



# FCC PART 15.247 TEST REPORT

For

## Zeeva International Limited

Suite 1007B, 10th Floor, Exchange Tower, 33 Wang Chiu Road, Kowloon Bay,  
Hong Kong, China

**FCC ID: 2ADM5-EP-0653**

<b>Report Type:</b> Original Report	<b>Product Type:</b> TWS SLIM FIT AST
<b>Report Number:</b> SZ3210727-31363E-RF-00	
<b>Report Date:</b> 2021-09-10	
<b>Reviewed By:</b> RF Engineer	Jimmy Xiao
<b>Prepared By:</b> Bay Area Compliance Laboratories Corp. (Shenzhen) 5F(B-West), 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, China Tel: +86-755-33320018 Fax: +86-755-33320008 <a href="http://www.baclcorp.com.cn">www.baclcorp.com.cn</a>	

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

BACL 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.

## TABLE OF CONTENTS

<b>GENERAL INFORMATION</b> .....	<b>4</b>
PRODUCT DESCRIPTION FOR EQUIPMENT UNDER TEST (EUT).....	4
OBJECTIVE .....	4
TEST METHODOLOGY .....	4
MEASUREMENT UNCERTAINTY.....	5
TEST FACILITY .....	5
<b>SYSTEM TEST CONFIGURATION</b> .....	<b>6</b>
DESCRIPTION OF TEST CONFIGURATION .....	6
EUT EXERCISE SOFTWARE .....	6
SPECIAL ACCESSORIES.....	6
EQUIPMENT MODIFICATIONS .....	6
SUPPORT EQUIPMENT LIST AND DETAILS .....	6
EXTERNAL I/O CABLE.....	6
BLOCK DIAGRAM OF TEST SETUP .....	7
<b>SUMMARY OF TEST RESULTS</b> .....	<b>8</b>
<b>TEST EQUIPMENT LIST</b> .....	<b>9</b>
<b>FCC§15.247 (i), §1.1307 (b) (1) &amp;§2.1093 – RF EXPOSURE</b> .....	<b>10</b>
APPLICABLE STANDARD .....	10
<b>FCC §15.203 – ANTENNA REQUIREMENT</b> .....	<b>11</b>
APPLICABLE STANDARD .....	11
ANTENNA CONNECTOR CONSTRUCTION .....	11
<b>FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS</b> .....	<b>12</b>
APPLICABLE STANDARD .....	12
EUT SETUP .....	12
EMI TEST RECEIVER SETUP.....	12
TEST PROCEDURE .....	12
CORRECTED FACTOR & MARGIN CALCULATION .....	13
TEST DATA .....	13
<b>FCC §15.205, §15.209 &amp; §15.247(d) – RADIATED EMISSIONS</b> .....	<b>16</b>
APPLICABLE STANDARD .....	16
EUT SETUP .....	16
EMI TEST RECEIVER & SPECTRUM ANALYZER SETUP .....	17
TEST PROCEDURE .....	17
CORRECTED AMPLITUDE & MARGIN CALCULATION .....	17
TEST DATA .....	17
<b>FCC §15.247(a) (1)-CHANNEL SEPARATION TEST</b> .....	<b>24</b>
APPLICABLE STANDARD .....	24
TEST PROCEDURE .....	24
TEST DATA .....	24
<b>FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH</b> .....	<b>25</b>
APPLICABLE STANDARD .....	25
TEST PROCEDURE .....	25
TEST DATA .....	25

**FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST .....26**  
 APPLICABLE STANDARD .....26  
 TEST PROCEDURE .....26  
 TEST DATA .....26

**FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).....27**  
 APPLICABLE STANDARD .....27  
 TEST PROCEDURE .....27  
 TEST DATA .....27

**FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT .....28**  
 APPLICABLE STANDARD .....28  
 TEST PROCEDURE .....28  
 TEST DATA .....28

**FCC §15.247(d) - BAND EDGES TESTING .....29**  
 APPLICABLE STANDARD .....29  
 TEST PROCEDURE .....29  
 TEST DATA .....29

**APPENDIX .....30**  
 APPENDIX A: 20dB EMISSION BANDWIDTH.....30  
 APPENDIX B: OCCUPIED CHANNEL BANDWIDTH .....34  
 APPENDIX C: MAXIMUM CONDUCTED PEAK OUTPUT POWER.....38  
 APPENDIX D: CARRIER FREQUENCY SEPARATION .....42  
 APPENDIX E: TIME OF OCCUPANCY .....44  
 APPENDIX F: NUMBER OF HOPPING CHANNELS .....51  
 APPENDIX G: BAND EDGE MEASUREMENTS .....53

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

Product	TWS SLIM FIT AST
Tested Model	EP-0653
SKU Number	Black: 4550025 White: 4550026 Blue: 4550027 Pink: 4550028
UPC Number	Black: 1922340850222 White: 1922340850239 Blue: 1922340850246 Pink: 1922340850253
Frequency Range	Bluetooth: 2402-2480MHz
Maximum conducted Peak output power	Bluetooth: 7.94 dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification*	-0.58dBi(It is provided by the applicant)
Voltage Range	DC 3.7V from battery
Date of Test	2021-08-02 to 2021-09-10
Sample number	SZ3210727-31363E-RF-S1 , SZ3210727-31363E-RF-S2 (Assigned by BAACL, Shenzhen)
Received date	2021-07-27
Sample/EUT Status	Good condition

### Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions 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 Bay Area Compliance Laboratories Corp. (Shenzhen). 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 Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
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 Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, 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.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

## SYSTEM TEST CONFIGURATION

### Description of Test Configuration

The system was configured for testing in an engineering mode.

### EUT Exercise Software

“BT\_TOOL”\* software was used to the EUT tested and power level is 7. The software and power level was provided by the applicant.

### Special Accessories

No special accessory.

### Equipment Modifications

No modification was made to the EUT tested.

### Support Equipment List and Details

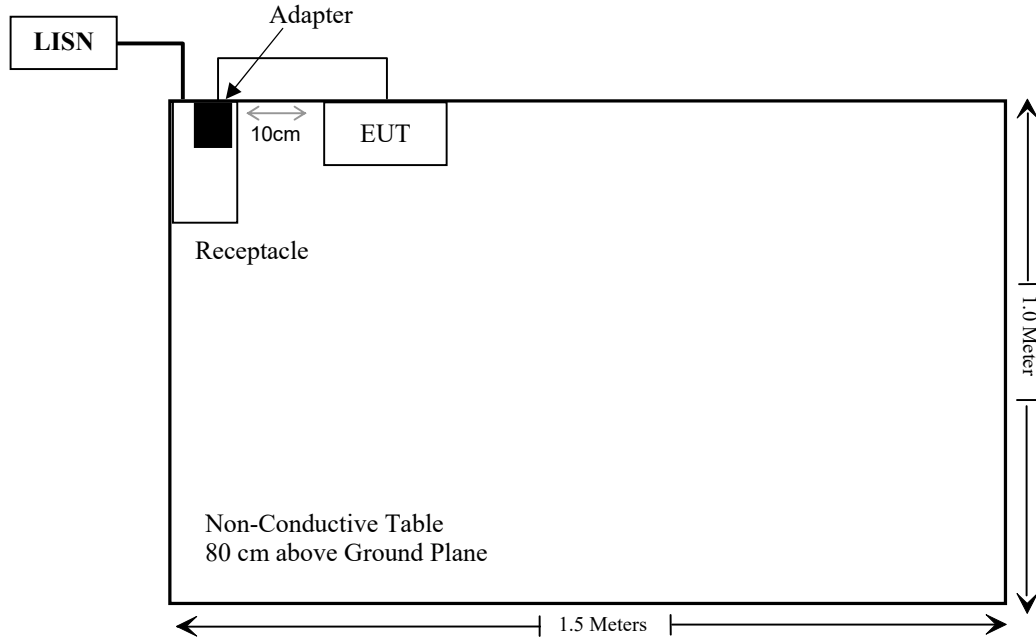
Manufacturer	Description	Model	Serial Number
ZTE	Adapter	STC-A51A	/
BULL	Receptacle	GN-415K	5503290068073

### External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Detachable USB Cable	0.2	EUT	Adapter

### Block Diagram of Test Setup

For conducted emission:



**SUMMARY OF TEST RESULTS**

<b>FCC Rules</b>	<b>Description of Test</b>	<b>Result</b>
§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	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
<b>Conducted Emissions Test</b>					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2021/07/07	2022/07/06
Rohde & Schwarz	LISN	ENV216	101613	2021/07/07	2022/07/06
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2020/11/29	2021/11/28
Unknown	CE Cable	CE Cable	UF A210B-1-0720-504504	2020/11/29	2021/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
<b>Radiated Emission Test</b>					
R&S	EMI Test Receiver	ESR3	102455	2021/07/06	2022/07/05
Sonoma instrument	Pre-amplifier	310 N	186238	2021/08/04	2022/08/03
Sunol Sciences	Broadband Antenna	JB1	A040904-2	2020/12/22	2023/12/21
Unknown	Cable 2	RF Cable 2	F-03-EM197	2020/11/29	2021/11/28
Unknown	Cable	Chamber Cable 1	F-03-EM236	2020/11/29	2021/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2021/07/06	2022/07/05
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/28	2021/11/27
Sunol Sciences	Horn Antenna	3115	9107-3694	2021/01/15	2024/01/14
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28
Insulated Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2021/04/20	2022/04/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-021304	2020/12/06	2023/12/05
<b>RF Conducted Test</b>					
Tonscend Corporation	RF control Unit	JS0806-2	19D8060154	2021/07/06	2022/07/05
Rohde & Schwarz	Signal and Spectrum Analyzer	FSV40	101473	2021/07/06	2022/07/05
Unknown	RF Cable	Unknown	2301 276	2020/11/29	2021/11/28
Yijia	Temperature & Humidity Meter	10316377	T-03-EM397	2020/09/30	2021/09/29

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) 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  $\leq 50$  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  $\leq 7.5$  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.

**For worst case:**

Frequency (MHz)	Maximum Tune-up power		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2402-2480	8.50	7.08	5	2.2	3.0	Yes

**Result: No Standalone 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 an internal antenna arrangement, which was permanently attached and the antenna gain is  $-0.58\text{dBi}$ , fulfill the requirement of this section. Please refer to the EUT photos.

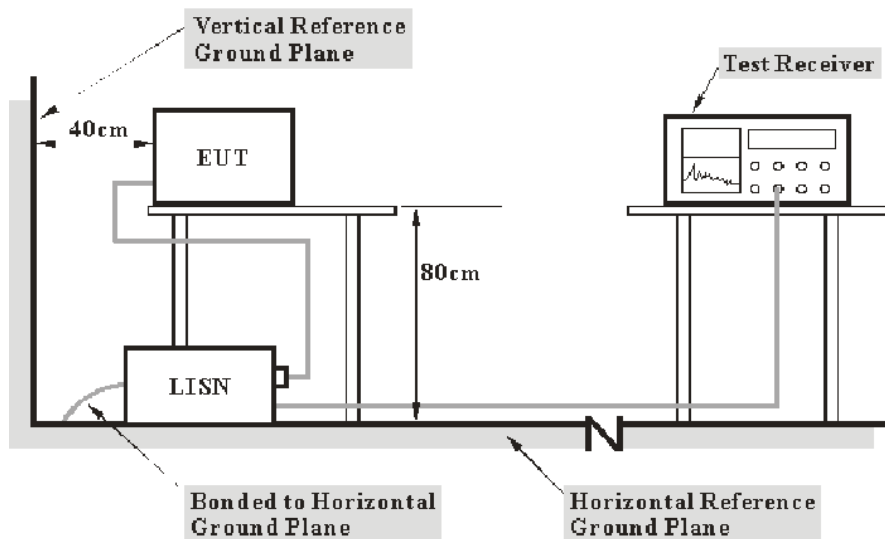
**Result:** Compliant.

## 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

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.

## Corrected Factor & Margin Calculation

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

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Data

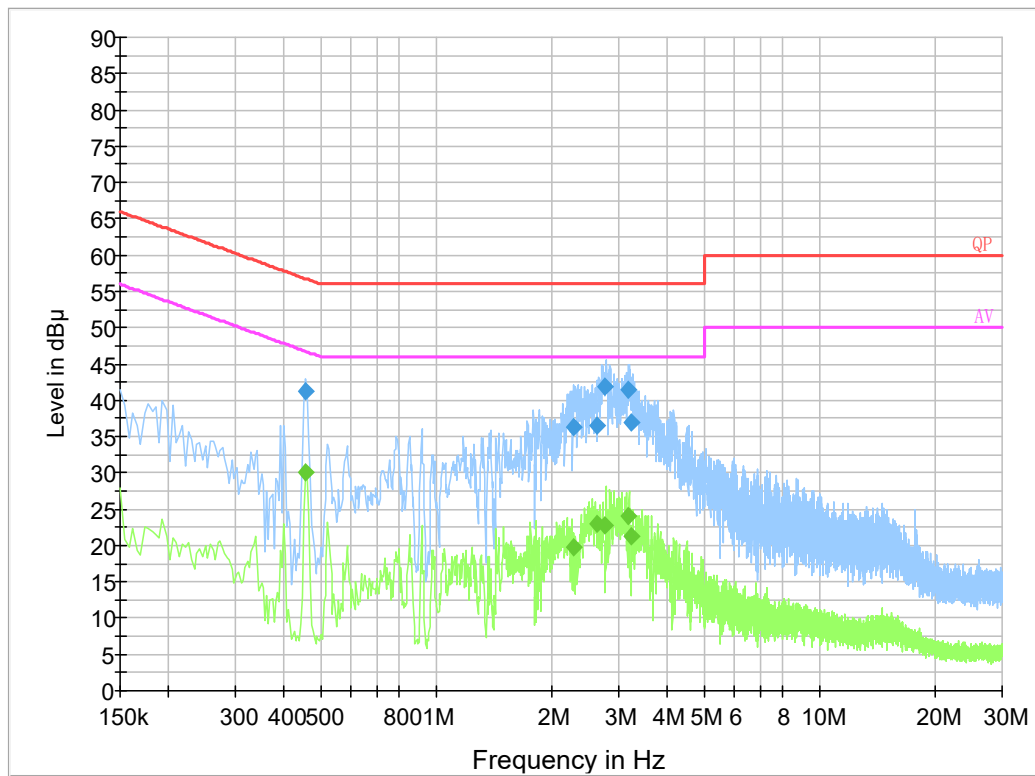
### Environmental Conditions

<b>Temperature:</b>	25 °C
<b>Relative Humidity:</b>	65 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Haiguo Li on 2021-08-02.*

*EUT operation mode: Charging*

AC 120V/60 Hz, Line



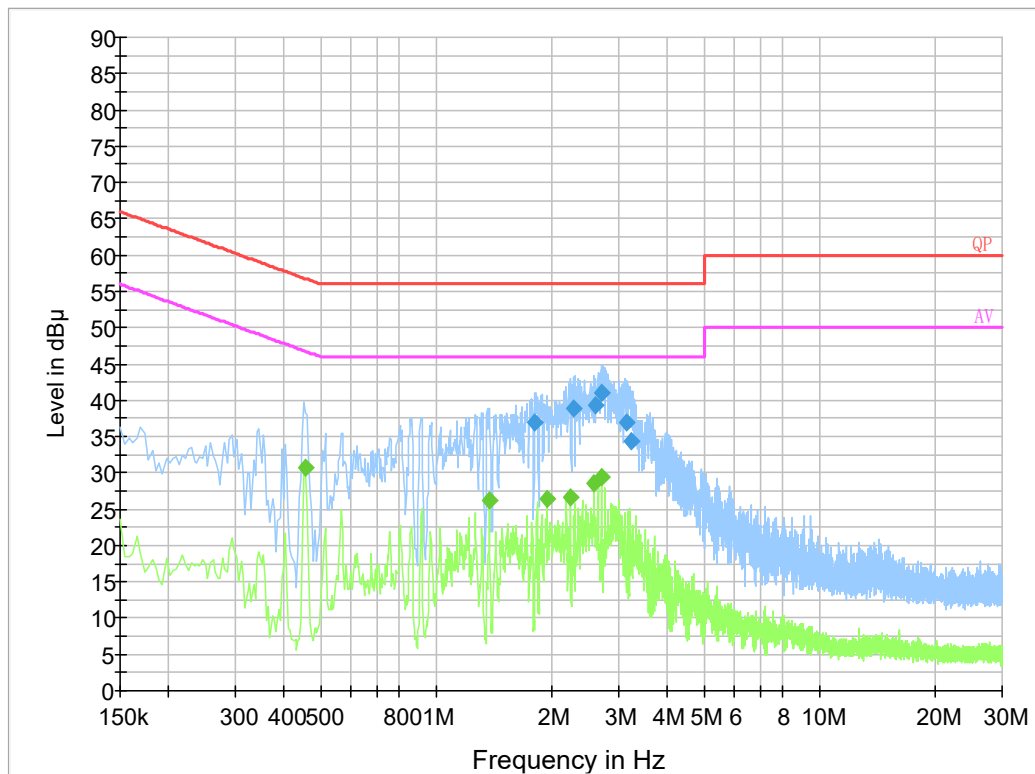
Final Result 1

Frequency (MHz)	QuasiPeak (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
0.455130	41.2	9.000	L1	19.8	15.6	56.8
2.283650	36.4	9.000	L1	19.9	19.6	56.0
2.634670	36.5	9.000	L1	19.9	19.5	56.0
2.760270	41.8	9.000	L1	19.9	14.2	56.0
3.170210	41.5	9.000	L1	19.9	14.5	56.0
3.245190	36.9	9.000	L1	19.9	19.1	56.0

