



# **TEST REPORT**

**Report Number. :** 12875574-E2V1

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

**Model :** S24

**FCC ID :** SBVRM024

**IC :** 5373A-RM024

**EUT Description :** 802.11 a/b/g/n 4x4 (HT20) Client Device

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

**Date Of Issue:**

February 03, 2020

**Prepared by:**

UL Verification Services Inc.  
47173 Benicia Street  
Fremont, CA 94538 U.S.A.  
TEL: (510) 319-4000  
FAX: (510) 661-0888



NVLAP Lab code: 200065-0

## REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2/3/2020	Initial Issue	

<b>REPORT REVISION HISTORY .....</b>	<b>2</b>
<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>5</b>
<b>2. TEST METHODOLOGY .....</b>	<b>7</b>
<b>3. FACILITIES AND ACCREDITATION .....</b>	<b>7</b>
<b>4. CALIBRATION AND UNCERTAINTY .....</b>	<b>8</b>
4.1. MEASURING INSTRUMENT CALIBRATION .....	8
4.2. SAMPLE CALCULATION .....	8
4.3. MEASUREMENT UNCERTAINTY .....	8
<b>5. EQUIPMENT UNDER TEST .....</b>	<b>9</b>
5.1. EUT DESCRIPTION .....	9
5.2. MAXIMUM OUTPUT POWER.....	9
5.3. DESCRIPTION OF AVAILABLE ANTENNAS .....	9
5.4. SOFTWARE .....	9
5.5. WORST-CASE CONFIGURATION AND MODE.....	10
5.6. DESCRIPTION OF TEST SETUP.....	11
<b>6. MEASUREMENT METHOD.....</b>	<b>13</b>
<b>7. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>14</b>
<b>8. ANTENNA PORT TEST RESULTS .....</b>	<b>15</b>
8.1. ON TIME AND DUTY CYCLE.....	15
8.2. 99% BANDWIDTH.....	17
8.2.1. 802.11b MODE .....	18
8.2.2. 802.11g MODE .....	24
8.2.3. 802.11n HT20 MODE .....	31
8.3. 6 dB BANDWIDTH.....	37
8.3.1. 802.11b MODE .....	38
8.3.2. 802.11g MODE .....	44
8.3.3. 802.11n HT20 MODE .....	51
8.4. OUTPUT POWER.....	57
8.4.1. 802.11b MODE .....	59
8.4.2. 802.11g MODE .....	60
8.4.3. 802.11n HT20 MODE .....	61
8.5. POWER SPECTRAL DENSITY .....	62
8.5.1. 802.11b MODE .....	63
8.5.2. 802.11g MODE .....	69
8.5.3. 802.11n HT20 MODE .....	76
8.6. CONDUCTED SPURIOUS EMISSIONS.....	82

8.6.1.	802.11b MODE .....	83
8.6.2.	802.11g MODE .....	91
8.6.3.	802.11n HT20 MODE .....	99
<b>9.</b>	<b>RADIATED TEST RESULTS.....</b>	<b>107</b>
9.1.	TRANSMITTER ABOVE 1 GHz .....	109
9.1.1.	TX ABOVE 1 GHz 802.11b MODE IN THE 2.4 GHz BAND .....	109
9.1.2.	TX ABOVE 1 GHz 802.11g MODE IN THE 2.4 GHz BAND .....	123
9.1.3.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 2.4 GHz BAND.....	139
9.2.	WORST CASE BELOW 30MHz.....	153
9.3.	WORST CASE BELOW 1 GHz.....	155
9.4.	WORST CASE 18-26 GHz.....	157
<b>10.</b>	<b>AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>159</b>
<b>11.</b>	<b>SETUP PHOTOS.....</b>	<b>162</b>

## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** SONOS, INC.  
614 CHAPALA STREET  
SANTA BARBARA, CA 93101, U.S.A.

**EUT DESCRIPTION:** 802.11 a/b/g/n 4x4 (HT20) Client Device

**MODEL:** S24

**SERIAL NUMBER:** D100 1909CP 34-7E-5C-D0-02-60-7 (Conducted Sample)  
D100 1909CP 34-7E-5C-D0-02-5C-3 (Radiated Sample)  
D100 1909CP 34-7E-5C-D0-02-7E-3(Radiated Sample)

**DATE TESTED:** November 11 – December 3, 2019

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	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 NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

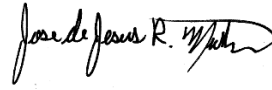
Approved & Released For  
UL Verification Services Inc. By:

Prepared By:



---

DAN CORONIA  
Operations Leader  
Consumer Technology Division  
UL Verification Services Inc.



---

JOSE MARTINEZ  
Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

Reviewed By:



---

KIYA KEDIDA  
Senior Project Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 414788 D01 Radiated Test Site v01r01, and KDB 558074 D01 15.247 Meas Guidance v05r02, RSS-GEN Issue 5, and RSS-247 Issue 2.

## 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd.
<input checked="" type="checkbox"/> Chamber A	<input type="checkbox"/> Chamber D	<input checked="" type="checkbox"/> Chamber I
<input type="checkbox"/> Chamber B	<input type="checkbox"/> Chamber E	<input type="checkbox"/> Chamber J
<input type="checkbox"/> Chamber C	<input type="checkbox"/> Chamber F	<input checked="" type="checkbox"/> Chamber K
	<input type="checkbox"/> Chamber G	<input type="checkbox"/> Chamber L
	<input type="checkbox"/> Chamber H	

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

## 4. CALIBRATION AND UNCERTAINTY

### 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

### 4.2. SAMPLE CALCULATION

#### **RADIATED EMISSIONS**

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – 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:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

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

### 4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.39 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.07 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

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



## 5. EQUIPMENT UNDER TEST

### 5.1. EUT DESCRIPTION

The EUT is an 802.11 a/b/g/n 4x4 (HT20) Client Device.

### 5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
<b>4Tx</b>			
2412 - 2462	802.11b	26.76	474.24
2412 - 2462	802.11g	25.89	388.15
2412 - 2462	802.11n HT20	24.40	275.42

### 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes antenna with maximums gain per chain as follows:

Frequency (MHz)	Peak Antenna Gain (dBi)			
	Ant0 Wifi P/N 105-00152 Vertical Polarization	Ant1 Wifi Vertical Polarization	Ant2 Wifi P/N 105-00153 Horizontal Polarization	Ant3 Wifi Horizontal Polarization
2400 – 2483.5	4.2	3.4	3.5	2.9

#### **NOTE:**

Antenna 1 = Chain 0  
Antenna 2 = Chain 1  
Antenna 3 = Chain 2  
Antenna 4 = Chain 3

### 5.4. SOFTWARE

The test utility software used during testing was:  
Sonos build 55.0-70090\_mainline\_integ\_int\_release

## 5.5. 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 fundamental of the EUT was investigated in three orthogonal orientations X,Y Left, Y Right, it was determined that Y Left orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y Left orientation.

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

802.11b mode: 1 Mbps

802.11g mode: 6 Mbps

802.11n HT20mode: MCS0

## 5.6. DESCRIPTION OF TEST SETUP

### SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	T440p	SON-00008522	N/A
AC Adapter	Lenovo	ADLX90NDC2A	11S36200285ZZ3004758D2	N/A

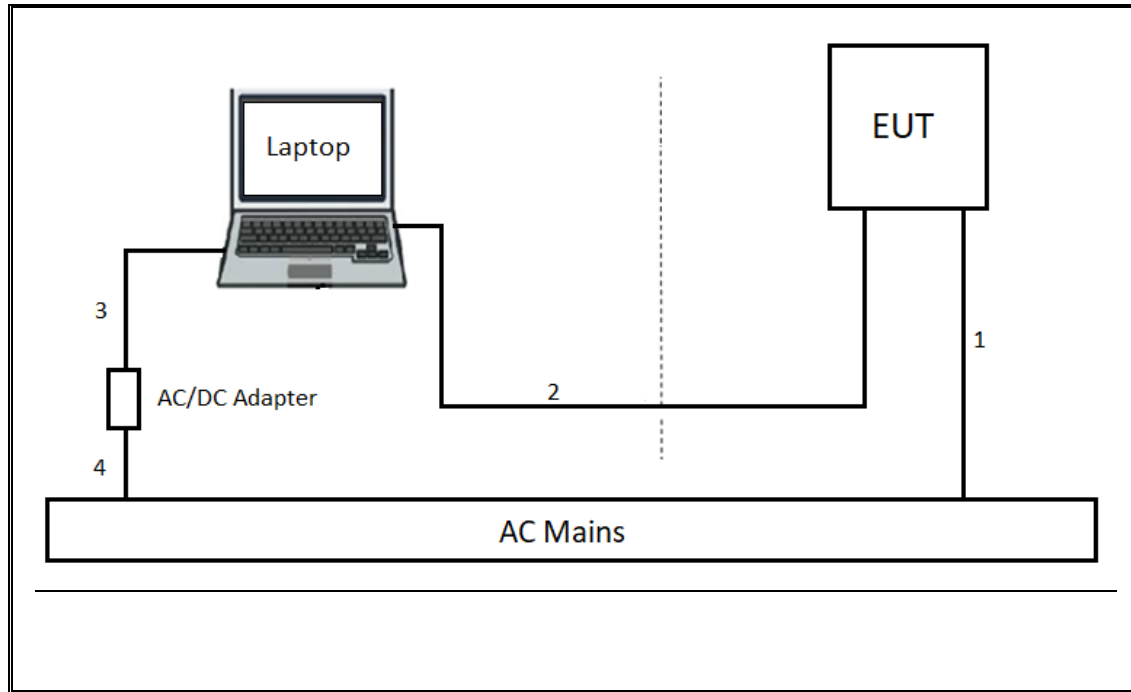
### I/O CABLES

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC Power	1	AC	Unshielded	2	AC Mains to EUT
2	Ethernet	1	RJ45	Unshielded	10	EUT to Laptop
3	DC Power	1	DC	Shielded	1.2	AC/DC Adapter to Laptop
4	AC Power	1	AC	Unshielded	1	AC Mains to AC/DC Adapter

### TEST SETUP

The EUT connected to support laptop via the ethernet cable during testing.  
The test utility software on support laptop exercised the radio card.  
For radiated testing, the support laptop was set up outside the chamber.

**SETUP DIAGRAM**



## 6. MEASUREMENT METHOD

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6.

6 dB BW: ANSI C63.10-2013 Section 11.8.1. Option 1

Output Power: ANSI C63.10-2013 Section 11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

Power Spectral Density: ANSI C63.10-2013 Section 11.10.3 Method AVGPS-1.

Radiated emissions non-restricted frequency bands: ANSI C63.10-2013 Section 11.11

Radiated emissions restricted frequency bands: ANSI C63.10-2013 Section 11.12.1.

Conducted emissions in restricted frequency bands: ANSI C63.10-2013 Section 11.12

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

Band-edge: ANSI C63.10-2013 Section -11.13.3.4 Integration method -Trace averaging across ON and OFF times DC correction

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

## 7. 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
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies (Formerly Agilent)	N9030A	T908	01/23/2020	01/23/2019
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T1165	11/06/2020	11/06/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T346	05/14/2020	05/14/2019
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179372	02/16/2020	02/16/2019
Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	T1569	06/04/2020	06/04/2019
Antenna	ETS-Lindgren	3117	EMC4294	06/14/2020	06/14/2019
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179376	02/14/2020	02/14/2019
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	PRE0180175	05/29/2020	06/29/2019
Antenna, Broadband Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	PRE0184052	11/12/2020	11/12/2019
Antenna, Active Loop 9KHz to 30MHz	COM-POWER	AL-130R	PRE0165308	04/11/2020	04/11/2019
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T447	08/13/2020	08/13/2019
Rf Amplifier, 18-26.5GHz, 60dB gain	AMPLICAL	Rf Amplifier, 18-26.5GHz, 60dB gain	PRE0181238	05/01/2020	05/01/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T1265	01/29/2020	01/29/2019
Power Sensor, P-series, 50MHz to 18GHz, Wideband	Agilent (Keysight) Technologies	N1921A	T1227	02/05/2020	02/05/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies (Formerly Agilent)	N9030A	T917	01/24/2020	01/24/2019
Spectrum Analyzer, PSA, 3Hz to 26.5GHz	Keysight Technologies (Formerly Agilent)	E4440A	T200	01/28/2020	01/28/2019
AC Line Conducted					
EMI Receiver	Rohde & Schwarz	ESR	T1436	02/14/2020	02/14/2019
LISN for Conducted Emissions CISPR-16	FCC INC.	FCC LISN 50/250	T1310	01/24/2020	01/24/2019
Test Software List					
Radiated Software	UL	UL EMC	Ver 9.5, September 24, 2019		
Antenna Port Software	UL	UL RF	Ver 2019.10.18, October 18, 2019		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		

## 8. ANTENNA PORT TEST RESULTS

### 8.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

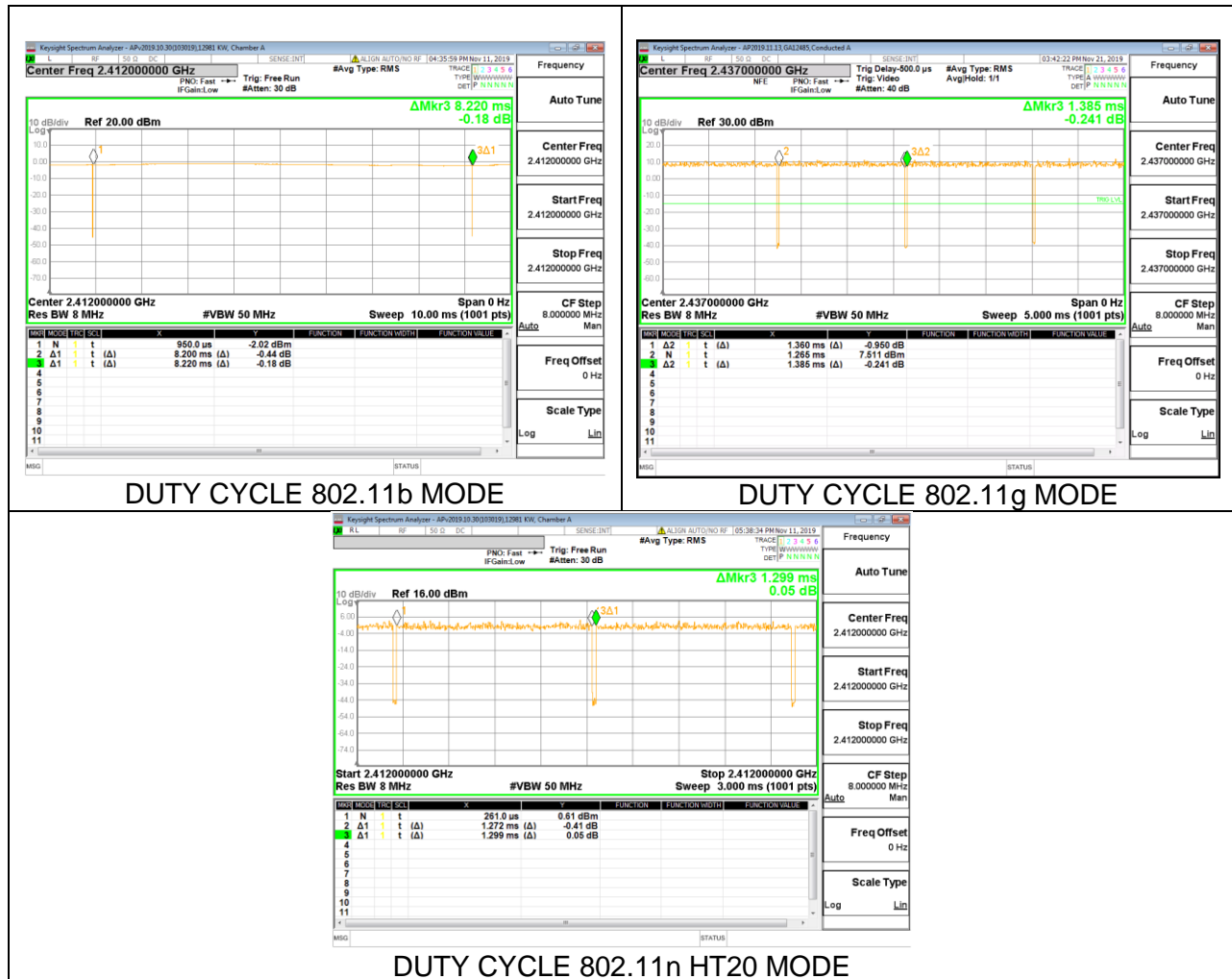
#### PROCEDURE

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 Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
802.11b	8.200	8.220	0.998	99.76	0.00	0.010
802.11g	1.360	1.385	0.982	98.19	0.00	0.010
802.11n HT20	1.272	1.299	0.979	97.92	0.09	0.786

## DUTY CYCLE PLOTS





## **8.2. 99% BANDWIDTH**

### **LIMITS**

None; for reporting purposes only.

