

# TEST REPORT

**Report Number.:** 14093504-E5V3

**Applicant :** SONOS INC.  
614 CHAPALA ST.  
SANTA BARBARA, CA, 93101, U.S.A.

**Model :** S39

**Brand :** SONOS

**FCC ID :** SBVRM039

**IC :** 5373A-RM039

**EUT Description :** 802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART E  
ISED RSS-247 ISSUE 2  
ISED RSS-GEN ISSUE 5 + A1 + A2

**Date Of Issue:**  
2022-10-13

**Prepared by:**  
UL VERIFICATION SERVICES  
47173 Benicia Street  
Fremont, CA 94538 U.S.A.  
TEL: (510) 319-4000  
FAX: (510) 661-0888



---

## REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2022-09-23	Initial Issue	---
V2	2022-10-03	Updated Section 6.3, 9.2, 9.3,9.5 and 10.1	K.Kedida
V3	2022-10-13	Updated Section 9.5	K.Kedida

## TABLE OF CONTENTS

<b>REPORT REVISION HISTORY .....</b>	<b>2</b>
<b>TABLE OF CONTENTS .....</b>	<b>3</b>
<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>6</b>
<b>2. TEST RESULT SUMMARY .....</b>	<b>8</b>
<b>3. TEST METHODOLOGY .....</b>	<b>9</b>
<b>4. FACILITIES AND ACCREDITATION .....</b>	<b>9</b>
<b>5. DECISION RULES AND MEASUREMENT UNCERTAINTY .....</b>	<b>10</b>
5.1. METROLOGICAL TRACEABILITY .....	10
5.2. DECISION RULES.....	10
5.3. MEASUREMENT UNCERTAINTY.....	10
5.4. SAMPLE CALCULATION .....	10
<b>6. EQUIPMENT UNDER TEST .....</b>	<b>11</b>
6.1. EUT DESCRIPTION .....	11
6.2. MAXIMUM OUTPUT POWER.....	11
6.3. DESCRIPTION OF AVAILABLE ANTENNAS .....	13
6.4. SOFTWARE AND FIRMWARE.....	13
6.5. WORST-CASE CONFIGURATION AND MODE.....	13
6.6. DESCRIPTION OF TEST SETUP.....	14
<b>7. MEASUREMENT METHOD.....</b>	<b>16</b>
<b>8. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>17</b>
<b>9. ANTENNA PORT TEST RESULTS .....</b>	<b>18</b>
9.1. ON TIME AND DUTY CYCLE.....	18
9.2. 26 dB BANDWIDTH.....	20
9.2.1. 802.11a MODE IN THE 5.2 GHz BAND.....	21
9.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND .....	23
9.2.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND .....	25
9.2.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND .....	26
9.2.5. 802.11a MODE IN THE 5.3 GHz BAND.....	27
9.2.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND .....	29
9.2.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND .....	31
9.2.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND .....	32
9.2.9. 802.11a MODE IN THE 5.6 GHz BAND.....	33

9.2.10.	802.11n HT20 MODE IN THE 5.6 GHz BAND .....	35
9.2.11.	802.11n HT40 MODE IN THE 5.6 GHz BAND .....	37
9.2.12.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND .....	39
9.2.13.	802.11a MODE IN THE 5.8 GHz BAND.....	40
9.2.14.	802.11n HT20 MODE IN THE 5.8 GHz BAND .....	42
9.2.15.	802.11n HT40 MODE IN THE 5.8 GHz BAND .....	44
9.2.16.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND .....	45
9.3.	<b>99% BANDWIDTH.....</b>	<b>46</b>
9.3.1.	802.11a MODE IN THE 5.2 GHz BAND.....	47
9.3.2.	802.11n HT20 MODE IN THE 5.2 GHz BAND .....	49
9.3.3.	802.11n HT40 MODE IN THE 5.2 GHz BAND .....	51
9.3.4.	802.11ac VHT80 MODE IN THE 5.2 GHz BAND .....	52
9.3.5.	802.11a MODE IN THE 5.3 GHz BAND.....	53
9.3.6.	802.11n HT20 MODE IN THE 5.3 GHz BAND .....	55
9.3.7.	802.11n HT40 MODE IN THE 5.3 GHz BAND .....	57
9.3.8.	802.11ac VHT80 MODE IN THE 5.3 GHz BAND .....	58
9.3.9.	802.11a MODE IN THE 5.6 GHz BAND.....	59
9.3.10.	802.11n HT20 MODE IN THE 5.6 GHz BAND .....	61
9.3.11.	802.11n HT40 MODE IN THE 5.6 GHz BAND .....	63
9.3.12.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND .....	65
9.3.13.	802.11a MODE IN THE 5.8 GHz BAND.....	66
9.3.14.	802.11n HT20 MODE IN THE 5.8 GHz BAND .....	68
9.3.15.	802.11n HT40 MODE IN THE 5.8 GHz BAND .....	70
9.3.16.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND .....	71
9.4.	<b>6 dB BANDWIDTH.....</b>	<b>72</b>
9.4.1.	802.11a MODE IN THE 5.8 GHz BAND.....	73
9.4.2.	802.11n HT20 MODE IN THE 5.8 GHz BAND .....	75
9.4.3.	802.11n HT40 MODE IN THE 5.8 GHz BAND .....	77
9.4.4.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND .....	78
9.5.	<b>OUTPUT POWER AND PSD.....</b>	<b>79</b>
9.5.1.	802.11a MODE IN THE 5.2 GHz BAND.....	83
9.5.2.	802.11n HT20 MODE IN THE 5.2 GHz BAND .....	87
9.5.3.	802.11n HT40 MODE IN THE 5.2 GHz BAND .....	91
9.5.4.	802.11ac VHT80 MODE IN THE 5.2 GHz BAND .....	95
9.5.5.	802.11a MODE IN THE 5.3 GHz BAND.....	98
9.5.6.	802.11n HT20 MODE IN THE 5.3 GHz BAND .....	100
9.5.7.	802.11n HT40 MODE IN THE 5.3 GHz BAND .....	102
9.5.8.	802.11ac VHT80 MODE IN THE 5.3 GHz BAND .....	104
9.5.9.	802.11a MODE IN THE 5.6 GHz BAND.....	106
9.5.10.	802.11n HT20 MODE IN THE 5.6 GHz BAND .....	108
9.5.11.	802.11n HT40 MODE IN THE 5.6 GHz BAND .....	110
9.5.12.	802.11ac VHT80 MODE IN THE 5.6 GHz BAND .....	112
9.5.13.	802.11a MODE IN THE 5.8 GHz BAND.....	114
9.5.14.	802.11n HT20 MODE IN THE 5.8 GHz BAND .....	116
9.5.15.	802.11n HT40 MODE IN THE 5.8 GHz BAND .....	118
9.5.16.	802.11ac VHT80 MODE IN THE 5.8 GHz BAND .....	120
<b>10.</b>	<b>RADIATED TEST RESULTS.....</b>	<b>122</b>
10.1.	<b>TRANSMITTER ABOVE 1 GHz.....</b>	<b>124</b>
10.1.1.	TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND .....	124

10.1.2.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND.....	132
10.1.3.	TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND.....	140
10.1.4.	TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.2 GHz BAND .....	146
10.1.5.	TX ABOVE 1 GHz 802.11a MODE IN THE 5.3 GHz BAND .....	150
10.1.6.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND.....	158
10.1.7.	TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.3 GHz BAND.....	166
10.1.8.	TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.3 GHz BAND .....	172
10.1.9.	TX ABOVE 1 GHz 802.11a MODE IN THE 5.6 GHz BAND .....	176
10.1.10.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND.....	186
10.1.11.	TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.6 GHz BAND.....	196
10.1.12.	TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.6 GHz BAND .....	206
10.1.13.	TX ABOVE 1 GHz 802.11a MODE IN THE 5.8 GHz BAND .....	214
10.1.14.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.8 GHz BAND.....	224
10.1.15.	TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.8 GHz BAND.....	234
10.1.16.	TX ABOVE 1 GHz 802.11ac VHT80 MODE IN THE 5.8 GHz BAND .....	242
10.2.	<i>WORST CASE BELOW 30MHz .....</i>	<i>248</i>
10.3.	<i>WORST CASE BELOW 1 GHz .....</i>	<i>249</i>
10.4.	<i>WORST CASE 18-26 GHz .....</i>	<i>251</i>
10.5.	<i>WORST CASE 26-40 GHz .....</i>	<i>253</i>
<b>11.</b>	<b>AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>255</b>
<b>12.</b>	<b>SETUP PHOTOS.....</b>	<b>258</b>

# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** SONOS INC.  
614 Chapala St.  
Santa Barbara, CA, 93101, U.S.A.

**EUT DESCRIPTION:** 802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE

**MODEL:** S39

**BRAND:** SONOS

**SERIAL NUMBER:** Radiated Sample: A100 2207CP F0-F6-C1-A0-0D-80:1 and  
A100 2207CP F0-F6-C1-A0-0D-CC:9  
Conducted Sample: 7885B

**SAMPLE RECEIPT DATE:** 2022-07-25

**DATE TESTED:** 2022-07-25 to 2022-08-23

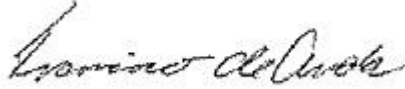
APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart E	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5 + A1 + A2	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For  
UL Verification Services Inc. By:



---

Francisco de Anda  
Staff Engineer  
Consumer Technology Division  
UL Verification Services Inc.

Prepared By:



---

Gerardo Abrego  
Senior Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

1<sup>st</sup> Reviewed By:



---

Vien Tran  
Senior Laboratory Engineer  
Consumer Technology Division  
UL Verification Services Inc.

2<sup>nd</sup> Reviewed By:



---

Kiya Kedida  
Senior Project Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST RESULT SUMMARY

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for the validity of results after the integration of the data provided by the customer.

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	Per ANSI C63.10, Section 12.2.
See Comment	RSS-GEN 6.7	26dB BW/99% OBW	Reporting purposes only	Per ANSI C63.10 Sections 6.9.2 and 6.9.3
15.407 (e)	RSS-247 6.2.4.1	6 dB BW	Compliant	None.
15.407 (a) (1-4), (h) (1)	RSS-247 6.2	Output Power	Compliant	None.
15.407 (a) (1-3, 5)	RSS-247 6.2	PSD	Compliant	None.
15.209, 15.205, 15.407 (b)	RSS-GEN 8.9, 8.10, RSS-247 6.2	Radiated Emissions	Compliant	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Compliant	None.



### 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with:

- FCC CFR 47 Part 2
- FCC CFR 47 Part 15,
- FCC KDB 662911 D01 v02r01,
- FCC KDB 905462 D02 v02/D03 v01r02/D06 v02
- FCC KDB 789033 D02 v02r01,
- KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013,
- RSS-GEN Issue 5 + A1 + A2
- RSS-247 Issue 2

### 4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, Certificate Number #0751.05, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
<input checked="" type="checkbox"/>	Building 1: 47173 Benicia Street Fremont, CA 94538, U.S.A	US0104	2324A	208313
<input type="checkbox"/>	Building 2: 47266 Benicia Street Fremont, CA 94538, U.S.A	US0104	22541	208313
<input checked="" type="checkbox"/>	Building 4: 47658 Kato Rd Fremont, CA 94538, U.S.A	US0104	2324B	208313

## 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

### 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

### 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

### 5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U <sub>Lab</sub>
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.78 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.29 dB

Uncertainty figures are valid to a confidence level of 95%.

### 5.4. SAMPLE CALCULATION

#### RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\text{Field Strength (dBuV/m)} = \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Preamp Gain (dB)}$$

$$36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$$

#### MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\text{Final Voltage (dBuV)} = \text{Measured Voltage (dBuV)} + \text{Cable Loss (dB)} + \text{Limiter Factor (dB)} + \text{LISN Insertion Loss}$$

$$36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$$

## 6. EQUIPMENT UNDER TEST

### 6.1. EUT DESCRIPTION

The EUT is an 802.11 a/b/g/n/ac/ax 2x2 Client Device with BT and BLE.

This report covers non-ax 5GHz Wifi radio.

