



CERTIFICATION TEST REPORT

Report Number. : 12148309-E3V3

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

Model : S17

FCC ID : SBVRM017

IC : 5373A-RM017

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:

July 30, 2019

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	5/8/2019	Initial Issue	
V2	6/20/2019	Updated Section 5.5 & 7	K.Kedida
V3	7/30/2019	Updated Section 5.5	K.Kedida

REPORT REVISION HISTORY	2
1. ATTESTATION OF TEST RESULTS	5
2. TEST METHODOLOGY	6
3. FACILITIES AND ACCREDITATION	6
4. CALIBRATION AND UNCERTAINTY	7
4.1. MEASURING INSTRUMENT CALIBRATION	7
4.2. SAMPLE CALCULATION	7
4.3. MEASUREMENT UNCERTAINTY	7
5. EQUIPMENT UNDER TEST	8
5.1. EUT DESCRIPTION	8
5.2. MAXIMUM OUTPUT POWER	8
5.3. DESCRIPTION OF AVAILABLE ANTENNAS	9
5.4. SOFTWARE AND FIRMWARE	9
5.5. WORST-CASE CONFIGURATION AND MODE	9
5.6. DESCRIPTION OF TEST SETUP	10
6. MEASUREMENT METHOD	12
7. TEST AND MEASUREMENT EQUIPMENT	13
8. ANTENNA PORT TEST RESULTS	14
8.1. ON TIME AND DUTY CYCLE	14
8.2. 99% BANDWIDTH	16
8.2.1. 802.11b MODE	17
8.2.2. 802.11g MODE	21
8.2.3. 802.11n HT20 MODE	30
8.3. 6 dB BANDWIDTH	39
8.3.1. 802.11b MODE	40
8.3.2. 802.11g MODE	44
8.3.3. 802.11n HT20 MODE	53
8.4. OUTPUT POWER	62
8.4.1. 802.11b MODE	64
8.4.2. 802.11g MODE	65
8.4.3. 802.11n HT20 MODE	66
8.5. POWER SPECTRAL DENSITY	67
8.5.1. 802.11b MODE	68
8.5.2. 802.11g MODE	72
8.5.3. 802.11n HT20 MODE	81
8.6. CONDUCTED SPURIOUS EMISSIONS	90
8.6.1. 802.11b MODE	91
8.6.2. 802.11g MODE	95

8.6.3.	802.11n HT20 MODE	107
9.	RADIATED TEST RESULTS.....	119
9.1.	TRANSMITTER ABOVE 1 GHz	121
9.1.1.	TX ABOVE 1 GHz 802.11b MODE IN THE 2.4 GHz BAND	121
9.1.2.	TX ABOVE 1 GHz 802.11g MODE IN THE 2.4 GHz BAND	131
9.1.3.	TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 2.4 GHz BAND.....	151
9.2.	WORST CASE BELOW 30MHZ	171
9.3.	WORST CASE BELOW 1 GHZ.....	173
9.4.	WORST CASE 18-26 GHZ	175
10.	AC POWER LINE CONDUCTED EMISSIONS	177
11.	SETUP PHOTOS.....	180

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: S17

SERIAL NUMBER: 5C-AA-FD-D0-08-14 (Radiated Sample)
5C-AA-FD-D0-08-DA (Radiated Sample)
5C-FF-DD-00-03-69 (Conducted Sample)

DATE TESTED: February 25 – April 2, 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:



Dan Corona
Operations Leader
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 558074 D01 15.247 Meas Guidance v05, 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 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 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 dBuV + 0 dB + 10.1 dB + 0 dB = 46.6 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 4x4 (HT20) Client Device. Product model S17 is a high-performance wireless speaker and part of the Sonos sound system. The device's primary function will be for streaming via WiFi, but also features Bluetooth audio streaming and Bluetooth Low Energy, used for simplified set-up.

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)
4Tx			
2412 - 2462	802.11b	24.96	313.33
2412 - 2462	802.11g	24.06	254.68
2412 - 2462	802.11n HT20	24.26	266.69

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes FPC and PCB antenna, with maximums gain per chain as follows:

Frequency (MHz)	Peak Antenna Gain (dBi)			
	Chain 0 (Vertical Polarization)	Chain 1 (Vertical Polarization)	Chain 2 (Vertical Polarization)	Chain 3 (Vertical Polarization)
2400 – 2483.5	2.3	2.2	3.2	2.4

5.4. SOFTWARE AND FIRMWARE

The test utility software used during testing was Sonos Compliance GUI 4.0.

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. The test set-up includes the power supply and USB-C Cord. Note that the USB-C Cord is not supplied with the product, it is used as support equipment for testing purposes only.

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	X230	SON-00002240	N/A
AC Adapter	Lenovo	42T4418	11S42T4418Z1ZGWG0B5776	N/A

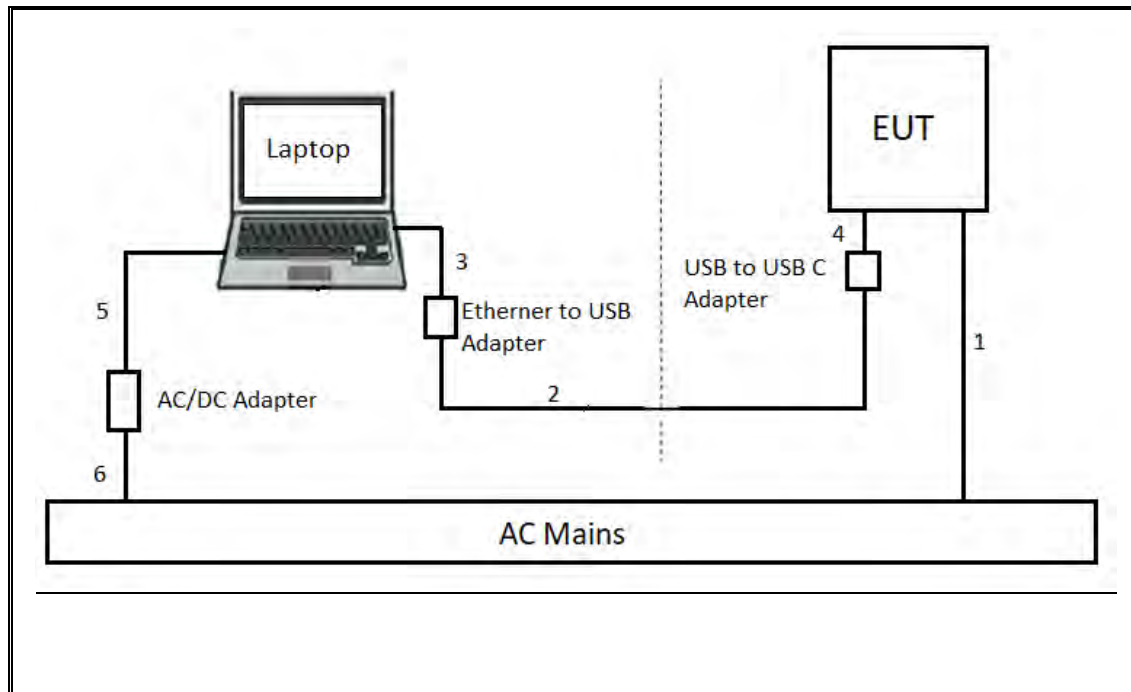
I/O CABLES

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	Ethernet to Ethernet converter
3	Ethernet to USB	1	RJ45 to USB	Unshielded	0.2	USB to USB adapter
4	USB adapter to USB C	1	USB to USB C	Unshielded	0.12	USB C to EUT
5	DC Power	1	DC	Shielded	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: 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
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	PRE0180174	05/31/2019	05/31/2018
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	175953	12/13/2019	12/13/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	AT0067	03/26/2019	03/26/2018
Antenna, Horn 1-18GHz	AR	AMPL-ATH1G18	PRE0189055	4/20/2019	4/20/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T344	4/30/2019	4/30/2018
Amplifier, 1-7GHz, 24dB	AMPLICAL	AMP1G7-24-27	T1608	07/30/2019	07/30/2018
Amplifier, 1-7GHz, 24dB	AMPLICAL	AMP1G7-24-27	T1609	11/03/2019	11/03/2018
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179372	05/04/2019	05/04/2018
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179375	05/08/2019	05/08/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1450	01/23/2020	01/23/2019
Power Sensor	ETS-Lindgren	7002-006	T1022	01/22/2020	01/22/2019
Hybrid Antenna, 30MHz to 3GHz	SunAR rf motion	JB3	PRE0181575	08/01/2019	08/01/2018
18 - 26.5 GHz Horn Antenna	ARA	MWH-1826/B	T448	03/13/2019	03/13/2018
Pre-Amp 1-26.5 GHz	Agilent	8449B	T404	03/09/2020	03/09/2019
Antenna, Passive Loop 30Hz to 1MHz	ELETRO METRICS	EM-6871	PRE0179465	05/22/2019	05/22/2018
Antenna, Passive Loop 100kHz to 30MHz	ELETRO METRICS	EM-6872	PRE0179467	05/22/2019	05/22/2018
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	06/15/2019	06/15/2018

Test Software List			
Description	Manufacturer	Model	Version
Radiated Software	UL	UL EMC	Ver 9.5, June 22, 2018
Antenna Port Software	UL	UL RF	Ver 9.3.2, Jan. 07, 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.

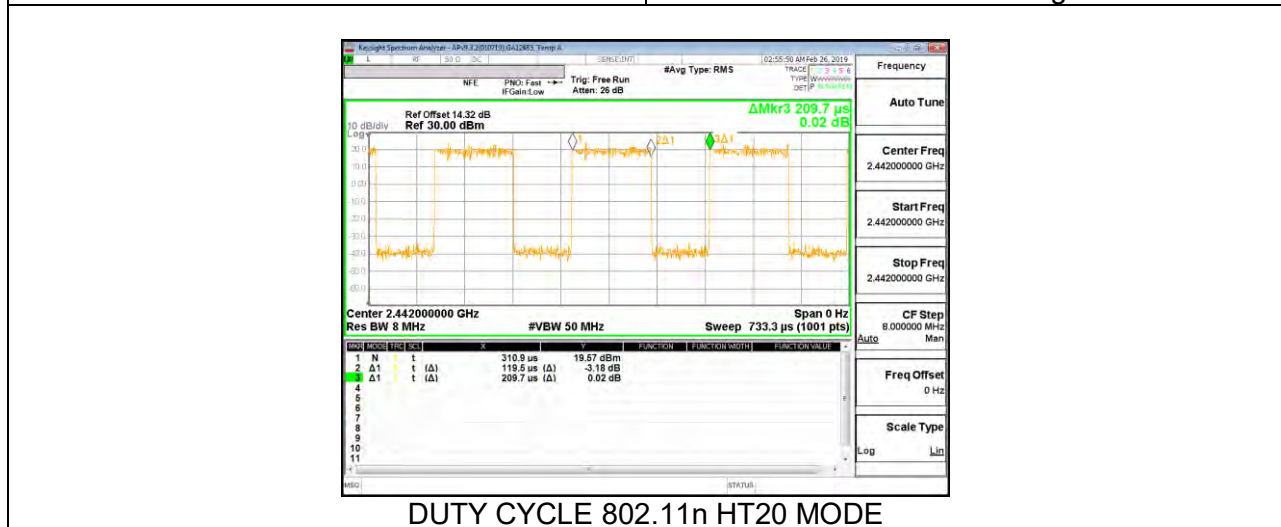
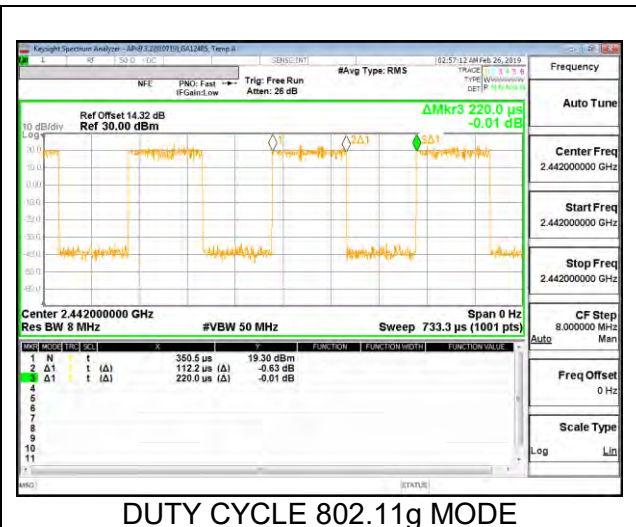
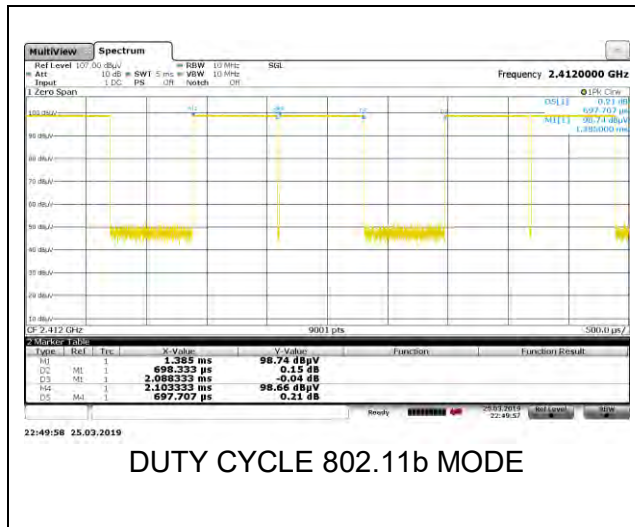
PROCEDURE

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 1TX	1.396	2.088	0.668	66.85%	1.75	0.716
802.11g 1TX	0.112	0.220	0.510	51.00%	2.92	8.913
802.11n HT20 1TX	0.120	0.210	0.570	56.99%	2.44	8.368

DUTY CYCLE PLOTS



8.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

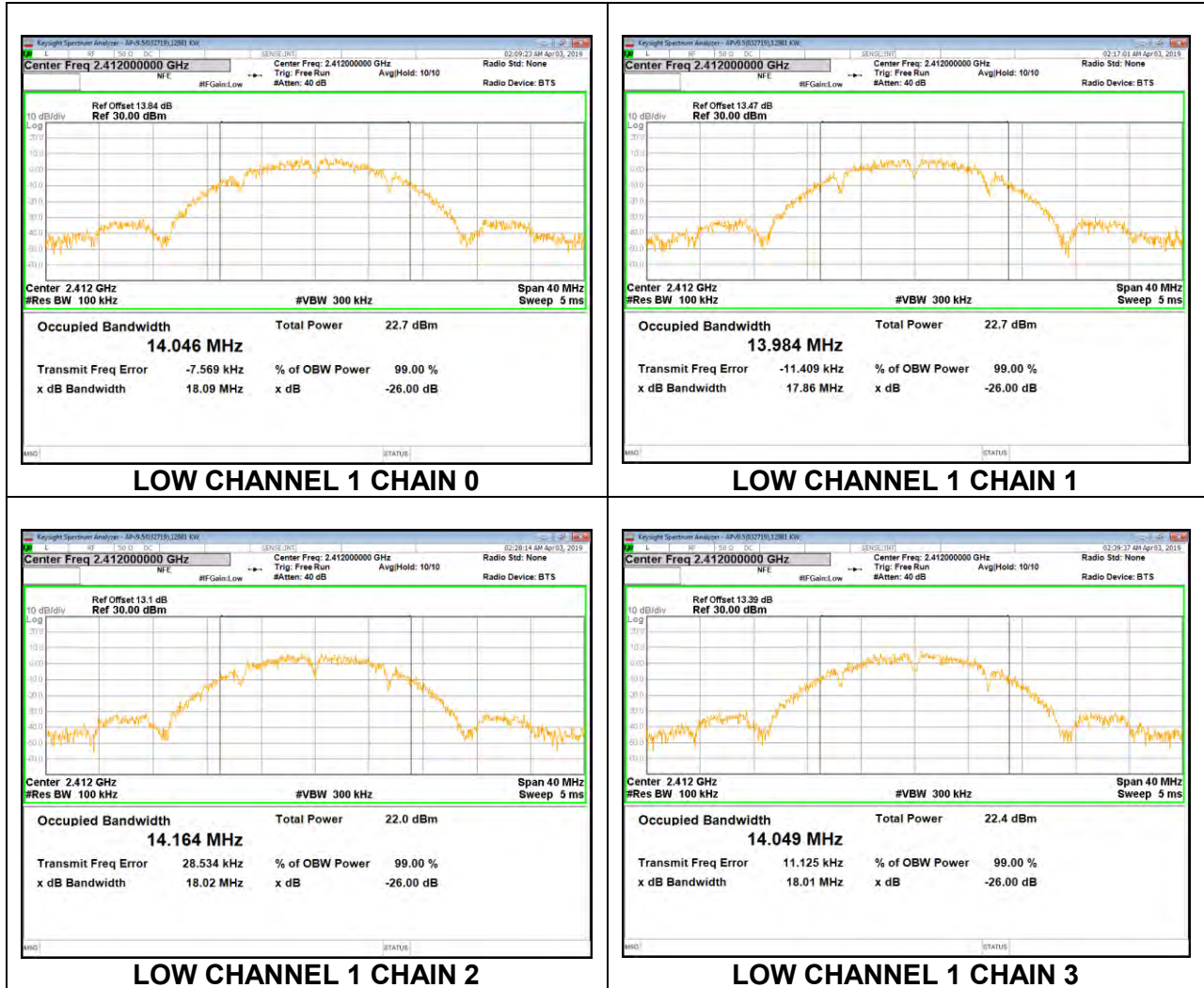
RESULTS

8.2.1. 802.11b MODE

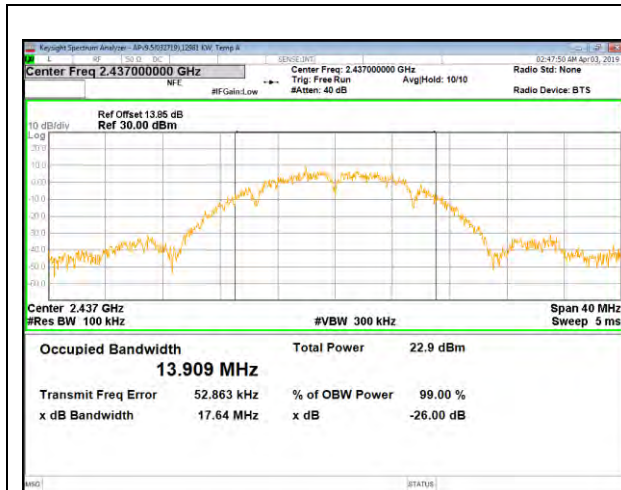
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

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	14.046	13.984	14.164	14.049
Mid 6	2437	13.909	13.811	13.782	13.991
High 11	2462	13.595	13.611	13.891	13.810

