



TEST REPORT

Report Number. : 12934025-E3V2

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

Model : S19

FCC ID : SBVRM019

IC : 5373A-RM019

EUT Description : 802.11 a/b/g/n (HT20) 4x4 master device with BLE and NFC

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

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REPORT REVISION HISTORY

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V1	1/10/2020	Initial Issue	
V2	1/16/2020	Updated Section 2 & 5.2	K.Kedida

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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 (HT20) 4x4 master device with BLE and NFC

MODEL: S19

SERIAL NUMBER: A100 1908W 48-A6-B8-00-03-60:B (Conducted Sample)
A100 1908W 48-A6-B8-B0-05-FD:6 (Radiated Sample)

DATE TESTED: October 15 – December 30, 2019

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart E (EXCEPT DFS)	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.

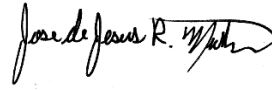
This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This 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.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 905462 D06 v02, FCC KDB 789033 D02 v02r01, FCC KDB 662911 D01 v02r01, FCC KDB 662911 D02 v01, ANSI C63.10-2013, FCC 06-96, 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.
☒ Chamber A	☐ Chamber D	☒ Chamber I
☐ Chamber B	☐ Chamber E	☐ Chamber J
☐ Chamber C	☐ Chamber F	☒ Chamber K
	☐ Chamber G	☐ Chamber L
	☐ 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	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 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 (HT20) 4x4 master device with BLE and NFC.

The model S19 is a high performance wireless smart speaker.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

FCC

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5.2 GHz band, 4TX			
5180-5240	802.11a	17.04	50.58
5180-5240	802.11n HT20	17.00	50.12
5.3 GHz band, 4TX			
5260-5320	802.11a	18.13	65.01
5260-5320	802.11n HT20	18.14	65.16
5.6 GHz band, 4TX			
5500-5700	802.11a	18.82	76.21
5500-5700	802.11n HT20	18.86	76.91
5.8 GHz band, 4TX			
5725-5850	802.11a	24.84	304.79
5725-5850	802.11n HT20	24.30	269.15

IC

Frequency Range (MHz)	Mode	EIRP (dBm)	EIRP (mW)
5.2 GHz band, 4TX			
5180-5240	802.11a	18.84	76.56
5180-5240	802.11n HT20	20.06	101.39

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an PCB antenna, with a maximum gain per chain as follows:

5GHz Antenna Identification / Max Antenna Gain dBi				
Frequency Range (MHz)	105-00142: Rear-Right (Vertical Polarization)	105-00141: Rear-Left (Vertical Polarization)	105-00139: Top-Right (Horizontal Polarization)	105-00140: Top-Left (Horizontal Polarization)
U-NII-1 (5180-5240)	Chain 0 / 7.40 dBi	Chain 1 / 5.13 dBi	Chain 2 / 3.79 dBi	Chain 3 / 1.61 dBi
U-NII-2 (5260-5320)	Chain 0 / 7.08 dBi	Chain 1 / 6.19 dBi	Chain 2 / 3.49 dBi	Chain 3 / 1.90 dBi
U-NII-3 (5500-5720)	Chain 0 / 6.57 dBi	Chain 1 / 5.30 dBi	Chain 2 / 3.38 dBi	Chain 3 / 1.90 dBi
U-NII-4 (5745-5825)	Chain 0 / 5.41 dBi	Chain 1 / 4.69 dBi	Chain 2 / 2.54 dBi	Chain 3 / 1.04 dBi

NOTE:

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

5.4. SOFTWARE AND FIRMWARE

The EUT software/firmware installed during testing was version 11.0 Build 55070020.

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

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

802.11a mode: 6 Mbps
802.11n HT20 mode: 6 Mbps

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Lenovo	T450s	PC-06YXZP 15/08	PD97265NGU
AC Adapter	Lenovo	ADLX90NLC2A	11S45N0247Z1ZS9B58BA9G	

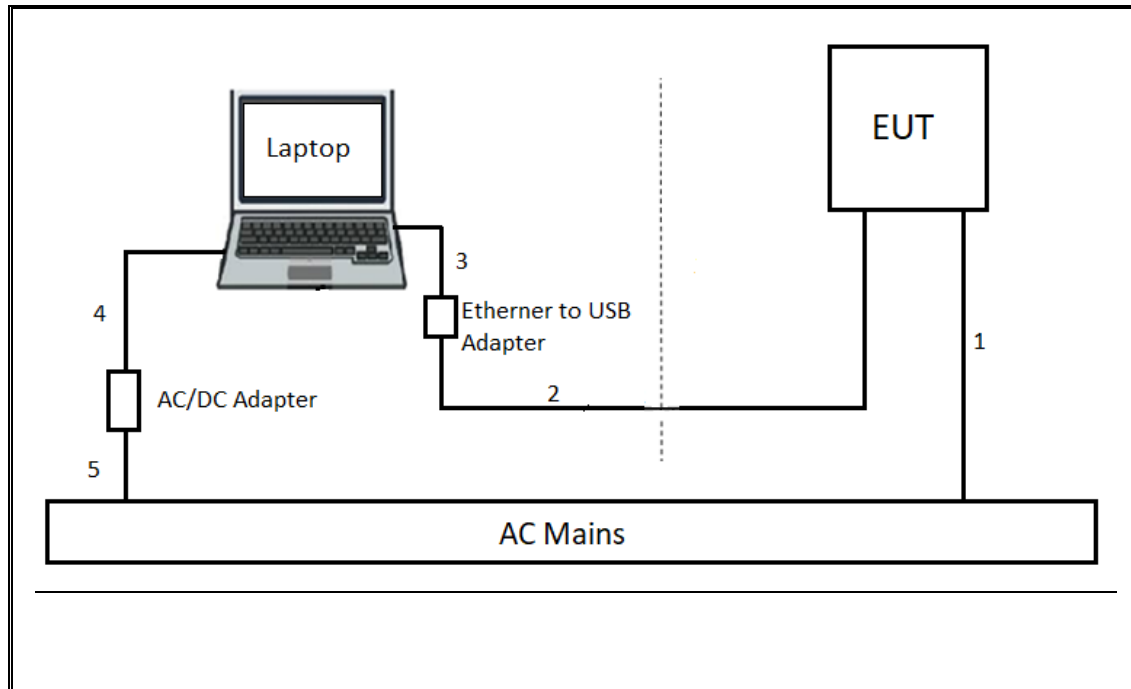
I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	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	Ethernet to Ethernet Converter
3	Ethernet to USB	1	RJ45 to USB	Unshielded	0.2	USB to Ethernet Adapter
5	DC Power	1	DC	Unshielded	1.2	AC/DC Adapter to Laptop
6	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: KDB 789033 D02 v02r01, Section II B.

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

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

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

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

Power Spectral Density: KDB 789033 D02 v02r01, Section II F.

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

Unwanted emissions: KDB 789033 D02 v02r01, Sections II.G.3 – II.G.6.

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
Amplifier, 100KHz to 1GHz, 32dB	Keysight Technologies (Formerly Agilent)	8447D	T15	10/20/2019	10/20/2018
Antenna, Broadband Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	PRE0181575	09/05/2020	09/05/2019
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T1165	05/24/2020	06/24/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T346	05/14/2020	05/14/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies (Formerly Agilent)	N9030A	T908	01/23/2020	01/23/2019
Antenna, Passive Loop 30Hz to 1MHz	ELETRO METRICS	EM-6871	PRE0179465	05/31/2020	05/31/2019
Antenna, Passive Loop 100kHz to 30MHz	ELETRO METRICS	EM-6872	PRE0179467	05/31/2020	05/31/2019
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	PRE0180175	05/29/2020	06/29/2019
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
Antenna, Horn 1-18GHz	3117	ETS-Lindgren	T344	05/07/2020	05/07/2019
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179376	02/14/2020	02/14/2019
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
26.5 – 40 GHz Horn Antenna	ARA	MWH-2640	T445	03/26/2020	03/26/2019
Pre-Amp 26-40GHz	MITEQ	NSTTA2640-35-HG	T1864	03/09/2020	03/09/2019
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, PSA, 3Hz to 44GHz	Keysight Technologies (Formerly Agilent)	E4446A	T146	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 10.4, October 10, 2019		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		

NOTES:

- Equipment listed above that calibrated during the testing period was set for test after the calibration.
- Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

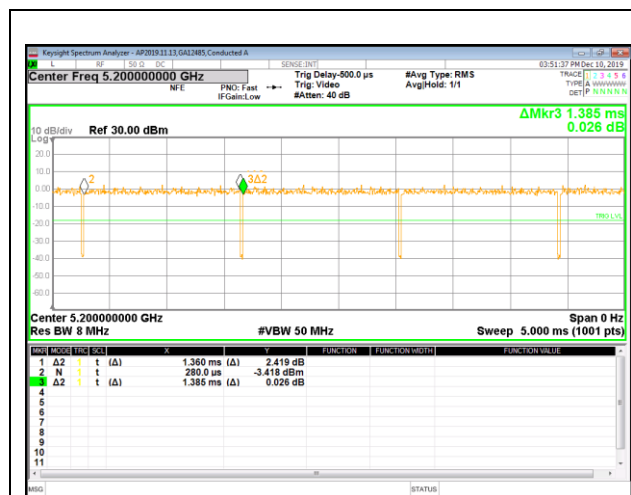
None; for reporting purposes only.

PROCEDURE

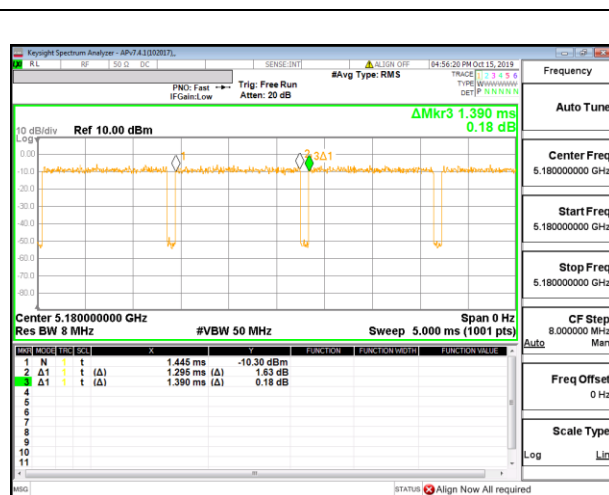
KDB 558074 Zero-Span Spectrum Analyzer Method.

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)
802.11a	1.360	1.385	0.982	98.19%	0.00	0.010
802.11n HT20	1.295	1.390	0.932	93.17%	0.31	0.772



