



TEST REPORT

Report Number. : R13541206-E6

Applicant : Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
USA

Model : 1964

FCC ID : C3K1964

IC : 3048A-1964

EUT Description : Portable Computing Device

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

Date Of Issue:
2021-08-09

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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
v1	2021-06-02	Initial Issue	Niklas Haydon
v2	2021-06-22	Reformatted 802.11a data as CDD mode is not supported.	Brian T. Kiewra
v3	2021-08-09	Added note in Radiated section	Cristian Melara

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399
USA

EUT DESCRIPTION: Portable Computing Device

MODEL: 1964

SERIAL NUMBER: 0F0002Z211200C (radiated)
0F000AN211200C (radiated)
0F0008Z211200C (radiated)
0F0003K211200C (antenna port conducted)
0F0003W211200C (antenna port conducted)
0F0003V211200C (antenna port conducted)

SAMPLE RECEIPT DATE: 2021-04-12

DATE TESTED: 2021-04-13 to 2021-05-24

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

UL LLC 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.

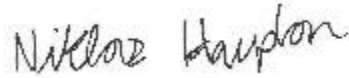
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2. TEST RESULT SUMMARY

This report contains data provided by the applicant which can impact the validity of results. UL LLC 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 (a) (1-4), (h) (1)	RSS-247 6.2	Output Power	Complies	None.
15.407 (a) (1-3, 5)	RSS-247 6.2	PSD	Complies	None.
15.209, 15.205, 15.407 (b)	RSS-GEN 8.9, 8.10, RSS-247 6.2	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	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 D06 v02
- FCC KDB 789033 D02 v02r01,
- KDB 414788 D01 Radiated Test Site v01r01
- ANSI C63.10-2013
- RSS-GEN Issue 5 + A2
- RSS-247 Issue 2

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification #0751.06, 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: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	703469
<input checked="" type="checkbox"/>	Building: 2800 Perimeter Park Dr Morrisville, NC 27560, U.S.A			

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	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57%
Humidity	3.39%
DC Supply voltages	1.70%
Time	3.39%

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 a portable computing device. This report covers the 5.6 WLAN non-ax radio in the device.

6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

5.6 GHz BAND (FCC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.6 GHz band, 1TX, ANT A			
5500-5720	802.11a	16.54	45.08
5500-5720	802.11n HT20	19.40	87.10
5510-5710	802.11n HT40	18.89	77.45
5530-5690	802.11ac VHT80	16.63	46.03
5570	802.11ac VHT160	13.99	25.06
5.6 GHz band, 1TX, ANT B			
5500-5720	802.11a	16.67	46.45
5500-5720	802.11n HT20	16.42	43.85
5510-5710	802.11n HT40	18.55	71.61
5530-5690	802.11ac VHT80	16.54	45.08
5570	802.11ac VHT160	13.62	23.01
5.6 GHz band, 2TX			
5500-5720	802.11n HT20 SDM	18.38	68.87
5510-5710	802.11n HT40 SDM	18.45	69.98
5530-5690	802.11ac VHT80 SDM	17.55	56.89
5570	802.11ac VHT160 SDM	14.78	30.06

5.6 GHz BAND (IC)

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.6 GHz band, 1TX, ANT A			
5500-5720	802.11a	16.54	45.08
5500-5720	802.11n HT20	19.40	87.10
5510-5710	802.11n HT40	18.89	77.45
5530-5690	802.11ac VHT80	16.63	46.03
5570	802.11ac VHT160	13.99	25.06
5.6 GHz band, 1TX, ANT B			
5500-5720	802.11a	16.37	43.35
5500-5720	802.11n HT20	16.42	43.85
5510-5710	802.11n HT40	18.55	71.61
5530-5690	802.11ac VHT80	16.54	45.08
5570	802.11ac VHT160	13.62	23.01
5.6 GHz band, 2TX			
5500-5720	802.11n HT20 SDM	18.38	68.87
5510-5710	802.11n HT40 SDM	18.45	69.98
5530-5690	802.11ac VHT80 SDM	17.55	56.89
5570	802.11ac VHT160 SDM	14.78	30.06

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

The radio utilizes two PIFA antennas, with the following gains:

Frequency	Antenna A	Antenna B
5470 to 5725MHz	6.4 dBi	6.9 dBi

6.4. SOFTWARE AND FIRMWARE

OS: Windows Build 19041.vb_release 191206-1406
 Test tool version 22.35020.0.0-01924
 WLAN driver 22.20.0.5
 BT driver 22.30.0.4

6.5. WORST-CASE CONFIGURATION AND MODE

The fundamental of the EUT was investigated in the three available configurations (A, B and C as described in the test setup photos) for Antenna A. Where a configuration can be portable it was also investigated in three orthogonal orientations (X, Y, Z) modes. It was determined that C (portable) configuration in Y orientation was the worst-case configuration orientation; therefore, all final radiated testing was performed with the EUT in C (portable) configuration in Y orientation. for Antenna A.

The fundamental of the EUT was investigated in the three available configurations (A, B and C as described in the test setup photos) for Antenna B. Where a configuration can be portable it was also investigated in three orthogonal orientations (X, Y, Z) modes. It was determined that C (portable) configuration in Z orientation was the worst-case configuration orientation; therefore, all final radiated testing was performed with the EUT in C (portable) configuration in Z orientation. for Antenna B.

The fundamental of the EUT was investigated in the three available configurations (A, B and C as described in the test setup photos) for Antenna A + Antenna B. Where a configuration can be portable it was also investigated in three orthogonal orientations (X, Y, Z) modes. It was determined that A configuration was the worst-case configuration orientation; therefore, all final radiated testing was performed with the EUT in configuration A for Antenna A + Antenna B.

All radios that can transmit simultaneously have been evaluated for radiated for all possible combinations of transmission and found to be in compliance.

Note: 802.11a does not support CDD mode, however for radiated testing this mode was tested as ANT A + ANT B using SISO power as worst-case scenario, except if this was non-compliant. In this case 1 Tx mode was tested.

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

802.11a 1TX mode: 6 Mbps
802.11n HT20 1Tx mode: MCS0
802.11n HT40 1Tx mode: MCS0
802.11ac VHT80 1Tx mode: MCS0
802.11ac VHT160 1Tx mode: MCS0
802.11n HT20 2Tx, SDM mode: MCS8
802.11n HT40 2Tx, SDM mode: MCS8
802.11ac VHT80 2Tx, SDM mode: MCS0 NSS2
802.11ac VHT160 2Tx, SDM mode: MCS0 NSS2

Radiated band edge emissions, output power, average power, and power spectral density were performed with the EUT set to the max power setting of each modulation/channel/mode the EUT will be set at:

Frequency Band	2Tx CCD/SDM				
	Wi-Fi Channels	802.11a	802.11n20	Wi-Fi Channels	802.11n40
5470 to 5725 MHz	100	16	14	102	13
	104	-	15		
	108	-	-	110	15
	112	-	-		
	116	16	15	118	15
	120	-	-		
	124	-	-	126	15
	128	-	-		
	132	-	-	134	14
	136	-	15		
	140	16	14	142	15
	144	16	15		

Frequency Band	2Tx CCD/SDM			
	Wi-Fi Channels	802.11ac80	Wi-Fi Channels	802.11ac160
5470 to 5725 MHz	106	13	114	11
	122	14		
	138	14		

Frequency Band	1 Tx Antenna A/B				
	Wi-Fi Channels	802.11n20 ANT A	802.11n20 ANT B	Wi-Fi Channels	802.11n40
5470 to 5725 MHz	100	16	16	102	15
	104	19	-		
	108	-	-	110	18
	112	-	-		
	116	19	16	118	18
	120	-	-		
	124	-	-	126	18
	128	-	-		
	132	-	-	134	16
	136	19	-		
	140	17	16	142	19
	144	19	16		

Frequency Band	1 Tx Antenna A/B			
	Wi-Fi Channels	802.11ac80	Wi-Fi Channels	802.11ac160
5470 to 5725 MHz	106	14	114	13
	122	16		
	138	16		

26dB and 99% bandwidth were performed with the EUT set in 2Tx modes at 1Tx power levels:

Frequency Band	2Tx CCD/SDM				
	Wi-Fi Channels	802.11a	802.11n20	Wi-Fi Channels	802.11n40
5470 to 5725 MHz	100	16	16	102	15
	104	-	19		
	108	-	-	110	18
	112	-	-		
	116	16	-	118	-
	120	-	-		
	124	-	-	126	18
	128	-	-		
	132	-	-	134	16
	136	-	19		
	140	16	17	142	19
	144	16	19		

Frequency Band	2Tx CCD/SDM			
	Wi-Fi Channels	802.11ac80	Wi-Fi Channels	802.11ac160
5470 to 5725 MHz	106	14	114	13
	122	16		
	138	16		

Radiated spurious emissions between 1GHz and 18GHz not including radiated band edge emissions), were performed with the EUT set to transmit on low, middle and high channels on each modulation with the highest power spectral density (Note that 11a ANT A was run to cover 11n HT20 ANT A, 11a will not be set this high in the field. Additionally, 11a mode is considered worst-case power and PSD when set at the max. power settings and yields the worst-case spurious emissions).

Frequency Band	2Tx CCD/SDM				
	Wi-Fi Channels	802.11a	802.11n20	Wi-Fi Channels	802.11n40
5470 to 5725 MHz	100	16	-	102	-
	104	-	-		
	108	-	-	110	-
	112	-	-		
	116	16	-	118	-
	120	-	-		
	124	-	-	126	-
	128	-	-		
	132	-	-	134	-
	136	-	-		
	140	16	-	142	-
144	16	-			

Frequency Band	1 Tx Antenna A	
	Wi-Fi Channels	802.11a ANT A
5470 to 5725 MHz	100	19
	104	-
	108	-
	112	-
	116	19
	120	-
	124	-
	128	-
	132	-
	136	19
	140	-
144	19	

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed in UL LLC report R13541206-E7.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
USB Hub	J5create	JCA374	AY2A1904000477	NA
USB Hub	J5create	JCA374	AY3A2010013253	NA
USB Hub	J5create	JCD383	DL3A1903011541	NA
USB Hub	J5create	JCD383	FY5A2010034764	NA
Earbuds	Sony	MDR-EX14AP	NA	NA
Earbuds	Sony	MDR-EX14AP	NA	NA
Earbuds	JVC	HA-FXL	NA	NA
Power Supply	Microsoft	1706	0D130U0HD210C	NA
Power Supply	Microsoft	1706	0D130U0GX310C	N/A
Power Supply	Microsoft	1706	0D130U0HD710C	N/A
Power Supply	Microsoft	1706	0D130U0GU310C	N/A
Power Supply	Microsoft	1706	0D130U0HDL10C	N/A

I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Mains	1	12-pin	Mains	<3	Goes to ac/dc adapter
2	USB-C	2	USB-C	USB	<3	None

TEST SETUP

Test software on the EUT exercised the radio card.

SETUP DIAGRAMS

Please refer to R13541206-EP2 for setup diagrams.

7. MEASUREMENT METHOD

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

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)

Power Spectral Density: KDB 789033 D02 v02r01, Section F

Unwanted emissions in restricted bands: KDB 789033 D02 v02r01, Sections G.1, G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v02r01, Sections G.2, G.3, G.4, and G.5.

General Radiated Spurious Emissions: ANSI C63.10-2013 Section 6.3-6.6

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

8. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used - Wireless Conducted Measurement Equipment

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
Conducted Room 1					
SA0025	Spectrum Analyzer	Agilent	N9030A	2021-04-01	2022-04-01
PWM002 (PRE0137344)	RF Power Meter	Keysight Technologies	N1911A	2020-07-31	2021-07-31
PWS001 (PRE0137347)	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2020-05-27	2021-05-27
PWS002 (PRE0137348)	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2020-07-31	2021-07-31
HI0090 (PRE0191271)	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
SOFTEMI	Antenna Port Software	UL	Version 2021.04.28	NA	NA
Conducted Room 2					
SA0027 (PRE0126407)	Spectrum Analyzer	Keysight Technologies	N9030A	2020-06-10	2021-06-10
PWM004 (PRE0137346)	RF Power Meter	Keysight Technologies	N1911A	2020-07-31	2021-07-31
PWS002 (PRE0137348)	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2020-07-31	2021-07-31
HI0091	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26
SOFTEMI	Antenna Port Software	UL	Version 2021.4.13, 2021.4.28, 2021.4.29, 2021.5.13	NA	NA

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - North Chamber)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
1-18 GHz					
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-27	2021-04-27
Gain-Loss Chains					
N-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-28	2021-07-28
Receiver & Software					
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2021-03-30	2022-03-30
SOFTEMI	EMI Software	UL	Version 9.5 (04 Mar 2021)		
Additional Equipment used					
s/n 181474341	Environmental Meter	Fisher Scientific	15-077-963	2020-08-06	2021-08-06

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - South Chamber)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
AT0067	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-04-28	2021-04-28
AT0069	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-05-26	2021-05-26
	Gain-Loss Chains				
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-06	2021-07-06
	Receiver & Software				
197955	Spectrum Analyzer	Rohde & Schwarz	ESW44	2021-03-10	2022-03-10
SOFTEMI	EMI Software	UL	Version 9.5 (04 Mar 2021)		
	Additional Equipment used				
s/n 200037635	Environmental Meter	Fisher Scientific	06-662-4	2020-01-22	2022-01-22

Test Equipment Used - Radiated Disturbance Emissions (E-field) – Chamber C

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
AT0062	HORN Antenna	ETS-Lindgren	3117	2021-02-03	2022-02-03
	Gain-Loss Chains				
C-SAC02	Gain-loss string: 1-18GHz	Various	Various	2021-04-15	2022-04-15
C-SAC02 Path 7	Gain-loss string 1-7GHz	Various	Various	2021-04-15	2022-04-15
	Receiver & Software				
206496	Spectrum Analyzer	Rohde & Schwarz	ESW44	2020-03-09	2022-03-09
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA
	Additional Equipment used				
HI0085	Temp/Humid/Pressure Meter	EXTECH	SD700	2020-04-20	2021-04-30

NOTES:

1. For equipment listed above that was calibrated during the testing period, please note the equipment was used for testing after calibration.
2. For equipment listed above that has a calibration due date during the testing period, the testing was completed before the equipment expiration date.

