

TEST REPORT

Reference No...... : WTF22D04074006W004
FCC ID..... : BRWSPMR20500
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 : NX20 20 Channel Transmitter
Model(s)..... : SPMR20500, SPMR205001(alternate stickconfig),
SPMR20500EU (EU only version), SPMR20500 Regular US,
SPMR20500EU EU Version
Standards : FCC 47CFR Part15 Subpart C §15.247
Date of Receipt sample : 2022-04-20
Date of Test : 2022-04-20 to 2022-07-18
Date of Issue : 2022-08-30
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.

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3 Revision History

Test Report No.	Date of Receipt Sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF22D04074006W004	2022-04-20	2022-04-20 to 2022-07-18	2022-08-30	Original	-	Valid

4 General Information

4.1 General Description of E.U.T

Product:	NX20 20 Channel Transmitter
Model(s):	SPMR20500, SPMR205001(alternate stickconfig), SPMR20500EU (EU only version), SPMR20500 Regular US, SPMR20500EU EU Version
Model difference:	Only the model names are different for different market requirement. The test sample's model name is SPMR20500.
Hardware Version:	Rev K
Software Version:	1.0

4.2 Details of E.U.T

Operation Frequency:	2404-2476MHz
2.4G Transmitter Module:	2.4G PLANO
Max. RF output power:	2.4G (ANT 1): 24.24dBm 2.4G (ANT 2): 24.24dBm
Modulation Technology:	FHSS
Antenna installation:	internal permanent antenna
Antenna Gain:	0dBi
Ratings:	Cylindrical Li-Ion Battery 3.7V 1S 3P 10500mAh 38.85Wh

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2404	2	2407	3	2411	4	2414
5	2417	6	2420	7	2424	8	2427
9	2430	10	2433	11	2437	12	2440
13	2443	14	2446	15	2450	16	2453
17	2456	18	2459	19	2463	20	2466
21	2469	22	2473	23	2476		

4.4 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.

4.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

Yes No

If Yes, list the related test items and lab information:

Test Lab: N/A

Lab address: N/A

Test items: N/A

4.6 Abnormalities from Standard Conditions

None.

4.7 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	2404MHz	2440MHz	2476MHz

Note: The EUT has been tested under its typical operating condition. Pre-defined engineering program for regulatory testing used to control the EUT for staying in continuous transmitting. Only the worst-case data were reported.

5 Equipment Used during Test

5.1 Equipments List

Conducted Emissions						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	EMI Test Receiver	R&S	ESCI	100947	2021-07-26	2022-07-25
2	LISN	R&S	ENV216	100115	2021-07-26	2022-07-25
3	Cable	Top	TYPE16(3.5M)	-	2021-07-26	2022-07-25
4	Test software	EZ-EMC	RA-03A1-1	-	N/A	N/A
3m Semi-anechoic Chamber for Radiation Emissions (SAEMC)						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Spectrum Analyzer	R&S	FSP30	100091	2021-04-26 2022-04-28	2022-04-25 2023-04-27
2	Amplifier	Agilent	8447D	2944A10178	2021-04-26 2022-04-28	2022-04-25 2023-04-27
3	Tri-log Broadband Antenna	SCHWARZBECK	VULB9163	336	2021-08-23	2022-08-22
4	Coaxial Cable	Top	TYPE16(13M)	-	2021-04-26 2022-04-28	2022-04-25 2023-04-27
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120D	667	2021-04-30 2022-04-29	2022-04-29 2023-04-28
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2021-07-30	2022-07-29
7	Broadband Pre-amplifier	COMPLIANCE	PAP-1G18	2004	2021-07-26	2022-07-25
8	Coaxial Cable	Top	ZT26-NJ-NJ-8M/FA	-	2021-04-26 2022-04-28	2022-04-25 2023-04-27
9	Microwave Amplifier	SCHWARZBECK	BBV 9721	100472	2021-07-26	2022-07-25
10	Coaxial Cable	Top	ZT40-2.92J-2.92J-2.0M	17100919	2021-04-26 2022-04-28	2022-04-25 2023-04-27
11	Test software	EZ-EMC	RA-03A1-1	-	N/A	N/A
3m Semi-anechoic Chamber for Radiation Emissions (TDK)						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Test Receiver	R&S	ESCI	101296	2021-04-26 2022-04-28	2022-04-25 2023-04-27
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2021-04-26 2022-04-28	2022-04-25 2023-04-27
3	Active Loop Antenna	Com-Power	AL-130R	10160007	2022-05-05	2023-05-04
4	Amplifier	ANRITSU	MH648A	M43381	2021-04-26 2022-04-28	2022-04-25 2023-04-27
5	Cable	HUBER+SUHNER	CBL2	525178	2021-04-26 2022-04-28	2022-04-25 2023-04-27
6	Test software	EZ-EMC	RA-03A1-1	-	N/A	N/A
RF Conducting						
Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Valid
1	Spectrum Analyzer	R&S	FSP40	100501	2021-07-26	2022-07-25
2	Spectrum Analyzer	Agilent	N9020A	MY49100060	2021-07-26	2022-07-25

5.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
-	-	-	-
-	-	-	-

5.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	± 3.64 dB (AC mains 150KHz~30MHz)
Radiated Spurious Emissions	± 5.08 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)
Radio Frequency	± 1 x 10 ⁻⁷ Hz
RF Power	± 0.42 dB
RF Power Density	± 0.7dB
Conducted Spurious Emissions	± 2.76 dB (9kHz~26500MHz)
Confidence interval: 95%. Confidence factor: k=2	

5.4 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P. R. China.

6 Test Summary

Test Items	Test Requirement	Result
Conduct Emission	15.207	Pass
Radiated Spurious Emissions	15.205(a) 15.209 15.247(d)	Pass
Band edge	15.247(d) 15.205(a)	Pass
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	Pass
RF Exposure	1.1307(b)(1)	Pass
Note: Pass=Compliance; NC=Not Compliance; NT=Not Tested; N/A=Not Applicable.		

7 Conducted Emission

Test Requirement: FCC CFR 47 Part 15 Section 15.207
 Test Method: ANSI C63.10:2013
 Test Result: PASS
 Frequency Range: 150kHz to 30MHz
 Class/Severity: Class B
 Limit:

Frequency (MHz)	Limit (dB μ V)	
	Quasi-peak	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 :

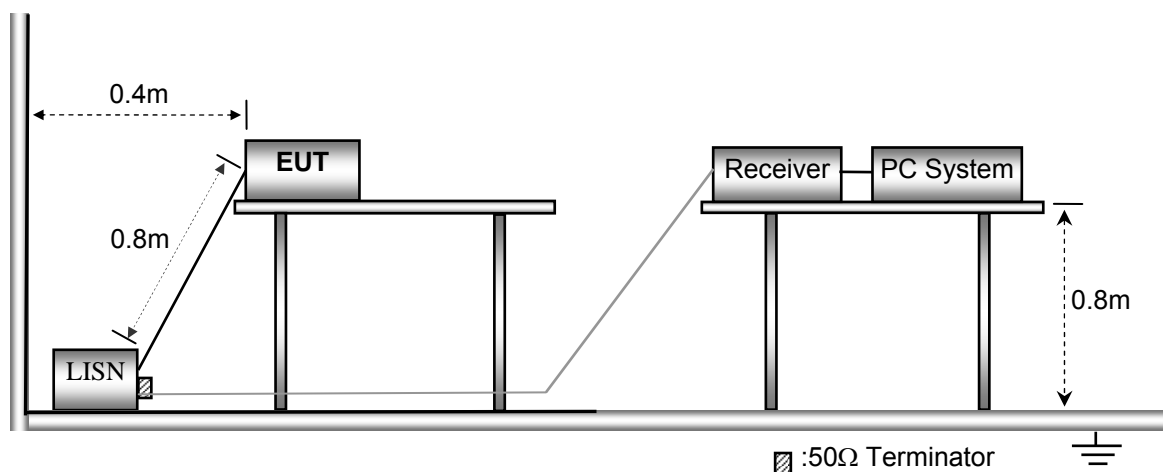
Temperature: 22.8 °C
 Humidity: 52.6 % RH
 Atmospheric Pressure: 101.2kPa

EUT Operation :

The test was performed in TX Transmitting 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.



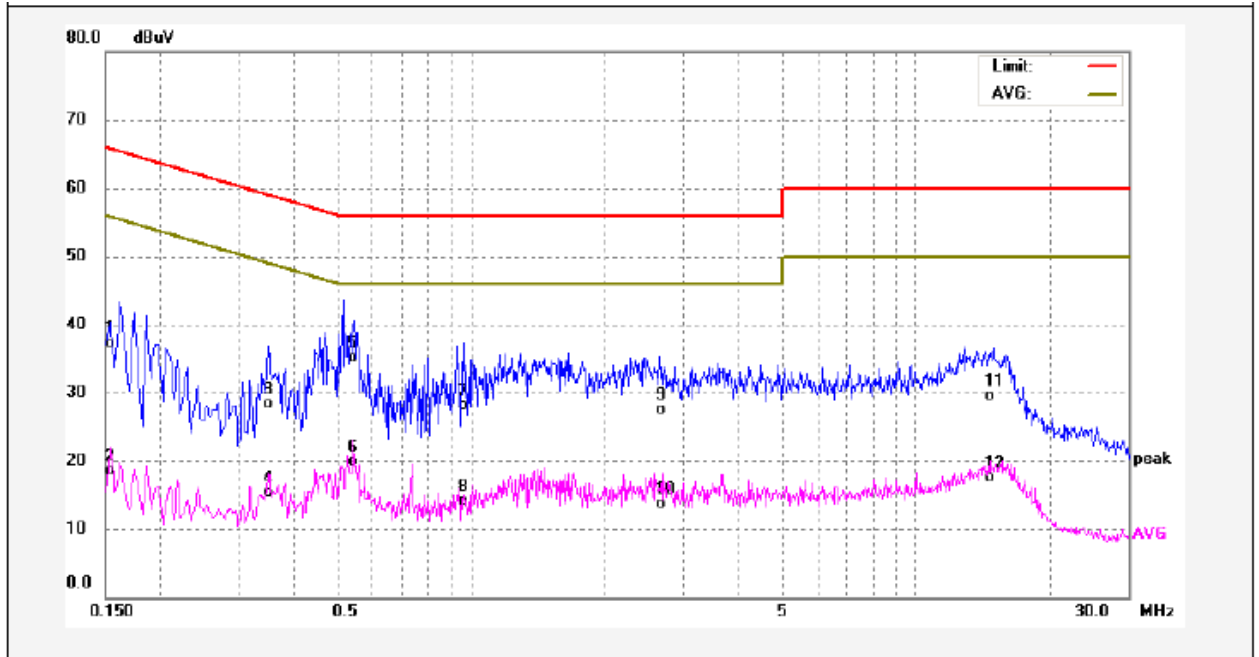
7.3 Measurement Description

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

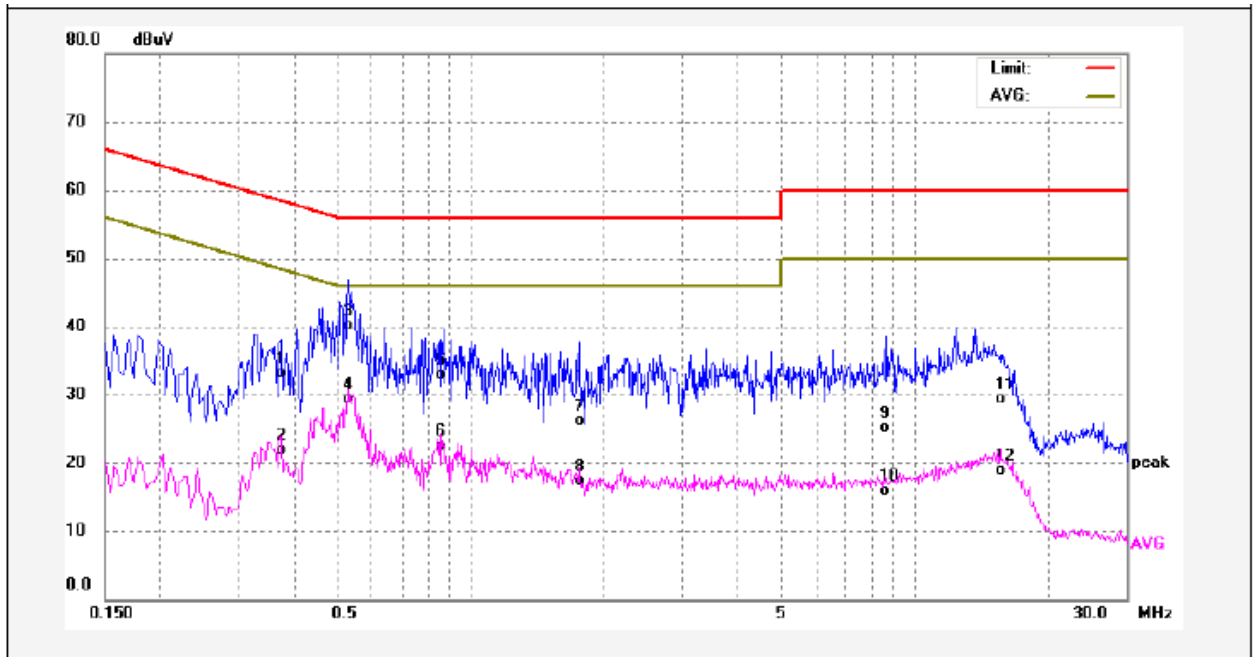
Remark: only the worst data (Low channel mode) were reported