DUTY CYCLE 802.11a CDD MODE



DUTY CYCLE 802.11n CDD MODE

8.2. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

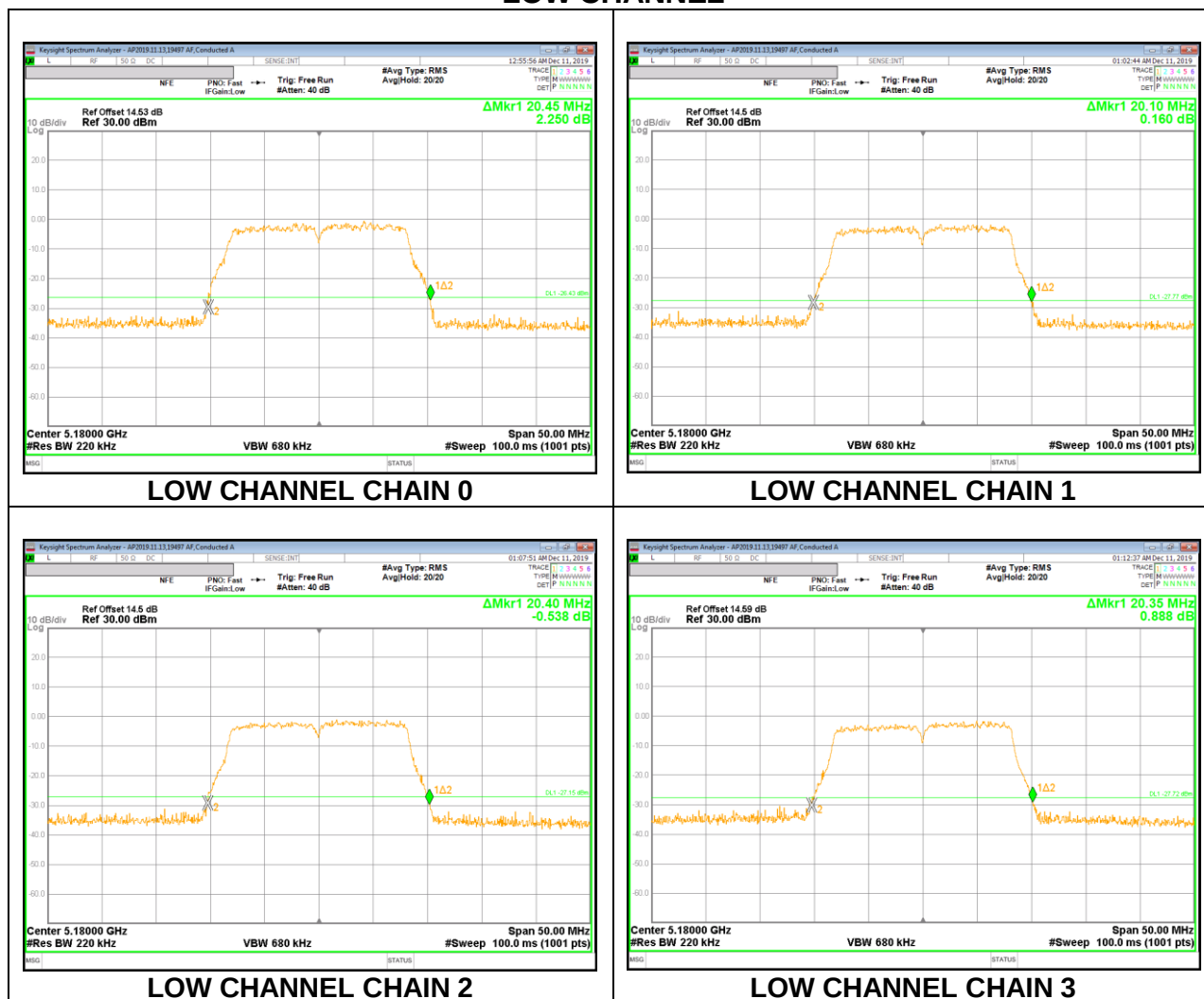
RESULTS

8.2.1. 802.11a MODE IN THE 5.2 GHz BAND

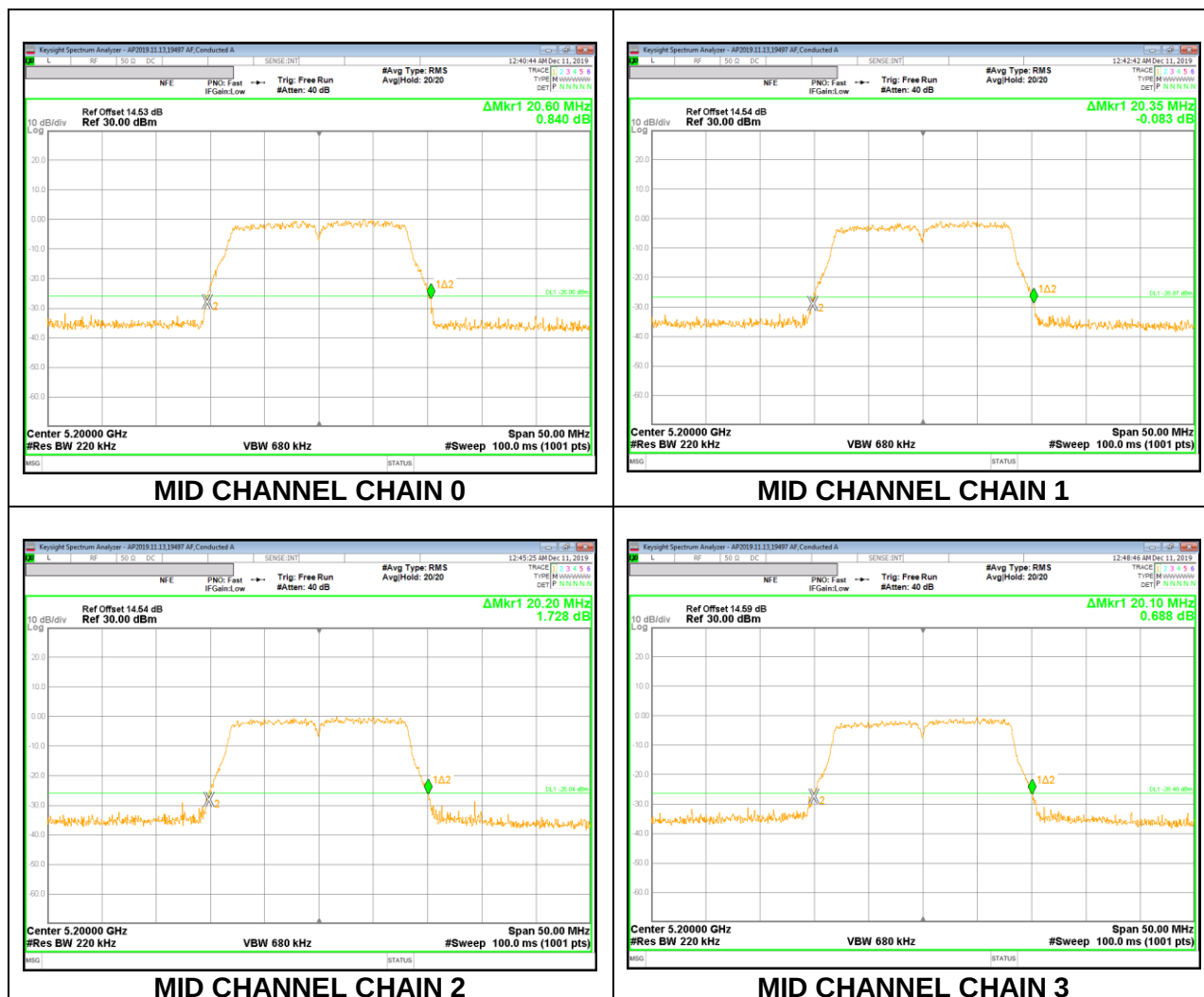
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5180	20.45	20.10	20.40	20.35
Mid	5200	20.60	20.35	20.20	20.10
High	5240	20.55	20.20	20.30	20.35

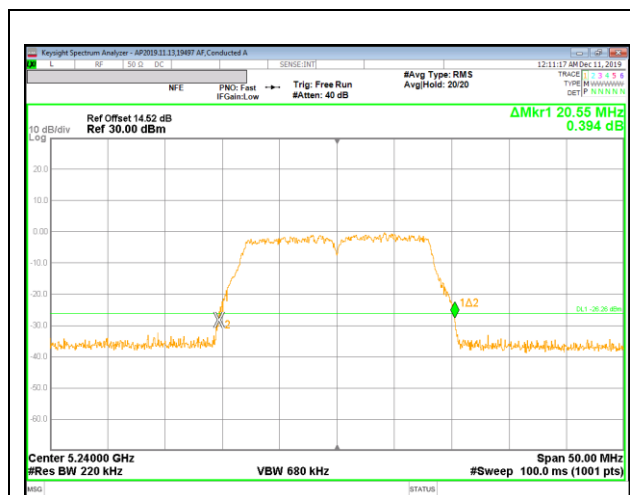
LOW CHANNEL



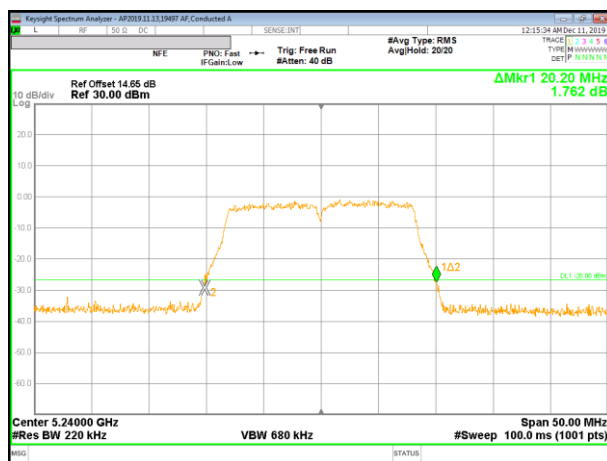
MID CHANNEL



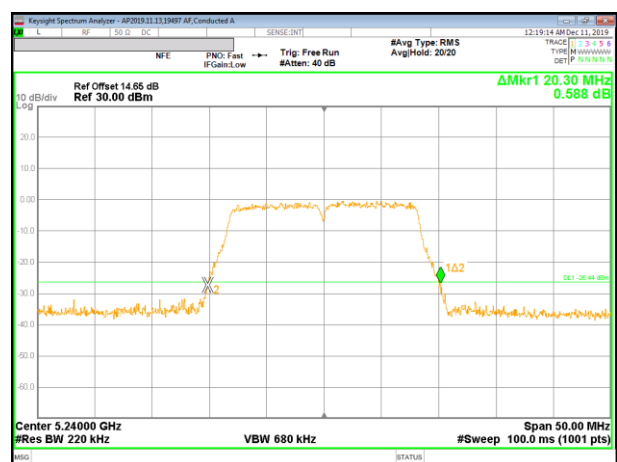
HIGH CHANNEL



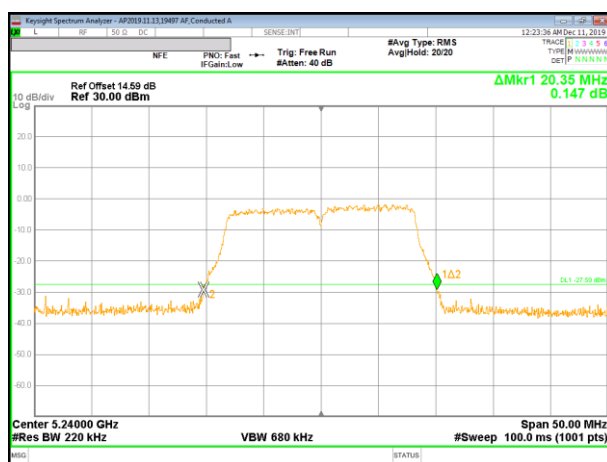
HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1



HIGH CHANNEL CHAIN 2



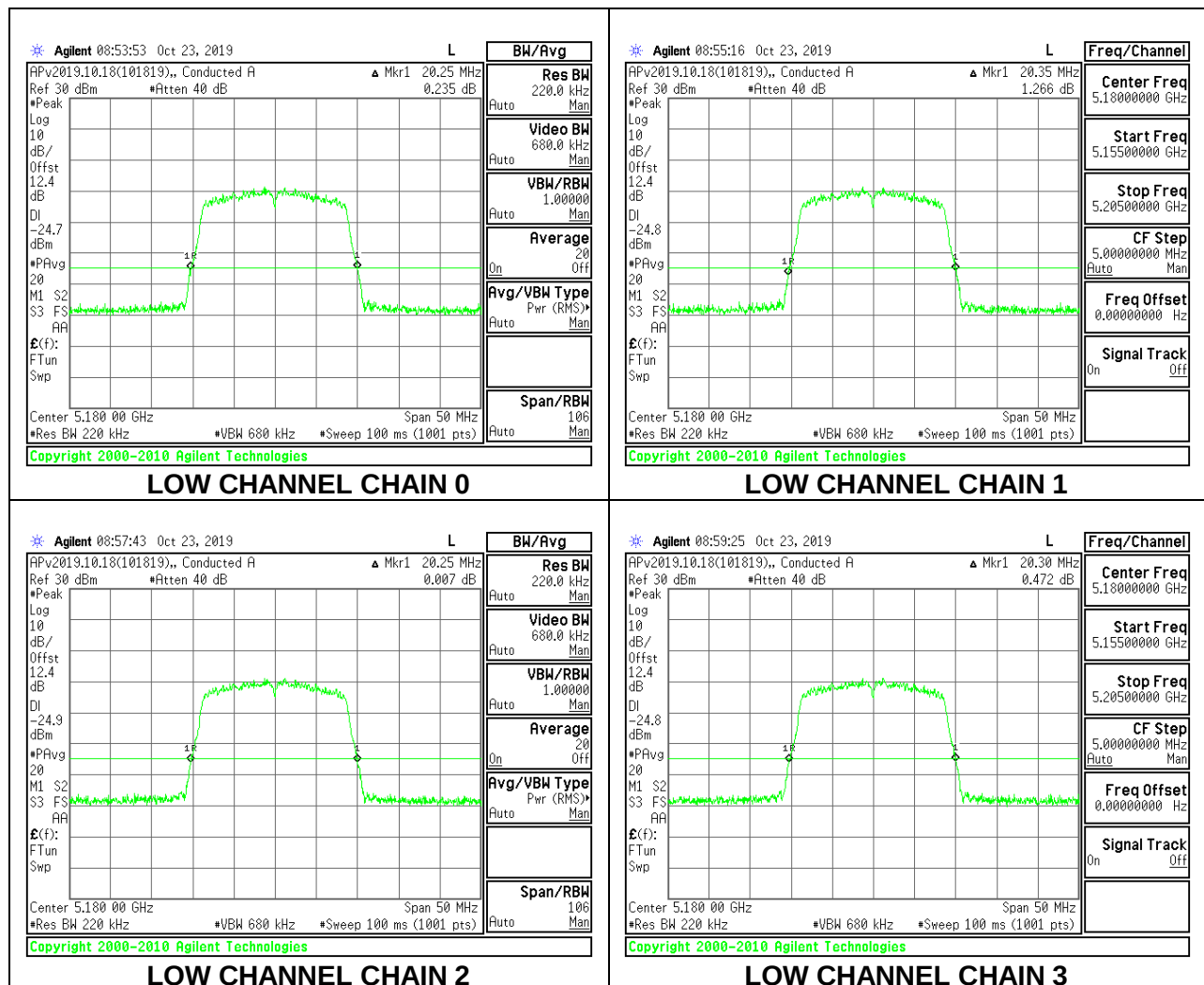
HIGH CHANNEL CHAIN 3

8.2.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

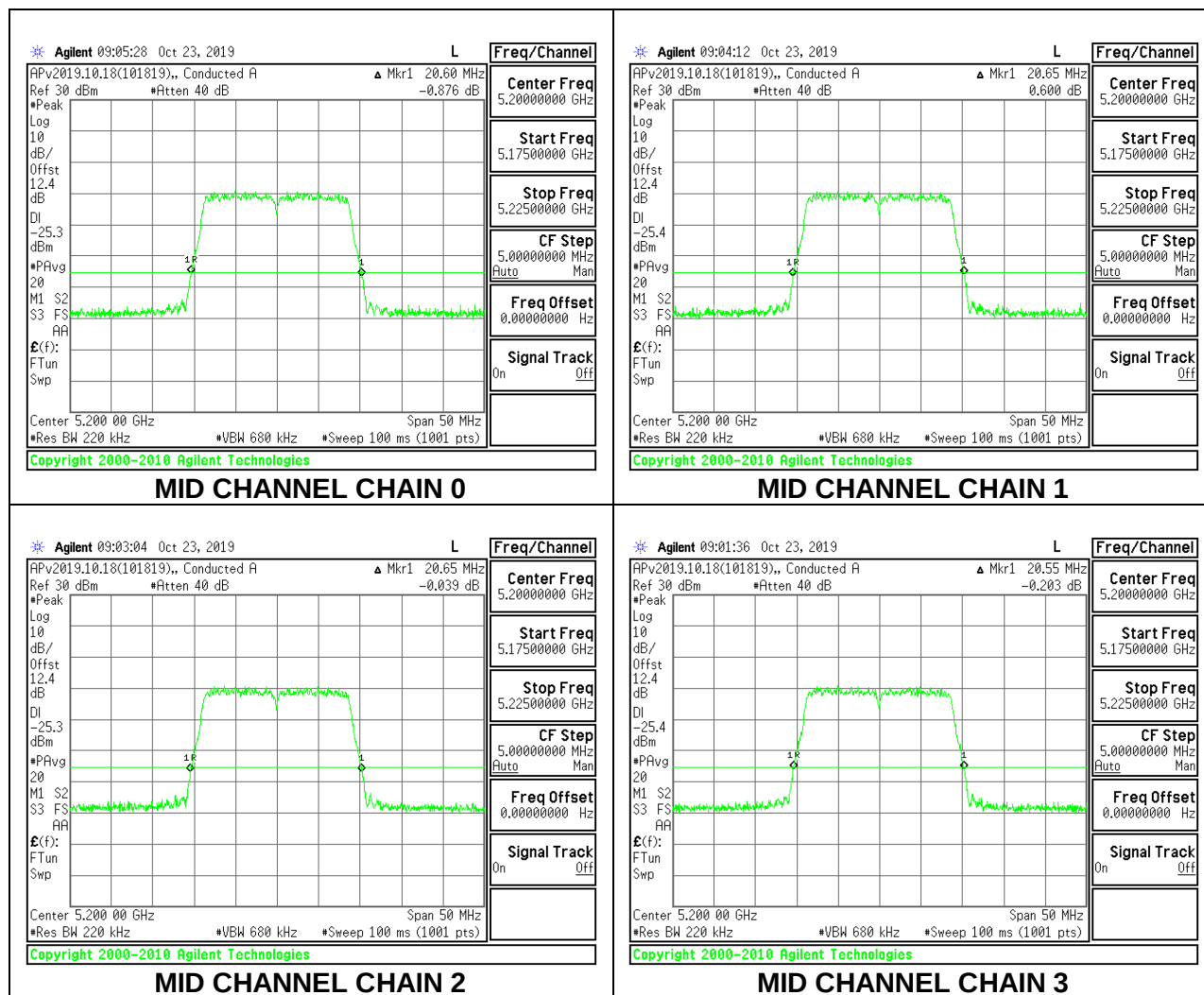
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5180	20.25	20.35	20.25	20.30
Mid	5200	20.60	20.65	20.65	20.55
High	5240	20.60	20.55	20.65	20.60