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

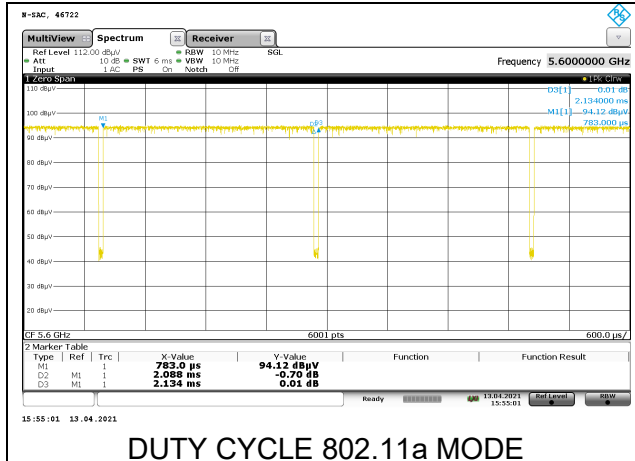
PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

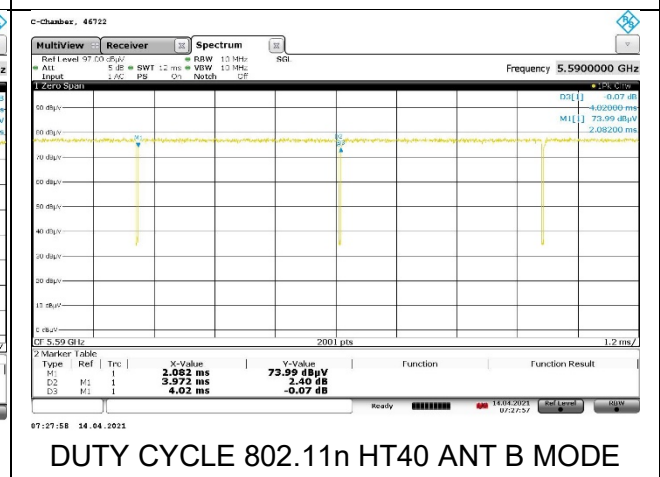
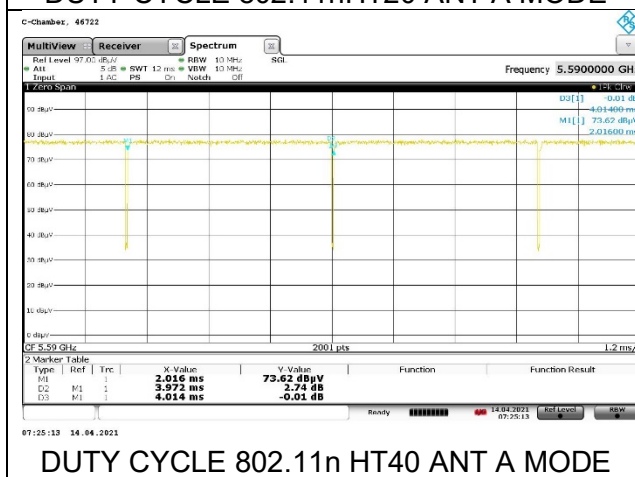
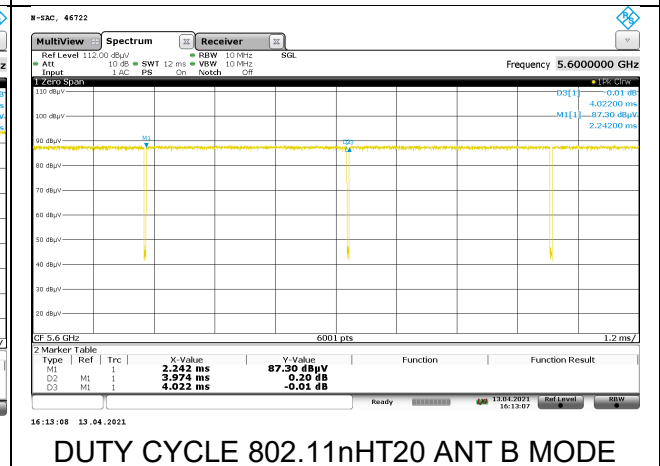
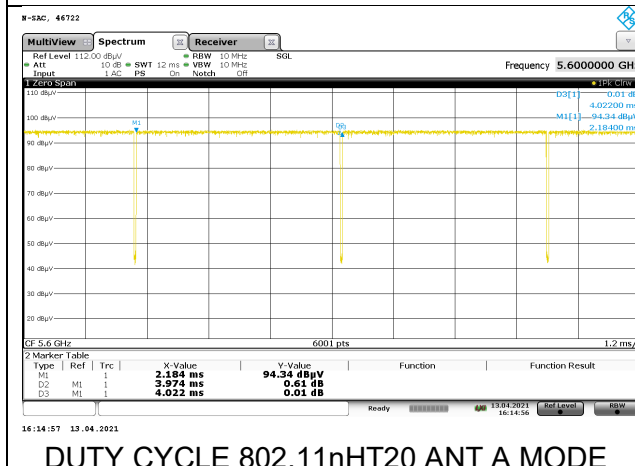
ON TIME AND DUTY CYCLE RESULTS

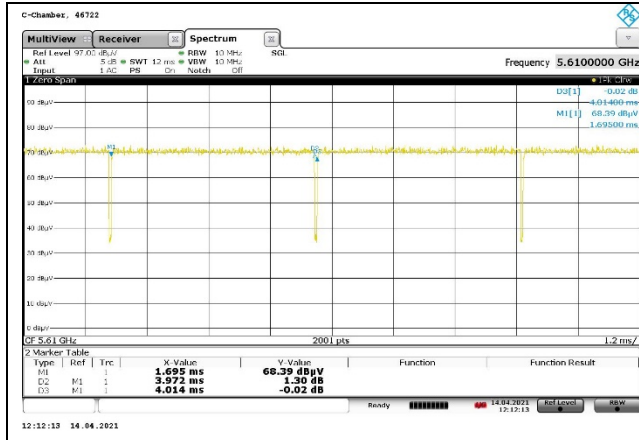
Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction - RMS (dB)	Duty Cycle Correction - Voltage (dB)	1/B Minimum VBW (kHz)
802.11a	2.088	2.134	0.978	97.84%	0.09	0.19	0.479
802.11n HT20 Ant A	3.974	4.022	0.988	98.81%	0.00	0.00	0.010
802.11n HT20 Ant B	3.974	4.022	0.988	98.81%	0.00	0.00	0.010
802.11n HT40 Ant A	3.972	4.014	0.990	98.95%	0.00	0.00	0.010
802.11n HT40 Ant B	3.972	4.020	0.988	98.81%	0.00	0.00	0.010
802.11ac VHT80 Ant A	3.972	4.014	0.990	98.95%	0.00	0.00	0.010
802.11ac VHT80 Ant B	3.972	4.014	0.990	98.95%	0.00	0.00	0.010
802.11ac VHT160 Ant A	4.658	4.710	0.989	98.89%	0.00	0.00	0.010
802.11ac VHT160 Ant B	4.658	4.710	0.989	98.89%	0.00	0.00	0.010

DUTY CYCLE PLOTS

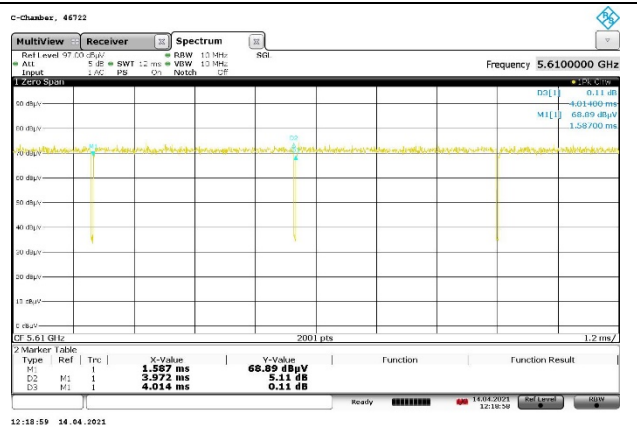


INTENTIONALLY LEFT BLANK





DUTY CYCLE 802.11ac VHT80 ANT A MODE



DUTY CYCLE 802.11ac VHT80 ANT B MODE



DUTY CYCLE 802.11ac VHT160 ANT A MODE



DUTY CYCLE 802.11ac VHT160 ANT B MODE

9.2. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

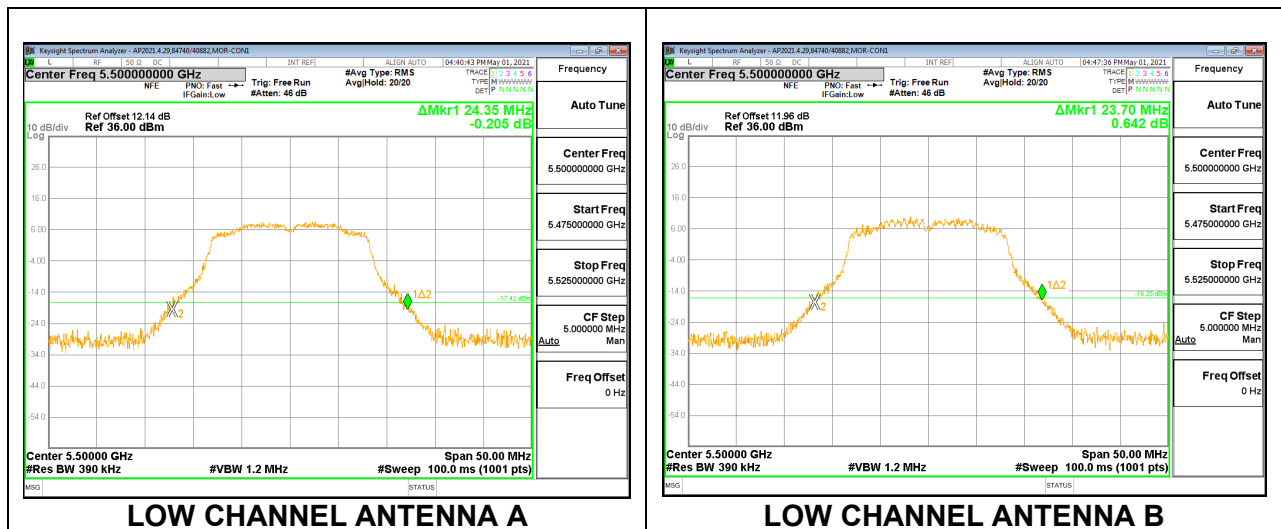
RESULTS

9.2.1. 802.11a MODE IN THE 5.6 GHz BAND

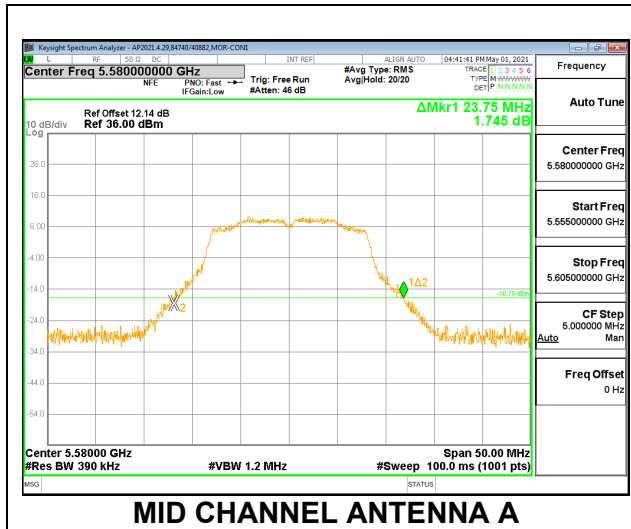
1TX Antenna A and 1TX Antenna B MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna A (MHz)	26 dB Bandwidth Antenna B (MHz)
Low	5500	24.35	23.70
Mid	5580	23.75	23.65
High	5700	24.15	23.10
144	5720	16.70	17.45

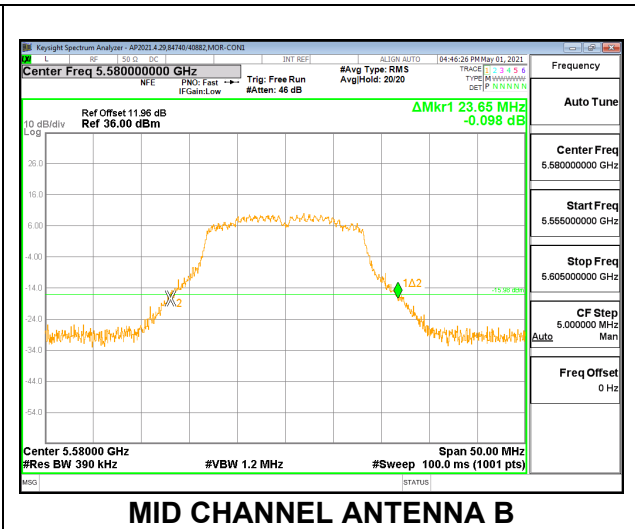
LOW CHANNEL



MID CHANNEL

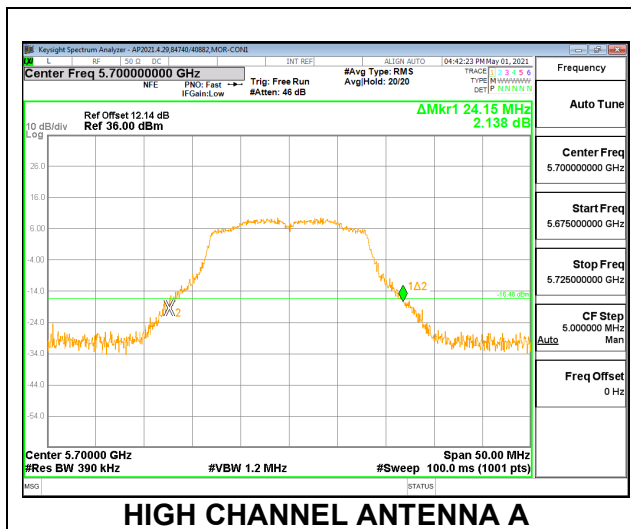


MID CHANNEL ANTENNA A

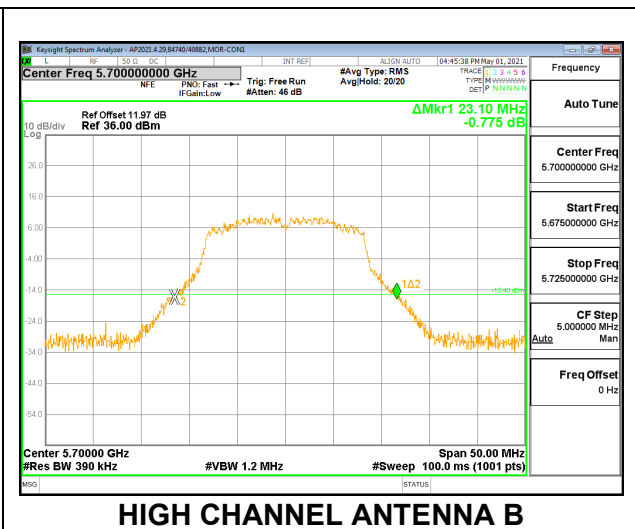


MID CHANNEL ANTENNA B

HIGH CHANNEL

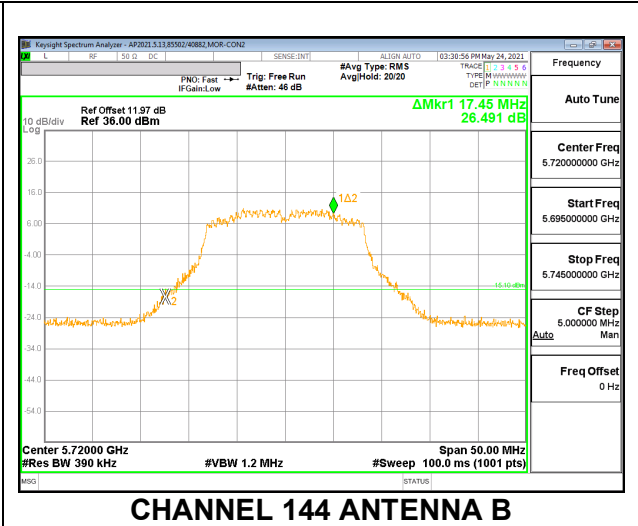
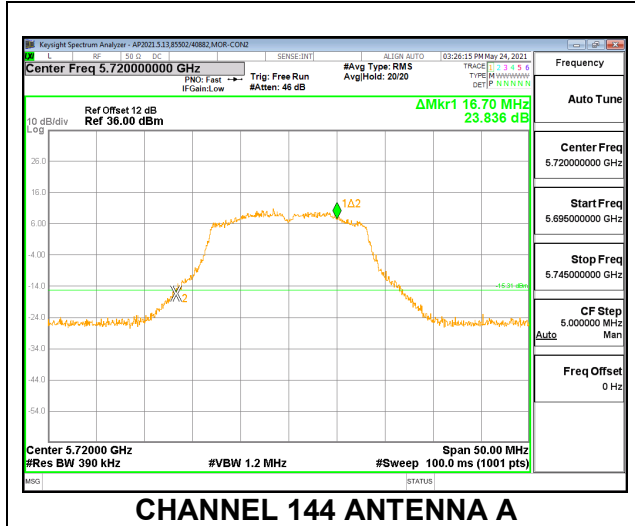