Final Result 2

Frequency (MHz)	Average (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
0.455130	30.2	9.000	L1	19.8	16.6	46.8
2.283650	19.8	9.000	L1	19.9	26.2	46.0
2.634670	23.0	9.000	L1	19.9	23.0	46.0
2.760270	22.7	9.000	L1	19.9	23.3	46.0
3.170210	24.0	9.000	L1	19.9	22.0	46.0
3.245190	21.2	9.000	L1	19.9	24.8	46.0

**AC 120V/60 Hz, Neutral**



**Final Result 1**

Frequency (MHz)	QuasiPeak (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
1.814790	36.9	9.000	N	19.8	19.1	56.0
2.287530	38.8	9.000	N	19.8	17.2	56.0
2.603270	39.3	9.000	N	19.8	16.7	56.0
2.701470	40.9	9.000	N	19.8	15.1	56.0
3.131170	37.0	9.000	N	19.9	19.0	56.0
3.244950	34.3	9.000	N	19.9	21.7	56.0

**Final Result 2**

Frequency (MHz)	Average (dB µ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB µ V)
0.458000	30.8	9.000	N	19.8	15.9	46.7
1.378000	26.2	9.000	N	19.8	19.8	46.0
1.946000	26.3	9.000	N	19.9	19.7	46.0
2.246000	26.5	9.000	N	19.8	19.5	46.0
2.590000	28.5	9.000	N	19.8	17.5	46.0
2.702000	29.5	9.000	N	19.8	16.5	46.0

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

**Applicable Standard**

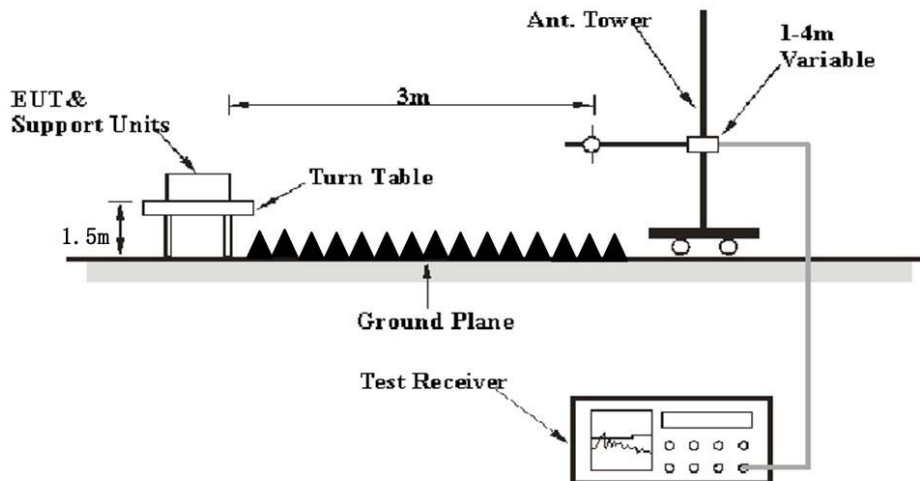
FCC §15.205; §15.209; §15.247(d)

**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

During the radiated emission test, 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 Amplitude & Margin Calculation

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

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

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

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

## Test Data

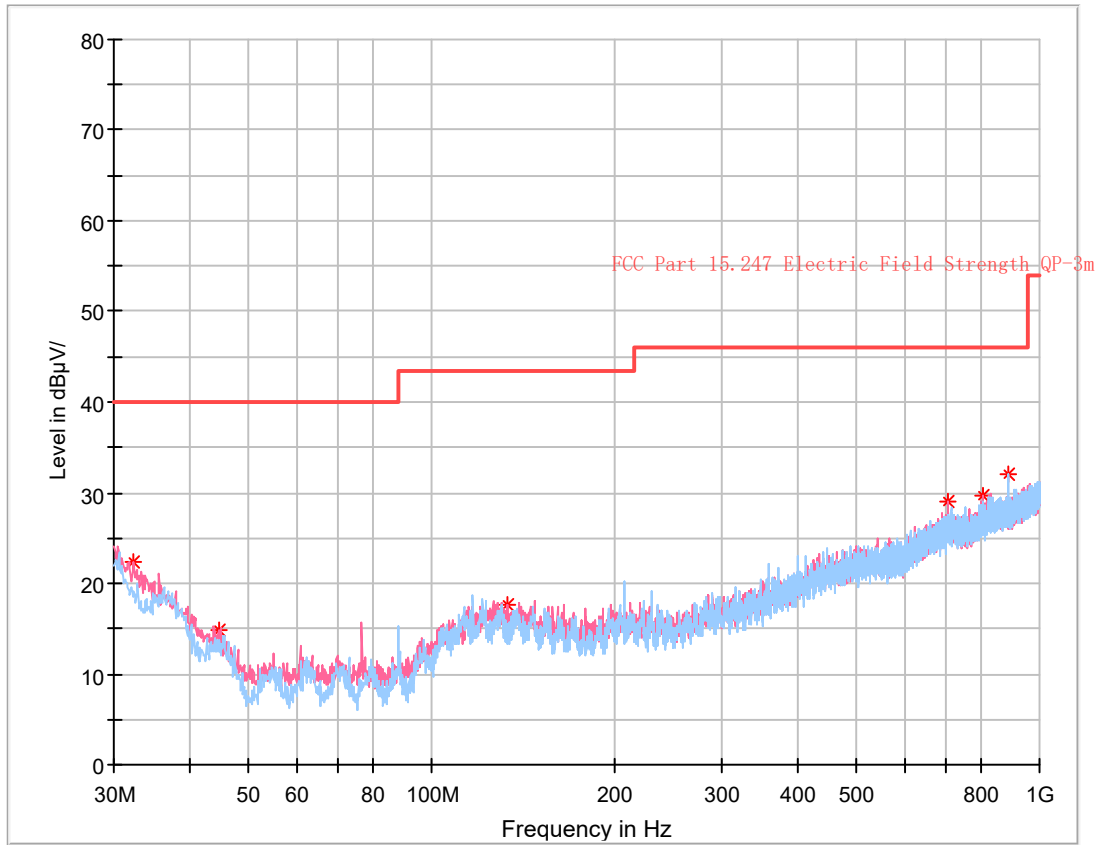
### Environmental Conditions

<b>Temperature:</b>	25.8~30 °C
<b>Relative Humidity:</b>	51~56 %
<b>ATM Pressure:</b>	101~101.2 kPa

*The testing was performed by William Wang on 2021-09-10 for below 1GHz and Bruce Lin on 2021-08-04 for above 1GHz.*

*EUT operation mode: Transmitting*

**30 MHz~1 GHz: (Low channel in 8DPSK is worst case)**



**Critical Freqs**

Frequency (MHz)	MaxPeak (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
32.303750	22.35	40.00	17.65	300.0	V	157.0	-5.3
44.550000	14.80	40.00	25.20	200.0	V	191.0	-13.5
133.305000	17.70	43.50	25.80	100.0	V	301.0	-10.4
706.938750	29.14	46.00	16.86	200.0	V	191.0	-1.5
804.666250	29.70	46.00	16.30	200.0	V	0.0	-0.5
889.662500	31.99	46.00	14.01	200.0	H	0.0	0.8

1 GHz - 25 GHz: (Scan with GFSK,  $\pi/4$ -DQPSK, 8DPSK mode, the worst case is 8DPSK Mode)

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
	Reading (dB $\mu$ V)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2389.91	29.13	PK	55	1.1	H	31.87	61.00	74	13.00
2389.91	14.73	Ave.	55	1.1	H	31.87	46.60	54	7.40
2484.43	29.45	PK	300	1.5	H	32.13	61.58	74	12.42
2484.43	14.51	Ave.	300	1.5	H	32.13	46.64	54	7.36
4804.00	50.11	PK	46	2.3	H	6.28	56.39	74	17.61
4804.00	40.33	Ave.	46	2.3	H	6.28	46.61	54	7.39
Middle Channel (2441 MHz)									
4882.00	48.25	PK	42	1.8	H	6.76	55.01	74	18.99
4882.00	37.14	Ave.	42	1.8	H	6.76	43.90	54	10.10
High Channel (2480 MHz)									
2389.60	29.54	PK	146	2.0	H	31.87	61.41	74	12.59
2389.60	14.77	Ave.	146	2.0	H	31.87	46.64	54	7.36
2483.55	29.61	PK	336	2.2	H	32.13	61.74	74	12.26
2483.55	14.74	Ave.	336	2.2	H	32.13	46.87	54	7.13
4960.00	47.53	PK	165	1.8	H	6.80	54.33	74	19.67
4960.00	36.06	Ave.	165	1.8	H	6.80	42.86	54	11.14

Note:

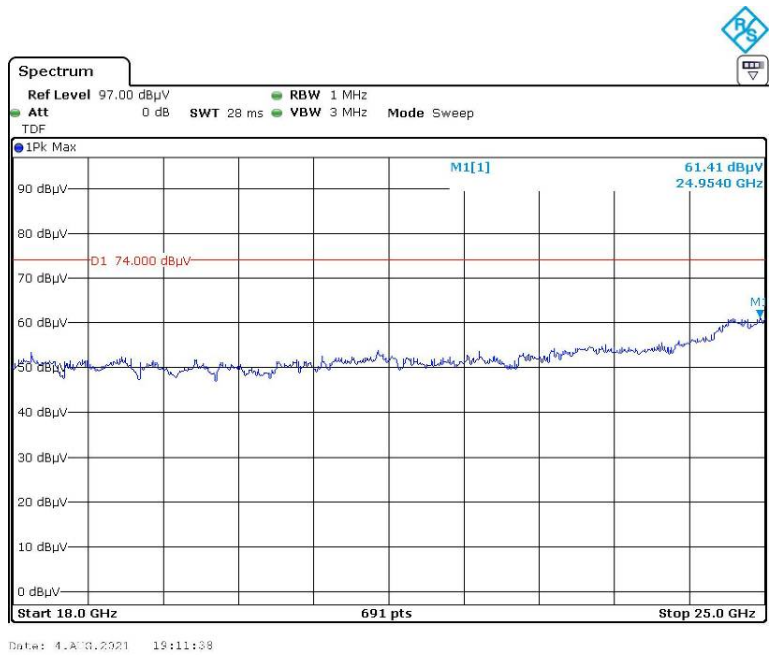
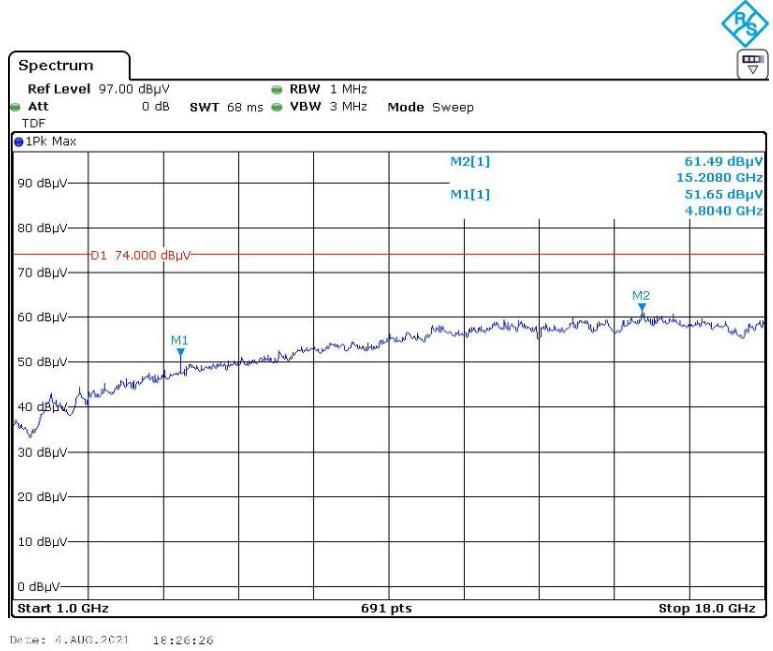
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

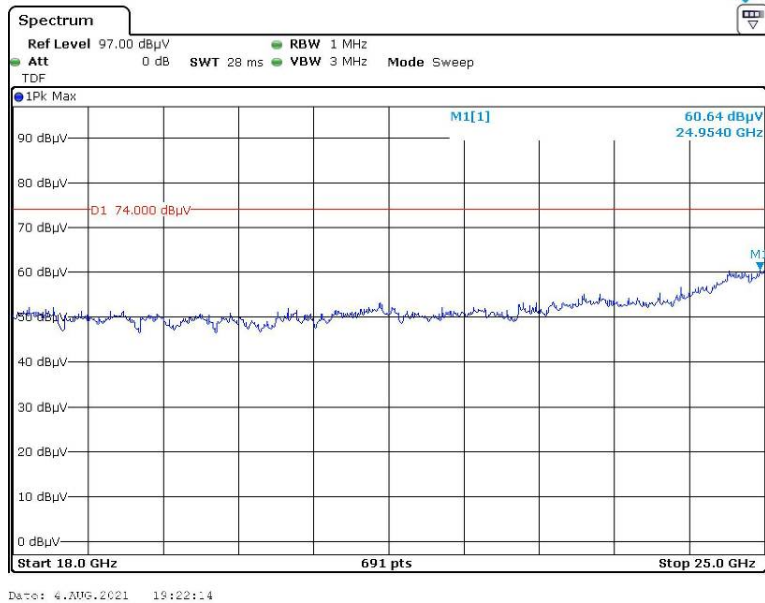
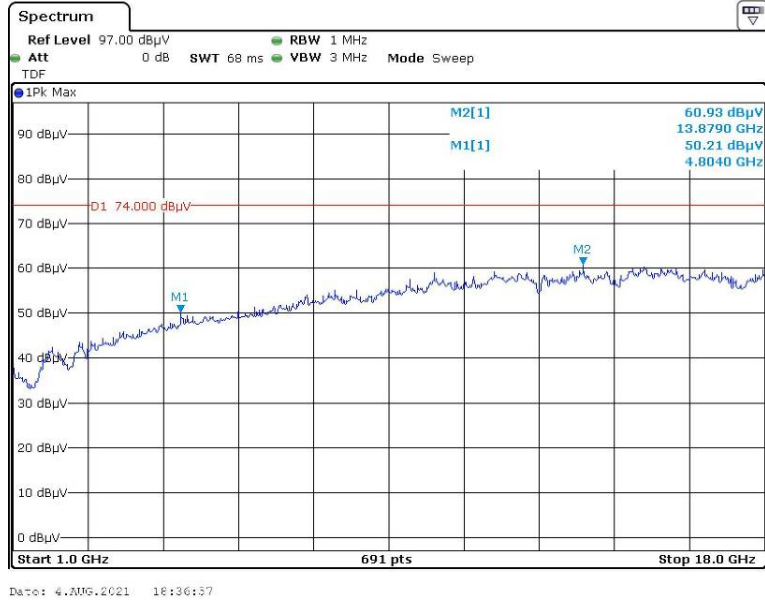
Margin = Limit - Corrected. Amplitude

The other spurious emission which is 20dB to the limit was not recorded.

