



FCC PART 15.247 TEST REPORT

For

Crestron Electronics Inc

15 Volvo Drive, Rockleigh, New Jersey, 07647, USA

FCC ID: EROAM-3200

Report Type: Original Report	Product Type: Wireless Presentation System
Report Number: SZ1210222-04663E-00A	
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Reviewed By: RF Engineer	Jacob Kong 
Prepared By: 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 www.baclcorp.com.cn	

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Wireless Presentation System
Tested Model	M202011001
SKU	AM-3200-WF/AM-3200-WF-I
Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth: 9.00dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification*	3dBi(It is provided by the applicant)
Voltage Range	DC 24V from adapter or DC 48V from POE
Date of Test	2021-03-09 to 2021-04-13
Sample number	For AC line conducted&Radiated emission(Below 1GHz) test: SZ1210222-04663E-EM-S1 For other items: SZ1210222-04663E-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2021-02-22
Sample/EUT Status	Good condition
Applicant	Crestron Electronics Inc
Applicant Address	15 Volvo Drive, Rockleigh, New Jersey, 07647, USA
Manufacturer	Crestron Electronics Inc
Manufacturer Address	15 Volvo Drive, Rockleigh, New Jersey, 07647, USA

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.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

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.

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

“SecureCRT*” was use to the EUT tested and power level is default*. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

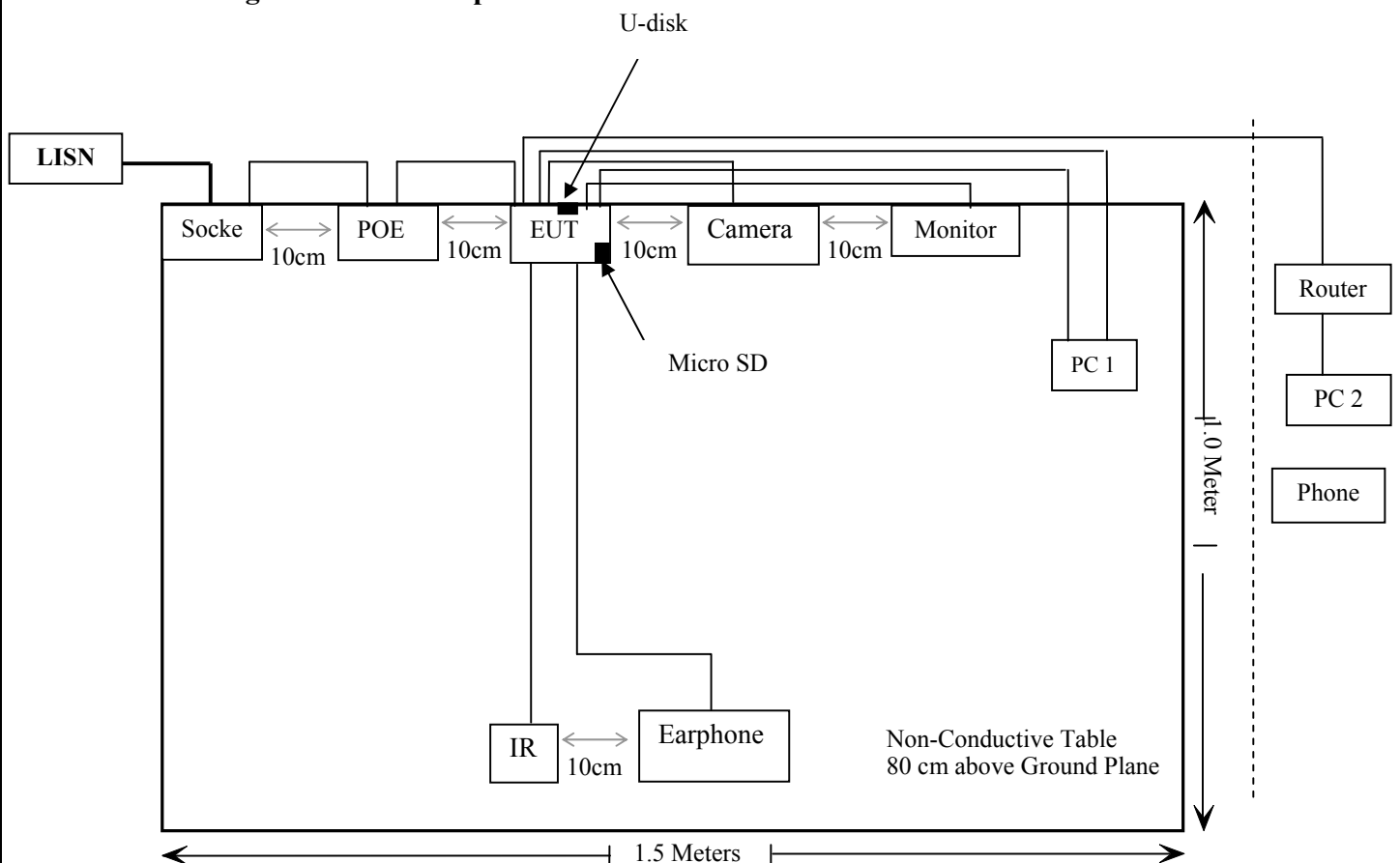
No modification was made to the EUT tested.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
Gospower	POE	G0720-480-050	G0720-480-050
DELL	PC1	Inspiron 15-3543	11429208685
DELL	PC 2	Latitude E5430	590NLV1
HIKVISION	Router	DS-3WR03-E	10021642429
Grandstream	Camera	GUV3105	GUV3105
SAMSUNG	Monitor	S24E390HL	ZZFRH4ZN303357K
HUAWEI	Phone	Mate 30 pro 5G	Mate 30 pro 5G
Kingston	USB disk	DTSE9H/16G	DTSE9H/16G
Unknown	IR	Unknown	IR
Unknown	Earphone	Unknown	Earphone
Sandisk	SD	SDSDXXY-256G-ZN4IN	SDSDXXY-256G-ZN4IN

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielded detachable AC cable	1.0	LISN	POE
Un-shielded detachable RJ45 cable	1.0	POE	EUT
Un-shielded detachable RJ45 cable	1.0	EUT	PC1
Un-shielded detachable RJ45 cable	5.0	EUT	Router
Un-shielded detachable HDMI cable	1.0	EUT	Monitor
Un-shielded detachable USB cable	2.0	EUT	PC 1
Un-shielded detachable HDMI cable	1.0	EUT	PC 1
Un-shielded Un-detachable USB cable	1.2	EUT	Camera
Un-shielded detachable IR cable	2.98	EUT	IR
Un-shielded detachable Earphone cable	1.2	EUT	Earphone
Un-shielded detachable RJ45 cable	1.0	Router	PC 2
Un-shielded detachable AC cable	1.0	POE	LISN

Block Diagram of Test Setup

SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §2.1091	Maximum Permissible Exposure(MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

Note: the EUT has two types power supply, the adapter and POE, according the test result of FCC Part 15B test result, the POE power supply is worser, so worst case POE power test data was record in report.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2020/08/04	2021/08/03
Rohde & Schwarz	LISN	ENV216	101613	2020/08/04	2021/08/03
Rohde & Schwarz	Transient Limitor	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
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2020/08/04	2021/08/03
Sonoma instrument	Pre-amplifier	310 N	186238	2020/08/04	2021/08/03
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	2020/08/04	2021/08/03
COM-POWER	Pre-amplifier	PA-122	181919	2020/11/29	2021/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/29	2021/11/28
Sunol Sciences	Horn Antenna	3115	9107-3694	2021/01/15	2024/01/14
Insulated Wire Inc.	RF Cable	SPS-2503-3150	02222010	2020/11/29	2021/11/28
Unknown	RF Cable	W1101-EQ1 OUT	F-19-EM005	2020/11/29	2021/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2020/04/20	2021/04/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-021304	2020/12/06	2023/12/05
RF Conducted Test					
Tonscend Corporation	RF control Unit	JS0806-2	19D8060154	2020/08/04	2021/08/03
Rohde & Schwarz	Signal and Spectrum Analyzer	FSV40	101473	2020/08/04	2021/08/03
Unknown	RF Cable	Unknown	2301 276	2020/11/29	2021/11/28

*** 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) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and 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 General Population/Uncontrolled Exposure

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	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	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/cm²)

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 simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Mode	Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
		(dBi)	(numeric)	(dBm)	(mW)			
Bluetooth	2402-2480	3.0	2.0	9.5	8.91	20	0.004	1
BLE	2402-2480	3.0	2.0	8.0	6.31	20	0.003	1
2.4G Wi-Fi	2412-2462	3.0	2.0	27.0	501.19	20	0.199	1
5G Wi-Fi	5150-5250	0	1.0	20.0	100	20	0.020	1
	5250-5350	0	1.0	19.0	79.43	20	0.016	1
	5470-5725	0	1.0	19.0	79.43	20	0.016	1
	5725-5850	0	1.0	19.0	79.43	20	0.016	1

Note: 1. the tune up conducted power was declared by the applicant
 2. The Bluetooth can transmit at the same time with Wi-Fi, the 2.4G Wi-Fi can't transmit at the same time with the 5G Wi-Fi.

Simultaneous transmitting consideration:

The ratio=MPEWi-Fi/limit + MPEBT/limit=0.199/1+0.004/1=0.203<1.0

So simultaneous exposure comply with the limit.

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

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 external antenna with unique antenna connector for Bluetooth and the antenna gain is 3dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



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

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

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

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

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

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

Test Procedure

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

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

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

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:

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

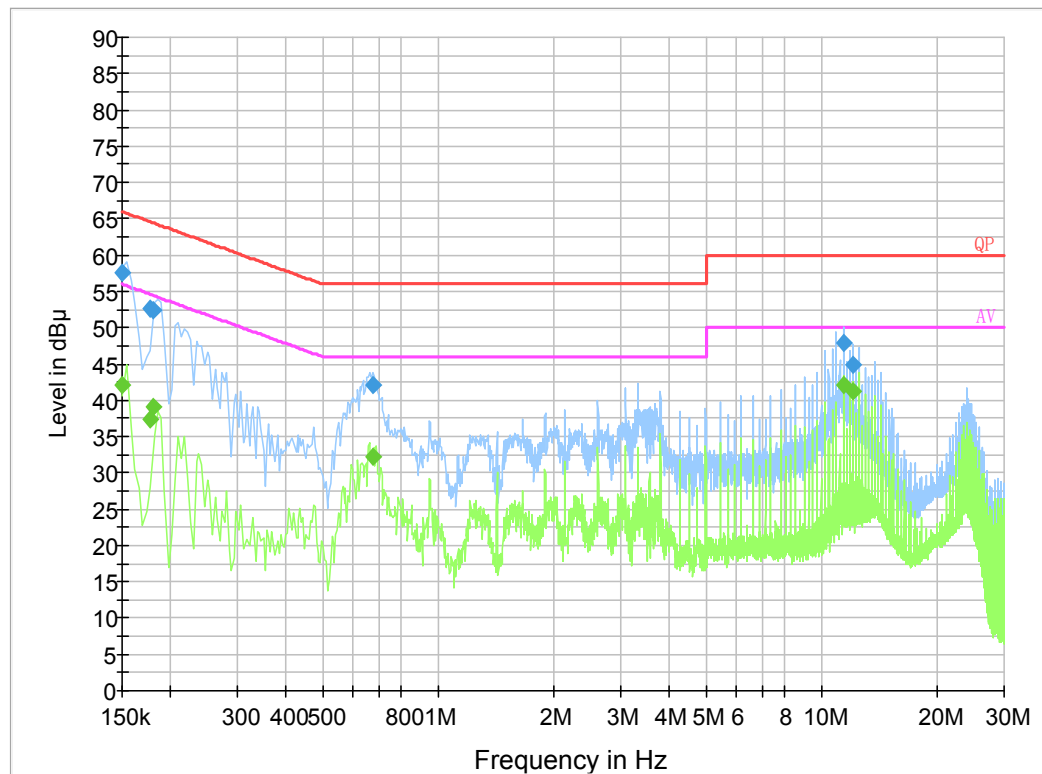
Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2021-04-13

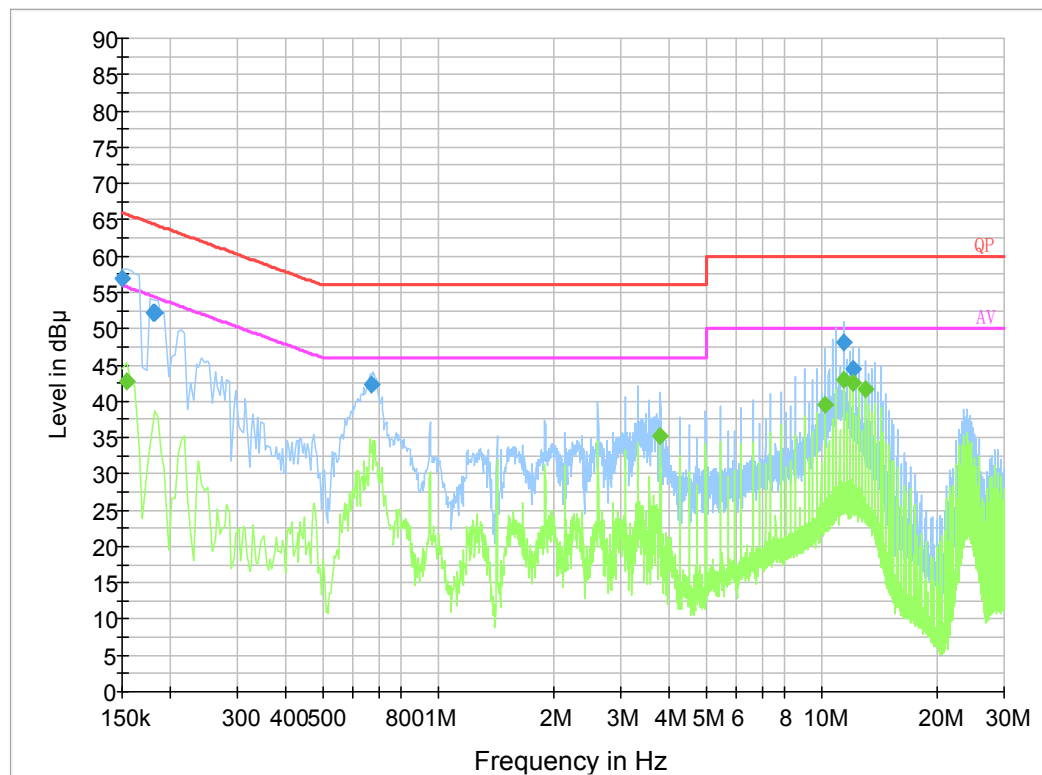
EUT operation mode: BT&Wi-Fi Link (the worst case is powered by the POE)

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)
0.150000	57.7	0.200	L1	19.8	8.3	66.0
0.177500	52.7	9.000	L1	19.9	11.9	64.6
0.181500	52.5	9.000	L1	19.9	11.9	64.4
0.679830	42.1	9.000	L1	19.8	13.9	56.0
11.418730	47.9	9.000	L1	20.0	12.1	60.0
12.132050	44.8	9.000	L1	20.0	15.2	60.0

Final Result 2

Frequency (MHz)	Average (dB μ V)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μ V)
0.150000	42.1	9.000	L1	19.8	13.9	56.0
0.177500	37.4	9.000	L1	19.9	17.2	54.6
0.181500	39.0	9.000	L1	19.9	15.4	54.4
0.679830	32.3	9.000	L1	19.8	13.7	46.0
11.418730	42.1	9.000	L1	20.0	7.9	50.0
12.132050	41.3	9.000	L1	20.0	8.7	50.0

AC 120V/60 Hz, Neutral**Final Result 1**

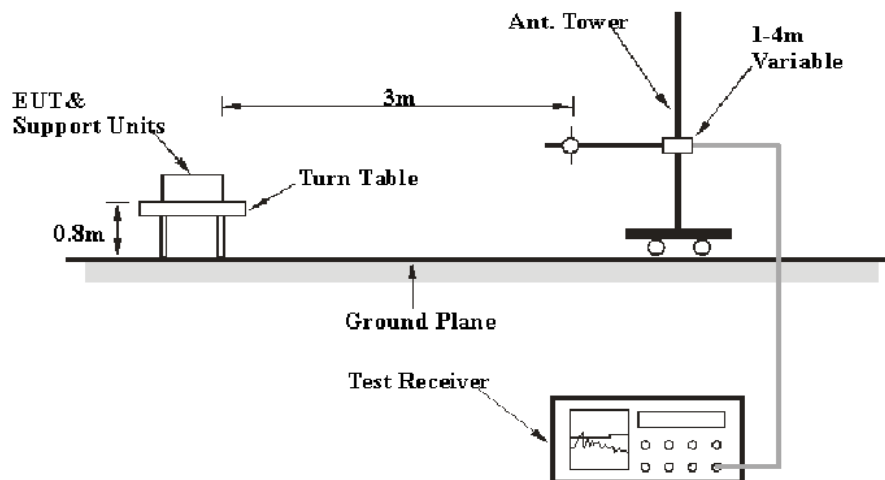
Frequency (MHz)	QuasiPeak (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.150000	57.0	0.200	N	19.8	9.0	66.0
0.181500	52.2	9.000	N	19.8	12.2	64.4
0.181900	52.2	9.000	N	19.8	12.2	64.4
0.671830	42.3	9.000	N	19.8	13.7	56.0
11.418730	48.1	9.000	N	20.0	11.9	60.0
12.128050	44.5	9.000	N	20.0	15.5	60.0