HIGH CHANNEL ANTENNA A



HIGH CHANNEL ANTENNA B

CHANNEL 144



CHANNEL 144 ANTENNA A

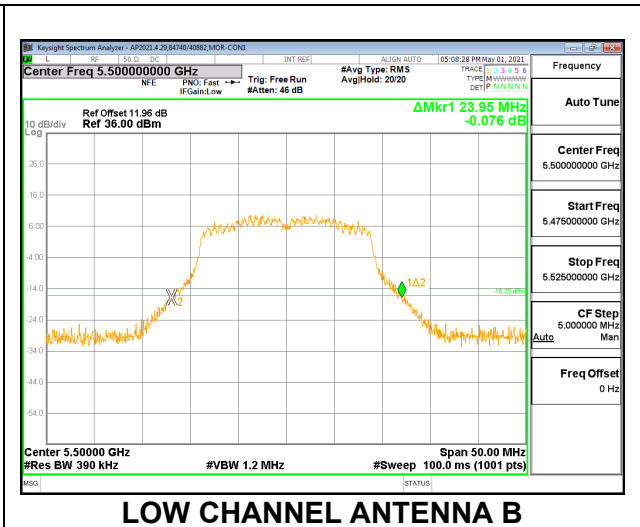
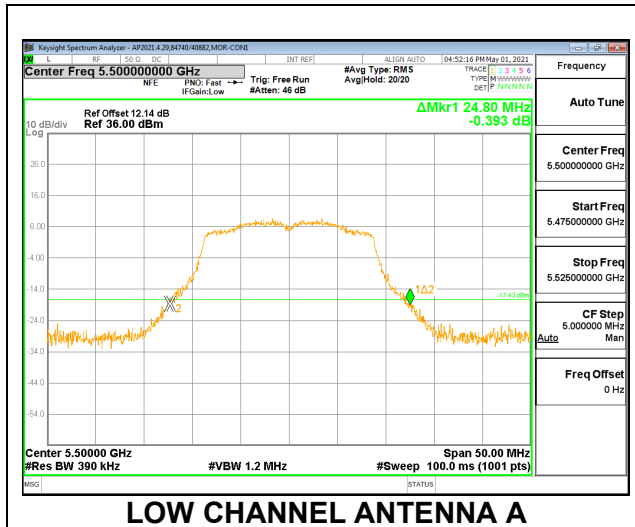
CHANNEL 144 ANTENNA B

9.2.2. 802.11n HT20 MODE IN THE 5.6 GHz BAND

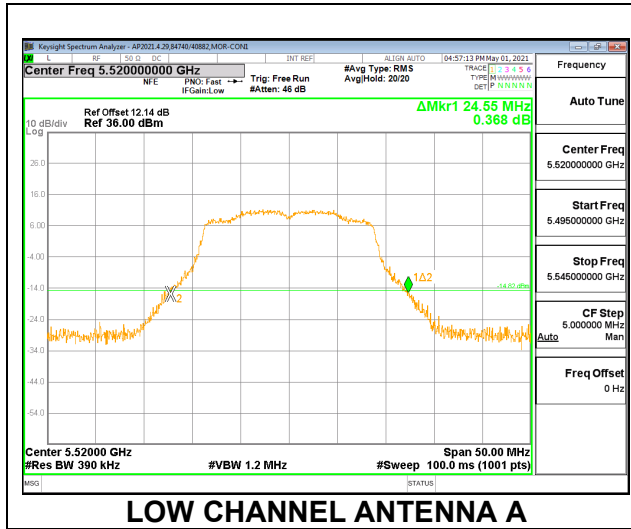
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna A (MHz)	26 dB Bandwidth Antenna B (MHz)
Low	5500	24.80	23.95
Low	5520	24.55	24.60
Mid	5580	24.60	24.20
High	5680	24.35	23.95
High	5700	25.05	23.90
144	5720	17.40	17.30

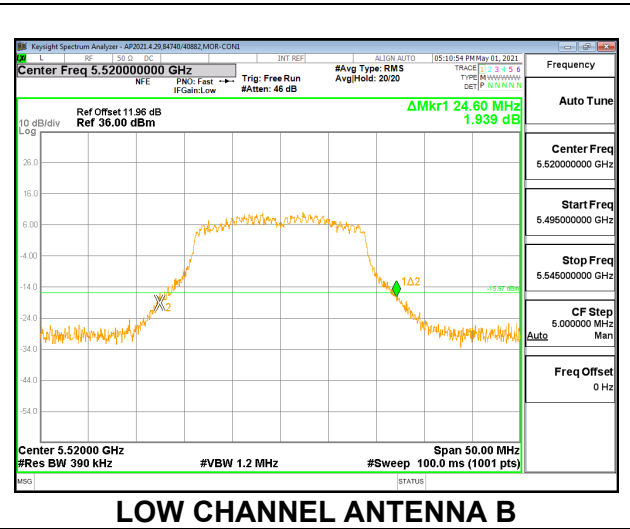
LOW CHANNEL



LOW CHANNEL

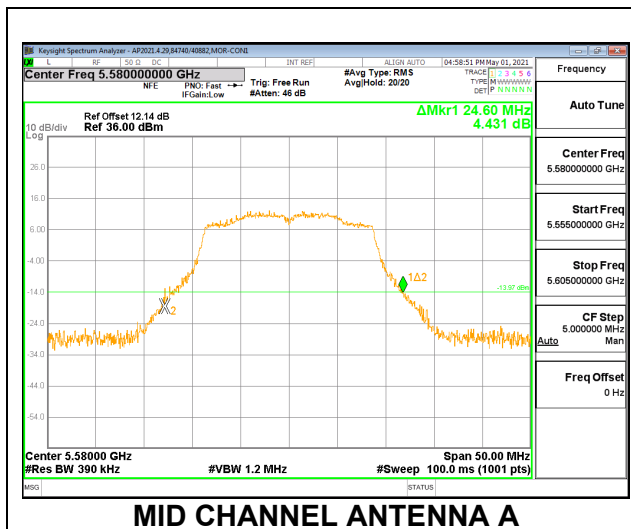


LOW CHANNEL ANTENNA A

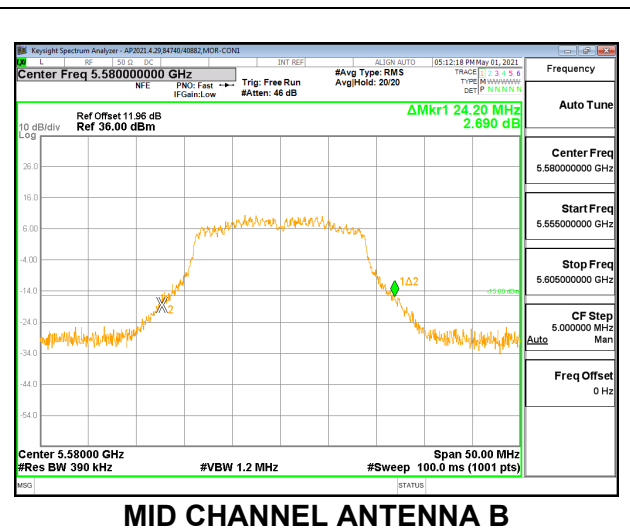


LOW CHANNEL ANTENNA B

MID CHANNEL

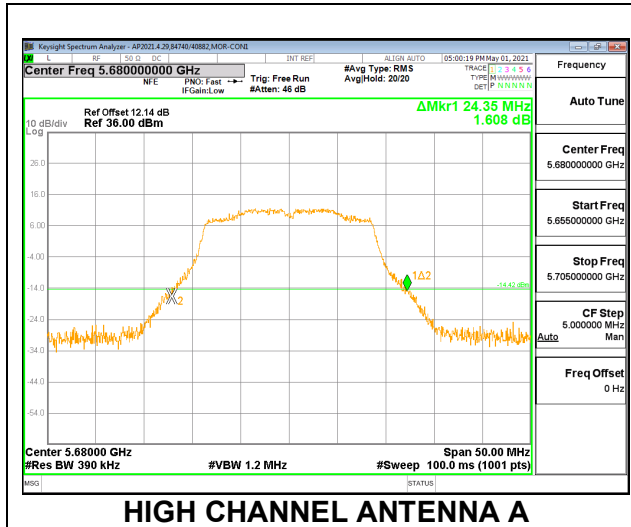


MID CHANNEL ANTENNA A

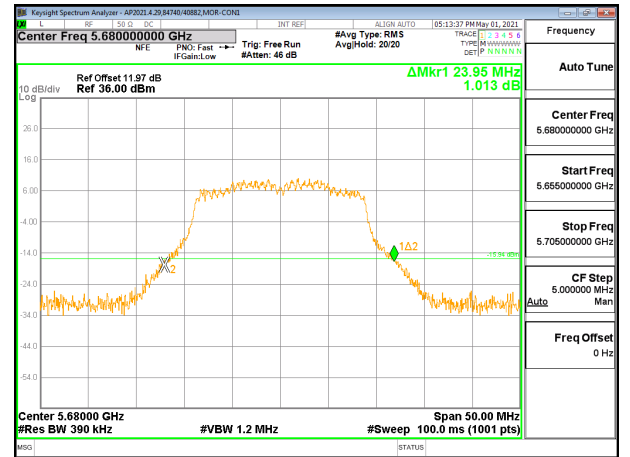


MID CHANNEL ANTENNA B

HIGH CHANNEL

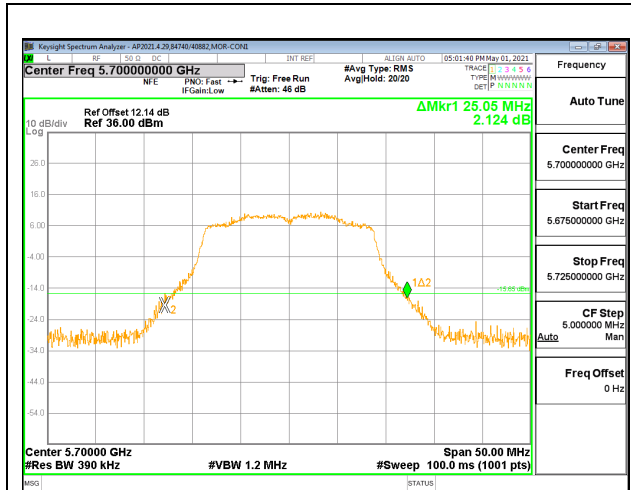


HIGH CHANNEL ANTENNA A

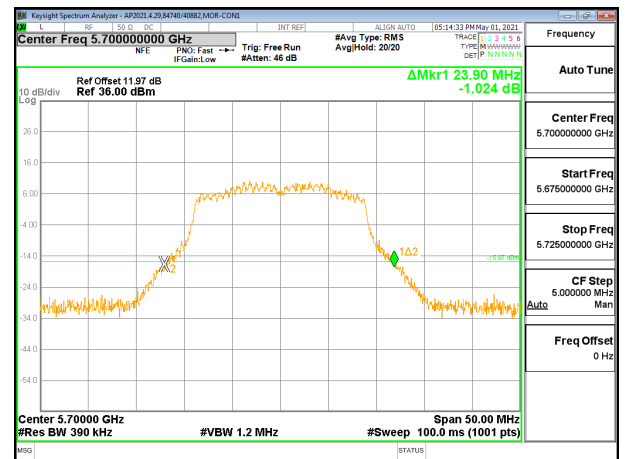


HIGH CHANNEL ANTENNA B

HIGH CHANNEL

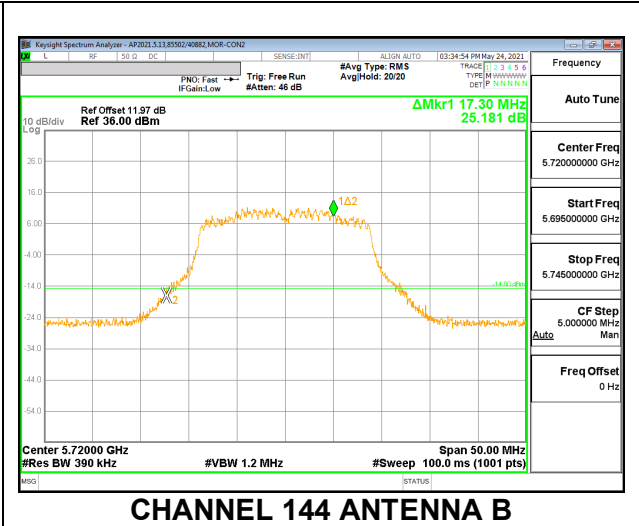
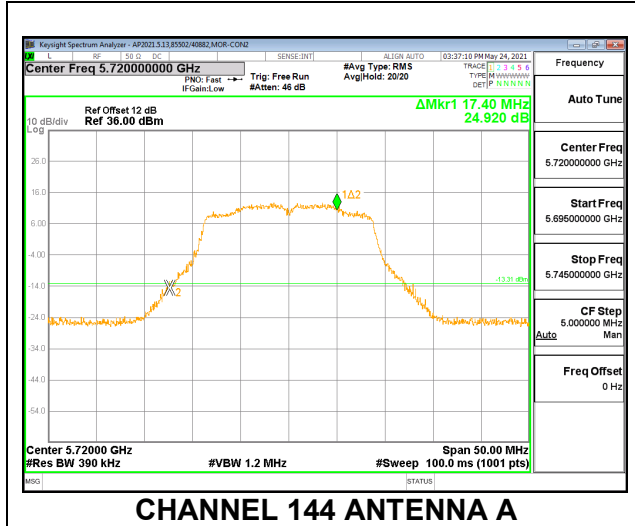


HIGH CHANNEL ANTENNA A



HIGH CHANNEL ANTENNA B

CHANNEL 144

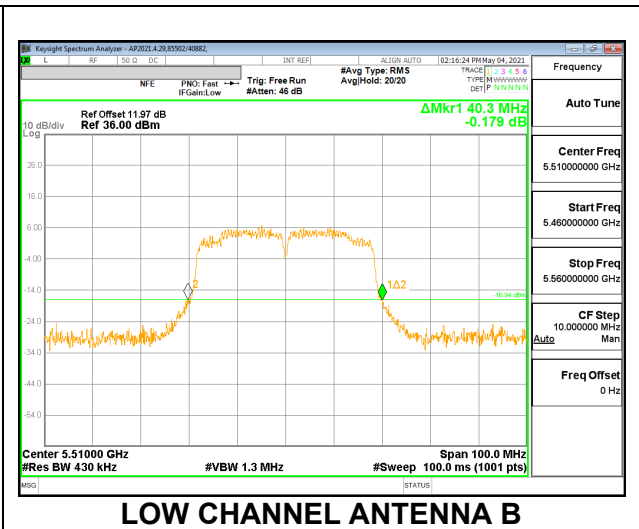
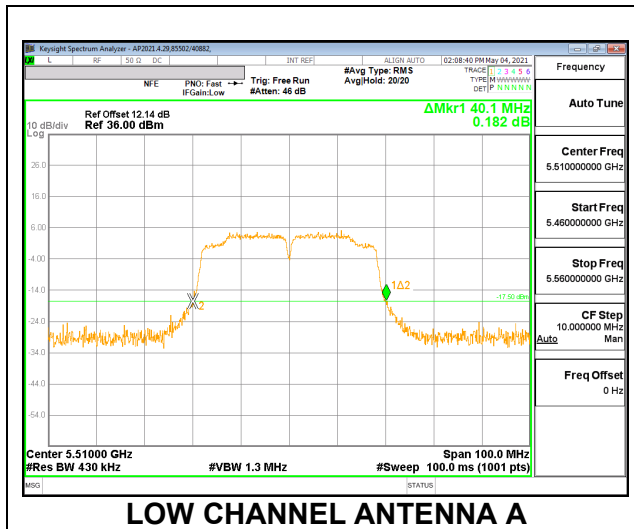