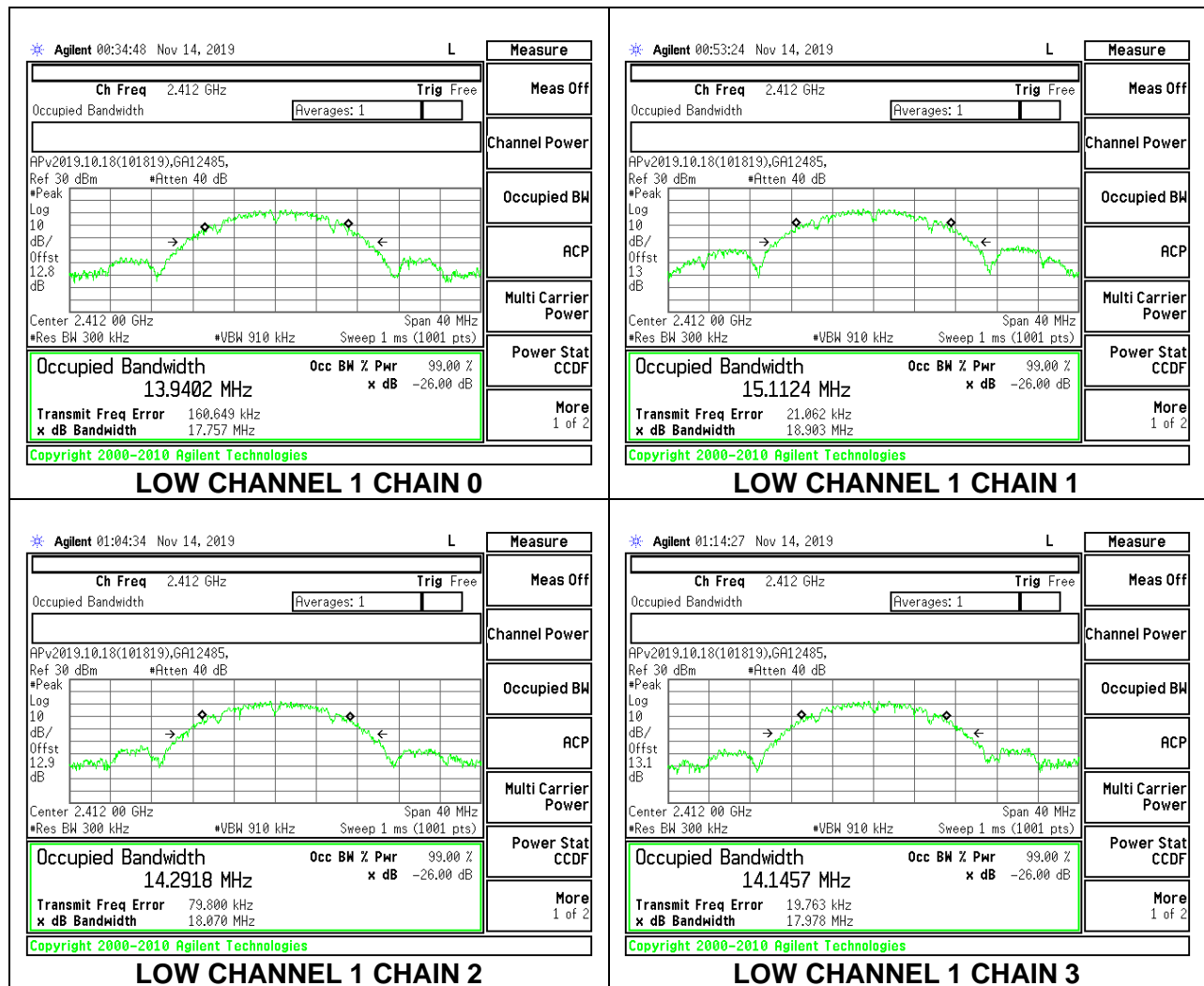
### **RESULTS**

### 8.2.1. 802.11b MODE

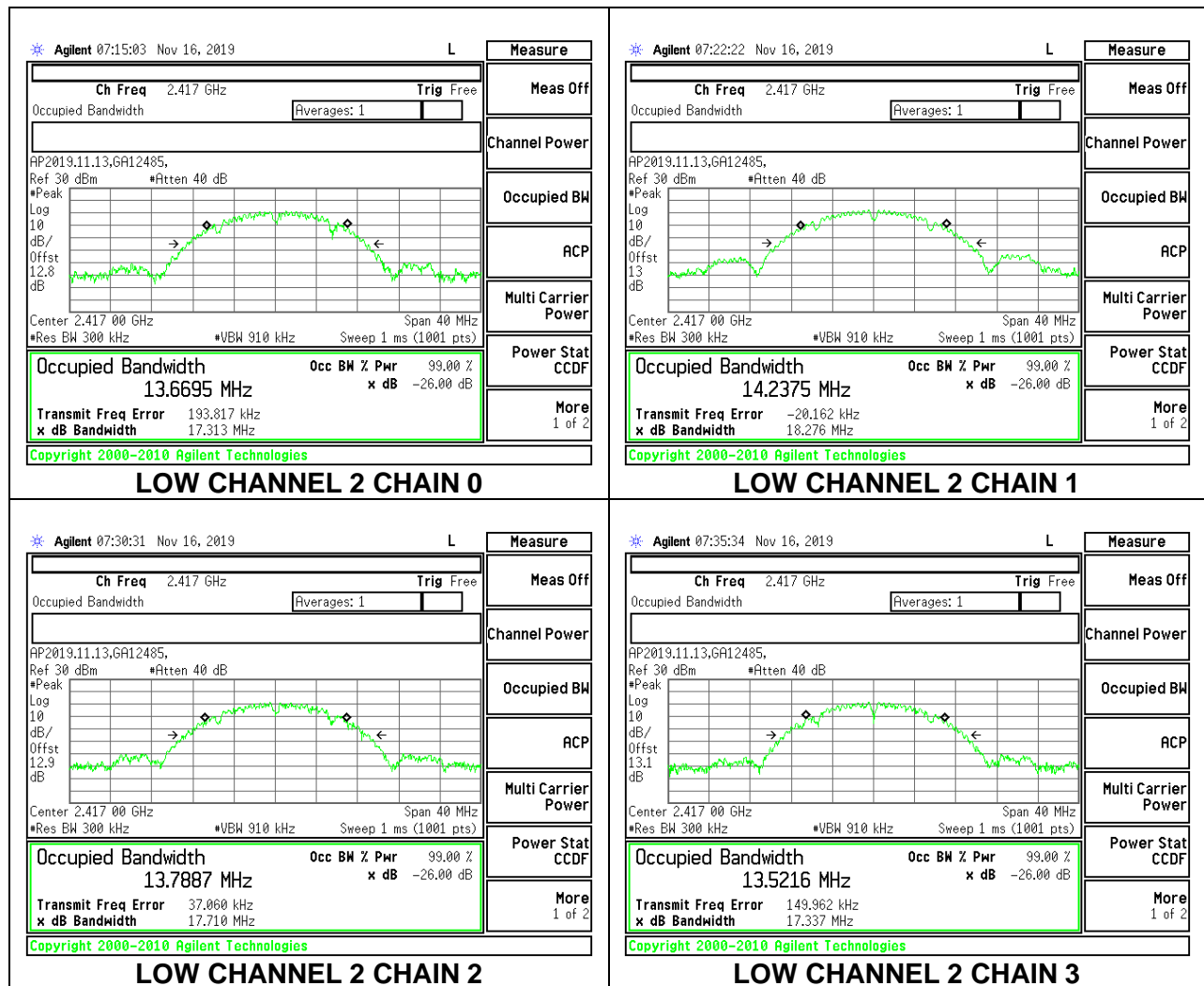
#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)	99% Bandwidth Chain 2 (MHz)	99% Bandwidth Chain 3 (MHz)
Low 1	2412	13.940	15.112	14.292	14.146
Low 2	2417	13.670	14.238	13.789	13.522
Mid 6	2437	14.626	16.015	14.793	14.285
High 10	2457	13.872	14.229	14.153	13.591
High 11	2462	14.005	14.338	14.209	13.677

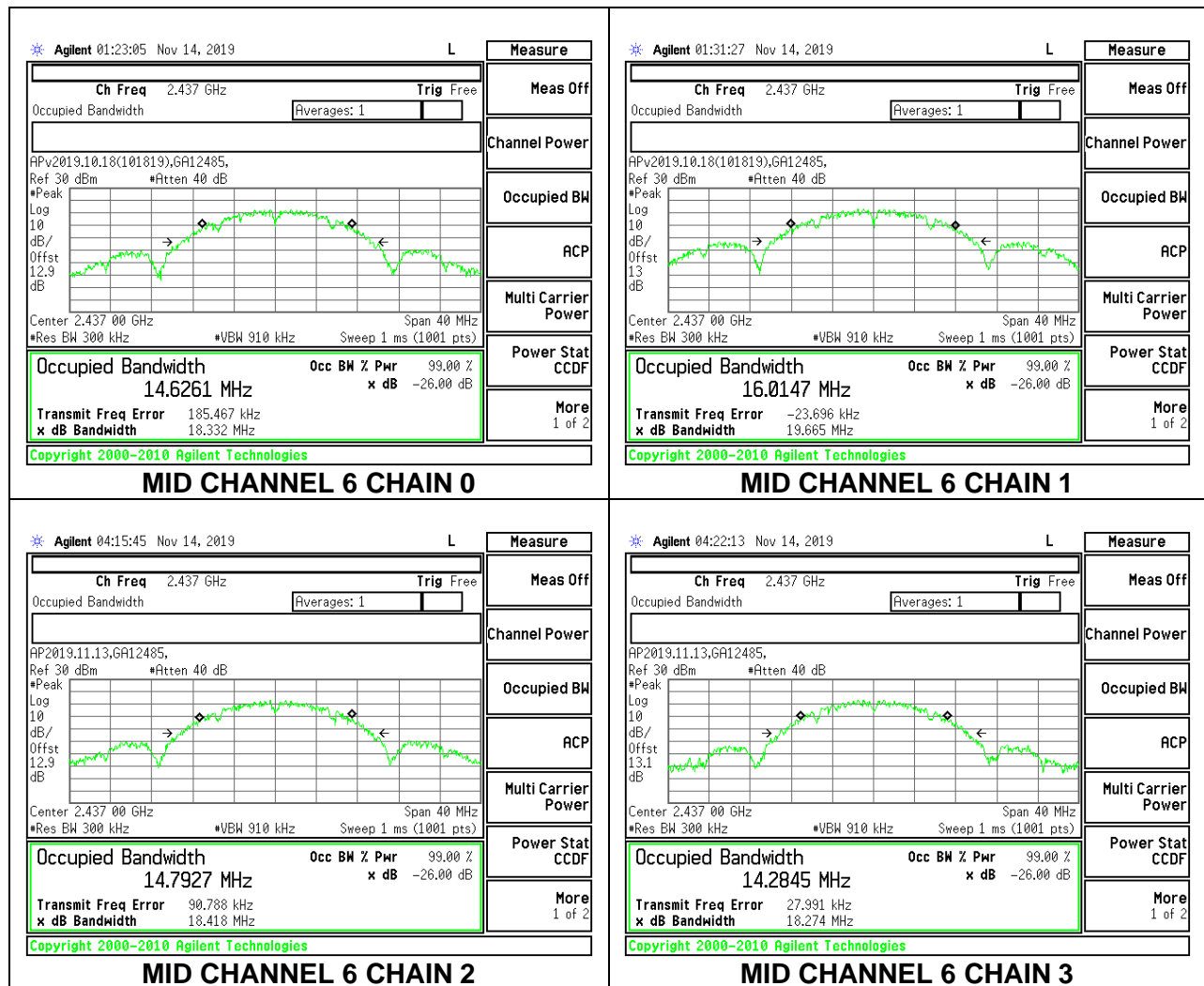
## LOW CHANNEL 1



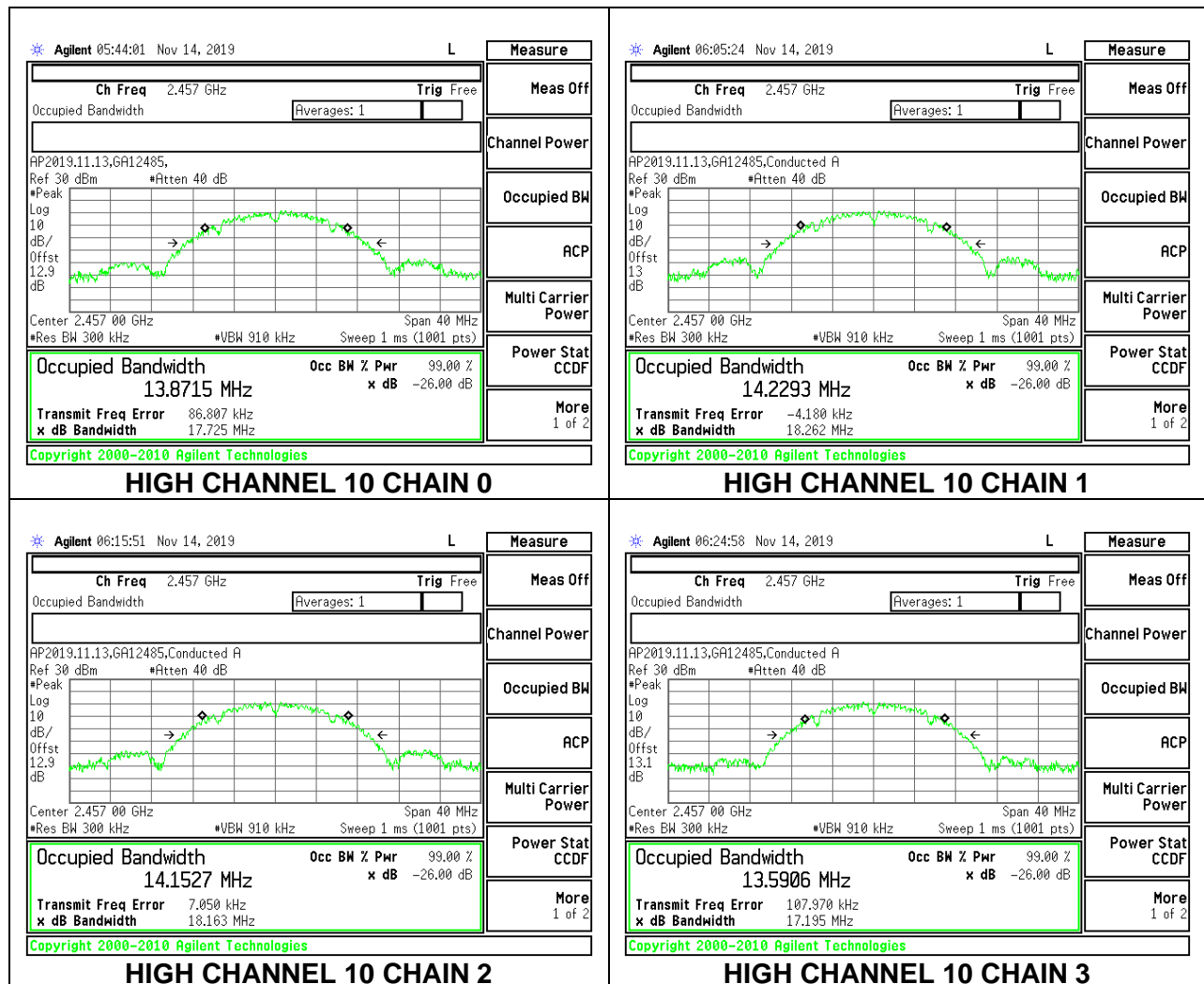
## LOW CHANNEL 2



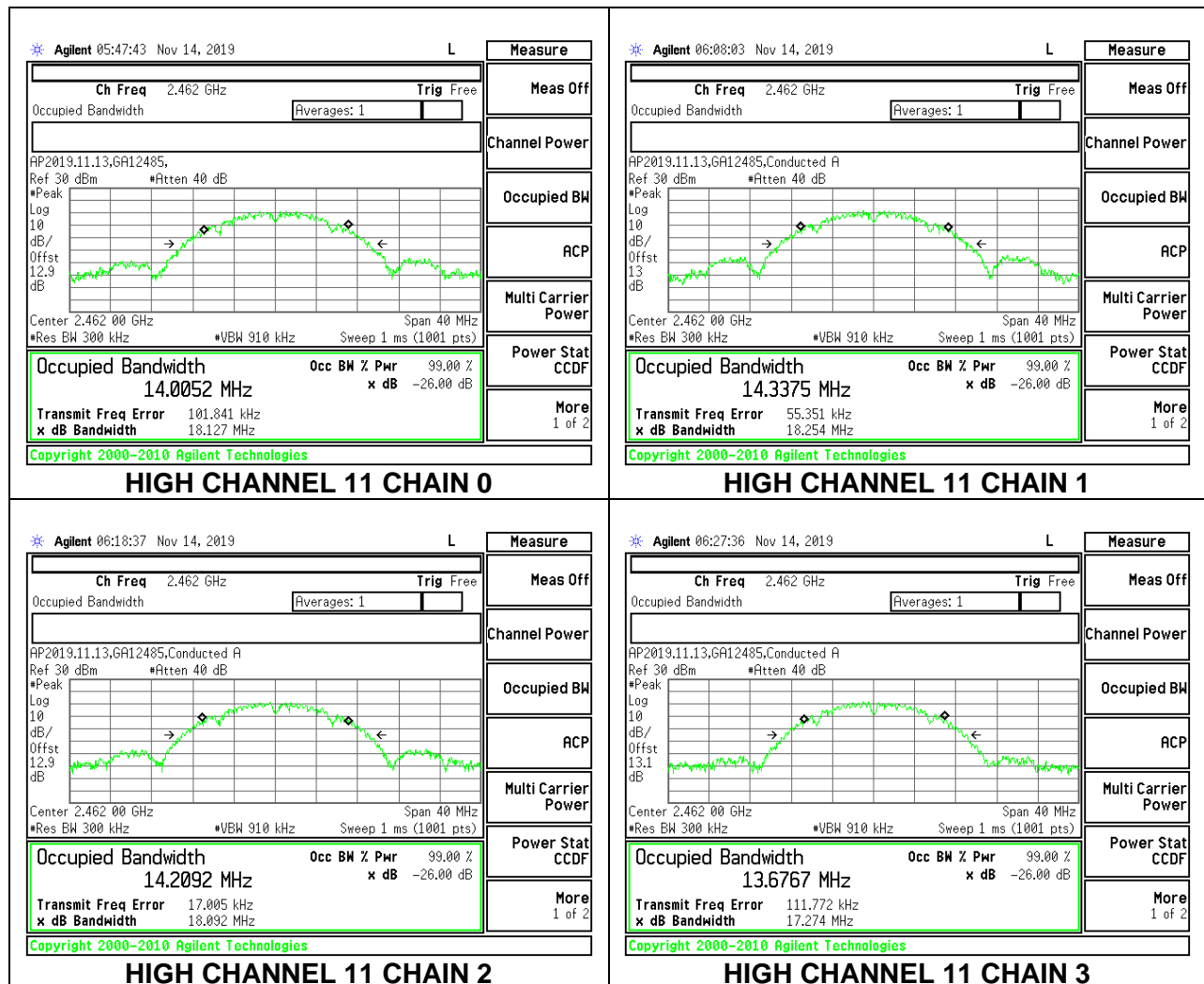
## MID CHANNEL 6



## HIGH CHANNEL 10



## HIGH CHANNEL 11



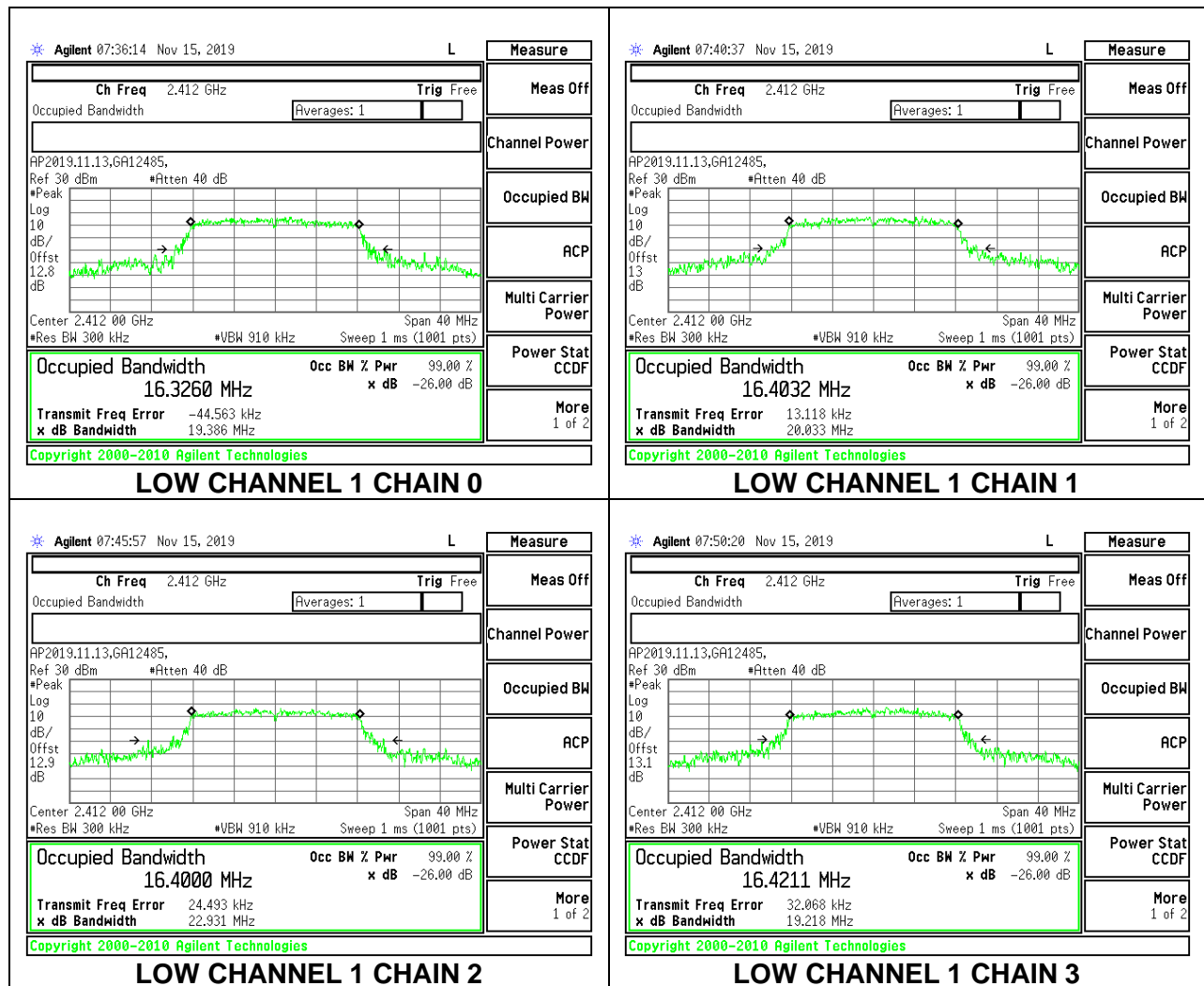
## 8.2.2. 802.11g MODE

### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

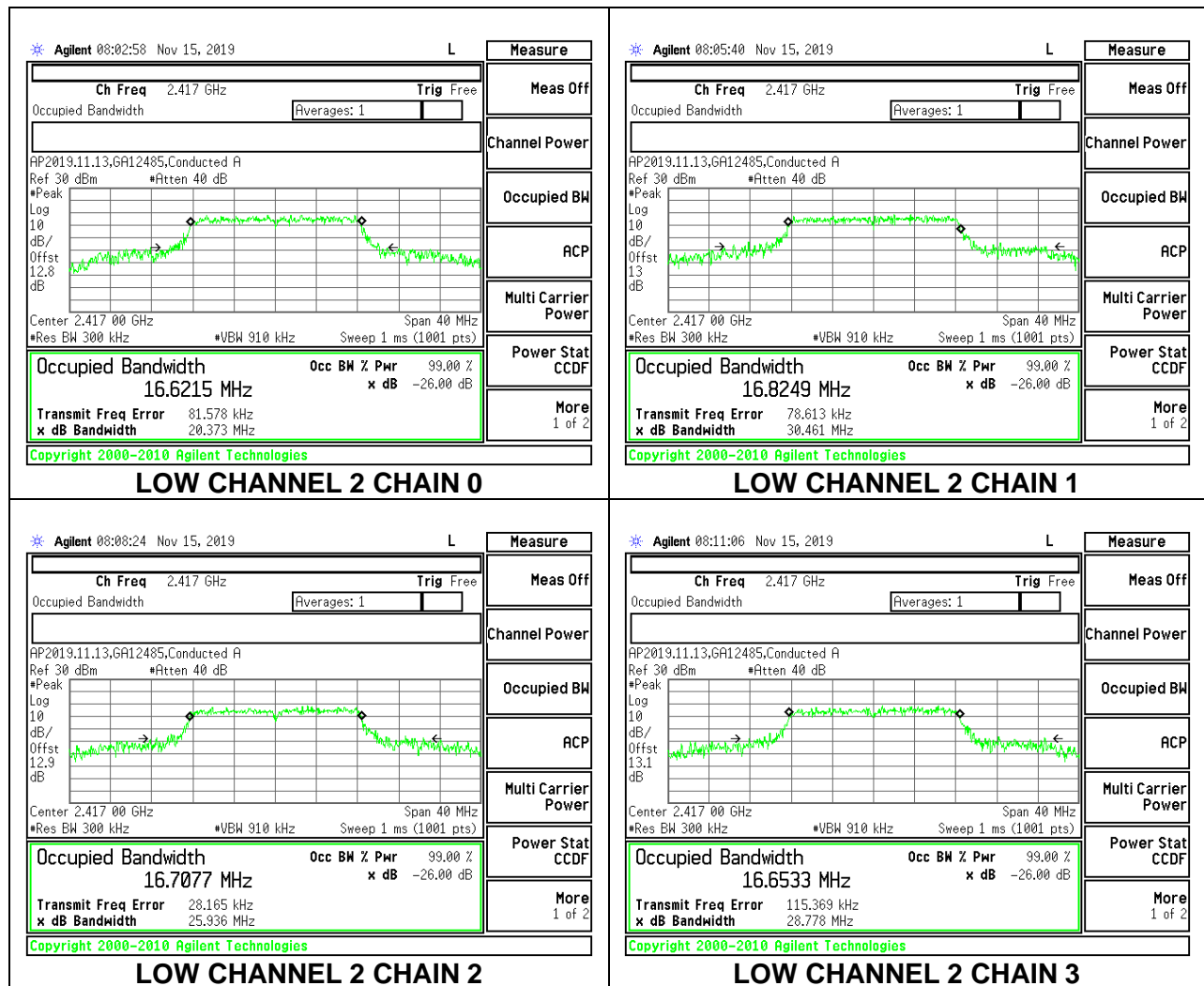
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)	99% Bandwidth Chain 2 (MHz)	99% Bandwidth Chain 3 (MHz)
Low 1	2412	16.326	16.403	16.400	16.421
Low 2	2417	16.622	16.825	16.708	16.653
Mid 6	2437	16.629	16.913	16.752	16.609
High 9	2452	16.601	16.651	16.987	16.625
High 10	2457	17.043	16.654	16.726	16.573
High 11	2462	16.757	16.622	16.578	16.584



