

FCC PART 15.247 TEST REPORT

For

AudioCodes Ltd.

1 Hayarden Street, Airport City, Lod, Israel 70151

FCC ID: XAKC450DB

Report Type: Original Report	Product Type: IP Phone C450HD
Report Number: RSZ200623012-00A	
Report Date: 2020-07-28	
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	IP Phone C450HD
Model	C450HD
Frequency Range	Bluetooth: 2402~2480MHz
Maximum conducted Peak output power	Bluetooth: 8.22dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification	2.5 dBi
Voltage Range	DC12V from adapter or DC48V from POE
Date of Test	2020-07-01 to 2020-07-20
Sample serial number	RSZ200623012-RF-S1 (Assigned by BACL, Shenzhen)
Received date	2020-06-23
Sample/EUT Status	Good condition
Adapter information	Model:KSAS0121200100D5 Input: 100-240V~ 50/60Hz 0.4A Output: DC 12V, 1.0A

Objective

This test report is prepared on behalf of *AudioCodes Ltd.* 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.

Related Submittal(s)/Grant(s)

FCC Part 15.247 DTS, Part 15.407 NII submissions with FCC ID: XAKC450DB.

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 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, 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.: 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” software was use to the EUT tested and power level is default.

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
BULL	Socket	GN-212	A37209315081183
HP	Laptop	Compaq CQ45	5CG33407QL
SAGEM	Router	SAGEM F@STTM 2604 White	SE20546325821
TECLAST	USB disk(*2)	8GB	8GB
Dora	Handset	Dora	Dora
GOSPELL	POE	G0720-480-050	200200013

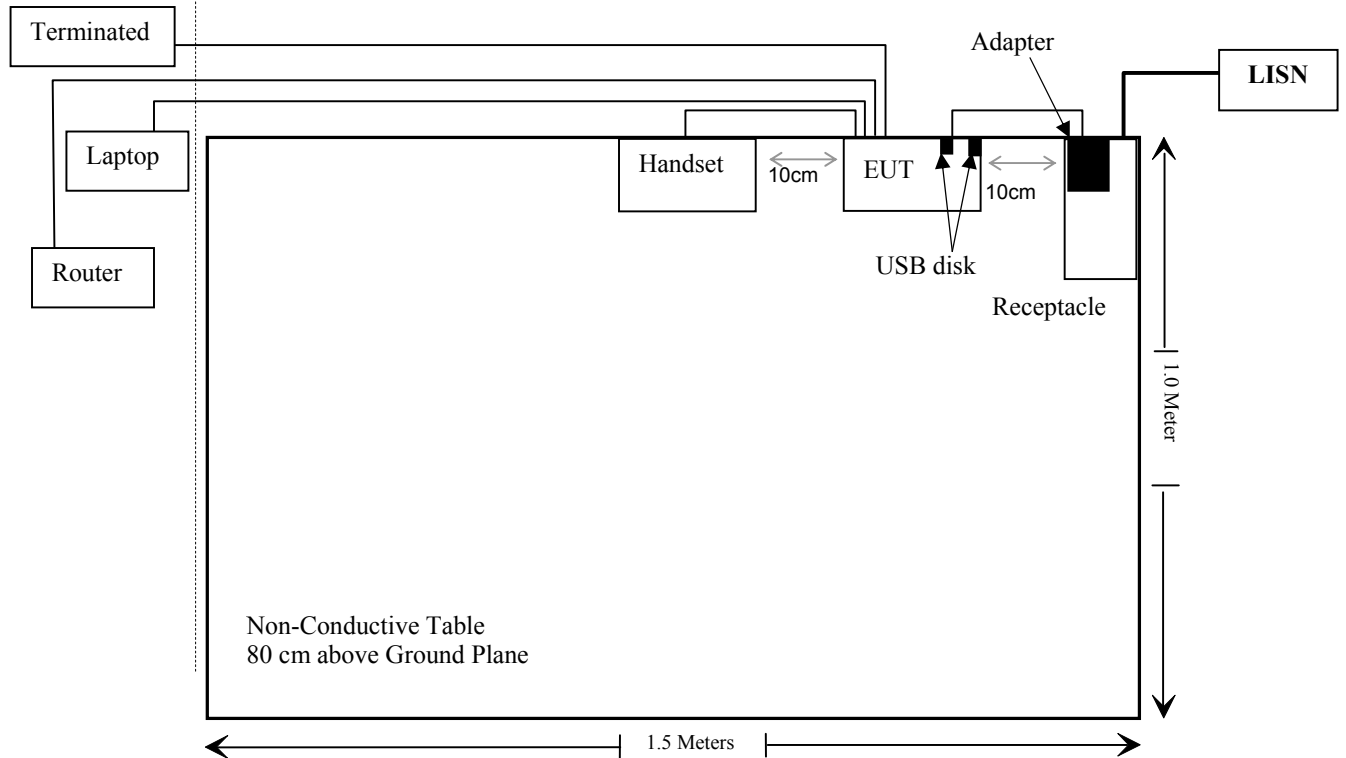
External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielded Un-detachable AC Cable	1.2	LISN	Socket
Un-shielding Un-detachable DC Cable	1.0	EUT	Adapter
Un-shielded detachable RJ45 Cable	8.0	EUT	Laptop
Un-shielded detachable RJ45 Cable	8.0	EUT	Router
Un-shielded detachable RJ9 Cable	0.5	EUT	Handset
Un-shielded detachable signal Cable	8.0	EUT	Terminated
Un-shielded detachable RJ45 Cable	8.0	POE	EUT
Un-shielded detachable RJ45 Cable	8.0	POE	Laptop
Un-shielded detachable RJ45 Cable	1.0	POE	EUT

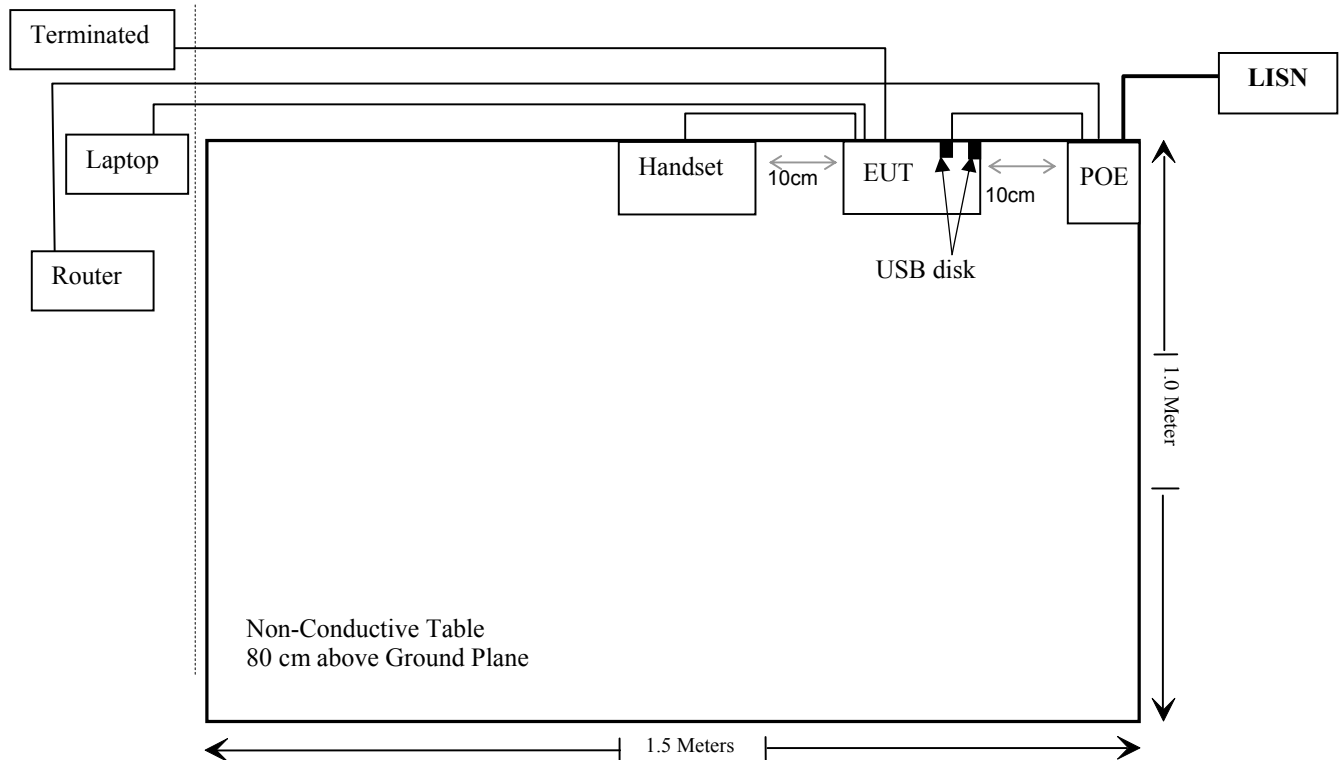
Block Diagram of Test Setup

For conducted emission:

Adapter:



POE:



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

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde & Schwarz	EMI Test Receiver	ESCI	101120	2019/7/9	2020/7/8
Rohde & Schwarz	LISN	ENV216	101613	2020/1/22	2021/1/21
Rohde & Schwarz	Transient Limitor	ESH3Z2	DE25985	2019/11/29	2020/11/28
Unknow	CE Cable	CE Cable	UF A210B-1-0720-504504	2019/11/29	2020/11/28
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2019/7/9	2020/7/8
Sonoma instrument	Pre-amplifier	310 N	186238	2020/4/20	2021/4/20
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017/12/22	2020/12/21
Unknow	Cable 2	RF Cable 2	F-03-EM197	2019/11/29	2020/11/28
Unknow	Cable	Chamber Cable 1	F-03-EM236	2019/11/29	2020/11/28
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2019/7/22	2020/7/21
COM-POWER	Pre-amplifier	PA-122	181919	2019/11/29	2020/11/28
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2019/11/29	2020/11/28
Sunol Sciences	Horn Antenna	DRH-118	A052604	2017/12/22	2020/12/21
Insulated Wire Inc.	RF Cable	SPS-2503-3150	02222010	2019/11/29	2020/11/28
Unknow	RF Cable	W1101-EQ1 OUT	F-19-EM005	2019/11/29	2020/11/28
SNSD	Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2020/4/20	2021/4/20
Ducommun Technologies	Horn antenna	ARH-4223-02	1007726-021304	2017/12/6	2020/12/5
RF Conducted Test					
Tonscend Corporation	RF control Unit	JS0806-2	19D8060154	2020/7/09	2021/7/8
Rohde & Schwarz	Signal and Spectrum Analyzer	FSV40	101473	2019/7/22	2020/7/21
Unknow	RF Cable	Unknow	2301 276	2019/11/29	2020/11/28

*** 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)

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)			
2402-2480	2.5	1.78	8.5	7.1	20	0.003	1

Note: The BT can't transmit with the 5G Wi-Fi/BLE at the same time, but BT can transmit with 2.4G Wi-Fi simultaneously.

For the simultaneously consideration:

Refer to the DTS report, the power density is $0.013\text{mW}/\text{cm}^2$ for 2.4G Wi-Fi

The ratio= $\text{MPE}_{\text{BT}}/\text{Limit}_{\text{BT}} + \text{MPE}_{2.4\text{G Wi-Fi}}/\text{Limit}_{2.4\text{G Wi-Fi}} = 0.003/1 + 0.013/1 = 0.016 < 1.0$

Note: 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 internal antenna arrangement, which was permanently attached and the antenna gain is 2.5dBi, 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

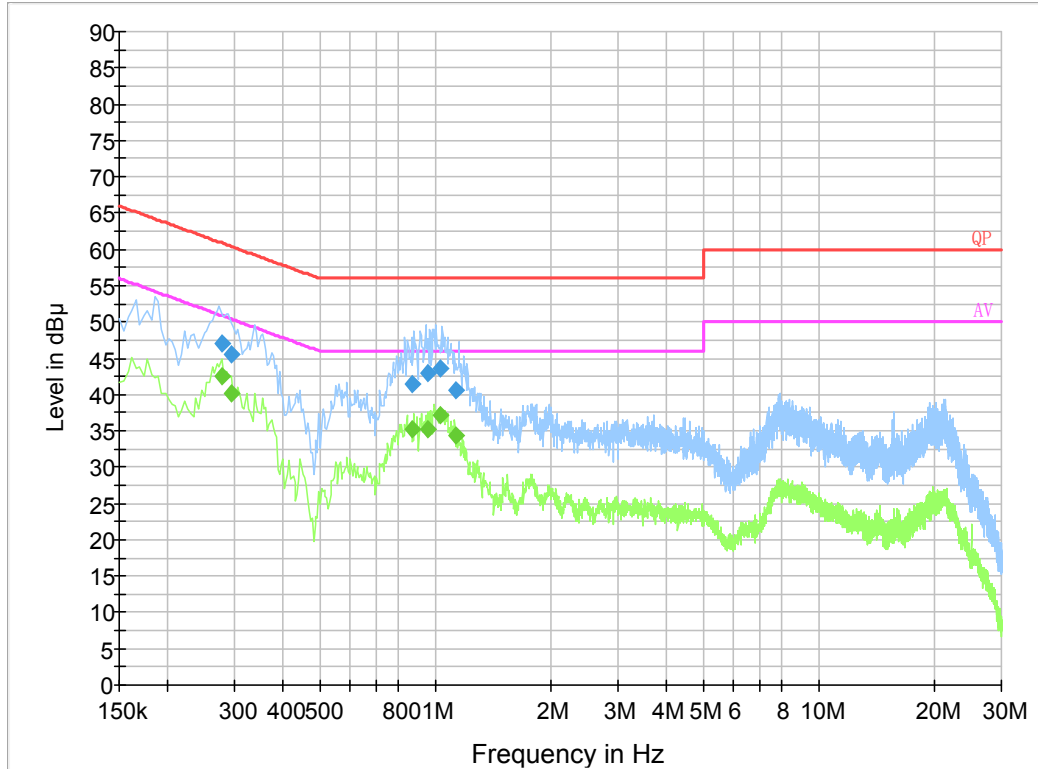
Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2020-07-06 and 2020-07-07.

