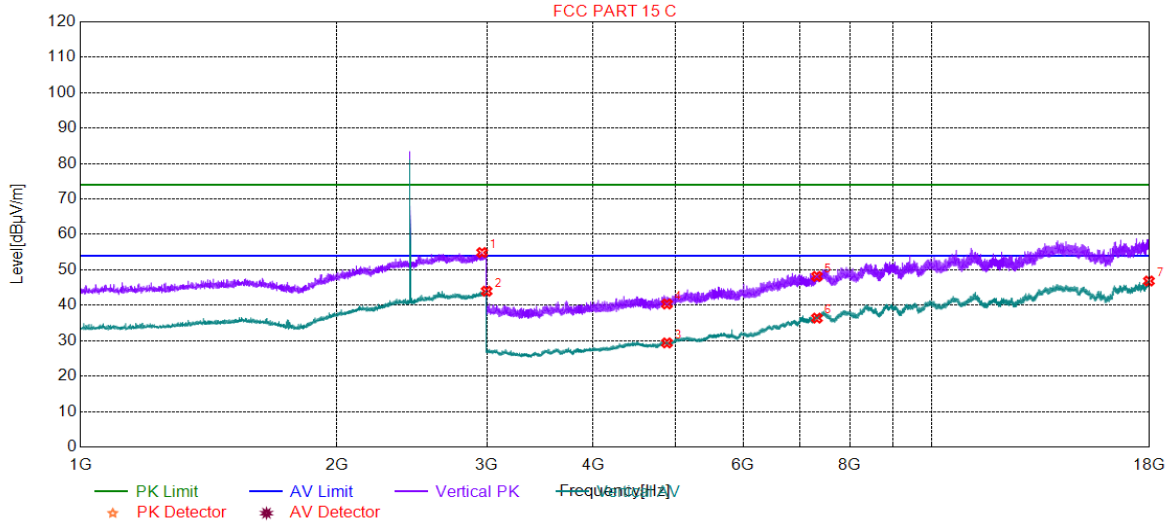
4.9.2.4 GFSK _Middle Channel_ Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2961.99	54.88	9.62	74.00	19.12	150	99	Vertical
2	2998.99	43.98	9.45	54.00	10.02	150	319	Vertical
3	4882.00	29.38	-17.96	54.00	24.62	150	39	Vertical
4	4882.00	40.36	-17.96	74.00	33.64	150	204	Vertical
5	7323.00	48.15	-9.71	74.00	25.85	150	18	Vertical
6	7323.00	36.38	-9.71	54.00	17.62	150	172	Vertical
7	17968.6	46.85	0.71	54.00	7.15	150	326	Vertical

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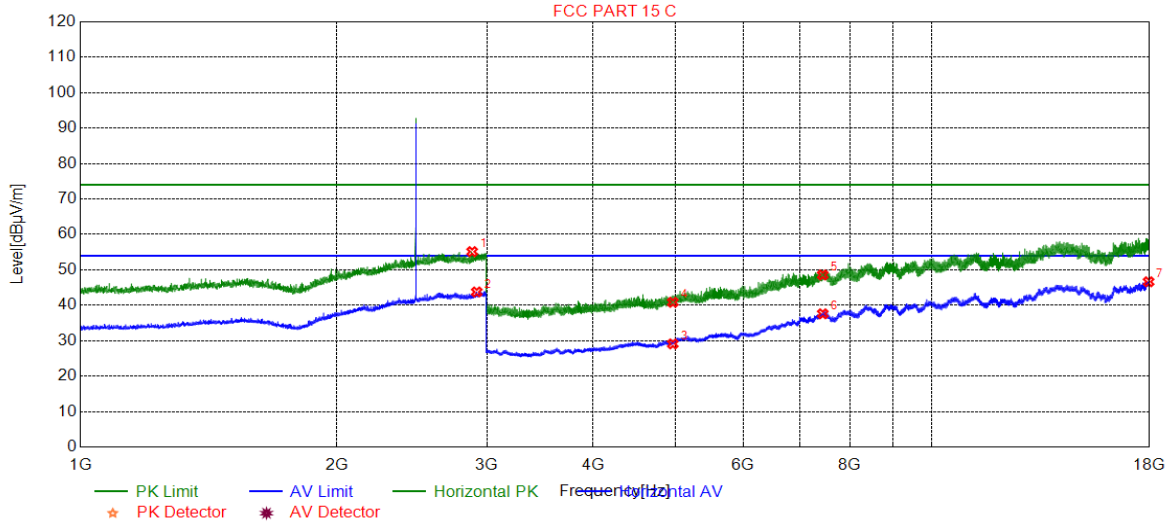
4.9.2.5 GFSK _High Channel_ Horizontal



