

TEST REPORT

Reference No...... : WTF22D11240326W004
FCC ID : BRWSPMR6420
Applicant..... : Horizon Hobby, LLC.
Address..... : 2904 Research Rd., Champaign, IL, 61822 United States
Manufacturer : Horizon Hobby, LLC.
Address..... : 2904 Research Rd., Champaign, IL, 61822 United States
Product..... : Surface Radio Transmitter
Part Number : SPM6420, SPMR6420
Model(s) : iXSR
Standards..... : FCC 47CFR Part 15.247
Date of Receipt sample : 2022-11-30
Date of Test : 2022-11-30 to 2023-08-03
Date of Issue..... : 2023-08-18
Test Result..... : **Pass**

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

Prepared By:

Waltek Testing Group Co., Ltd.

Address: No. 77, Houjie Section, Guantai Road, Houjie Town, Dongguan City, Guangdong, China

Tel: +86-769-2267 6998

Fax: +86-769-2267 6828

Compiled by:

Approved by:

James Cheng
James Cheng / Project Engineer

Deval Qin
Deval Qin / Designated Reviewer



2 Contents

	Page
1 COVER PAGE.....	1
2 CONTENTS	2
3 REVISION HISTORY.....	4
4 GENERAL INFORMATION.....	5
4.1 GENERAL DESCRIPTION OF E.U.T.....	5
4.2 DETAILS OF E.U.T.....	5
4.3 CHANNEL LIST.....	6
4.4 TEST MODE	6
4.5 TEST FACILITY	6
5 TEST SUMMARY	7
6 EQUIPMENT USED DURING TEST.....	8
6.1 EQUIPMENTS LIST	8
6.2 DESCRIPTION OF SUPPORT UNITS.....	9
6.3 MEASUREMENT UNCERTAINTY	9
7 CONDUCTED EMISSION	10
7.1 E.U.T. OPERATION.....	10
7.2 EUT SETUP	10
7.3 MEASUREMENT DESCRIPTION	10
7.4 CONDUCTED EMISSION TEST RESULT	11
8 RADIATED SPURIOUS EMISSIONS	13
8.1 EUT OPERATION.....	13
8.2 TEST SETUP	14
8.3 SPECTRUM ANALYZER SETUP	15
8.4 TEST PROCEDURE.....	16
8.5 CORRECTED AMPLITUDE & MARGIN CALCULATION.....	16
8.6 SUMMARY OF TEST RESULTS.....	17
9 CONDUCTED SPURIOUS EMISSIONS.....	20
9.1 TEST PROCEDURE.....	20
9.2 TEST RESULT	21
10 BAND EDGE MEASUREMENT	23
10.1 TEST PROCEDURE	23
10.2 TEST RESULT	24
11 20 DB BANDWIDTH AND 99% BANDWIDTH MEASUREMENT	25
11.1 TEST PROCEDURE	25
11.2 TEST RESULT	25
12 MAXIMUM PEAK OUTPUT POWER.....	29
12.1 TEST PROCEDURE	29
12.2 TEST RESULT	30
13 HOPPING CHANNEL SEPARATION.....	32
13.1 TEST PROCEDURE	32
13.2 TEST RESULT	33

14 NUMBER OF HOPPING FREQUENCY.....34
14.1 TEST PROCEDURE34
14.2 TEST RESULT35

15 DWELL TIME36
15.1 TEST PROCEDURE36
15.2 TEST RESULT36

16 ANTENNA REQUIREMENT39

17 RF EXPOSURE.....39

18 PHOTOGRAPHS OF TEST SETUP AND EUT.....39

3 Revision History

Test Report No.	Date of Receipt sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF22D11240326W004	2022-11-30	2022-11-30 to 2023-08-03	2023-08-18	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	Surface Radio Transmitter
Part Number:	SPM6420, SPMR6420
Model(s):	iXSR
Model Description:	N/A
Wi-Fi Specification:	2.4G-802.11b/g/n HT20 5G-802.11a/ n(HT20/40)/ac(HT20/40/80)
Bluetooth Version:	Bluetooth v5.0
DSMR	GFSK
Hardware Version:	V1.0
Software Version:	3.00.01

4.2 Details of E.U.T.

Operation Frequency:	2405-2478MHz
Max. RF output power:	24.05dBm
Type of Modulation:	GFSK
Antenna installation:	Rod antenna
Antenna Gain:	3dBi

Note:

#: The antenna gain is provided by the applicant, and the applicant should be responsible for its authenticity, WALTEK lab has not verified the authenticity of its information.

Ratings:	Input: DC 5V or DC 3.7V by Li-ion Battery
Battery:	DC 3.7V, 10500mAh, 38.85Wh

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2405	1	2408	2	2412	3	2415
4	2418	5	2421	6	2425	7	2428
8	2431	9	2434	10	2438	11	2441
12	2444	13	2447	14	2451	15	2454
16	2457	17	2460	18	2464	19	2467
20	2470	21	2474	22	2478	/	/

4.4 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests; the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting	2405MHz	2441MHz	2478MHz

4.5 Test Facility

The test facility has a test site registered with the following organizations:

ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

Waltek Testing Group Co., Ltd. Has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files.

Registration number 7760A, October 15, 2016.

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.

Waltek Testing Group Co., Ltd. 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 number 523476, September 10, 2019.

5 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	PASS
Conducted Spurious emissions	15.247(d)	PASS
Band edge	15.247(d) 15.205(a)	PASS
Conducted Emission	15.207	PASS
20 dB Bandwidth and 99% Bandwidth	15.247(a)(1)	PASS
Maximum Peak Output Power	15.247(b)(1)	PASS
Frequency Separation	15.247(a)(1)	PASS
Number of Hopping Frequency	15.247(a)(1)(iii)	PASS
Dwell time	15.247(a)(1)(iii)	PASS
Antenna Requirement	15.203	Complies
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS

6 Equipment Used during Test

6.1 Equipments List

Conducted Emissions Test Site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	EMI Test Receiver	R&S	ESCI	100947	2022-08-01 2023-07-27	2023-07-27 2024-07-26
2.	LISN	R&S	ENV216	100115	2022-08-01 2023-07-27	2023-07-27 2024-07-26
3.	Cable	Top	TYPE16(3.5M)	-	2022-08-01 2023-07-27	2023-07-27 2024-07-26
3m Semi-anechoic Chamber for Radiation Emissions Test site 1#						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1	Spectrum Analyzer	R&S	FSP30	100091	2022-04-25 2023-04-24	2023-04-24 2024-04-23
2	Amplifier	Agilent	8447D	2944A10178	2022-08-01 2023-07-27	2023-07-27 2024-07-26
3	Trilog Broadband Antenna	SCHWARZBECK	VULB9163	336	2022-08-07	2023-08-06
4	Coaxial Cable (below 1GHz)	Top	TYPE16(13M)	-	2022-04-25 2023-04-24	2023-04-24 2024-04-23
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120 D	667	2022-02-03 2023-02-02	2023-02-02 2024-02-01
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2022-08-01 2023-07-27	2023-07-27 2024-07-26
7	Broadband Preamplifier	COMPLIANCE DIRECTION	PAP-1G18	2004	2022-08-08	2023-08-07
8	Coaxial Cable (above 1GHz)	ZT26-NJ-NJ-8M/FA	1GHz-18GHz	NA	2022-02-03 2023-02-02	2023-02-02 2024-02-01
3m Semi-anechoic Chamber for Radiation Emissions Test site 2#						
Item	Equipment	Manufacturer	Model No.	Serial No	Last Calibration Date	Calibration Due Date
1	Test Receiver	R&S	ESCI	101296	2022-04-25 2023-04-24	2023-04-24 2024-04-23
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2022-04-25 2023-04-24	2023-04-24 2024-04-23
3	Active Loop Antenna	Com-Power Corp.	AL-130R	10160007	2022-05-08 2023-05-07	2023-05-07 2024-05-06
4	Amplifier	ANRITSU	MH648A	M43381	2022-04-25 2023-04-24	2023-04-24 2024-04-23
5	Cable	HUBER+SUHNER	CBL2	525178	2022-04-25 2023-04-24	2023-04-24 2024-04-23