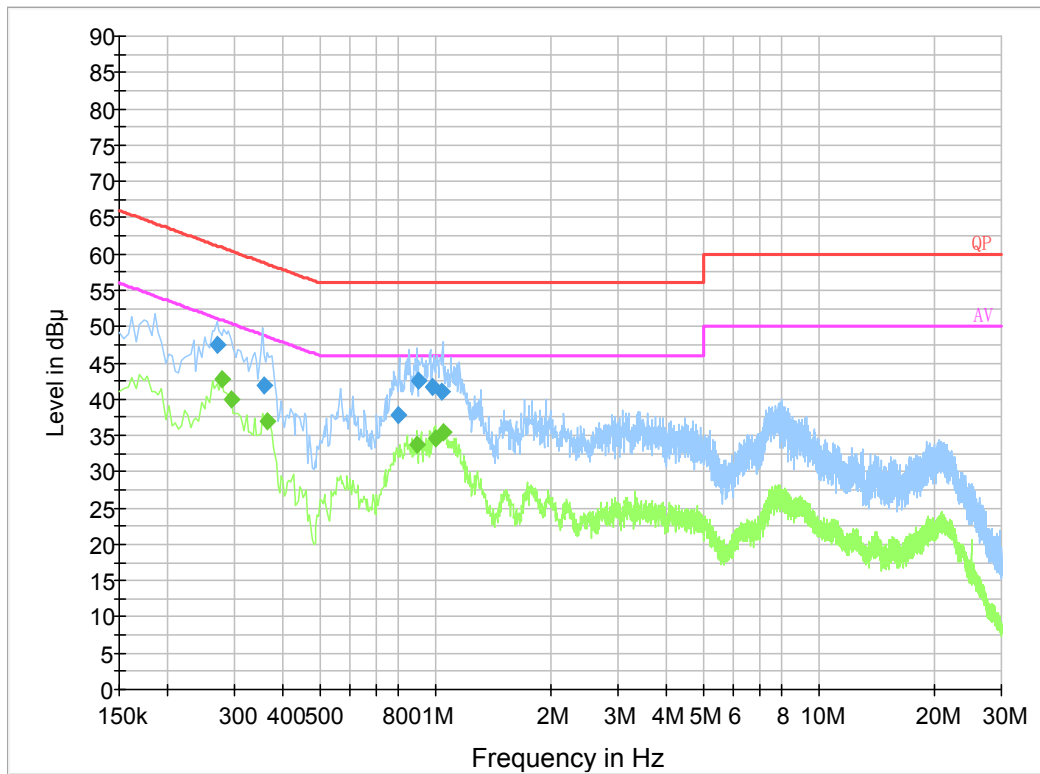
EUT operation mode: Transmitting (the worst case is 8DPSK Mode, High channel)

Power by adapter:

AC 120V/60 Hz, Line

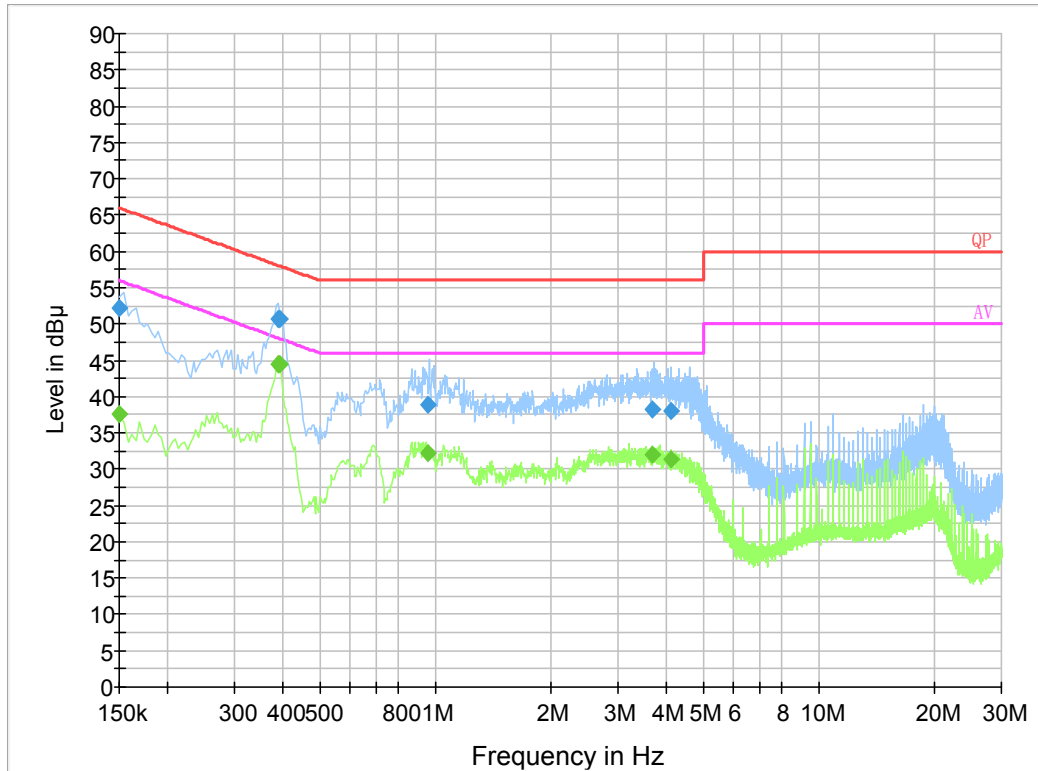


Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.278501	47.1	19.8	60.9	13.8	QP
0.294500	45.5	19.7	60.4	14.9	QP
0.868770	41.5	19.8	56.0	14.5	QP
0.959810	43.0	19.8	56.0	13.0	QP
1.034310	43.5	19.9	56.0	12.5	QP
1.136690	40.6	19.8	56.0	15.4	QP
0.278501	42.6	19.8	50.9	8.3	Ave.
0.294500	40.1	19.7	50.4	10.3	Ave.
0.868770	35.3	19.8	46.0	10.7	Ave.
0.959810	35.2	19.8	46.0	10.8	Ave.
1.034310	37.2	19.9	46.0	8.8	Ave.
1.136690	34.4	19.8	46.0	11.6	Ave.

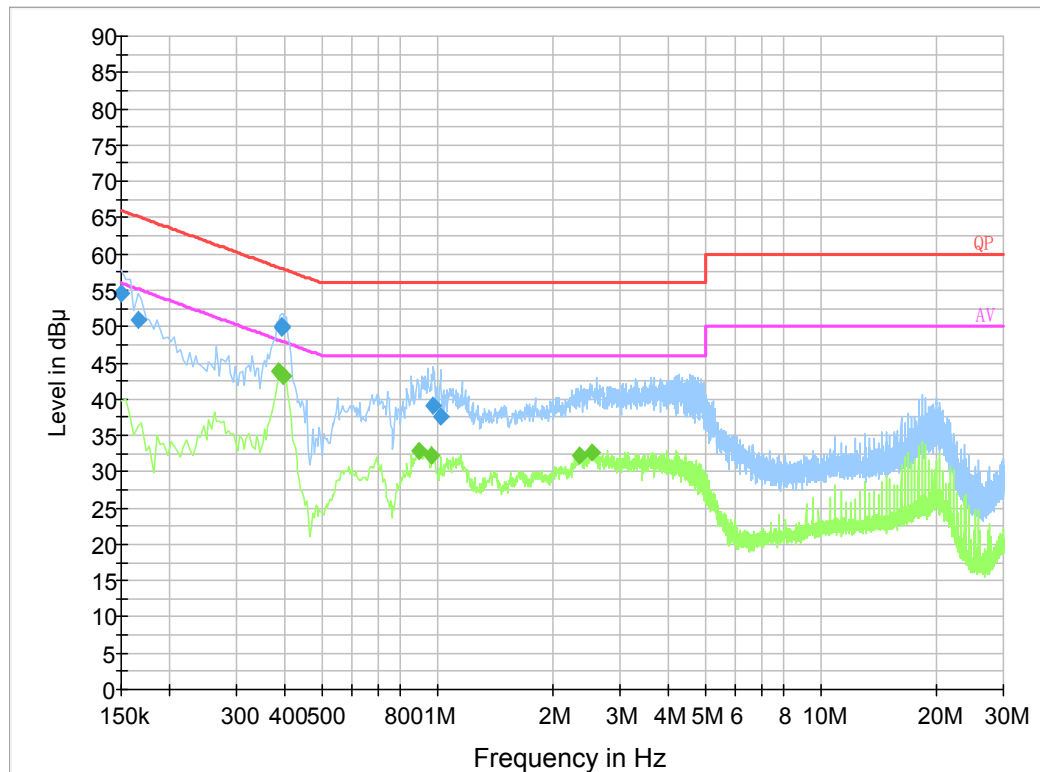
AC 120V/60 Hz, Neutral

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.269500	47.5	19.7	61.1	13.6	QP
0.356690	41.8	19.9	58.8	17.0	QP
0.797910	37.8	19.8	56.0	18.2	QP
0.908530	42.6	19.7	56.0	13.4	QP
0.983390	41.6	19.8	56.0	14.4	QP
1.042250	41.1	19.8	56.0	14.9	QP
0.278000	42.7	19.7	50.9	8.2	Ave.
0.294000	39.9	19.7	50.4	10.5	Ave.
0.366000	37.0	19.9	48.6	11.6	Ave.
0.898000	33.6	19.7	46.0	12.4	Ave.
1.002000	34.5	19.8	46.0	11.5	Ave.
1.050000	35.5	19.8	46.0	10.5	Ave.

Power by POE:

AC 120V/60 Hz, Line

Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.150000	52.2	19.8	66.0	13.8	QP
0.388210	50.8	19.9	58.1	7.3	QP
0.392150	50.6	19.9	58.0	7.4	QP
0.959510	38.8	19.8	56.0	17.2	QP
3.678050	38.3	19.9	56.0	17.7	QP
4.140110	38.1	19.9	56.0	17.9	QP
0.150000	37.6	19.8	56.0	18.4	Ave.
0.388210	44.4	19.9	48.1	3.7	Ave.
0.392150	44.4	19.9	48.0	3.6	Ave.
0.959510	32.3	19.8	46.0	13.7	Ave.
3.678050	31.9	19.9	46.0	14.1	Ave.
4.140110	31.4	19.9	46.0	14.6	Ave.

AC 120V/60 Hz, Neutral

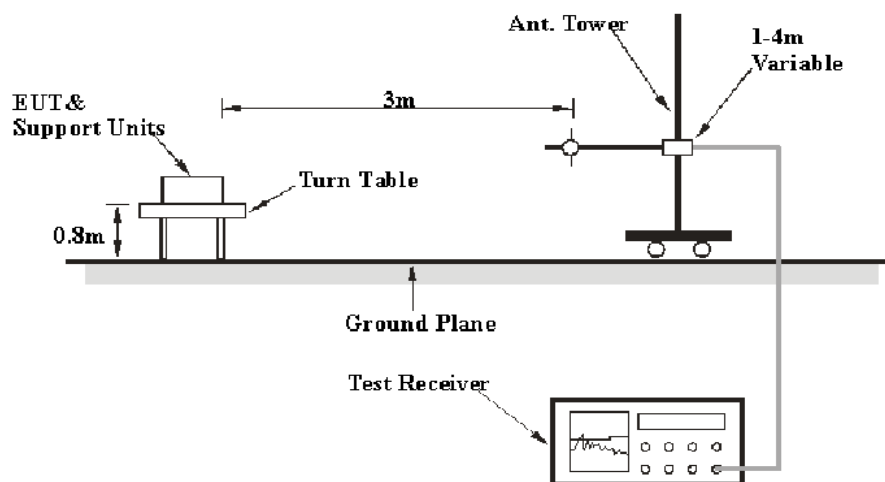
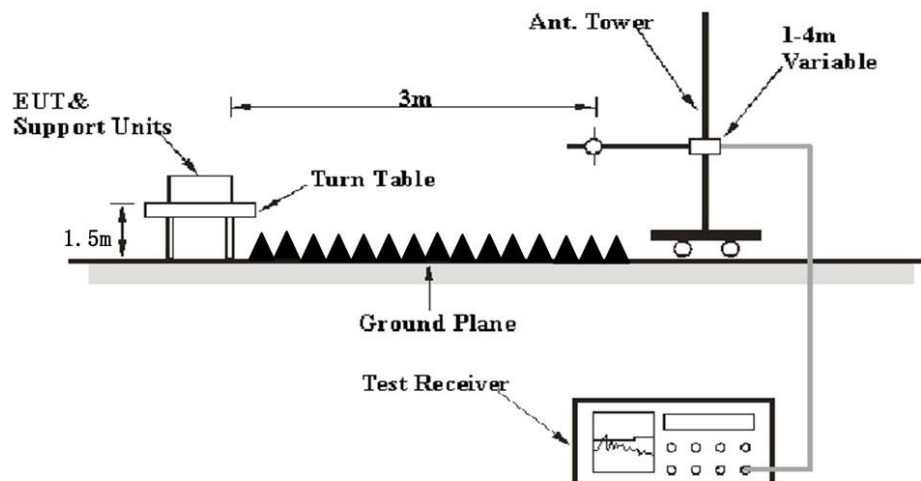
Frequency (MHz)	Corrected Amplitude (dBμV)	Correction Factor (dB)	Limit (dBμV)	Margin (dB)	Detector (PK/Ave./QP)
0.150000	54.5	19.8	66.0	11.5	QP
0.165500	51.0	19.8	65.2	14.2	QP
0.391790	49.9	19.8	58.0	8.1	QP
0.392030	50.0	19.8	58.0	8.0	QP
0.971330	39.0	19.8	56.0	17.0	QP
1.022670	37.6	19.8	56.0	18.4	QP
0.386000	43.9	19.8	48.1	4.2	Ave.
0.398000	43.1	19.8	47.9	4.8	Ave.
0.894000	32.9	19.7	46.0	13.1	Ave.
0.970000	32.3	19.8	46.0	13.7	Ave.
2.346000	32.1	19.8	46.0	13.9	Ave.
2.542000	32.7	19.8	46.0	13.3	Ave.