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1539	25.22	12.04	37.26	65.78	-28.52	QP	
2	0.1539	6.38	12.04	18.42	55.78	-37.36	AVG	
3	0.3500	16.48	11.74	28.22	58.96	-30.74	QP	
4	0.3500	3.51	11.74	15.25	48.96	-33.71	AVG	
5	0.5420	23.32	11.78	35.10	56.00	-20.90	QP	
6	0.5420	8.07	11.78	19.85	46.00	-26.15	AVG	
7	0.9620	16.17	11.90	28.07	56.00	-27.93	QP	
8	0.9620	2.25	11.90	14.15	46.00	-31.85	AVG	
9	2.6540	15.54	12.04	27.58	56.00	-28.42	QP	
10	2.6540	1.61	12.04	13.65	46.00	-32.35	AVG	
11	14.6420	17.62	11.82	29.44	60.00	-30.56	QP	
12	14.6420	5.71	11.82	17.53	50.00	-32.47	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.3740	21.85	11.20	33.05	58.41	-25.36	QP	
2	0.3740	10.69	11.20	21.89	48.41	-26.52	AVG	
3	0.5299	28.91	11.16	40.07	56.00	-15.93	QP	
4	0.5299	18.17	11.16	29.33	46.00	-16.67	AVG	
5	0.8580	21.61	11.30	32.91	56.00	-23.09	QP	
6	0.8580	11.15	11.30	22.45	46.00	-23.55	AVG	
7	1.7540	14.86	11.30	26.16	56.00	-29.84	QP	
8	1.7540	6.00	11.30	17.30	46.00	-28.70	AVG	
9	8.6820	13.65	11.46	25.11	60.00	-34.89	QP	
10	8.6820	4.40	11.46	15.86	50.00	-34.14	AVG	
11	15.6300	17.84	11.47	29.31	60.00	-30.69	QP	
12	15.6300	7.51	11.47	18.98	50.00	-31.02	AVG	

8 Radiated Emissions

Test Requirement: FCC 47CFR Part15 Subpart C §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	$2400/F(\text{kHz})$	300	$10000 * 2400/F(\text{kHz})$	$20\log^{(2400/F(\text{kHz}))} + 80$
0.490 ~ 1.705	$24000/F(\text{kHz})$	30	$100 * 24000/F(\text{kHz})$	$20\log^{(24000/F(\text{kHz}))} + 40$
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: 21.3 °C

Humidity: 50.3 % RH

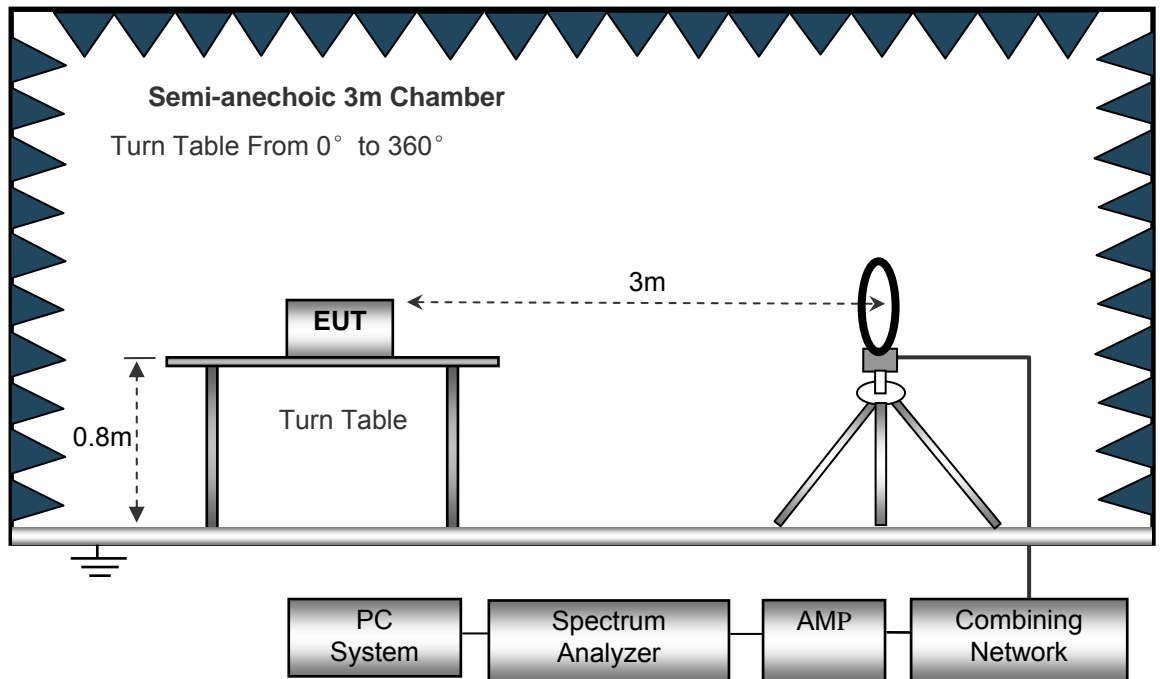
Atmospheric Pressure: 101.6kPa

EUT Operation: The test was performed in Transmitting mode

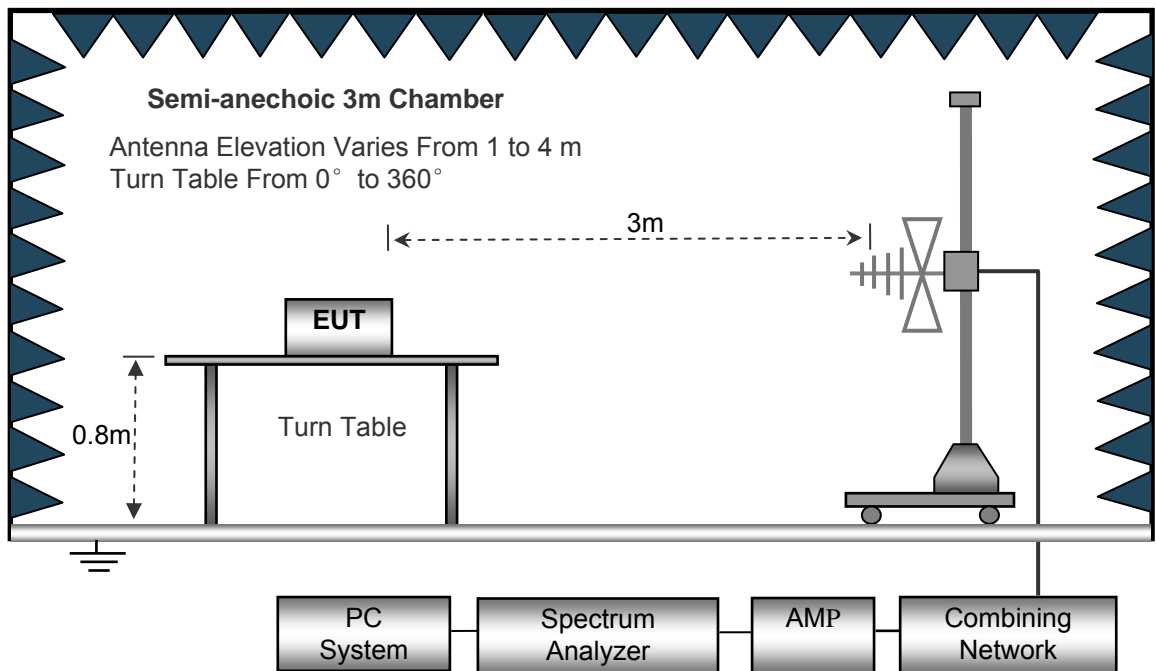
8.2 Test Setup

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

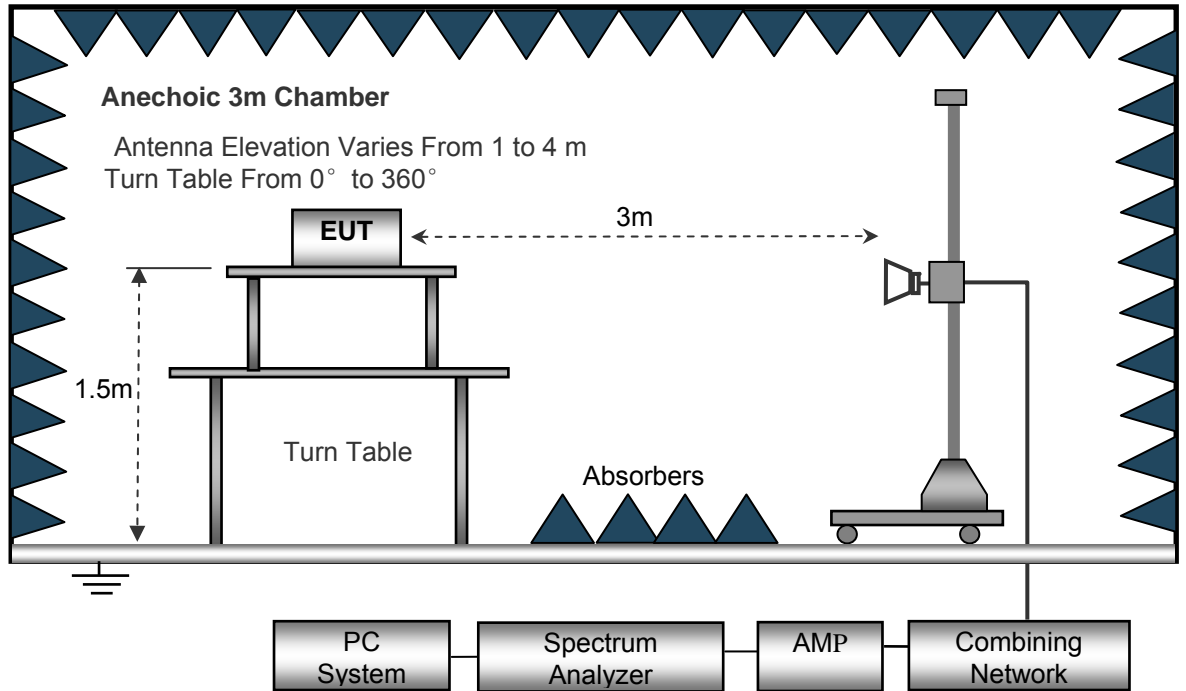
The test setup for emission measurement below 30MHz.