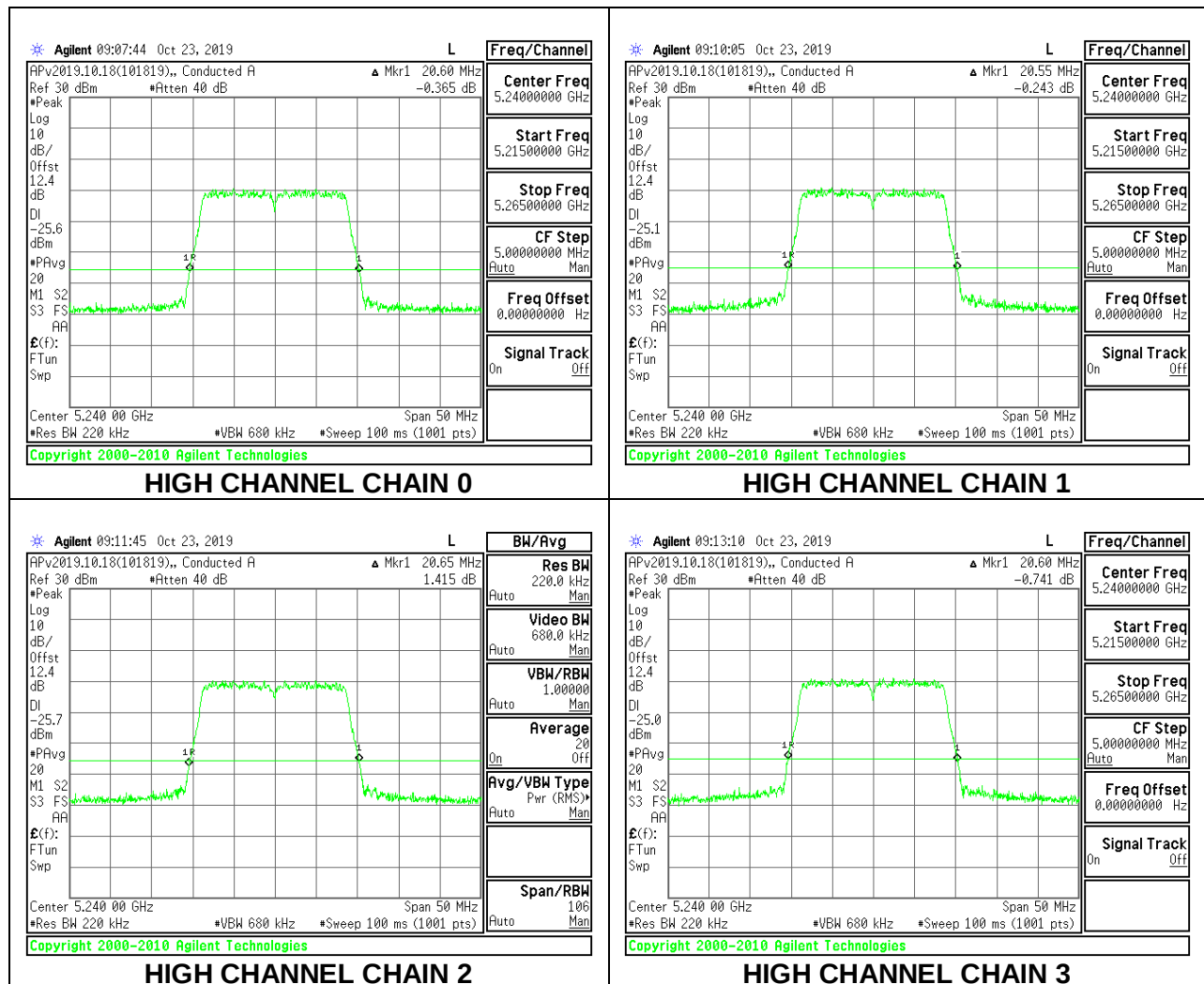
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

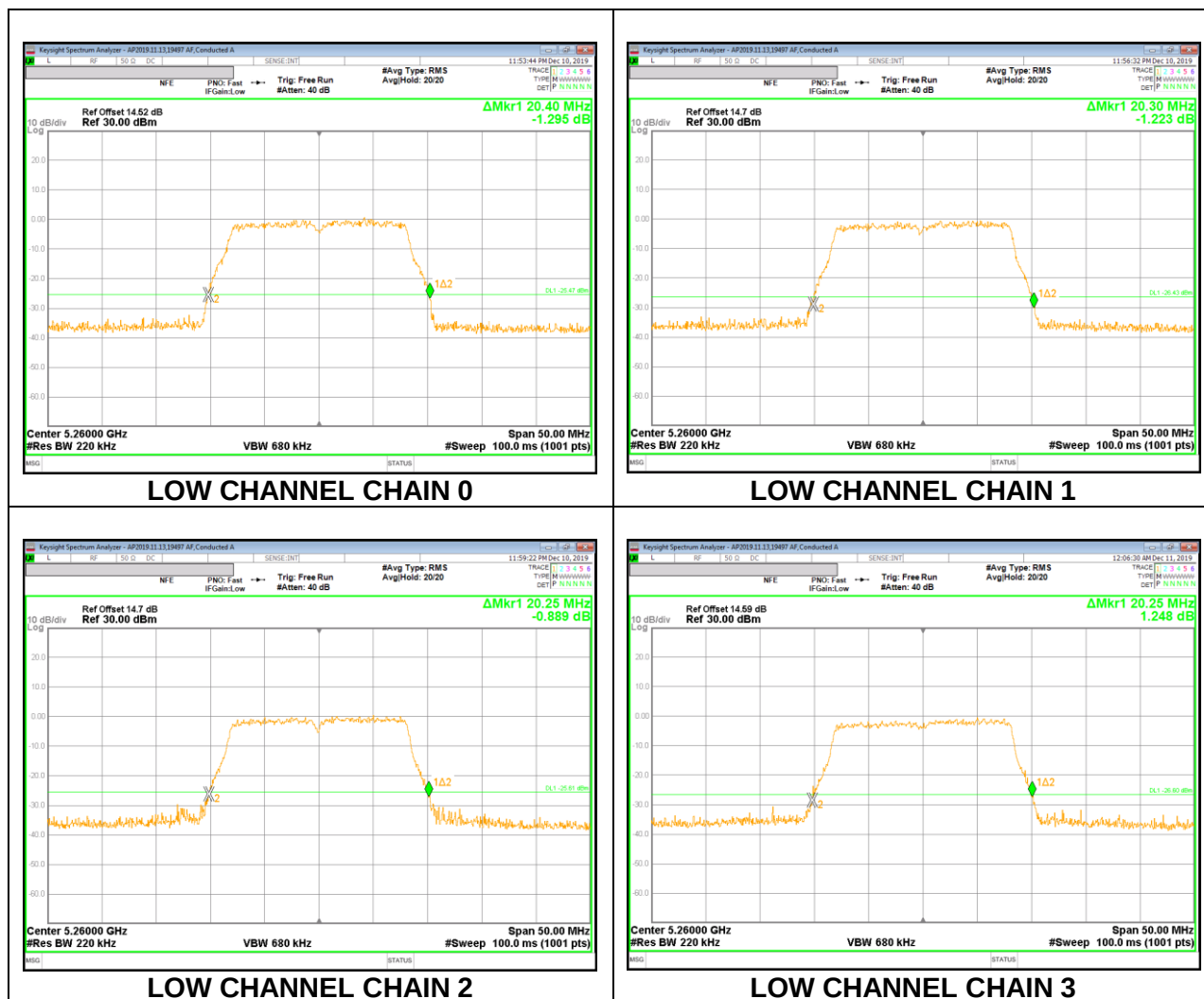


8.2.3. 802.11a MODE IN THE 5.3 GHz BAND

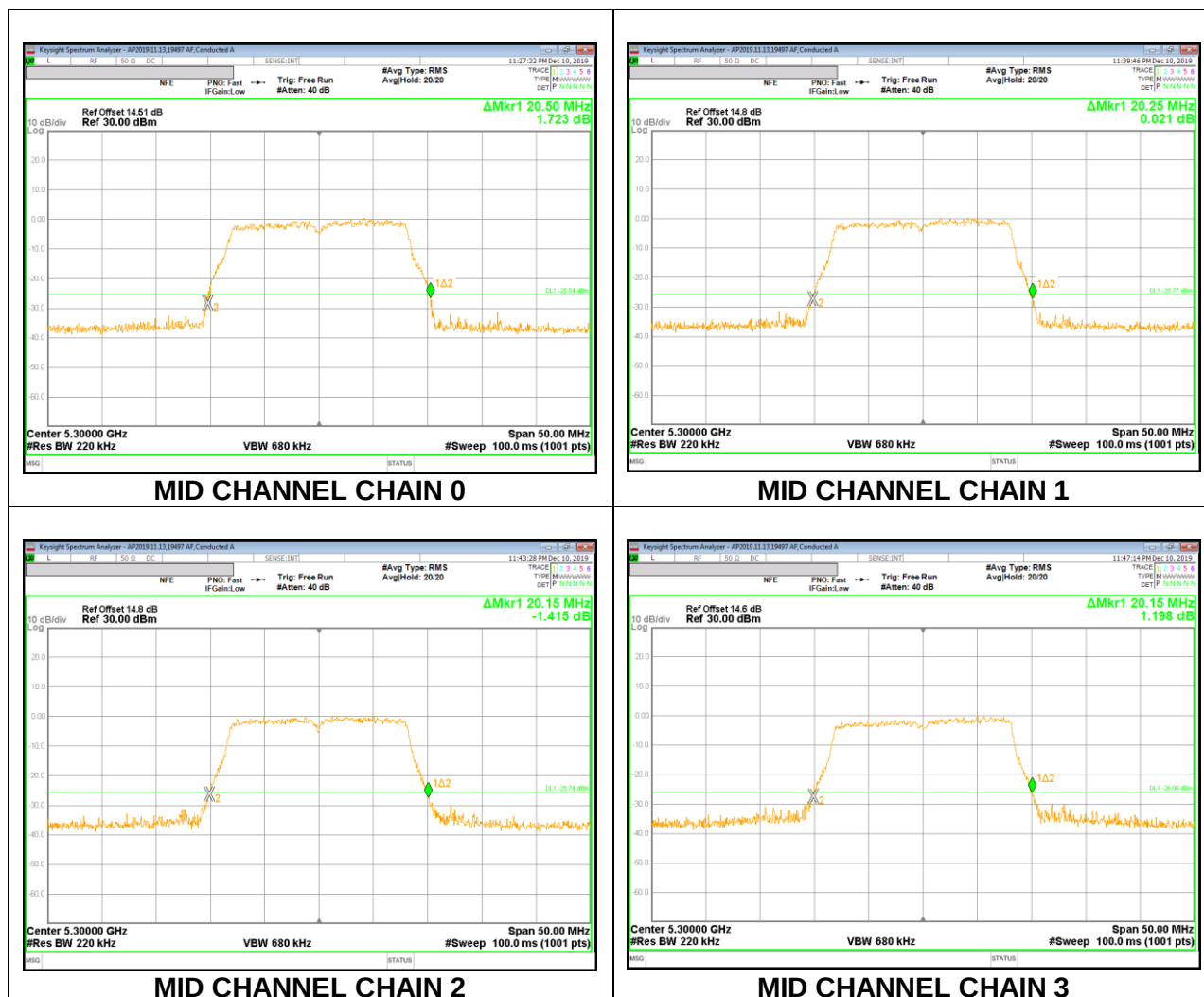
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5260	20.40	20.30	20.25	20.25
Mid	5300	20.50	20.25	20.15	20.15
High	5320	20.60	20.15	20.20	20.40