RF Conducted Testing						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Calibration Date	Calibration Due Date
1.	Spectrum Analyzer	R&S	FSP40	100501	2022-08-01 2023-07-27	2023-07-27 2024-07-26
2.	EXA Signal Analyzer	Malaysia Keysight	N9010A	MY50520207	2022-04-25 2023-04-24	2023-04-24 2024-04-23

Test Software:

Test Item	Software name	Software version
Conduction disturbance Radiated Emission(3m)	EZ-EMC	EZ-EMC(RA-03A1-1)

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
/	/	/	/

6.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	± 3.64 dB(AC mains 150KHz~30MHz)
Radiated Spurious Emissions	± 5.08 dB (Bilog antenna 30M~1000MHz)
	± 4.99 dB (Horn antenna 1000M~25000MHz)
Radio Frequency	± 1 x 10 ⁻⁷ Hz
RF Power	± 0.42 dB
Dwell time	1.0%
Conducted Spurious Emissions	± 2.76 dB (9kHz~26500MHz)
Confidence interval: 95%. Confidence factor:k=2	

7 Conducted Emission

Test Requirement: FCC 47CFR Part 15 Section 15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Limit:

Frequency (MHz)	Limit (dB μ V)	
	Quasi-pea	Average
0.15 to 0.5	66 to 56*	56 to 46
0.5 to 5	56	46
5 to 30	60	50

7.1 E.U.T. Operation

Operating Environment:

Temperature: 22.8 °C

Humidity: 52.6 % RH

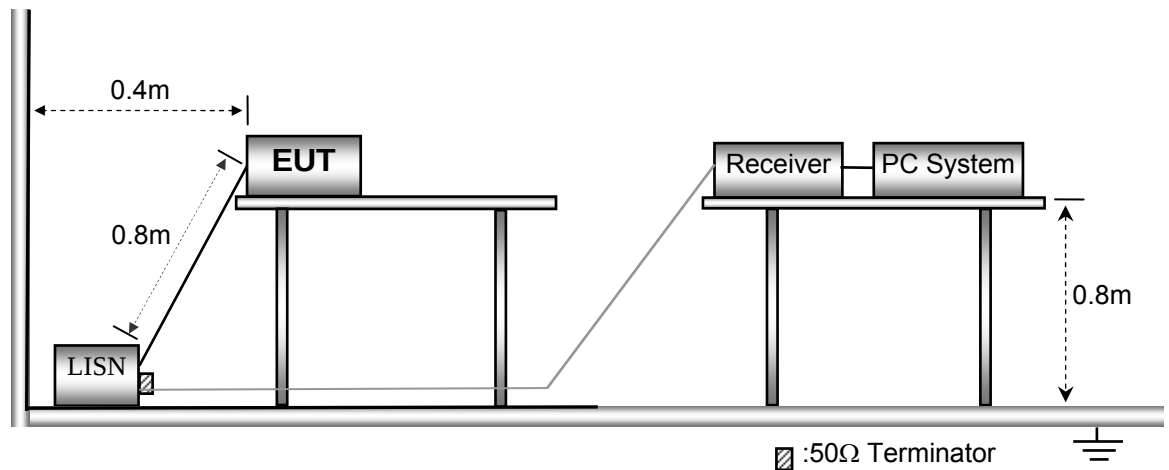
Atmospheric Pressure: 101.2kPa

EUT Operation:

The test was performed in TX High channel mode, the test data were shown in the report.

7.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10: 2013.



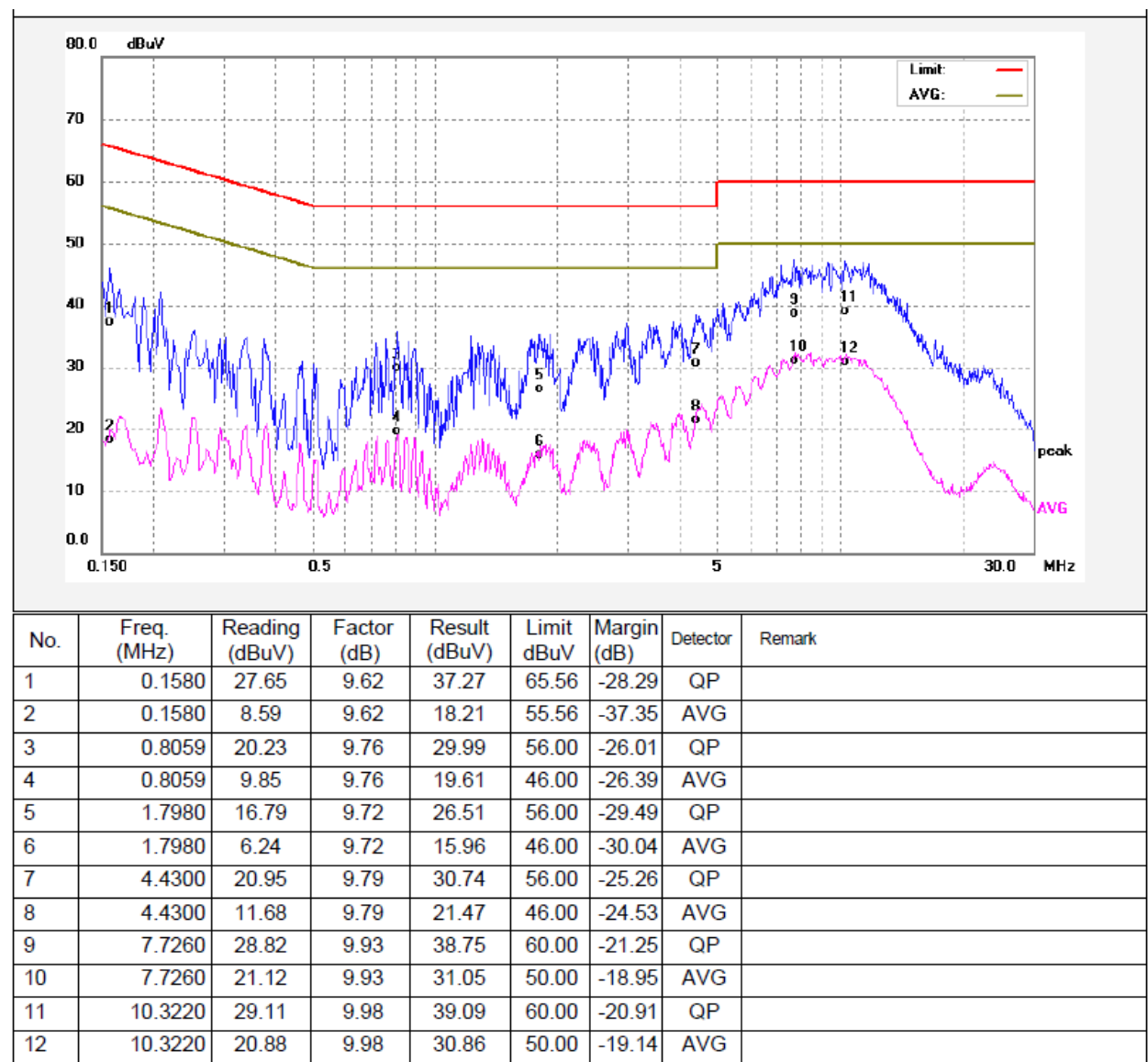
7.3 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