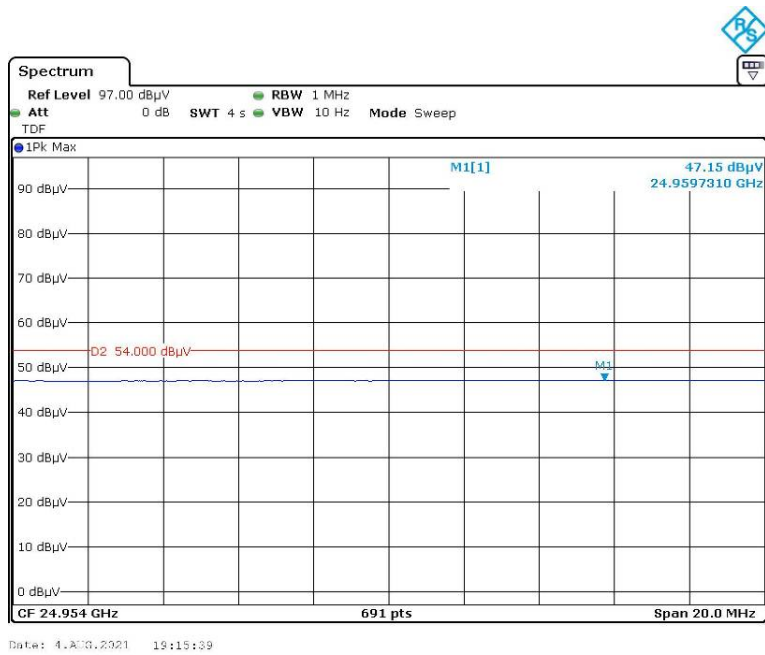
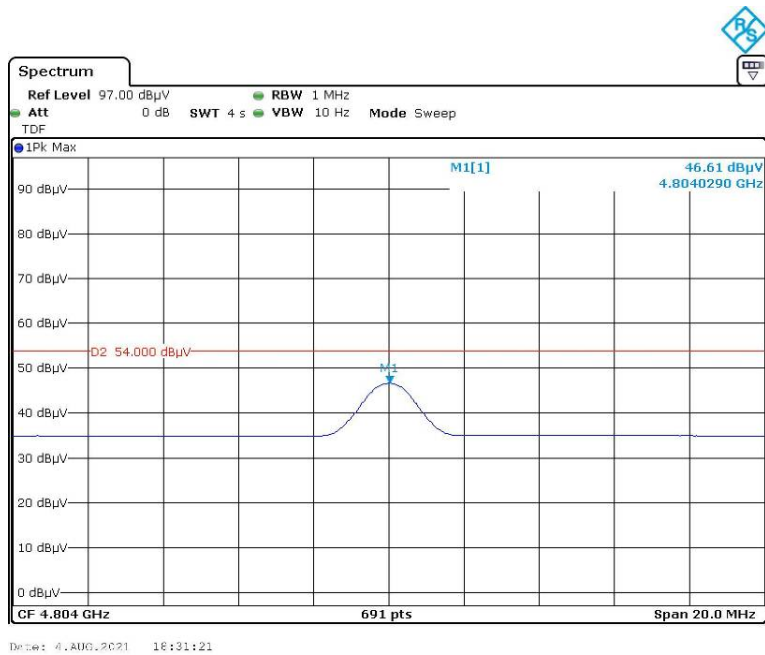
### Pre-scan with Low channel Peak Horizontal



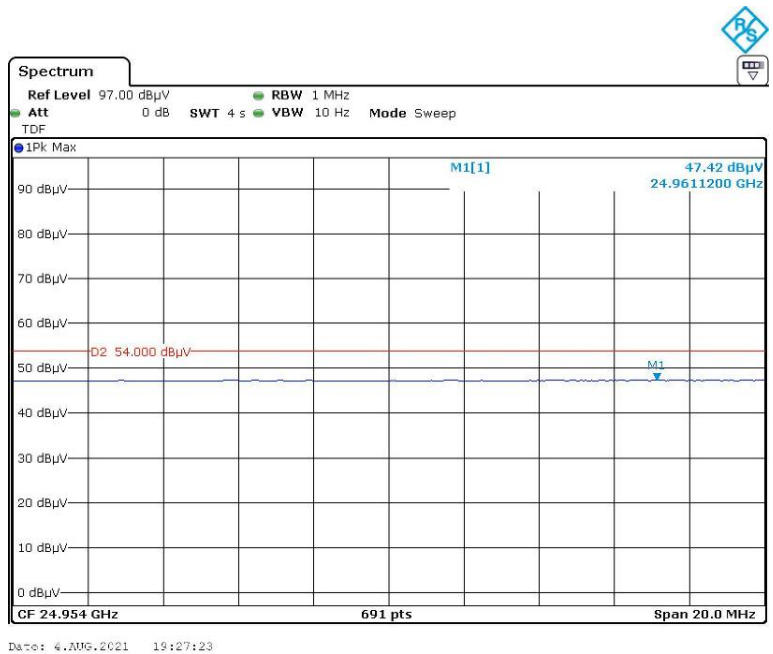
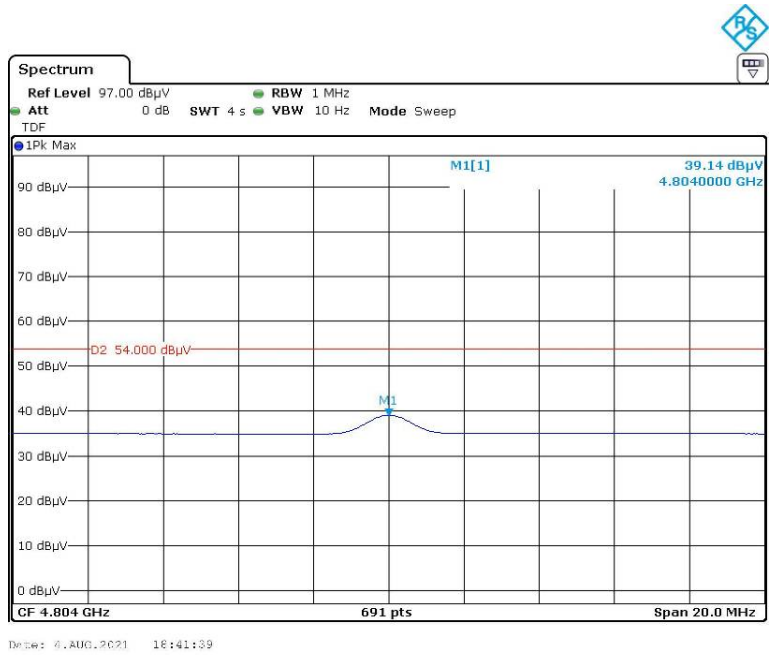
Vertical



### Average 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

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.



## **FCC §15.247(a) (1) – 20 dB EMISSION 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**

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

### **Test Data**

#### **Environmental Conditions**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

**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**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

**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**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

## 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

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

*EUT operation mode: Transmitting*

Test Result: Compliant. Please refer to the Appendix.

## 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

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	55 %
<b>ATM Pressure:</b>	101.0 kPa

*The testing was performed by Bravos Zhao on 2021-08-05.*

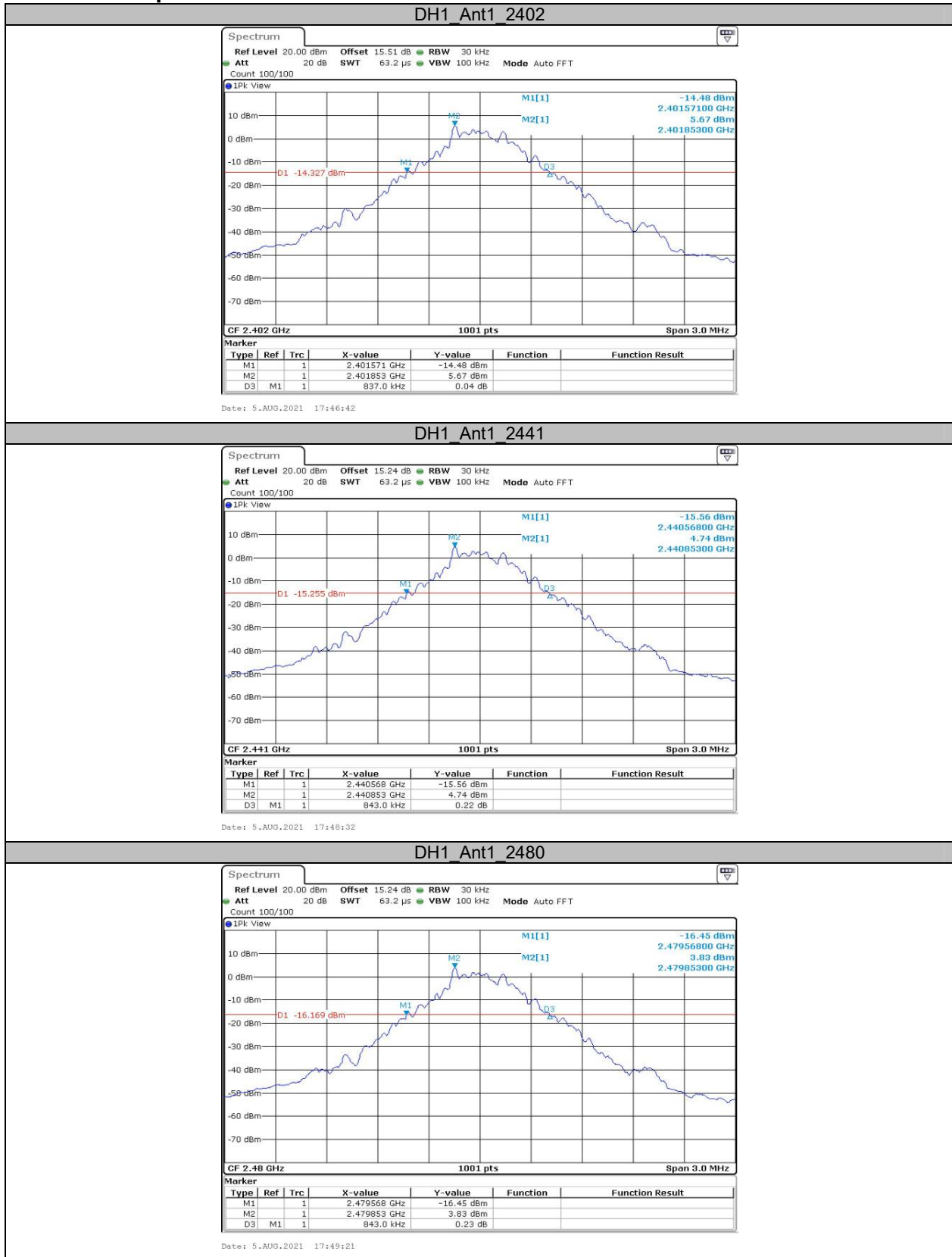
*EUT operation mode: Transmitting*

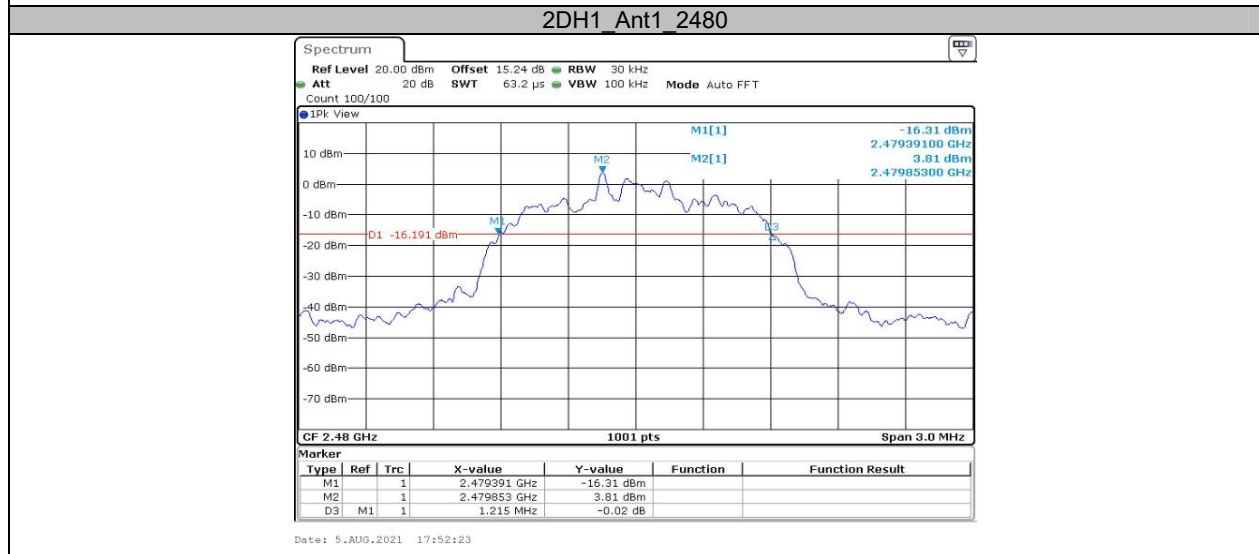
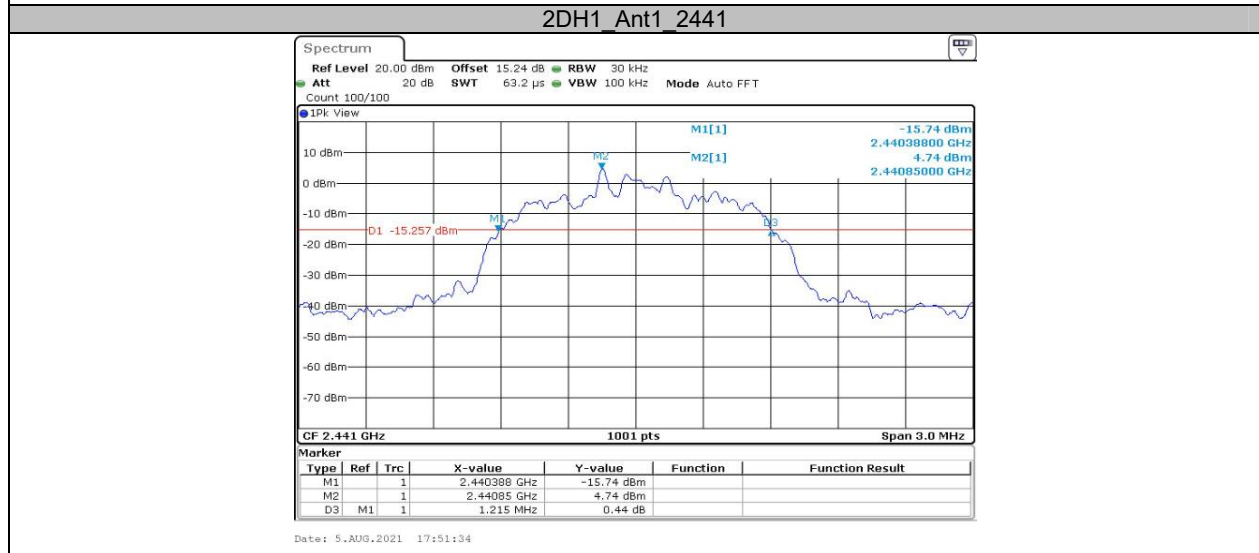
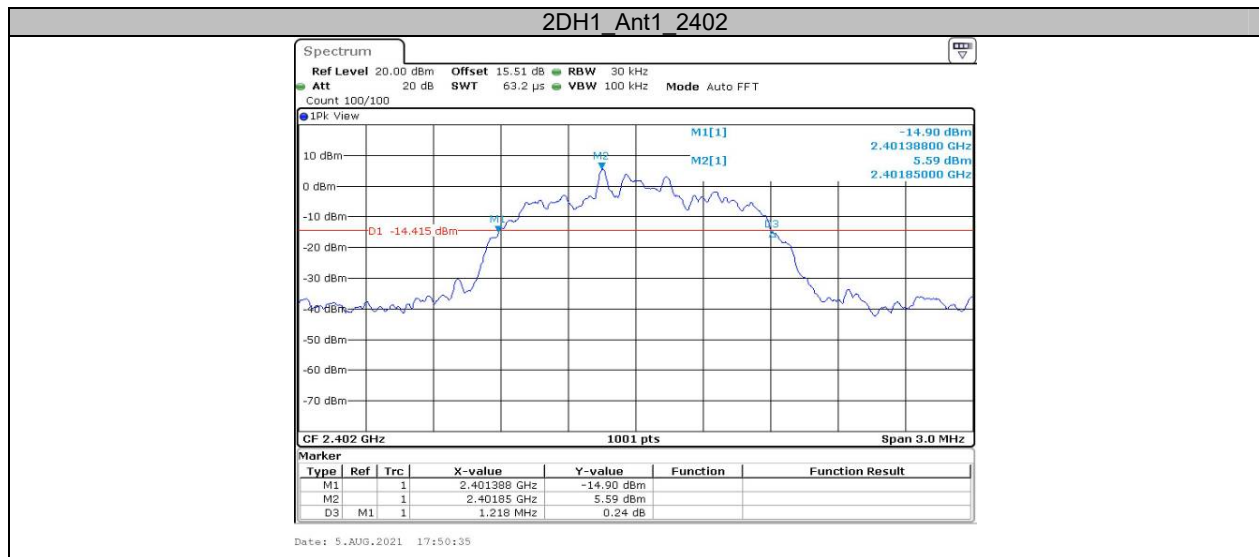
Test Result: Compliant. Please refer to the Appendix.