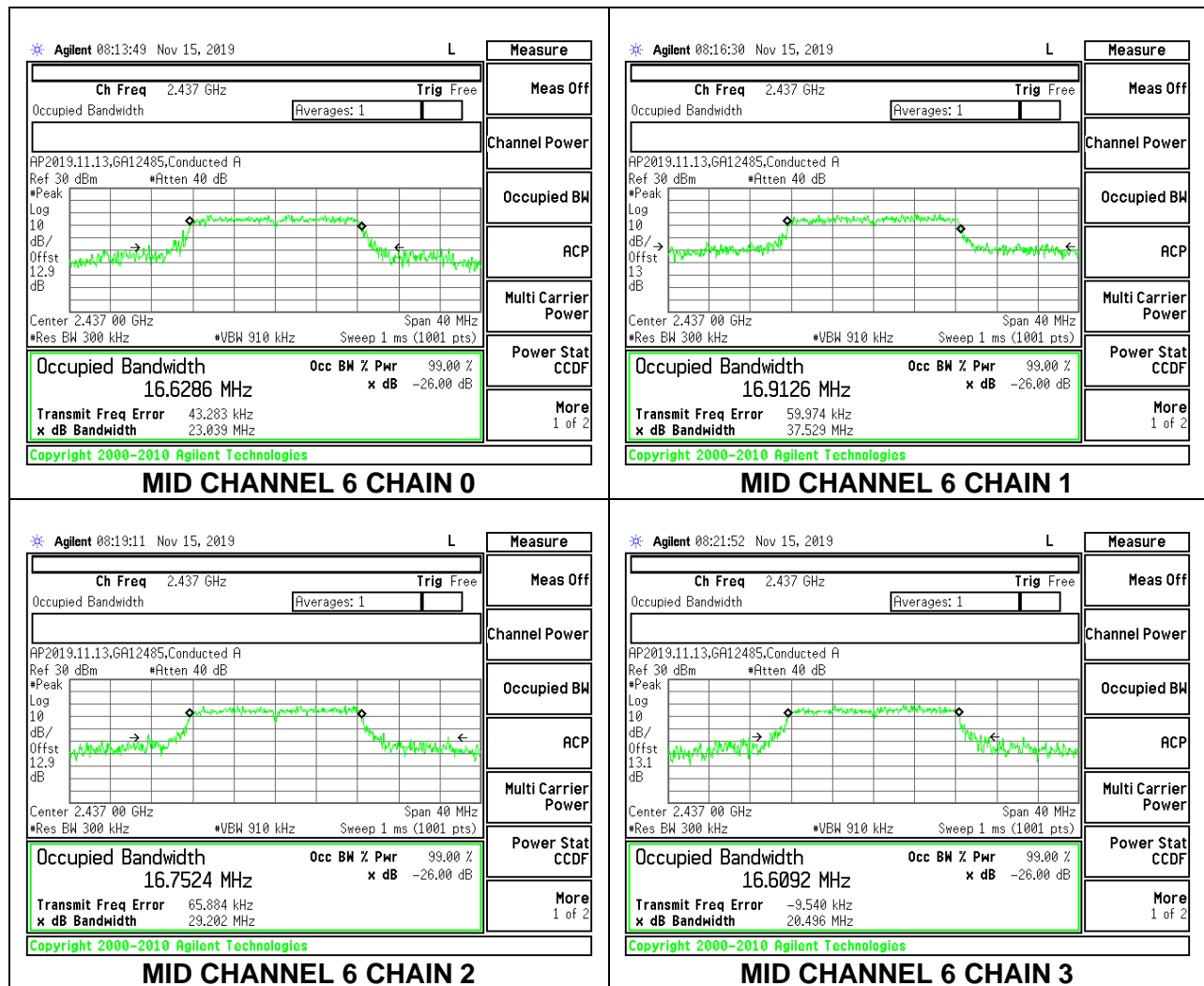
## LOW CHANNEL 1



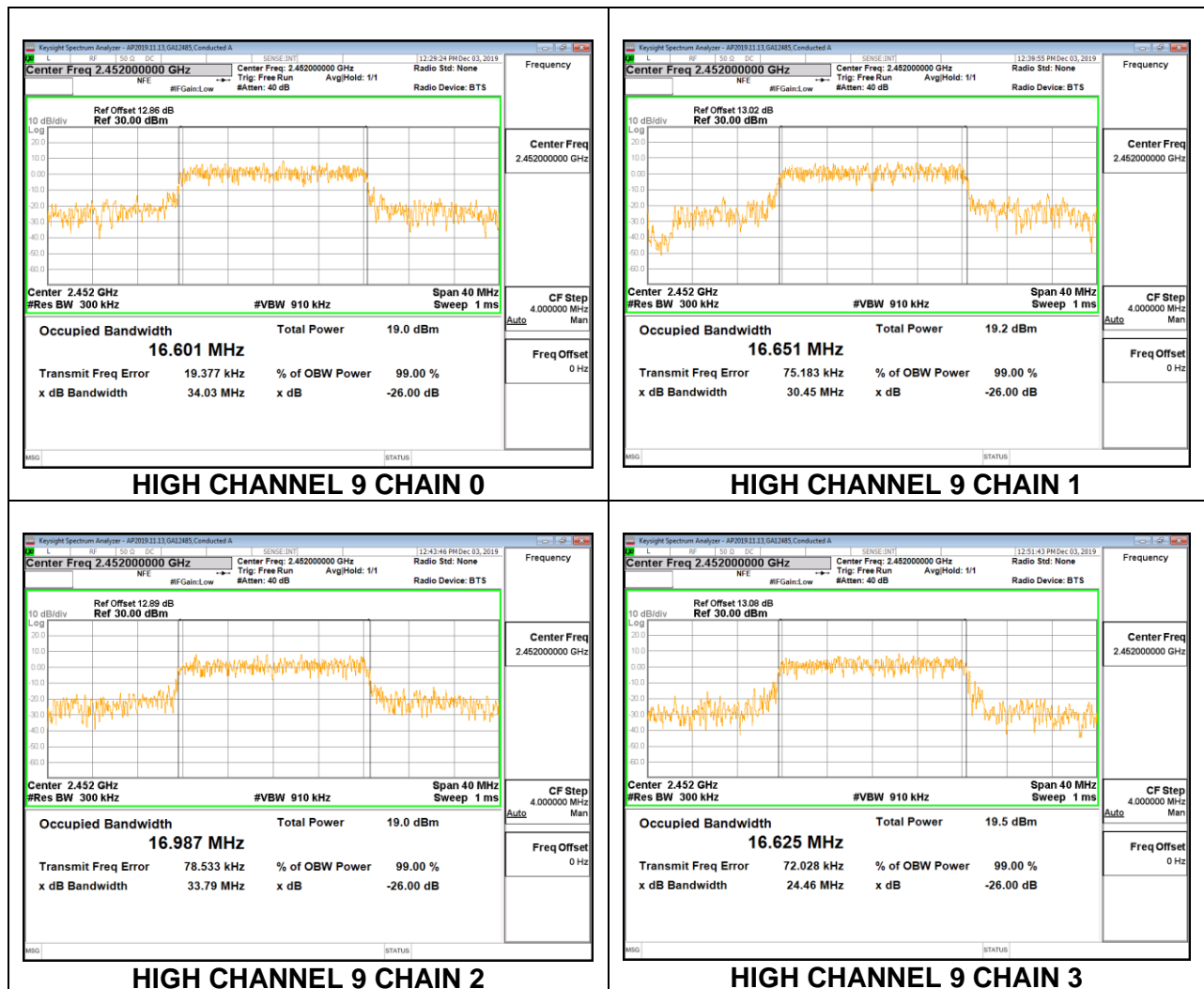
## LOW CHANNEL 2



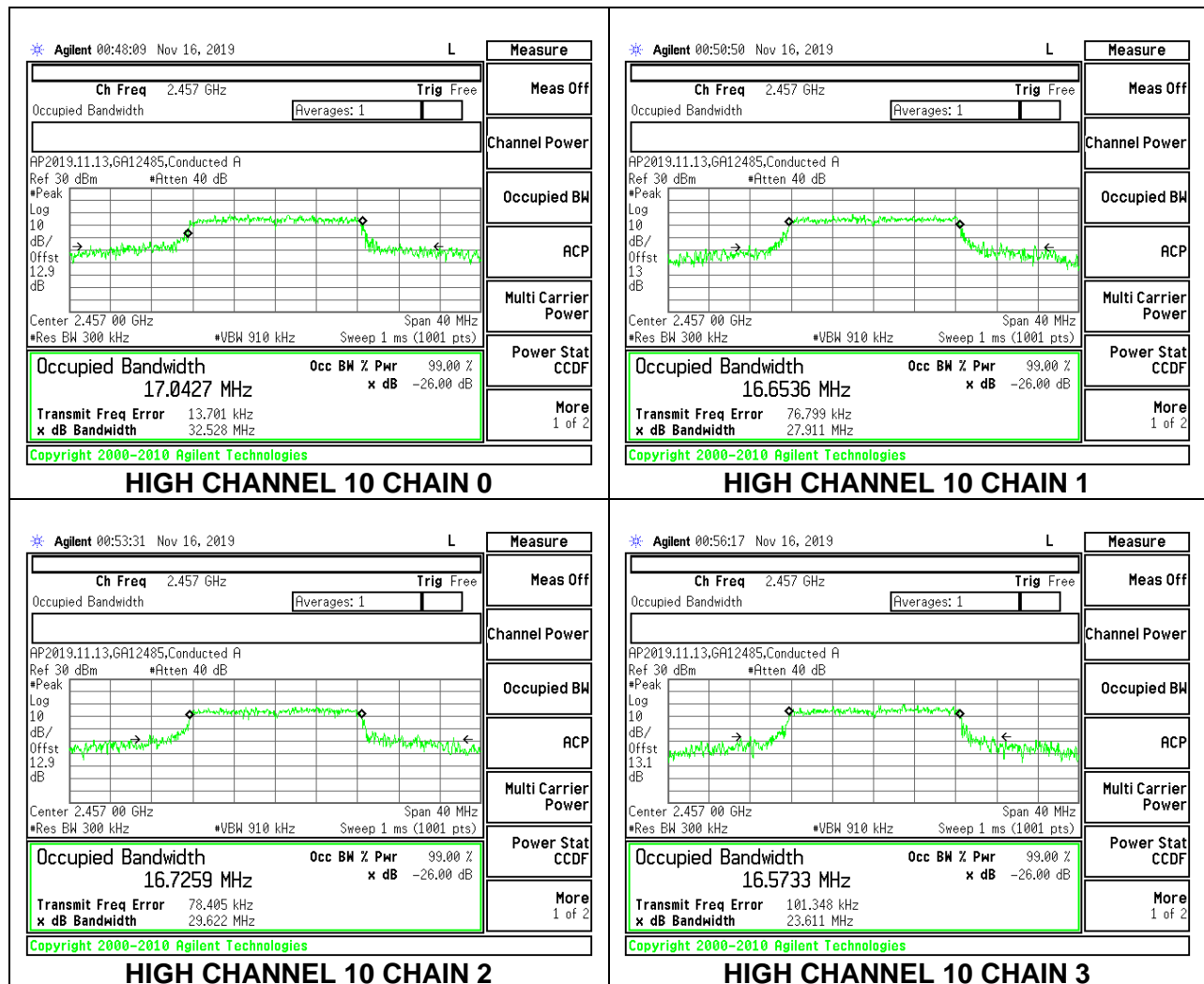
## MID CHANNEL 6



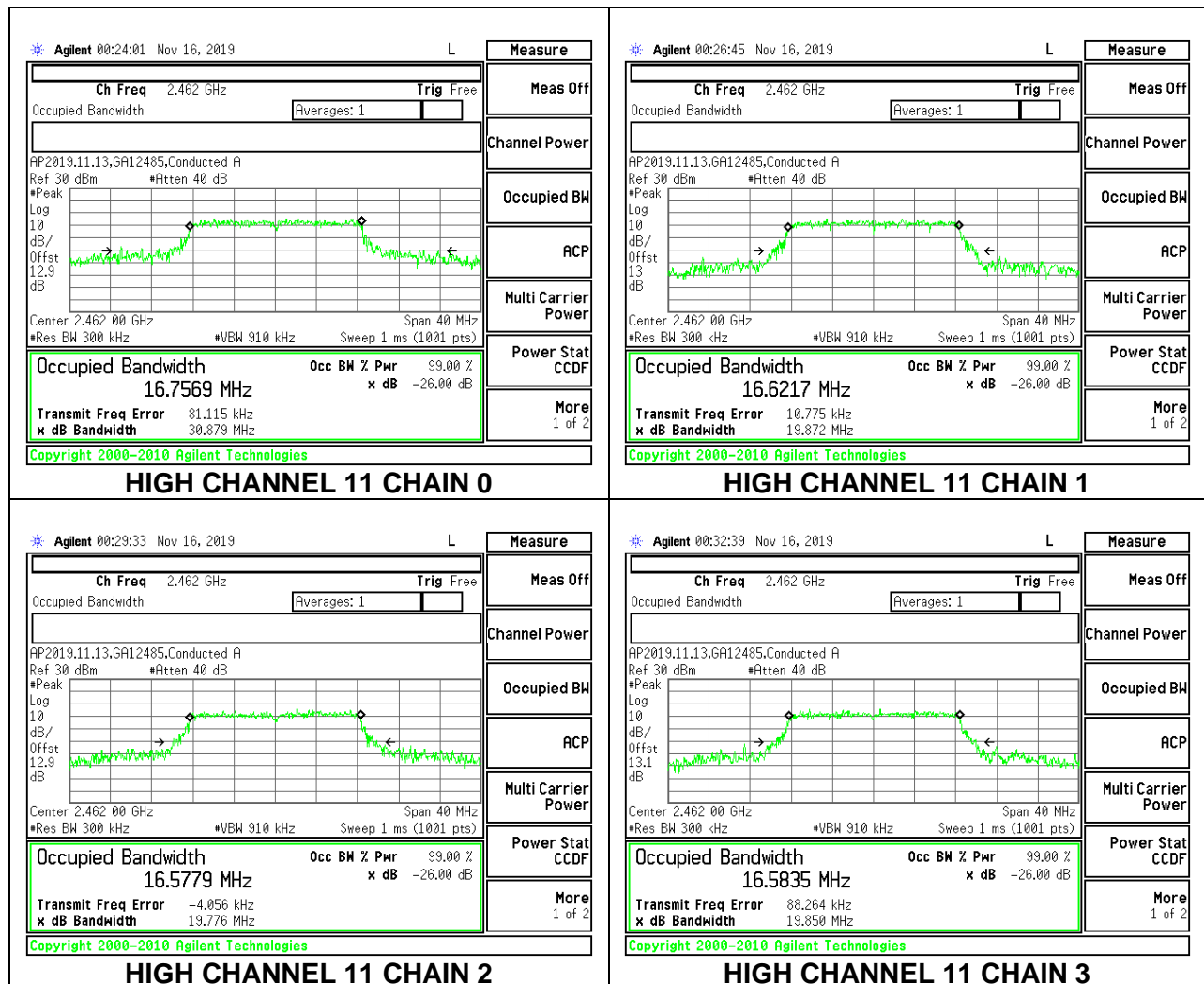
## HIGH CHANNEL 9



## HIGH CHANNEL 10



## HIGH CHANNEL 11

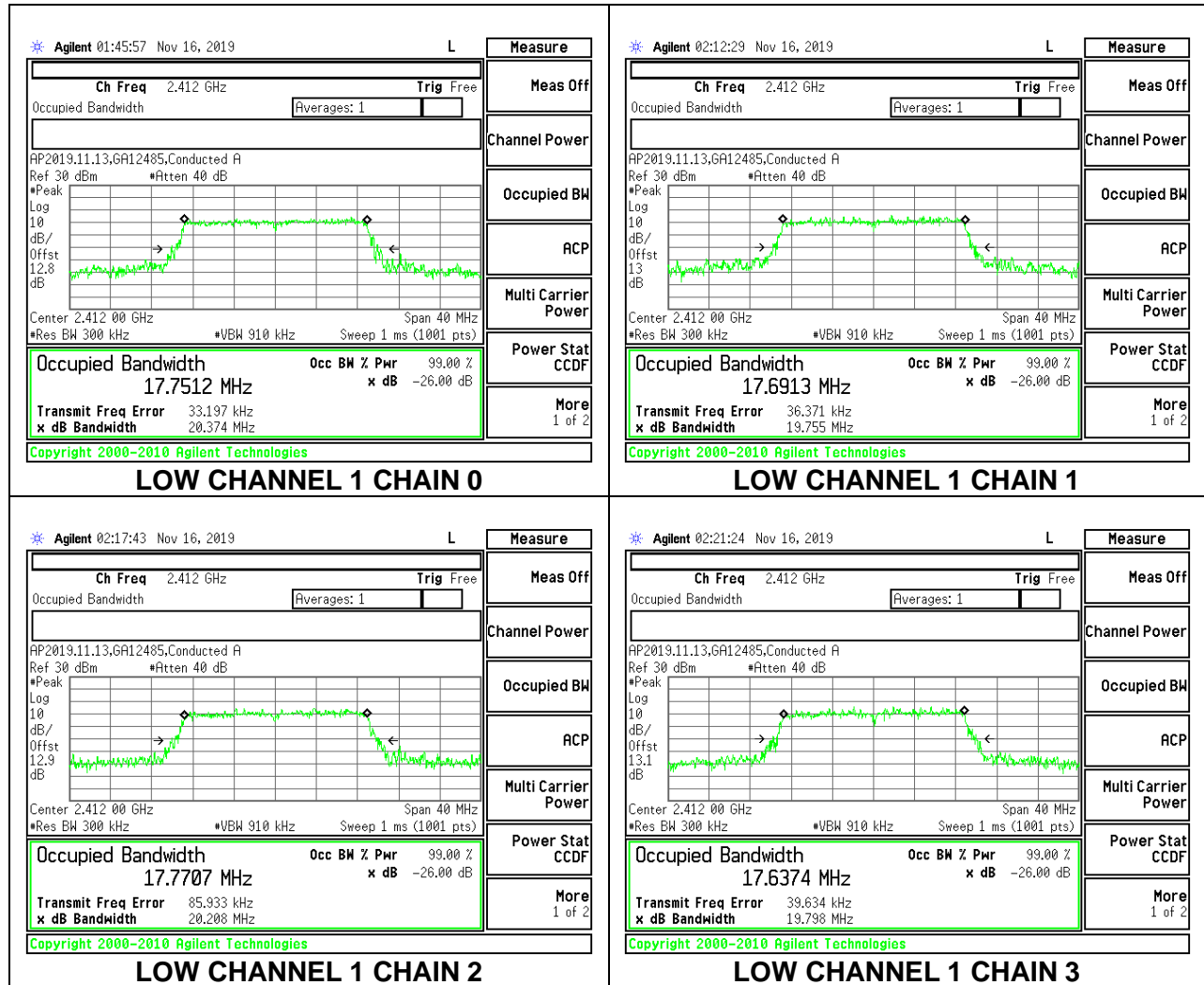


### 8.2.3. 802.11n HT20 MODE

#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

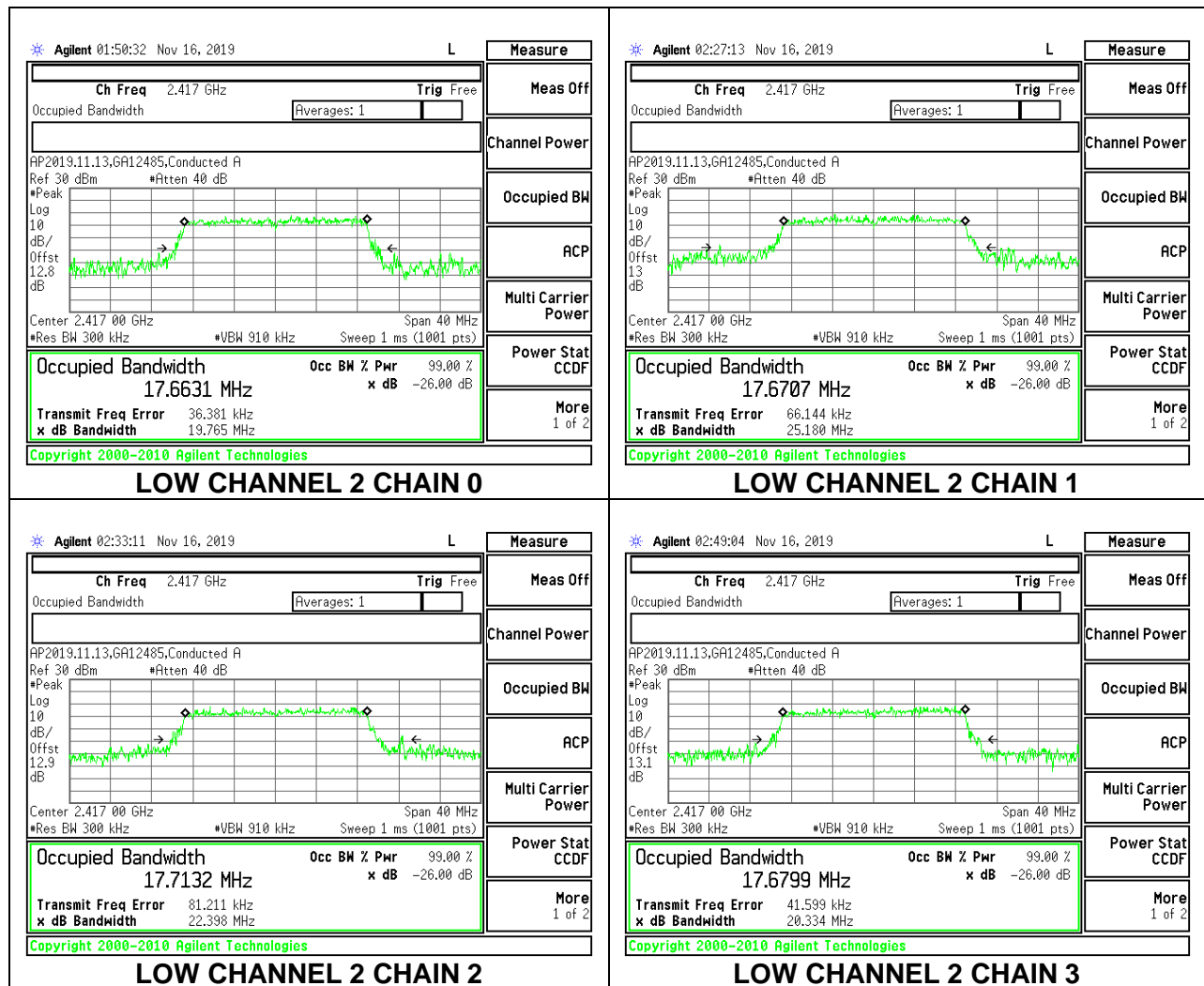
Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)	99% Bandwidth Chain 2 (MHz)	99% Bandwidth Chain 3 (MHz)
Low 1	2412	17.751	17.691	17.771	17.637
Low 2	2417	17.663	17.671	17.713	17.680
Mid 6	2437	17.760	17.964	17.759	17.935
High 10	2457	17.657	17.695	17.988	17.719
High 11	2462	17.595	17.724	17.830	17.662

## LOW CHANNEL 1

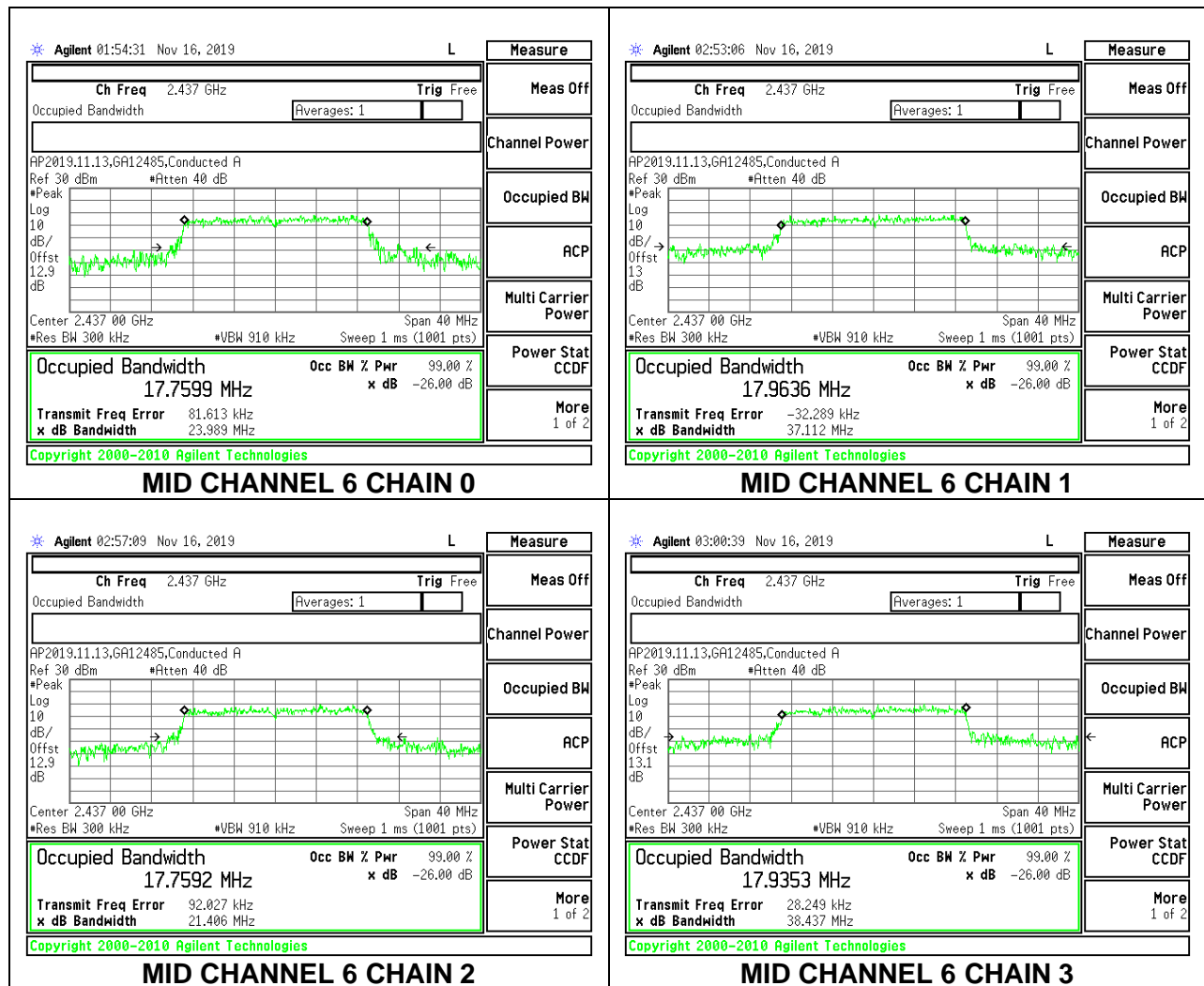




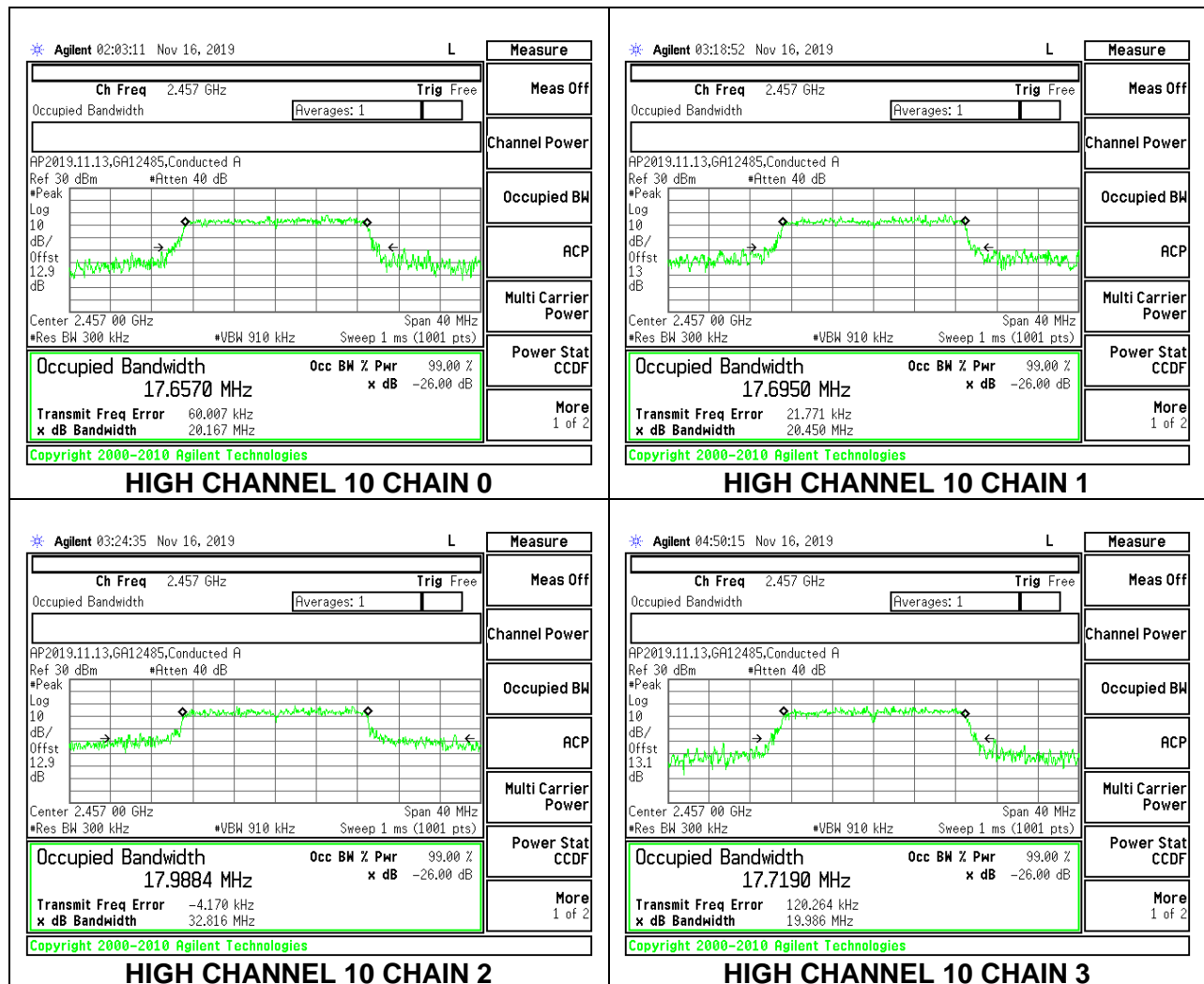
## LOW CHANNEL 2



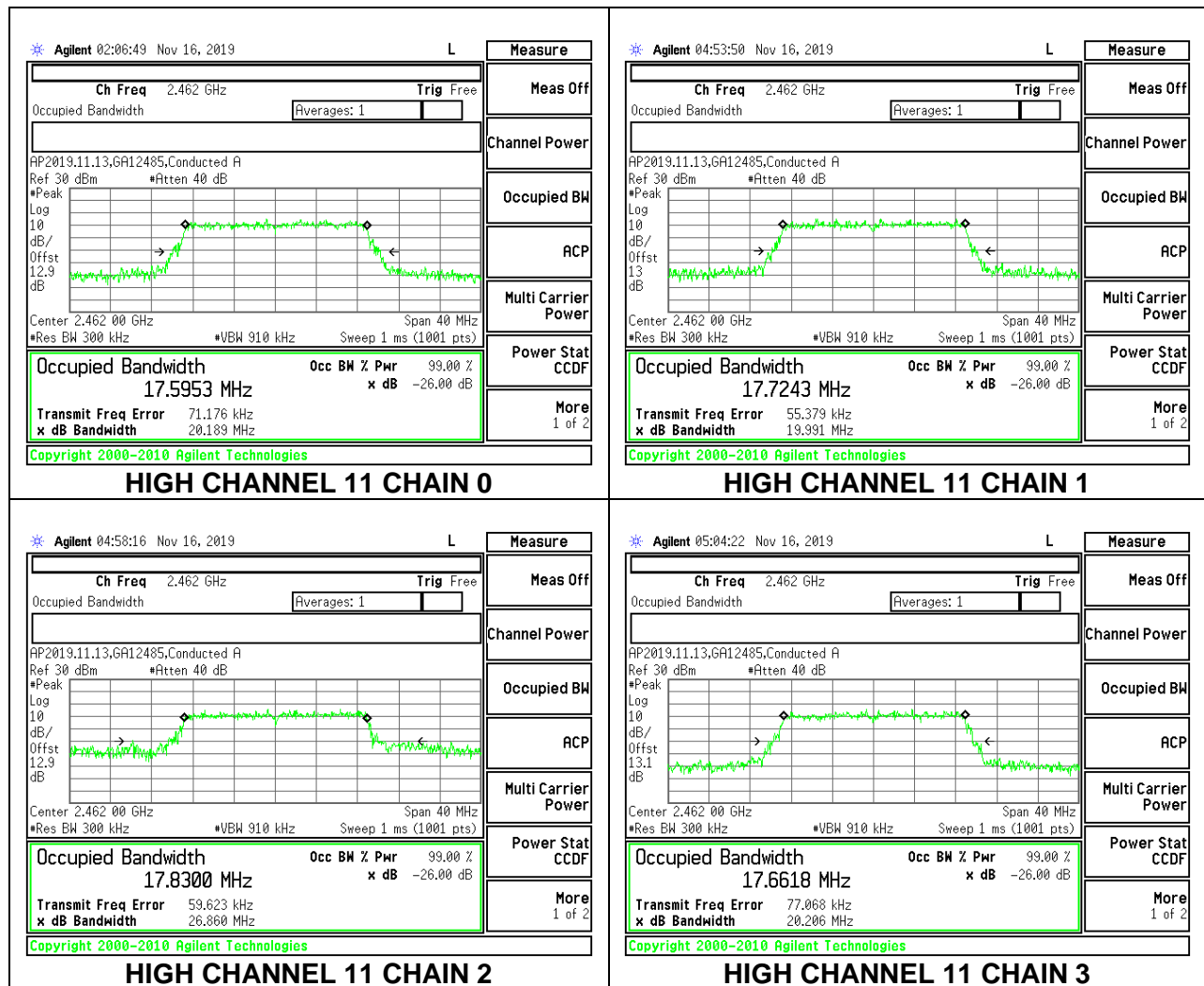
## MID CHANNEL 6



## HIGH CHANNEL 10



## HIGH CHANNEL 11



### **8.3. 6 dB BANDWIDTH**

#### **LIMITS**

FCC §15.247 (a) (2)

RSS-247 5.2 (a)

The minimum 6 dB bandwidth shall be at least 500 kHz.