### 6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

**(FCC)**

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
<b>5.2 GHz band, 2TX</b>			
5180-5240	802.11a	19.77	94.84
5180-5240	802.11n HT20	19.91	97.95
5190-5230	802.11n HT40	17.70	58.88
5210	802.11ac VHT80	14.54	28.44
<b>5.3 GHz band, 2TX</b>			
5260-5320	802.11a	20.52	112.72
5260-5320	802.11n HT20	21.09	128.53
5270-5310	802.11n HT40	17.27	53.33
5290	802.11ac VHT80	14.17	26.12
<b>5.6 GHz band, 2TX</b>			
5500 - 5700	802.11a	19.53	89.74
5500 - 5700	802.11n HT20	20.05	101.16
5510 - 5670	802.11n HT40	19.07	80.72
5530 - 5610	802.11ac VHT80	21.42	138.68
<b>5.8 GHz band, 2TX</b>			
5745 - 5825	802.11a	22.58	181.13
5745 - 5825	802.11n HT20	23.01	199.99
5755 - 5795	802.11n HT40	20.52	112.72
5775	802.11ac VHT80	21.51	141.58

**(IC)**

The transmitter has a maximum e.i.r.p as follows:

Frequency Range (MHz)	Mode	EIRP (dBm)	EIRP (mW)
<b>5.2 GHz band, 2TX</b>			
5180-5240	802.11a	17.30	53.74
5180-5240	802.11n HT20	18.09	64.42
5190-5230	802.11n HT40	17.43	55.34
5210	802.11ac VHT80	15.02	31.77

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna gains and type, as provided by the manufacturer are as follows:

The radio utilizes a PCB (onboard) antenna, with maximum gains as follows:

Frequency Range (MHz)	Peak Antenna Gain (dBi)			
	CHAIN 0		CHAIN 1	
	ANT1 (LOB) (dBi)	ANT2 (LRM) (dBi)	ANT3 (RRM) (dBi)	ANT4 (ROB) (dBi)
5150 – 5250	3.2	3.4	3.2	4.6
5250 – 5350	3.6	2.9	3.2	4.4
5500 – 5700	5.0	4.3	4.3	5.1
5725 - 5850	5.2	4.3	4.6	5.1

### 6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 70.1-29190-diag.

The test utility software used during testing was GUI\_V8.

### 6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle, and high channels.

The EUT can only be setup in desktop orientation; therefore, all radiated testing was performed with the EUT in desktop orientation.

The fundamental of the EUT was investigated with the antenna combinations, it was determined that:

\_ANT2 and ANT4 was the worst case in the 5.2GHz band.

\_ANT1 and ANT4 was the worst case in the 5.3GHz,5.6GHz & 5.8GHz bands.

Therefore, all final testing was performed with ANT2 and ANT4 and ANT1 and ANT4 as stated above.

Worst-case data rates as provided by the manufacturer were:

802.11a mode: 6 Mbps

802.11n HT20mode: MCS0

802.11n HT40mode: MCS0

802.11ac VHT80 mode: MCS0

**Note:** 802.11ac VHT20 and VHT40 has the same power as 802.11n HT20 and 802.11n HT40 so 802.11n HT20 and 802.11n HT40 were test as worst case.

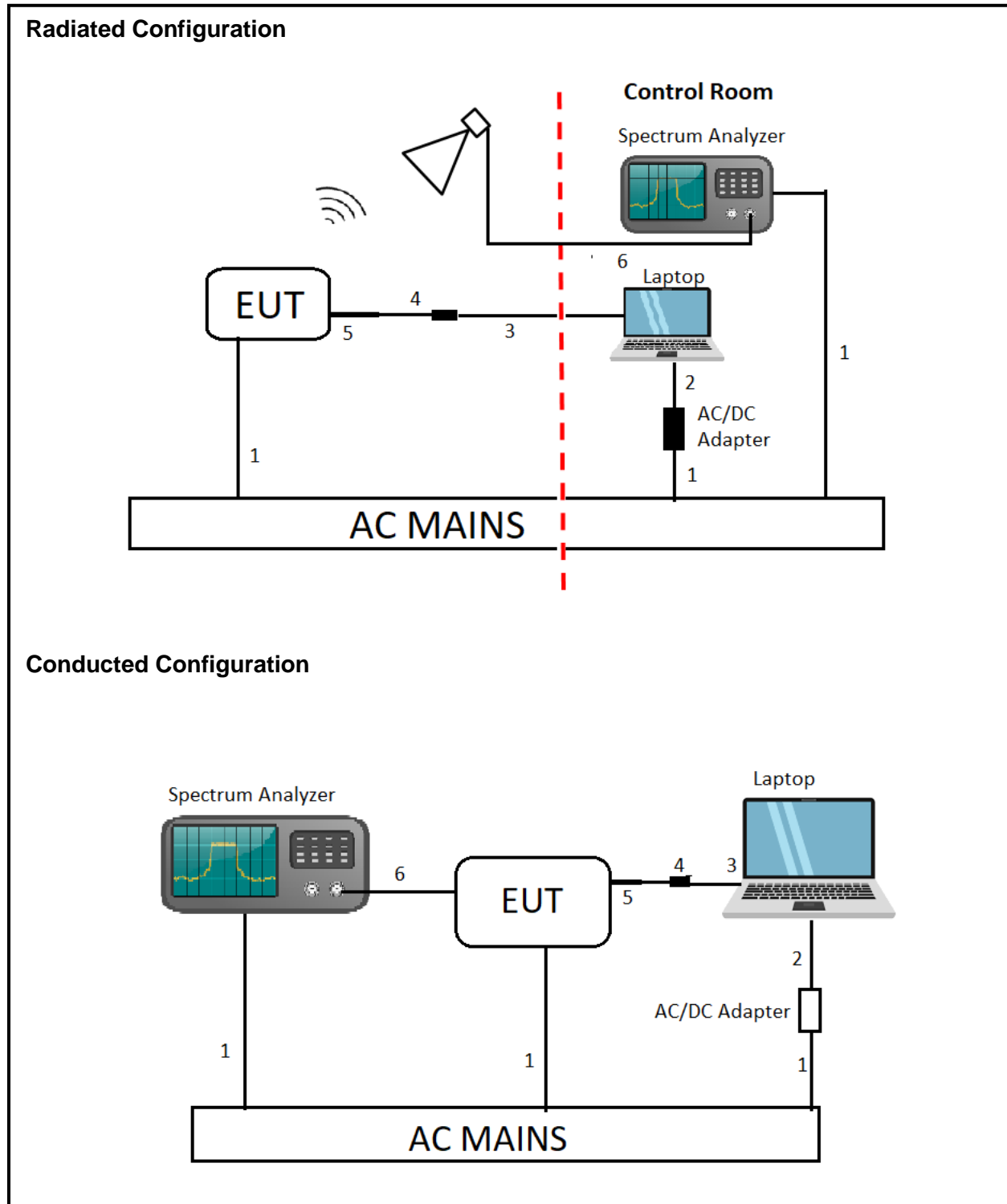
## 6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT						
Description	Manufacturer	Model	Serial Number	FCC ID/ DoC		
Laptop	Lenovo	T460s	PC0JMBF8	Doc		
Laptop AC/DC Adapter	Lenovo	ADLX90NLC2A	11S45N0247Z1ZSHH448JEY	Doc		
USB-A to Ethernet Adapter	Plugable	USB2-E100	8CAE4CE46AFA	Doc		
USB-C to USB-A Female Adapter	Amazon Basics	L6LUC160-CS-R	N/A	Doc		
I/O CABLES (CONDUCTED TEST)						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	3	AC	Un-shielded	1.25	AC Mains to EUT/Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	Ethernet	1	RJ45	Un-shielded	1.5	Laptop to USB Ethernet Adapter
4	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
5	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
6	SMA Cable	1	SMA	Un-Shielded	0.1	EUT to Spectrum Analyzer
I/O CABLES (RADIATED TEST)						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	3	AC	Un-shielded	1.25	AC Mains to EUT/Spectrum Analyzer/AC/DC Adapter
2	DC	1	DC	Un-shielded	1	AC/DC Adapter to Laptop
3	Ethernet	1	RJ45	Un-shielded	10	Laptop to USB Ethernet Adapter
4	USB-A	1	USB-A	Shielded	0.05	USB Ethernet Adapter to USB
5	USB-C	1	USB-C	Shielded	0.05	EUT to USB-C/USB-A Female Adapter
6	SMA Cable	1	SMA	Un-Shielded	10	EUT to Horn Antenna

### TEST SETUP

The EUT is a stand-alone unit, and the radio is exercised remotely by Sonos Compliance GUI test utility software via ethernet.

**SETUP DIAGRAM**



## 7. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 789033 D02 v02r01, Section B.

6 dB Emission BW: KDB 789033 D02 v02r01, Section C.2

26 dB Emission BW: KDB 789033 D02 v02r01, Section C.1

99% Occupied BW: KDB 789033 D02 v02r01, Section D.

Conducted Output Power: KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and KDB 789033 D02 v02r01, Section E.2.b (Method SA-1)

Power Spectral Density: KDB 789033 D02 v02r01, Section F

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.3, G.4, and G.5.

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4



## 8. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
Antenna, Broadband Hybrid, 30MHz to 2GHz	Sunol Sciences Corp.	JB1	82258	2022-10-01	2021-10-01
Amplifier, 10KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	175953	2023-02-08	2022-02-08
Amplifier, 10KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310N	29654	2023-04-24	2022-04-24
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	80707	2023-04-28	2022-04-28
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	206086	2022-09-22	2021-09-22
Antenna, Horn 1-18GHz	ETS-Lindgren (Cedar Park, Texas)	3117	80402	2023-07-05	2022-07-05
RF Filter Box, 1-18GHz	FREMONT	SAC-L1	171013	2023-06-24	2022-06-24
RF Filter Box, 1-18GHz	UL-FR1 (CTECH)	SAC 8 port rf box 1	171875	2023-08-12	2022-08-12
RF Filter Box, 1-18GHz	UL-FR1 (CTECH)	SAC 8 port rf box 1	197920	2023-04-19	2022-04-19
EMI TEST RECEIVER, with B8 option	Rohde & Schwarz	ESW44	169937	2023-02-20	2022-02-20
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	169927	2023-02-16	2022-02-16
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201501	2023-02-19	2022-02-19
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	81138	2022-10-13	2021-10-13
Amplifier 18-26.5GHz, +5Vdc, 60dB min	AMPLICAL	AMP18G26.5-60	215705	2023-02-26	2022-02-26
Antenna, Horn 26 to 40GHz	ARA	MWH-2640/B	81104	2022-10-14	2021-10-14
Amplifier 26-40GHz +5Vdc, -62dBm P1dB	AMPLICAL	AMP26G40-65	172345	2023-06-22	2022-06-22
Antenna, Passive Loop 30Hz - 1MHz	ELECTRO METRICS	EM-6871	219909	2023-05-10	2022-05-10
Antenna, Passive Loop 100KHz - 30MHz	ELECTRO METRICS	EM-6872	219911	2023-05-10	2022-05-10
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent Technologies	N9030A	80396	2023-01-02	2022-01-02
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	T1268	2023-02-03	2022-02-03
AC Line Conducted					
LISN	Fischer Custom Communications, Inc	FCC-LISN-50/250-25-2-01-480V	175765	2023-01-26	2022-01-26
EMI TEST RECEIVER	Rohde & Schwarz	ESR	93091	2023-02-21	2022-02-21
Transient Limiter	Com-Power	LIT-930	127455	2023-02-02	2022-02-02
UL TEST SOFTWARE LIST					
Radiated Software	UL	UL EMC	Ver 2014-07-15, 2016-08-23, 2020-06-04, 2022-05-05, 2022-05-18, and 2022-07-06		
Antenna Port Software	UL	UL RF	Ver 2022-05-31		
AC Line Conducted Software	UL	UL EMC	Rev 9.5, 2022-02-17		

\*Test performed before calibration expired.

## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

#### PROCEDURE

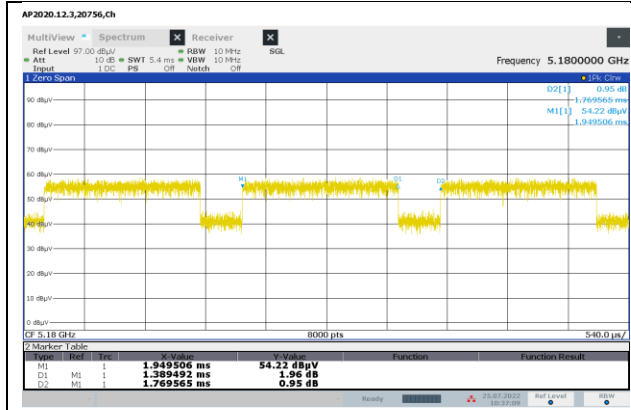
KDB 558074 Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS

<b>Test Engineer:</b>	GA12485
<b>Test Date:</b>	2022/25/7

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a	1.39	1.77	0.79	78.52	1.05	0.72
802.11n HT20	1.30	1.68	0.77	77.47	1.11	0.77
802.11n HT40	0.65	1.04	0.62	62.04	2.07	1.54
802.11ac VHT80	0.32	0.70	0.46	46.18	3.36	3.09

### DUTY CYCLE PLOTS



10:37:10 25.07.2022  
**DUTY CYCLE 802.11a MODE**



10:41:24 25.07.2022  
**DUTY CYCLE 802.11n HT20 MODE**



10:44:49 25.07.2022  
**DUTY CYCLE 802.11n HT40 MODE**



10:50:23 25.07.2022  
**DUTY CYCLE 802.11ac VHT80 MODE**

## **9.2. 26 dB BANDWIDTH**

### **LIMITS**

None; for reporting purposes only.

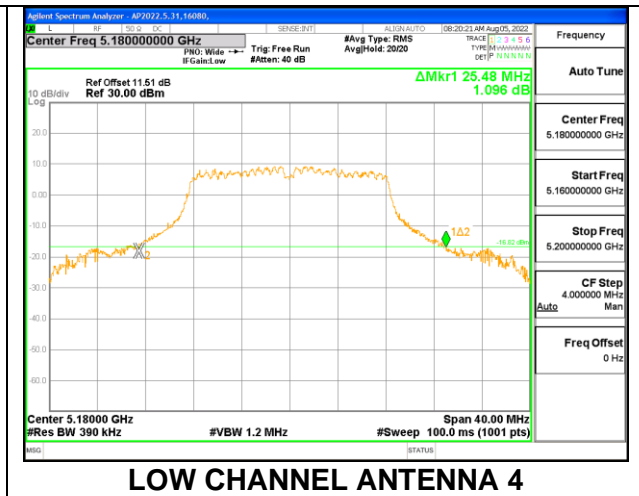
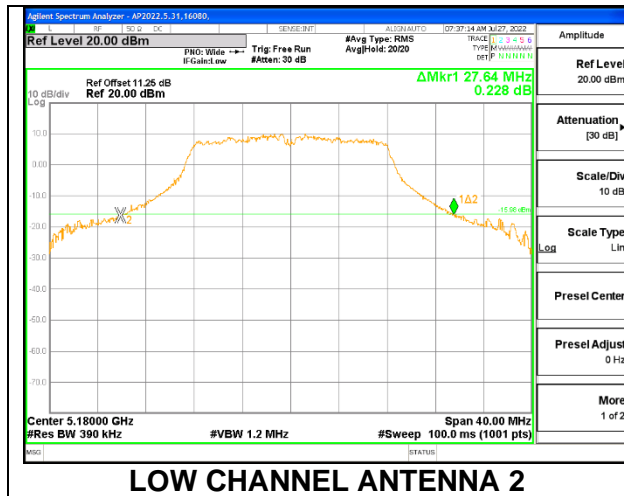
### **RESULTS**

### 9.2.1. 802.11a MODE IN THE 5.2 GHz BAND

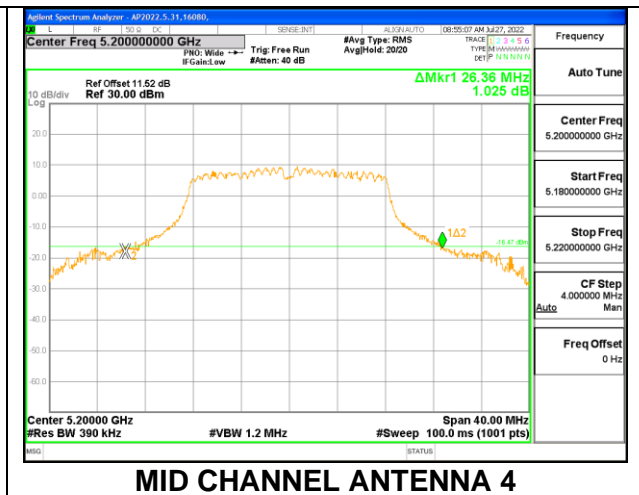
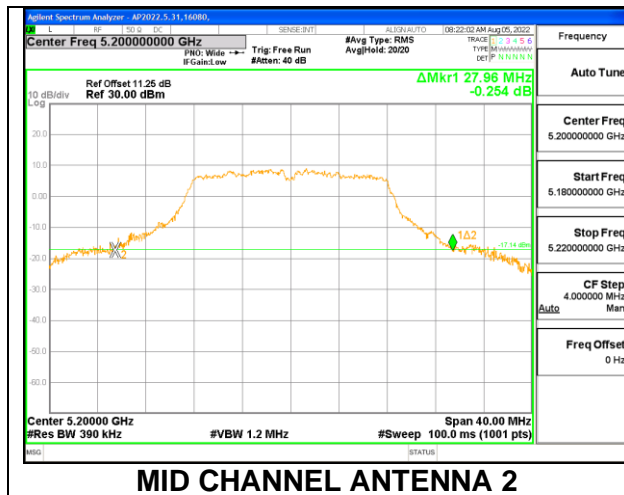
#### 2TX Antenna 2 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5180	27.64	25.48
Mid	5200	27.96	26.36
High	5240	27.48	25.52

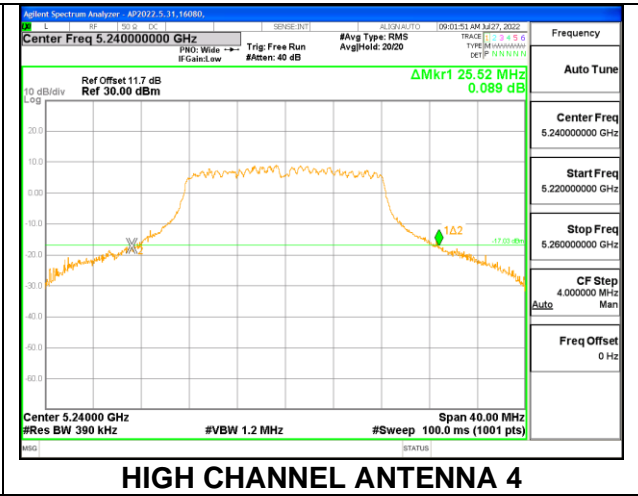
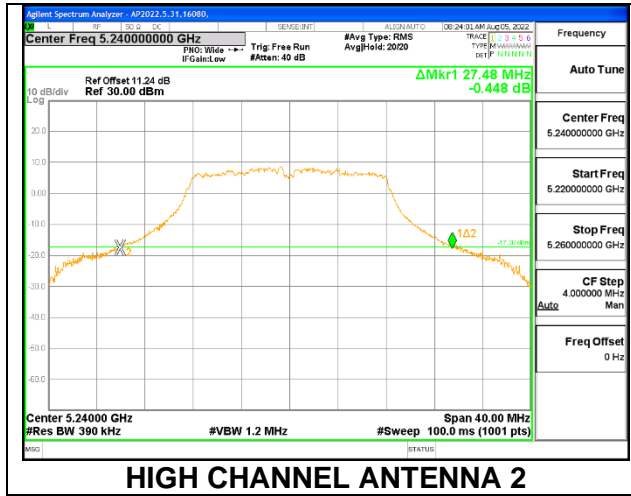
#### LOW CHANNEL



#### MID CHANNEL



### HIGH CHANNEL

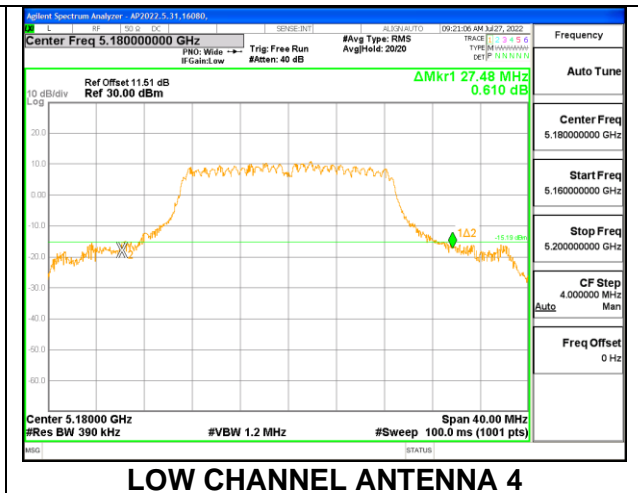
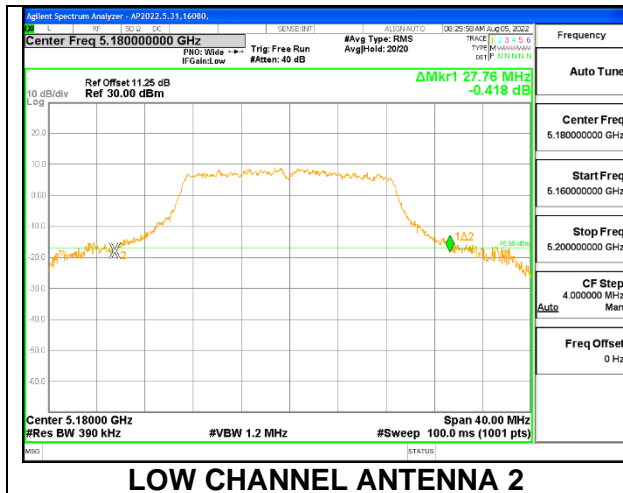


### 9.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

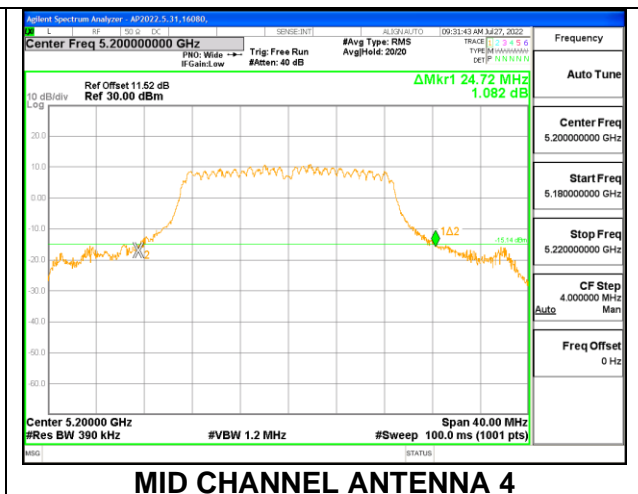
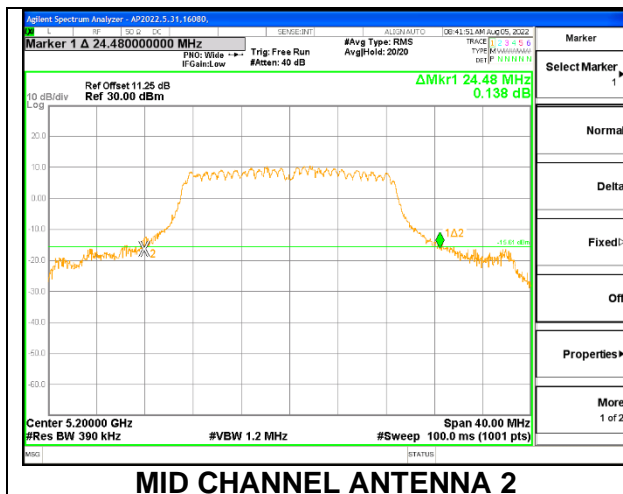
#### 2TX Antenna 2 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5180	27.76	27.48
Mid	5200	24.48	24.72
High	5240	24.56	24.48