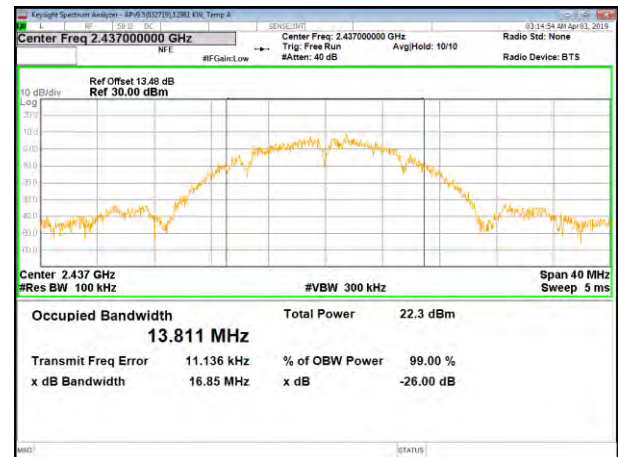
LOW CHANNEL 1



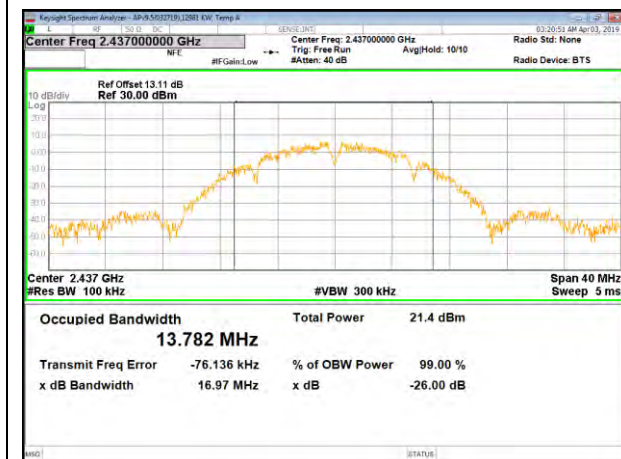
MID CHANNEL 6



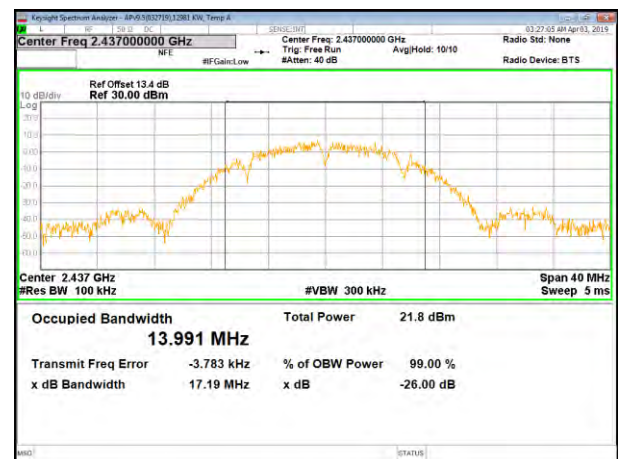
MID CHANNEL 6 CHAIN 0



MID CHANNEL 6 CHAIN 1

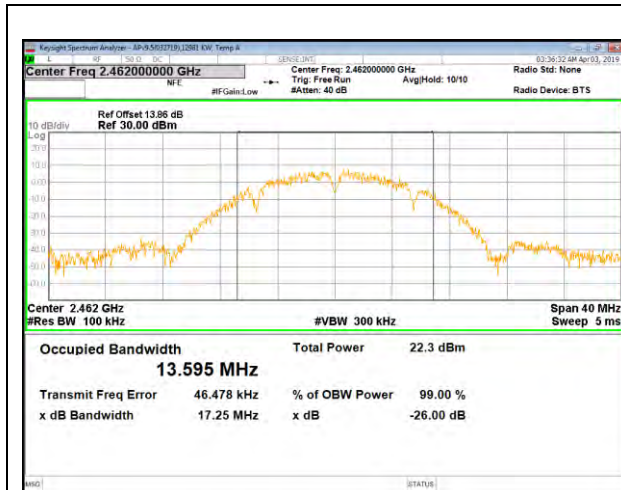


MID CHANNEL 6 CHAIN 2

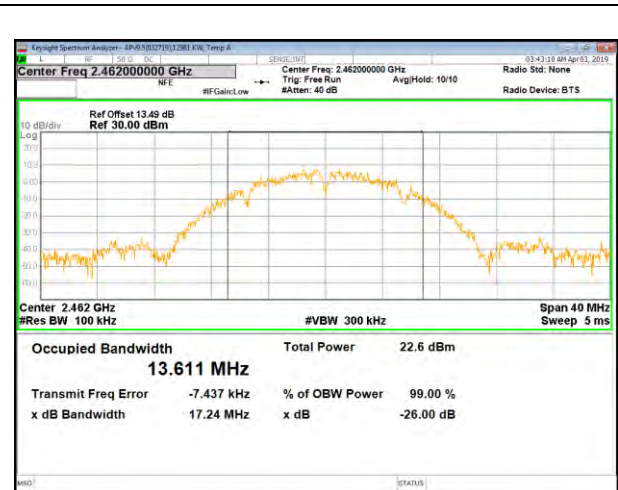


MID CHANNEL 6 CHAIN 3

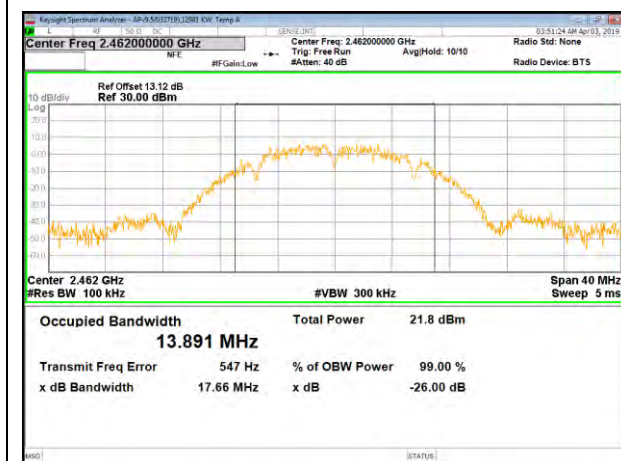
HIGH CHANNEL 11



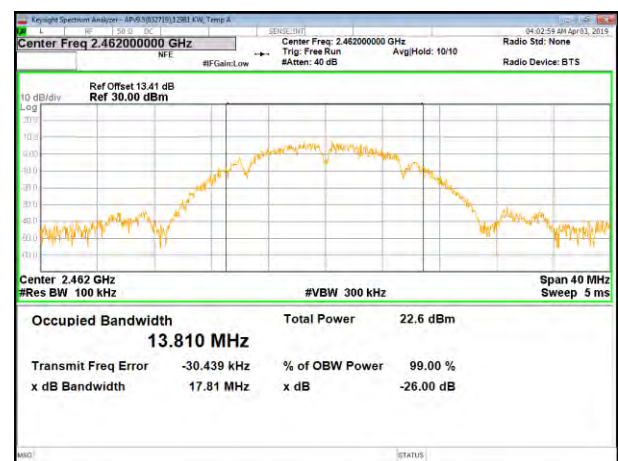
HIGH CHANNEL 11 CHAIN 0



HIGH CHANNEL 11 CHAIN 1



HIGH CHANNEL 11 CHAIN 2



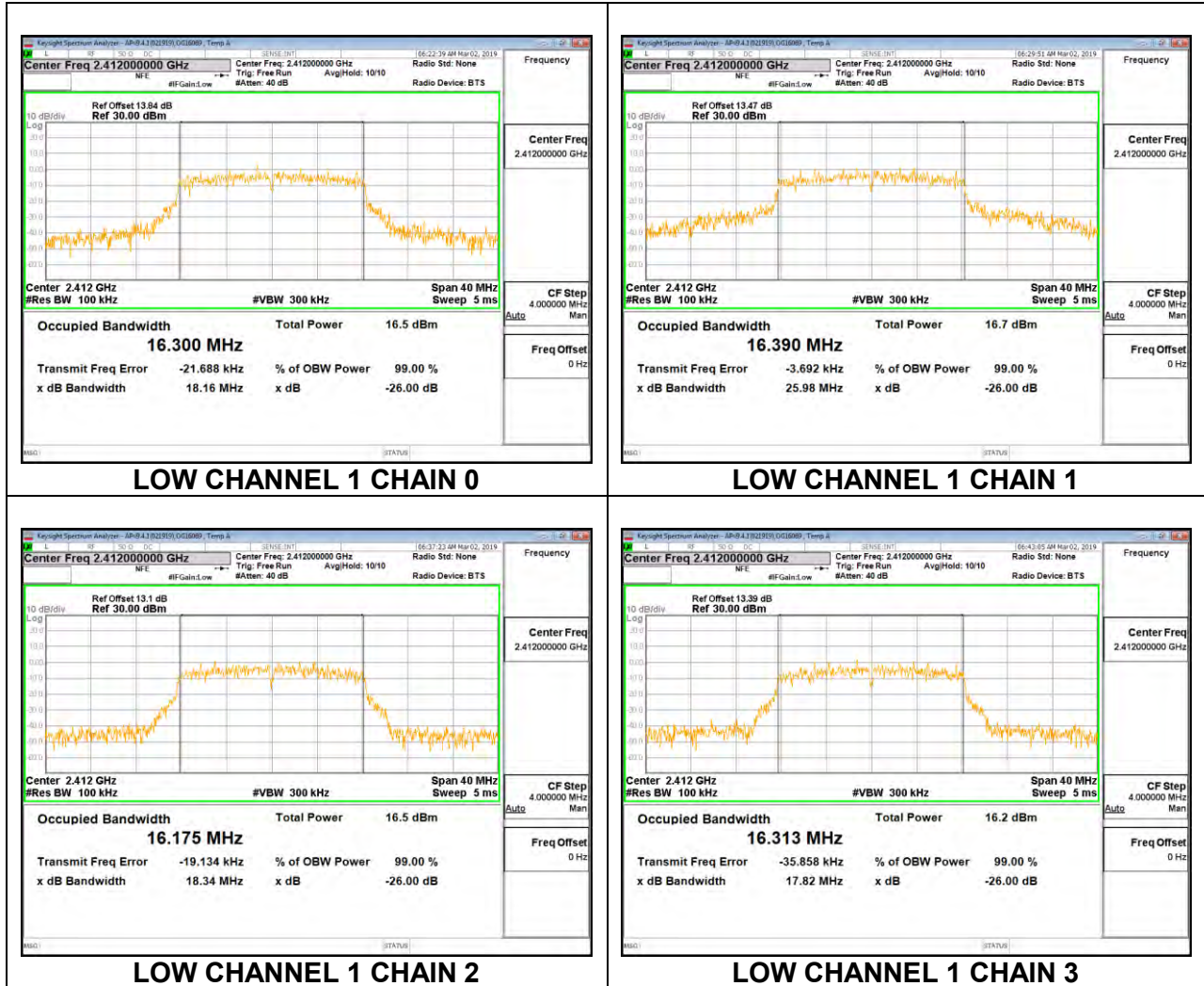
HIGH CHANNEL 11 CHAIN 3

8.2.2. 802.11g MODE

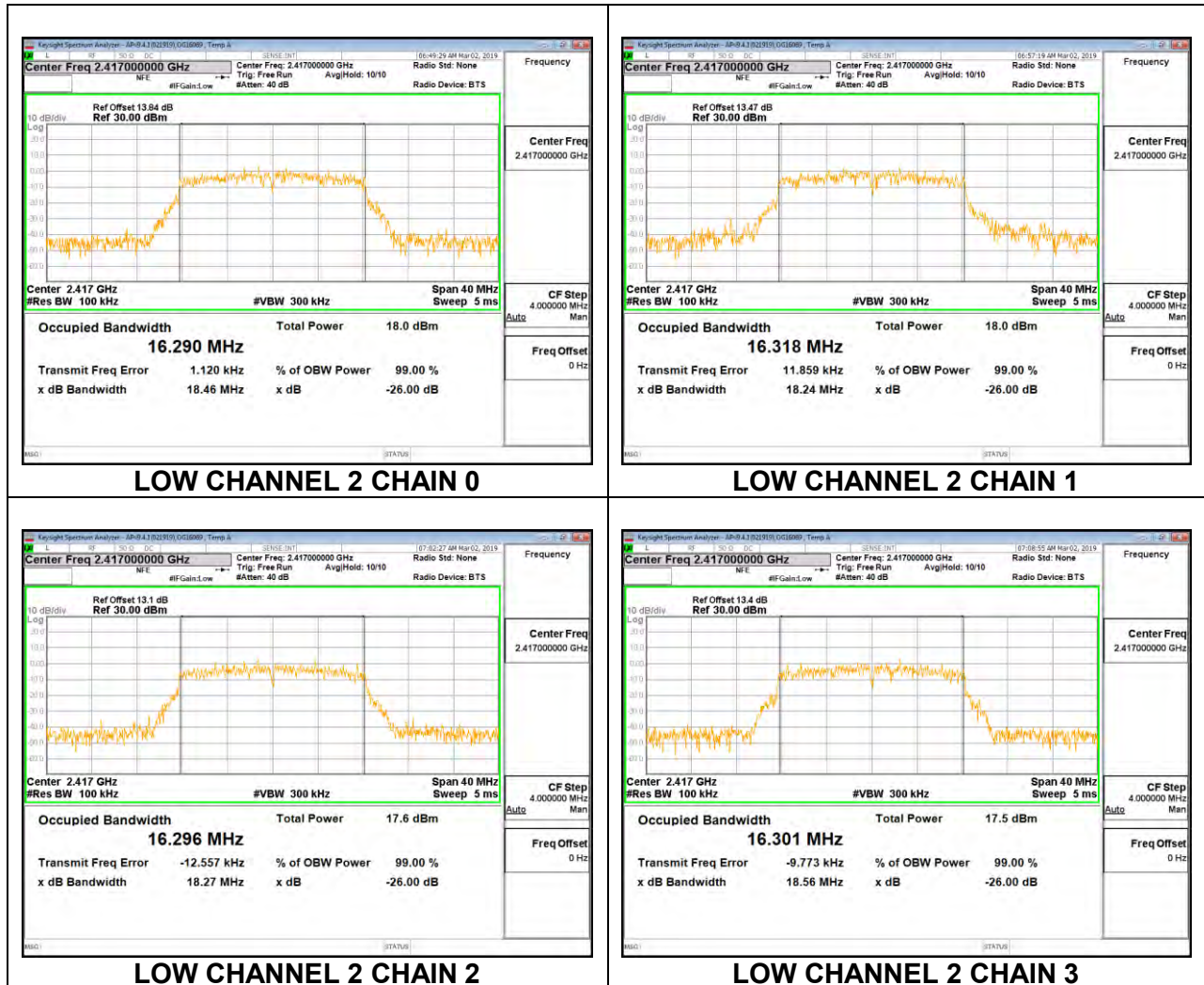
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

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	16.3000	16.3900	16.1750	16.3130
Low 2	2417	16.2900	16.3180	16.2960	16.3010
Low 3	2422	16.3810	16.2870	16.2970	16.2710
Low 4	2427	16.3350	16.2550	16.3220	16.3670
Mid 6	2437	16.3800	16.3420	16.3520	16.3250
High 9	2452	16.3330	16.3070	16.3130	16.2970
High 10	2457	16.3450	16.2720	16.3040	16.3070
High 11	2462	16.3060	16.3000	16.2760	16.2910