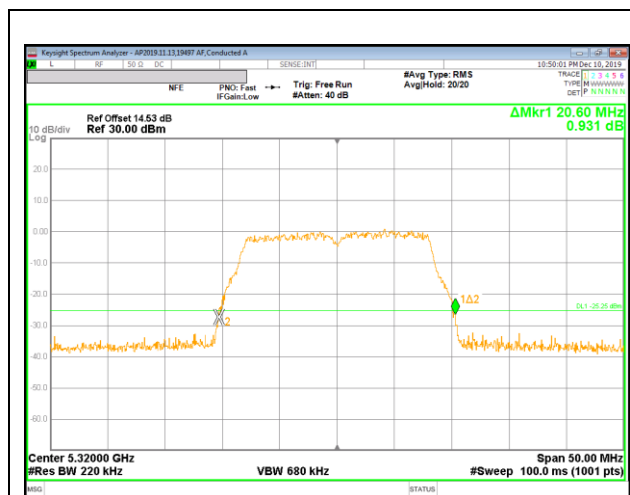
LOW CHANNEL



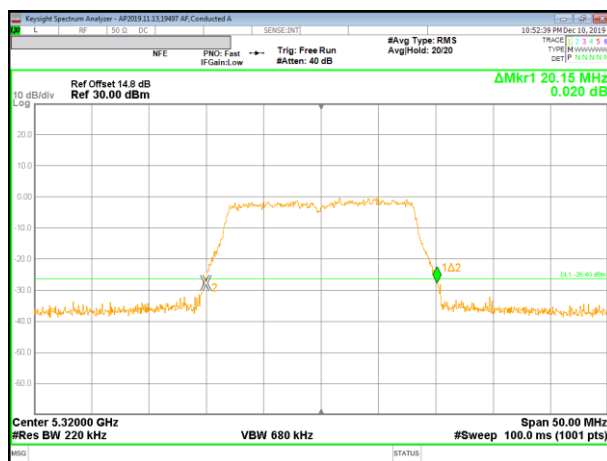
MID CHANNEL



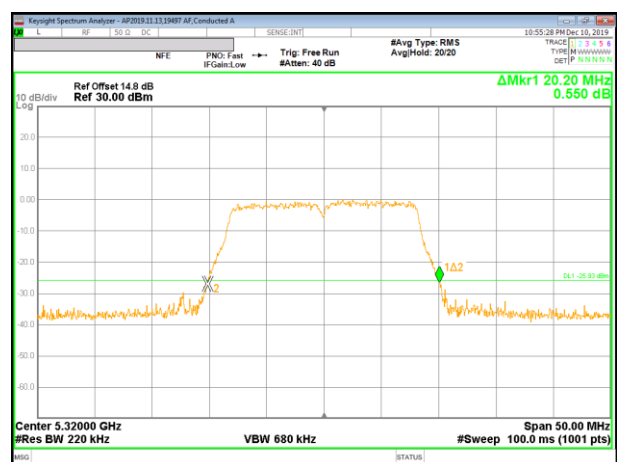
HIGH CHANNEL



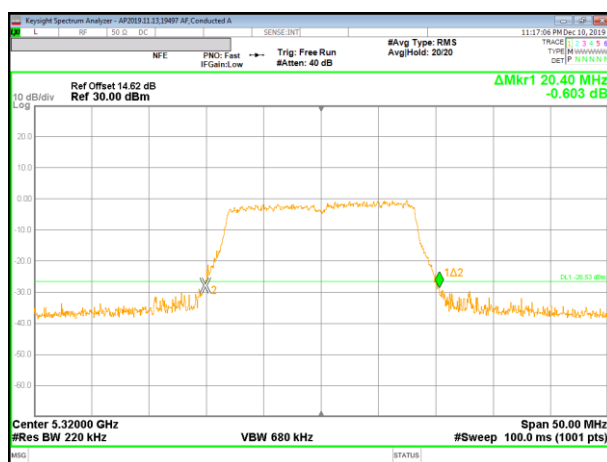
HIGH CHANNEL CHAIN 0



HIGH CHANNEL CHAIN 1



HIGH CHANNEL CHAIN 2



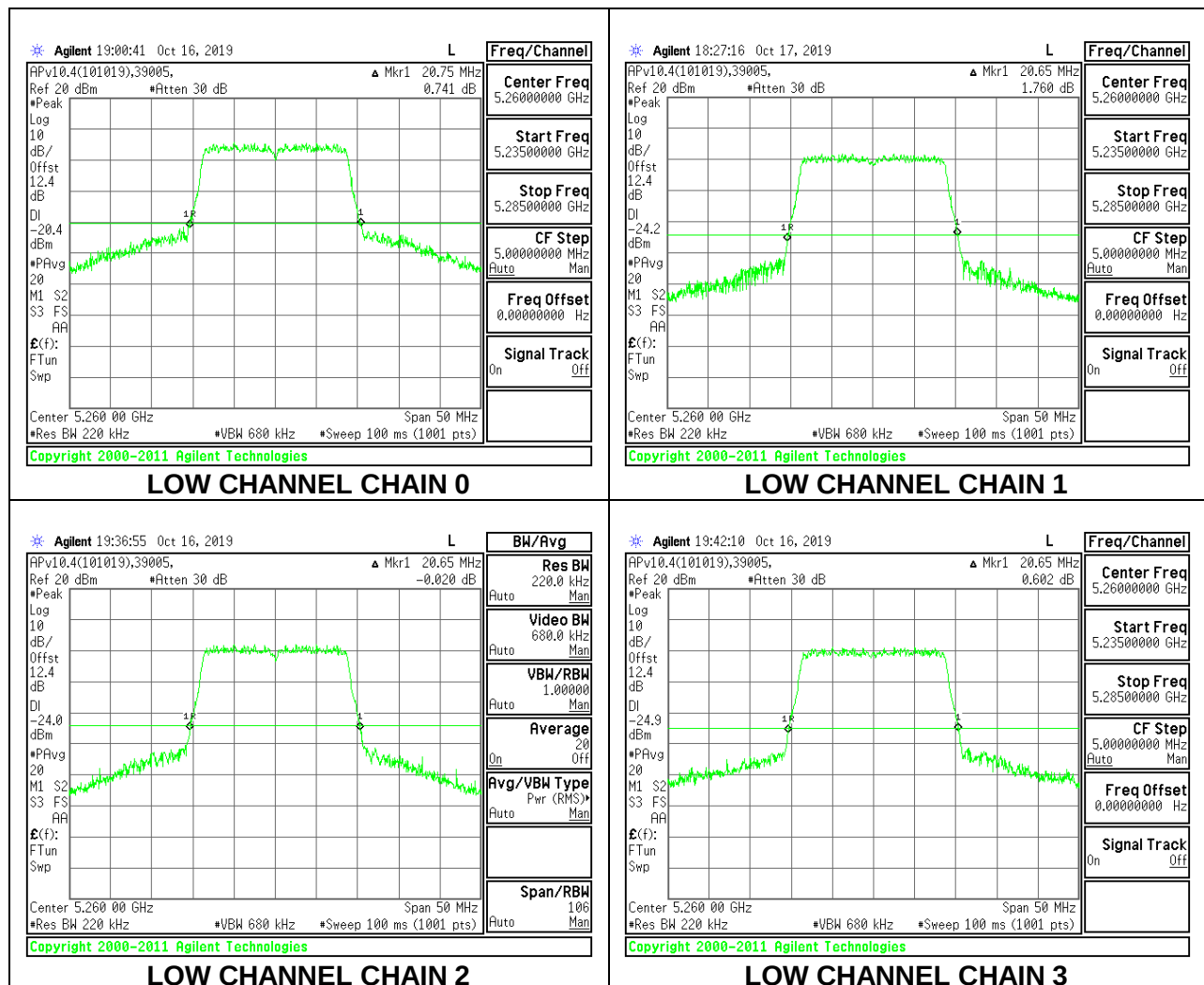
HIGH CHANNEL CHAIN 3

8.2.4. 802.11n HT20 MODE IN THE 5.3 GHz BAND

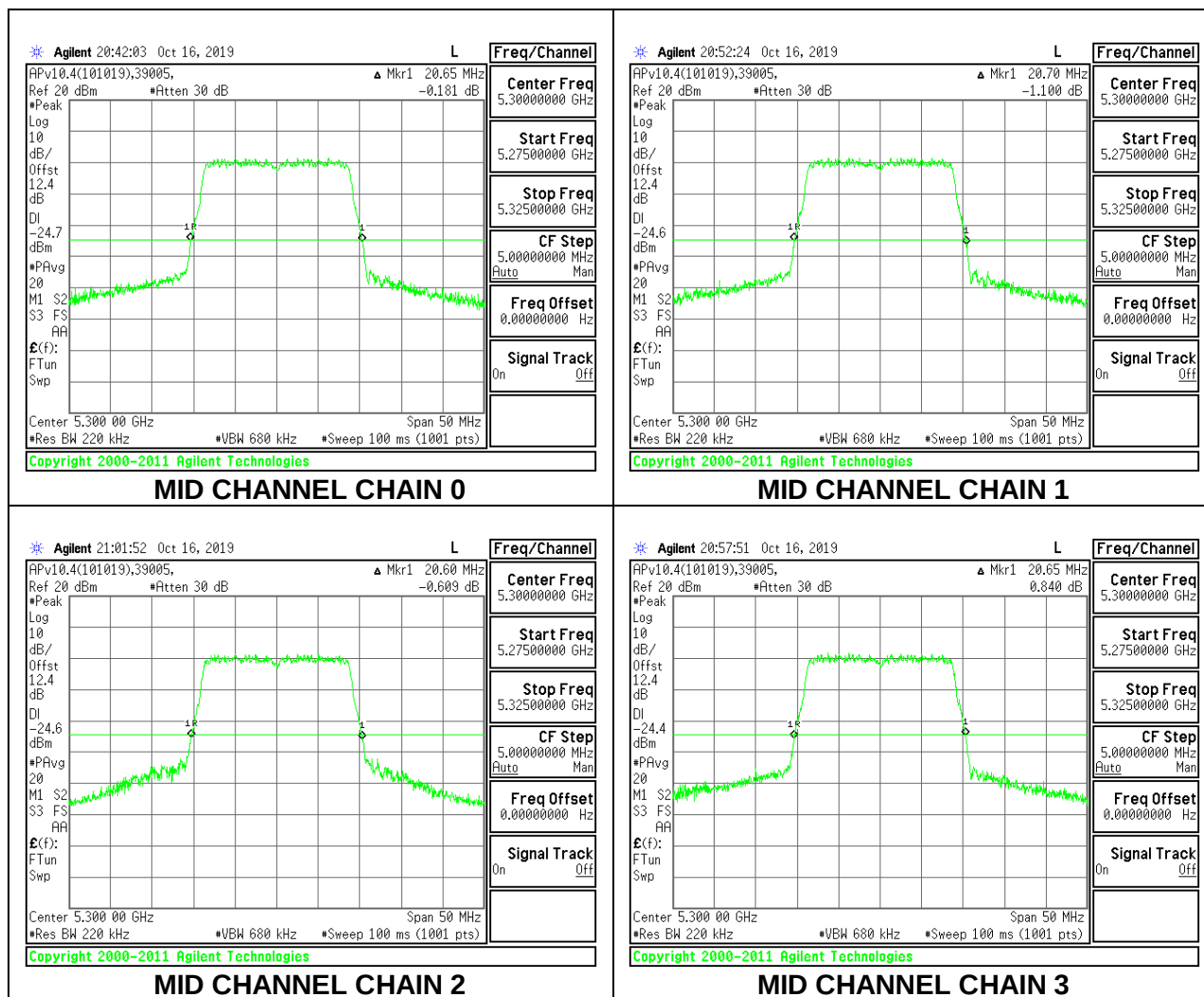
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5260	20.75	20.65	20.65	20.65
Mid	5300	20.65	20.70	20.60	20.65
High	5320	20.30	20.30	20.15	20.30

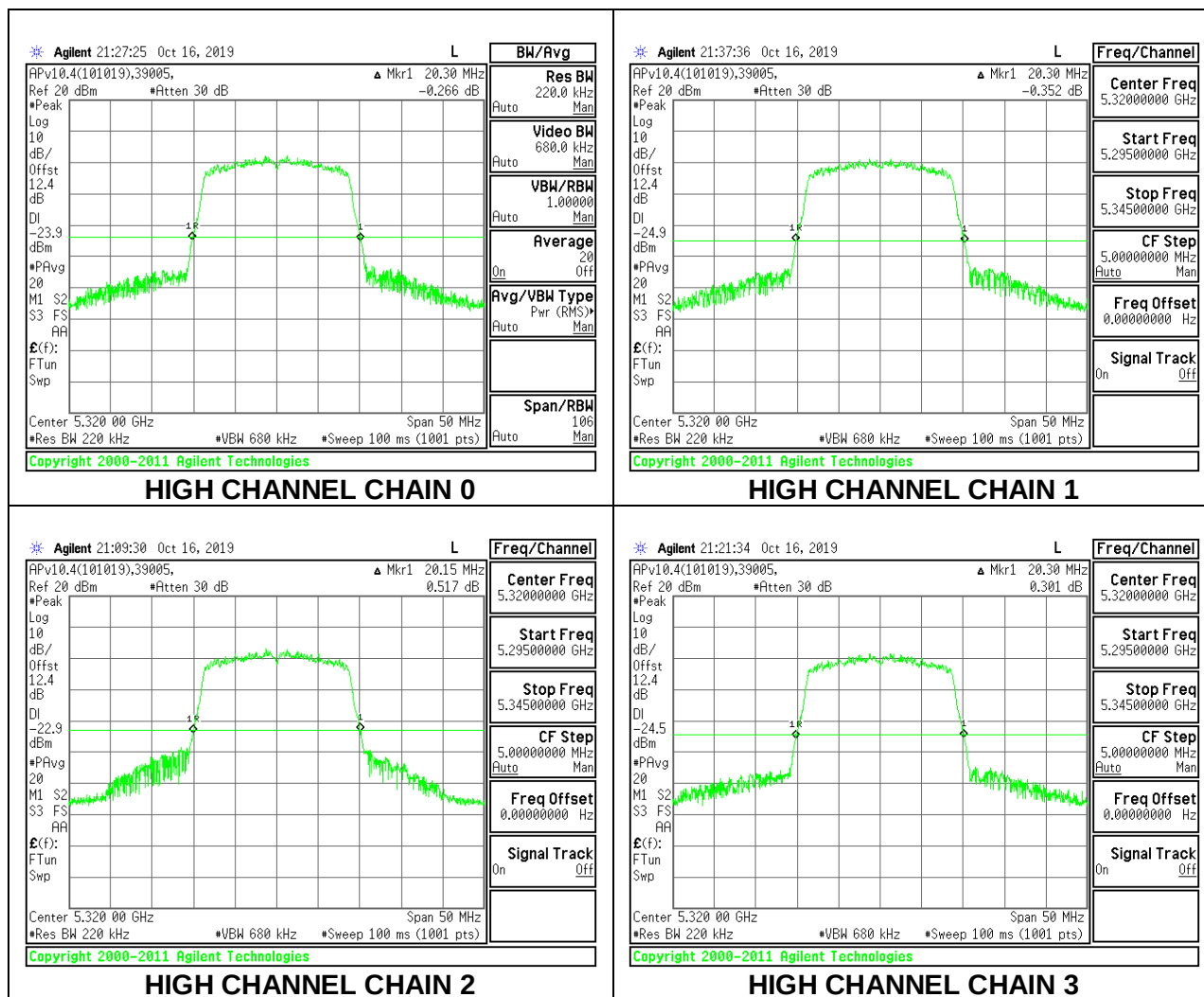
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