Final Result 2

Frequency (MHz)	Average (dB μV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB μV)
0.154000	42.7	9.000	N	19.8	13.1	55.8
3.806000	35.2	9.000	N	19.9	10.8	46.0
10.226000	39.4	9.000	N	20.0	10.6	50.0
11.418000	43.0	9.000	N	20.0	7.0	50.0
12.130000	42.4	9.000	N	20.0	7.6	50.0
13.082000	41.7	9.000	N	19.9	8.3	50.0

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, according to the DA 00-705 Released March 30, 2000, 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:

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

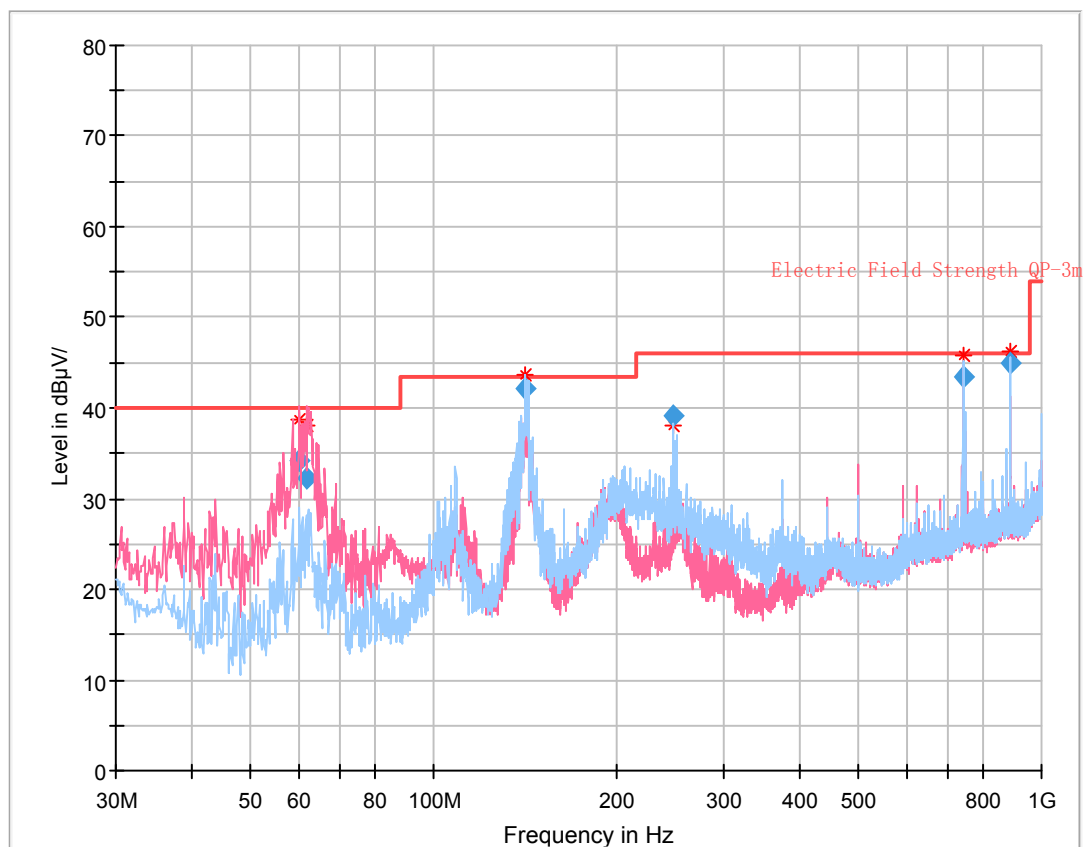
Test Data

Environmental Conditions

Temperature:	24.8~25 °C
Relative Humidity:	51~52 %
ATM Pressure:	101.0~101.2 kPa

The testing was performed by Kilroy Deng on 2021-04-12 for below 1GHz and Alan He on 2021-03-15 for above 1GHz.

30 MHz~1 GHz: (EUT operation mode: BT&Wi-Fi Link, the worst case is powered by the POE)



Final_Result

Frequency (MHz)	QuasiPeak (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
60.254500	34.18	40.00	5.82	267.0	V	0.0	-16.5
62.066000	32.35	40.00	7.65	188.0	V	253.0	-16.4
141.187250	42.18	43.50	1.32	331.0	H	246.0	-10.8
248.435375	39.05	46.00	6.95	228.0	H	346.0	-11.8
741.741125	43.51	46.00	2.49	255.0	H	307.0	-0.7
890.100375	44.99	46.00	1.01	331.0	H	307.0	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 (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2382.07	28.74	PK	160	1.2	H	31.87	60.61	74	13.39
2382.07	13.85	Ave.	160	1.2	H	31.87	45.72	54	8.28
2485.39	28.62	PK	158	1.3	H	32.13	60.75	74	13.25
2485.39	13.92	Ave.	158	1.3	H	32.13	46.05	54	7.95
4804.00	43.99	PK	42	1.5	H	6.28	50.27	74	23.73
4804.00	28.82	Ave.	42	1.5	H	6.28	35.10	54	18.90
Middle Channel (2441 MHz)									
4882.00	44.04	PK	111	1.1	H	6.76	50.80	74	23.20
4882.00	28.83	Ave.	111	1.1	H	6.76	35.59	54	18.41
High Channel (2480 MHz)									
2329.51	28.91	PK	300	1.9	H	31.64	60.55	74	13.45
2329.51	13.85	Ave.	300	1.9	H	31.64	45.49	54	8.51
2490.62	28.94	PK	161	1.3	H	32.13	61.07	74	12.93
2490.62	13.98	Ave.	161	1.3	H	32.13	46.11	54	7.89
4960.00	44.20	PK	94	1.1	H	6.80	51.00	74	23.00
4960.00	28.87	Ave.	94	1.1	H	6.80	35.67	54	18.33

Note:

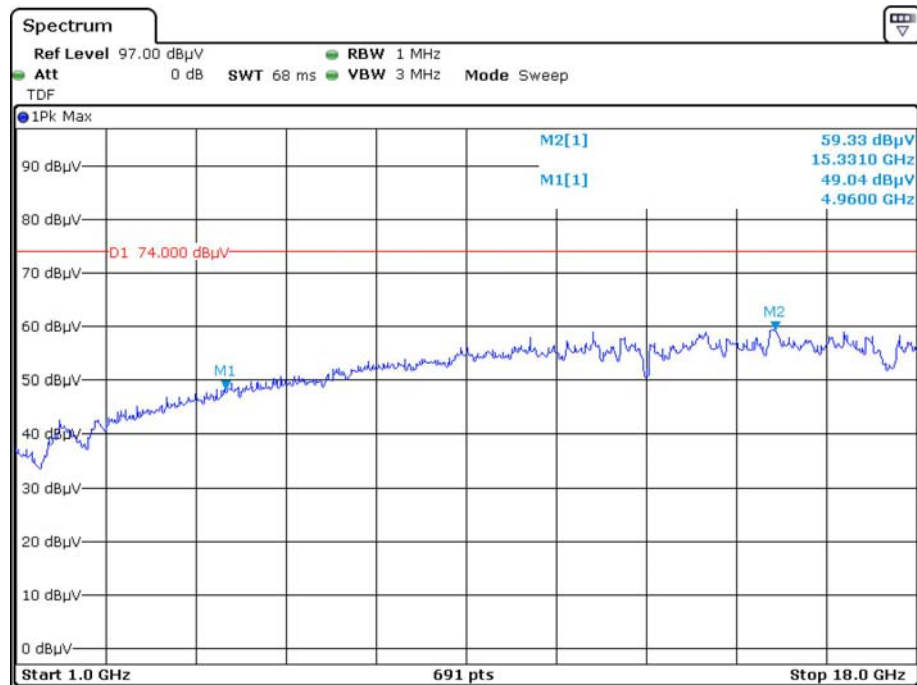
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Corrected Amplitude = Corrected Factor + Reading