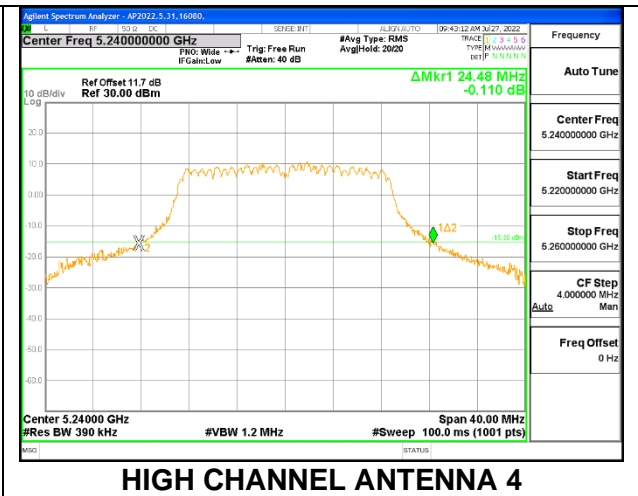
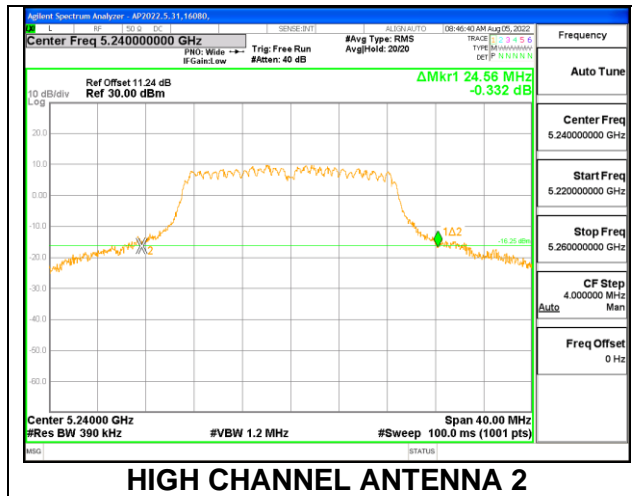
#### LOW CHANNEL



#### MID CHANNEL



### HIGH CHANNEL



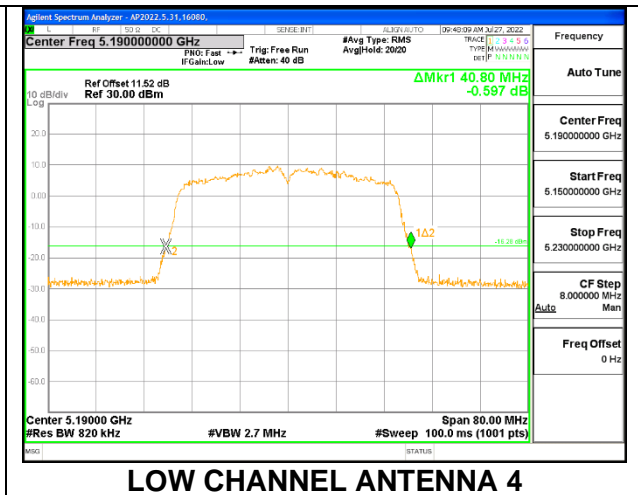
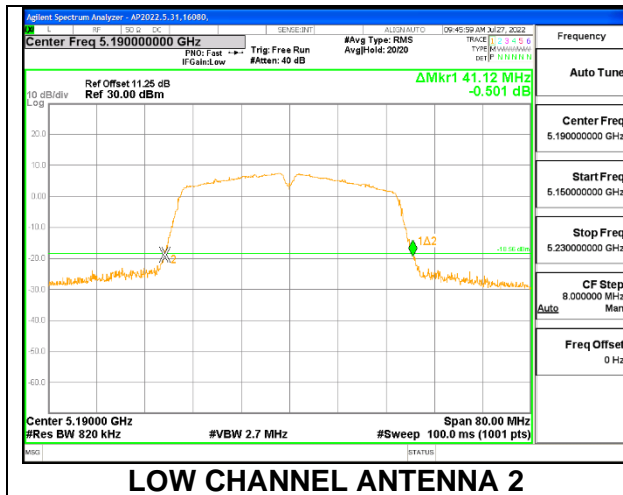


### 9.2.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

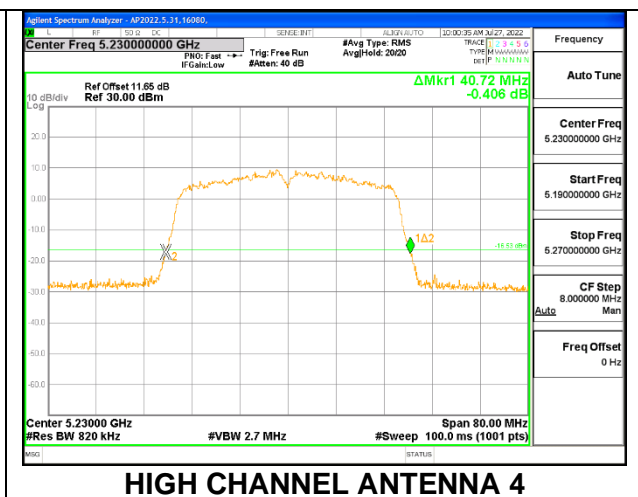
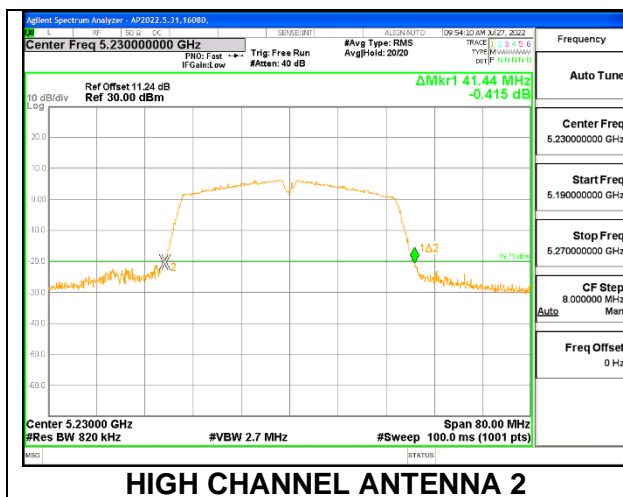
#### 2TX Antenna 2 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5190	41.12	40.80
High	5230	41.44	40.72

#### LOW CHANNEL



#### HIGH CHANNEL

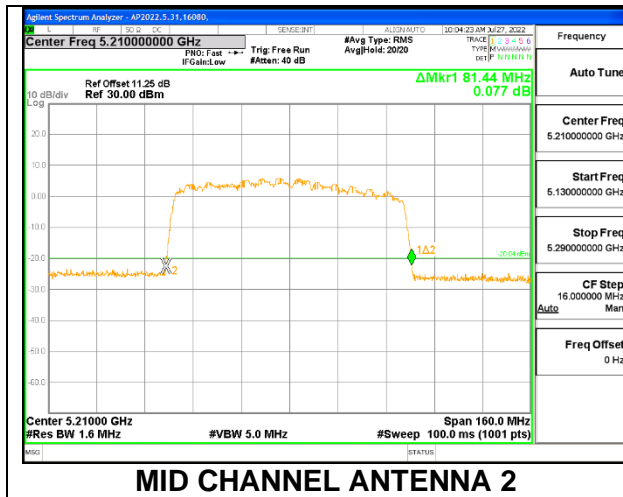


### 9.2.4. 802.11ac VHT80 MODE IN THE 5.2 GHz BAND

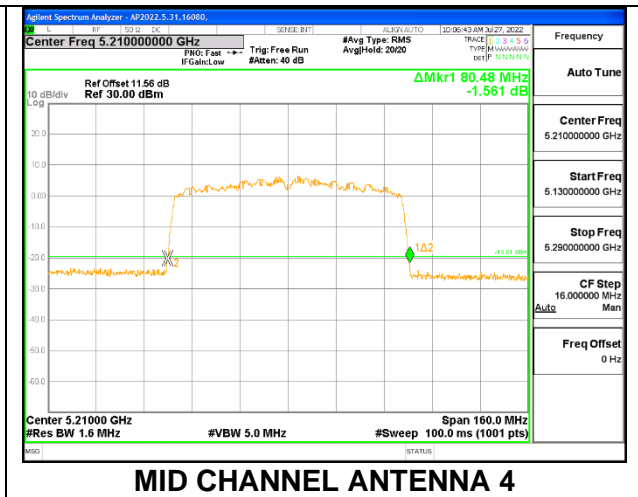
#### 2TX Antenna 2 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Mid	5210	81.44	80.48

#### MID CHANNEL



MID CHANNEL ANTENNA 2



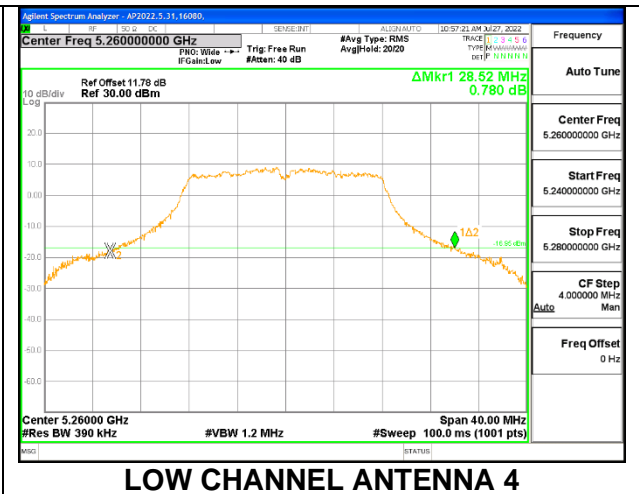
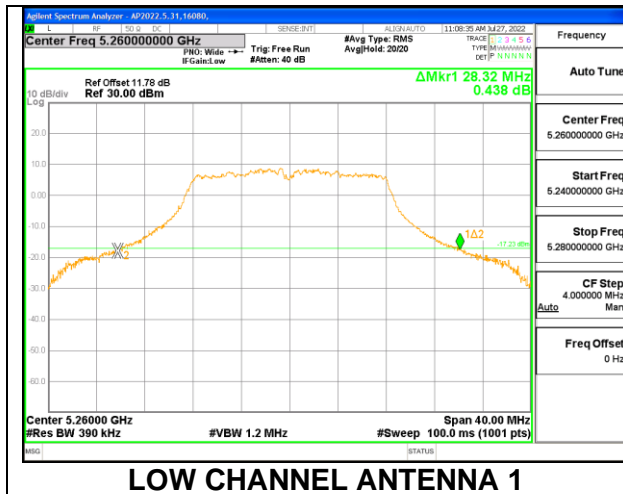
MID CHANNEL ANTENNA 4

### 9.2.5. 802.11a MODE IN THE 5.3 GHz BAND

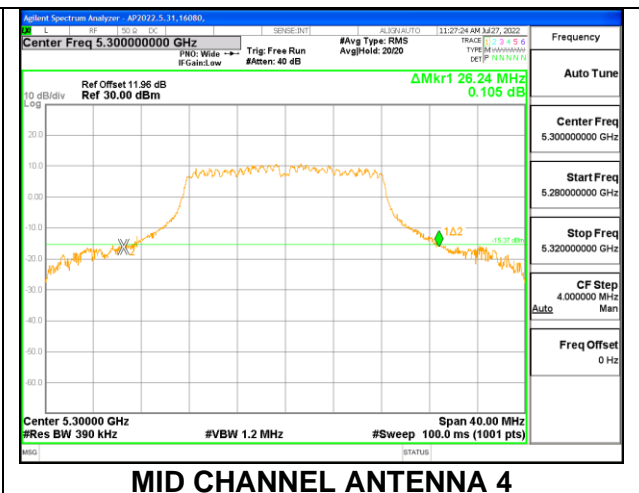
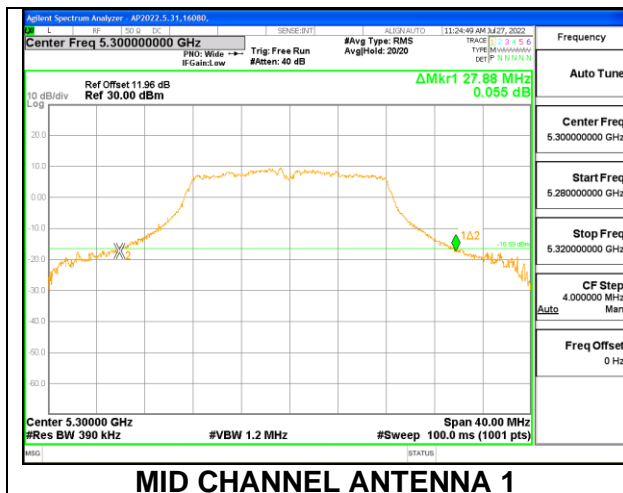
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5260	28.32	28.52
Mid	5300	27.88	26.24
High	5320	27.40	25.84