Note:

- 1) Correction Factor = LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
- 2) Corrected Amplitude = Reading + Correction Factor
- 3) Margin = Limit – Corrected Amplitude

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

FCC §15.205; §15.209; §15.247(d)

EUT Setup**Below 1 GHz:****Above 1GHz:**

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

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

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

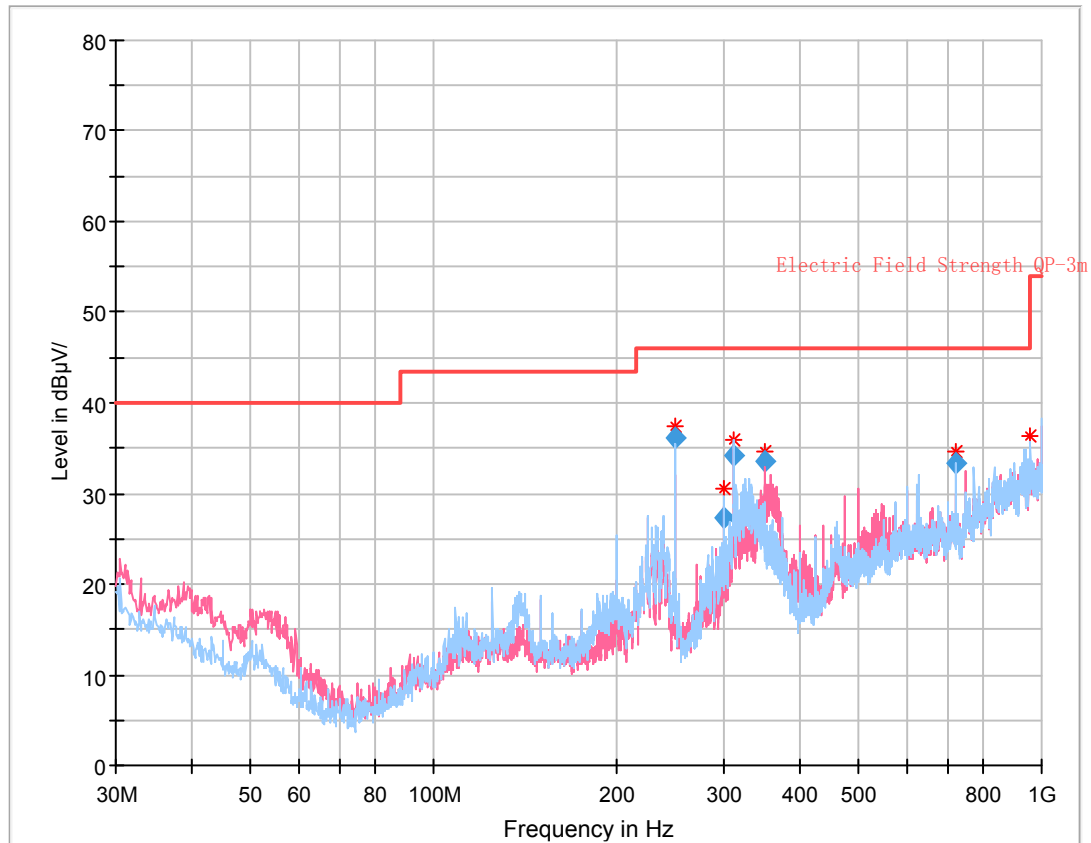
Temperature:	28 °C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

The testing was performed by Charlie Cha on 2020-07-06 for below 1GHz and by Leven Gan on 2020-07-01 for above 1GHz.

EUT operation mode: Transmitting

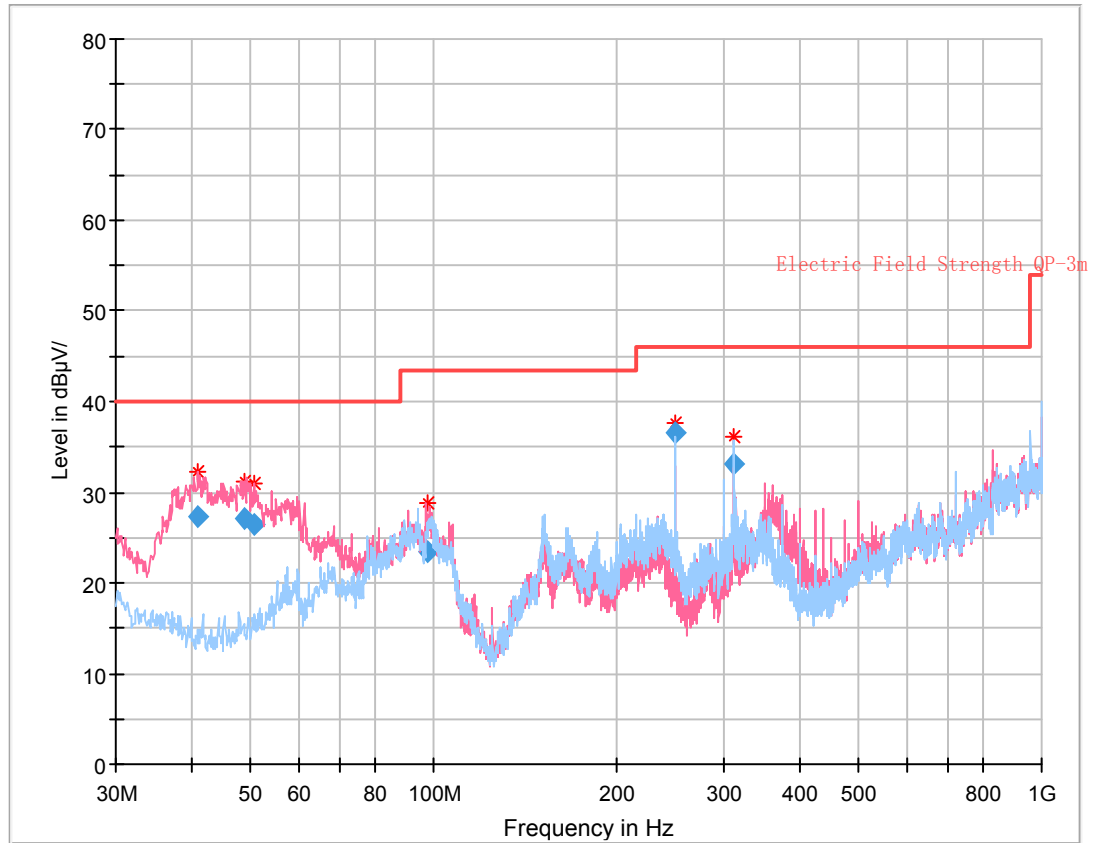
30 MHz~1 GHz: (the worst case is 8DPSK Mode, High channel)

Power by adapter:



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
250.002250	36.06	110.0	H	72.0	-14.1	46.00	9.94
300.024500	27.26	108.0	H	356.0	-10.6	46.00	18.74
312.514250	34.20	102.0	H	15.0	-10.7	46.00	11.80
350.001500	33.63	133.0	V	262.0	-10.8	46.00	12.37
725.023375	33.39	293.0	H	164.0	-0.8	46.00	12.61
960.047625	31.57	186.0	H	187.0	5.3	54.00	22.43

Power by POE:



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
40.856875	27.25	101.0	V	0.0	-14.4	40.00	12.75
48.927250	27.00	129.0	V	197.0	-19.1	40.00	13.00
50.686875	26.43	109.0	V	174.0	-19.7	40.00	13.57
97.534750	23.36	109.0	V	0.0	-17.7	43.50	20.14
250.001000	36.54	115.0	H	288.0	-14.1	46.00	9.46
312.476750	33.12	103.0	H	26.0	-10.7	46.00	12.88

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)									
2388.87	28.24	PK	256	2.1	H	31.87	60.11	74	13.89
2388.87	13.71	Ave.	256	2.1	H	31.87	45.58	54	8.42
2484.47	28.10	PK	155	1.1	H	32.13	60.23	74	13.77
2484.47	13.68	Ave.	155	1.1	H	32.13	45.81	54	8.19
4804.00	42.57	PK	145	1.4	H	6.28	48.85	74	25.15
4804.00	28.14	Ave.	145	1.4	H	6.28	34.42	54	19.58
Middle Channel (2441 MHz)									
4882.00	42.67	PK	14	1.7	H	6.76	49.43	74	24.57
4882.00	28.15	Ave.	14	1.7	H	6.76	34.91	54	19.09
High Channel (2480 MHz)									
2388.65	28.20	PK	24	1.9	H	31.87	60.07	74	13.93
2388.65	13.70	Ave.	24	1.9	H	31.87	45.57	54	8.43
2484.12	28.54	PK	92	2.5	H	32.13	60.67	74	13.33
2484.12	13.76	Ave.	92	2.5	H	32.13	45.89	54	8.11
4960.00	42.88	PK	302	1.5	H	6.80	49.68	74	24.32
4960.00	28.45	Ave.	302	1.5	H	6.80	35.25	54	18.75

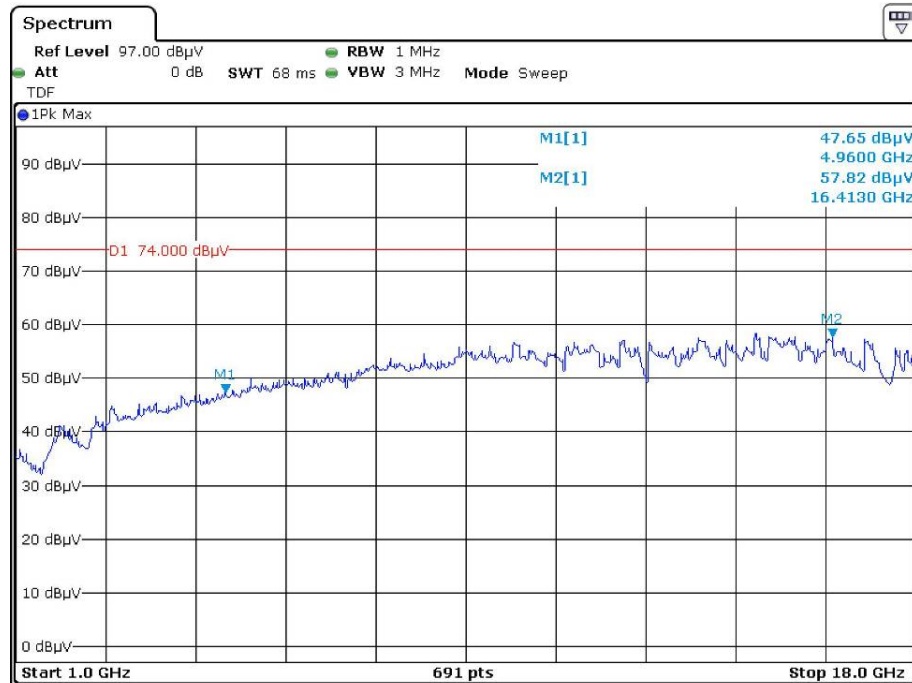
Note:

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

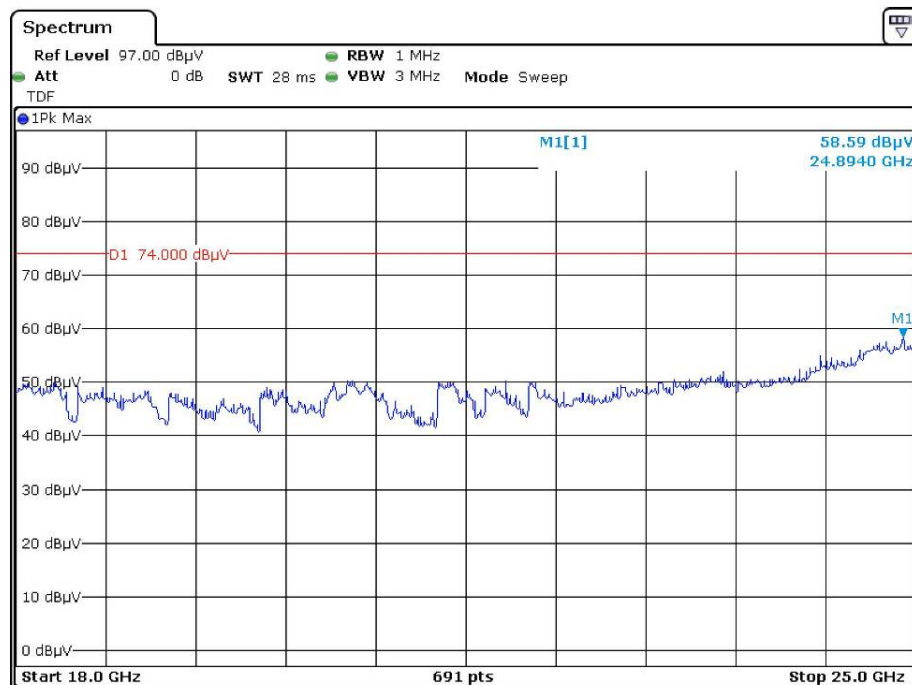
Corrected Amplitude = Corrected Factor + Reading

Margin = Limit - Corrected. Amplitude

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

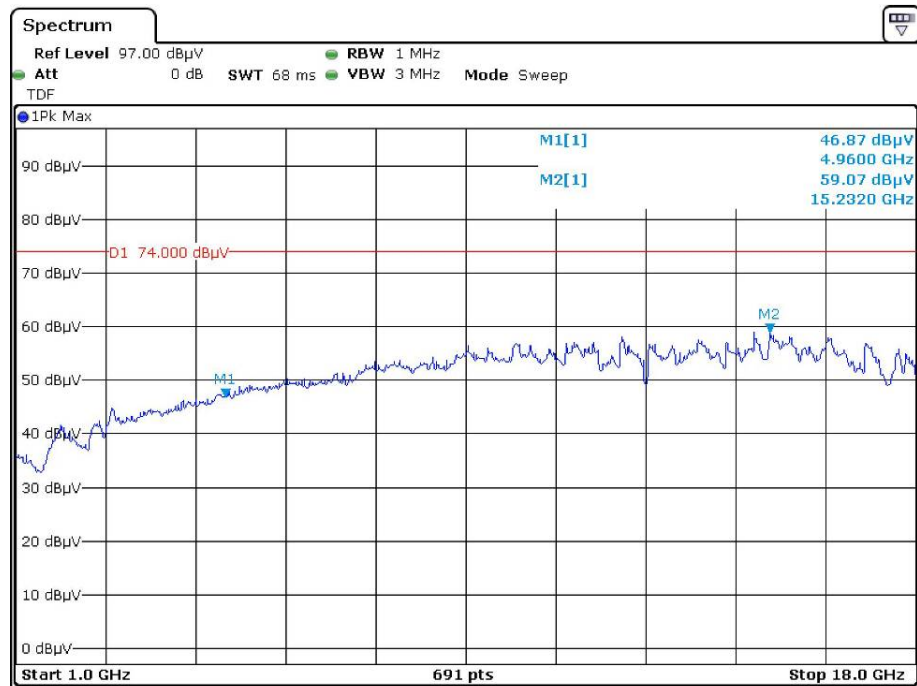
**Pre-scan with high channel Peak
Horizontal**

