TEST REPORT

Applicant Name :	South Surveying & Mapping Technology Co., Ltd.
Address :	No.39, Sicheng Road, Tianhe District, Guangzhou,China
Report Number :	RA230407-17721E-RF-00A
FCC ID:	2AJTU-INSIGHTV2

Test Standard (s)
FCC PART 15.247

Sample Description

Product Type:	GNSS RECEIVER
Model No.:	Insight V2, K58plus, G6pro, T5, C7, C8, C9, G3, G5, G9, RT300, J1, T12, ROVA 1S, ROVA 2S, ROVA 3S, ROVA 4S, ROVA 5S, Insight V1, Insight V3, Insight V4, Insight V5, S1, S2, S3, S4, S5, S6, S7,Rova1, Rova2, Rova3, Rova4, Rova5, INNO7, INNO8, INNO9, GalaxyG7, GalaxyG8, GalaxyG9, K6, K6S, K6X, K7, K7S, K7X, K8, K8S, K8X, K9, K9S, K9X, K30, K30Pro, K30X, K40, K40Pro, K40X, K50, K50Pro, K50X, RENO1, RENO2, RENO3, RENO4, RENO5, T12, T13, T14, T15, V2
Trade Mark:	SOUTH, KOLIDA, SANDING, RUIDE, TIANYU
Date Received:	2023-04-15
Date of Test:	2023-04-15 to 2023-06-05
Report Date:	2023-06-10

Test Result:	Pass*

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

Prepared and Checked By:

Bob. Liao

Bob.Liao
EMC Engineer

Approved By:

Candy. Li

Candy Li
EMC Engineer

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

Revision Number	Report Number	Description of Revision	Date of Revision
0	RA230407-17721E-RF-00A	Original Report	2023-06-10

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product Type	GNSS RECEIVER
Tested Model	Insight V2
Multiple Model	K58plus, G6pro, T5, C7, C8, C9, G3, G5, G9, RT300, J1, T12, ROVA 1S, ROVA 2S, ROVA 3S, ROVA 4S, ROVA 5S, Insight V1, Insight V3, Insight V4, Insight V5, S1, S2, S3, S4, S5, S6, S7,Rova1, Rova2, Rova3, Rova4, Rova5, INNO7, INNO8, INNO9, GalaxyG7, GalaxyG8, GalaxyG9, K6, K6S, K6X, K7, K7S, K7X, K8, K8S, K8X, K9, K9S, K9X, K30, K30Pro, K30X, K40, K40Pro, K40X, K50, K50Pro, K50X, RENO1, RENO2, RENO3, RENO4, RENO5, T12, T13, T14, T15, V2
Model Difference	Please refer to DOS letter
Frequency Range	Bluetooth:2402-2480MHz
Maximum conducted Peak output power	6.61dBm
Modulation Technique	BDR(GFSK)/EDR(π/4-DQPSK)/EDR(8DPSK)
Antenna Specification*	Internal Antenna:2.43dBi(provided by the applicant)
Voltage Range	DC 7.2V from battery DC 5V/9V/15V/20V from adapter(PD) DC 3.3-11V from adapter(PPS) DC 5V/9V/12V from adapter(QC)
Sample serial number	24CH-11(CE&RE), 24CH-12 (RF Conducted Test)
Sample/EUT Status	Good condition
Adapter Information	Model No.: S045SU2000225 Input: 100-240V~50/60Hz 1.4A MAX Output: PD3.0: 5V ⎓3A/9V ⎓3A/15V ⎓3A/20V ⎓2.25A PSS: 3.3-11V ⎓3A QC: 5V ⎓3A/9V ⎓3A/12V ⎓3A

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.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF Frequency		$0.082*10^{-7}$
RF output power, conducted		0.71dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.74dB
Emissions, Radiated	30MHz - 1GHz	5.08dB
	1GHz - 18GHz	4.96dB
	18GHz - 26.5GHz	5.16dB
Temperature		1℃
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 Floor 1, KuMaKe Building, Dongzhou Community, Guangming Street, Guangming District, Shenzhen, Guangdong, 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 4297.01.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0016. The Registration Number is 30241.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

EUT Exercise Software

Software "QRCT" was used during testing and the power level was default*.

Special Accessories

N/A.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

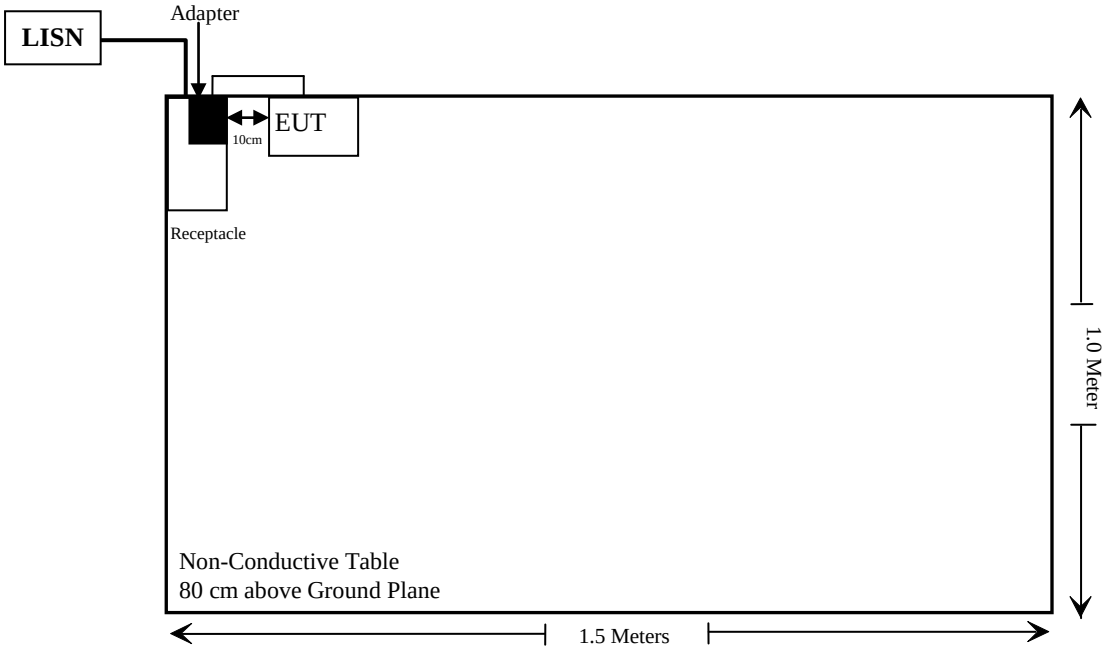
Manufacturer	Description	Model	Serial Number
listed	Adapter	S045SU2000225	UNKNOW

External I/O Cable

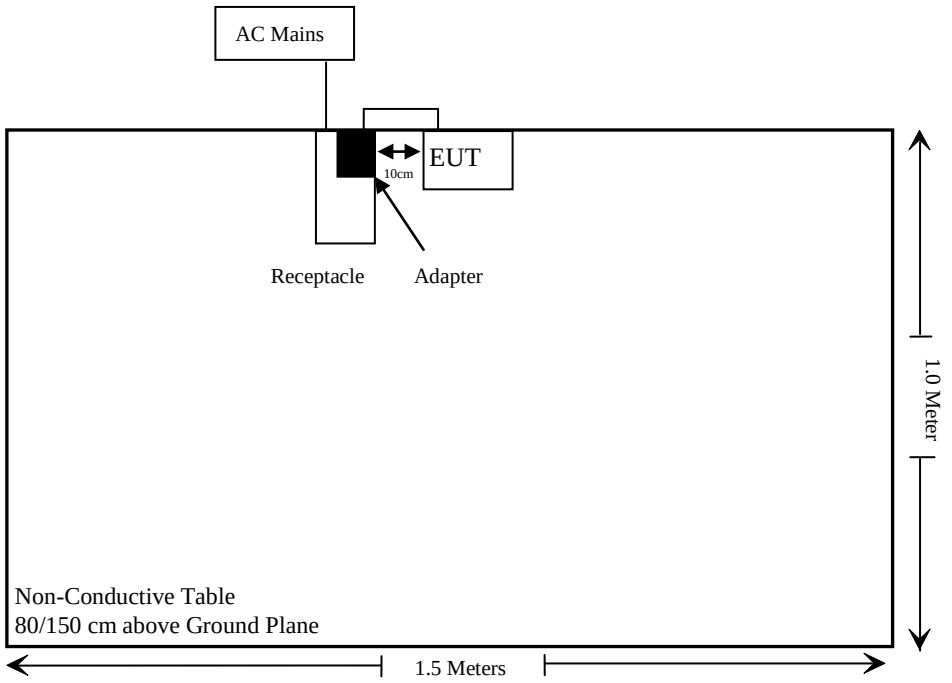
Cable Description	Length (m)	From Port	To
Un-shielding Un-Detachable DC Cable	1.0	Adapter	EUT

Block Diagram of Test Setup

For Conducted Emission:



For Radiated Emission:



Note: the support table edge was flush with the center of turntable.

SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§2.1091	MPE	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 Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	100784	2022/11/25	2023/11/24
Rohde & Schwarz	L.I.S.N.	ENV216	101314	2022/11/25	2023/11/24
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2022/12/07	2023/12/06
Unknown	RF Coaxial Cable	No.17	N0350	2022/11/25	2023/11/24
Conducted Emission Test Software: e3 191218 (V9)					
Radiated Emissions Test					
Rohde & Schwarz	Test Receiver	ESR	102725	2022/11/25	2023/11/24
Rohde & Schwarz	Spectrum Analyzer	FSV40	101949	2022/11/25	2023/11/24
SONOMA INSTRUMENT	Amplifier	310 N	186131	2022/11/08	2023/11/07
A.H. Systems, inc.	Preamplifier	PAM-0118P	135	2022/11/08	2023/11/07
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2022/11/08	2023/11/07
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2021/07/06	2024/07/05
Schwarzbeck	Horn Antenna	BBHA9120D	837	2023/02/22	2026/02/21
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2022/12/26	2025/12/25
Unknown	RF Coaxial Cable	No.10	N050	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.11	N1000	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.12	N040	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.13	N300	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.14	N800	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.15	N600	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.16	N650	2022/11/25	2023/11/24
Wainwright	High Pass Filter	WHKX3.6/18G-10SS	5	2022/11/25	2023/11/24
Radiated Emission Test Software: e3 191218 (V9)					
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2022/11/25	2023/11/24
Rohde & Schwarz	Open Switch and Control Unit	OSP120 + OSP-B157	101244 + 100866	2022/11/25	2023/11/24
WEINSCHEL	10dB Attenuator	5324	AU 3842	2022/11/25	2023/11/24
Unknown	RF Coaxial Cable	No.31	RF-01	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).

§2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for Maximum Permissible Exposure (MPE)

Limits for Occupational/Controlled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3 - 3.0	614	1.63	(100)*	6
3.0 - 30	1842/f	4.89/f	($900/f^2$)*	6
30 - 300	61.4	0.163	1.0	6
300 - 1500	/	/	f/300	6
1500 - 100000	/	/	5	6
Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3 - 1.34	614	1.63	(100)*	30
1.34 - 30	842/f	2.19/f	($180/f^2$)*	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	/	/	f/1500	30
1500 - 100000	/	/	1.0	30

f = frequency in MHz;
* = Plane-wave equivalent power density;

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm^2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator,the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For worst case

Frequency (MHz)	Antenna Gain		Tune up conducted power		Distance (cm)	Power density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
2402-2480	2.43	1.75	7	5.0119	40	0.0004	1
2412-2462	2.43	1.75	23	199.5262	40	0.0174	1
410-470	2.14	1.64	34.2	2630.2680	40	0.2142	0.2733

Note1: The BT function can't transmit at the same time with the Wi-Fi function.
Note2: The BT/Wi-Fi function can transmit at the same time with the DMR function.

Simultaneous transmitting consideration:

The ratio= $MPE_{2.4G\ Wi\text{-}Fi}$ /limit+MPE_{DMR} /limit=0.0174/1+0.2142/0.2733=0.80＜1.0

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 40cm from nearby persons.

Result: Compliant.

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 2.43dBi, fulfill the requirement of this section. Please refer to the EUT photos.

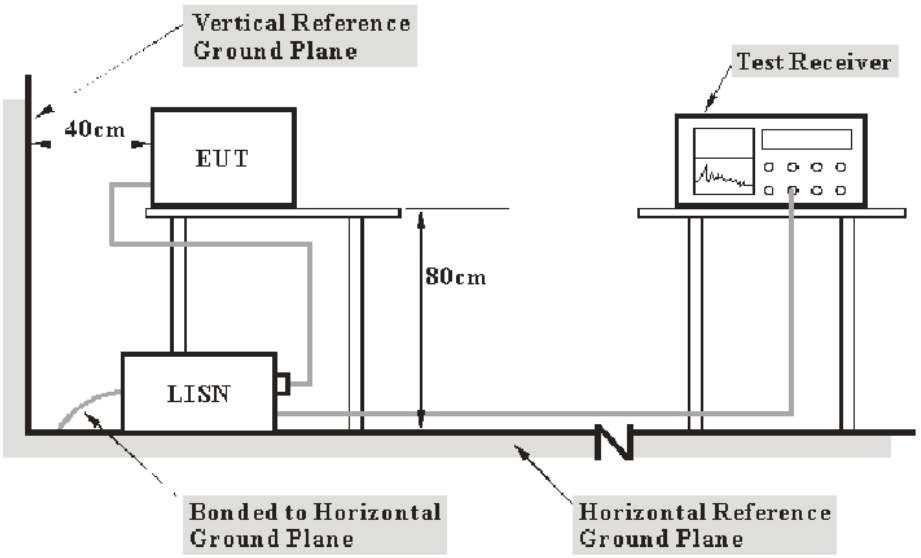
Result: Compliant.

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.

Calculation

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

Factor = LISN VDF + Cable Loss

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

Over Limit = Level – Limit
Level = Read Level + Factor

Test Data

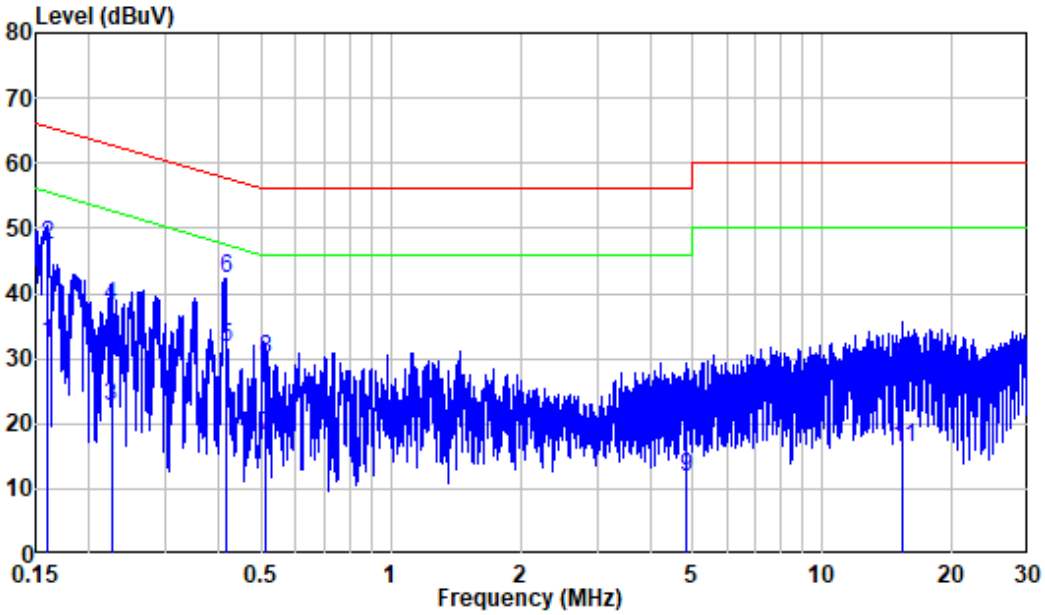
Environmental Conditions

Temperature:	23℃
Relative Humidity:	49%
ATM Pressure:	101.0kPa

The testing was performed by Jerry Wu on 2023-06-05.

EUT operation mode: Charging + BT Transmitting (8DPSK high channel test results are the worst)

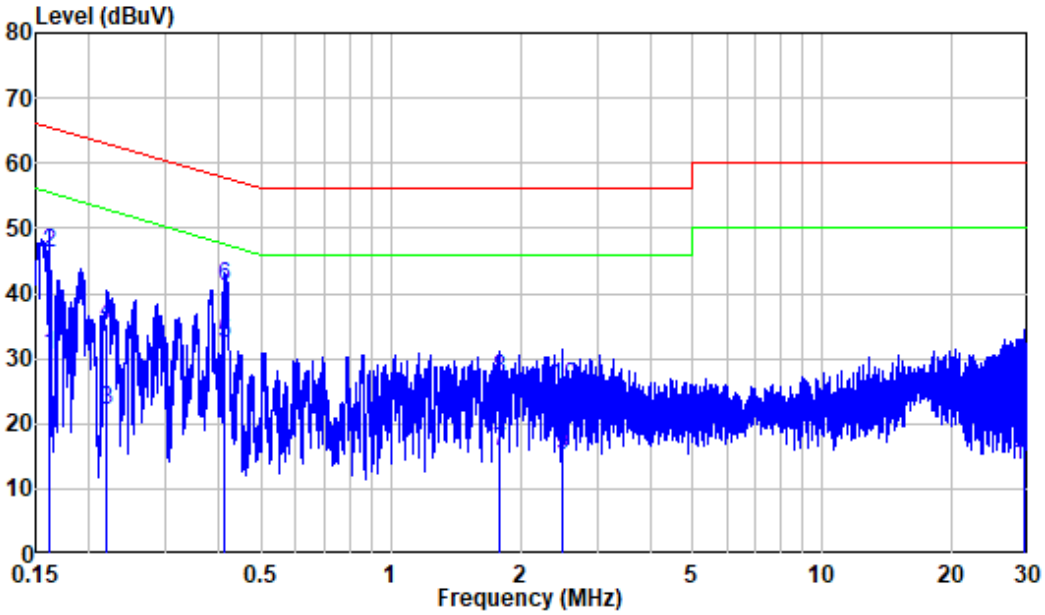
AC 120V/60 Hz, Line



Site : Shielding Room
Condition: Line
Job No. : RA230407-17721E-RF
Mode : Charging+BT Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.159	10.36	21.91	32.27	55.50	-23.23	Average
2	0.159	10.36	37.12	47.48	65.50	-18.02	QP
3	0.225	10.32	12.27	22.59	52.64	-30.05	Average
4	0.225	10.32	27.58	37.90	62.64	-24.74	QP
5	0.415	10.51	21.29	31.80	47.55	-15.75	Average
6	0.415	10.51	31.69	42.20	57.55	-15.35	QP
7	0.510	10.58	7.67	18.25	46.00	-27.75	Average
8	0.510	10.58	19.36	29.94	56.00	-26.06	QP
9	4.822	10.55	1.28	11.83	46.00	-34.17	Average
10	4.822	10.55	11.67	22.22	56.00	-33.78	QP
11	15.399	10.19	5.97	16.16	50.00	-33.84	Average
12	15.399	10.19	18.37	28.56	60.00	-31.44	QP

AC 120V/60 Hz, Neutral



Site : Shielding Room
Condition: Neutral
Job No. : RA230407-17721E-RF
Mode : Charging+BT Transmitting
Power : AC 120V 60Hz

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dBuV	dBuV	dBuV	dB	
1	0.161	10.28	20.29	30.57	55.41	-24.84	Average
2	0.161	10.28	35.94	46.22	65.41	-19.19	QP
3	0.220	10.30	11.75	22.05	52.84	-30.79	Average
4	0.220	10.30	24.95	35.25	62.84	-27.59	QP
5	0.412	10.43	21.88	32.31	47.60	-15.29	Average
6	0.412	10.43	30.70	41.13	57.60	-16.47	QP
7	1.786	10.47	5.28	15.75	46.00	-30.25	Average
8	1.786	10.47	16.27	26.74	56.00	-29.26	QP
9	2.502	10.51	4.51	15.02	46.00	-30.98	Average
10	2.502	10.51	15.22	25.73	56.00	-30.27	QP
11	29.293	10.23	3.32	13.55	50.00	-36.45	Average
12	29.293	10.23	17.02	27.25	60.00	-32.75	QP

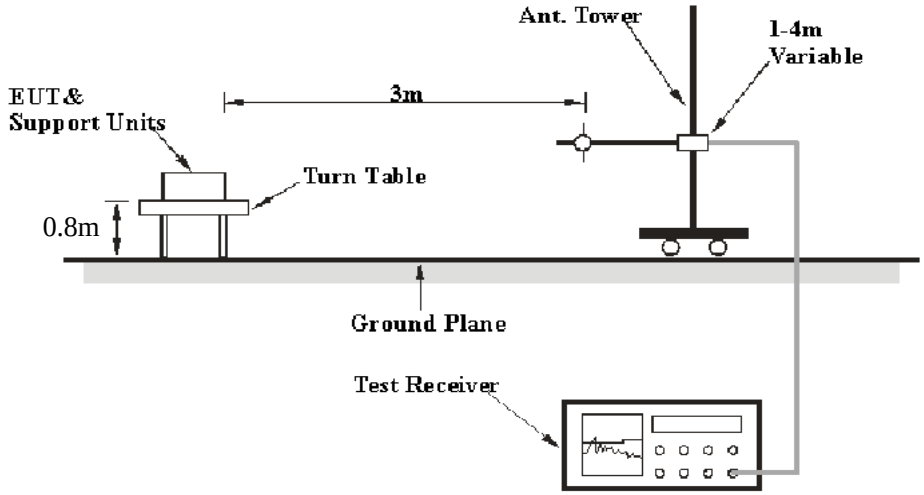
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

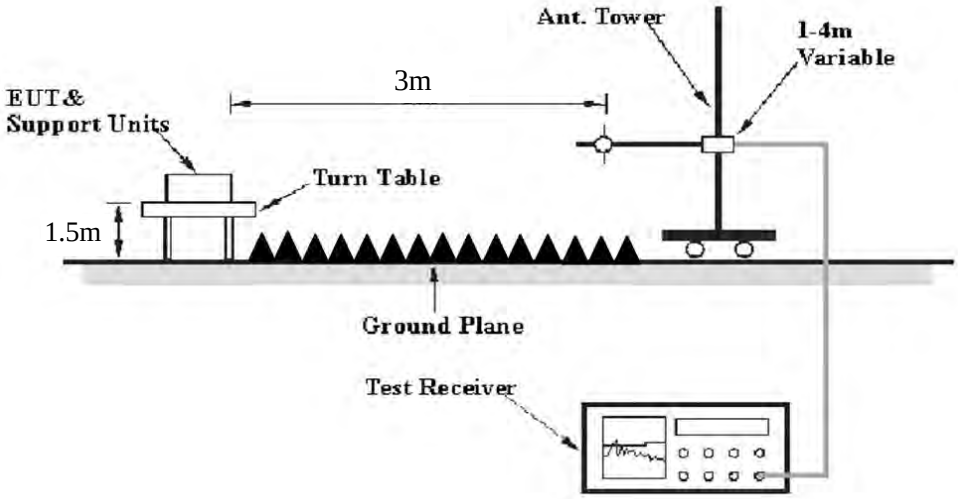
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



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

For average measurement:

Use the duty cycle factor correction factor method per 15.35(c).
Duty cycle=On time/100milliseconds, On time=N1*L1+N2*L2+…Nn-1*Ln-1+Nn*Ln,
Where N1 is number of type 1 pulses, L1 is length of type 1 pulse, etc.
Average Emission Level=Peak Emission Level+20*log(Duty cycle)

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.