9.2.3. 802.11n HT40 MODE IN THE 5.6 GHz BAND

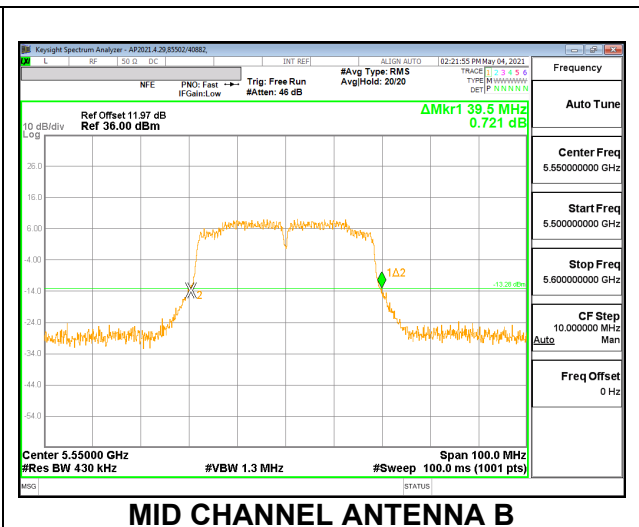
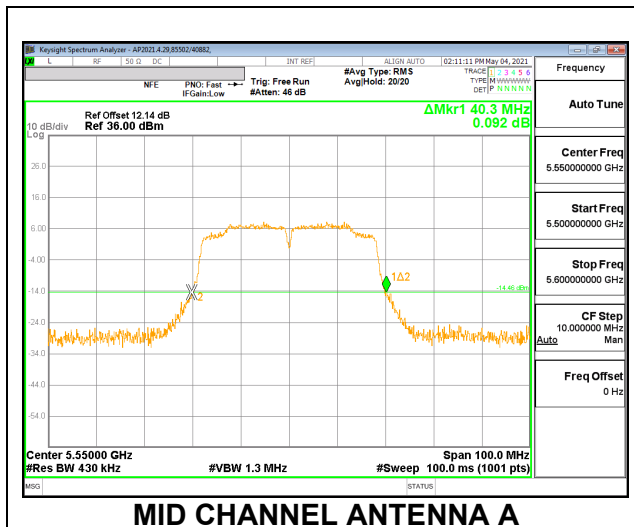
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna A (MHz)	26 dB Bandwidth Antenna B (MHz)
Low	5510	40.10	40.30
Mid	5550	40.30	39.50
Mid	5630	40.00	39.80
High	5670	40.70	39.70
142	5710	37.60	36.10

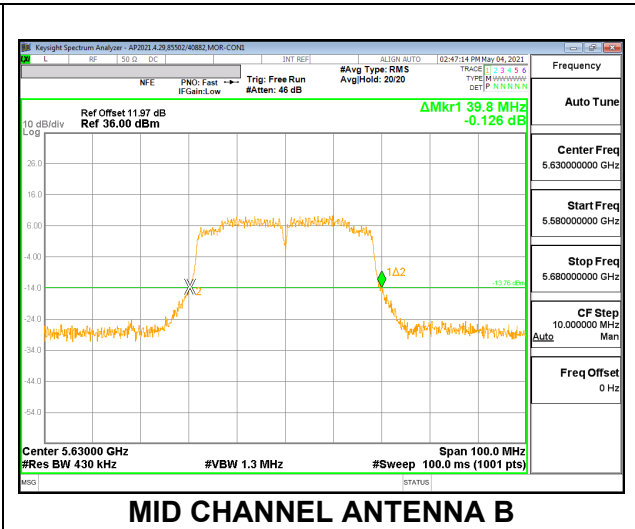
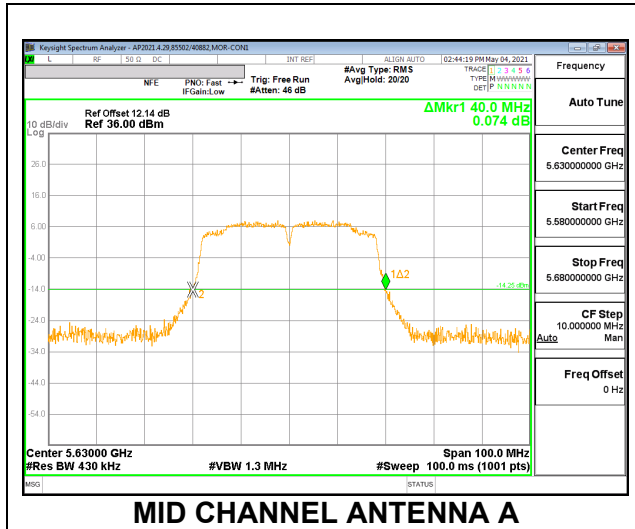
LOW CHANNEL



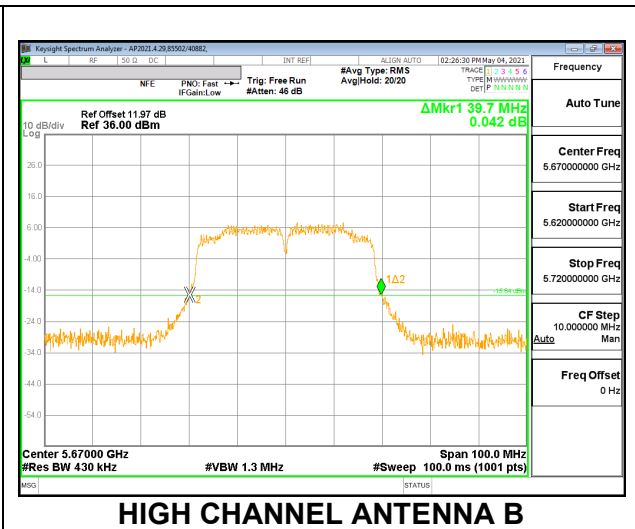
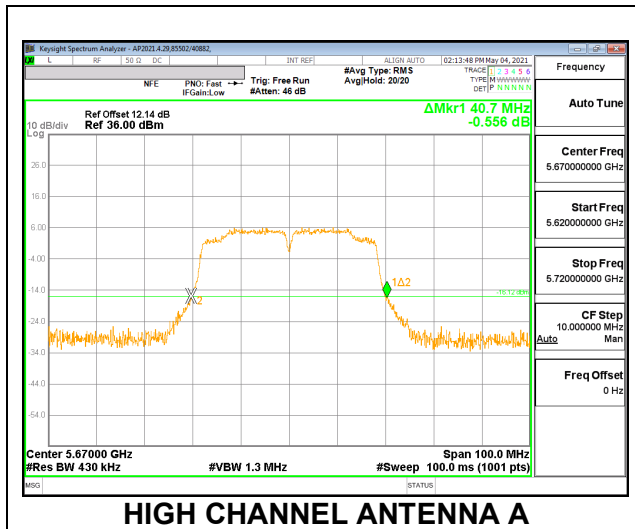
MID CHANNEL



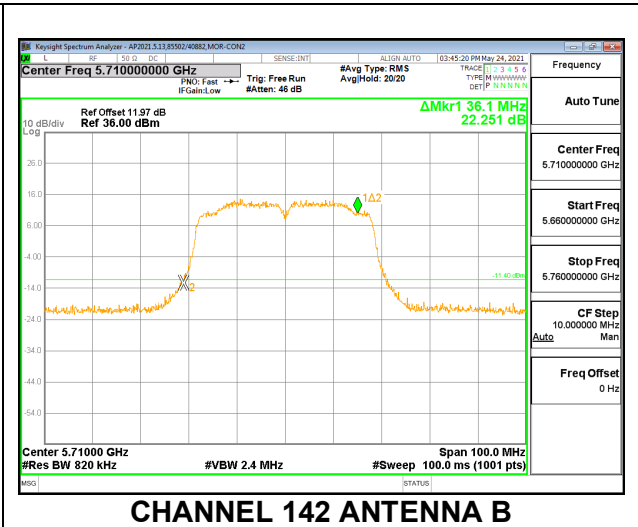
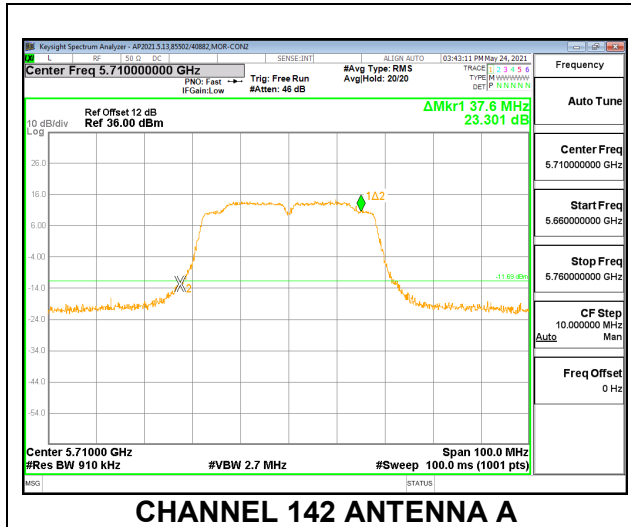
MID CHANNEL



HIGH CHANNEL



CHANNEL 142

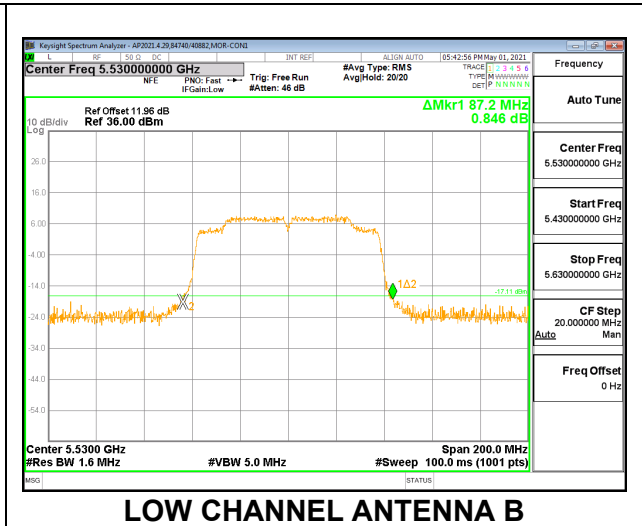
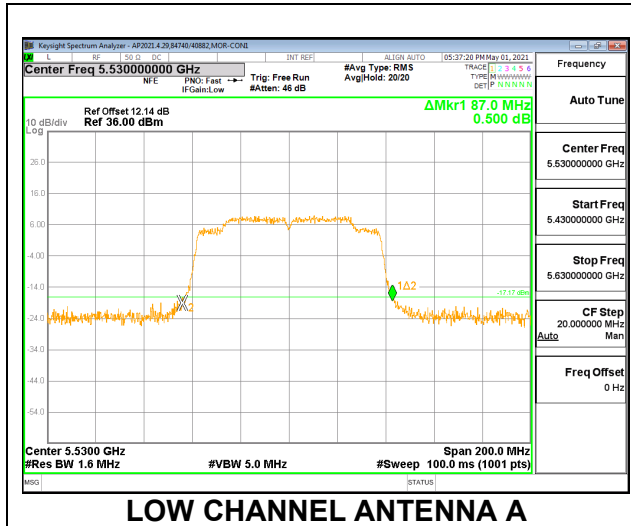


9.2.4. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND

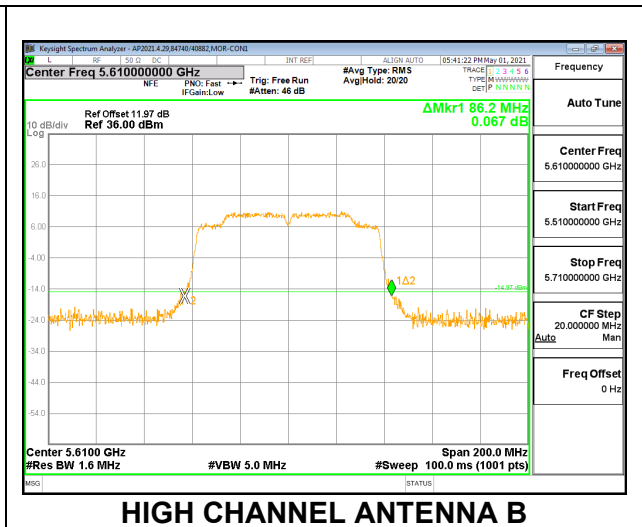
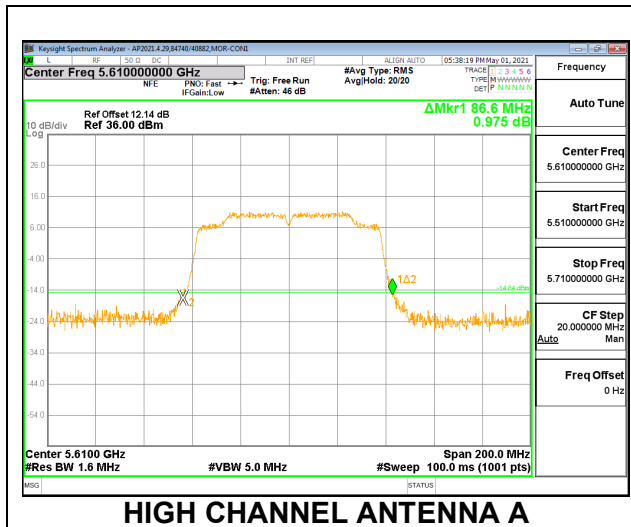
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna A (MHz)	26 dB Bandwidth Antenna B (MHz)
Low	5530	87.00	87.20
High	5610	86.60	86.20
138	5690	78.40	78.80