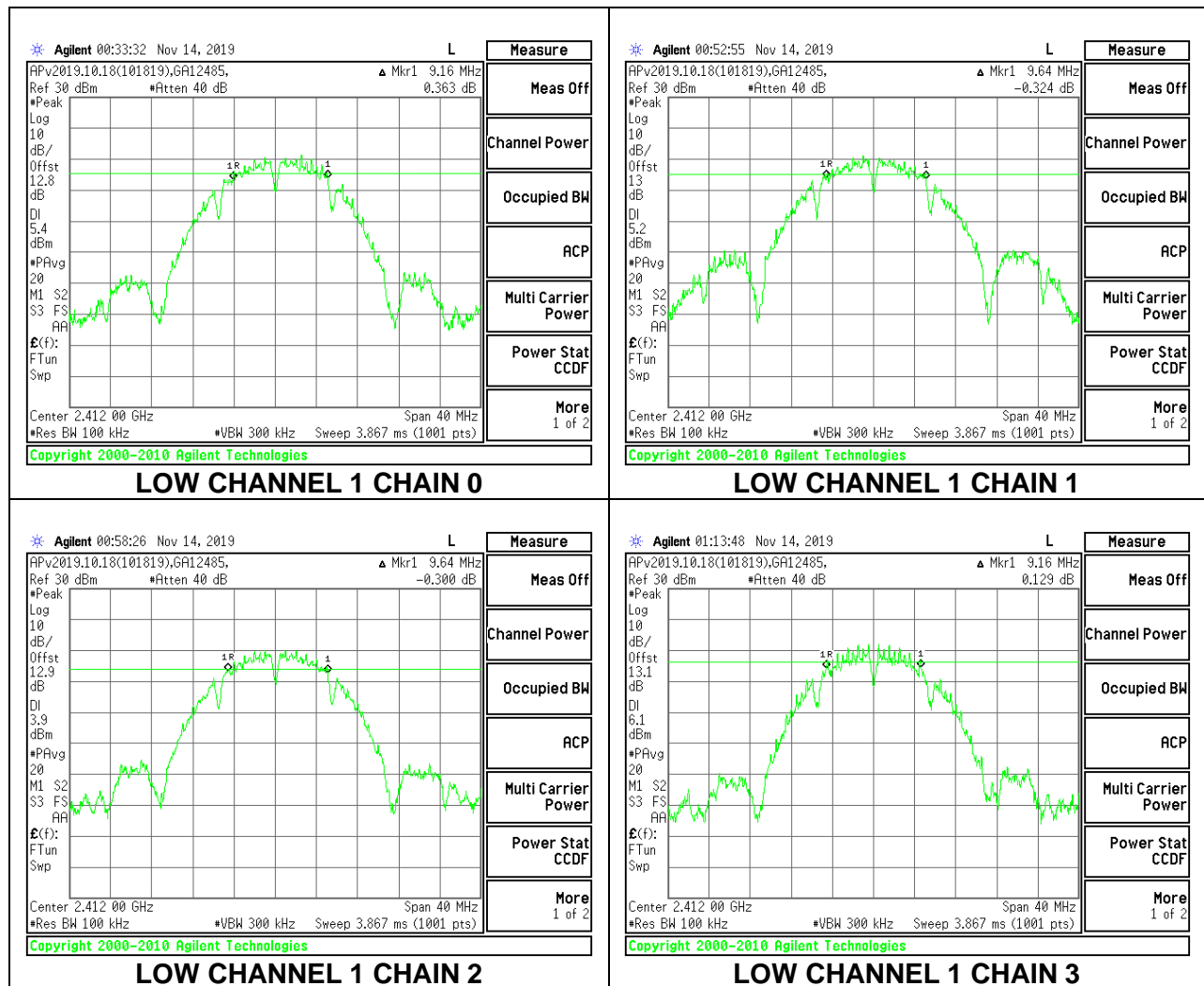
#### **RESULTS**

### 8.3.1. 802.11b MODE

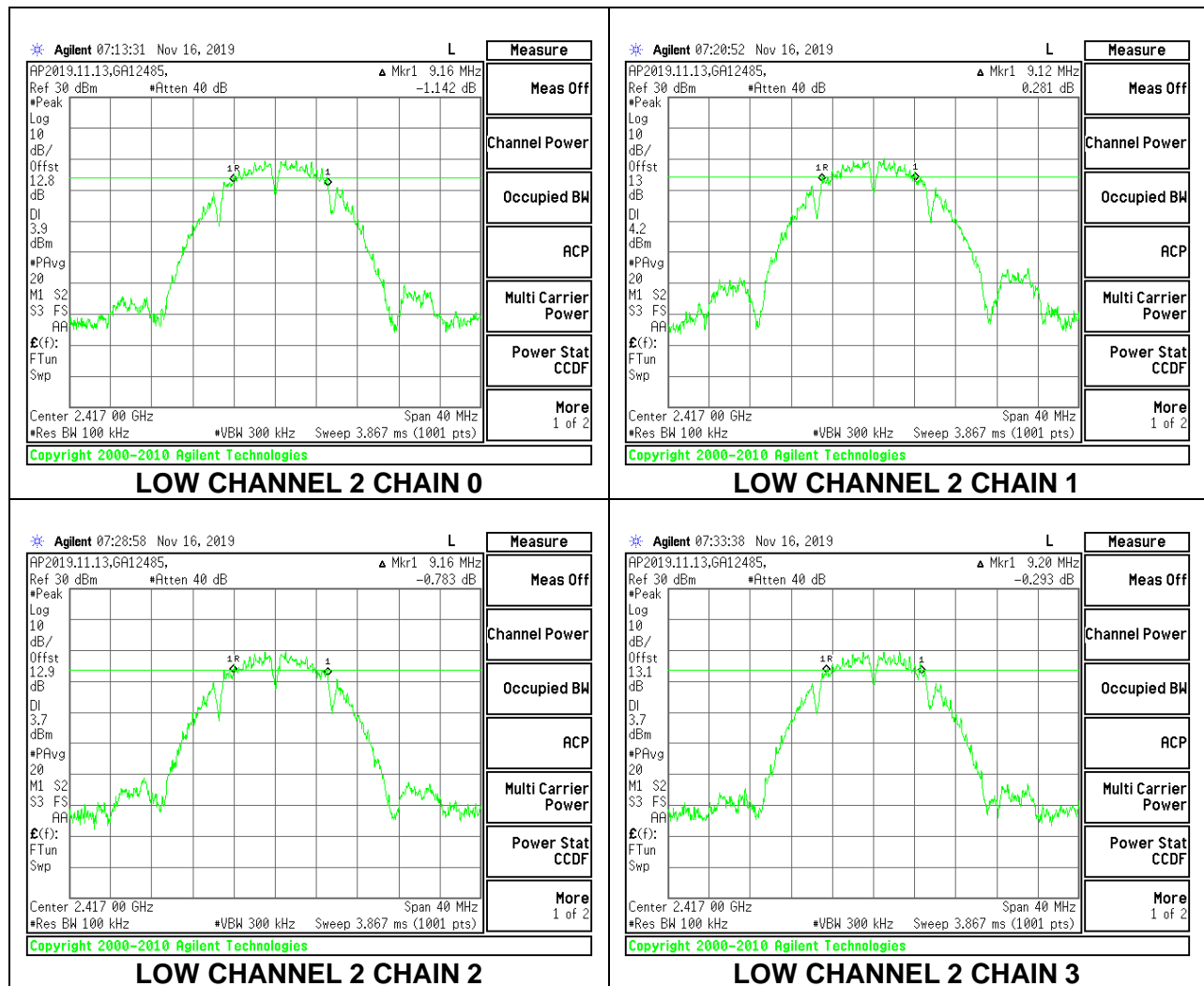
#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	6 dB BW Chain 2 (MHz)	6 dB BW Chain 3 (MHz)	Minimum Limit (MHz)
Low 1	2412	9.160	9.640	9.640	9.160	0.5
Low 2	2417	9.160	9.120	9.160	9.200	0.5
Mid 6	2437	9.200	9.800	9.680	9.120	0.5
High 10	2457	9.160	9.160	9.160	9.600	0.5
High 11	2462	9.160	9.080	9.160	9.160	0.5