If the maximized peak measured value complies with the limit, then it is unnecessary to perform an QP/Average measurement

Calculation

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

Factor = Antenna Factor + Cable Loss - Amplifier Gain

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

Over Limit/Margin = Level / Corrected Amplitude – Limit
Level / Corrected Amplitude = Read Level + Factor

Test Data

Environmental Conditions

Temperature:	23-24℃
Relative Humidity:	53-57%
ATM Pressure:	101.0kPa

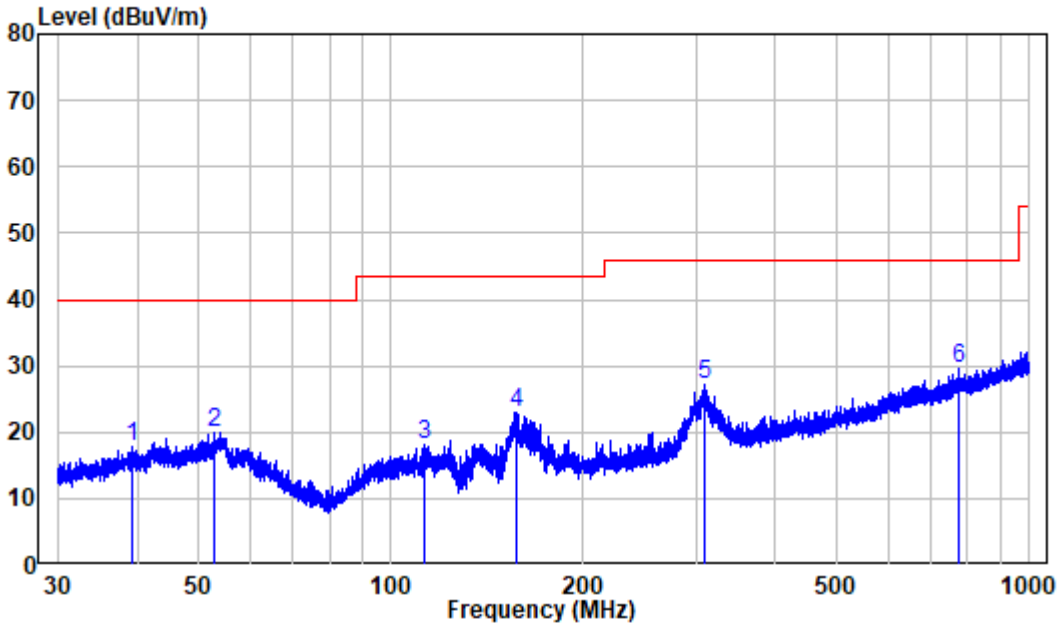
The Below 1GHz testing was performed by Jason Liu on 2023-06-05.
The Above 1GHz testing was performed by Jason Liu on 2023-04-15.

*EUT operation mode: Charging + BT Transmitting (*Pre-scanned in X, Y, and Z axis directions, and record the X-axis 8DPSK for worst-case)

Below 1GHz:

Worst case for 8DPSK, High Channel:

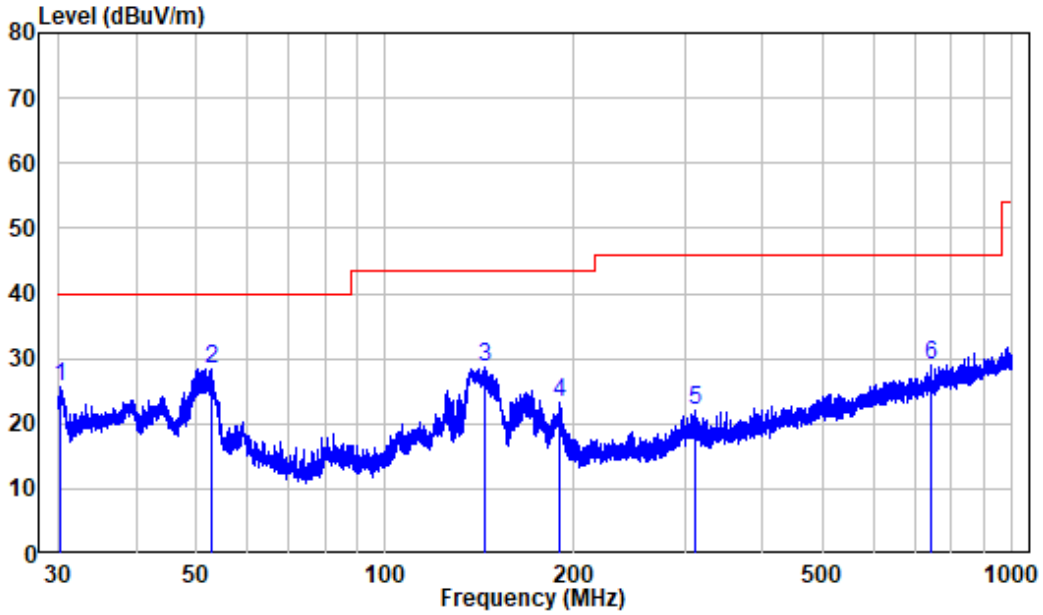
Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No. : RA230407-17721E-RF
Test Mode: Charging+BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	39.162	-10.55	28.28	17.73	40.00	-22.27	Peak
2	52.714	-10.11	30.10	19.99	40.00	-20.01	Peak
3	112.377	-12.31	30.55	18.24	43.50	-25.26	Peak
4	157.421	-14.61	37.58	22.97	43.50	-20.53	Peak
5	310.678	-8.87	36.08	27.21	46.00	-18.79	Peak
6	776.197	0.05	29.49	29.54	46.00	-16.46	Peak

Vertical



Site : chamber
Condition: 3m VERTICAL
Job No. : RA230407-17721E-RF
Test Mode: Charging+BT Transmitting

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	30.264	-12.37	38.04	25.67	40.00	-14.33	Peak
2	52.853	-10.14	38.63	28.49	40.00	-11.51	Peak
3	144.335	-15.51	44.23	28.72	43.50	-14.78	Peak
4	190.155	-11.56	34.77	23.21	43.50	-20.29	Peak
5	311.087	-8.86	30.98	22.12	46.00	-23.88	Peak
6	739.985	-0.79	29.70	28.91	46.00	-17.09	Peak

Above 1GHz (worst case for 8DPSK):

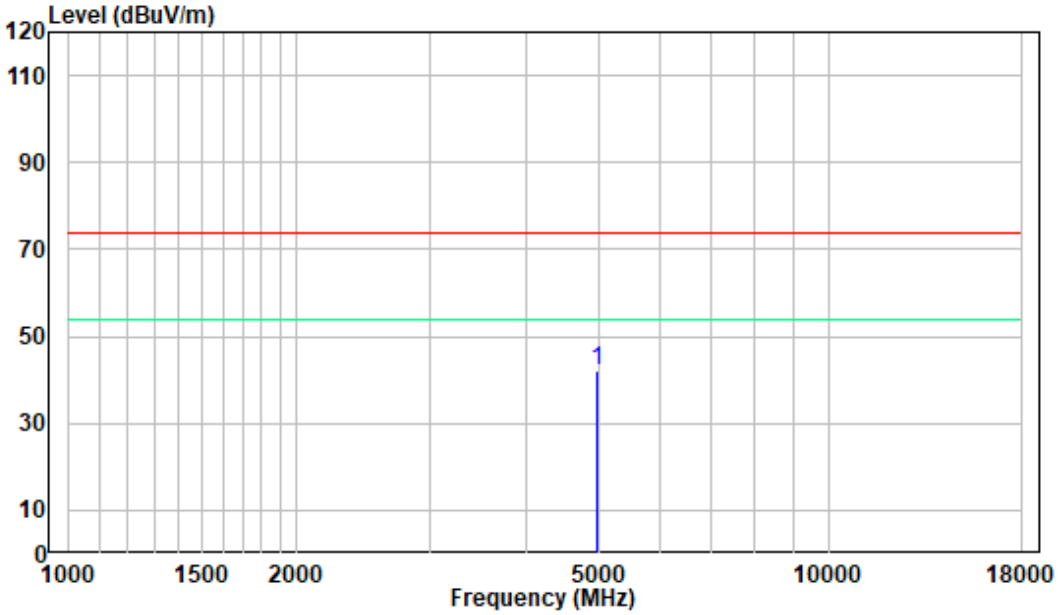
Frequency (MHz)	Receiver		Turntable Angle Degree	Rx Antenna		Factor (dB/m)	Absolute Level (dBuV/m)	Limit (dBuV/m)	Margin (dB) Reading (dBuV)
	Reading (dBuV)	PK/Ave		Height (m)	Polar (H/V)				
BT DH5, Low Channel									
2310	46.48	PK	136	1.6	H	-10.32	36.16	2310	46.48
2310	48.94	PK	339	1.2	V	-10.32	38.62	2310	48.94
2390	50.1	PK	201	1.6	H	-10.62	39.48	2390	50.1
2390	50.16	PK	194	1.4	V	-10.62	39.54	2390	50.16
4804	46.98	PK	201	1.6	H	-5.58	41.4	4804	46.98
4804	47.36	PK	20	1.7	V	-5.58	41.78	4804	47.36
BT DH5, Middle Channel									
4882	48.34	PK	95	1.9	H	-5.23	43.11	4882	48.34
4882	46.98	PK	121	1.9	V	-5.23	41.75	4882	46.98
BT DH5, High Channel									
2483.5	54.44	PK	220	1.6	H	-10.46	43.98	2483.5	54.44
2483.5	53.92	PK	85	1.6	V	-10.46	43.46	2483.5	53.92
2500	48.83	PK	36	1.9	H	-10.32	38.51	2500	48.83
2500	49.05	PK	345	1.5	V	-10.32	38.73	2500	49.05
4960	47.23	PK	36	1.9	H	-4.90	42.33	4960	47.23
4960	48.4	PK	274	1.5	V	-4.90	43.5	4960	48.4

Note:
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Factor + Reading
Margin = Corrected Amplitude – Limit
Average level= Peak level+ Duty Cycle Corrected Factor
The other spurious emission which is in the noise floor level was not recorded.
For above 1GHz, when the test result of peak was 20dB below to the limit of peak, which can be compliant to the average limit, just peak value was recorded.

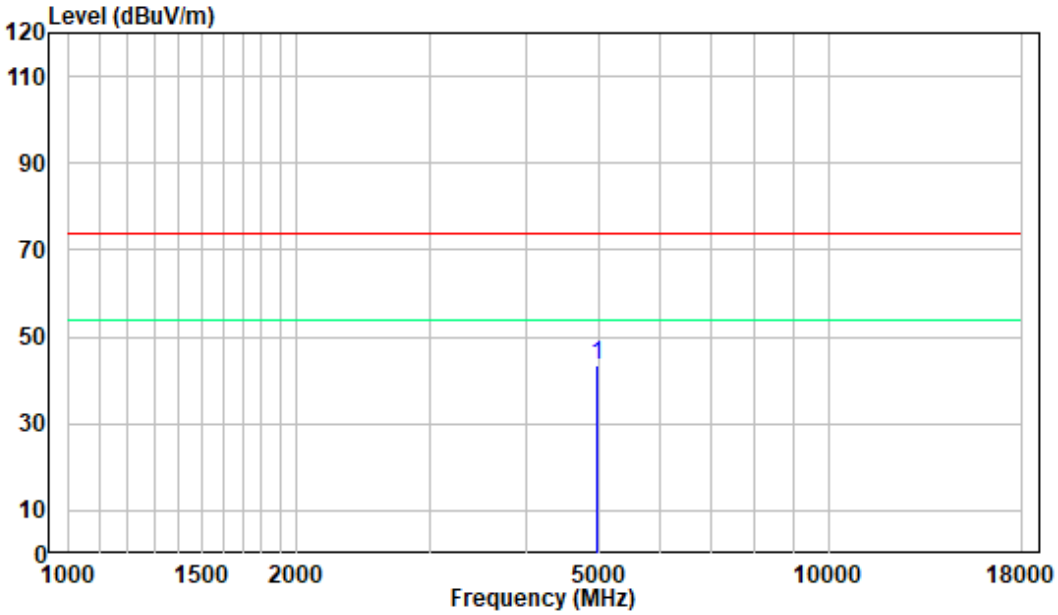
1 GHz - 18 GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



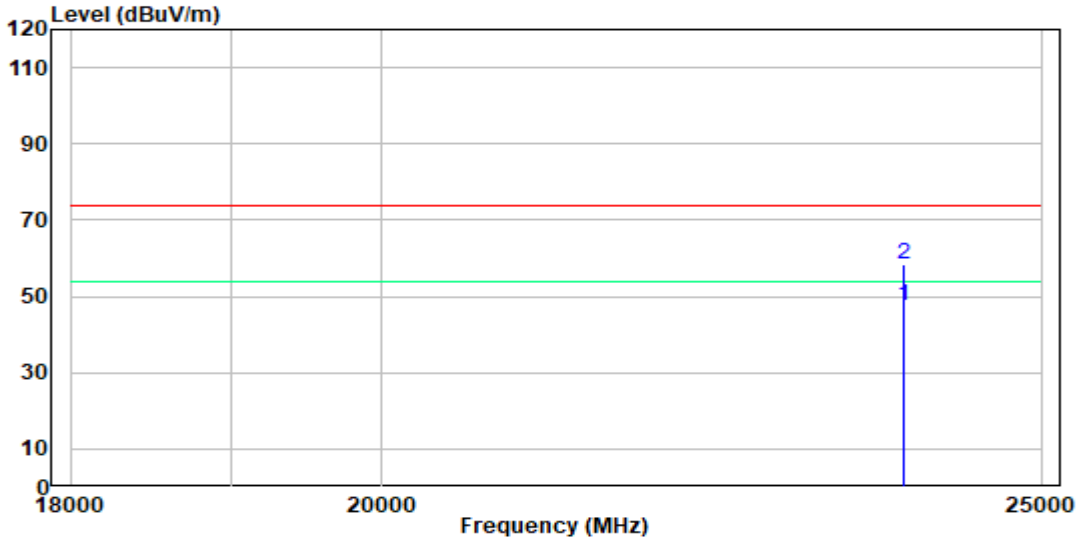
Vertical



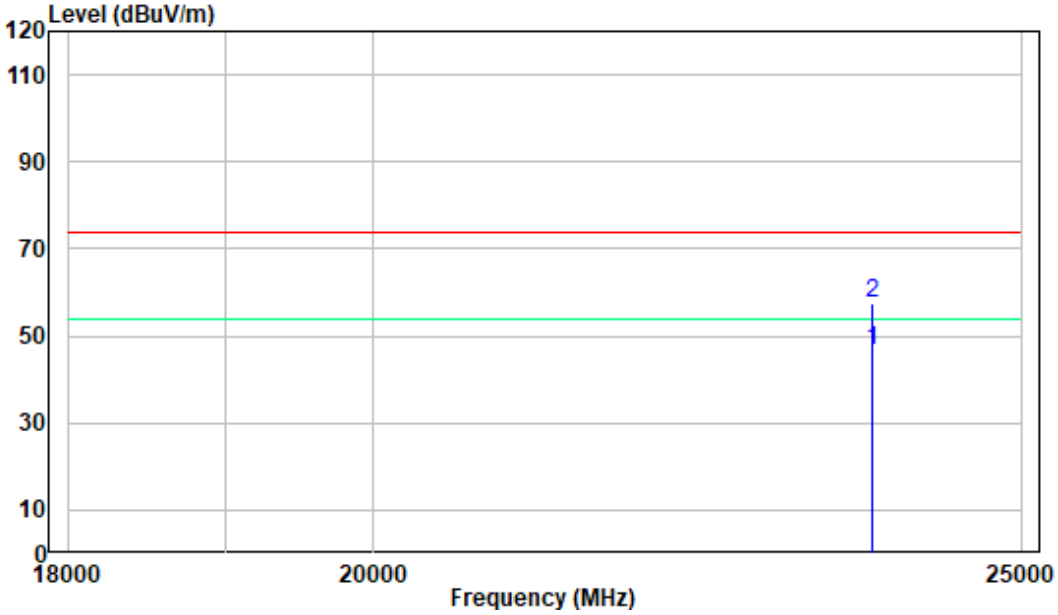
18-25GHz: (Pre-Scan plots)

Worst case for 8DPSK, High Channel:

Horizontal



Vertical



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

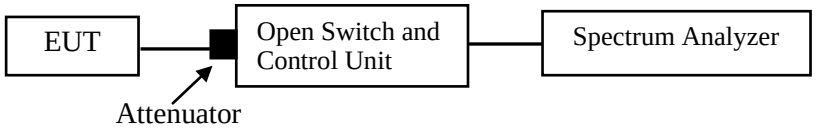
Applicable Standard

Frequency hopping systems shall have hoping 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

According to ANSI C63.10-2013, section 7.8.2

1. Set the EUT in TX 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:	23℃
Relative Humidity:	49%
ATM Pressure:	101.0kPa

The testing was performed by Jacob Huang on 2023-04-20.

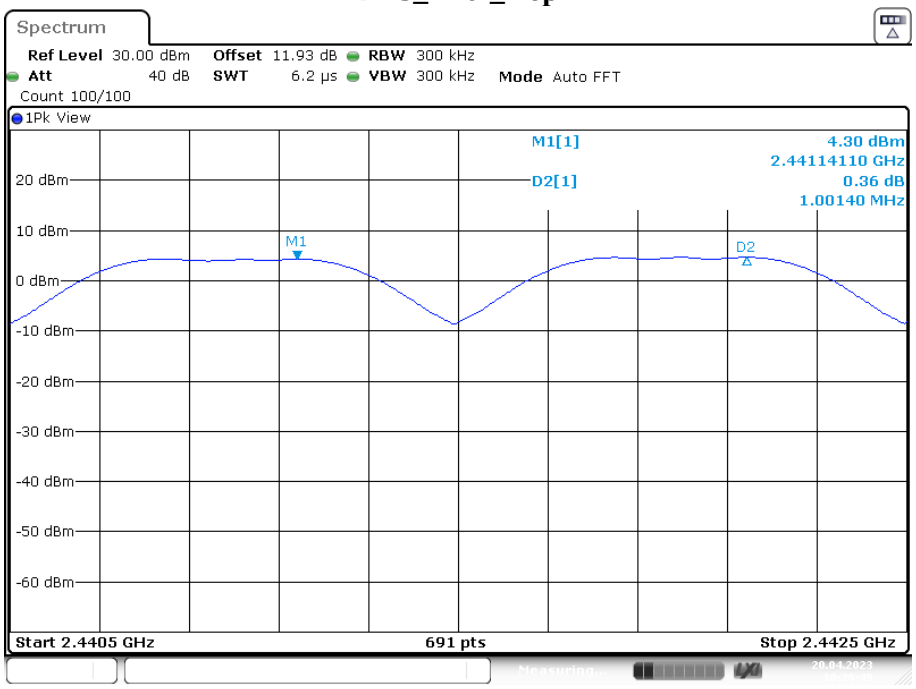
EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the below table and plots:

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	1.001	≥0.633	PASS
2DH5	Ant1	Hop	1	≥0.853	PASS
3DH5	Ant1	Hop	1.006	≥0.853	PASS

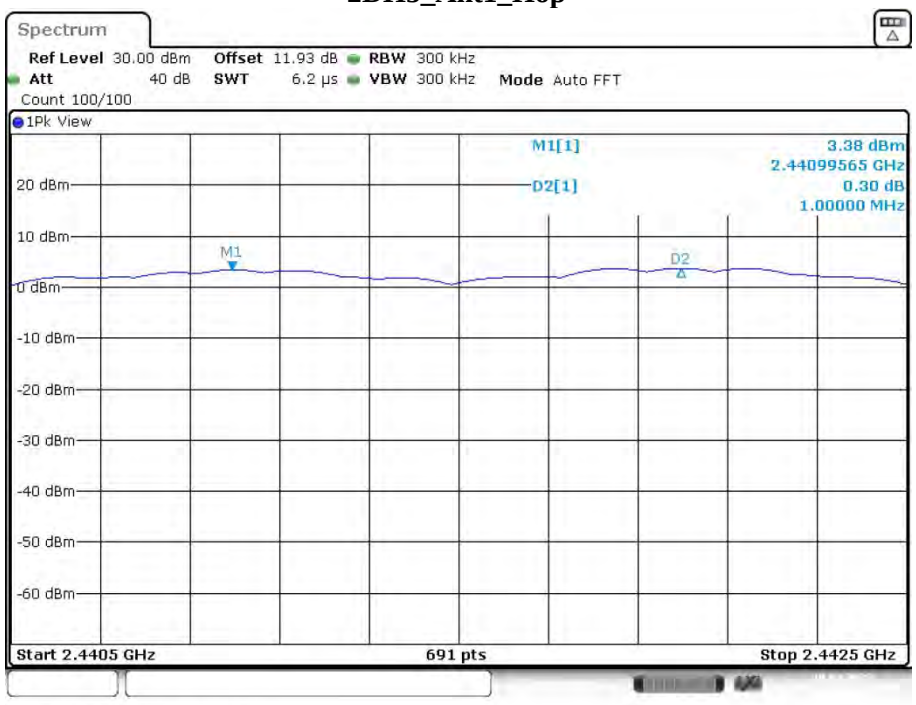
Note: The limit = (2/3) * 20dB bandwidth