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..... 10 kHz
 Video Bandwidth..... 10 kHz
 Resolution Bandwidth 10 kHz

30MHz ~ 1GHz

Sweep Speed Auto
 Detector PK
 Resolution Bandwidth..... 100 kHz
 Video Bandwidth..... 300 kHz

Above 1GHz

Sweep Speed Auto
 Detector PK
 Resolution Bandwidth..... 1 MHz
 Video Bandwidth..... 3 MHz
 Detector Ave.
 Resolution Bandwidth..... 1 MHz
 Video Bandwidth..... 10 Hz

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 X position. So the data shown was the X position only.
8. 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.

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

Note:

1. Lowest frequency generated in the device is 40MHz, frequency range of measurement should be above 30MHz.

Test Frequency: 30MHz ~ 8GHz

Remark: only the worst data (ANT1) were recorded.

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
Low Channel 2404MHz									
268.32	36.20	QP	320	1.6	H	-13.35	22.85	46.00	-23.15
268.32	43.83	QP	254	1.7	V	-13.35	30.48	46.00	-15.52
4808.00	47.62	PK	326	1.7	V	-1.06	46.56	74.00	-27.44
4808.00	43.91	Ave	326	1.7	V	-1.06	42.85	54.00	-11.15
7212.00	42.82	PK	249	1.3	H	1.33	44.15	74.00	-29.85
7212.00	35.42	Ave	249	1.3	H	1.33	36.75	54.00	-17.25

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
Middle Channel 2440MHz									
268.32	34.93	QP	174	1.2	H	-13.35	21.58	46.00	-24.42
268.32	43.46	QP	313	1.2	V	-13.35	30.11	46.00	-15.89
4880.00	48.28	PK	351	1.2	V	-0.62	47.66	74.00	-26.34
4880.00	43.75	Ave	351	1.2	V	-0.62	43.13	54.00	-10.87
7320.00	44.28	PK	25	1.0	H	2.21	46.49	74.00	-27.51
7320.00	34.90	Ave	25	1.0	H	2.21	37.11	54.00	-16.89

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	FCC Part 15.247/209/205	
				Height	Polar			Limit	Margin
(MHz)	(dB μ V)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dB μ V/m)	(dB μ V/m)	(dB)
High Channel 2476MHz									
268.32	35.74	QP	296	1.5	H	-13.35	22.39	46.00	-23.61
268.32	42.09	QP	238	1.0	V	-13.35	28.74	46.00	-17.26
4952.00	47.13	PK	15	1.8	V	-0.24	46.89	74.00	-27.11
4952.00	42.69	Ave	15	1.8	V	-0.24	42.45	54.00	-11.55
7428.00	45.61	PK	35	1.2	H	2.84	48.45	74.00	-25.55
7428.00	33.91	Ave	35	1.2	H	2.84	36.75	54.00	-17.25

Test Frequency: 8GHz~25GHz

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

9 Conducted Spurious Emissions

Test Requirement: FCC CFR47 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 1GHz:

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

Detector function = peak, Trace = max hold

Above 1GHz:

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

Detector function = peak, Trace = max hold

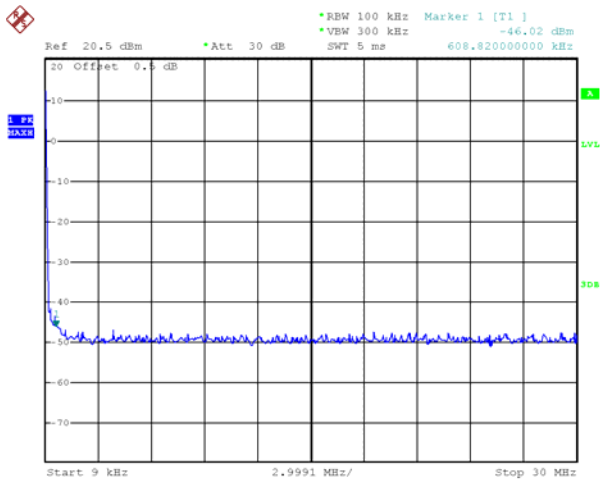
9.2 Test Result

9KHz - 30MHz

(ANT 1)

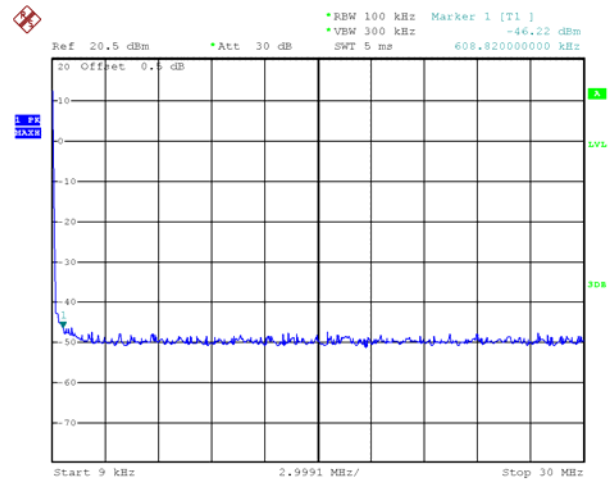
Modulation: FHSS

Low Channel



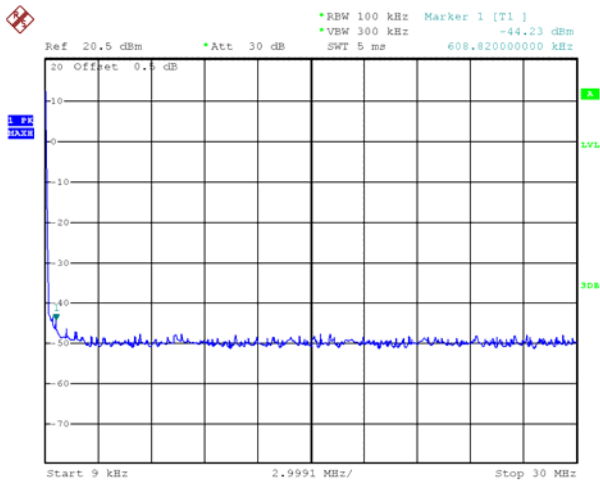
Date: 30.MAY.2022 17:43:33

Middle Channel



Date: 30.MAY.2022 17:44:22

High Channel

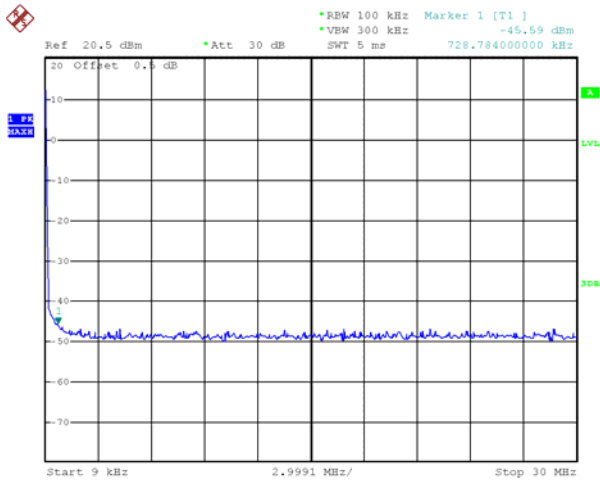


Date: 30.MAY.2022 17:43:51

(ANT 2)