## LOW CHANNEL 1

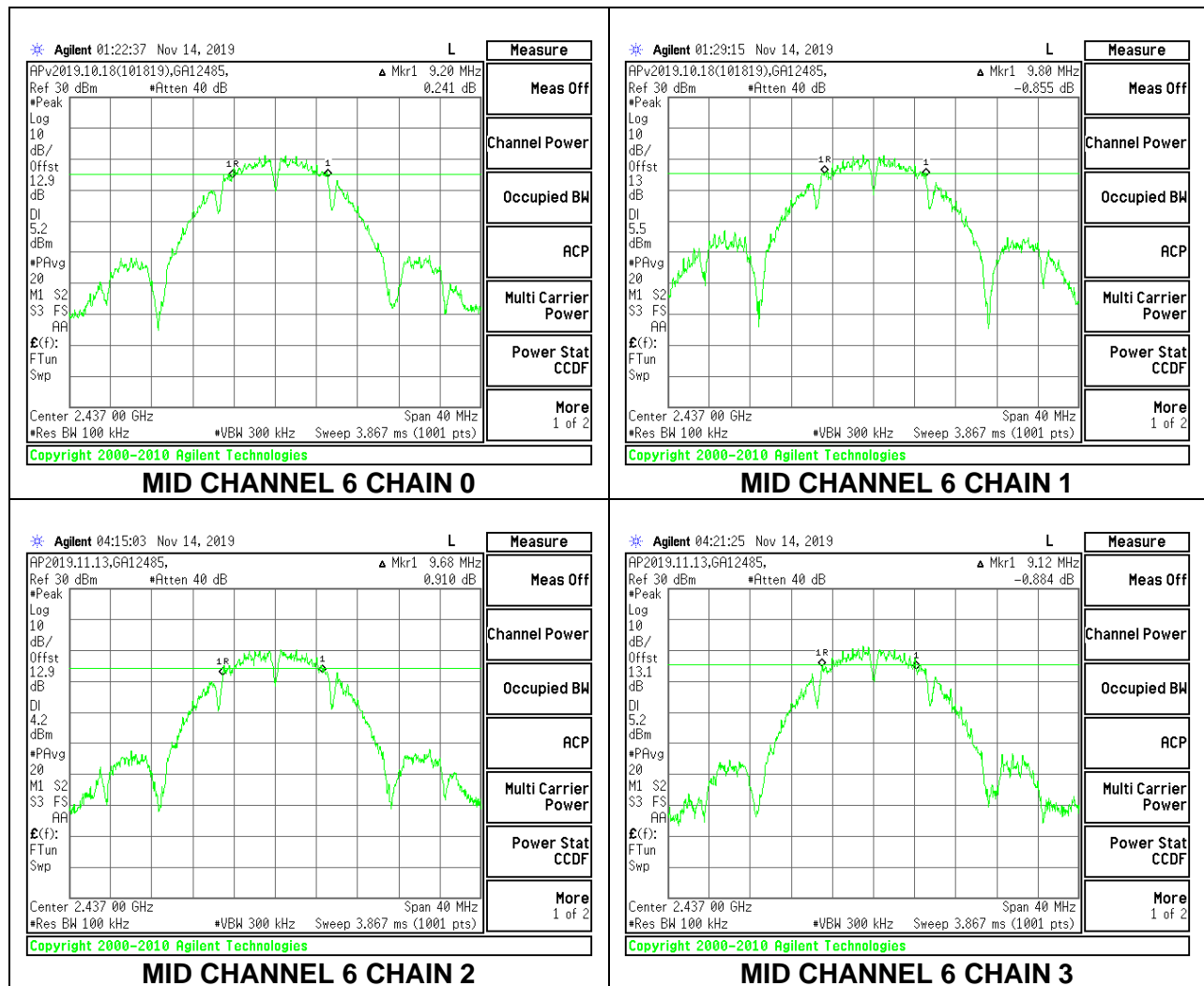


## LOW CHANNEL 2

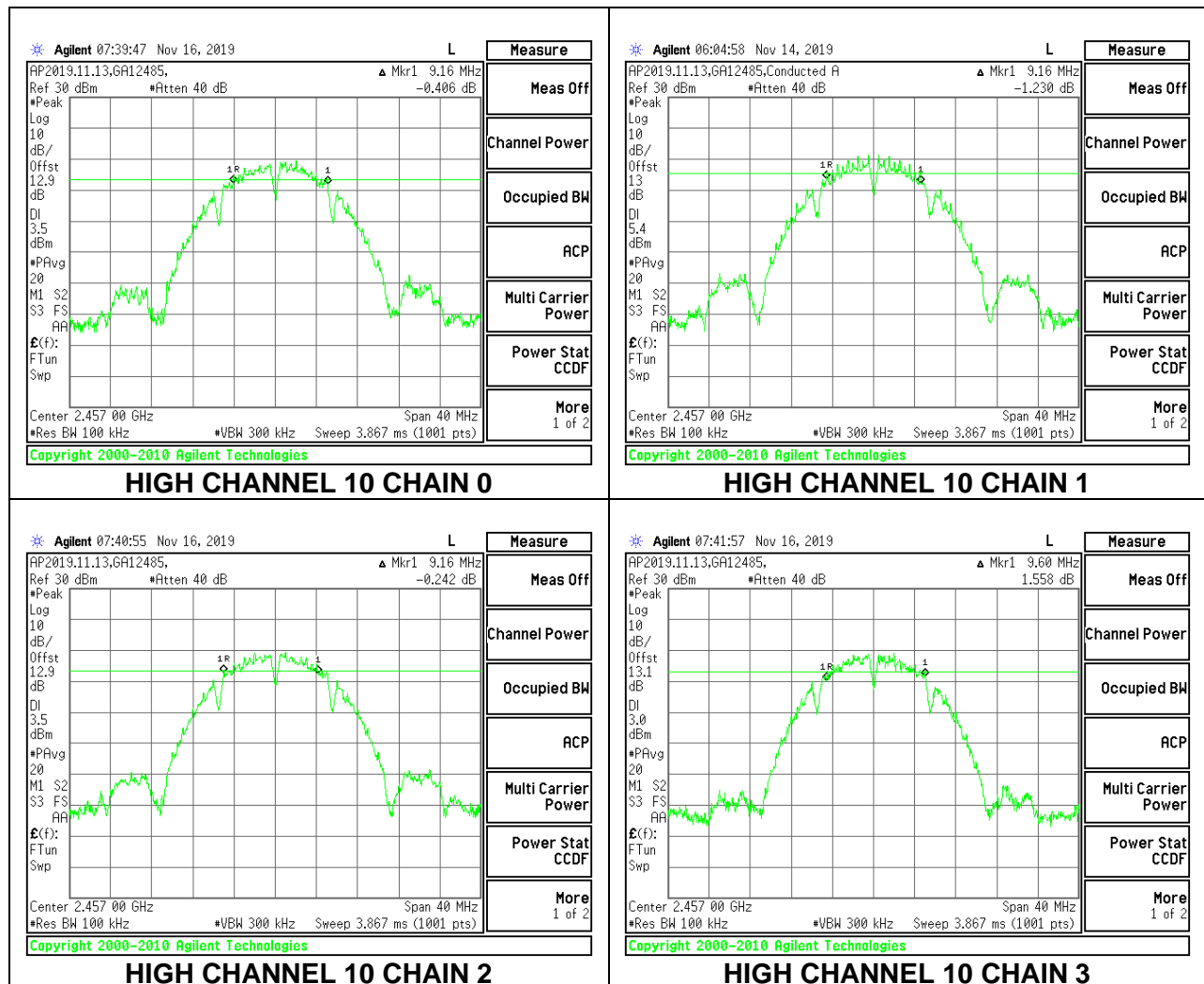




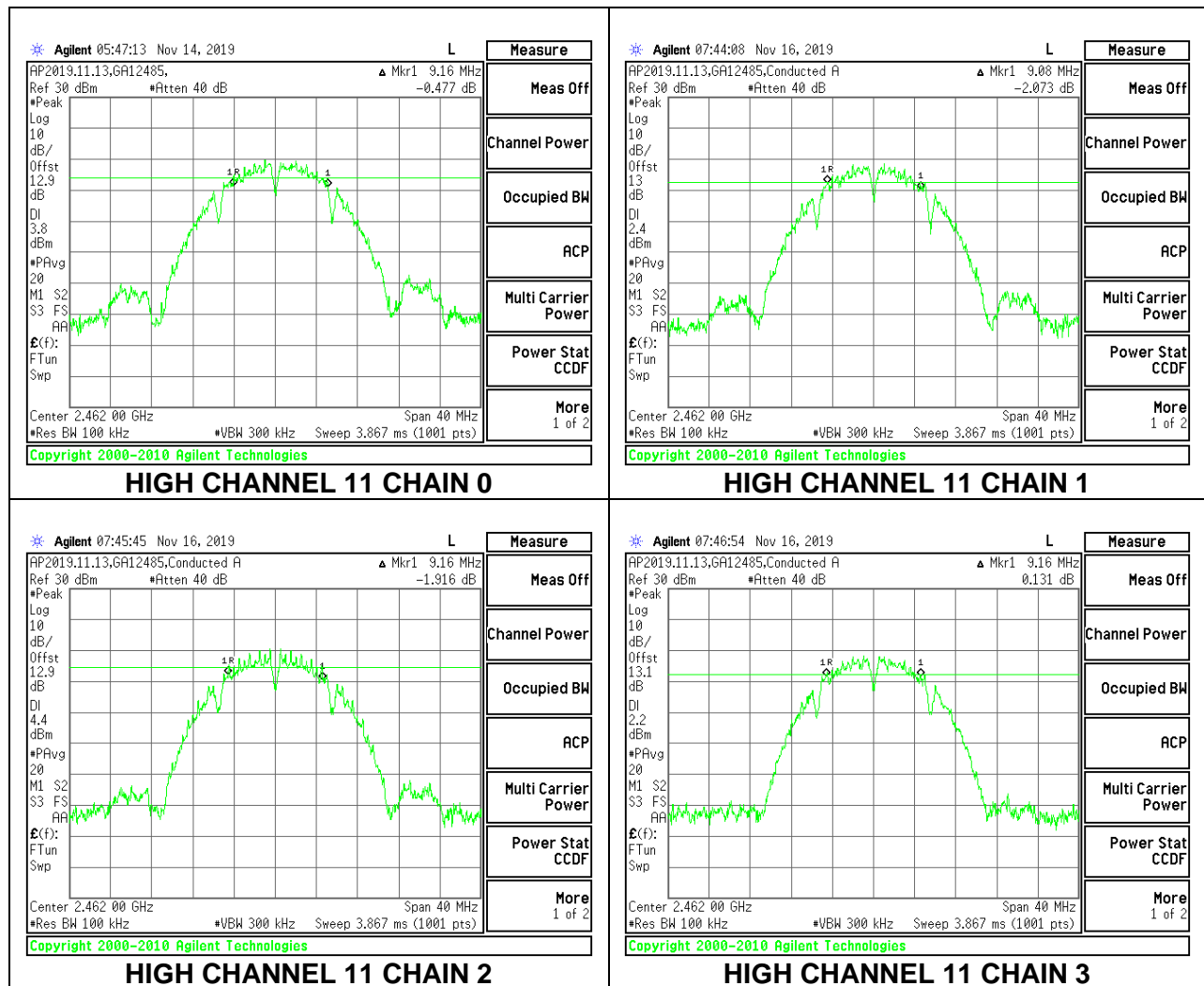
## MID CHANNEL 6



## HIGH CHANNEL 10



## HIGH CHANNEL 11

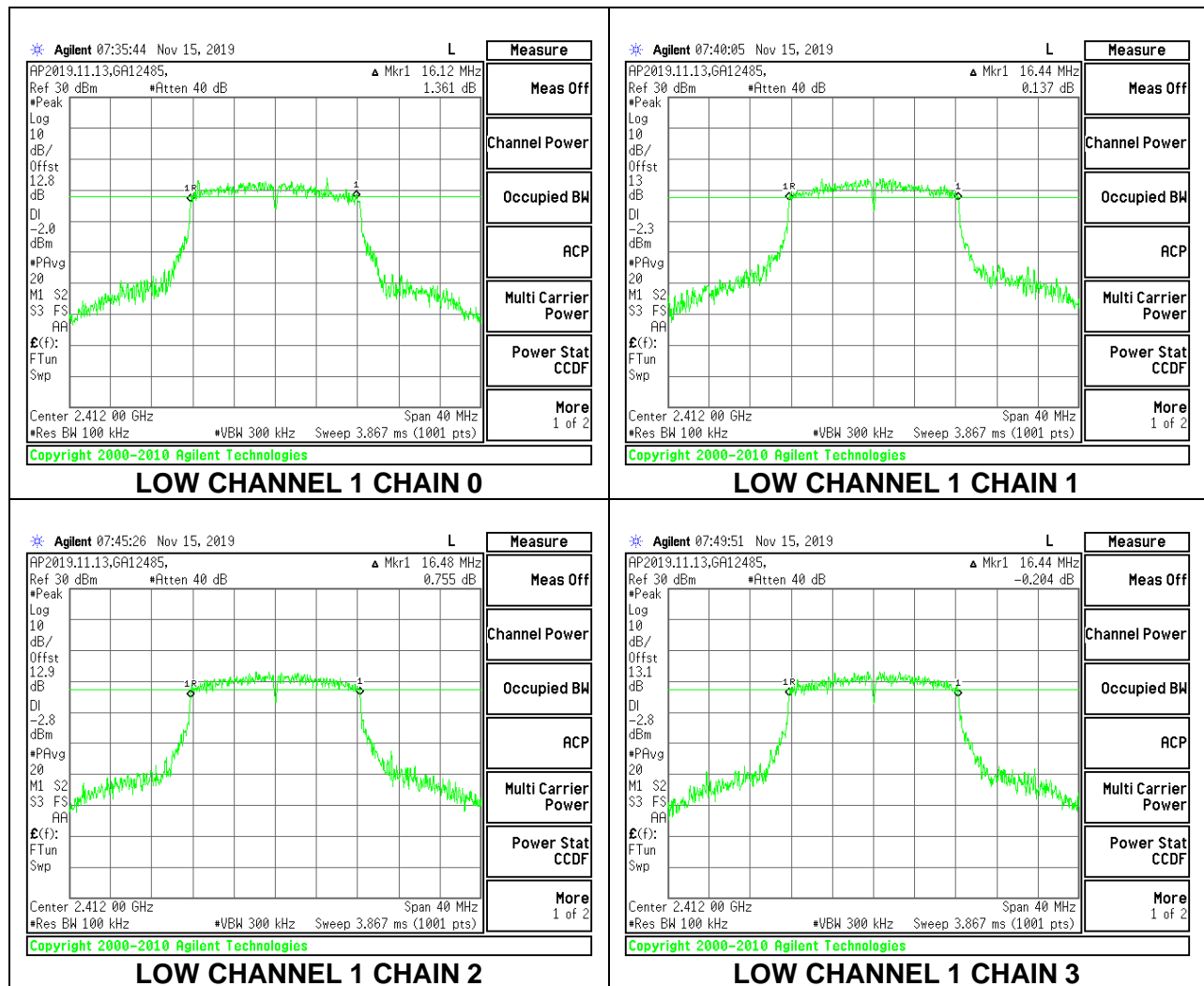


### 8.3.2. 802.11g MODE

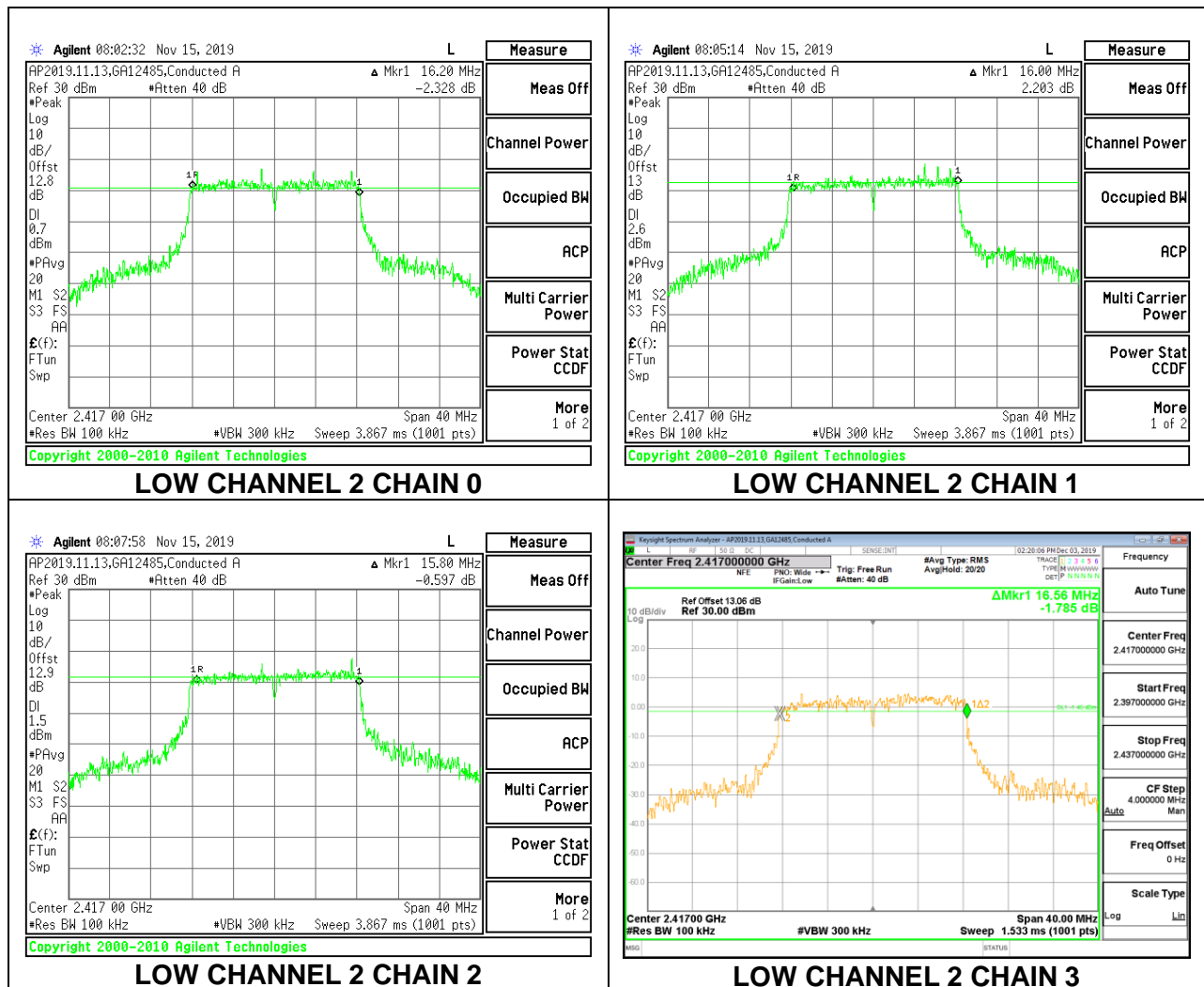
#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	6 dB BW Chain 2 (MHz)	6 dB BW Chain 3 (MHz)	Minimum Limit (MHz)
Low 1	2412	16.12	16.44	16.48	16.44	0.5
Low 2	2417	16.20	16.00	15.80	16.56	0.5
Mid 6	2437	16.44	16.08	16.56	16.48	0.5
High 9	2452	16.16	16.48	16.44	16.56	0.5
High 10	2457	16.48	16.44	16.56	16.40	0.5
High 11	2462	16.48	16.40	16.48	16.44	0.5