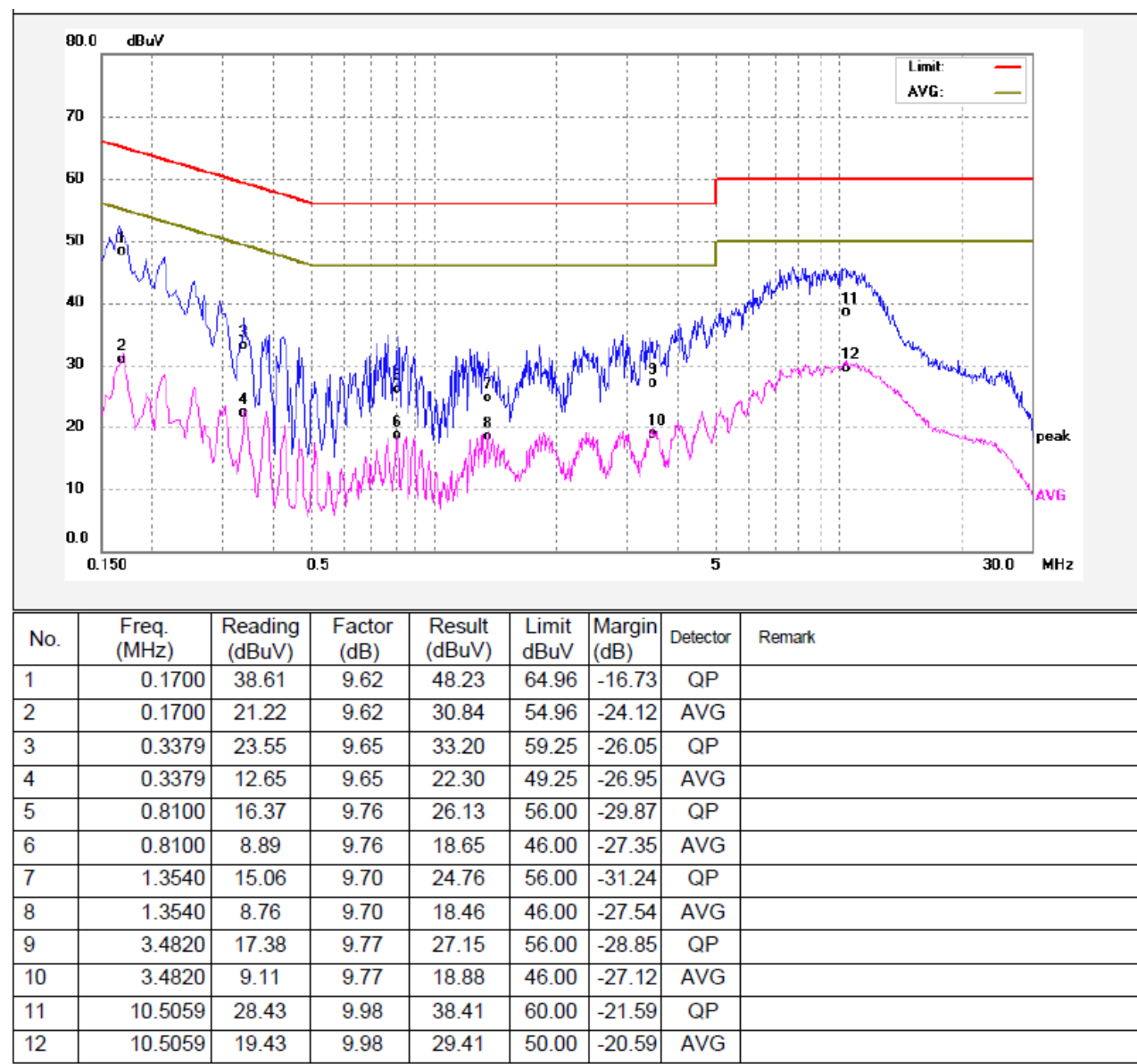
7.4 Conducted Emission Test Result

Remark: only the worst data (TX High channel mode) were reported

Live line:



Neutral line:



8 Radiated Spurious Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.205 &15.209 & 15.247

Test Method: ANSI C63.10: 2013

Test Result: PASS

Measurement Distance: 3m

Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

8.1 EUT Operation

Operating Environment :

Temperature: 23.5 °C

Humidity: 51.1 % RH

Atmospheric Pressure: 101.2kPa

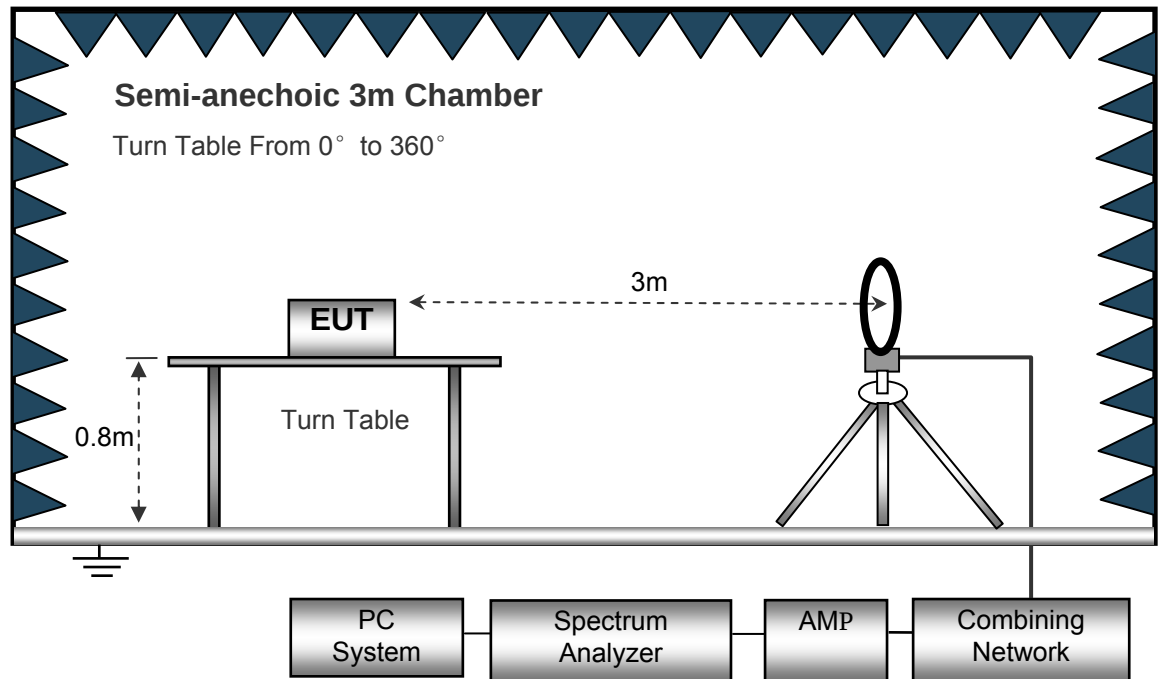
EUT Operation :

The test was performed in TX Transmitting mode, the test data were shown in the report.

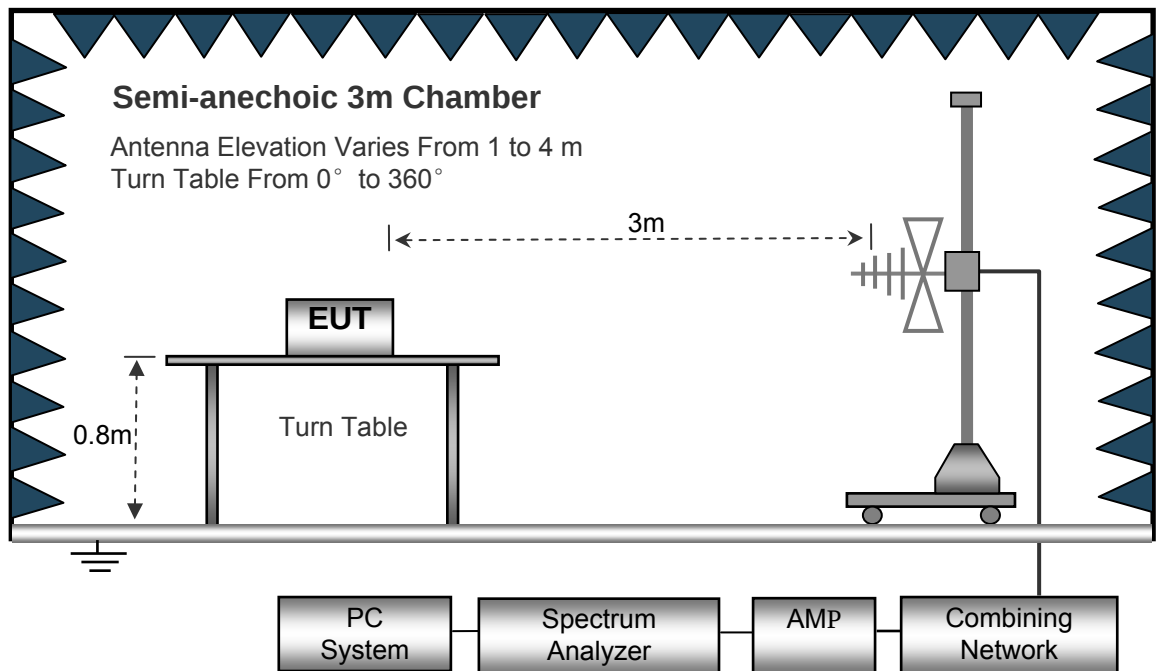
8.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10: 2013.