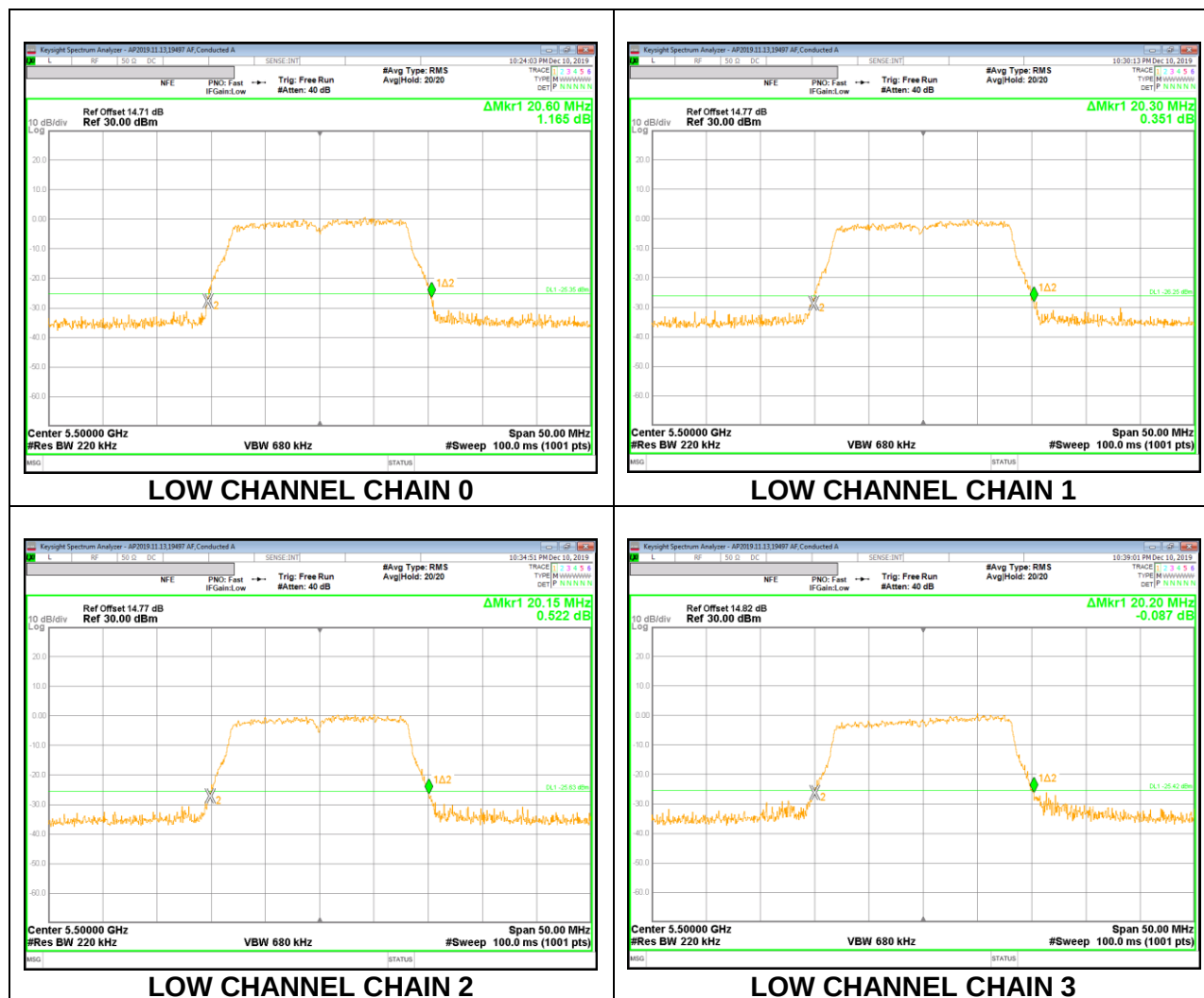


8.2.5. 802.11a MODE IN THE 5.6 GHz BAND

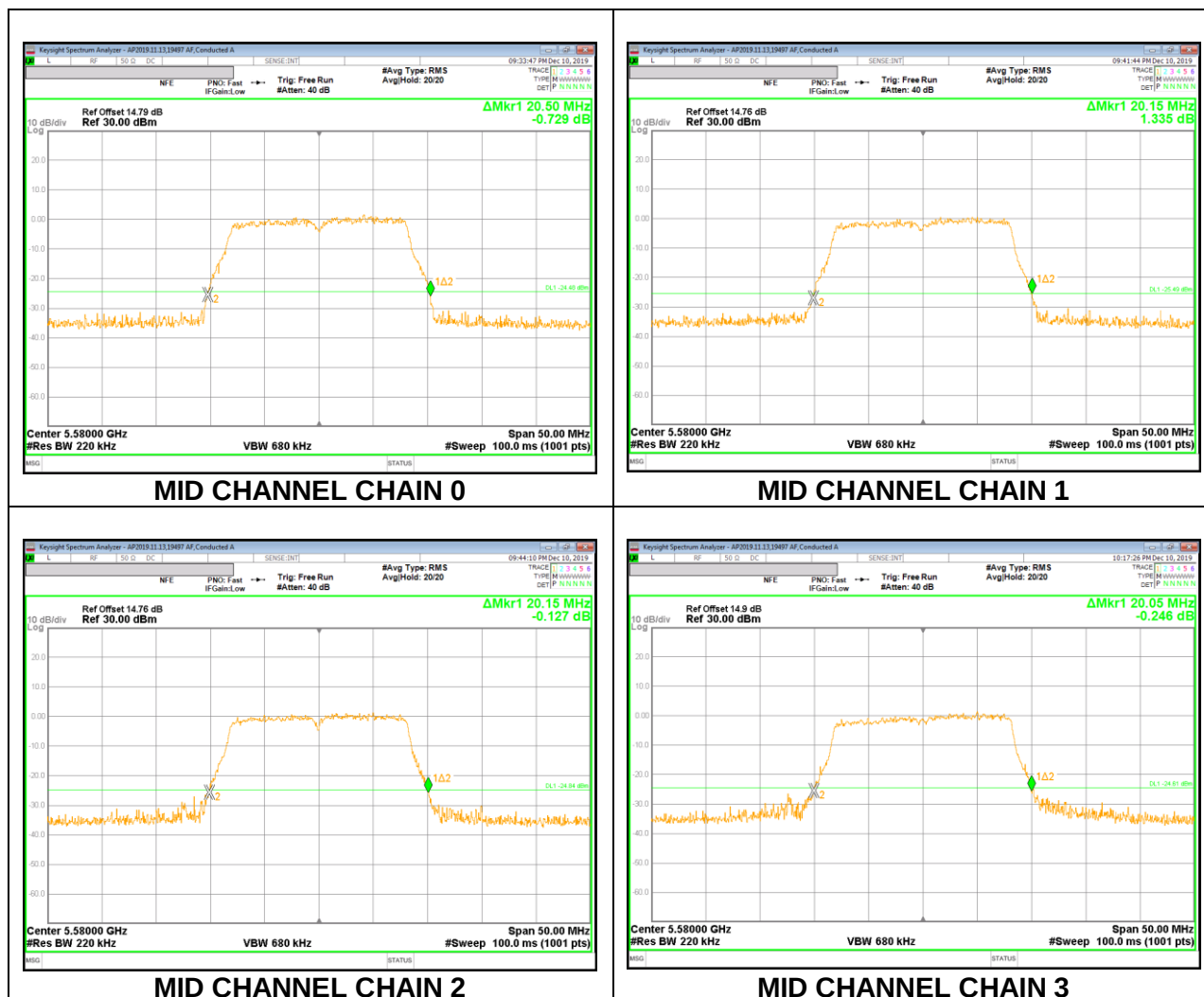
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5500	20.60	20.30	20.15	20.20
Mid	5580	20.50	20.15	20.15	20.05
High	5700	20.55	20.20	20.30	20.80

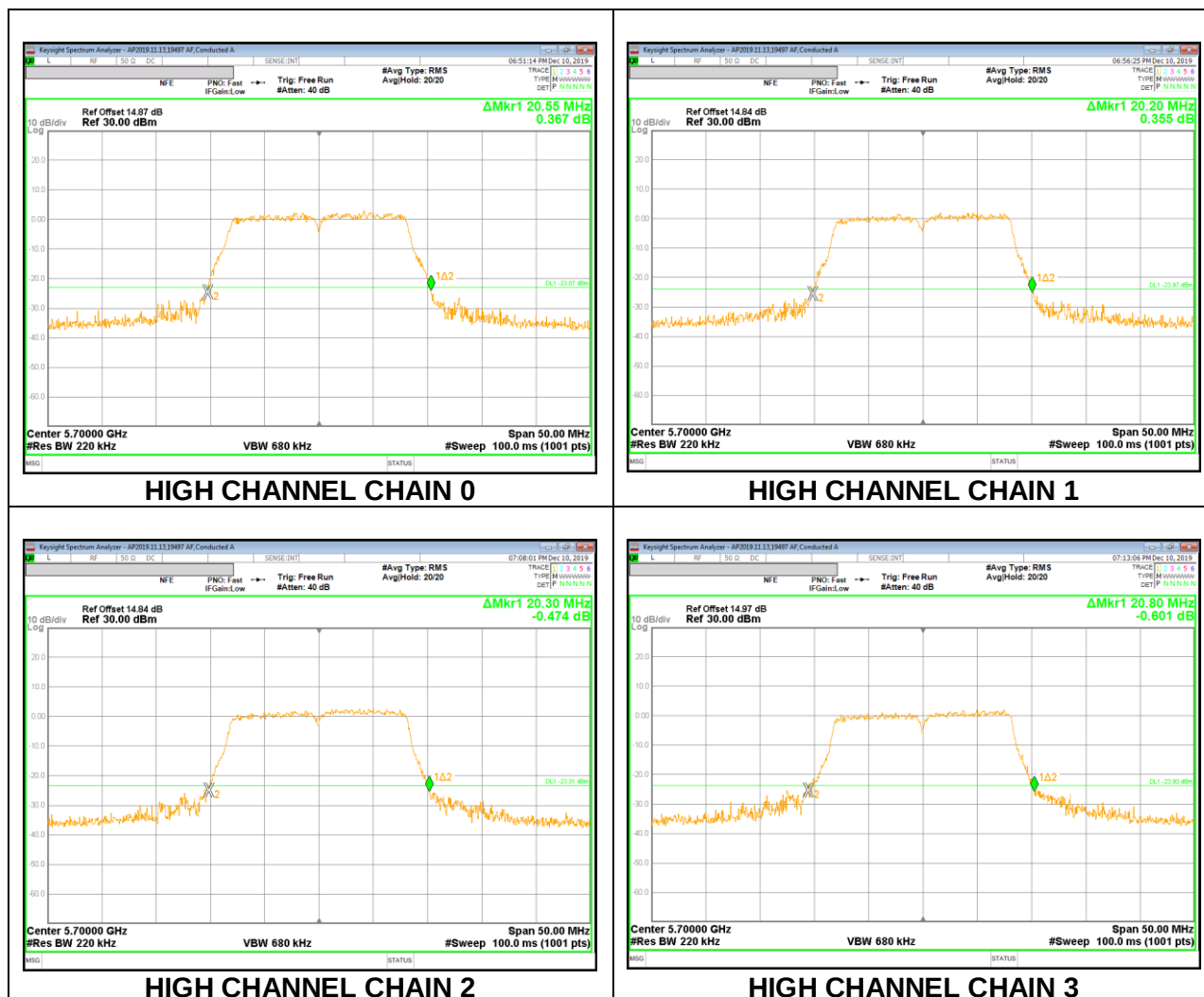
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