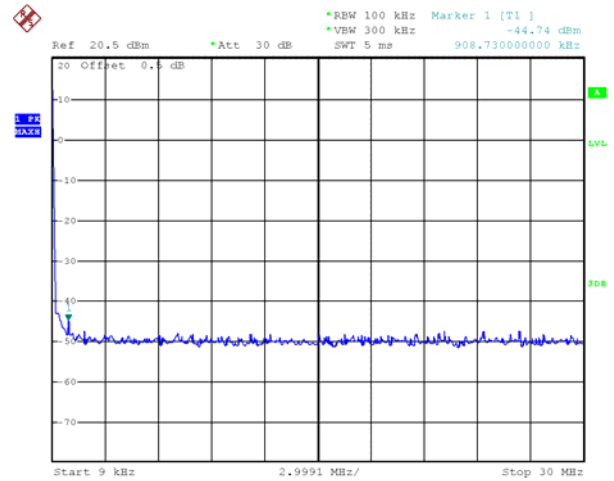
Modulation: FHSS

Low Channel



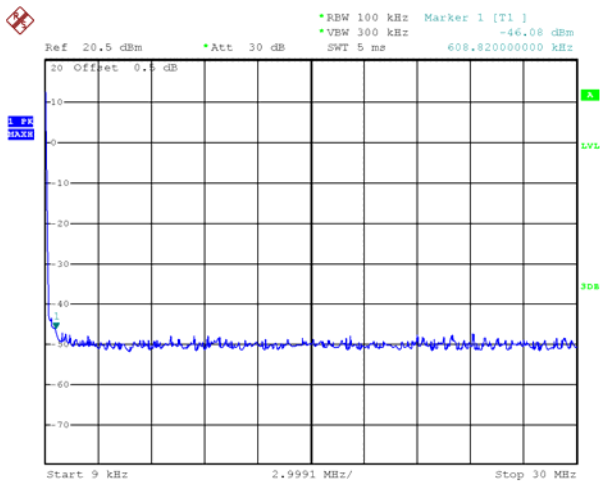
Date: 30.MAY.2022 17:43:03

Middle Channel



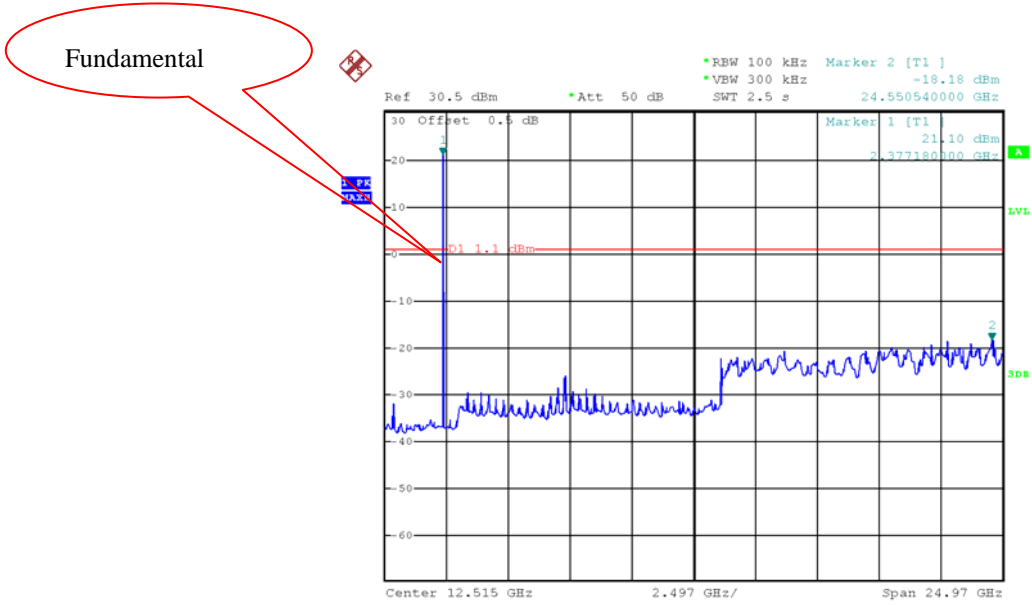
Date: 30.MAY.2022 17:44:35

High Channel



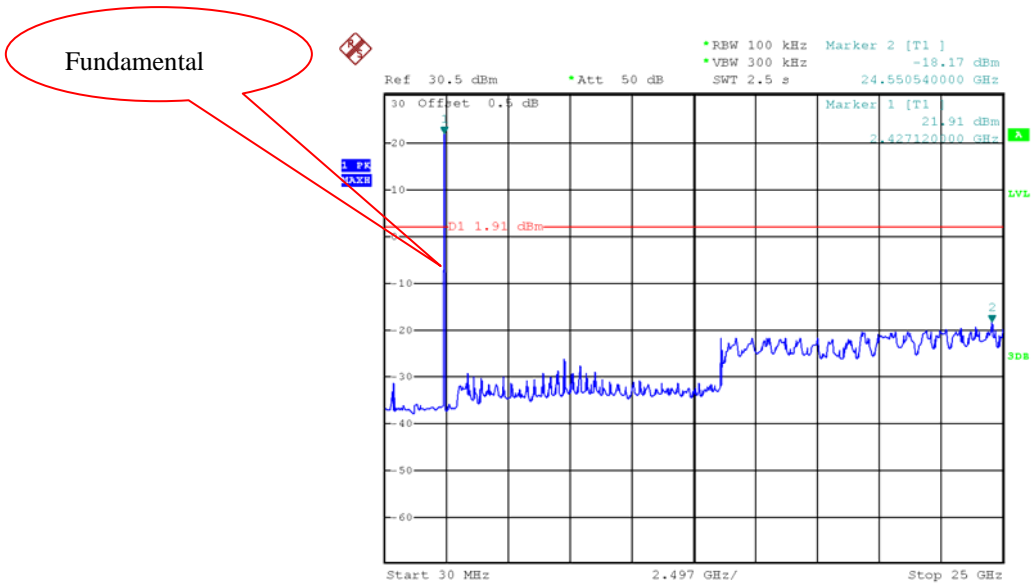
Date: 30.MAY.2022 17:44:02

30MHz – 25GHz
(ANT 1)
FHSS Low Channel



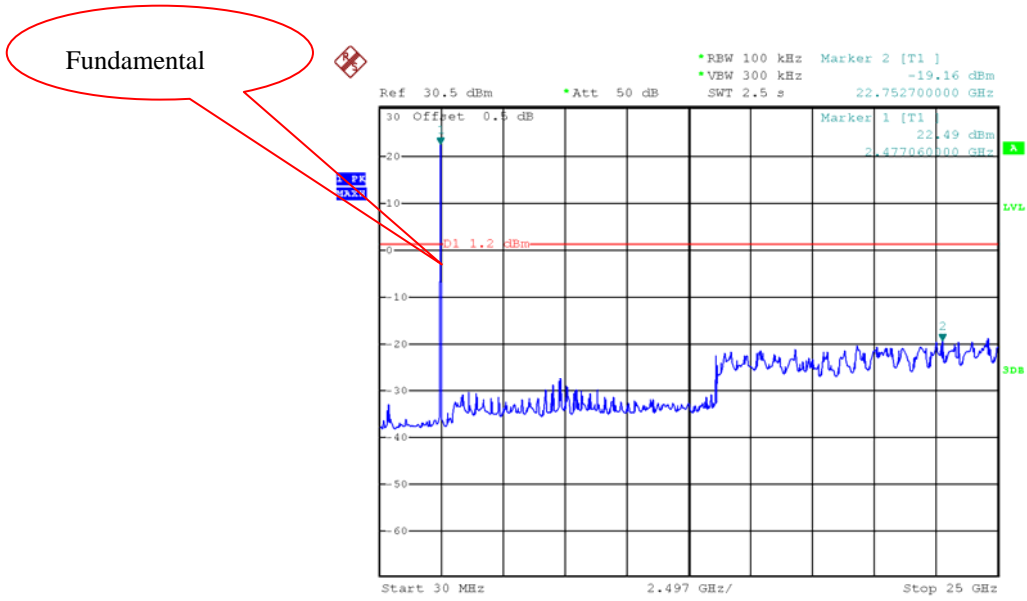
Date: 30.MAY.2022 17:48:17

FHSS Middle Channel



Date: 30.MAY.2022 17:51:41

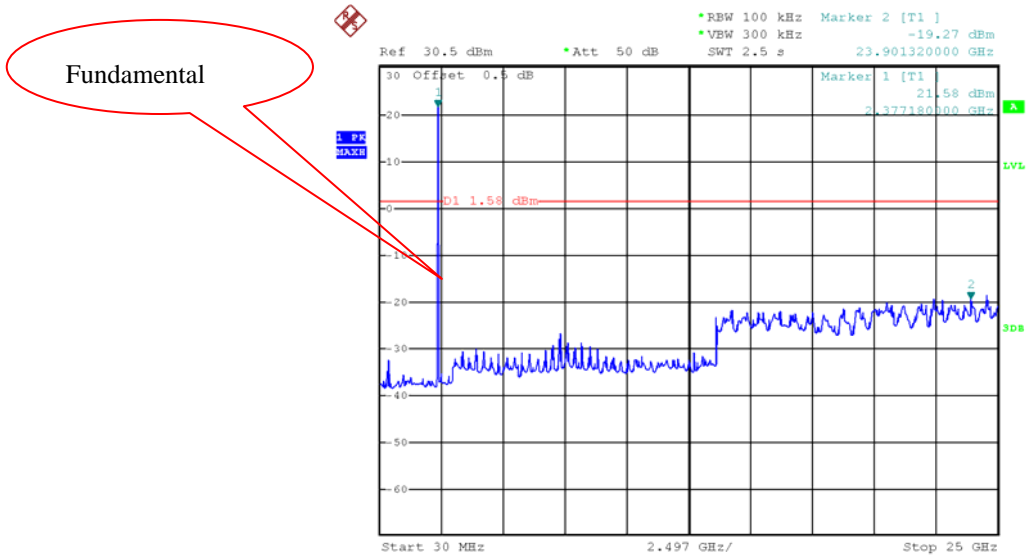
FHSS High Channel



Date: 30.MAY.2022 17:56:09

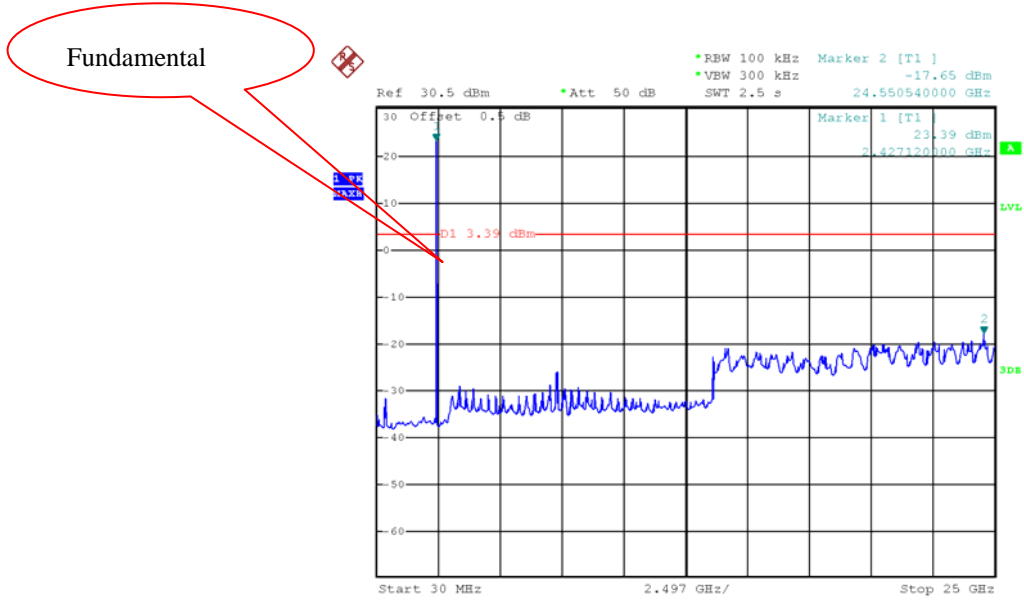
(ANT 2)

FHSS Low Channel



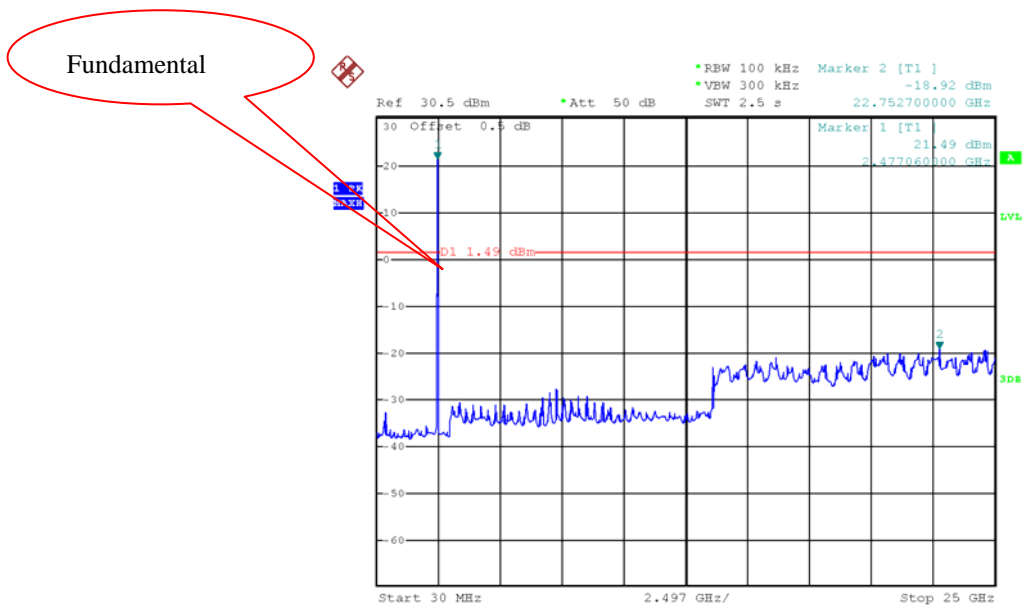
Date: 31.MAY.2022 11:48:19

FHSS Middle Channel



Date: 30.MAY.2022 17:54:03

FHSS High Channel



Date: 30.MAY.2022 17:55:00

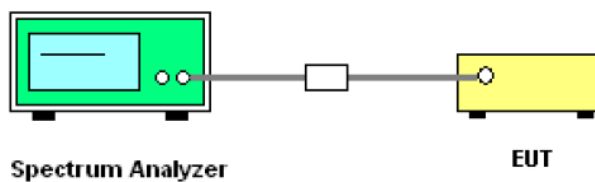
10 Band Edge Measurement

Test Requirement:	FCC 47CFR Part15 Subpart C §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 20dB. 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 = 100 kHz, VBW = 300 kHz, Sweep = auto
Detector function = peak, Trace = max hold

10.2 Test Setup



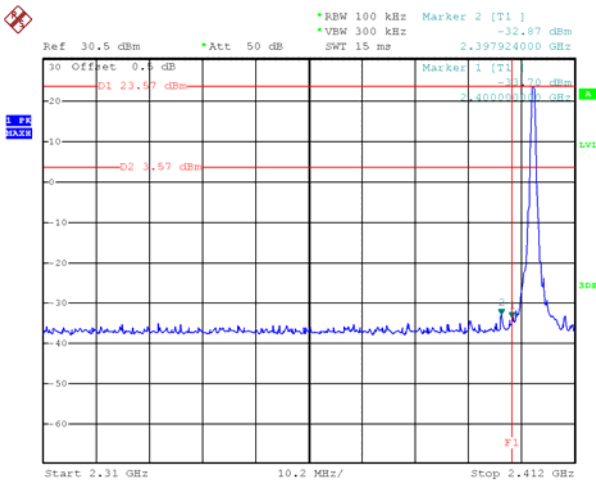
10.3 Test Result

Test plots

(ANT 1)