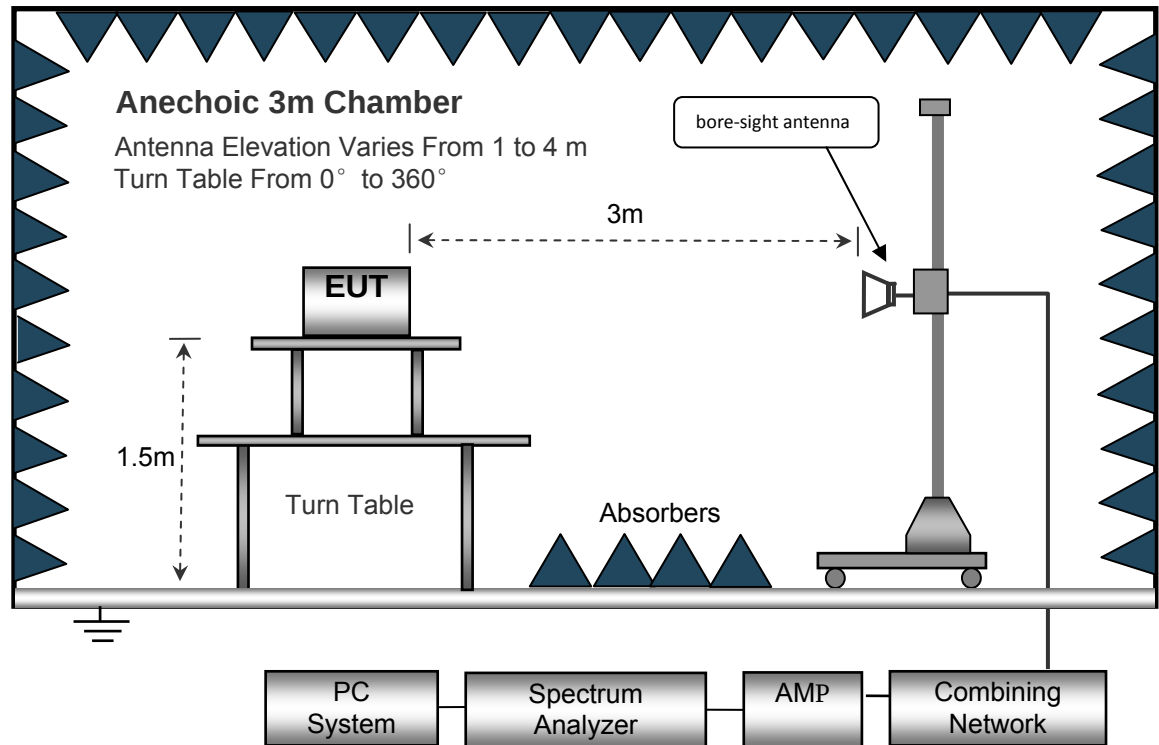
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.



8.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed Auto
IF Bandwidth.....10kHz
Video Bandwidth.....10kHz
Resolution Bandwidth.....10kHz

30MHz ~ 1GHz

Sweep Speed Auto
DetectorPK
Resolution Bandwidth.....100kHz
Video Bandwidth.....300kHz

Above 1GHz

Sweep Speed Auto
DetectorPK
Resolution Bandwidth.....1MHz
Video Bandwidth.....3MHz
DetectorAve.
Resolution Bandwidth.....1MHz
Video Bandwidth.....10Hz

8.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions. The spectrum was investigated from the lowest radio frequency signal generated in the device, without going below 9 kHz, up to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are tested under 3-axes(X,Y,Z) position(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand), After pre-test, It was found that the worse radiation emission was get at the Z position. So the data shown was the Z position only.

8.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corr. Ampl.} - \text{Limit}$$

8.6 Summary of Test Results

Test Frequency: 9KHz~30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 8GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2405MHz									
218.58	38.80	QP	195	1.4	H	-11.88	26.92	46.00	-19.08
218.58	45.53	QP	359	1.8	V	-11.88	33.65	46.00	-12.35
4810.00	51.68	PK	40	1.7	V	-1.06	50.62	74.00	-23.38
4810.00	39.11	Ave	40	1.7	V	-1.06	38.05	54.00	-15.95
7215.00	45.01	PK	26	1.7	H	1.33	46.34	74.00	-27.66
7215.00	35.27	Ave	26	1.7	H	1.33	36.60	54.00	-17.40
2340.25	45.93	PK	163	1.6	V	-13.19	32.74	74.00	-41.26
2340.25	37.49	Ave	163	1.6	V	-13.19	24.30	54.00	-29.70
2369.92	43.16	PK	46	1.1	H	-13.14	30.02	74.00	-43.98
2369.92	36.98	Ave	46	1.1	H	-13.14	23.84	54.00	-30.16
2486.36	44.33	PK	239	2.0	V	-13.08	31.25	74.00	-42.75
2486.36	37.05	Ave	239	2.0	V	-13.08	23.97	54.00	-30.03

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK Middle Channel 2441MHz									
218.58	39.53	QP	160	1.3	H	-13.35	26.18	46.00	-19.82
218.58	45.45	QP	78	1.3	V	-13.35	32.10	46.00	-13.90
4882.00	50.70	PK	116	1.1	V	-0.62	50.08	74.00	-23.92
4882.00	38.52	Ave	116	1.1	V	-0.62	37.90	54.00	-16.10
7323.00	45.37	PK	25	1.4	H	2.21	47.58	74.00	-26.42
7323.00	34.91	Ave	25	1.4	H	2.21	37.12	54.00	-16.88
2334.54	45.17	PK	93	1.6	V	-13.19	31.98	74.00	-42.02
2334.54	39.74	Ave	93	1.6	V	-13.19	26.55	54.00	-27.45
2366.64	43.50	PK	124	1.4	H	-13.14	30.36	74.00	-43.64
2366.64	38.45	Ave	124	1.4	H	-13.14	25.31	54.00	-28.69
2483.64	43.94	PK	138	1.9	V	-13.08	30.86	74.00	-43.14
2483.64	37.13	Ave	138	1.9	V	-13.08	24.05	54.00	-29.95

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
GFSK High Channel 2478MHz									
218.58	40.80	QP	349	1.1	H	-13.35	27.45	46.00	-18.55
218.58	38.46	QP	360	1.6	V	-13.35	25.11	46.00	-20.89
4956.00	48.81	PK	189	1.6	V	-0.24	48.57	74.00	-25.43
4956.00	36.55	Ave	189	1.6	V	-0.24	36.31	54.00	-17.69
7434.00	47.17	PK	245	1.8	H	2.84	50.01	74.00	-23.99
7434.00	36.14	Ave	245	1.8	H	2.84	38.98	54.00	-15.02
2314.41	45.43	PK	310	1.3	V	-13.19	32.24	74.00	-41.76
2314.41	38.24	Ave	310	1.3	V	-13.19	25.05	54.00	-28.95
2381.57	43.99	PK	96	1.5	H	-13.14	30.85	74.00	-43.15
2381.57	36.90	Ave	96	1.5	H	-13.14	23.76	54.00	-30.24
2486.59	43.74	PK	173	1.4	V	-13.08	30.66	74.00	-43.34
2486.59	36.16	Ave	173	1.4	V	-13.08	23.08	54.00	-30.92

Test Frequency: 8GHz~25GHz

The measurements were more than 20 dB below the limit and not recorded

9 Conducted Spurious Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Result: PASS

Limit:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

9.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;

2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

Above 30MHz:

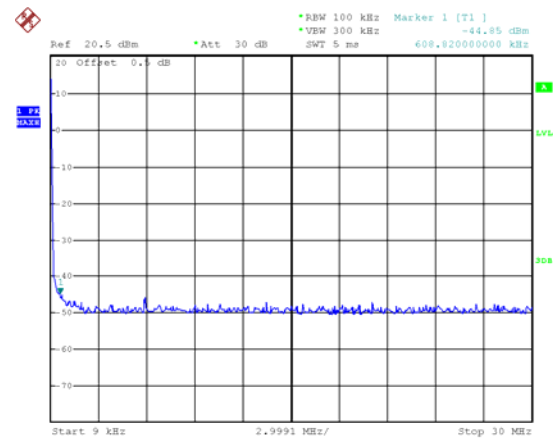
RBW = 100kHz, VBW = 300kHz, Sweep = auto

Detector function = peak, Trace = max hold

9.2 Test Result

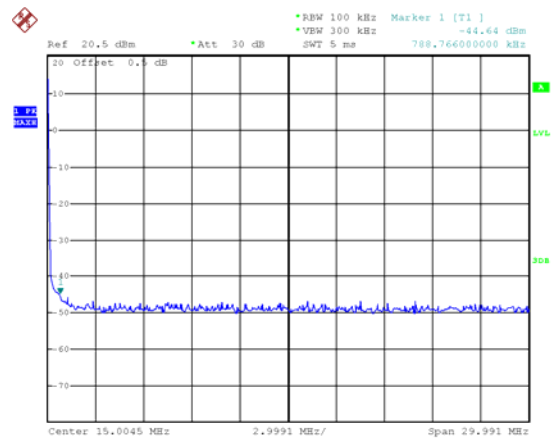
9KHz - 30MHz

Mode: channel 0



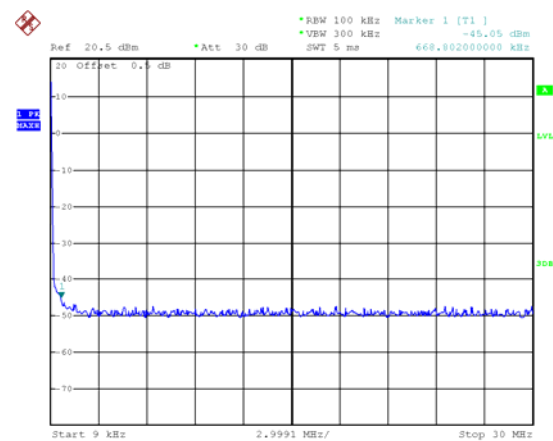
Date: 12.JUL.2023 15:04:06

Mode: channel 11



Date: 12.JUL.2023 15:13:14

Mode: channel 22

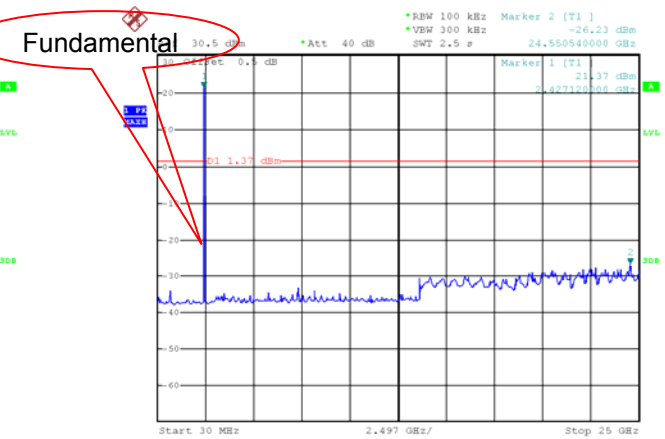
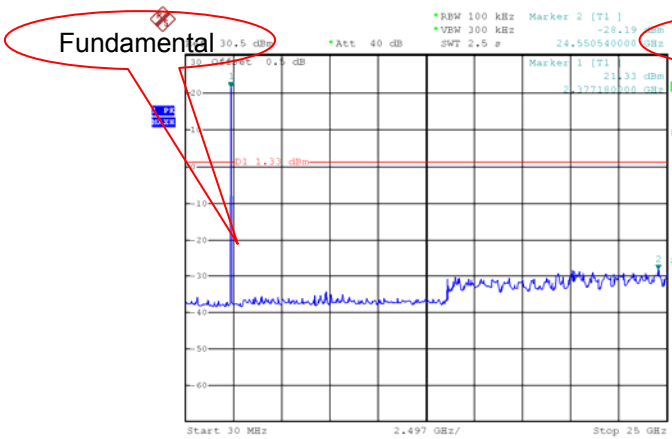


Date: 12.JUL.2023 15:13:53

30MHz – 25GHz

Mode: channel 0

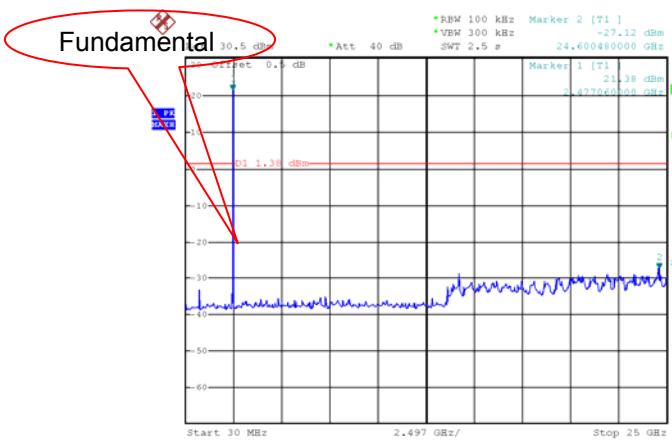
Mode: channel 11



Date: 12.JUL.2023 15:03:05

Date: 12.JUL.2023 14:58:57

Mode: channel 22



Date: 12.JUL.2023 14:43:21

10 Band Edge Measurement

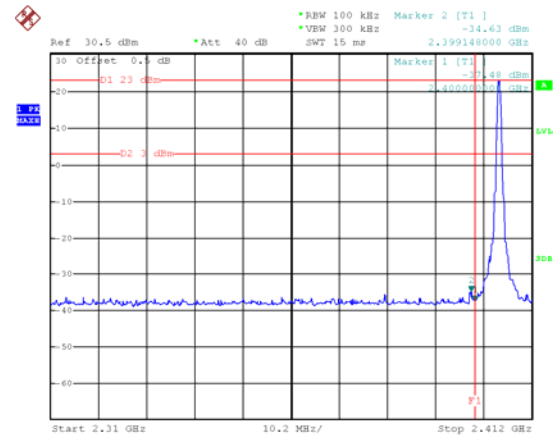
Test Requirement:	Section 15.247(d) In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Test Method:	ANSI C63.10: 2013
Test Limit:	Regulation 15.247 (d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
Test Mode:	Transmitting

10.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 100kHz, VBW = 300kHz, Sweep = auto
Detector function = peak, Trace = max hold

