

TEST REPORT

Applicant Name : TECNO MOBILE LIMITED
Address : FLAT 39 8/F BLOCK D WAH LOK INDUSTRIAL CENTRE 31-35
SHAN MEI STREET FOTAN NT Hong Kong
Report Number : SZNS220422-15992E-RF-00A
FCC ID: 2ADYY-KG5KS

Test Standard (s)

FCC PART 15.247

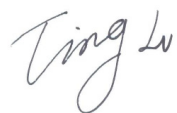
Sample Description

Product Type: Mobile Phone
Model No.: KG5ks
Multiple Model(s) No.: N/A
Trade Mark: TECNO SPARK
Date Received: 2022/04/22
Report Date: 2022/05/30

Test Result:	Pass*
--------------	-------

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

Prepared and Checked By:



Ting Lü
EMC Engineer

Approved By:



Robert Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★".

Shenzhen Accurate Technology Co., Ltd. is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with an asterisk "★". Customer model name, addresses, names, trademarks etc. are not considered data.

This report cannot be reproduced except in full, without prior written approval of the Company. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

Shenzhen Accurate Technology Co., Ltd.

1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China
Tel: +86 755-26503290 Fax: +86 755-26503396 Web: www.atc-lab.com

TABLE OF CONTENTS

GENERAL INFORMATION	4
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT)	4
OBJECTIVE	4
TEST METHODOLOGY	4
MEASUREMENT UNCERTAINTY	5
TEST FACILITY	5
SYSTEM TEST CONFIGURATION	6
DESCRIPTION OF TEST CONFIGURATION	6
EUT EXERCISE SOFTWARE	6
SPECIAL ACCESSORIES	6
EQUIPMENT MODIFICATIONS	6
SUMMARY OF TEST RESULTS	8
TEST EQUIPMENT LIST	9
FCC§15.247 (I), §1.1307 (B) (1) & §2.1093 – RF EXPOSURE	11
APPLICABLE STANDARD	11
FCC §15.203 – ANTENNA REQUIREMENT	12
APPLICABLE STANDARD	12
ANTENNA CONNECTOR CONSTRUCTION	12
FCC §15.207 (A) – AC LINE CONDUCTED EMISSIONS	13
APPLICABLE STANDARD	13
EUT SETUP	13
EMI TEST RECEIVER SETUP	13
TEST PROCEDURE	13
TRANSD FACTOR & MARGIN CALCULATION	14
TEST DATA	14
FCC §15.205, §15.209 & §15.247(D) – RADIATED EMISSIONS	17
APPLICABLE STANDARD	17
EUT SETUP	17
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP	18
TEST PROCEDURE	18
CORRECTED FACTOR & MARGIN CALCULATION	18
TEST DATA	18
FCC §15.247(A) (1)-CHANNEL SEPARATION TEST	24
APPLICABLE STANDARD	24
TEST PROCEDURE	24
TEST DATA	24
FCC §15.247(A) (1) – 20 DB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH	27
APPLICABLE STANDARD	27
TEST PROCEDURE	27
TEST DATA	28
FCC §15.247(A) (1) (III)-QUANTITY OF HOPPING CHANNEL TEST	39
APPLICABLE STANDARD	39
TEST PROCEDURE	39

TEST DATA	39
FCC §15.247(A) (1) (III) - TIME OF OCCUPANCY (DWELL TIME).....	42
APPLICABLE STANDARD	42
TEST PROCEDURE	42
TEST DATA	42
FCC §15.247(B) (1) - PEAK OUTPUT POWER MEASUREMENT	53
APPLICABLE STANDARD	53
TEST PROCEDURE	53
TEST DATA	53
FCC §15.247(D) - BAND EDGES TESTING.....	59
APPLICABLE STANDARD	59
TEST PROCEDURE	59
TEST DATA	59

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth: 2.88dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification*	1.2 dBi (provided by the applicant)
Voltage Range	DC 3.85V from battery or DC 5.0V from adapter
Sample serial number	SZNS220422-15992E-RF-S1 for Conducted and Radiated Emissions SZNS220422-15992E-RF-S2 for RF Conducted Test (Assigned by ATC)
Sample/EUT Status	Good condition
Adapter information	Model: U100TSA Input: AC 100-240V, 50/60Hz, 0.3A Output: DC 5.0V, 2.0A

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		0.082×10^{-7}
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	9kHz - 30MHz	2.66dB
	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
	26.5GHz - 40GHz	4.72dB
Temperature		1 °C
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISED), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

Test in the engineering mode and the power level set is 8*.The power level was provided by applicant

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

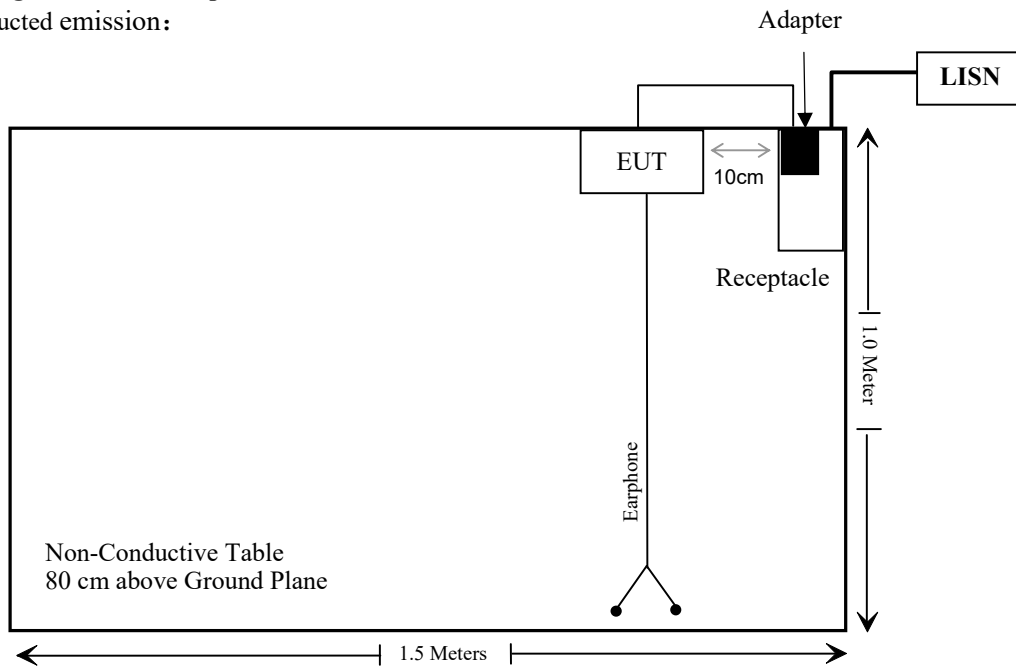
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

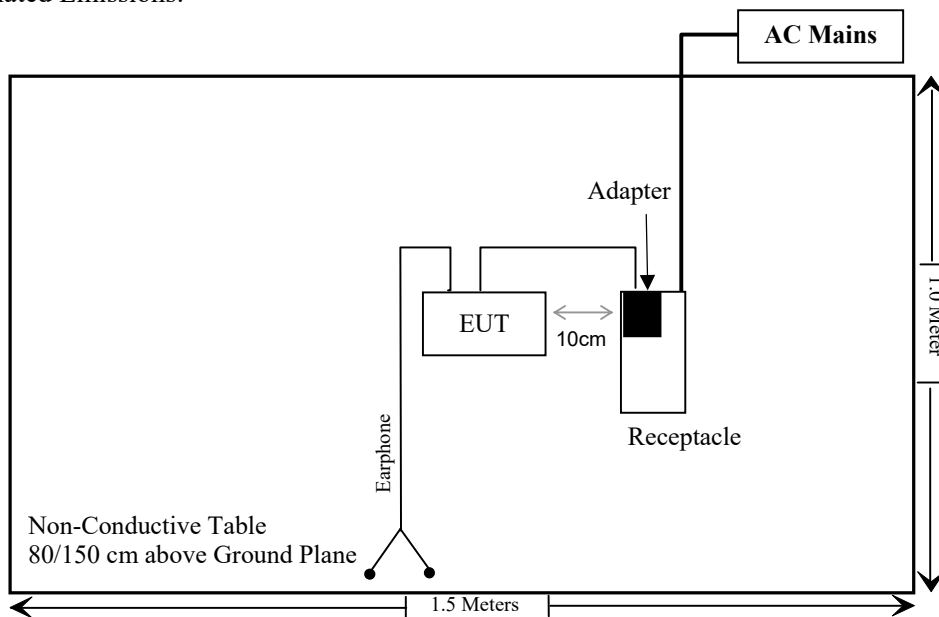
Cable Description	Length (m)	From/Port	To
Un-shielding Detachable USB Cable	1.0	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



For Radiated Emissions:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §1.1307 (b) (1) & §2.1093	RF Exposure	Compliant
§15.203	Antenna Requirement	Compliant
§15.207(a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliant
§15.247(a)(1)	20 dB Emission Bandwidth & 99% Occupied Bandwidth	Compliant
§15.247(a)(1)	Channel Separation Test	Compliant
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
§15.247(b)(1)	Peak Output Power Measurement	Compliant
§15.247(d)	Band edges	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	EMI Test Receiver	ESCI	100784	2021/12/13	2022/12/12
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2021/12/13	2022/12/12
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2021/12/13	2022/12/12
Unknown	RF Coaxial Cable	No.17	N0350	2021/12/14	2022/12/13
Conducted Emission Test Software: e3 19821b (V9)					
Radiated Emissions Test					
Rohde& Schwarz	Test Receiver	ESR	102725	2021/12/13	2022/12/12
Rohde&Schwarz	Spectrum Analyzer	FSV40	101949	2021/12/13	2022/12/12
SONOMA INSTRUMENT	Amplifier	310 N	186131	2021/11/09	2022/11/08
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2021/11/09	2022/11/08
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2021/11/11	2022/11/10
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Radiated Emission Test Software: e3 19821b (V9)					
Unknown	RF Coaxial Cable	No.10	N050	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.11	N1000	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.12	N040	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.13	N300	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.14	N800	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.15	N600	2021/12/14	2022/12/13
Unknown	RF Coaxial Cable	No.16	N650	2021/12/14	2022/12/13
Wainwright	High Pass Filter	WHKX3.6/18 G-10SS	5	2021/12/14	2022/12/13

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
SPECTRUM ANALYZER	Rohde & Schwarz	FSU26	200982	2021/07/06	2022/07/05
HP	6dB Attenuator	8493B	2708A 04769	2021/12/14	2022/12/13
Unknown	RF Cable	Unknown	Unknown	Each time	

* **Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1307 (b) (1) & §2.1093 – RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. $f(\text{GHz})$ is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Measurement Result

For worst case:

Frequency (MHz)	Tune-up power (dBm)	Tune-up power (mW)	Distance (mm)	Calculated value	Threshold (1-g SAR)	SAR Test Exclusion
2480	3.0	2.0	5.0	0.6	3.0	Yes

Result: No SAR test is required

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. 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.

Antenna Connector Construction

The EUT has one internal Antenna arrangement, which was permanently attached and the antenna gain is 1.2 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

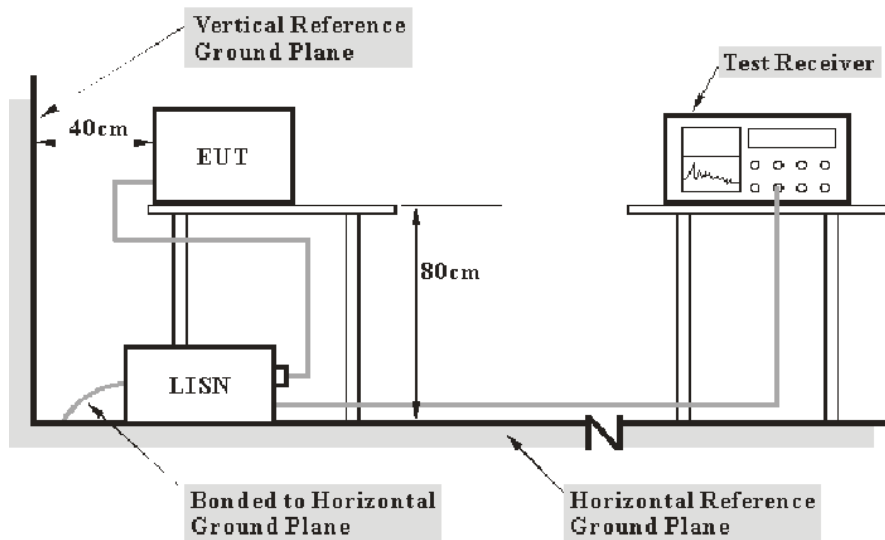
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Transd Factor & Margin Calculation

The Transd factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Transd Factor} = \text{LISN VDF} + \text{Cable Loss}$$

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

$$\text{Over Limit} = \text{level} - \text{Limit}$$

$$\text{Level} = \text{reading level} + \text{Transd Factor}$$

Test Data

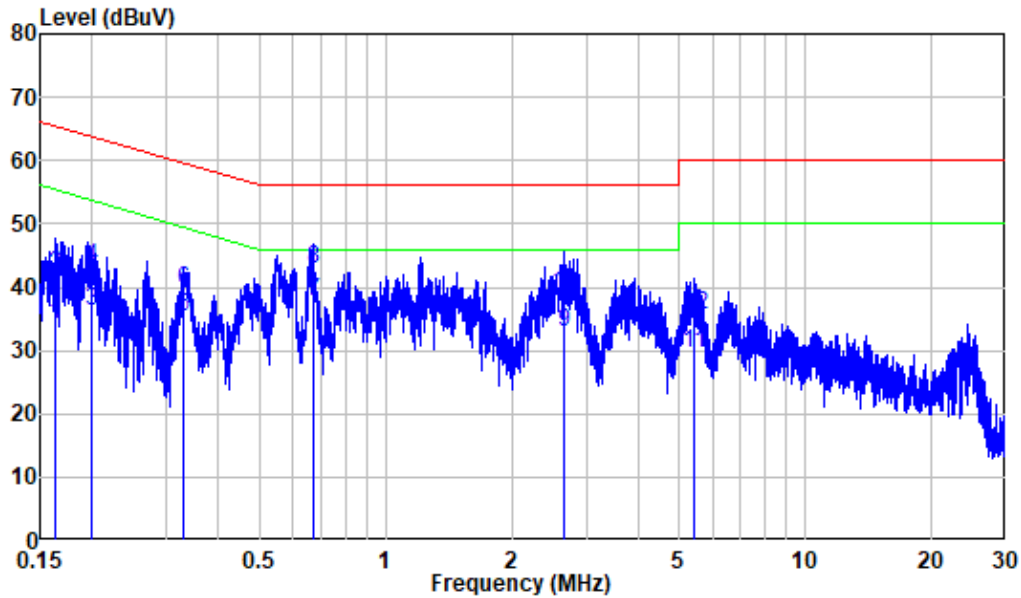
Environmental Conditions

Temperature:	23 °C
Relative Humidity:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by Jason Liu on 2022-05-20.

EUT operation mode: Transmitting (the worst case for 8DPSK Mode, High channel)

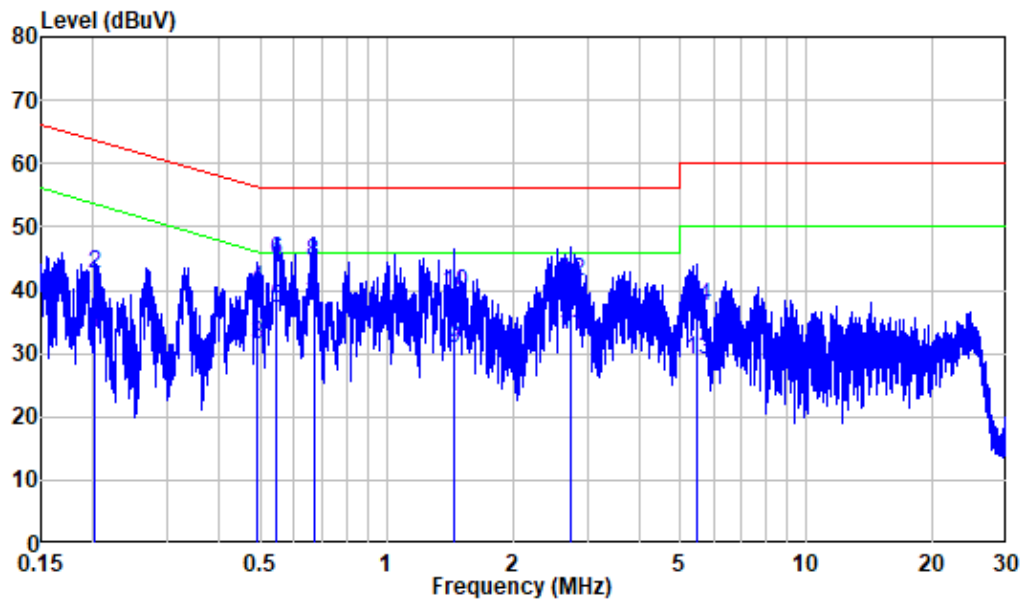
AC 120V/60 Hz, Line



Site : Shielding Room
 Condition: Line
 Job No. : SZNS220422-15992E-RF
 Mode : BT
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.163	9.80	24.19	33.99	55.28	-21.29	Average
2	0.163	9.80	32.13	41.93	65.28	-23.35	QP
3	0.200	9.80	26.31	36.11	53.61	-17.50	Average
4	0.200	9.80	33.42	43.22	63.61	-20.39	QP
5	0.330	9.80	25.58	35.38	49.46	-14.08	Average
6	0.330	9.80	29.82	39.62	59.46	-19.84	QP
7	0.671	9.81	27.86	37.67	46.00	-8.33	Average
8	0.671	9.81	32.96	42.77	56.00	-13.23	QP
9	2.652	9.83	23.22	33.05	46.00	-12.95	Average
10	2.652	9.83	29.22	39.05	56.00	-16.95	QP
11	5.422	9.85	19.71	29.56	50.00	-20.44	Average
12	5.422	9.85	25.74	35.59	60.00	-24.41	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
 Condition: Neutral
 Job No. : SZNS220422-15992E-RF
 Mode : BT
 Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.202	9.80	23.41	33.21	53.52	-20.31	Average
2	0.202	9.80	32.77	42.57	63.52	-20.95	QP
3	0.492	9.80	21.74	31.54	46.13	-14.59	Average
4	0.492	9.80	30.45	40.25	56.13	-15.88	QP
5	0.548	9.81	27.41	37.22	46.00	-8.78	Average
6	0.548	9.81	34.90	44.71	56.00	-11.29	QP
7	0.669	9.81	27.64	37.45	46.00	-8.55	Average
8	0.669	9.81	34.64	44.45	56.00	-11.55	QP
9	1.451	9.81	20.94	30.75	46.00	-15.25	Average
10	1.451	9.81	29.70	39.51	56.00	-16.49	QP
11	2.734	9.83	23.07	32.90	46.00	-13.10	Average
12	2.734	9.83	31.50	41.33	56.00	-14.67	QP
13	5.473	9.91	19.22	29.13	50.00	-20.87	Average
14	5.473	9.91	27.48	37.39	60.00	-22.61	QP