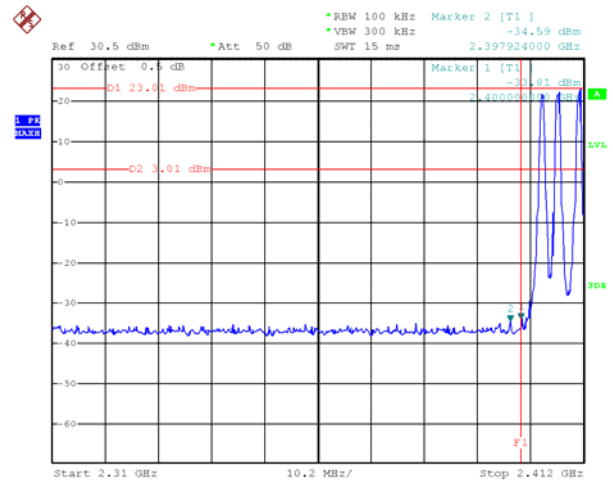
Modulation: FHSS

Transmitting Band edge-left side



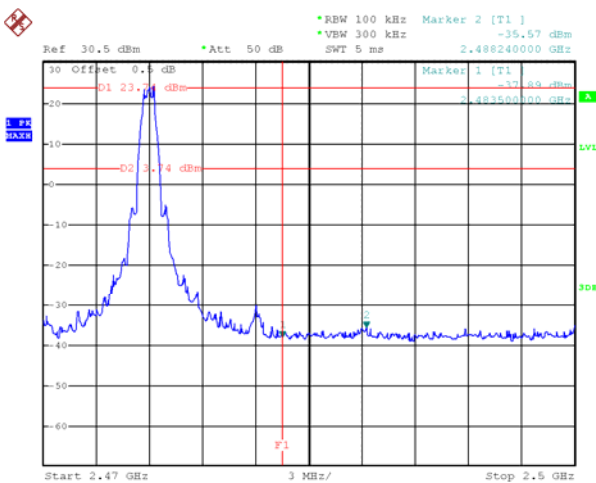
Date: 30.MAY.2022 17:31:00

Hopping Band edge-left side



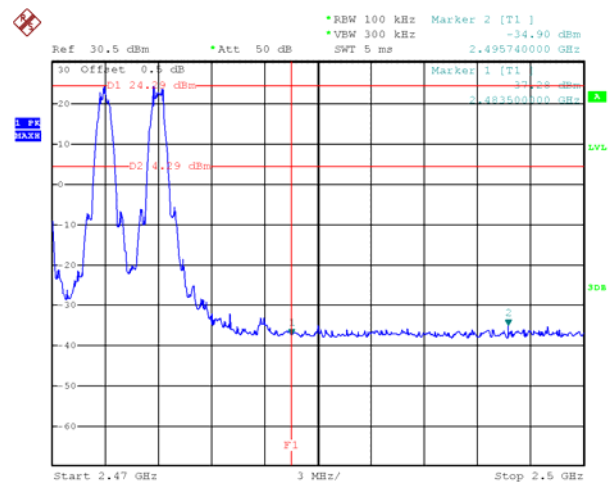
Date: 30.MAY.2022 17:11:12

Transmitting Band edge-right side



Date: 30.MAY.2022 17:32:15

Hopping Band edge-right side

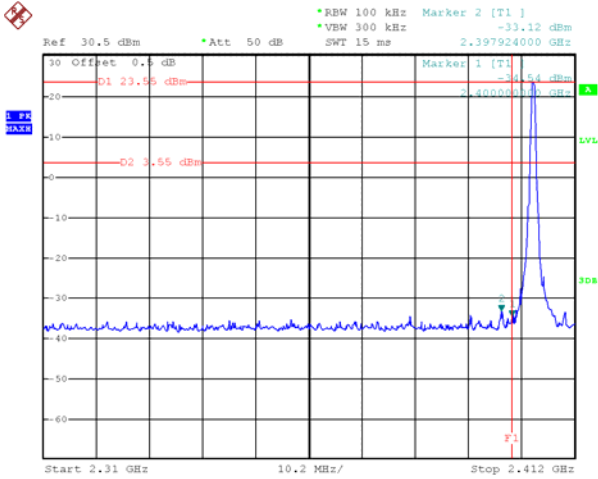


Date: 30.MAY.2022 17:37:30

(ANT 2)

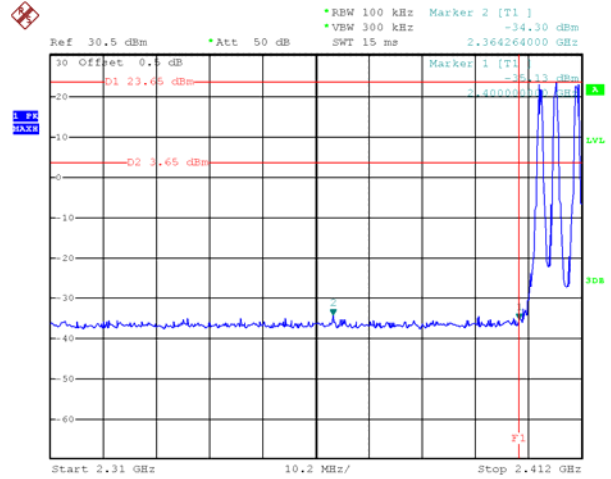
Modulation: FHSS

Transmitting Band edge-left side



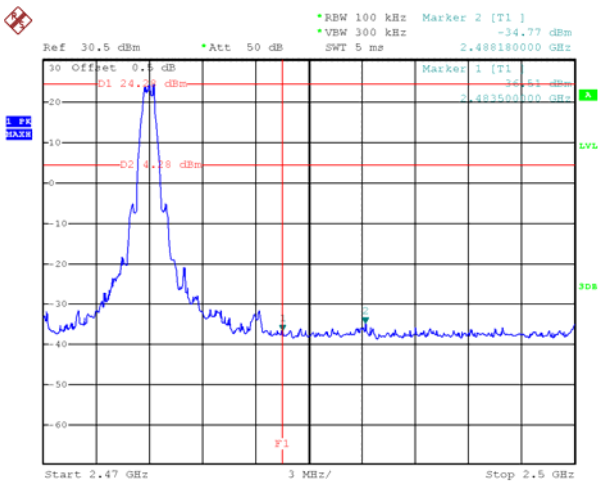
Date: 30.MAY.2022 17:29:03

Hopping Band edge-left side



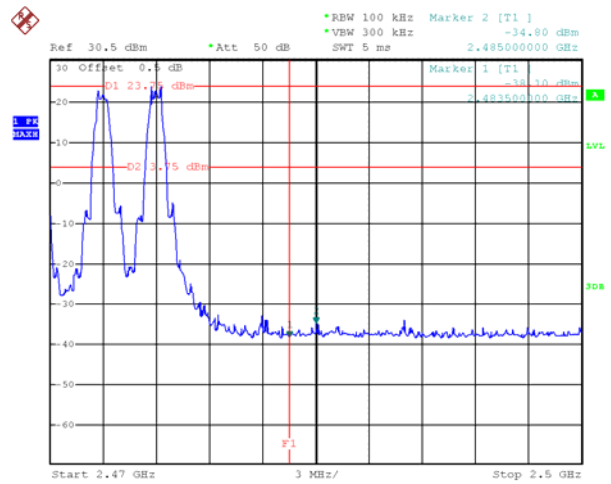
Date: 30.MAY.2022 17:27:52

Transmitting Band edge-right side



Date: 30.MAY.2022 17:33:18

Hopping Band edge-right side



Date: 30.MAY.2022 17:35:06

11 Bandwidth Measurement

Test Requirement: FCC 47CFR Part15 Subpart C §15.247(a) (2)

Test Method: ANSI C63.10:2013

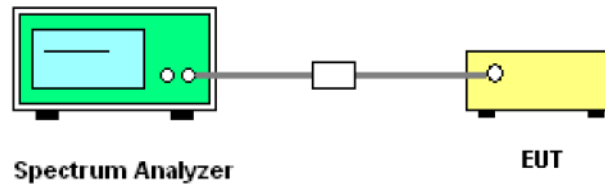
Test Limit: The minimum 6 dB bandwidth shall be at least 500 kHz.

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 Setup



11.3 Test Result

Modulation	Test Channel	20 dB Bandwidth MHz	99% Bandwidth MHz
FHSS(ANT 1)	Low	1.188	1.032
	Middle	1.188	1.038
	High	1.158	1.056
FHSS(ANT 2)	Low	1.182	1.032
	Middle	1.200	1.038
	High	1.164	1.050

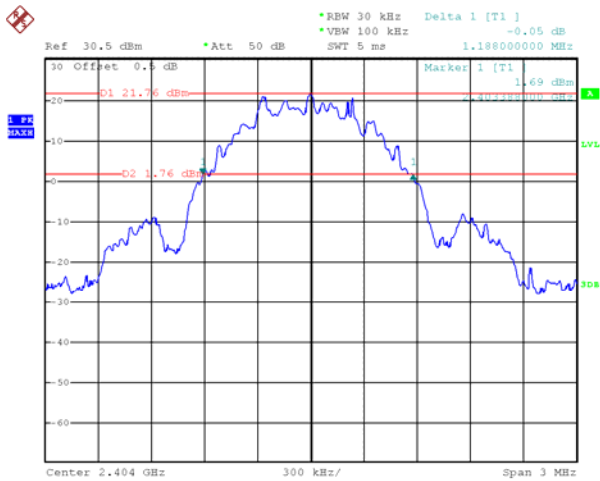
Test plots

20 dB Bandwidth

(ANT 1)

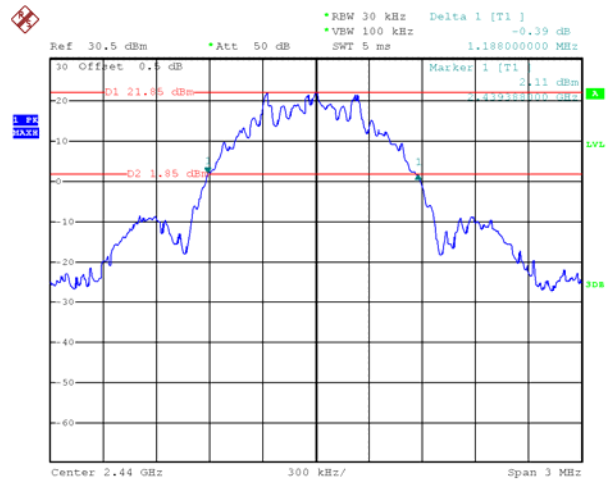
Modulation: FHSS

Low Channel



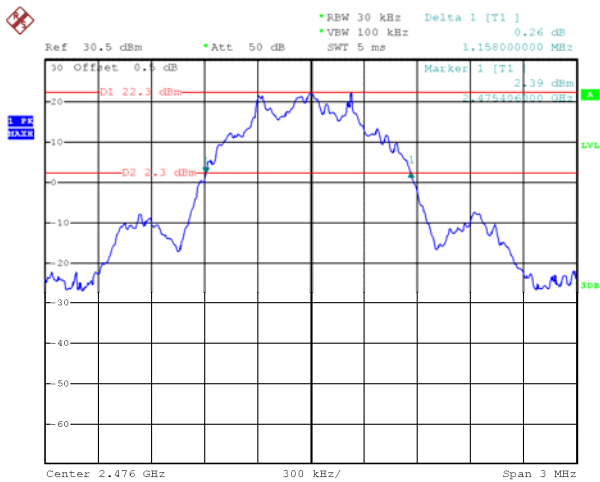
Date: 30.MAY.2022 14:57:14

Middle Channel



Date: 30.MAY.2022 14:54:25

High Channel

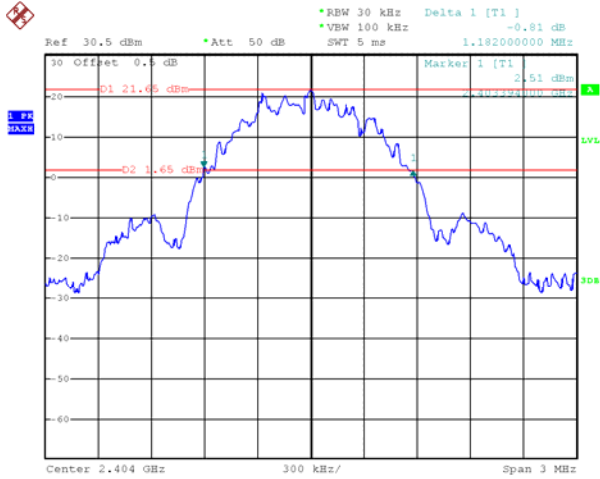


Date: 30.MAY.2022 14:49:55

(ANT 2)