DH5_Ant1_Hop



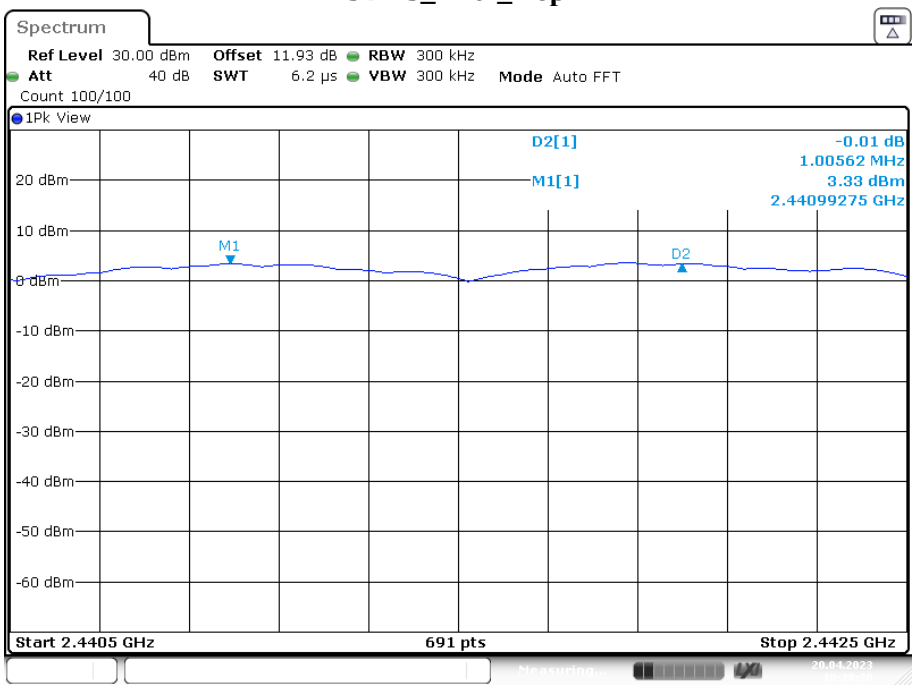
Date: 20.APR.2023 10:29:49

2DH5_Ant1_Hop



Date: 20.APR.2023 10:09:20

3DH5_Ant1_Hop



Date: 20.APR.2023 10:28:21

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

According to ANSI C63.10-2013, section 7.8.7 and section 6.9.2

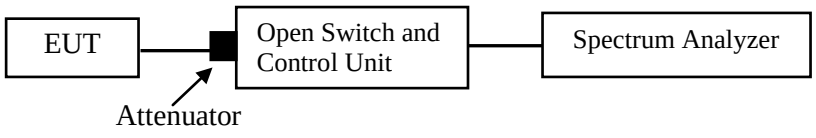
The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

• 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 TX 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:	23℃
Relative Humidity:	48-49%
ATM Pressure:	101.0kPa

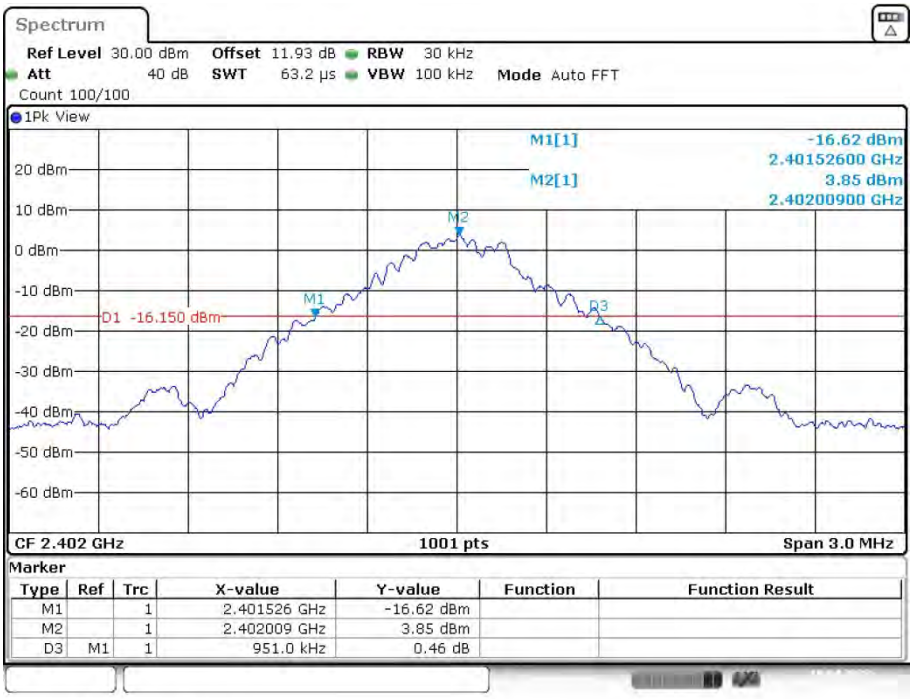
The testing was performed by Jacob Huang on 2023-04-19 and 2023-04-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the below table and plots:

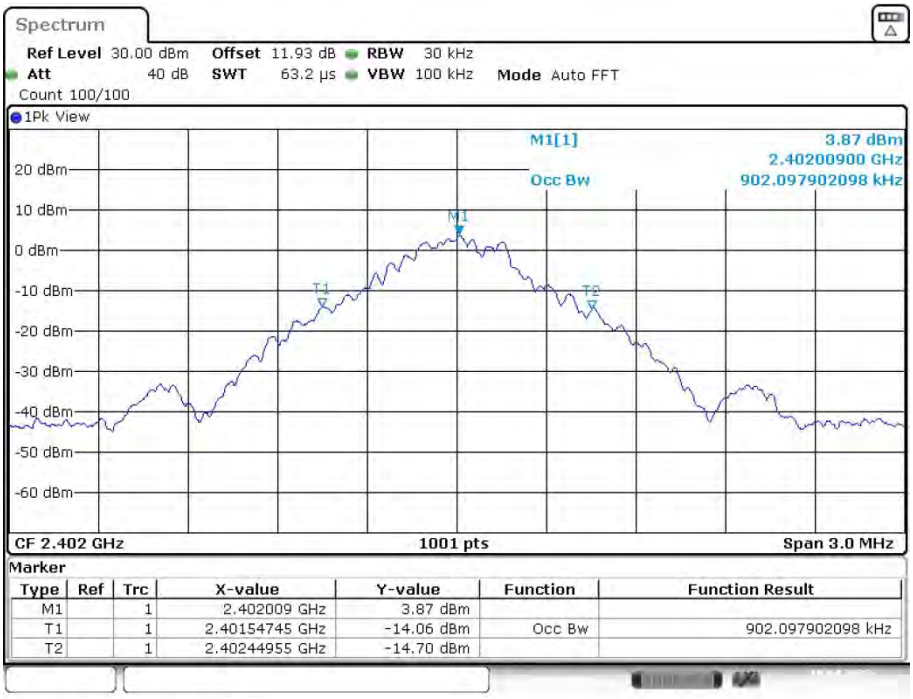
Test Mode	Antenna	Channel	20db EBW[MHz]	OCB [MHz]	Verdict
DH5	Ant1	2402	0.95	0.902	PASS
		2441	0.95	0.902	PASS
		2480	0.95	0.905	PASS
2DH5	Ant1	2402	1.28	1.175	PASS
		2441	1.28	1.172	PASS
		2480	1.28	1.175	PASS
3DH5	Ant1	2402	1.28	1.172	PASS
		2441	1.28	1.178	PASS
		2480	1.28	1.175	PASS