**APPENDIX****Appendix A: 20dB Emission Bandwidth****Test Result**

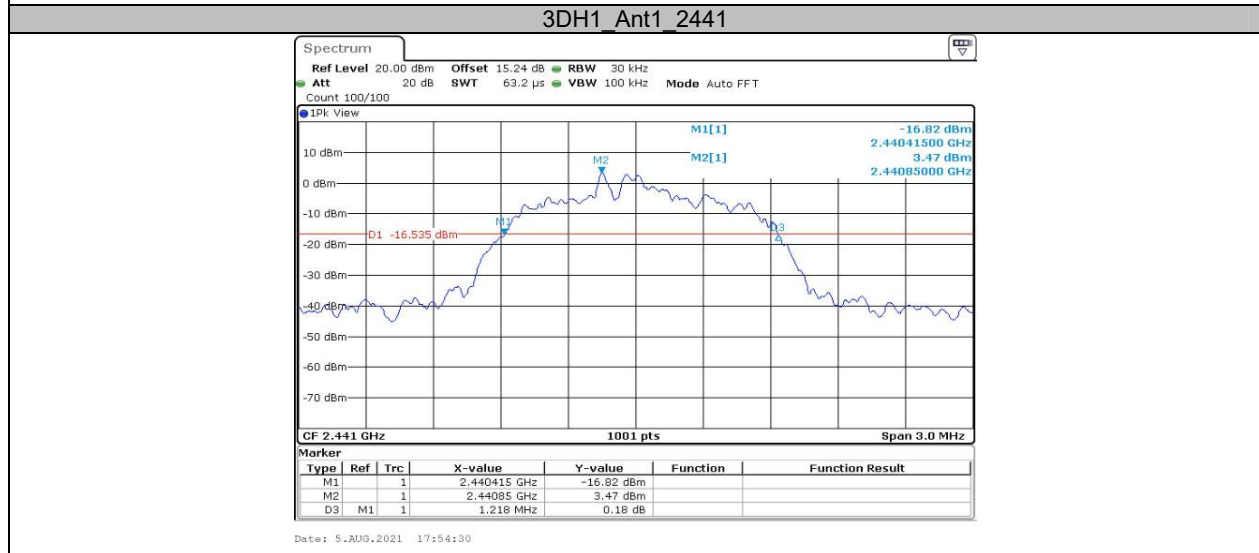
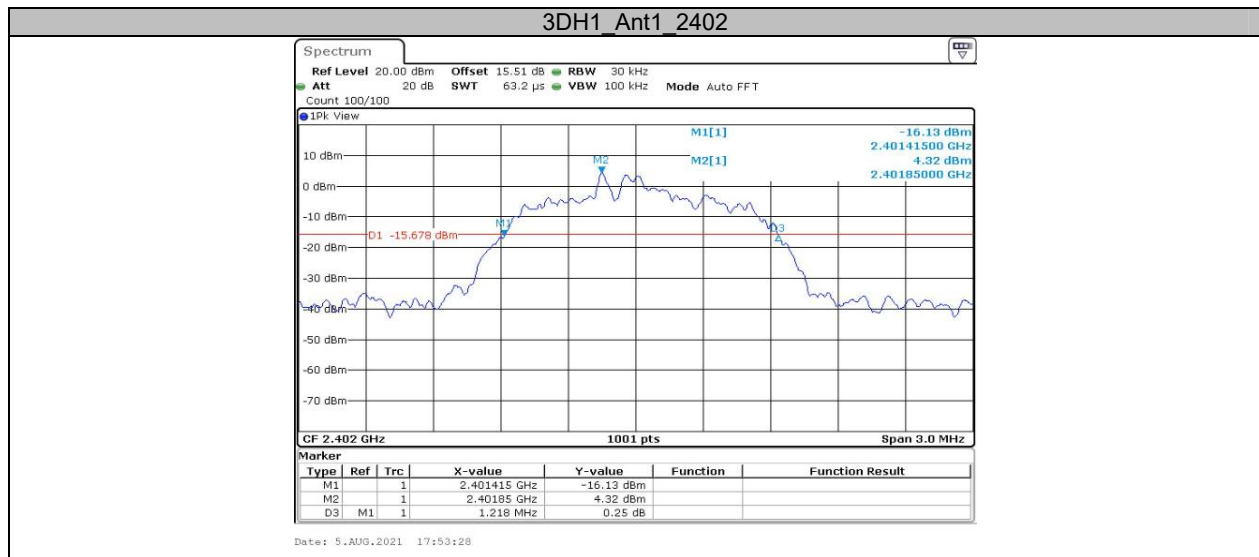
TestMode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.837	---	PASS
		2441	0.843	---	PASS
		2480	0.843	---	PASS
2DH1	Ant1	2402	1.218	---	PASS
		2441	1.215	---	PASS
		2480	1.215	---	PASS
3DH1	Ant1	2402	1.218	---	PASS
		2441	1.218	---	PASS
		2480	1.212	---	PASS

Test Graphs





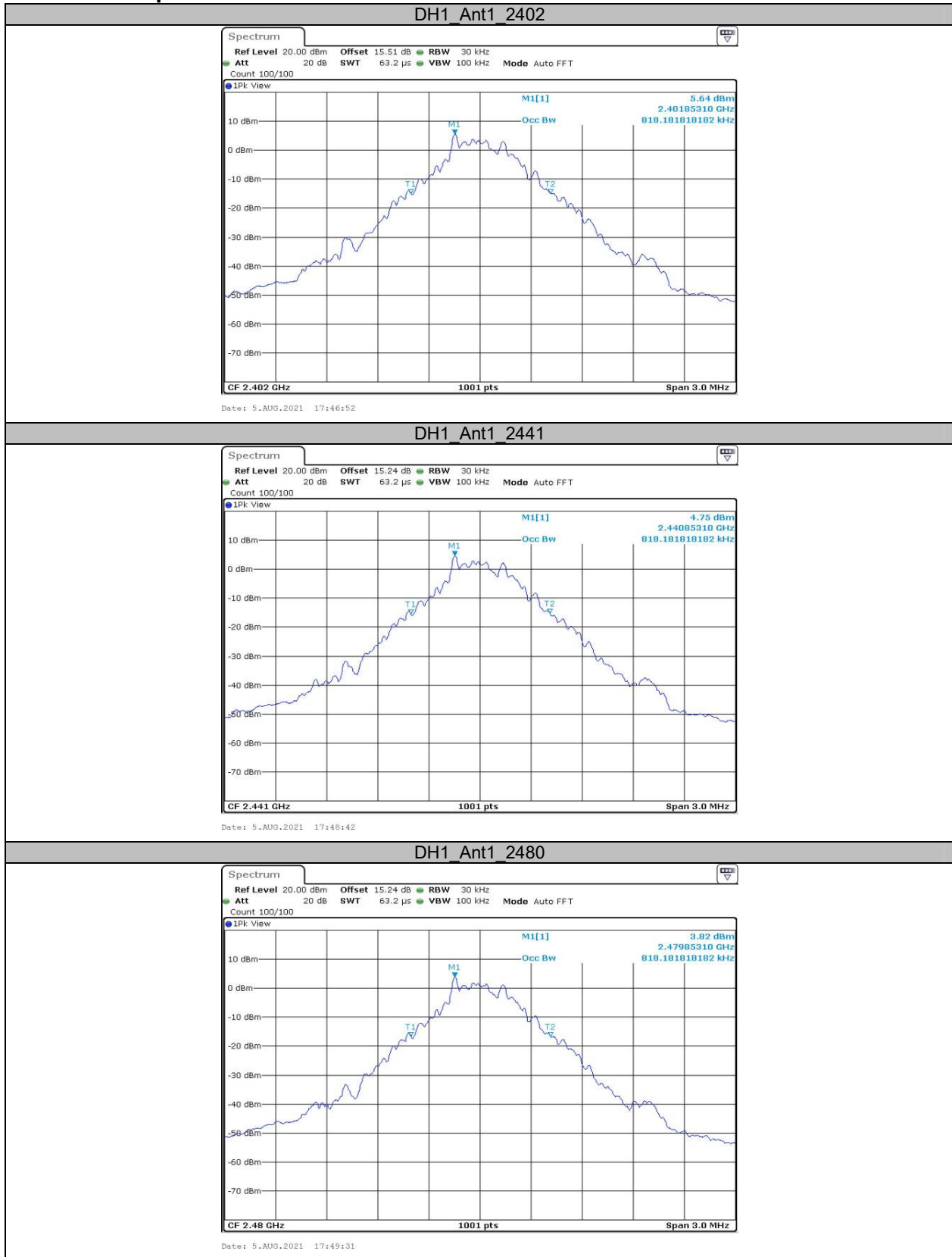


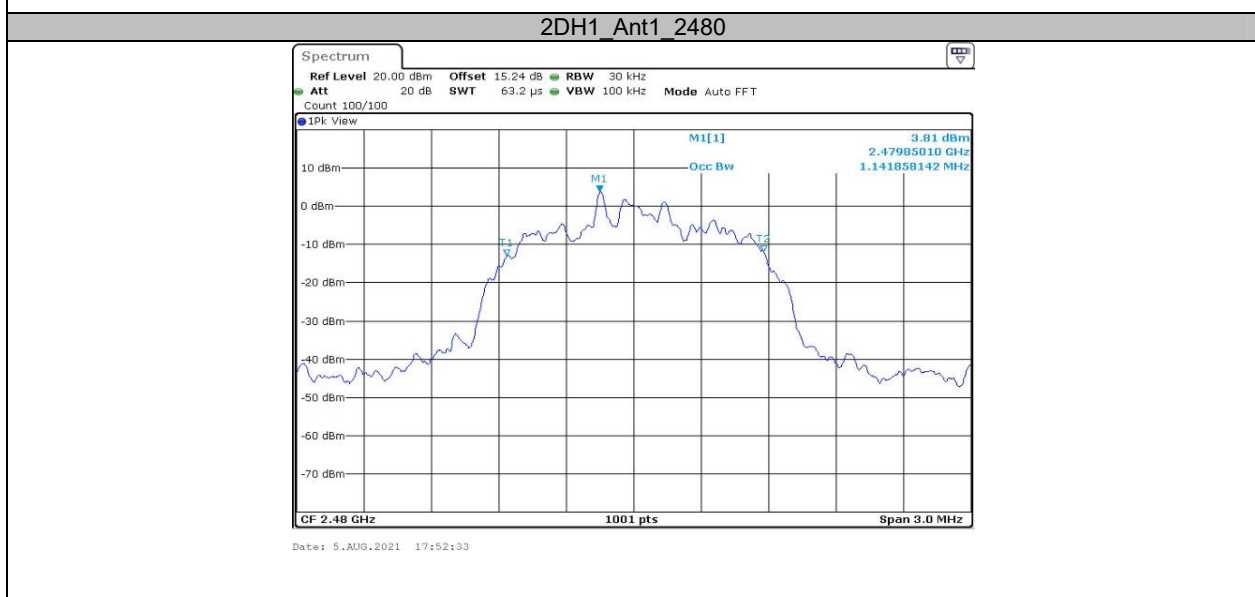


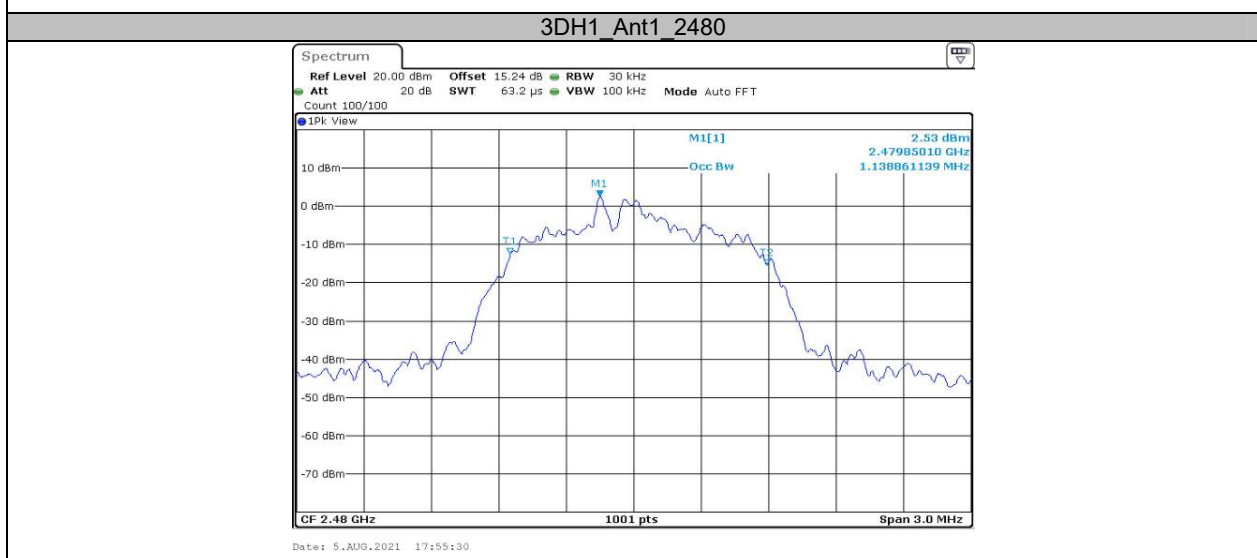
**Appendix B: Occupied Channel Bandwidth****Test Result**

TestMode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.818	---	PASS
		2441	0.818	---	PASS
		2480	0.818	---	PASS
2DH1	Ant1	2402	1.145	---	PASS
		2441	1.142	---	PASS
		2480	1.142	---	PASS
3DH1	Ant1	2402	1.142	---	PASS
		2441	1.142	---	PASS
		2480	1.139	---	PASS

