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Report Template Version: V04
Report Template Revision Date: 2018-07-06

Test Report

Report No. :	CQASZ20200800831E-03
Applicant:	Aidios Limited.
Address of Applicant:	D41, 14/F., Blk D, Wah Lok Center, 31-35 Shan Mei St., FoTan, Shatin, N.T., HongKong
Equipment Under Test (EUT):	
EUT Name:	2.4GHz Wireless Monitoring System
Model No.:	M1M and series
Test Model No.:	M1M
Brand Name:	aidios
FCC ID:	2AS8PAIDIOSM1M
Standards:	47 CFR Part 15, Subpart C
Date of Receipt:	2020-08-12
Date of Test:	2020-08-12 to 2020-12-03
Date of Issue:	2020-12-03
Test Result :	**PASS***

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

Tested By: Jun Li

(Jun Li)

Reviewed By: Sheek.Luo

(Sheek Luo)

Approved By:

(Jack Ai)

1 Version

Revision History Of Report

Report No.	Version	Description	Issue Date
CQASZ20200800831E-03	Rev.01	Initial report	2020-12-03

2 Test Summary

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203/15.247 (c)	ANSI C63.10 (2013)	PASS
AC Power Line Conducted Emission	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10 (2013)	PASS
Conducted Peak Output Power	47 CFR Part 15, Subpart C Section 15.247 (b)(1)	ANSI C63.10 (2013)	PASS
20dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Carrier Frequencies Separation	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Hopping Channel Number	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Dwell Time	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10 (2013)	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15, Subpart C Section 15.247(b)(4)&TCB Exclusion List (7 July 2002)	ANSI C63.10 (2013)	PASS
Band-edge for RF Conducted Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
RF Conducted Spurious Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10 (2013)	PASS
Radiated Spurious emissions	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS
Restricted bands around fundamental frequency (Radiated Emission)	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10 (2013)	PASS

Model No.: M1M and series

Only the model M1M was tested, since the electrical circuit design, layout, components used and internal wiring were identical for the above models, with difference being color of appearance, pack and model name.

3 Contents

4 General Information

4.1 Client Information

Applicant:	Aidios Limited.
Address of Applicant:	D41, 14/F., Blk D, Wah Lok Center, 31-35 Shan Mei St., FoTan, Shatin, N.T., HongKong
Manufacturer:	Aidios Limited.
Address of Manufacturer:	D41, 14/F., Blk D, Wah Lok Center, 31-35 Shan Mei St., FoTan, Shatin, N.T., HongKong
Factory:	Exvision Industries Ltd,
Factory of Manufacturer:	3/F., No. 65 Longyan 6th Road, Humen, Dongguan, China, ZIP 523925

4.2 General Description of EUT

Product Name:	2.4GHz Wireless Monitoring System
Model No.:	M1M and series
Test Model No.:	M1M
Trade Mark:	aidios
Hardware Version:	V7
Software Version:	V1.0
Operation Frequency:	2406-2475MHz
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	FSK/GFSK
Transfer Rate:	4Mbps
Number of Channel:	24
Hopping Channel Type:	Adaptive Frequency Hopping systems
Product Type:	☐ Mobile ☒ Portable ☐ Fix Location
Test Software of EUT:	RF Test (manufacturer declare)
Antenna Type:	Dipole Antenna
Antenna Gain:	2 dBi
Power Supply:	either Adapter or Li-ion Polymer Battery 3.7V/1800mAH
Adapter:	Model: K05B050100U Input: 100-240V 50/60Hz 0.2A Output: DC 5V 1A

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2406MHz	8	2427MHz	15	2448MHz	22	2469MHz
2	2409MHz	9	2430MHz	16	2451MHz	23	2472MHz
3	2412MHz	10	2433MHz	17	2454MHz	24	2475MHz
4	2415MHz	11	2436MHz	18	2457MHz		
5	2418MHz	12	2439MHz	19	2460MHz		
6	2421MHz	13	2442MHz	20	2463MHz		
7	2424MHz	14	2445MHz	21	2466MHz		

Note:
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	2406MHz
The Middle channel	2442MHz
The Highest channel	2475MHz

4.3 Additional Instructions

EUT Test Software Settings:		
Mode:	☐Special software is used. ☒Through engineering command into the engineering mode. Type "right, up, right, down, right, up, right, down, EXIT" in the following order to enter ”engineering mode”	
EUT Power level:	Class2 (Power level is built-in set parameters and cannot be changed and selected)	
Use test software to set the lowest frequency, the middle frequency and the highest frequency keep transmitting of the EUT.		
Mode	Channel	Frequency(MHz)
FSK/GFSK	CH1	2406
	CH13	2442
	CH24	2475

4.4 Test Environment

Operating Environment:	
Radiated Emissions:	
Temperature:	25.6 °C
Humidity:	56 % RH
Atmospheric Pressure:	1009mbar
Conducted Emissions:	
Temperature:	25.6 °C
Humidity:	56 % RH
Atmospheric Pressure:	1009mbar
Radio conducted item test (RF Conducted test room):	
Temperature:	25.4 °C
Humidity:	53 % RH
Atmospheric Pressure:	1009 mbar
Test mode:	
Test Mode:	Use test software to set the lowest frequency, the middle frequency and the highest frequency keep transmitting of the EUT.

4.5 Description of Support Units

The EUT has been tested with associated equipment below.

1）Support equipment

Description	Manufacturer	Model No.	Certification	Supplied by
Adapter	Guanjin	K05B050100U	/	Client

4.6 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate.

The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities.

The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16 - 4 „Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements“ and is documented in the **Shenzhen Huaxia Testing Technology Co., Ltd.** quality system acc. to DIN EN ISO/IEC 17025.

Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CQA laboratory is reported:

No.	Item	Uncertainty	Notes
1	Radiated Emission (Below 1GHz)	5.12dB	(1)
2	Radiated Emission (Above 1GHz)	4.60dB	(1)
3	Conducted Disturbance (0.15~30MHz)	3.34dB	(1)
4	Radio Frequency	3×10^{-8}	(1)
5	Duty cycle	0.6 %.	(1)
6	Occupied Bandwidth	1.1%	(1)
7	RF conducted power	0.86dB	(1)
8	RF power density	0.74	(1)
9	Conducted Spurious emissions	0.86dB	(1)
10	Temperature test	0.8℃	(1)
11	Humidity test	2.0%	(1)
12	Supply voltages	0.5 %.	(1)
13	Frequency Error	5.5 Hz	(1)

(1)This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

4.7 Test Location

Shenzhen Huaxia Testing Technology Co., Ltd,

1F., Block A of Tongsheng Technology Building, Huahui Road, Dalang Street, Longhua District, Shenzhen, China

4.8 Test Facility

- **A2LA (Certificate No. 4742.01)**
Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 4742.01.
- **FCC Registration No.: 522263**
Shenzhen Huaxia Testing Technology Co., Ltd., Shenzhen EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration No.:522263

4.9 Abnormalities from Standard Conditions

None.

4.10 Other Information Requested by the Customer

None.

4.11 Equipment List

Test Equipment	Manufacturer	Model No.	Instrument No.	Calibration Date	Calibration Due Date
EMI Test Receiver	R&S	ESR7	CQA-005	2019/10/25 2020/10/25	2020/10/24 2021/10/24
Spectrum analyzer	R&S	FSU26	CQA-038	2019/10/25 2020/10/25	2020/10/24 2021/10/24
Preamplifier	MITEQ	AMF-6D-02001800-29-20P	CQA-036	2019/10/25 2020/10/25	2020/10/24 2021/10/24
Loop antenna	Schwarzbeck	FMZB1516	CQA-060	2019/10/21 2020/10/21	2020/10/20 2021/10/20
Bilog Antenna	R&S	HL562	CQA-011	2019/9/26 2020/9/26	2020/9/25 2021/9/25
Horn Antenna	R&S	HF906	CQA-012	2019/9/26 2020/9/26	2020/9/25 2021/9/25
Horn Antenna	Schwarzbeck	BBHA 9170	CQA-088	2019/9/25 2020/9/25	2020/9/24 2021/9/24
Coaxial Cable (Above 1GHz)	CQA	N/A	C007	2019/9/26 2020/9/26	2020/9/25 2021/9/25
Coaxial Cable (Below 1GHz)	CQA	N/A	C013	2019/9/26 2020/9/26	2020/9/25 2021/9/25
Antenna Connector	CQA	RFC-01	CQA-080	2019/9/26 2020/9/26	2020/9/25 2021/9/25
RF cable(9KHz~40GHz)	CQA	RF-01	CQA-079	2019/9/26 2020/9/26	2020/9/25 2021/9/25
Power divider	MIDWEST	PWD-2533-02-SMA-79	CQA-067	2019/9/26 2020/9/26	2020/9/25 2021/9/25
EMI Test Receiver	R&S	ESR7	CQA-005	2019/10/25 2020/10/25	2020/10/24 2021/10/24
LISN	R&S	ENV216	CQA-003	2019/10/23 2020/10/23	2020/10/22 2020/10/22
Coaxial cable	CQA	N/A	CQA-C009	2019/9/26 2020/9/26	2020/9/25 2021/9/25
DC power	KEYSIGHT	E3631A	CQA-028	2019/9/26 2020/9/26	2020/9/25 2021/9/25

Note:

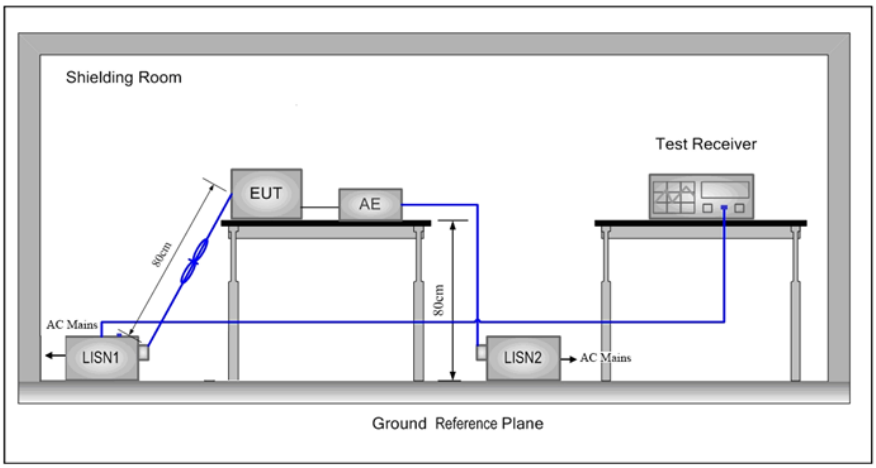
The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.

5 Test results and Measurement Data

5.1 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.	
EUT Antenna:	Please see EUT internal photos.
The antenna is soldering on the main PCB and no consideration of replacement. The best case gain of the antenna is 2.0dBi.	

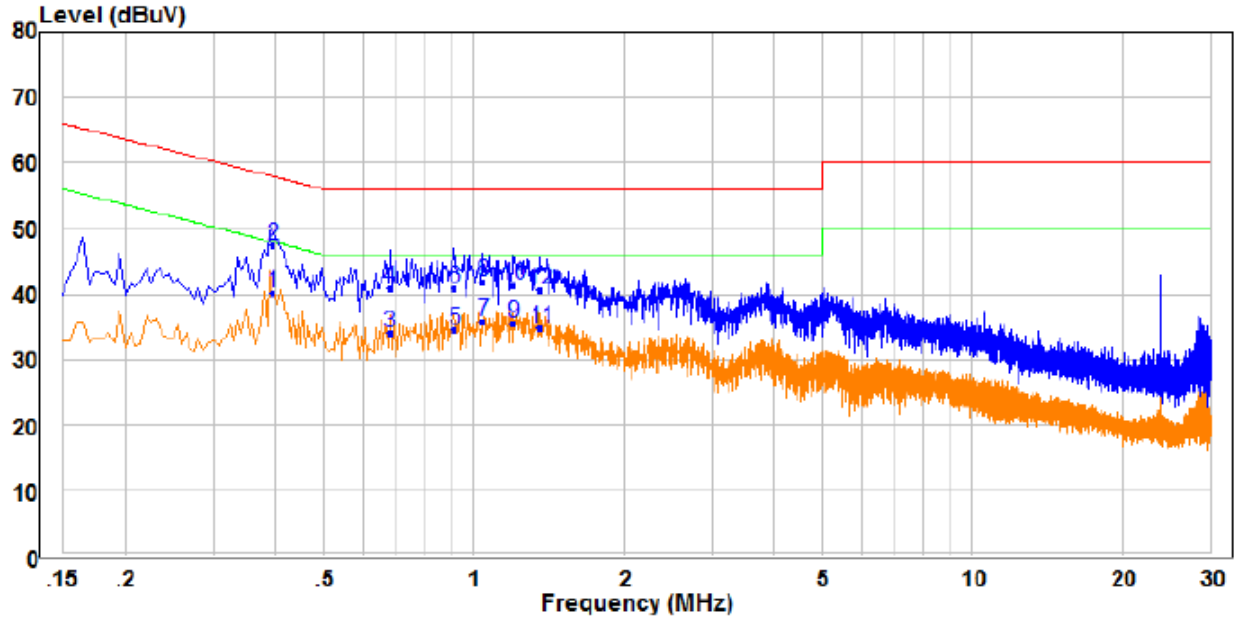
5.2 Conducted Emissions

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

Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type at the lowest, middle, high channel.
Final Test Mode:	Through Pre-scan, find the GFSK modulation at the highest channel is the worst case. Only the worst case is recorded in the report.
Test Voltage:	AC 120V/60Hz
Test Results:	Pass