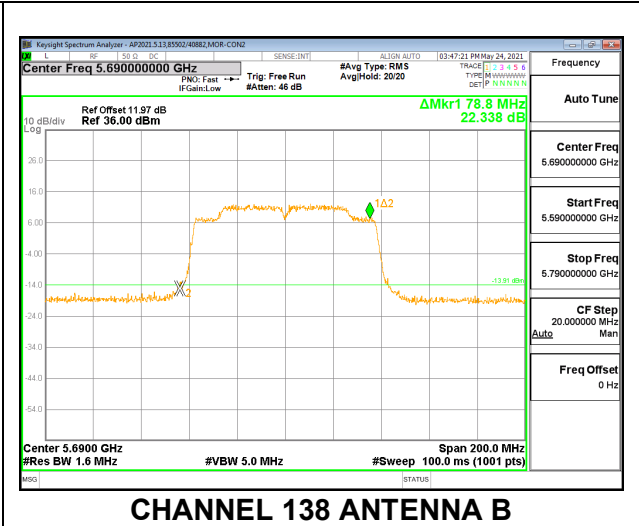
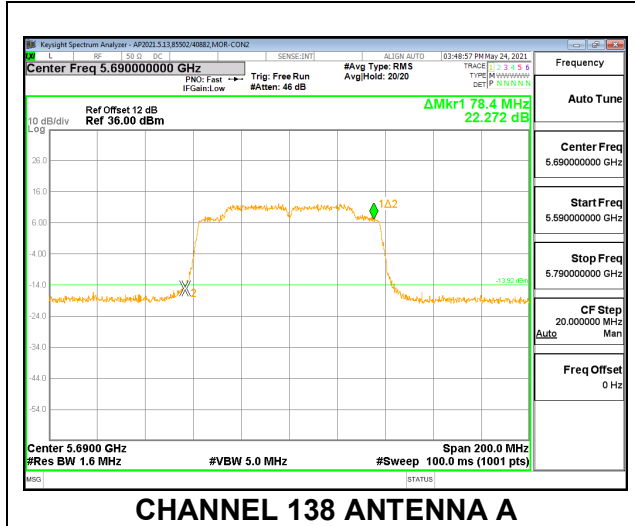
LOW CHANNEL



HIGH CHANNEL



CHANNEL 138

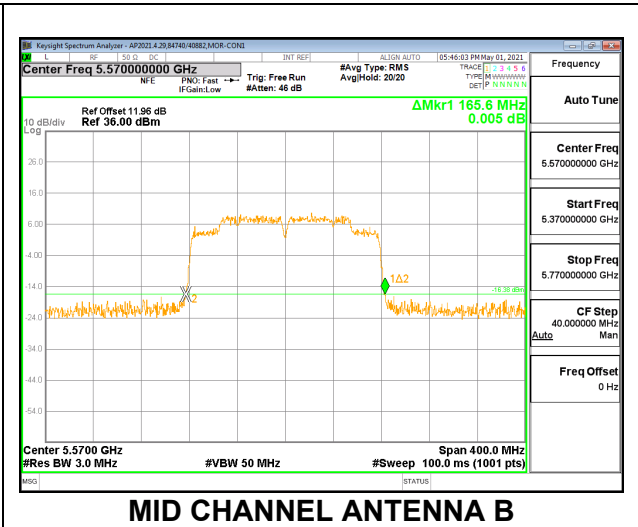
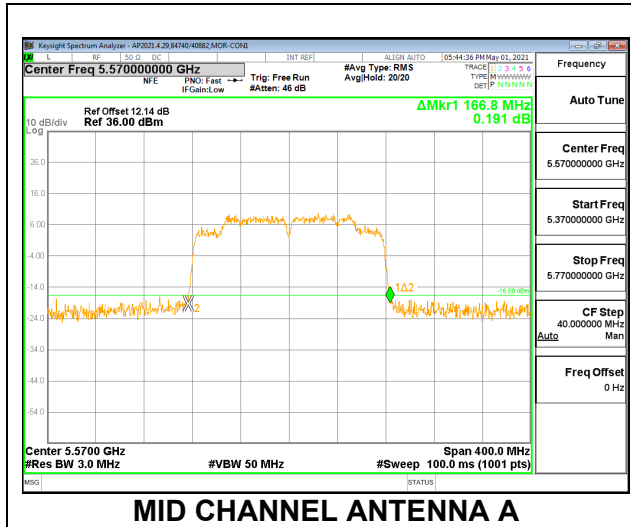


9.2.1. 802.11ac VHT160 MODE IN THE 5.6 GHz BAND

2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna A (MHz)	26 dB Bandwidth Antenna B (MHz)
Mid	5570	166.80	165.60

MID CHANNEL



9.3. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

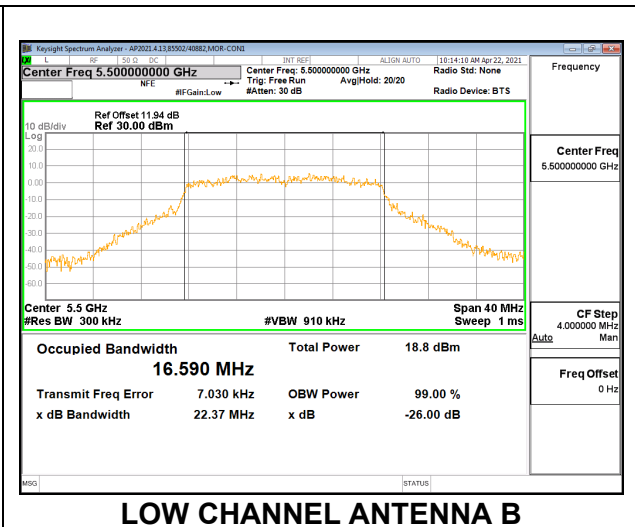
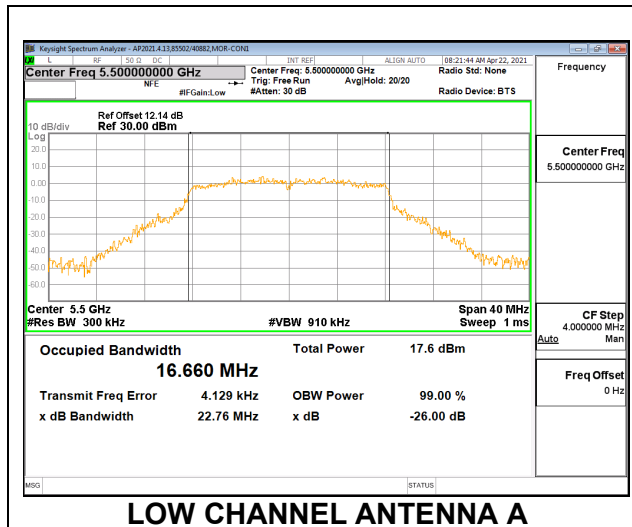
RESULTS

9.3.1. 802.11a MODE IN THE 5.6 GHz BAND

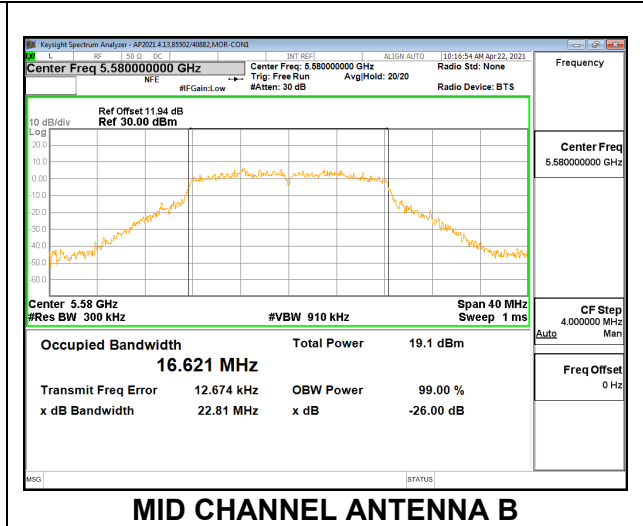
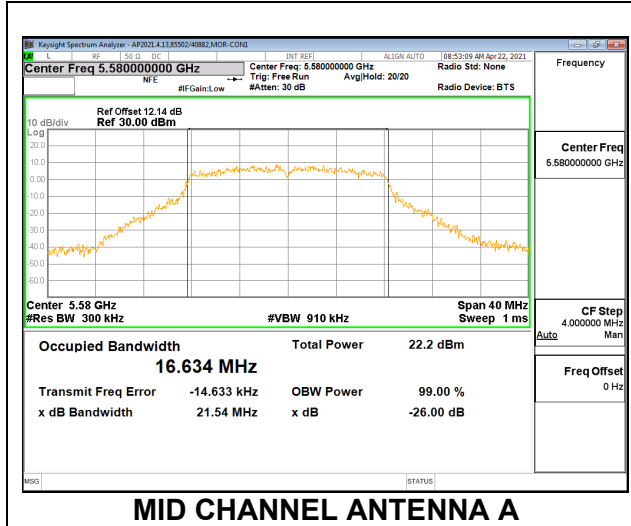
1TX Antenna A and 1TX Antenna B MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)	99% Bandwidth Antenna B (MHz)
Low	5500	16.6600	16.5900
Mid	5580	16.6340	16.6210
High	5700	16.6310	16.5440
144	5720	16.6510	16.6000

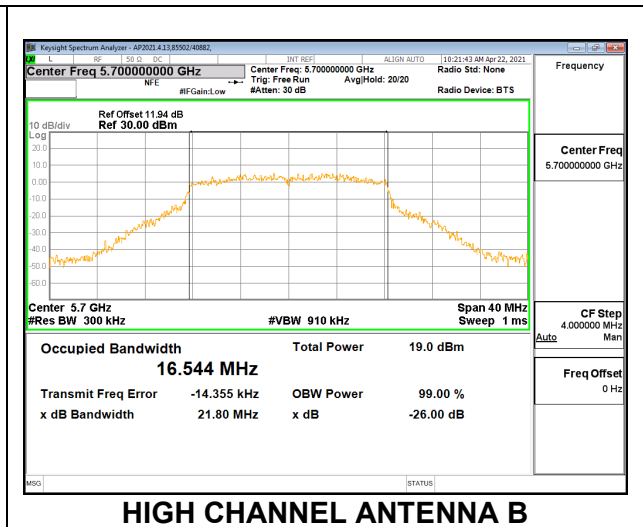
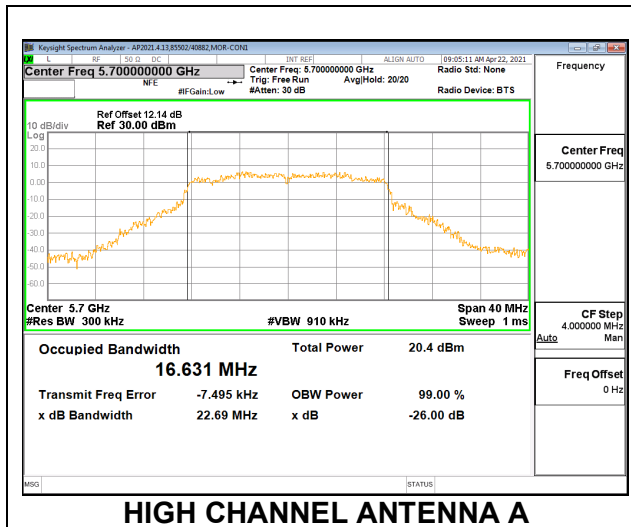
LOW CHANNEL



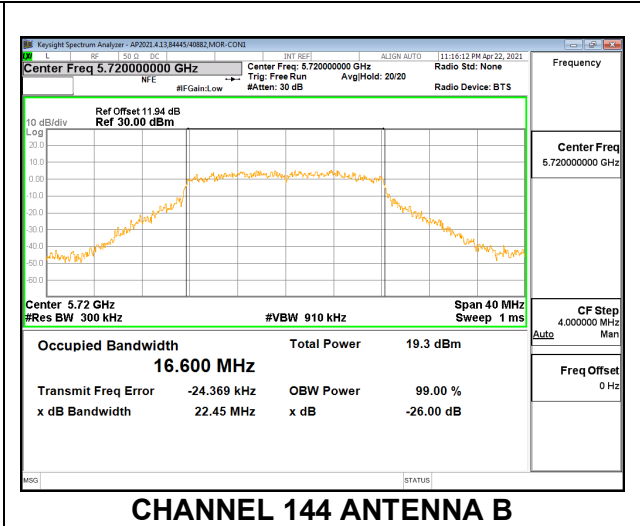
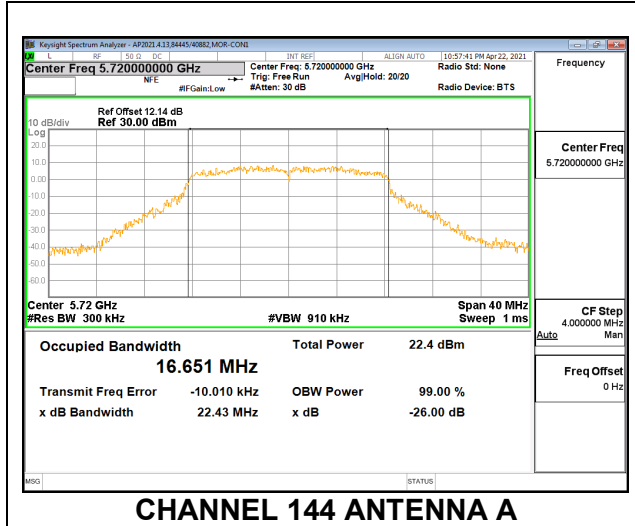
MID CHANNEL



HIGH CHANNEL



CHANNEL 144

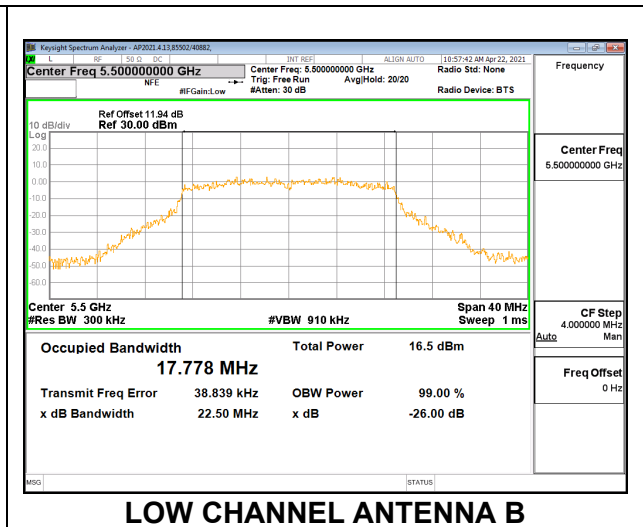
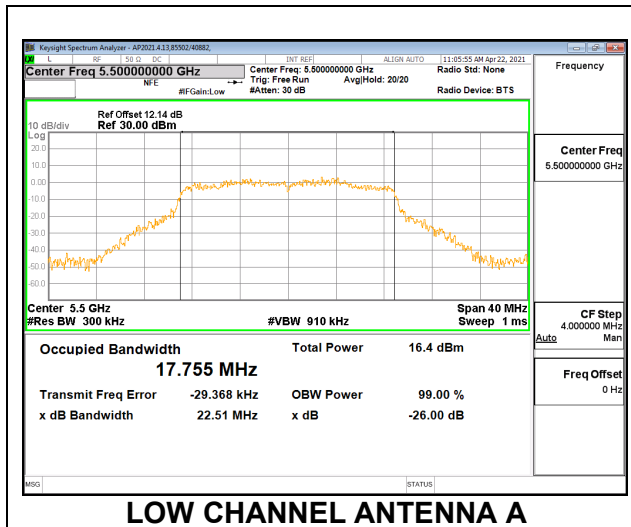