Test Graphs



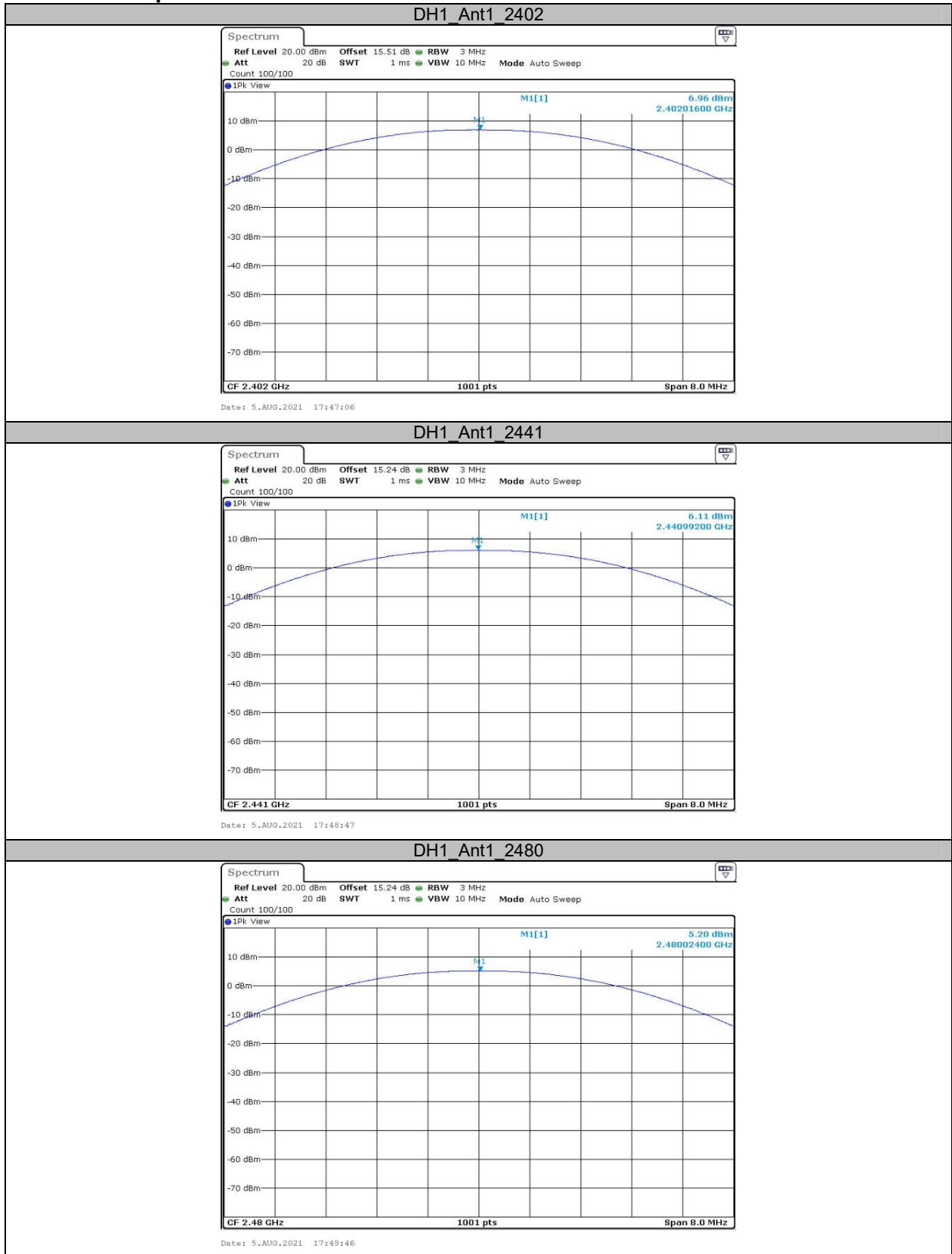


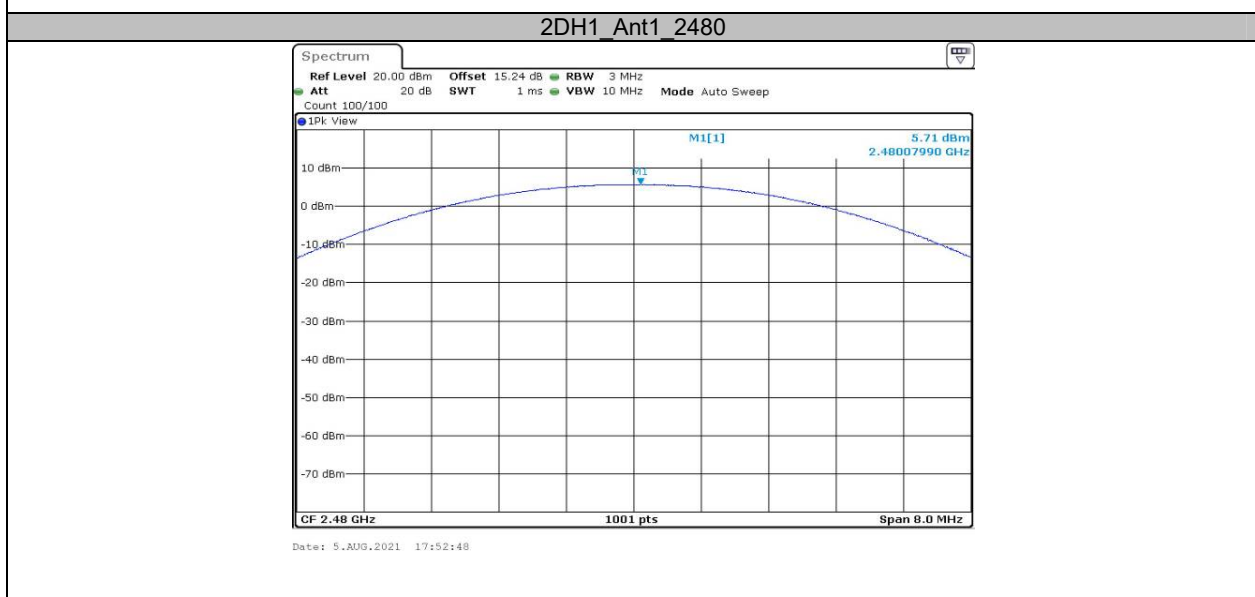
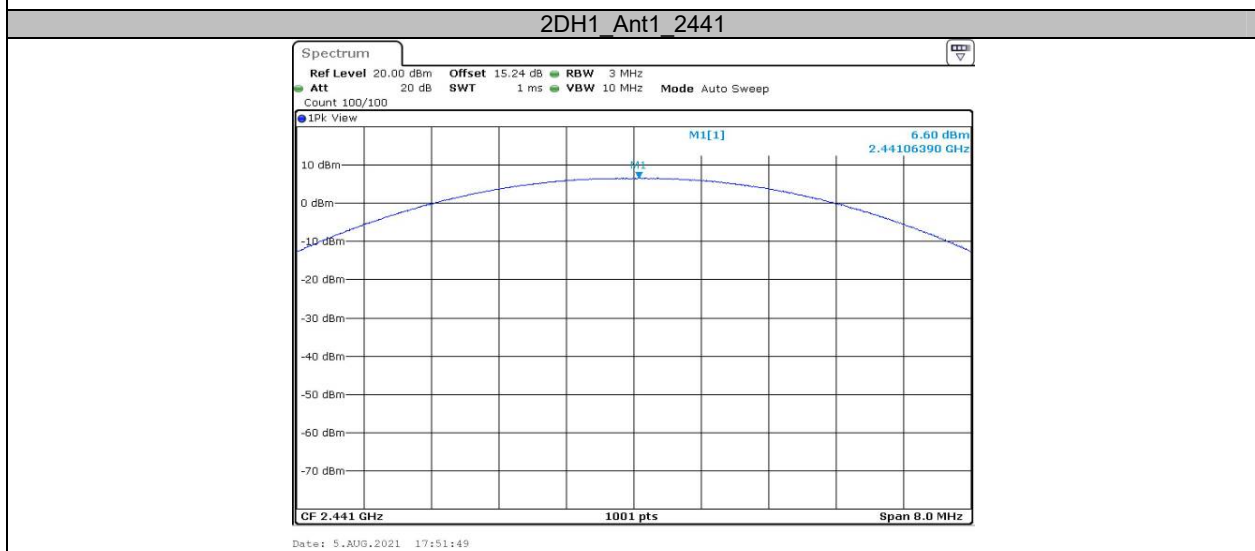
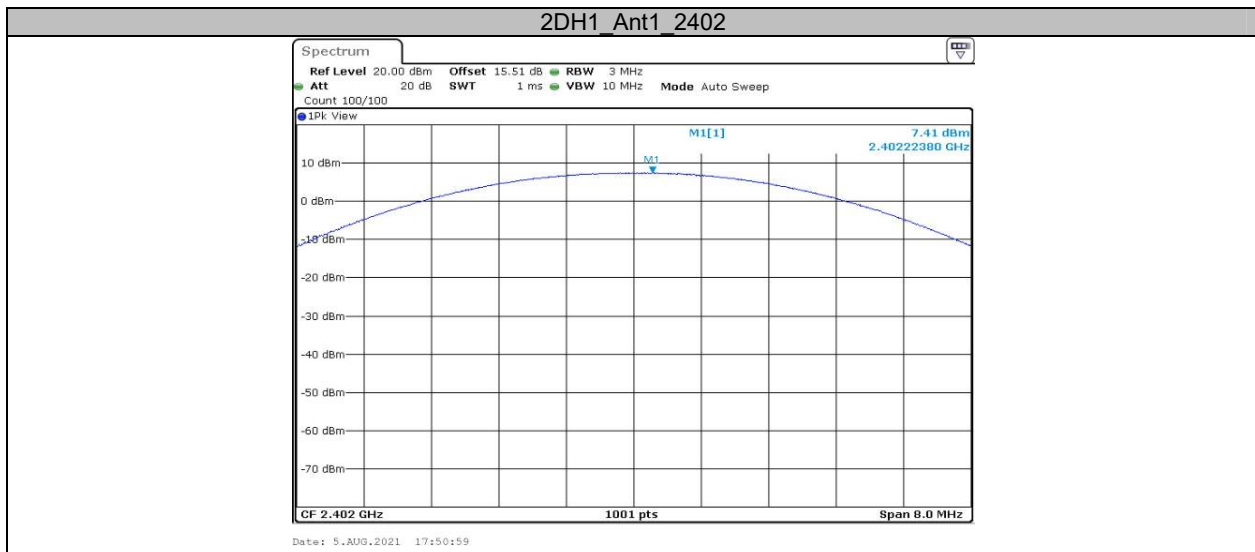


**Appendix C: Maximum conducted Peak output power****Test Result**

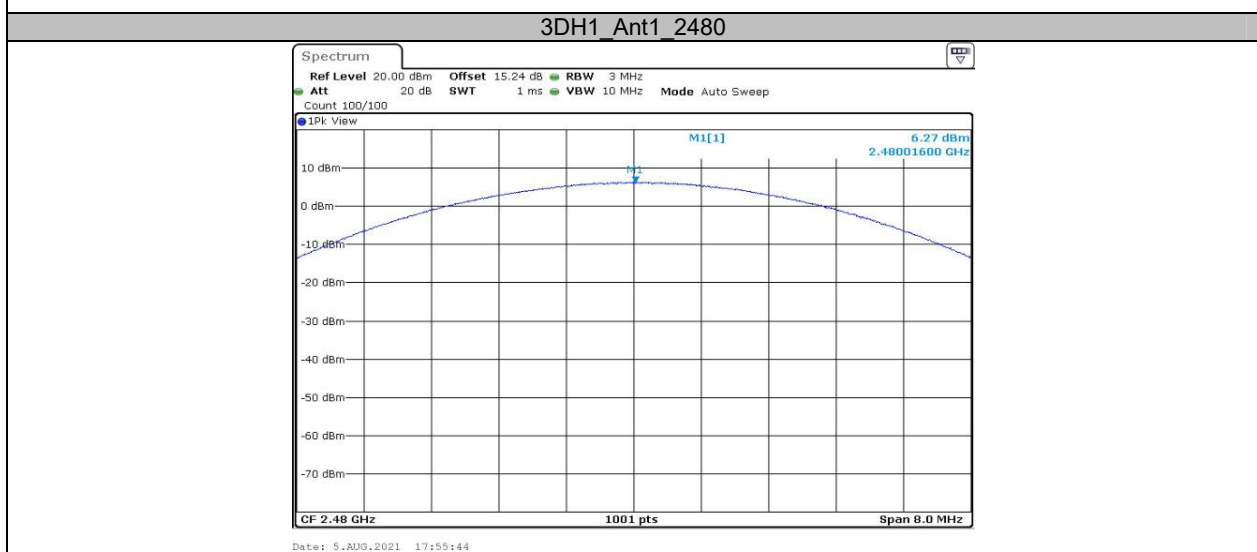
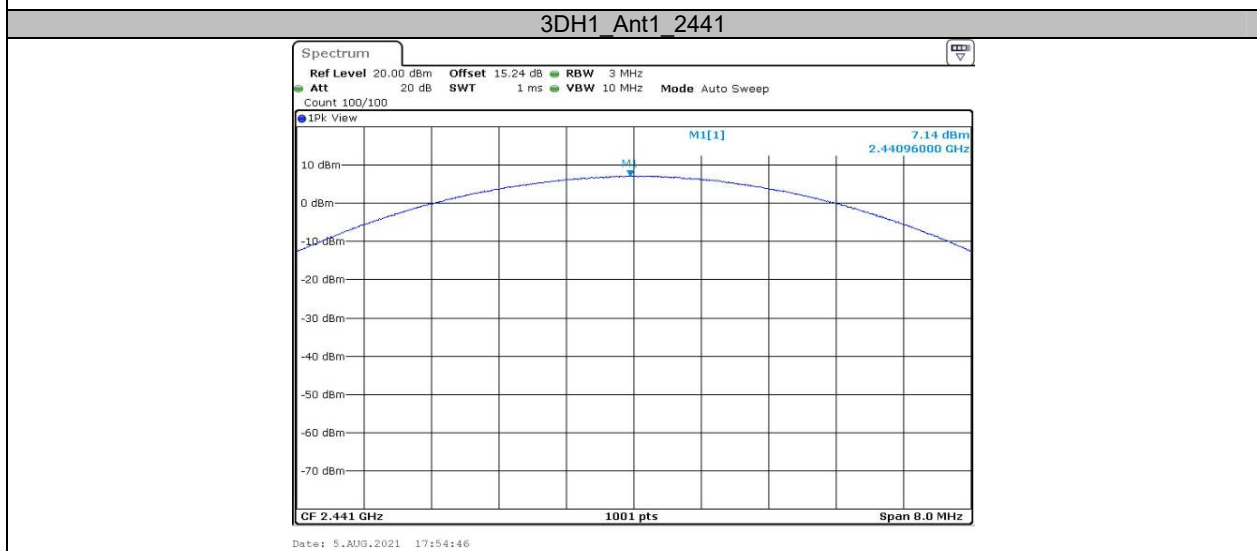
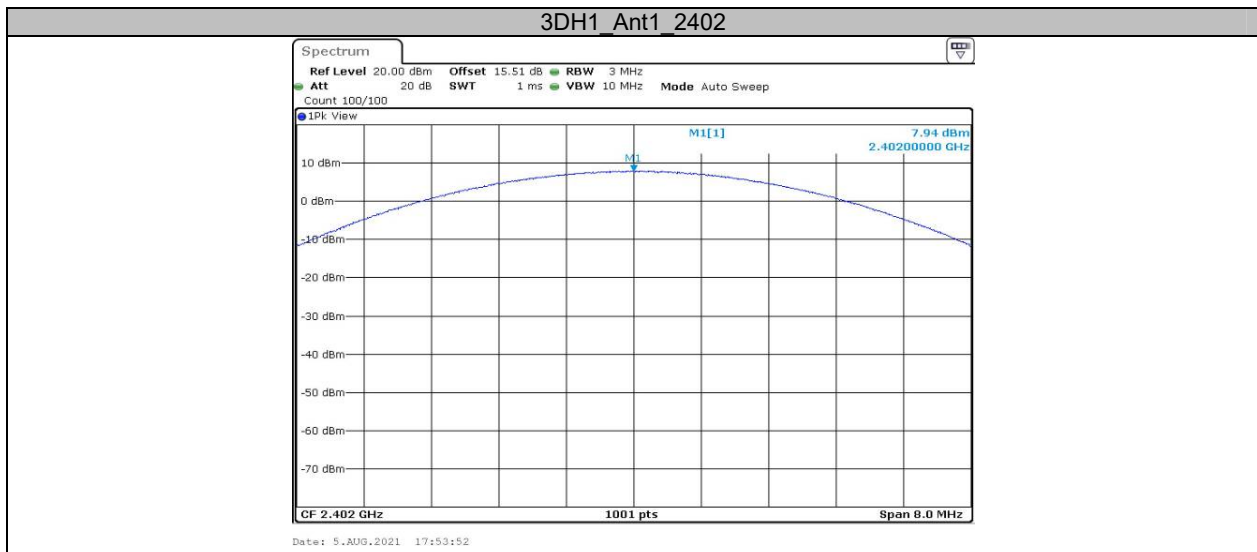
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	6.96	≤20.97	PASS
		2441	6.11	≤20.97	PASS
		2480	5.2	≤20.97	PASS
2DH1	Ant1	2402	7.41	≤20.97	PASS
		2441	6.6	≤20.97	PASS
		2480	5.71	≤20.97	PASS
3DH1	Ant1	2402	7.94	≤20.97	PASS
		2441	7.14	≤20.97	PASS
		2480	6.27	≤20.97	PASS