Measurement Data

Live line:

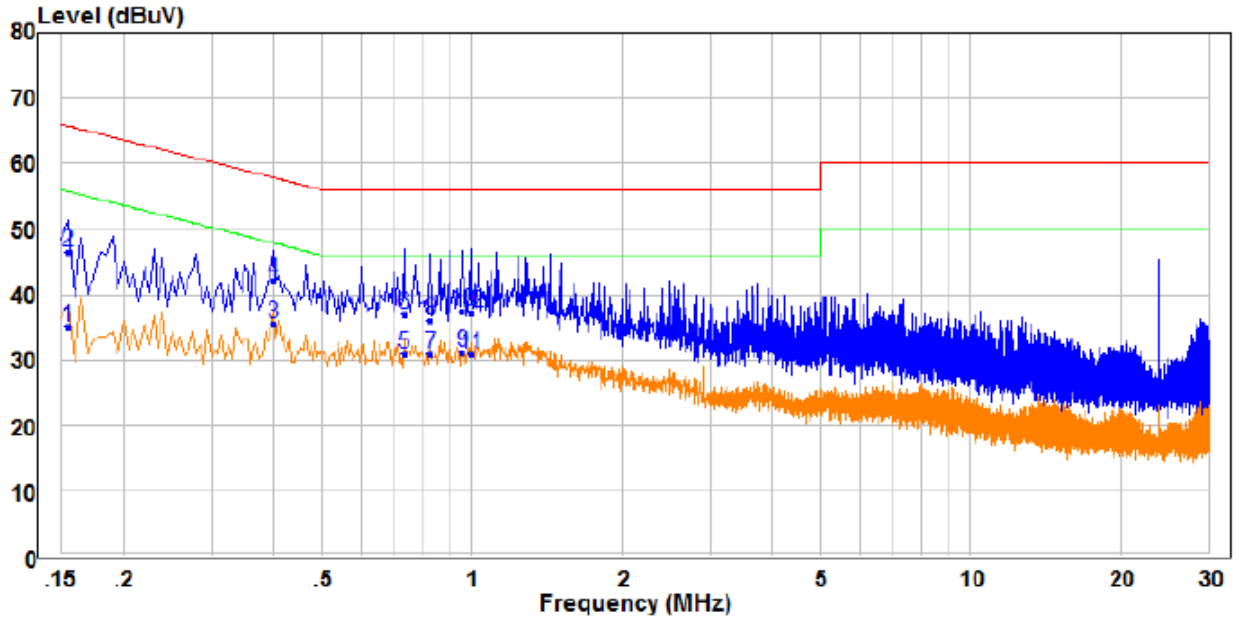


		Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase
		MHz	dBuV	dB	dBuV	dBuV	dB		
1	PP	0.395	30.56	9.51	40.07	47.96	-7.89	Average	Line
2	QP	0.395	37.97	9.51	47.48	57.96	-10.48	QP	Line
3		0.680	24.23	9.84	34.07	46.00	-11.93	Average	Line
4		0.680	31.10	9.84	40.94	56.00	-15.06	QP	Line
5		0.915	24.94	9.62	34.56	46.00	-11.44	Average	Line
6		0.915	31.34	9.62	40.96	56.00	-15.04	QP	Line
7		1.045	26.14	9.53	35.67	46.00	-10.33	Average	Line
8		1.045	32.26	9.53	41.79	56.00	-14.21	QP	Line
9		1.200	26.00	9.53	35.53	46.00	-10.47	Average	Line
10		1.200	31.94	9.53	41.47	56.00	-14.53	QP	Line
11		1.360	25.18	9.53	34.71	46.00	-11.29	Average	Line
12		1.360	31.15	9.53	40.68	56.00	-15.32	QP	Line

Remark:

1. The following Quasi-Peak and Average measurements were performed on the EUT:
2. Final Test Level =Receiver Reading + LISN Factor + Cable Loss.
3. If the Peak value under Average limit, the Average value is not recorded in the report.

Neutral line:



		Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase
		MHz	dBuV	dB	dBuV	dBuV	dB		
1		0.155	25.44	9.48	34.92	55.73	-20.81	Average	Neutral
2		0.155	36.89	9.48	46.37	65.73	-19.36	QP	Neutral
3	PP	0.400	25.91	9.54	35.45	47.85	-12.40	Average	Neutral
4	QP	0.400	32.42	9.54	41.96	57.85	-15.89	QP	Neutral
5		0.730	21.17	9.82	30.99	46.00	-15.01	Average	Neutral
6		0.730	27.14	9.82	36.96	56.00	-19.04	QP	Neutral
7		0.825	21.06	9.79	30.85	46.00	-15.15	Average	Neutral
8		0.825	26.31	9.79	36.10	56.00	-19.90	QP	Neutral
9		0.955	21.50	9.74	31.24	46.00	-14.76	Average	Neutral
10		0.955	27.73	9.74	37.47	56.00	-18.53	QP	Neutral
11		0.995	21.12	9.72	30.84	46.00	-15.16	Average	Neutral
12		0.995	27.41	9.72	37.13	56.00	-18.87	QP	Neutral

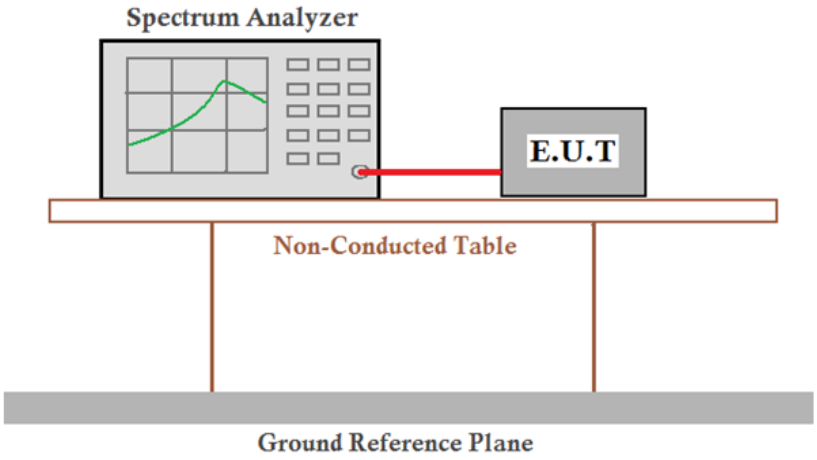
Remark:

1. The following Quasi-Peak and Average measurements were performed on the EUT:

2. Final Test Level =Receiver Reading + LISN Factor + Cable Loss.

3. If the Peak value under Average limit, the Average value is not recorded in the report.

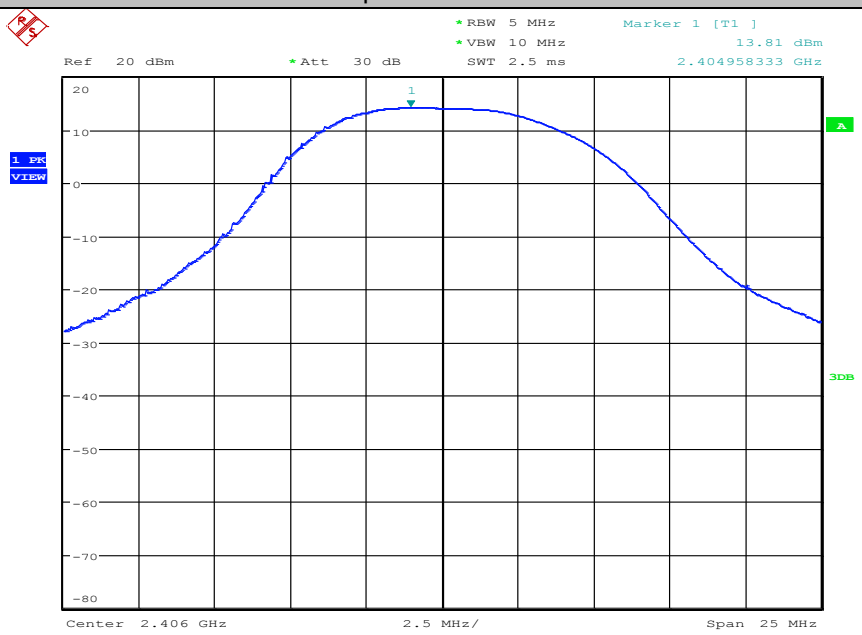
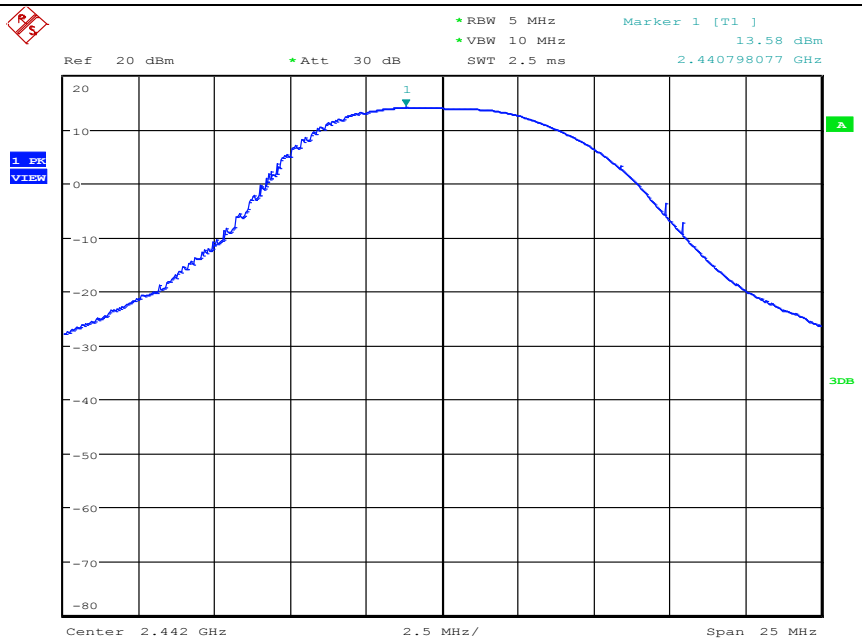
5.3 Conducted Peak Output Power

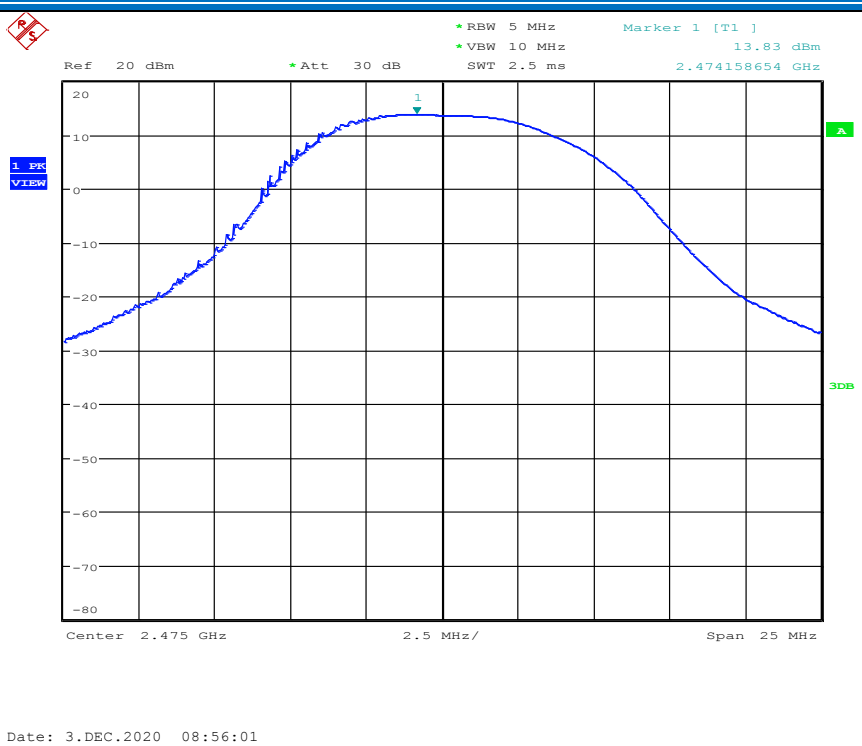
Test Requirement:	47 CFR Part 15C Section 15.247 (b)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark: Offset=Cable loss+ attenuation factor.*
Limit:	21dBm
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the worst case of GFSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

Measurement Data

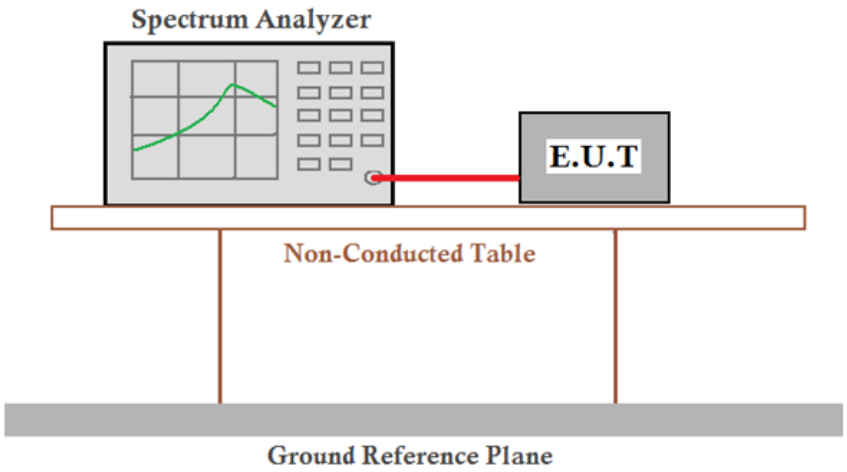
GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	13.81	21.00	Pass
Middle	13.58	21.00	Pass
Highest	13.83	21.00	Pass