Date: 1.JUL.2020 18:52:11

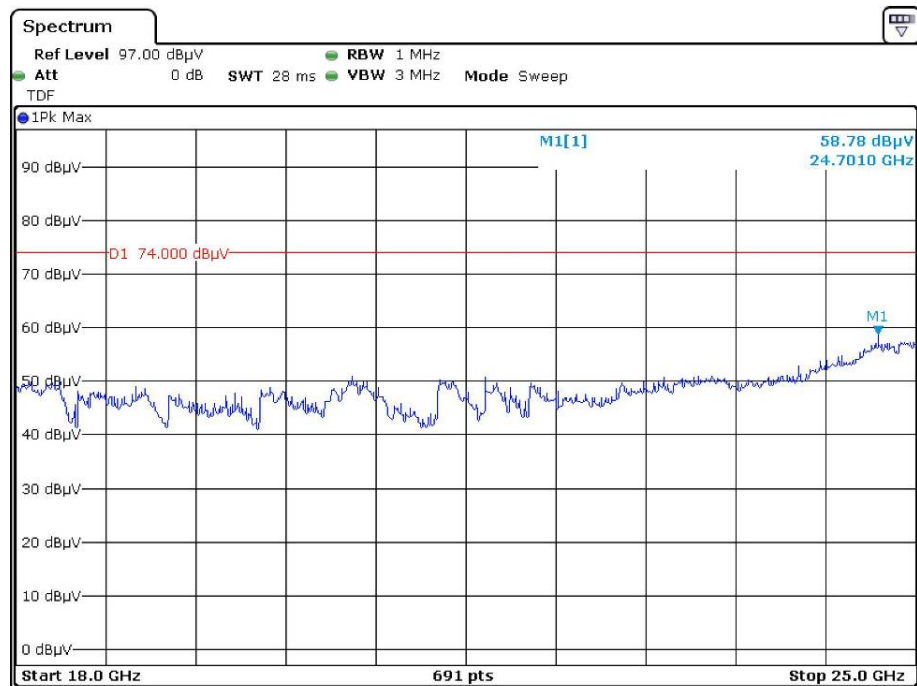


Date: 1.JUL.2020 19:36:32

Vertical

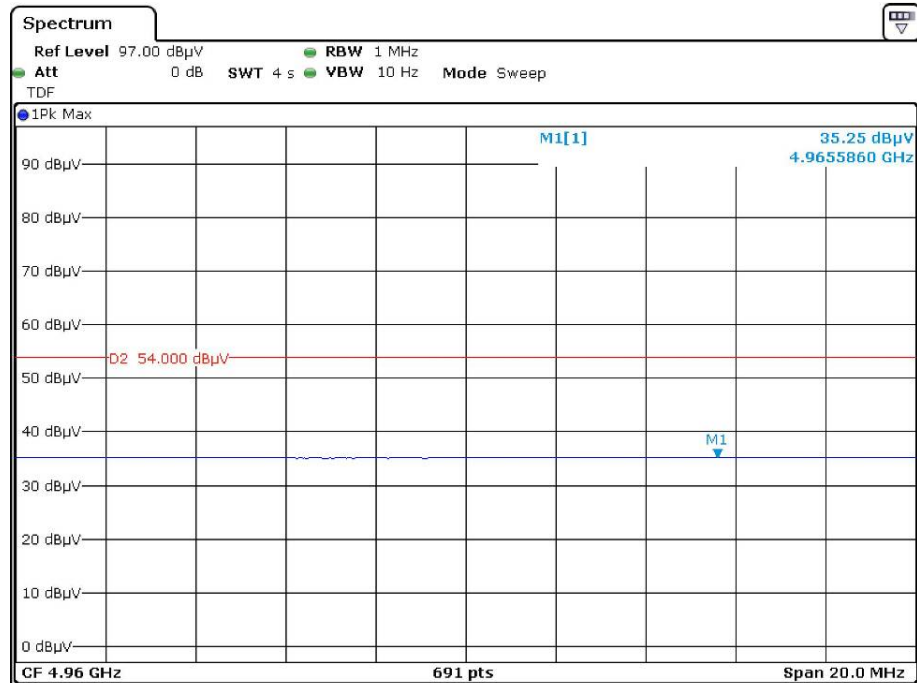


Date: 1.JUL.2020 19:02:16

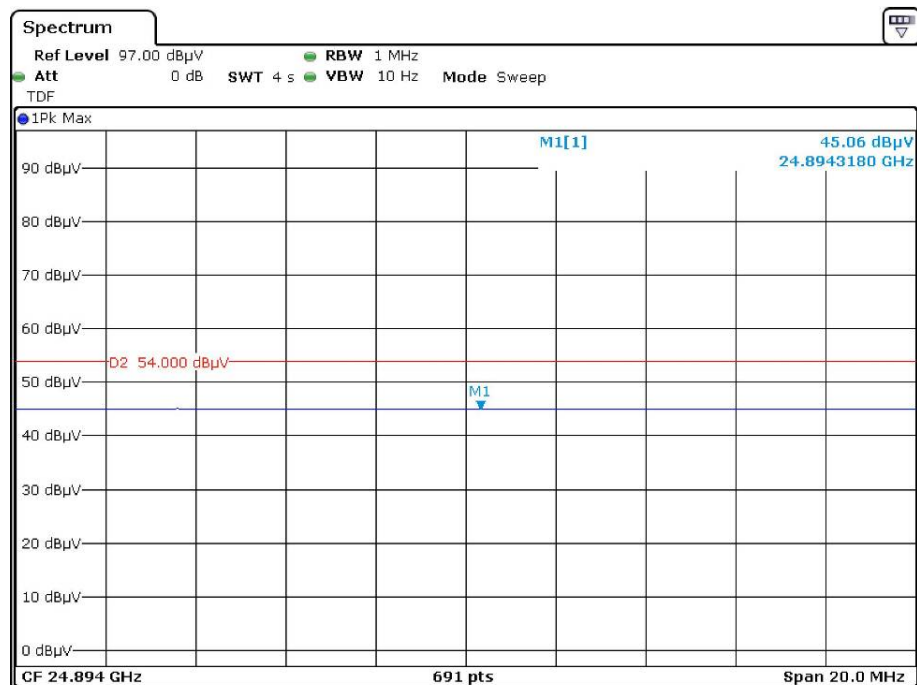


Date: 1.JUL.2020 19:43:17

Pre-scan for Average Horizontal

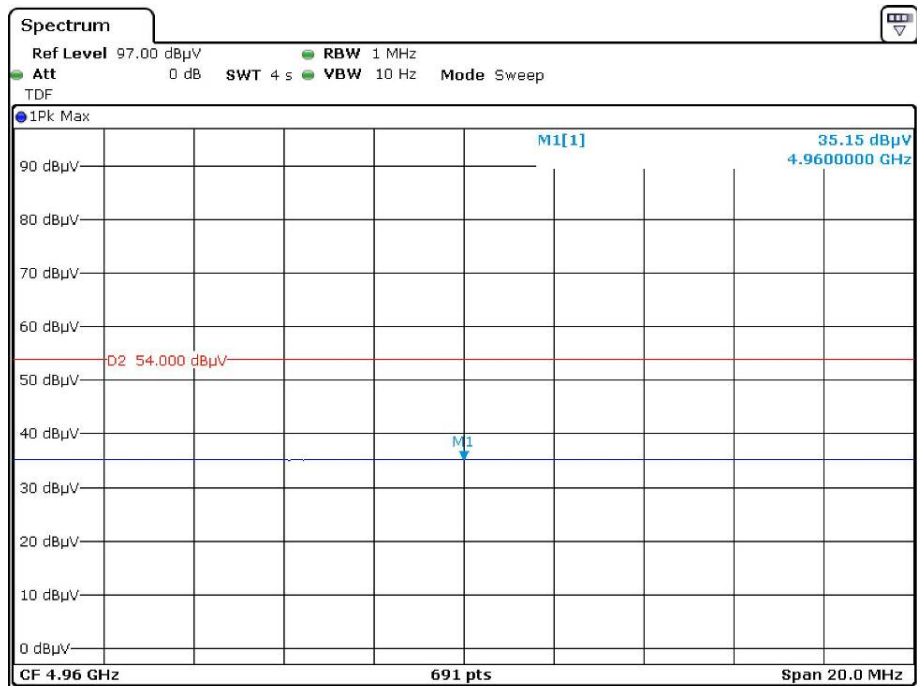


Date: 1.JUL.2020 18:57:31

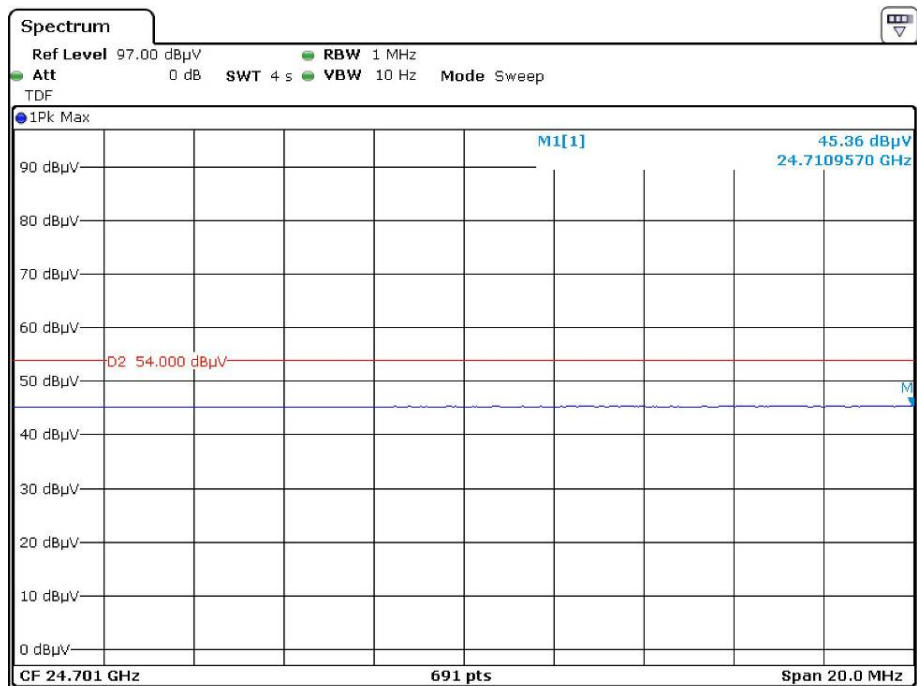


Date: 1.JUL.2020 19:39:58

Vertical



Date: 1.JUL.2020 19:05:49



Date: 1.JUL.2020 19:43:38

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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWEELL 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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

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:	50 %
ATM Pressure:	101.0 kPa

The testing was performed by James Fu on 2020-07-20.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix.

APPENDIX**AppendixA: 20dBEmission Bandwidth
Test Result**

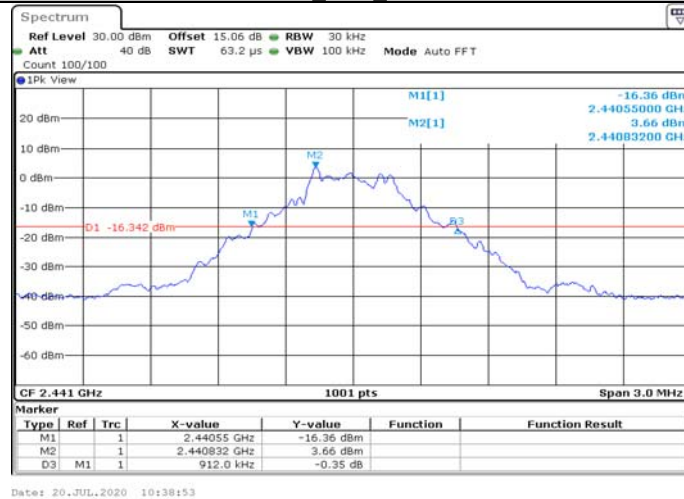
TestMode	Antenna	Channel	20db EBW[MHz]	Limit[MHz]	Verdict
DH1	Ant1	2402	0.894	---	PASS
		2441	0.912	---	PASS
		2480	1.017	---	PASS
2DH1	Ant1	2402	1.182	---	PASS
		2441	1.182	---	PASS
		2480	1.233	---	PASS
3DH1	Ant1	2402	1.212	---	PASS
		2441	1.242	---	PASS
		2480	1.233	---	PASS