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2883.47	55.14	9.17	74.00	18.86	150	275	Horizontal
2	2919.47	43.77	9.35	54.00	10.23	150	96	Horizontal
3	4960.00	29.11	-17.47	54.00	24.89	150	314	Horizontal
4	4960.00	40.85	-17.47	74.00	33.15	150	260	Horizontal
5	7440.00	48.57	-9.35	74.00	25.43	150	320	Horizontal
6	7440.00	37.60	-9.35	54.00	16.40	150	270	Horizontal
7	17954.3	46.64	0.71	54.00	7.36	150	18	Horizontal

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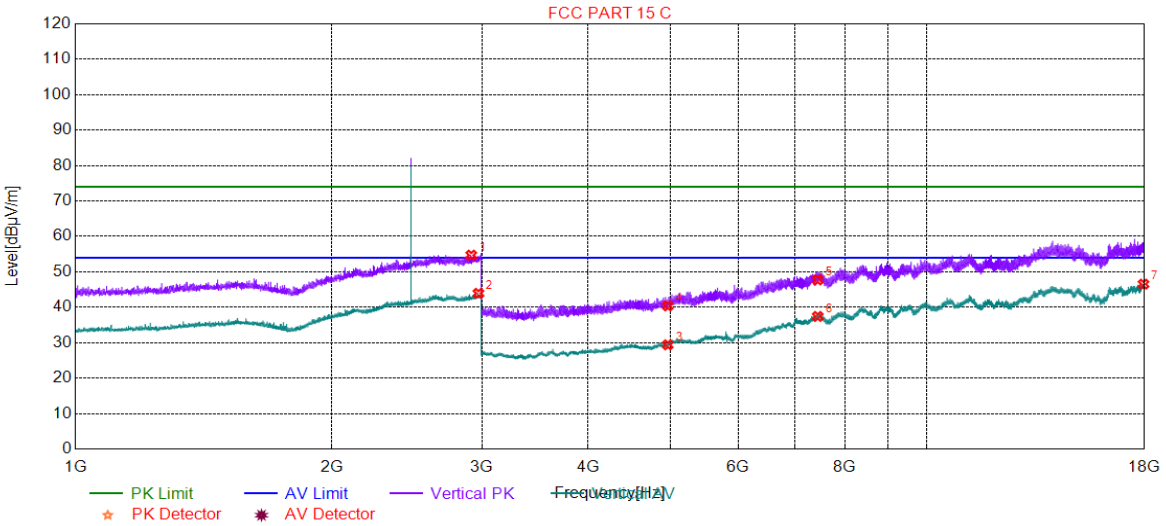
4.9.2.6 GFSK _High Channel_ Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2915.47	54.71	9.31	74.00	19.29	150	278	Vertical
2	2972.99	43.94	9.57	54.00	10.06	150	210	Vertical
3	4960.00	29.41	-17.47	54.00	24.59	150	117	Vertical
4	4960.00	40.39	-17.47	74.00	33.61	150	309	Vertical
5	7440.00	47.74	-9.35	74.00	26.26	150	219	Vertical
6	7440.00	37.43	-9.35	54.00	16.57	150	270	Vertical
7	17948.8	46.54	0.70	54.00	7.46	150	118	Vertical

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:			