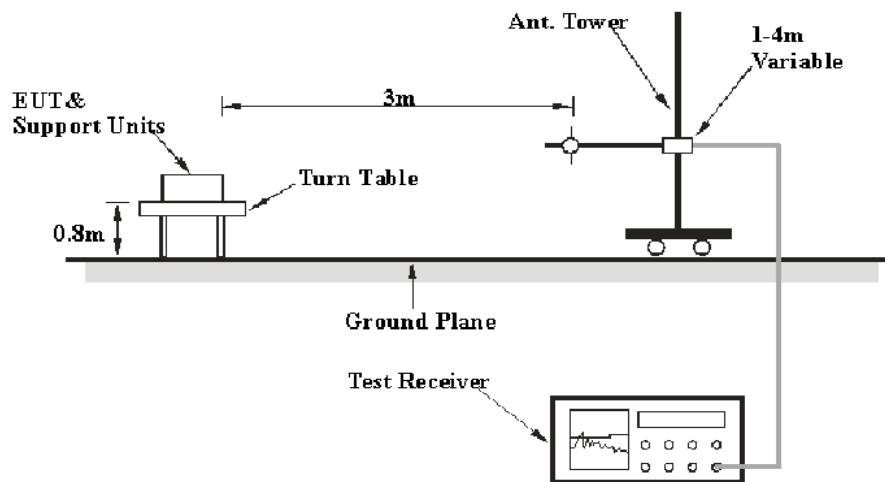
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Corrected Factor & Margin Calculation

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

$$\text{Corrected Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Over Limit or Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a overlimit/margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\begin{aligned} \text{Margin/Over Limit} &= \text{Corrected Amplitude/Level-Limit} \\ \text{Corrected Amplitude/Level} &= \text{Reading} + \text{Corrected Factor} \end{aligned}$$

Test Data

Environmental Conditions

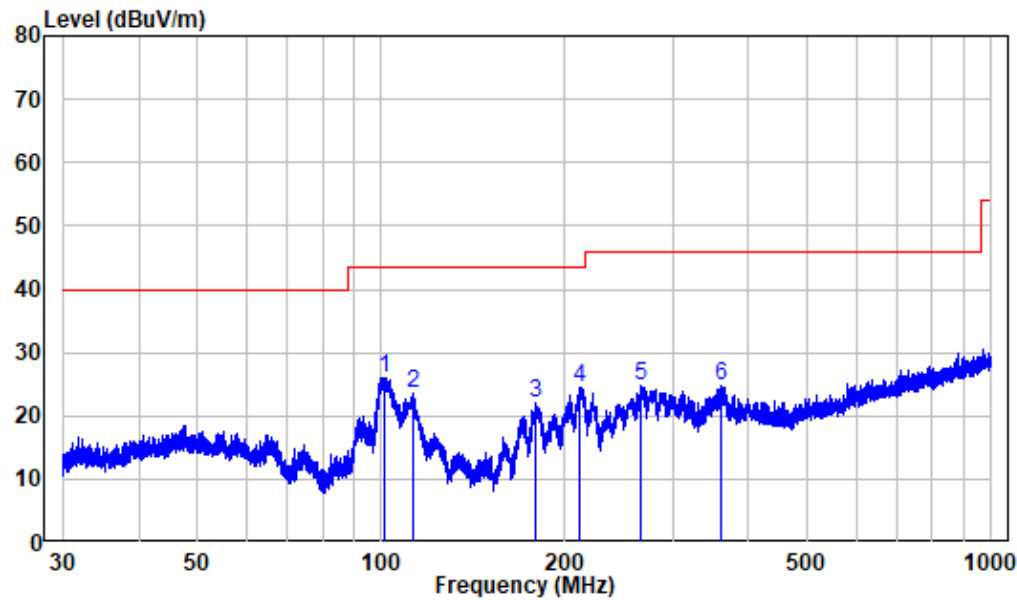
Temperature:	25.8~26 °C
Relative Humidity:	57~60 %
ATM Pressure:	101.0 kPa

The testing was performed by Level Li on 2022-05-21 for below 1GHz, on 2022-04-30 and 2022-05-26 for above 1GHz.

EUT operation mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axes orientation was recorded)

30MHz-1GHz: (worst case is 8DPSK Mode, High channel)

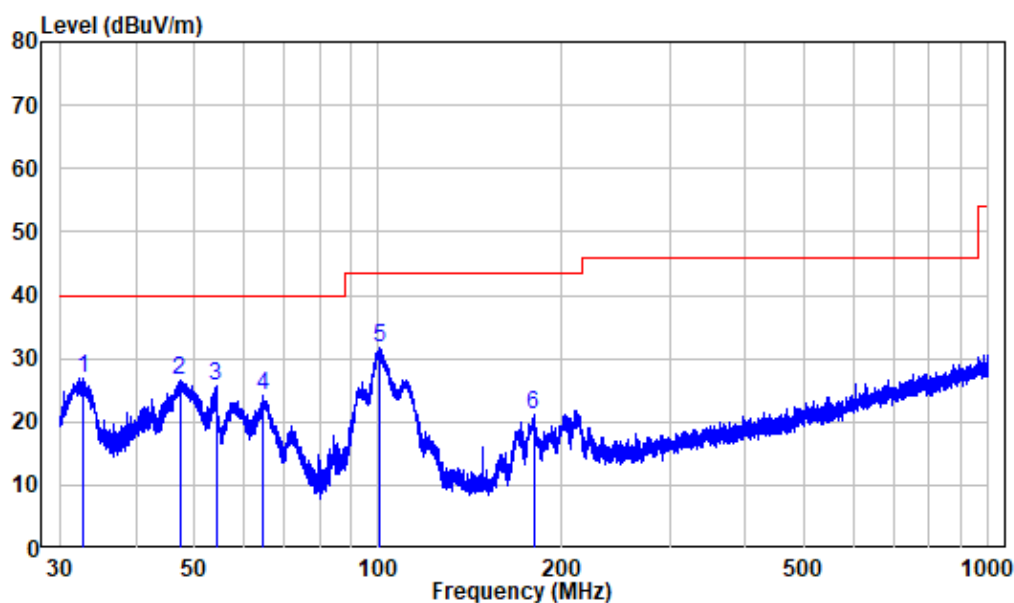
Horizontal:



Site : chamber
Condition: 3m HORIZONTAL
Job No. : SZNS220422-15992E-RF
Test Mode: BT

	Freq Factor		Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	100.978	-11.69	37.70	26.01	43.50	-17.49	Peak
2	113.019	-12.42	35.86	23.44	43.50	-20.06	Peak
3	178.524	-12.92	34.86	21.94	43.50	-21.56	Peak
4	211.991	-11.78	36.19	24.41	43.50	-19.09	Peak
5	266.843	-10.37	35.03	24.66	46.00	-21.34	Peak
6	361.397	-7.64	32.26	24.62	46.00	-21.38	Peak

Vertical



Site : chamber
 Condition: 3m VERTICAL
 Job No. : SZNS220422-15992E-RF
 Test Mode: BT

	Freq	Factor	Read Level	Limit Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	32.806	-12.05	38.82	26.77	40.00	-13.23	Peak
2	47.222	-10.00	36.59	26.59	40.00	-13.41	Peak
3	54.166	-10.34	35.96	25.62	40.00	-14.38	Peak
4	64.801	-12.44	36.71	24.27	40.00	-15.73	Peak
5	100.141	-11.79	43.50	31.71	43.50	-11.79	Peak
6	179.622	-12.81	33.90	21.09	43.50	-22.41	Peak

Above 1GHz: (the worst case is 8DPSK Mode)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/AV		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2310	68.00	PK	242	1.4	H	-7.24	60.76	74	-13.24
2310	53.43	AV	242	1.4	H	-7.24	46.19	54	-7.81
2310	67.92	PK	350	2.4	V	-7.24	60.68	74	-13.32
2310	53.35	AV	350	2.4	V	-7.24	46.11	54	-7.89
2390	69.02	PK	167	2	H	-7.22	61.80	74	-12.20
2390	54.05	AV	167	2	H	-7.22	46.83	54	-7.17
2390	68.90	PK	277	1.6	V	-7.22	61.68	74	-12.32
2390	53.96	AV	277	1.6	V	-7.22	46.74	54	-7.26
4804	55.14	PK	198	2	H	-3.51	51.63	74	-22.37
4804	55.97	PK	57	2	V	-3.51	52.46	74	-21.54
Middle Channel(2441MHz)									
4882	54.87	PK	32	1.7	H	-3.37	51.50	74	-22.50
4882	55.18	PK	162	1.7	V	-3.37	51.81	74	-22.19
High Channel(2480 MHz)									
2483.5	69.89	PK	200	1	H	-7.20	62.69	74	-11.31
2483.5	54.77	AV	200	1	H	-7.20	47.57	54	-6.43
2483.5	69.78	PK	276	1.3	V	-7.20	62.58	74	-11.42
2483.5	54.69	AV	276	1.3	V	-7.20	47.49	54	-6.51
2500	69.00	PK	211	2.3	H	-7.18	61.82	74	-12.18
2500	54.62	AV	211	2.3	H	-7.18	47.44	54	-6.56
2500	68.89	PK	35	1.3	V	-7.18	61.71	74	-12.29
2500	54.56	AV	35	1.3	V	-7.18	47.38	54	-6.62
4960	54.17	PK	84	1.7	H	-3.01	51.16	74	-22.84
4960	54.34	PK	118	1.7	V	-3.01	51.33	74	-22.67

Note:

Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

Margin = Corrected. Amplitude - Limit

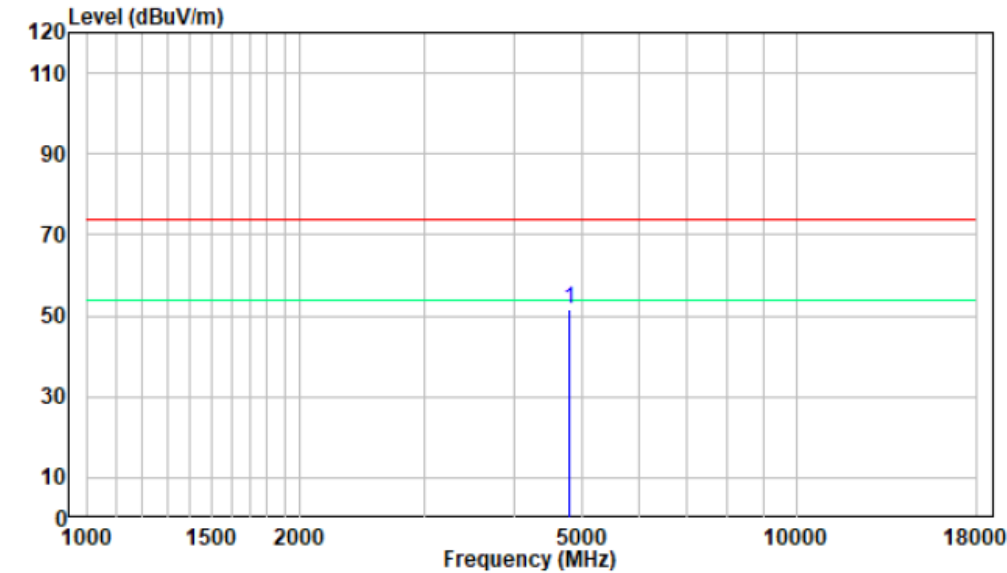
The other spurious emission which is 20dB to the limit or in noise floor was not recorded.

The test result of peak was less than the limit of average, so just peak value were recorded.

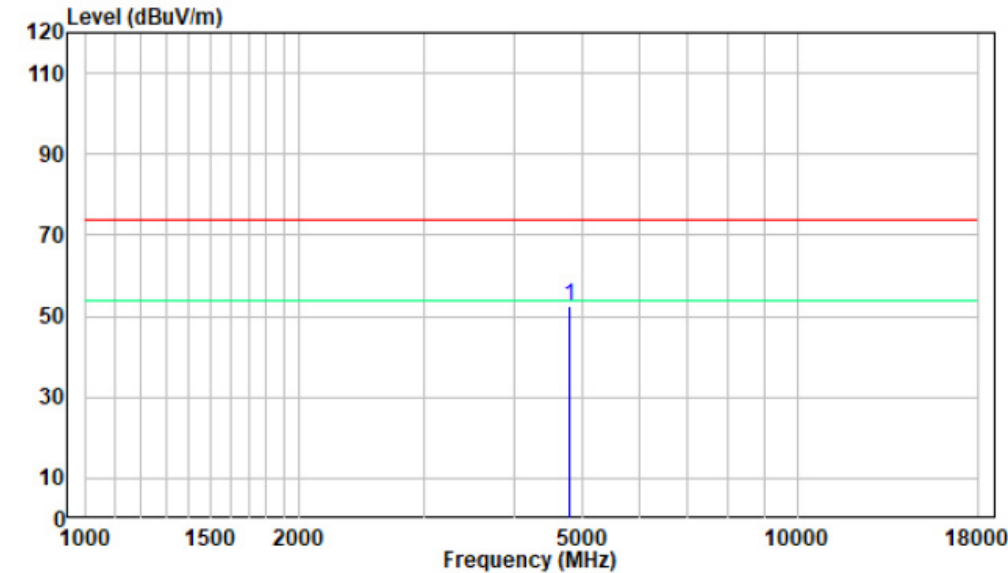
1-18GHz

Pre-scan for Low Channel

Horizontal:



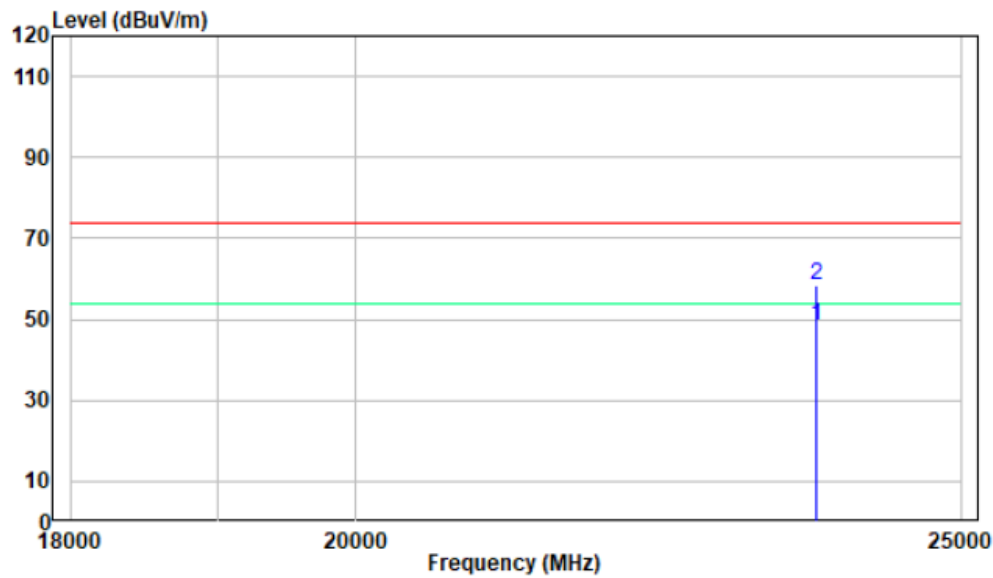
Vertical:



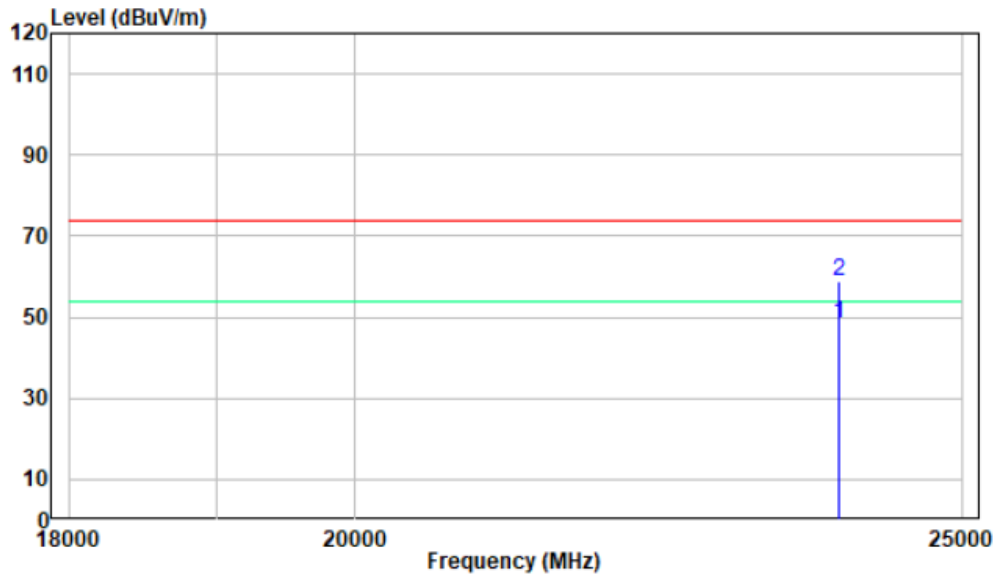
18-25GHz

Pre-scan for Low Channel

Horizontal:



Vertical:



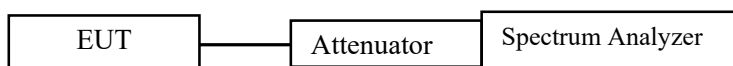
FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

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 pseudo randomly 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.

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2022-05-26.