### Test Graphs









**Appendix D: Carrier frequency separation****Test Result**

TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1.003	≥0.562	PASS
2DH1	Ant1	Hop	1.003	≥0.812	PASS
3DH1	Ant1	Hop	1.003	≥0.812	PASS

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

### Test Graphs



**Appendix E: Time of occupancy****Test Result**

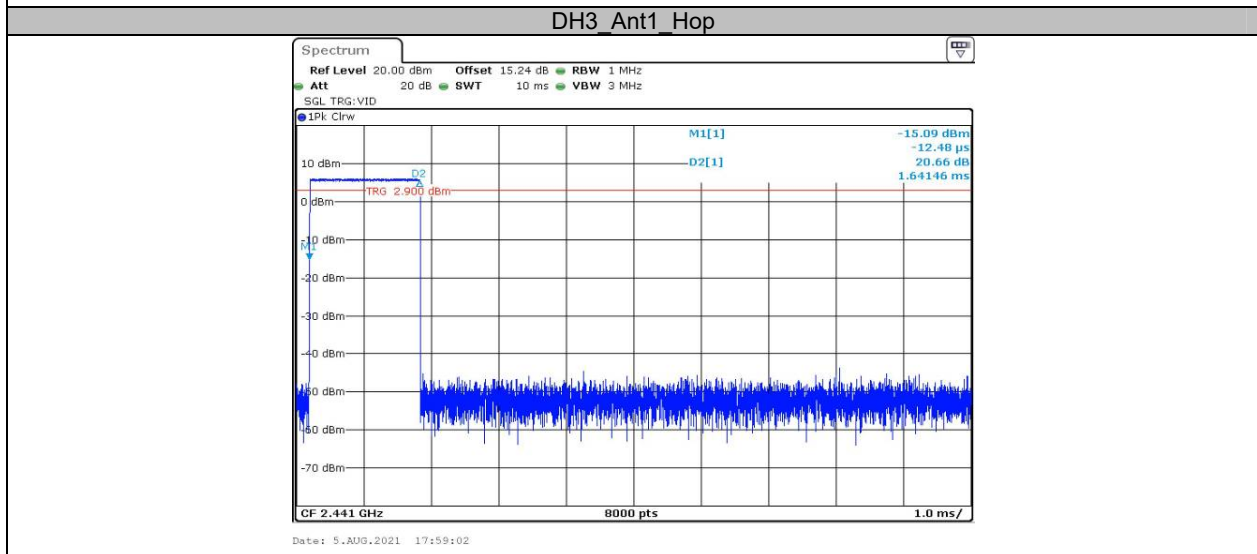
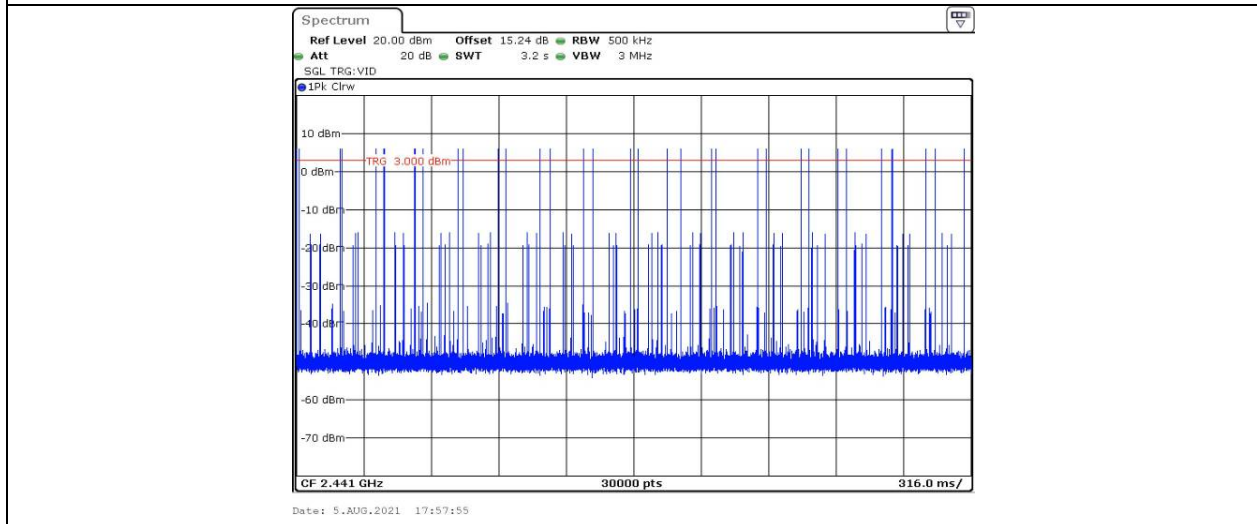
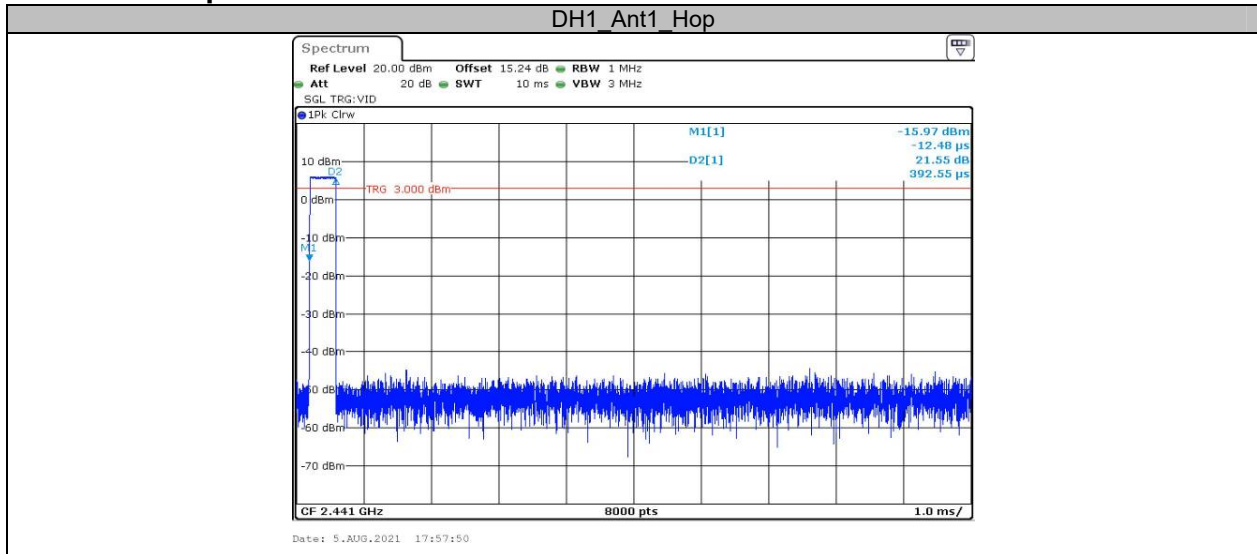
TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.39	330	0.129	≤0.4	PASS
DH3	Ant1	Hop	1.64	130	0.213	≤0.4	PASS
DH5	Ant1	Hop	2.88	120	0.346	≤0.4	PASS
2DH1	Ant1	Hop	0.40	330	0.132	≤0.4	PASS
2DH3	Ant1	Hop	1.65	130	0.215	≤0.4	PASS
2DH5	Ant1	Hop	2.89	110	0.318	≤0.4	PASS
3DH1	Ant1	Hop	0.41	320	0.131	≤0.4	PASS
3DH3	Ant1	Hop	1.65	180	0.297	≤0.4	PASS
3DH5	Ant1	Hop	2.89	110	0.318	≤0.4	PASS

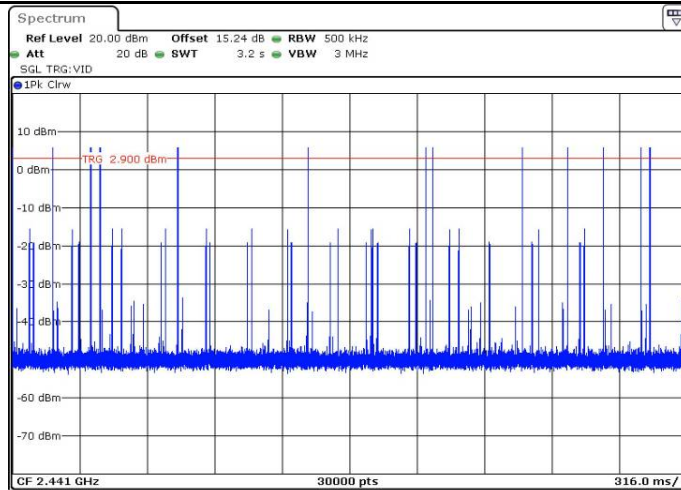
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=BurstWidth\*Totalhops