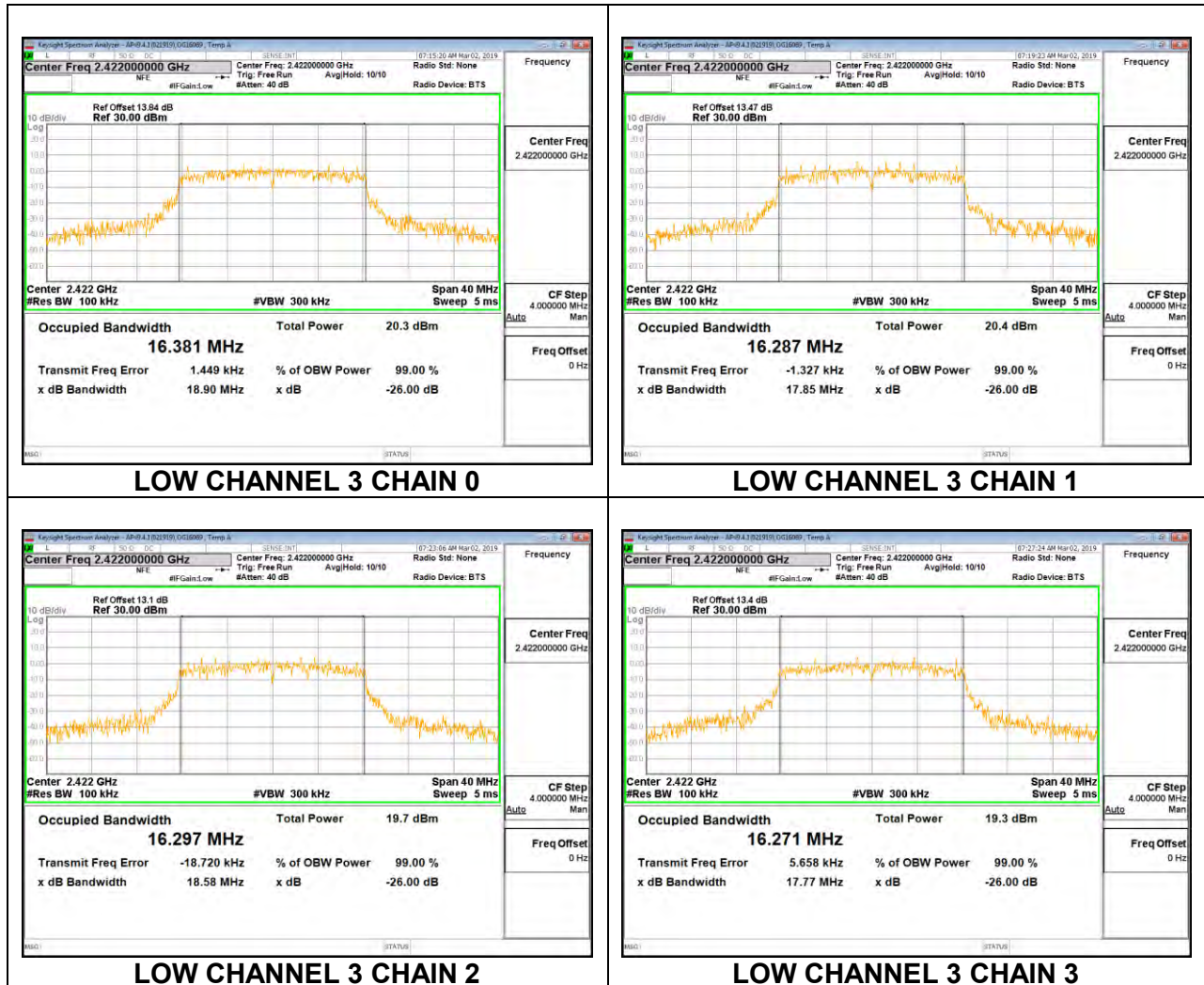
LOW CHANNEL 1



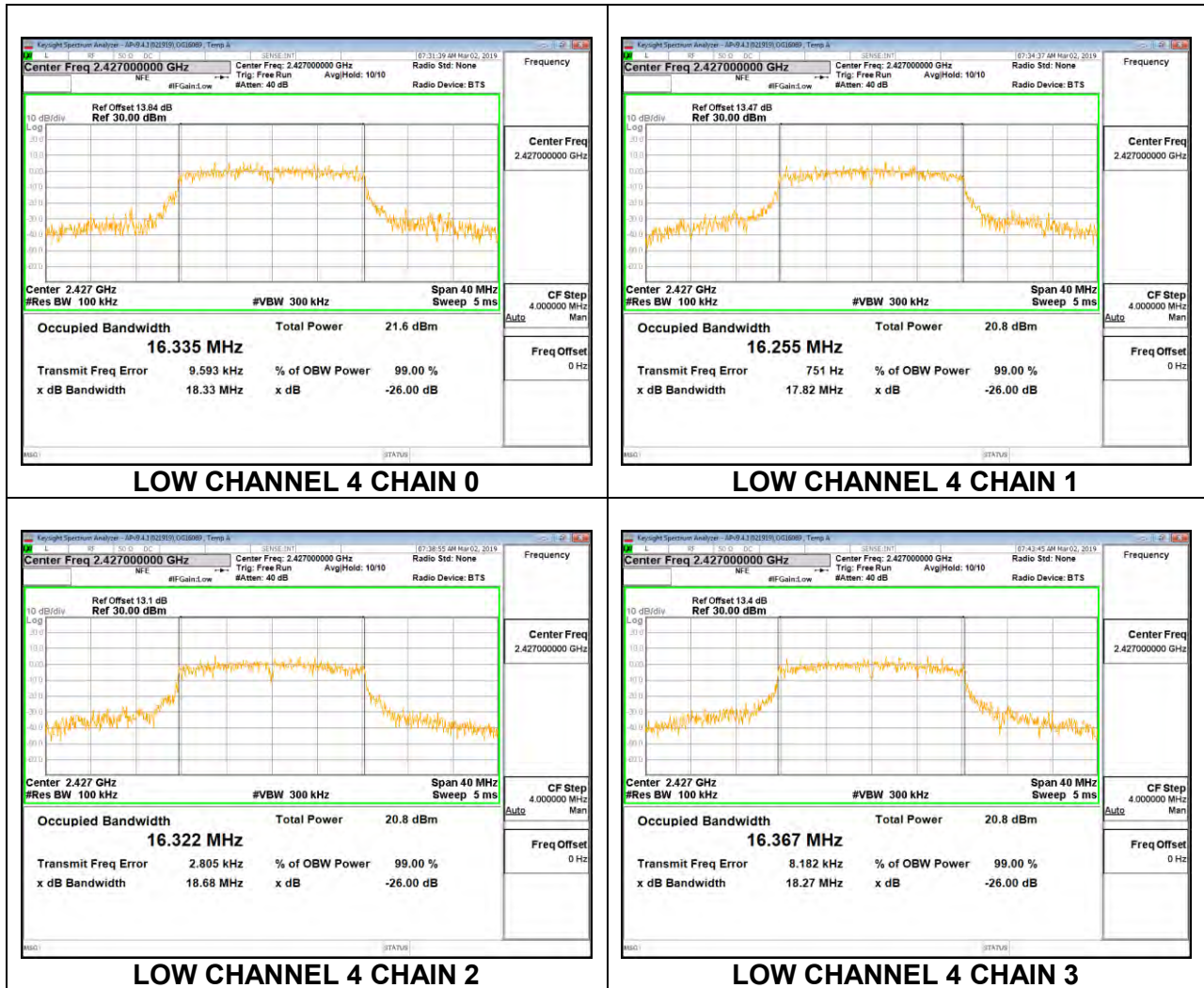
LOW CHANNEL 2



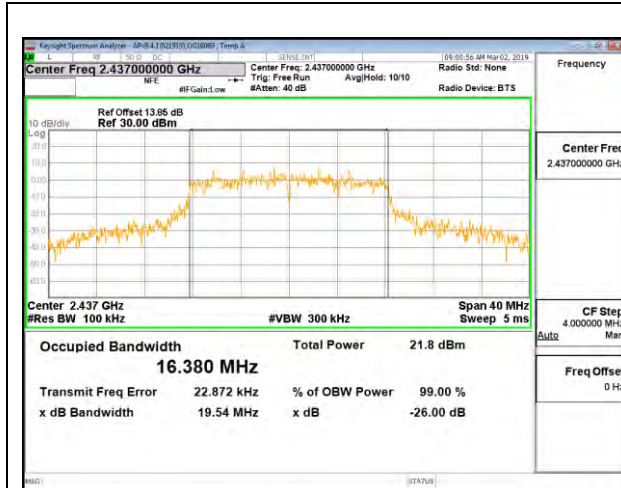
LOW CHANNEL 3



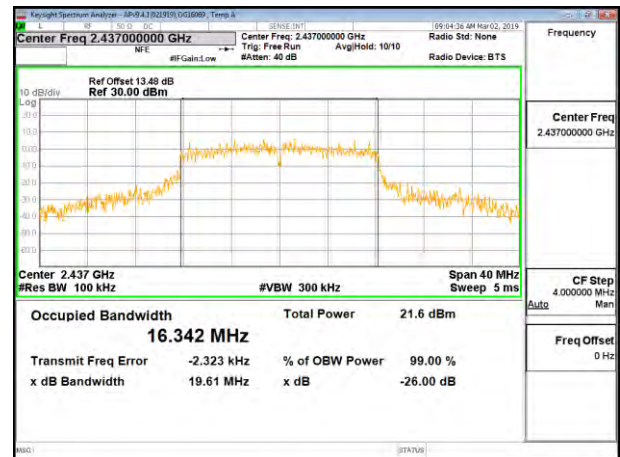
LOW CHANNEL 4



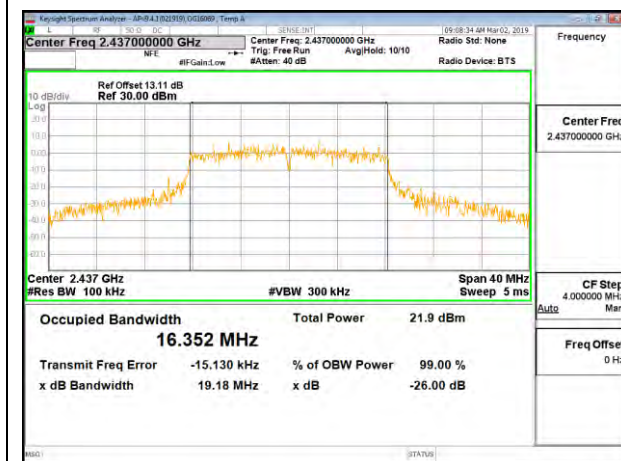
MID CHANNEL 6



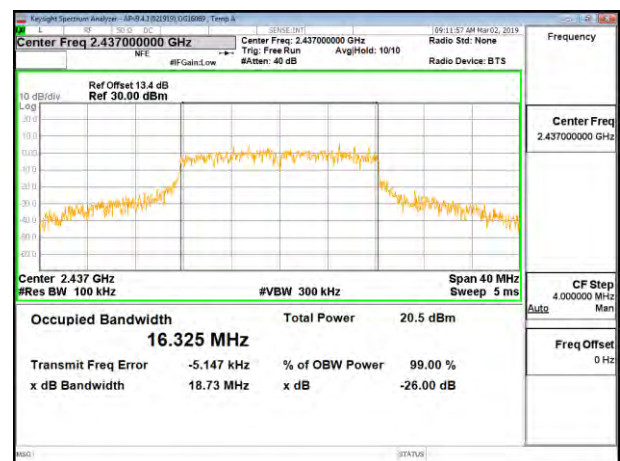
MID CHANNEL 6 CHAIN 0



MID CHANNEL 6 CHAIN 1

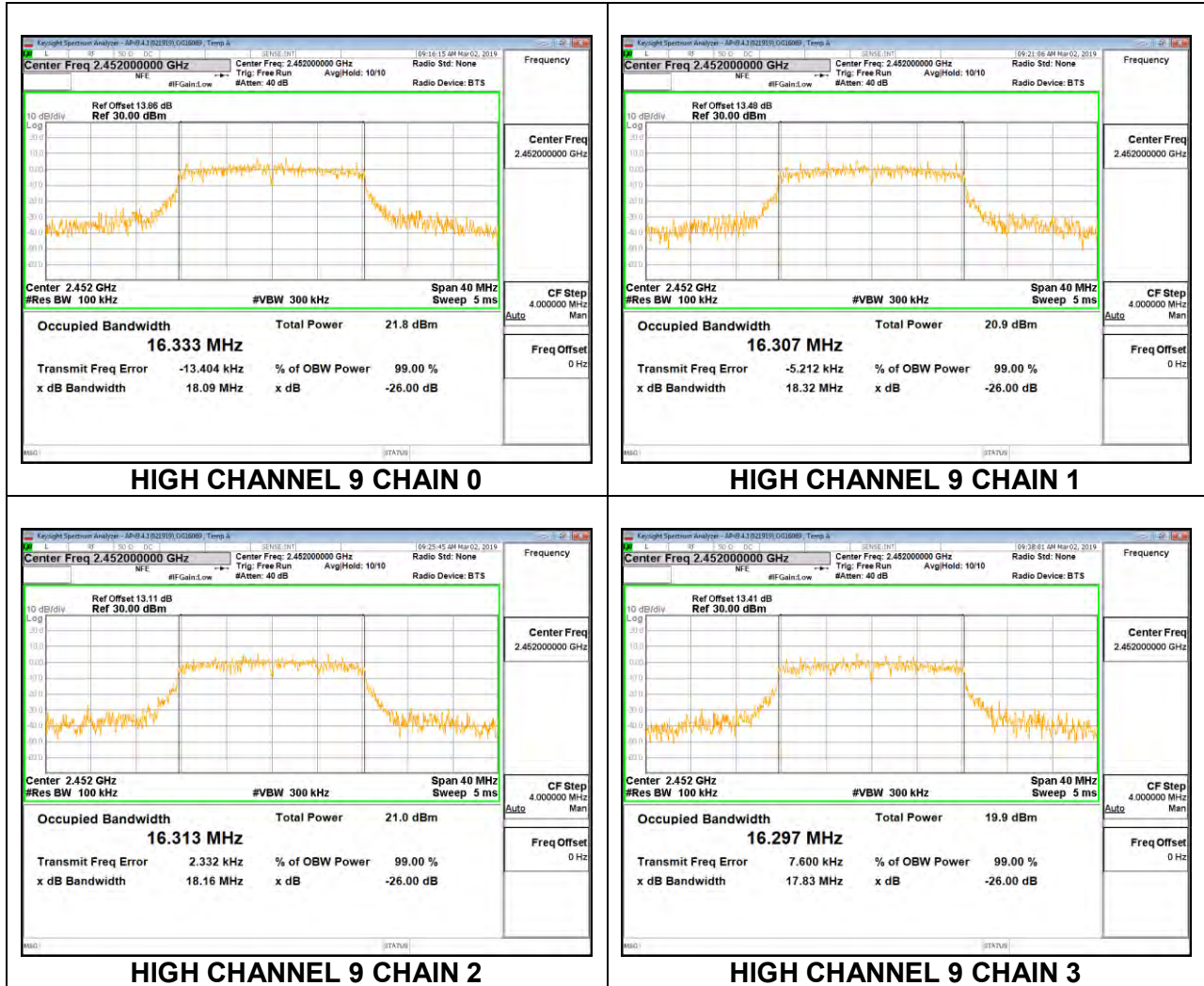


MID CHANNEL 6 CHAIN 2

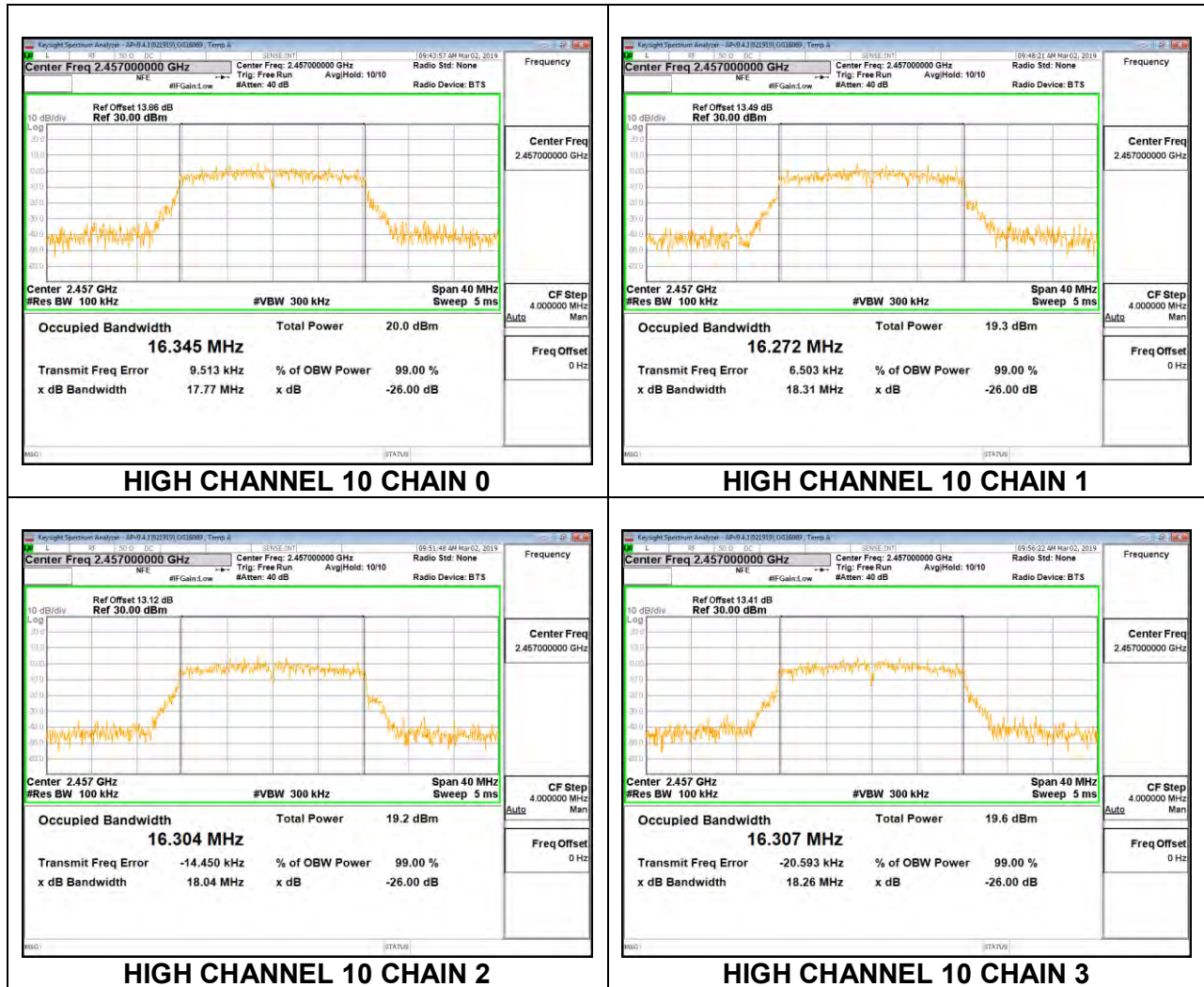


MID CHANNEL 6 CHAIN 3

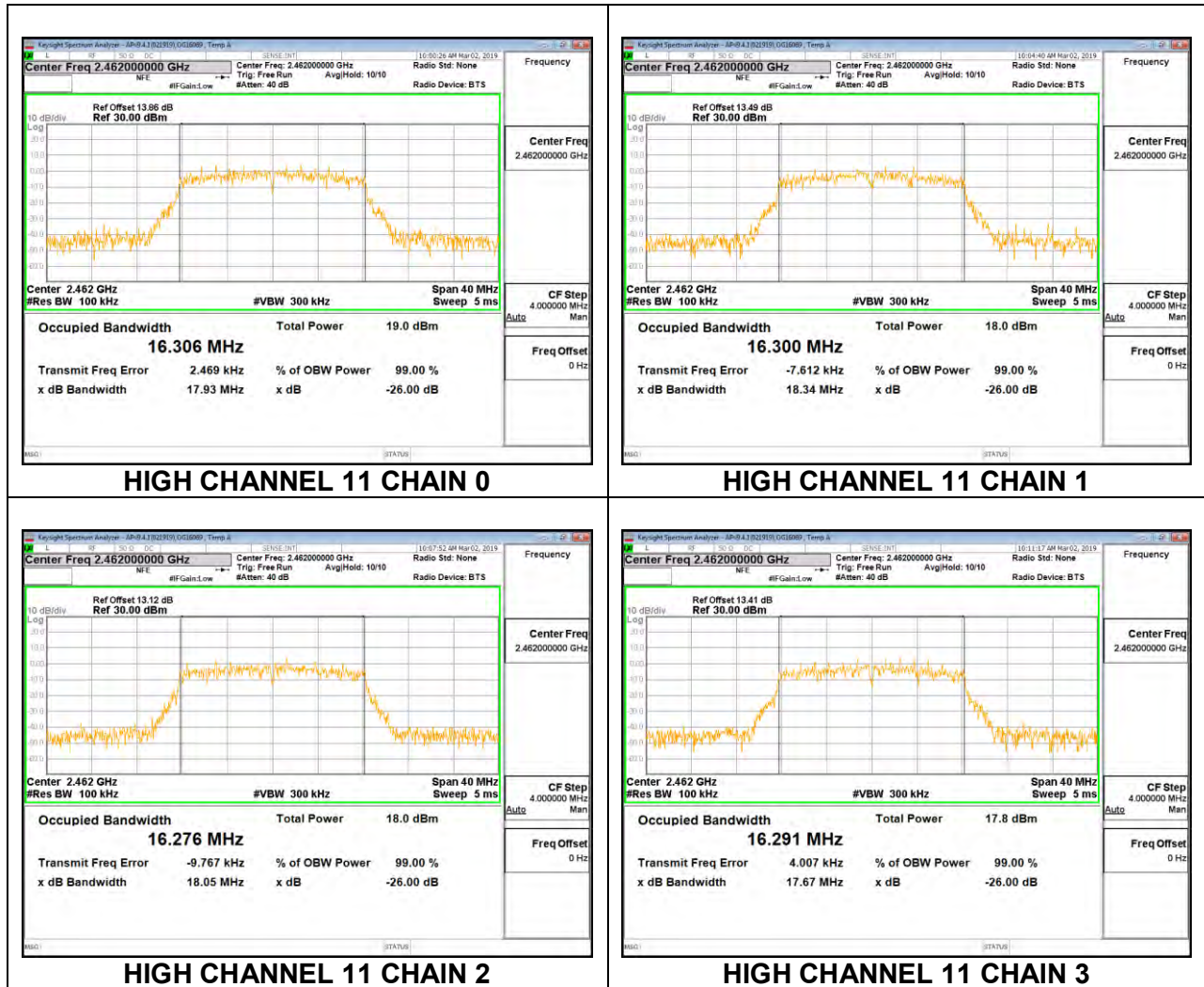
HIGH CHANNEL 9



HIGH CHANNEL 10



HIGH CHANNEL 11

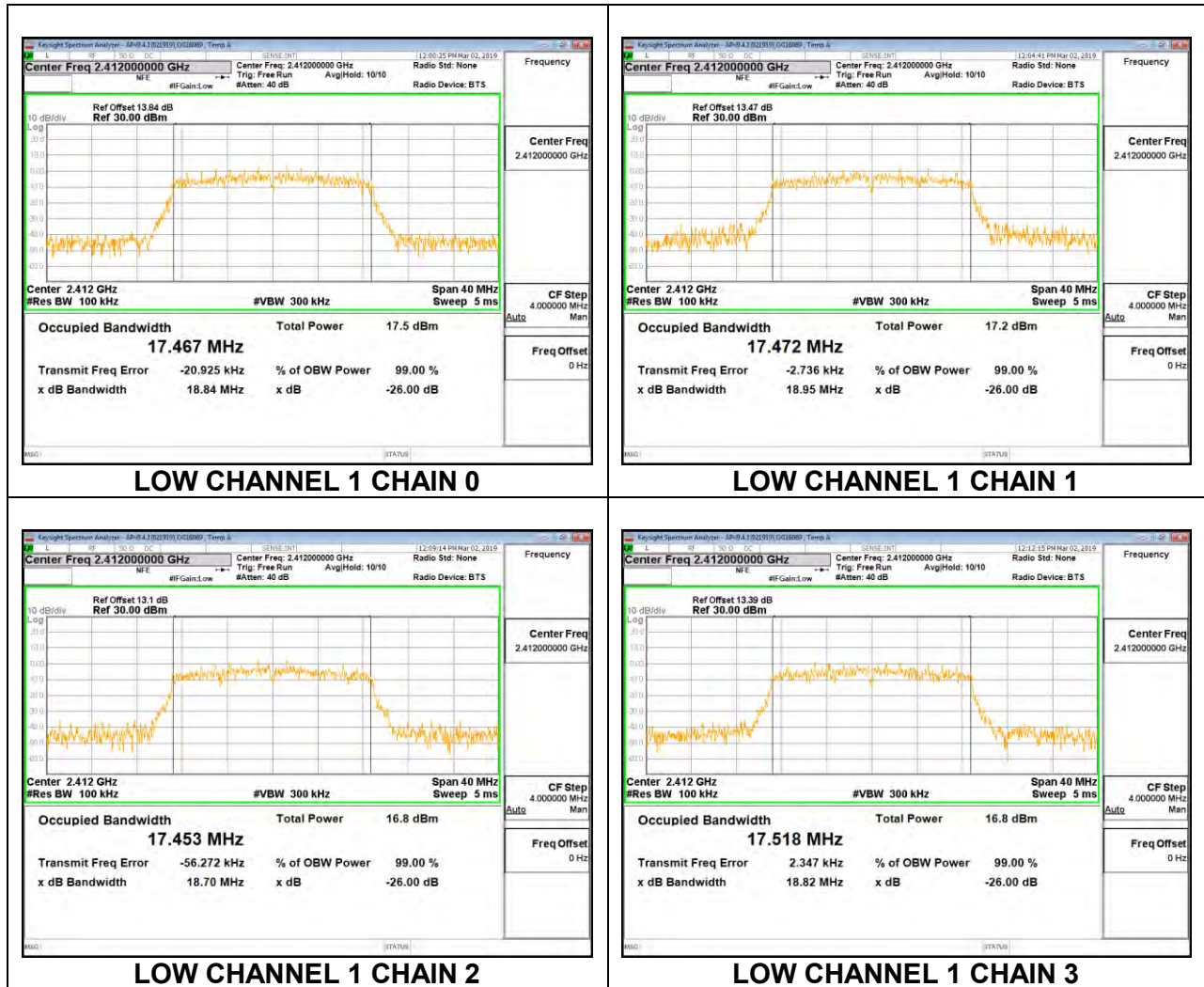


8.2.3. 802.11n HT20 MODE

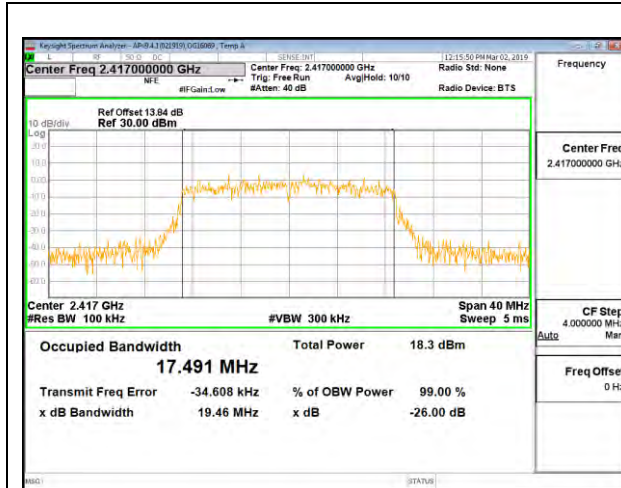
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