Test plot as follows:

Graphs	
GFSK/LCH	 Date: 3.DEC.2020 08:57:40
GFSK/MCH	 Date: 3.DEC.2020 08:56:46

GFSK/HCH	 RBW 5 MHz VBW 10 MHz SWT 2.5 ms Marker 1 [T1] 13.83 dBm 2.474158654 GHz Ref 20 dBm Att 30 dB 1 PK VIEW 3DB Center 2.475 GHz 2.5 MHz/ Span 25 MHz Date: 3.DEC.2020 08:56:01

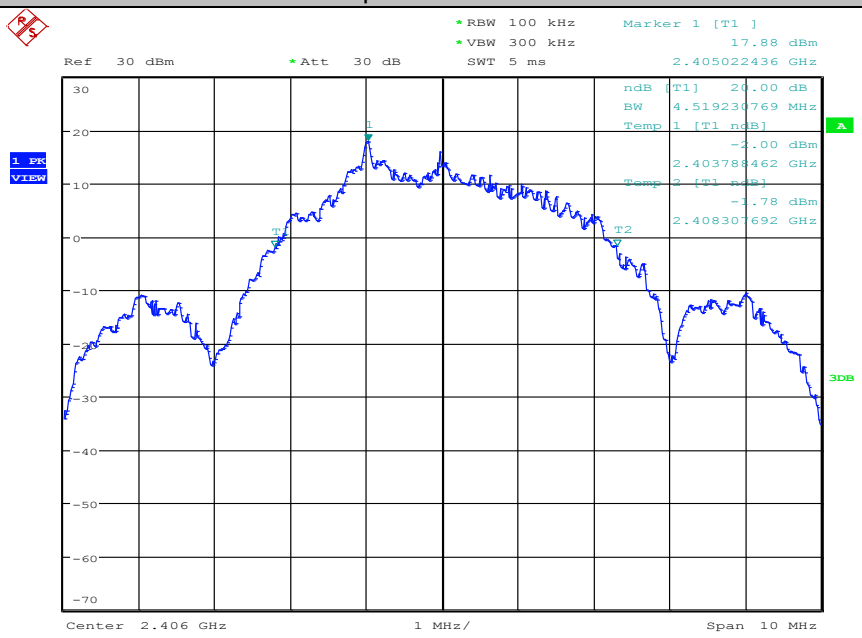
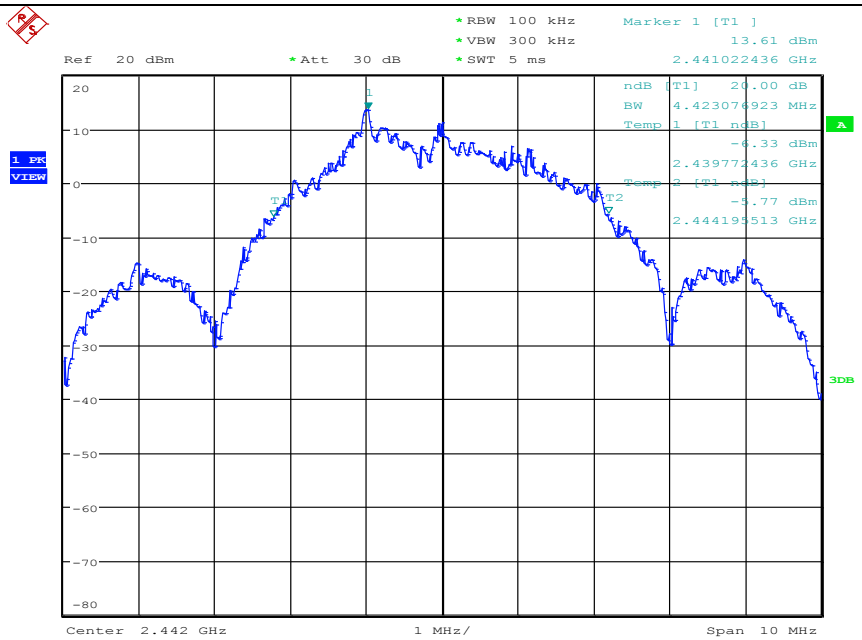
5.4 20dB Occupy Bandwidth

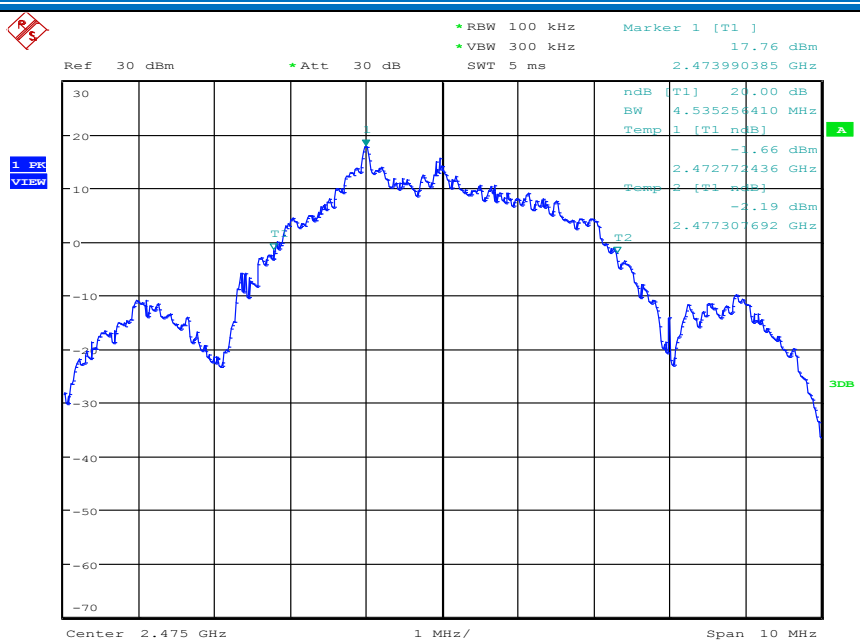
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	NA
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the worst case of GFSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

Measurement Data

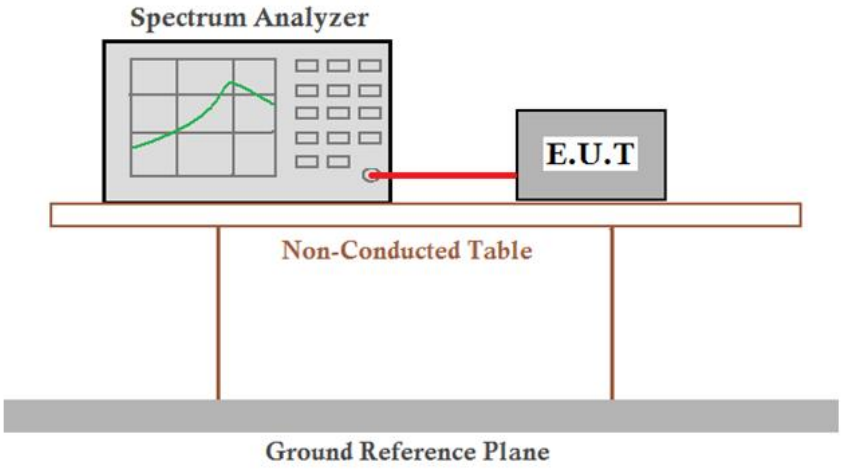
Test channel	20dB Occupy Bandwidth (MHz)
	GFSK
Lowest	4.519
Middle	4.423
Highest	4.535

Test plot as follows:

Graphs	
GFSK/LCH	 Date: 24.NOV.2020 15:20:16
GFSK/MCH	 Date: 1.DEC.2020 14:02:41

GFSK/HCH	 RBW 100 kHz VBW 300 kHz Ref 30 dBm Att 30 dB SWT 5 ms Marker 1 [T1] 17.76 dBm 2.473990385 GHz ndB [T1] 20.00 dB BW 4.535256410 MHz Temp 1 [T1 ndB] -1.66 dBm 2.472772436 GHz Temp 2 [T1 ndB] -2.19 dBm 2.477307692 GHz 1 PK VIEW 3DB Center 2.475 GHz 1 MHz/ Span 10 MHz Date: 24.NOV.2020 15:23:18

5.5 Carrier Frequencies Separation

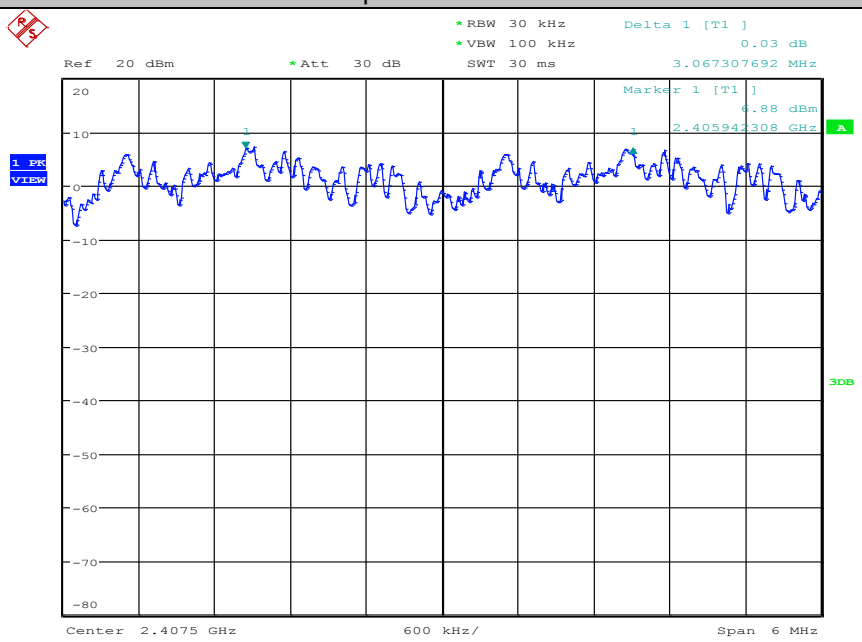
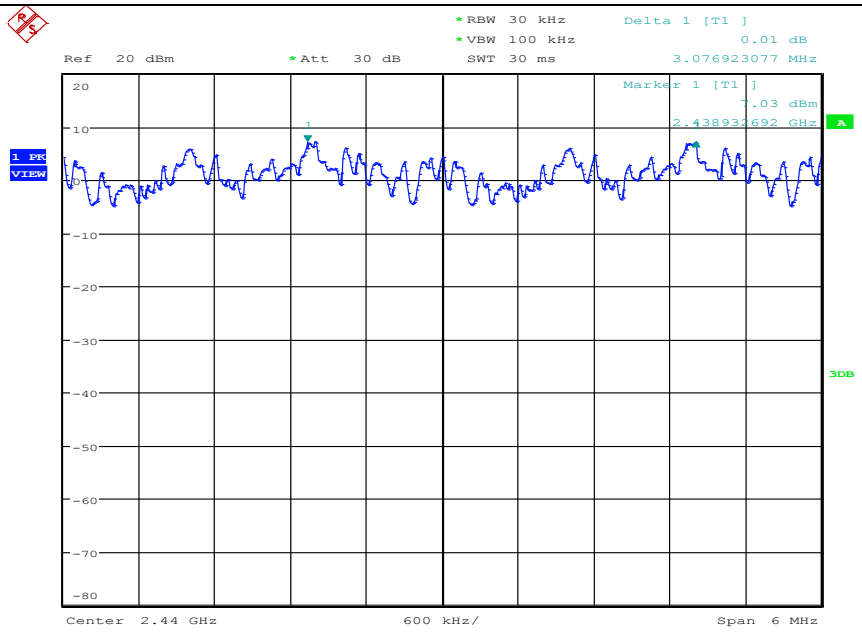
Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 Remark: Offset=Cable loss+ attenuation factor.
Limit:	2/3 of the 20dB bandwidth
	Remark: the transmission power is less than 0.125W.
Exploratory Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the worst case of GFSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

