

FCC REPORT

(Bluetooth)

Applicant: Ubio Labs, Inc.

Address of Applicant: 2821 Northup Way, Suite 250 Bellevue, WA 98004 USA

Equipment Under Test (EUT)

Product Name: Wireless Speaker & Charging Hub

Model No.: WSP1000

Trade mark: ubiolabs

FCC ID: 2ATGY-WSP1000

Applicable standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247

Date of sample receipt: 24 Jun., 2020

Date of Test: 24 Jun., to 14 Jul., 2020

Date of report issued: 15 Jul., 2020

Test Result: PASS *

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

Authorized Signature:



Bruce Zhang
Laboratory Manager

This report details the results of the testing carried out on one sample. The results contained in this test report do not relate to other samples of the same product and does not permit the use of the CCIS product certification mark. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards.

This document cannot be reproduced except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

2 Version

Version No.	Date	Description
00	15 Jul., 2020	Original
01	03 Aug., 2020	Update page 6

Tested by:

Mike.ou

Test Engineer

Date:

03 Aug., 2020

Reviewed by:

Winner Zhang

Project Engineer

Date:

03 Aug., 2020

3 Contents

Page

1 COVER PAGE.....	1
2 VERSION.....	2
3 CONTENTS	3
4 TEST SUMMARY.....	4
5 GENERAL INFORMATION.....	5
5.1 CLIENT INFORMATION.....	5
5.2 GENERAL DESCRIPTION OF E.U.T.	5
5.3 TEST ENVIRONMENT AND TEST MODE	6
5.4 DESCRIPTION OF SUPPORT UNITS	6
5.5 MEASUREMENT UNCERTAINTY.....	6
5.6 ADDITIONS TO, DEVIATIONS, OR EXCLUSIONS FROM THE METHOD	6
5.7 LABORATORY FACILITY.....	6
5.8 LABORATORY LOCATION.....	6
5.9 TEST INSTRUMENTS LIST	7
6 TEST RESULTS AND MEASUREMENT DATA.....	8
6.1 ANTENNA REQUIREMENT.....	8
6.2 CONDUCTED EMISSIONS	9
6.3 CONDUCTED OUTPUT POWER	12
6.4 20dB OCCUPY BANDWIDTH.....	15
6.5 CARRIER FREQUENCIES SEPARATION	18
6.6 HOPPING CHANNEL NUMBER.....	22
6.7 DWELL TIME	24
6.8 PSEUDORANDOM FREQUENCY HOPPING SEQUENCE.....	27
6.9 BAND EDGE.....	28
6.9.1 Conducted Emission Method	28
6.9.2 Radiated Emission Method	32
6.10 SPURIOUS EMISSION.....	45
6.10.1 Conducted Emission Method.....	45
6.10.2 Radiated Emission Method.....	48
7 TEST SETUP PHOTO	53
8 EUT CONSTRUCTIONAL DETAILS	55

4 Test Summary

Test Items	Section in CFR 47	Result
Antenna Requirement	15.203 & 15.247 (b)	Pass
AC Power Line Conducted Emission	15.207	Pass
Conducted Peak Output Power	15.247 (b)(1)	Pass
20dB Occupied Bandwidth	15.247 (a)(1)	Pass
Carrier Frequencies Separation	15.247 (a)(1)	Pass
Hopping Channel Number	15.247 (a)(1)	Pass
Dwell Time	15.247 (a)(1)	Pass
Spurious Emission	15.205 & 15.209	Pass
Band Edge	15.247(d)	Pass
Remark: 1. Pass: The EUT complies with the essential requirements in the standard. 2. N/A: Not Applicable. 3. The cable insertion loss used by "RF Output Power" and other conduction measurement items is 0.5dB (provided by the customer).		
Test Method:	ANSI C63.4-2014 ANSI C63.10-2013 KDB 558074 D01 15.247 Meas Guidance v05r02	

5 General Information

5.1 Client Information

Applicant:	Ubio Labs, Inc.
Address:	2821 Northup Way, Suite 250 Bellevue, WA 98004 USA
Factory:	SHENZHEN JUNLAN ELECTRONIC LTD.
Address:	No.277 PingKui Road, Shijing Community, Pingshan Street, Pingshan New District, Shenzhen, China.

5.2 General Description of E.U.T.

Product Name:	Wireless Speaker & Charging Hub
Model No.:	WSP1000
Operation Frequency:	2402MHz~2480MHz
Transfer rate:	1/2/3 Mbits/s
Number of channel:	79
Modulation type:	GFSK, $\pi/4$ -DQPSK, 8DPSK
Modulation technology:	FHSS
Antenna Type:	Internal Antenna
Antenna gain:	0 dBi
AC adapter:	Model: CHG1085 Input: AC110-240V, 50/60Hz, 0.7A Output: DC 9.0V, 3.0A
Test Sample Condition:	The test samples were provided in good working order with no visible defects.

Operation Frequency each of channel for GFSK, $\pi/4$ -DQPSK, 8DPSK							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402MHz	20	2422MHz	40	2442MHz	60	2462MHz
1	2403MHz	21	2423MHz	41	2443MHz	61	2463MHz
2	2404MHz	22	2424MHz	42	2444MHz	62	2464MHz
3	2405MHz	23	2425MHz	43	2445MHz	63	2465MHz
4	2406MHz	24	2426MHz	44	2446MHz	64	2466MHz
5	2407MHz	25	2427MHz	45	2447MHz	65	2467MHz
...	...	...	...	...	...	...	...
15	2417MHz	35	2437MHz	55	2457MHz	75	2477MHz
16	2418MHz	36	2438MHz	56	2458MHz	76	2478MHz
17	2419MHz	37	2439MHz	57	2459MHz	77	2479MHz
18	2420MHz	38	2440MHz	58	2460MHz	78	2480MHz
19	2421MHz	39	2441MHz	59	2461MHz		
Remark: Channel 0, 39 & 78 selected for GFSK, $\pi/4$ -DQPSK and 8DPSK.							

5.3 Test environment and test mode

Operating Environment:	
Temperature:	24.0 °C
Humidity:	54 % RH
Atmospheric Pressure:	1010 mbar
Test Modes:	
Non-hopping mode:	Keep the EUT in continuous transmitting mode with worst case data rate.
Hopping mode:	Keep the EUT in hopping mode.
Remark	GFSK (1 Mbps) is the worst case mode.
Radiated Emission: The sample was placed 0.8m (below 1GHz)/1.5m (above 1GHz) above the ground plane of 3m chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating the turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.	

5.4 Description of Support Units

Manufacturer	Description	Model	S/N	FCC ID/DoC
LENOVO	Laptop	SL510	2847A65	DoC

5.5 Measurement Uncertainty

Parameters	Expanded Uncertainty
Conducted Emission (9kHz ~ 30MHz)	±1.60 dB (k=2)
Radiated Emission (9kHz ~ 30MHz)	±3.12 dB (k=2)
Radiated Emission (30MHz ~ 1000MHz)	±4.32 dB (k=2)
Radiated Emission (1GHz ~ 18GHz)	±5.16 dB (k=2)
Radiated Emission (18GHz ~ 40GHz)	±3.20 dB (k=2)

5.6 Additions to, deviations, or exclusions from the method

No

5.7 Laboratory Facility

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

● **FCC - Designation No.: CN1211**

Shenzhen Zhongjian Nanfang Testing Co., Ltd. has been accredited as a testing laboratory by FCC(Federal Communications Commission). The test firm Registration No. is 727551.

● **ISED – CAB identifier.: CN0021**

The 3m Semi-anechoic chamber of Shenzhen Zhongjian Nanfang Testing Co., Ltd. has been Registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 10106A-1.

● **A2LA - Registration No.: 4346.01**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories. The test scope can be found as below link: <https://portal.a2la.org/scopepdf/4346-01.pdf>

5.8 Laboratory Location

Shenzhen Zhongjian Nanfang Testing Co., Ltd.