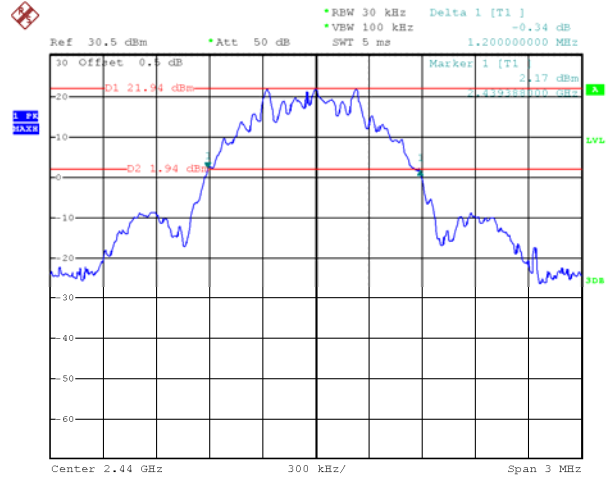
Modulation: FHSS

Low Channel



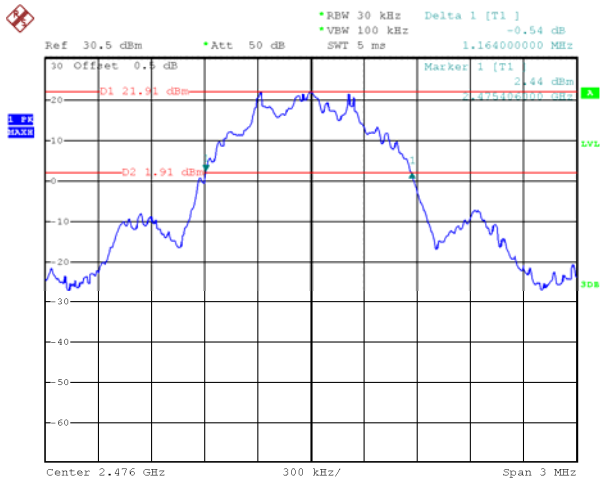
Date: 30.MAY.2022 14:55:50

Middle Channel



Date: 30.MAY.2022 14:53:33

High Channel



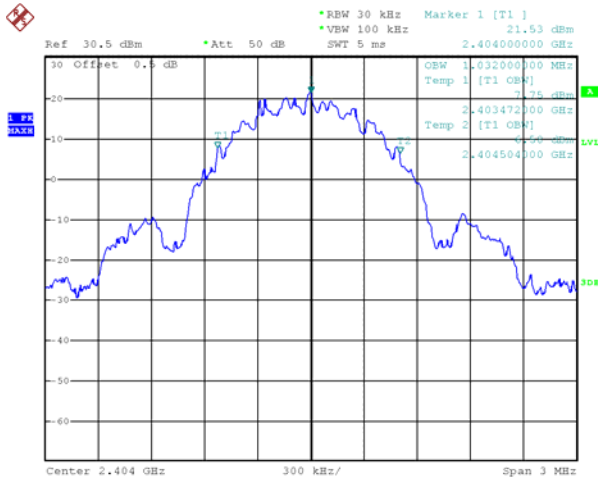
Date: 30.MAY.2022 14:51:31

99% Bandwidth

(ANT 1)

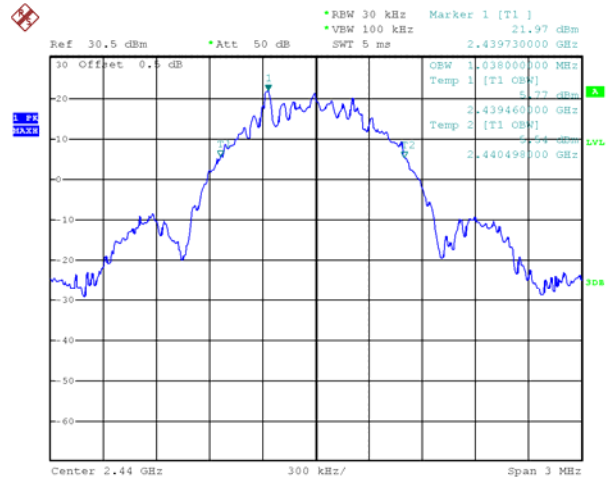
Modulation: FHSS

Low Channel



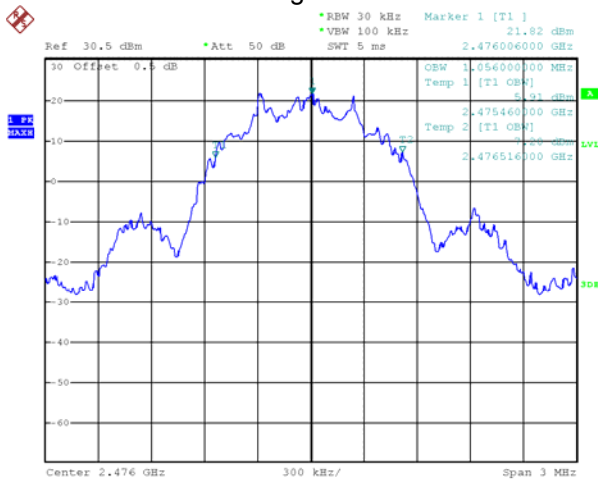
Date: 30.MAY.2022 14:59:51

Middle Channel



Date: 30.MAY.2022 15:03:39

High Channel

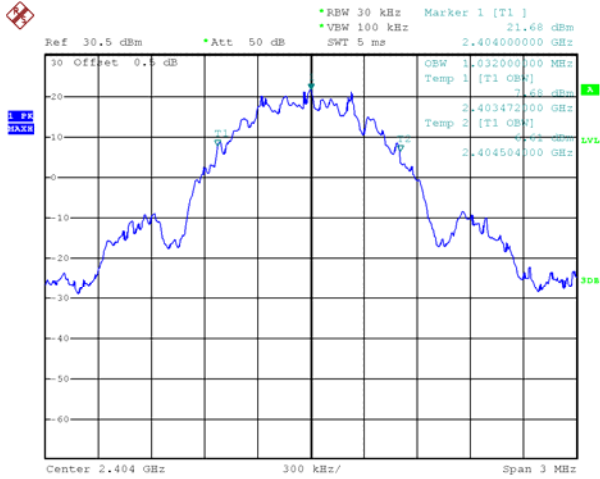


Date: 30.MAY.2022 15:04:29

(ANT 2)

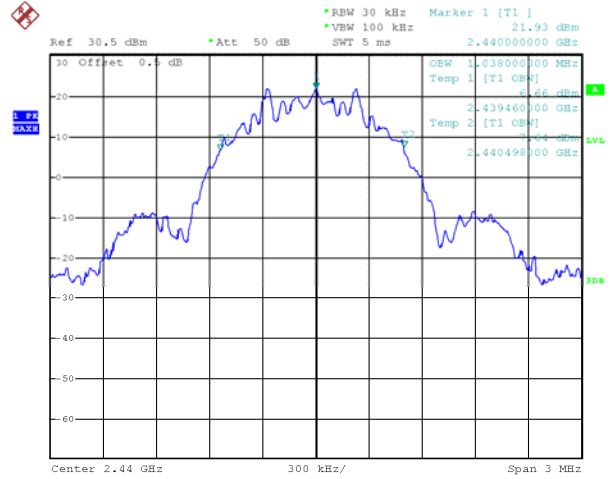
Modulation: FHSS

Low Channel



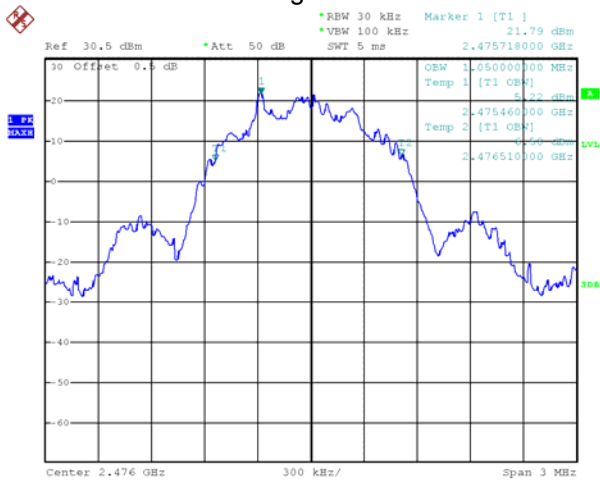
Date: 30.MAY.2022 15:00:53

Middle Channel



Date: 30.MAY.2022 15:03:12

High Channel



Date: 30.MAY.2022 15:04:56

12 Maximum Peak Output Power

Test Requirement: FCC 47CFR Part15 Subpart C §15.247(b)

Test Method: ANSI C63.10:2013

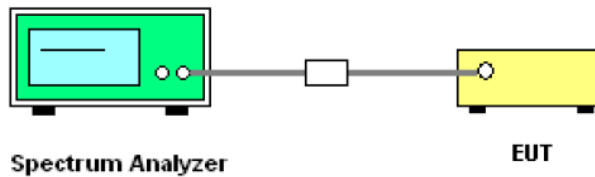
Test Limit: The maximum output power limit for DTS devices is specified as 1 W and is expressed in terms of either maximum peak conducted output power or maximum conducted output power.

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

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: RBW = 3 MHz. VBW =3 MHz. Sweep = auto; Detector Function = Peak.
3. Keep the EUT in transmitting at lowest, medium and highest channel individually. Record the max value.