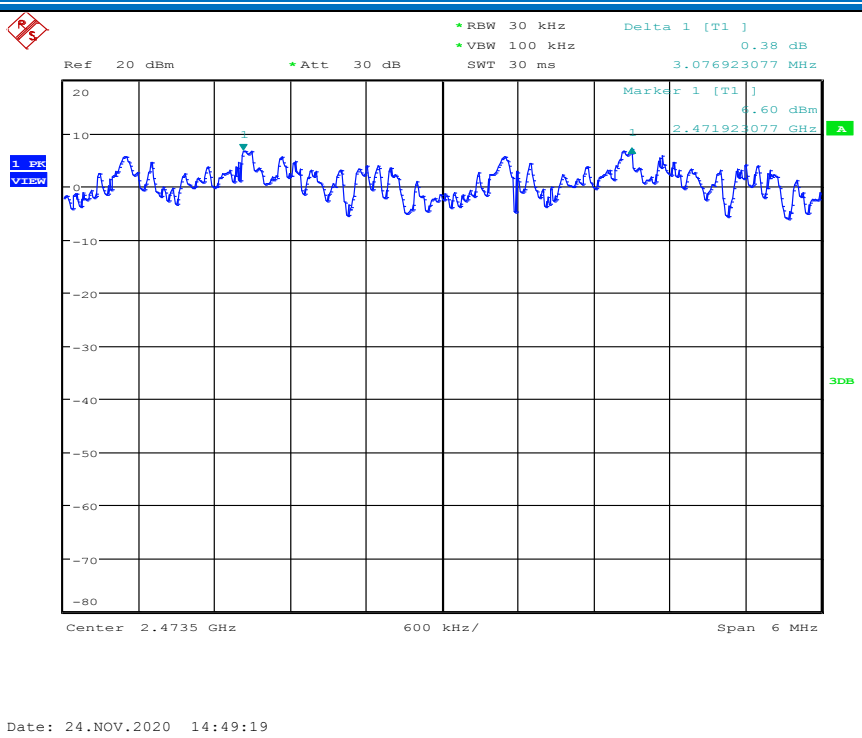
Measurement Data

GFSK mode			
Test channel	Carrier Frequencies Separation (MHz)	Limit (MHz)	Result
Lowest	3.067	≥3.023	Pass
Middle	3.077	≥3.023	Pass
Highest	3.077	≥3.023	Pass

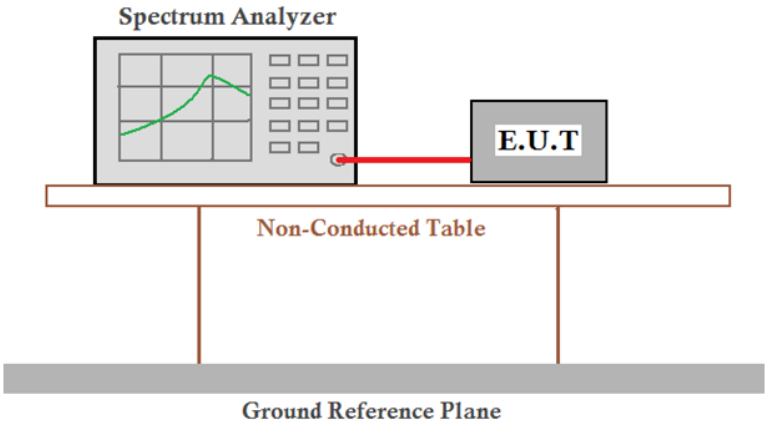
Mode	20dB bandwidth (MHz) (worse case)	Limit (MHz) (Carrier Frequencies Separation)
GFSK	4.535	3.023

Test plot as follows:

Graphs	
GFSK/LCH	 Date: 24.NOV.2020 14:51:26
GFSK/MCH	 Date: 24.NOV.2020 14:46:47

GFSK/HCH	 RBW 30 kHz VBW 100 kHz SWT 30 ms Delta 1 [T1] 0.38 dB 3.076923077 MHz Marker 1 [T1] 6.60 dBm 2.471923077 GHz Ref 20 dBm Att 30 dB 1 PK VIEW 3DB Center 2.4735 GHz 600 kHz/ Span 6 MHz Date: 24.NOV.2020 14:49:19

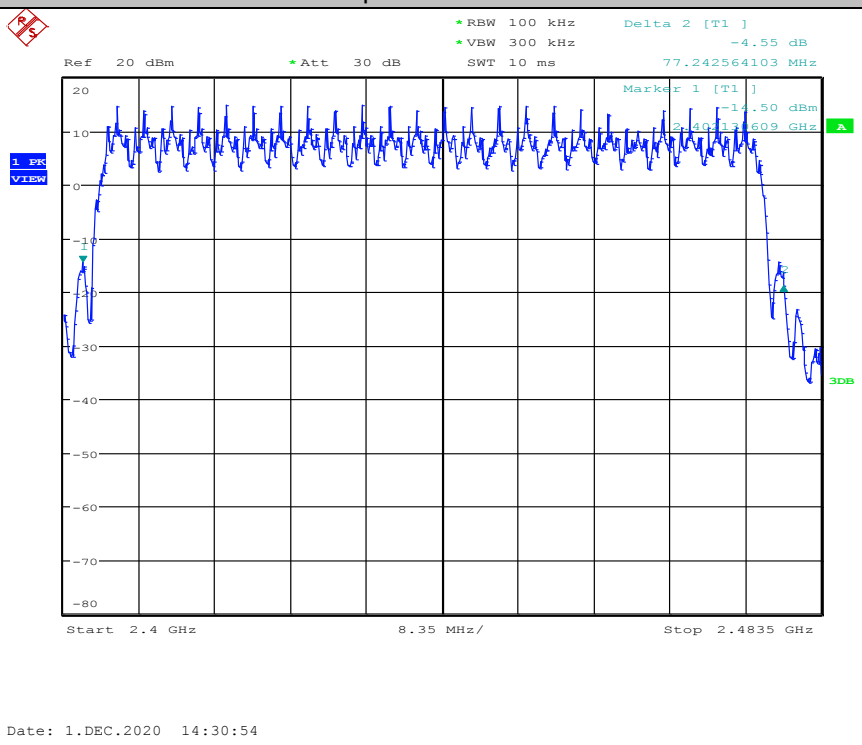
5.6 Hopping Channel Number

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark: Offset=Cable loss+ attenuation factor.*
Limit:	At least 15 channels
Exploratory Test Mode:	hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the worst case of GFSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

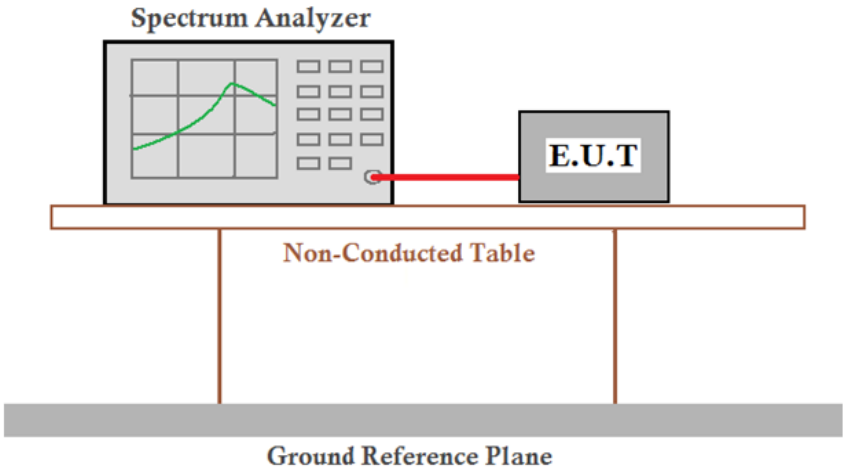
Measurement Data

Mode	Hopping channel numbers	Limit
GFSK	24	≥15

Test plot as follows:

Graphs	
GFSK/Hop	

5.7 Dwell Time

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark: Offset=Cable loss+ attenuation factor.*
Test Mode:	Hopping transmitting with all kind of modulation and all kind of data type.
Limit:	0.4 Second
Test Results:	Pass

Measurement Data

Mode	Channel	Burst Width [ms/hop/ch]	Dwell Time[s]	Limit (second)
GFSK	LCH	0.56	0.0039	≤0.4
GFSK	MCH	0.56	0.0034	≤0.4
GFSK	HCH	0.57	0.0034	≤0.4

Remark:

The test period: T= 0.4 Second/Channel x 24 Channel = 9.6 s

On (ms)*total number=dwell time (ms)

The lowest channel, as below:

dwell time (ms)=0.56 (ms)*7 =3.9 (ms)

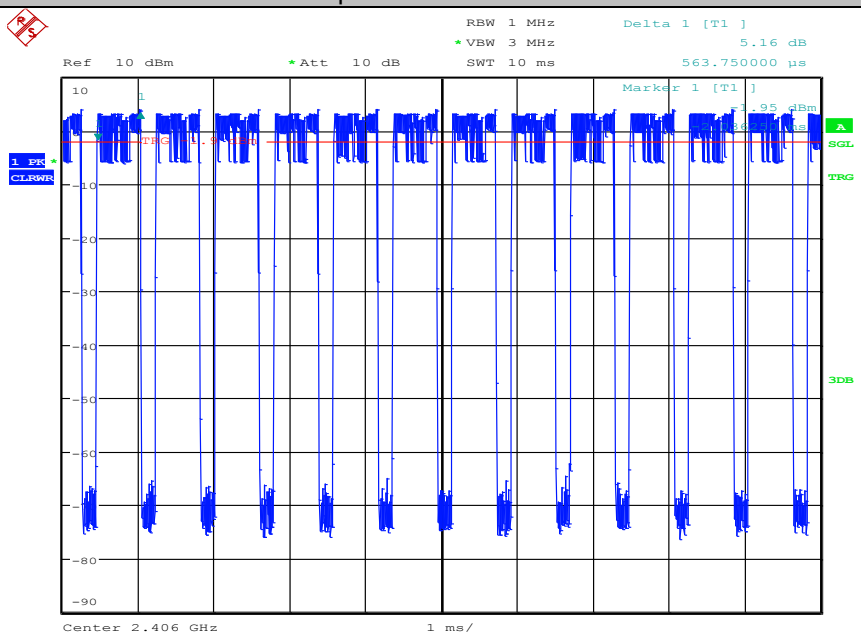
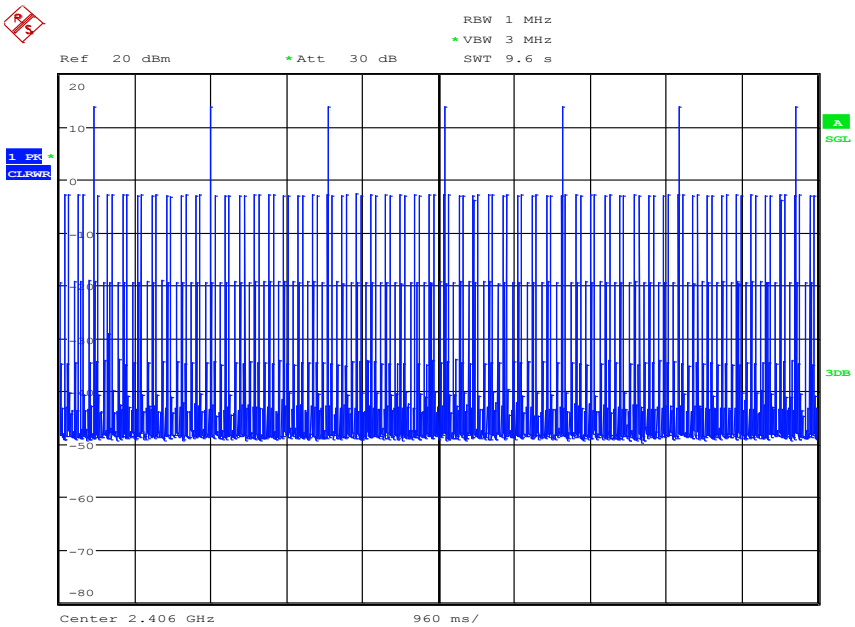
The middle channel, as below:

dwell time (ms)=0.56 (ms)*6=3.4 (ms)

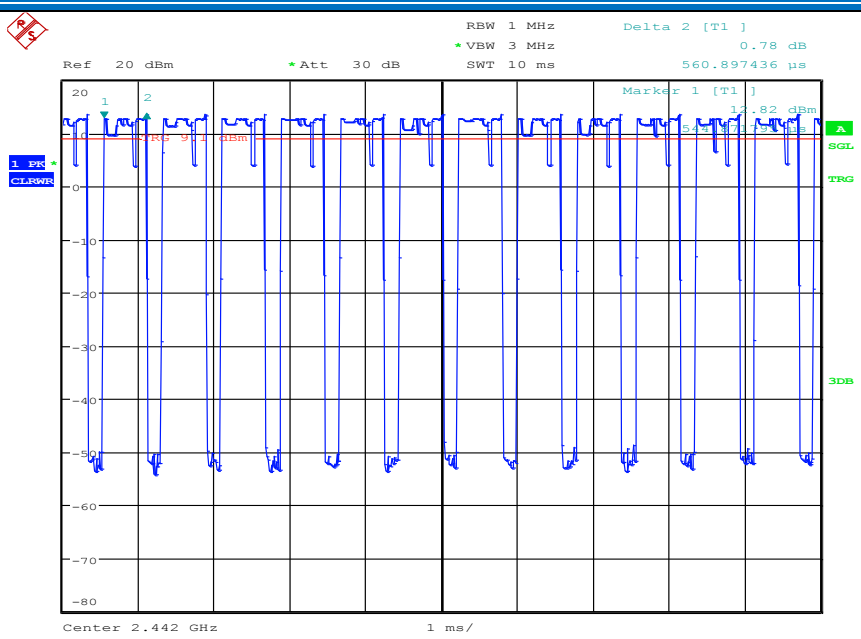
The highest channel, as below:

dwell time (ms)=0.57 (ms)*6 =3.4 (ms)