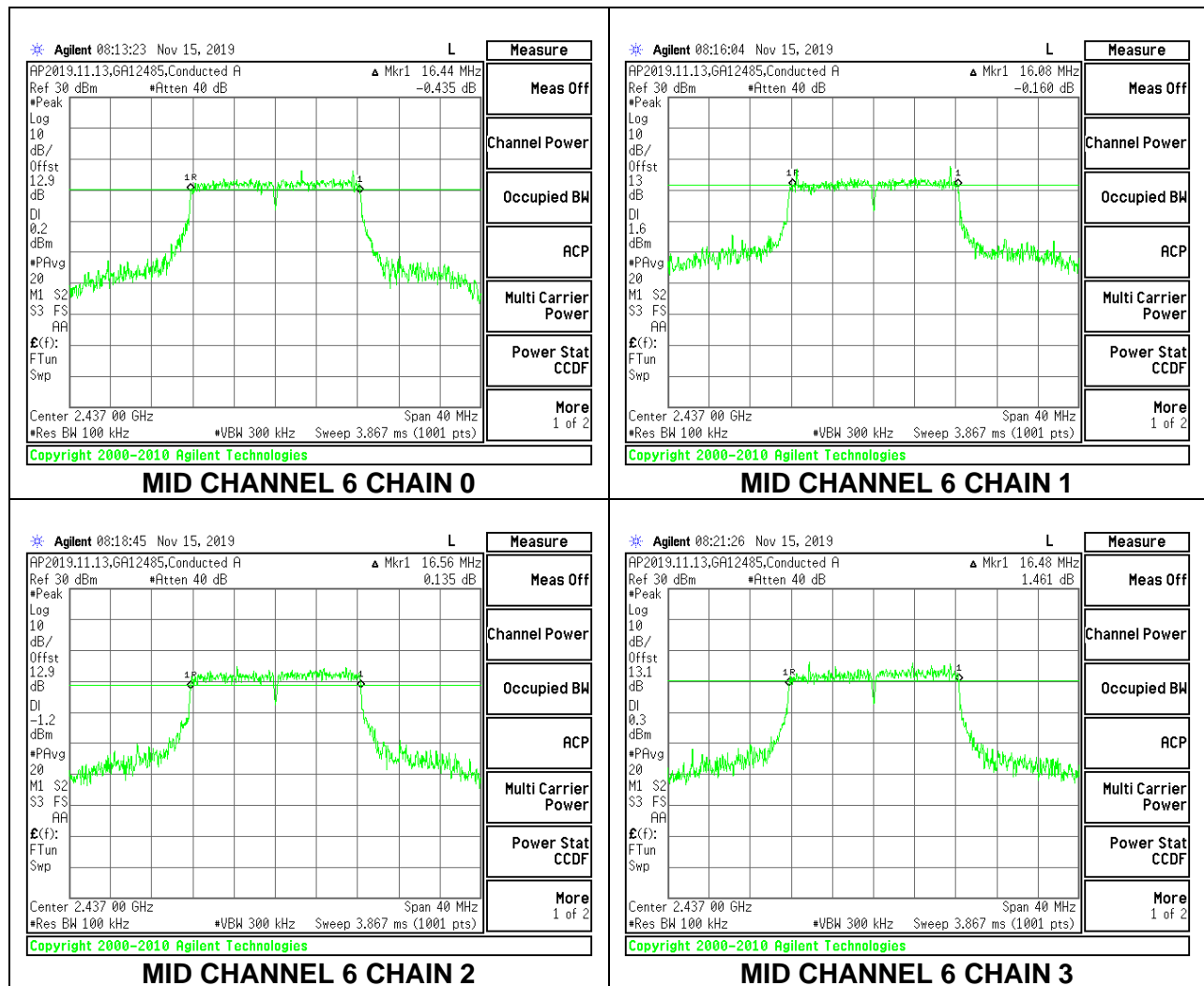
## LOW CHANNEL 1



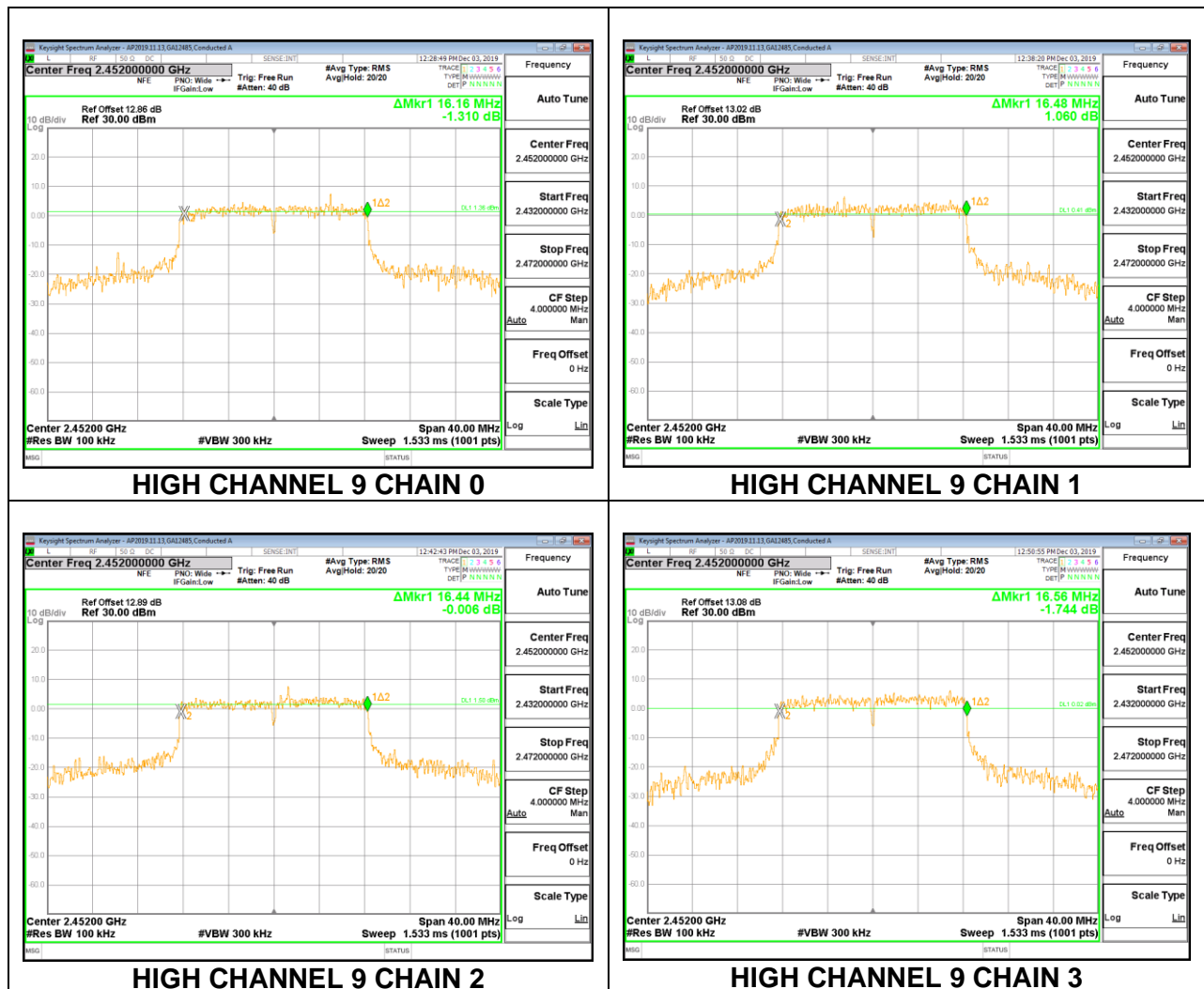
## LOW CHANNEL 2



## MID CHANNEL 6

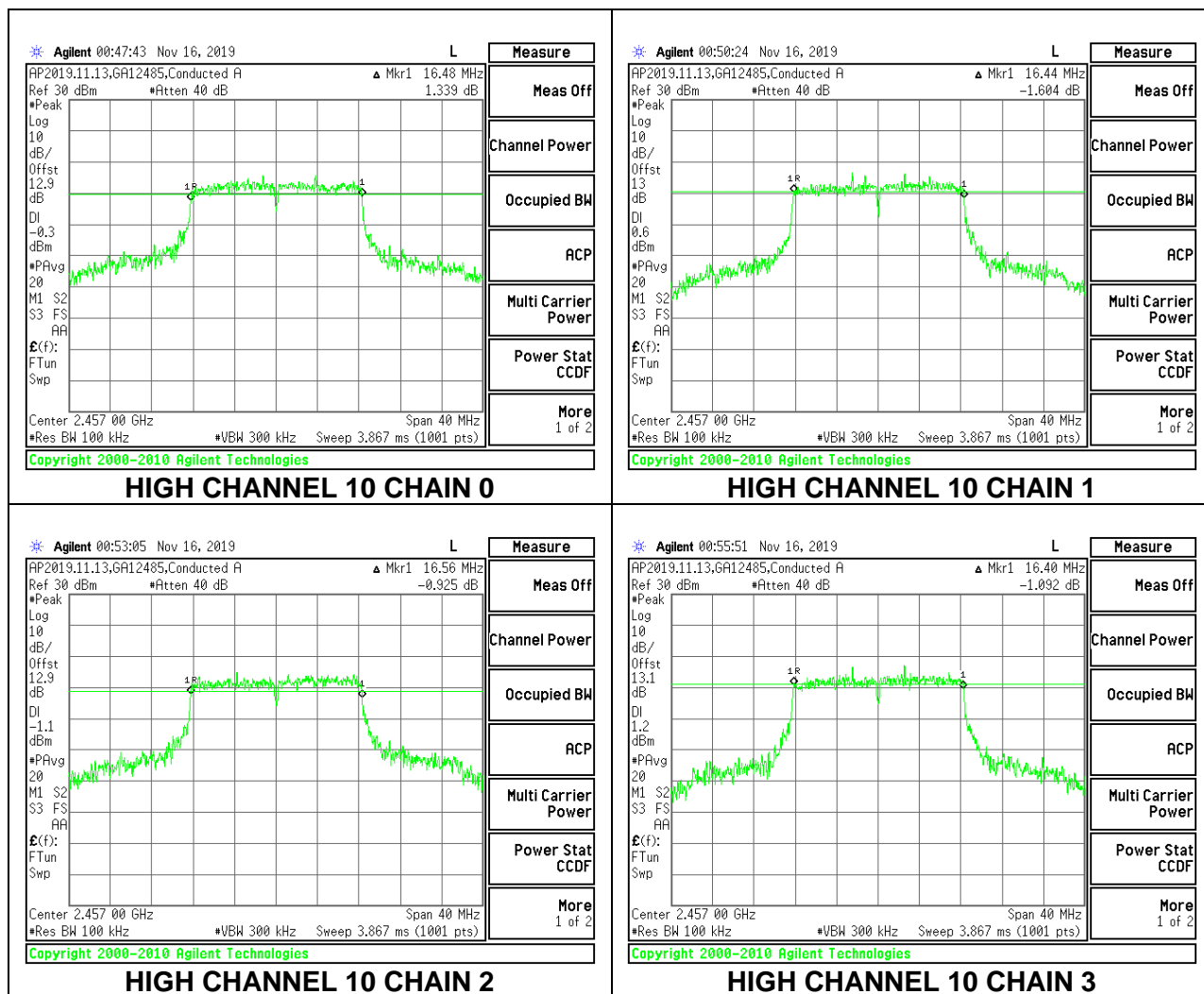


## HIGH CHANNEL 9

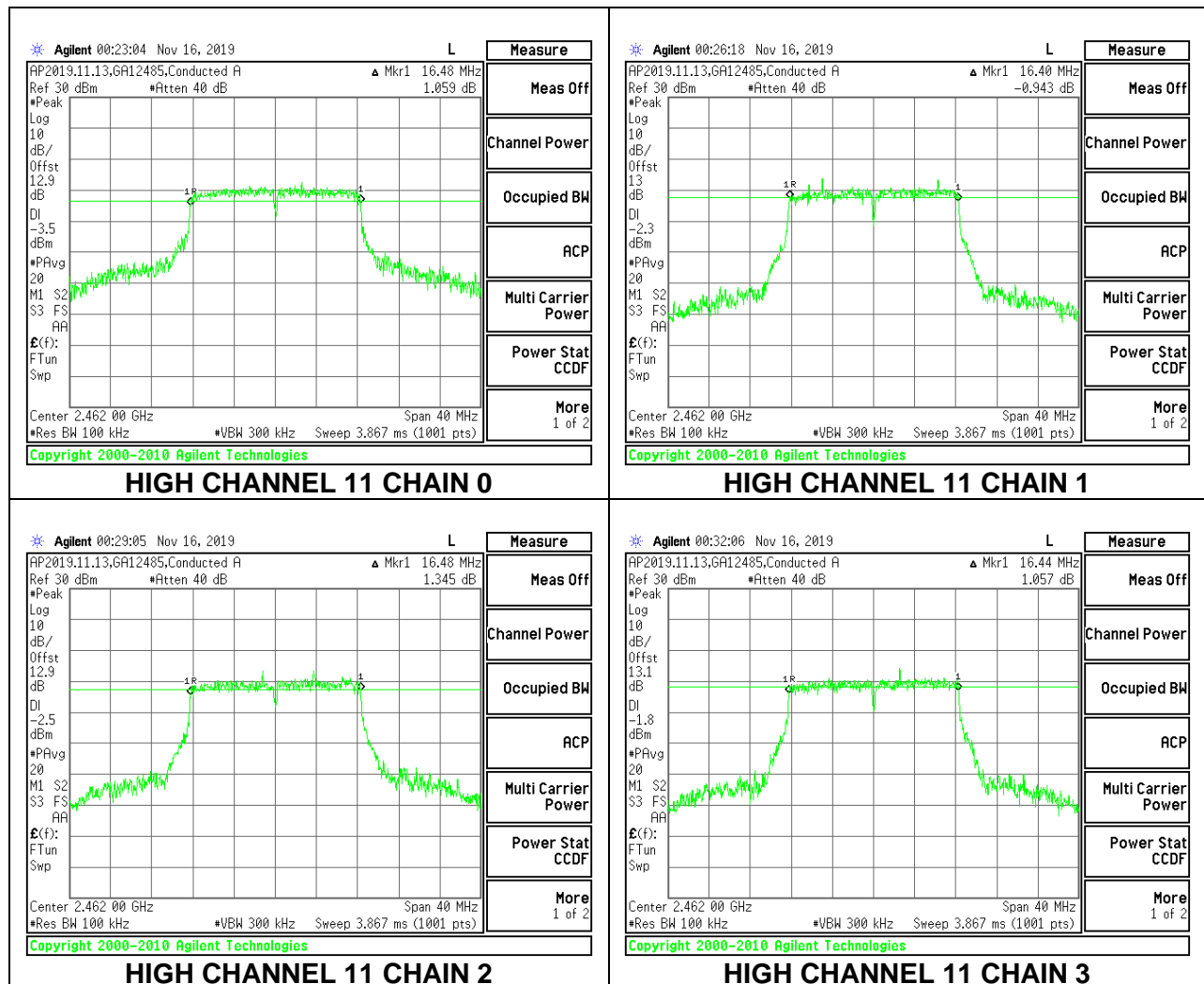




## HIGH CHANNEL 10



## HIGH CHANNEL 11

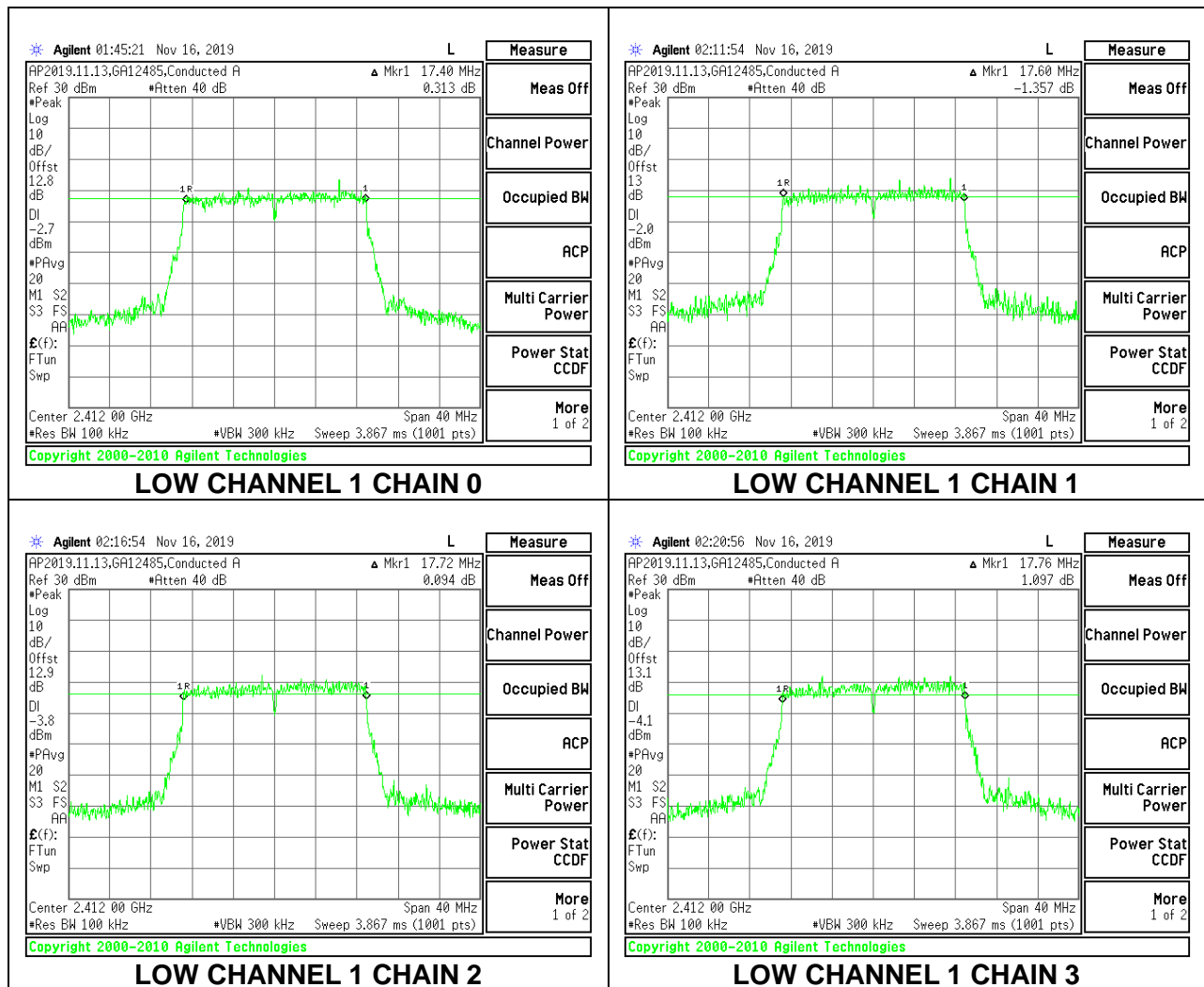


### 8.3.3. 802.11n HT20 MODE

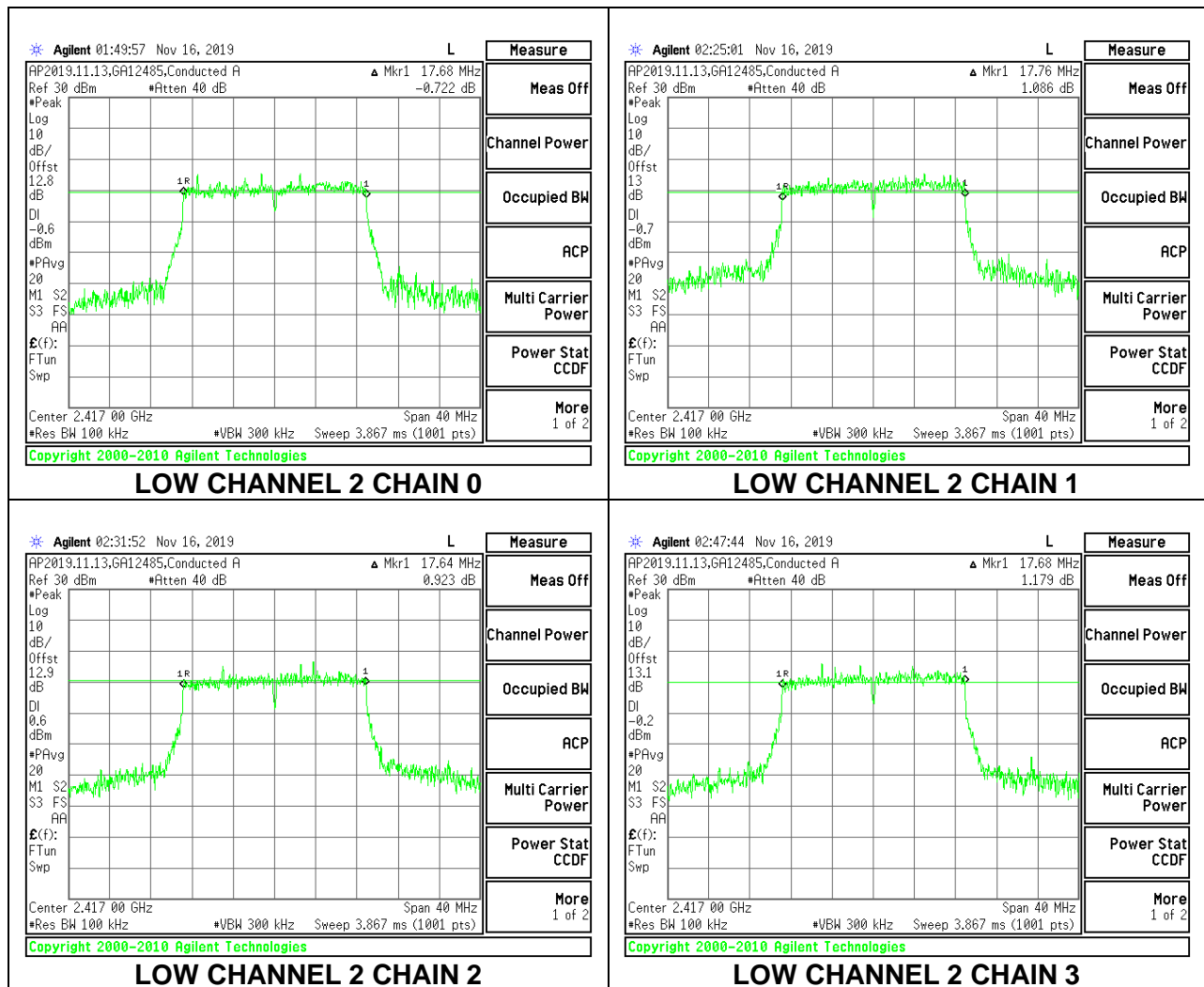
#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	6 dB BW Chain 2 (MHz)	6 dB BW Chain 3 (MHz)	Minimum Limit (MHz)
Low 1	2412	17.400	17.600	17.720	17.760	0.5
Low 2	2417	17.680	17.760	17.640	17.680	0.5
Mid 6	2437	17.680	17.680	17.680	17.680	0.5