Address: No.110~116, Building B, Jinyuan Business Building, Xixiang Road, Bao'an District, Shenzhen, Guangdong, China

Tel: +86-755-23118282, Fax: +86-755-23116366

Email: info@ccis-cb.com, Website: <http://www.ccis-cb.com>

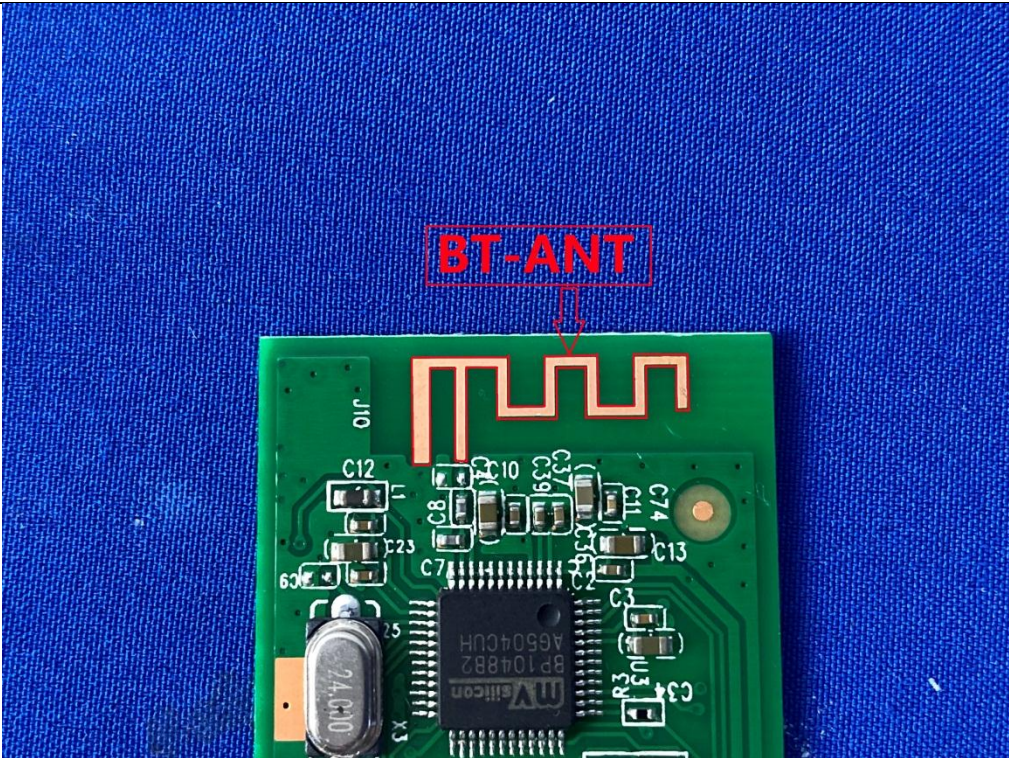
5.9 Test Instruments list

Radiated Emission:					
Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
3m SAC	SAEMC	9m*6m*6m	966	07-22-2017	07-21-2020
Loop Antenna	SCHWARZBECK	FMZB1519B	044	03-07-2020	03-06-2021
BiConiLog Antenna	SCHWARZBECK	VULB9163	497	03-07-2020	03-06-2021
Horn Antenna	SCHWARZBECK	BBHA9120D	916	03-07-2020	03-06-2021
Horn Antenna	SCHWARZBECK	BBHA9120D	1805	06-22-2020	06-21-2021
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170582	11-18-2019	11-17-2020
EMI Test Software	AUDIX	E3	Version: 6.110919b		
Pre-amplifier	HP	8447D	2944A09358	03-07-2020	03-06-2021
Pre-amplifier	CD	PAP-1G18	11804	03-07-2020	03-06-2021
Spectrum analyzer	Rohde & Schwarz	FSP30	101454	03-05-2020	03-04-2021
Spectrum analyzer	Rohde & Schwarz	FSP40	100363	11-18-2019	11-17-2020
EMI Test Receiver	Rohde & Schwarz	ESRP7	101070	03-05-2020	03-04-2021
Cable	ZDECL	Z108-NJ-NJ-81	1608458	03-07-2020	03-06-2021
Cable	MICRO-COAX	MFR64639	K10742-5	03-07-2020	03-06-2021
Cable	SUHNER	SUCOFLEX100	58193/4PE	03-07-2020	03-06-2021
RF Switch Unit	MWRFTTEST	MW200	N/A	N/A	N/A
Test Software	MWRFTTEST	MTS8200	Version: 2.0.0.0		

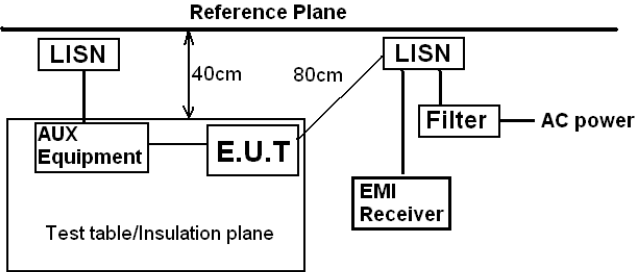
Conducted Emission:					
Test Equipment	Manufacturer	Model No.	Serial No.	Cal. Date (mm-dd-yy)	Cal. Due date (mm-dd-yy)
EMI Test Receiver	Rohde & Schwarz	ESCI	101189	03-05-2020	03-04-2021
Pulse Limiter	SCHWARZBECK	OSRAM 2306	9731	03-05-2020	03-04-2021
LISN	CHASE	MN2050D	1447	03-05-2020	03-04-2021
LISN	Rohde & Schwarz	ESH3-Z5	8438621/010	07-21-2017	07-20-2020
Cable	HP	10503A	N/A	03-05-2020	03-04-2021
EMI Test Software	AUDIX	E3	Version: 6.110919b		

6 Test results and measurement data

6.1 Antenna Requirement

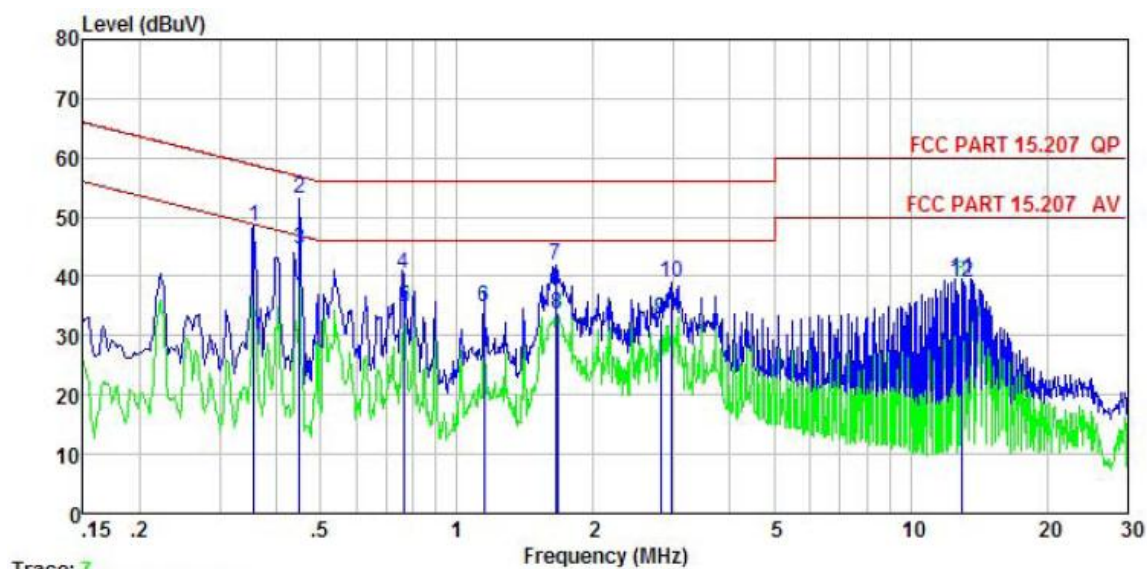
Standard requirement:	FCC Part 15 C Section 15.203 & 247(b)
15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a 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: (4) 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.	
E.U.T Antenna:	
The Bluetooth antenna is an Internal antenna which permanently attached, and the best case gain of the antenna is 0 dBi.	
	

6.2 Conducted Emissions

Test Requirement:	FCC Part 15 C Section 15.207		
Test Frequency Range:	150 kHz to 30 MHz		
Class / Severity:	Class B		
Receiver setup:	RBW=9 kHz, VBW=30 kHz, Sweep time=auto		
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 setup:	 <i>Remark</i> E.U.T: Equipment Under Test LISN: Line Impedance Stabilization Network Test table height=0.8m		
Test procedure:	1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment. 2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs). 3. Both sides of A.C. line are checked for maximum conducted interference. 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 (latest version) on conducted measurement.		
Test Instruments:	Refer to section 5.9 for details		
Test mode:	Hopping mode (worse case)		
Test results:	Pass		

Measurement Data:

Product name:	Wireless Speaker & Charging Hub	Product model:	WSP1000
Test by:	Mike	Test mode:	BT Tx mode
Test frequency:	150 kHz ~ 30 MHz	Phase:	Line
Test voltage:	AC 120 V/60 Hz	Environment:	Temp: 22.5°C Humi: 55%