9.3.2. 802.11n HT20 MODE IN THE 5.6 GHz BAND

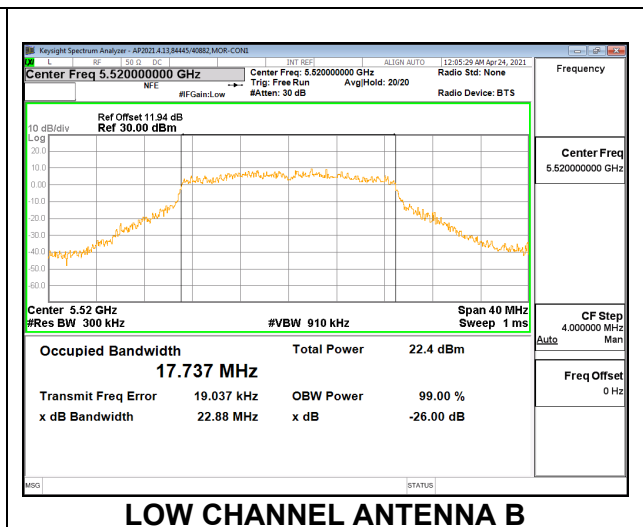
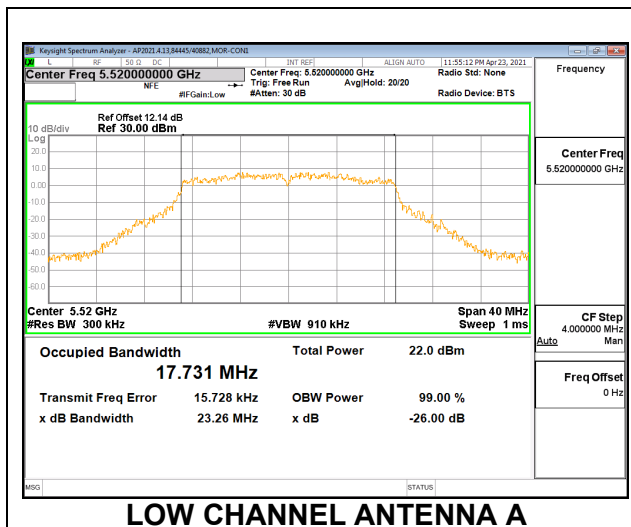
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)	99% Bandwidth Antenna B (MHz)
Low	5500	17.7550	17.7780
Low	5520	17.7310	17.7370
Mid	5580	17.7900	17.7820
High	5680	17.6690	17.7520
High	5700	17.7650	17.7620
144	5720	17.7470	17.7460

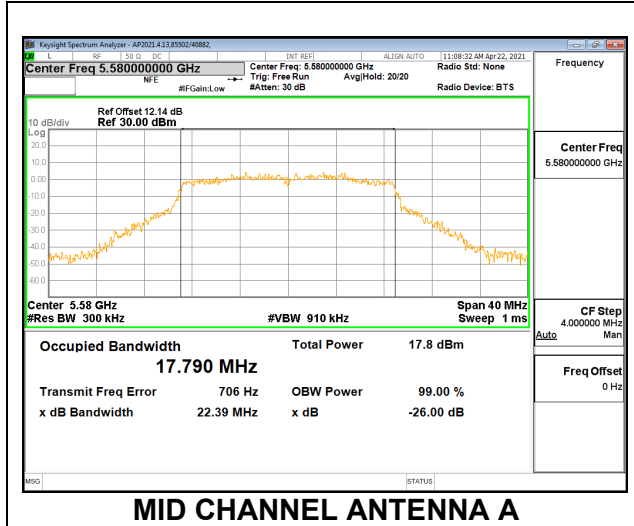
LOW CHANNEL



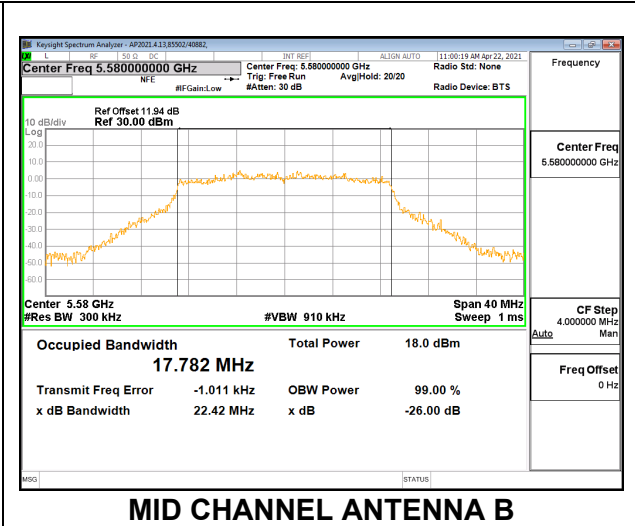
LOW CHANNEL



MID CHANNEL

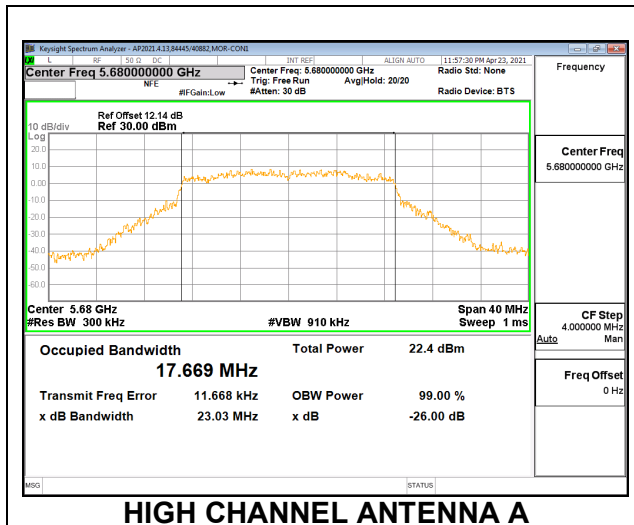


MID CHANNEL ANTENNA A

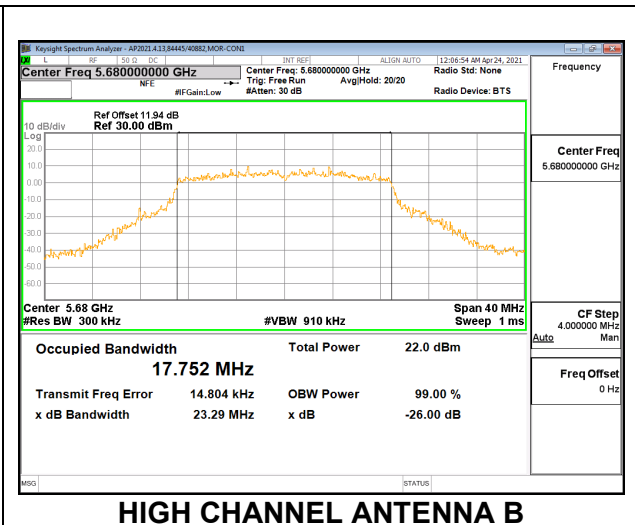


MID CHANNEL ANTENNA B

HIGH CHANNEL

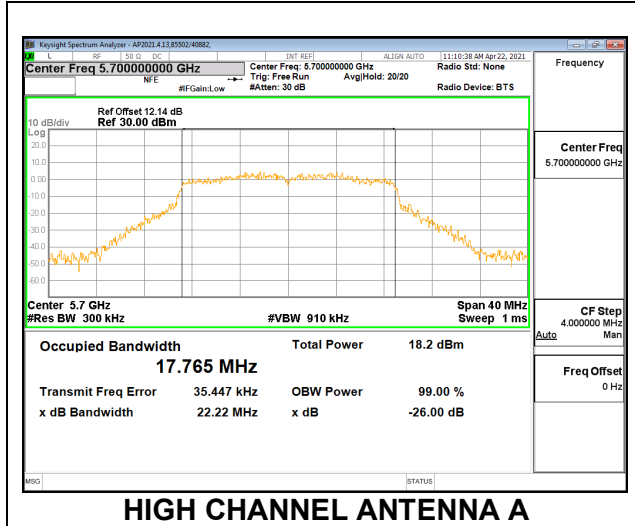


HIGH CHANNEL ANTENNA A

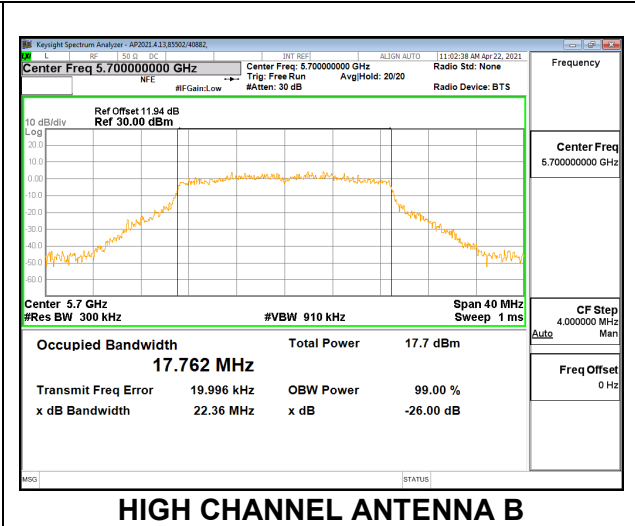


HIGH CHANNEL ANTENNA B

HIGH CHANNEL

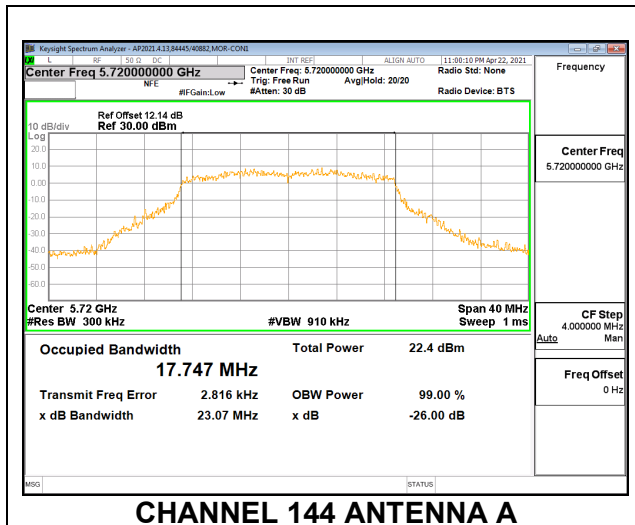


HIGH CHANNEL ANTENNA A

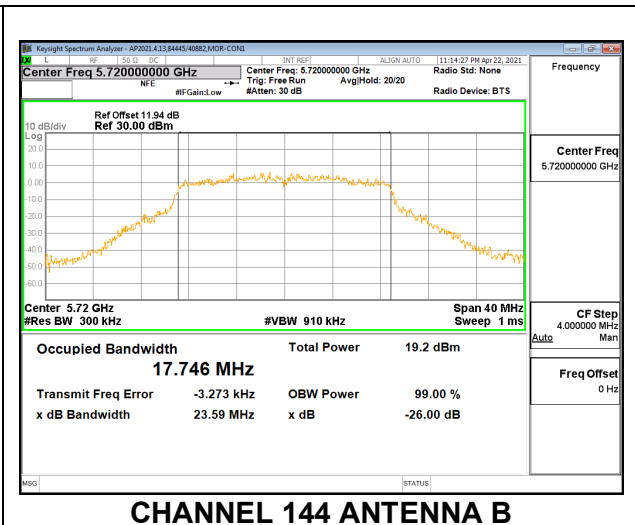


HIGH CHANNEL ANTENNA B

CHANNEL 144



CHANNEL 144 ANTENNA A



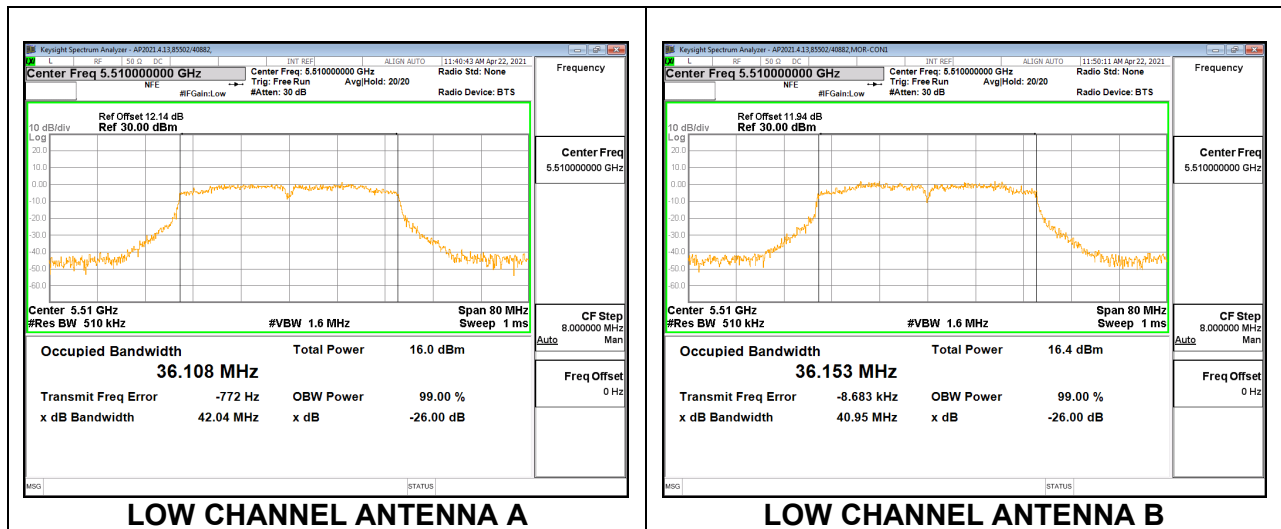
CHANNEL 144 ANTENNA B

9.3.3. 802.11n HT40 MODE IN THE 5.6 GHz BAND

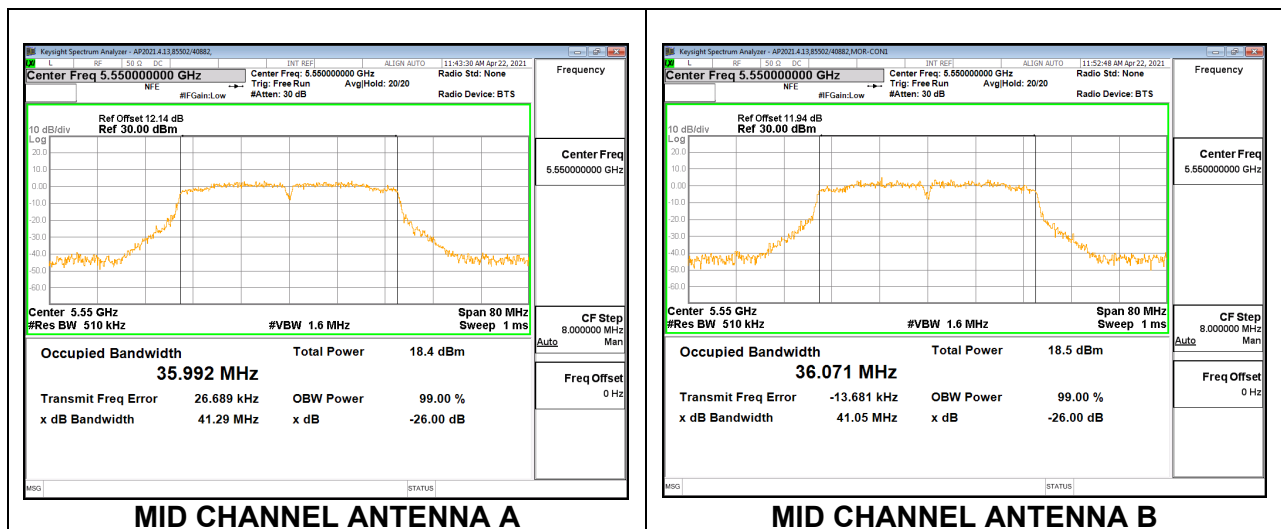
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)	99% Bandwidth Antenna B (MHz)
Low	5510	36.1080	36.1530
Mid	5550	35.9920	36.0710
Mid	5630	35.9810	36.1440
High	5670	36.0360	35.9980
142	5710	36.0410	36.0150