20 dB EMISSION BANDWIDTH_DH5_Ant1_2402



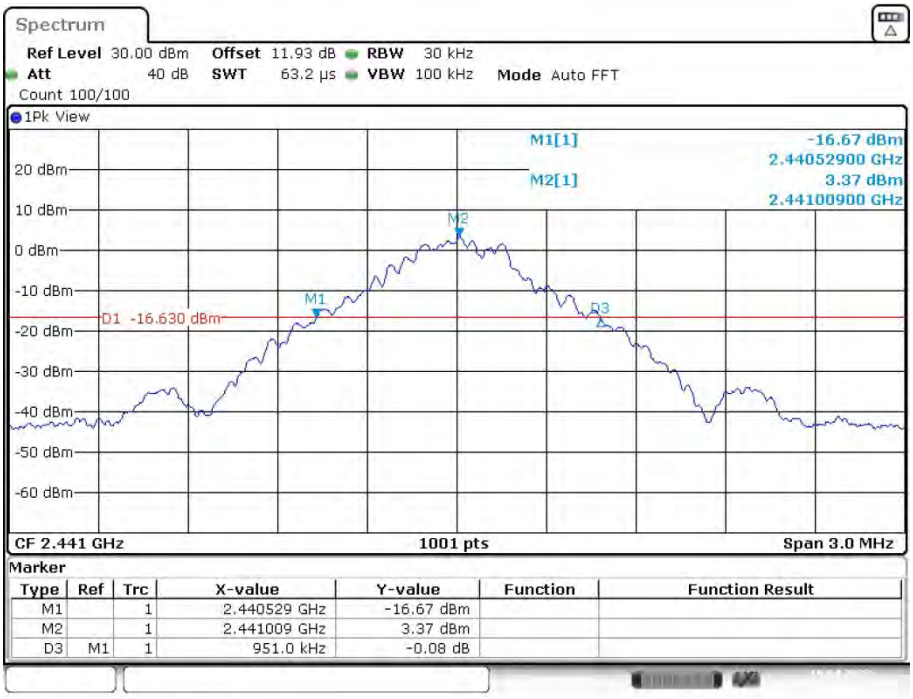
Date: 19.APR.2023 18:06:31

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2402



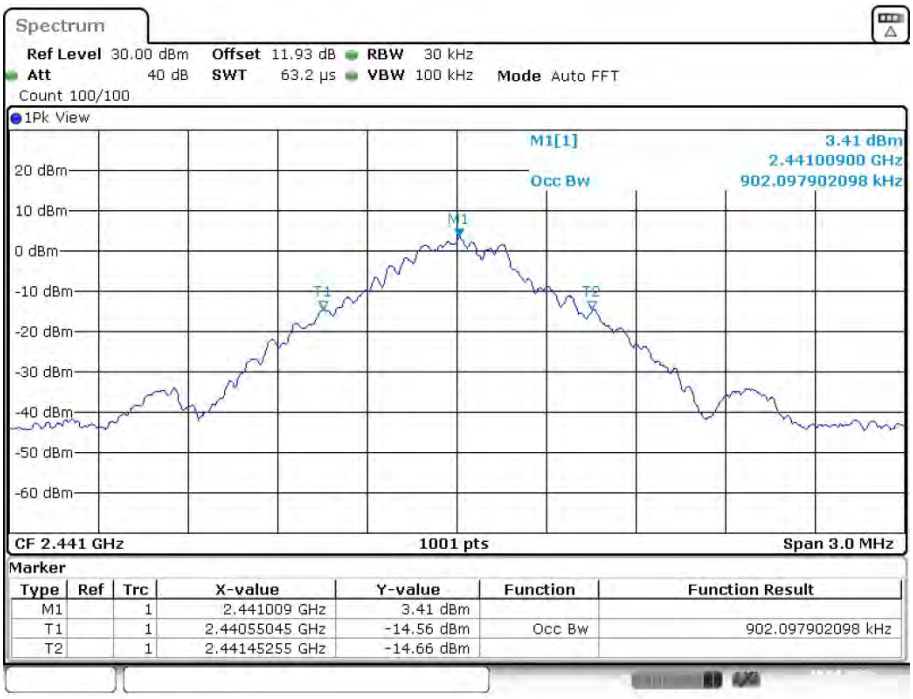
Date: 19.APR.2023 18:06:37

20 dB EMISSION BANDWIDTH_DH5 _Ant1_2441



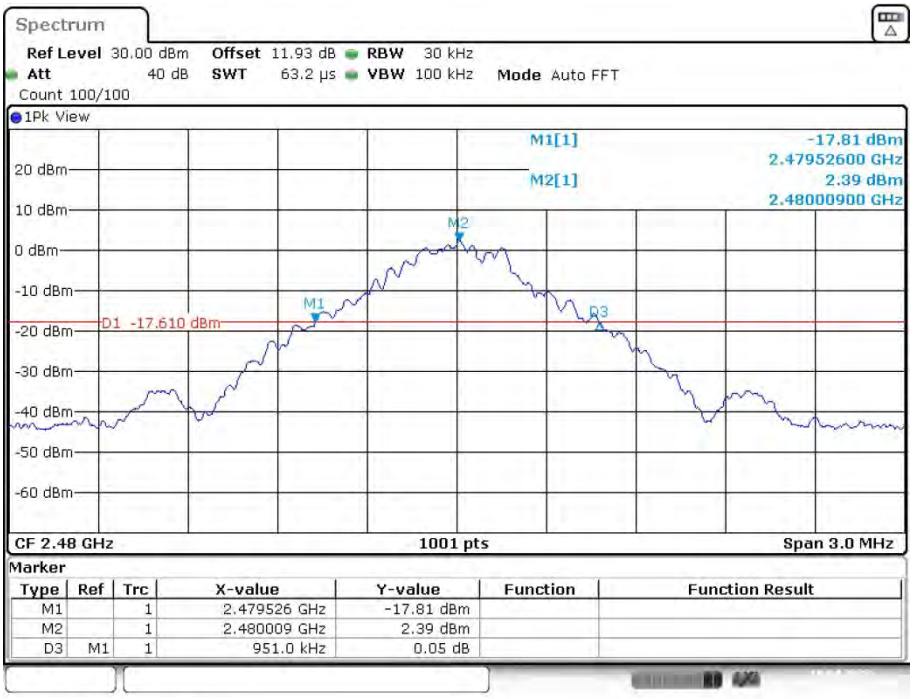
Date: 19.APR.2023 18:25:41

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2441



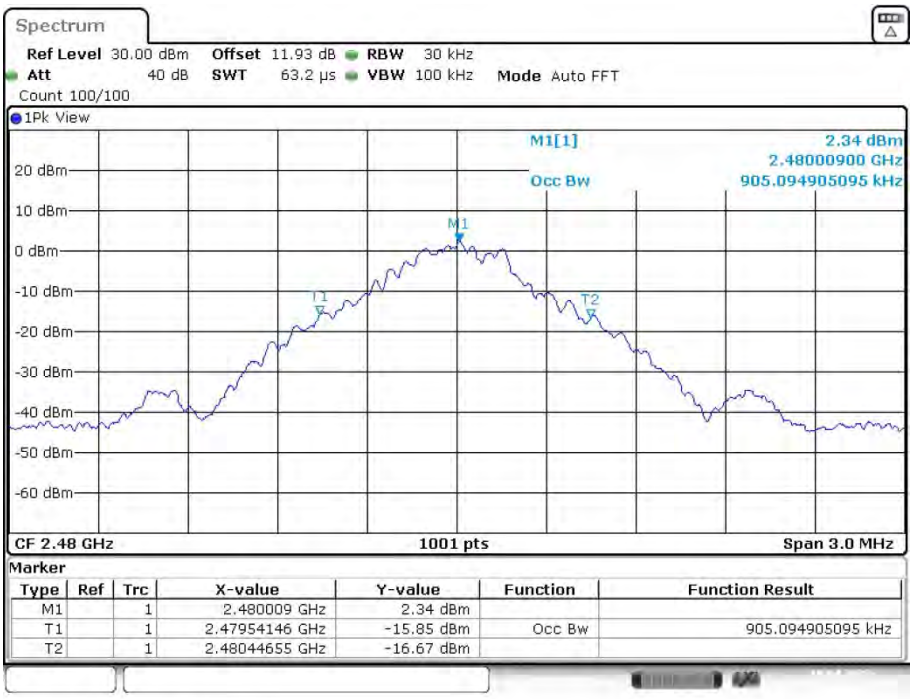
Date: 19.APR.2023 18:25:47

20 dB EMISSION BANDWIDTH_DH5 _Ant1_2480



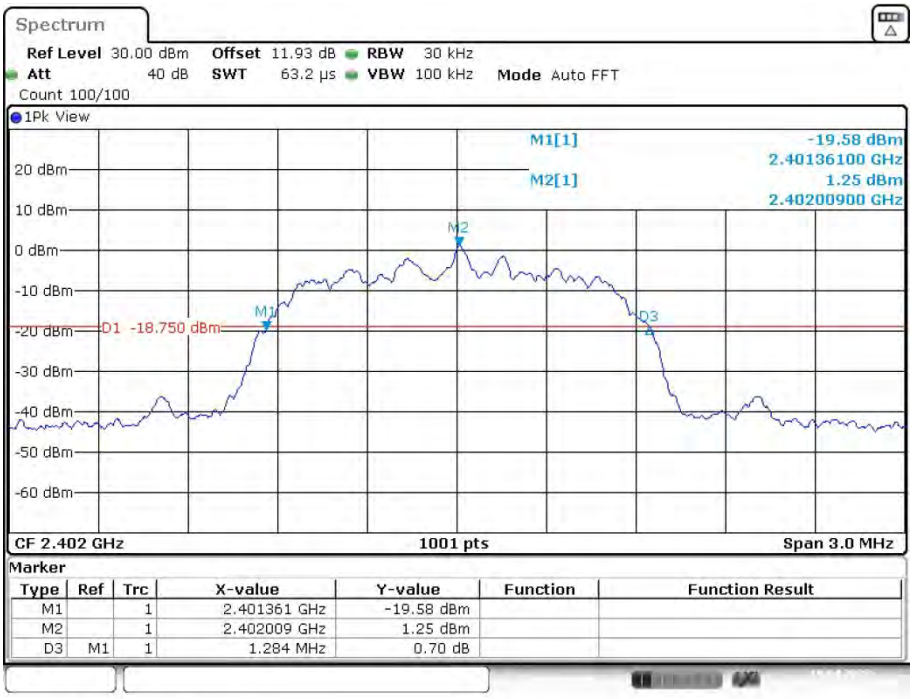
Date: 19.APR.2023 18:50:33

99% OCCUPIED BANDWIDTH_DH5 _Ant1_2480



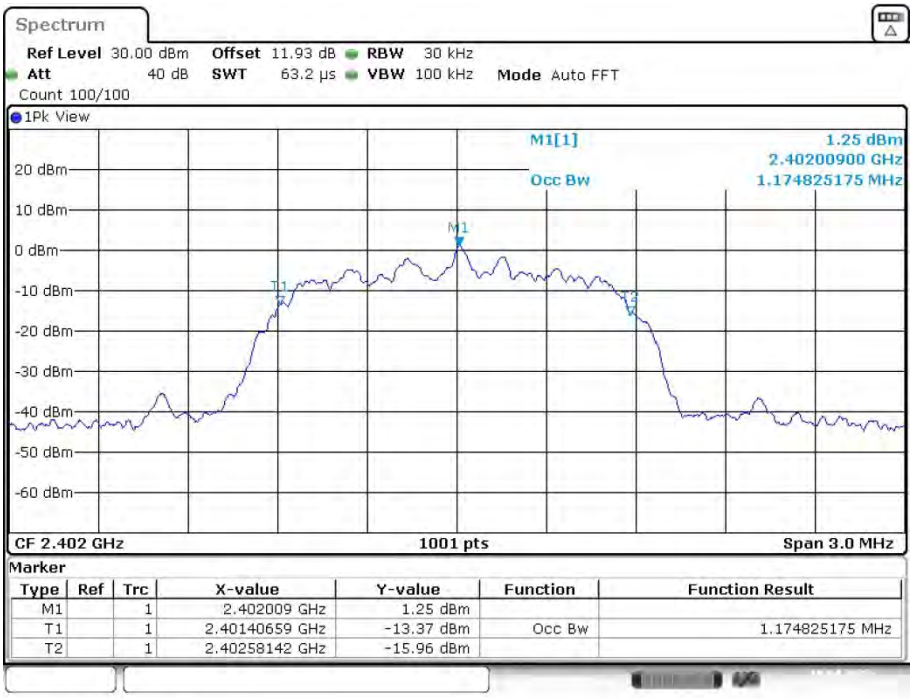
Date: 19.APR.2023 18:50:39

20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2402



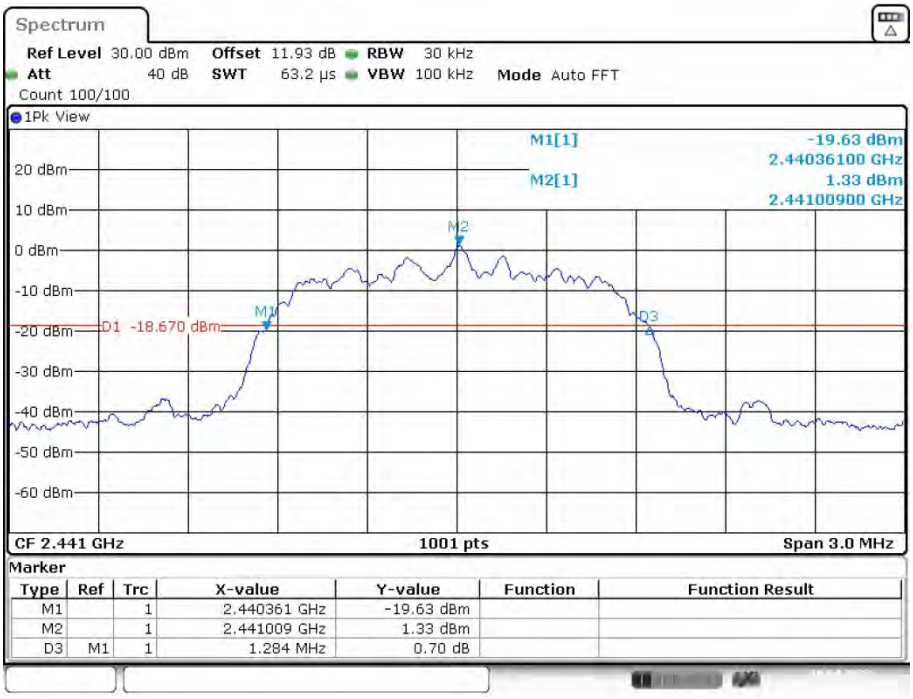
Date: 19.APR.2023 18:53:26

99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2402



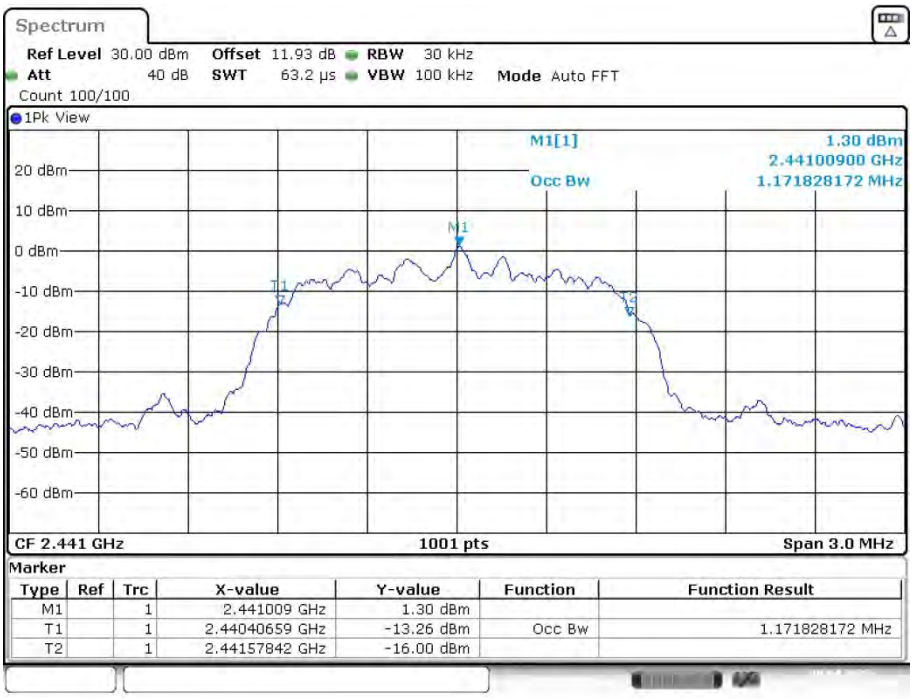
Date: 19.APR.2023 18:53:32

20 dB EMISSION BANDWIDTH_2DH5 _Ant1_2441



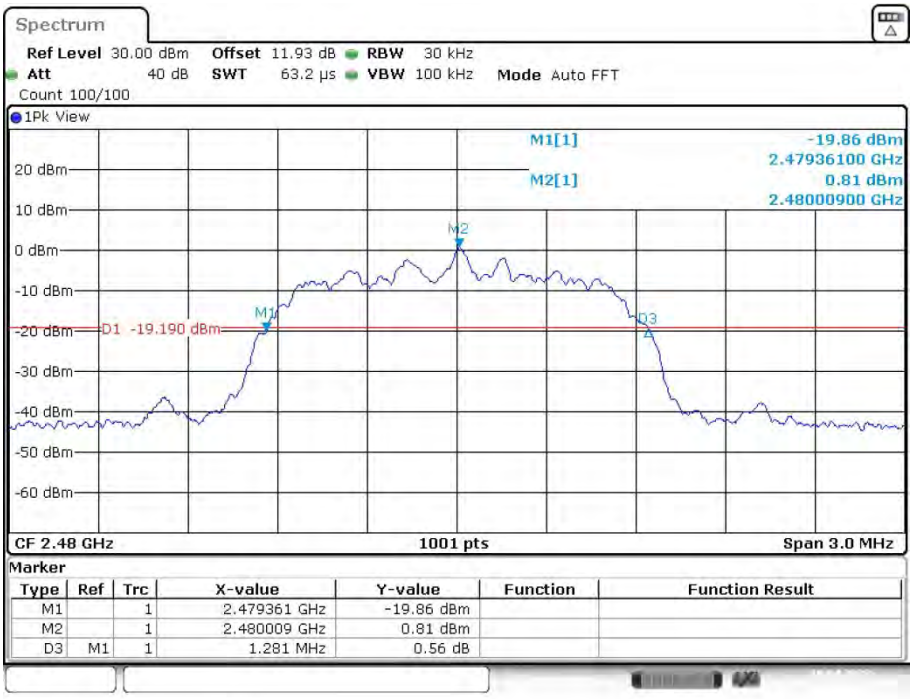
Date: 20.APR.2023 09:34:54

99% OCCUPIED BANDWIDTH_2DH5 _Ant1_2441



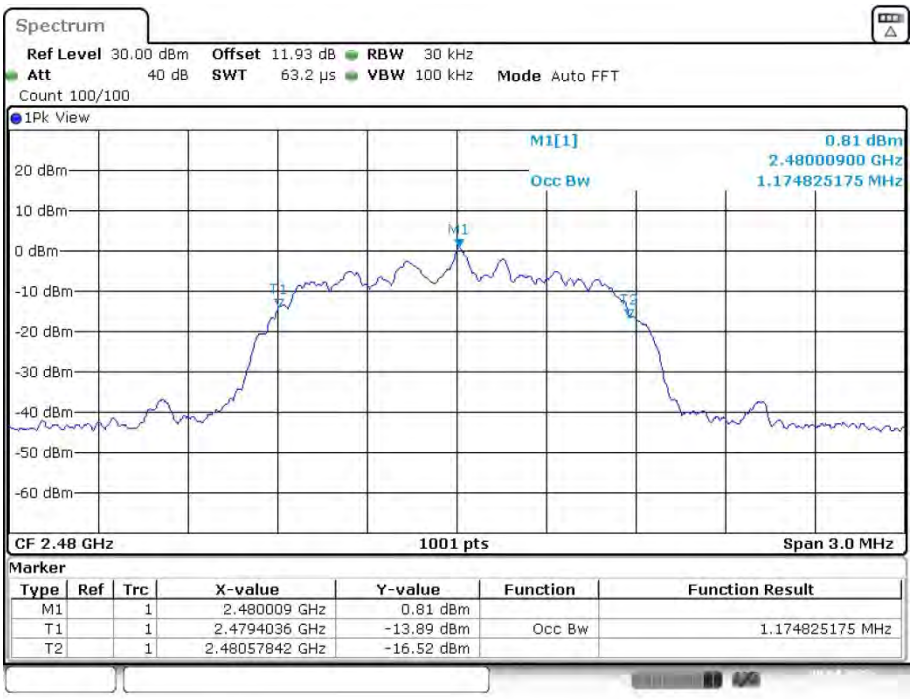
Date: 20.APR.2023 09:34:59

20 dB EMISSION BANDWIDTH _2DH5_Ant1_2480



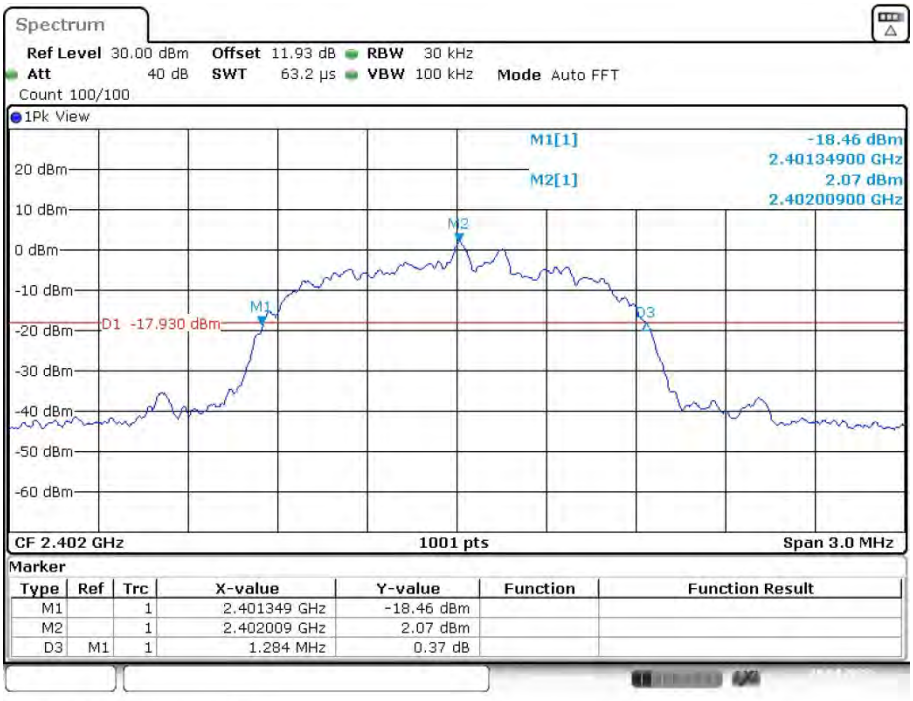
Date: 20.APR.2023 09:36:27

99% OCCUPIED BANDWIDTH _2DH5_Ant1_2480



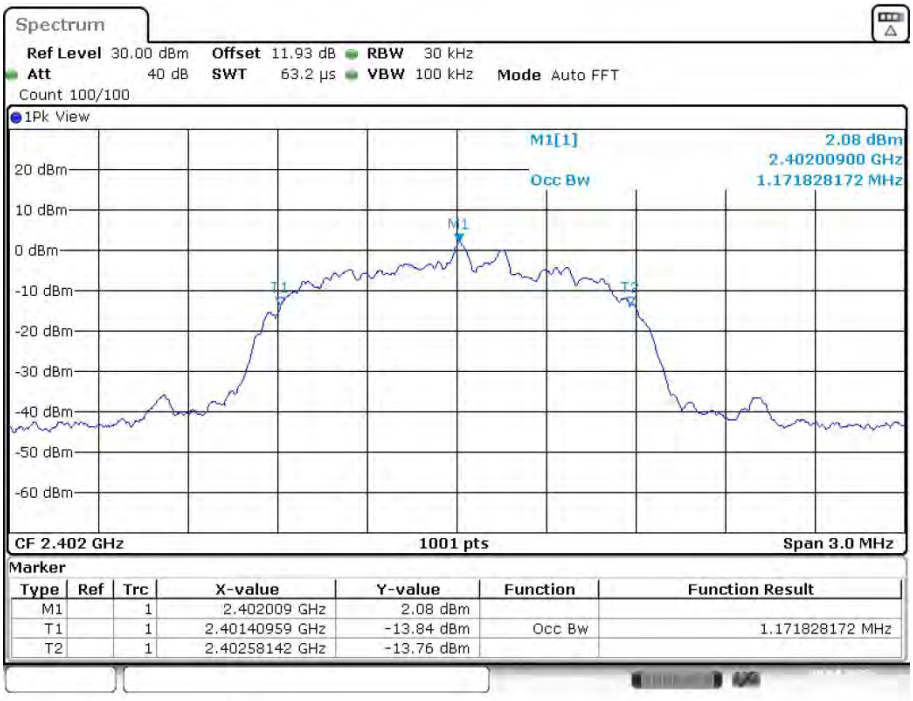
Date: 20.APR.2023 09:36:32

20 dB EMISSION BANDWIDTH _3DH5_Ant1_2402



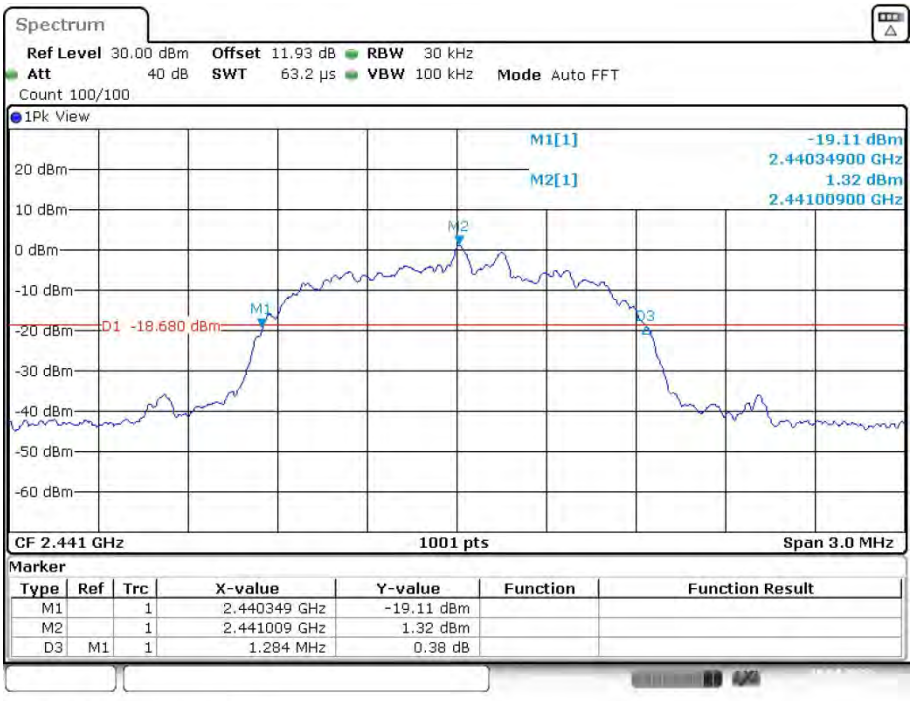
Date: 20.APR.2023 09:39:48

99% OCCUPIED BANDWIDTH _3DH5_Ant1_2402



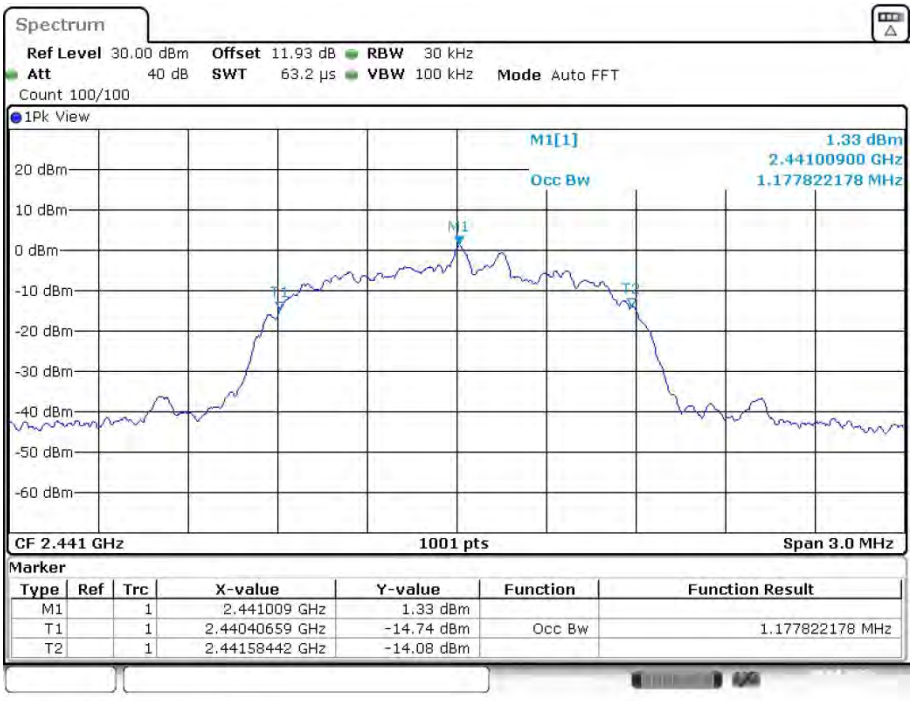
Date: 20.APR.2023 09:39:53

20 dB EMISSION BANDWIDTH _3DH5_Ant1_2441



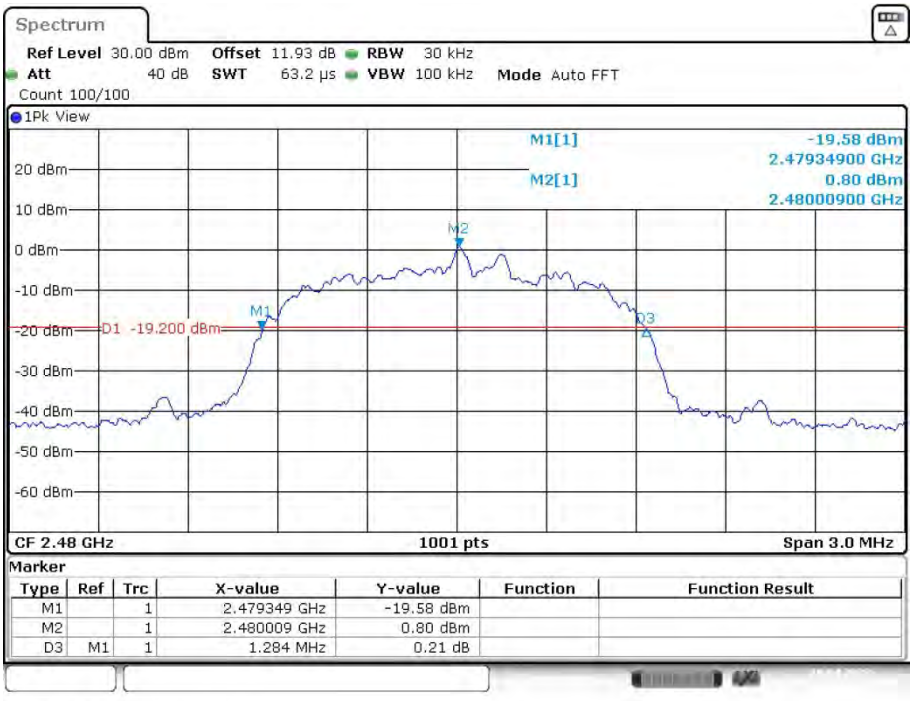
Date: 20.APR.2023 09:42:29

99% OCCUPIED BANDWIDTH _3DH5_Ant1_2441



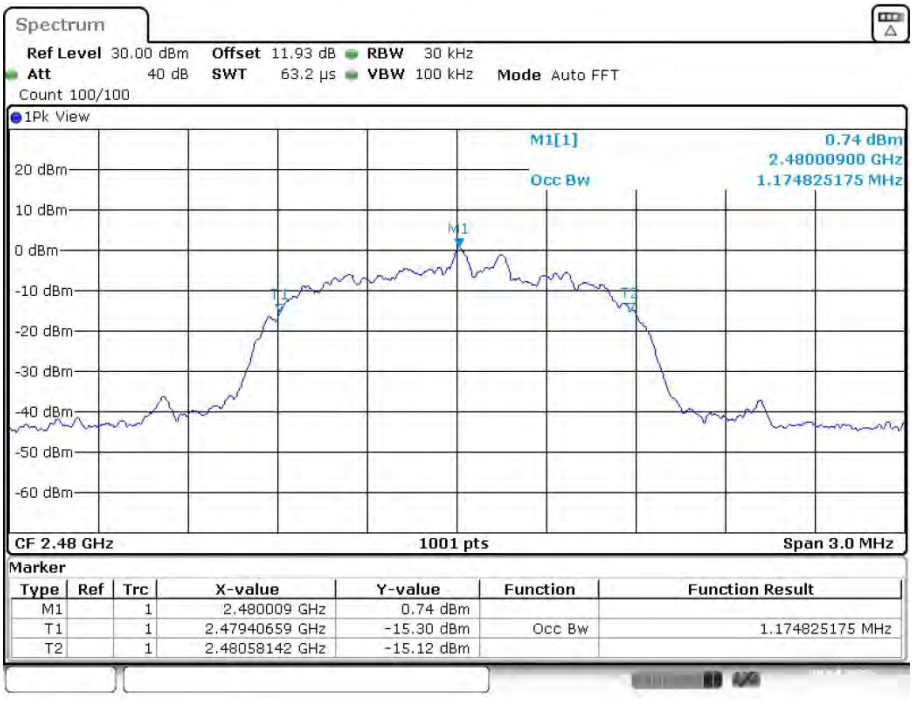
Date: 20.APR.2023 09:42:35

20 dB EMISSION BANDWIDTH _3DH5_Ant1_2480



Date: 20.APR.2023 09:44:03

99% OCCUPIED BANDWIDTH _3DH5_Ant1_2480



Date: 20.APR.2023 09:44:08

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.