Test Graphs

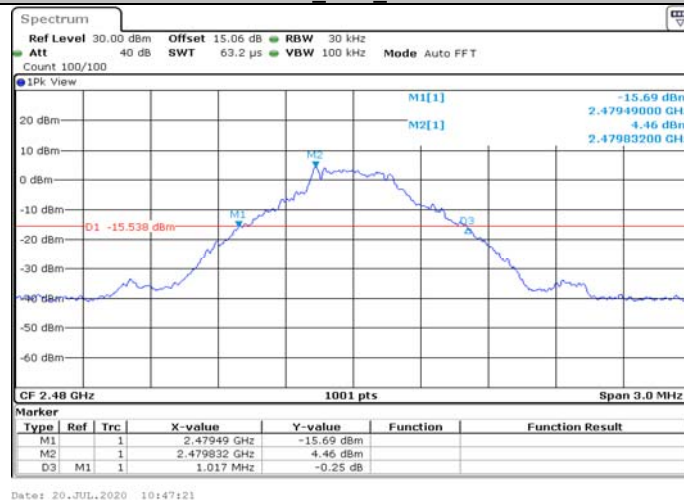
DH1_Ant1_2402



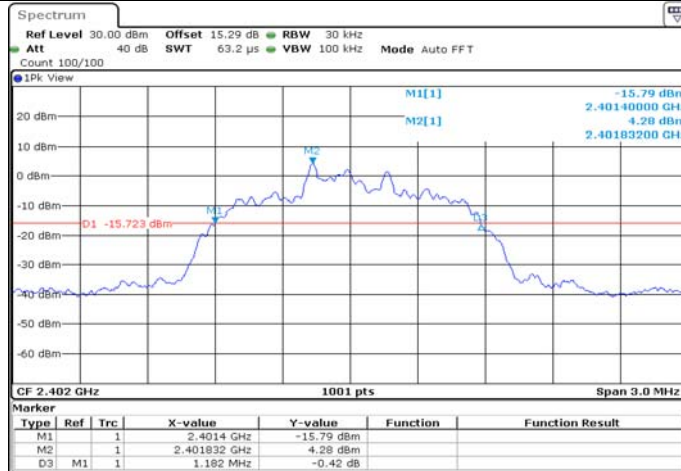
DH1_Ant1_2441



DH1_Ant1_2480

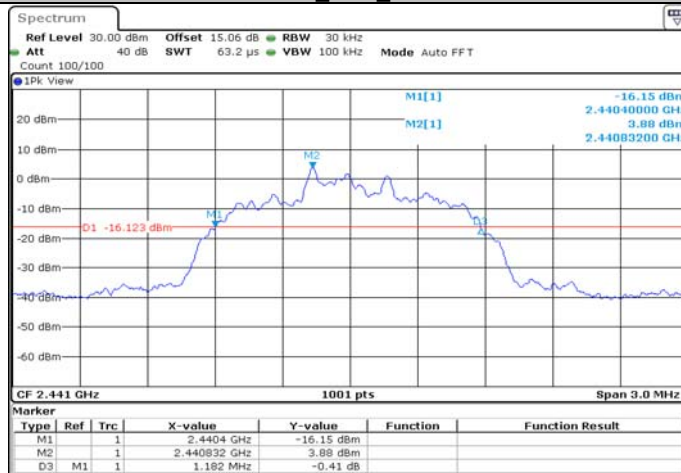


2DH1_Ant1_2402



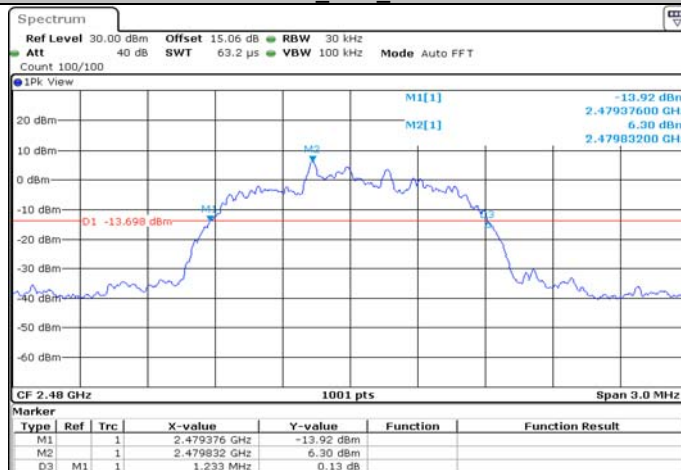
Date: 20.JUL.2020 10:48:49

2DH1_Ant1_2441



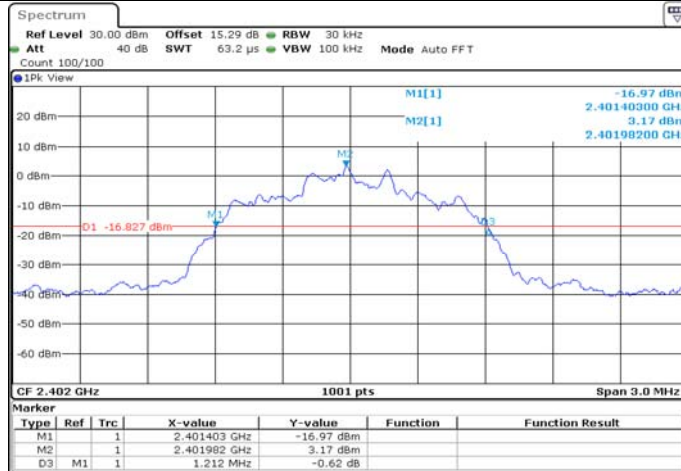
Date: 20.JUL.2020 10:40:23

2DH1_Ant1_2480



Date: 20.JUL.2020 10:41:07

3DH1_Ant1_2402



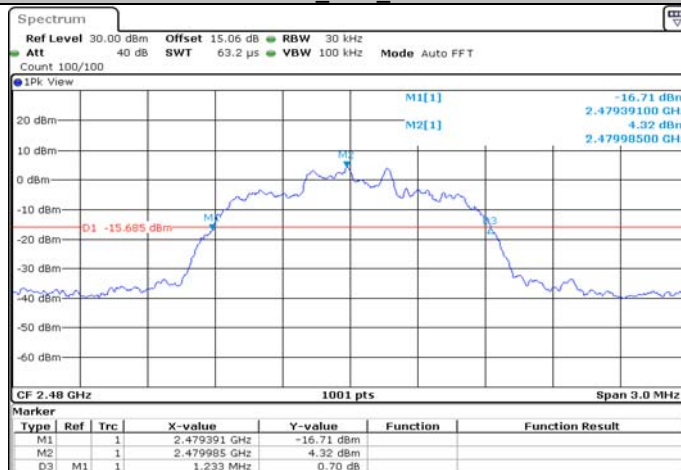
Date: 20.JUL.2020 10:46:11

3DH1_Ant1_2441



Date: 20.JUL.2020 10:42:16

3DH1_Ant1_2480



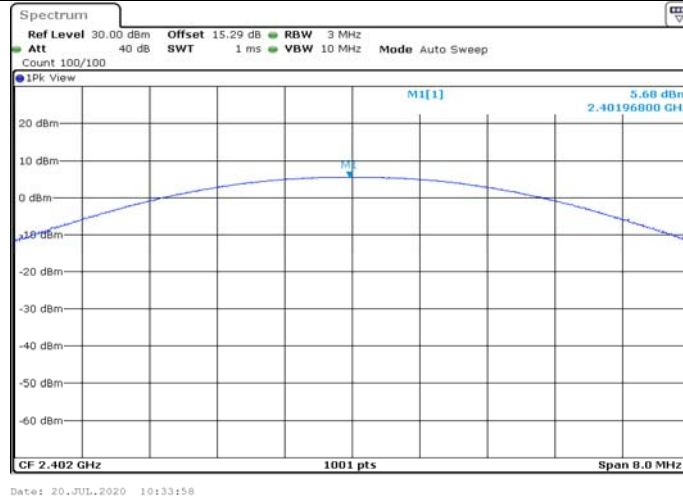
Date: 20.JUL.2020 10:21:40

**AppendixC: Maximum conducted Peak output power
Test Result**

TestMode	Antenna	Channel	Result[dBm]	Limit[dBm]	Verdict
DH1	Ant1	2402	5.68	<=20.97	PASS
		2441	5.45	<=20.97	PASS
		2467	6.21	<=20.97	PASS
		2480	5.74	<=20.97	PASS
2DH1	Ant1	2402	5.81	<=20.97	PASS
		2441	5.44	<=20.97	PASS
		2473	8.04	<=20.97	PASS
		2480	7.65	<=20.97	PASS
3DH1	Ant1	2402	6.12	<=20.97	PASS
		2441	5.86	<=20.97	PASS
		2466	8.22	<=20.97	PASS
		2480	7.57	<=20.97	PASS