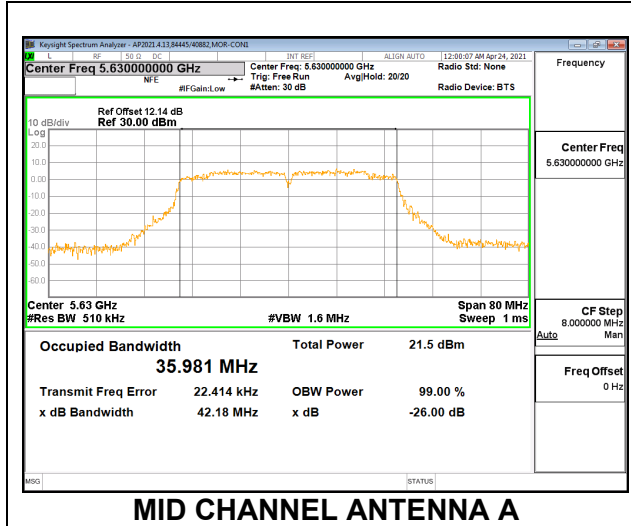
LOW CHANNEL



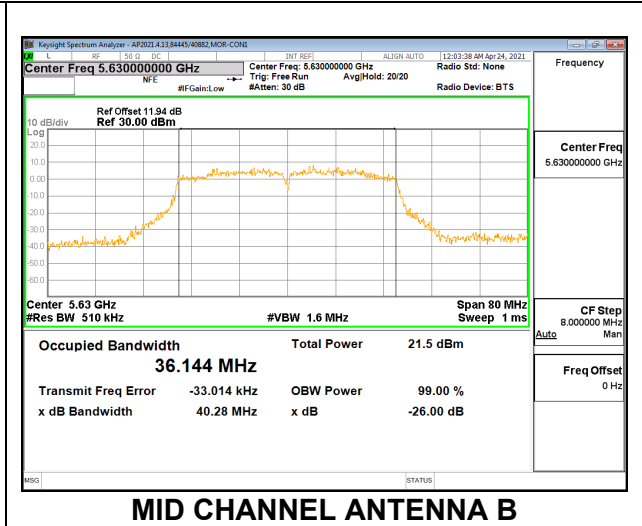
MID CHANNEL



MID CHANNEL

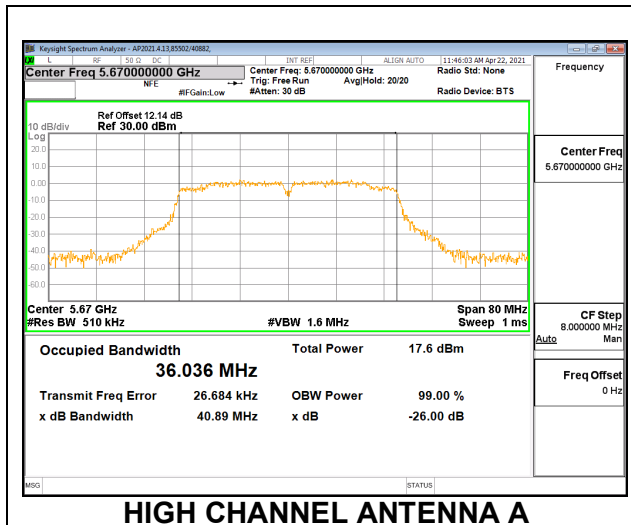


MID CHANNEL ANTENNA A

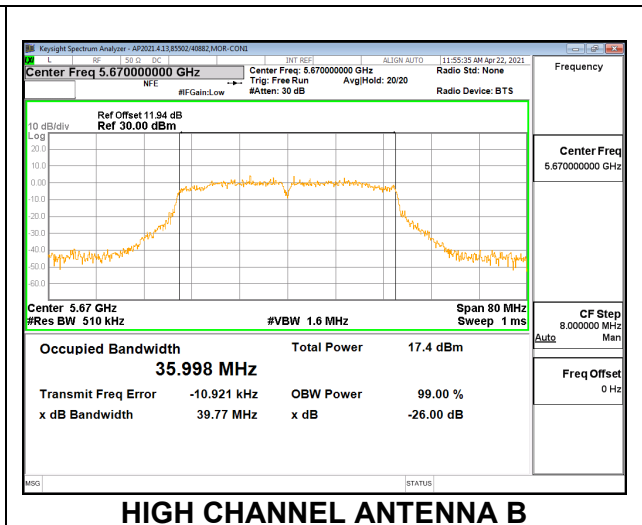


MID CHANNEL ANTENNA B

HIGH CHANNEL

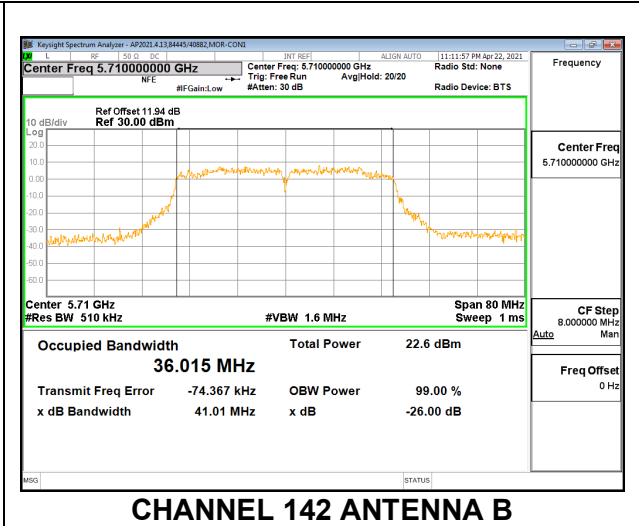
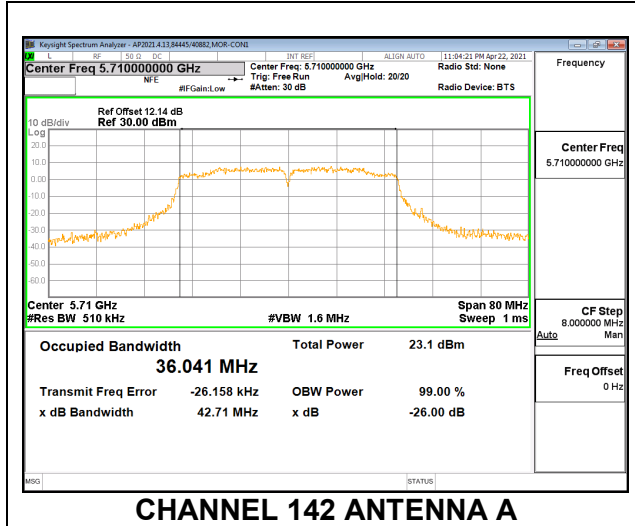


HIGH CHANNEL ANTENNA A



HIGH CHANNEL ANTENNA B

CHANNEL 142

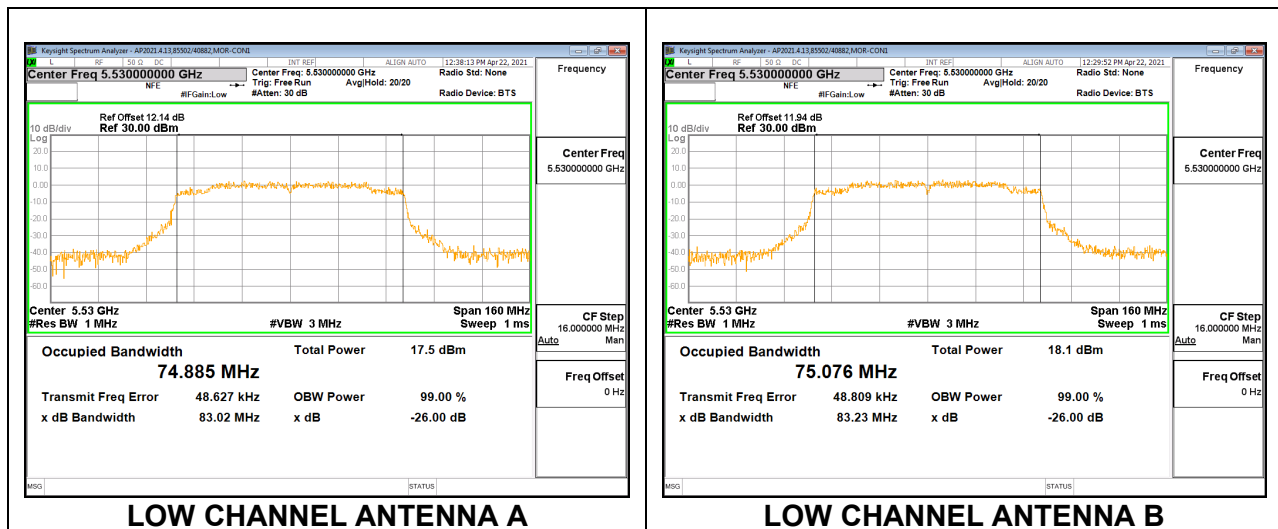


9.3.4. 802.11ac VHT80 MODE IN THE 5.6 GHz BAND

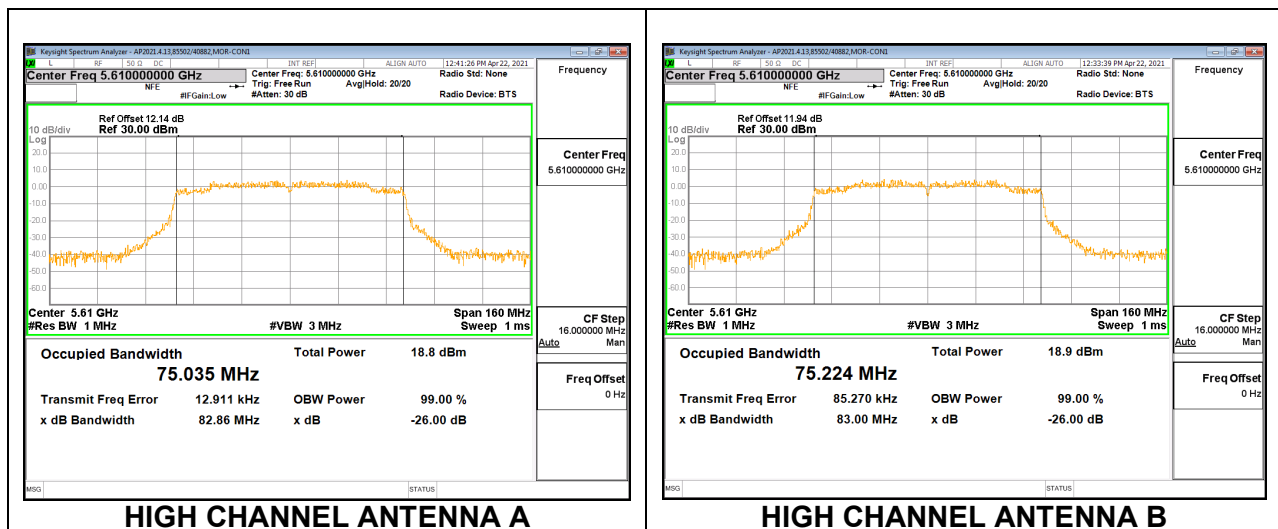
2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)	99% Bandwidth Antenna B (MHz)
Low	5530	74.8850	75.0760
High	5610	75.0350	75.2240
138	5690	75.1710	74.8470

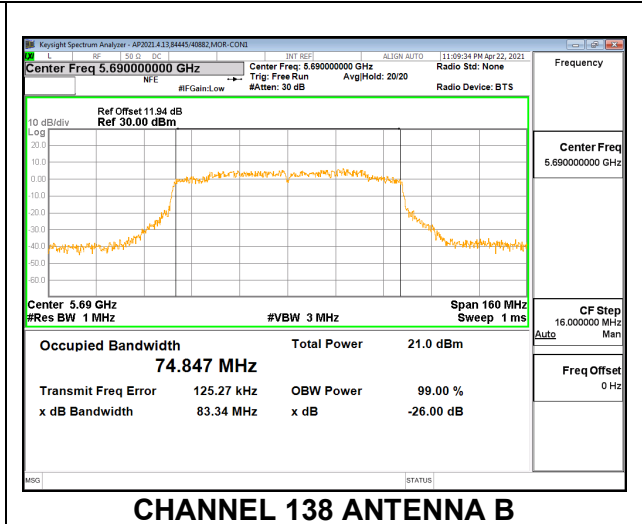
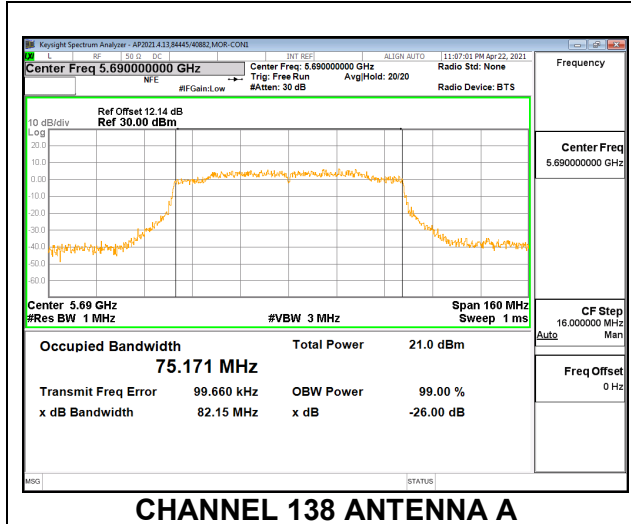
LOW CHANNEL



HIGH CHANNEL



CHANNEL 138

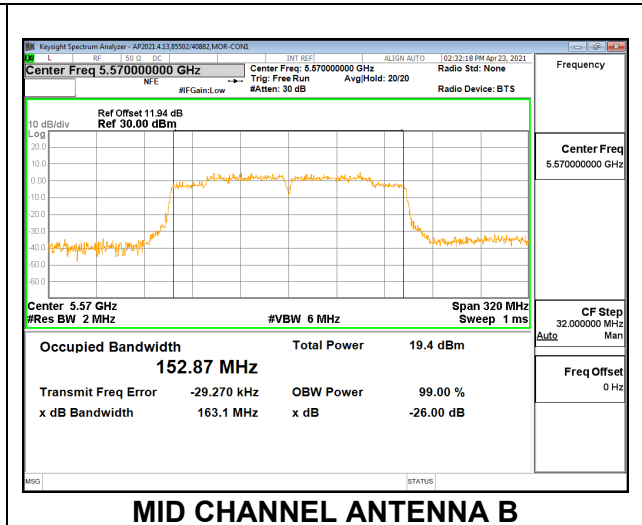
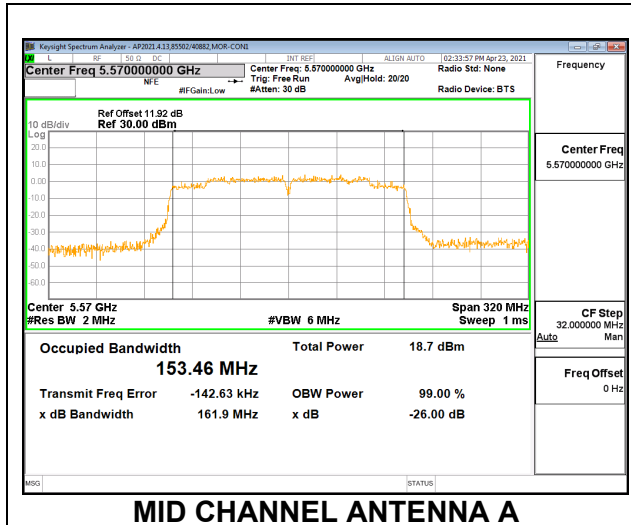


9.3.1. 802.11ac VHT160 MODE IN THE 5.6 GHz BAND

2TX Antenna A + Antenna B SDM MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna A (MHz)	99% Bandwidth Antenna B (MHz)
Mid	5570	153.46	152.87

MID CHANNEL



9.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407

Bands 5.25-5.35 GHz and 5.47-5.725 GHz

The maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 mW or $11 \text{ dBm} + 10 \log B$, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

RSS-247

Bands 5.47-5.6 GHz and 5.65-5.725 GHz

The maximum conducted output power shall not exceed 250 mW or $11 + 10 \log_{10} B$, dBm, whichever is less. The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10} B$, dBm, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

TEST PROCEDURE

The measurement method used for output power is KDB 789033 D02 v02r01, Section E.3.b (Method PM-G) and for straddles channels KDB 789033 D02 v02r01, Section E.2.b (Method SA-1) was used.