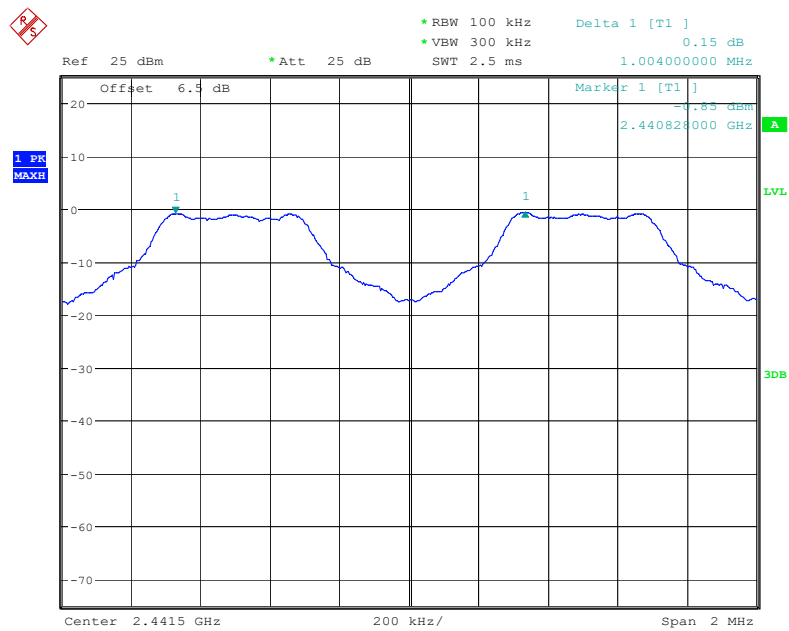
EUT operation mode: Transmitting

Test Result: Compliant.

Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit
BDR(GFSK)				
Hopping	1.004	0.955	0.637	> two-thirds of the 20 dB bandwidth
EDR($\pi/4$-DQPSK)				
Hopping	0.996	1.276	0.851	> two-thirds of the 20 dB bandwidth
EDR(8DPSK)				
Hopping	0.996	1.279	0.853	> two-thirds of the 20 dB bandwidth

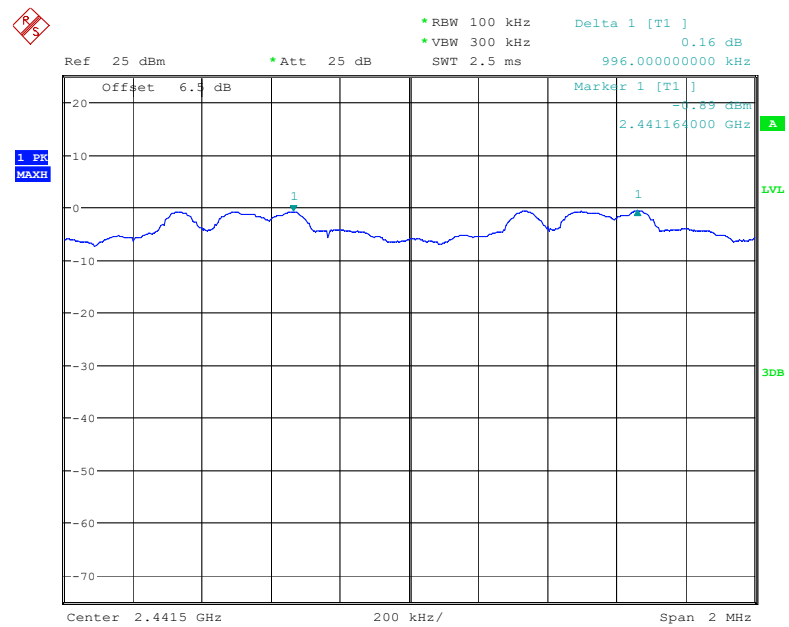
Please refer to the below plots:

DH1_Hop

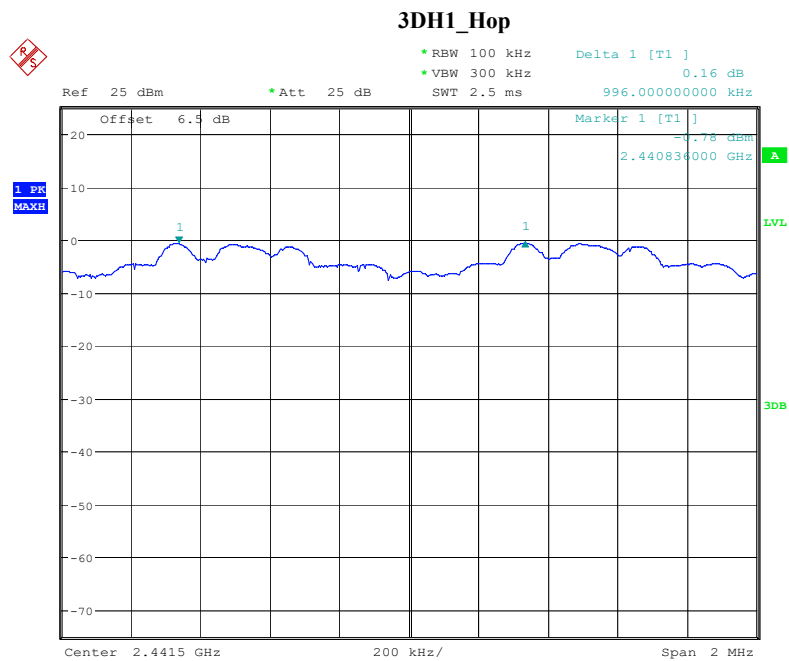


Date: 26.MAY.2022 15:52:15

2DH1_Hop



Date: 26.MAY.2022 15:51:14



Date: 26.MAY.2022 15:49:24

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH & 99% OCCUPIED BANDWIDTH

Applicable Standard

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.

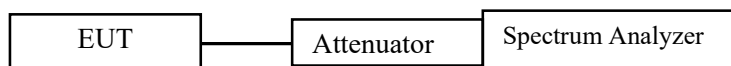
Test Procedure

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data**Environmental Conditions**

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding from 2022-05-19 to 2022-05-26.

EUT operation mode: Transmitting

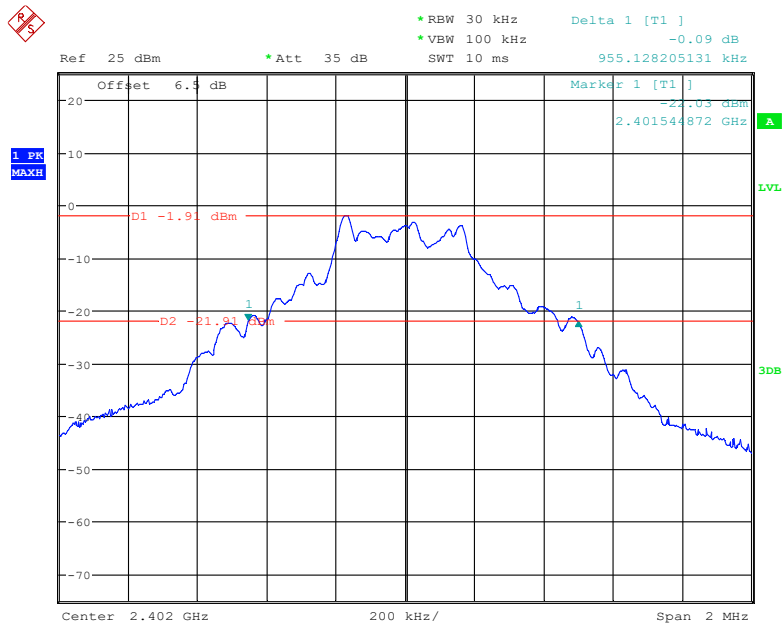
Test Result: Compliant.

Mode	Channel	Frequency (MHz)	99% Emission Bandwidth (MHz)	20 dB Emission Bandwidth (MHz)
BDR (GFSK)	Low	2402	0.870	0.955
	Middle	2441	0.873	0.946
	High	2480	0.873	0.949
EDR ($\pi/4$-DQPSK)	Low	2402	1.170	1.276
	Middle	2441	1.167	1.272
	High	2480	1.167	1.276
EDR (8DPSK)	Low	2402	1.160	1.268
	Middle	2441	1.163	1.279
	High	2480	1.163	1.276

Please refer to the below plots:

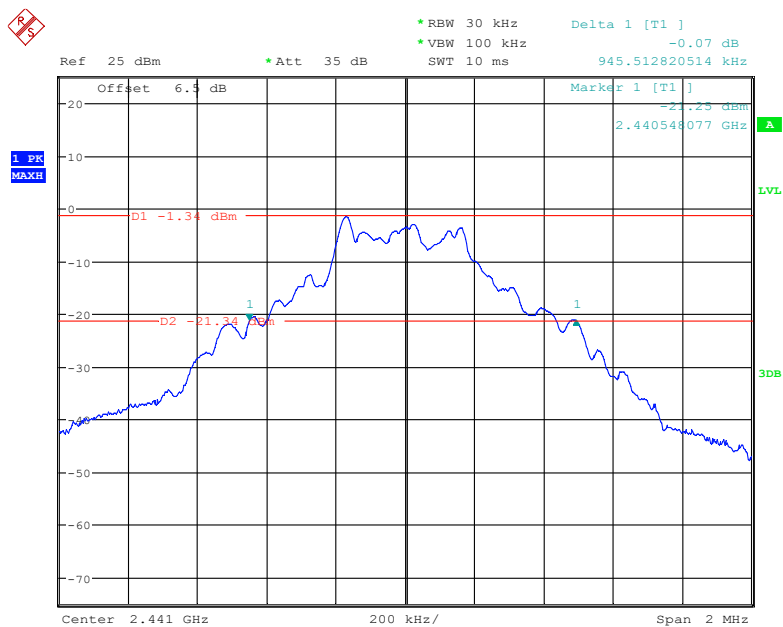
20 dB EMISSION BANDWIDTH

DH1_2402MHz



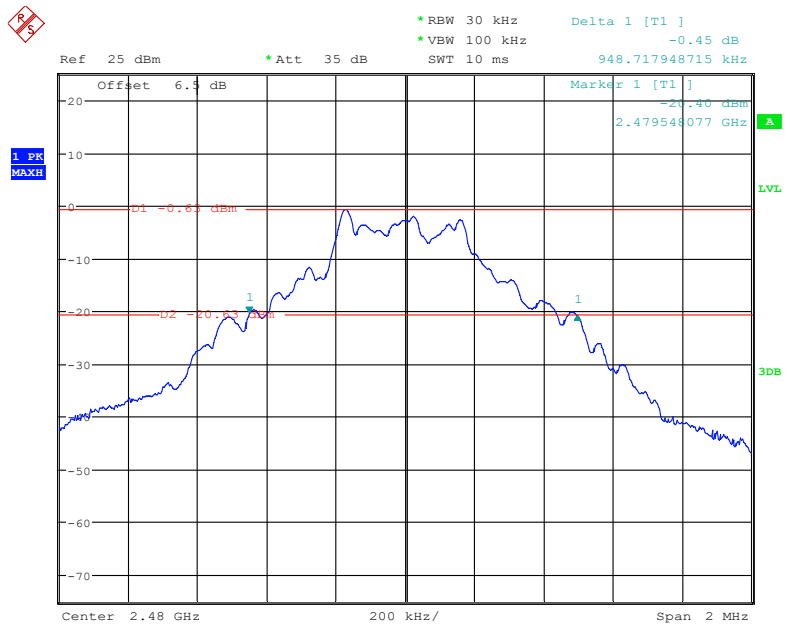
Date: 19.MAY.2022 17:38:21

DH1_2441MHz



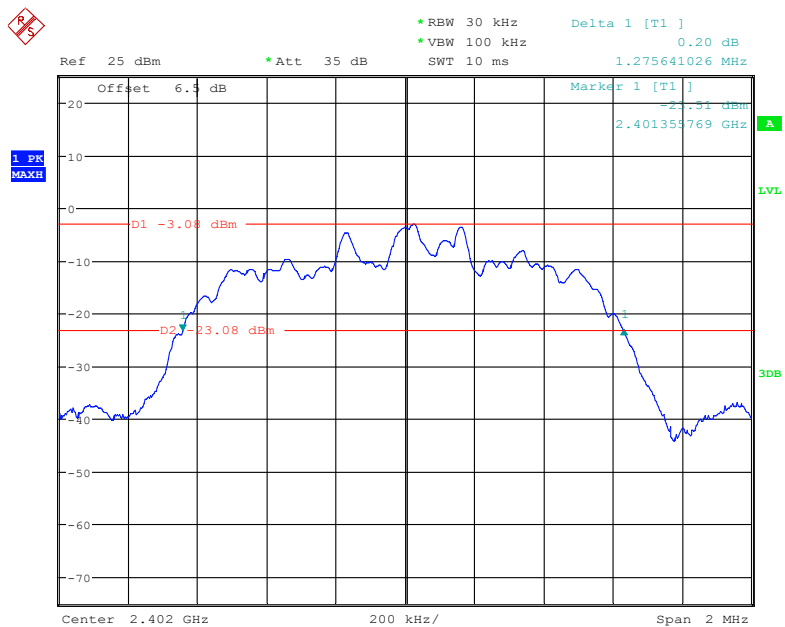
Date: 19.MAY.2022 17:39:33

DH1_2480MHz



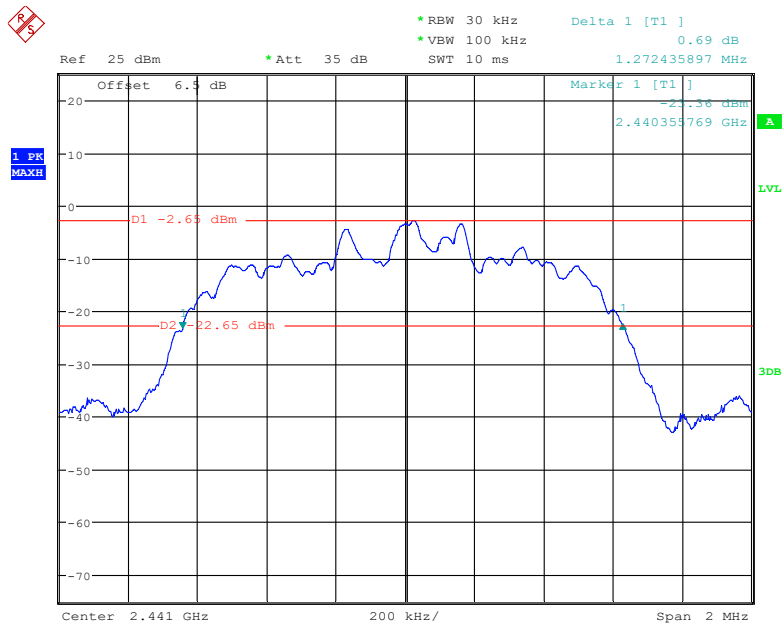
Date: 19.MAY.2022 17:40:29

2DH1_2402MHz



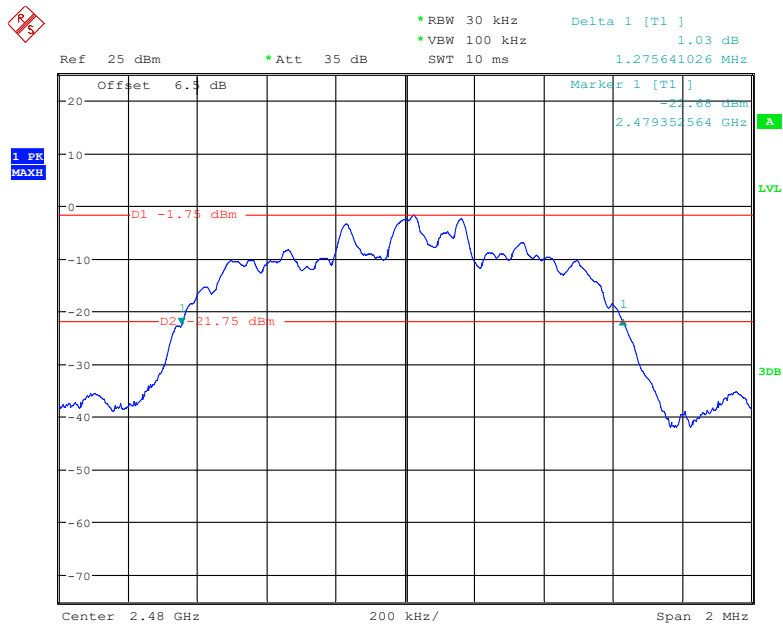
Date: 19.MAY.2022 17:37:12

2DH1_2441MHz



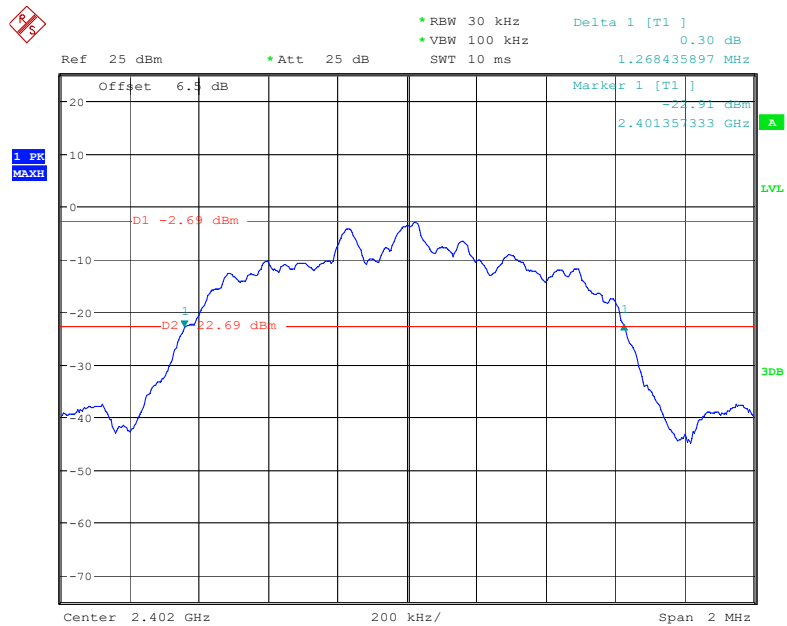
Date: 19.MAY.2022 17:36:01

2DH1_2480MHz



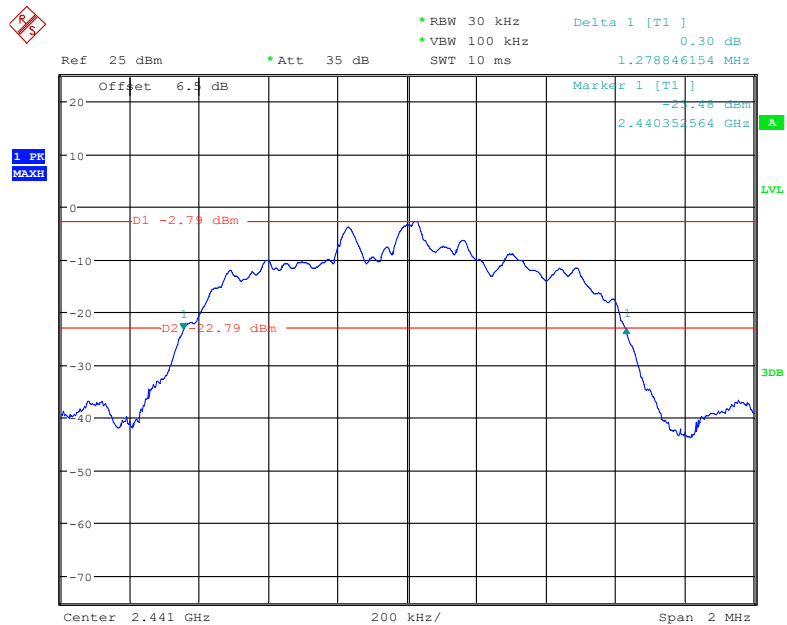
Date: 19.MAY.2022 17:34:17

3DH1_2402MHz

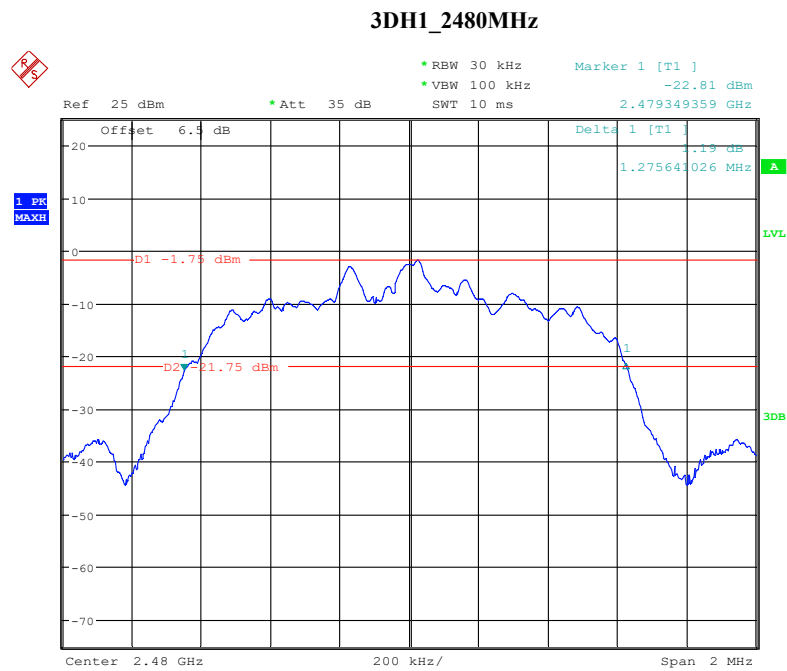


Date: 26.MAY.2022 15:44:58

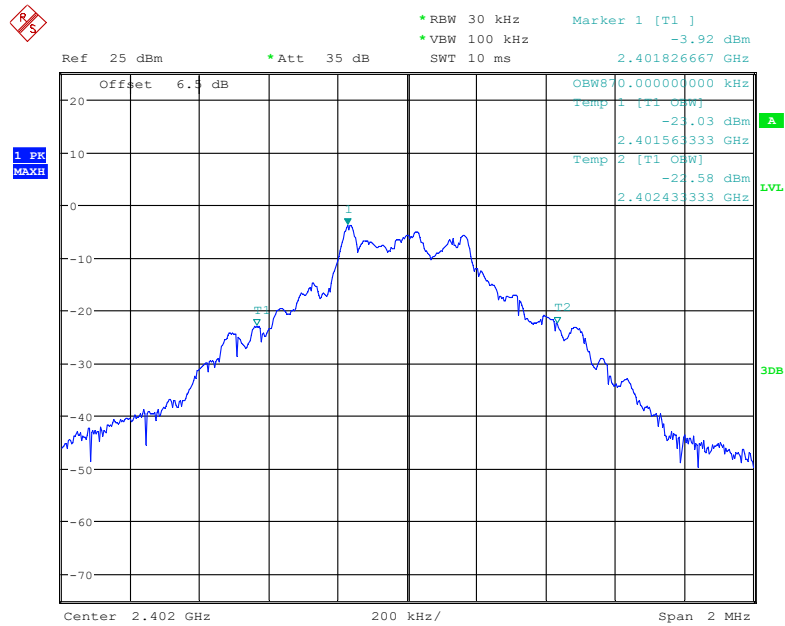
3DH1_2441MHz



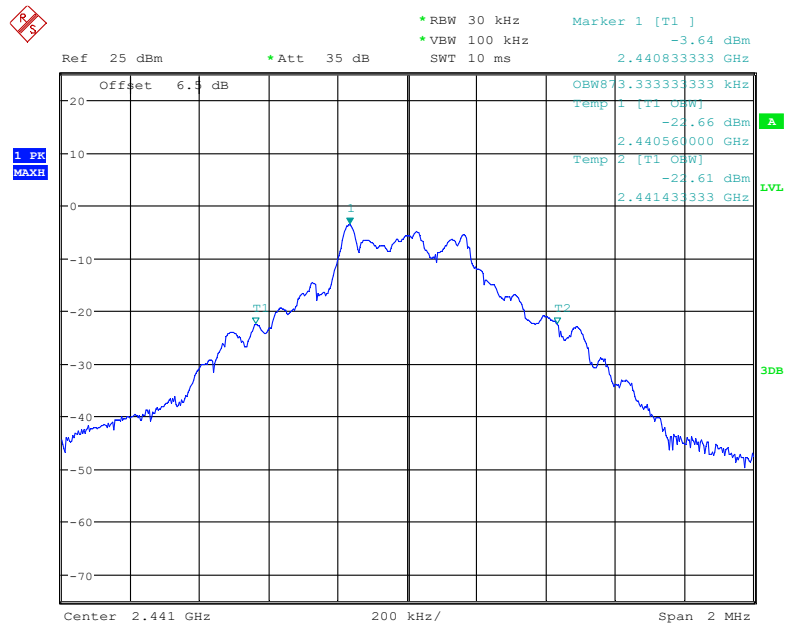
Date: 19.MAY.2022 17:31:54



Date: 19.MAY.2022 17:35:09

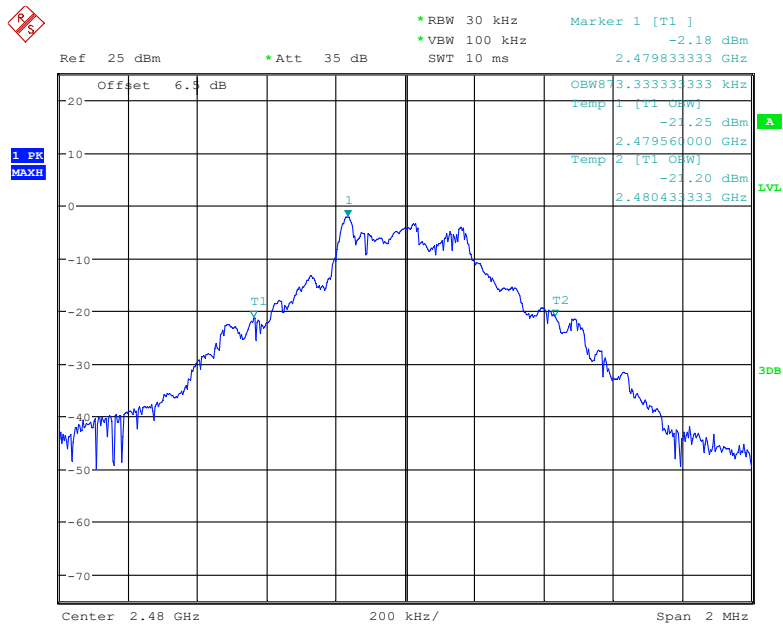
99% Occupied Bandwidth:**DH1_2402MHz**

Date: 20.MAY.2022 14:22:32

DH1_2441MHz

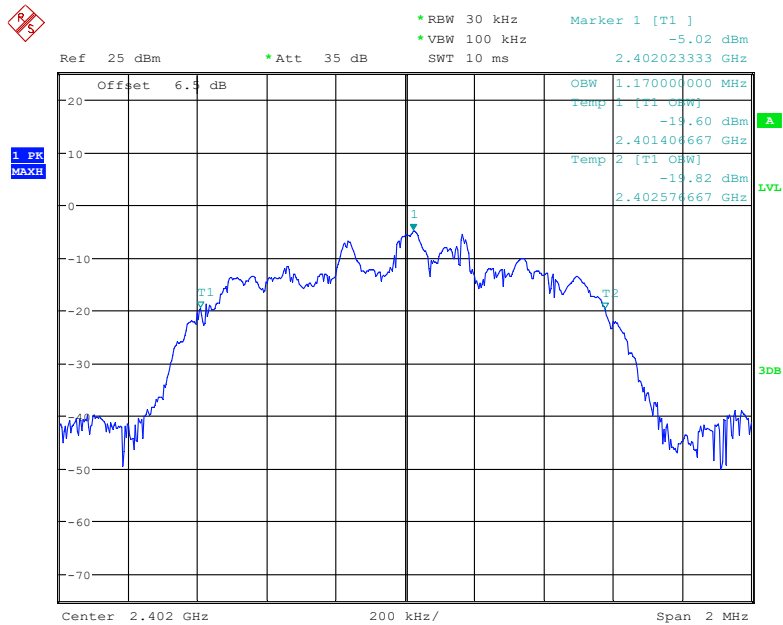
Date: 20.MAY.2022 14:22:08

DH1_2480MHz



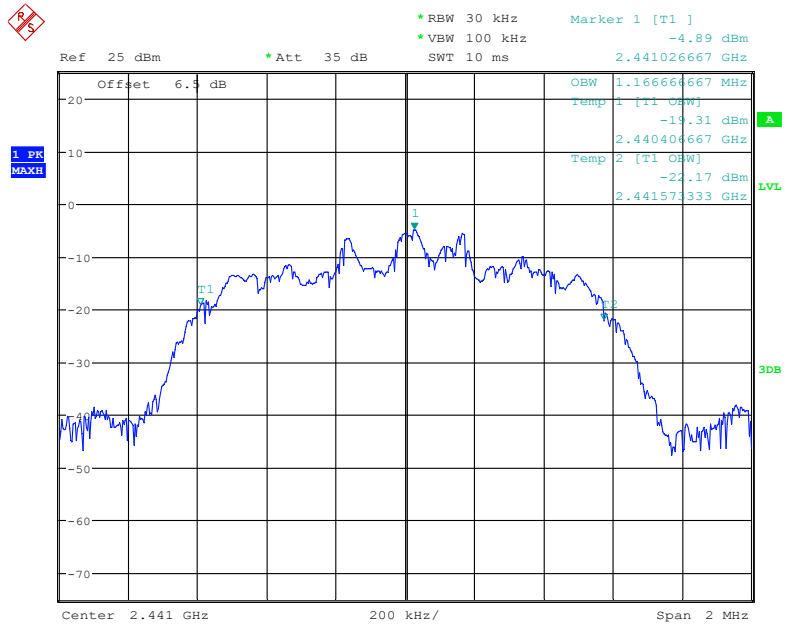
Date: 20.MAY.2022 14:22:56

2DH1_2402MHz



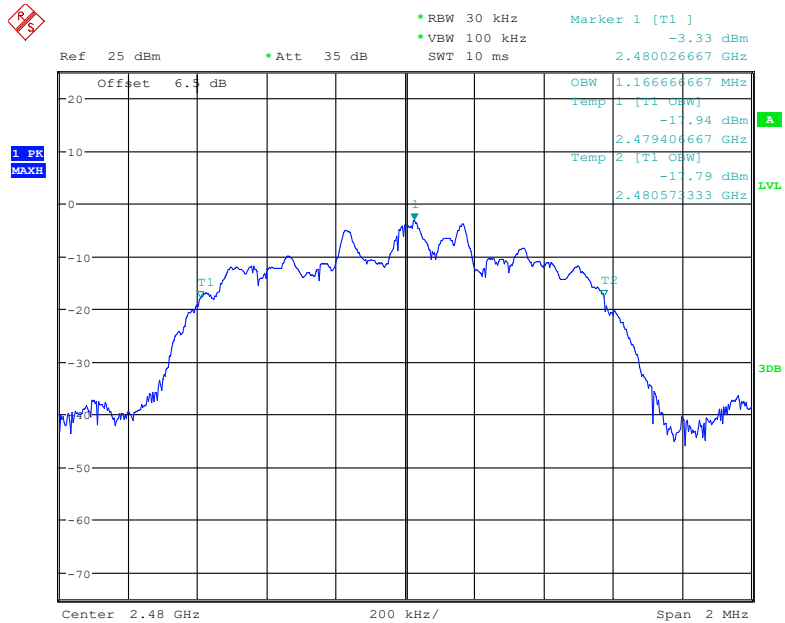
Date: 20.MAY.2022 14:24:38

2DH1_2441MHz



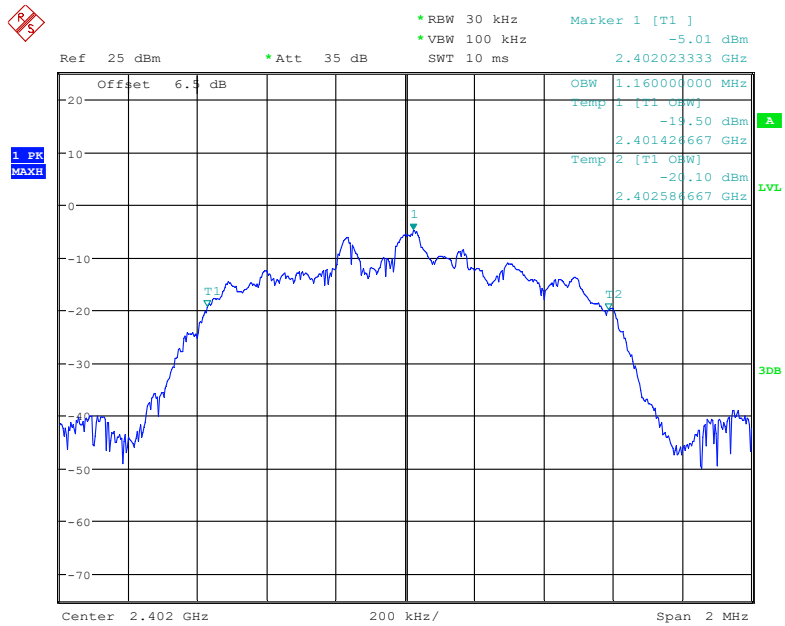
Date: 20.MAY.2022 14:24:18

2DH1_2480MHz



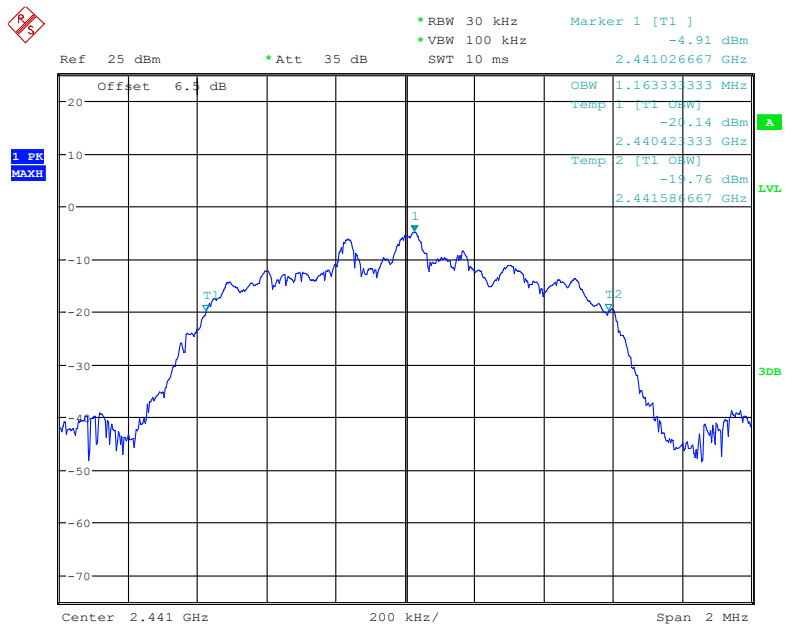
Date: 20.MAY.2022 14:23:51

3DH1_2402MHz



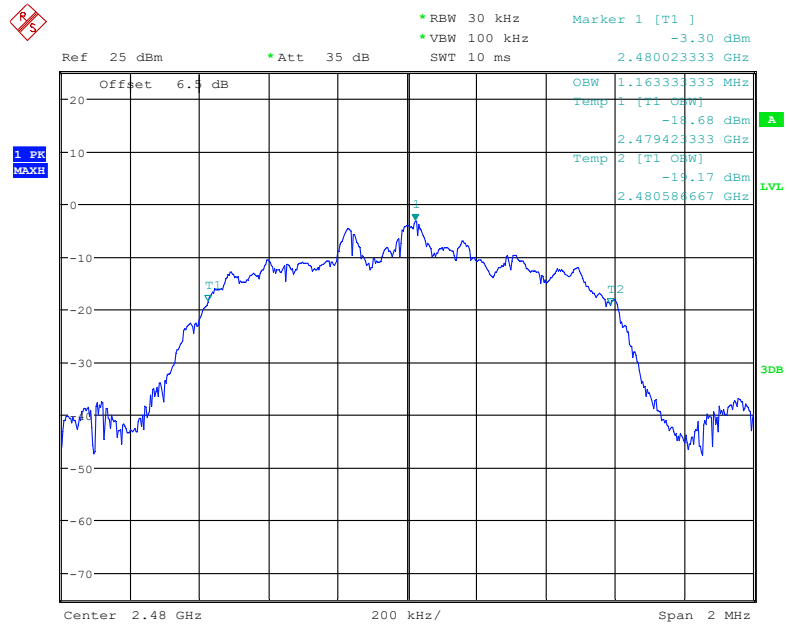
Date: 20.MAY.2022 14:25:02

3DH1_2441MHz



Date: 20.MAY.2022 14:25:27

3DH1_2480MHz



Date: 20.MAY.2022 14:25:44

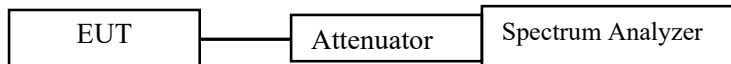
FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

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 Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
2. Set the EUT in hopping mode from first channel to last.
3. By using the max-hold function record the quantity of the channel.