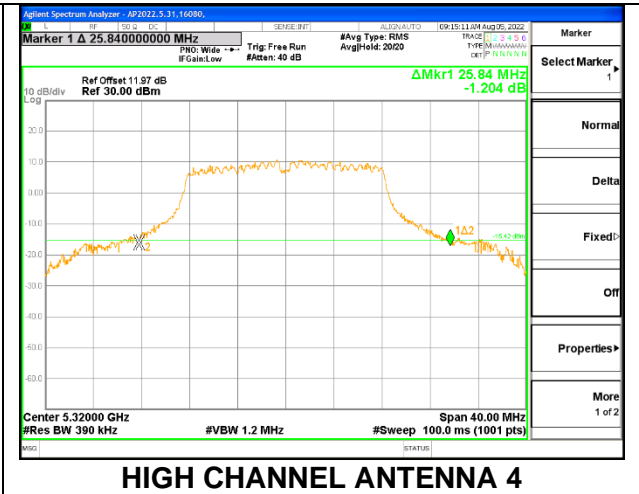
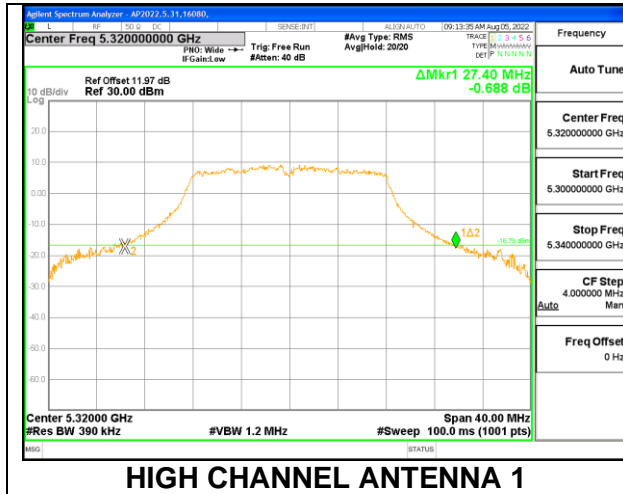
#### LOW CHANNEL



#### MID CHANNEL



### HIGH CHANNEL

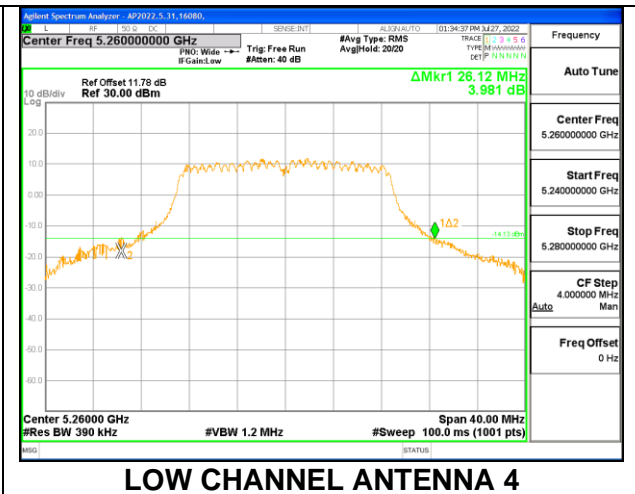
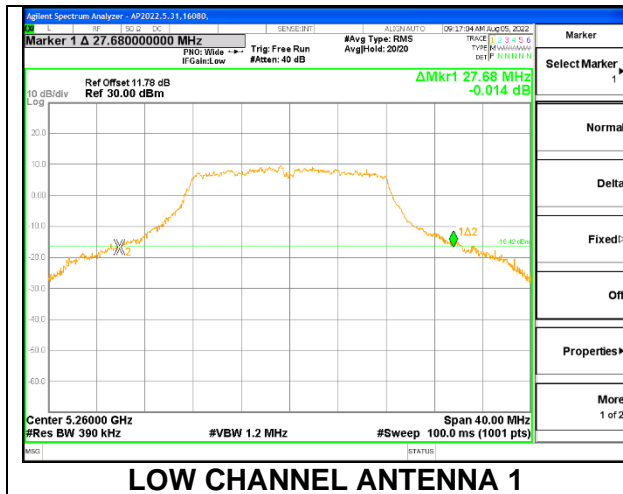


### 9.2.6. 802.11n HT20 MODE IN THE 5.3 GHz BAND

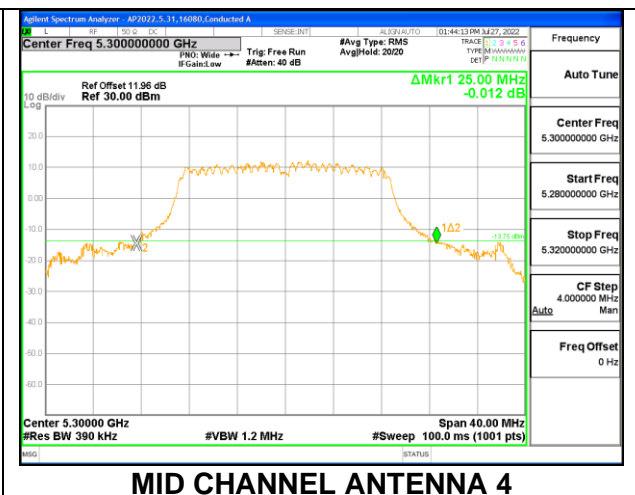
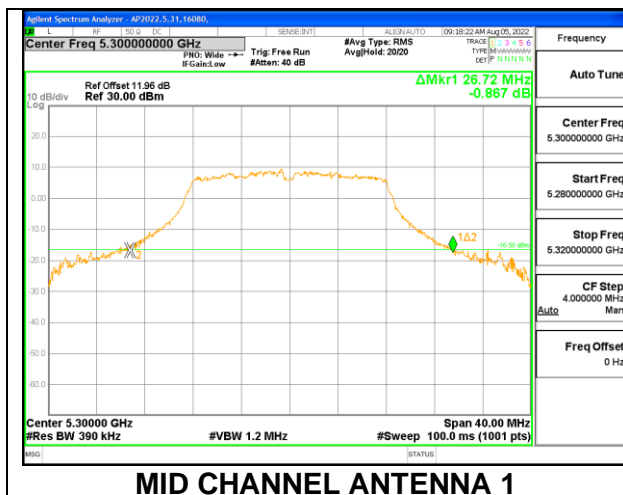
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5260	27.68	26.12
Mid	5300	26.72	25.00
High	5320	26.92	25.60

#### LOW CHANNEL



#### MID CHANNEL



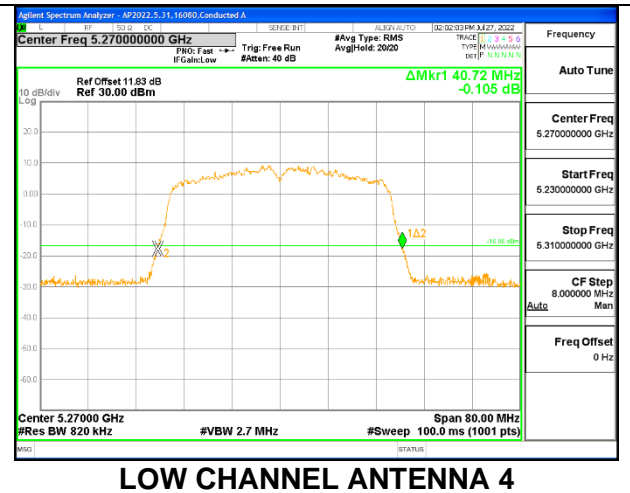
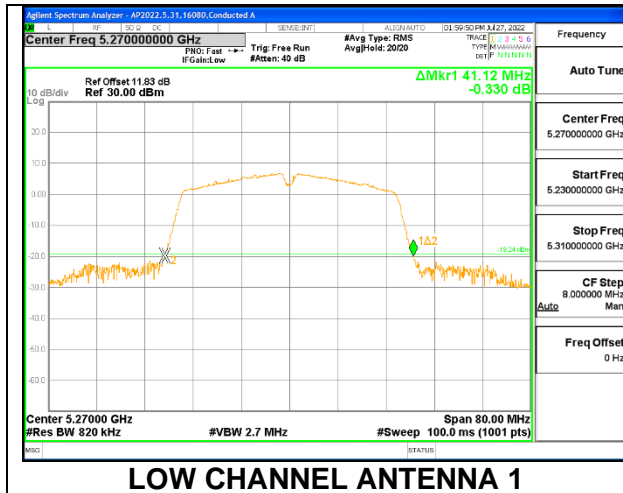


### 9.2.7. 802.11n HT40 MODE IN THE 5.3 GHz BAND

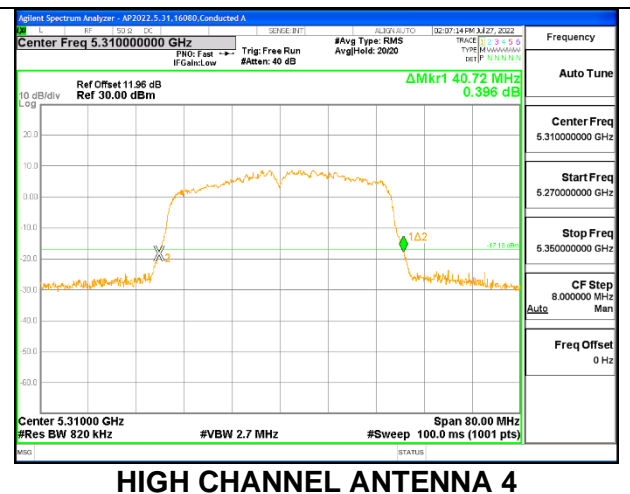
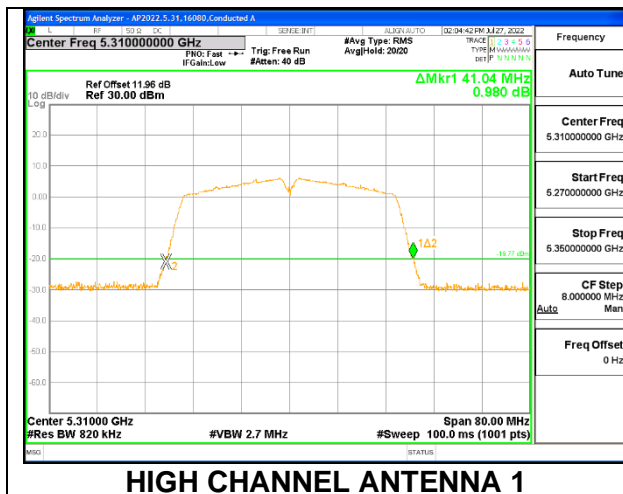
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5270	41.12	40.72
High	5310	41.04	40.72

#### LOW CHANNEL



#### HIGH CHANNEL

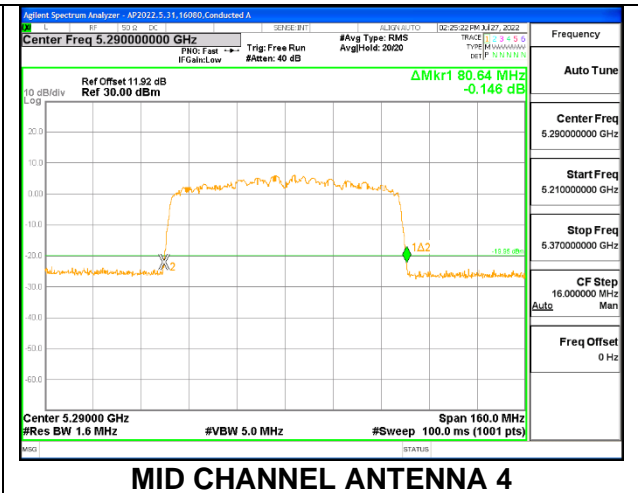
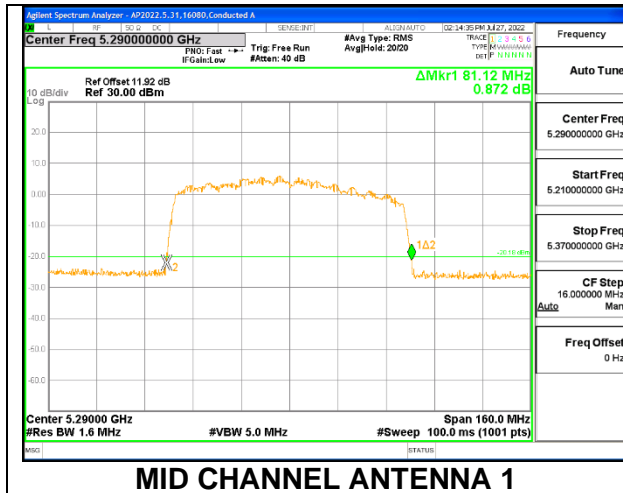