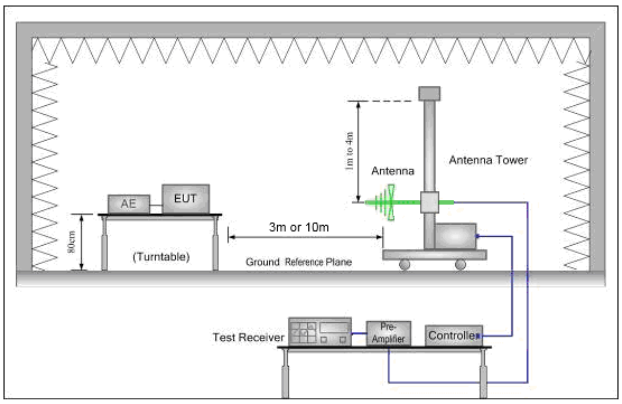

Figure 1. 30MHz to 1GHz

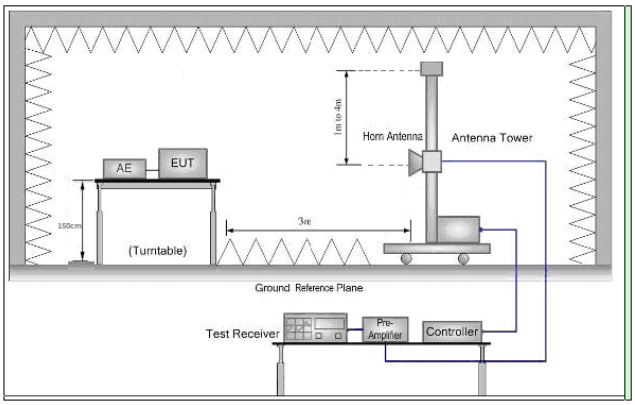

Figure 2. Above 1 GHz

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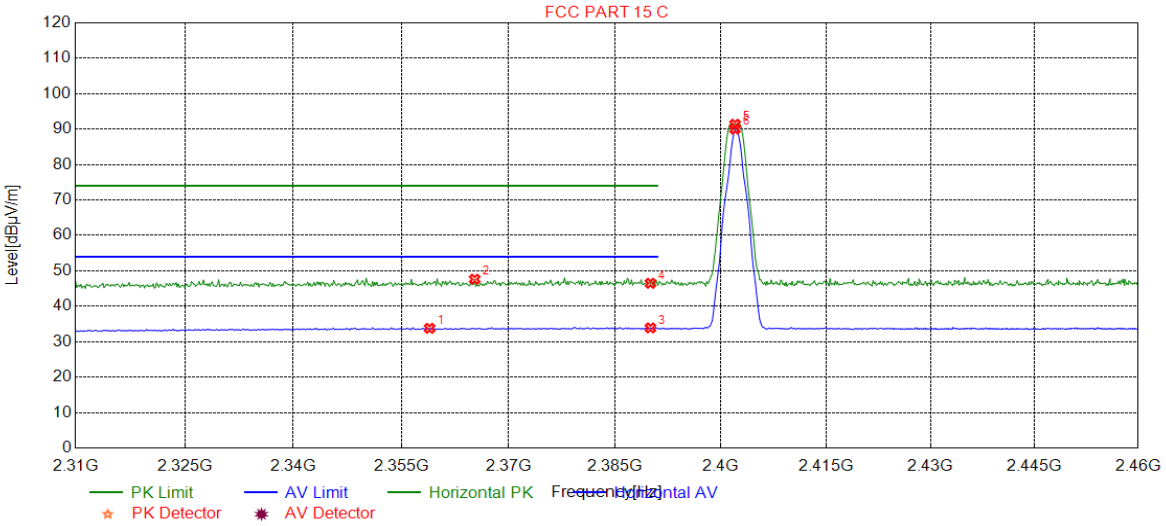
	i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case. j. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Transmitting with GFSK modulation. Charge + Transmitting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



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2358.94	33.80	7.80	54.00	20.20	150	0	Horizontal
2	2365.25	47.64	7.79	74.00	26.36	150	0	Horizontal
3	2390.00	33.90	7.77	54.00	20.10	150	45	Horizontal
4	2390.00	46.50	7.77	74.00	27.50	150	177	Horizontal
5	2402.00	91.39	7.77	0.00	-91.39	150	103	Horizontal
6	2402.00	90.02	7.77	0.00	-90.02	150	107	Horizontal

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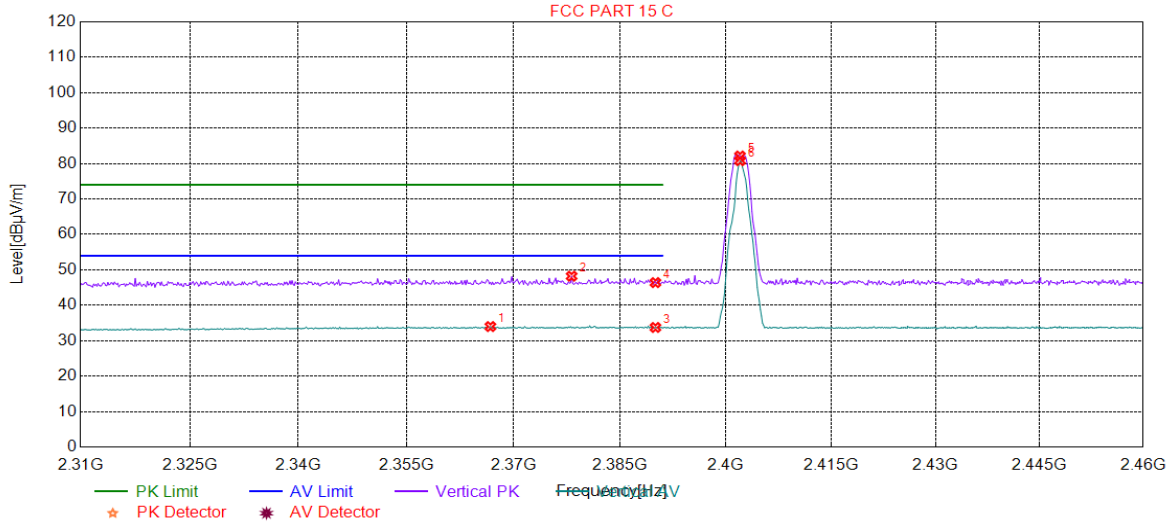
4.10.1.2 Worst Case Mode (GFSK) Lowest Channel_ Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2366.75	34.00	7.79	54.00	20.00	150	176	Vertical
2	2378.16	48.22	7.78	74.00	25.78	150	279	Vertical
3	2390.00	33.75	7.77	54.00	20.25	150	41	Vertical
4	2390.00	46.41	7.77	74.00	27.59	150	300	Vertical
5	2402.00	82.14	7.77	0.00	-82.14	150	259	Vertical
6	2402.00	80.81	7.77	0.00	-80.81	150	259	Vertical