Test Data

Environmental Conditions

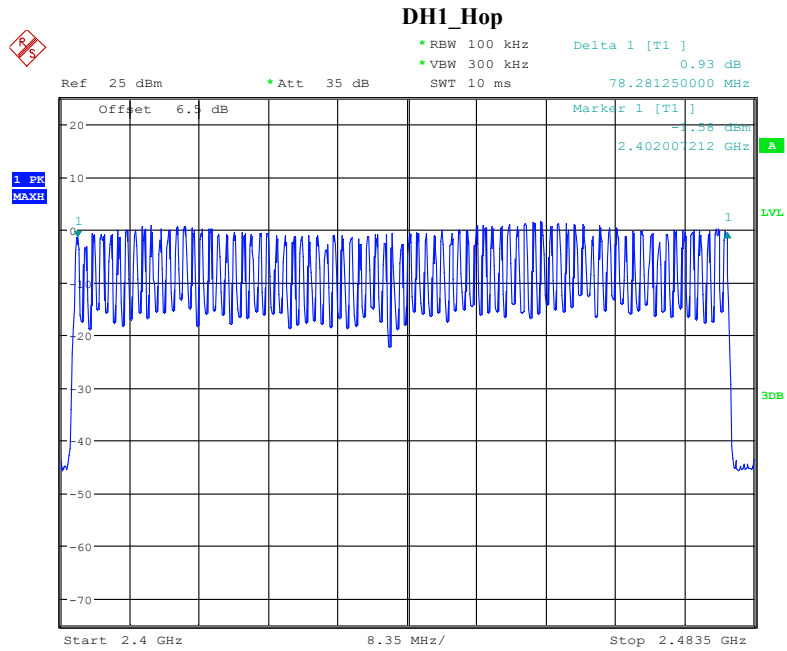
Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2022-05-19.

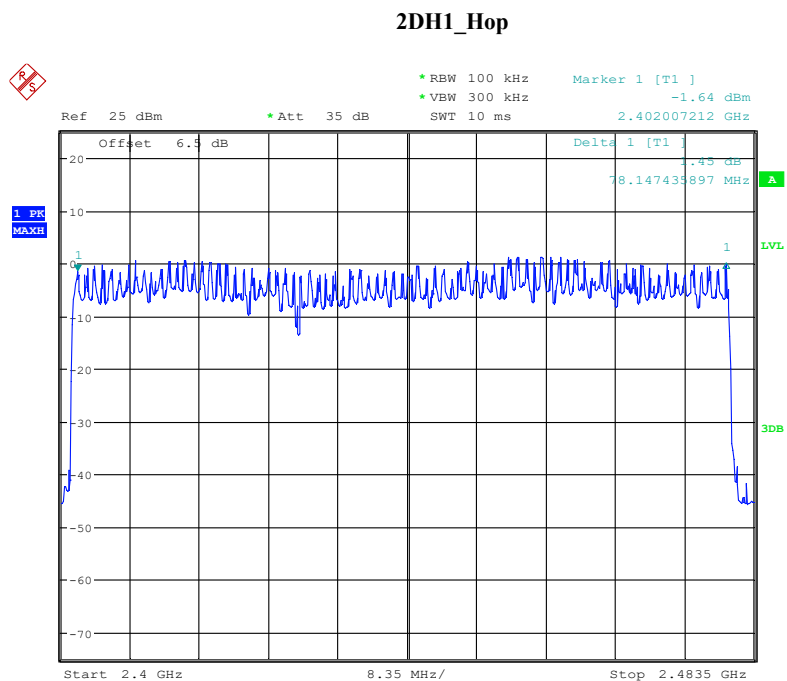
EUT operation mode: Transmitting

Test Result: Compliant.

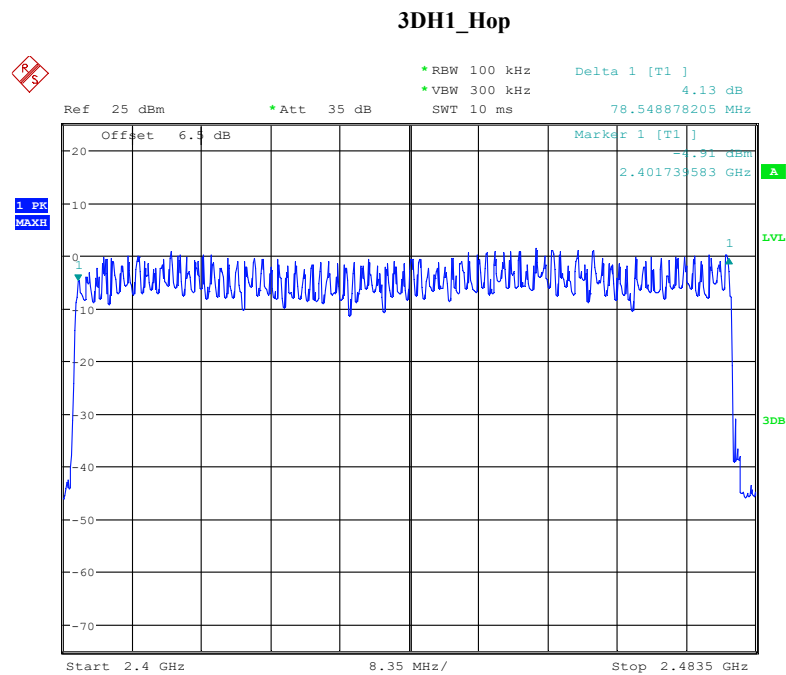
Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
BDR (GFSK)	2400-2483.5	79	≥15
EDR (π/4-DQPSK)	2400-2483.5	79	≥15
EDR (8DPSK)	2400-2483.5	79	≥15



Date: 19.MAY.2022 17:52:26



Date: 19.MAY.2022 17:50:49



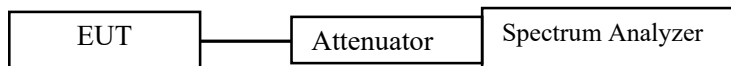
Date: 19.MAY.2022 17:48:57

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)**Applicable Standard**

Frequency hopping systems in the 2400-2483.5 MHz 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 Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW $\geq 3 \times$ RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

**Test Data****Environmental Conditions**

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Black Ding on 2022-05-19.

EUT operation mode: Transmitting

Test Result: Compliant.

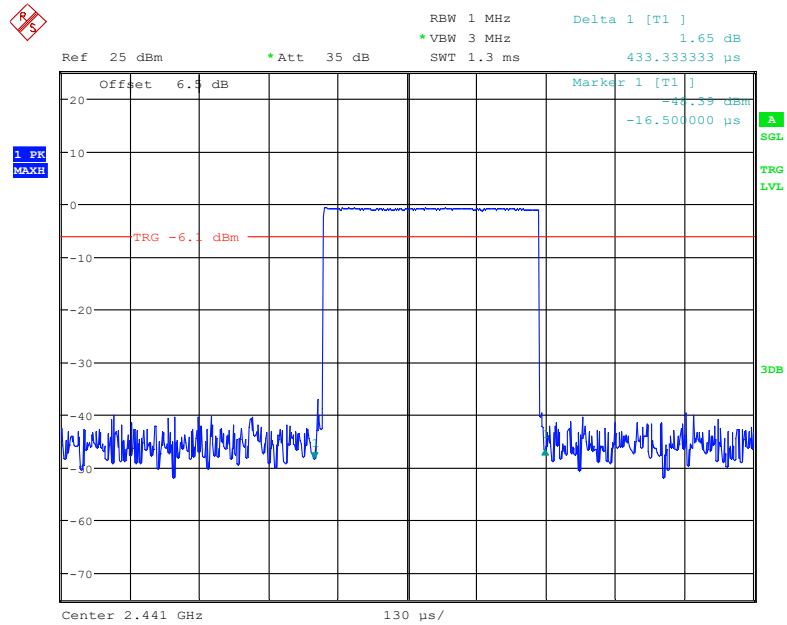
Test Mode	Channel	Pulse Time [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Hop	0.43	310	0.133	≤ 0.4	PASS
DH3	Hop	1.76	160	0.282	≤ 0.4	PASS
DH5	Hop	2.98	120	0.358	≤ 0.4	PASS
2DH1	Hop	0.44	320	0.141	≤ 0.4	PASS
2DH3	Hop	1.68	150	0.252	≤ 0.4	PASS
2DH5	Hop	2.96	110	0.326	≤ 0.4	PASS
3DH1	Hop	0.43	320	0.138	≤ 0.4	PASS
3DH3	Hop	1.69	150	0.254	≤ 0.4	PASS
3DH5	Hop	2.96	120	0.355	≤ 0.4	PASS

Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result= Pulse Time *Total hops

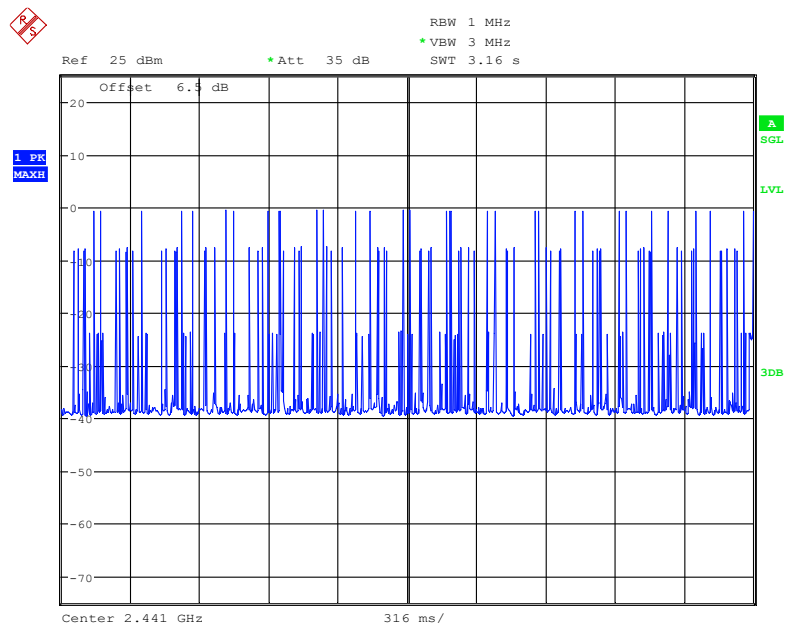
Note 2: Total hops=Hopping Number in $3.16\text{s} \times 10$

Note 3: Hopping Number in 3.16s =Total of highest signals in 3.16s (Second high signals were other channel)