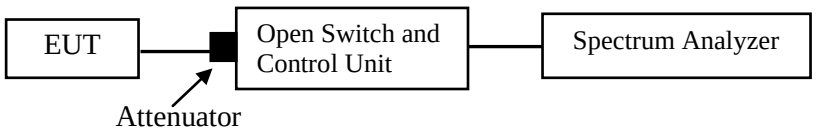
Test Procedure

According to ANSI C63.10-2013, section 7.8.3

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:	23℃
Relative Humidity:	49%
ATM Pressure:	101.0kPa

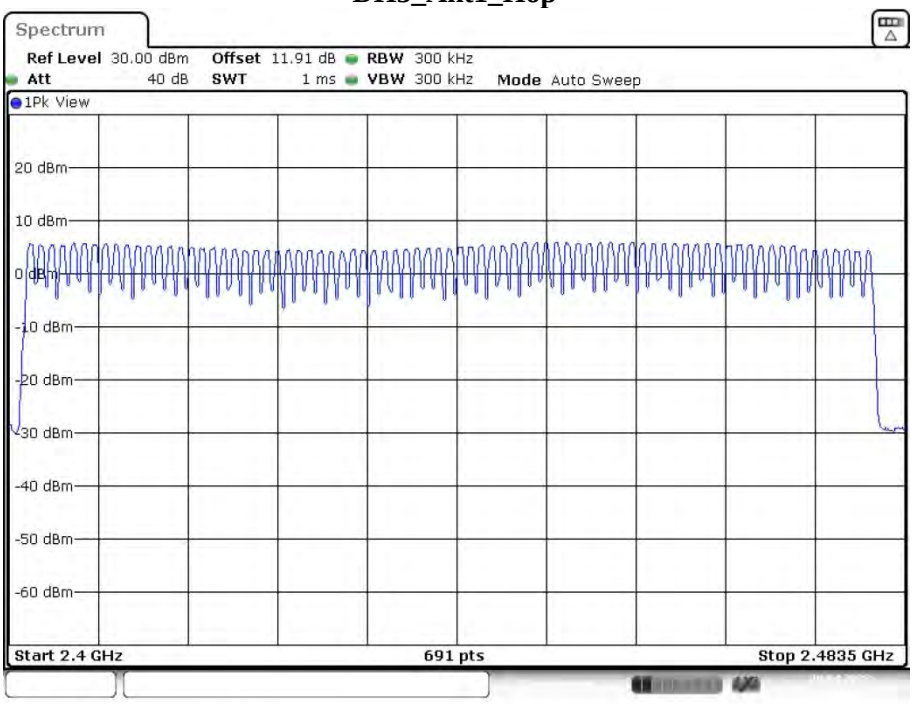
The testing was performed by Jacob Huang on 2023-04-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the below table and plots:

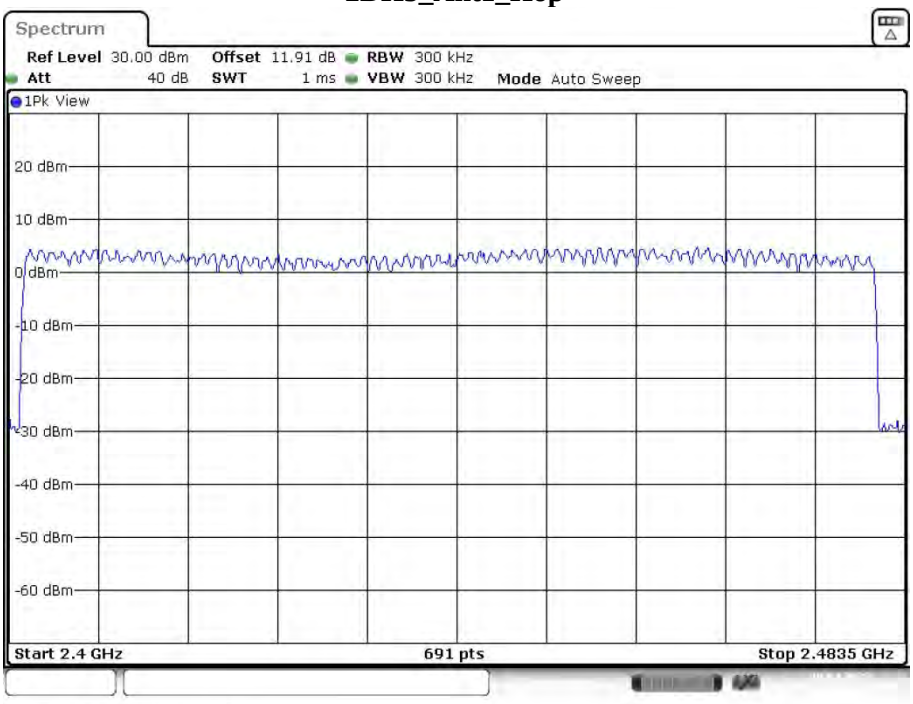
Test Mode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH5	Ant1	Hop	79	>=15	PASS
2DH5	Ant1	Hop	79	>=15	PASS
3DH5	Ant1	Hop	79	>=15	PASS

DH5_Ant1_Hop



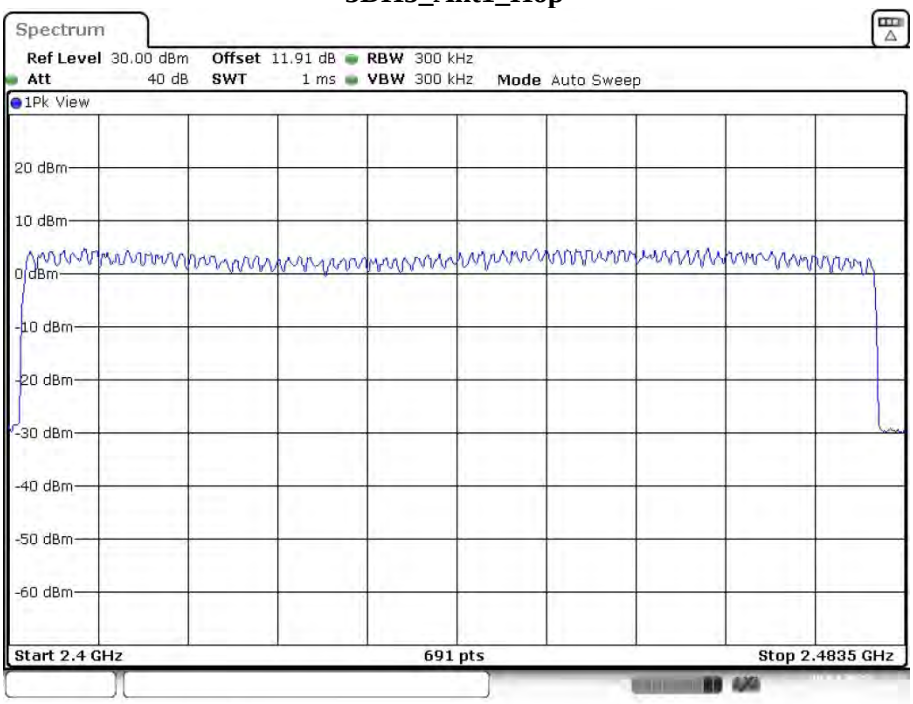
Date: 20.APR.2023 09:50:20

2DH5_Ant1_Hop



Date: 20.APR.2023 09:52:52

3DH5_Ant1_Hop



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

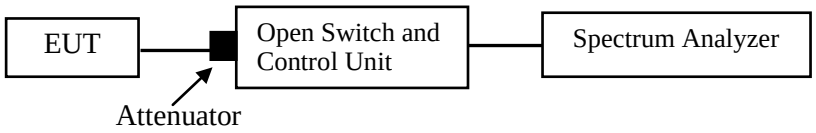
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.4

1. The EUT was worked in channel hopping.
2. Set the RBW to: 1MHz.
3. Set the VBW ≥ 3×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:	23℃
Relative Humidity:	49%
ATM Pressure:	101.0kPa

The testing was performed by Jacob Huang on 2023-04-20.

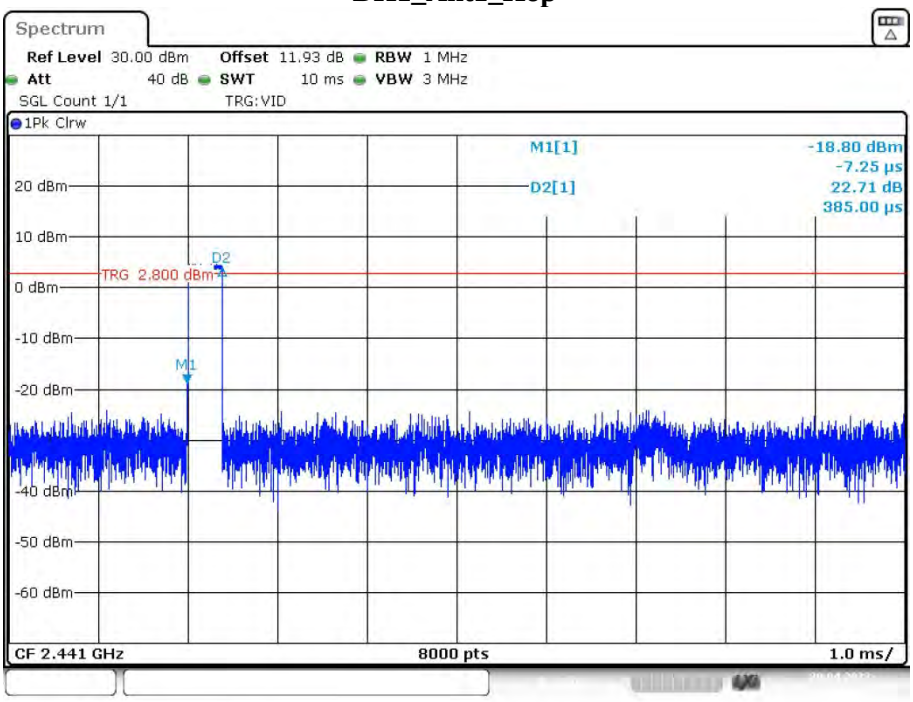
EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the below table and plots:

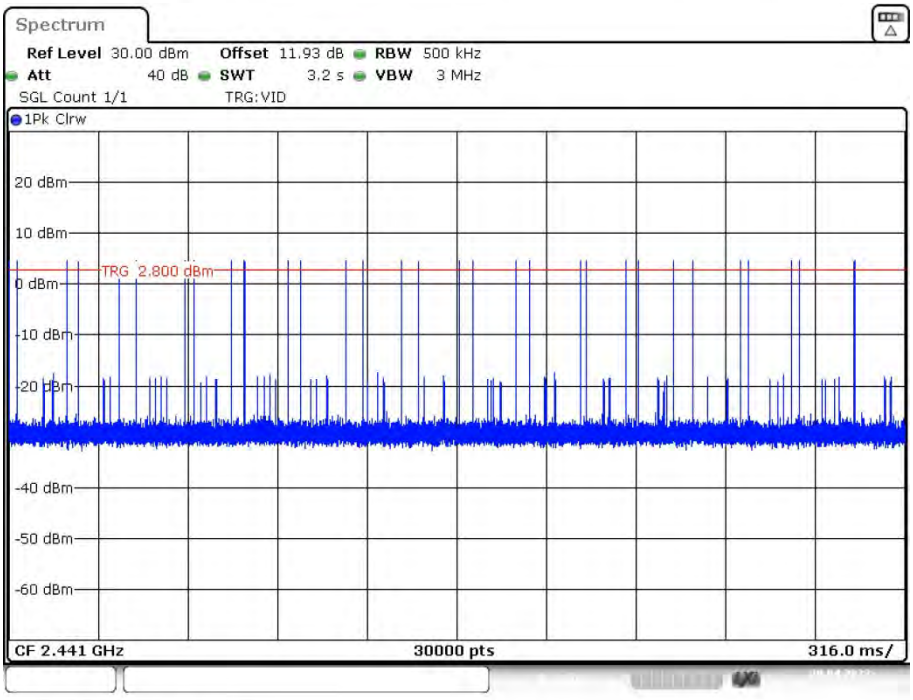
Test Mode	Antenna	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.385	320	0.123	≤0.4	PASS
DH3	Ant1	Hop	1.639	130	0.213	≤0.4	PASS
DH5	Ant1	Hop	2.877	90	0.259	≤0.4	PASS
2DH1	Ant1	Hop	0.398	330	0.131	≤0.4	PASS
2DH3	Ant1	Hop	1.628	200	0.326	≤0.4	PASS
2DH5	Ant1	Hop	2.870	100	0.287	≤0.4	PASS
3DH1	Ant1	Hop	0.389	320	0.124	≤0.4	PASS
3DH3	Ant1	Hop	1.640	150	0.246	≤0.4	PASS
3DH5	Ant1	Hop	2.870	110	0.316	≤0.4	PASS

Note 1: A period time=0.4*79=31.6(s), Result=Burst Width*Total Hops
Note 2: Total Hops =Hopping Number in 3.16s*10
Note 3: Hoping Number in 3.16s=Total of highest signals in 3.16s (Second high signals were other channel)

DH1_Ant1_Hop

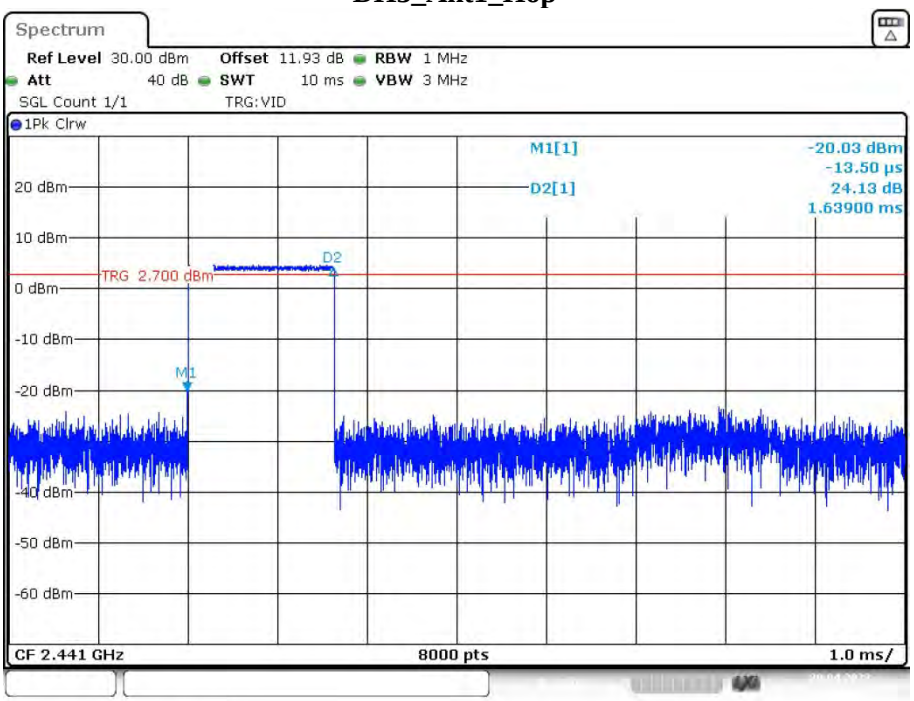


Date: 20.APR.2023 10:07:56



Date: 20.APR.2023 10:08:01

DH3_Ant1_Hop



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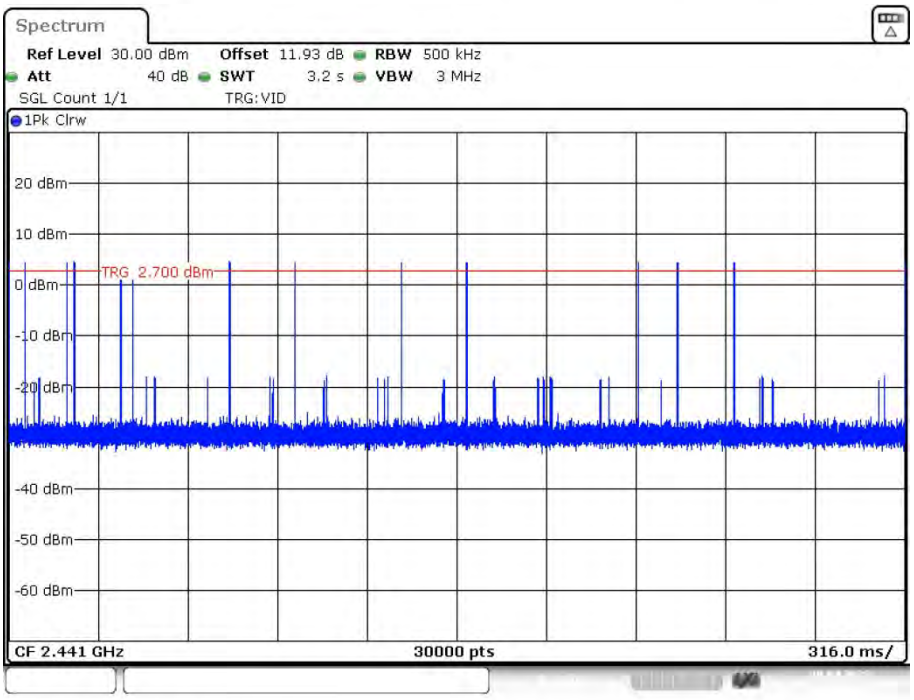
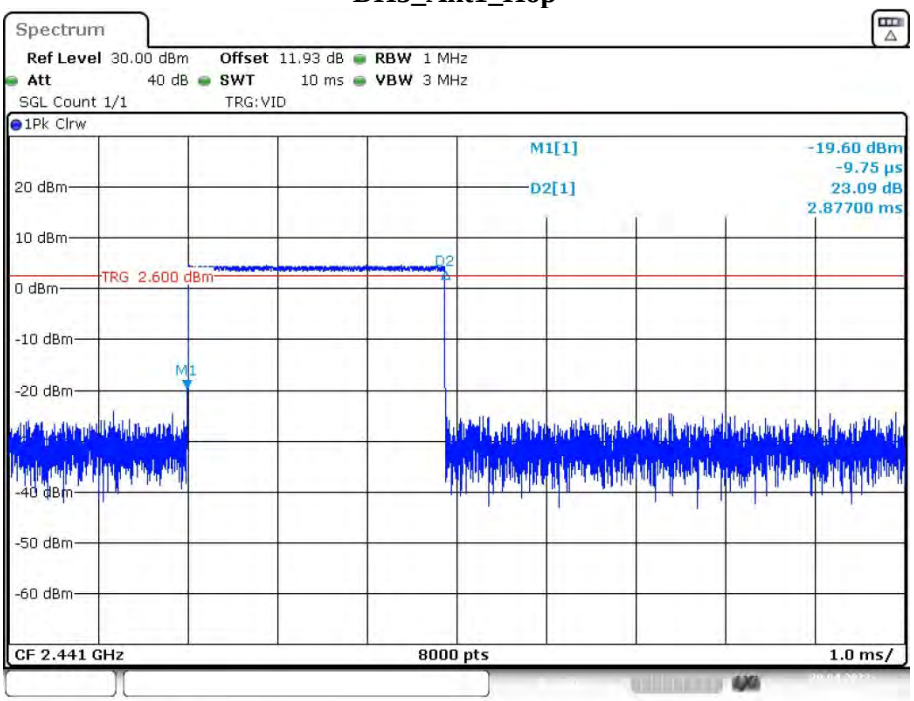
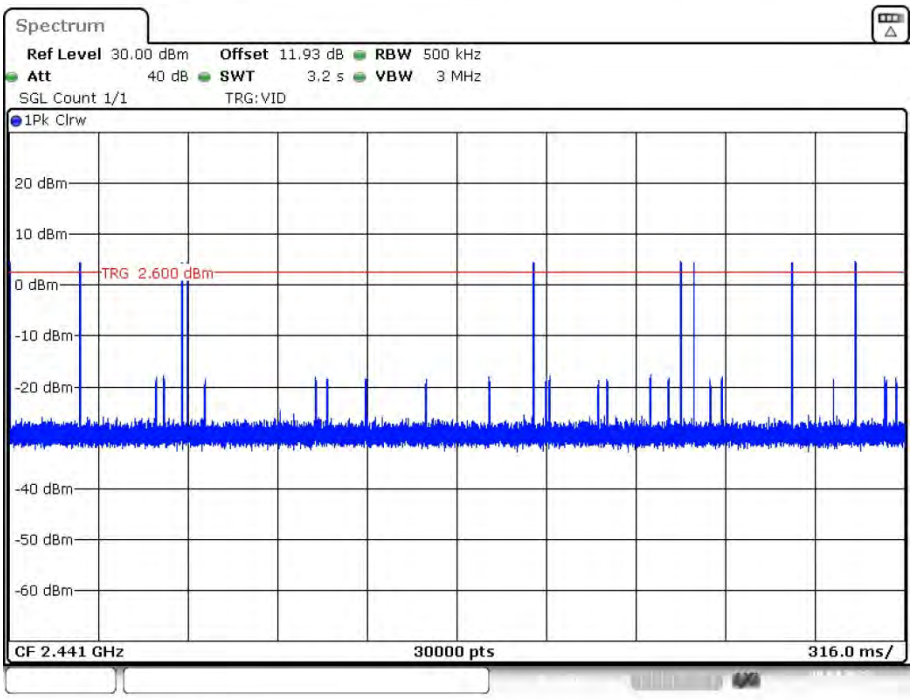


Date: 20.APR.2023 10:08:50

DH5_Ant1_Hop



Date: 20.APR.2023 10:06:49



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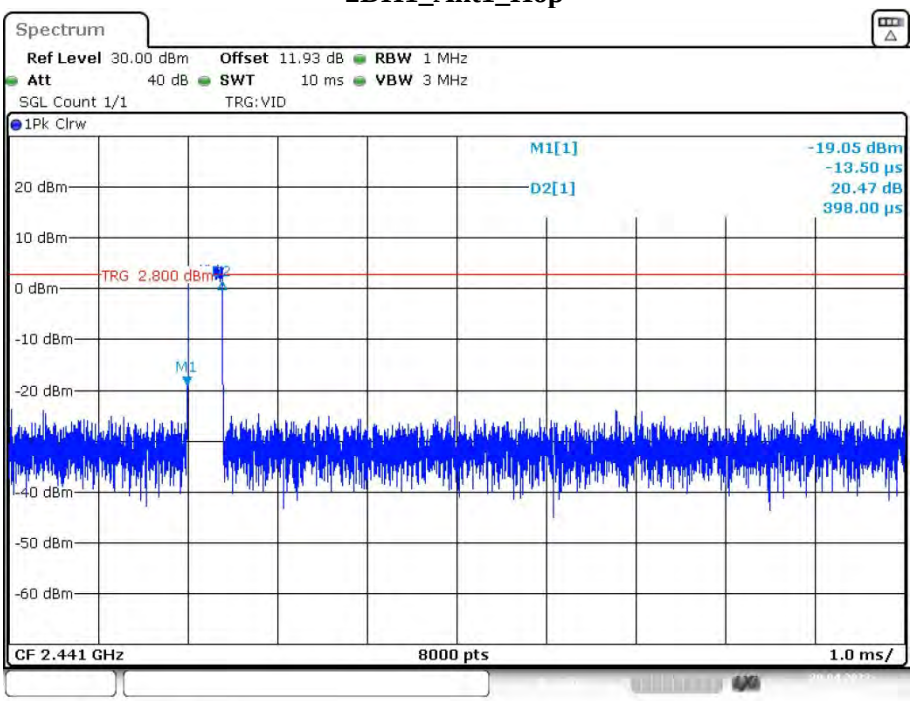
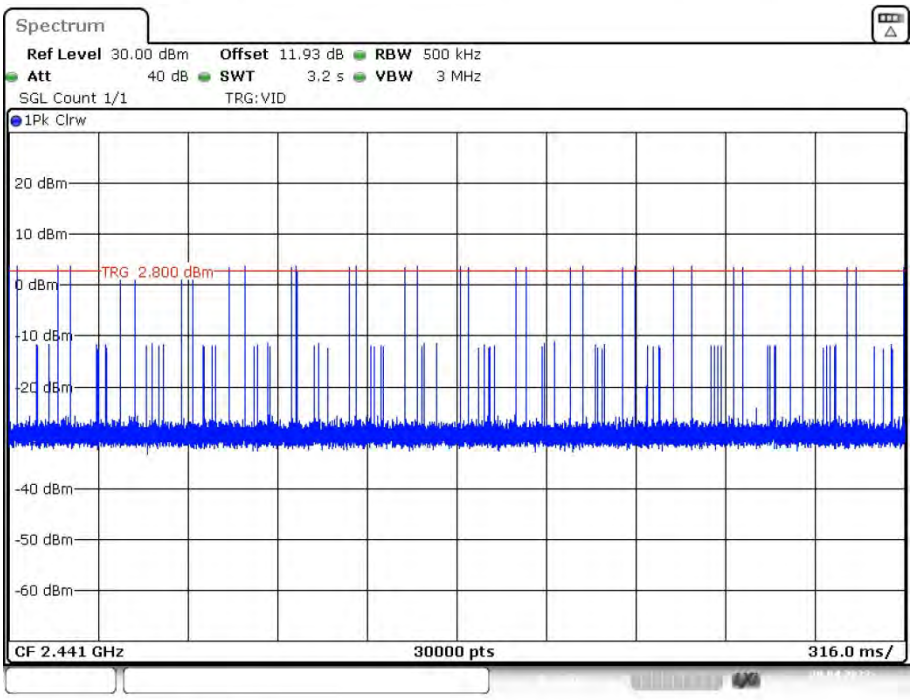
2DH1_Ant1_Hop