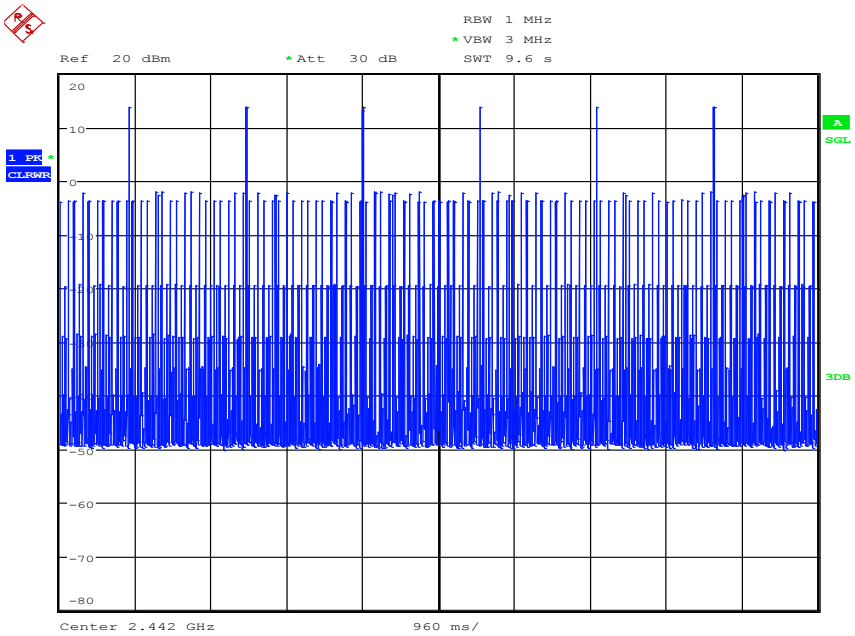
Test plot as follows:

Graphs	
GFSK_ /LCH	 Date: 30.SEP.2020 14:58:22  Date: 3.DEC.2020 14:00:00

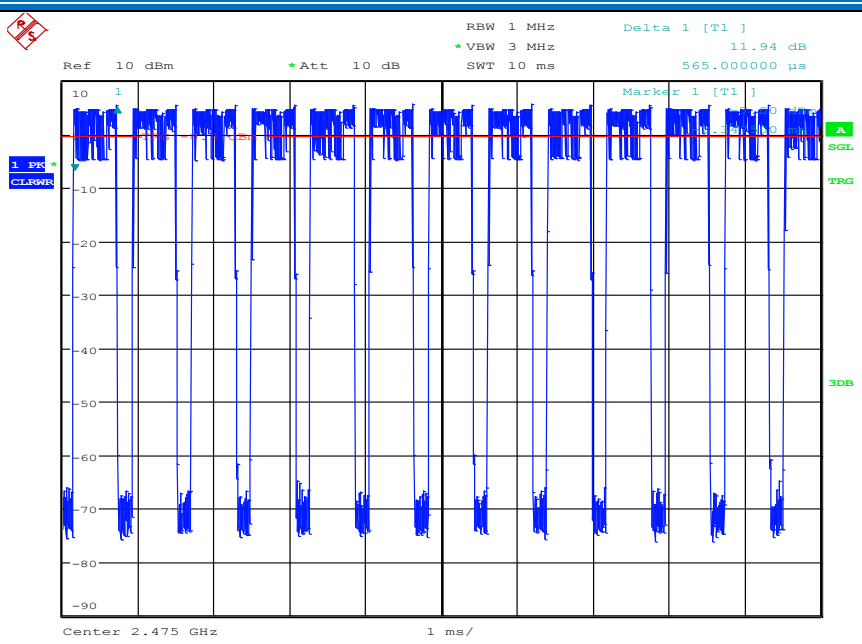
GFSK_ /MCH



Date: 1.DEC.2020 14:06:16

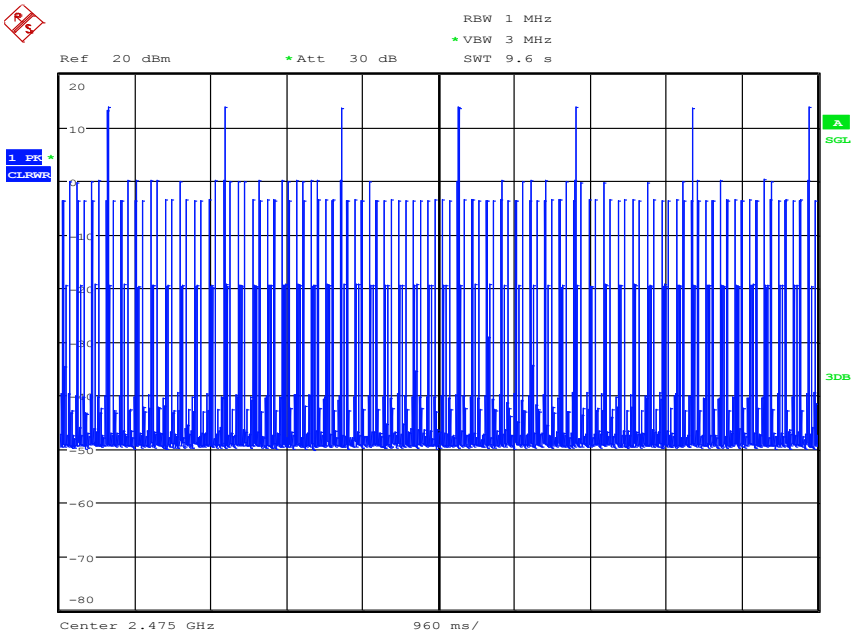


Date: 1.DEC.2020 15:39:04



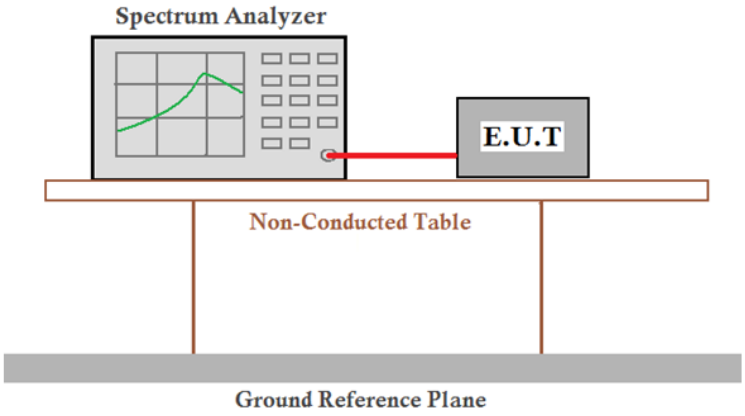
Date: 30.SEP.2020 15:15:39

GFSK_ /HCH



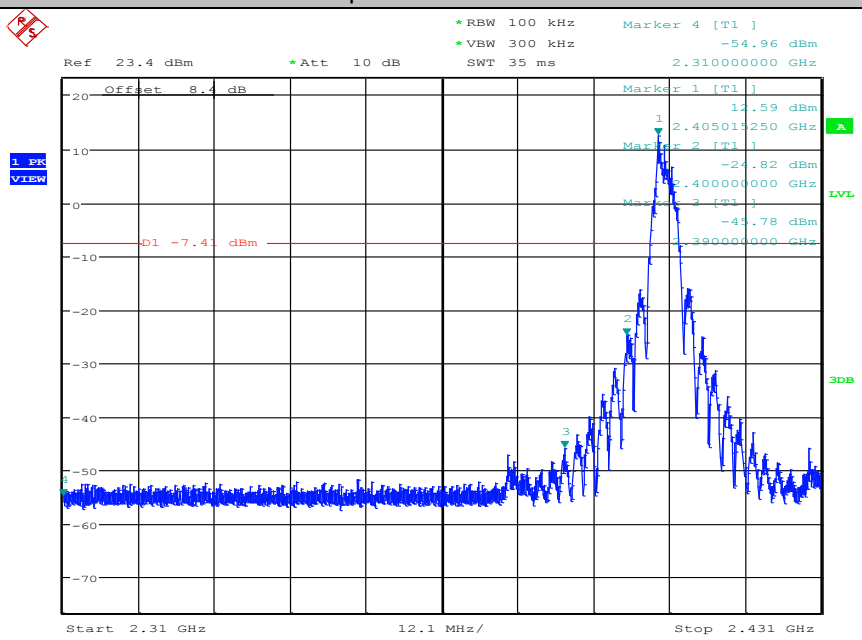
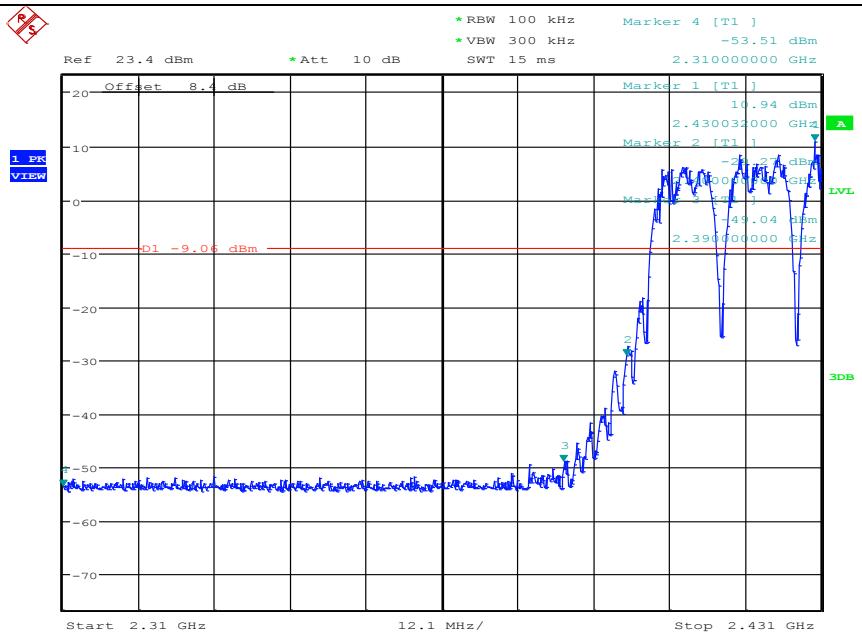
Date: 1.DEC.2020 15:38:37

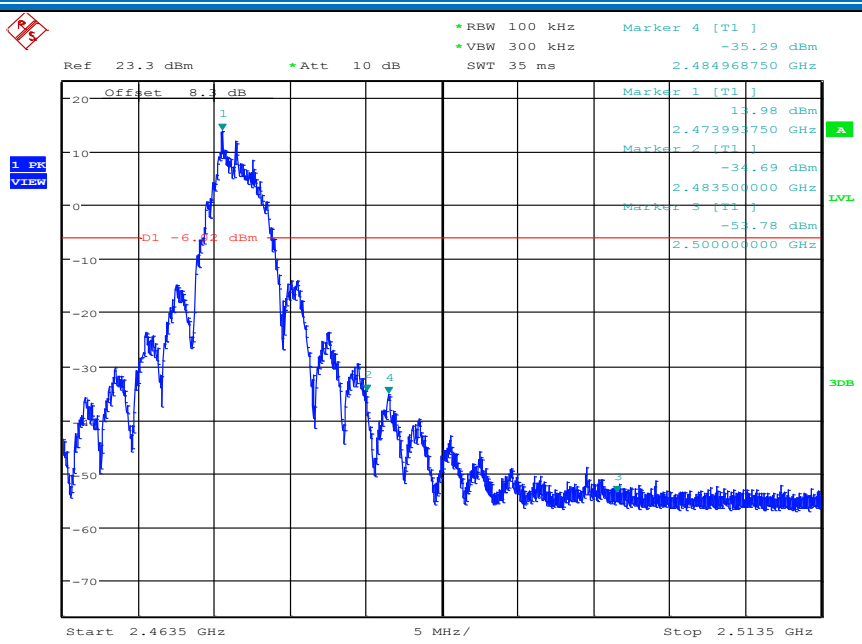
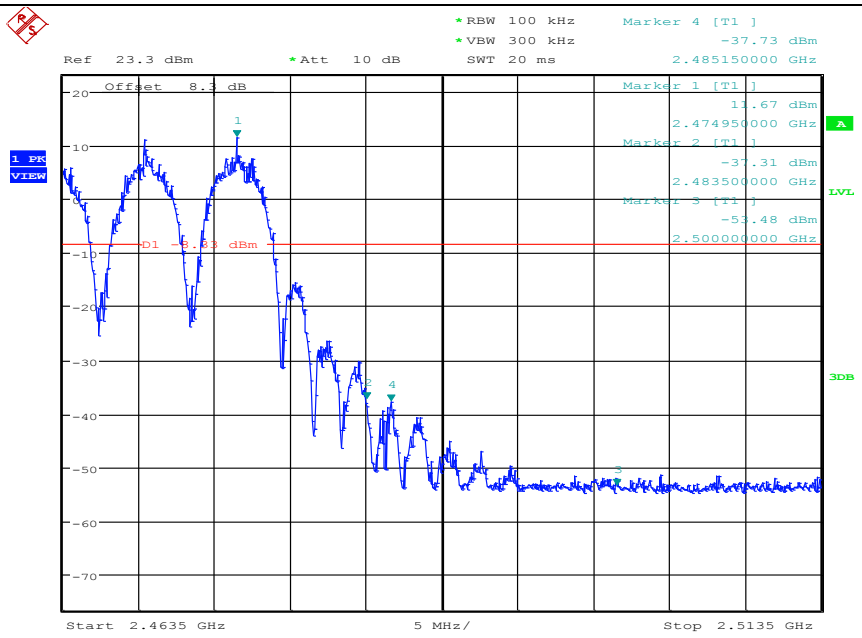
5.8 Band-edge for RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark: Offset=cable loss+ attenuation factor.*
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Hopping and Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the DH5 of data type is the worst case of GFSK modulation type, 2-DH5 of data type is the worst case of π/4DQPSK modulation type, 3-DH5 of data type is the worst case of 8DPSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