High 10	2457	17.480	17.680	17.680	17.800	0.5
High 11	2462	17.760	17.480	17.720	17.720	0.5

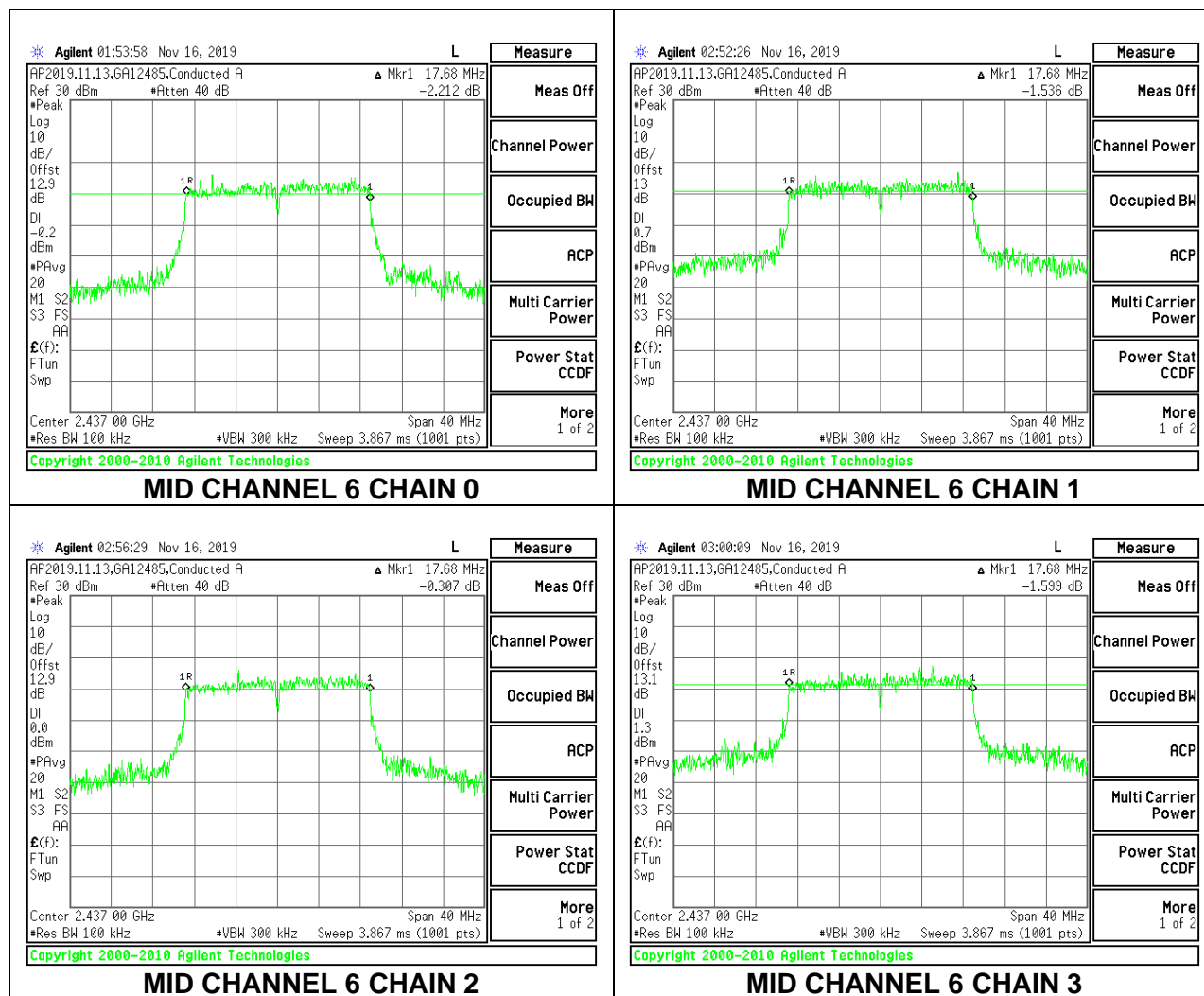
## LOW CHANNEL 1



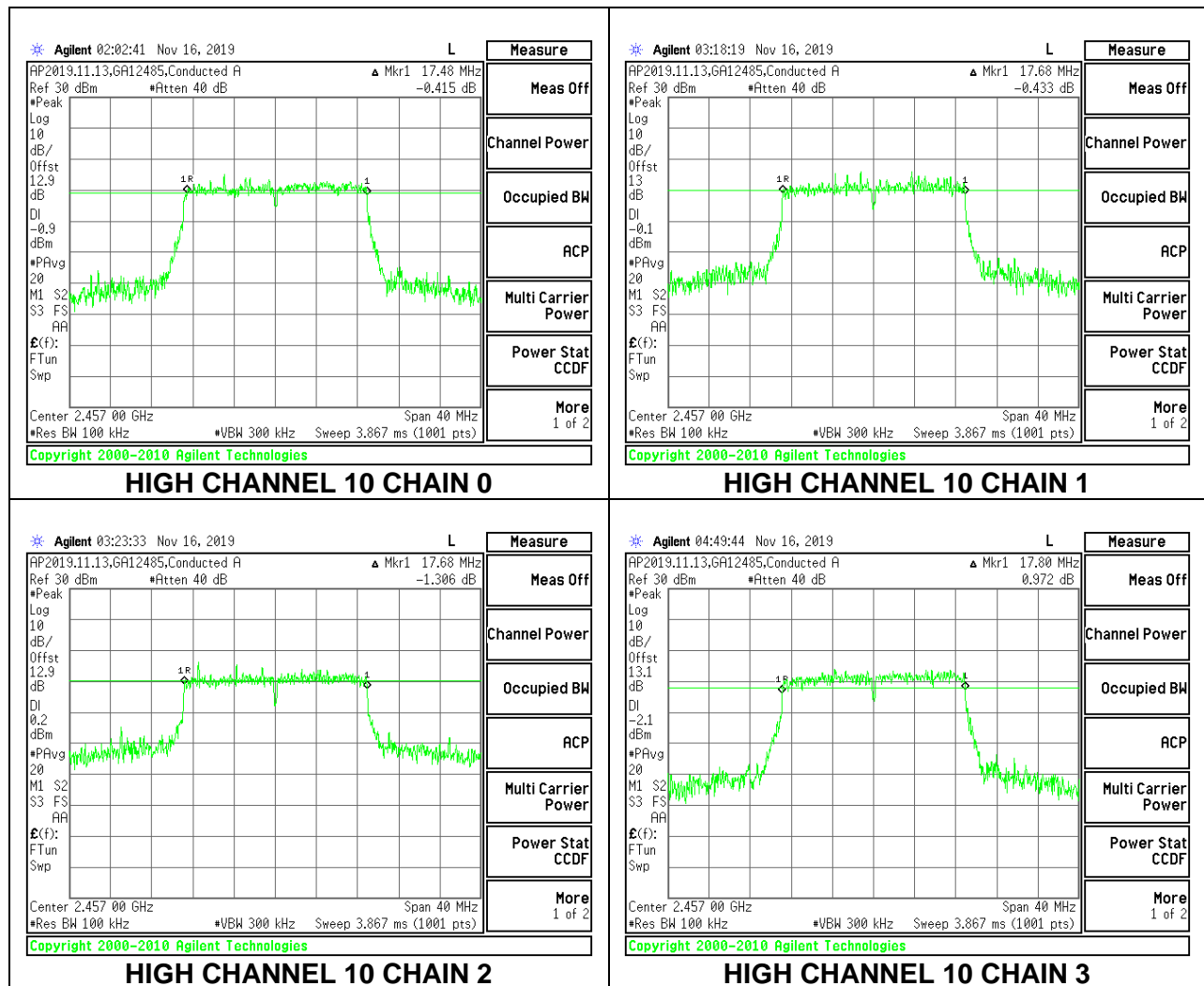
## LOW CHANNEL 2



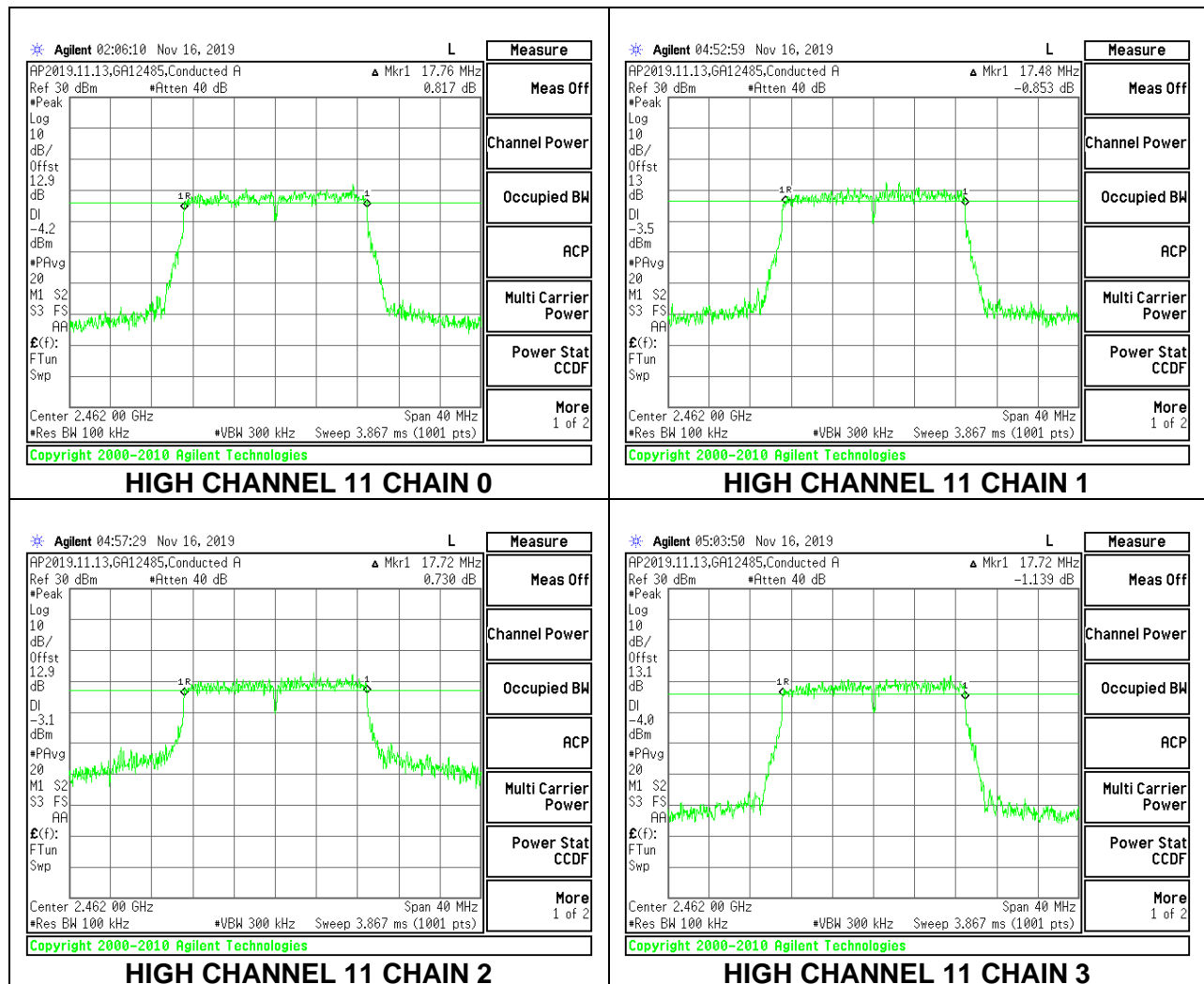
## MID CHANNEL 6



## HIGH CHANNEL 10



## HIGH CHANNEL 11





## **8.4. OUTPUT POWER**

### **LIMITS**

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### **TEST PROCEDURE**

The transmitter output is connected to a power meter. The cable assembly insertion loss was entered as an offset in the power meter to allow for a gated RF average reading of power.