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	17.467	17.472	17.453	17.518
Low 2	2417	17.491	17.318	17.449	17.447
Low 3	2422	17.518	17.467	17.441	17.444
Low 4	2427	17.568	17.500	17.514	17.502
Mid 6	2437	17.553	17.566	17.518	17.496
High 9	2452	17.459	17.515	17.540	17.554
High 10	2457	17.367	17.494	17.514	17.532
High 11	2462	17.540	17.496	17.489	17.487

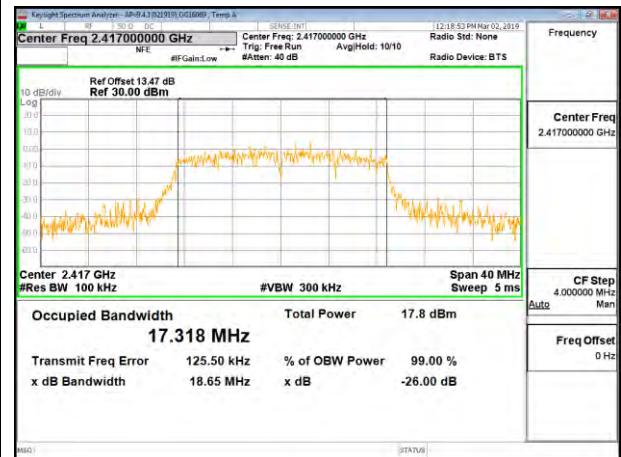
LOW CHANNEL 1



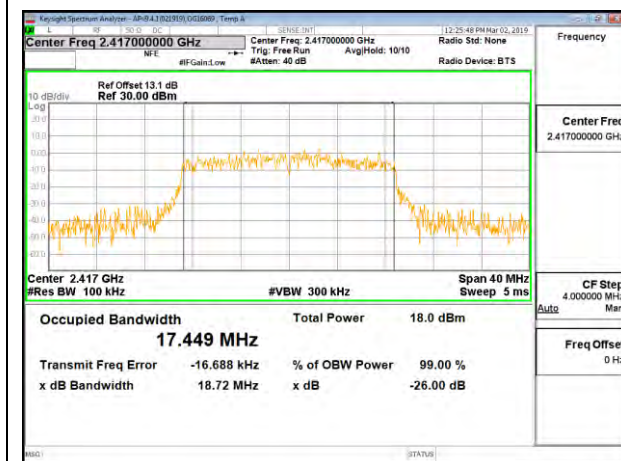
LOW CHANNEL 2



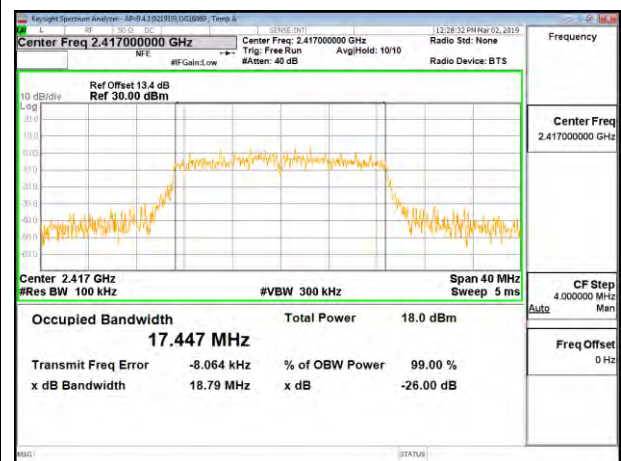
LOW CHANNEL 2 CHAIN 0



LOW CHANNEL 2 CHAIN 1

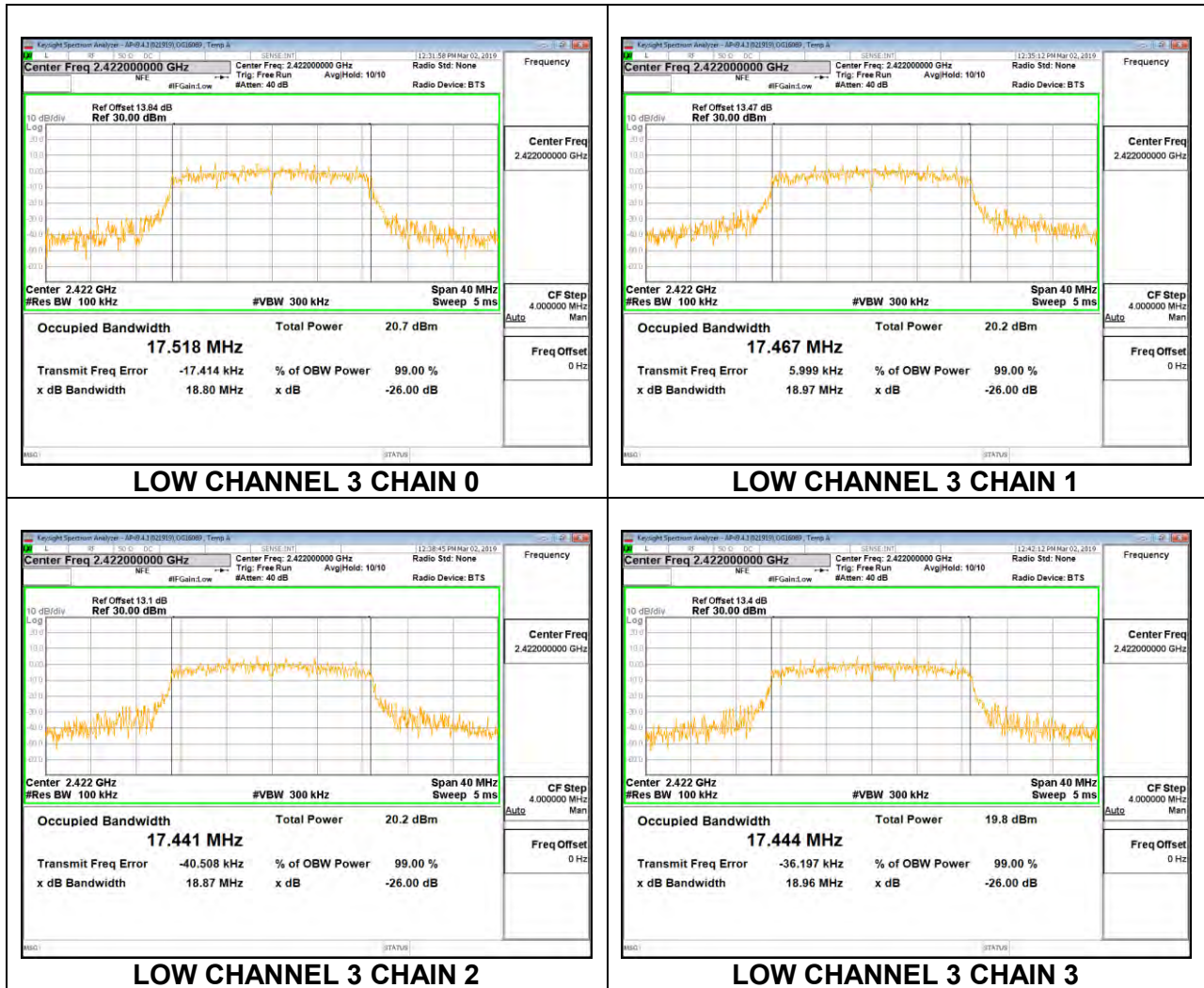


LOW CHANNEL 2 CHAIN 2

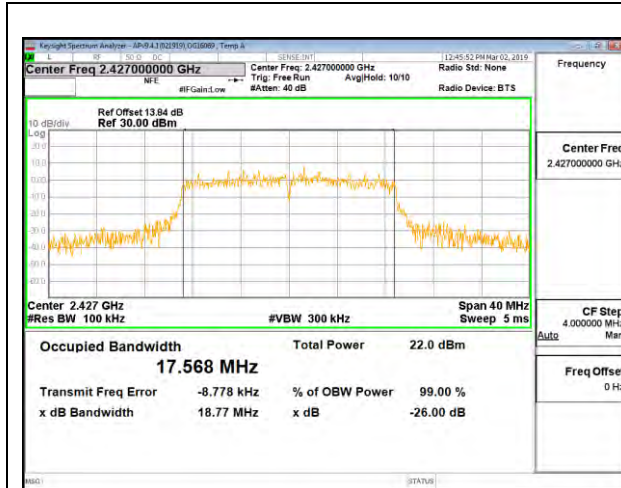


LOW CHANNEL 2 CHAIN 3

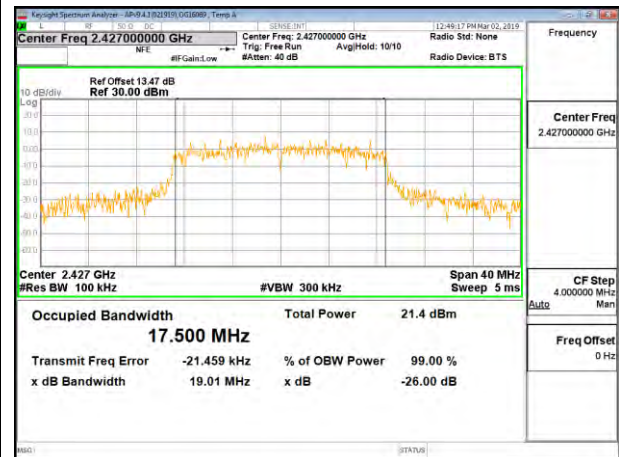
LOW CHANNEL 3



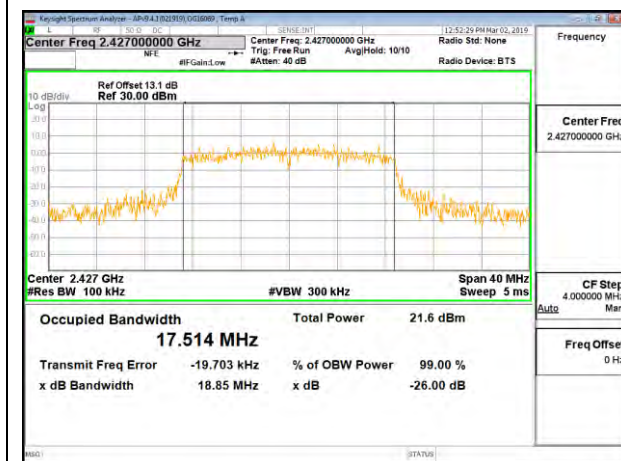
LOW CHANNEL 4



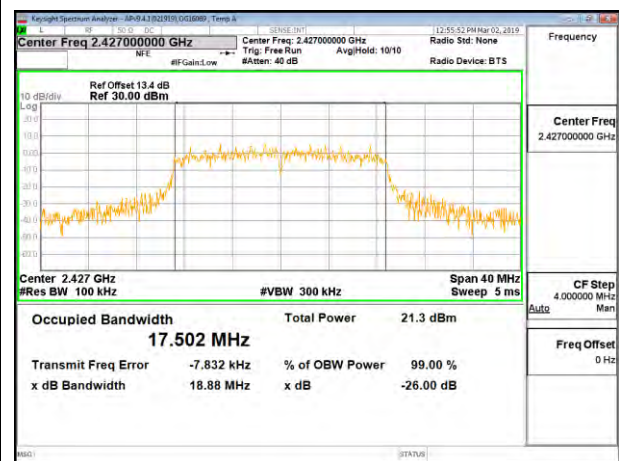
LOW CHANNEL 4 CHAIN 0



LOW CHANNEL 4 CHAIN 1

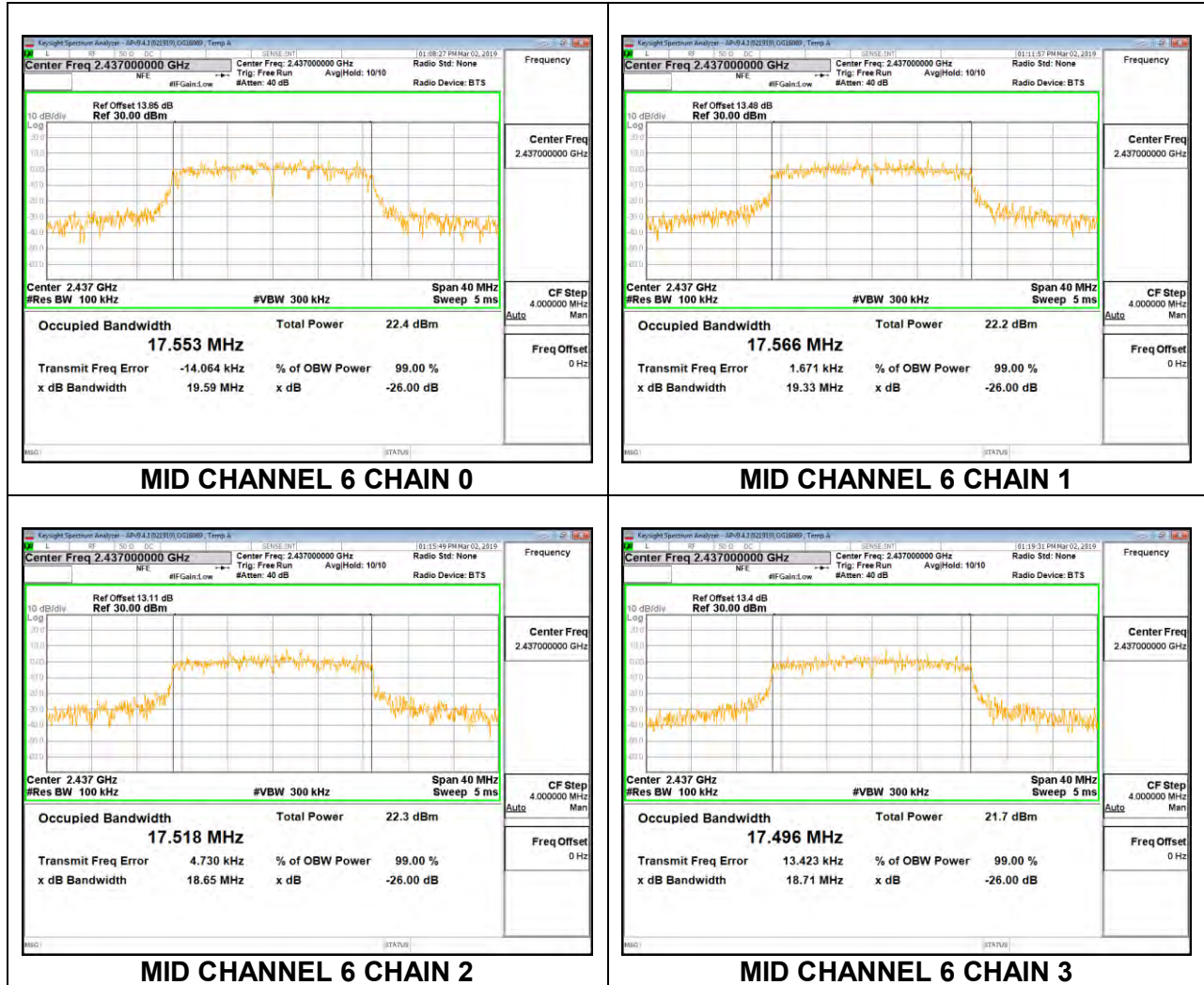


LOW CHANNEL 4 CHAIN 2

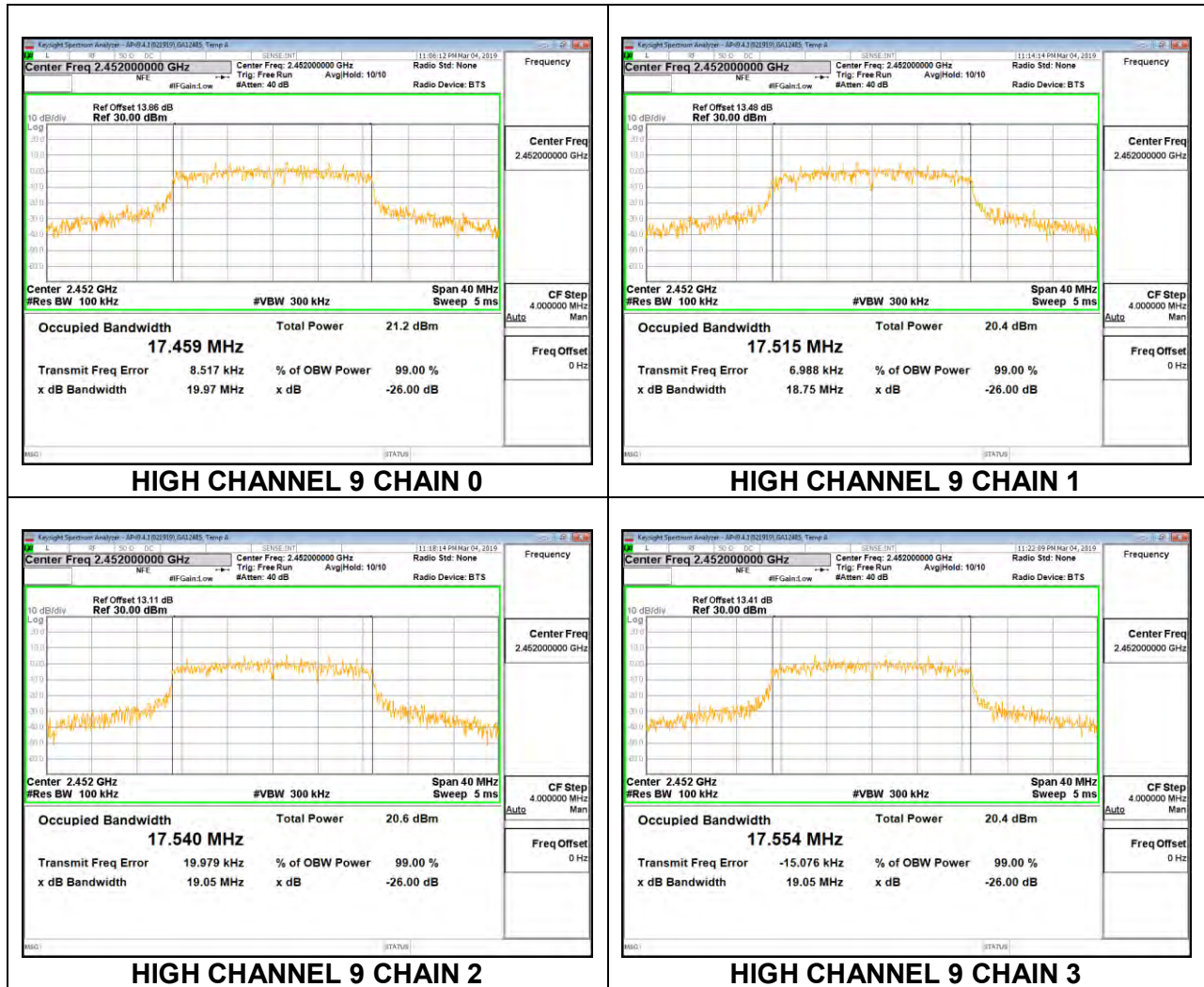


LOW CHANNEL 4 CHAIN 3

MID CHANNEL 6



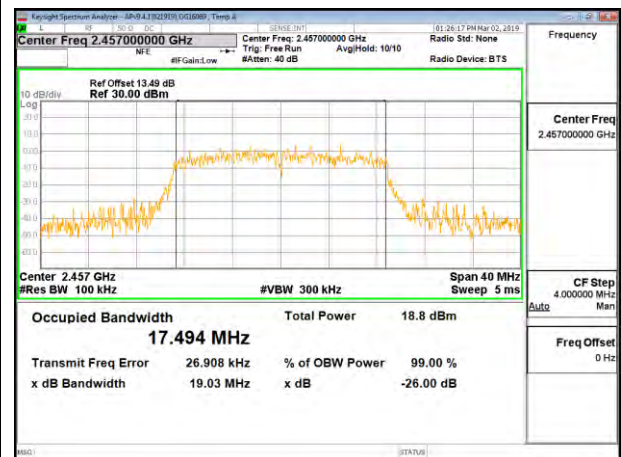
HIGH CHANNEL 9



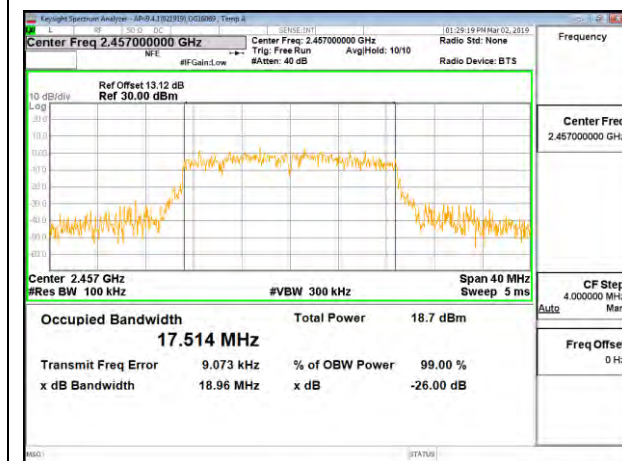
HIGH CHANNEL 10



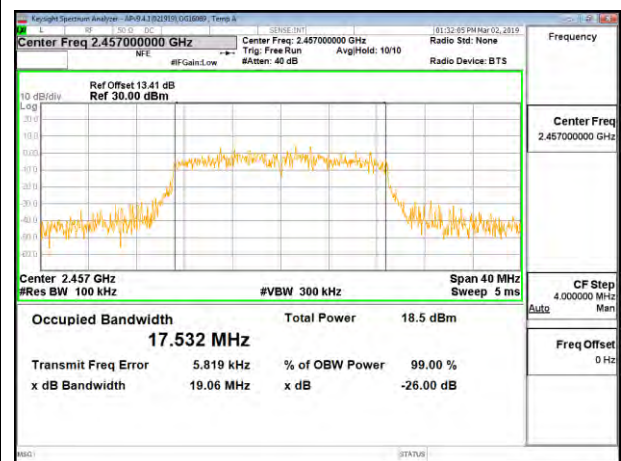
HIGH CHANNEL 10 CHAIN 0



HIGH CHANNEL 10 CHAIN 1