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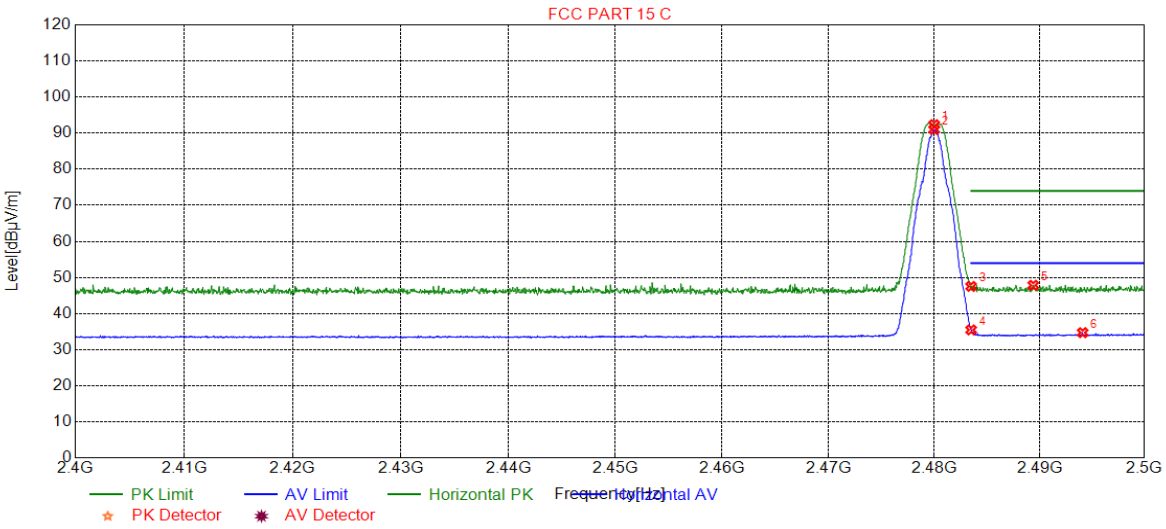
4.10.1.3 Worst Case Mode (GFSK) Highest Channel_ Horizontal



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	92.35	8.01	0.00	-92.35	150	73	Horizontal
2	2480.00	91.00	8.01	0.00	-91.00	150	73	Horizontal
3	2483.50	47.53	8.01	74.00	26.47	150	56	Horizontal
4	2483.50	35.48	8.01	54.00	18.52	150	84	Horizontal
5	2489.39	47.85	8.02	74.00	26.15	150	331	Horizontal
6	2494.09	34.72	8.02	54.00	19.28	150	276	Horizontal