Date: 20.APR.2023 10:10:24



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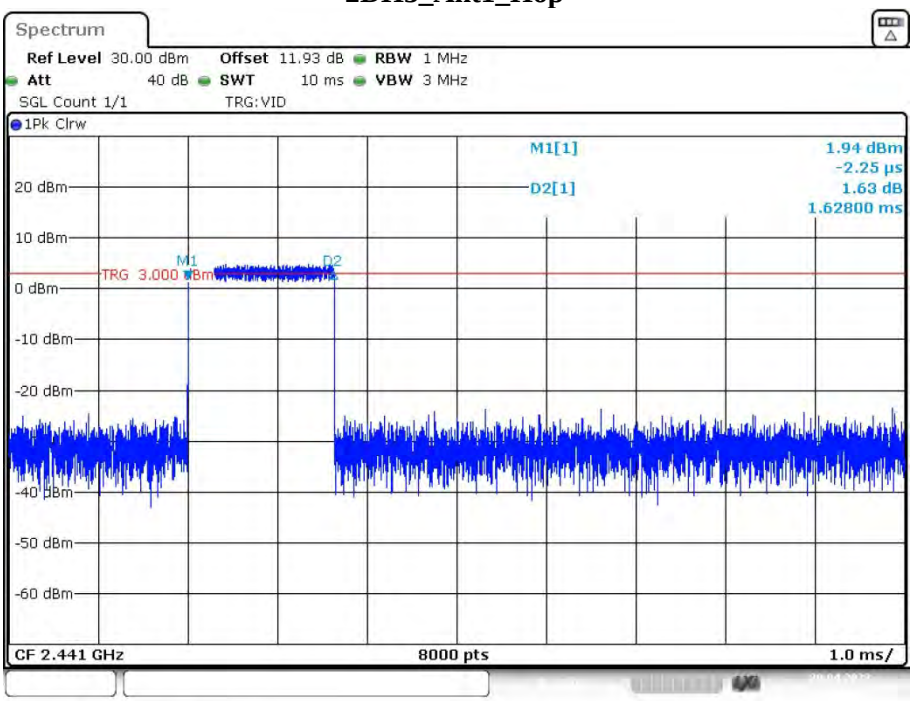
2DH3_Ant1_Hop



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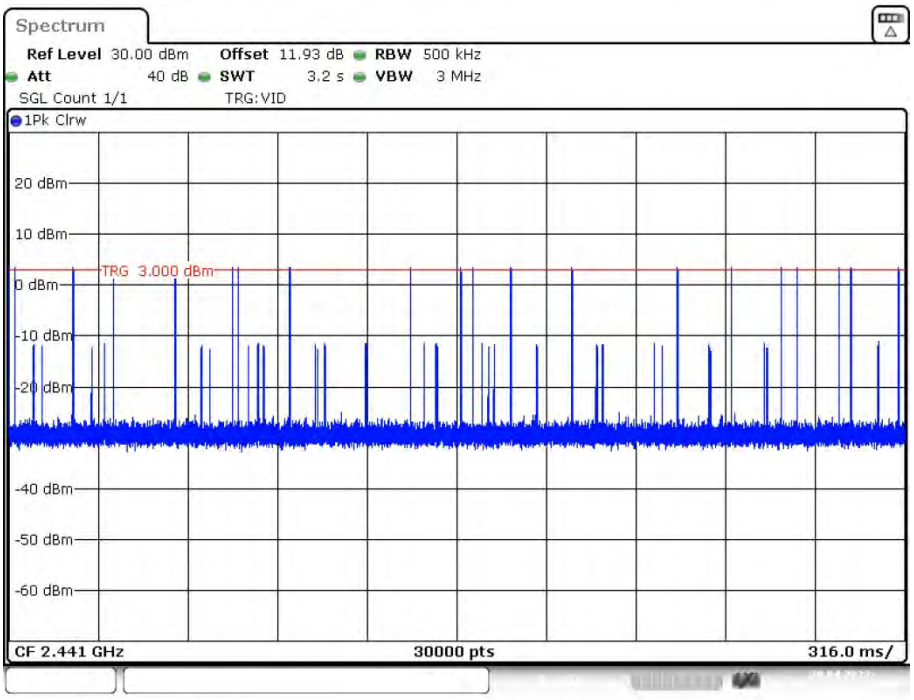
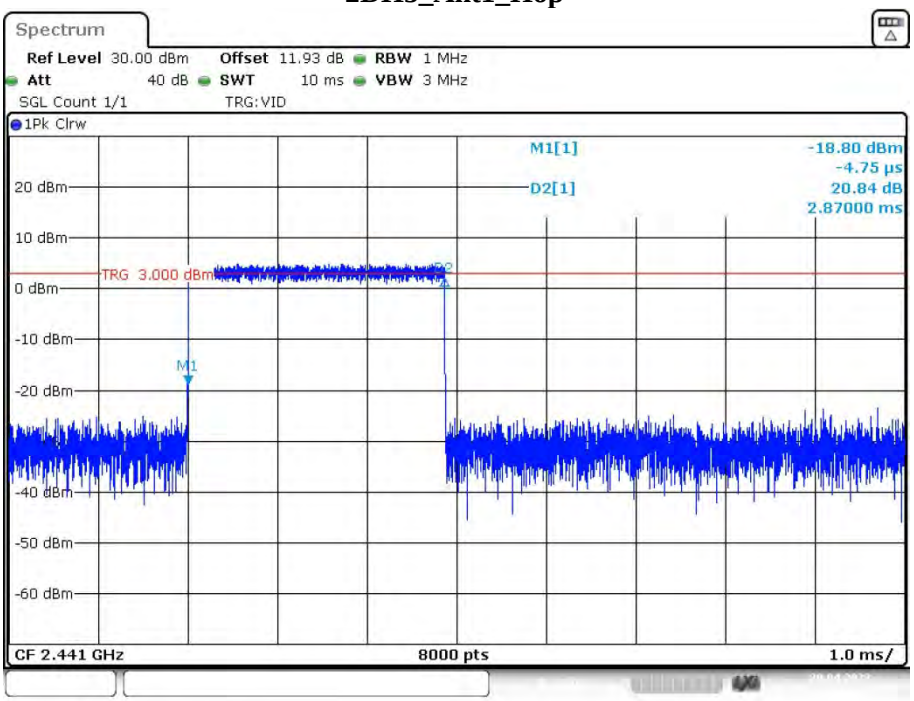
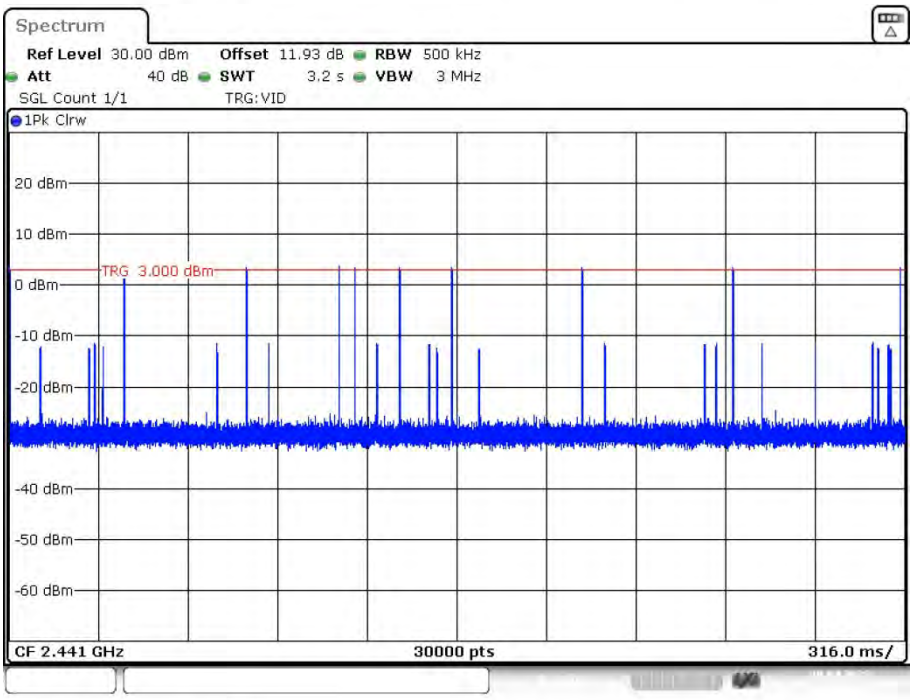


Date: 20.APR.2023 10:11:01

2DH5_Ant1_Hop

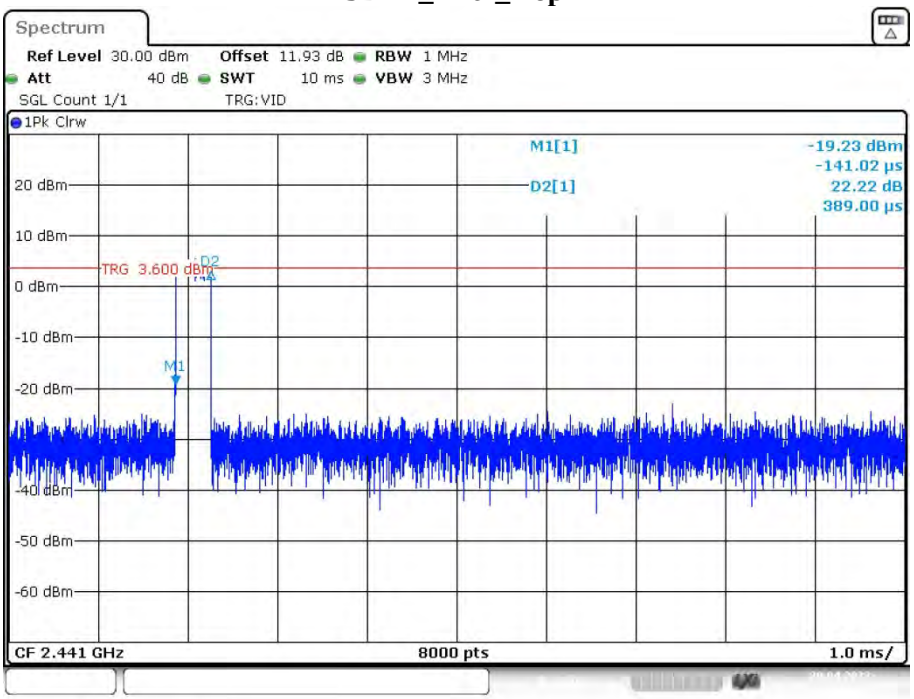


Date: 20.APR.2023 10:17:02



Date: 20.APR.2023 10:17:07

3DH1_Ant1_Hop



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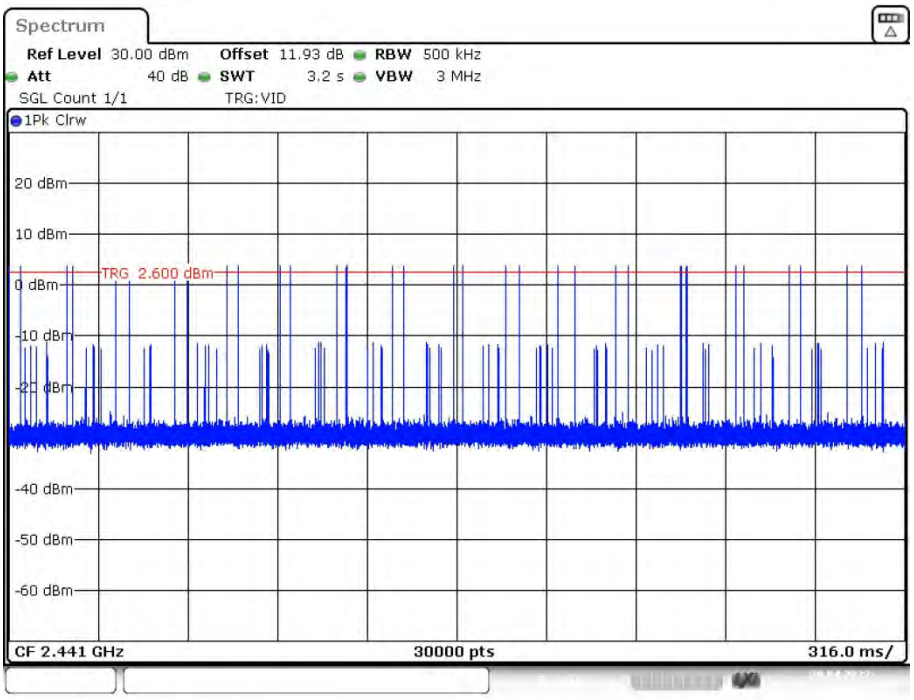

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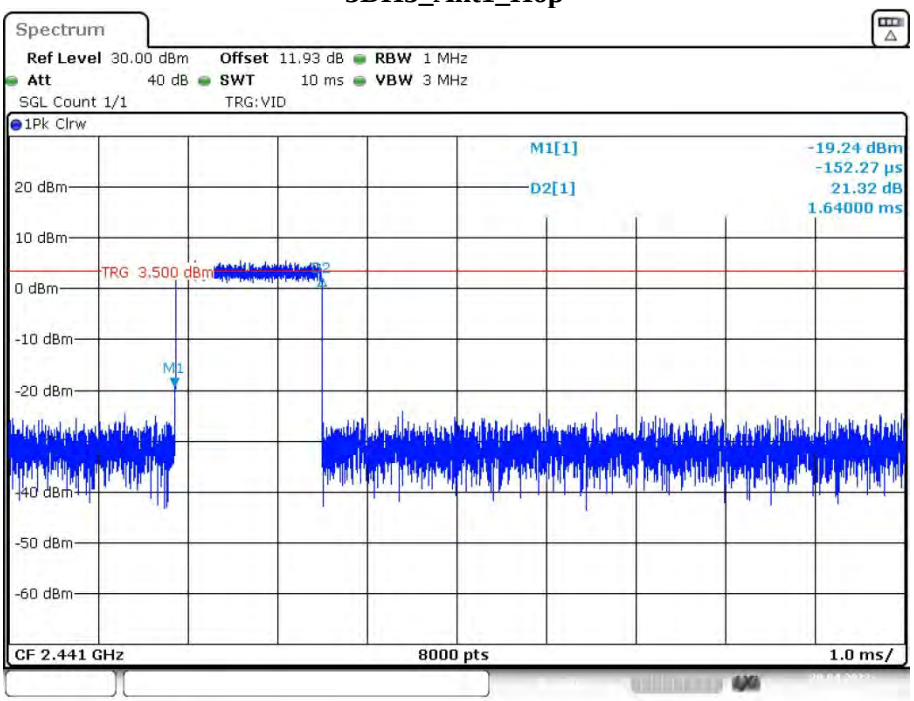
3DH3_Ant1_Hop



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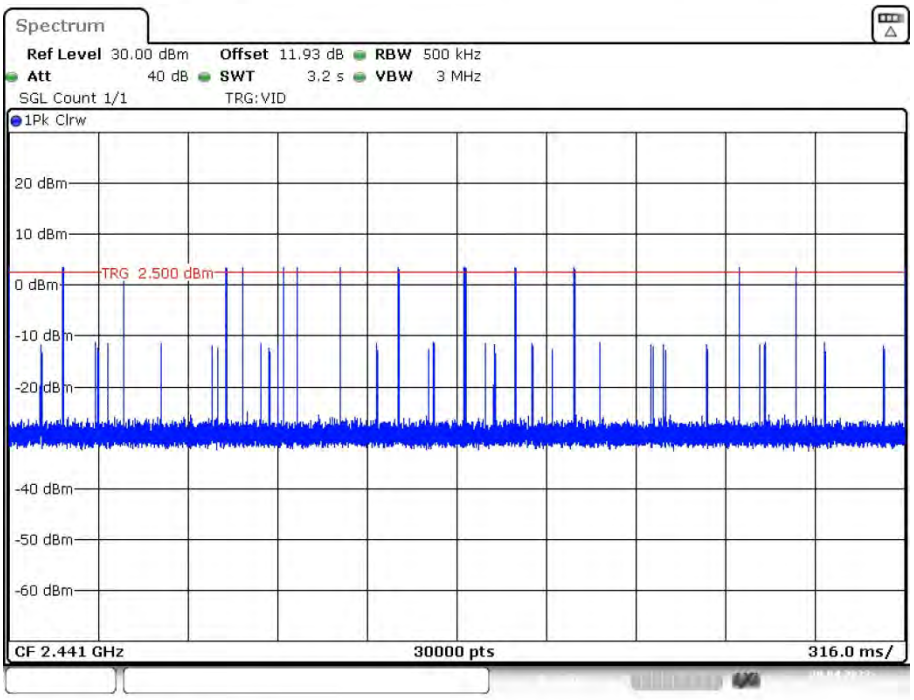
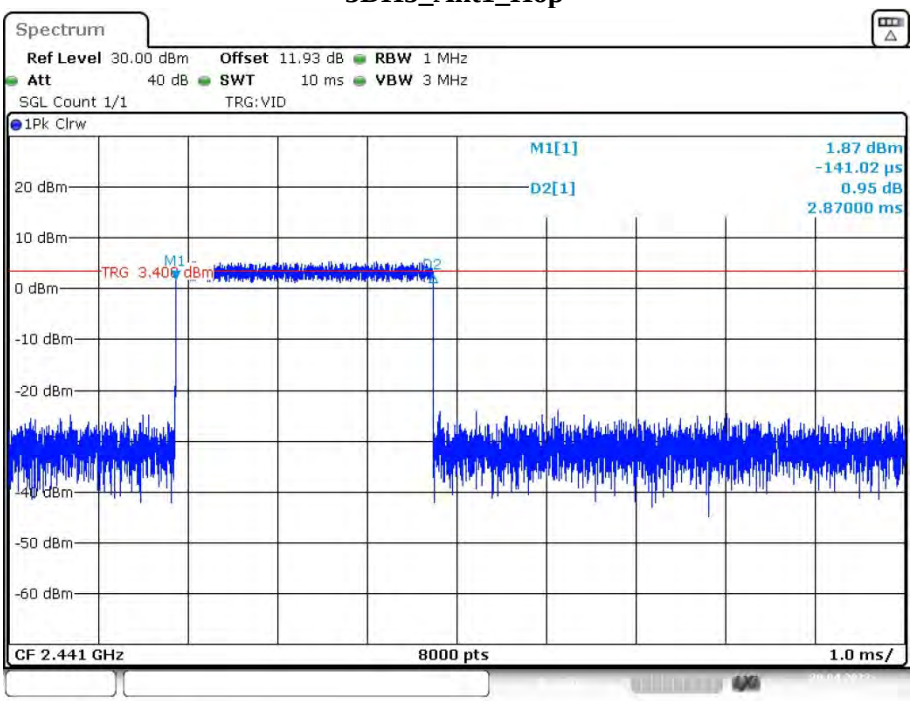
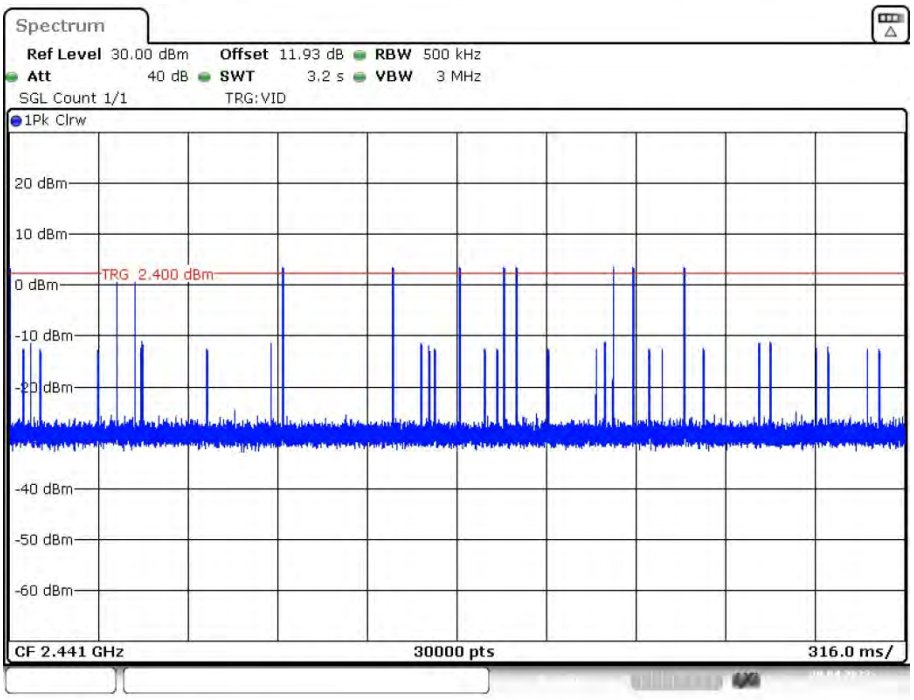


Date: 20.APR.2023 10:13:09

3DH5_Ant1_Hop



Date: 20.APR.2023 10:11:38



Date: 20.APR.2023 10:11:49

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

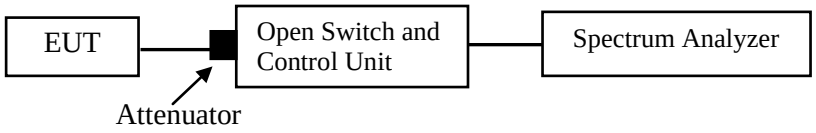
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.5

1. Place the EUT on a bench and set in TX 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:	23℃
Relative Humidity:	48%
ATM Pressure:	101.0kPa

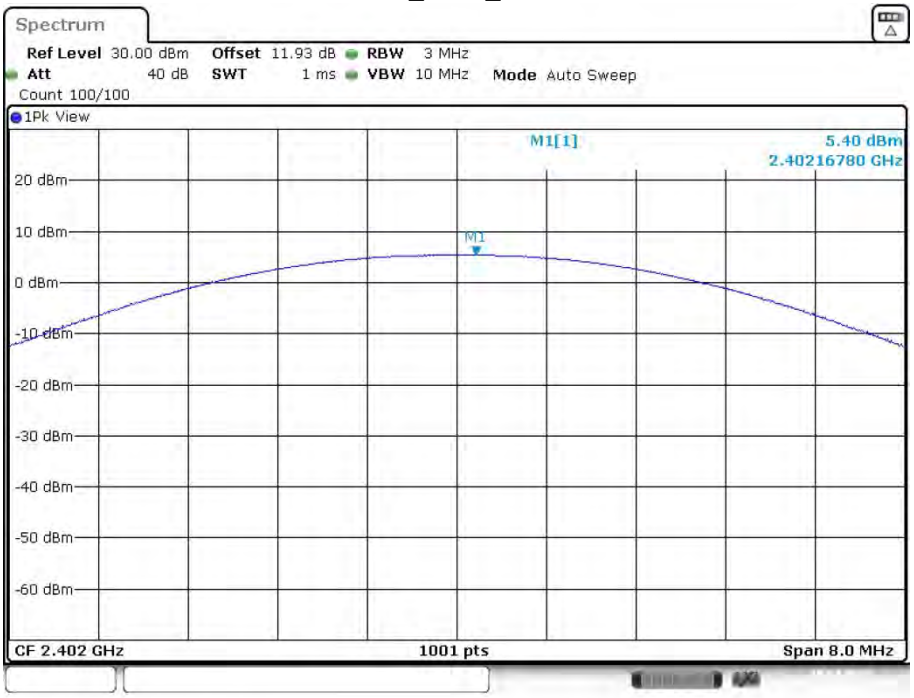
The testing was performed by Jacob Huang on 2023-04-19.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the below table and plots:

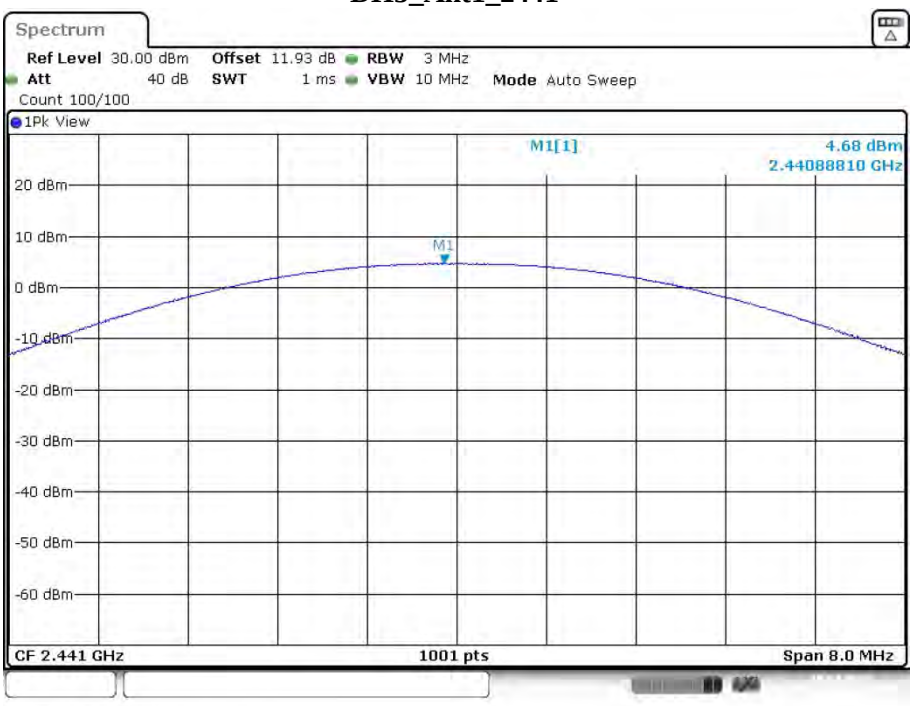
Test Mode	Antenna	Channel	Conducted Peak Output Power [dBm]	Limit[dBm]	Verdict
DH5	Ant1	2402	5.40	≤20.97	PASS
		2441	4.68	≤20.97	PASS
		2480	4.27	≤20.97	PASS
2DH5	Ant1	2402	6.29	≤20.97	PASS
		2441	5.55	≤20.97	PASS
		2480	5.05	≤20.97	PASS
3DH5	Ant1	2402	**6.61**	≤20.97	PASS
		2441	5.87	≤20.97	PASS
		2480	5.41	≤20.97	PASS

DH5_Ant1_2402



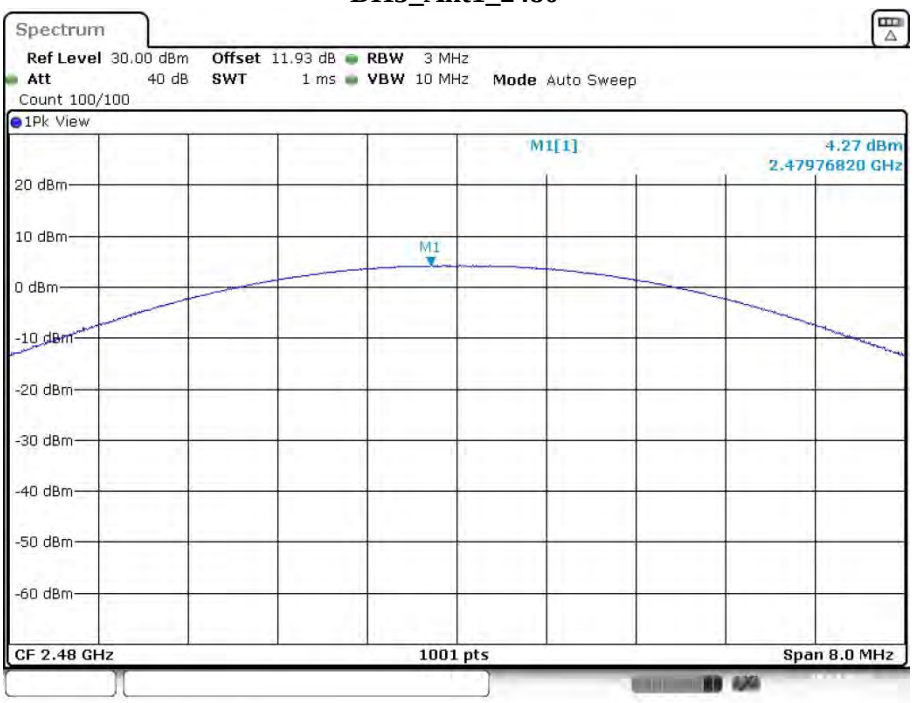
Date: 20.APR.2023 09:57:01

DH5_Ant1_2441

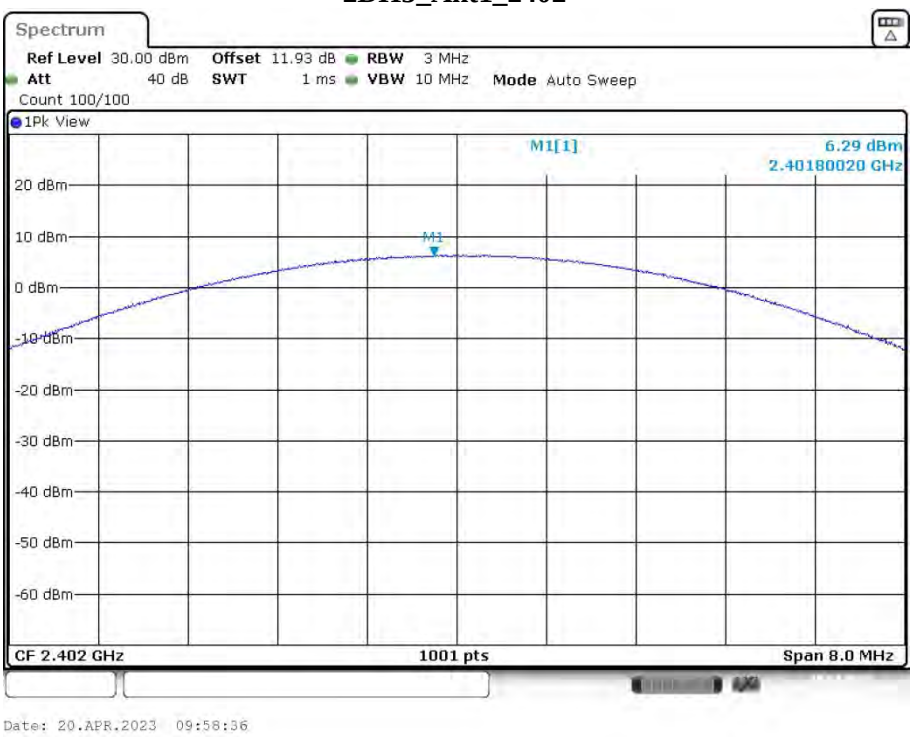


Date: 20.APR.2023 09:57:36

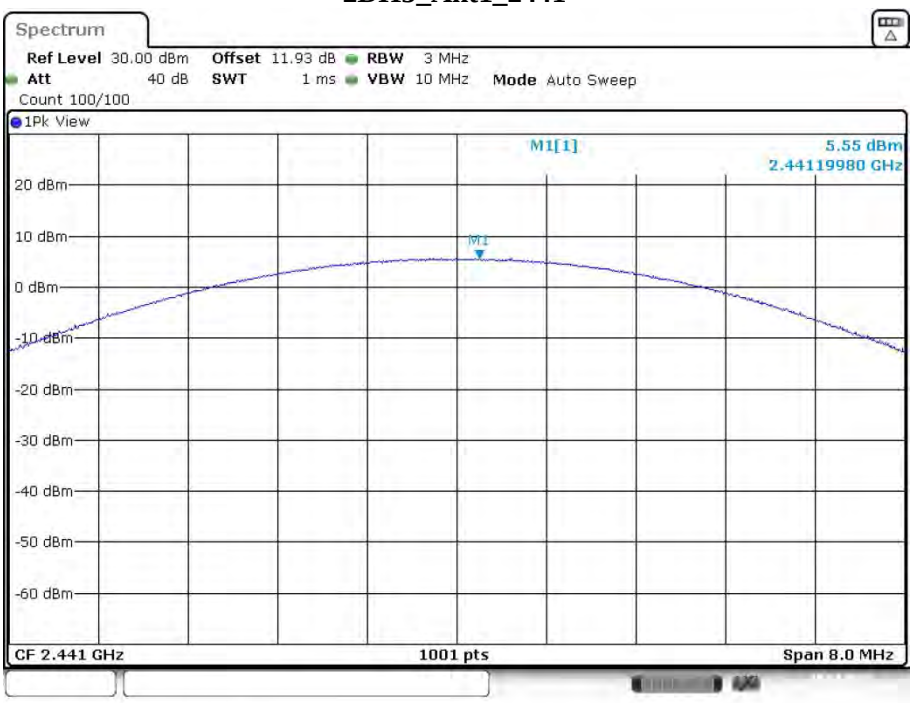
DH5_Ant1_2480



2DH5_Ant1_2402

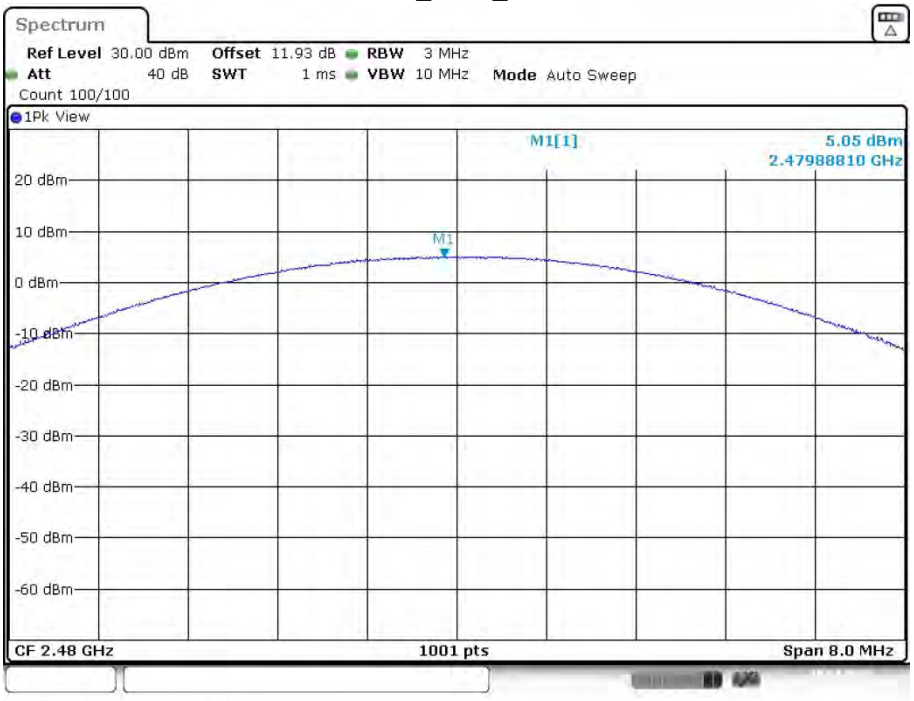


2DH5_Ant1_2441



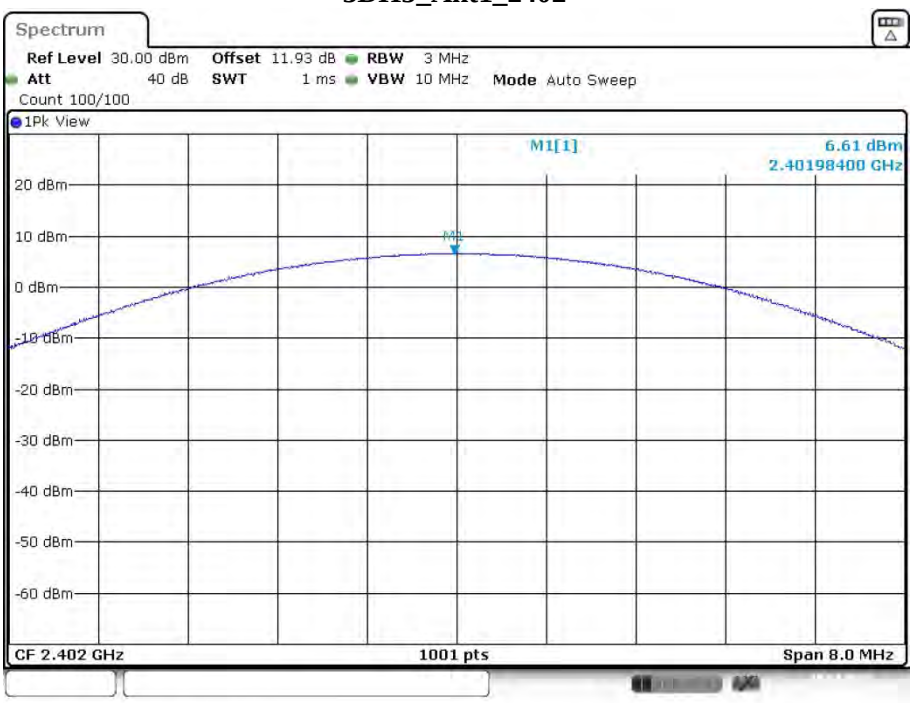
Date: 20.APR.2023 09:59:18

2DH5_Ant1_2480

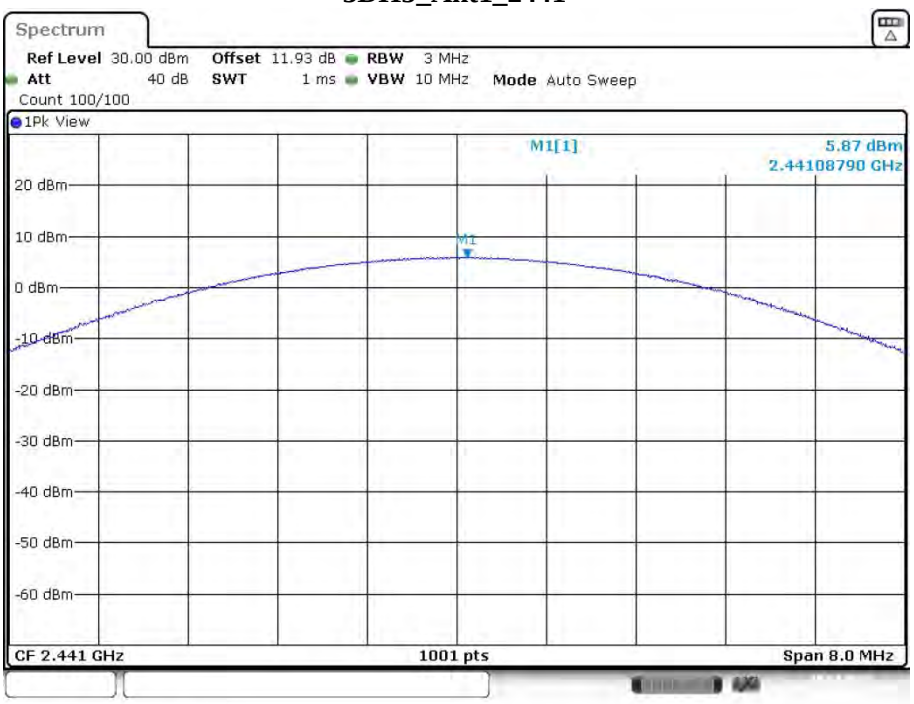


Date: 20.APR.2023 09:59:52

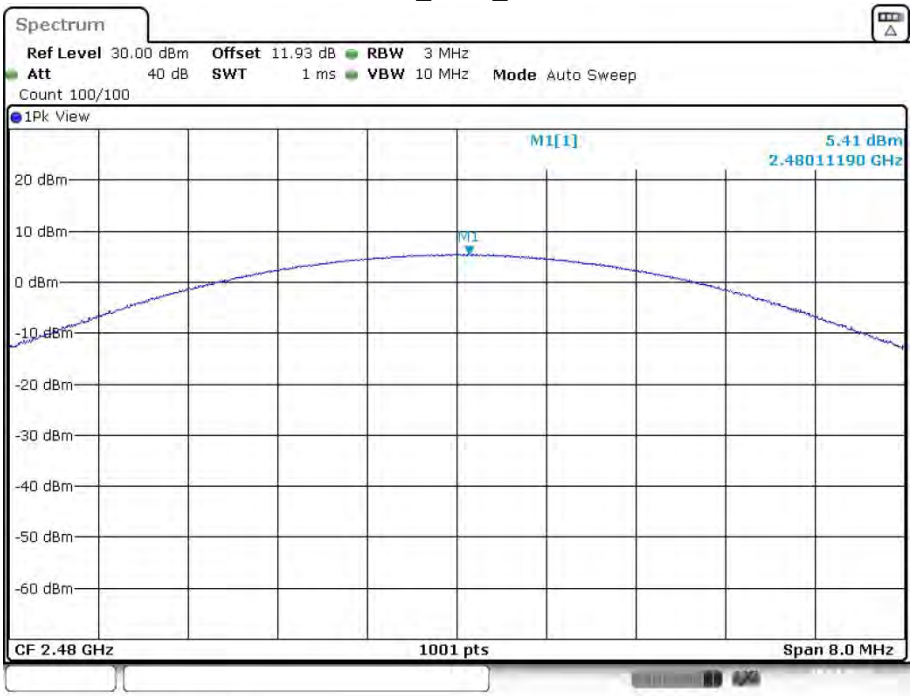
3DH5_Ant1_2402



3DH5_Ant1_2441



3DH5_Ant1_2480



FCC §15.247(d) - BAND EDGES TESTING

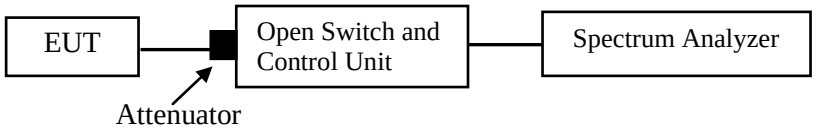
Applicable Standard

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

According to ANSI C63.10-2013, section 7.8.6 and section 6.10

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 TX 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

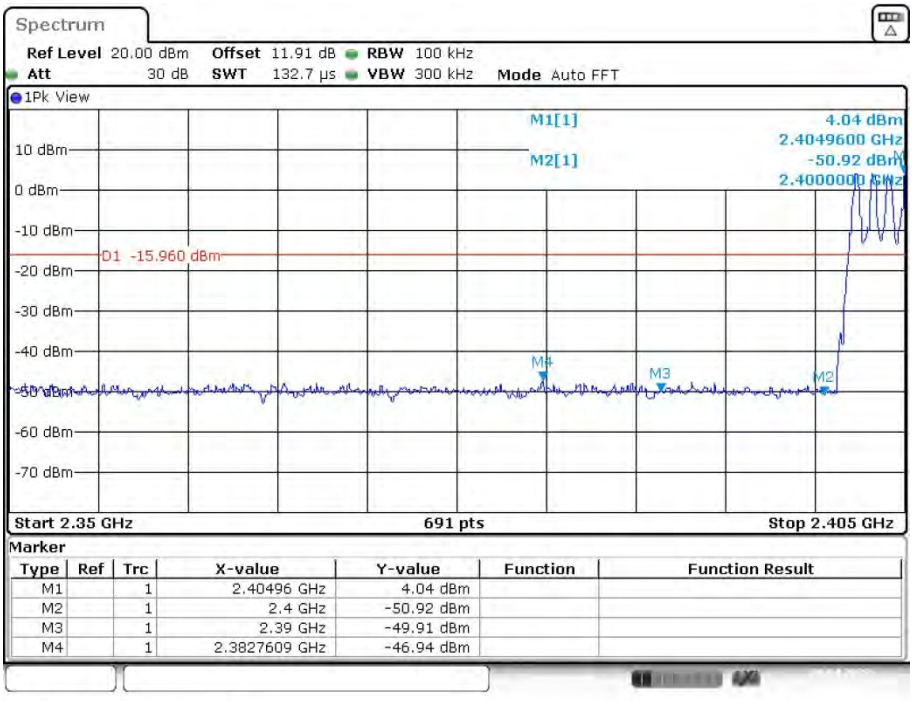
Temperature:	23℃
Relative Humidity:	48-49%
ATM Pressure:	101.0kPa

The testing was performed by Jacob Huang on 2023-04-19 and 2023-04-20.