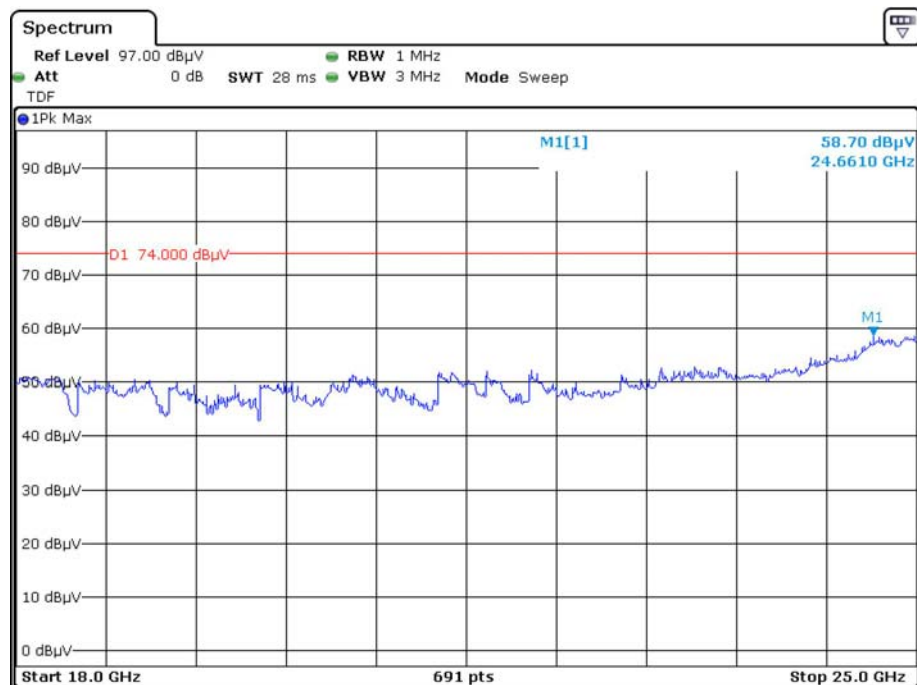
Margin = Limit - Corrected. Amplitude

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

Pre-scan with high channel Peak Horizontal

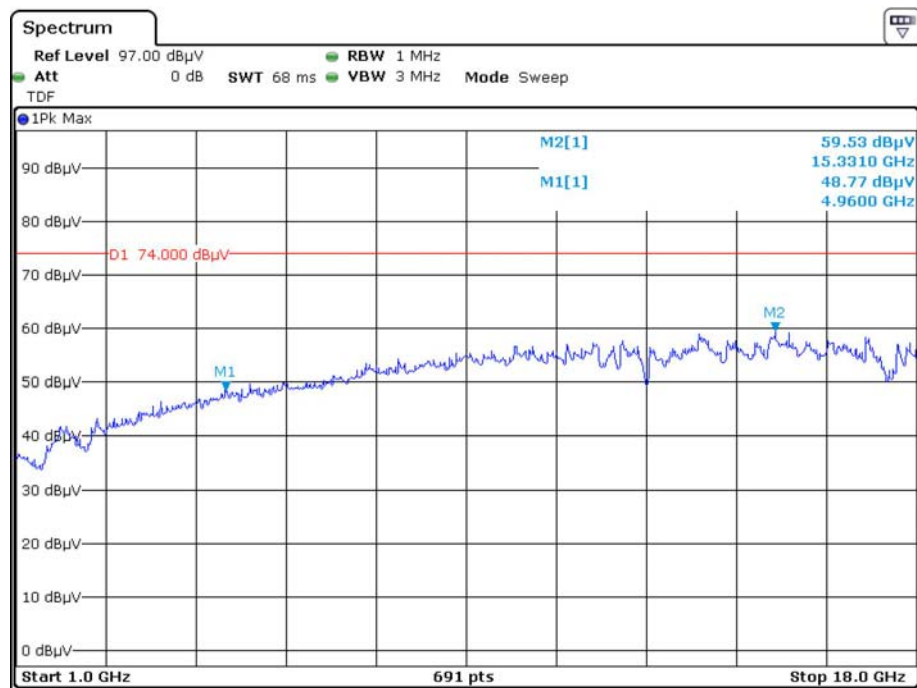


Date: 15.MAR.2021 12:51:36

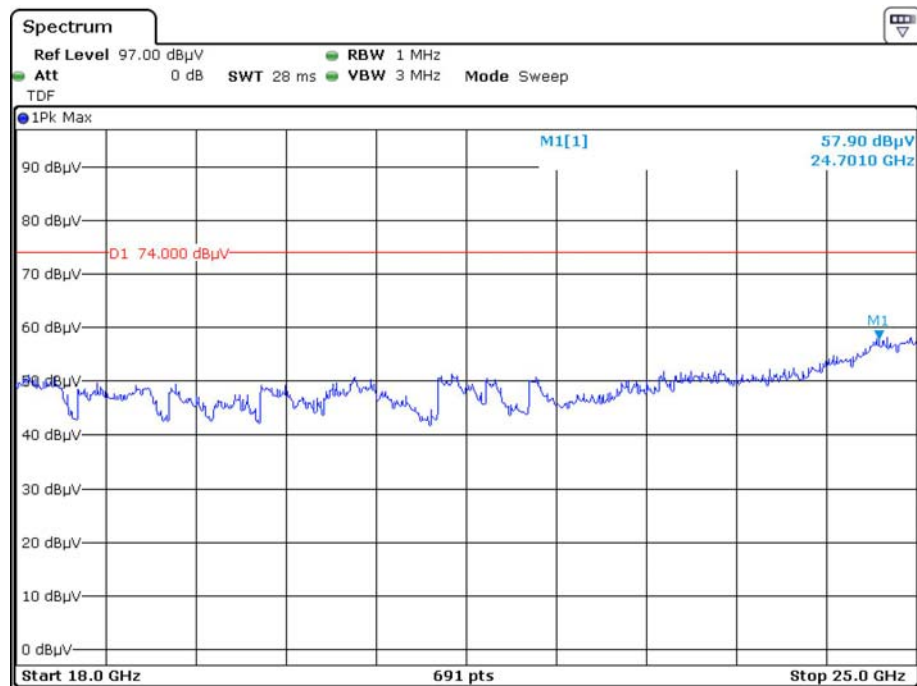


Date: 15.MAR.2021 13:43:19

Vertical

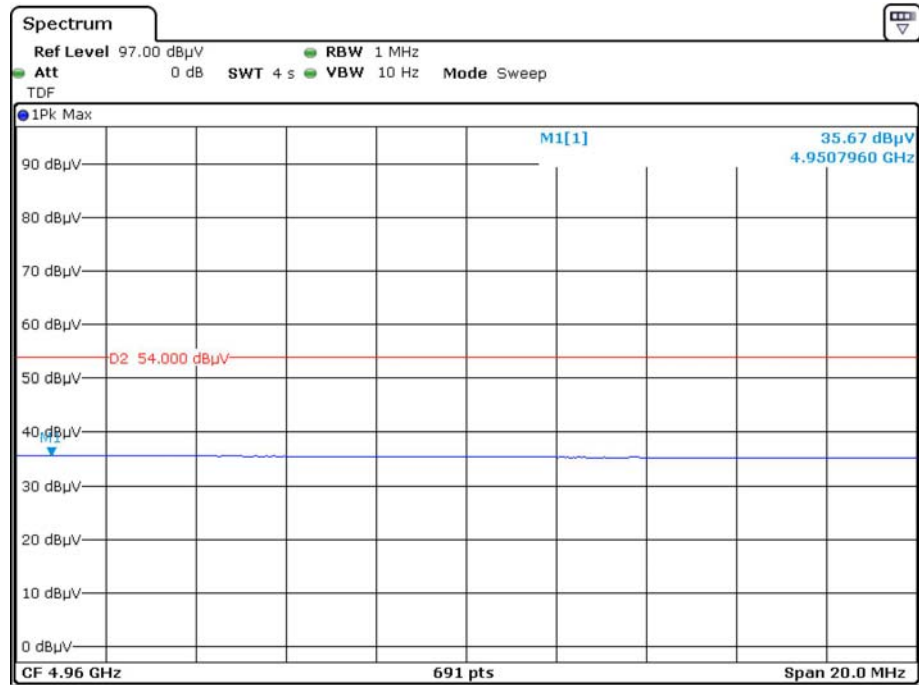


Date: 15.MAR.2021 13:04:25

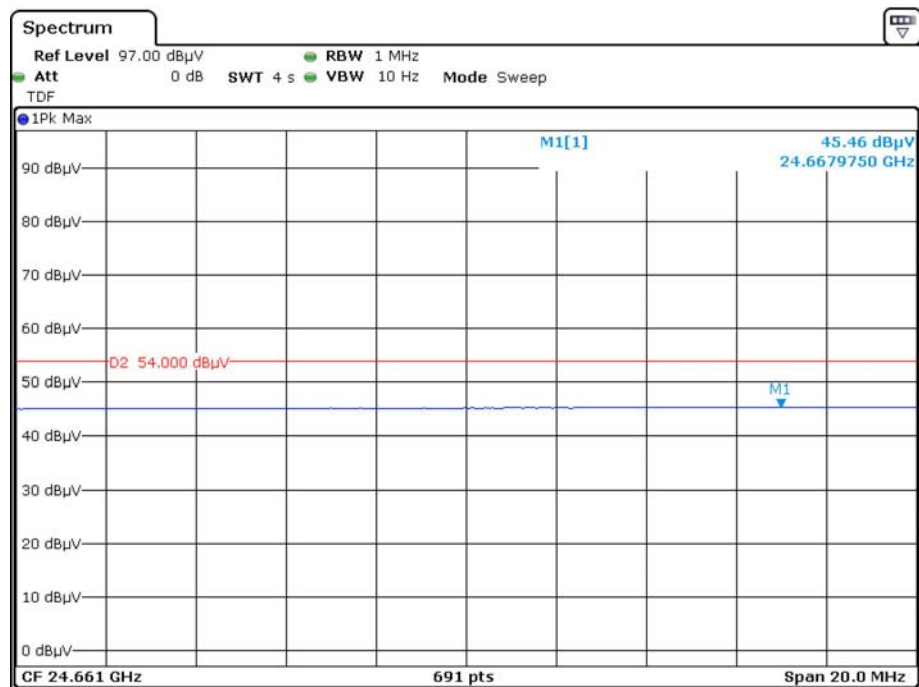


Date: 15.MAR.2021 13:52:45

Average Horizontal

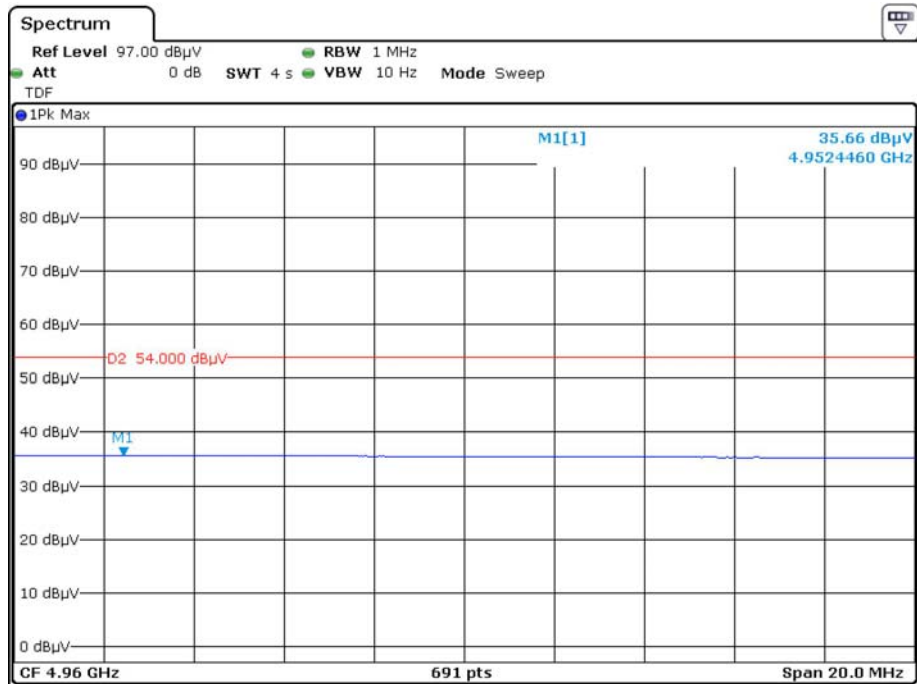


Date: 15.MAR.2021 12:56:48

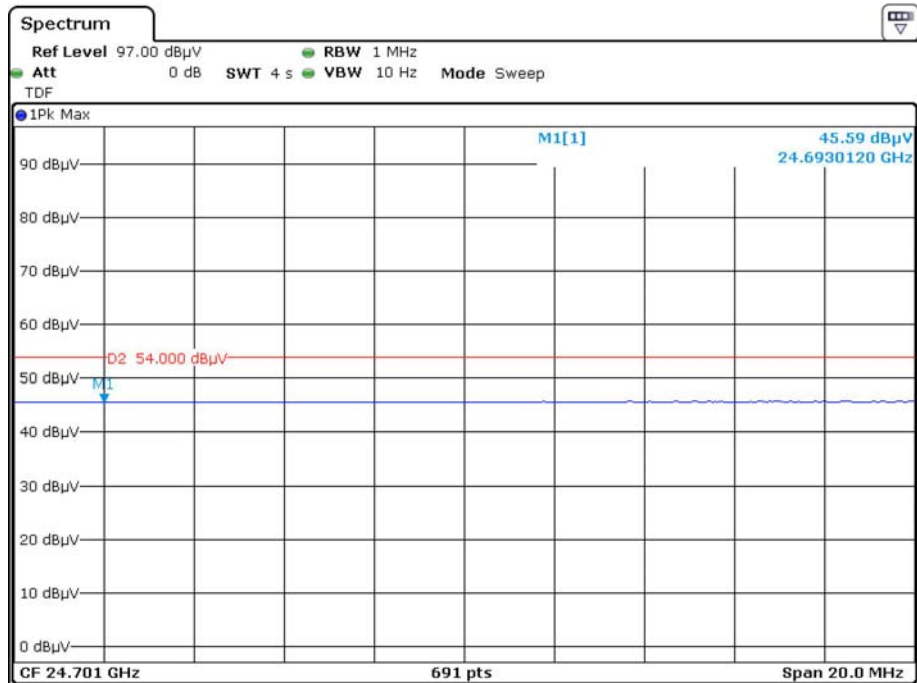


Date: 15.MAR.2021 13:46:31

Vertical



Date: 15.MAR.2021 13:11:16



Date: 15.MAR.2021 13:59:27

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

Applicable Standard

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

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

Test Data

Environmental Conditions

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

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**

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

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**

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

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**

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

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

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

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

Temperature:	24 °C
Relative Humidity:	56 %
ATM Pressure:	101.0 kPa

The testing was performed by Coco Liu on 2021-03-09.

EUT operation mode: Transmitting

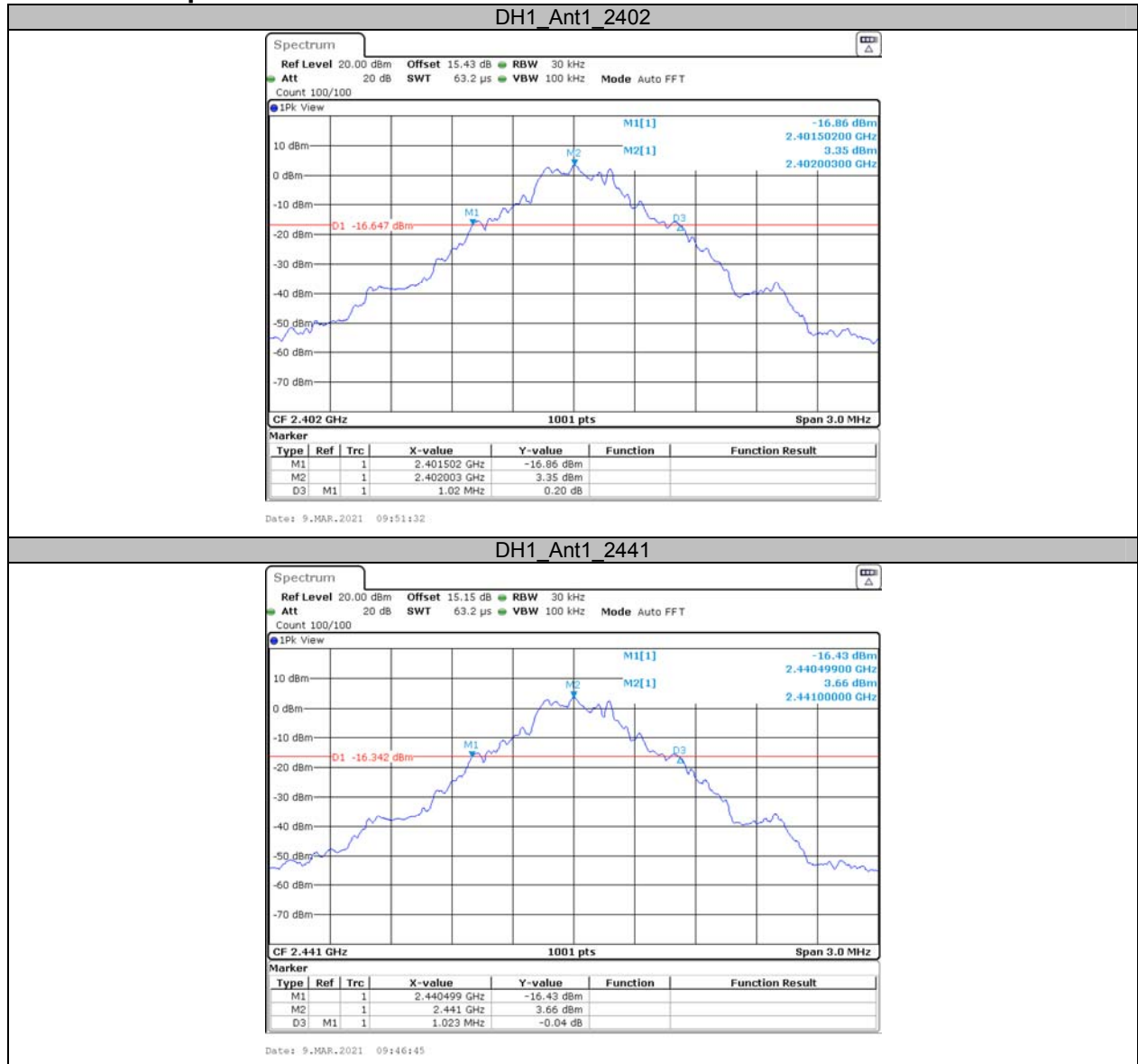
Test Result: Compliant. Please refer to the Appendix.

APPENDIX

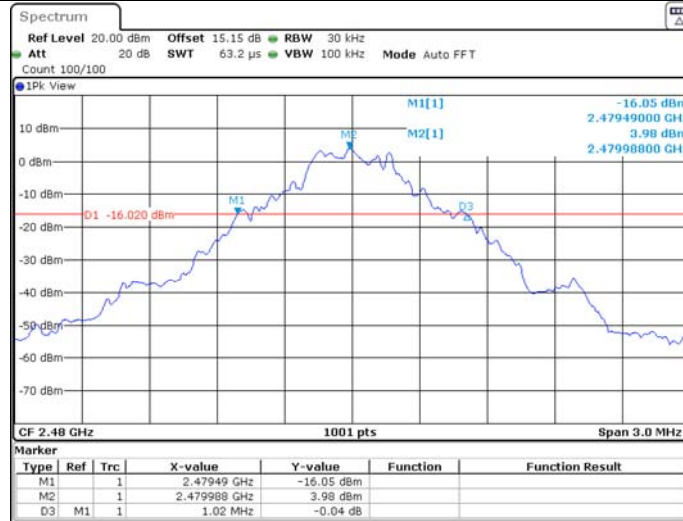
Appendix A: 20dB Emission Bandwidth Test Result

TestMode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	1.020	---	PASS
		2441	1.023	---	PASS
		2480	1.020	---	PASS
2DH1	Ant1	2402	1.320	---	PASS
		2441	1.320	---	PASS
		2480	1.320	---	PASS
3DH1	Ant1	2402	1.269	---	PASS
		2441	1.269	---	PASS
		2480	1.272	---	PASS