### 9.2.8. 802.11ac VHT80 MODE IN THE 5.3 GHz BAND

#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Mid	5290	81.12	80.64

#### MID CHANNEL



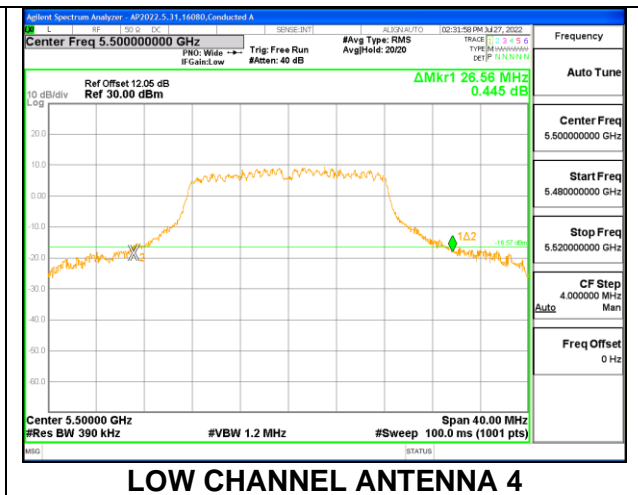
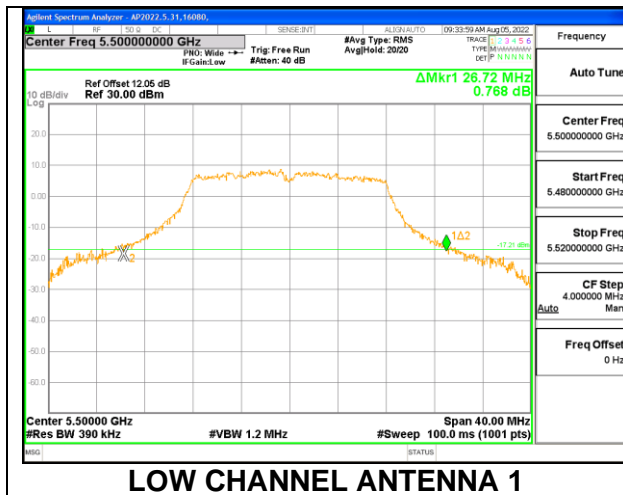


### 9.2.9. 802.11a MODE IN THE 5.6 GHz BAND

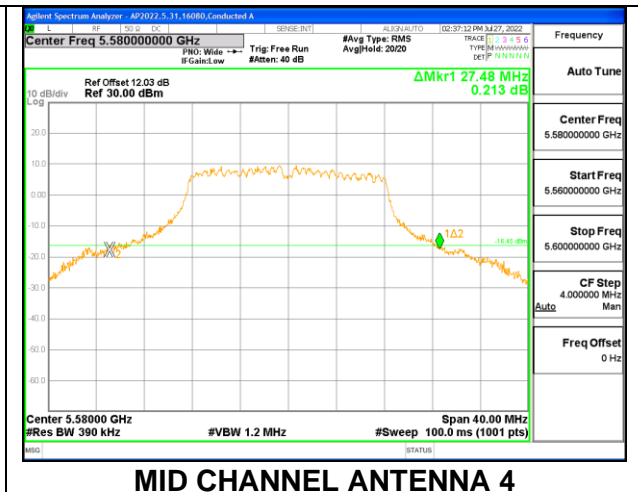
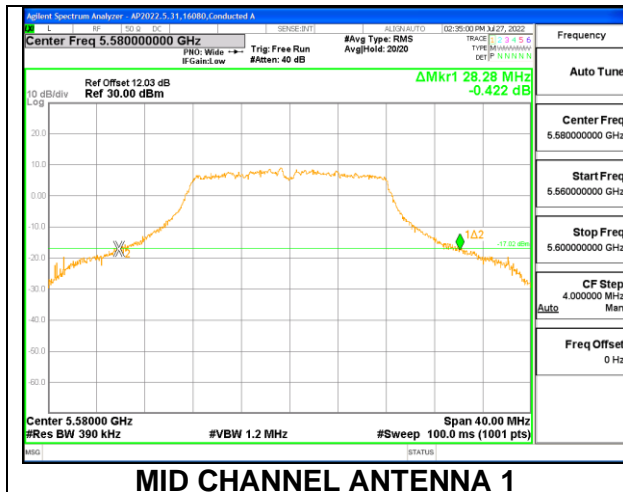
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5500	26.72	26.56
Mid	5580	28.28	27.49
High	5700	28.32	26.12

#### LOW CHANNEL



#### MID CHANNEL



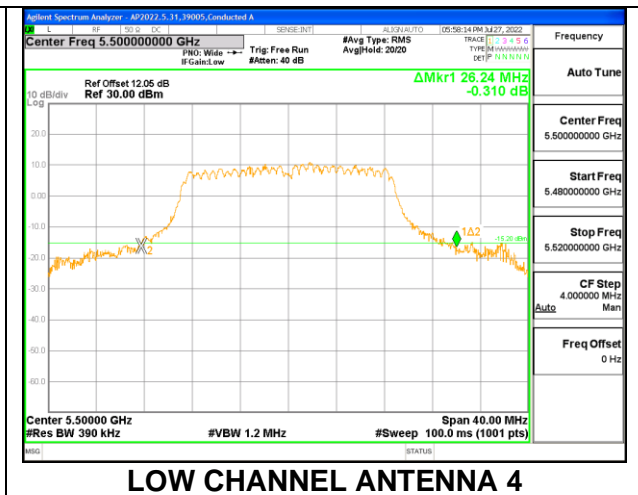
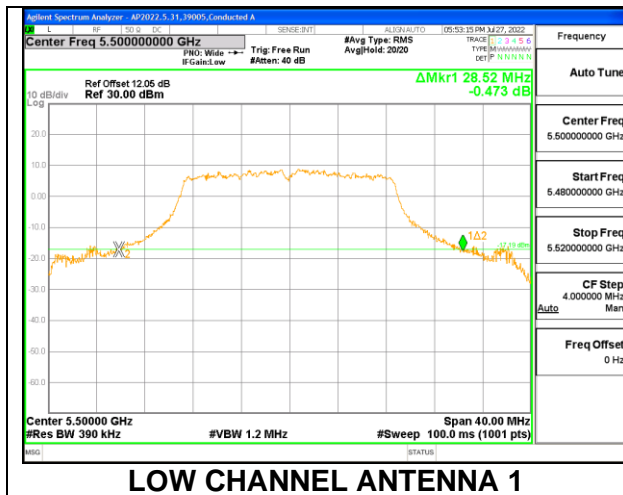


### 9.2.10. 802.11n HT20 MODE IN THE 5.6 GHz BAND

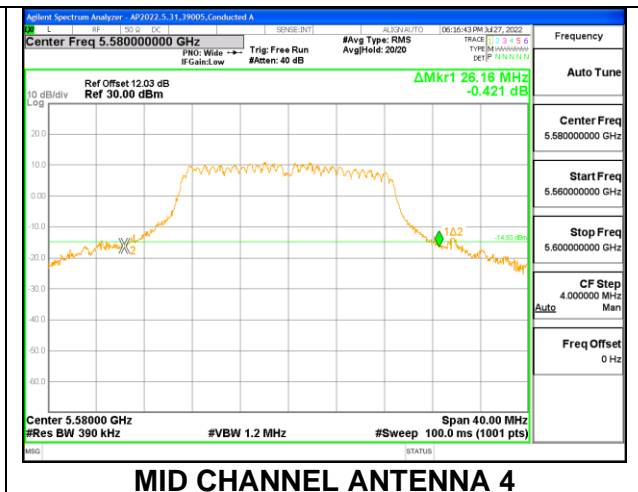
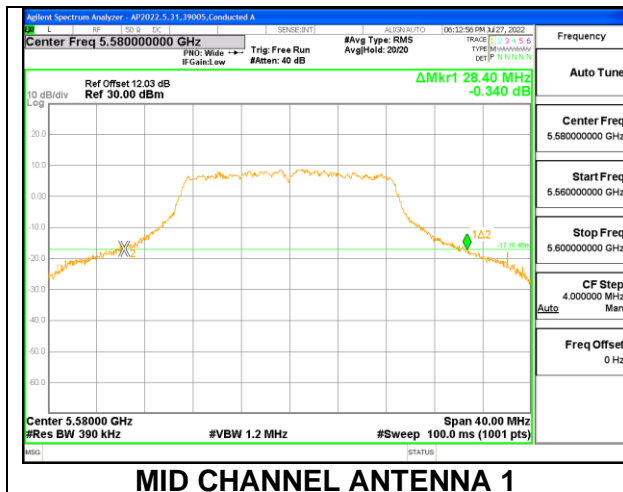
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5500	28.52	26.24
Mid	5580	28.40	26.16
High	5700	28.64	26.08

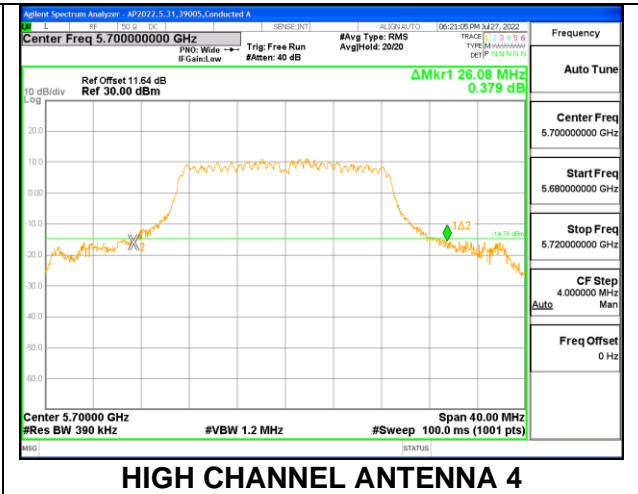
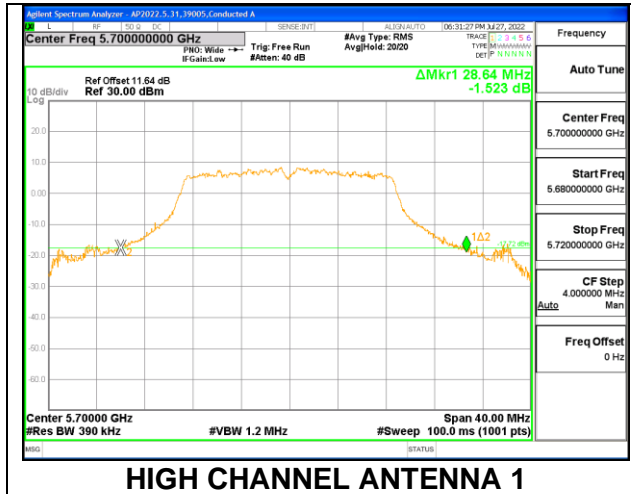
#### LOW CHANNEL



#### MID CHANNEL



### HIGH CHANNEL

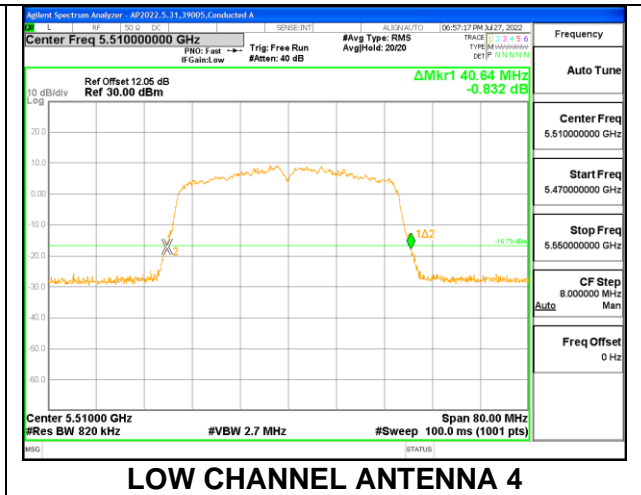
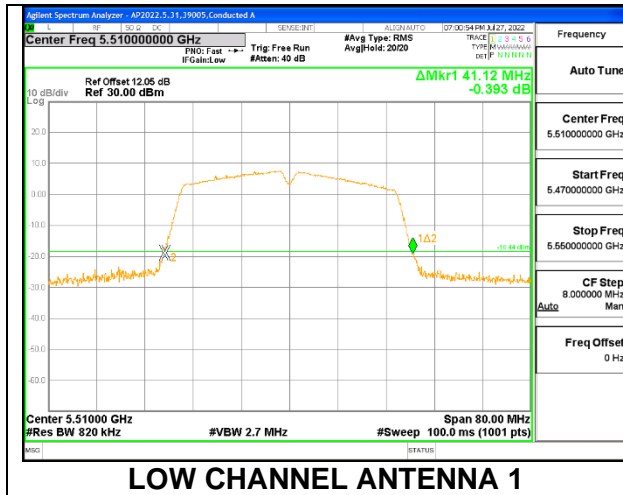