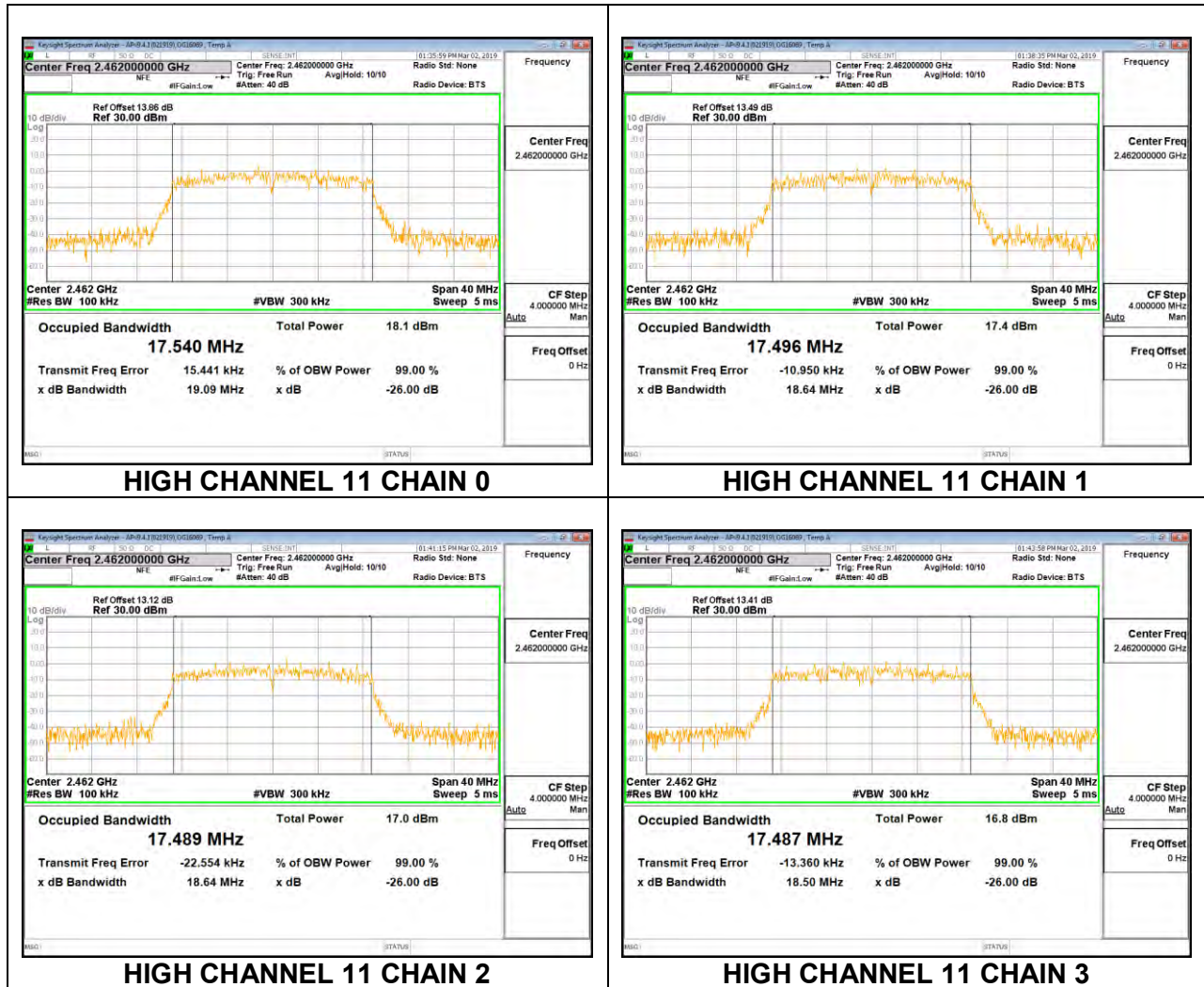


HIGH CHANNEL 10 CHAIN 2



HIGH CHANNEL 10 CHAIN 3

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	9.200	9.120	9.120	9.160	0.5
Mid 6	2437	9.200	8.720	9.120	9.040	0.5
High 11	2462	8.720	8.720	9.200	8.720	0.5

LOW CHANNEL 1



LOW CHANNEL 1 CHAIN 0



LOW CHANNEL 1 CHAIN 1

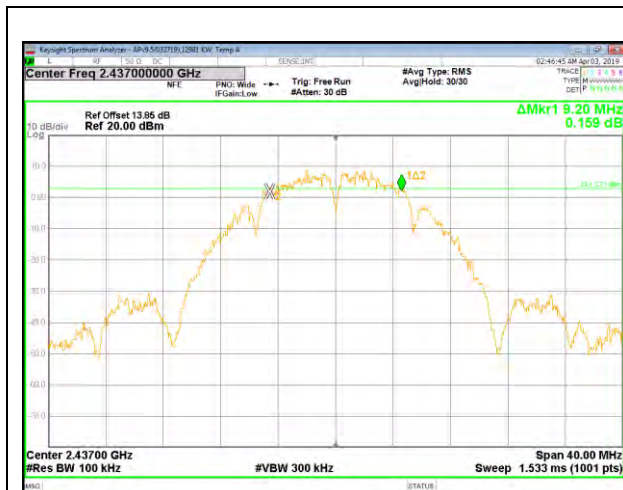


LOW CHANNEL 1 CHAIN 2



LOW CHANNEL 1 CHAIN 3

MID CHANNEL 6



MID CHANNEL 6 CHAIN 0



MID CHANNEL 6 CHAIN 1

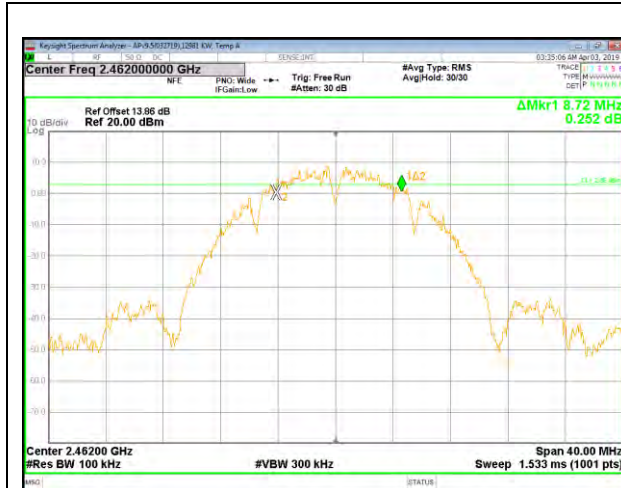


MID CHANNEL 6 CHAIN 2



MID CHANNEL 6 CHAIN 3

HIGH CHANNEL 11



HIGH CHANNEL 11 CHAIN 0



HIGH CHANNEL 11 CHAIN 1



HIGH CHANNEL 11 CHAIN 2



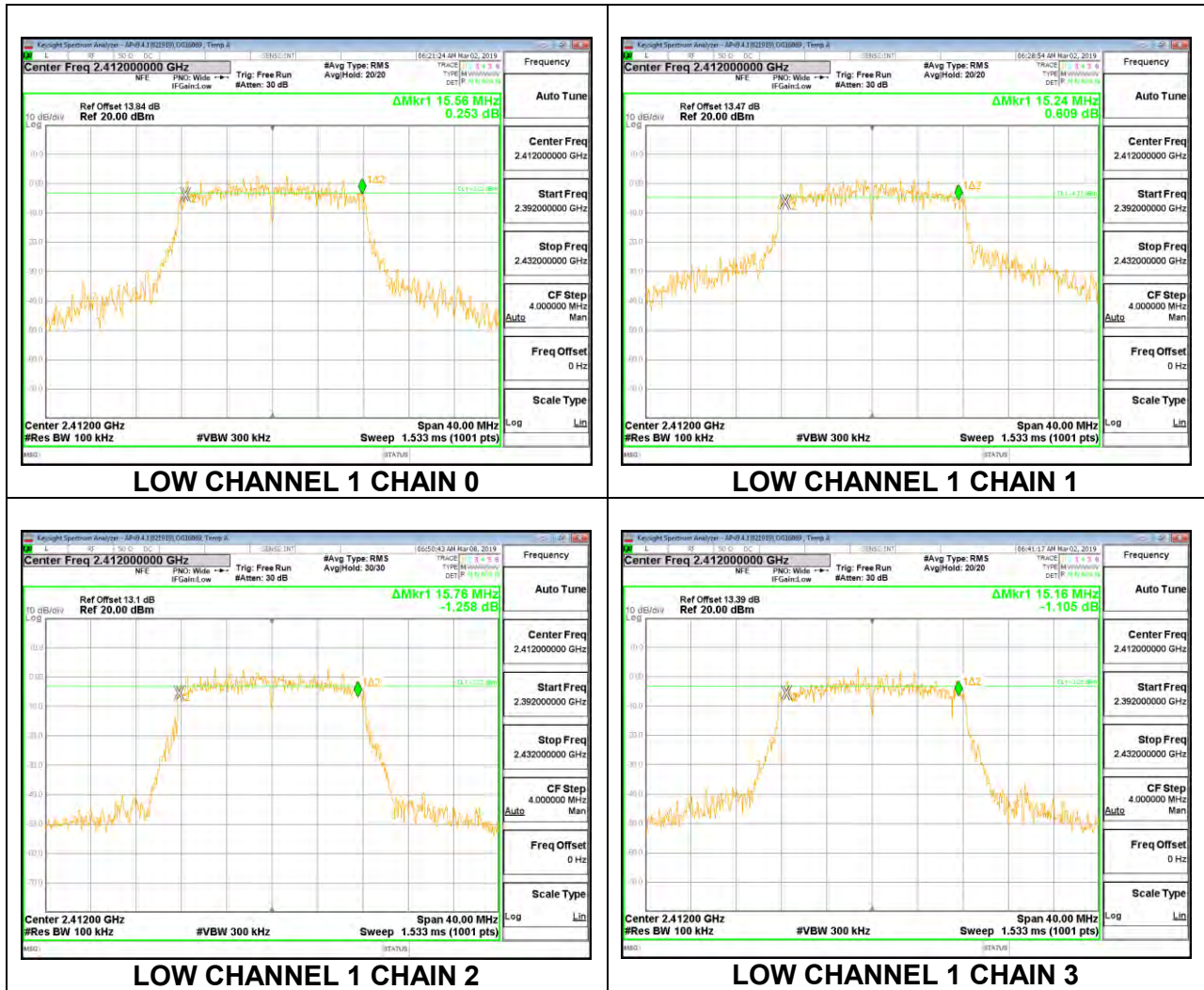
HIGH CHANNEL 11 CHAIN 3

8.3.2. 802.11g MODE

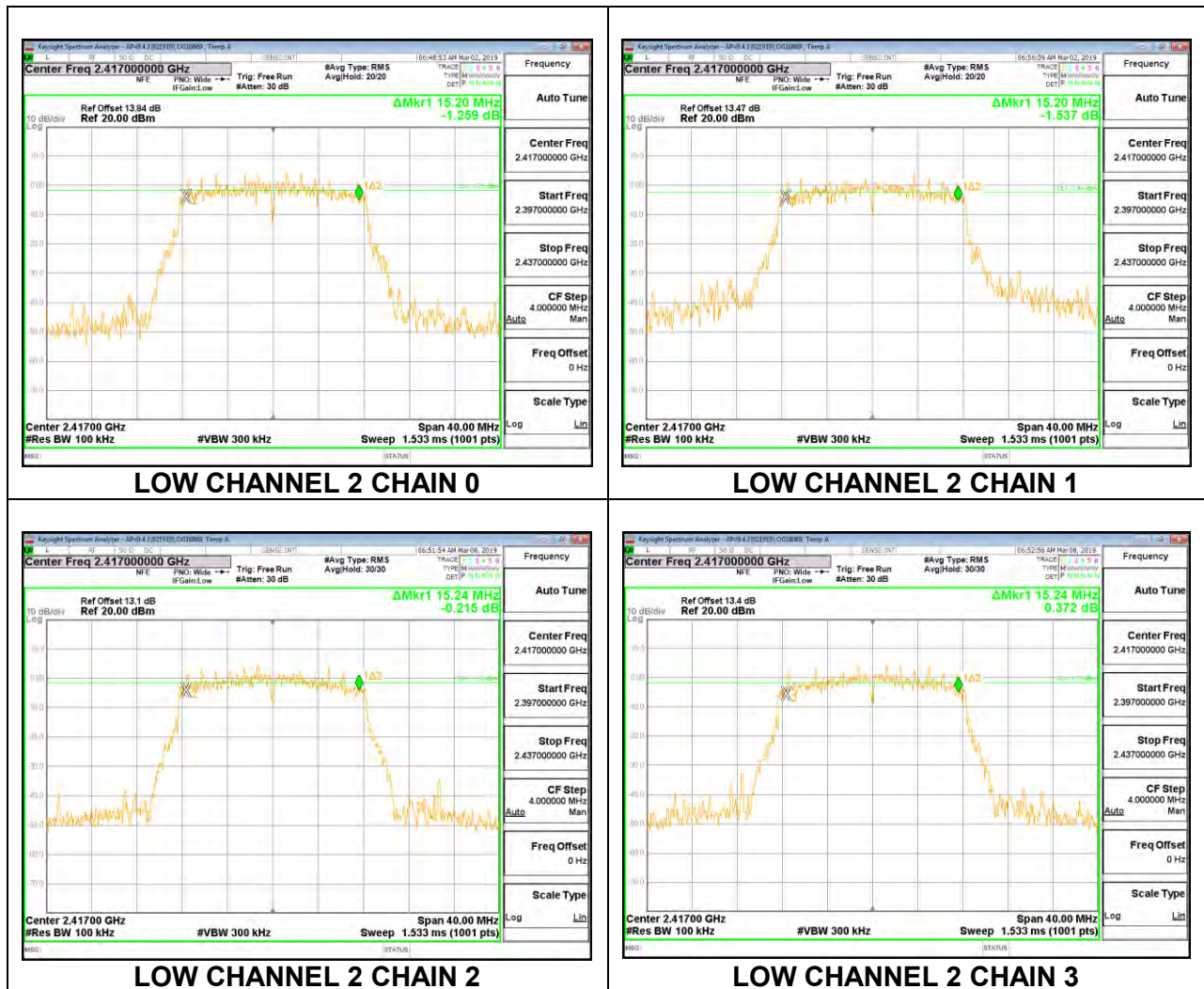
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

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	15.560	15.240	15.760	15.160	0.5
Low 2	2417	15.200	15.200	15.240	15.240	0.5
Low 3	2422	15.200	15.160	15.440	15.200	0.5
Low 4	2427	15.200	15.200	15.200	15.000	0.5
Mid 6	2437	15.200	15.240	15.280	15.280	0.5
High 9	2452	15.240	15.200	15.200	15.480	0.5
High 10	2457	15.200	15.240	15.120	15.160	0.5
High 11	2462	15.200	15.200	15.160	15.200	0.5