Test Graphs

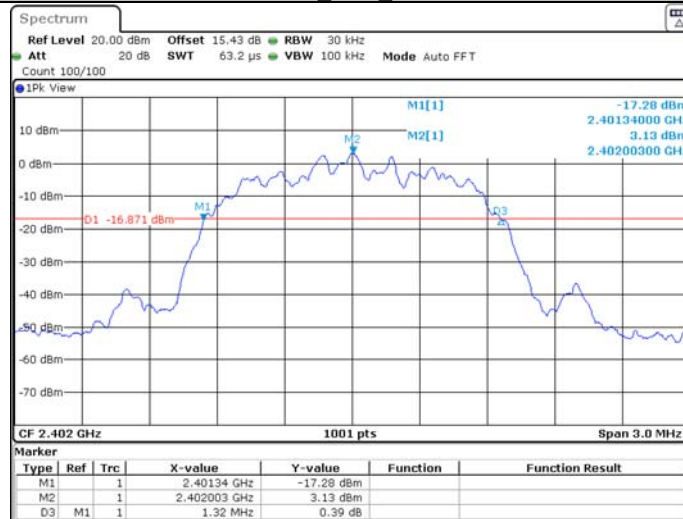


DH1_Ant1_2480



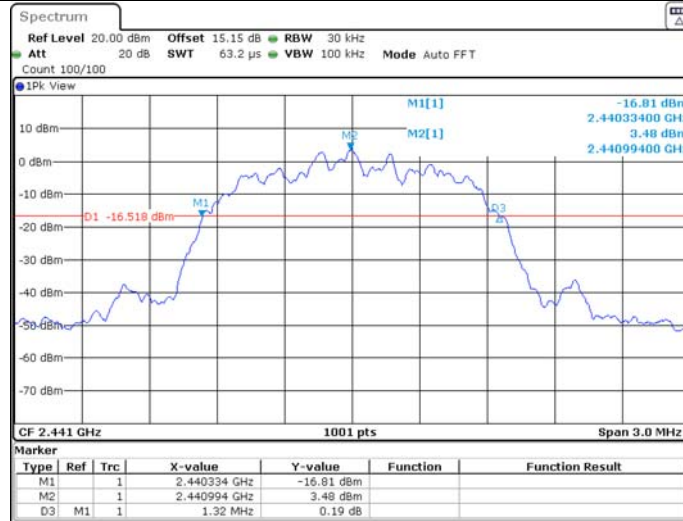
Date: 9.MAR.2021 09:55:10

2DH1_Ant1_2402



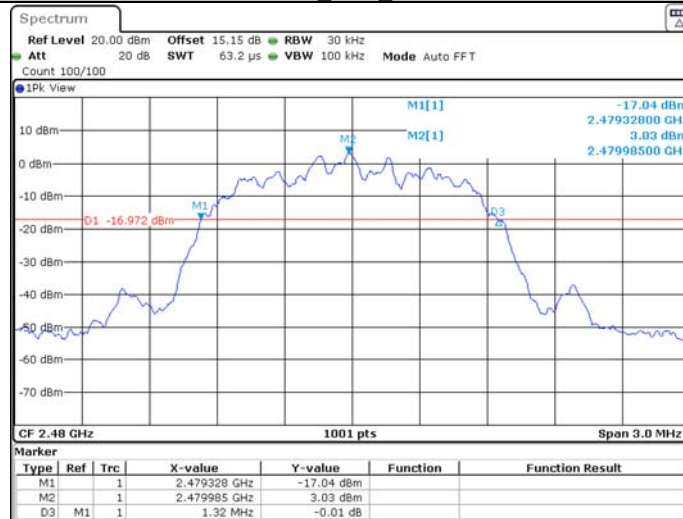
Date: 9.MAR.2021 10:04:38

2DH1_Ant1_2441

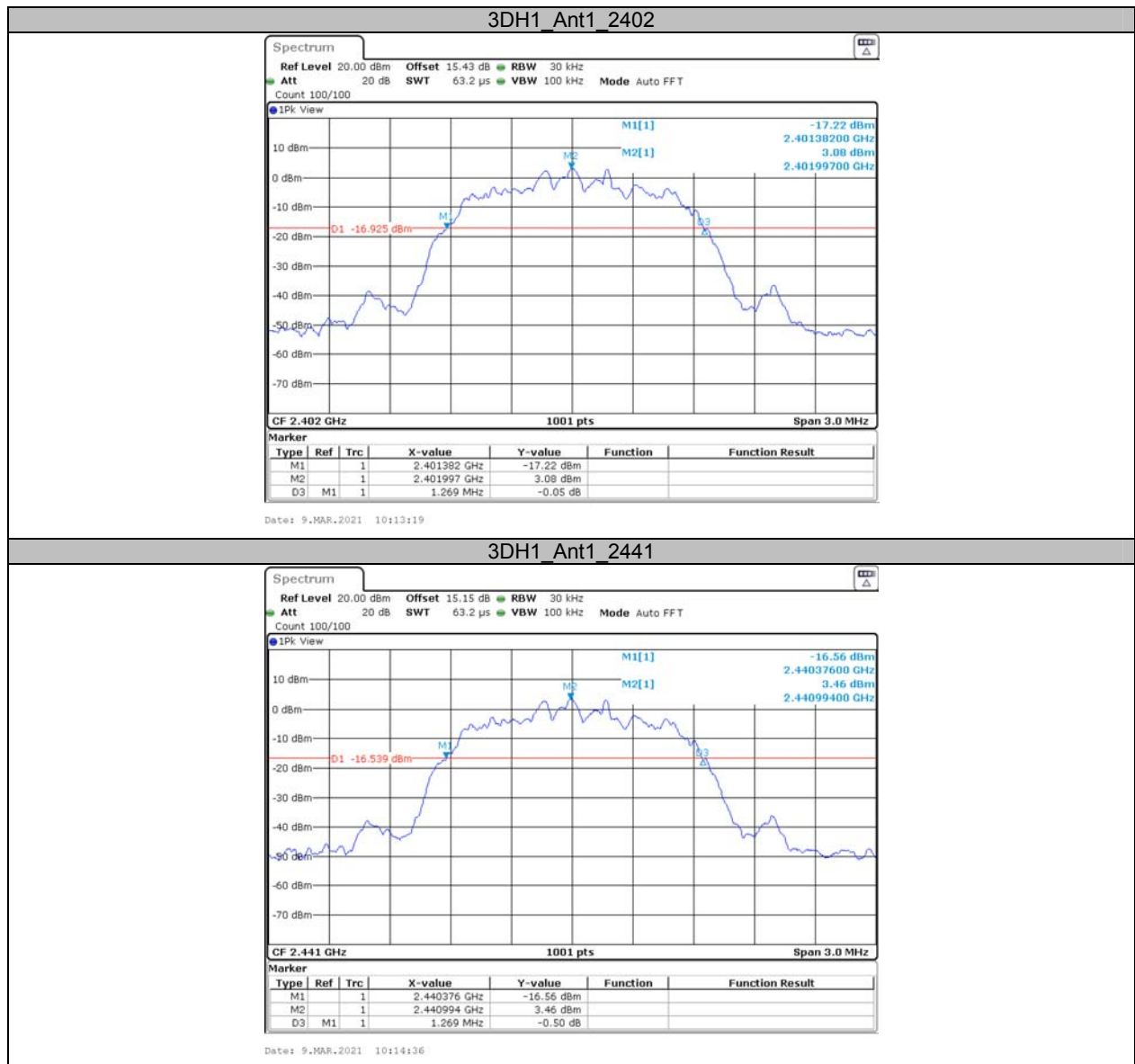


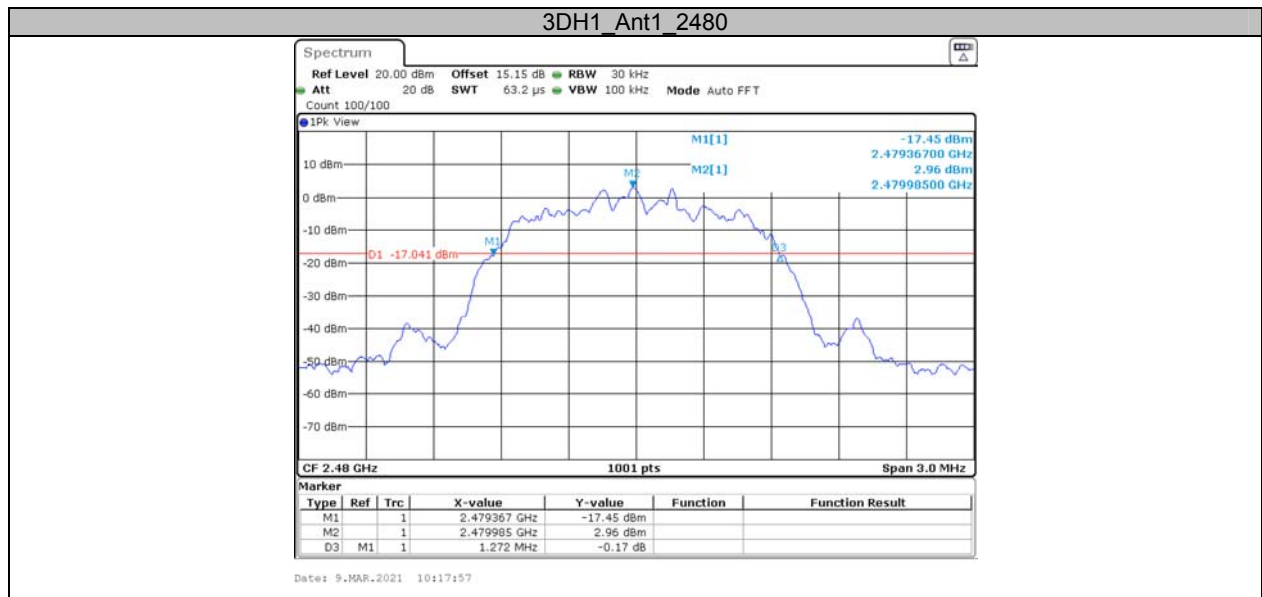
Date: 9.MAR.2021 10:06:35

2DH1_Ant1_2480



Date: 9.MAR.2021 10:07:33

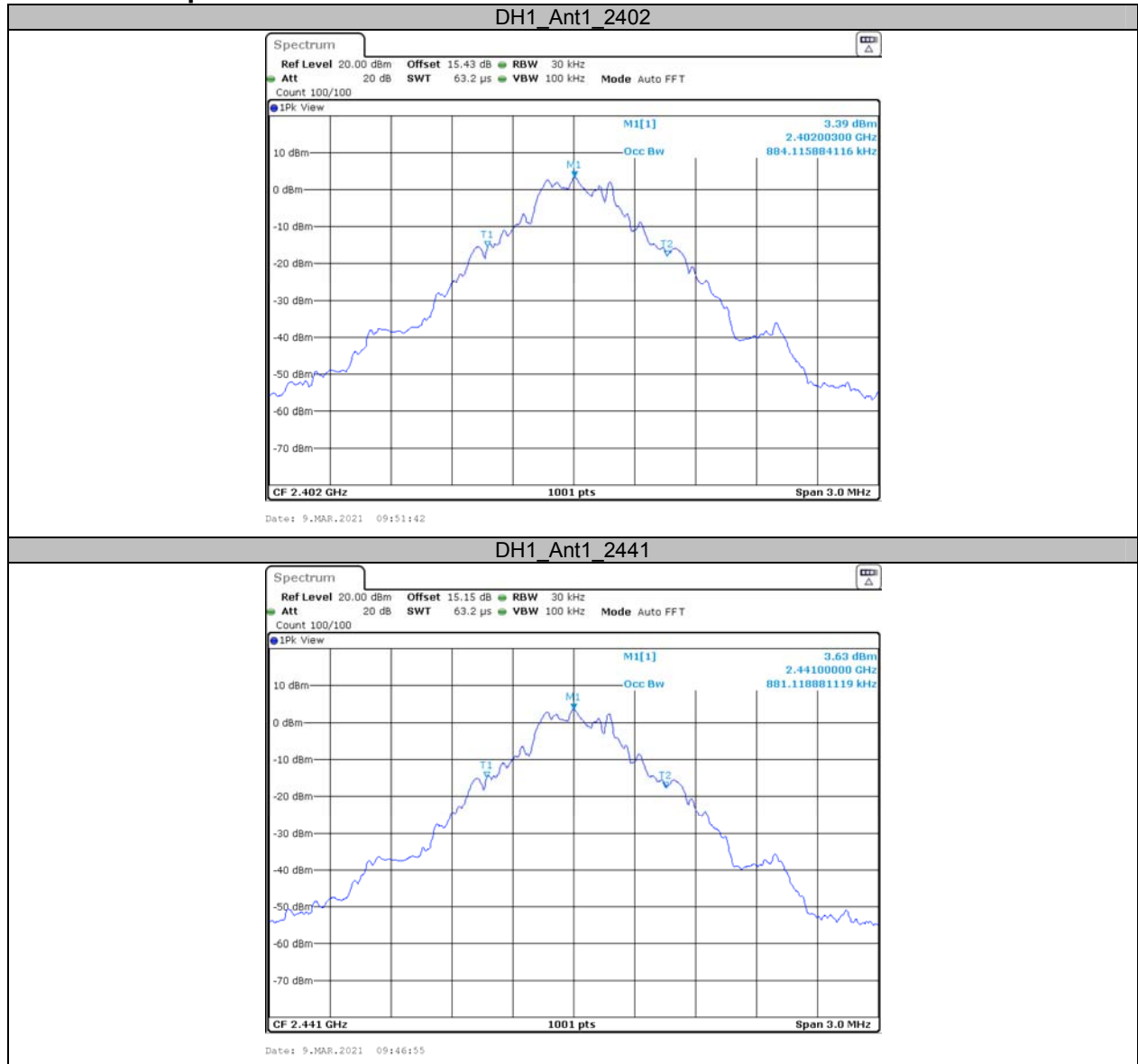


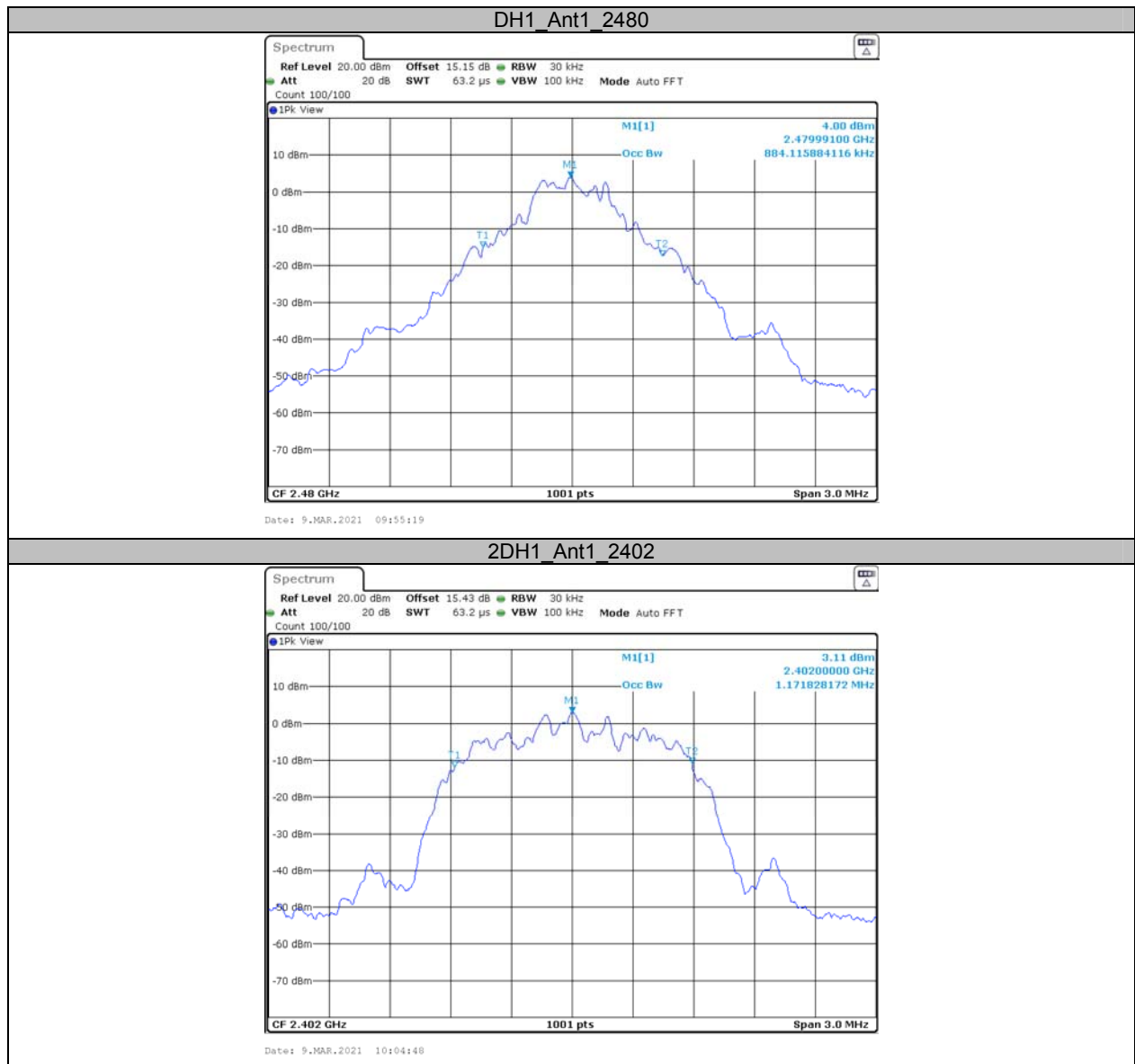


**Appendix B: Occupied Channel Bandwidth
Test Result**

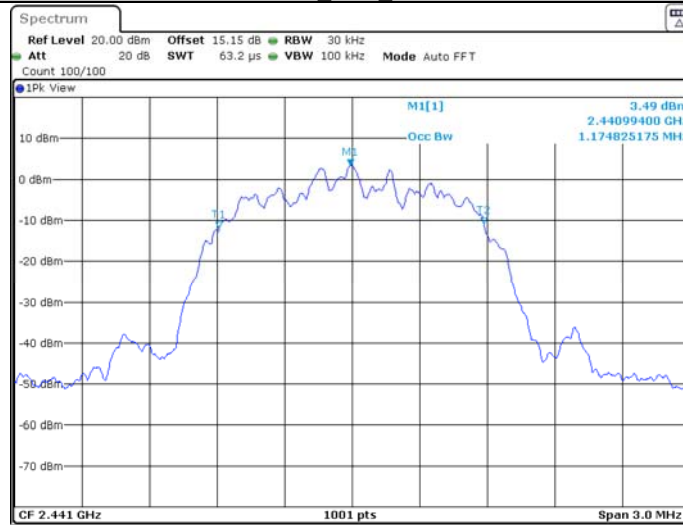
TestMode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.884	---	PASS
		2441	0.881	---	PASS
		2480	0.884	---	PASS
2DH1	Ant1	2402	1.172	---	PASS
		2441	1.175	---	PASS
		2480	1.175	---	PASS
3DH1	Ant1	2402	1.160	---	PASS
		2441	1.160	---	PASS
		2480	1.163	---	PASS