Note 2: Totalhops=Hopping Number in  $3.16s \times 10$

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

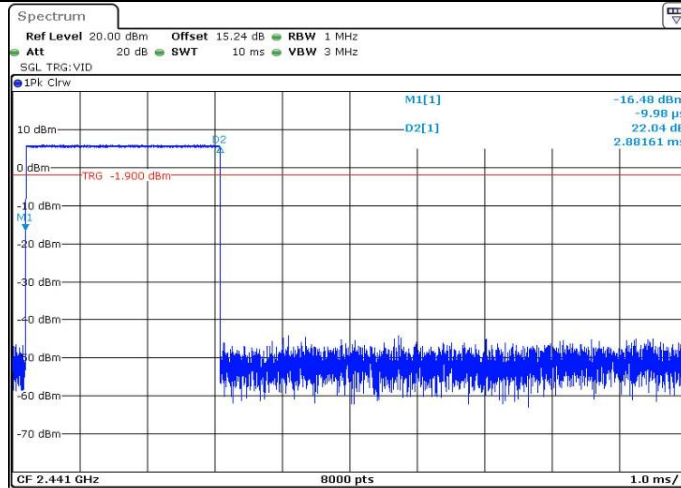
Test Graphs



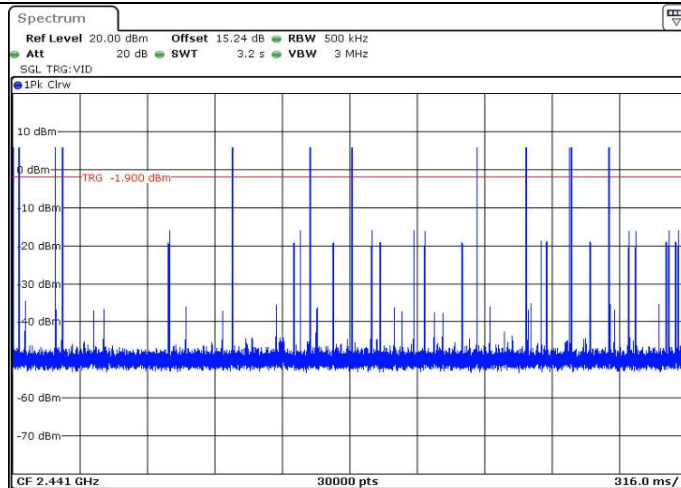


Date: 5.AUG.2021 17:59:08

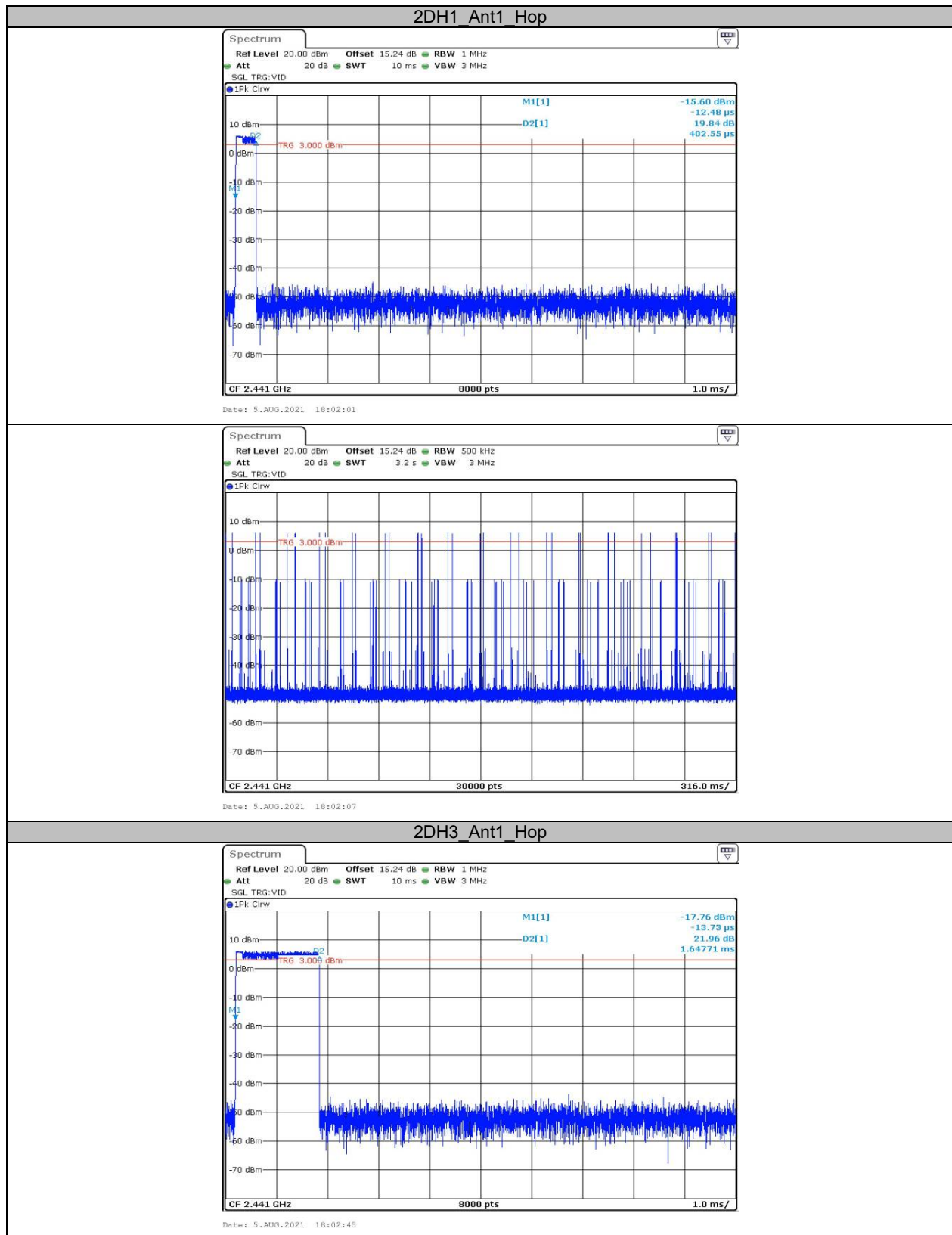
DH5\_Ant1\_Hop

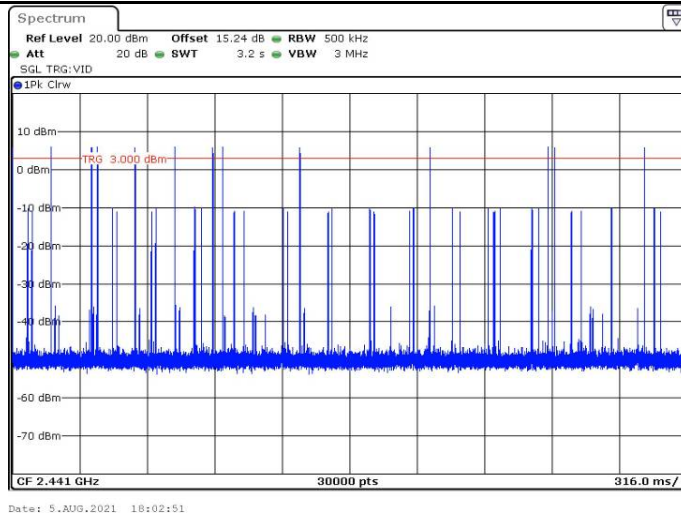


Date: 5.AUG.2021 17:59:35



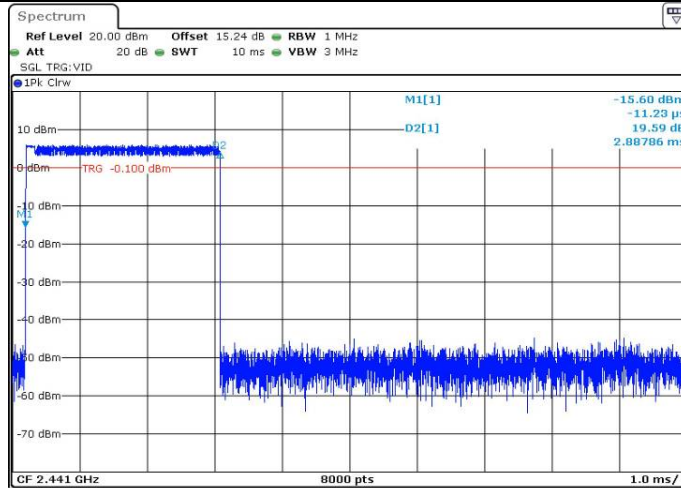
Date: 5.AUG.2021 17:59:40



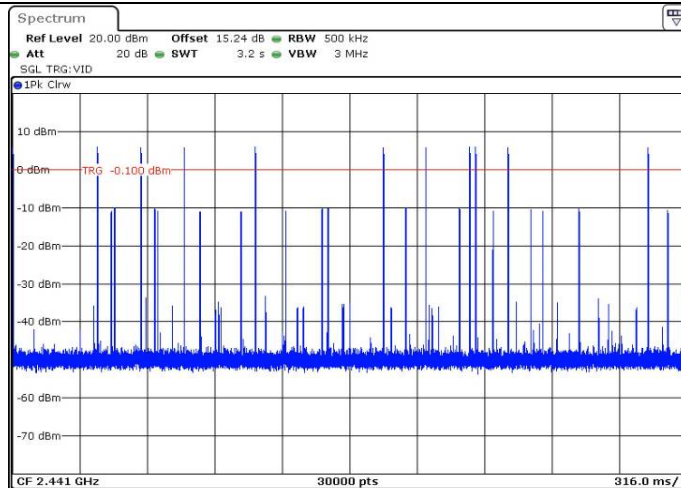


Date: 5.AUG.2021 18:02:51

2DH5\_Ant1\_Hop

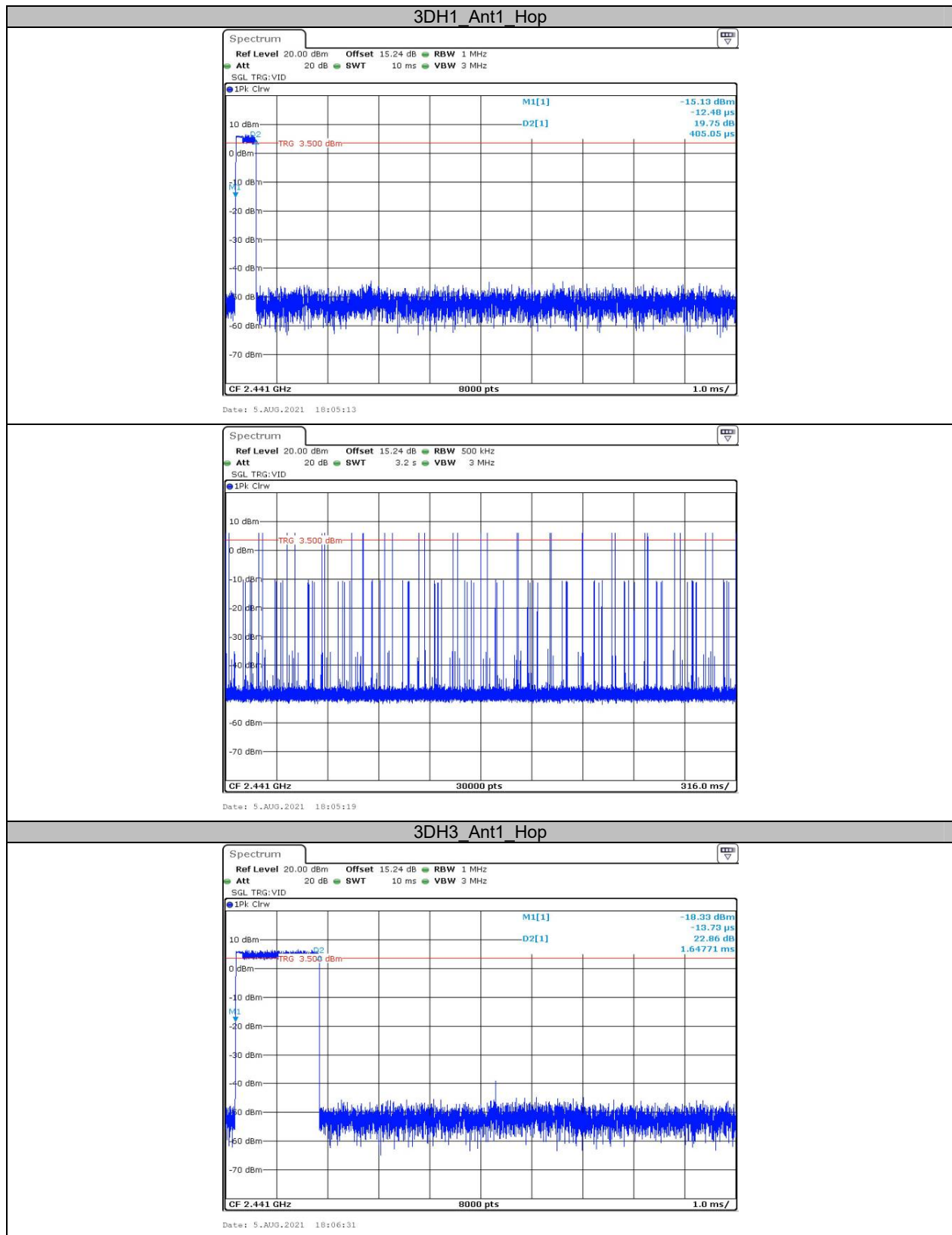


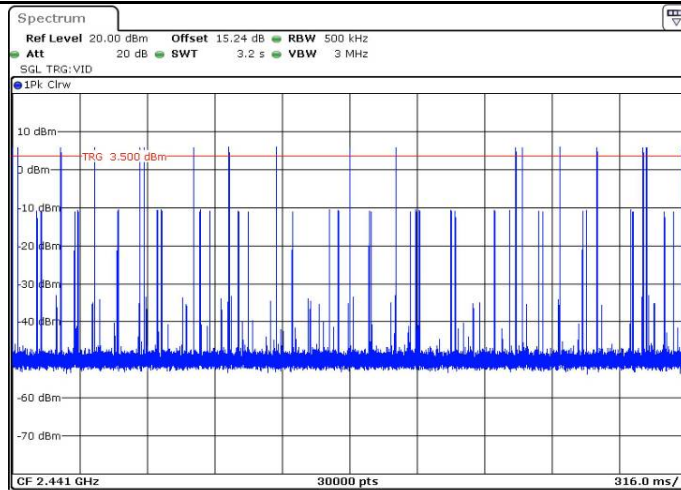
Date: 5.AUG.2021 18:03:41



Date: 5.AUG.2021 18:03:46

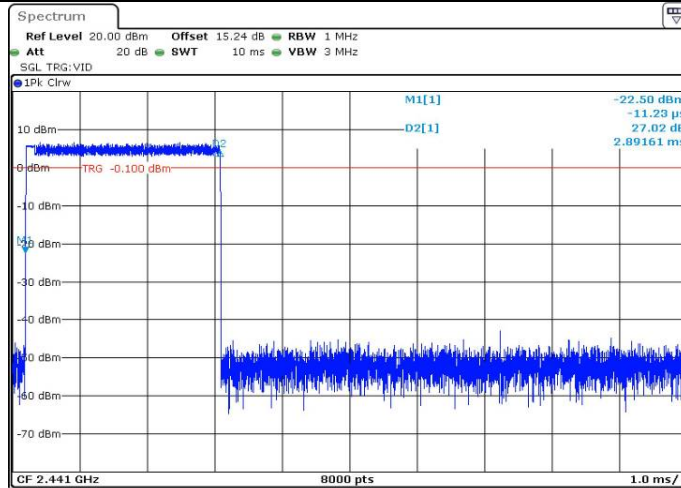




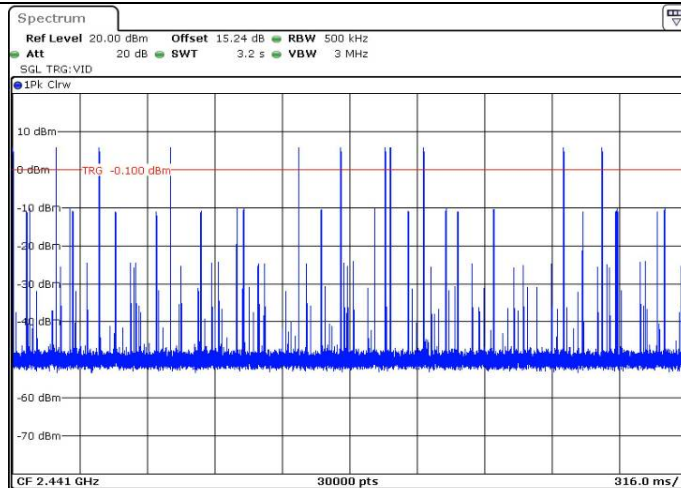


Date: 5.AUG.2021 18:06:37

3DH5\_Ant1\_Hop



Date: 5.AUG.2021 18:07:27



Date: 5.AUG.2021 18:07:33

**Appendix F: Number of hopping channels****Test Result**

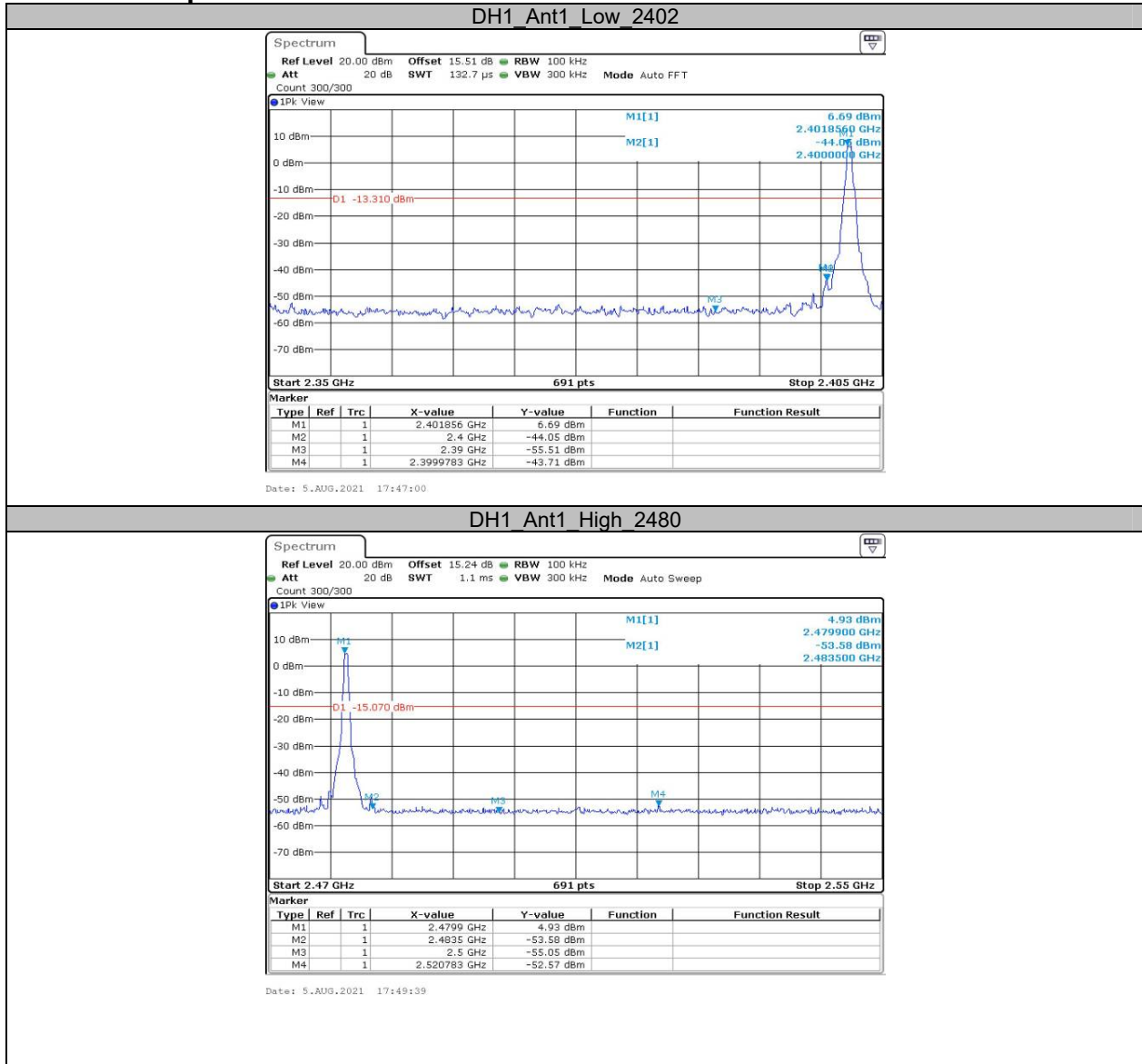
TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	≥15	PASS
2DH1	Ant1	Hop	79	≥15	PASS
3DH1	Ant1	Hop	79	≥15	PASS