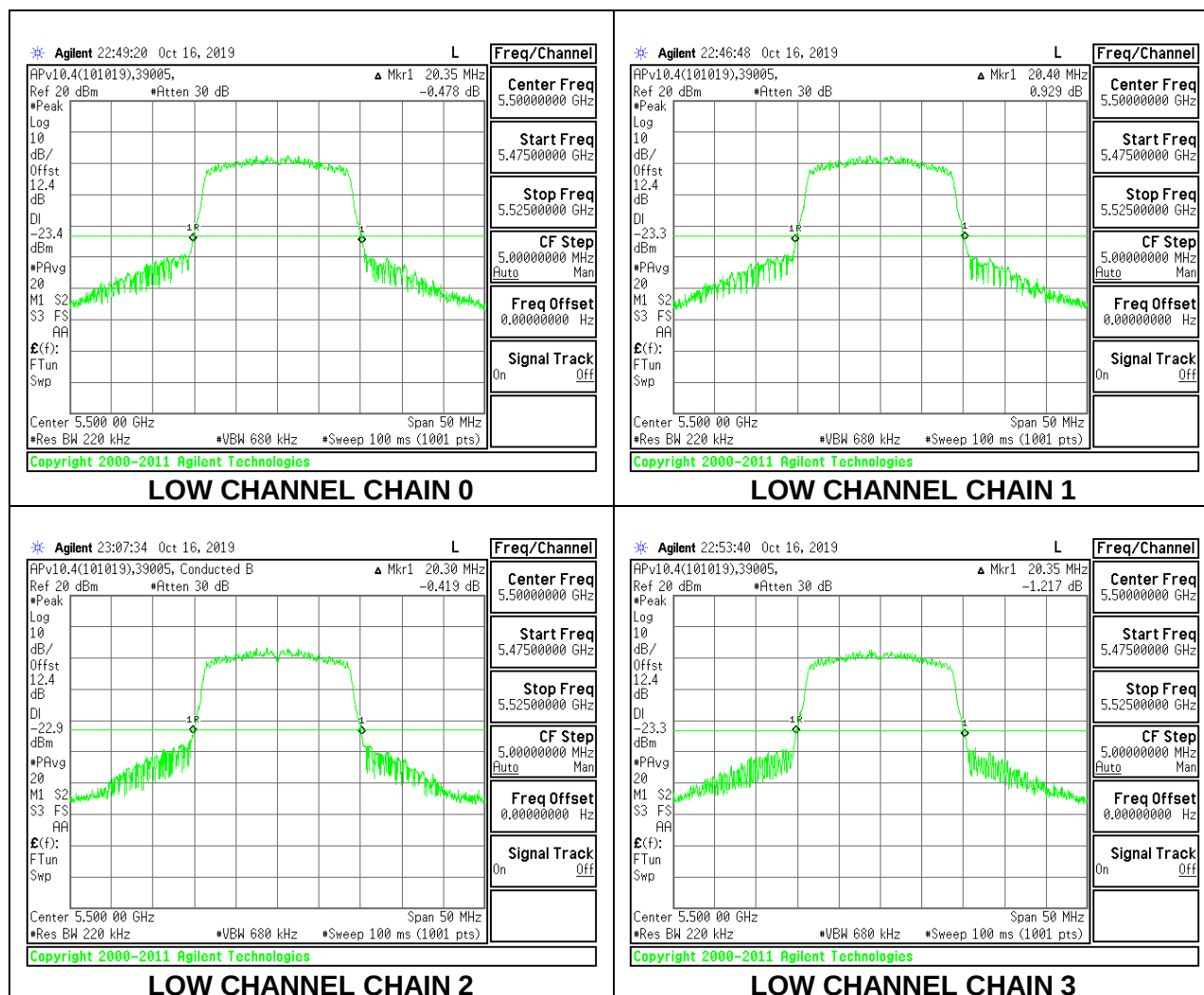


8.2.6. 802.11n HT20 MODE IN THE 5.6 GHz BAND

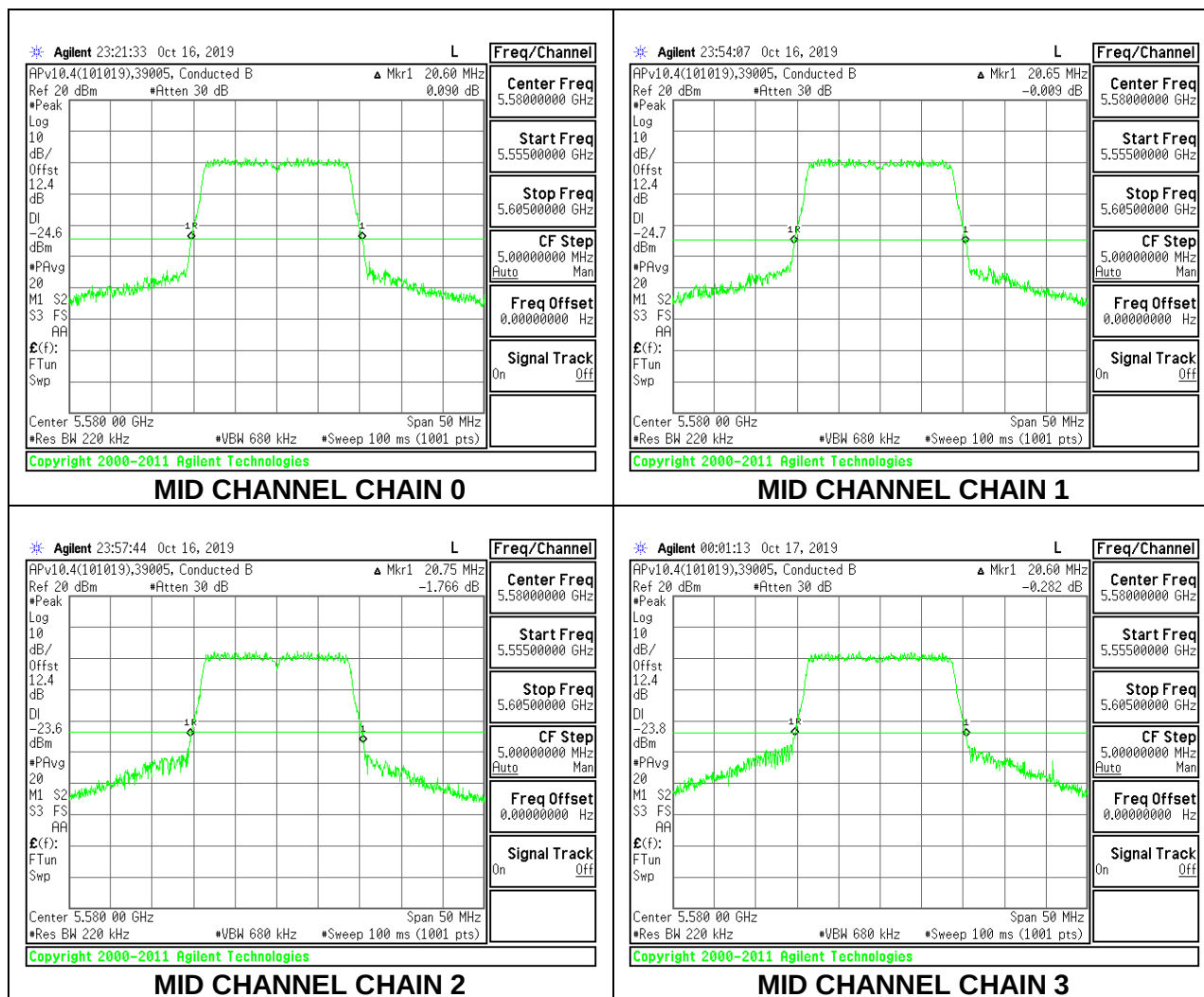
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5500	20.35	20.40	20.30	20.35
Mid	5580	20.60	20.65	20.75	20.60
High	5700	20.30	20.40	20.25	20.20

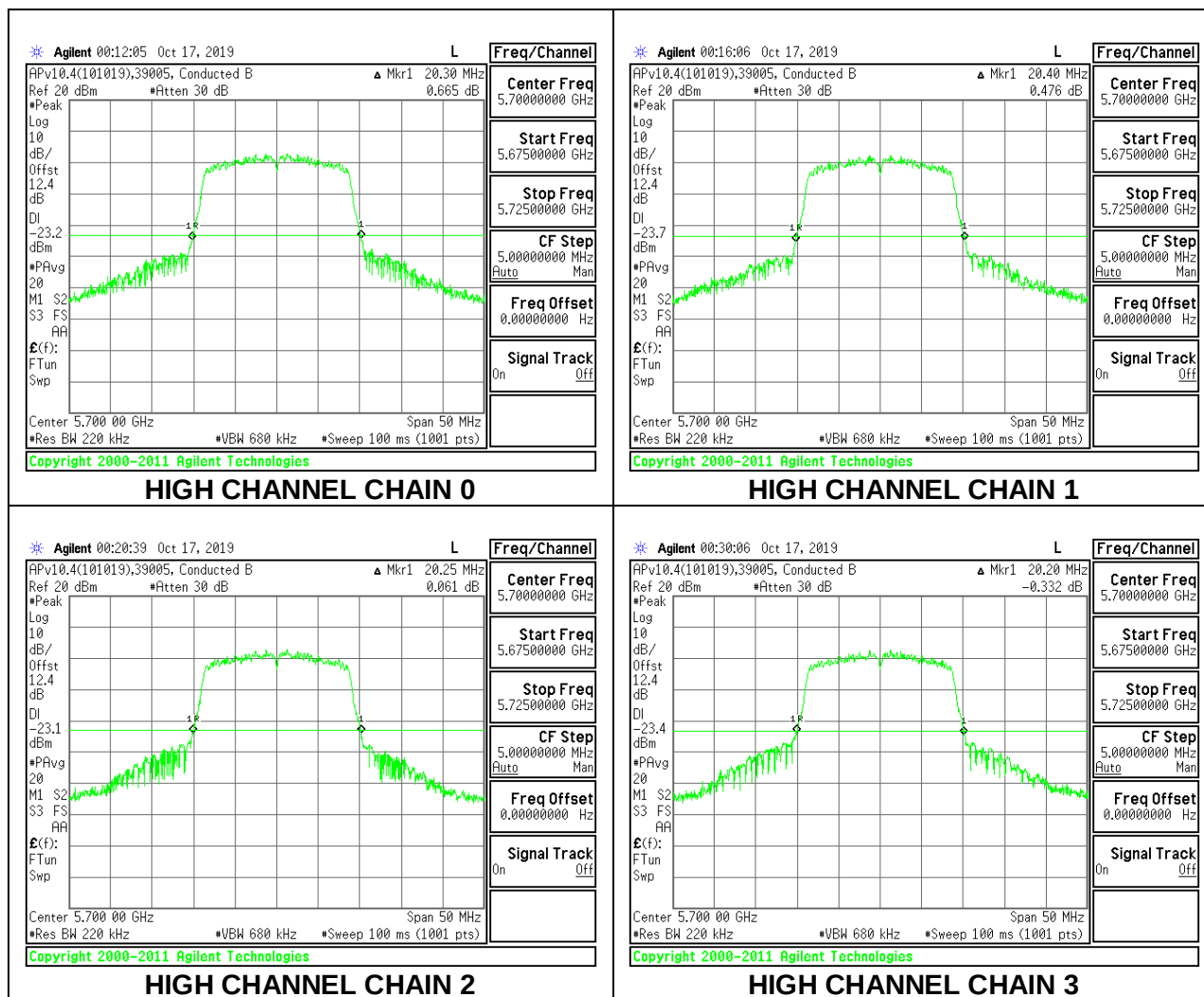
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

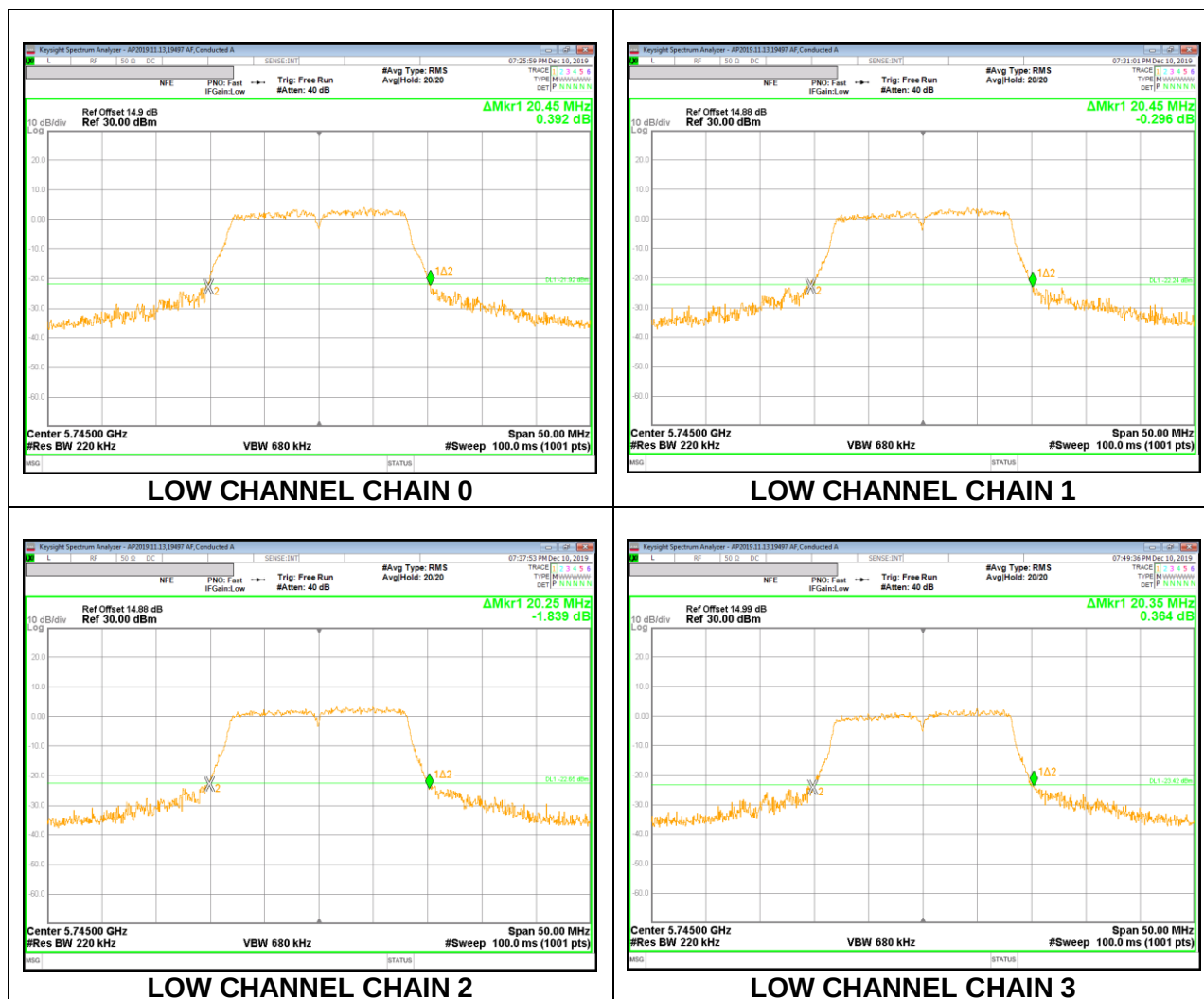


8.2.7. 802.11a MODE IN THE 5.8 GHz BAND

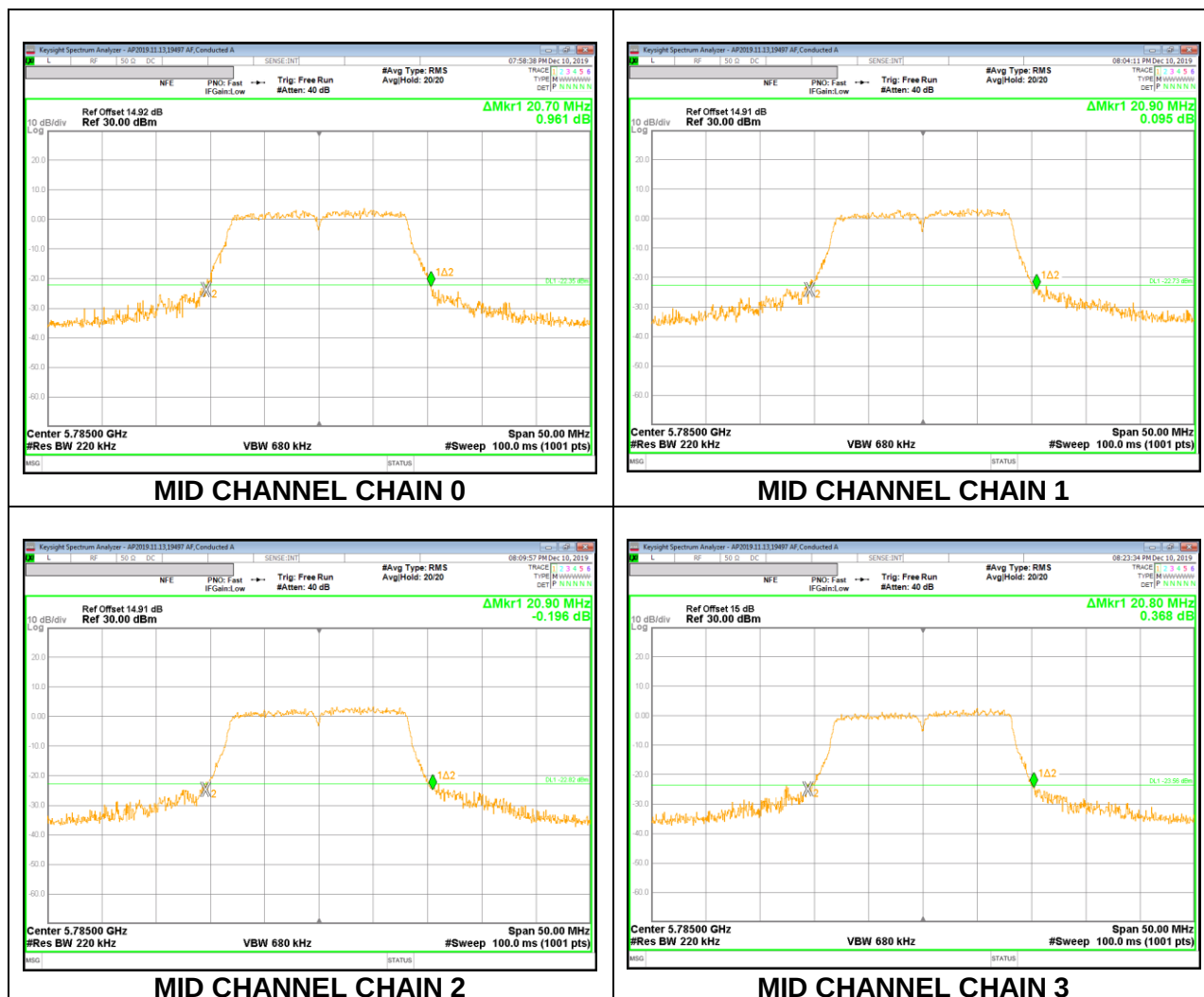
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency	26 dB Bandwidth Antenna 0	26 dB Bandwidth Antenna 1	26 dB Bandwidth Antenna 2	26 dB Bandwidth Antenna 3
Low	5745	20.45	20.45	20.25	20.35
Mid	5785	20.70	20.90	20.90	20.80
High	5825	20.60	20.50	20.50	21.15