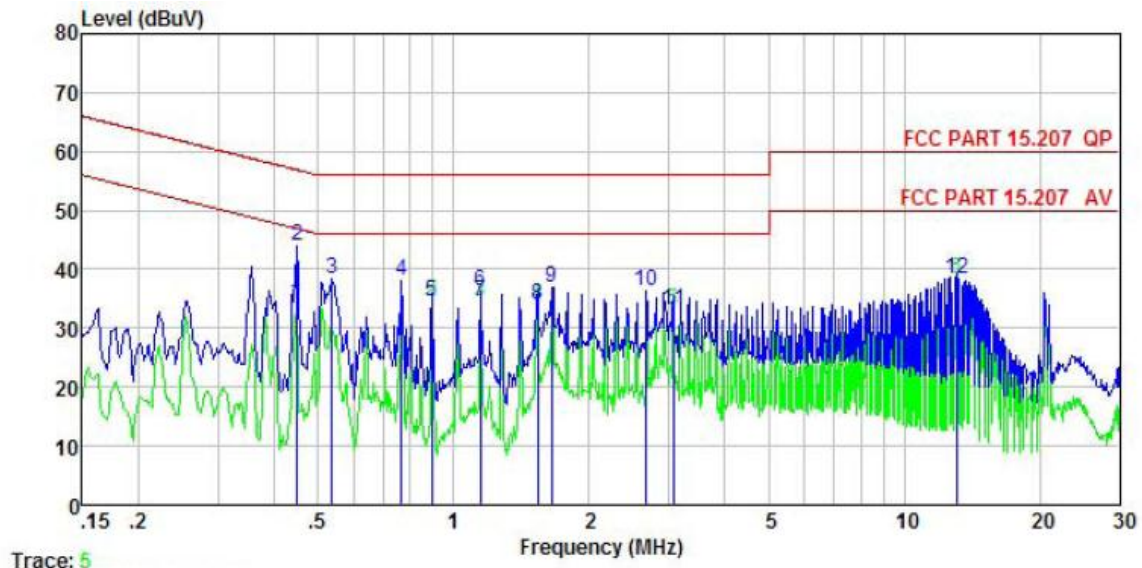


	Freq	Read Level	LISN Factor	Cable Loss	Aux Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1	0.358	37.96	-0.51	10.73	0.16	48.34	58.78	-10.44	QP
2	0.449	42.73	-0.45	10.74	0.02	53.04	56.89	-3.85	QP
3	0.449	34.12	-0.45	10.74	0.02	44.43	46.89	-2.46	Average
4	0.763	30.39	-0.55	10.80	-0.20	40.44	56.00	-15.56	QP
5	0.767	24.71	-0.55	10.80	-0.19	34.77	46.00	-11.23	Average
6	1.147	24.25	-0.60	10.89	0.30	34.84	46.00	-11.16	Average
7	1.654	31.49	-0.54	10.94	-0.11	41.78	56.00	-14.22	QP
8	1.662	23.46	-0.54	10.94	-0.11	33.75	46.00	-12.25	Average
9	2.809	22.64	-0.44	10.93	-0.23	32.90	46.00	-13.10	Average
10	2.962	28.63	-0.43	10.92	-0.21	38.91	56.00	-17.09	QP
11	12.920	26.50	-0.71	10.92	2.98	39.69	60.00	-20.31	QP
12	12.920	25.77	-0.71	10.92	2.98	38.96	50.00	-11.04	Average

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Final Level = Receiver Read level + LISN Factor + Aux Factor + Cable Loss.

Product name:	Wireless Speaker & Charging Hub	Product model:	WSP1000
Test by:	Mike	Test mode:	BT Tx mode
Test frequency:	150 kHz ~ 30 MHz	Phase:	Neutral
Test voltage:	AC 120 V/60 Hz	Environment:	Temp: 22.5℃ Humi: 55%

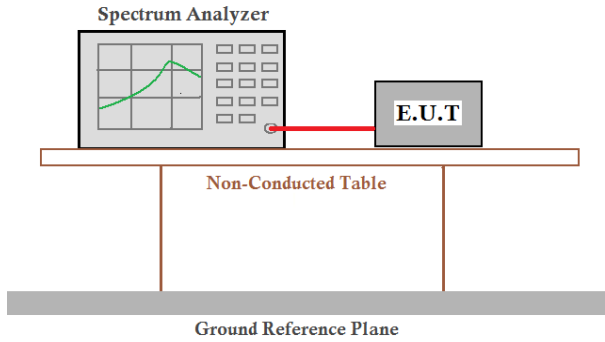


	Freq	Read Level	LISN Factor	Cable Loss	Aux Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dB	dB	dBuV	dBuV	dB	
1	0.447	24.04	-0.64	10.74	-0.02	34.12	46.93	-12.81	Average
2	0.449	33.76	-0.64	10.74	-0.01	43.85	56.89	-13.04	QP
3	0.538	28.27	-0.65	10.76	0.03	38.41	56.00	-17.59	QP
4	0.767	27.83	-0.65	10.80	0.05	38.03	56.00	-17.97	QP
5	0.894	24.43	-0.67	10.84	0.07	34.67	46.00	-11.33	Average
6	1.147	25.96	-0.69	10.89	0.10	36.26	56.00	-19.74	QP
7	1.147	24.34	-0.69	10.89	0.10	34.64	46.00	-11.36	Average
8	1.535	23.65	-0.70	10.93	0.14	34.02	46.00	-11.98	Average
9	1.654	26.54	-0.70	10.94	0.15	36.93	56.00	-19.07	QP
10	2.678	25.89	-0.67	10.93	0.27	36.42	56.00	-19.58	QP
11	3.074	22.36	-0.65	10.92	0.33	32.96	46.00	-13.04	Average
12	13.057	25.82	-0.80	10.91	2.50	38.43	50.00	-11.57	Average

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.
3. Final Level = Receiver Read level + LISN Factor + Aux Factor + Cable Loss.

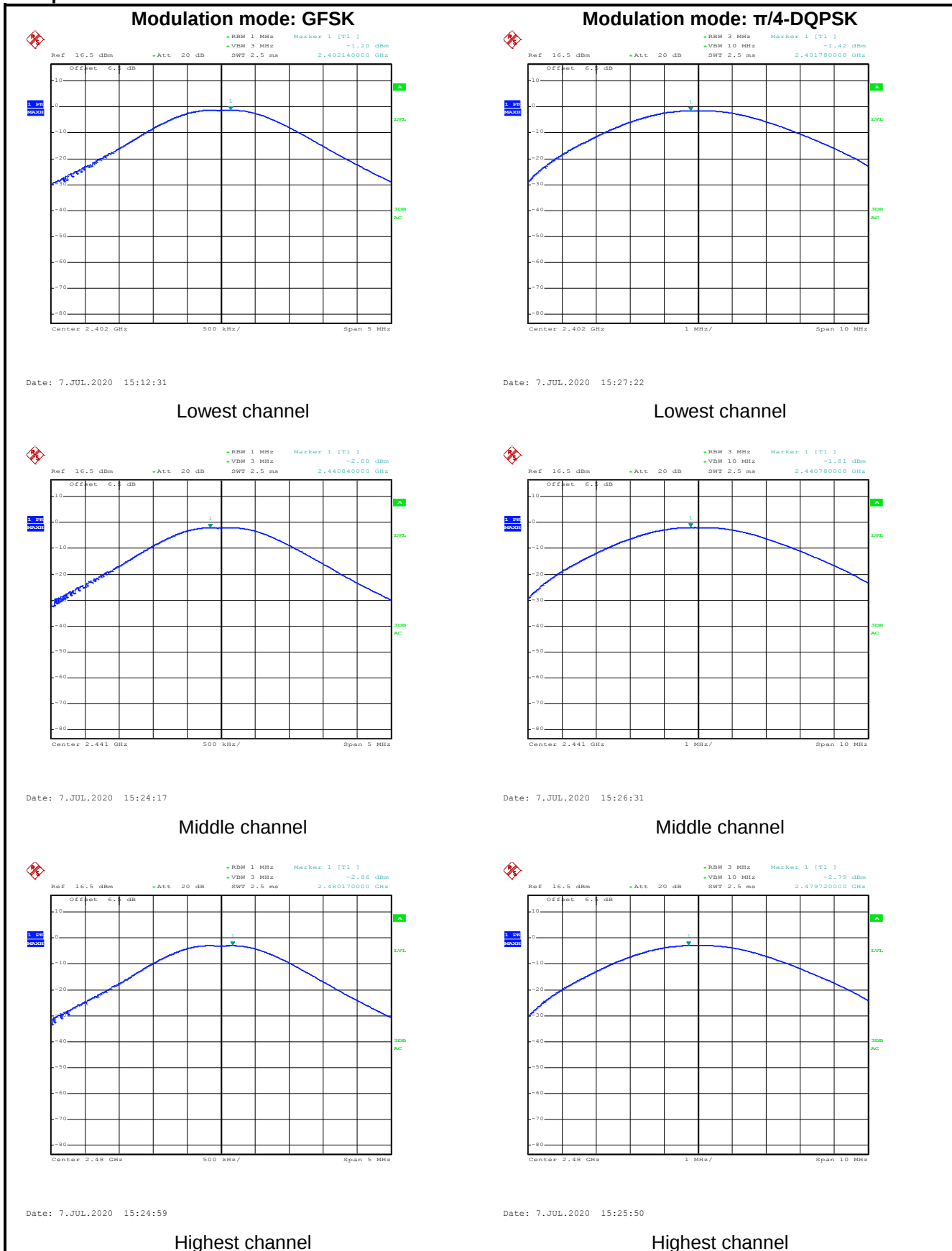
6.3 Conducted Output Power

Test Requirement:	FCC Part 15 C Section 15.247 (b)(1)
Receiver setup:	RBW=1MHz, VBW=3MHz, Detector=Peak (If 20dB BW ≤1 MHz) RBW=3MHz, VBW=10MHz, Detector=Peak (If 20dB BW > 1 MHz and < 3MHz)
Limit:	For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected via a red cable to an E.U.T. (Equipment Under Test). Both are placed on a Non-Conducted Table. The table is supported by a Ground Reference Plane.
Test Instruments:	Refer to section 5.9 for details
Test mode:	Non-hopping mode
Test results:	Pass