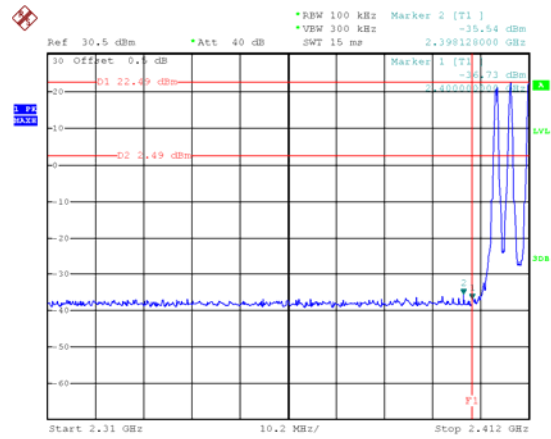
10.2 Test Result

GFSK Transmitting Band edge-left side



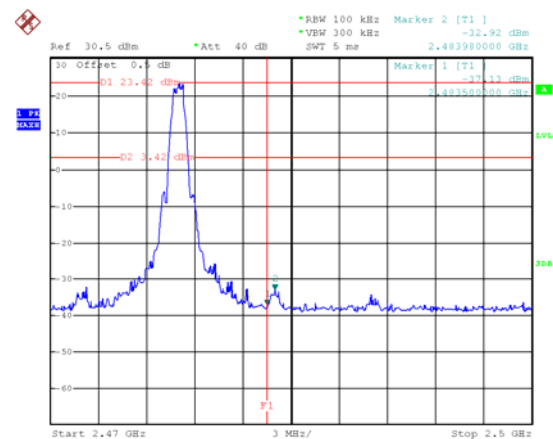
Date: 12.JUL.2023 11:27:10

GFSK Hopping Band edge-left side



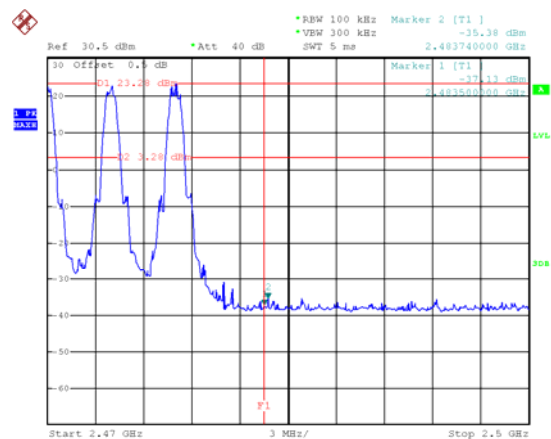
Date: 12.JUL.2023 11:23:59

GFSK Transmitting Band edge-right side



Date: 12.JUL.2023 11:35:24

GFSK Hopping Band edge-right side



Date: 12.JUL.2023 11:39:51

11 20 dB Bandwidth and 99% Bandwidth Measurement

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Mode: Test in fixing operating frequency at low, Middle, high channel.

11.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer: RBW = 30kHz, VBW = 100kHz

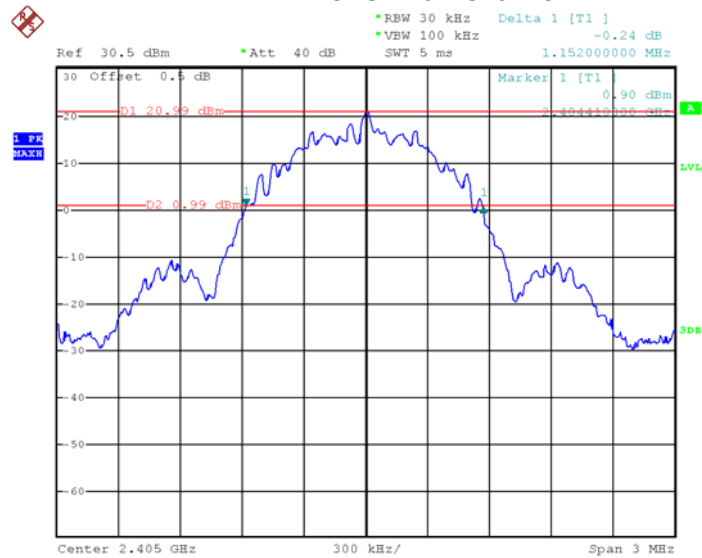
11.2 Test Result

Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
GFSK	Low	1.152	1.026
GFSK	Middle	1.158	1.032
GFSK	High	1.146	1.032