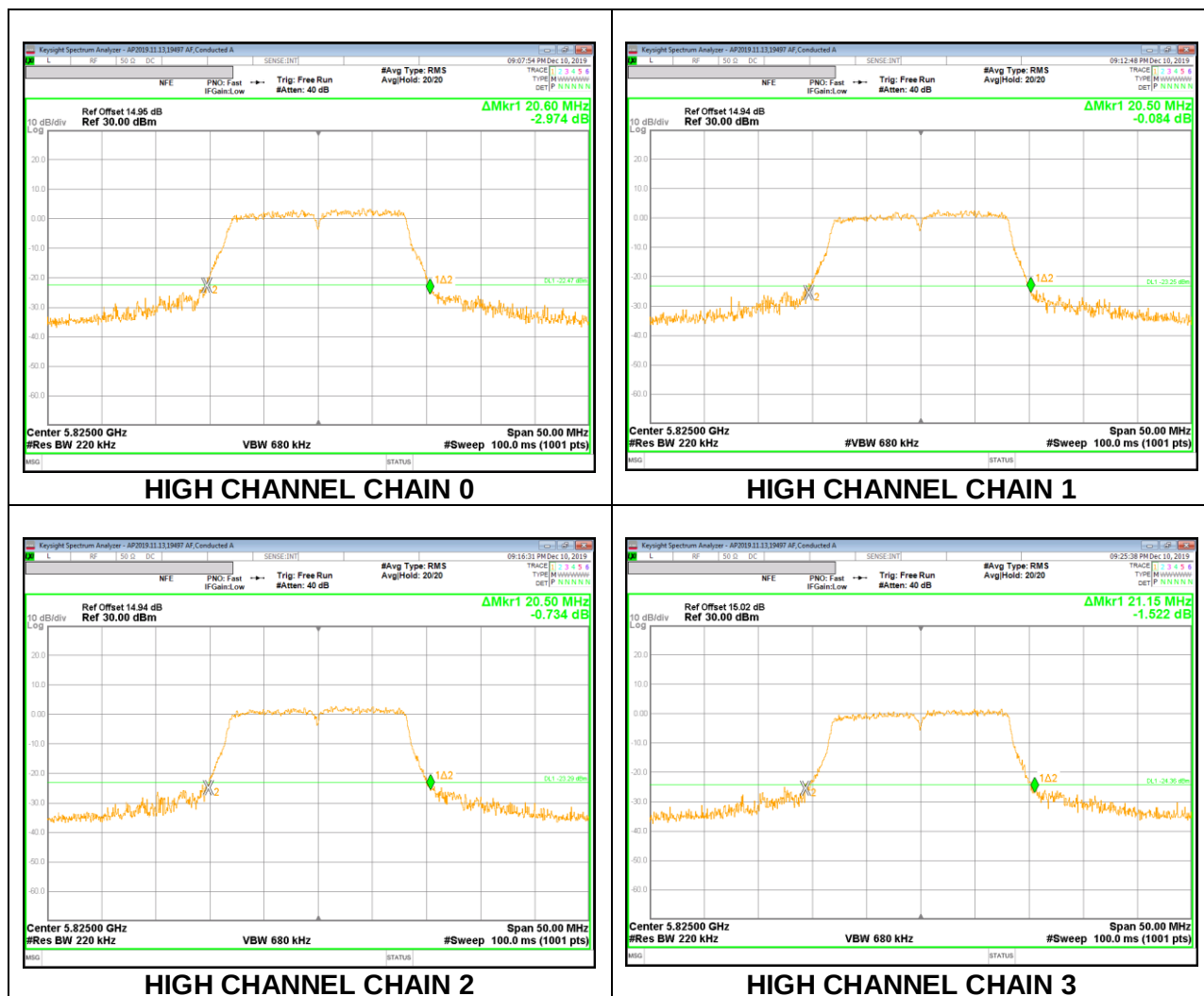
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

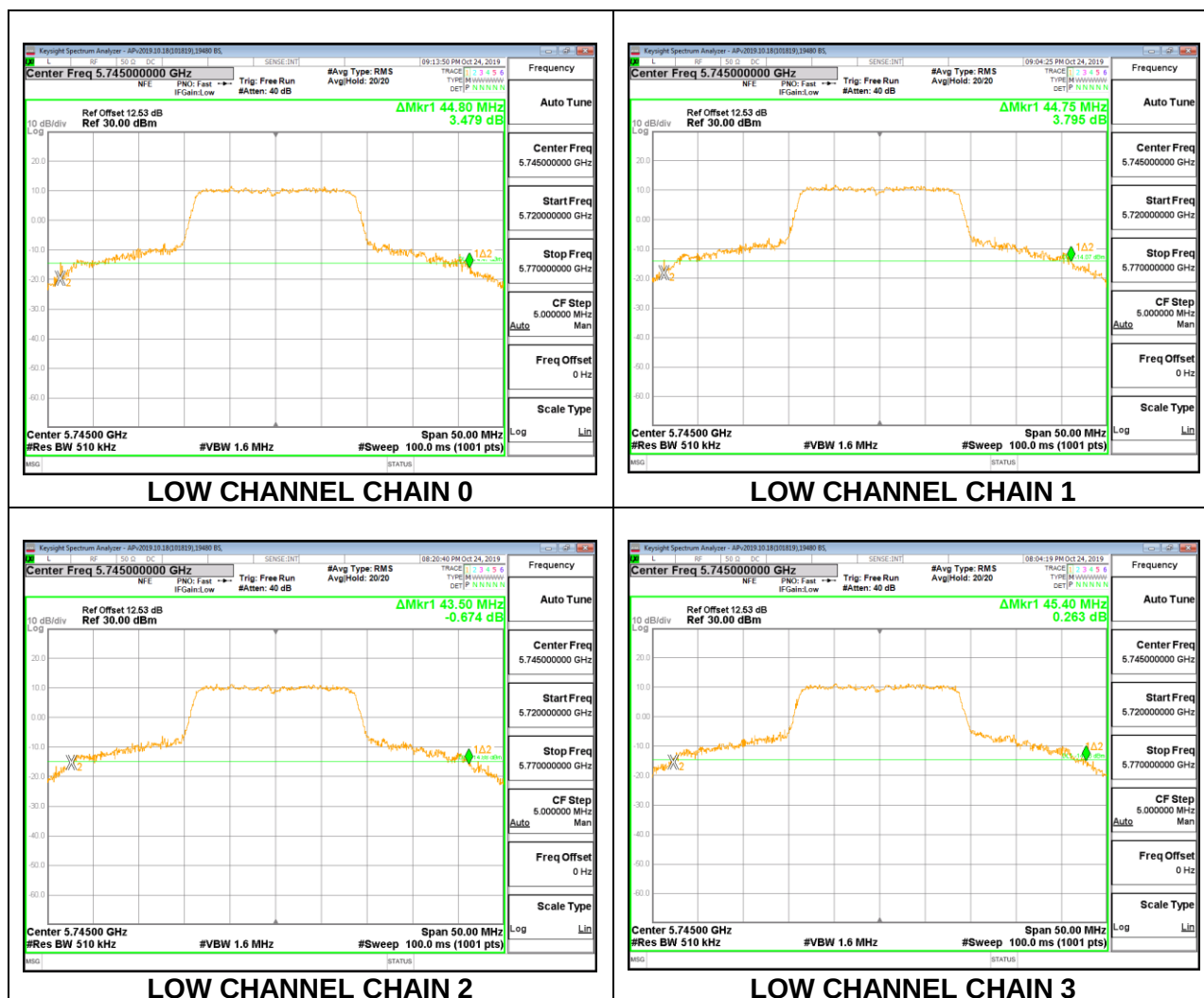


8.2.8. 802.11n HT20 MODE IN THE 5.8 GHz BAND

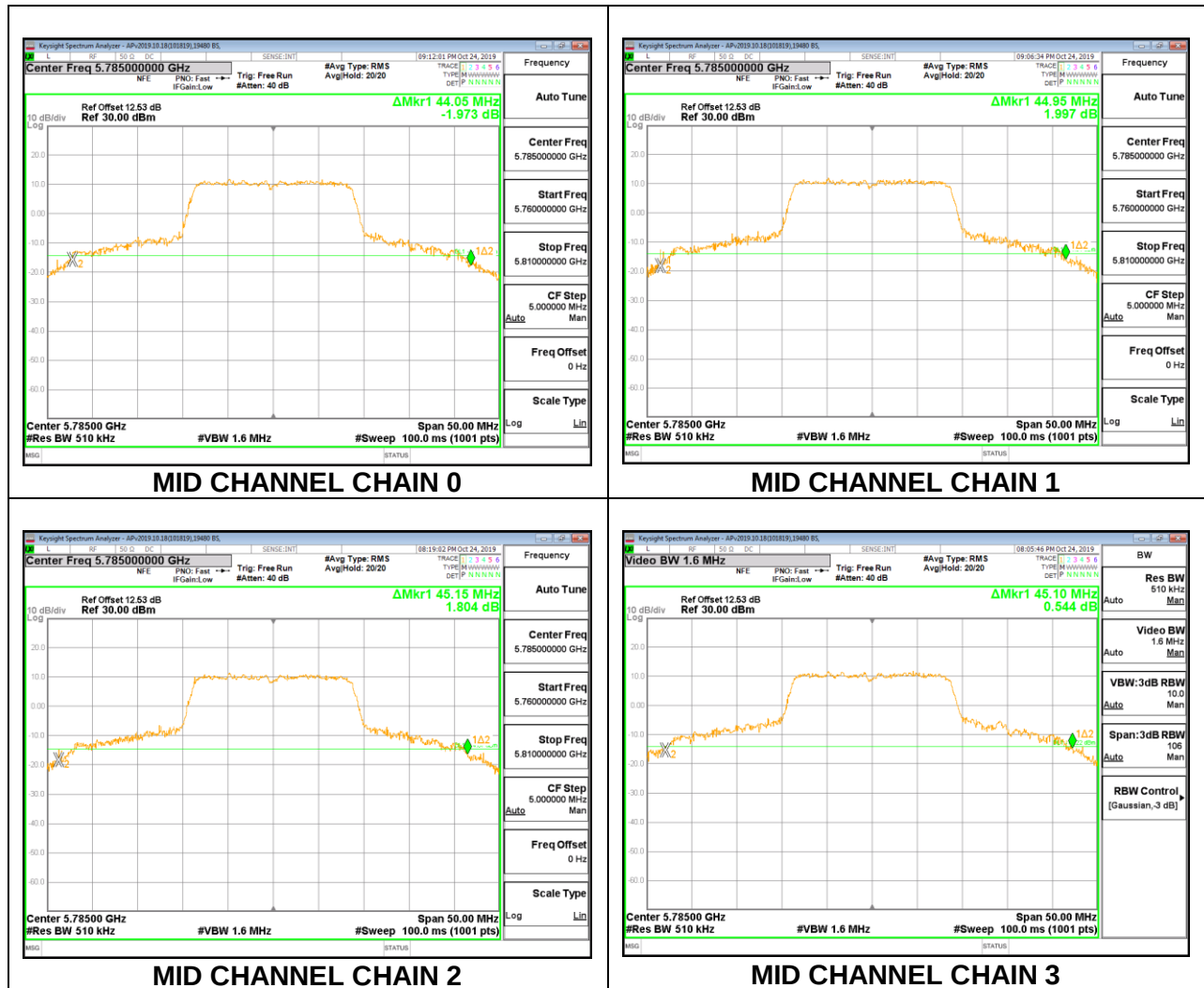
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Channel	Frequency (MHz)	26 dB Bandwidth Antenna 0 (MHz)	26 dB Bandwidth Antenna 1 (MHz)	26 dB Bandwidth Antenna 2 (MHz)	26 dB Bandwidth Antenna 3 (MHz)
Low	5745	44.80	44.75	43.50	45.40
Mid	5785	44.05	44.95	45.15	45.10
High	5825	45.90	44.05	44.60	46.15