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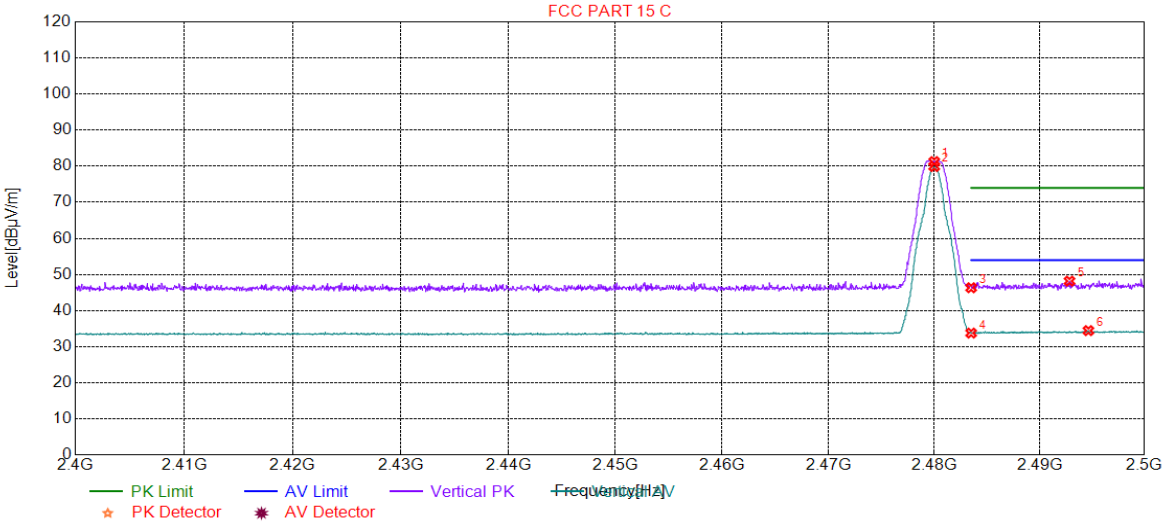
4.10.1.4 Worst Case Mode (GFSK) Highest Channel_ Vertical



Suspected List

Suspected List								
NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	2480.00	81.29	8.01	0.00	-81.29	150	260	Vertical
2	2480.00	79.91	8.01	0.00	-79.91	150	254	Vertical
3	2483.50	46.32	8.01	74.00	27.68	150	52	Vertical
4	2483.50	33.77	8.01	54.00	20.23	150	112	Vertical
5	2492.84	48.17	8.02	74.00	25.83	150	332	Vertical
6	2494.64	34.45	8.02	54.00	19.55	150	349	Vertical

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

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

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

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6 Equipment List

Conducted Emission					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Duedate (yyyy-mm-dd)
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2020/5/10	2023/5/9
LISN	Rohde & Schwarz	ENV216	SEM007-01	2019/7/14	2020/7/14
LISN	ETS-LINDGREN	Feb-16	SEM007-02	20120/4/1	2021/3/31
Measurement Software	AUDIX	e3 V5.4.1221d	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2019/6/12	2020/6/11
2 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T2-02	EMC0122	2020/2/11	2021/2/10
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2020/3/2	2021/3/1

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Duedate (yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	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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RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Due date (yyyy-mm-dd)
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018/3/13	2021/3/12
Measurement Software	AUDIX	e3V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2019/6/12	2020/6/11
EXA Signal Analyzer (10Hz-26.5GHz)	Agilent Technologies Inc	N9010A	SEM004-09	2020/3/12	2021/3/11
BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-01	2017/6/27	2020/6/26
Horn Antenna (0.8-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018/4/13	2021/4/12
Pre-amplifier(0.1-1.3GHz)	HP	8447D	SEM005-02	2019/7/14	2020/7/14
Low Noise Amplifier(100MHz-18GHz)	Black Diamond Series	BDLNA-0118-352810	SEM005-05	2019/9/3	2020/9/2
Horn Antenna (15-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017/10/17	2020/10/16
Pre-amplifier(18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2020/3/2	2021/3/1
Band filter	N/A	N/A	SEM023-01	N/A	N/A

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy-mm-dd)	Cal.Due date (yyyy-mm-dd)
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2017/8/5	2020/8/4
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2019/6/12	2020/6/11
MXE EMI Receiver (20Hz-8.4GHz)	Agilent Technologies	N9038A	SEM004-05	2019/7/14	2020/7/14
BiConiLog Antenna (26-3000MHz)	ETS-LINDGREN	3142C	SEM003-01	2017/6/27	2020/6/26
Pre-amplifier (0.1-1.3GHz)	Agilent Technologies	8447D	SEM005-01	2020/3/2	2021/3/1

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RE in Chamber					
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10m Semi-Anechoic Chamber	SAEMC	FSAC1018	SEM001-03	2018/3/31	2021/3/30
EMI Test Receiver (9k-7GHz)	Rohde & Schwarz	ESR	SEM004-03	2020/3/2	2021/3/1
Trilog-Broadband Antenna(25M-2GHz)	Schwarzbeck	VULB9168	SEM003-18	2020/3/15	2022/3/14
Pre-amplifier (9k-1GHz)	Sonoma	310N	SEM005-03	2020/3/12	2021/3/11
Loop Antenna (9kHz-30MHz)	ETS-Lindgren	6502	SEM003-08	2017/8/22	2020/8/21
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM029-01	2019/6/12	2020/6/11

7 Photographs - EUT Constructional Details

Refer to Appendix A - Photographs of Set-Up for ZR/2020/50001.

The End

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