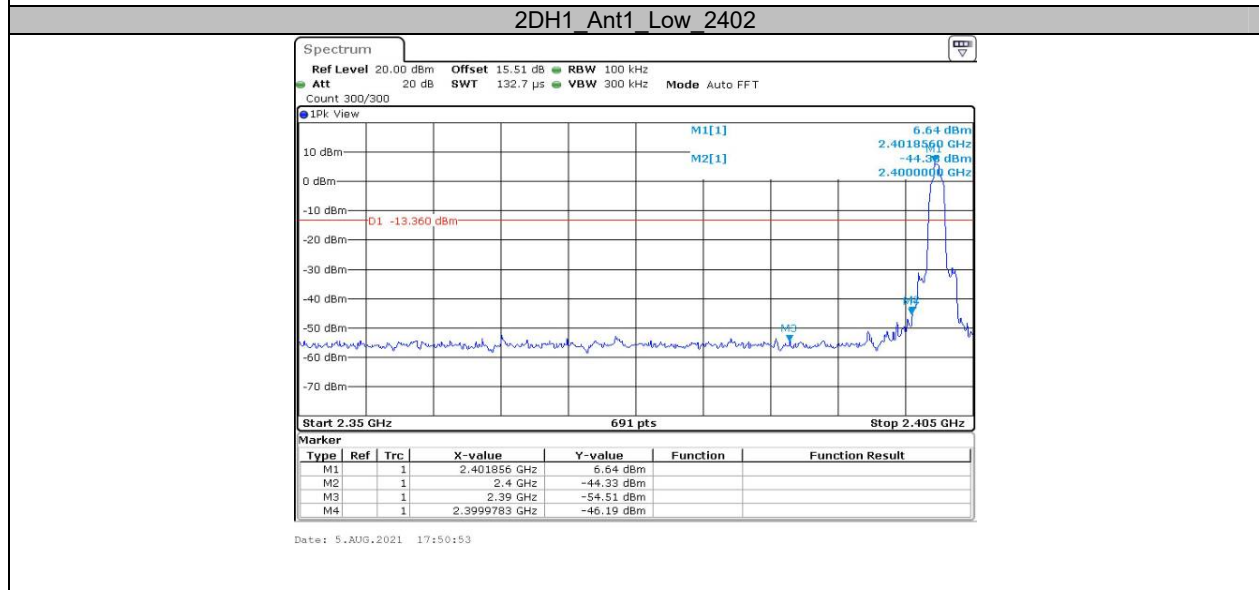
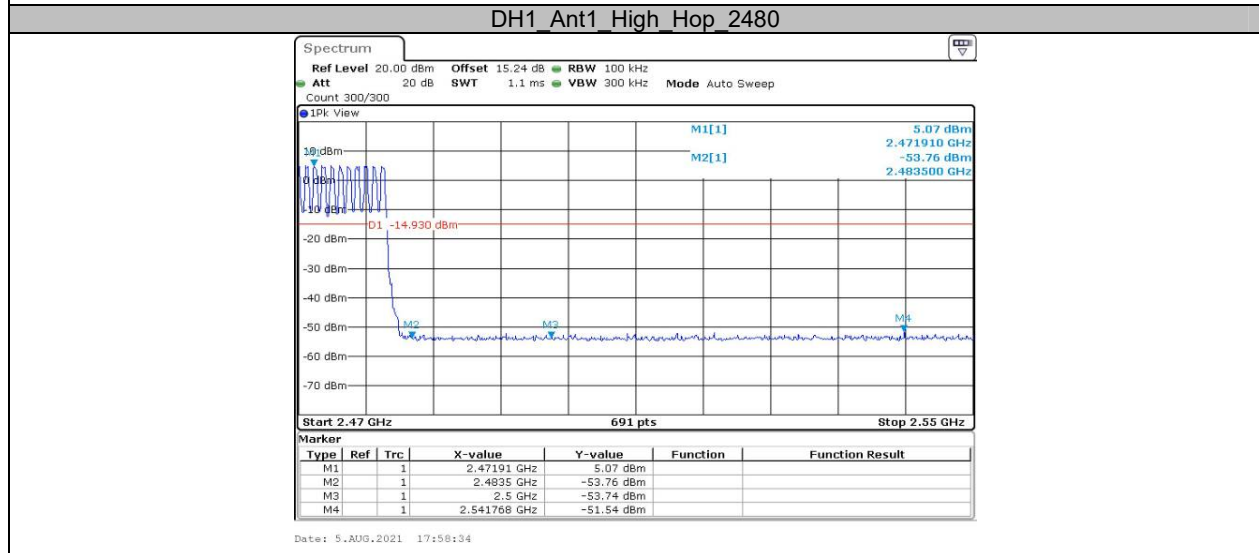
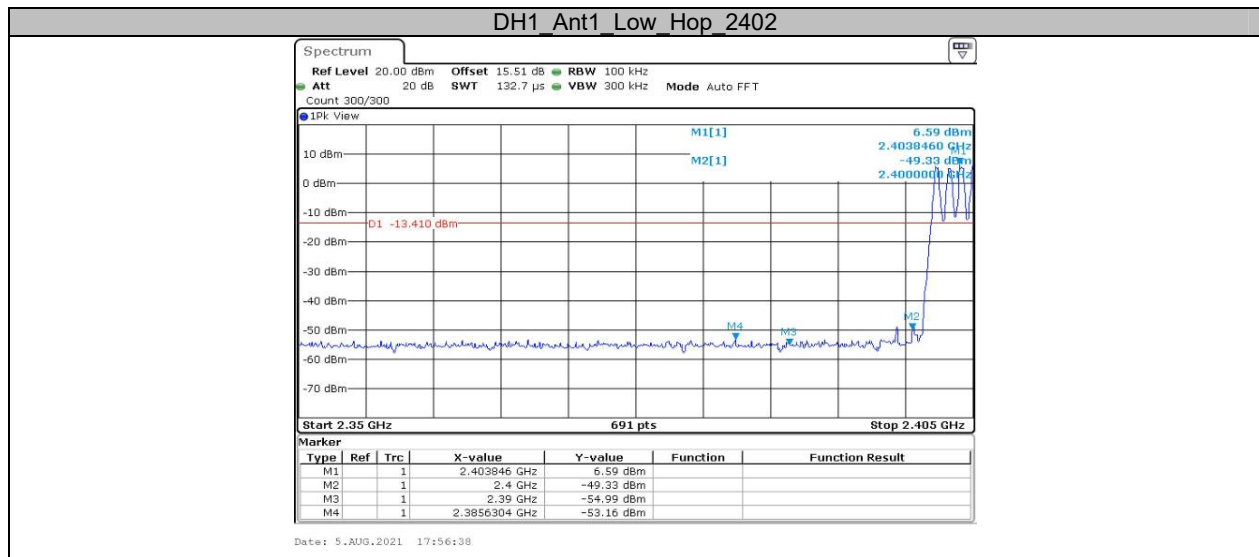
### Test Graphs



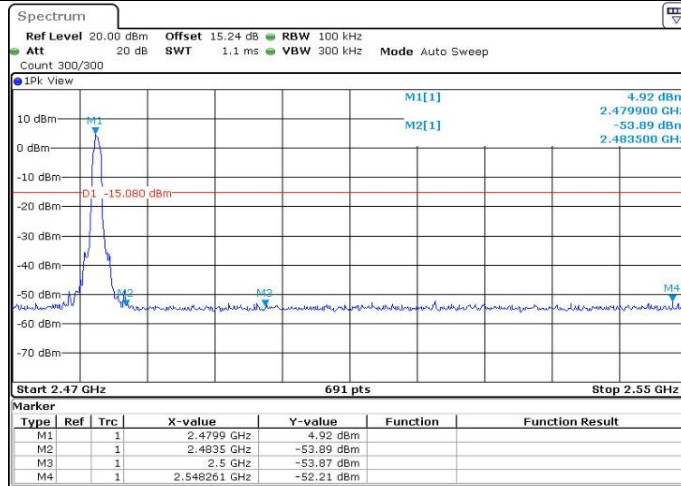
Appendix G: Band edge measurements

Test Graphs



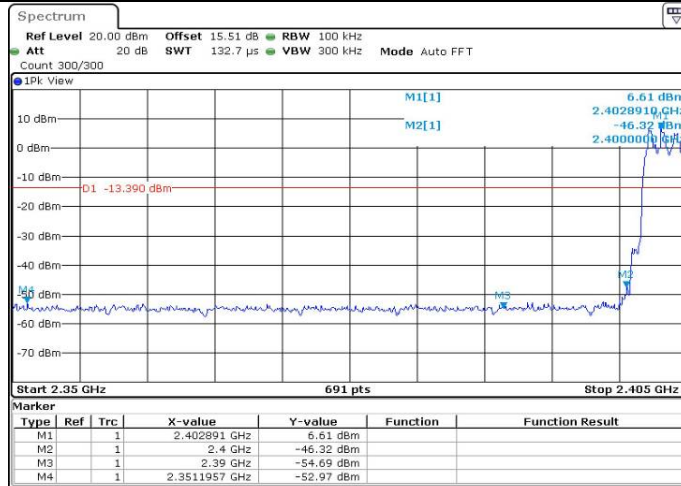


2DH1 Ant1 High 2480



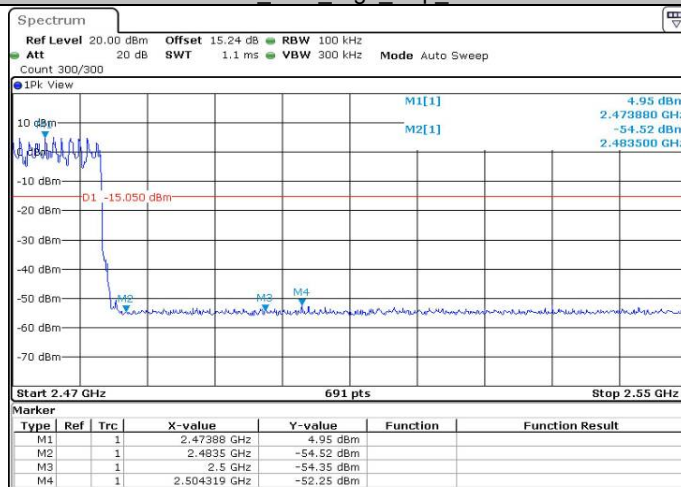
Date: 5.AUG.2021 17:52:42

2DH1 Ant1 Low Hop 2402

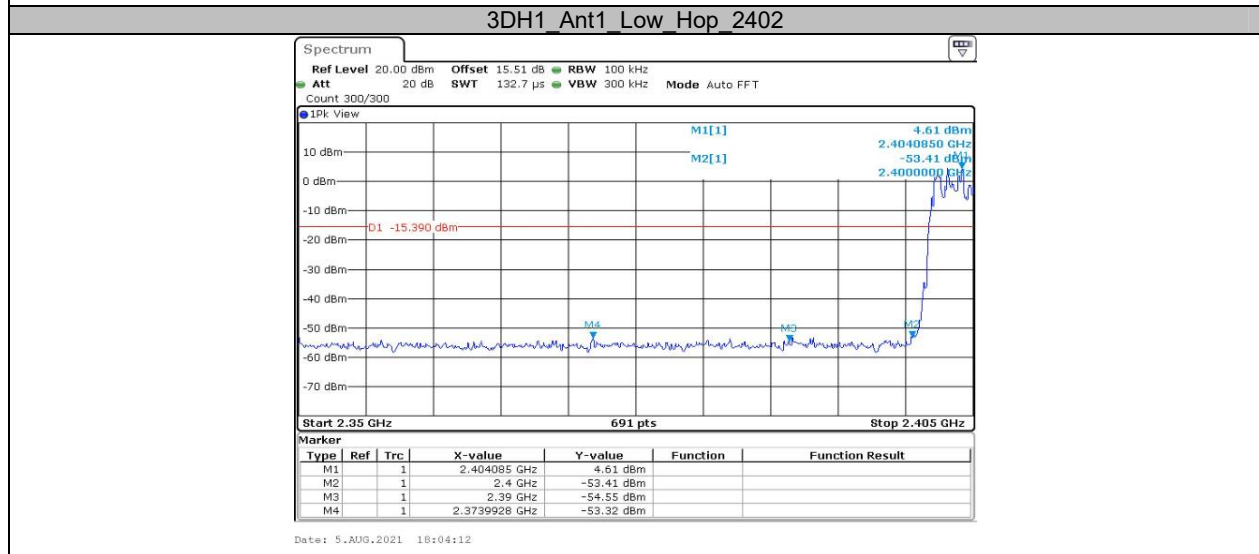
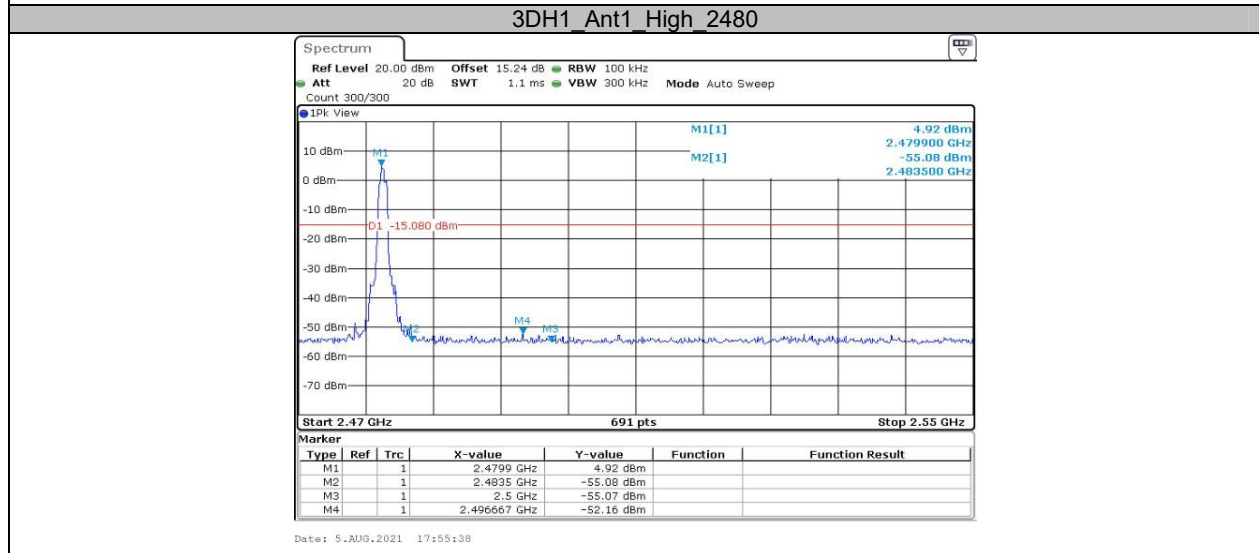
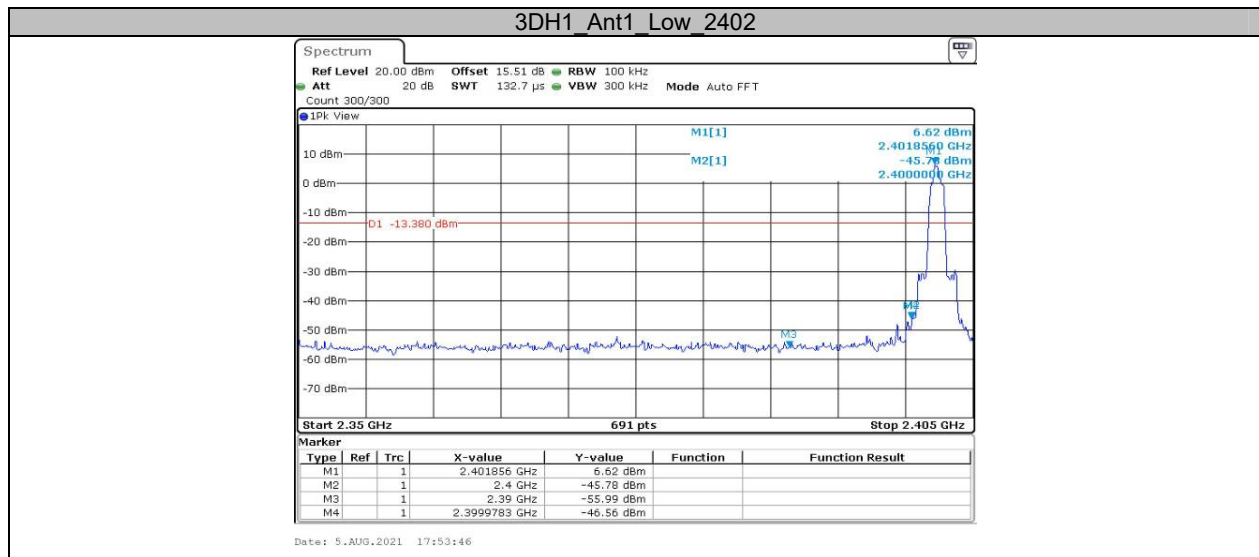


Date: 5.AUG.2021 18:00:41

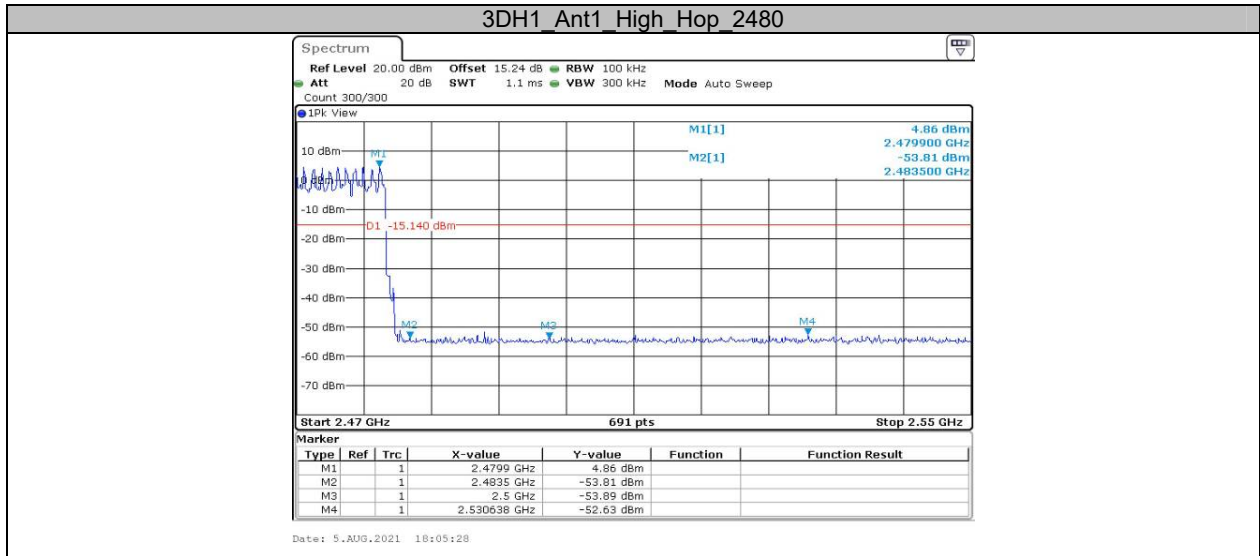
2DH1 Ant1 High Hop 2480



Date: 5.AUG.2021 18:02:17







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