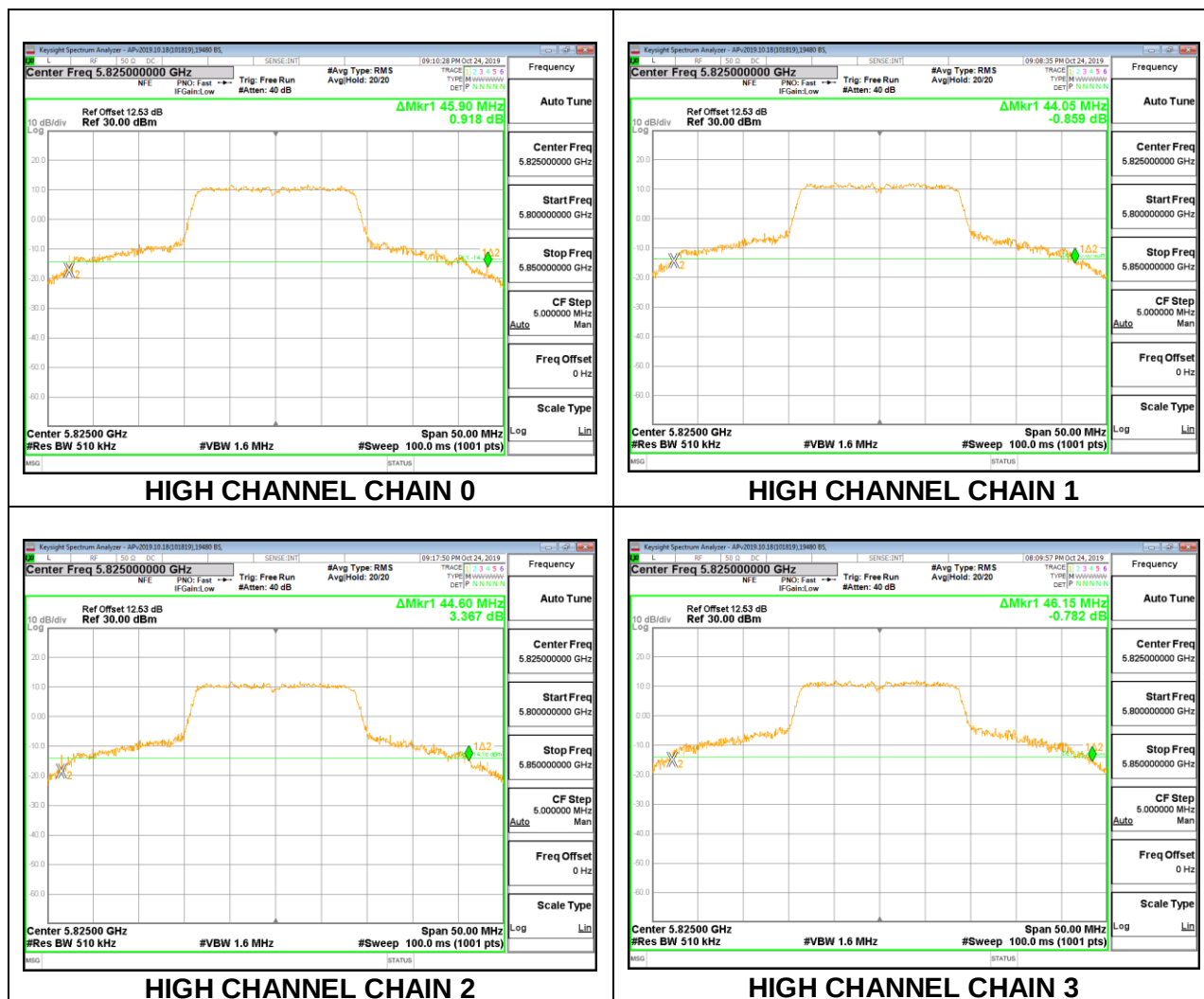
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



8.3. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

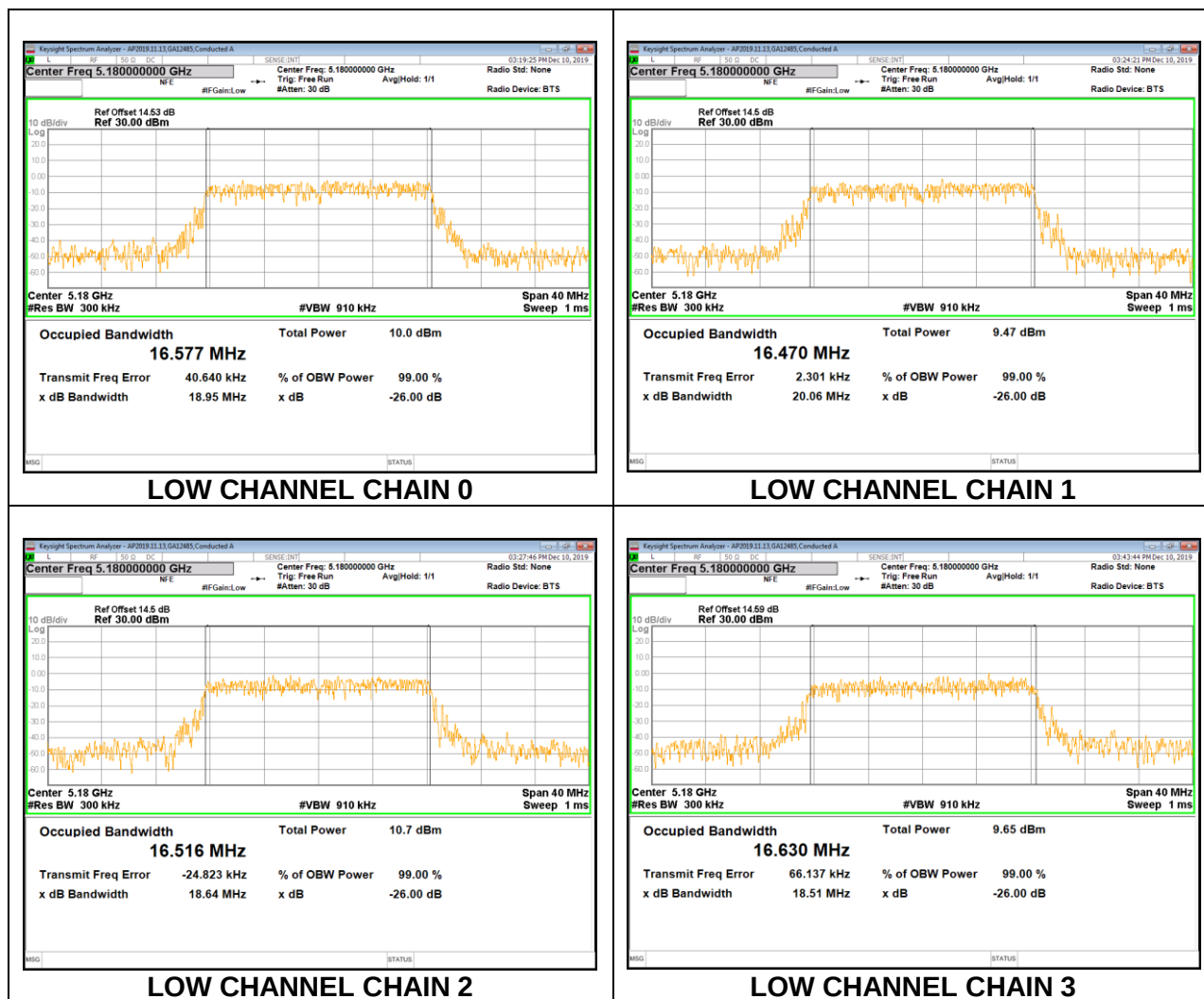
RESULTS

8.3.1. 802.11a MODE IN THE 5.2 GHz BAND

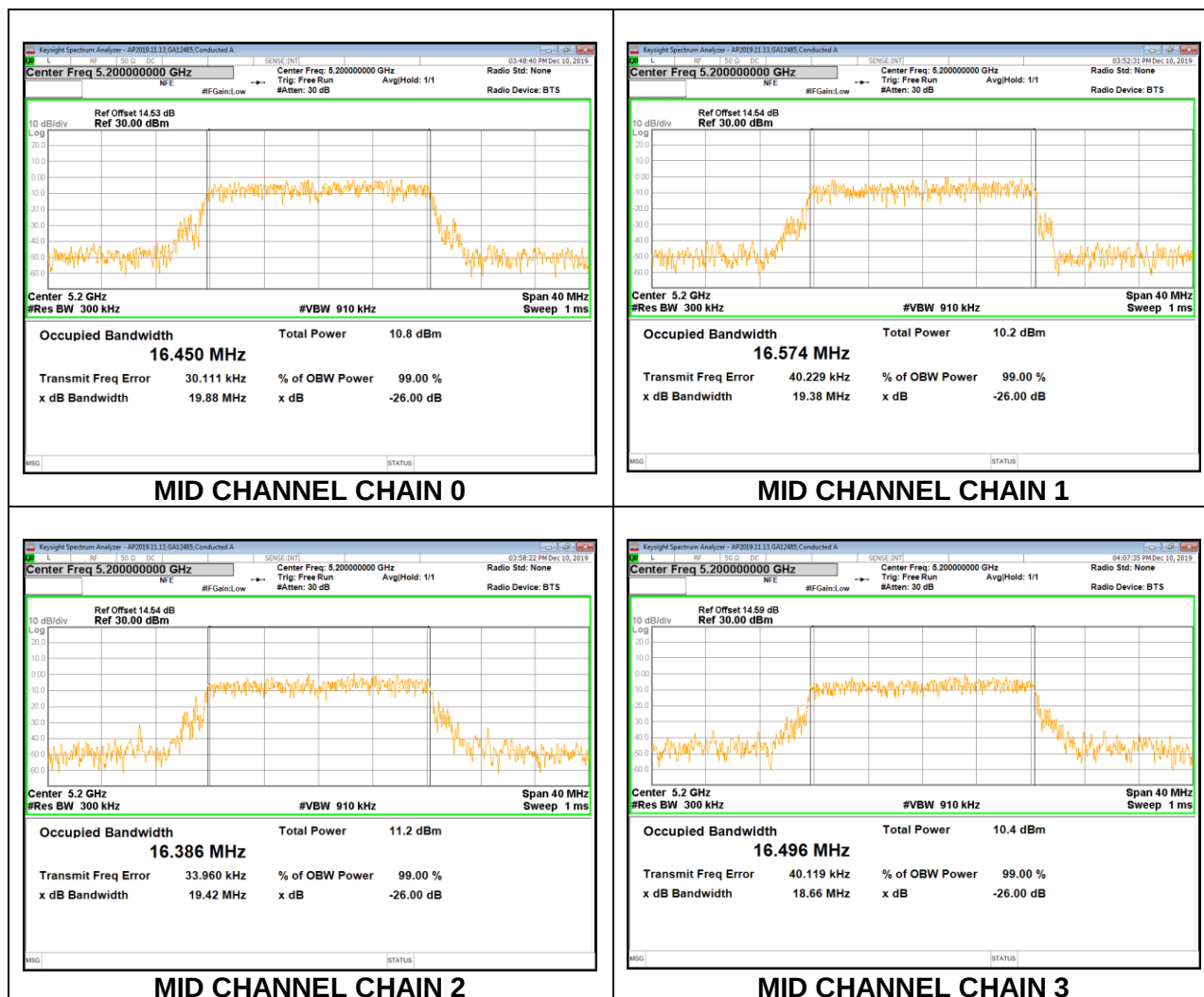
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Frequency (MHz)	99% Bandwidth Antenna 0 (MHz)	99% Bandwidth Antenna 1 (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 3 (MHz)
5180	16.577	16.470	16.516	16.630
5200	16.450	16.574	16.386	16.496
5240	16.585	16.480	16.609	16.512

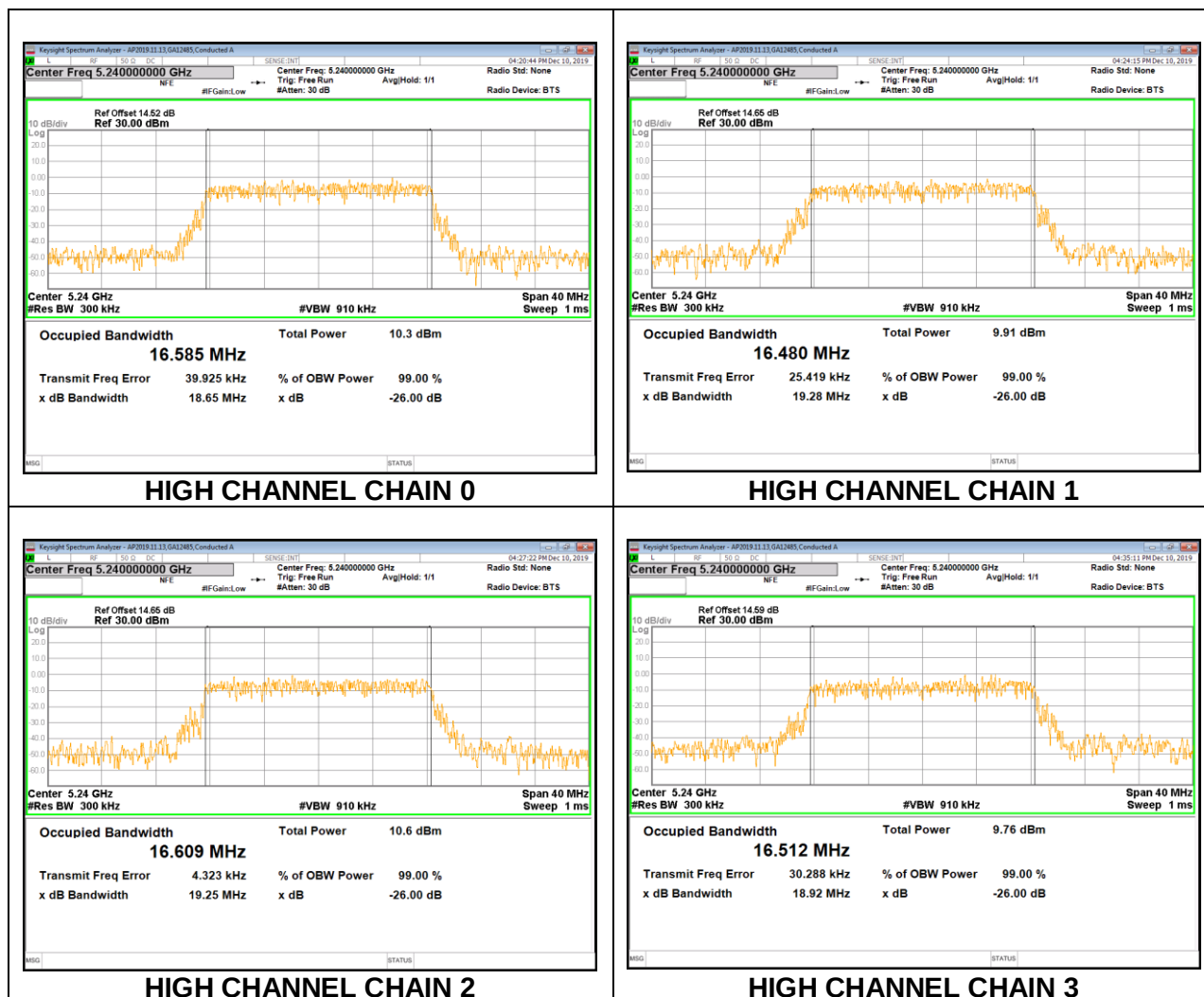
LOW CHANNEL



MID CHANNEL



HIGH CHANNEL



8.3.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

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

Frequency (MHz)	99% Bandwidth Antenna 0 (MHz)	99% Bandwidth Antenna 1 (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 3 (MHz)
5180	17.7572	17.6386	17.8024	17.8055
5200	17.7653	17.7028	17.8436	17.8285
5240	17.7502	17.7287	17.6922	17.7932

LOW CHANNEL