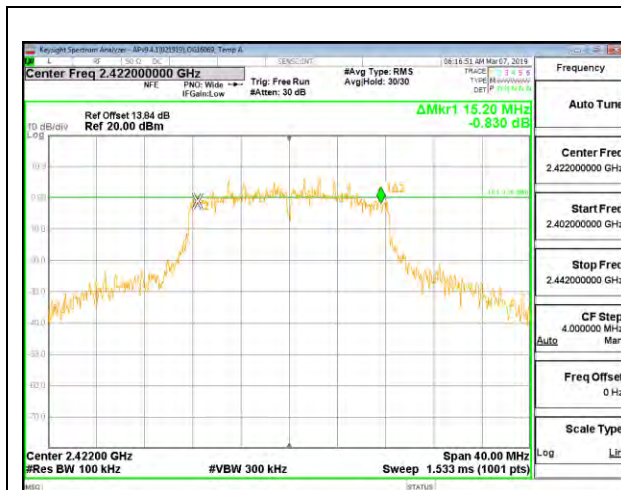
LOW CHANNEL 1



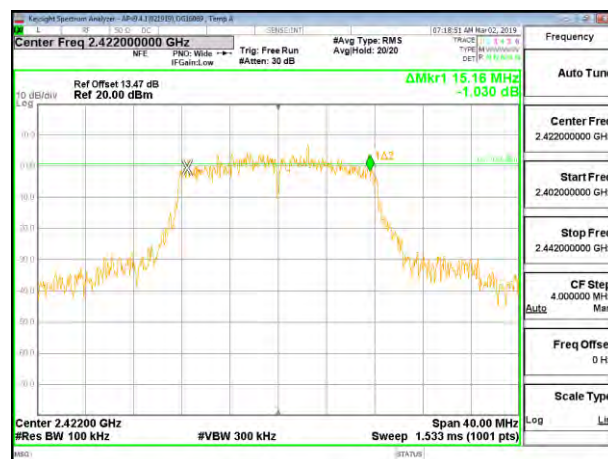
LOW CHANNEL 2



LOW CHANNEL 3



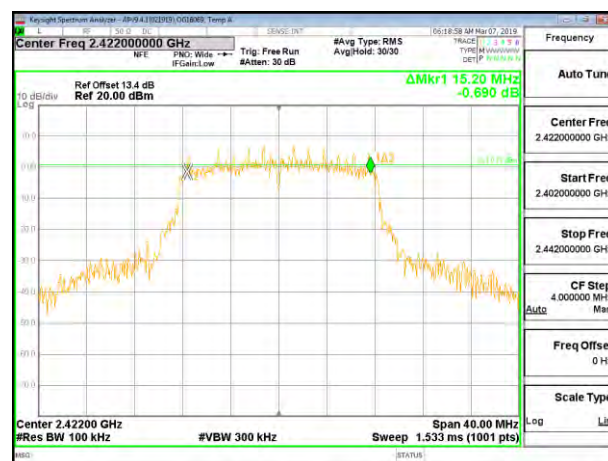
LOW CHANNEL 3 CHAIN 0



LOW CHANNEL 3 CHAIN 1



LOW CHANNEL 3 CHAIN 2



LOW CHANNEL 3 CHAIN 3

LOW CHANNEL 4



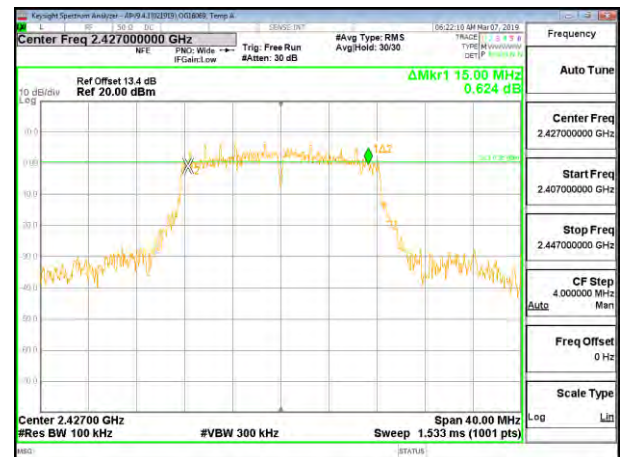
LOW CHANNEL 4 CHAIN 0



LOW CHANNEL 4 CHAIN 1



LOW CHANNEL 4 CHAIN 2



LOW CHANNEL 4 CHAIN 3

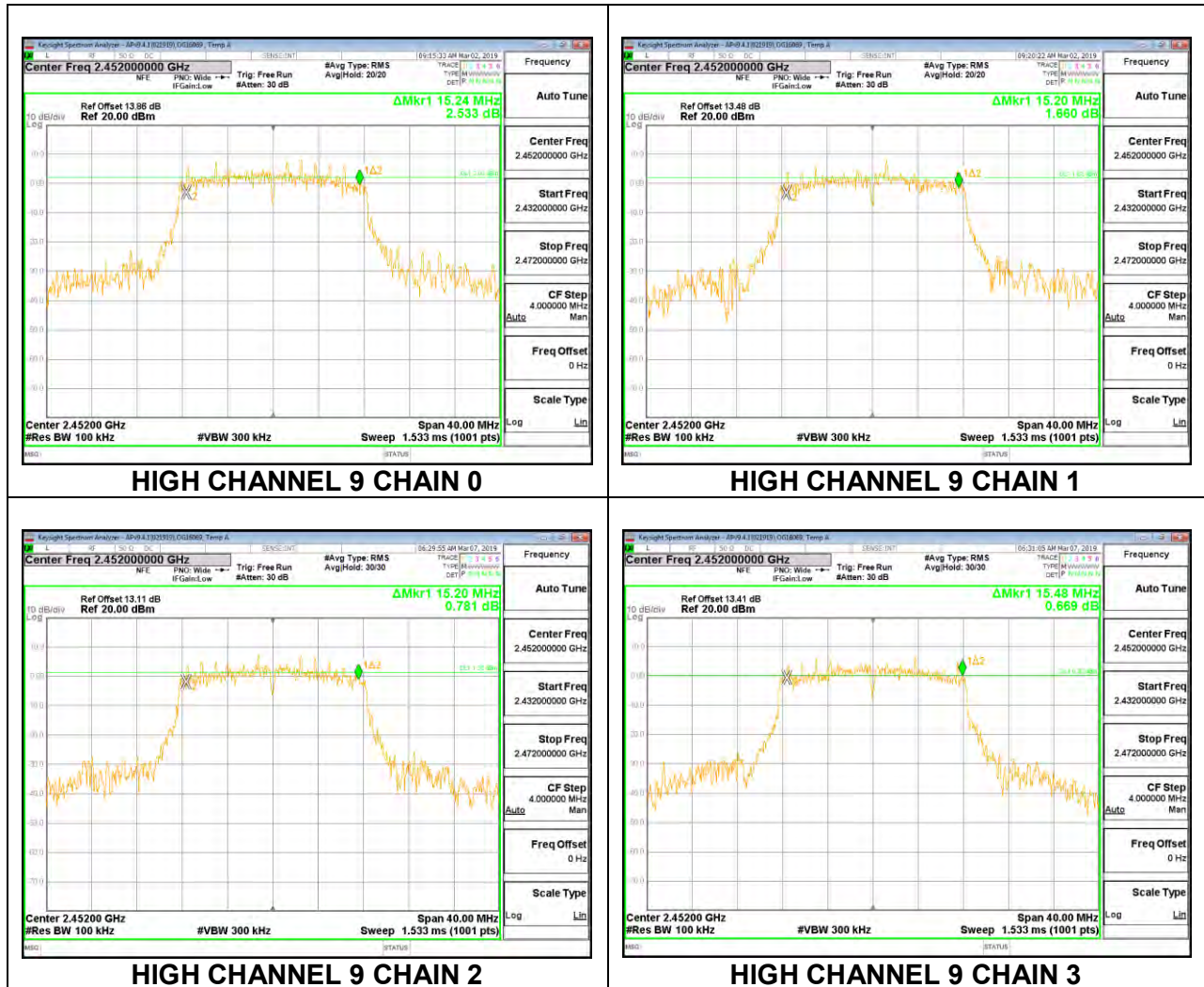
The figure displays four screenshots of a Keysight Spectrum Analyzer, arranged in a 2x2 grid. Each screenshot shows a signal spectrum with a peak at 15.28 MHz. The plots are labeled as follows:

- MID CHANNEL 6 CHAIN 0:** The peak is at 15.28 MHz with a magnitude of -0.615 dB. The reference offset is 13.85 dB.
- MID CHANNEL 6 CHAIN 1:** The peak is at 15.24 MHz with a magnitude of -1.357 dB. The reference offset is 13.48 dB.
- MID CHANNEL 6 CHAIN 2:** The peak is at 15.28 MHz with a magnitude of -1.933 dB. The reference offset is 13.11 dB.
- MID CHANNEL 6 CHAIN 3:** The peak is at 15.28 MHz with a magnitude of -1.647 dB. The reference offset is 13.4 dB.

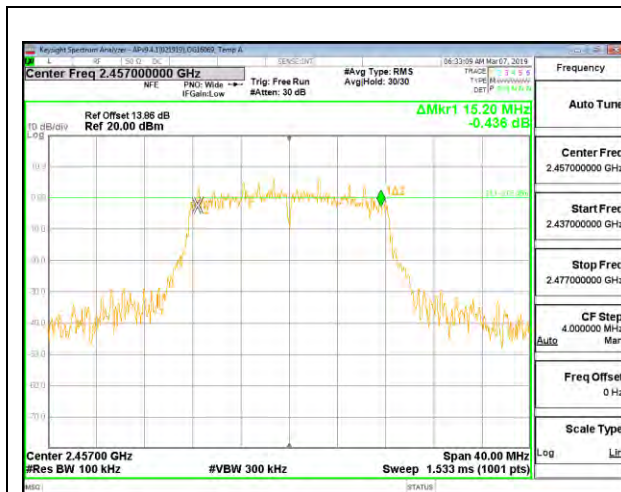
Each plot includes the following parameters:

- Center Freq: 2.437000000 GHz
- Start Freq: 2.417000000 GHz
- Stop Freq: 2.457000000 GHz
- CF Step: 4.000000 MHz
- Freq Offset: 0 Hz
- Scale Type: Log
- Center Freq: 2.43700 GHz
- #Res BW: 100 kHz
- #VBW: 300 kHz
- Sweep: 1.533 ms (1001 pts)

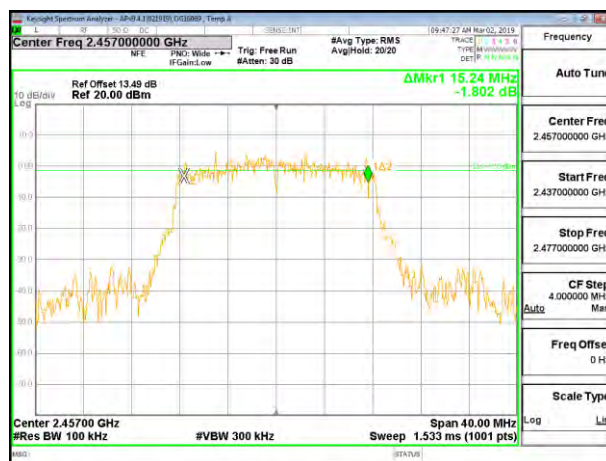
HIGH CHANNEL 9



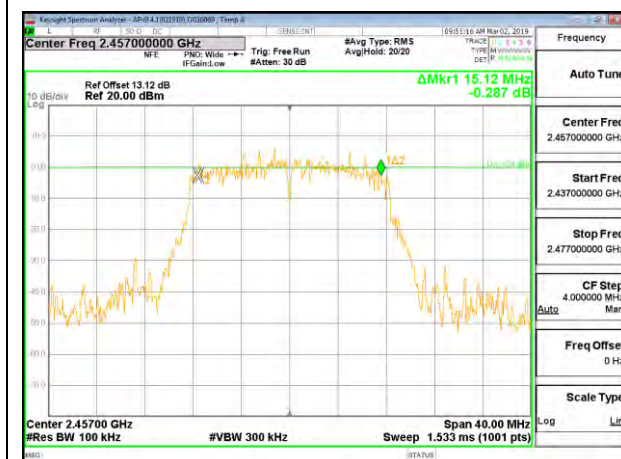
HIGH CHANNEL 10



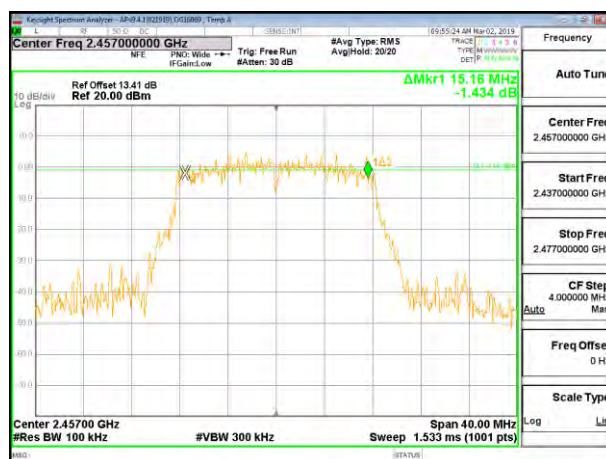
HIGH CHANNEL 10 CHAIN 0



HIGH CHANNEL 10 CHAIN 1

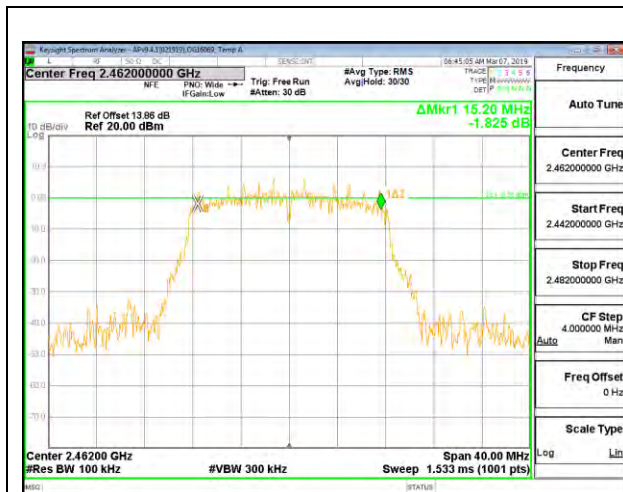


HIGH CHANNEL 10 CHAIN 2



HIGH CHANNEL 10 CHAIN 3

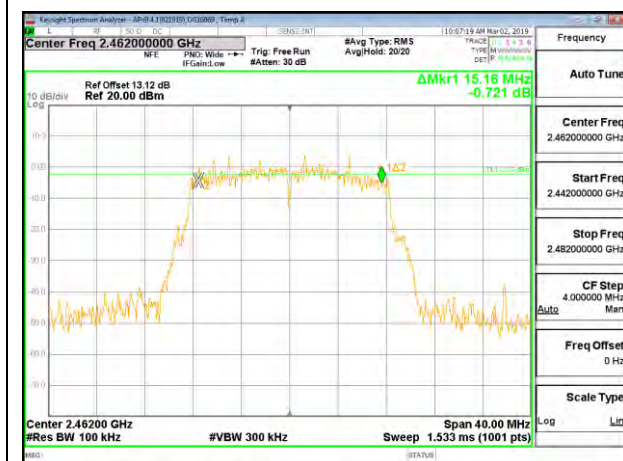
HIGH CHANNEL 11



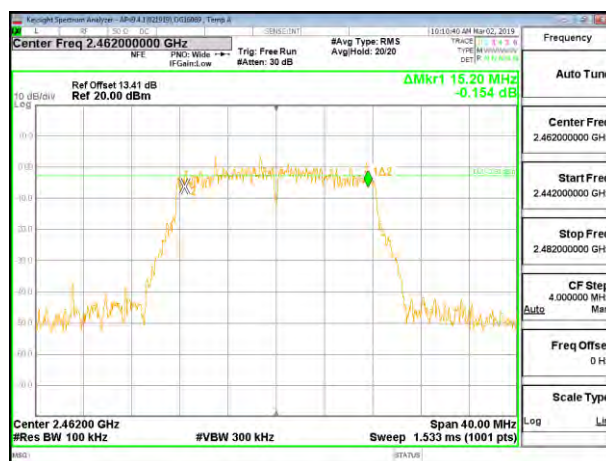
HIGH CHANNEL 11 CHAIN 0



HIGH CHANNEL 11 CHAIN 1



HIGH CHANNEL 11 CHAIN 2



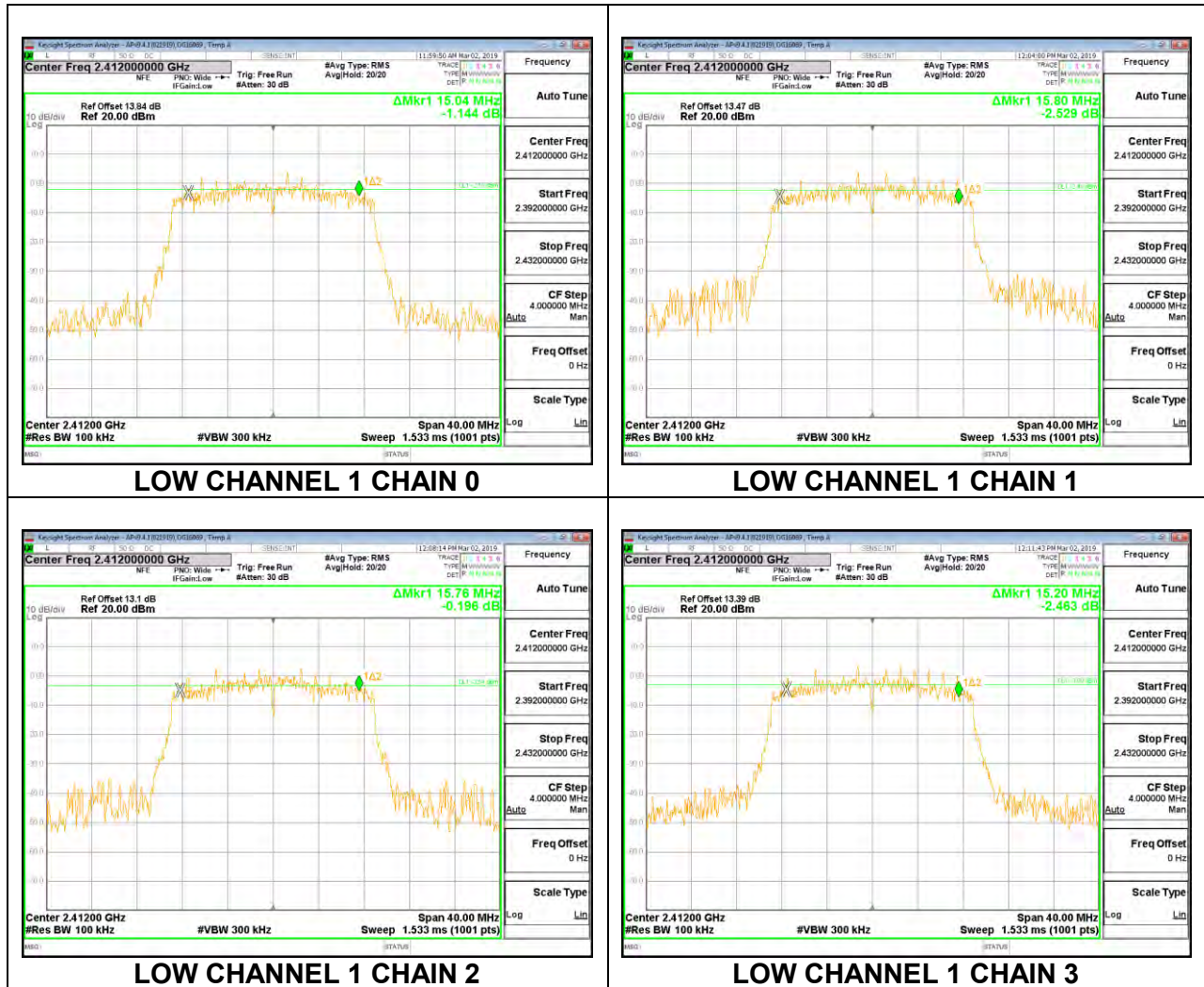
HIGH CHANNEL 11 CHAIN 3

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	15.040	15.800	15.760	15.200	0.5
Low 2	2417	15.200	15.120	15.200	15.800	0.5
Low 3	2422	15.240	15.200	15.240	15.200	0.5
Low 4	2427	15.200	15.120	15.240	15.120	0.5
Mid 6	2437	15.080	15.200	15.160	15.520	0.5
High 9	2452	15.200	15.240	15.200	15.200	0.5
High 10	2457	15.120	15.120	15.200	15.160	0.5
High 11	2462	15.080	15.360	15.160	15.200	0.5