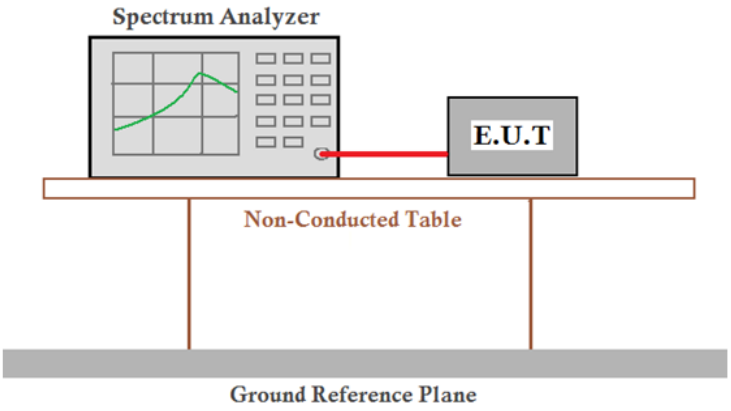
Mode	Test Channel	Frequency [MHz]	Frequency Hopping	Emission Level [dBm]	Limit [dBm]	Result
GFSK	LCH	2400	Off	-24.820	-7.41	PASS
			On	-29.270	-9.06	PASS
GFSK	HCH	2483.5	Off	-34.690	-6.02	PASS
			On	-37.310	-8.33	PASS

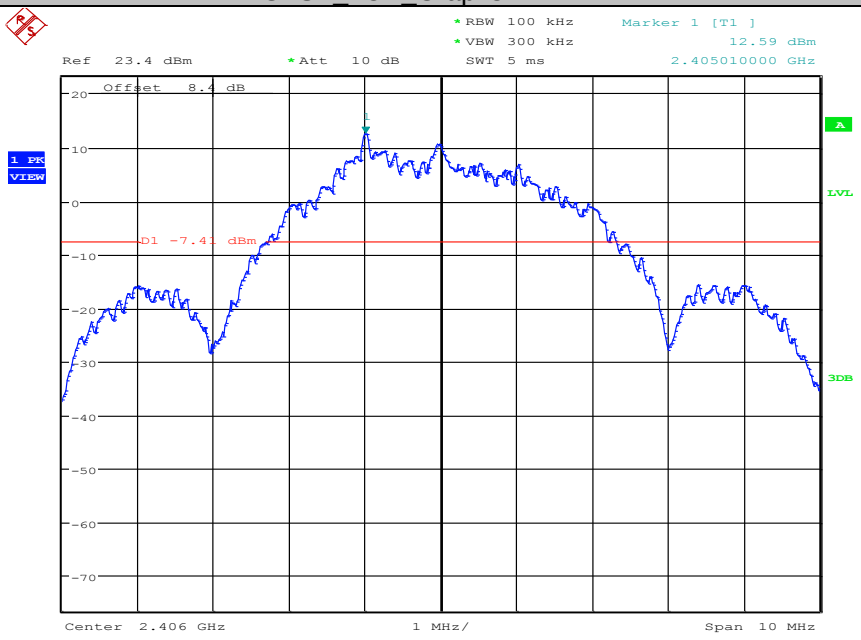
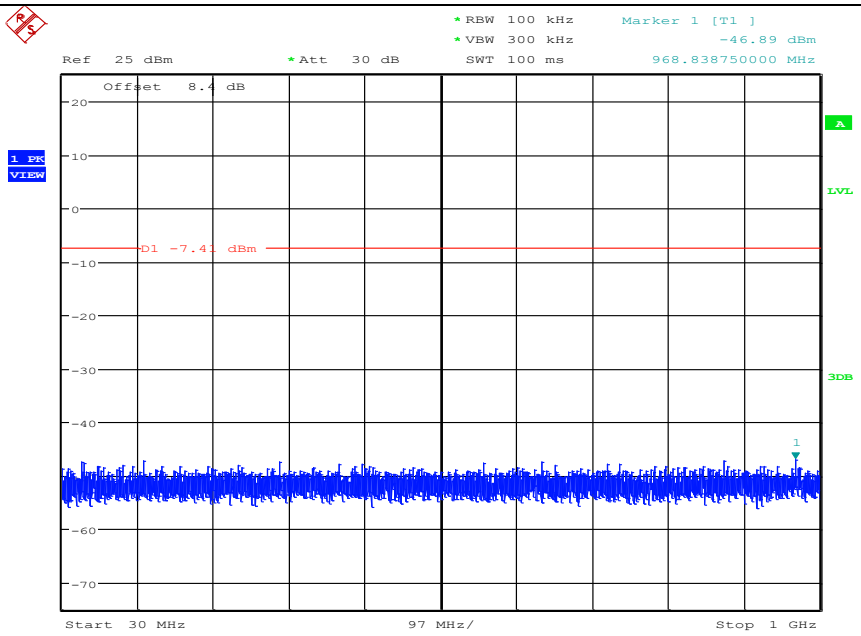
Test plot as follows:

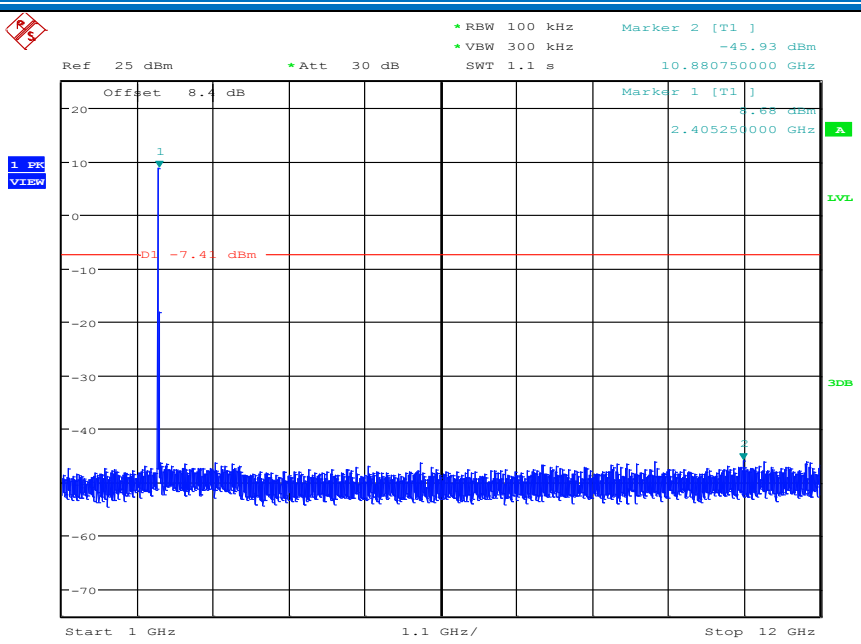
Graphs	
GFSK/LCH/No Hop	
GFSK/LCH/Hop	

GFSK/HCH/No Hop	
GFSK/HCH/Hop	

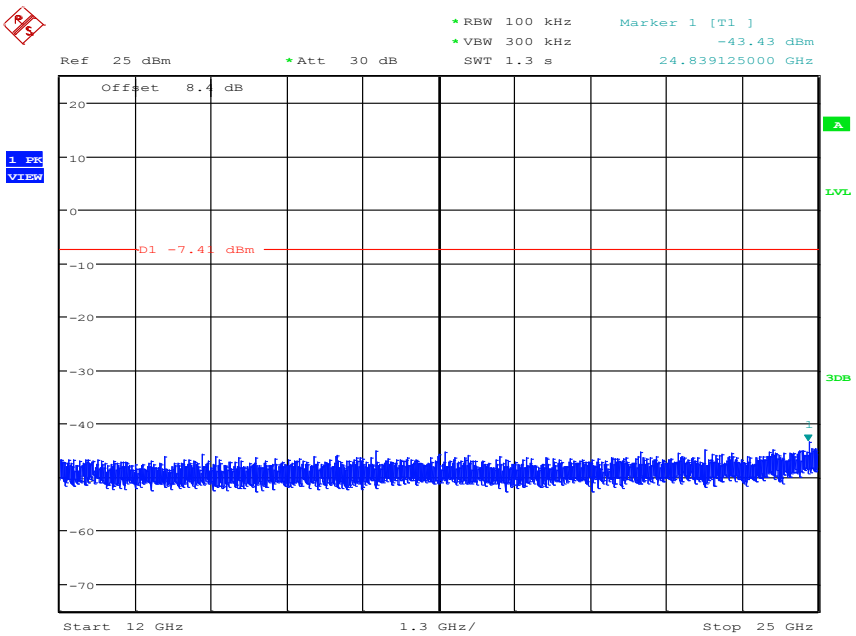
5.9 Spurious RF Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10:2013
Test Setup:	 *Remark: Offset=cable loss+ attenuation factor.*
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Exploratory Test Mode:	Non-hopping transmitting with all kind of modulation and all kind of data type
Final Test Mode:	Through Pre-scan, find the worst case of GFSK modulation type. Only the worst case is recorded in the report.
Test Results:	Pass

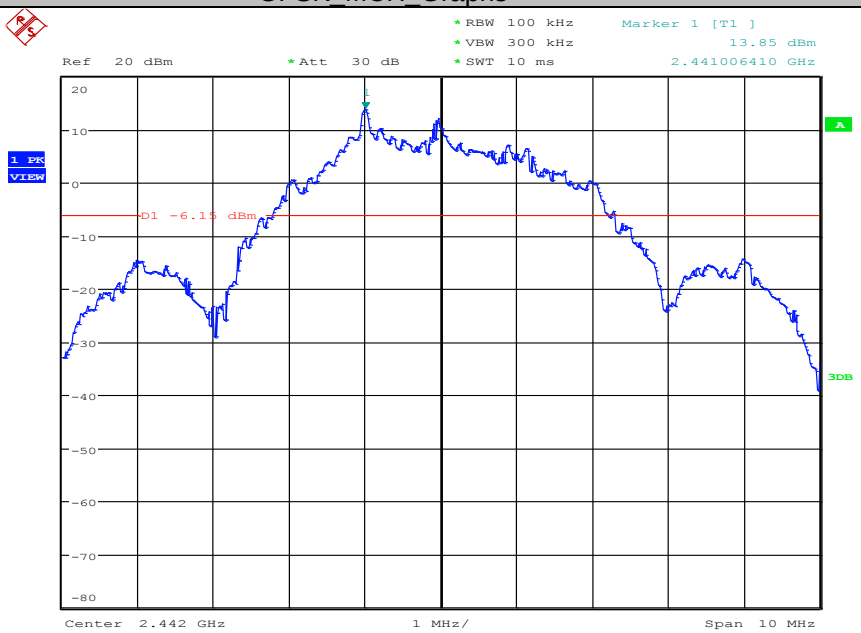
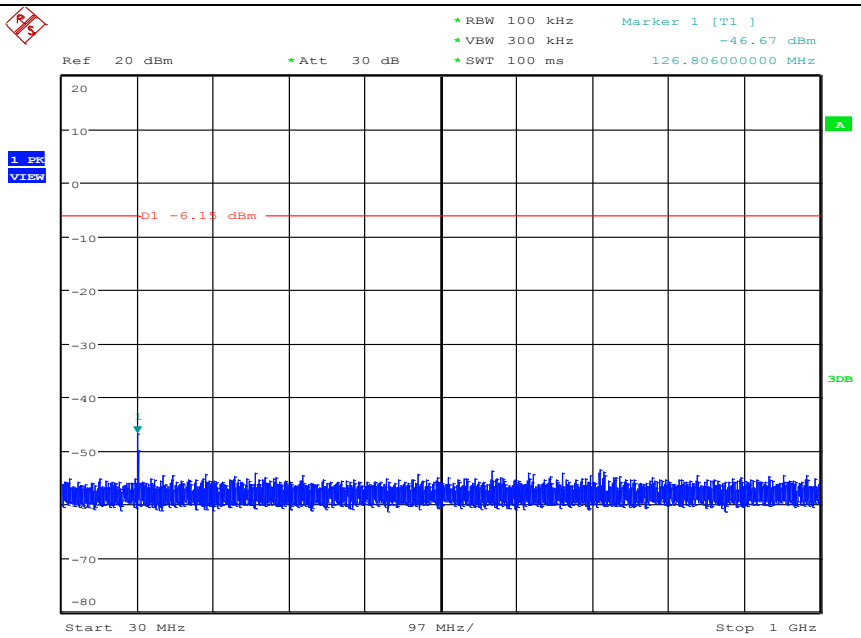
GFSK_LCH_Graphs	
Pref	 Date: 30.SEP.2020 15:04:14
Puw	 Date: 30.SEP.2020 15:04:26