DH1_Hop

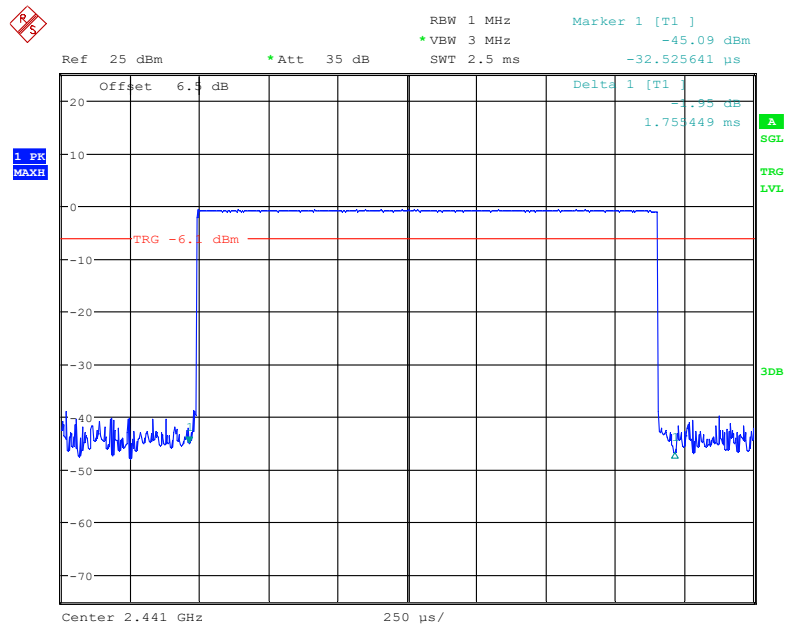


Date: 19.MAY.2022 18:15:38

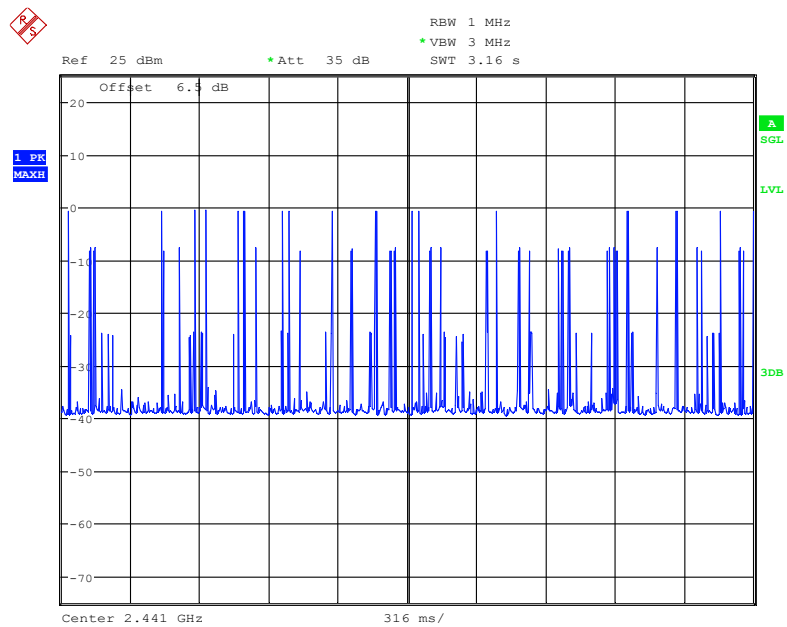


Date: 19.MAY.2022 18:31:31

DH3_Hop

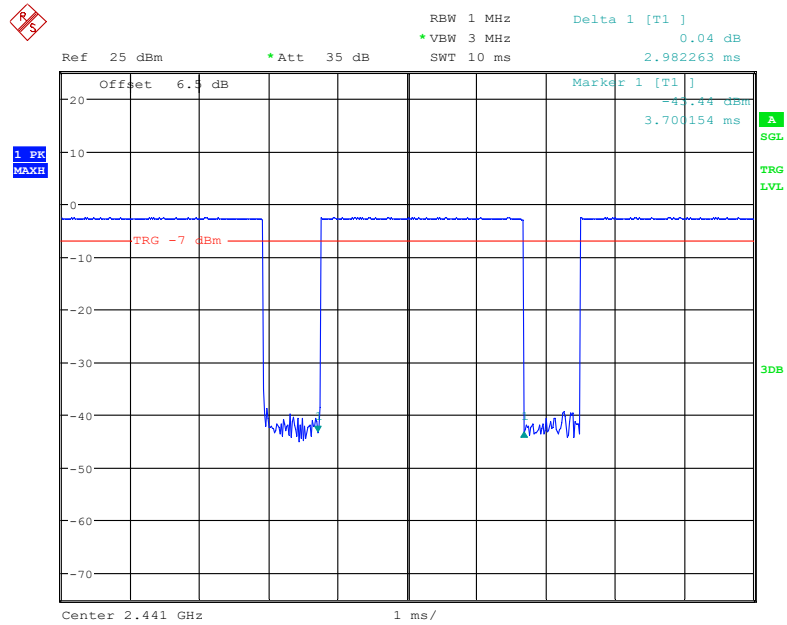


Date: 19.MAY.2022 18:16:31

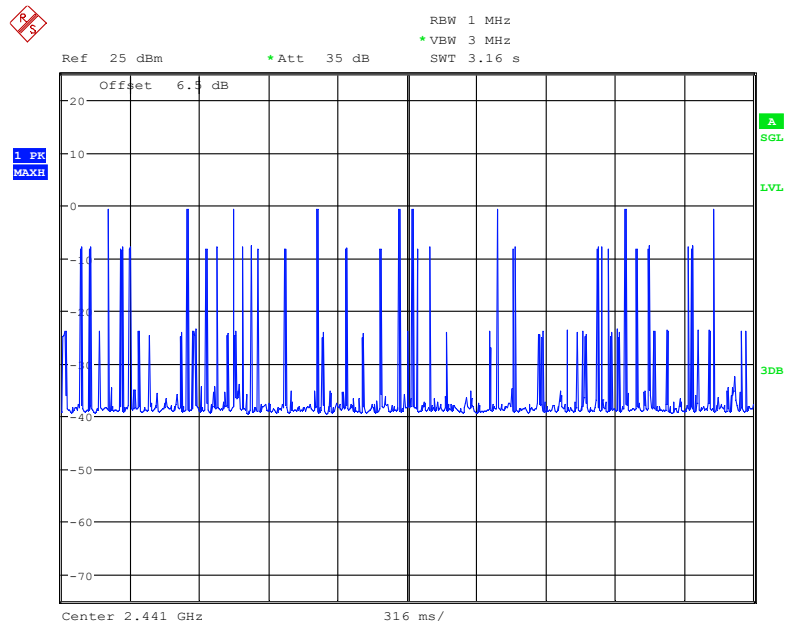


Date: 19.MAY.2022 18:32:12

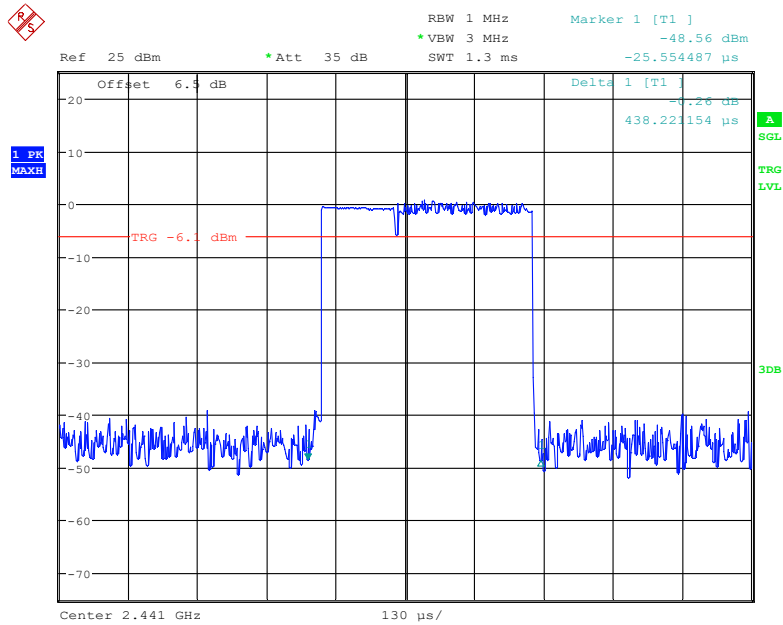
DH5_Hop



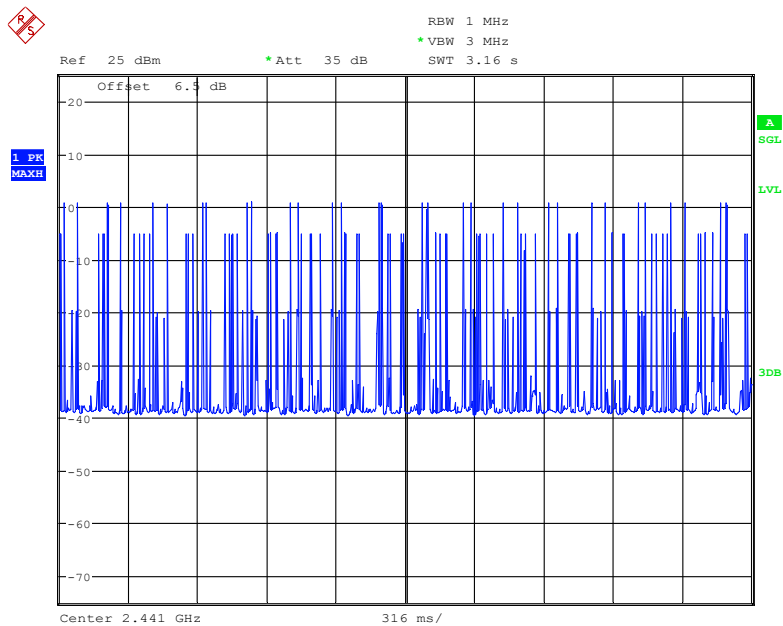
Date: 20.MAY.2022 14:16:23



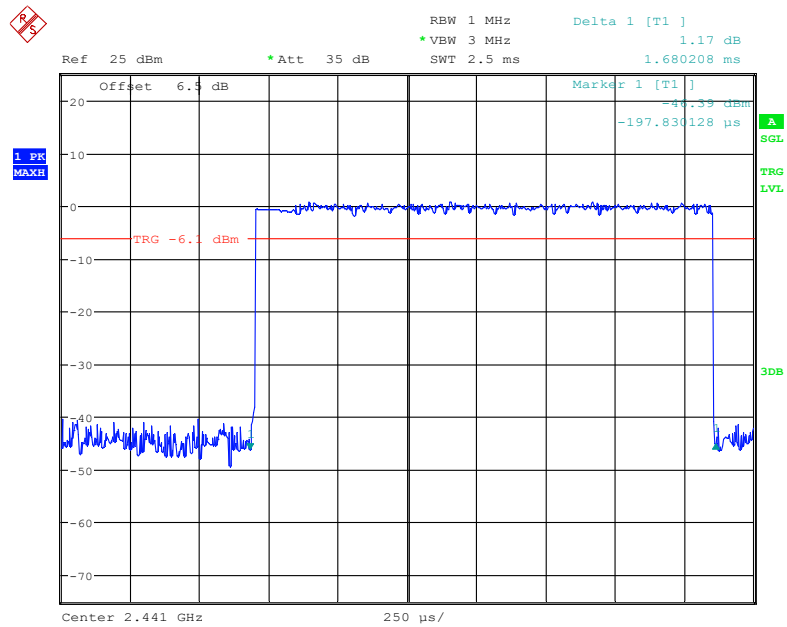
Date: 19.MAY.2022 18:33:43

2DH1_Hop

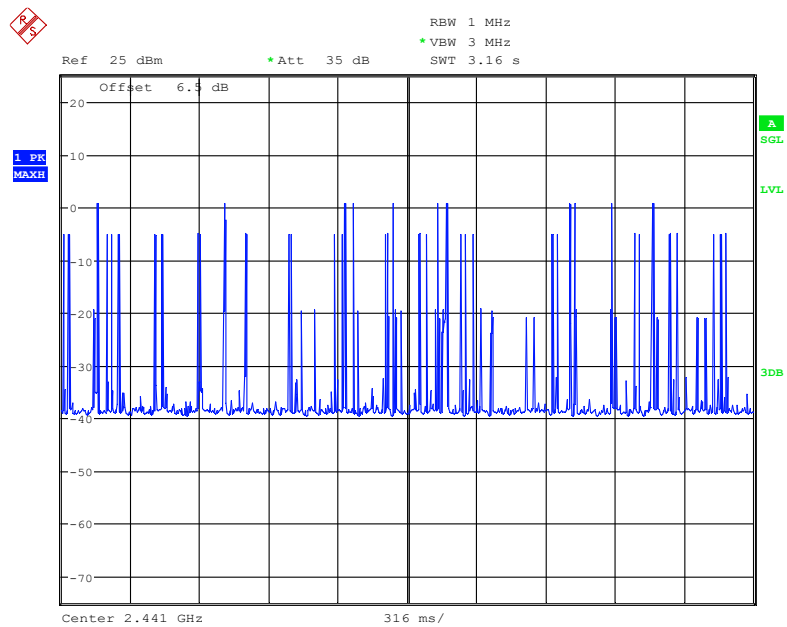
Date: 19.MAY.2022 18:19:12



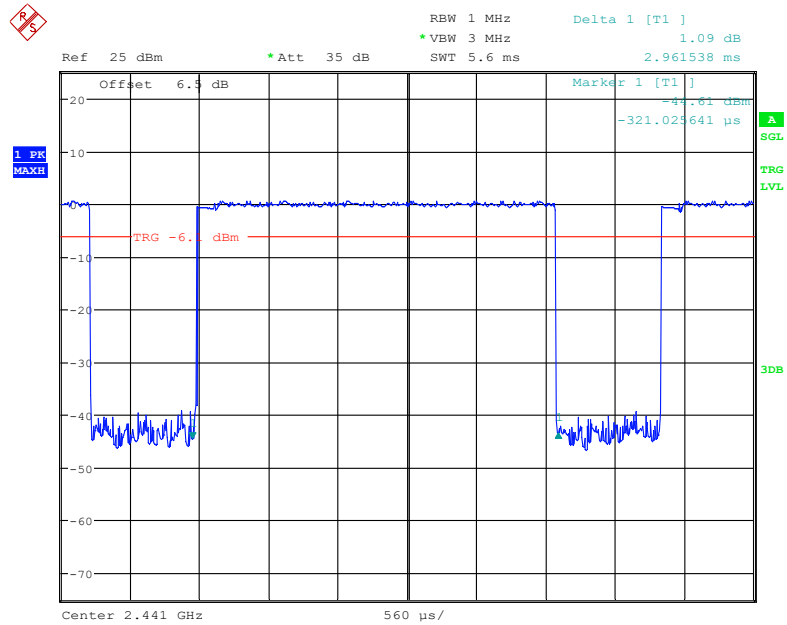
Date: 19.MAY.2022 18:34:14

2DH3_Hop

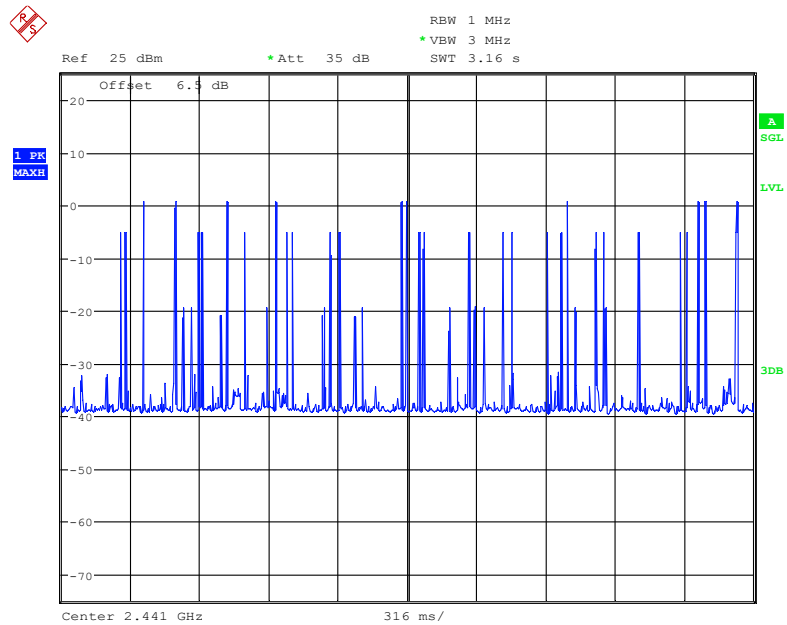
Date: 19.MAY.2022 18:20:54



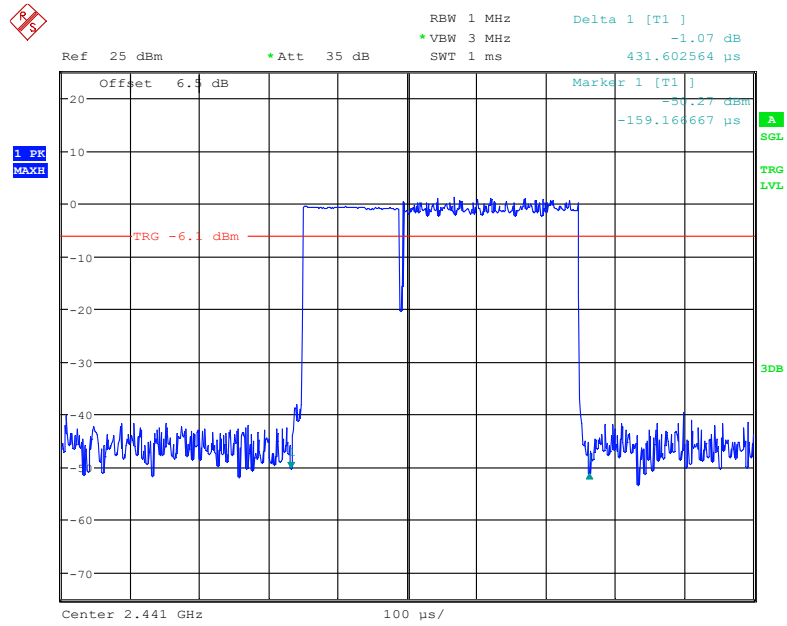
Date: 19.MAY.2022 18:34:54

2DH5_Hop

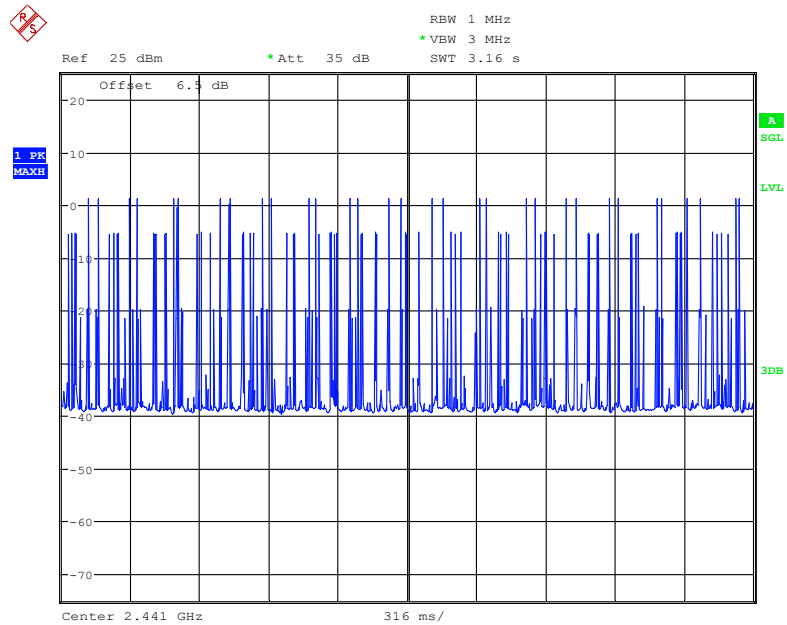
Date: 19.MAY.2022 18:22:33



Date: 19.MAY.2022 18:35:31

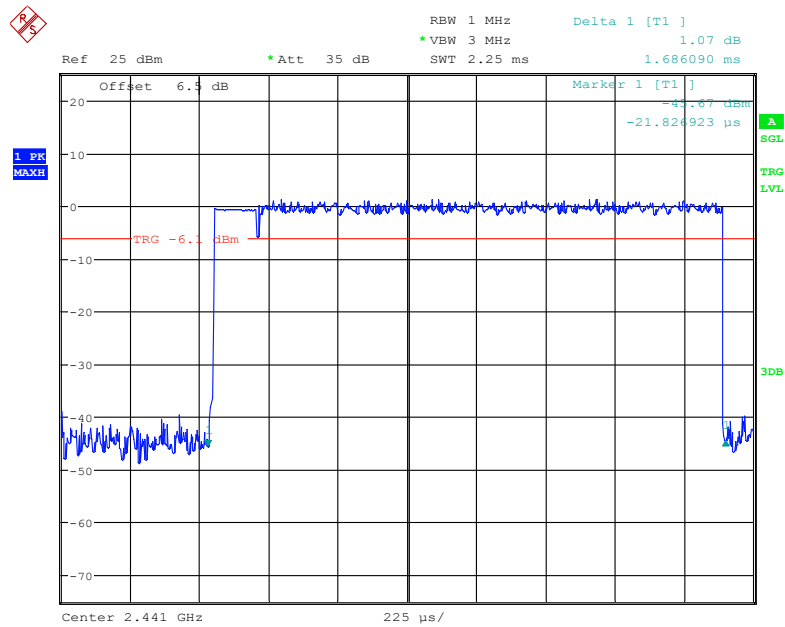
3DH1_Hop

Date: 19.MAY.2022 18:23:49

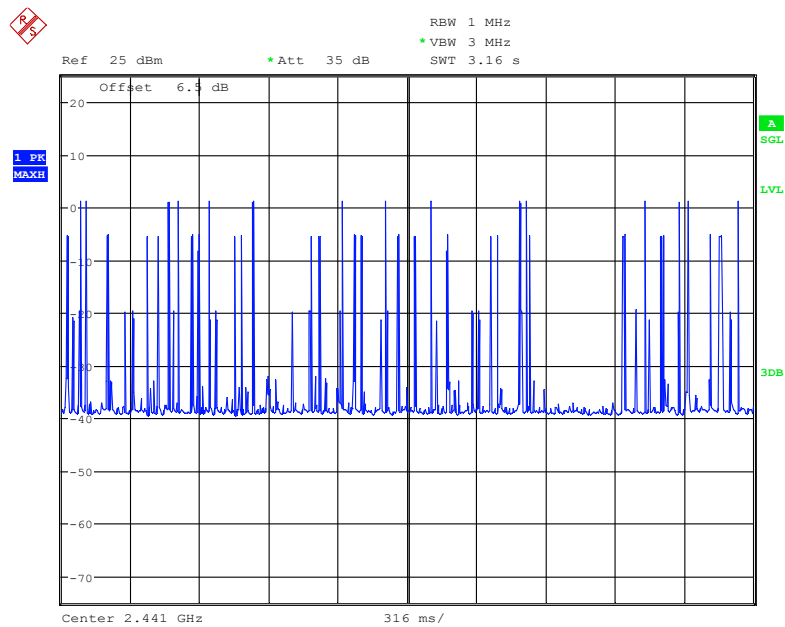


Date: 19.MAY.2022 18:35:56

3DH3_Hop

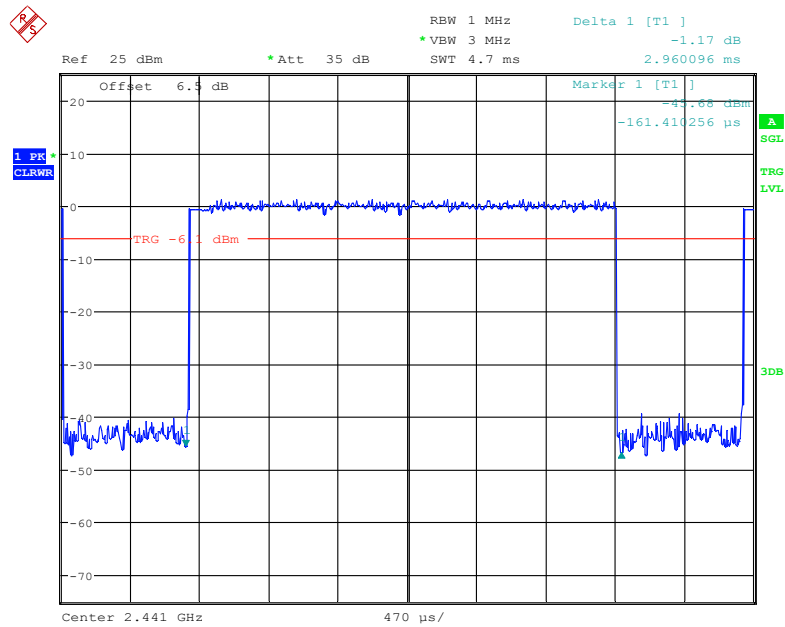


Date: 19.MAY.2022 18:26:30

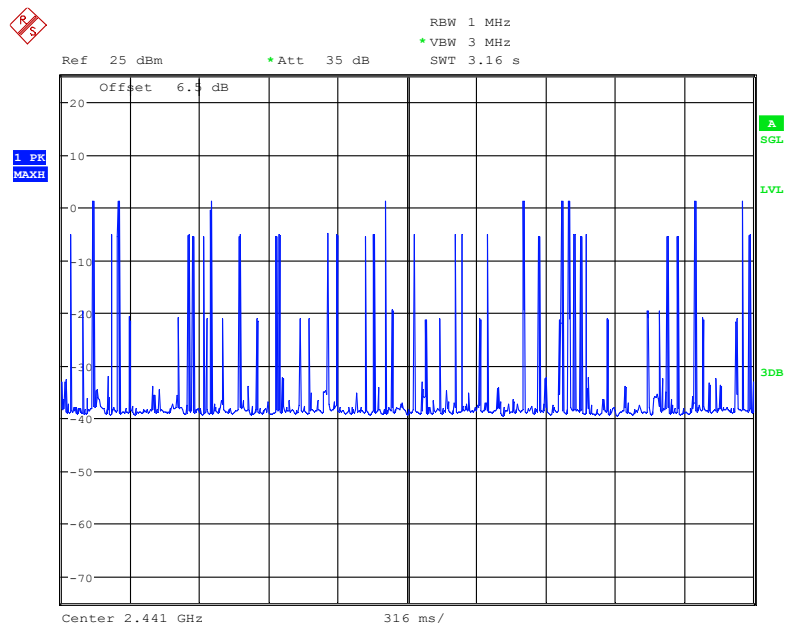


Date: 19.MAY.2022 18:36:40

3DH5_Hop



Date: 19.MAY.2022 18:30:22



Date: 19.MAY.2022 18:38:10

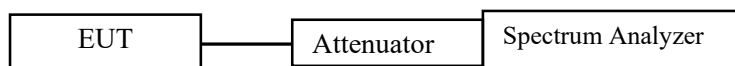
FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

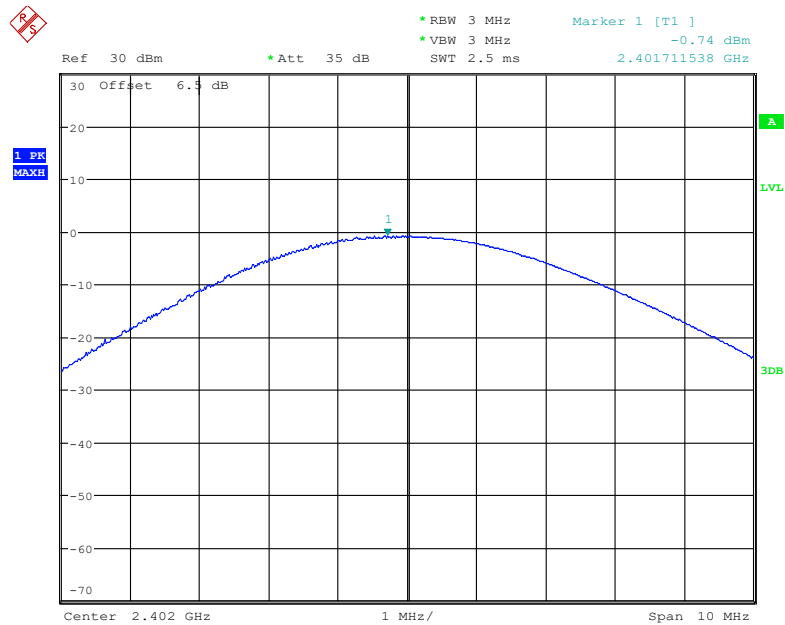
The testing was performed by Black Ding on 2022-05-19.