### 9.2.11. 802.11n HT40 MODE IN THE 5.6 GHz BAND

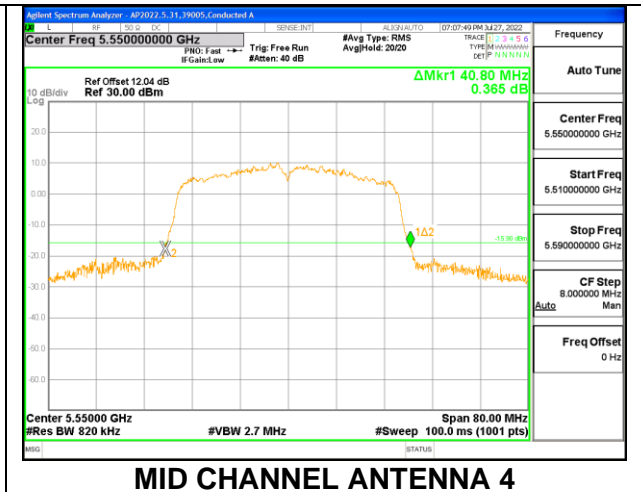
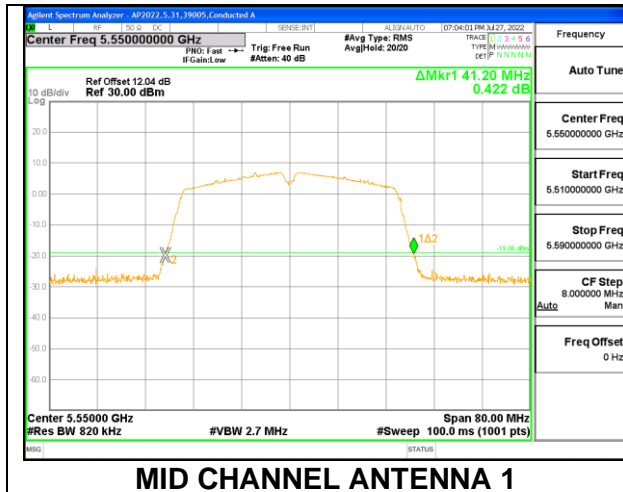
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5510	41.12	40.64
Mid	5550	41.20	40.80
High	5670	41.28	40.88

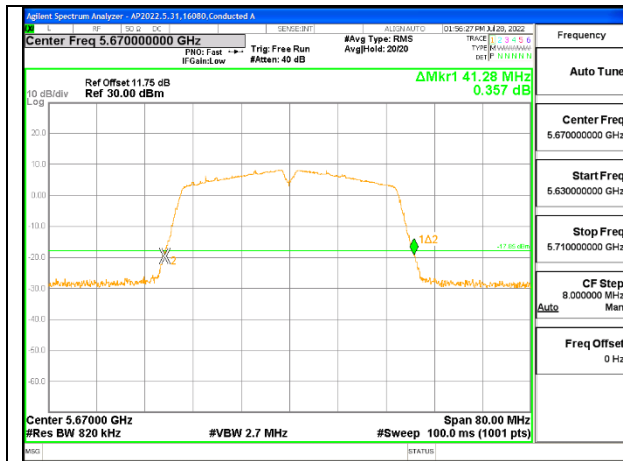
#### LOW CHANNEL



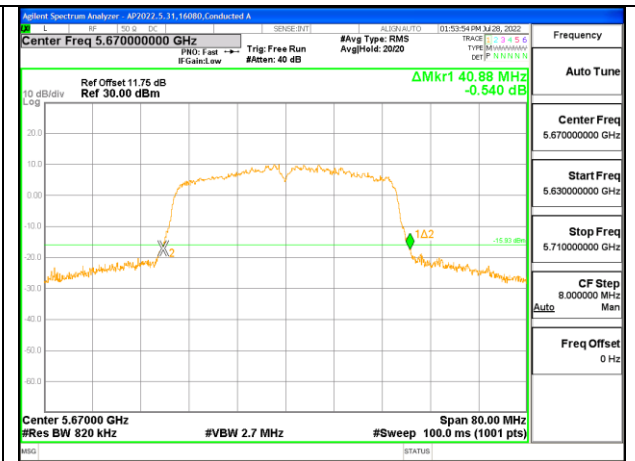
#### MID CHANNEL



### HIGH CHANNEL



HIGH CHANNEL ANTENNA 1



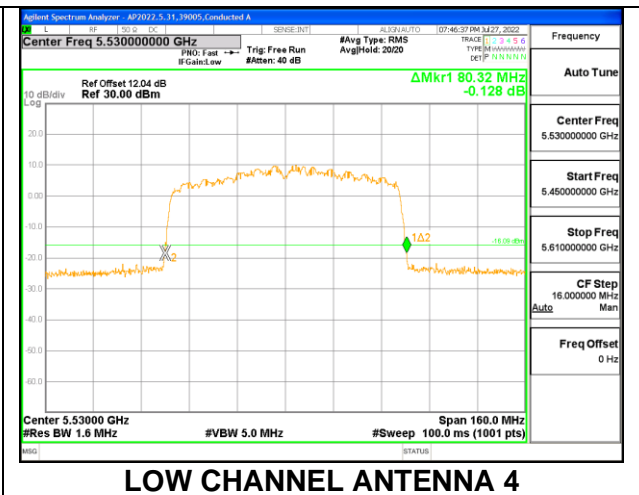
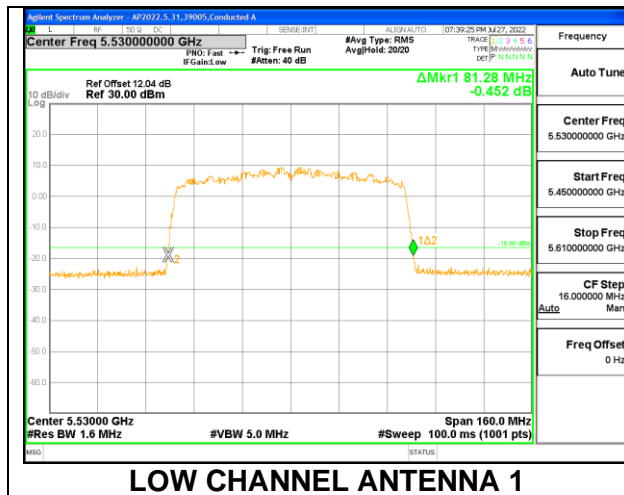
HIGH CHANNEL ANTENNA 4

### 9.2.12. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND

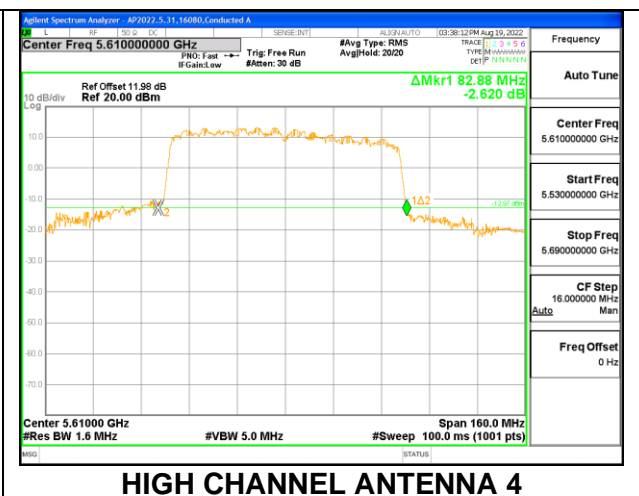
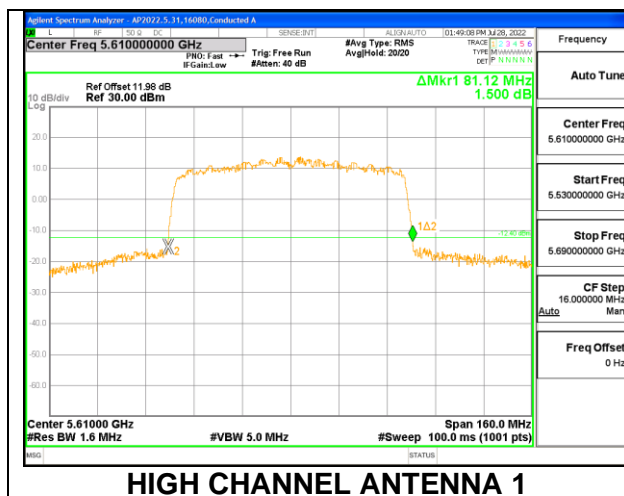
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5530	81.28	80.32
High	5610	81.12	82.88

#### LOW CHANNEL



#### HIGH CHANNEL

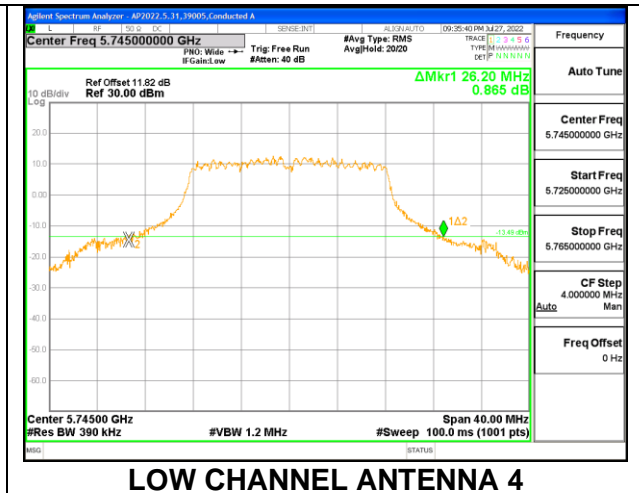
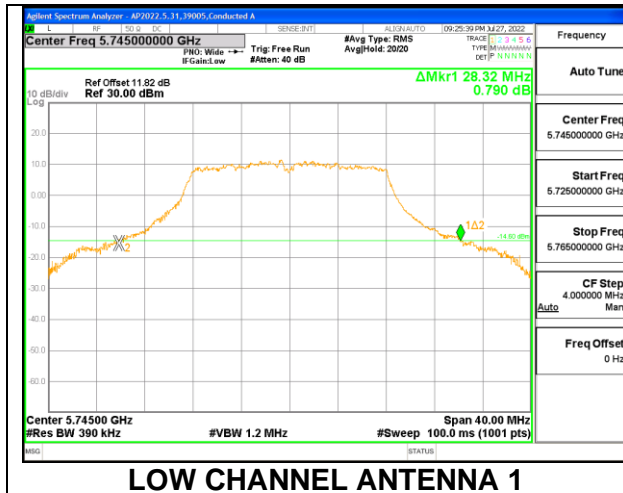