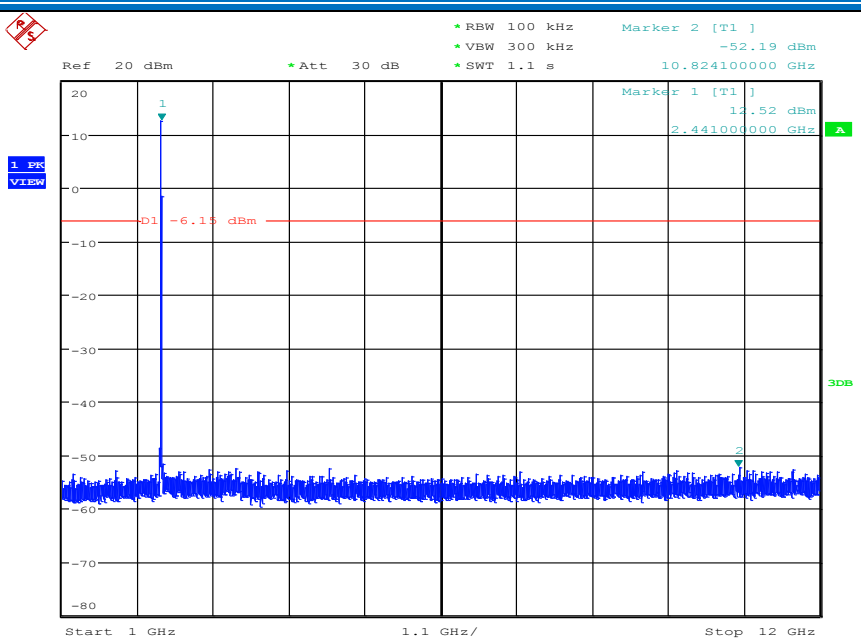


Date: 30.SEP.2020 15:04:37

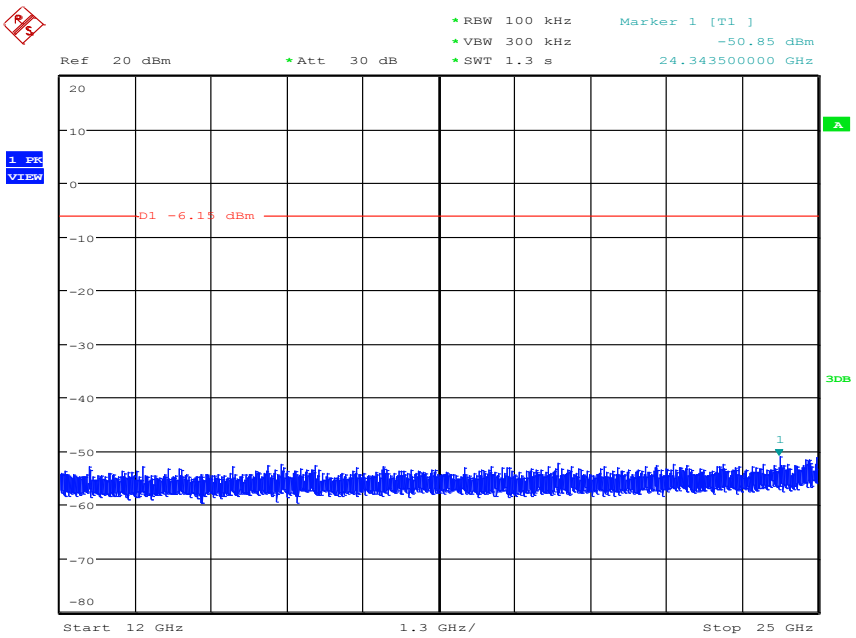


Date: 30.SEP.2020 15:04:49

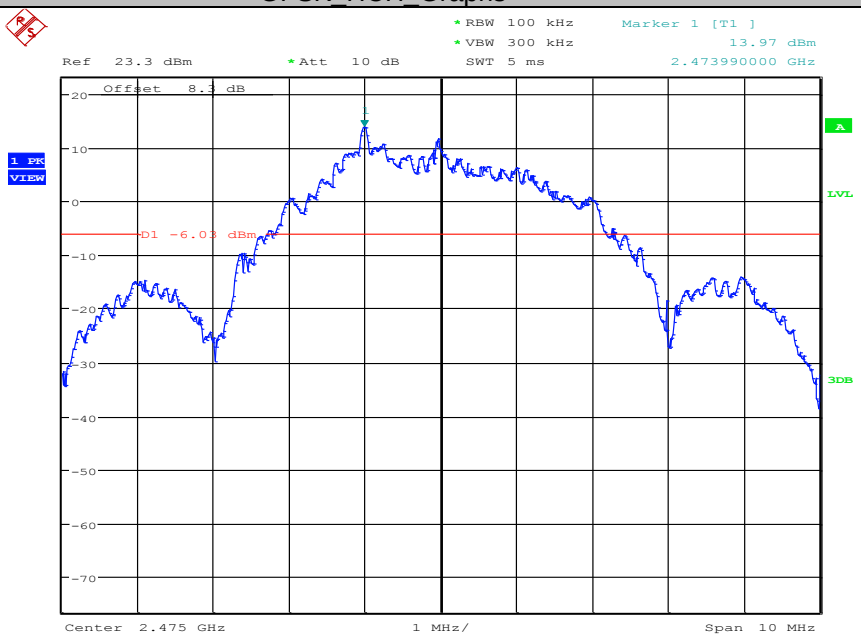
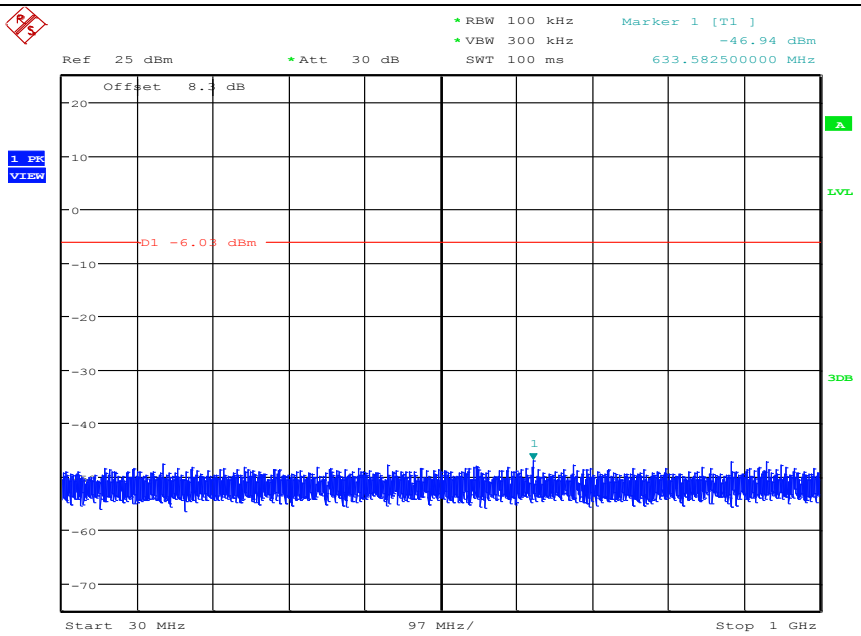
GFSK_MCH_Graphs	
Pref	 Date: 1.DEC.2020 14:09:33
Puw	 Date: 1.DEC.2020 14:11:08

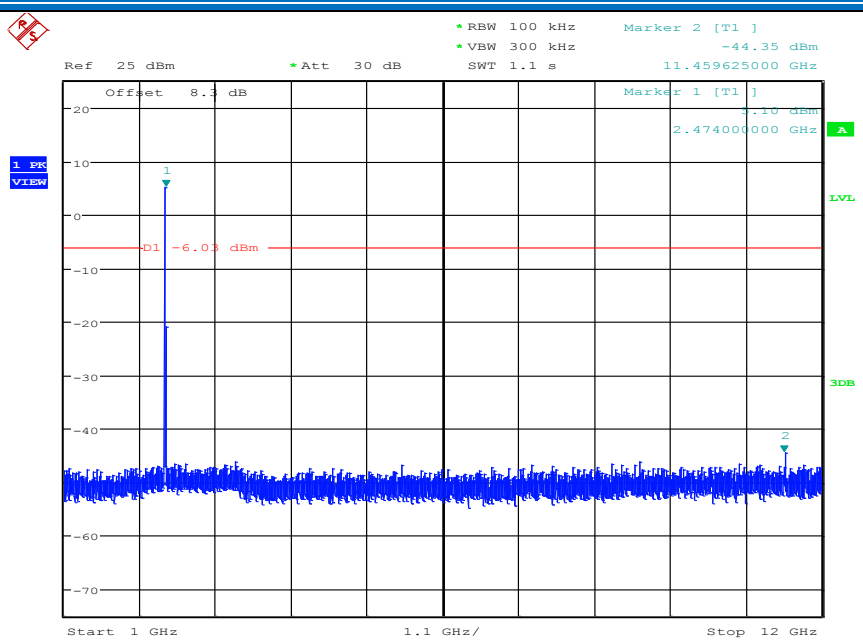


Date: 1.DEC.2020 14:12:53

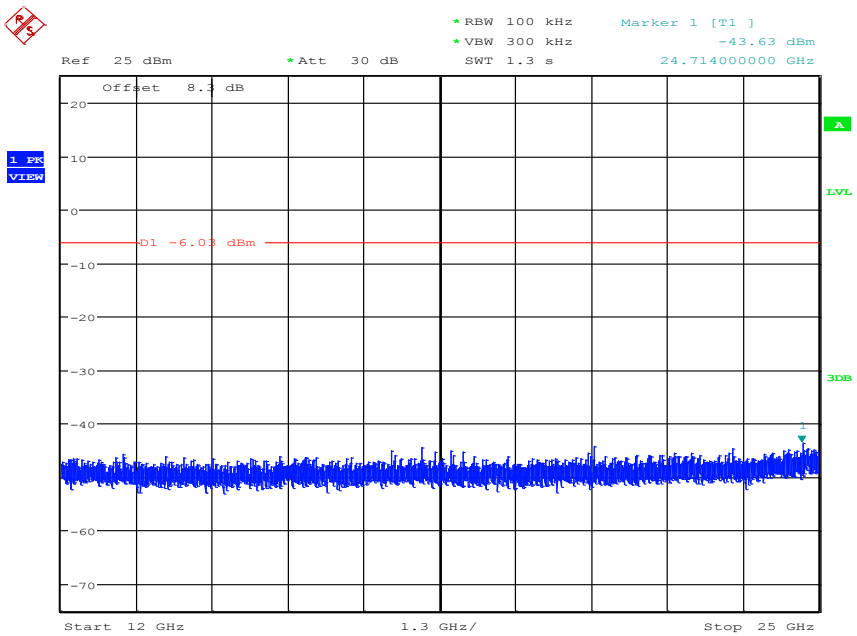


Date: 1.DEC.2020 14:14:23

GFSK_HCH_Graphs	
Pref	 Date: 30.SEP.2020 15:18:58
Puw	 Date: 30.SEP.2020 15:19:11



Date: 30.SEP.2020 15:19:21



Date: 30.SEP.2020 15:19:34

Remark:

Pre test 9kHz to 25GHz, find the highest point when testing, so only the worst data were shown in the test report. Per FCC Part 15.33 (a) and 15.31 (o) ,The amplitude of spurious emissions from intentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.10 Pseudorandom Frequency Hopping Sequence

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(1) requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence

The embedded FHSS engine uses 24 hopping frequencies. Each channel frequency is selected from a pseudorandom ordered list of hopping frequencies, from 2406MHz to 2475MHz with separating in 3.067MHz apart from each of the channels.A single data frame is transmitted on each frequency location before skipping to the next hopping frequency in the list. Each channel is occupied 3.9milliseconds.

Typically, the initiation of an FHSS communication is as follows:

1. The initiating party sends a request via a predefined frequency or control channel.

2. The receiving party sends a number, known as a seed back to the initiating party.

3. The initiating party sends a synchronization signal acknowledging to the receiving party as it has successfully established a transmission link.

4. The communication begins, and both the receiving and the sending party change their frequencies along an unpredictable hopping sequence with pseudorandom properties.

Pseudorandom Frequency Hopping Sequence:

2406; 2409; 2412; 2415; 2418; 2421; 2424; 2427; 2430; 2433; 2436; 2439; 2442; 2445; 2448; 2451; 2454; 2457; 2460; 2463; 2466; 2469; 2472; 2475.

System Receiver Input Bandwidth:

The receiver bandwidth is equal to the receiver bandwidth in the 24 hopping channel mode. The receiver bandwidth was verified during RF hopping to the relative channel.

Receiver Hopping Capability:

The associated receiver has the ability to shift frequencies in synchronization with the transmitted signals, with they start connect with a same channel and then hop to next channel with a same formula among each other.

5.11 Radiated Spurious Emission & Restricted bands

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205
Test Method:	ANSI C63.10: 2013
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Peak	100 kHz	300kHz	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

Note: 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.