Test Graphs



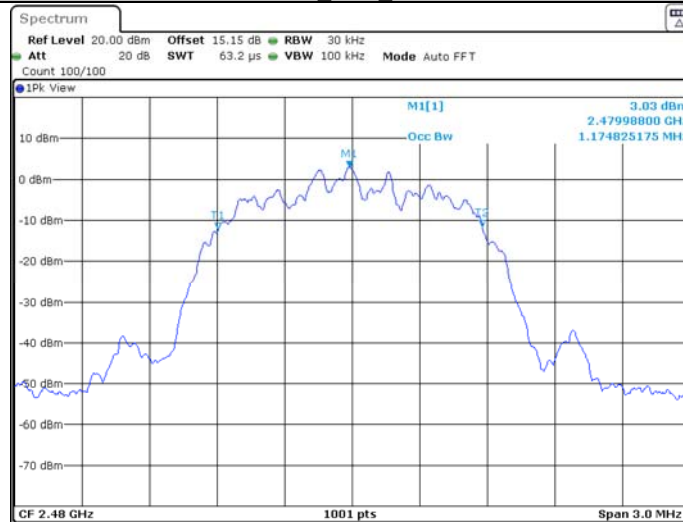


2DH1_Ant1_2441



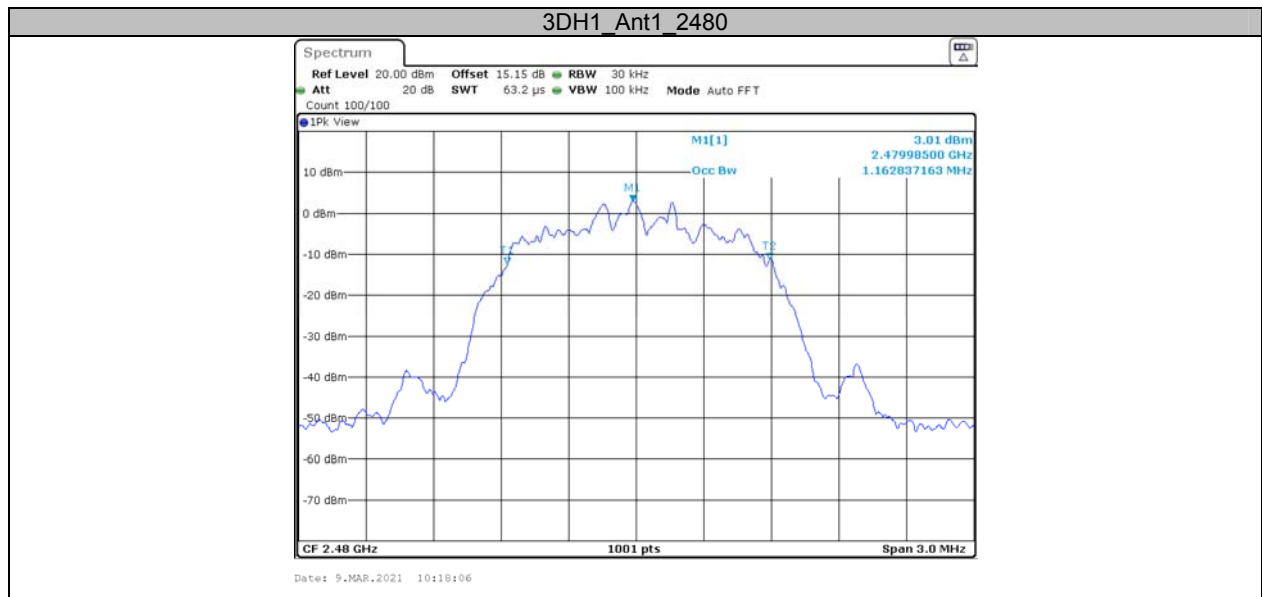
Date: 9.MAR.2021 10:06:45

2DH1_Ant1_2480



Date: 9.MAR.2021 10:07:43

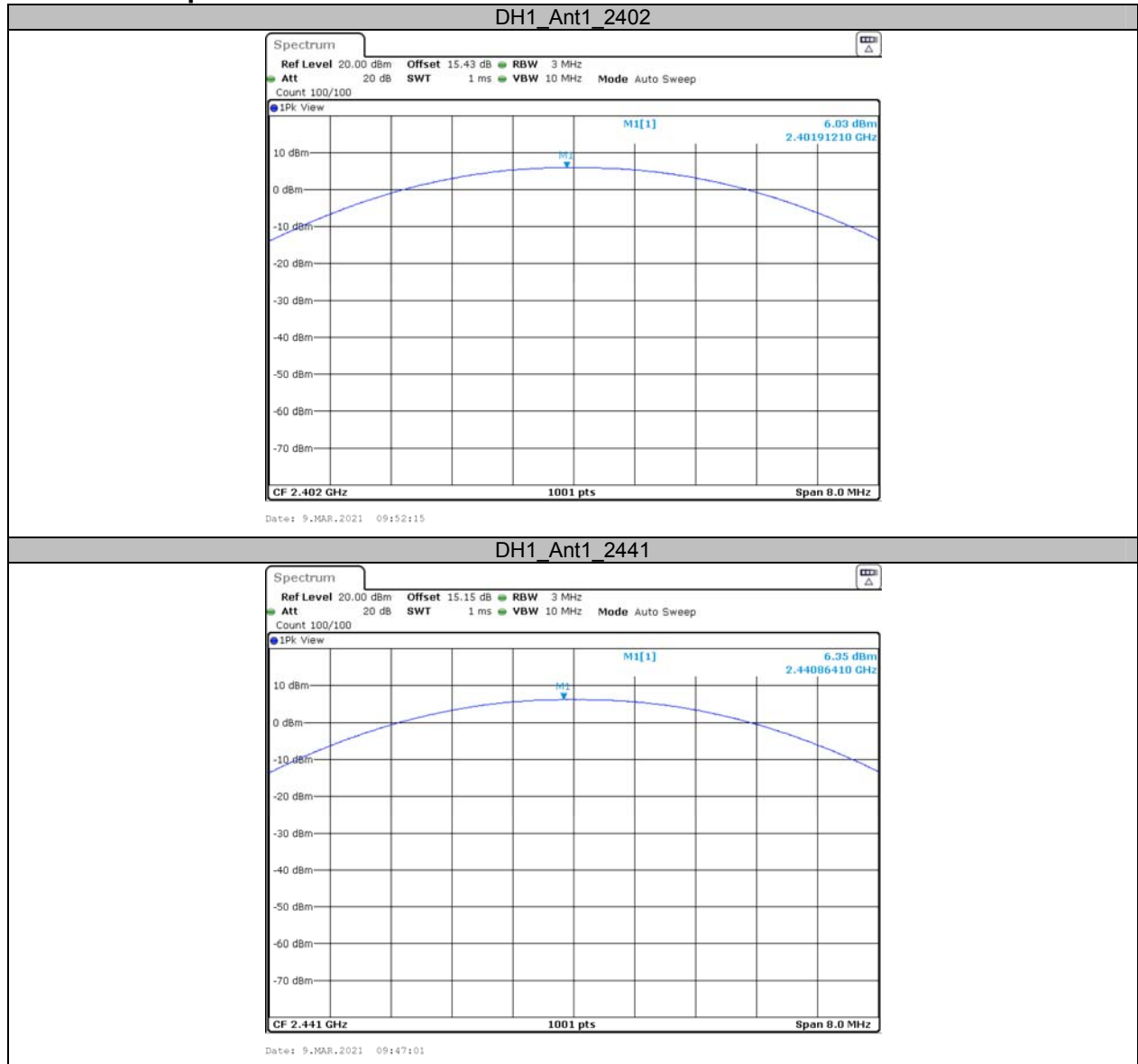


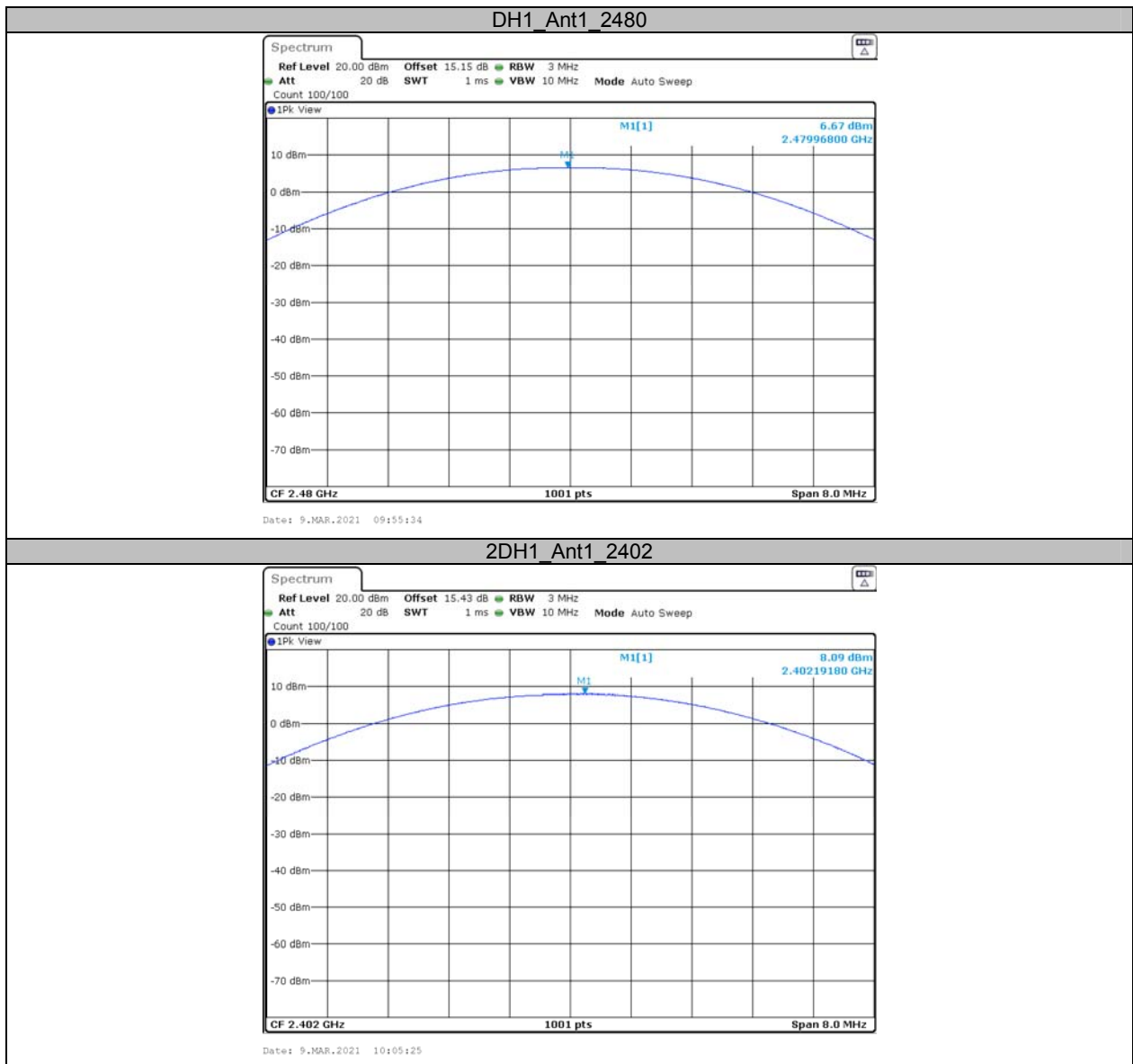


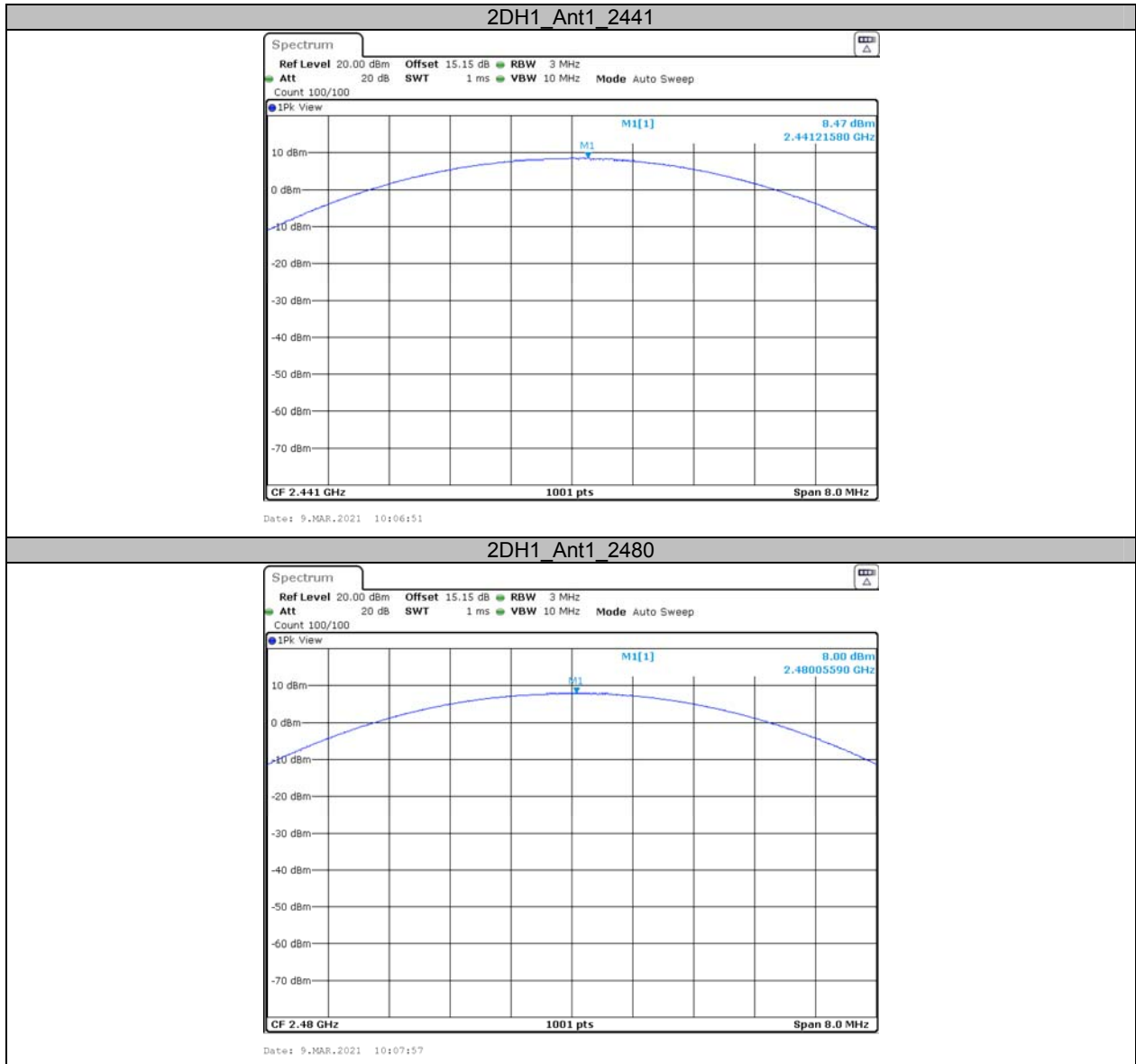
**Appendix C: Maximum conducted Peak output power
Test Result**

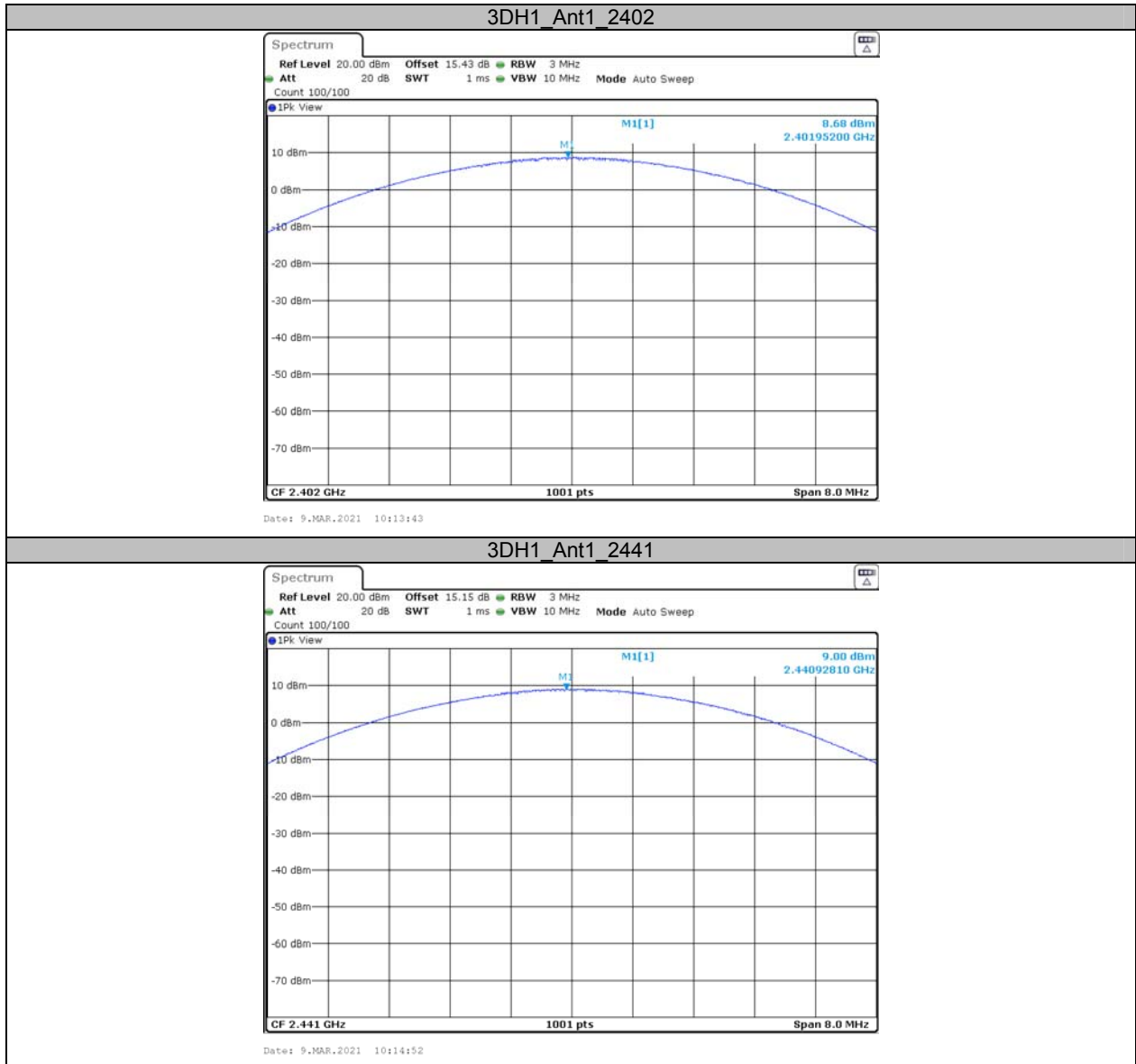
TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	6.03	<=20.97	PASS
		2441	6.35	<=20.97	PASS
		2480	6.67	<=20.97	PASS
2DH1	Ant1	2402	8.09	<=20.97	PASS
		2441	8.47	<=20.97	PASS
		2480	8.00	<=20.97	PASS
3DH1	Ant1	2402	8.68	<=20.97	PASS
		2441	9.00	<=20.97	PASS
		2480	8.59	<=20.97	PASS

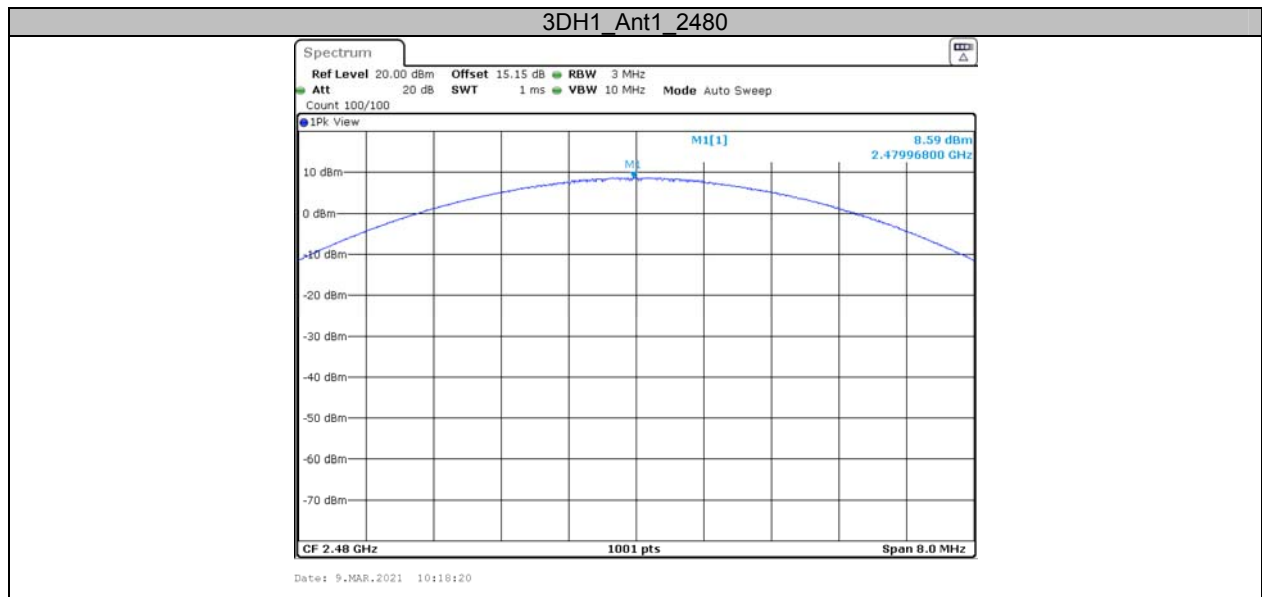
Test Graphs









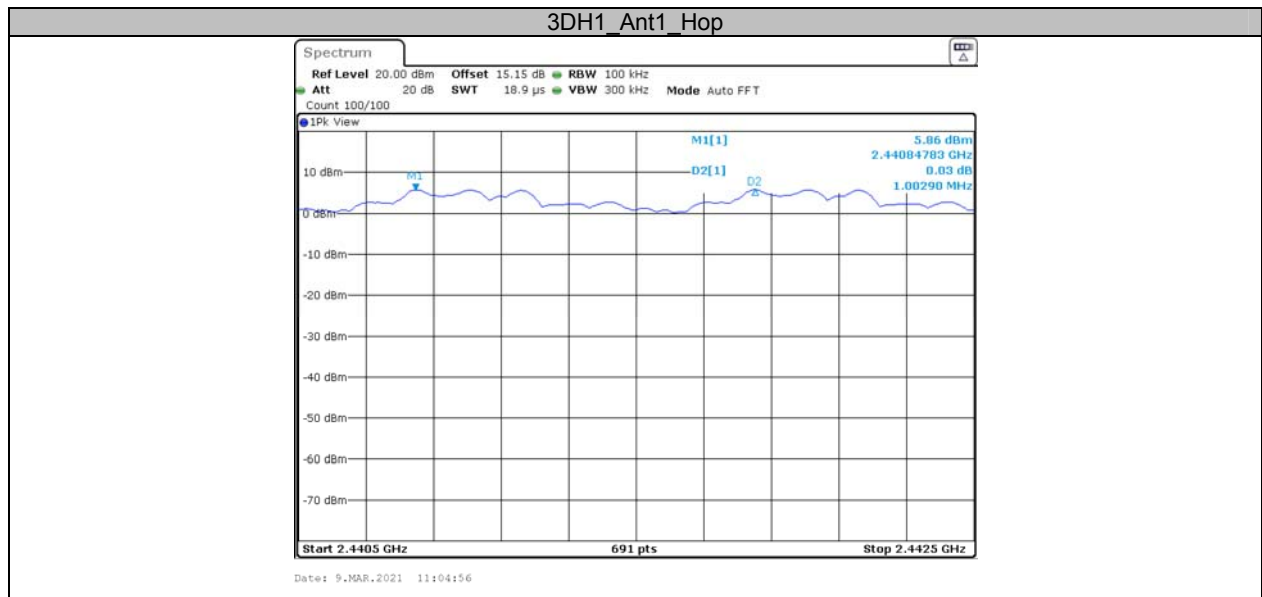


**Appendix D: Carrier frequency separation
Test Result**

TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1	≥ 0.682	PASS
2DH1	Ant1	Hop	1	≥ 0.880	PASS
3DH1	Ant1	Hop	1.003	≥ 0.846	PASS