The measurement method used for power spectral density is KDB 789033 D02 v02r01, Section F

DIRECTIONAL ANTENNA GAIN

For 1 TX:

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2 TX:

Tx antennas are uncorrelated for power.

Tx antennas are correlated for 11a PSD.

Tx antennas are uncorrelated for 11n/ac PSD.

The directional gains are as follows:

Band (GHz)	ANT A Antenna Gain (dBi)	ANT B Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)	Correlated Chains Directional Gain (dBi)
5.2	4.50	3.40	3.98	6.98
5.3	4.60	4.60	4.60	7.61
5.6	6.40	6.90	6.66	9.66
5.8	7.80	7.70	7.75	10.76

RESULT

Note: 99%OBW for straddle channels is calculated as:

20MHz: (99% OBW/2) + 5MHz

40MHz: (99% OBW/2) + 15MHz

80MHz: (99% OBW/2) + 35MHz

9.4.1. 802.11a MODE IN THE 5.6 GHz BAND

1TX Antenna A MODE (FCC)

Test Engineer:	84445/40882
Test Date:	4/23/2021-4/24/2021

Bandwidth, Antenna Gain, and Limits

Channel	Frequency (MHz)	Min 26 dB BW (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PSD Limit (dBm/ 1MHz)
Low	5500	24.35	6.40	23.60	10.60
Mid	5580	23.75	6.40	23.60	10.60
High	5700	24.15	6.40	23.60	10.60
144	5720	16.70	6.40	22.83	10.60

Duty Cycle CF (dB)	0.09	Included in Calculations of Corr'd PSD
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Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	16.52	16.52	23.60	-7.08
Mid	5580	16.54	16.54	23.60	-7.06
High	5700	16.00	16.00	23.60	-7.60
144	5720	15.81	15.90	22.83	-6.93

PSD Results

Channel	Frequency (MHz)	Meas PSD (dBm/ 1MHz)	Total Corr'd PSD (dBm/ 1MHz)	PSD Limit (dBm/ 1MHz)	PSD Margin (dB)
Low	5500	2.878	2.968	10.60	-7.63
Mid	5580	2.743	2.833	10.60	-7.77
High	5700	2.841	2.931	10.60	-7.67
144	5720	2.830	2.920	10.60	-7.68

1TX Antenna B MODE (FCC)

Test Engineer:	84445/40882
Test Date:	4/23/2021-4/24/2021

Bandwidth, Antenna Gain, and Limits

Channel	Frequency (MHz)	Min 26 dB BW (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PSD Limit (dBm/ 1MHz)
Low	5500	23.70	6.90	23.10	10.10
Mid	5580	23.65	6.90	23.10	10.10
High	5700	23.10	6.90	23.10	10.10
144	5720	17.45	6.90	22.52	10.10

Duty Cycle CF (dB)	0.09	Included in Calculations of Corr'd PSD
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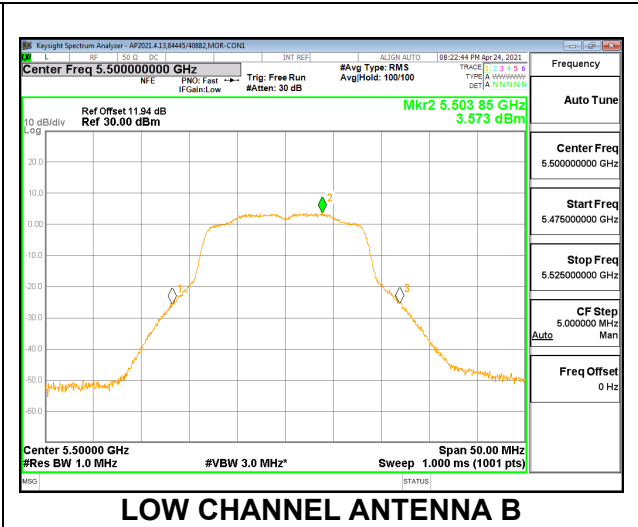
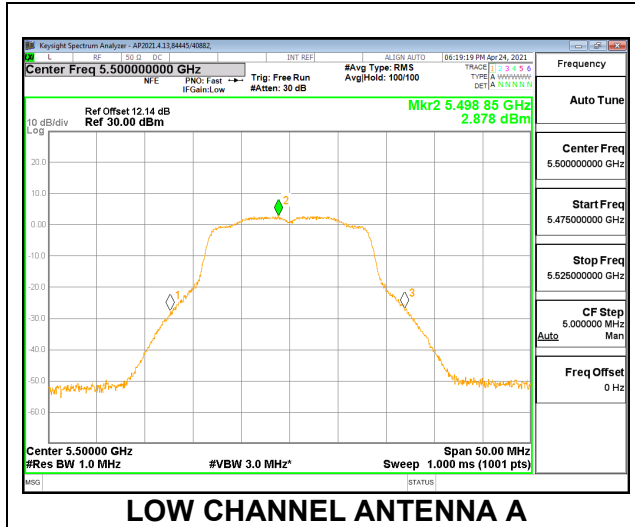
Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	16.37	16.37	23.10	-6.73
Mid	5580	16.18	16.18	23.10	-6.92
High	5700	16.14	16.14	23.10	-6.96
144	5720	15.70	15.79	22.52	-6.73

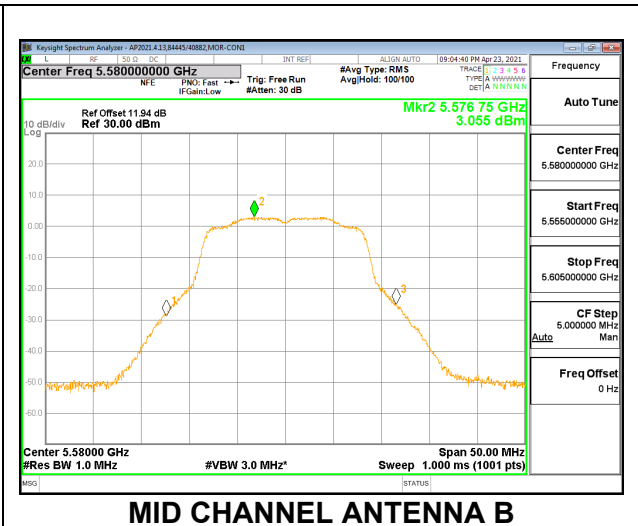
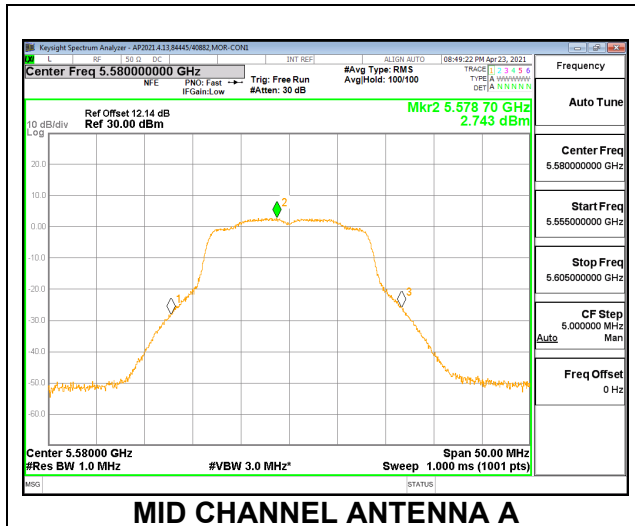
PSD Results

Channel	Frequency (MHz)	Meas PSD (dBm/ 1MHz)	Total Corr'd PSD (dBm/ 1MHz)	PSD Limit (dBm/ 1MHz)	PSD Margin (dB)
Low	5500	3.573	3.663	10.10	-6.44
Mid	5580	3.055	3.145	10.10	-6.96
High	5700	2.584	2.674	10.10	-7.43
144	5720	2.925	3.015	10.10	-7.09

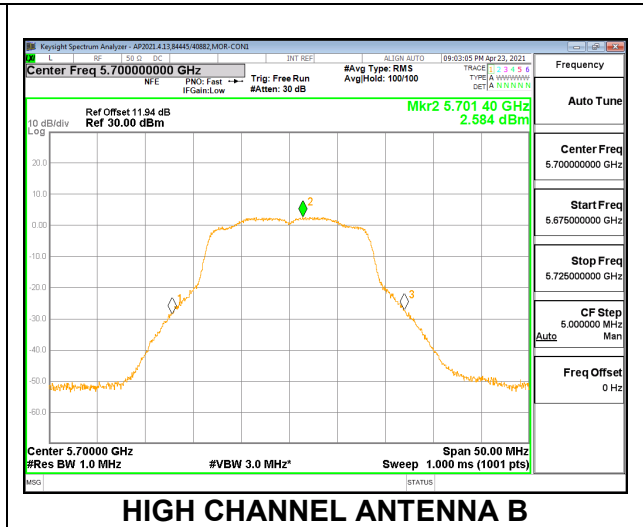
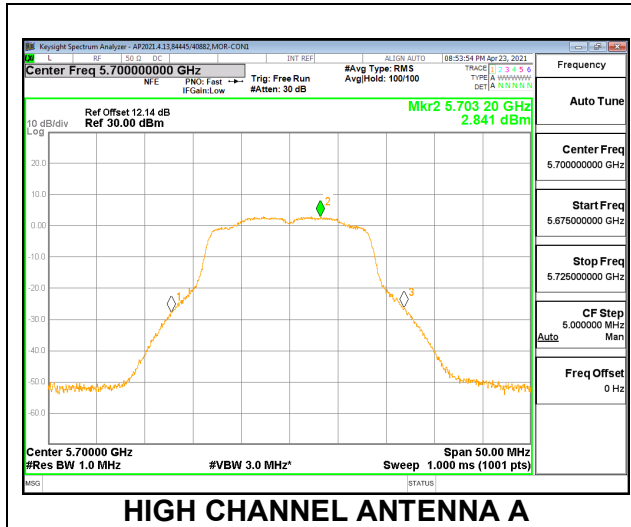
LOW CHANNEL



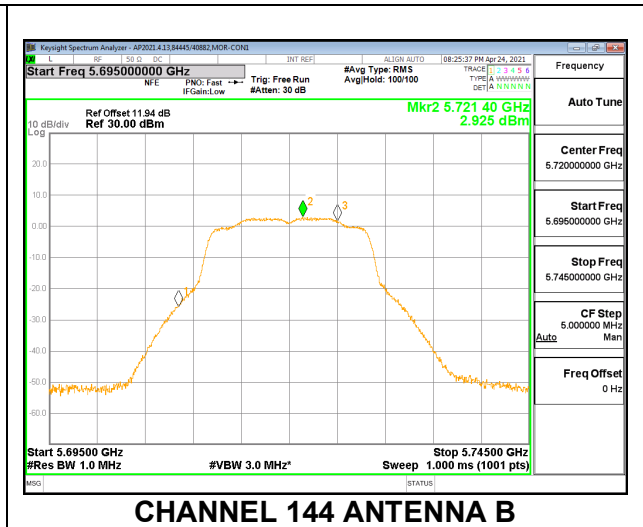
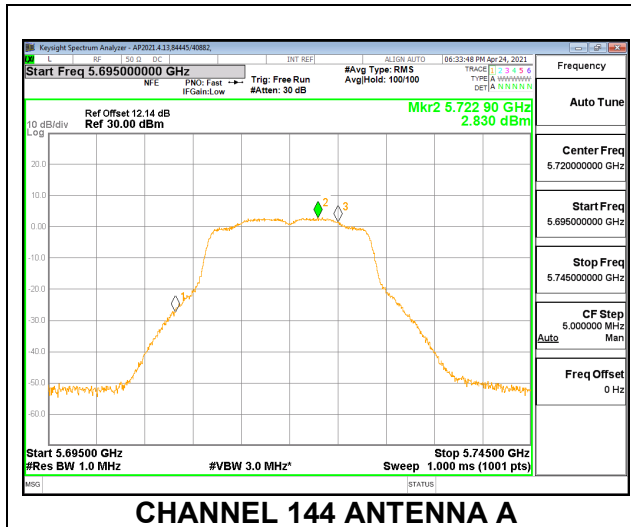
MID CHANNEL



HIGH CHANNEL



CHANNEL 144



1TX Antenna A MODE (IC)

Test Engineer:	84445/40882
Test Date:	4/23/2021-4/24/2021

Bandwidth, Antenna Gain, and Limits

Channel	Frequency (MHz)	Min 99% BW (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PSD Limit (dBm/ 1MHz)
Low	5500	16.660	6.40	22.82	10.60
Mid	5580	16.634	6.40	22.81	10.60
High	5700	16.631	6.40	22.81	10.60
144	5720	16.651	6.40	22.81	10.60

Duty Cycle CF (dB)	0.09	Included in Calculations of Corr'd PSD
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Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	16.52	16.52	22.82	-6.30
Mid	5580	16.54	16.54	22.81	-6.27
High	5700	16.00	16.00	22.81	-6.81
144	5720	15.81	15.90	22.81	-6.91

PSD Results

Channel	Frequency (MHz)	Meas PSD (dBm/ 1MHz)	Total Corr'd PSD (dBm/ 1MHz)	PSD Limit (dBm/ 1MHz)	PSD Margin (dB)
Low	5500	2.878	2.968	10.60	-7.63
Mid	5580	2.743	2.833	10.60	-7.77
High	5700	2.841	2.931	10.60	-7.67
144	5720	2.830	2.920	10.60	-7.68

1TX Antenna B MODE (IC)

Test Engineer:	84445/40882
Test Date:	4/23/2021-4/24/2021

Bandwidth, Antenna Gain, and Limits

Channel	Frequency (MHz)	Min 99% BW (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PSD Limit (dBm/ 1MHz)
Low	5500	16.590	6.90	22.30	10.10
Mid	5580	16.621	6.90	22.31	10.10
High	5700	16.544	6.90	22.29	10.10
144	5720	16.600	6.90	22.30	10.10

Duty Cycle CF (dB)	0.09	Included in Calculations of Corr'd PSD
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Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	16.37	16.37	22.30	-5.93
Mid	5580	16.18	16.18	22.31	-6.13
High	5700	16.14	16.14	22.29	-6.15
144	5720	15.70	15.79	22.30	-6.51

PSD Results

Channel	Frequency (MHz)	Meas PSD (dBm/ 1MHz)	Total Corr'd PSD (dBm/ 1MHz)	PSD Limit (dBm/ 1MHz)	PSD Margin (dB)
Low	5500	3.573	3.663	10.10	-6.44
Mid	5580	3.055	3.145	10.10	-6.96
High	5700	2.584	2.674	10.10	-7.43
144	5720	2.925	3.015	10.10	-7.09