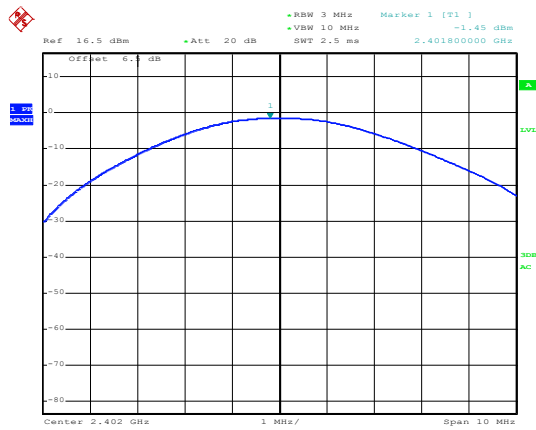
Measurement Data:

Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
GFSK mode			
Lowest channel	-1.20	30.00	Pass
Middle channel	-2.00	30.00	Pass
Highest channel	-2.86	30.00	Pass
$\pi/4$ -DQPSK mode			
Lowest channel	-1.42	21.00	Pass
Middle channel	-1.81	21.00	Pass
Highest channel	-2.79	21.00	Pass
8DPSK mode			
Lowest channel	-1.45	21.00	Pass
Middle channel	-1.93	21.00	Pass
Highest channel	-2.82	21.00	Pass

Test plot as follows:

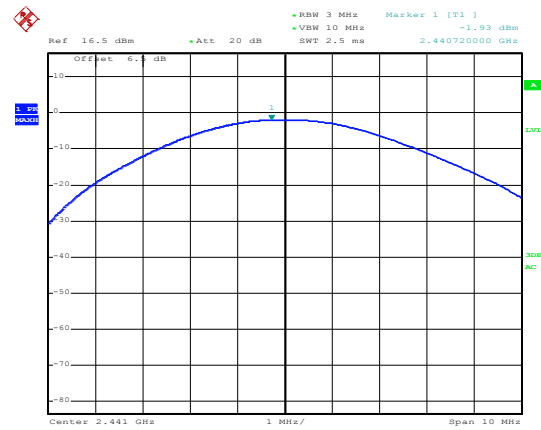


Modulation mode: 8DPSK



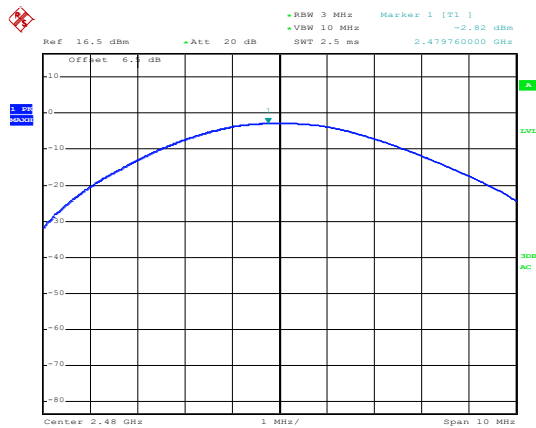
Date: 7.JUL.2020 15:27:39

Lowest channel



Date: 7.JUL.2020 15:28:06

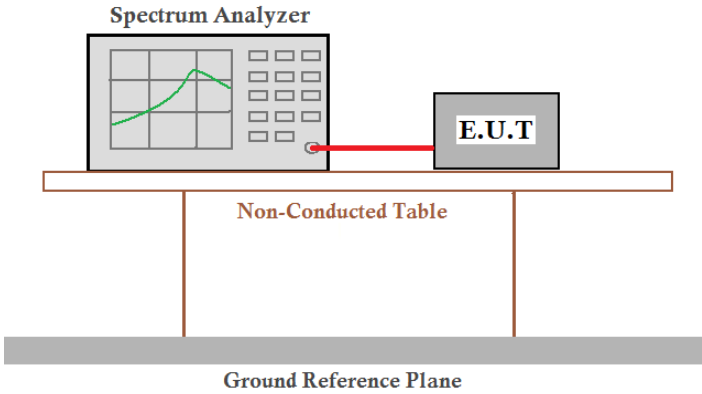
Middle channel



Date: 7.JUL.2020 15:28:28

Highest channel

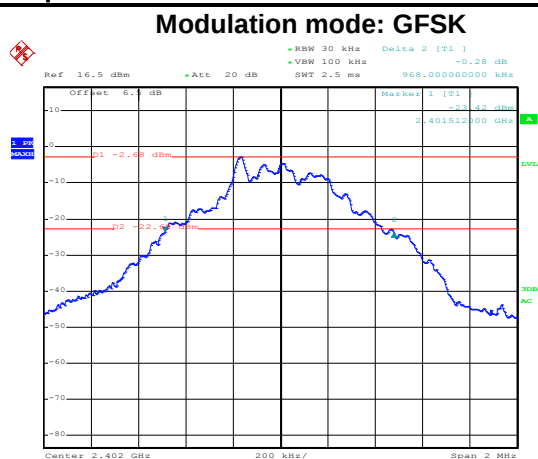
6.4 20dB Occupy Bandwidth

Test Requirement:	FCC Part 15 C Section 15.247 (a)(1)
Receiver setup:	RBW=30 kHz, VBW=100 kHz, detector=Peak
Limit:	N/A
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected to an E.U.T (Equipment Under Test) via a red cable. Both the Spectrum Analyzer and the E.U.T are placed on a Non-Conducted Table. Below the table is a Ground Reference Plane.
Test Instruments:	Refer to section 5.9 for details
Test mode:	Non-hopping mode
Test results:	Pass

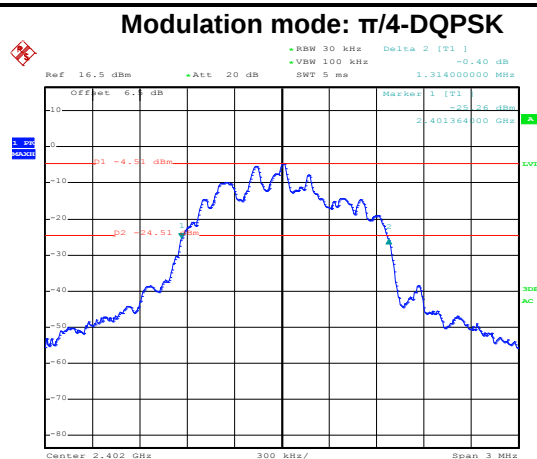
Measurement Data:

Test channel	20dB Occupy Bandwidth (kHz)		
	GFSK	$\pi/4$ -DQPSK	8DPSK
Lowest	968	1314	1302
Middle	968	1308	1296
Highest	968	1308	1302

Test plot as follows:

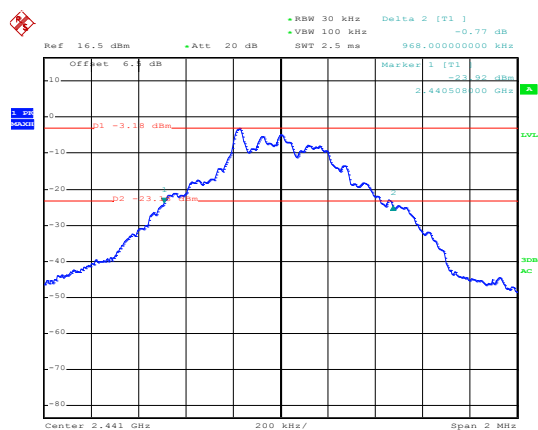


Date: 7.JUL.2020 15:29:34

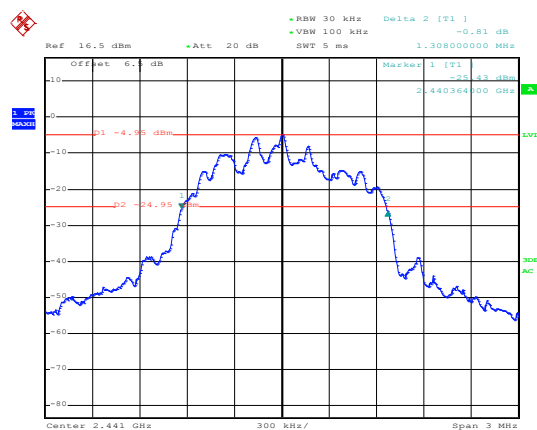


Date: 7.JUL.2020 15:35:15

Lowest channel

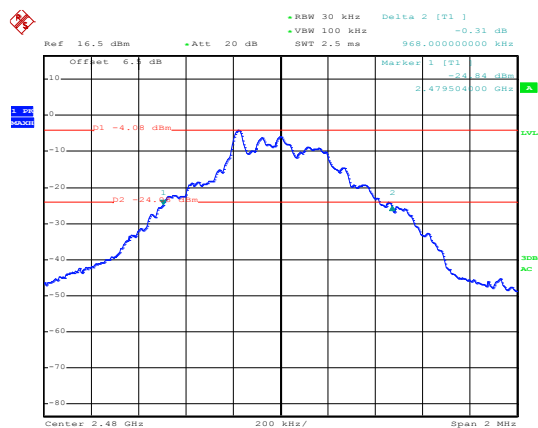


Date: 7.JUL.2020 15:30:34

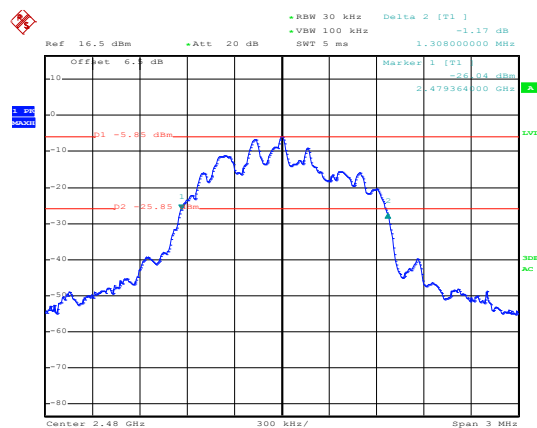


Date: 7.JUL.2020 15:34:14

Middle channel



Date: 7.JUL.2020 15:31:29

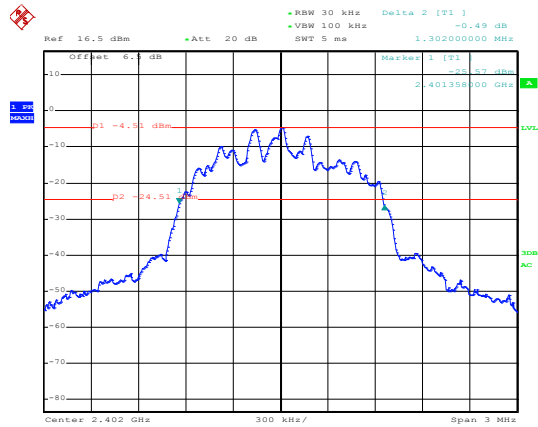


Date: 7.JUL.2020 15:33:12

Highest channel

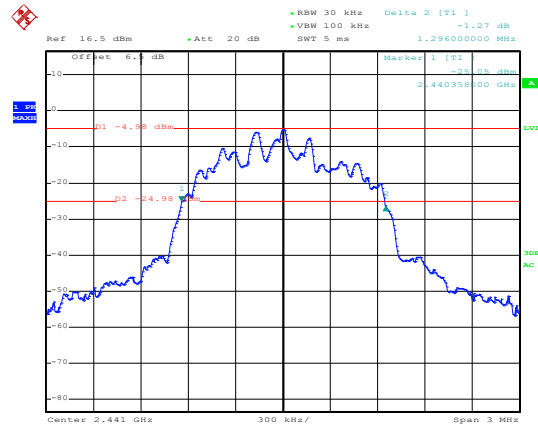
Highest channel

Modulation mode: 8DPSK



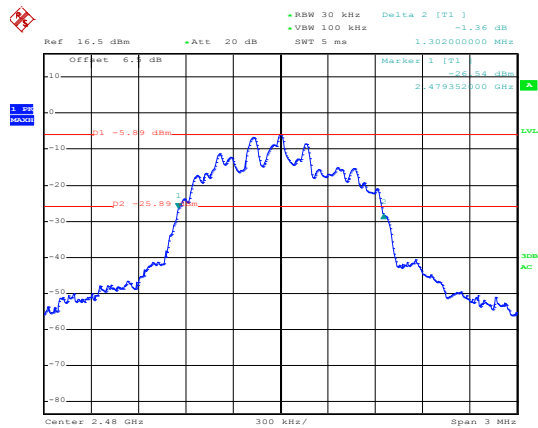
Date: 7.JUL.2020 15:36:44

Lowest channel



Date: 7.JUL.2020 15:38:11

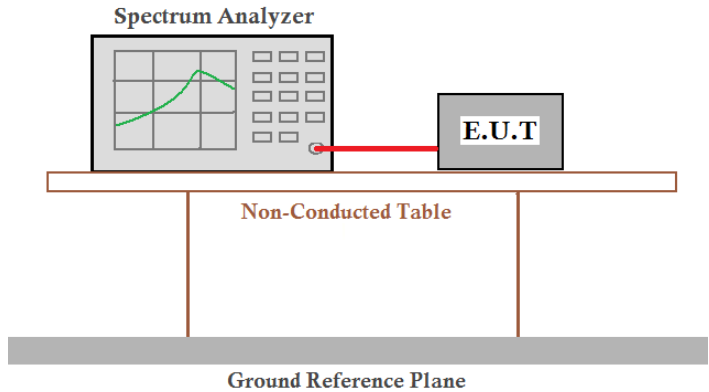
Middle channel



Date: 7.JUL.2020 15:39:18

Highest channel

6.5 Carrier Frequencies Separation

Test Requirement:	FCC Part 15 C Section 15.247 (a)(1)
Receiver setup:	RBW=100 kHz, VBW=300 kHz, detector=Peak
Limit:	a) 0.025MHz or the 20dB bandwidth (whichever is greater) b) 0.025MHz or two-thirds of the 20dB bandwidth (whichever is greater)
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer, shown with a grid and a green curve, is connected to an E.U.T. (Equipment Under Test) box by a red cable. Both the Spectrum Analyzer and the E.U.T. are placed on a table labeled 'Non-Conducted Table'. Below this table is a thick grey bar representing the 'Ground Reference Plane'.
Test Instruments:	Refer to section 5.9 for details
Test mode:	Hopping mode
Test results:	Pass

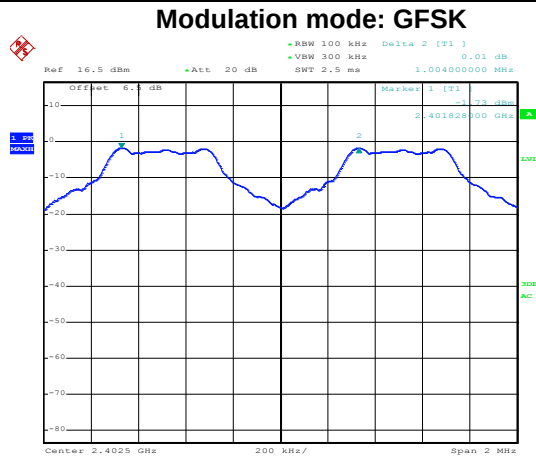
Measurement Data:

Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
GFSK			
Lowest	1004	968	Pass
Middle	1004	968	Pass
Highest	1004	968	Pass
$\pi/4$ -DQPSK mode			
Lowest	1004	876	Pass
Middle	1004	876	Pass
Highest	1004	876	Pass
8DPSK mode			
Lowest	1004	868	Pass
Middle	1000	868	Pass
Highest	1000	868	Pass

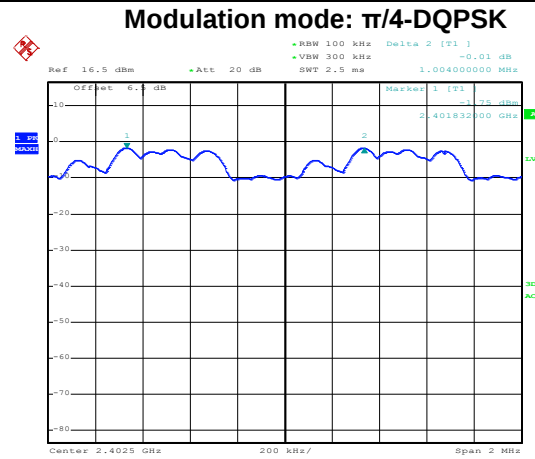
Note: According to section 6.4

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	968	968
$\pi/4$ -DQPSK	1314	876
8DPSK	1302	868

Test plot as follows:

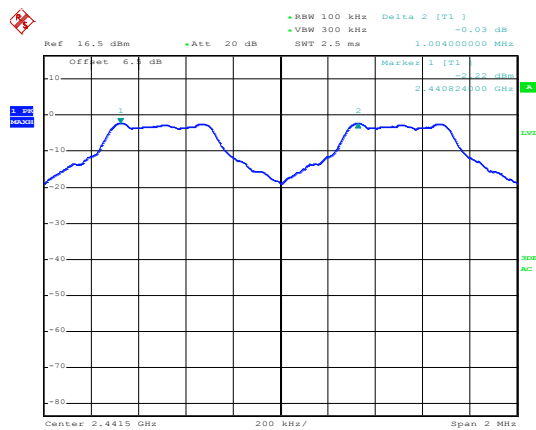


Date: 7.JUL.2020 15:57:35

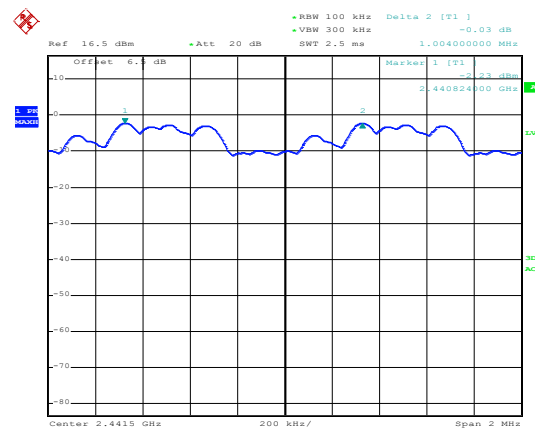


Date: 7.JUL.2020 16:01:07

Lowest channel

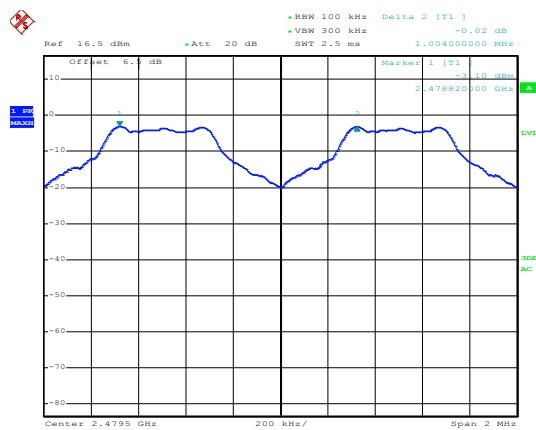


Date: 7.JUL.2020 15:58:51

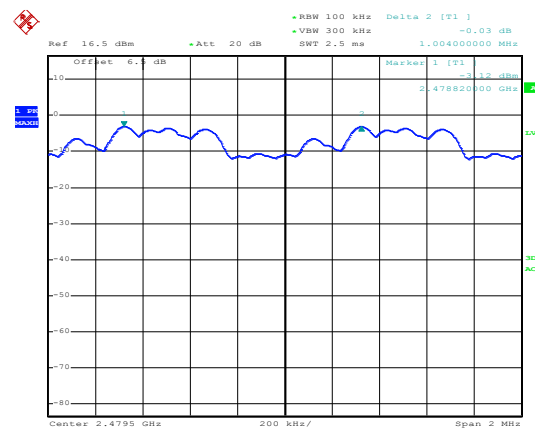


Date: 7.JUL.2020 16:02:26

Middle channel



Date: 7.JUL.2020 15:59:52

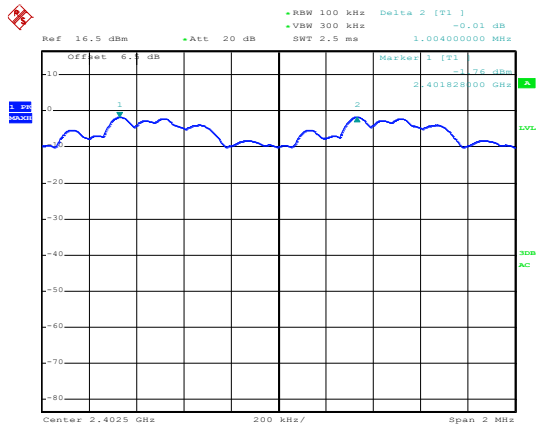


Date: 7.JUL.2020 16:03:41

Highest channel

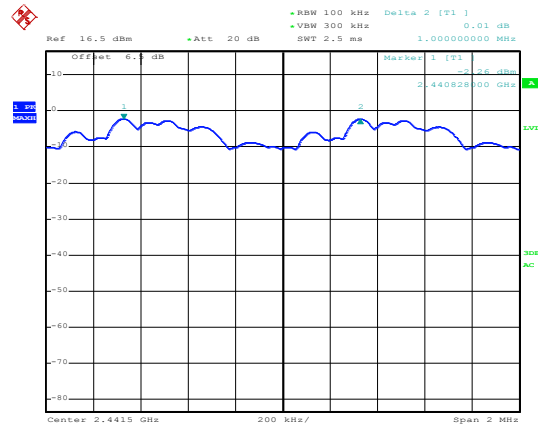
Highest channel

Modulation mode: 8DPSK



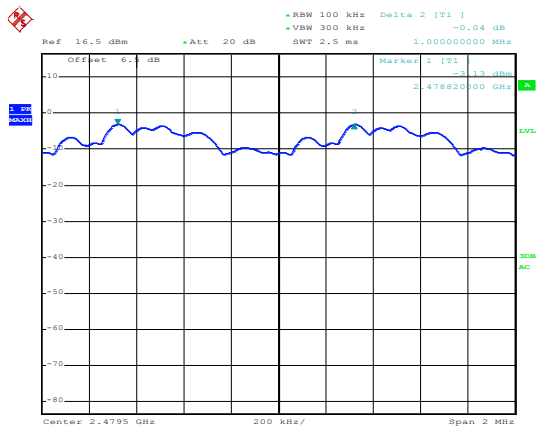
Date: 7.JUL.2020 16:04:50

Lowest channel



Date: 7.JUL.2020 16:06:10

Middle channel



Date: 7.JUL.2020 16:07:31

Highest channel

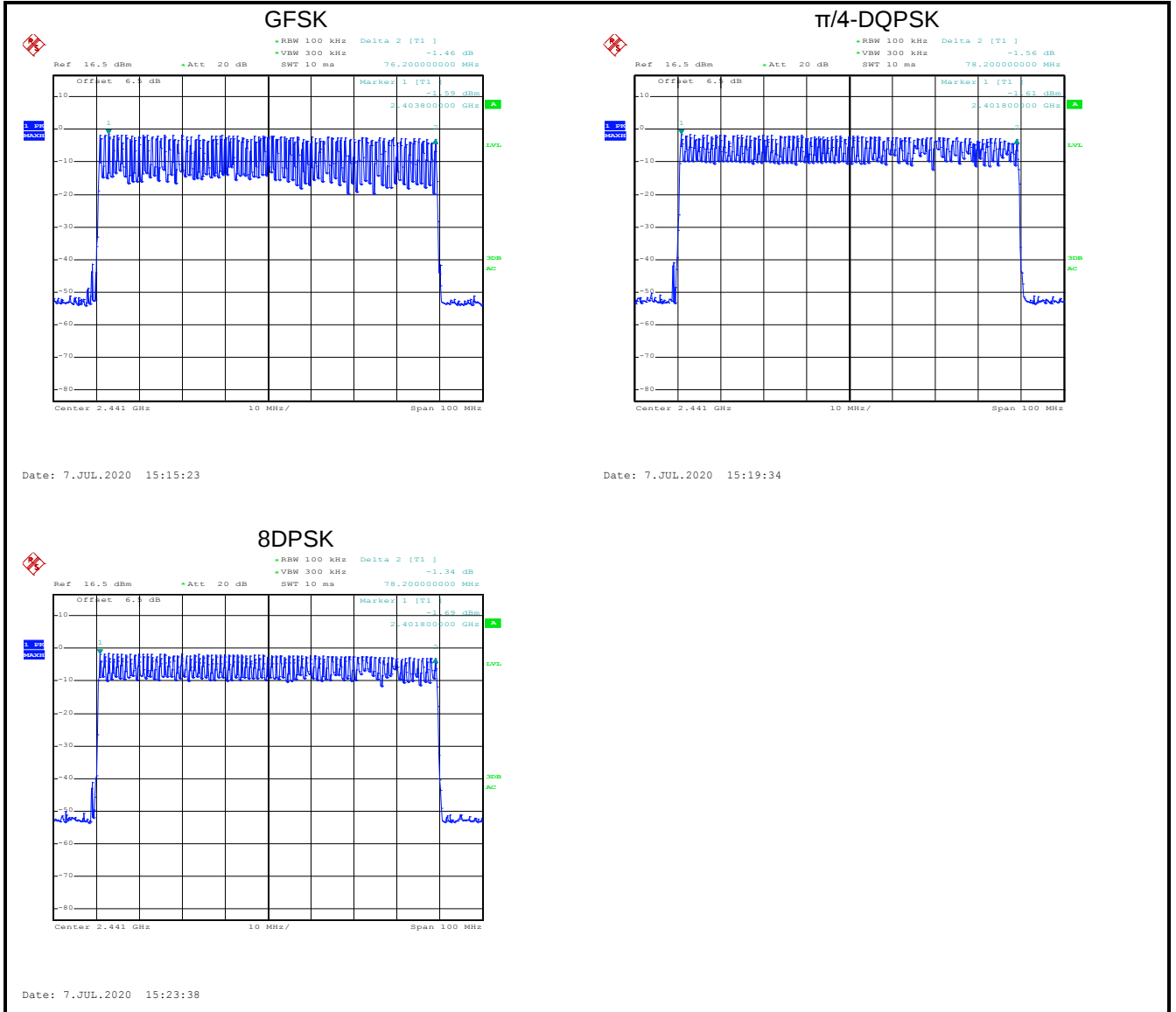
6.6 Hopping Channel Number

Test Requirement:	FCC Part 15 C Section 15.247 (a)(1)
Receiver setup:	RBW=100 kHz, VBW=300 kHz, Center Frequency=2441MHz, Span= 100MHz, Detector=Peak
Limit:	15 channels
Test setup:	 The diagram illustrates the test setup. A Spectrum Analyzer is connected to an E.U.T. (Equipment Under Test) via a red cable. Both the Spectrum Analyzer and the E.U.T. are placed on a Non-Conducted Table. The table is supported by two vertical legs. Below the table is a Ground Reference Plane.
Test Instruments:	Refer to section 5.9 for details
Test mode:	Hopping mode
Test results:	Pass