12.2 Test Setup



12.3 Test Result

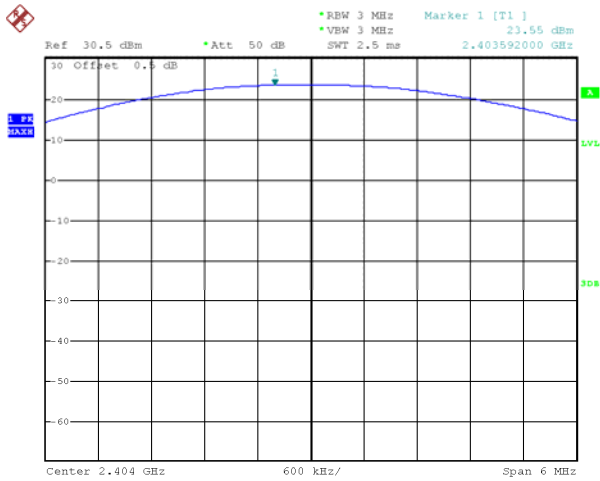
Test Mode	Data Rate	Peak Power(dBm)			Limit (dBm)
		Low Channel	Middle Channel	High Channel	
FHSS(ANT1)	1Mbps	23.55	24.03	24.24	30
FHSS(ANT2)	2Mbps	23.57	24.01	24.24	30

Test plots

(ANT 1)

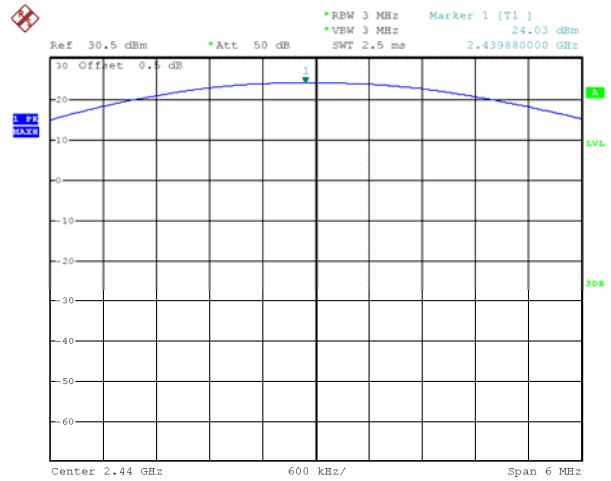
Modulation: FHSS

Low Channel



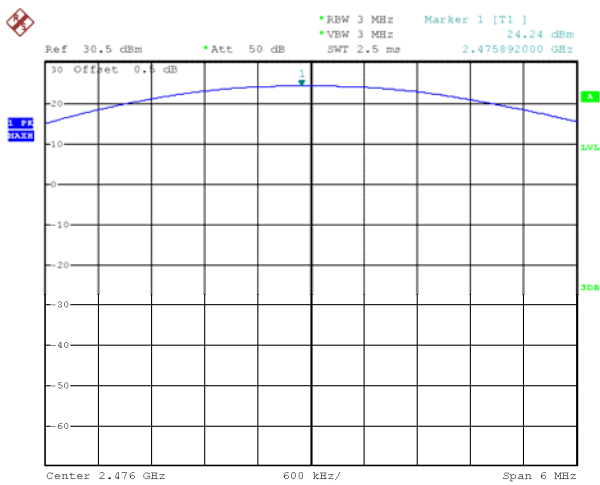
Date: 30.MAY.2022 15:42:03

Middle Channel



Date: 30.MAY.2022 15:42:49

High Channel

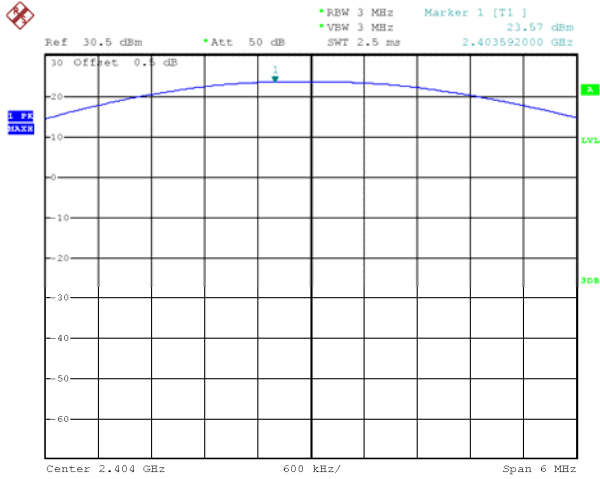


Date: 30.MAY.2022 15:43:42

(ANT 2)

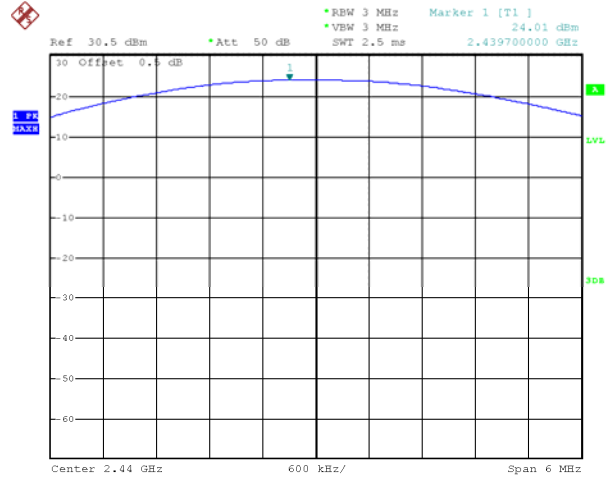
Modulation: FHSS

Low Channel



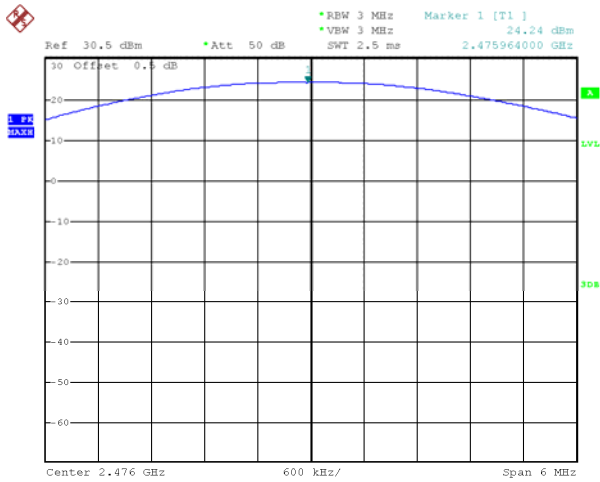
Date: 30.MAY.2022 15:41:39

Middle Channel



Date: 30.MAY.2022 15:43:02

High Channel



Date: 30.MAY.2022 15:43:29

13 Hopping Channel Separation

Test Requirement: FCC 47CFR Part15 Subpart C §15.247(a) (1)

Test Method: ANSI C63.10:2013

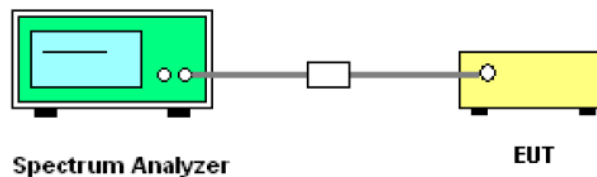
Test Limit: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.

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: RBW = 30 kHz. VBW = 100 kHz, Span = 3MHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
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 Setup



13.3 Test Result

Test result plot as follows:

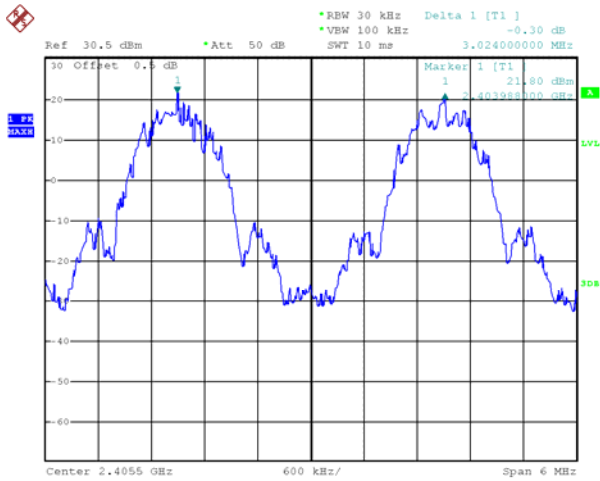
Modulation	Test Channel	Test Result MHz	20dB Bandwidth MHz	Limits (2/3 20dB Bandwidth) MHz
FHSS(ANT 1)	Low	3.024	1.188	0.792
	Middle	2.440	1.188	0.792
	High	3.048	1.158	0.772
FHSS(ANT 2)	Low	3.048	1.182	0.788
	Middle	3.012	1.200	0.800
	High	3.060	1.164	0.776

Test plots

(ANT 1)

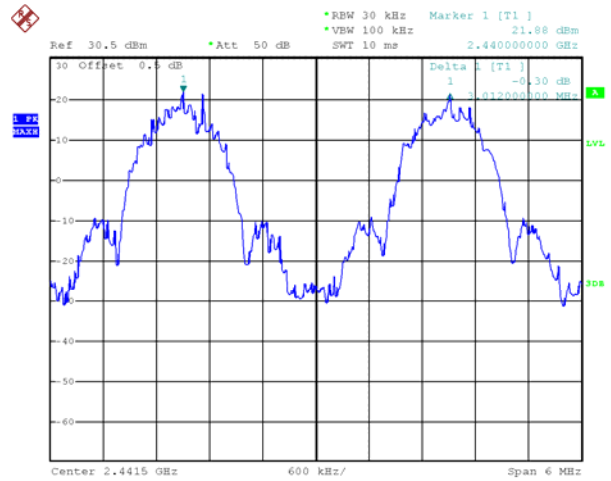
Modulation: FHSS

Low Channel



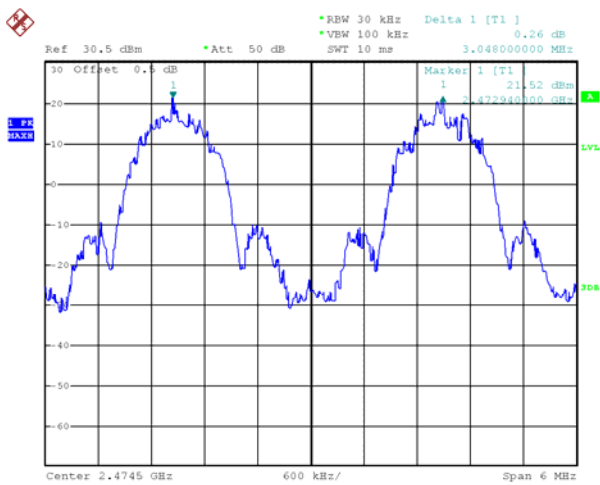
Date: 30.MAY.2022 16:59:03

Middle Channel



Date: 30.MAY.2022 17:01:15

High Channel

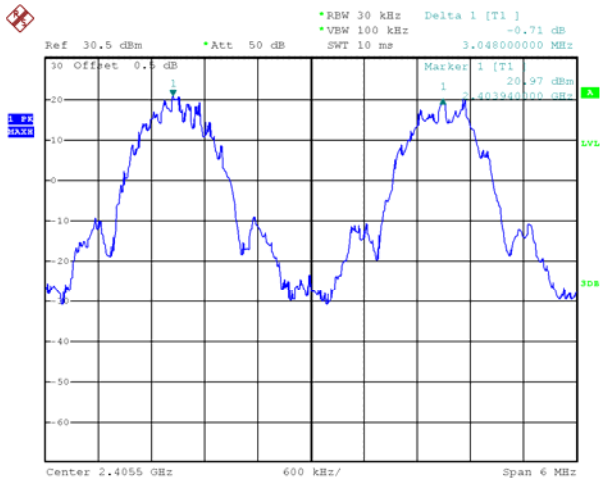


Date: 30.MAY.2022 17:08:32

(ANT 2)

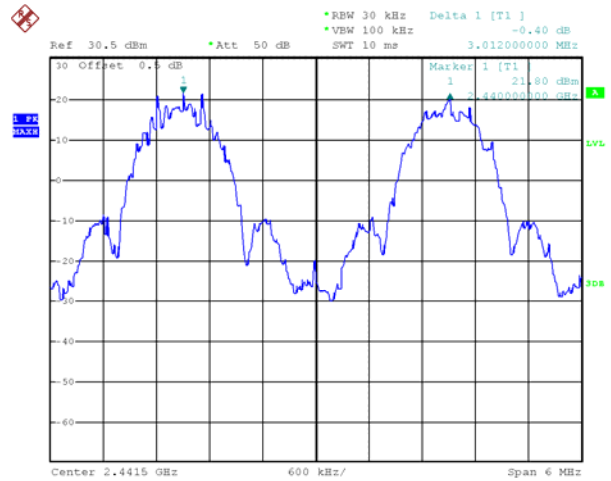
Modulation: FHSS

Low Channel



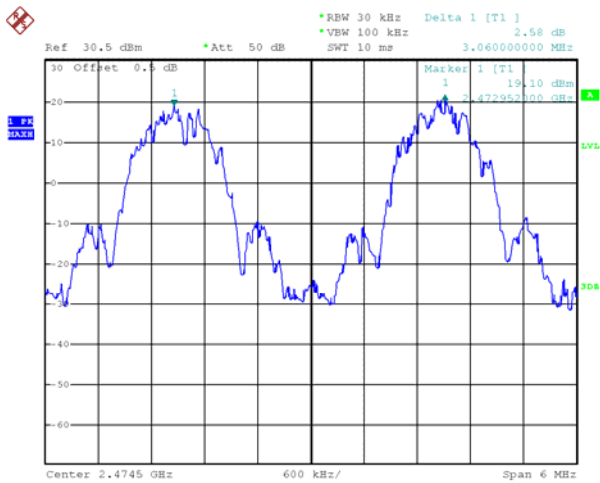
Date: 30.MAY.2022 16:57:43

Middle Channel



Date: 30.MAY.2022 17:04:25

High Channel



Date: 30.MAY.2022 17:07:22

14 Number of Hopping Frequency

Test Requirement: FCC 47CFR Part15 Subpart C §15.247(a) (1) (iii)

Test Method: ANSI C63.10:2013

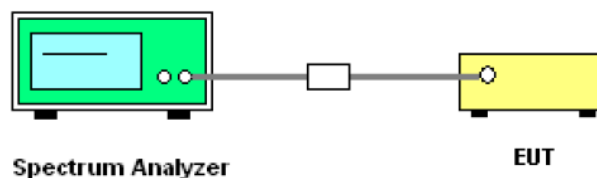
Test Limit: Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid 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.