Test Graphs





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

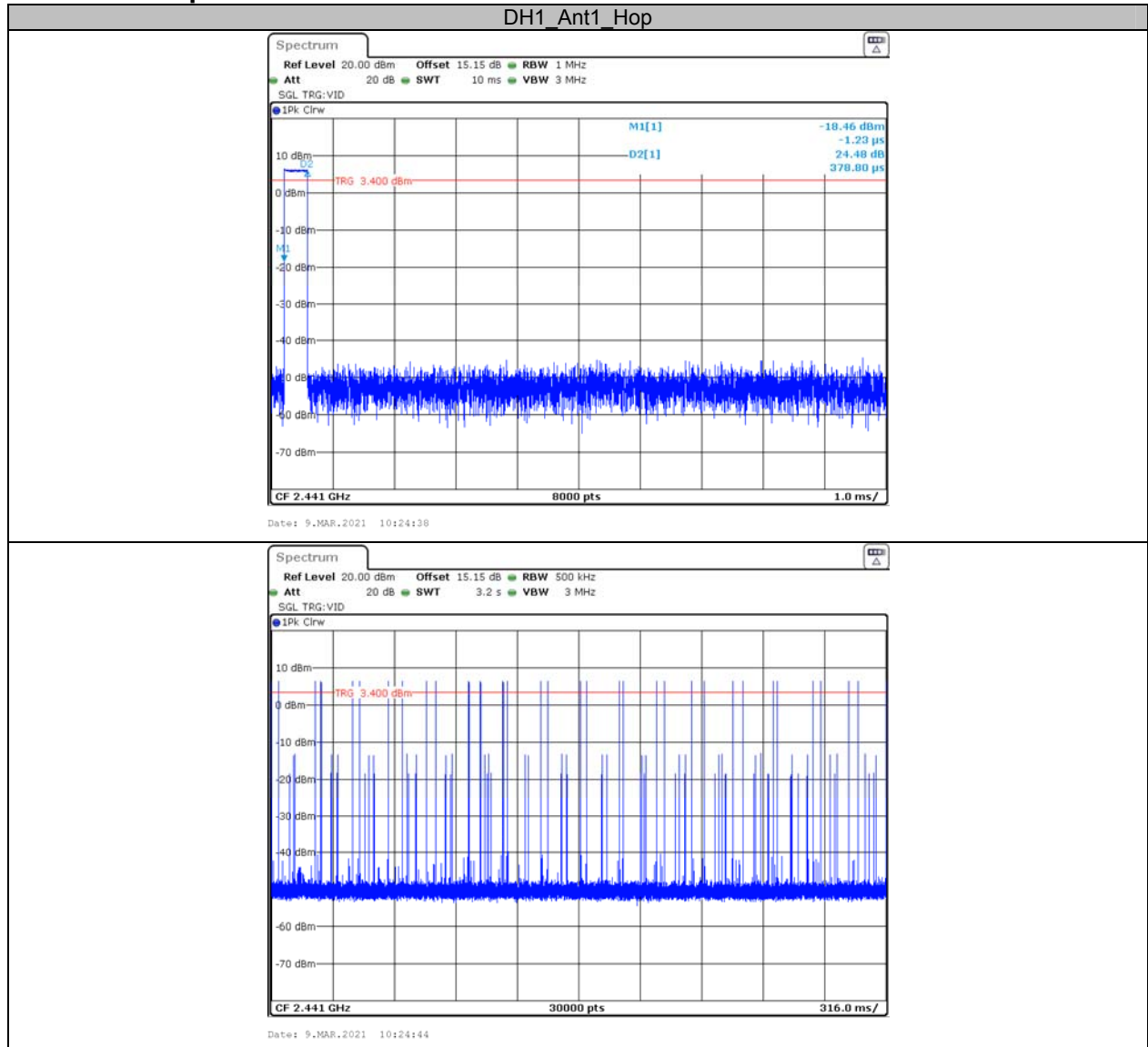
TestMode	Antenna	Channel	BurstWidth [ms]	TotalHops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.38	320	0.121	<=0.4	PASS
DH3	Ant1	Hop	1.63	160	0.26	<=0.4	PASS
DH5	Ant1	Hop	2.87	110	0.315	<=0.4	PASS
2DH1	Ant1	Hop	0.39	320	0.123	<=0.4	PASS
2DH3	Ant1	Hop	1.63	150	0.244	<=0.4	PASS
2DH5	Ant1	Hop	2.87	120	0.344	<=0.4	PASS
3DH1	Ant1	Hop	0.39	320	0.123	<=0.4	PASS
3DH3	Ant1	Hop	1.63	150	0.245	<=0.4	PASS
3DH5	Ant1	Hop	2.87	90	0.258	<=0.4	PASS

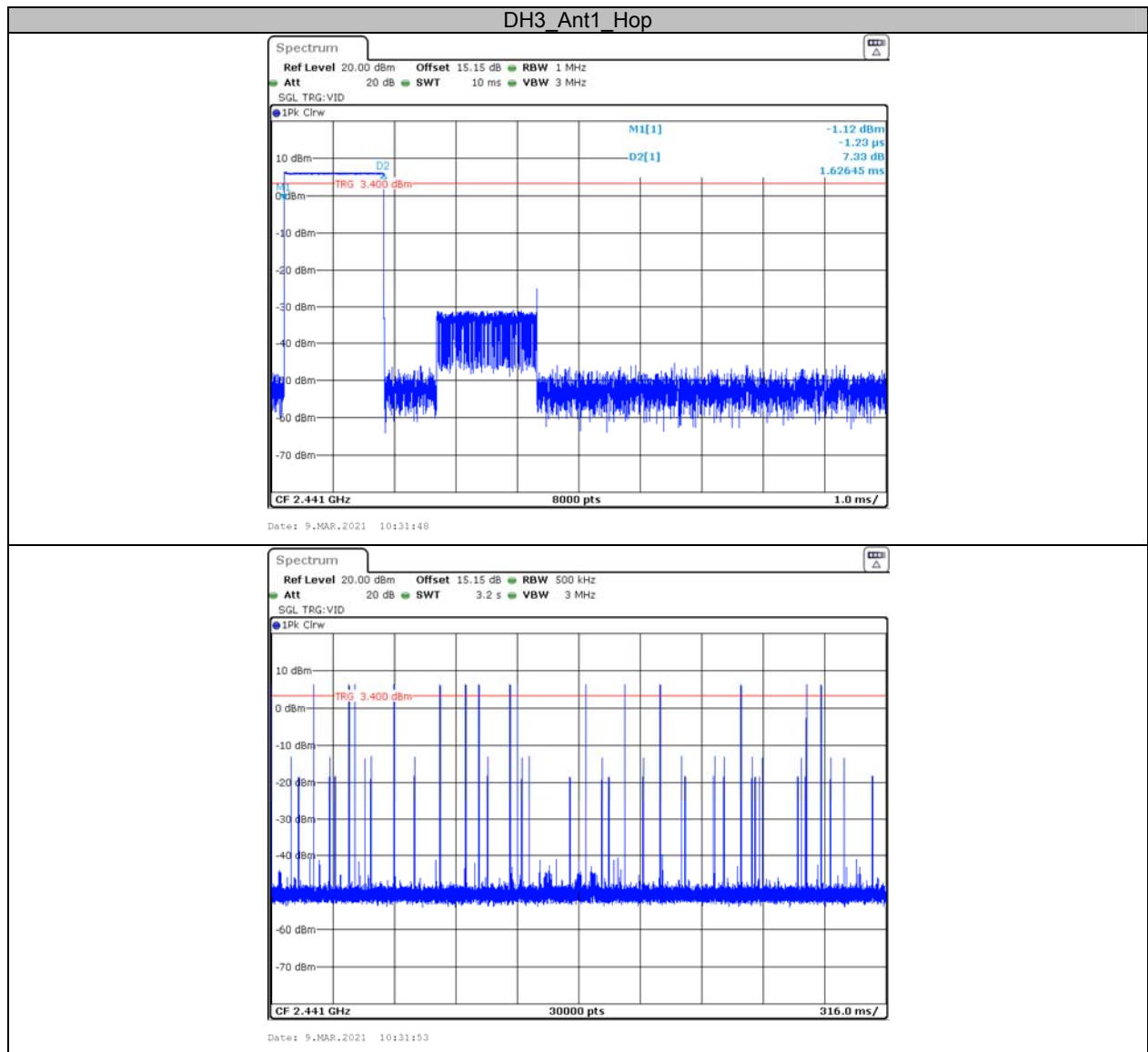
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=BurstWidth*Totalhops

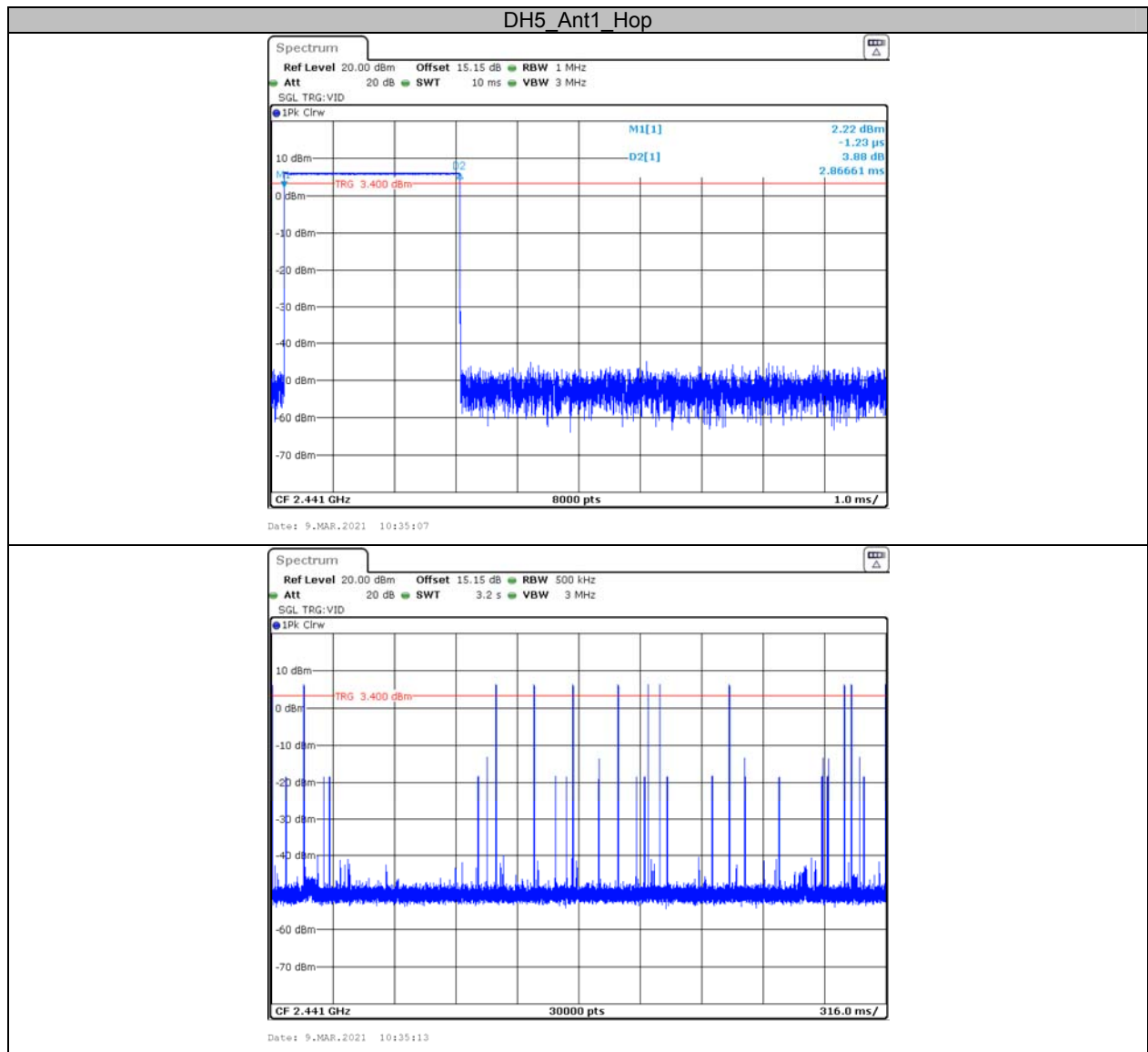
Note 2: Totalhops=Hopping Number in $3.16s \times 10$

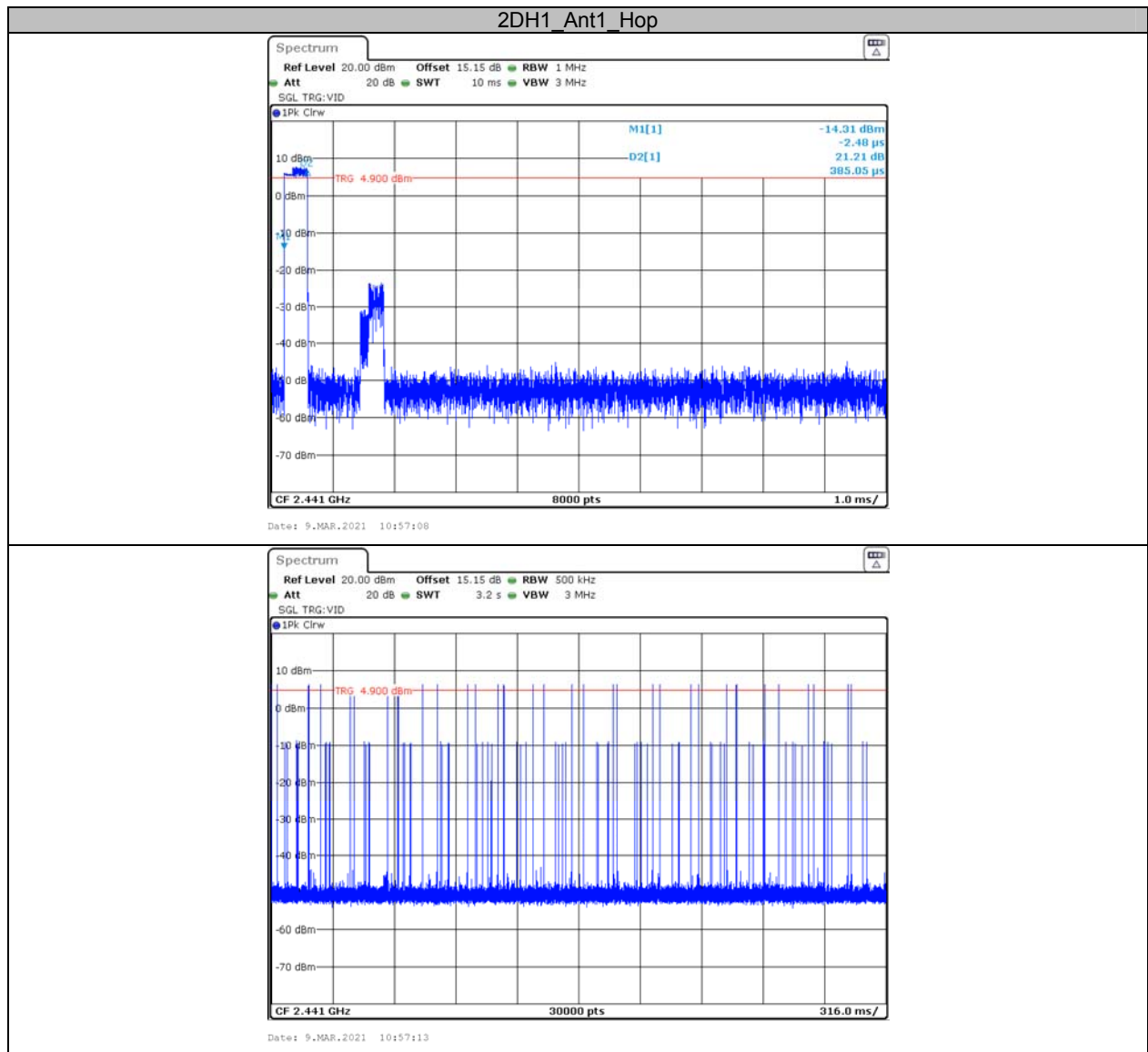
Note 3: Hopping Number in 3.16s=Total of highest signals in 3.16s(Second high signals were other channel)