Test Setup:	

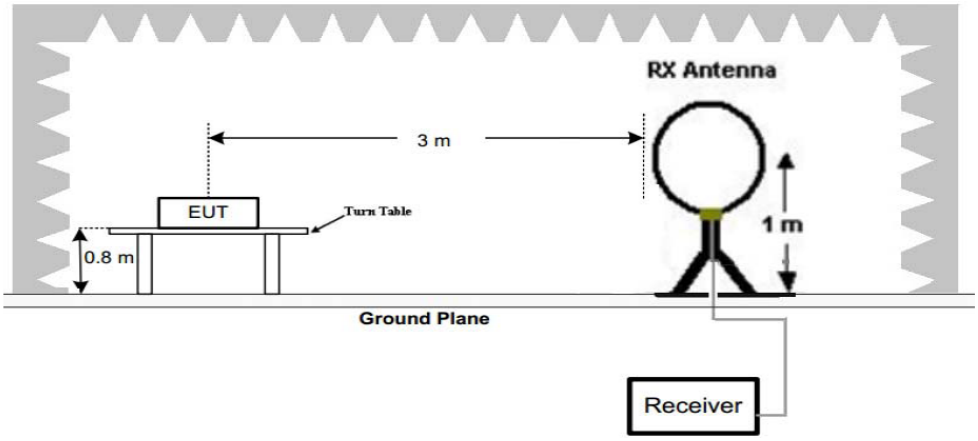


Figure 1. Below 30MHz

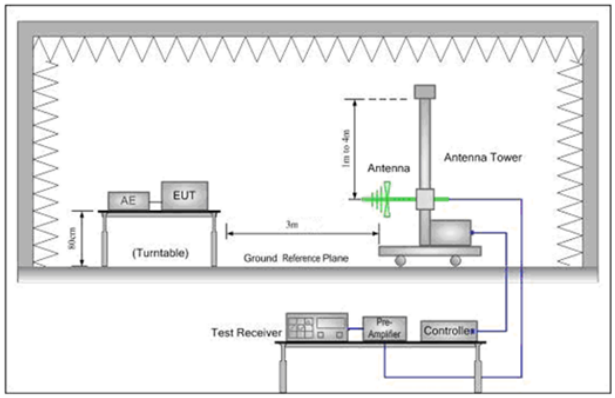


Figure 2. 30MHz to 1GHz

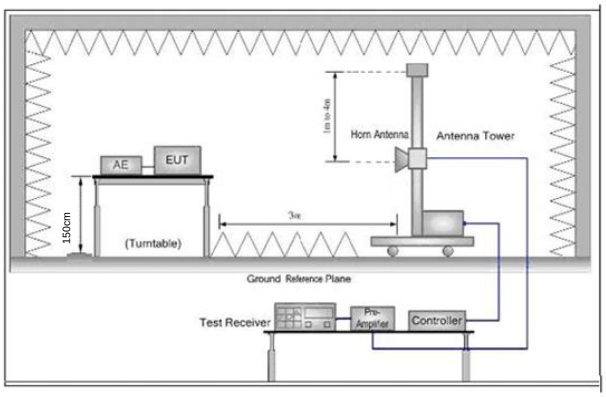


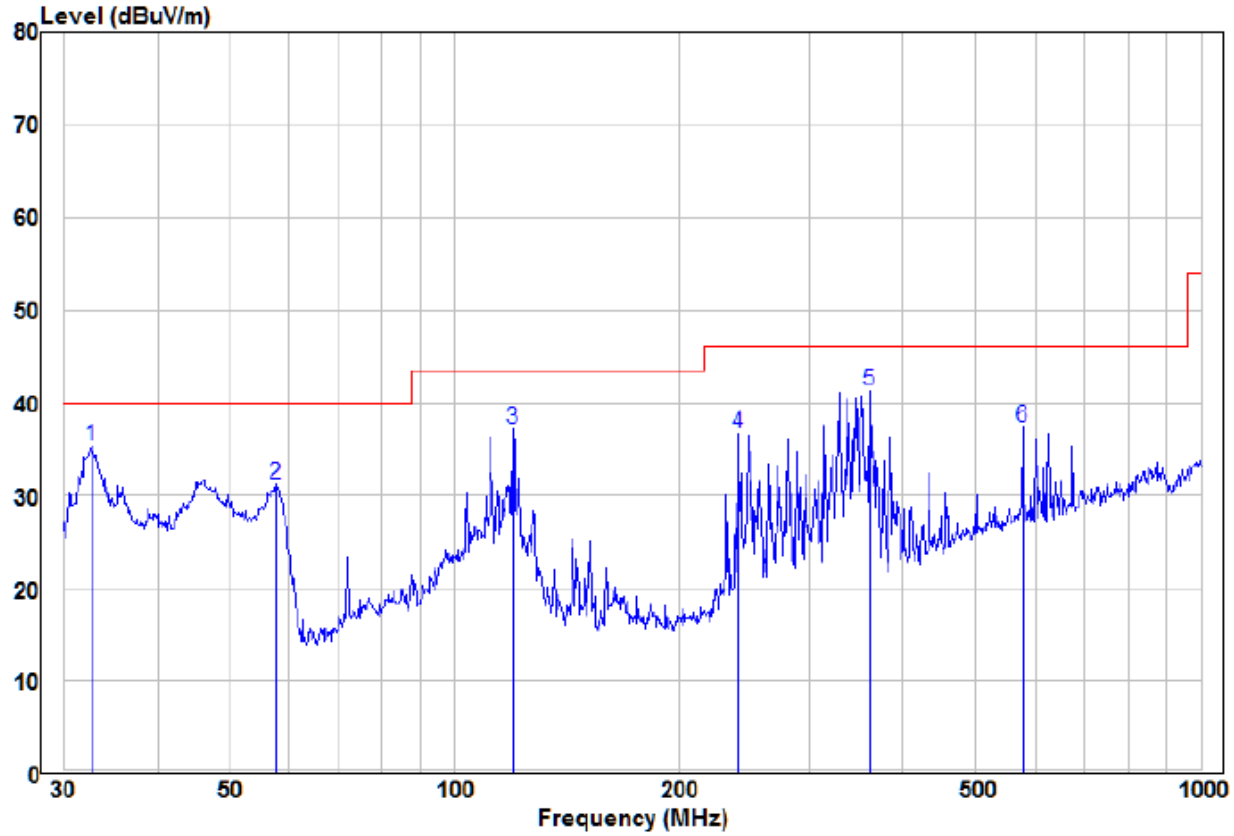
Figure 3. Above 1 GHz

Test Procedure:	a. 1) Below 1G: The EUT was placed on the top of a rotating table 0.8 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. 2) Above 1G: 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. Note: For the radiated emission test above 1GHz: Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower. c. 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.

	d. 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. e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. f. 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. g. Test the EUT in the lowest channel (2402MHz),the middle channel (2441MHz),the Highest channel (2480MHz) h. 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. i. Repeat above procedures until all frequencies measured was complete.
Exploratory Test Mode:	Non-hopping transmitting mode with all kind of modulation and all kind of data type Transmitting mode
Final Test Mode:	Through Pre-scan, find the GFSK modulation is the worst case. For below 1GHz part, through pre-scan, the worst case is the highest channel. Only the worst case is recorded in the report.
Test Results:	Pass

5.11.1 Radiated Emission below 1GHz

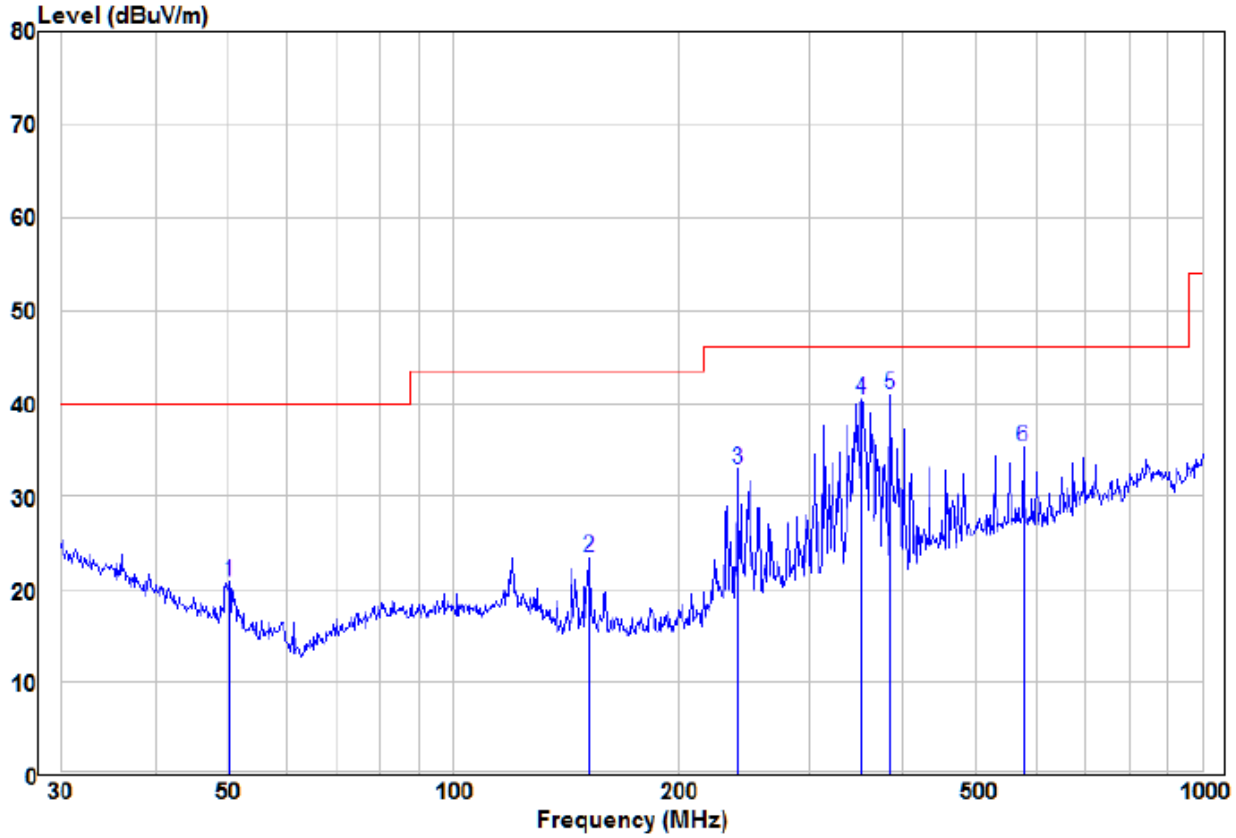
30MHz~1GHz		
Test mode:	Transmitting	Vertical



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB		
1	32.63	20.08	15.22	35.30	40.00	-4.70	Peak	VERTICAL
2	57.80	25.26	5.91	31.17	40.00	-8.83	Peak	VERTICAL
3	119.86	26.58	10.69	37.27	43.50	-6.23	Peak	VERTICAL
4	239.99	25.08	11.56	36.64	46.00	-9.36	Peak	VERTICAL
5 pp	360.45	26.14	15.20	41.34	46.00	-4.66	Peak	VERTICAL
6	576.64	18.43	18.91	37.34	46.00	-8.66	Peak	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:
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,
Level = Read Level + Factor,
Over Limit=Level-Limit Line.

Test mode:	Transmitting	Horizontal



	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark	Pol/Phase
	MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB		
1	50.41	12.77	8.00	20.77	40.00	-19.23	Peak	HORIZONTAL
2	152.13	15.07	8.33	23.40	43.50	-20.10	Peak	HORIZONTAL
3	239.99	21.42	11.56	32.98	46.00	-13.02	Peak	HORIZONTAL
4	351.71	25.50	14.99	40.49	46.00	-5.51	Peak	HORIZONTAL
5 pp	383.93	26.18	14.76	40.94	46.00	-5.06	Peak	HORIZONTAL
6	576.64	16.39	18.91	35.30	46.00	-10.70	Peak	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:
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,
Level = Read Level + Factor,
Over Limit=Level-Limit Line.

5.11.2 Transmitter Emission above 1GHz

Worse case mode:		GFSK		Test channel:		Lowest	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
2390	**53.75**	**-9.2**	**44.55**	**74**	**-29.45**	**Peak**	**H**
2400	56.41	-9.39	47.02	74	-26.98	Peak	H
4812	53.77	-4.32	49.45	74	-24.55	Peak	H
7218	49.12	1.02	50.14	74	-23.86	Peak	H
2390	**53.39**	**-9.2**	**44.19**	**74**	**-29.81**	**Peak**	**V**
2400	52.31	-9.39	42.92	74	-31.08	Peak	V
4812	53.62	-4.32	49.30	74	-24.70	Peak	V
7218	50.91	1.02	51.93	74	-22.07	Peak	V

Worse case mode:		GFSK		Test channel:		Middle	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
4884	50.39	-4.1	46.29	74	-27.71	peak	H
7326	49.93	1.52	51.45	74	-22.55	peak	H
4881	51.78	-4.1	47.68	74	-26.32	peak	V
7326	49.74	1.52	51.26	74	-22.74	peak	V

Worse case mode:		GFSK		Test channel:		Highest	
Frequency (MHz)	Meter Reading (dBμV)	Factor (dB)	Emission Level (dBμV/m)	Limits (dBμV/m)	Over (dB)	Detector Type	Ant. Pol. H/V
2483.5	**56.16**	**-9.29**	**46.87**	**74**	**-27.13**	**Peak**	**H**
4950	51.36	-4.05	47.31	74	-26.69	Peak	H
7425	48.87	1.56	50.43	74	-23.57	Peak	H
2483.5	**57.99**	**-9.29**	**48.70**	**74**	**-25.30**	**Peak**	**V**
4950	50.64	-4.05	46.59	74	-27.41	Peak	V
7425	49.17	1.56	50.73	74	-23.27	Peak	V

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 above 10GHz and below 30MHz was very low. 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.