EUT operation mode: Transmitting

Test Result: Compliant.

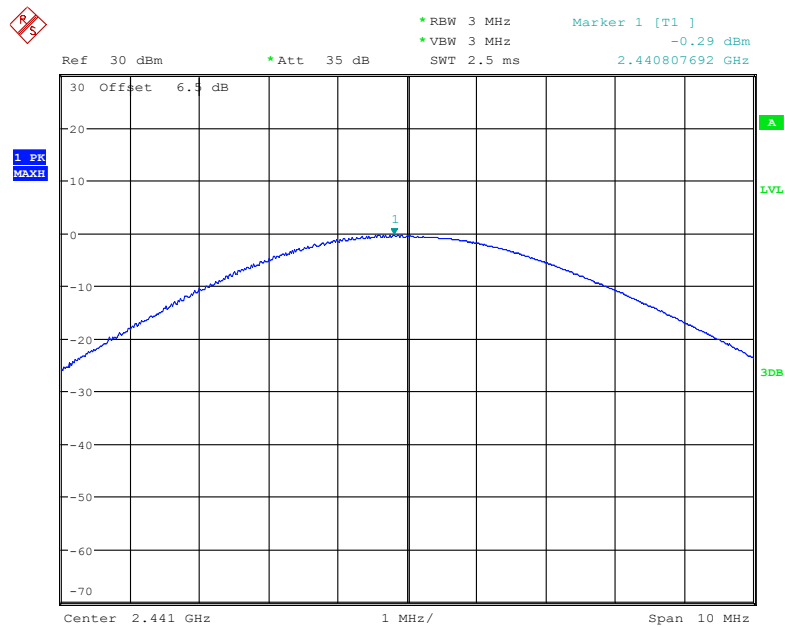
Mode	Channel	Frequency (MHz)	Peak Output Power	Limit (dBm)
			(dBm)	
BDR (GFSK)	Low	2402	-0.74	21
	Middle	2441	-0.29	21
	High	2480	0.66	21
EDR ($\pi/4$ -DQPSK)	Low	2402	1.11	21
	Middle	2441	1.45	21
	High	2480	2.42	21
EDR (8DPSK)	Low	2402	1.56	21
	Middle	2441	1.92	21
	High	2480	2.88	21

DH1_2402



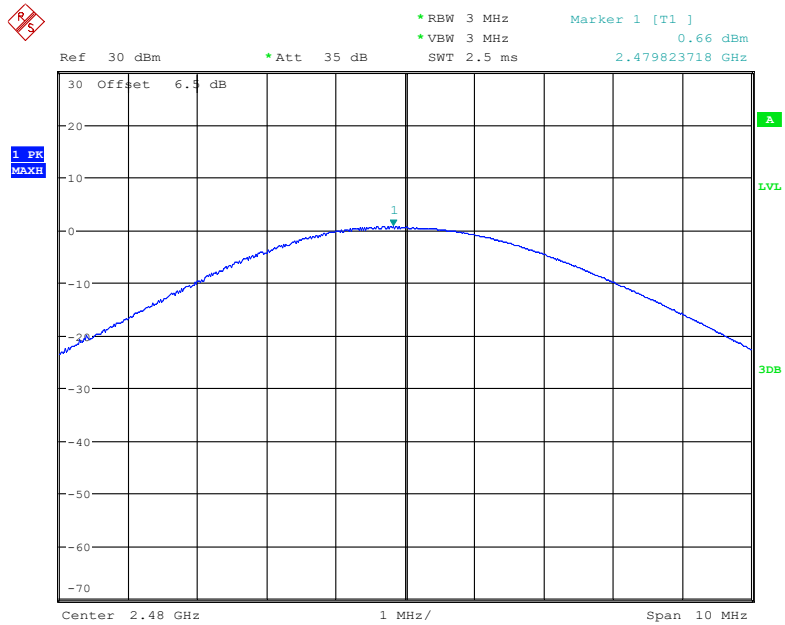
Date: 19.MAY.2022 17:27:06

DH1_2441



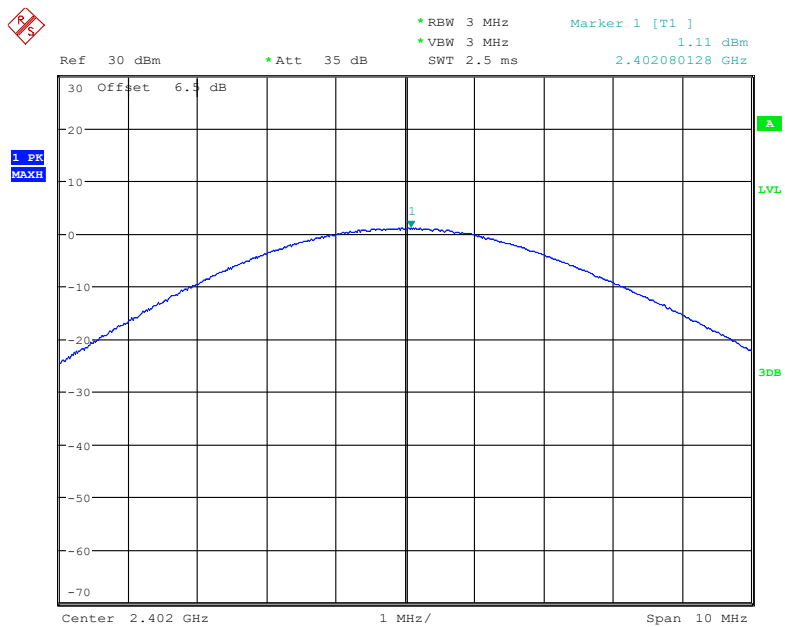
Date: 19.MAY.2022 17:26:39

DH1_2480



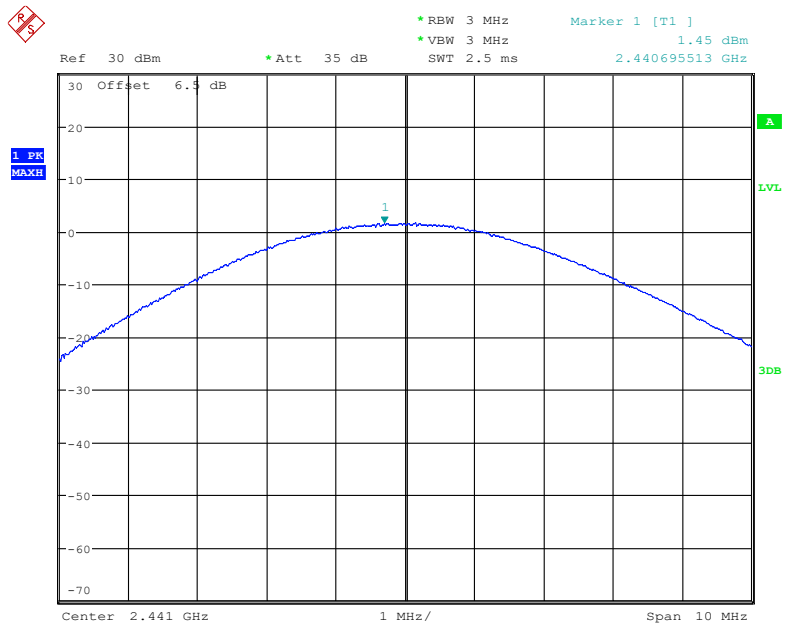
Date: 19.MAY.2022 17:25:54

2DH1_2402



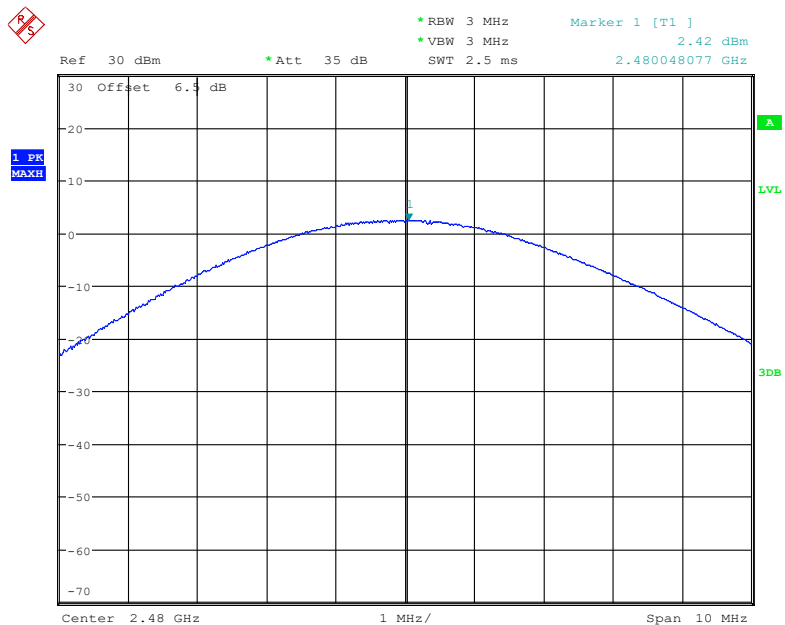
Date: 19.MAY.2022 17:27:28

2DH1_2441



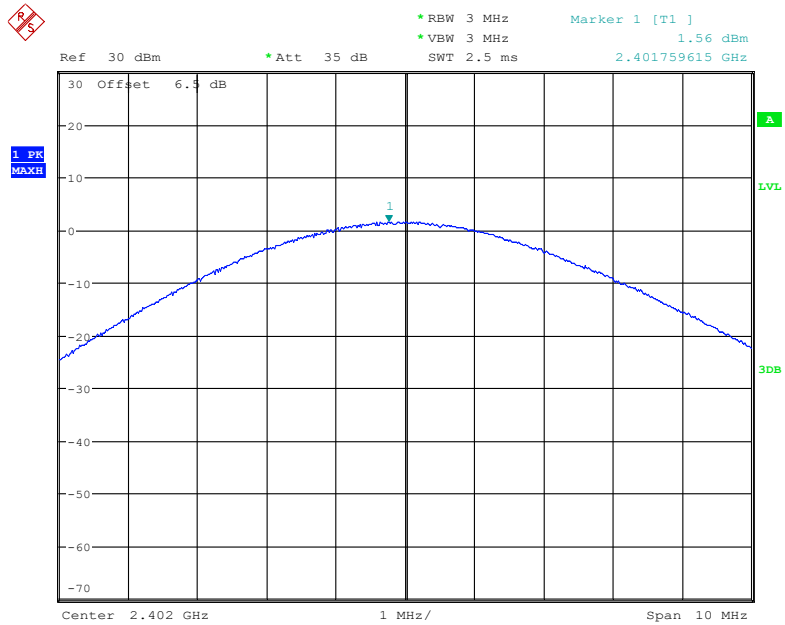
Date: 19.MAY.2022 17:27:50

2DH1_2480



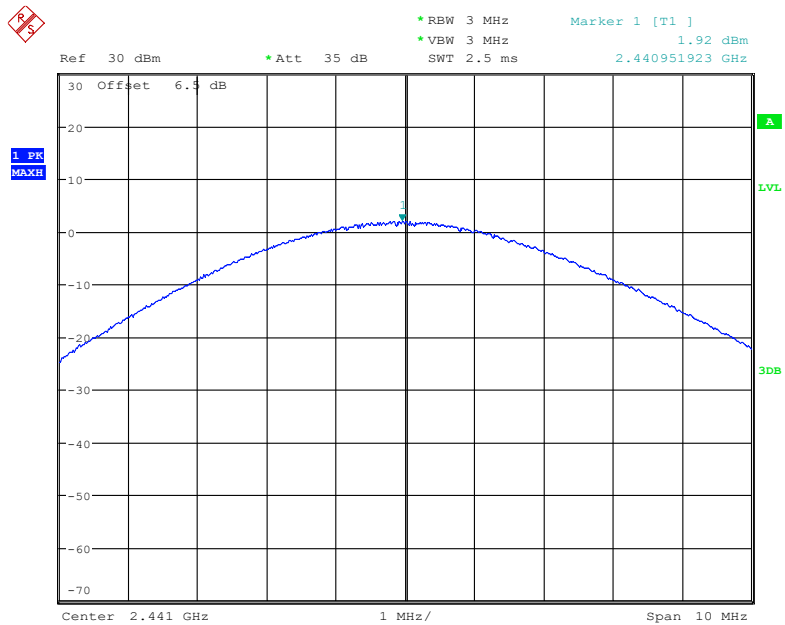
Date: 19.MAY.2022 17:28:11

3DH1_2402

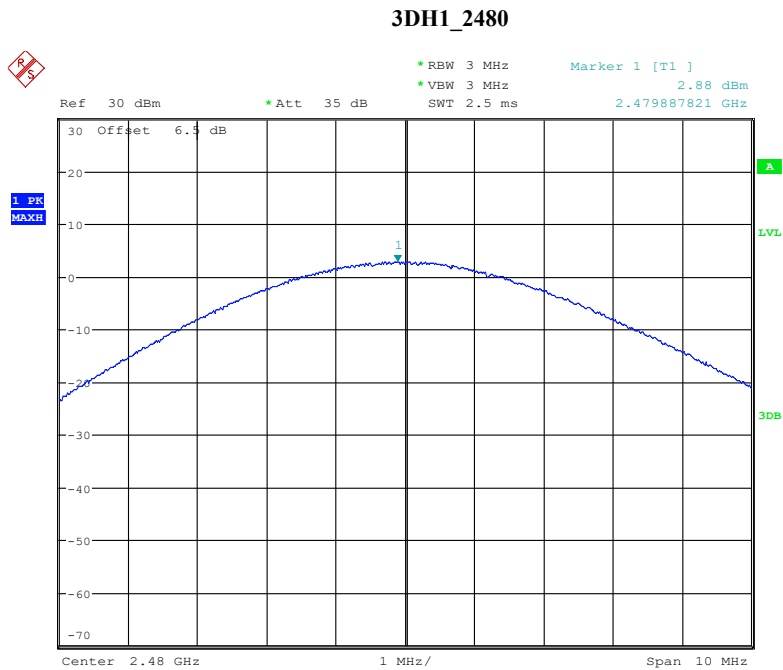


Date: 19.MAY.2022 17:29:15

3DH1_2441



Date: 19.MAY.2022 17:28:49



Date: 19.MAY.2022 17:28:32

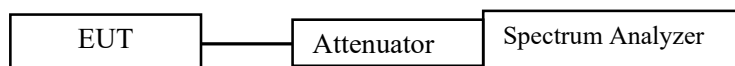
FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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 Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

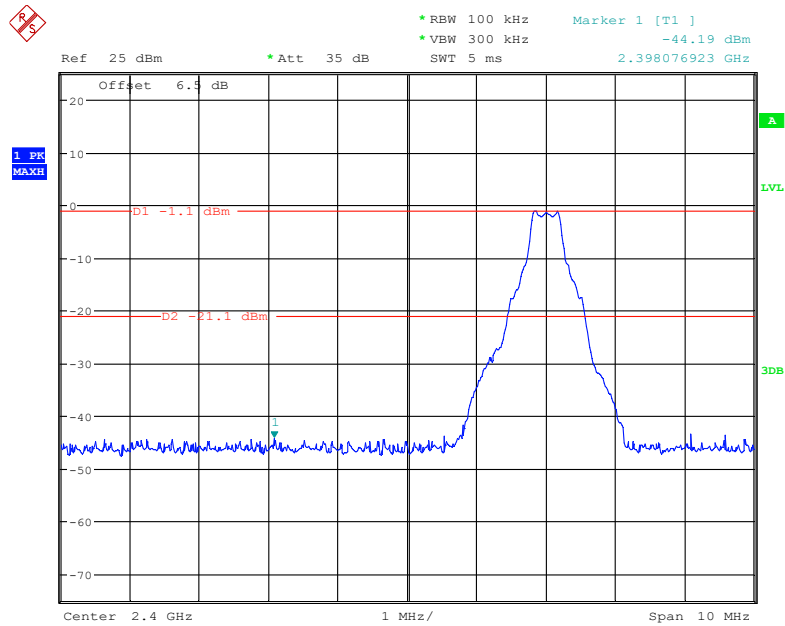
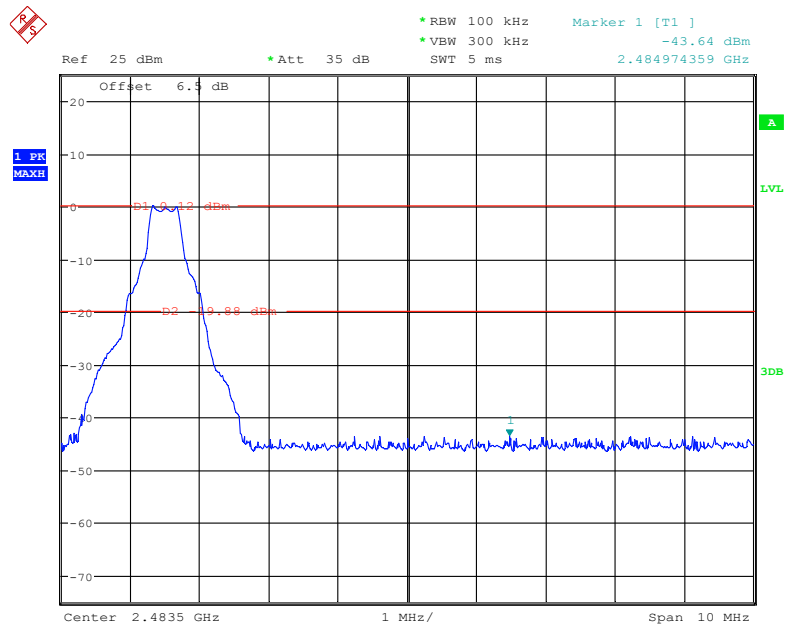
Environmental Conditions