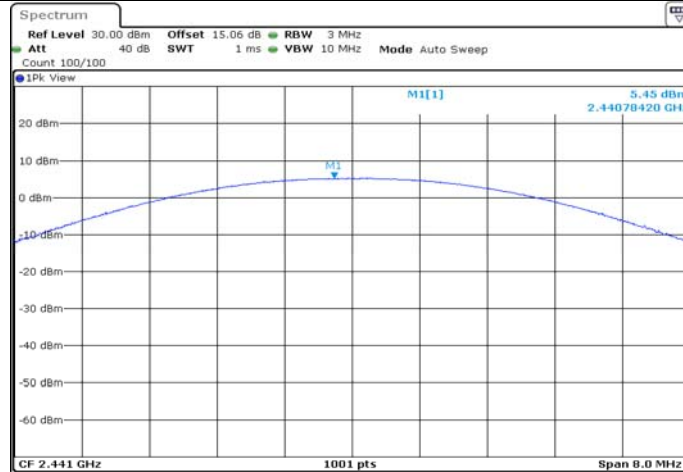
Test Graphs

DH1_Ant1_2402



Date: 20.JUL.2020 10:33:58

DH1_Ant1_2441

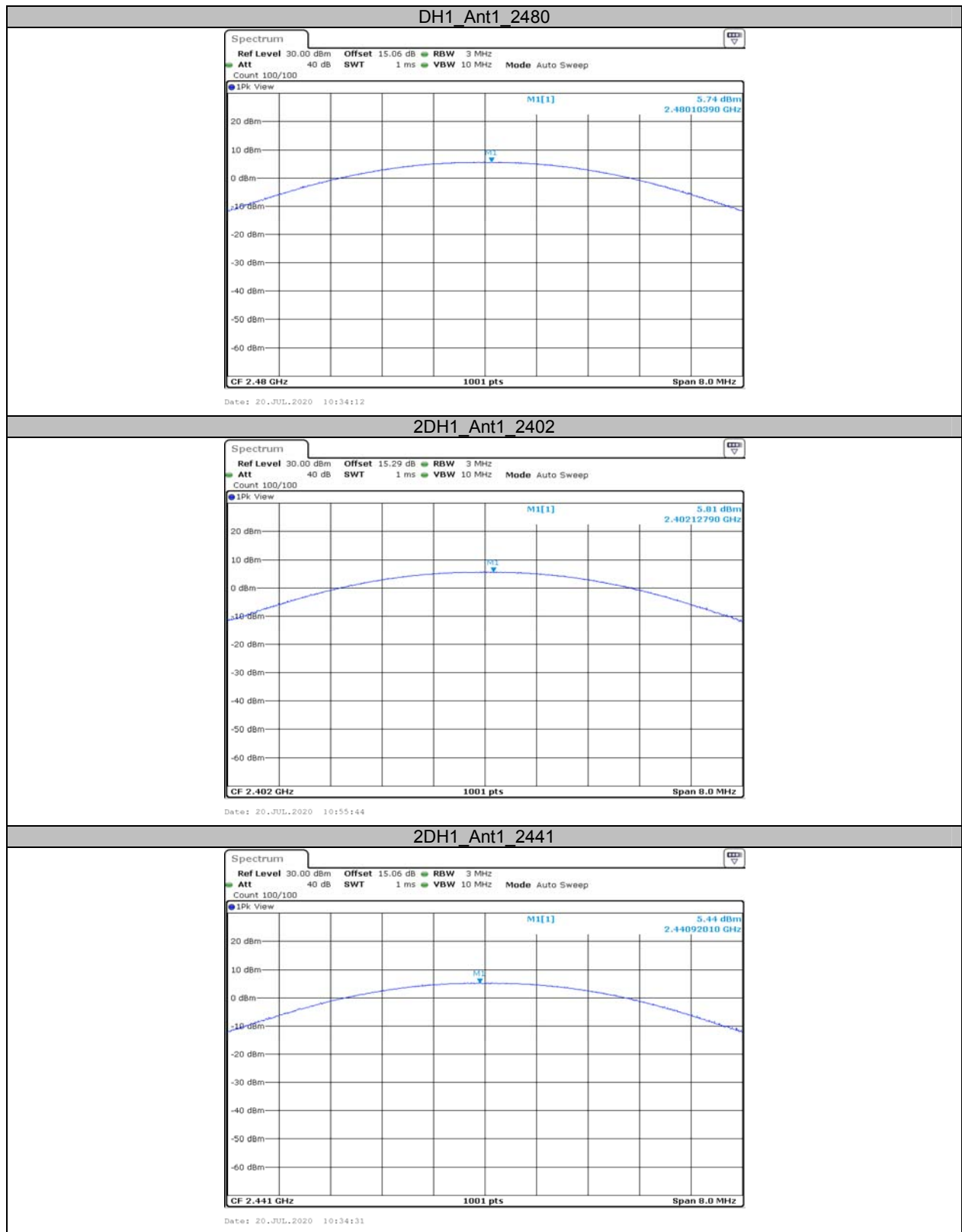


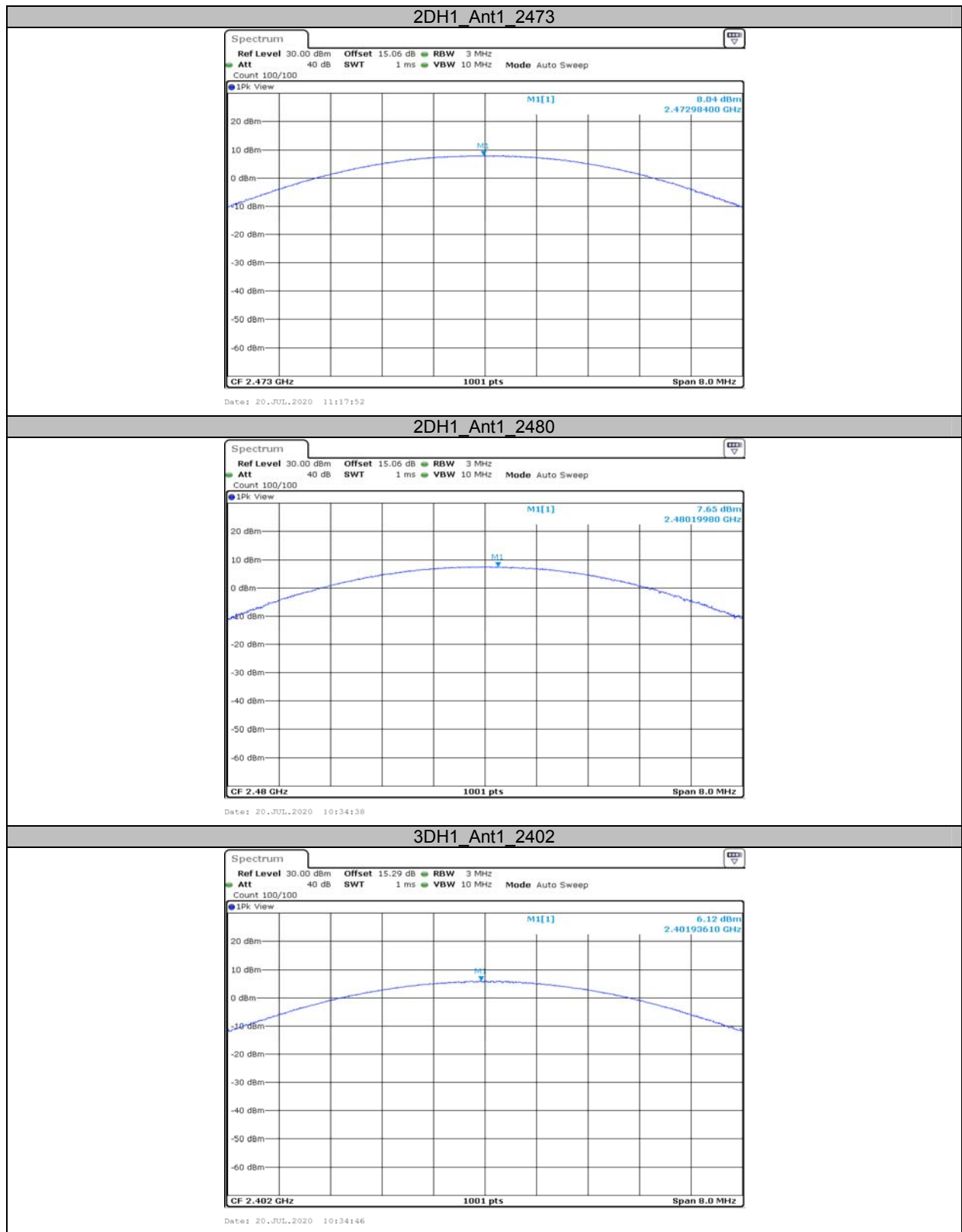
Date: 20.JUL.2020 10:34:05

DH1_Ant1_2467

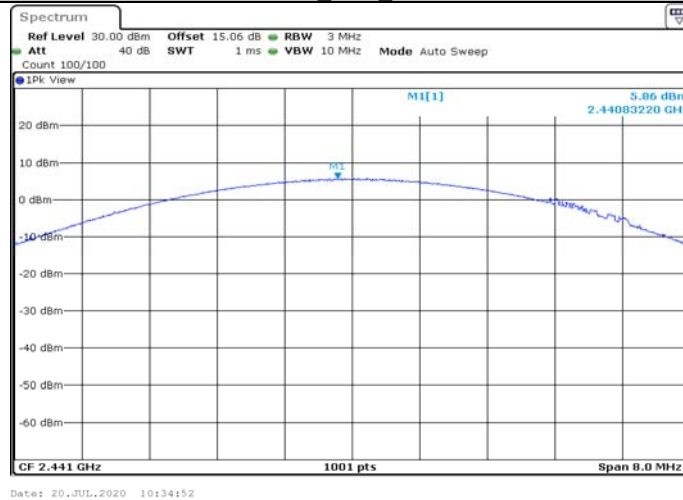


Date: 20.JUL.2020 11:16:40

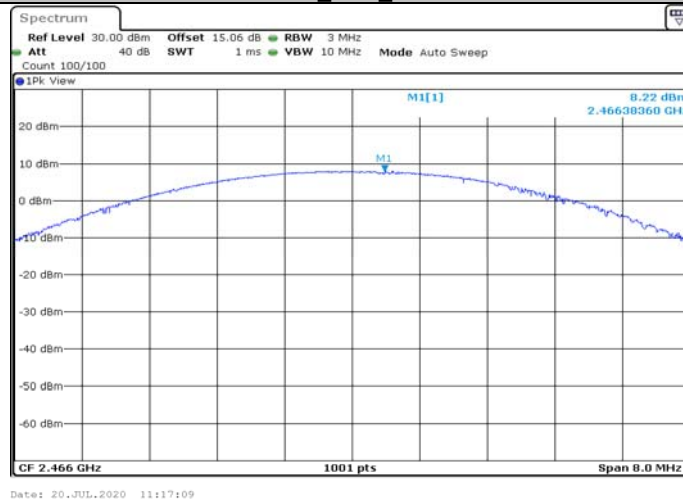




3DH1_Ant1_2441



3DH1_Ant1_2466



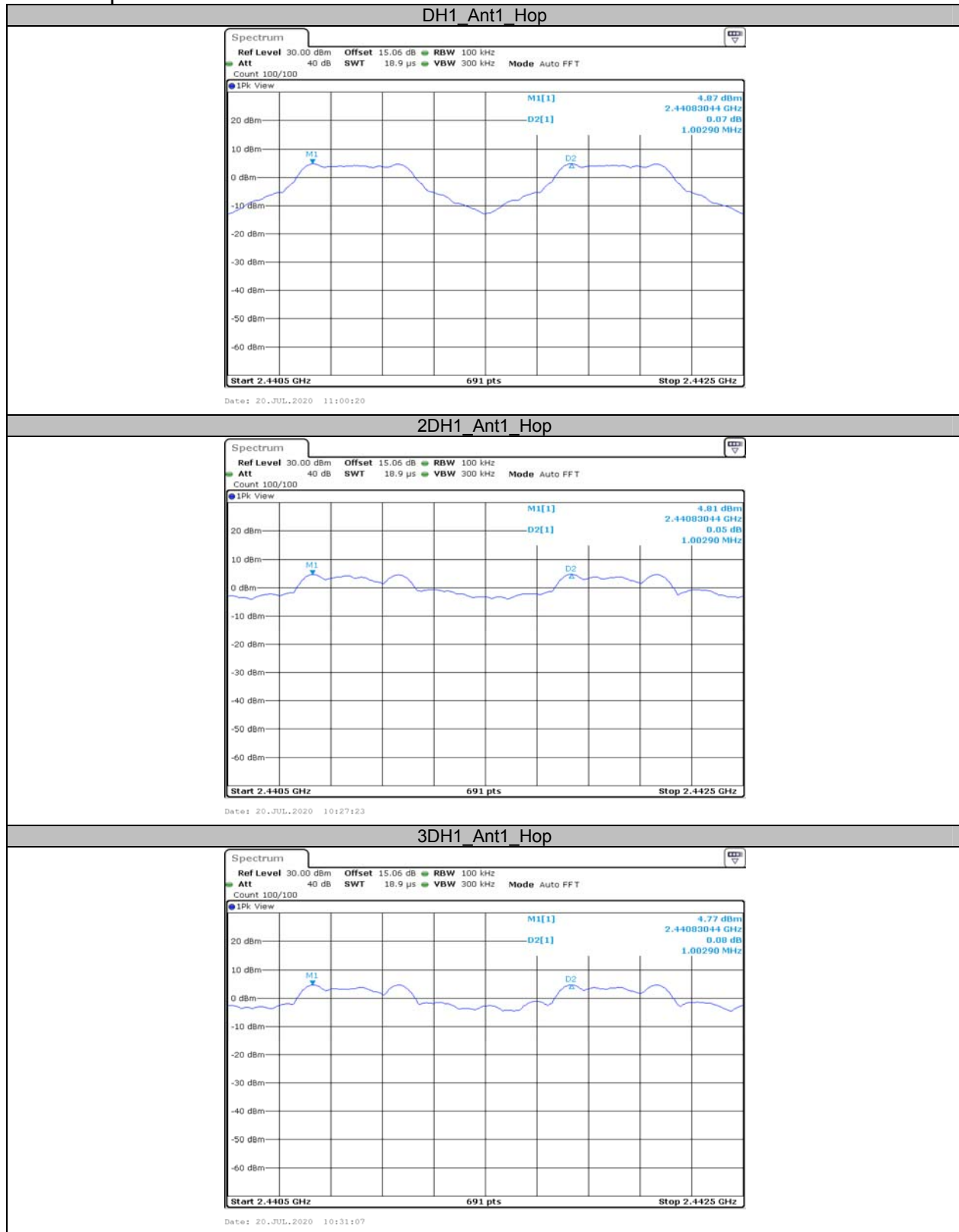
3DH1_Ant1_2480



**AppendixD: Carrier frequency separation
Test Result**

TestMode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH1	Ant1	Hop	1.003	≥ 0.608	PASS
2DH1	Ant1	Hop	1.003	≥ 0.788	PASS
3DH1	Ant1	Hop	1.003	≥ 0.828	PASS

Test Graphs



**AppendixE: Time of occupancy
Test Result**

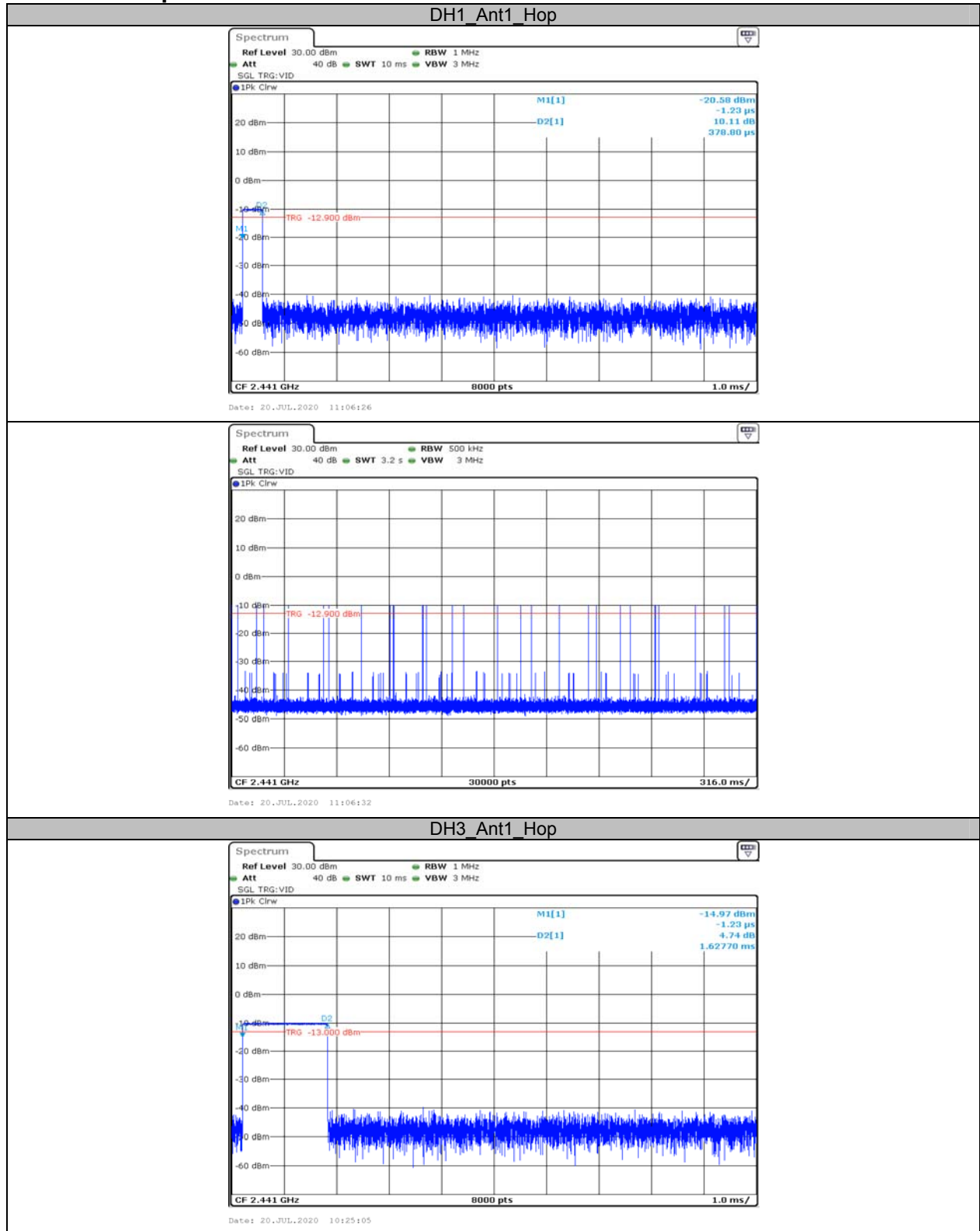
TestMode	Antenna	Channel	BurstWidth [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.38	270	0.102	<=0.4	PASS
DH3	Ant1	Hop	1.63	110	0.179	<=0.4	PASS
DH5	Ant1	Hop	2.87	70	0.201	<=0.4	PASS
2DH1	Ant1	Hop	0.39	310	0.120	<=0.4	PASS
2DH3	Ant1	Hop	1.63	130	0.212	<=0.4	PASS
2DH5	Ant1	Hop	2.87	100	0.287	<=0.4	PASS
3DH1	Ant1	Hop	0.39	310	0.120	<=0.4	PASS
3DH3	Ant1	Hop	1.63	110	0.179	<=0.4	PASS
3DH5	Ant1	Hop	2.88	70	0.201	<=0.4	PASS

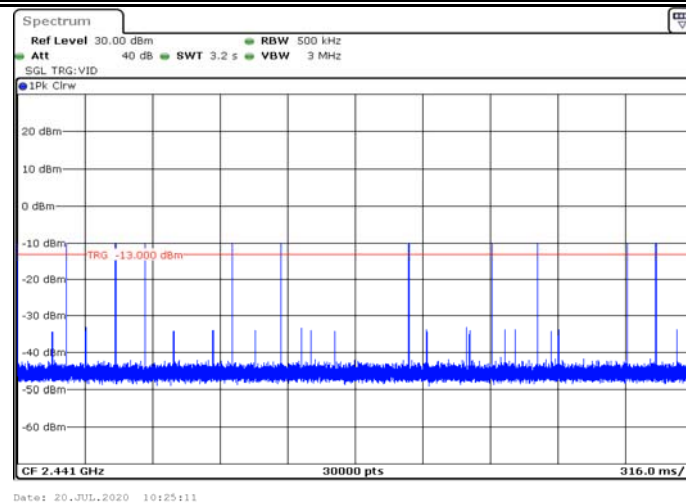
Note 1: A period time= $0.4 \times 79 = 31.6$ (S), Result=Burst Width*Total hops

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

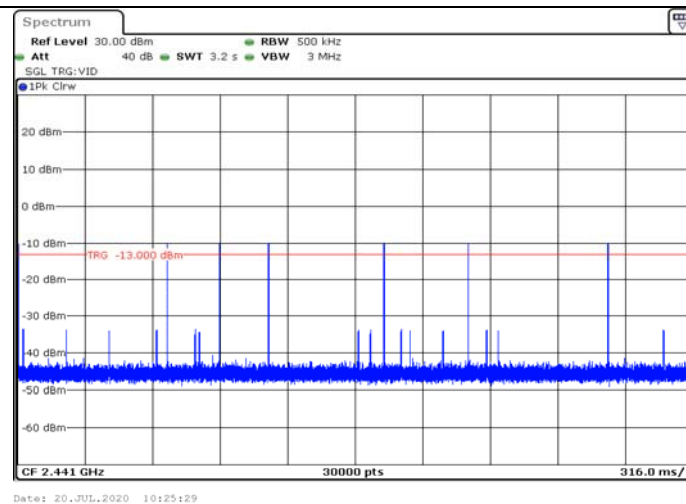
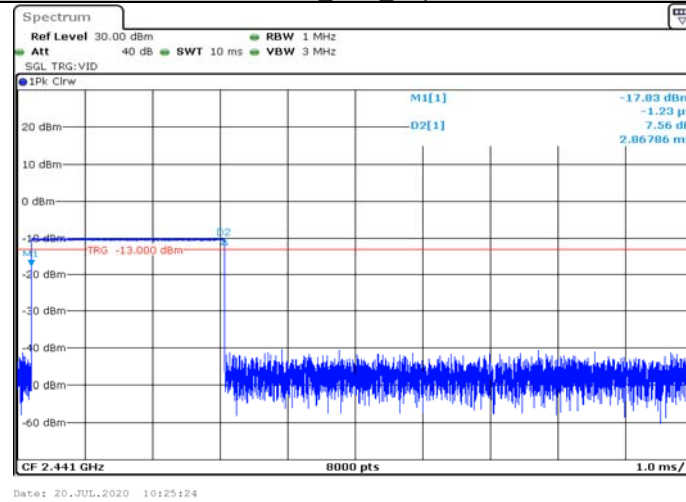
Note 3: Hopping Number in $3.16s$ =Total of highest signals in $3.16s$ (Second high signals were other channel)