**DIRECTIONAL ANTENNA GAIN**

For 4 TX:

Vertical Polarity (Worst Case)

Band (GHz)	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
2.4	4.20	3.40	3.82

Horizontal Polarity

Band (GHz)	Chain 2 Antenna Gain (dBi)	Chain 3 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
2.4	3.50	2.90	3.21

## RESULTS

<b>Tested By:</b>	12485 GA
<b>Date:</b>	11/21/2019

### 8.4.1. 802.11b MODE

#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

##### Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	3.82	30.00	36	30.00
Low 2	2417	3.82	30.00	36	30.00
Mid 6	2437	3.82	30.00	36	30.00
High 10	2457	3.82	30.00	36	30.00
High 11	2462	3.82	30.00	36	30.00

##### Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Chain 3 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	19.22	19.63	19.30	19.64	25.47	30.00	-4.53
Low 2	2417	19.79	19.93	19.53	19.78	25.78	30.00	-4.22
Mid 6	2437	20.71	20.82	20.63	20.81	26.76	30.00	-3.24
High 10	2457	19.31	19.15	19.11	19.25	25.23	30.00	-4.77
High 11	2462	18.77	18.82	18.95	18.86	24.87	30.00	-5.13

## 8.4.2. 802.11g MODE

### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

#### Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	3.82	30.00	36	30.00
Low 2	2417	3.82	30.00	36	30.00
Mid 6	2437	3.82	30.00	36	30.00
High 9	2452	3.82	30.00	36	30.00
High 10	2457	3.82	30.00	36	30.00
High 11	2462	3.82	30.00	36	30.00

#### Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Chain 3 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	15.58	15.74	15.41	15.44	21.57	30.00	-8.43
Low 2	2417	18.36	18.73	18.24	18.45	24.47	30.00	-5.53
Mid 6	2437	19.91	19.85	19.83	19.89	25.89	30.00	-4.11
High 9	2452	19.36	19.23	19.27	19.11	25.26	30.00	-4.74
High 10	2457	16.94	17.17	17.25	17.12	23.14	30.00	-6.86
High 11	2462	14.44	14.13	14.42	14.18	20.32	30.00	-9.68

### 8.4.3. 802.11n HT20 MODE

#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

##### Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	3.82	30.00	36	30.00
Low 2	2417	3.82	30.00	36	30.00
Mid 6	2437	3.82	30.00	36	30.00
High 10	2457	3.82	30.00	36	30.00
High 11	2462	3.82	30.00	36	30.00

##### Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Chain 3 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	14.95	15.10	15.01	15.09	21.06	30.00	-8.94
Low 2	2417	17.81	18.17	17.79	18.08	23.99	30.00	-6.01
Mid 6	2437	18.32	18.41	18.34	18.44	24.40	30.00	-5.60
High 10	2457	17.39	17.55	17.47	17.58	23.52	30.00	-6.48
High 11	2462	14.44	14.67	14.75	14.77	20.68	30.00	-9.32

## **8.5. POWER SPECTRAL DENSITY**

### **LIMITS**

FCC §15.247 (e)

RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### **RESULTS**

### 8.5.1. 802.11b MODE

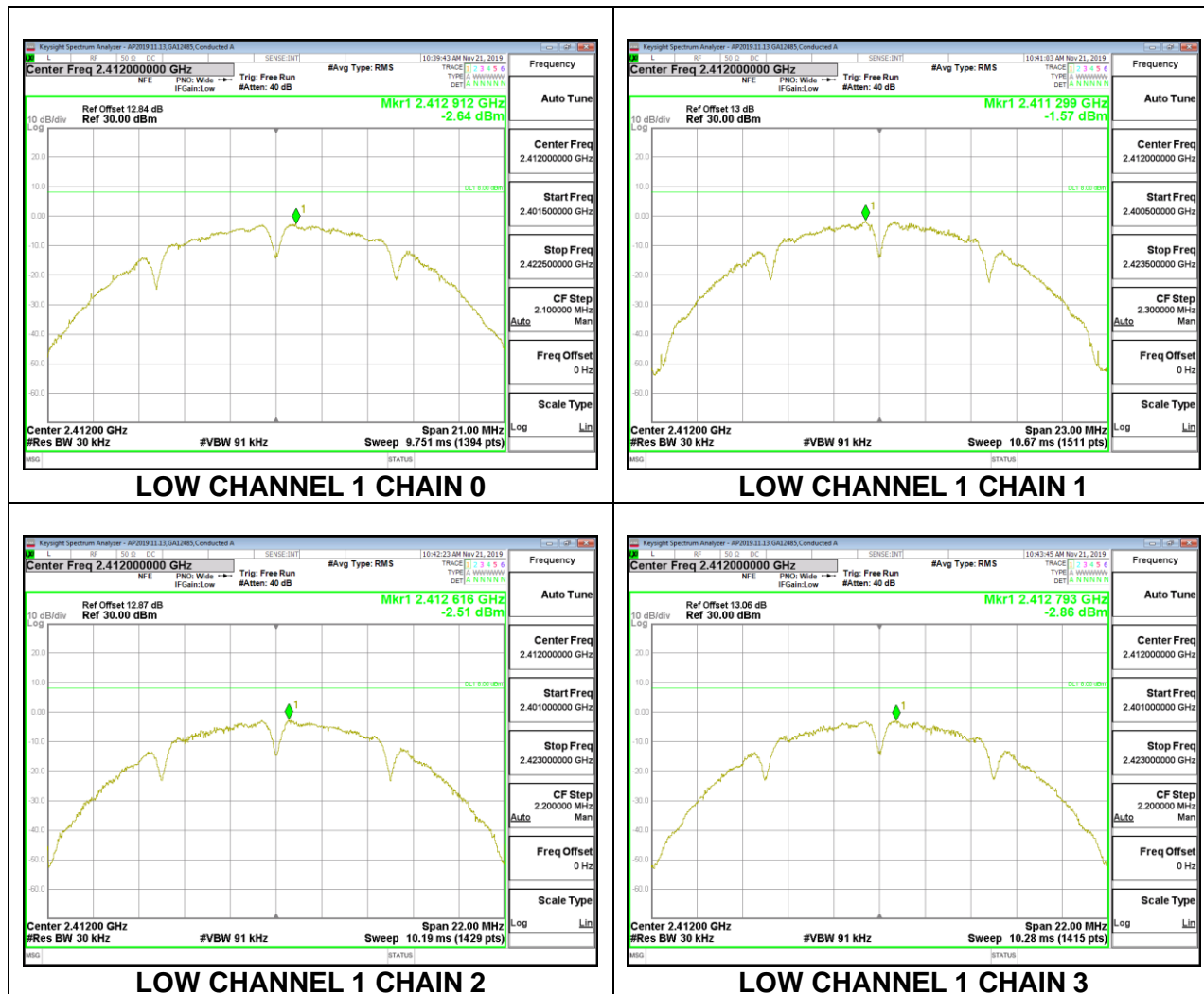
#### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
--------------------	------	--

#### PSD Results

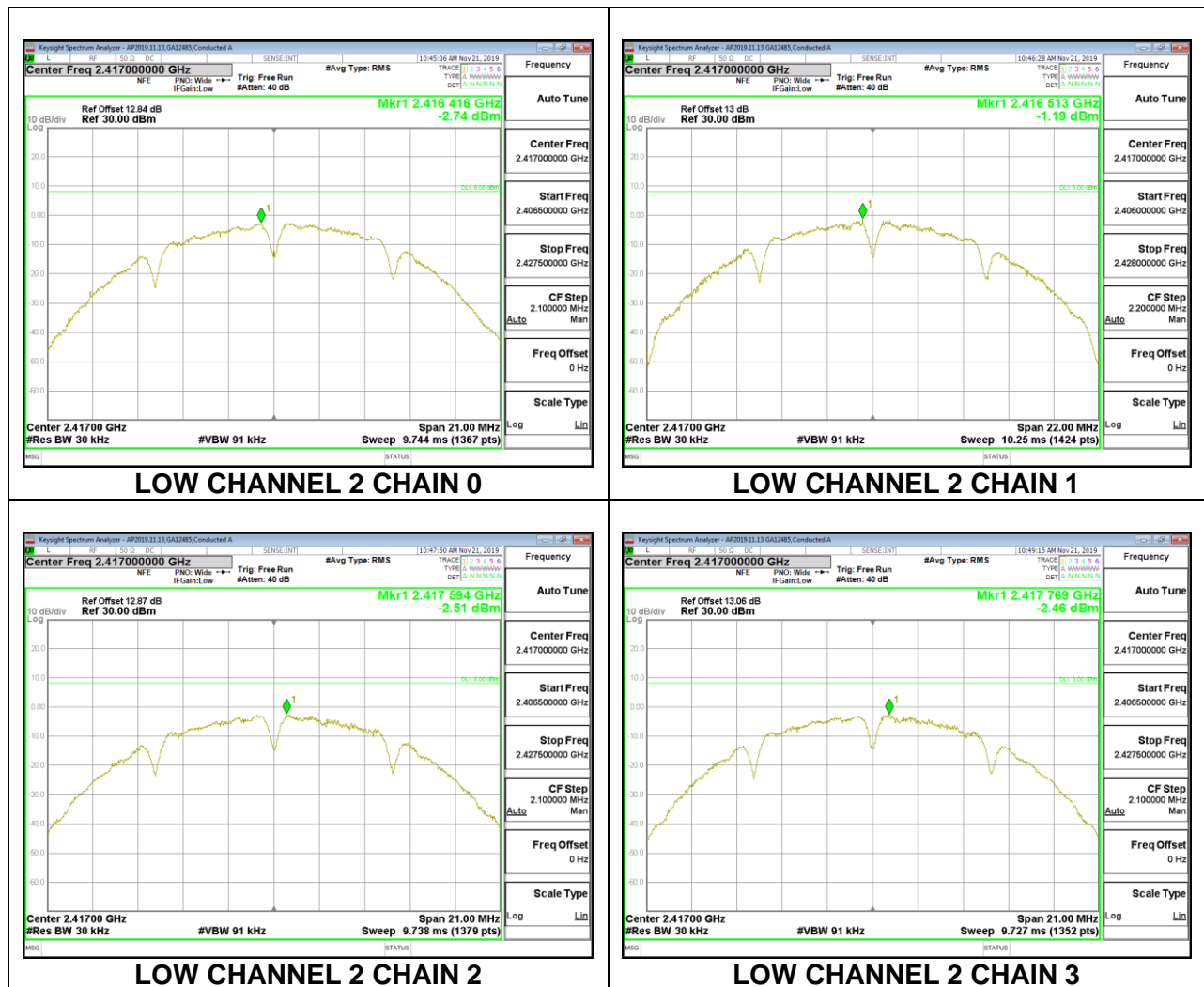
Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Chain 2 Meas (dBm/ 3kHz)	Chain 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-2.64	-1.57	-2.51	-2.86	3.65	8.0	-4.3
Low 2	2417	-2.74	-1.19	-2.51	-2.46	3.84	8.0	-4.2
Mid 6	2437	-1.16	-0.80	-1.20	-0.83	5.03	8.0	-3.0
High 10	2457	-1.43	-2.30	-2.67	-2.54	3.81	8.0	-4.2
High 11	2462	-3.24	-3.32	-3.22	-3.38	2.73	8.0	-5.3

## LOW CHANNEL 1

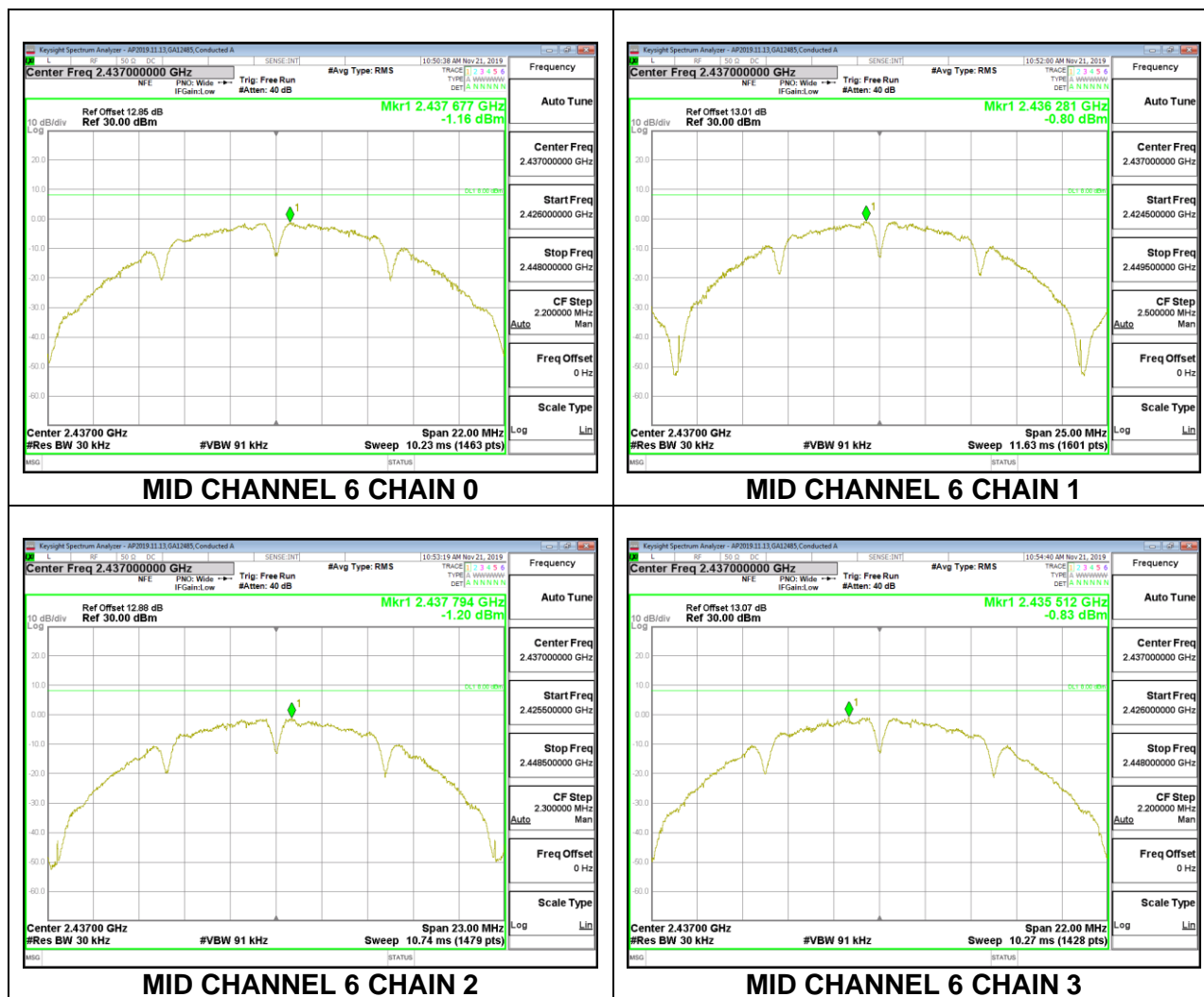




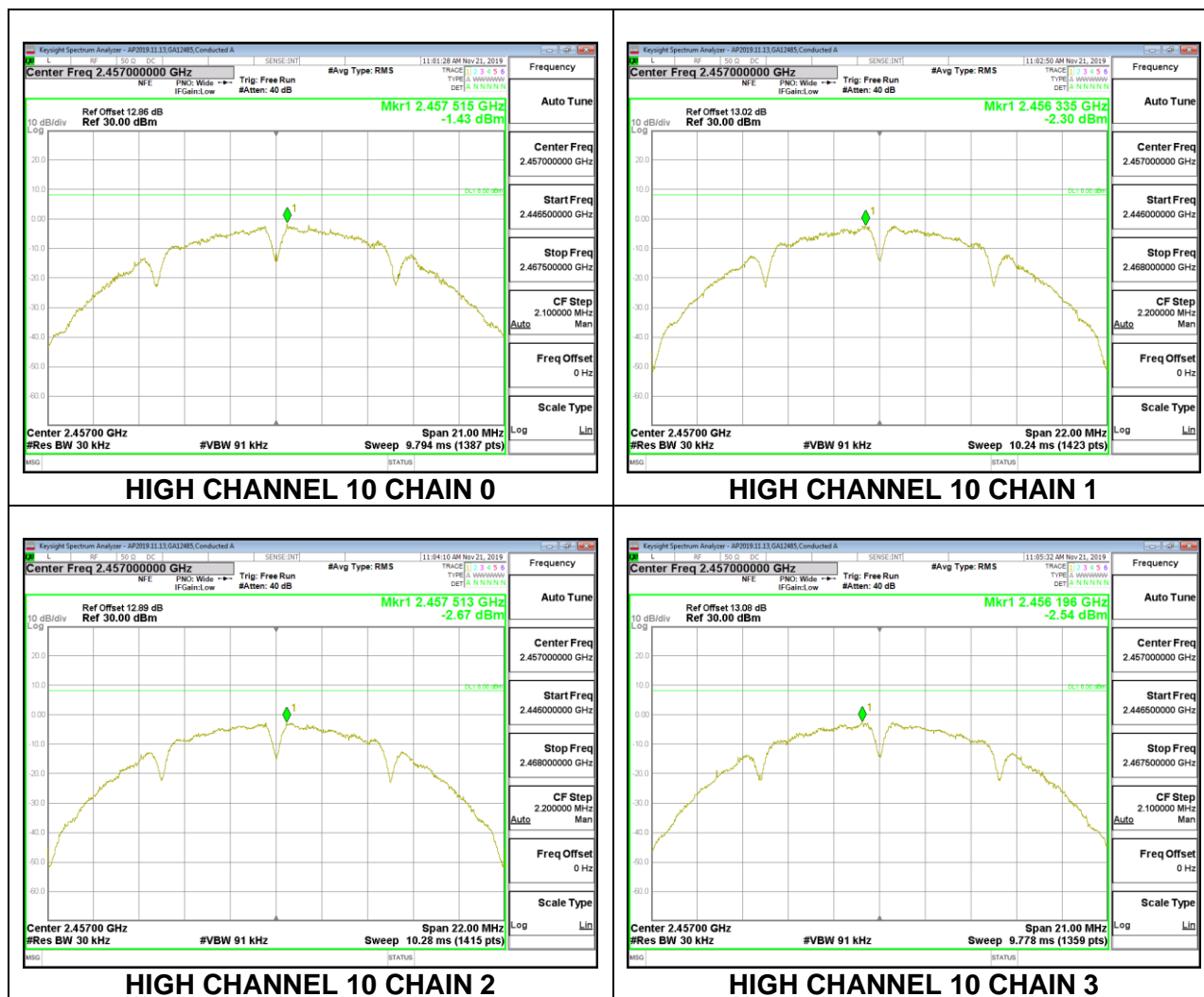
## LOW CHANNEL 2



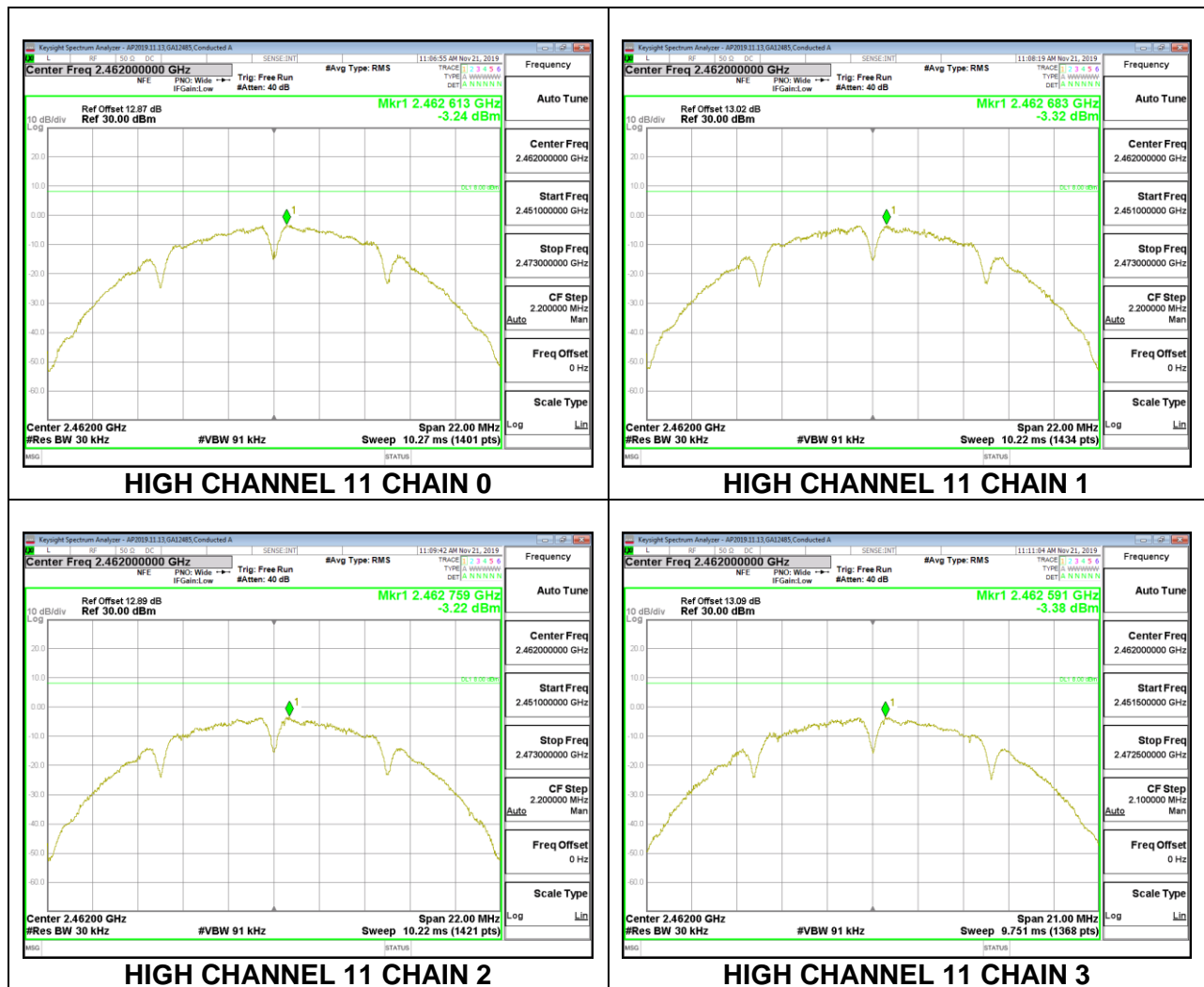
## MID CHANNEL 6



## HIGH CHANNEL 10



## HIGH CHANNEL 11



## 8.5.2. 802.11g MODE

### 4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
--------------------	------	--

#### PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Chain 2 Meas (dBm/ 3kHz)	Chain 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-9.08	-7.91	-8.93	-8.18	-2.48	8.0	-10.5
Low 2	2417	-6.45	-5.33	-6.09	-6.09	0.05	8.0	-7.9
Mid 6	2437	-6.26	-6.23	-5.96	-5.37	0.08	8.0	-7.9
High 9	2452	-5.74	-5.11	-5.16	-4.92	0.80	8.0	-7.2
High 10	2457	-7.28	-7.98	-7.53	-7.66	-1.58	8.0	-9.6
High 11	2462	-10.19	-11.06	-10.63	-10.64	-4.60	8.0	-12.6

## LOW CHANNEL 1