Temperature:	25 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

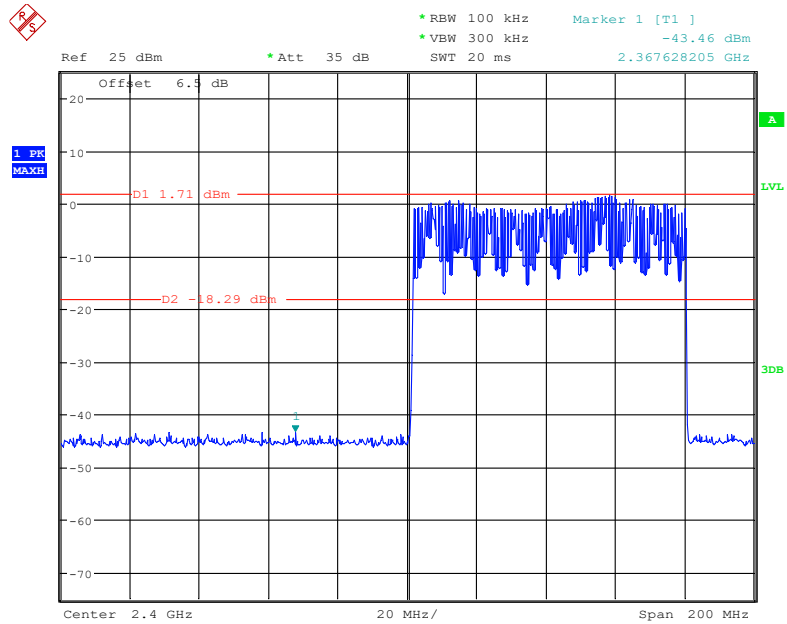
The testing was performed by Black Ding on 2022-05-19.

EUT operation mode: Transmitting

Test Result: Compliant.

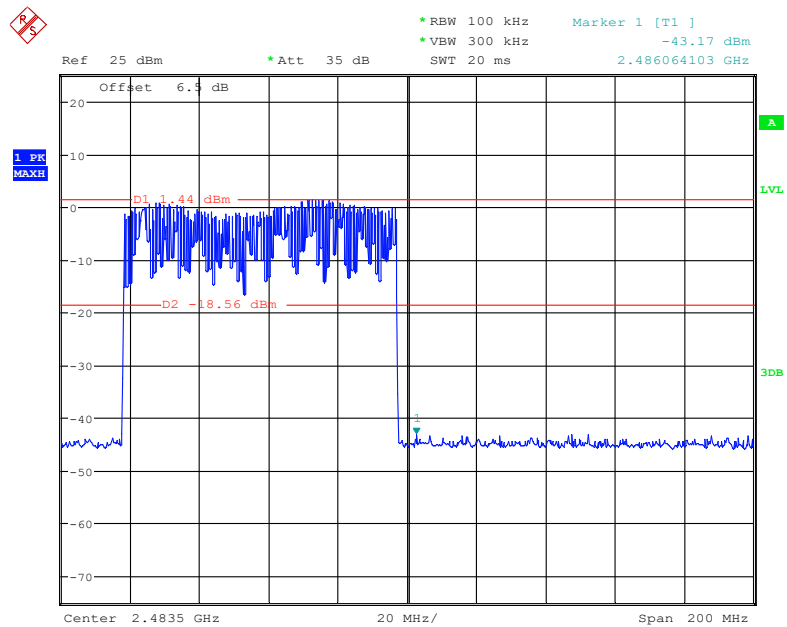
Conducted Band Edge Result:**DH1_Low_2402MHz****DH1_High_2480MHz**

DH1_Low_Hop_2402MHz



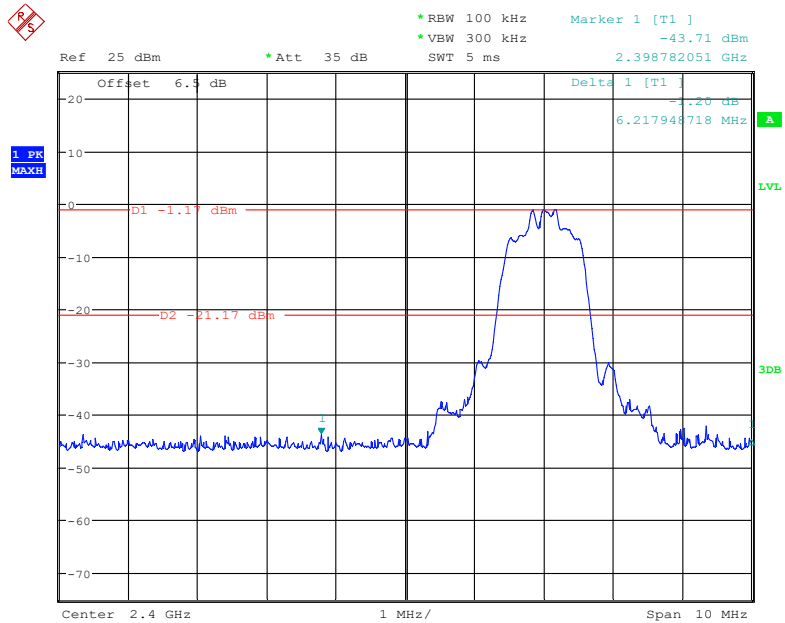
Date: 19.MAY.2022 17:54:09

DH1_High_Hop_2480MHz



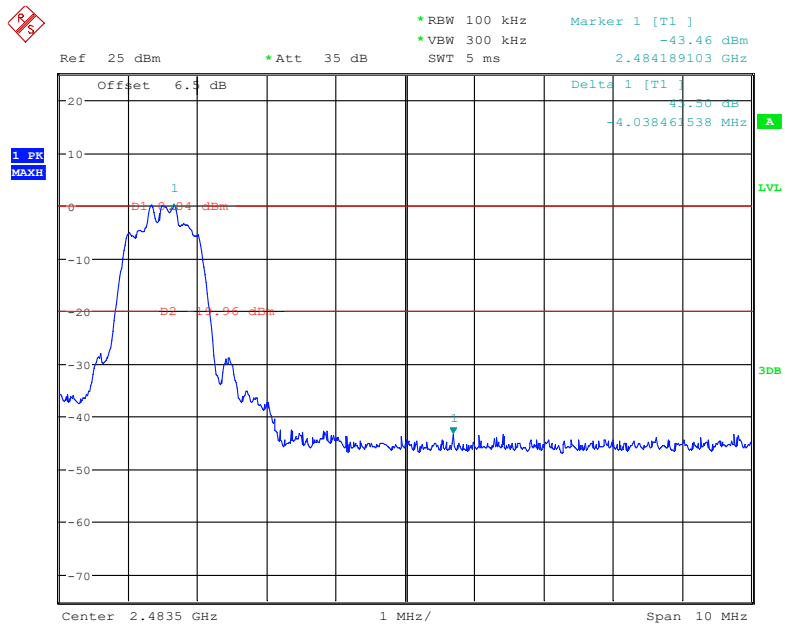
Date: 19.MAY.2022 17:55:36

2DH1_Low_2402MHz



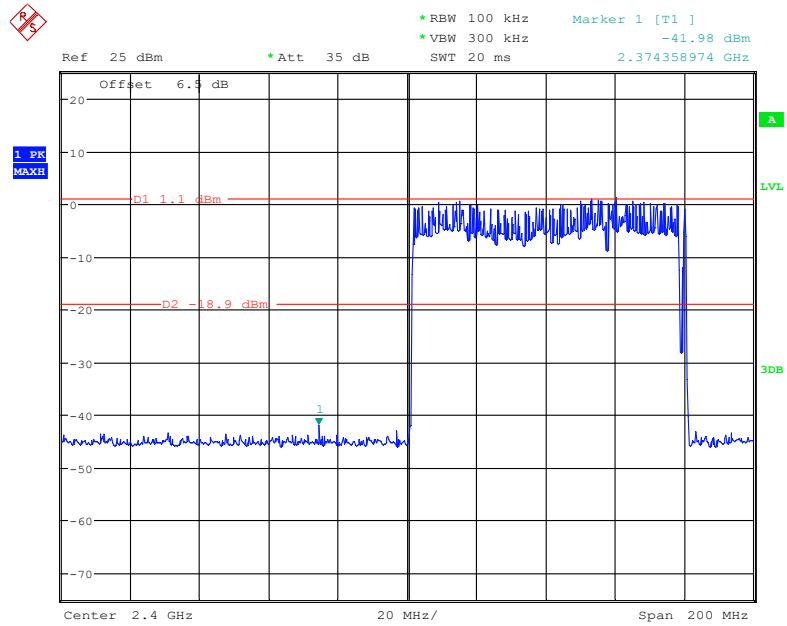
Date: 19.MAY.2022 18:07:19

2DH1_High_2480MHz



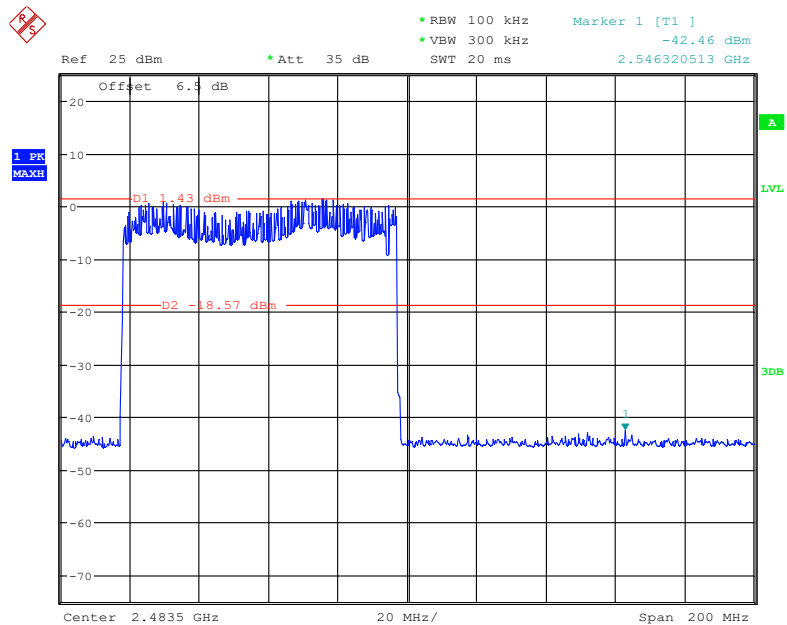
Date: 19.MAY.2022 18:06:12

2DH1_Low_Hop_2402MHz



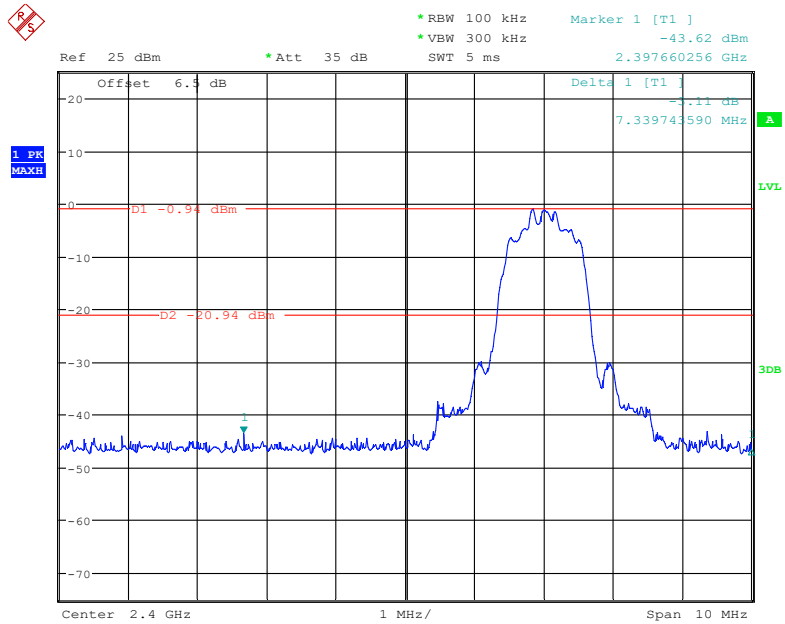
Date: 19.MAY.2022 17:58:44

2DH1_High_Hop_2480MHz



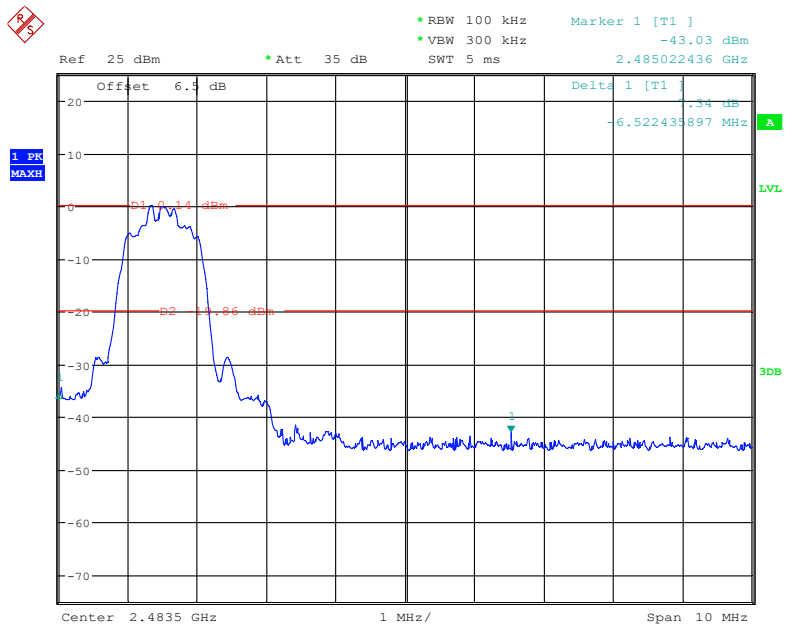
Date: 19.MAY.2022 17:57:17

3DH1_Low_2402MHz

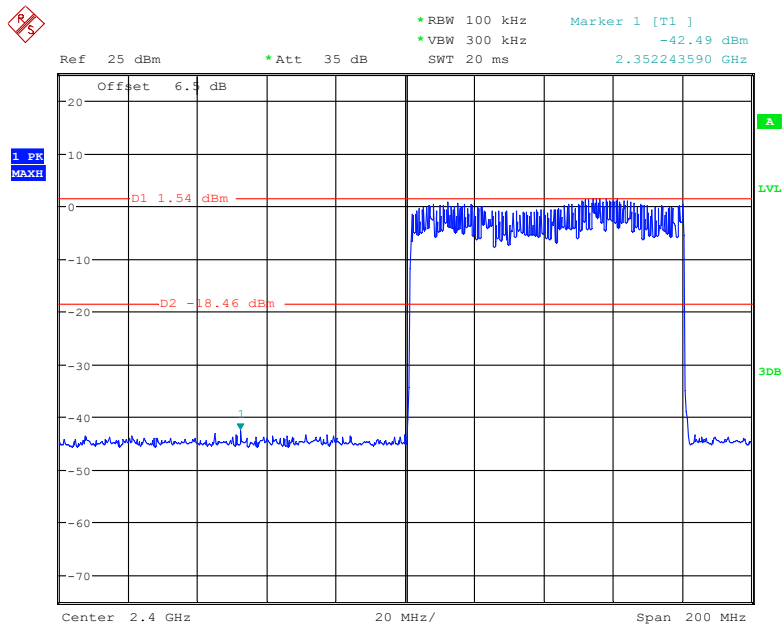


Date: 19.MAY.2022 18:08:53

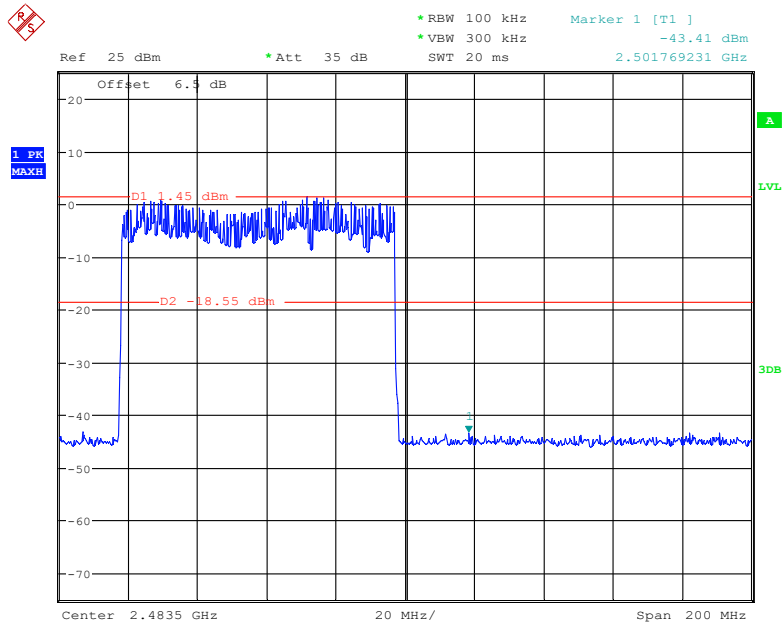
3DH1_High_2480MHz



Date: 19.MAY.2022 18:10:14

3DH1_Low_Hop_2402MHz

Date: 19.MAY.2022 18:01:26

3DH1_High_Hop_2480MHz

Date: 19.MAY.2022 18:02:41

******* END OF REPORT *******