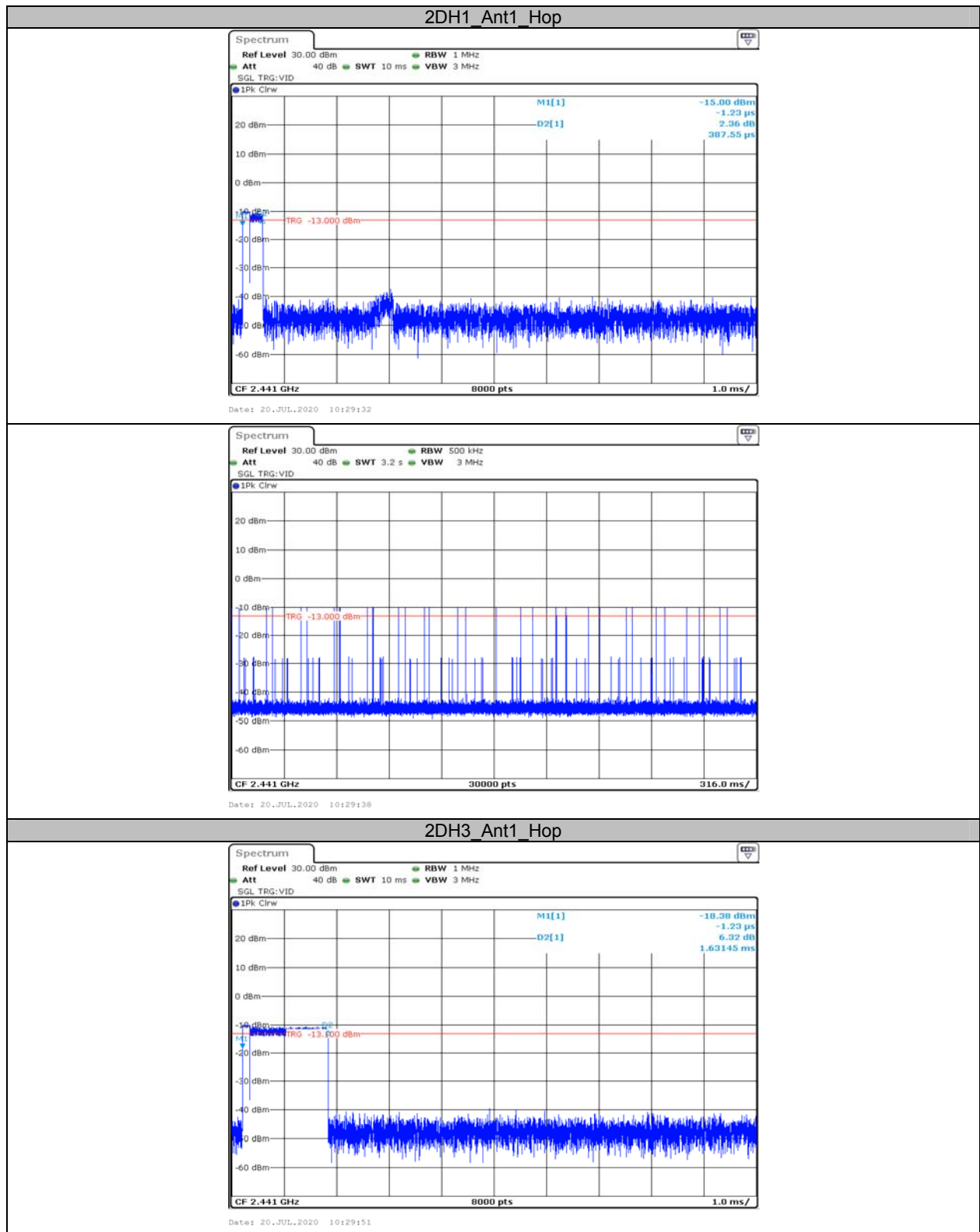
Test Graphs

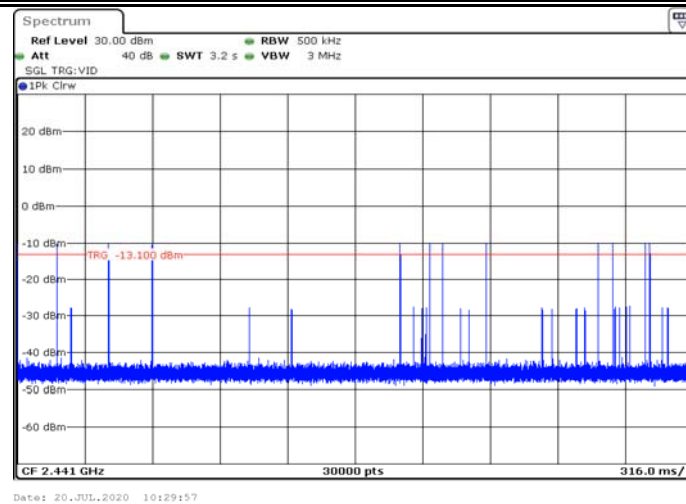




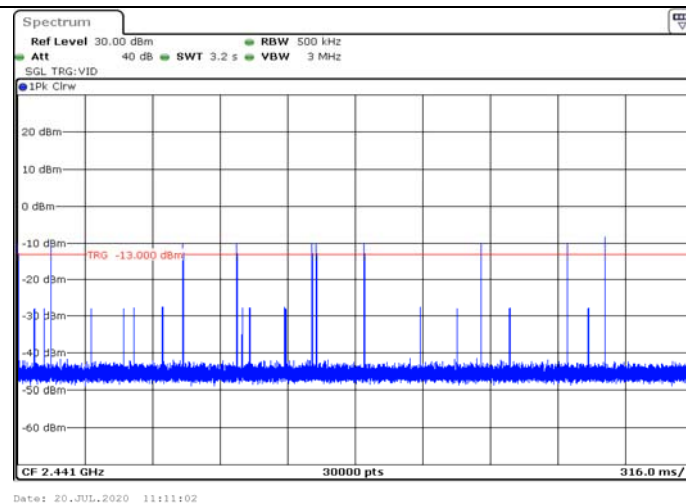
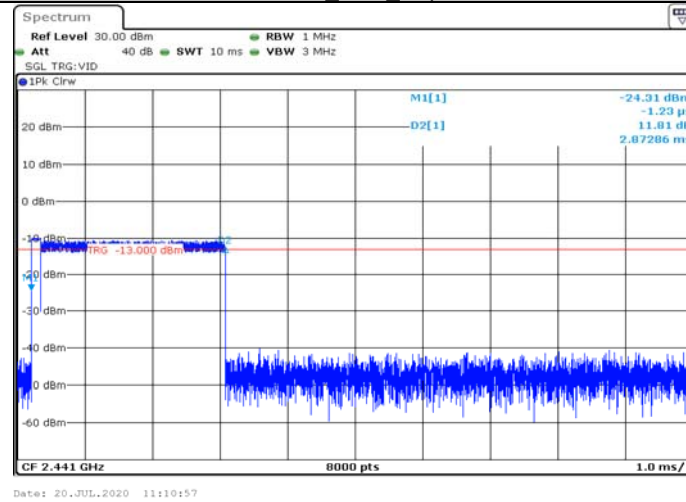
DH5_Ant1_Hop

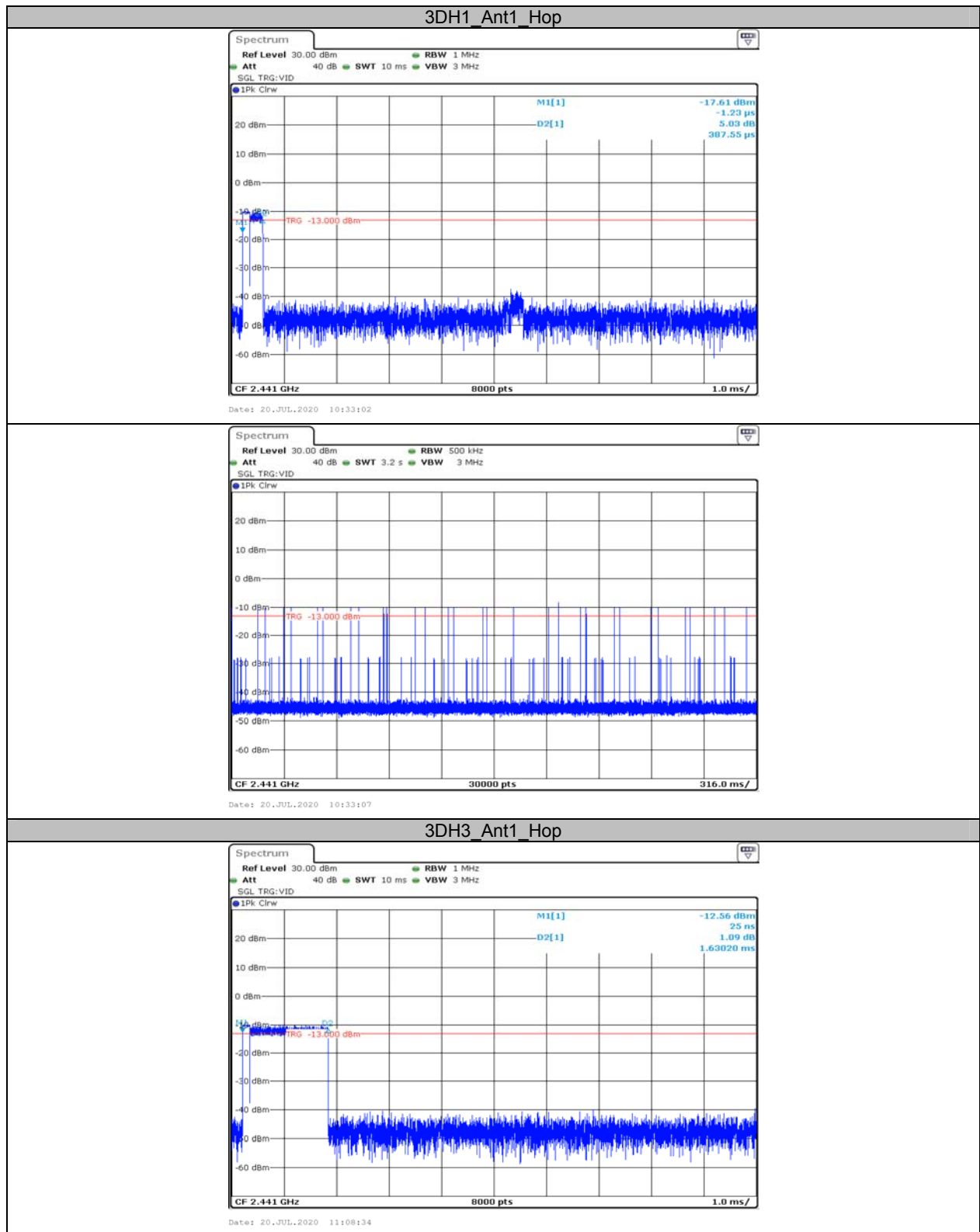


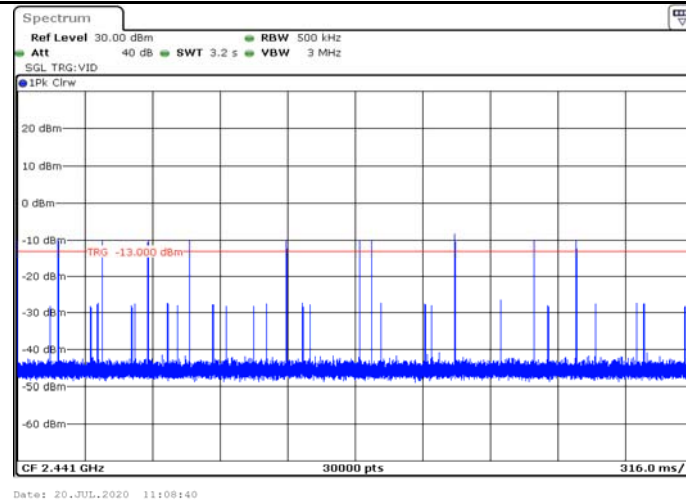




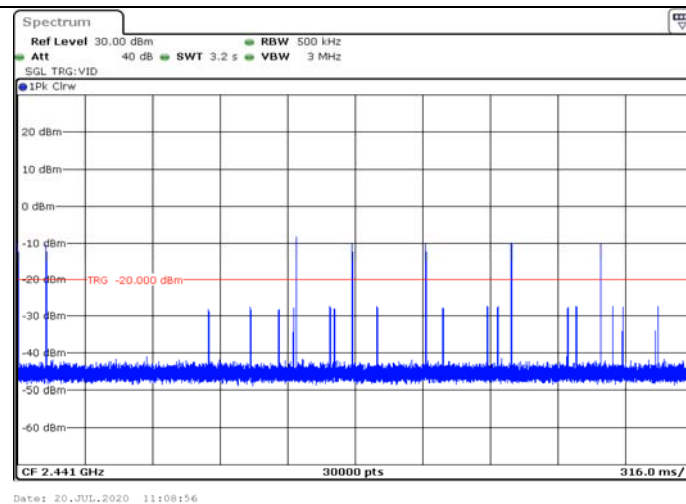
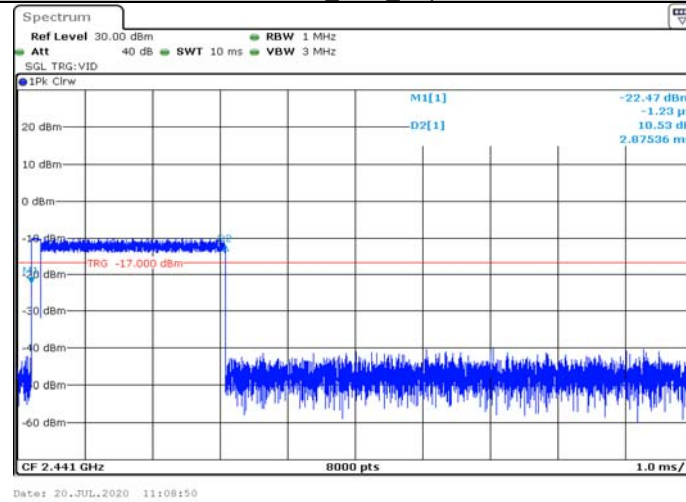
2DH5_Ant1_Hop