Test plots

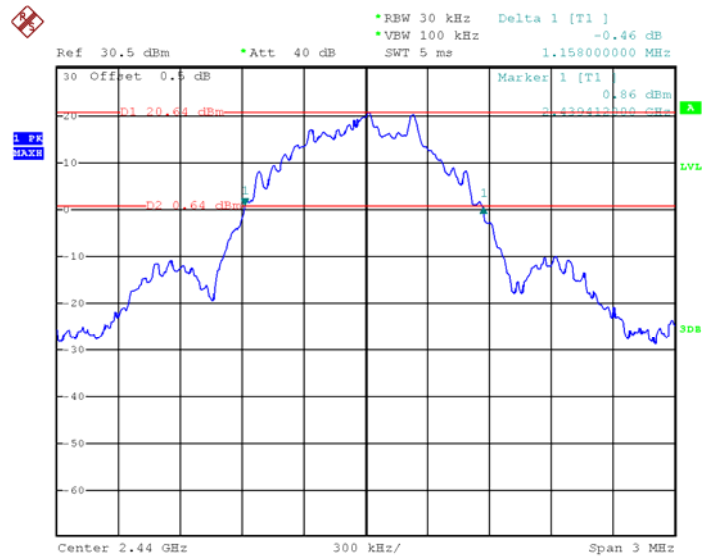
20 dB Bandwidth

GFSK Low Channel

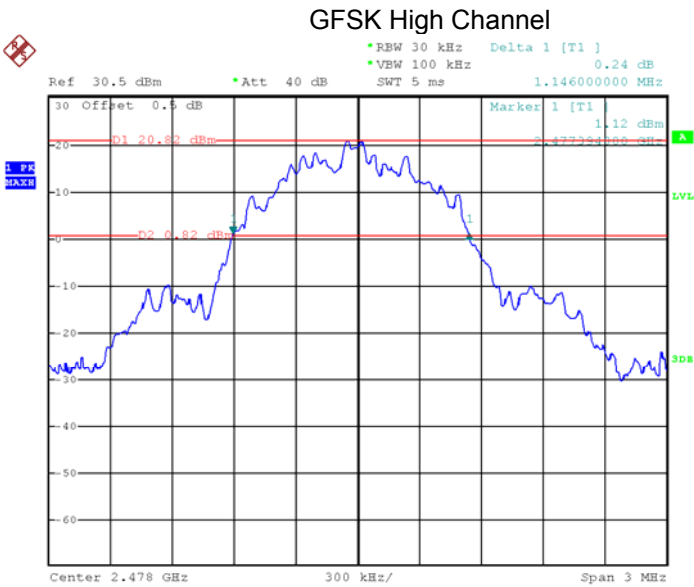


Date: 12.JUL.2023 10:23:25

GFSK Middle Channel

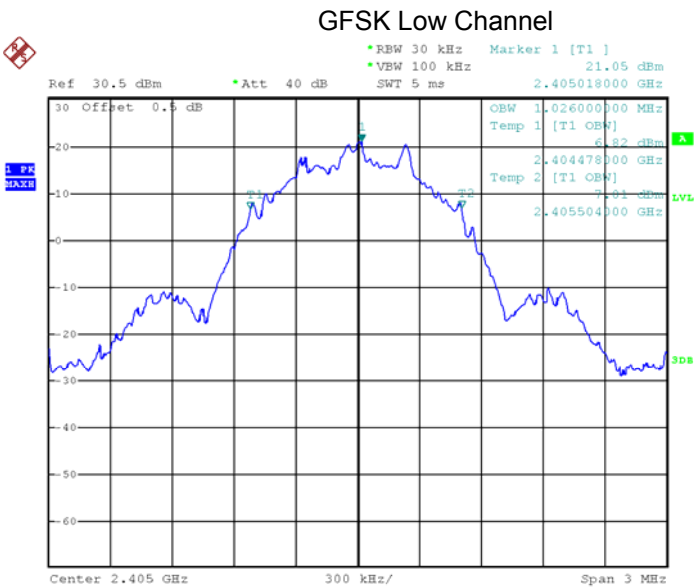


Date: 12.JUL.2023 10:20:12

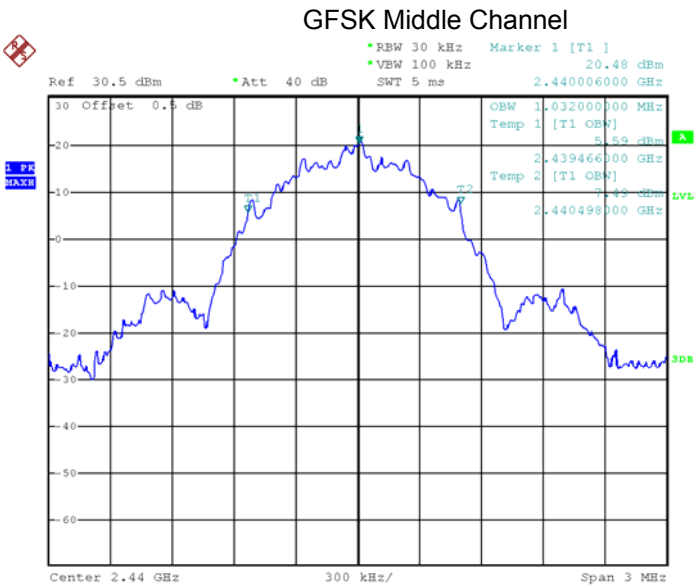


Date: 12.JUL.2023 10:17:34

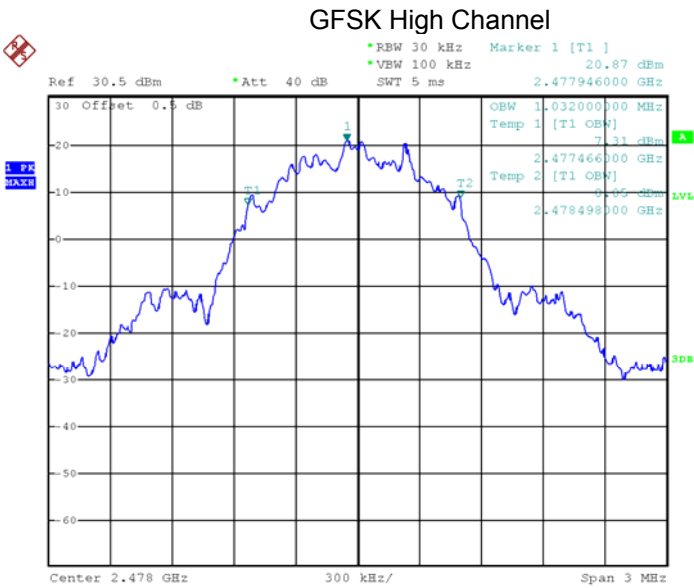
99% Bandwidth



Date: 12.JUL.2023 09:56:51



Date: 12.JUL.2023 09:58:58



Date: 12.JUL.2023 10:00:22

12 Maximum Peak Output Power

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247 (a)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater 0.125 watts..

Test mode: Test in fixing frequency transmitting mode.

12.1 Test Procedure

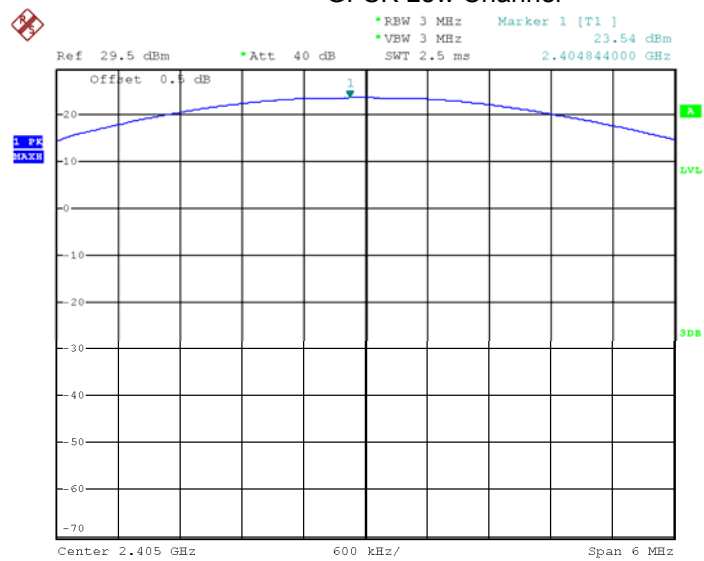
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
 - a) Use the following spectrum analyzer settings:
 - 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
 - 2) RBW $\geq$ 20 dB bandwidth of the emission being measured.
 - 3) VBW $\geq$ RBW.
 - 4) Sweep: Auto.
 - 5) Detector function: Peak.
 - 6) Trace: Max hold.
 - b) Allow trace to stabilize.
 - c) Use the marker-to-peak function to set the marker to the peak of the emission.
 - d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
 - e) A plot of the test results and setup description shall be included in the test report.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

12.2 Test Result

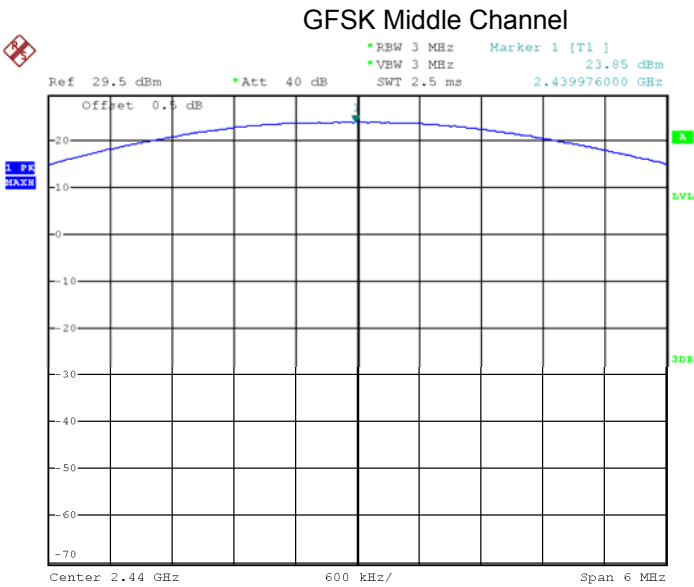
Modulation	Test Channel	Output Power (dBm)	Limit (dBm)
GFSK	Low	23.54	30
GFSK	Middle	23.85	30
GFSK	High	24.05	30

Test plots

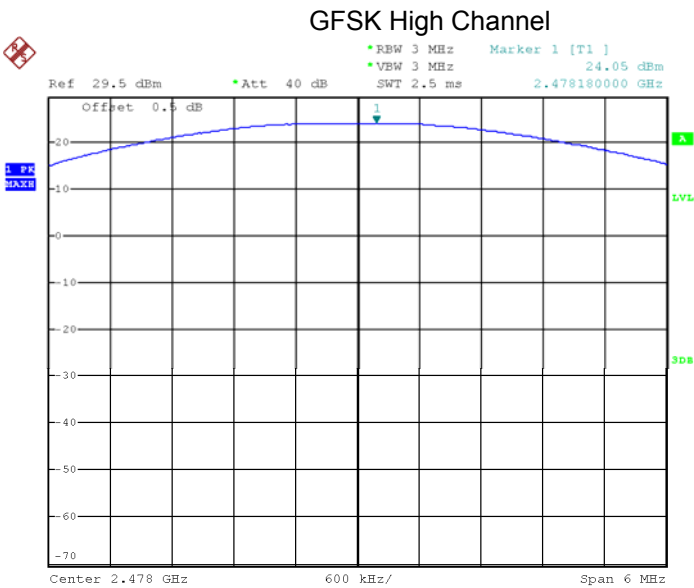
GFSK Low Channel



Date: 7.JUL.2023 10:12:20



Date: 7.JUL.2023 10:13:05



Date: 7.JUL.2023 10:13:41

13 Hopping Channel Separation

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247(a)(1) 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 power no greater than 0.125W.

Test Mode: Test in hopping transmitting operating mode.

13.1 Test Procedure

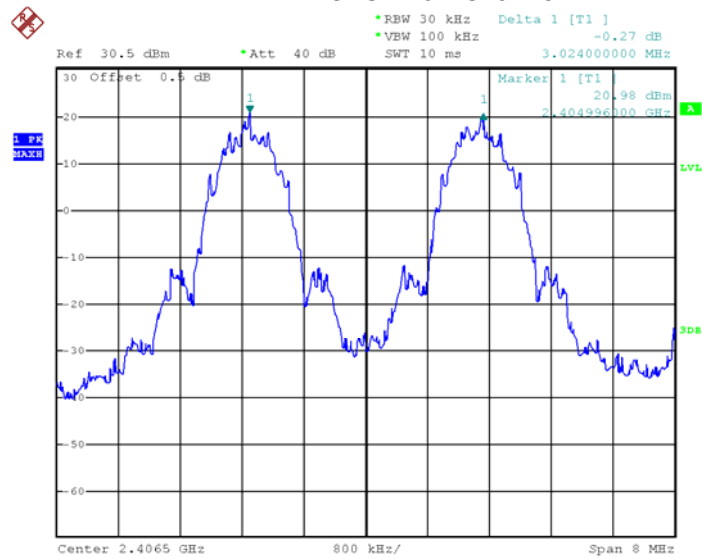
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
 - a) Span: Wide enough to capture the peaks of two adjacent channels.
 - b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
 - c) Video (or average) bandwidth (VBW) $\geq$ RBW.
 - d) Sweep: Auto.
 - e) Detector function: Peak.
 - f) Trace: Max hold.
 - g) Allow the trace to stabilize.
3. Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

13.2 Test Result

Modulation	Test Channel	Separation (MHz)	Limit(MHz)	Result
GFSK	Low	3.024	0.768	PASS

Test plots

GFSK Low Channel



Date: 12.JUL.2023 11:12:17

14 Number of Hopping Frequency

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Mode: Test in hopping transmitting operating mode.