### 9.2.13. 802.11a MODE IN THE 5.8 GHz BAND

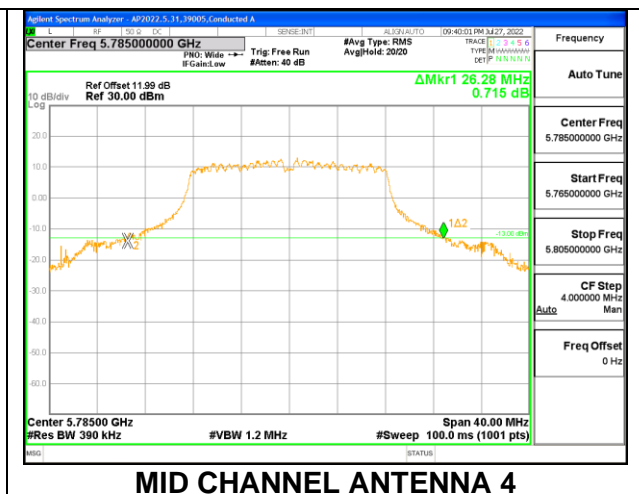
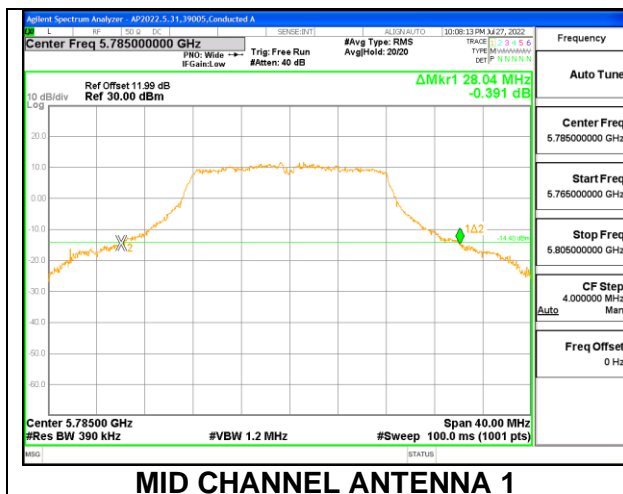
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5745	28.32	26.20
Mid	5785	28.04	26.28
High	5825	28.00	26.88

#### LOW CHANNEL

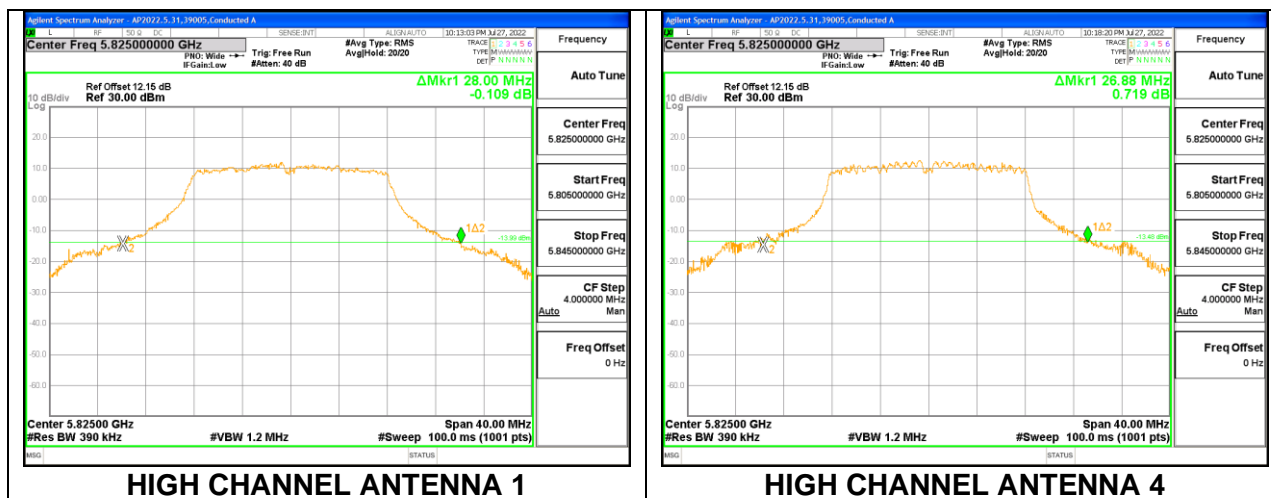


#### MID CHANNEL





### HIGH CHANNEL

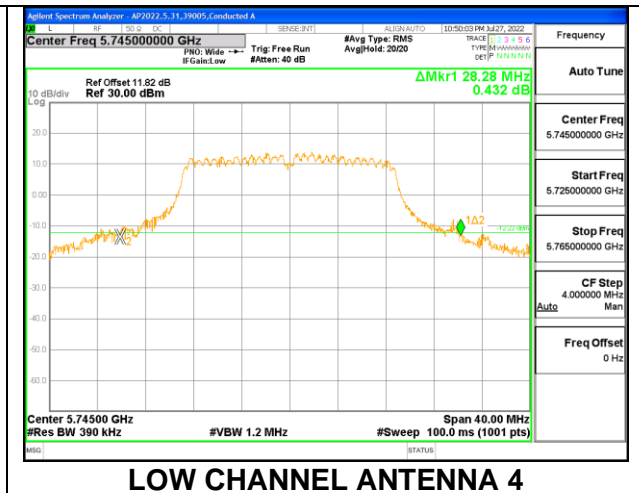
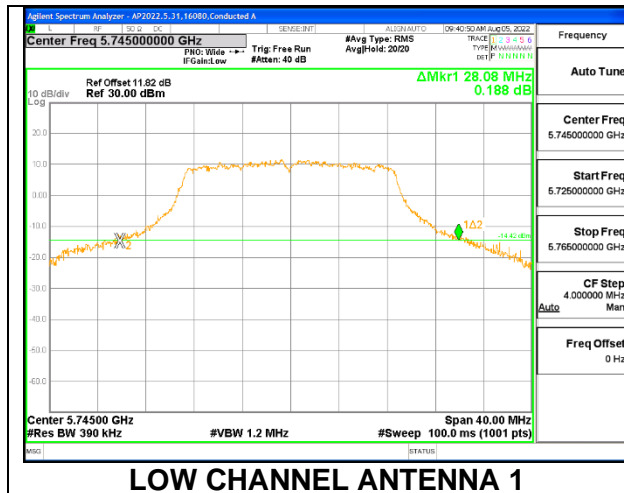


### 9.2.14. 802.11n HT20 MODE IN THE 5.8 GHz BAND

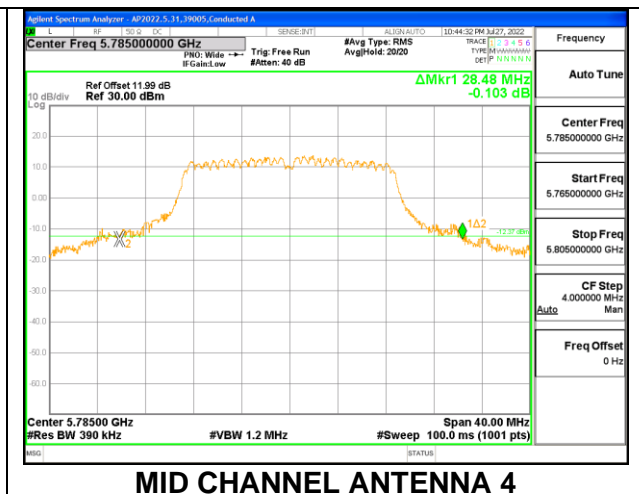
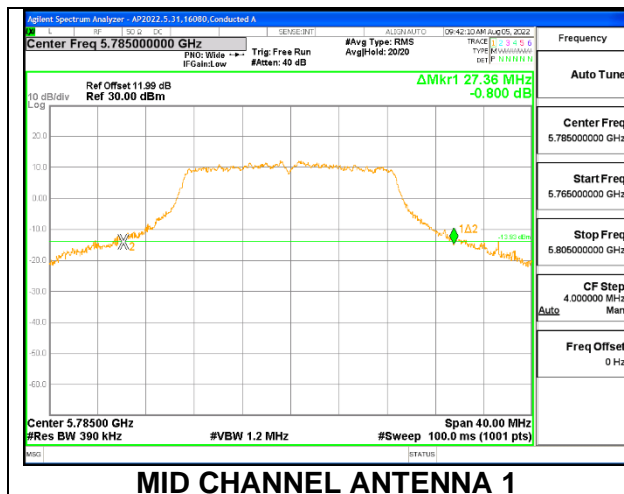
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5745	28.08	28.28
Mid	5785	27.36	28.48
High	5825	27.00	28.36

#### LOW CHANNEL



#### MID CHANNEL



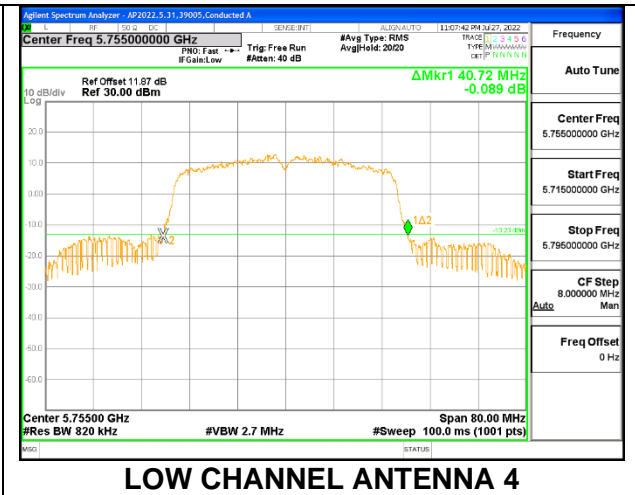
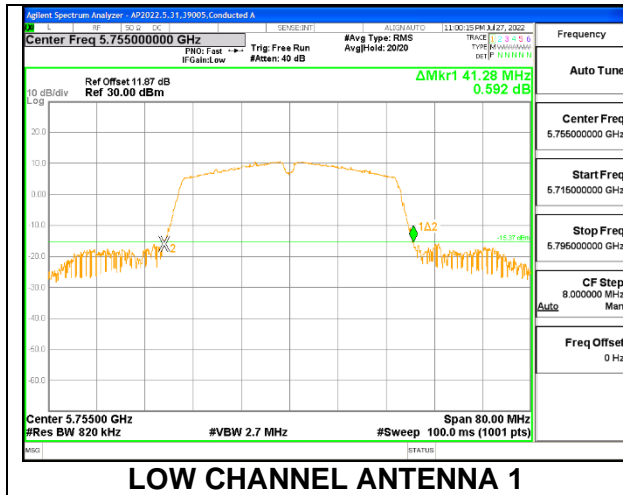


### 9.2.15. 802.11n HT40 MODE IN THE 5.8 GHz BAND

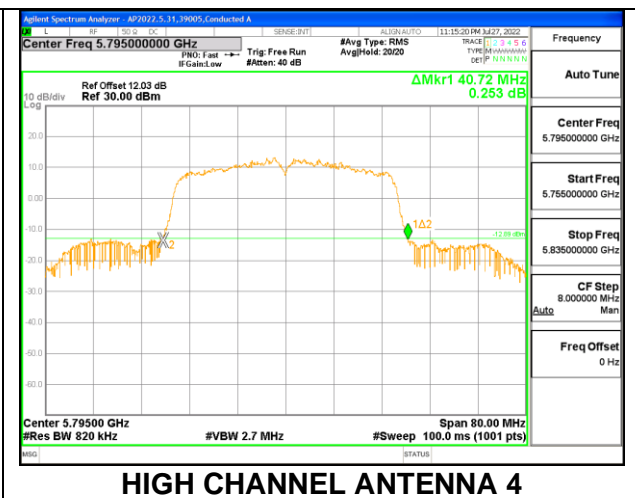
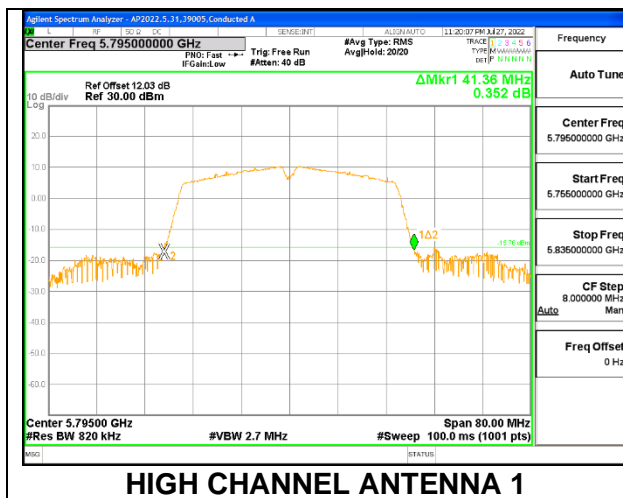
#### 2TX Antenna 1 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Low	5755	41.29	40.72
High	5795	41.36	40.72

#### LOW CHANNEL



#### HIGH CHANNEL



### 9.2.16. 802.11ac VHT80 MODE IN THE 5.8 GHz BAND

#### 2TX Antenna 1+ Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 4 (MHz)
Mid	5775	81.28	80.80

#### MID CHANNEL