3DH5_Ant1_Hop

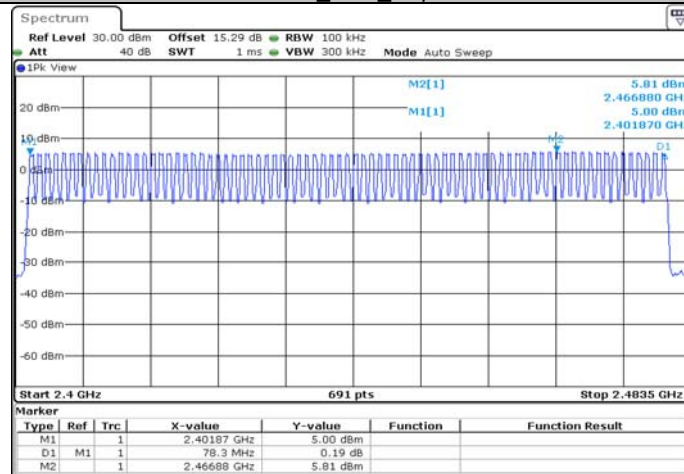


**AppendixF: Number of hopping channels
Test Result**

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

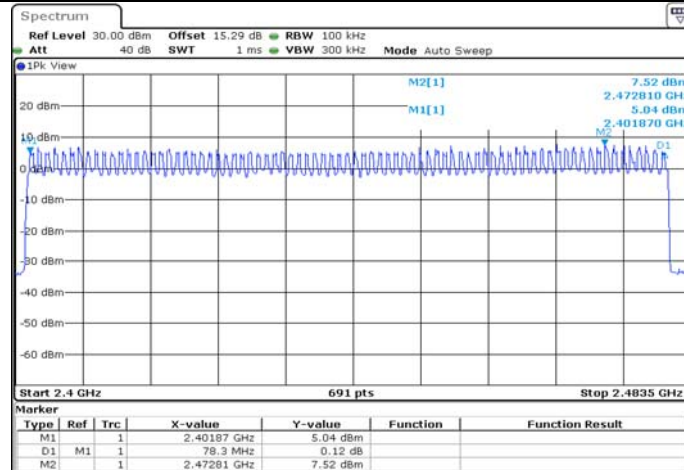
Test Graphs

DH1_Ant1_Hop



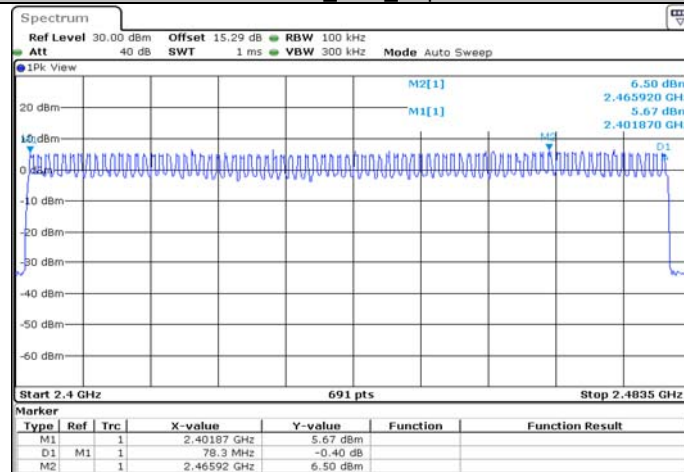
Date: 20_JUL_2020 11:14:11

2DH1_Ant1_Hop



Date: 20_JUL_2020 10:29:20

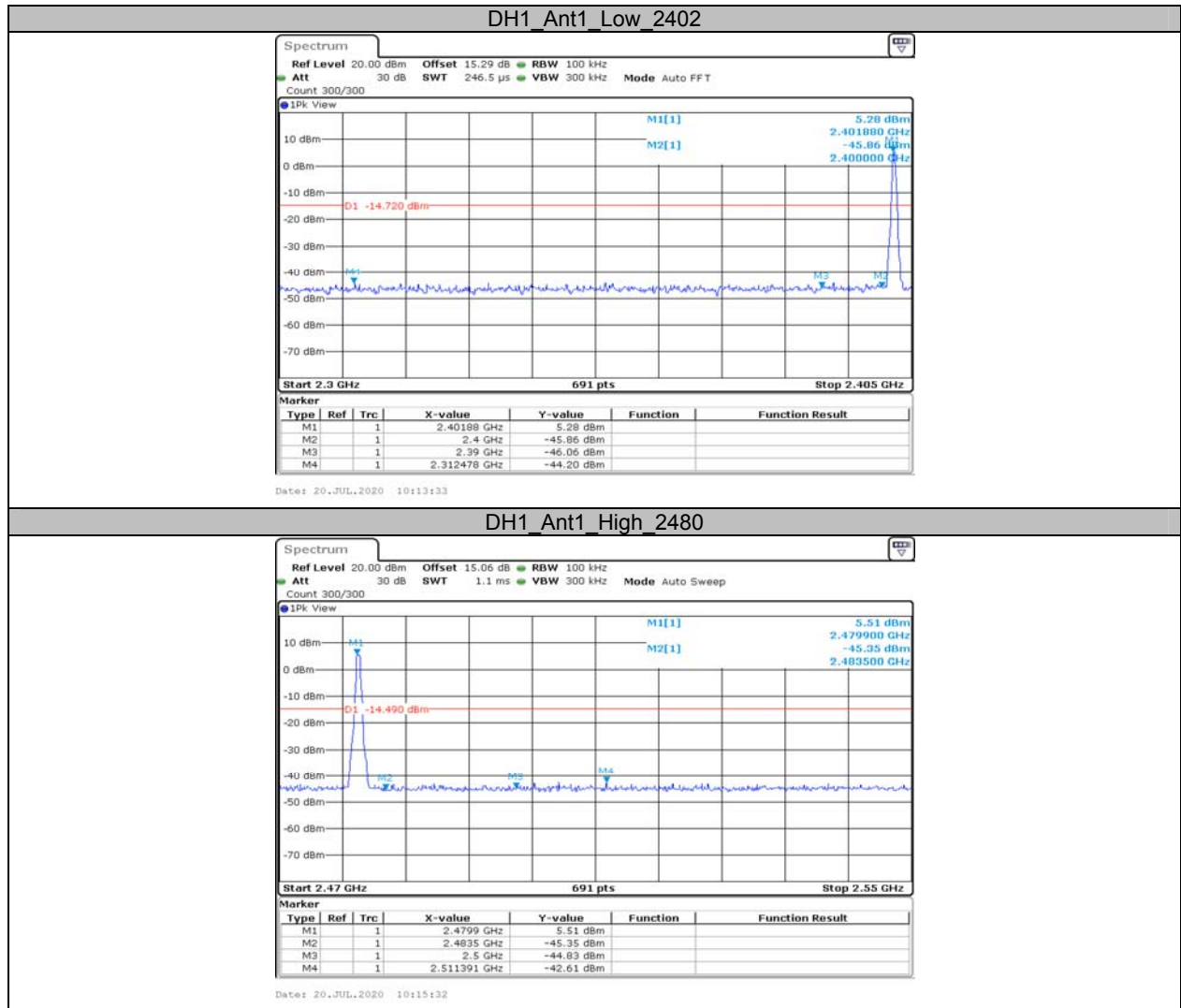
3DH1_Ant1_Hop



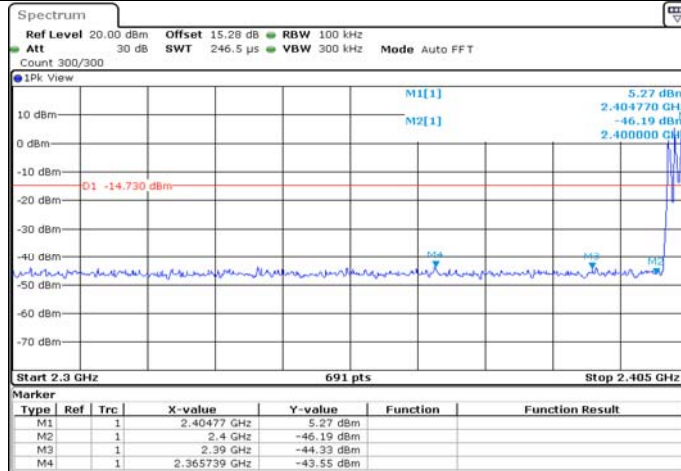
Date: 20_JUL_2020 10:32:49

Appendix G: Band edge measurements

Test Result

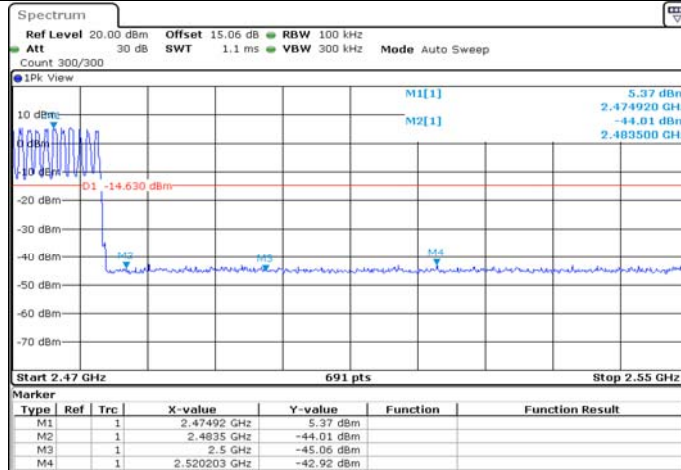


DH1_Ant1_Low_Hop_2402



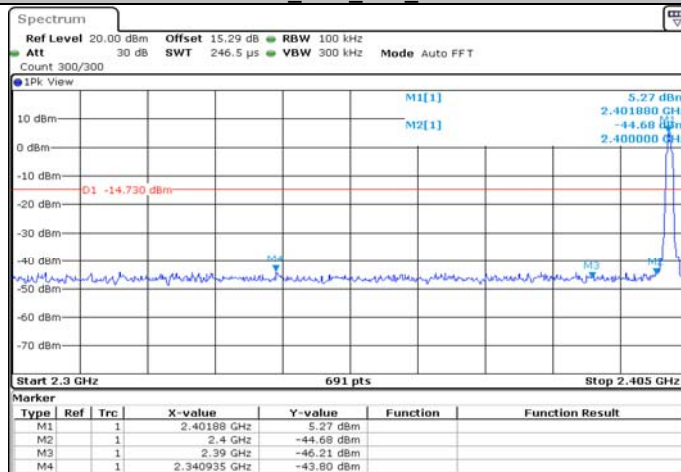
Date: 20.JUL.2020 11:21:55

DH1_Ant1_High_Hop_2480



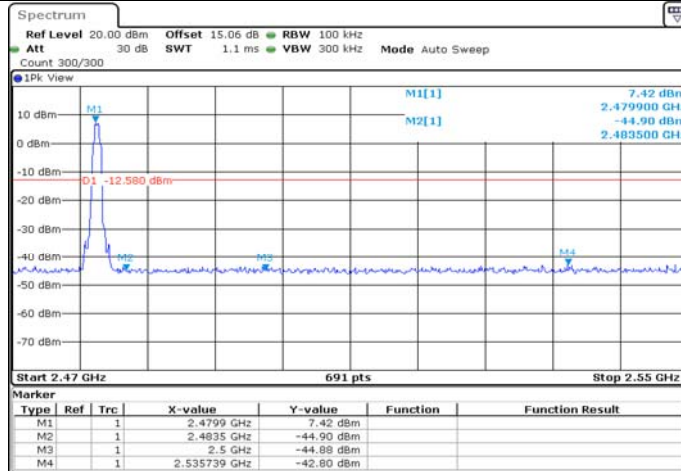
Date: 20.JUL.2020 10:25:39

2DH1_Ant1_Low_2402



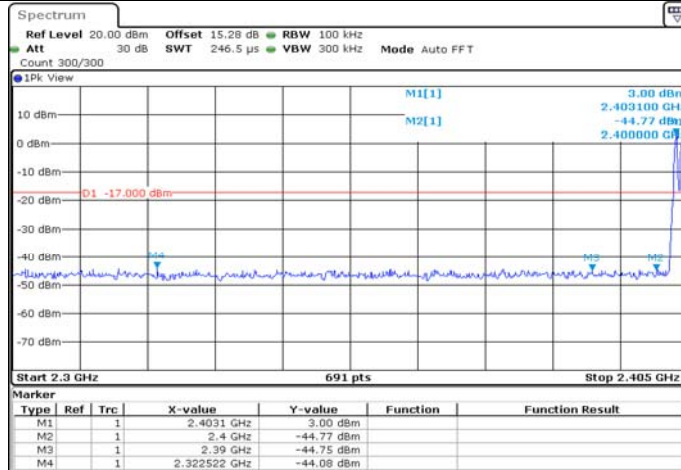
Date: 20.JUL.2020 11:20:36

2DH1_Ant1_High_2480



Date: 20.JUL.2020 10:18:52

2DH1_Ant1_Low_Hop_2402



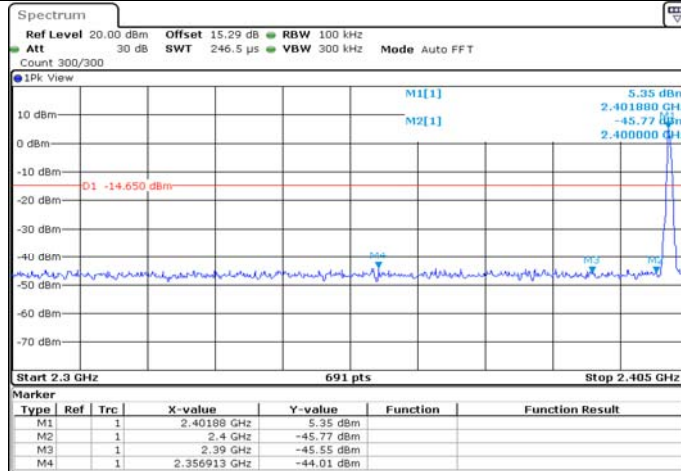
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2DH1_Ant1_High_Hop_2480



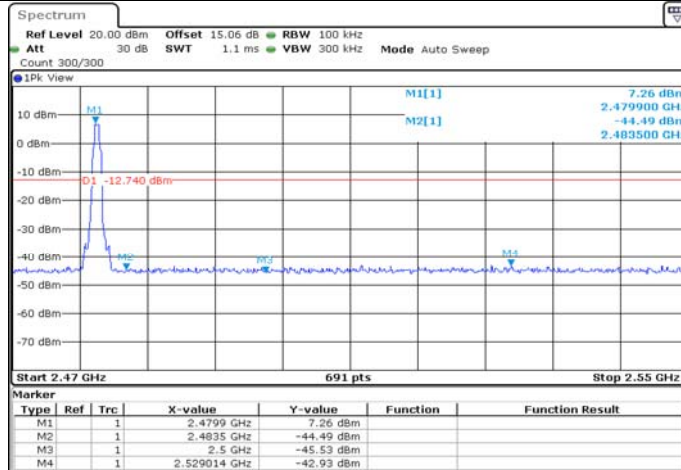
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3DH1_Ant1_Low_2402



Date: 20.JUL.2020 11:20:51

3DH1_Ant1_High_2480

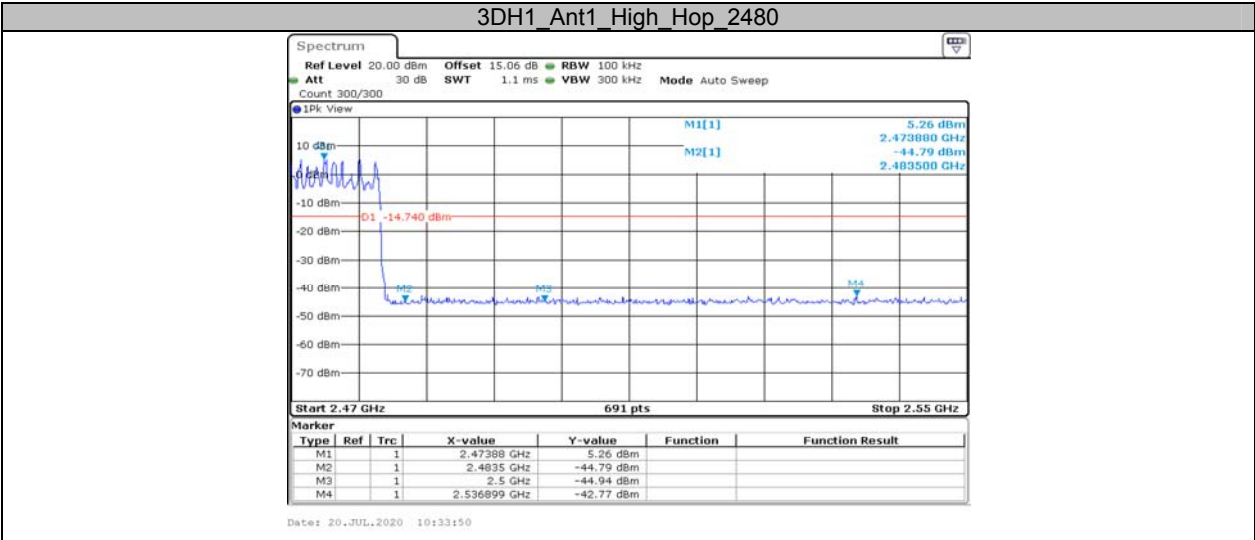


Date: 20.JUL.2020 10:22:00

3DH1_Ant1_Low_Hop_2402



Date: 20.JUL.2020 11:24:42



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