EUT operation mode: Transmitting

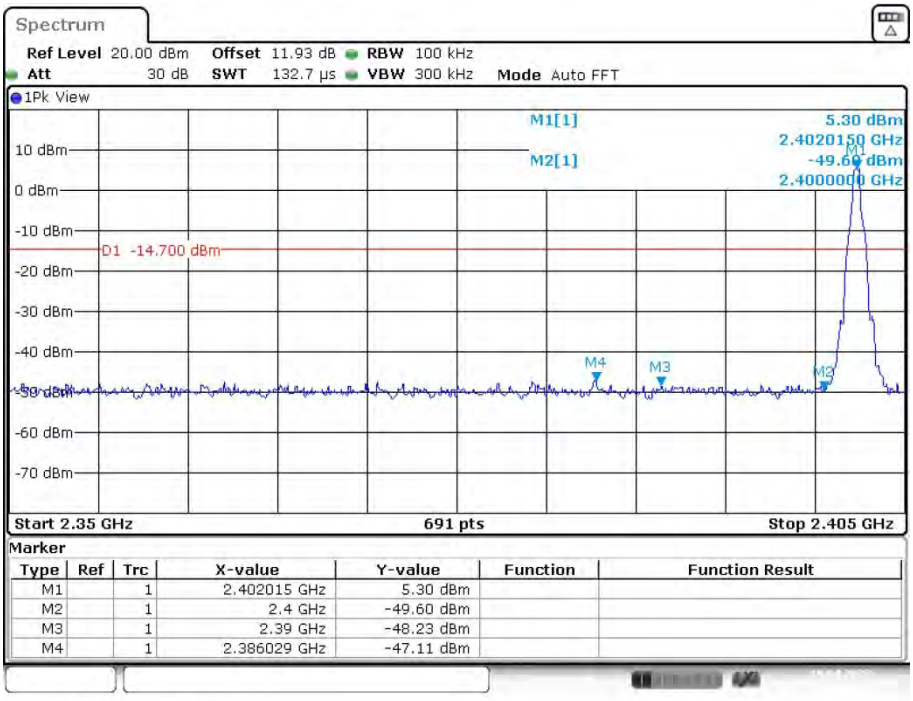
Test Result: Compliant. Please refer to the below plots:

DH5: Band Edge-Left Side
Hopping



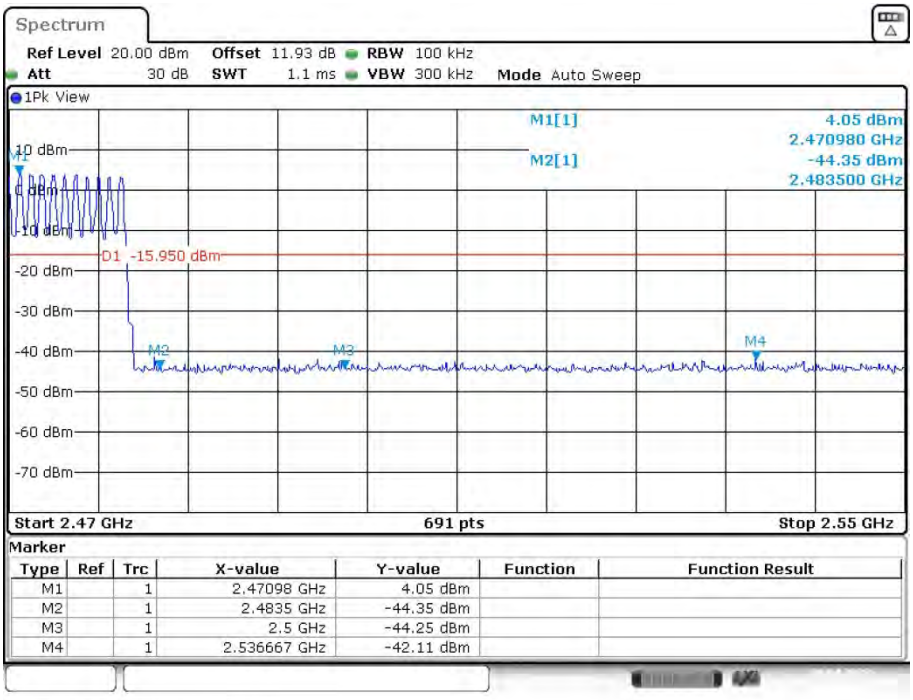
Date: 20.APR.2023 09:49:07

Single



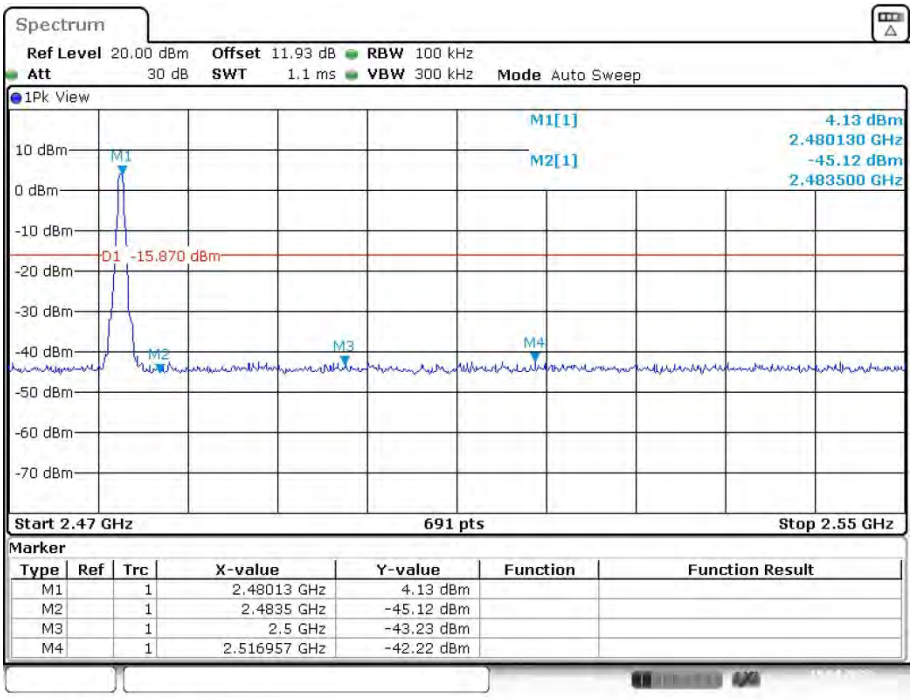
Date: 19.APR.2023 18:06:45

DH5: Band Edge- Right Side
Hopping



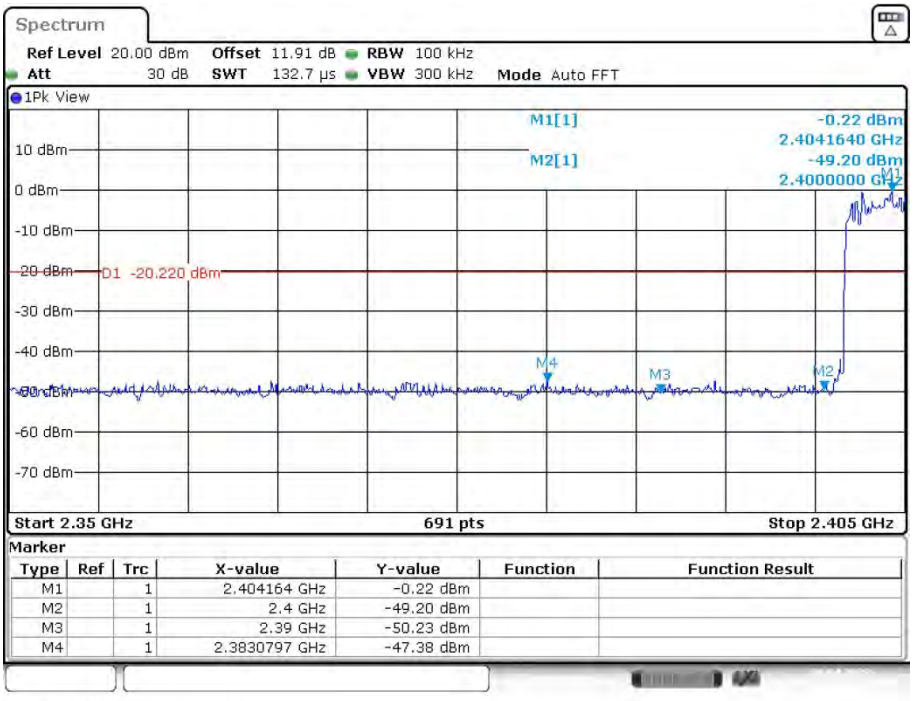
Date: 20.APR.2023 09:50:35

Single



Date: 19.APR.2023 18:50:48

2DH5: Band Edge-Left Side
Hopping

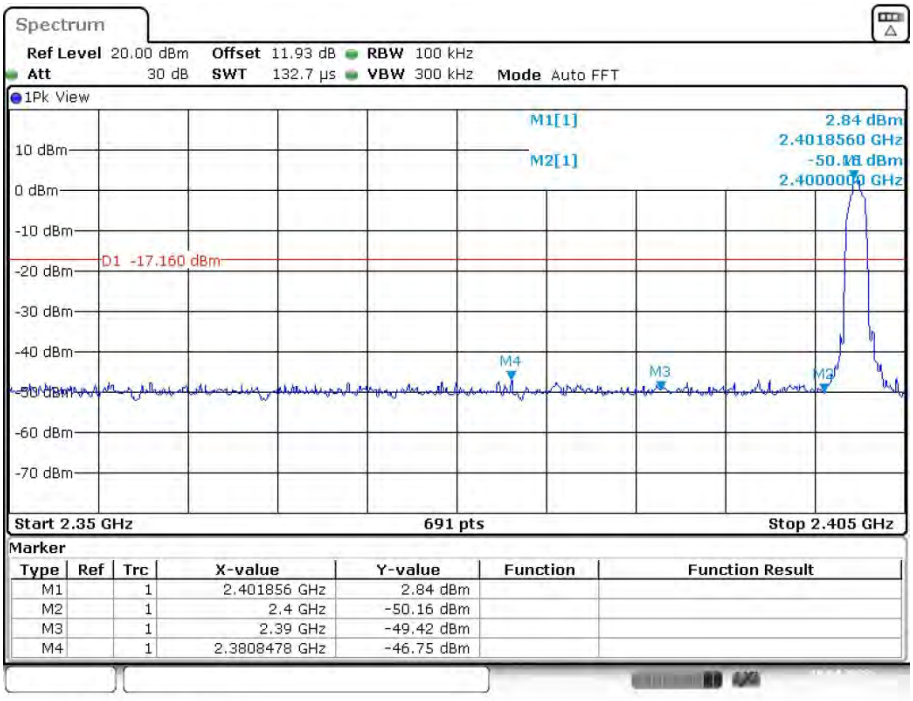


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.404164 GHz	-0.22 dBm		
M2		1	2.4 GHz	-49.20 dBm		
M3		1	2.39 GHz	-50.23 dBm		
M4		1	2.3830797 GHz	-47.38 dBm		

Date: 20.APR.2023 09:51:43

Single



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.401856 GHz	2.84 dBm		
M2		1	2.4 GHz	-50.16 dBm		
M3		1	2.39 GHz	-49.42 dBm		
M4		1	2.3808478 GHz	-46.75 dBm		

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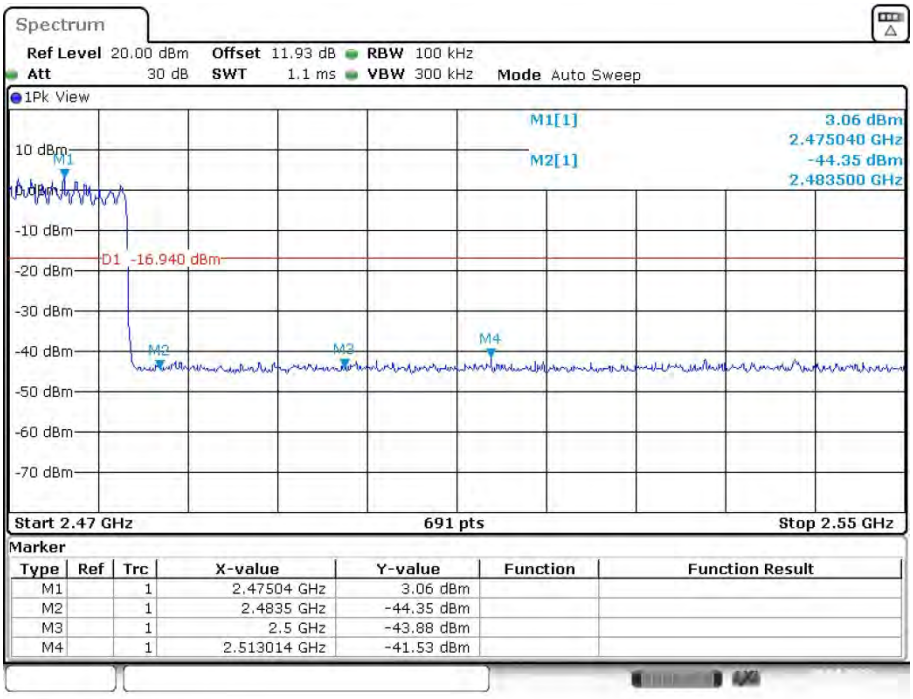
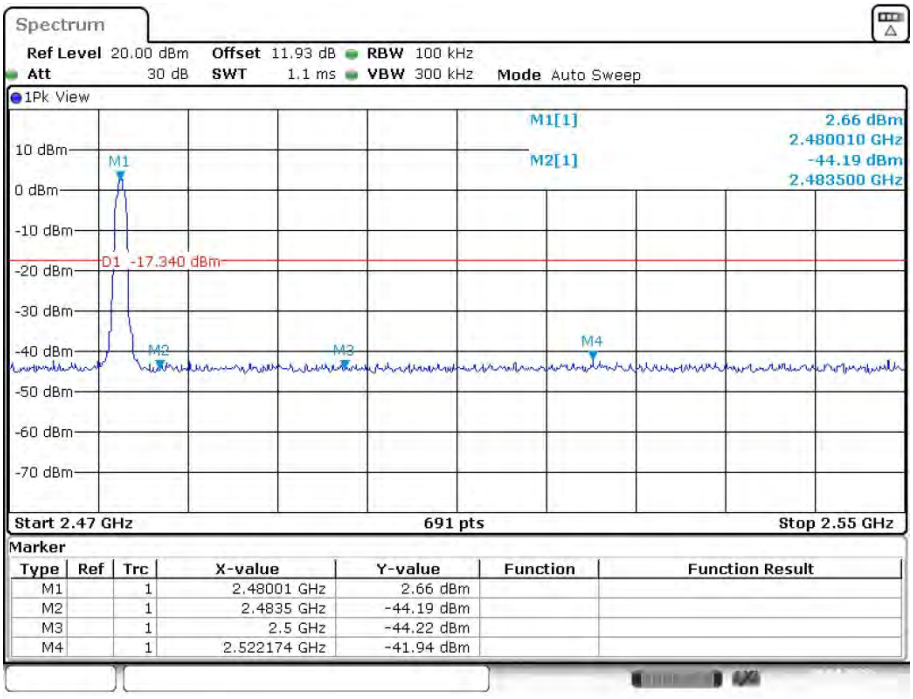
2DH5: Band Edge- Right Side
Hopping



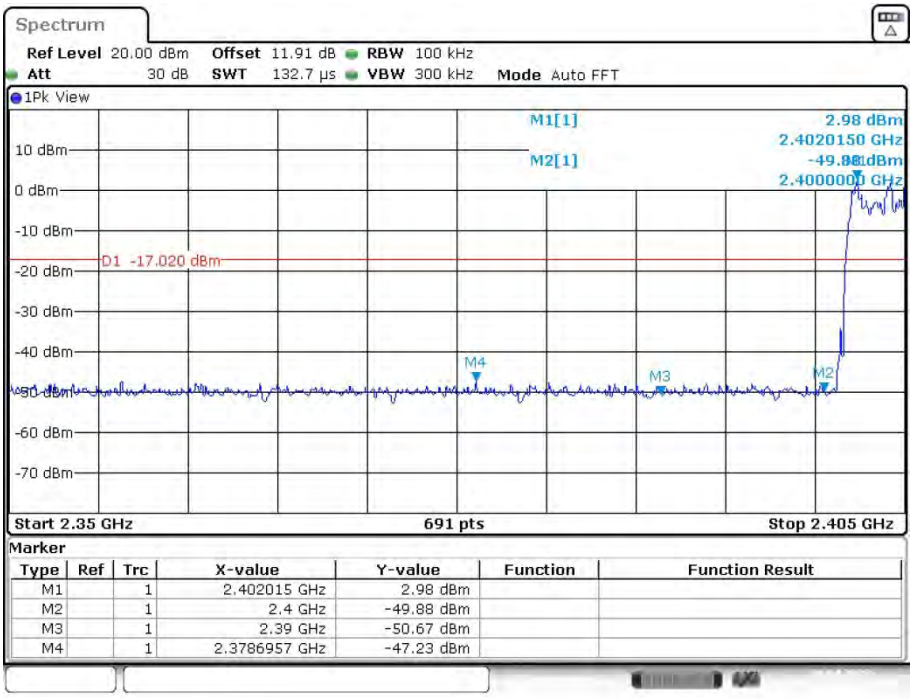
Date: 20.APR.2023 09:53:04

Single

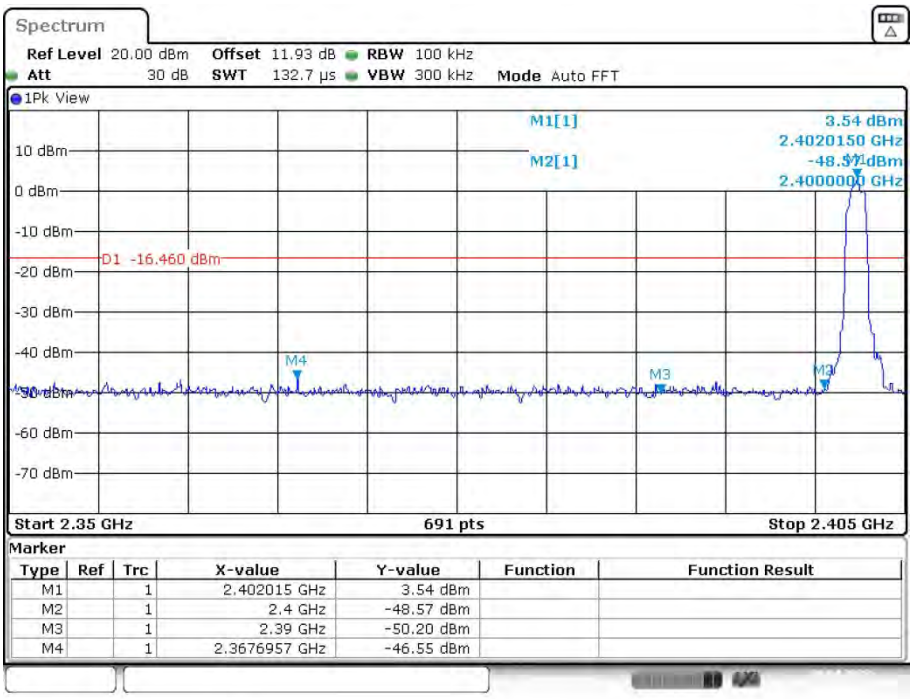


Date: 20.APR.2023 09:36:41

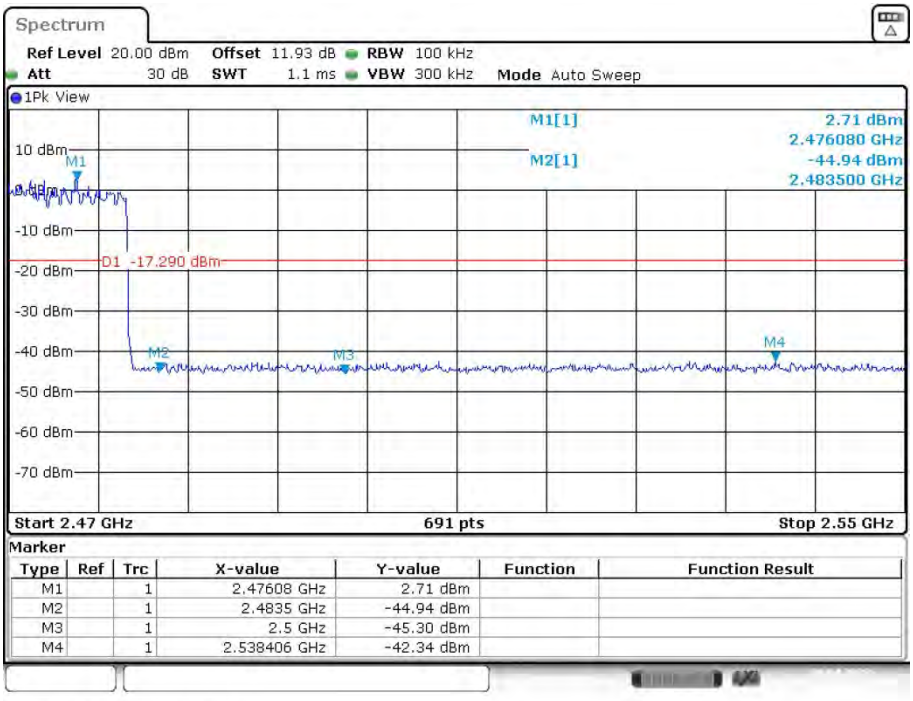
3DH5: Band Edge-Left Side
Hopping



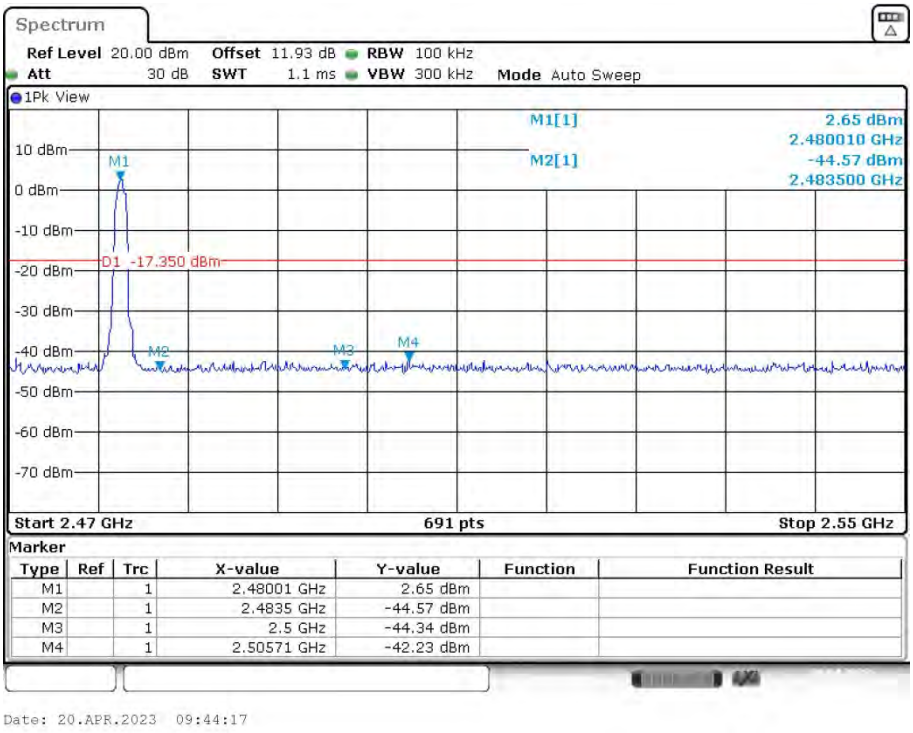
Single



3DH5: Band Edge- Right Side
Hopping



Single



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