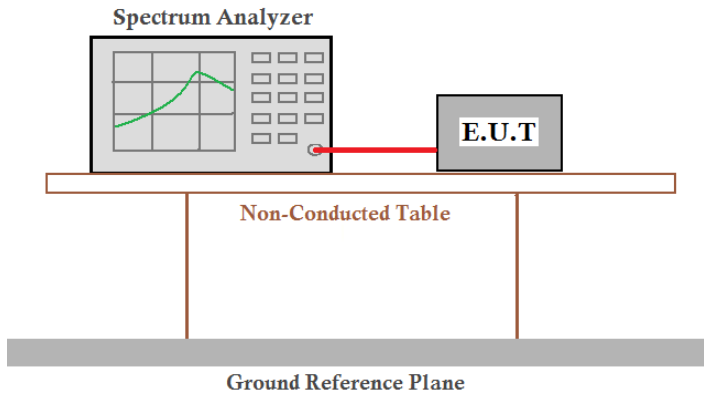
Measurement Data:

Mode	Hopping channel numbers	Limit	Result
GFSK, $\pi/4$ -DQPSK, 8DPSK	79	15	Pass

Test plot as follows:



6.7 Dwell Time

Test Requirement:	FCC Part 15 C Section 15.247 (a)(1)
Receiver setup:	RBW=1 MHz, VBW=1 MHz, Span=0 Hz, Detector=Peak
Limit:	0.4 Second
Test setup:	
Test Instruments:	Refer to section 5.9 for details
Test mode:	Hopping mode
Test results:	Pass

Measurement Data (Worse case):

Mode	Packet	Dwell time (second)	Limit (second)	Result
GFSK	DH1	0.21120	0.4	Pass
	DH3	0.30720		
	DH5	0.33963		
$\pi/4$ -DQPSK	2-DH1	0.20800	0.4	Pass
	2-DH3	0.31200		
	2-DH5	0.33877		
8DPSK	3-DH1	0.20864	0.4	Pass
	3-DH3	0.30816		
	3-DH5	0.33963		

Note:

The test period = 0.4 Second/Channel x 79 Channel = 31.6 s

Calculation Formula: Dwell time = Ton time per hop * Hopping numbers * Period

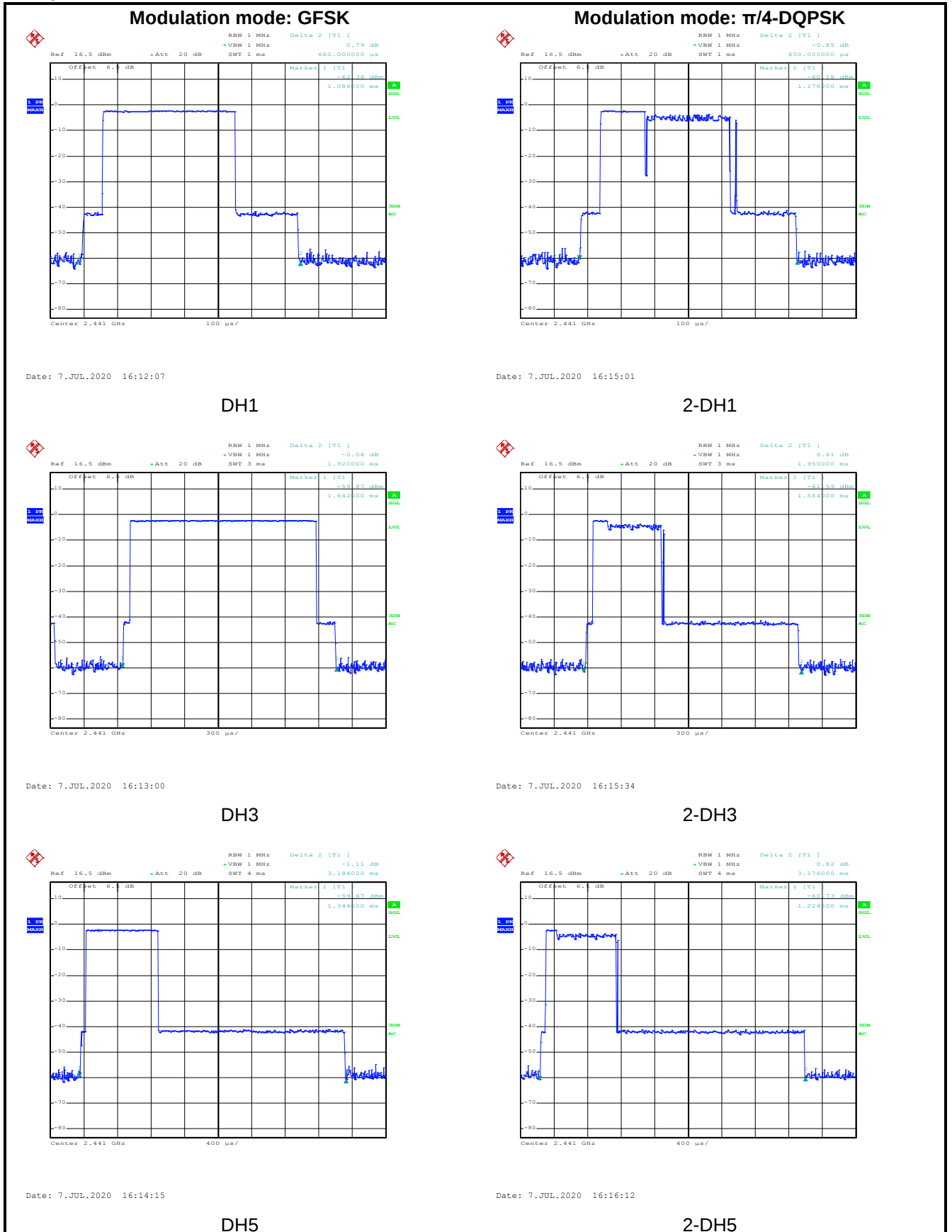
For example:

DH1 time slot = $0.660 \times (1600 / (2 \times 79)) \times 31.6 = 211.20\text{ms}$

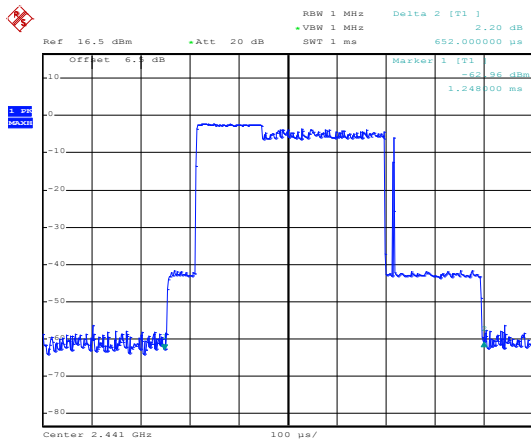
DH3 time slot = $1.920 \times (1600 / (4 \times 79)) \times 31.6 = 307.20\text{ms}$

DH5 time slot = $3.184 \times (1600 / (6 \times 79)) \times 31.6 = 339.63\text{ms}$

Test plot as follows:

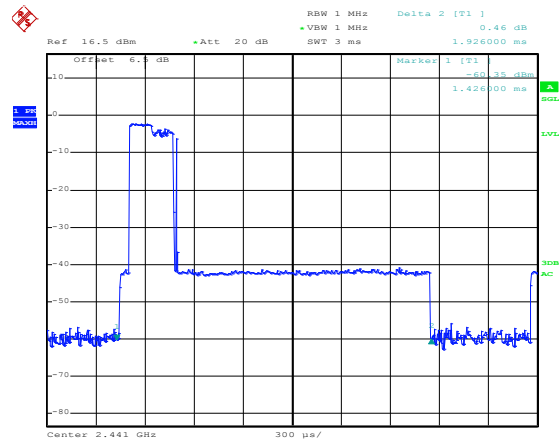


Modulation mode: 8DPSK



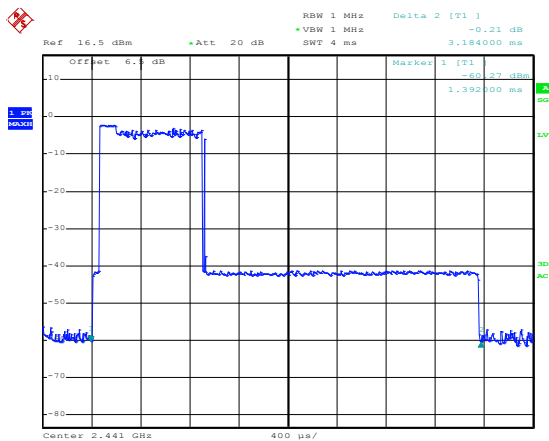
Date: 7.JUL.2020 16:16:49

3-DH1



Date: 7.JUL.2020 16:17:19

3-DH3



Date: 7.JUL.2020 16:17:50

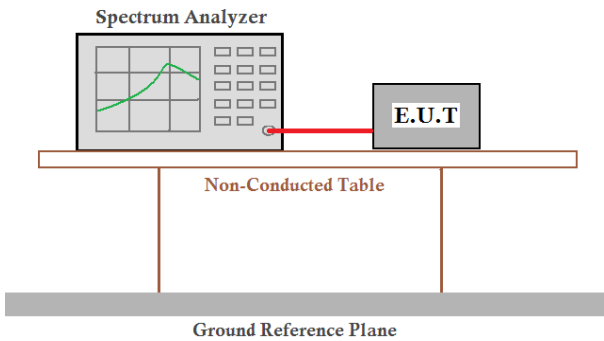
3-DH5

6.8 Pseudorandom Frequency Hopping Sequence

Test Requirement:	FCC Part 15 C 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 pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONES; i.e. the shift register is initialized with nine ones. • Number of shift register stages: 9 • Length of pseudo-random sequence: $2^9 - 1 = 511$ bits • Longest sequence of zeros: 8 (non-inverted signal) <i>Linear Feedback Shift Register for Generation of the PRBS sequence</i> An example of Pseudorandom Frequency Hopping Sequence as follow: Each frequency used equally on the average by each transmitter. The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.	