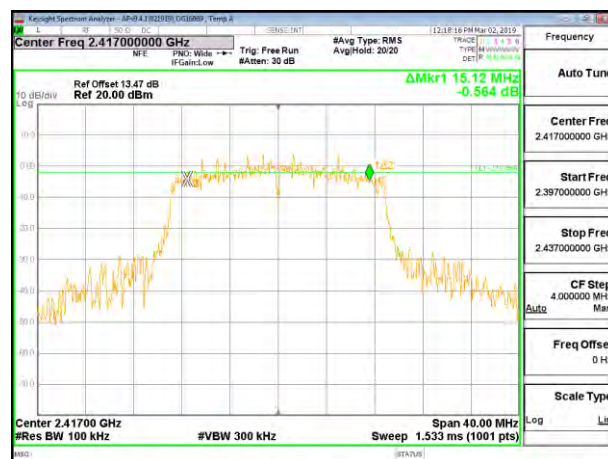
LOW CHANNEL 1



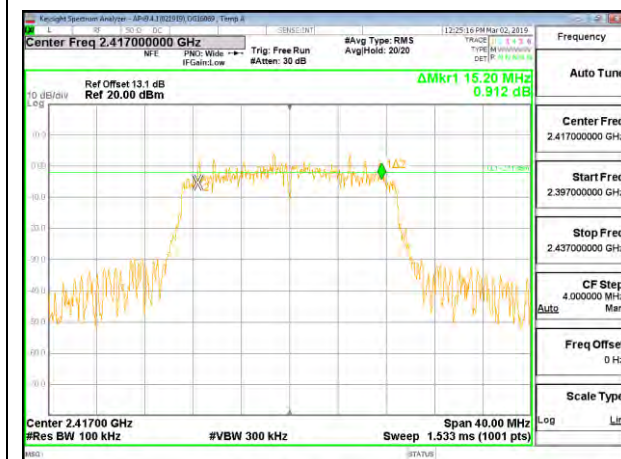
LOW CHANNEL 2



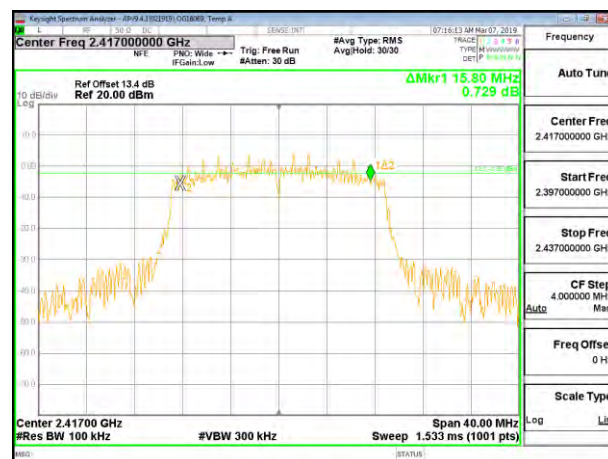
LOW CHANNEL 2 CHAIN 0



LOW CHANNEL 2 CHAIN 1

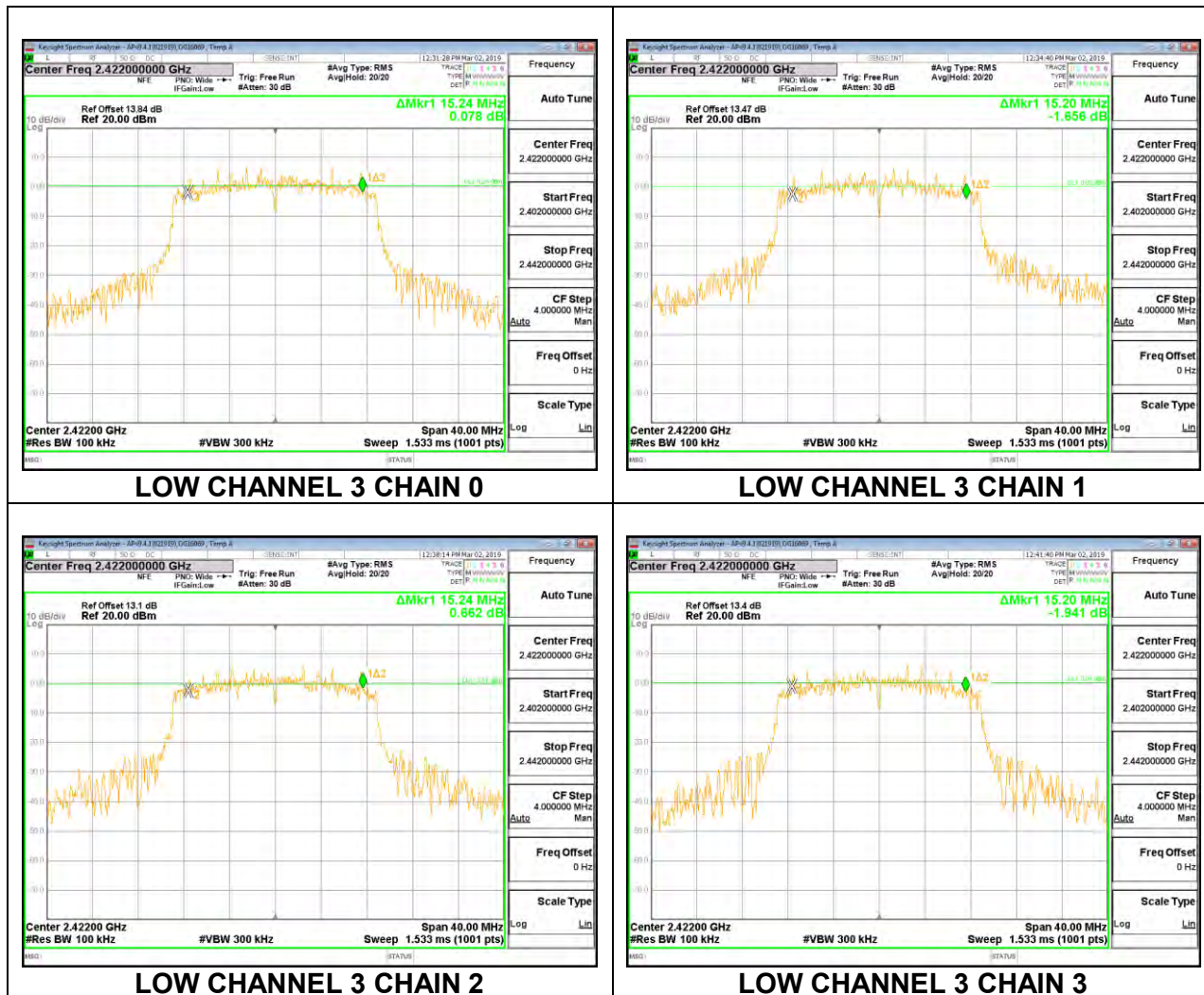


LOW CHANNEL 2 CHAIN 2

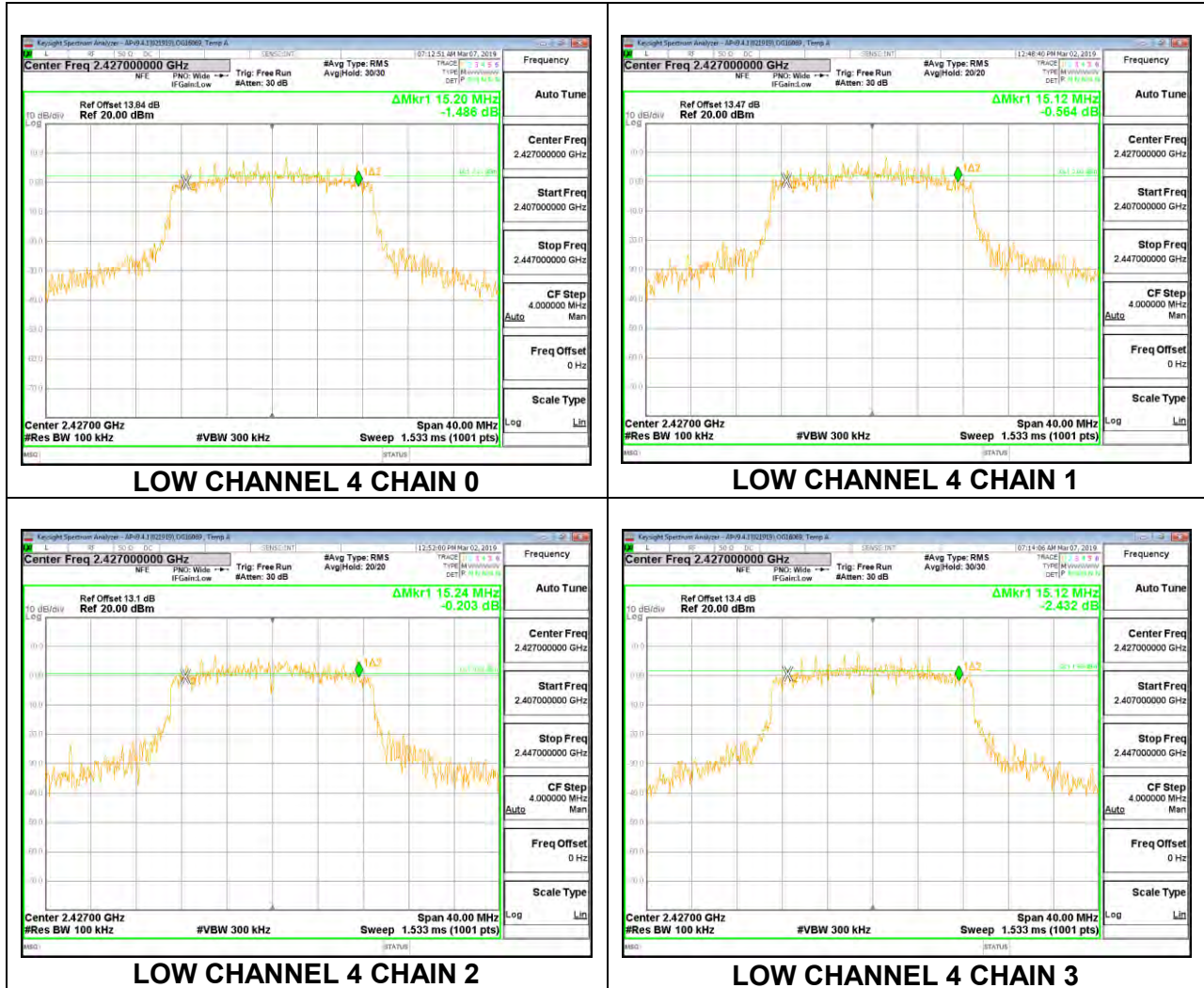


LOW CHANNEL 2 CHAIN 3

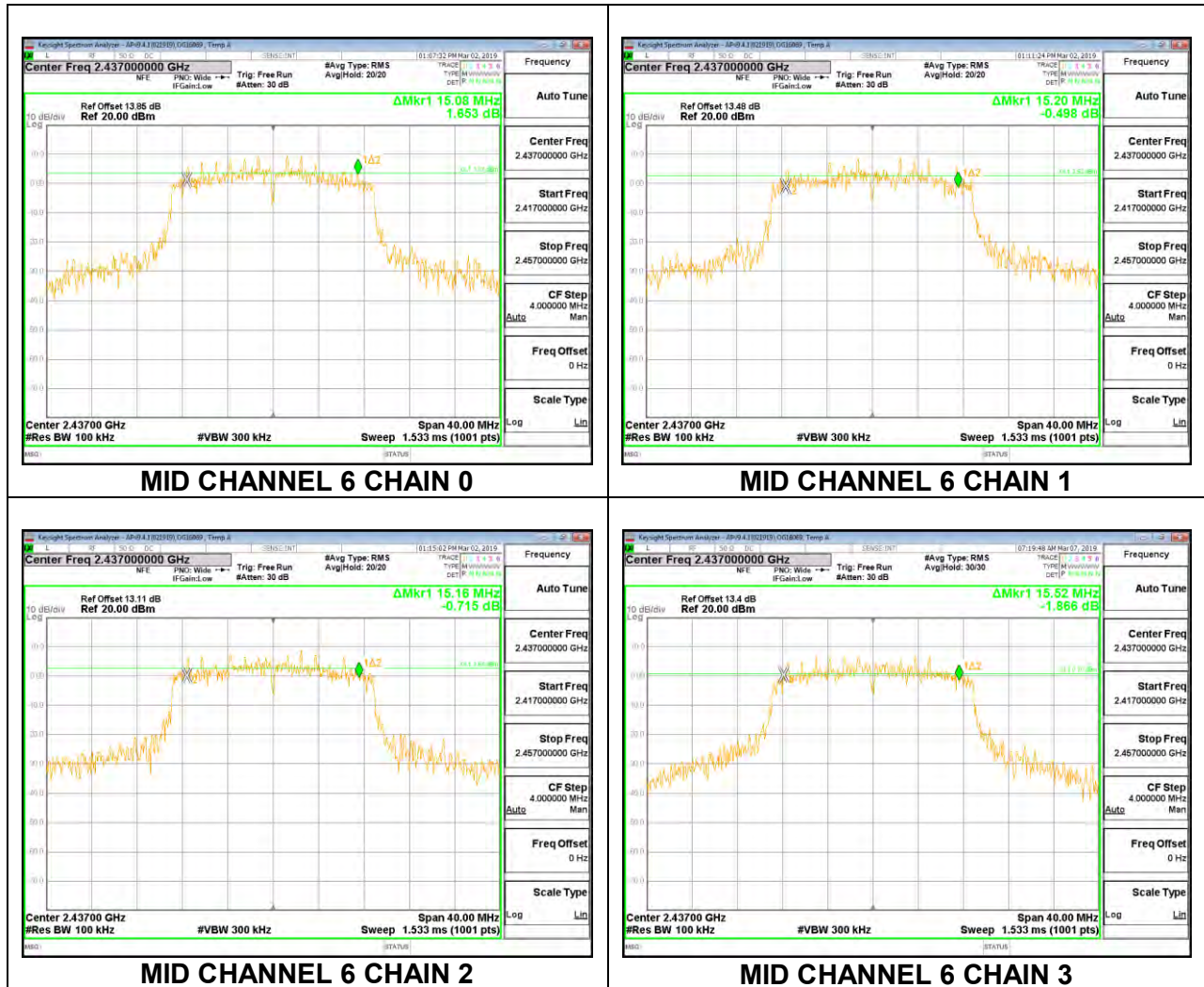
LOW CHANNEL 3



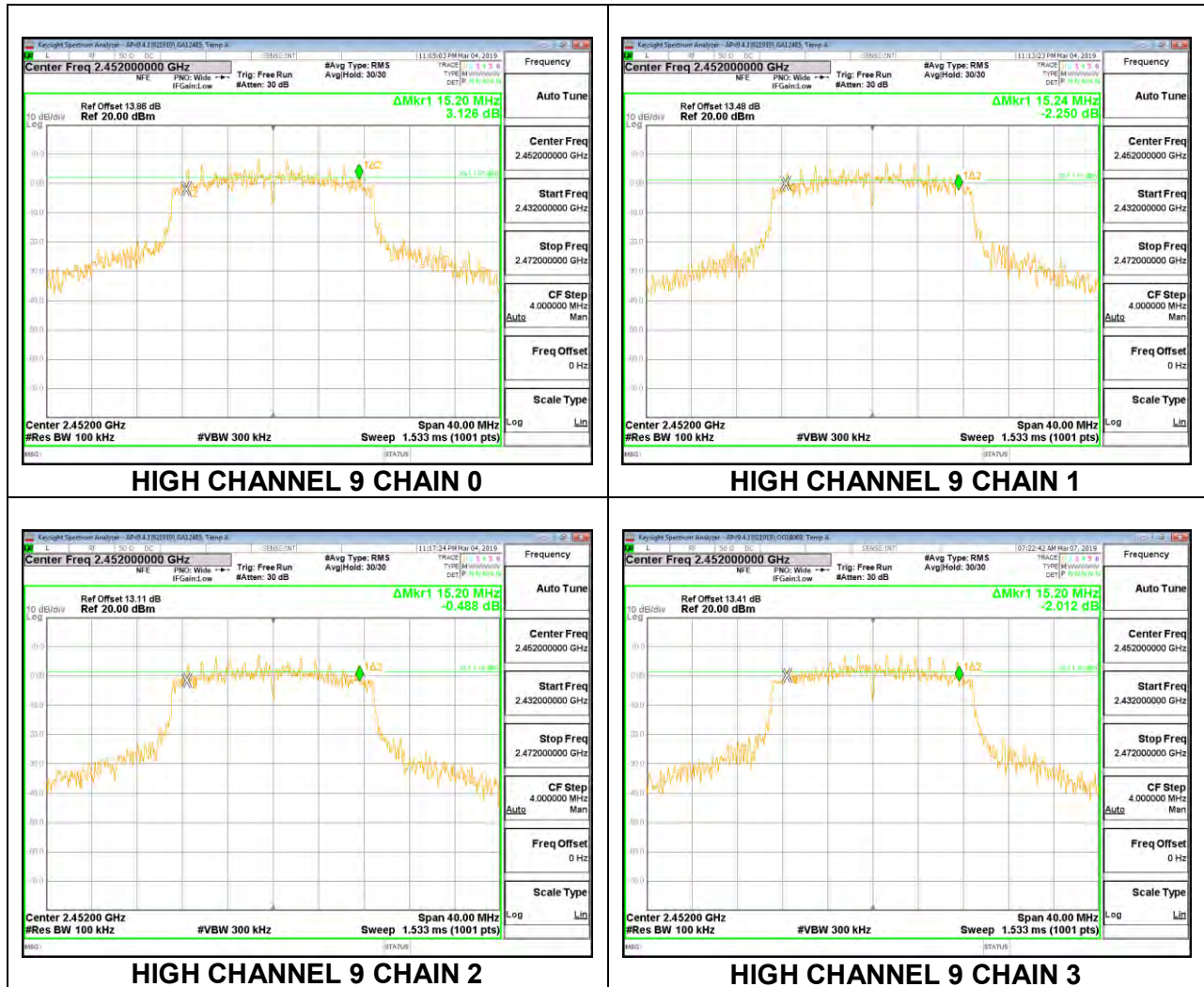
LOW CHANNEL 4



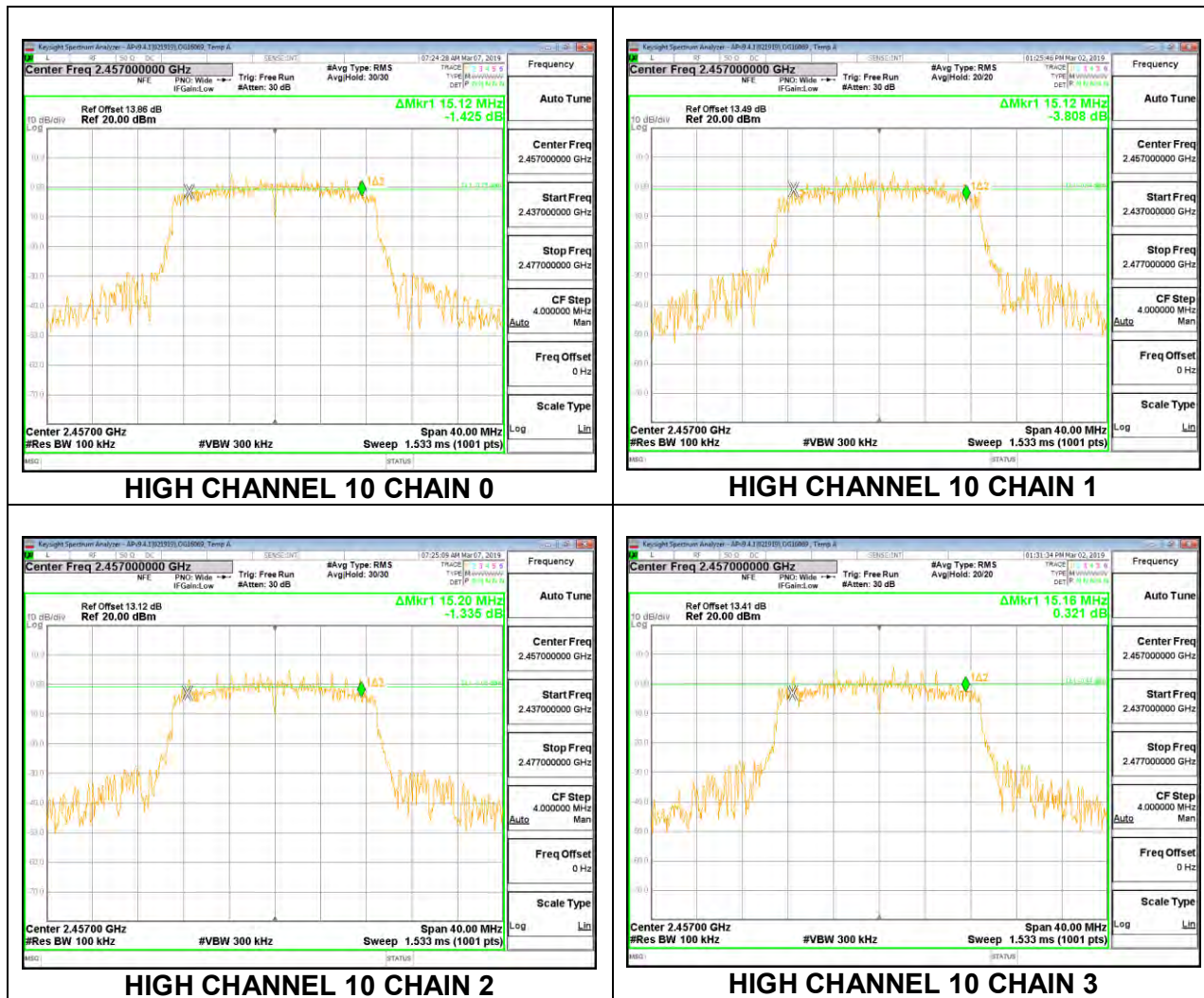
MID CHANNEL 6



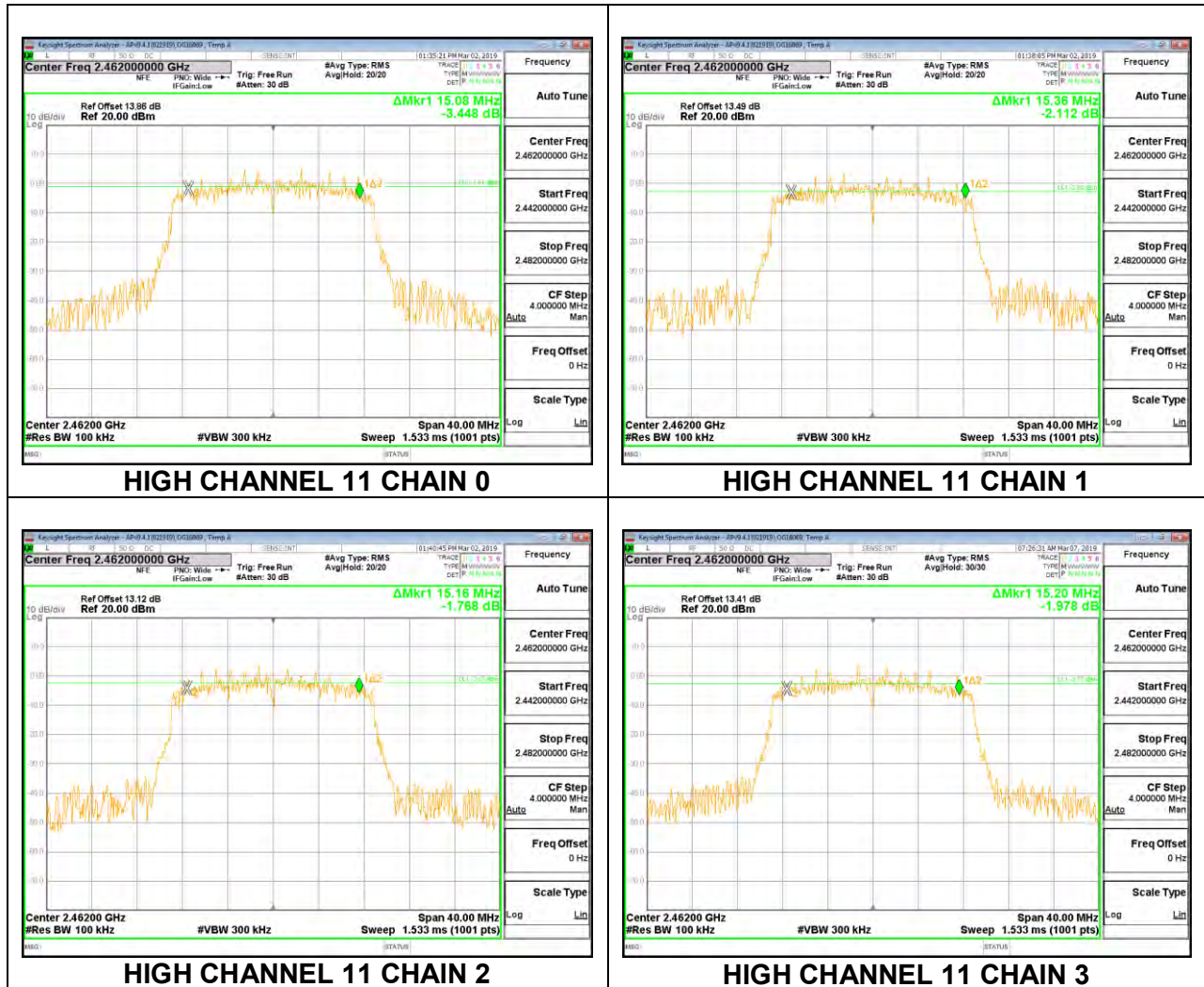
HIGH CHANNEL 9



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 Average reading of power.