14.1 Test Procedure

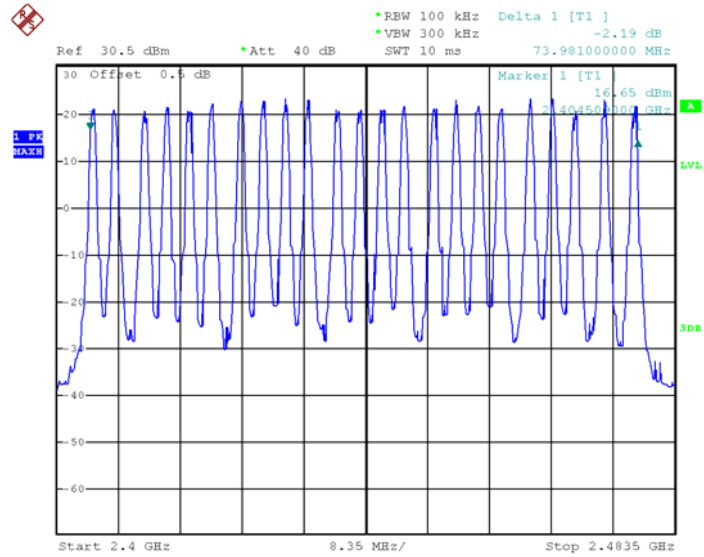
1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer:
 - a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
 - b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
 - c) VBW $\geq$ RBW.
 - d) Sweep: Auto.
 - e) Detector function: Peak.
 - f) Trace: Max hold.
 - g) Allow the trace to stabilize..
3. Allow the trace to stabilize. It may prove necessary to break the span up to sections. in order to clearly show all of the hopping frequencies. The limit is specified in one of the subparagraphs of this Section.
4. Set the spectrum analyzer: Start Frequency = 2.4GHz, Stop Frequency = 2.4835GHz. Sweep=auto;

14.2 Test Result

Test Plots:

23 Channels in total

GFSK



Date: 12.JUL.2023 11:42:26

15 Dwell Time

Test Requirement: FCC 47CFR Part 15 Section 15.247

Test Method: ANSI C63.10: 2013

Test Limit: Regulation 15.247(a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

Test Mode: Test in hopping transmitting operating mode.

15.1 Test Procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set spectrum analyzer span = 0. Centred on a hopping channel;
3. Set RBW = 1MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel. Set the EUT for DH5, DH3 and DH1 packet transmitting.
4. Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

15.2 Test Result

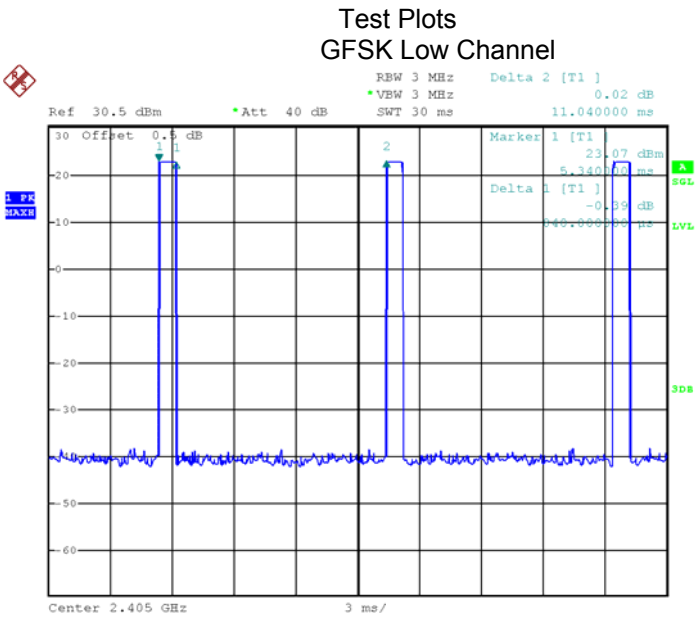
DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

So, the Dwell Time can be calculated as follows:

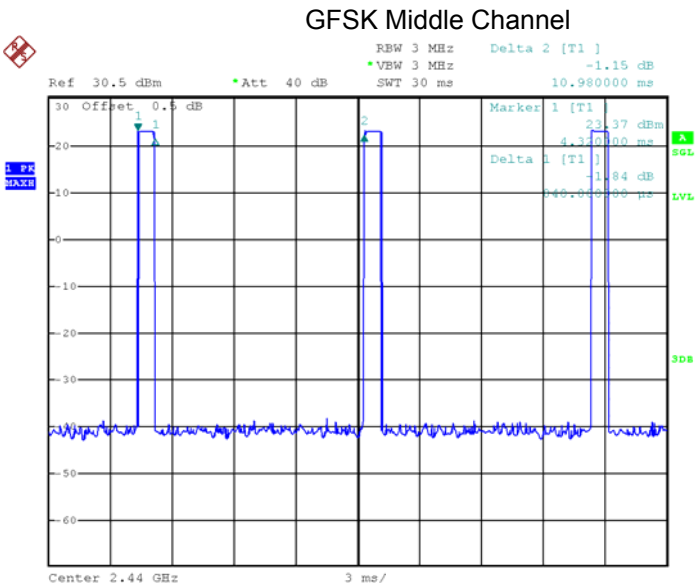
Data Packet	Dwell Time(s)
DH5	$1600/79/6*0.4*79*(MkrDelta)/1000$
Remark: Mkr Delta is once pulse time.	

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period

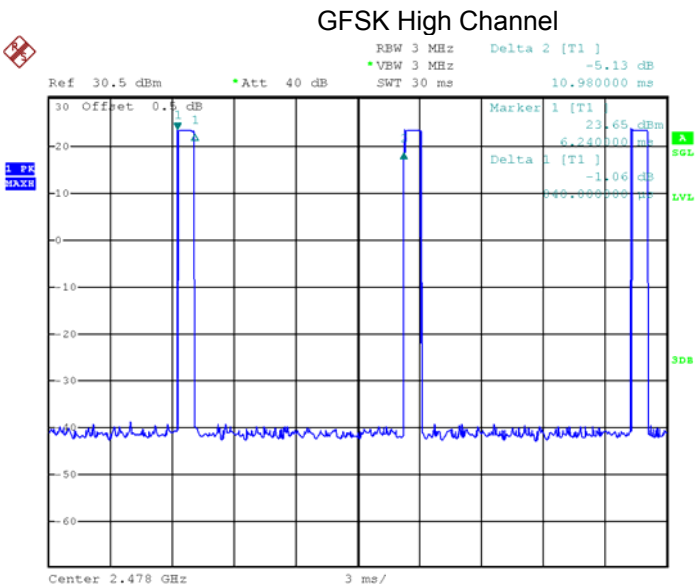
Modulation	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
GFSK	Low	0.840	0.090	0.4
	middle	0.840	0.090	0.4
	High	0.840	0.090	0.4



Date: 12.JUL.2023 10:28:50



Date: 12.JUL.2023 10:30:09



Date: 12.JUL.2023 10:30:58

16 Antenna Requirement

According to the FCC Part 15 Paragraph 15.203, 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. This product has an integrated antenna, fulfil the requirement of this section.

17 RF Exposure

Remark: refer to SAR test report: WTF22X11240330W.

18 Photographs of test setup and EUT.

Note: Please refer to appendix: Appendix-iXSR-Photos.

=====End of Report=====