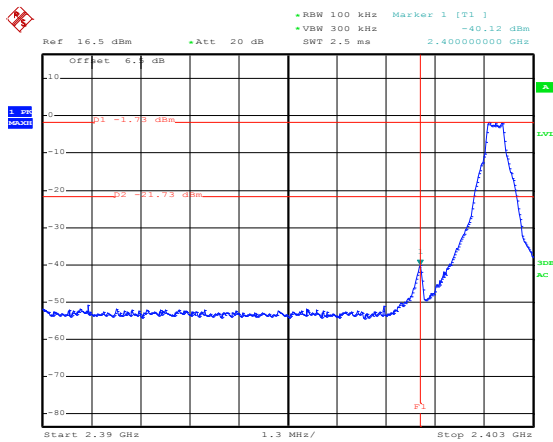
6.9 Band Edge

6.9.1 Conducted Emission Method

Test Requirement:	FCC Part 15 C Section 15.247 (d)
Receiver setup:	RBW=100 kHz, VBW=300 kHz, Detector=Peak
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test setup:	 The diagram illustrates the test setup for conducted emission measurement. A Spectrum Analyzer is connected via a red cable to an E.U.T (Equipment Under Test). Both are placed on a Non-Conducted Table, which is supported by two vertical legs. Below the table is a Ground Reference Plane.
Test Instruments:	Refer to section 5.9 for details
Test mode:	Non-hopping mode and hopping mode
Test results:	Pass

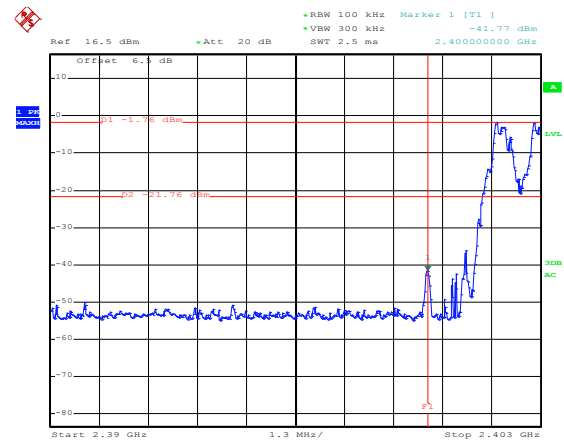
Test plot as follows:

GFSK
Lowest Channel



Date: 7.JUL.2020 15:41:25

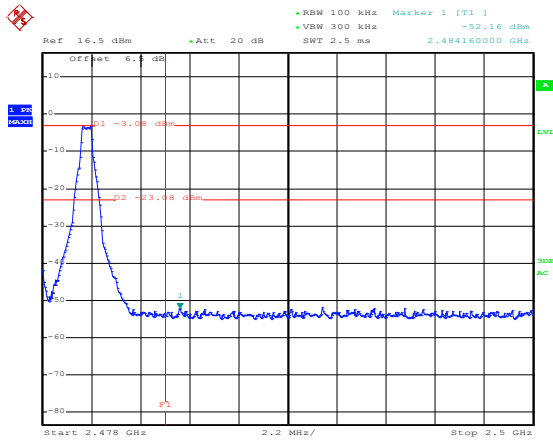
No-hopping mode



Date: 7.JUL.2020 15:42:57

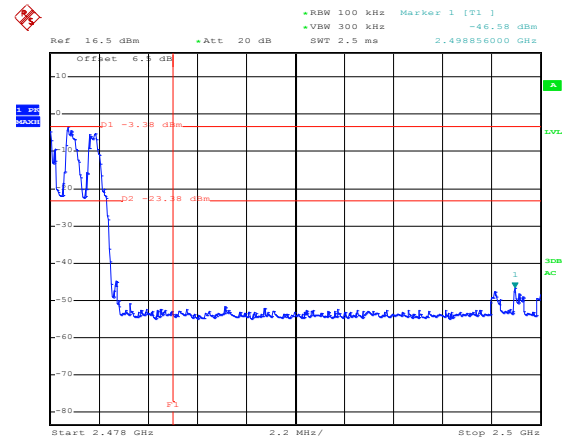
Hopping mode

Highest Channel



Date: 7.JUL.2020 15:50:21

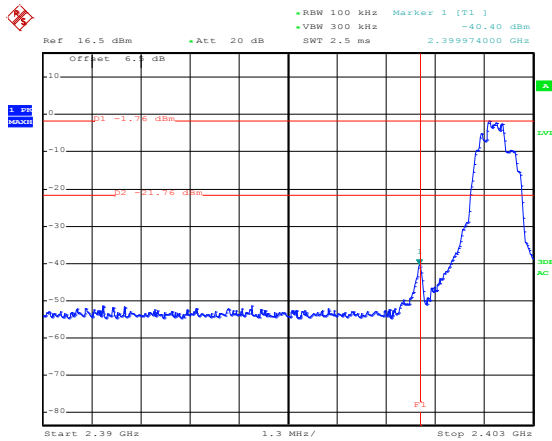
No-hopping mode



Date: 7.JUL.2020 15:51:15

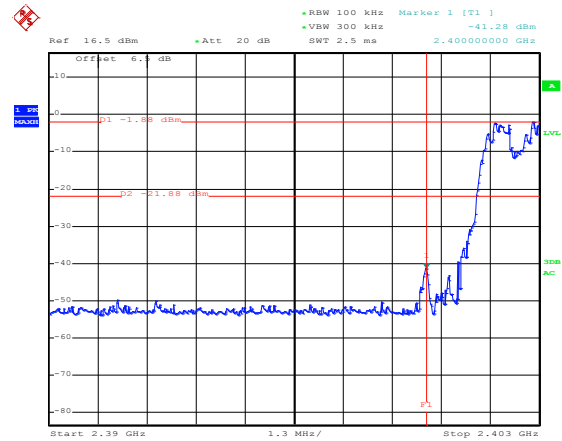
Hopping mode

$\pi/4$ -DQPSK Lowest Channel



Date: 7.JUL.2020 15:43:50

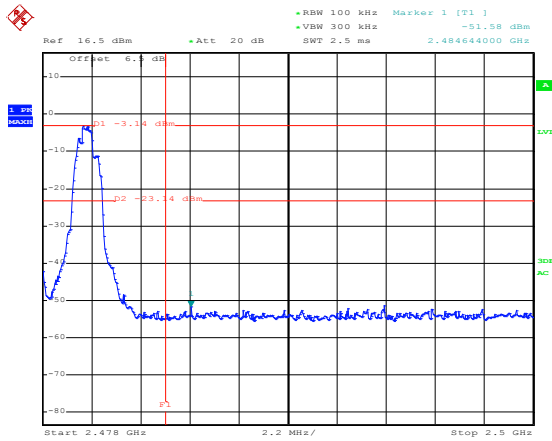
No-hopping mode



Date: 7.JUL.2020 15:47:35

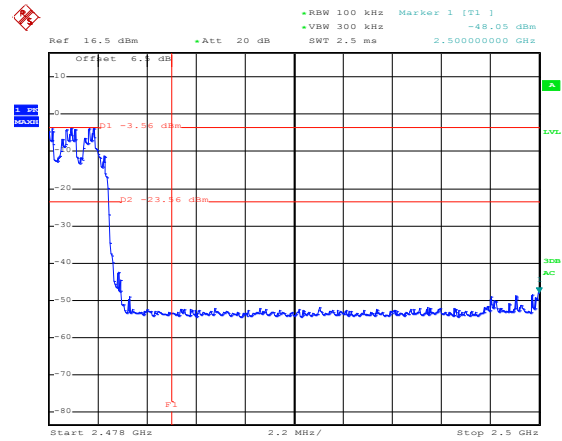
Hopping mode

Highest Channel



Date: 7.JUL.2020 15:51:52

No-hopping mode



Date: 7.JUL.2020 15:54:00

Hopping mode