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: RBW = 100 kHz. VBW = 300 kHz. Sweep = auto; Detector Function = Peak. Trace = Max hold.
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 Setup

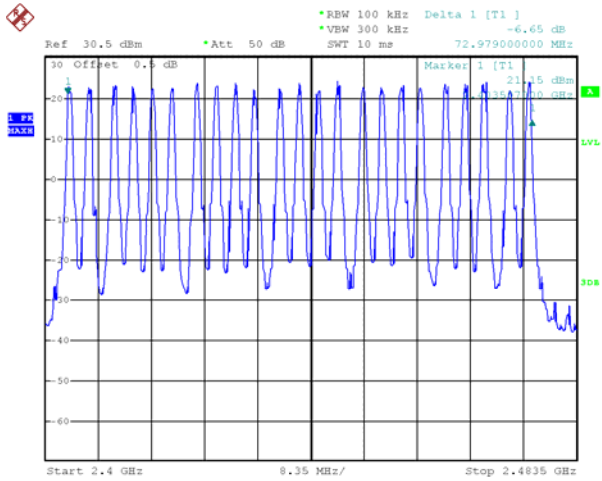


14.3 Test Result

Total Channels are 23 Channels.

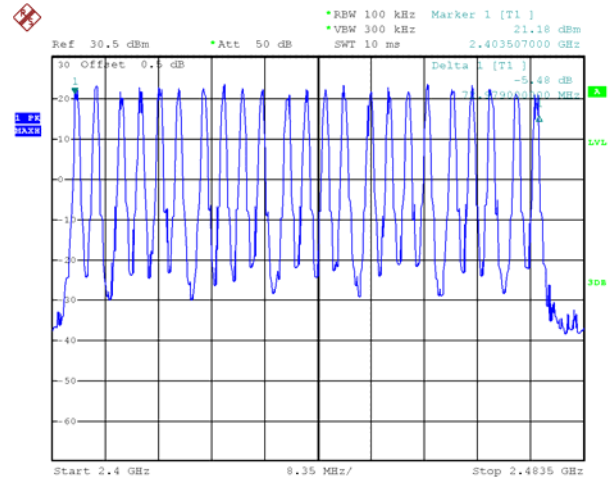
Test Plot

Modulation: FHSS(ANT 1)



Date: 30.MAY.2022 16:47:25

Modulation: FHSS(ANT 2)



Date: 30.MAY.2022 16:48:19

15 Dwell Time

Test Requirement: FCC 47CFR Part15 Subpart C §15.247(a) (1) (iii)

Test Method: ANSI C63.10:2013

Test Limit: 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 = 0Hz. Centred on a hopping channel;
- 3.Set RBW = 1 MHz and VBW = 3MHz. Sweep = as necessary to capture the entire dwell time per hopping channel.
- 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).

The test period: $T = 0.4(s) * 23 = 9.2(s)$

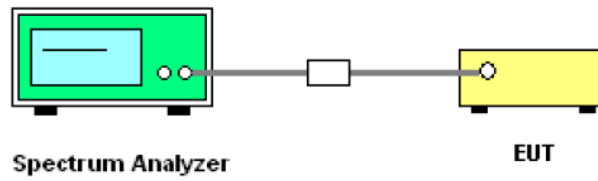
FHSS Packet permit maximum 1600 / 23 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

So, the Dwell Time can be calculated as follows:

Data Packet	Dwell Time(s)
FHSS	$1600/23/6*9.2*(MkrDelta)/1000$
Remark	Mkr Delta is single pulse time.

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

15.2 Test Setup



15.3 Test Result

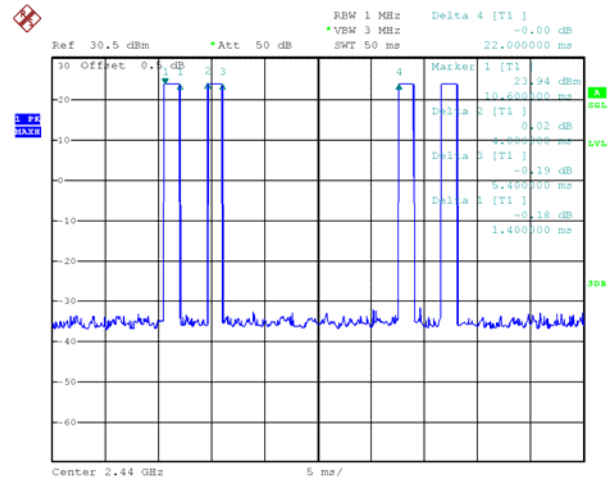
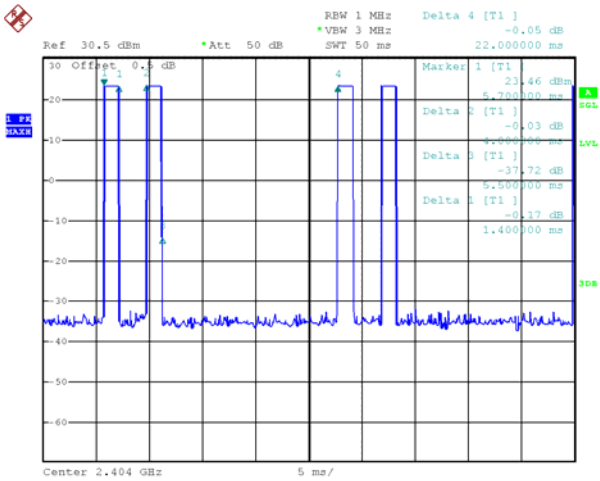
Modulation	Data Packet	Channel	pulse time(ms)	Dwell Time(s)	Limits(s)
FHSS(ANT 1)	FHSS	Low	1.400	0.149	<0.4
		Middle	1.400	0.149	<0.4
		High	1.500	0.160	<0.4
FHSS(ANT 2)	FHSS	Low	1.400	0.149	<0.4
		Middle	1.400	0.149	<0.4
		High	1.400	0.149	<0.4

Test Plot

Modulation: FHSS(ANT 1)

Low Channel

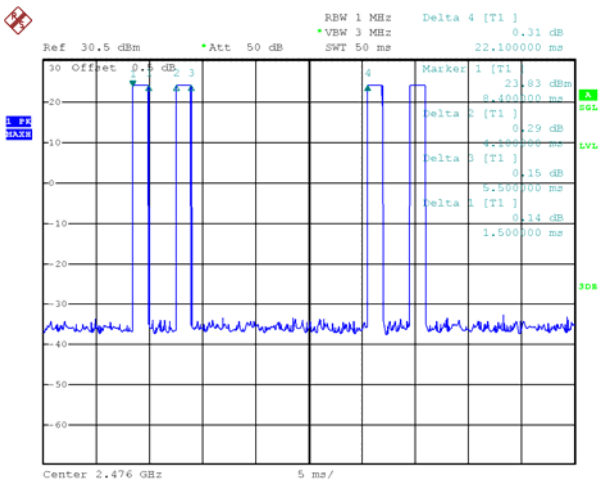
Middle Channel



Date: 30.MAY.2022 16:25:24

Date: 30.MAY.2022 16:23:27

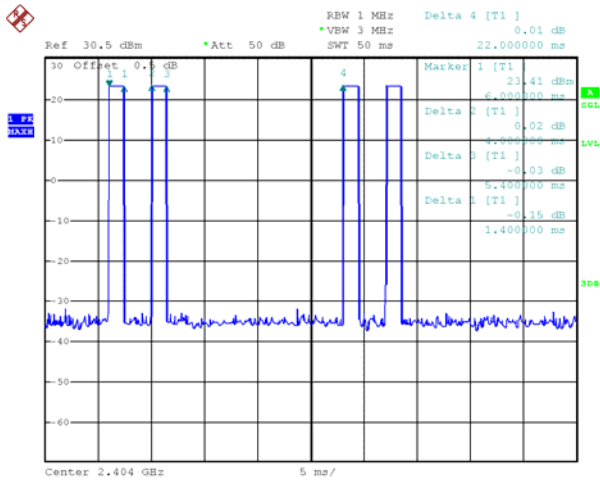
High Channel



Date: 30.MAY.2022 15:48:02

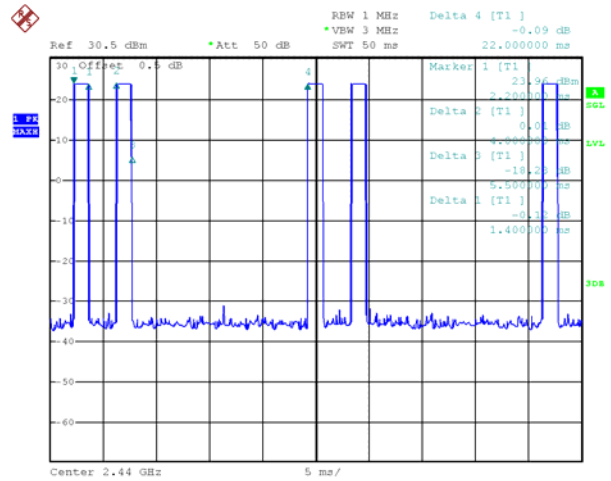
Modulation: FHSS(ANT 2)

Low Channel



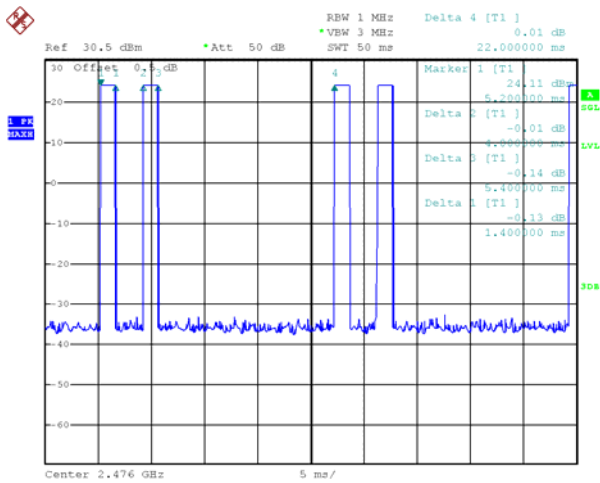
Date: 30.MAY.2022 16:26:08

Middle Channel



Date: 30.MAY.2022 16:22:33

High Channel



Date: 30.MAY.2022 15:49:03

16 Antenna Requirement

According to FCC 47CFR Part15 Subpart C §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 internal permanent antenna fulfill the requirement of this section.

Note: Please refer to EUT photos for more details.

17 RF Exposure

Remark: refer to SAR test report: WTF22X04076577W.

18 Photographs –Test Setup and EUT Photos

Note: Please refer to appendix: Appendix- SPMR20500-Photos.

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