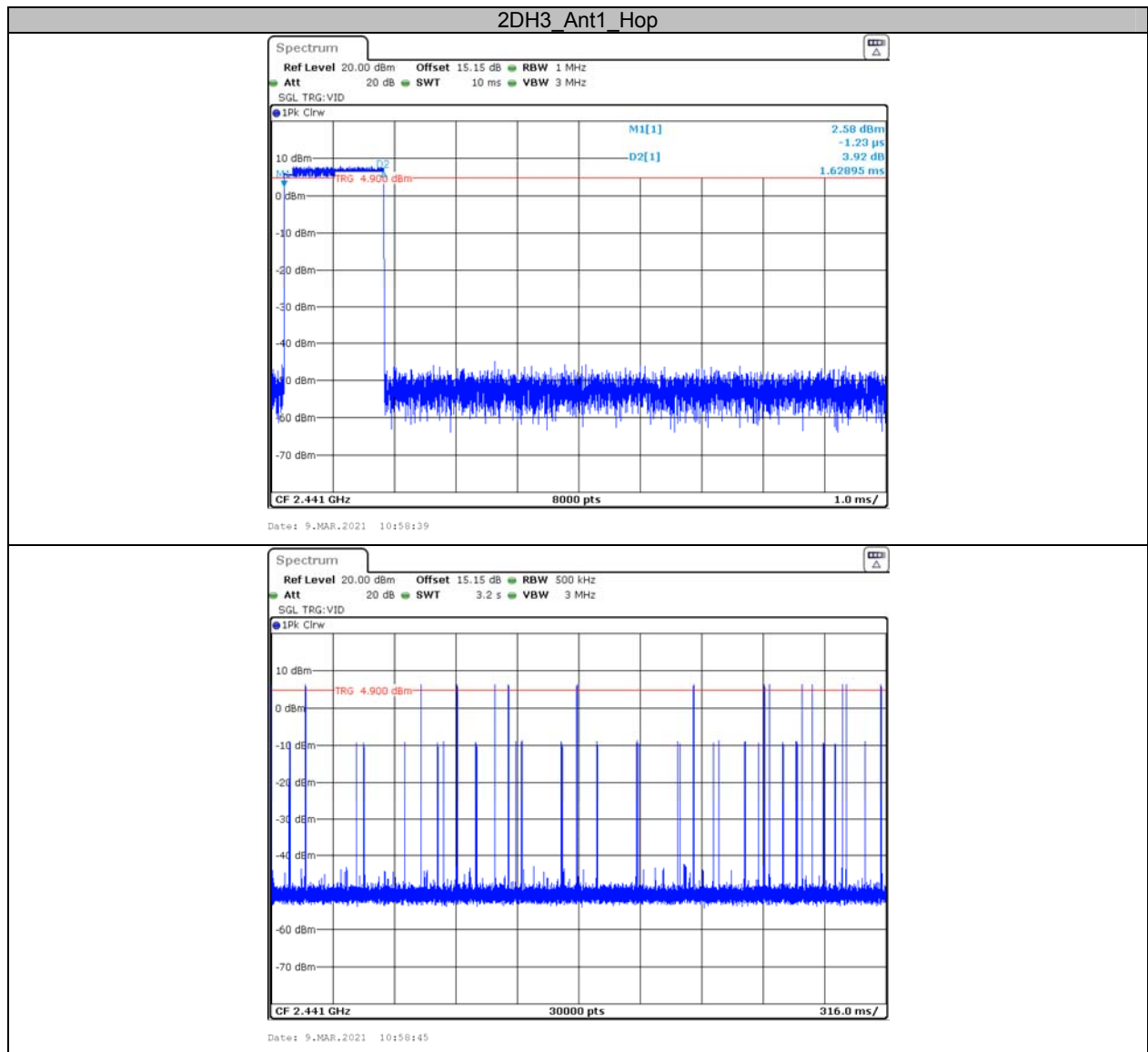
Test Graphs

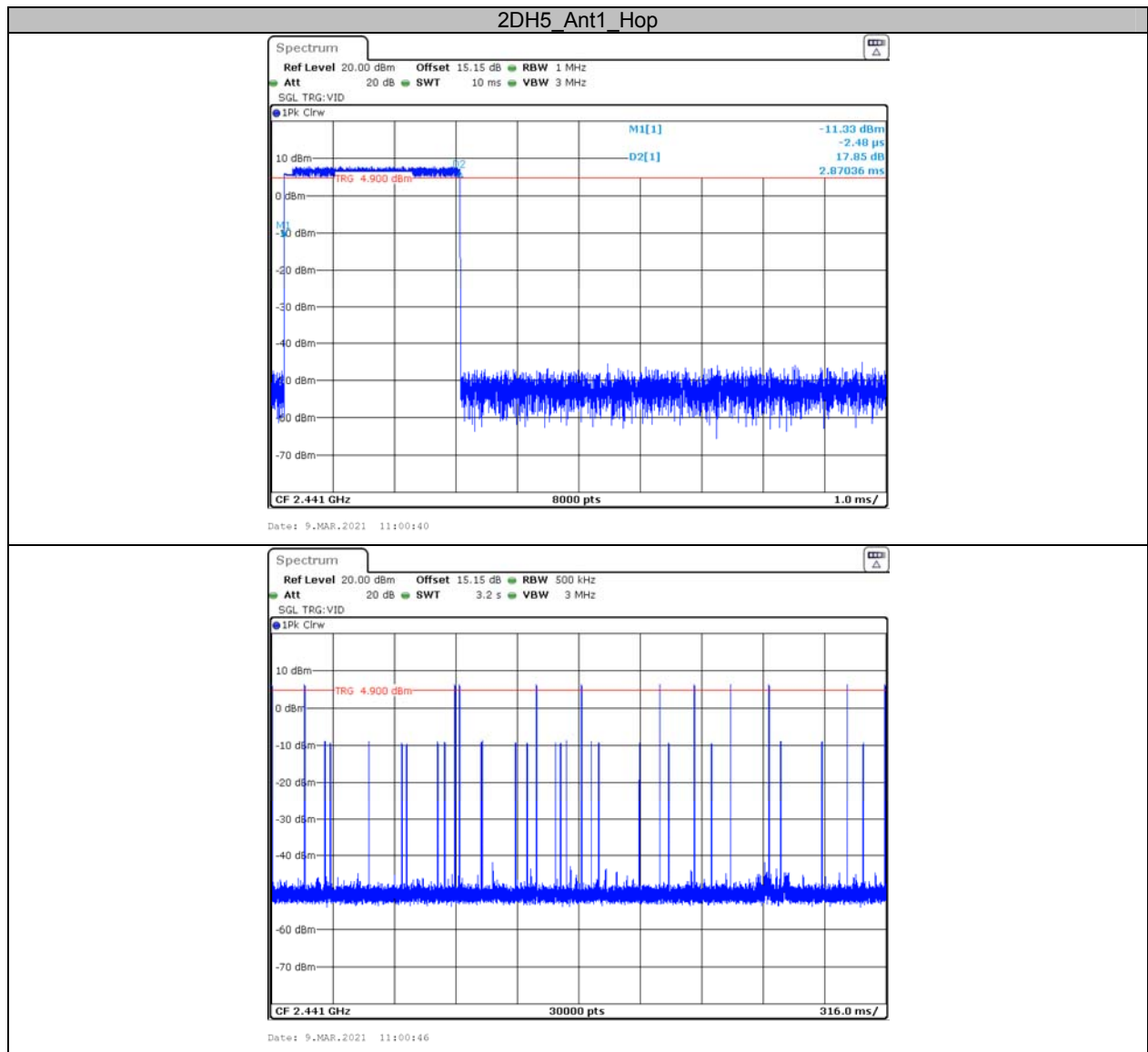


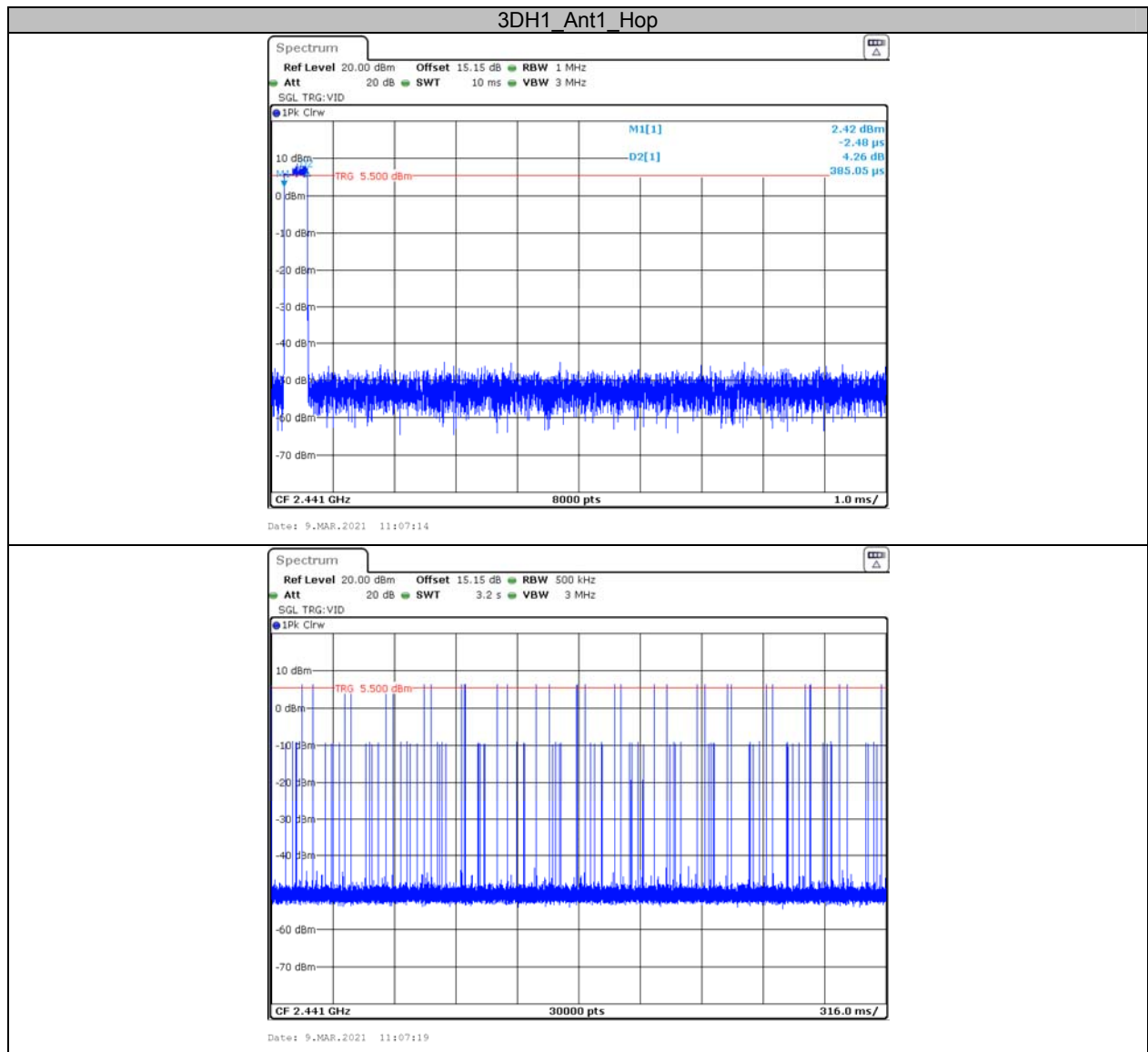


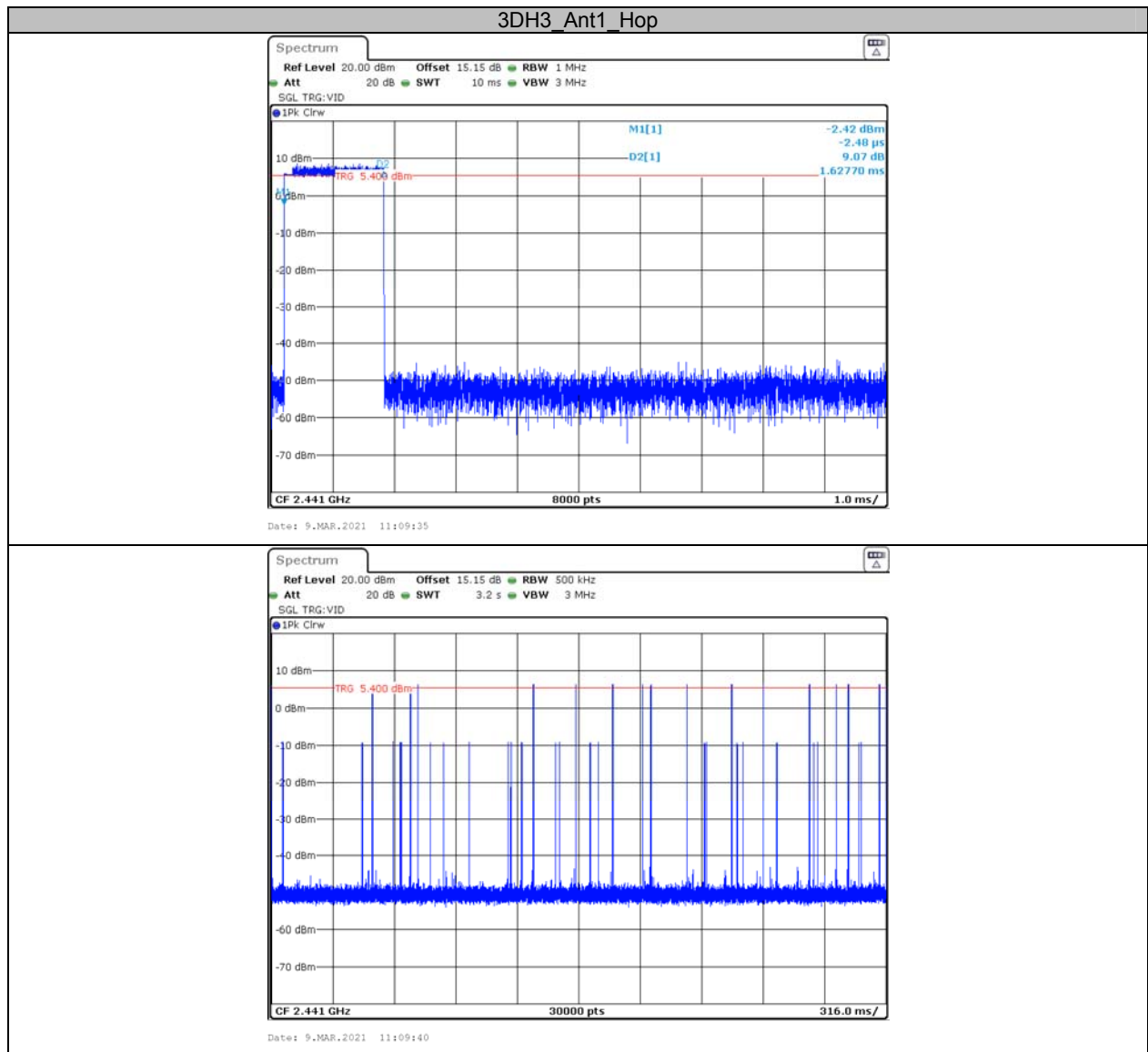


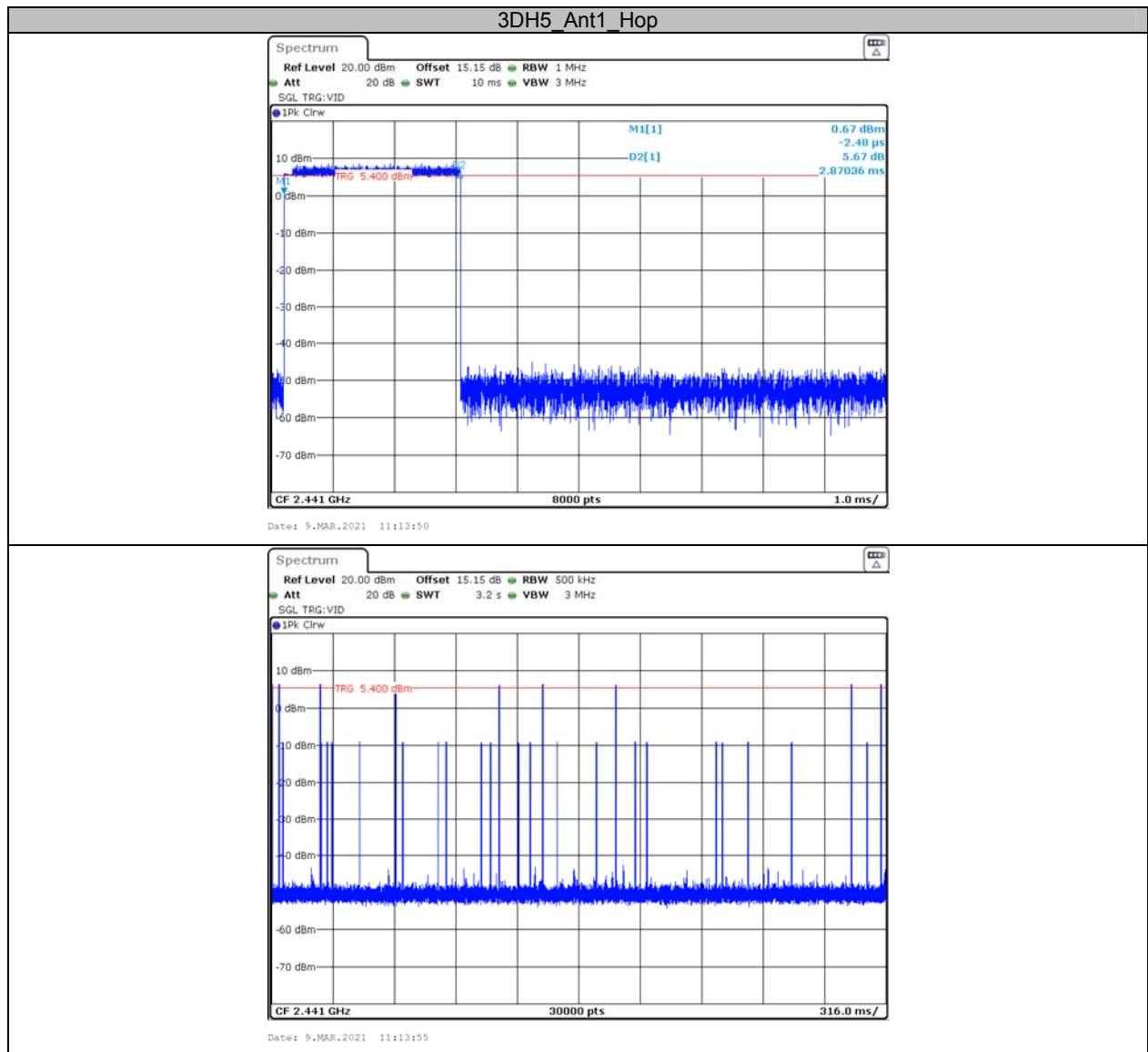








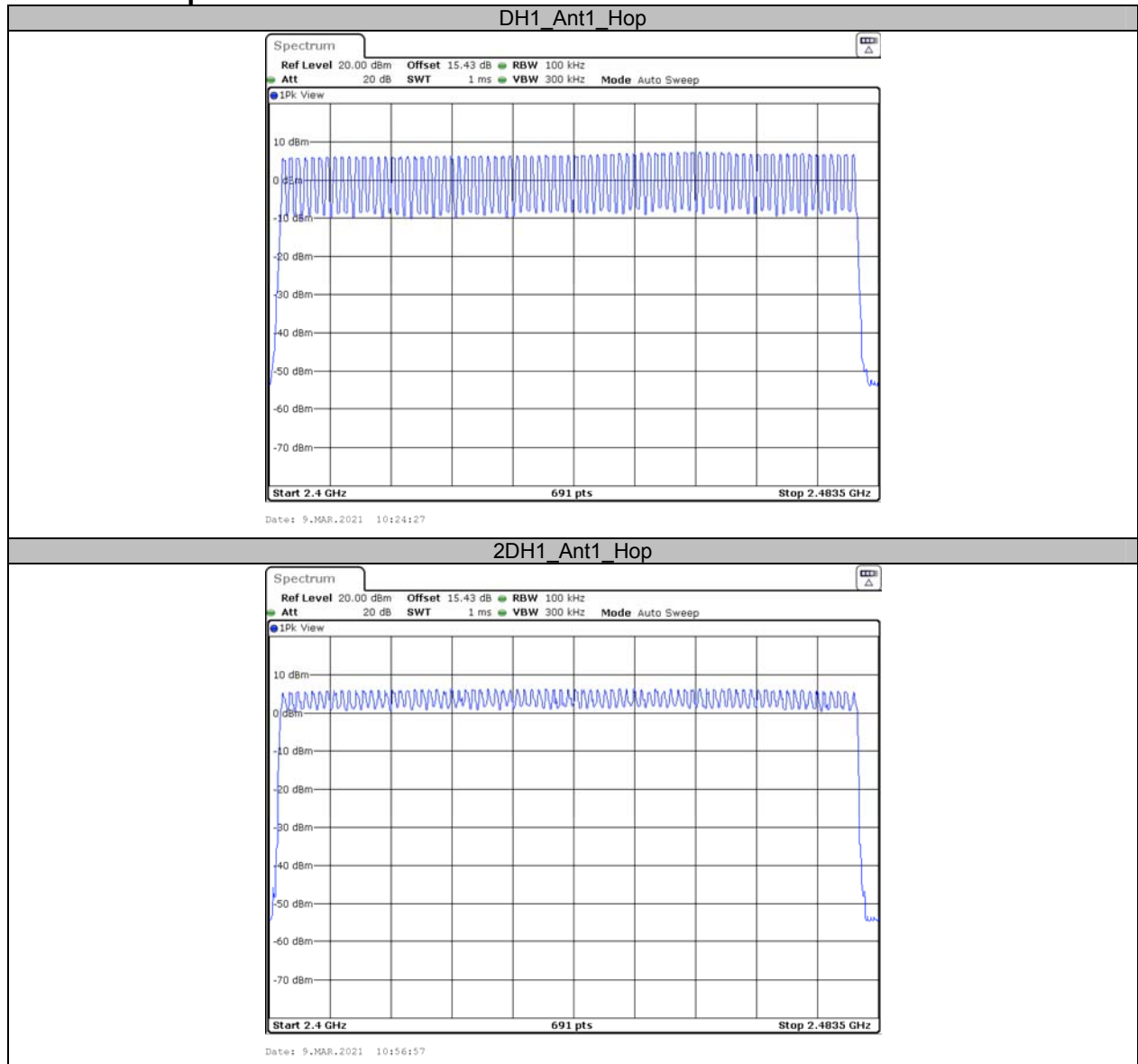


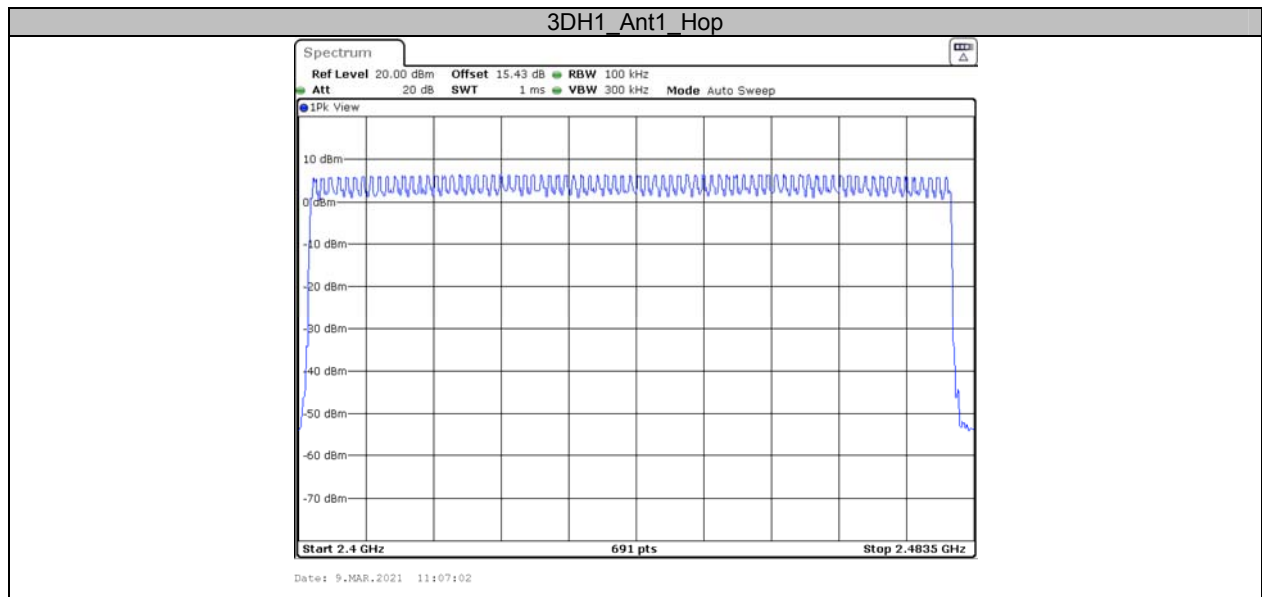


**Appendix F: Number of hopping channels
Test Result**

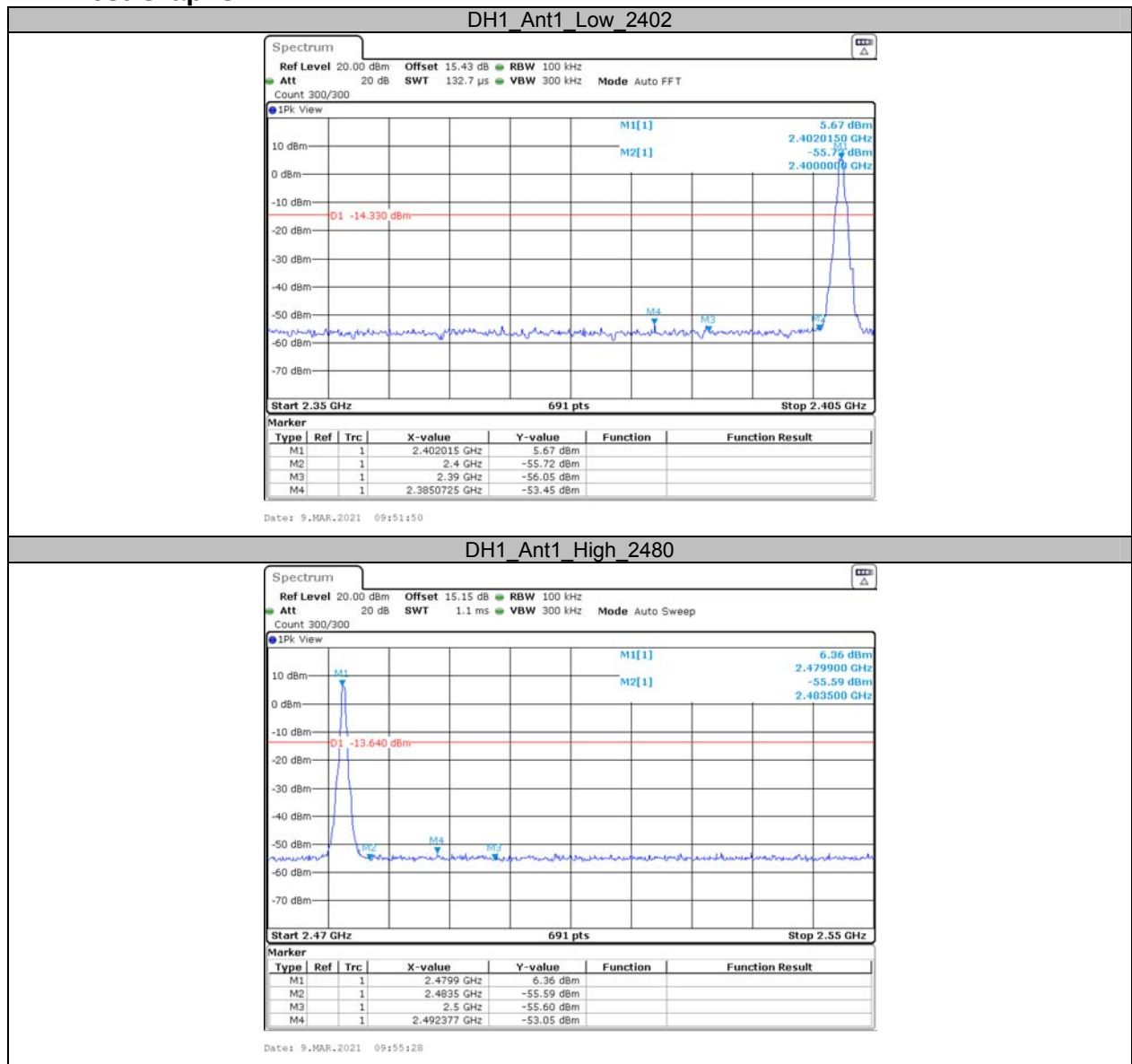
TestMode	Antenna	Channel	Result[Num]	Limit[Num]	Verdict
DH1	Ant1	Hop	79	>=15	PASS
2DH1	Ant1	Hop	79	>=15	PASS
3DH1	Ant1	Hop	79	>=15	PASS

Test Graphs



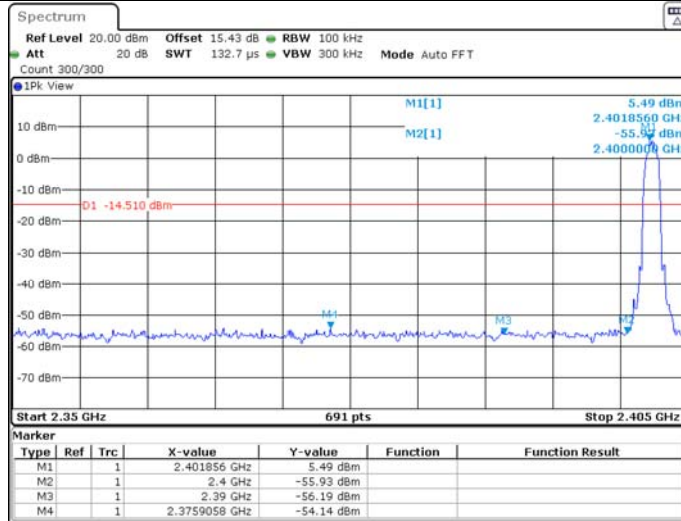


Appendix G: Band edge measurements Test Graphs



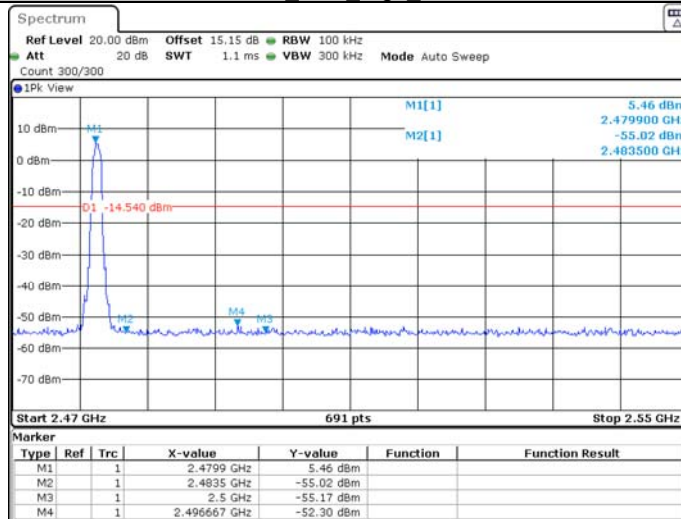


2DH1_Ant1_Low_2402



Date: 9.MAR.2021 10:04:56

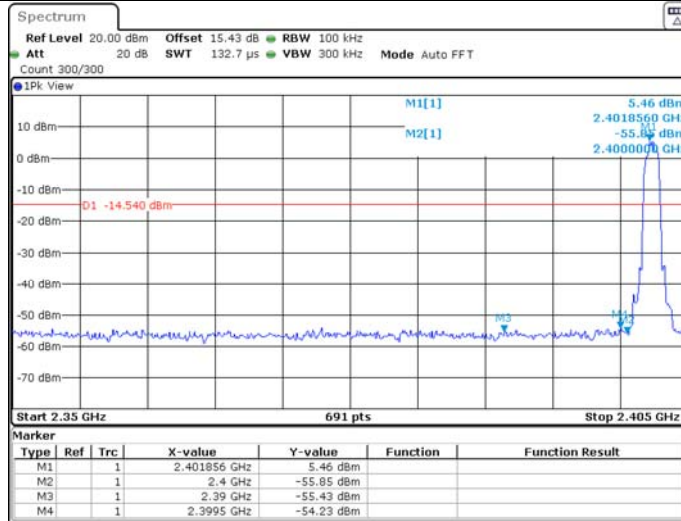
2DH1_Ant1_High_2480



Date: 9.MAR.2021 10:07:51

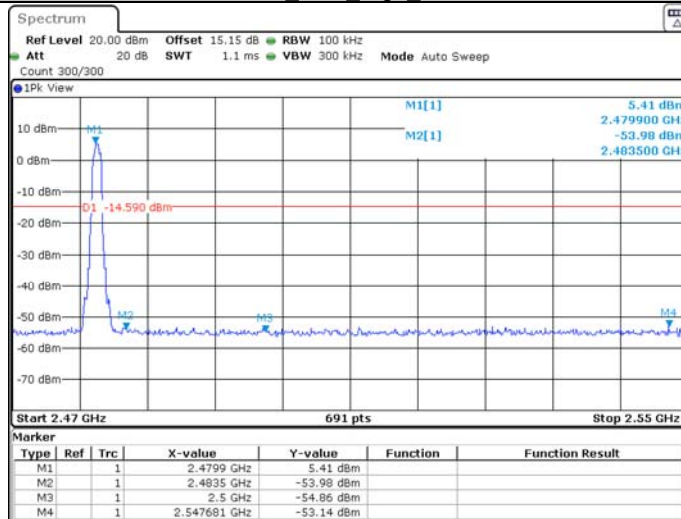


3DH1_Ant1_Low_2402



Date: 9.MAR.2021 10:13:37

3DH1_Ant1_High_2480



Date: 9.MAR.2021 10:18:15



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