DIRECTIONAL ANTENNA GAIN

For 4 TX:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Chain 3 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
2.30	2.20	3.20	2.40	2.54

RESULTS

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	2.54	30.00	36	30.00
Mid 6	2437	2.54	30.00	36	30.00
High 11	2462	2.54	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	19.08	19.06	18.99	18.60	24.96	30.00	-5.04
Mid 6	2437	18.73	18.57	18.72	18.41	24.63	30.00	-5.37
High 11	2462	19.37	18.67	18.77	18.35	24.83	30.00	-5.17

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	2.54	30.00	36	30.00
Low 2	2417	2.54	30.00	36	30.00
Low 3	2422	2.54	30.00	36	30.00
Low 4	2427	2.54	30.00	36	30.00
Mid 6	2437	2.54	30.00	36	30.00
High 9	2452	2.54	30.00	36	30.00
High 10	2457	2.54	30.00	36	30.00
High 11	2462	2.54	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	13.04	13.06	12.28	11.66	18.57	30.00	-11.43
Low 2	2417	15.51	14.94	15.03	14.74	21.08	30.00	-8.92
Low 3	2422	17.39	16.66	16.69	16.51	22.85	30.00	-7.15
Low 4	2427	18.53	17.85	18.04	17.71	24.06	30.00	-5.94
Mid 6	2437	17.53	17.36	17.46	16.72	23.30	30.00	-6.70
High 9	2452	18.55	17.61	17.64	17.57	23.88	30.00	-6.12
High 10	2457	17.39	16.48	16.4	16.36	22.70	30.00	-7.30
High 11	2462	14.58	13.92	14.07	13.09	19.97	30.00	-10.03

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	2.54	30.00	36	30.00
Low 2	2417	2.54	30.00	36	30.00
Low 3	2422	2.54	30.00	36	30.00
Low 4	2427	2.54	30.00	36	30.00
Mid 6	2437	2.54	30.00	36	30.00
High 9	2452	2.54	30.00	36	30.00
High 10	2457	2.54	30.00	36	30.00
High 11	2462	2.54	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	12.13	11.83	11.69	11.08	17.72	30.00	-12.28
Low 2	2417	13.9	13.75	13.73	12.22	19.47	30.00	-10.53
Low 3	2422	15.87	15.75	15.46	15.2	21.60	30.00	-8.40
Low 4	2427	17.1	17.2	17.04	16.27	22.94	30.00	-7.06
Mid 6	2437	17.76	17.59	17.42	17.17	23.51	30.00	-6.49
High 9	2452	18.85	17.98	17.8	18.25	24.26	30.00	-5.74
High 10	2457	15.14	14.59	14.43	14.06	20.59	30.00	-9.41
High 11	2462	12.81	12.34	12.68	12.15	18.52	30.00	-11.48

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.

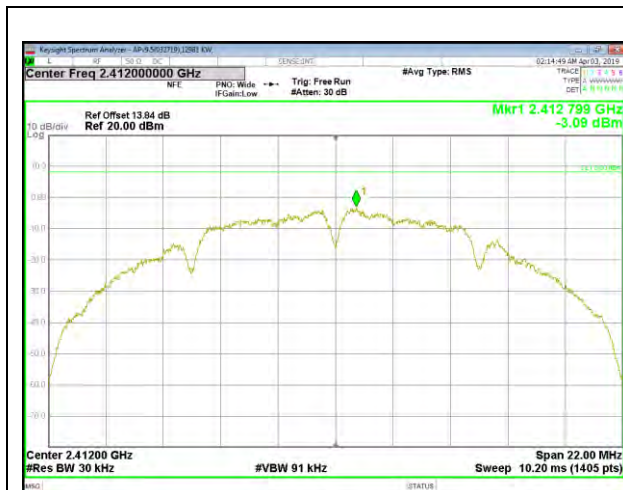
RESULTS

8.5.1. 802.11b MODE

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

Duty Cycle CF (dB)		1.75	Included in Calculations of Corr'd PSD					
PSD Results								
Channel	Frequency	Chain 0 Meas	Chain 1 Meas	Chain 2 Meas	Chain 3 Meas	Total Corr'd PSD	Limit	Margin
	(MHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dB)
Low 1	2412	-3.09	-3.99	-4.14	-3.94	4.00	8.0	-4.0
Mid 6	2437	-3.36	-4.82	-5.15	-5.12	3.22	8.0	-4.8
High 11	2462	-3.88	-4.12	-4.53	-4.06	3.63	8.0	-4.4

LOW CHANNEL 1



LOW CHANNEL 1 CHAIN 0



LOW CHANNEL 1 CHAIN 1

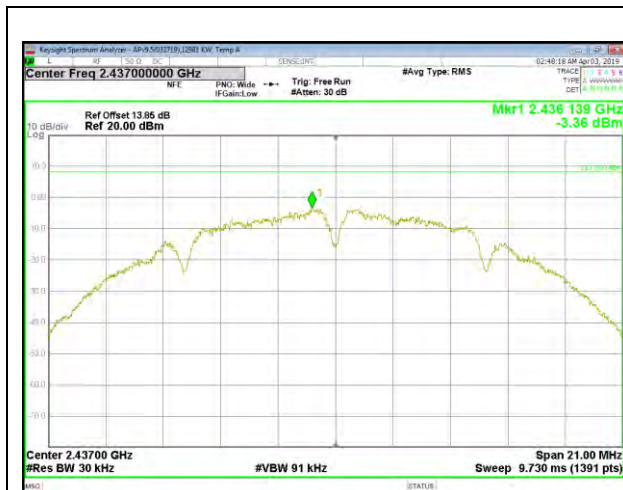


LOW CHANNEL 1 CHAIN 2



LOW CHANNEL 1 CHAIN 3

MID CHANNEL 6



MID CHANNEL 6 CHAIN 0



MID CHANNEL 6 CHAIN 1

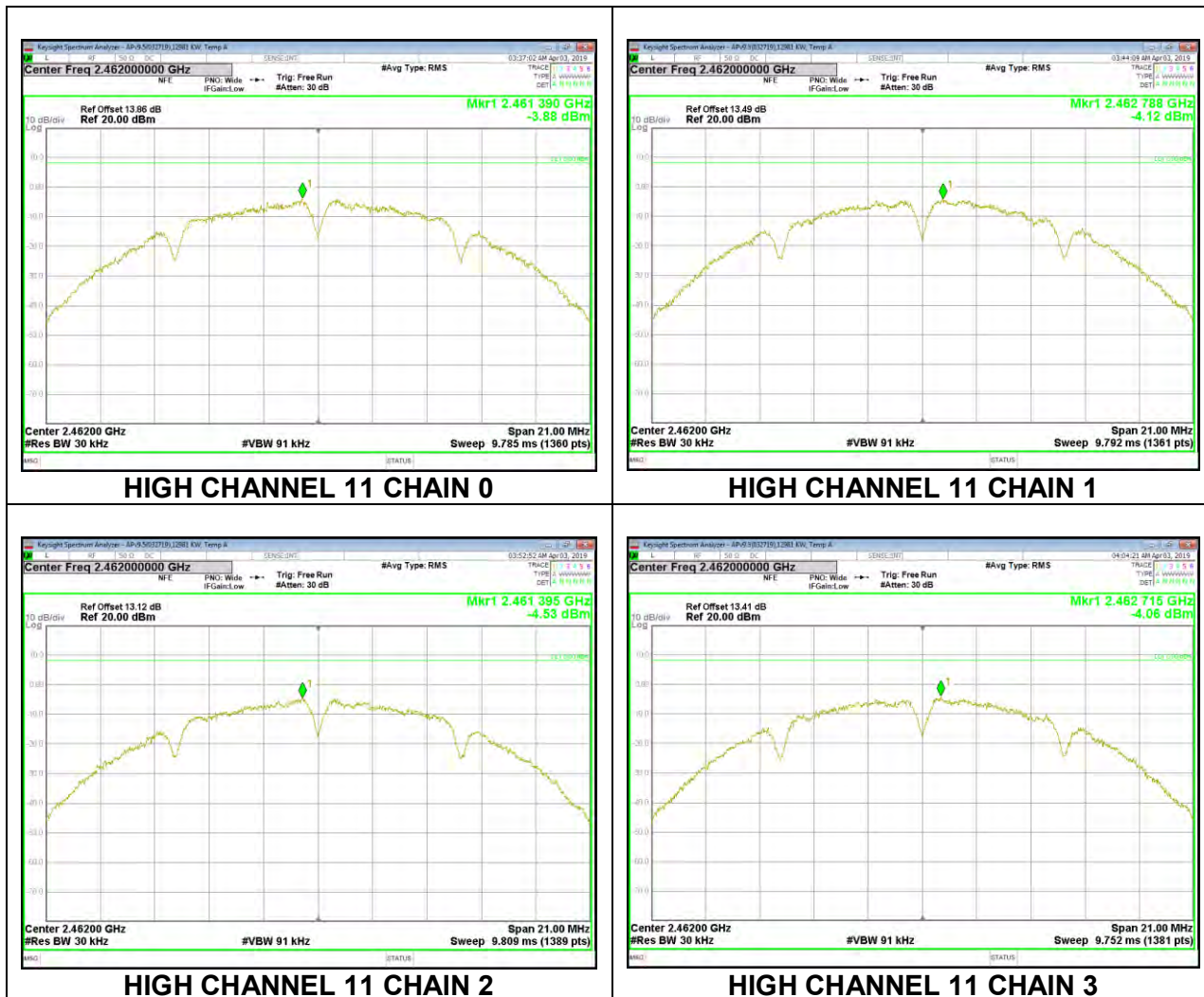


MID CHANNEL 6 CHAIN 2



MID CHANNEL 6 CHAIN 3

HIGH CHANNEL 11

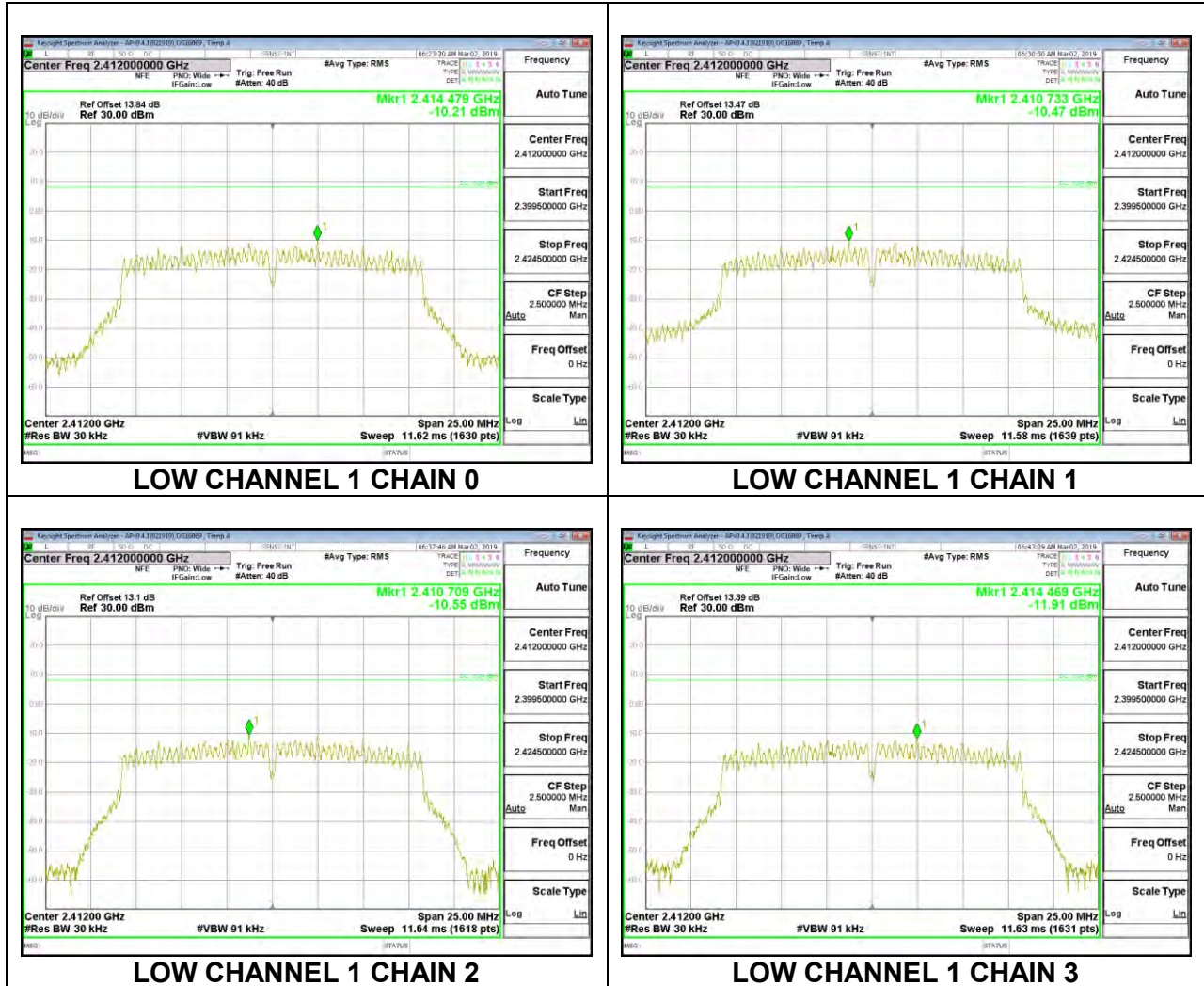


8.5.2. 802.11g MODE

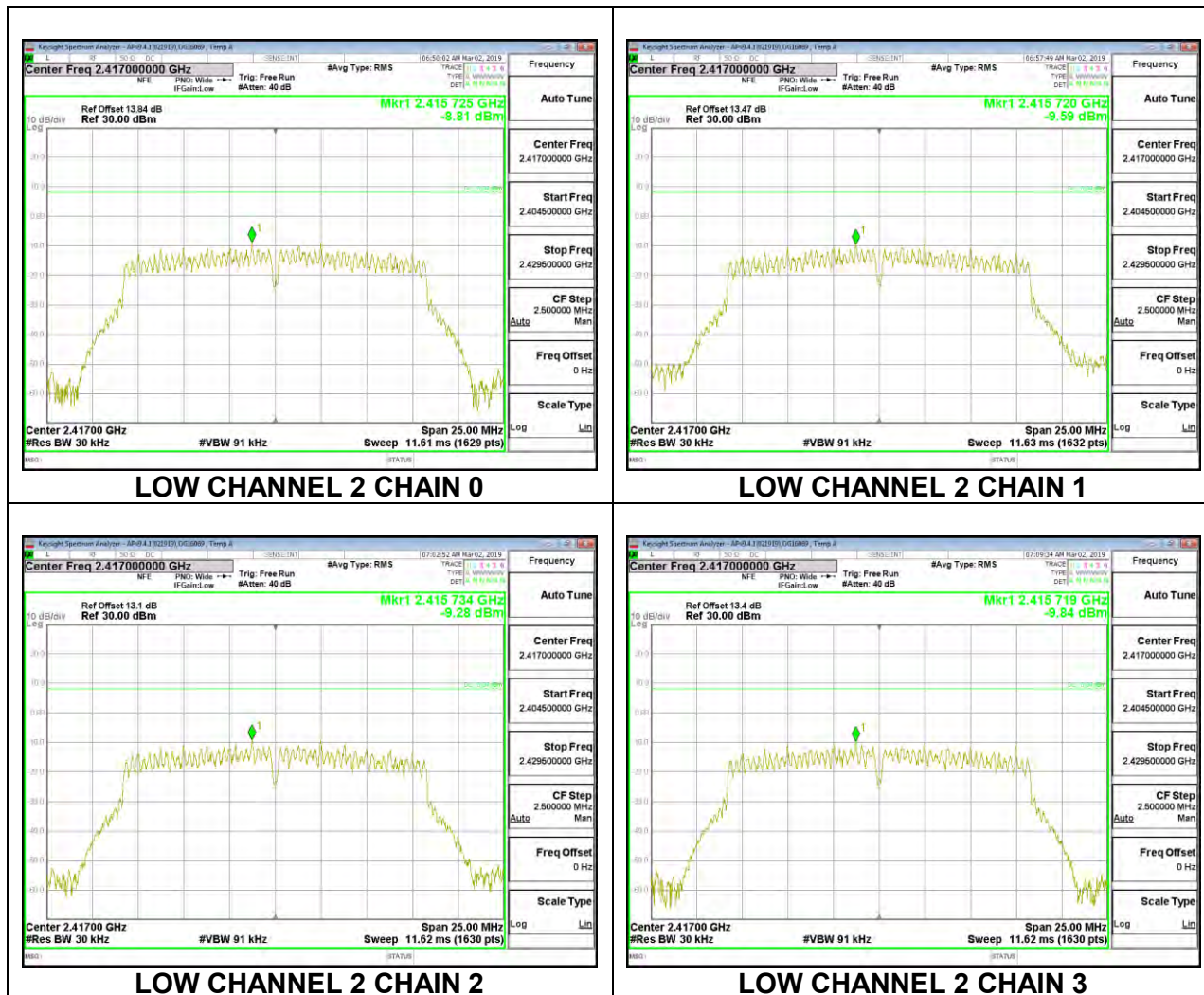
4TX Antenna 1 + Antenna 2 + Antenna 3 + Antenna 4 CDD MODE

Duty Cycle CF (dB)		2.92	Included in Calculations of Corr'd PSD					
PSD Results								
Channel	Frequency	Chain 0 Meas	Chain 1 Meas	Chain 2 Meas	Chain 3 Meas	Total Corr'd PSD	Limit	Margin
	(MHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dBm/30kHz)	(dB)
Low 1	2412	-10.21	-10.47	-10.54	-11.91	-1.79	8.0	-9.8
Low 2	2417	-8.81	-9.59	-9.28	-9.84	-0.42	8.0	-8.4
Low 3	2422	-6.45	-5.87	-7.59	-8.68	1.92	8.0	-6.1
Low 4	2427	-5.50	-5.77	-6.66	-5.45	3.12	8.0	-4.9
Mid 6	2437	-4.61	-5.67	-5.42	-6.62	3.42	8.0	-4.6
High 9	2452	-5.69	-6.27	-5.81	-6.92	2.79	8.0	-5.2
High 10	2457	-8.11	-8.13	-7.16	-7.21	1.31	8.0	-6.7
High 11	2462	-7.66	-9.47	-9.46	-9.72	-0.05	8.0	-8.1

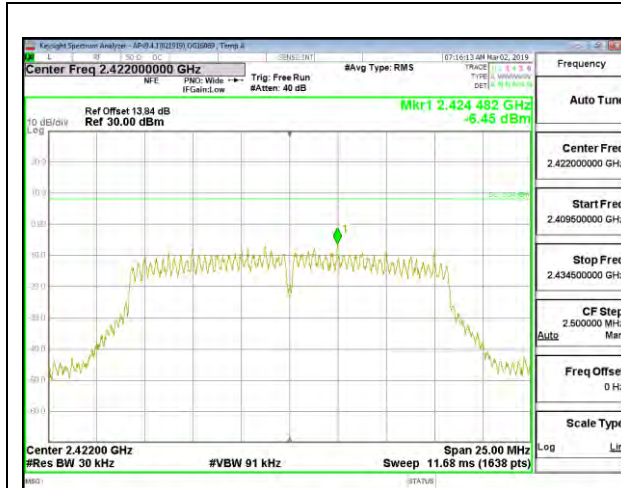
LOW CHANNEL 1



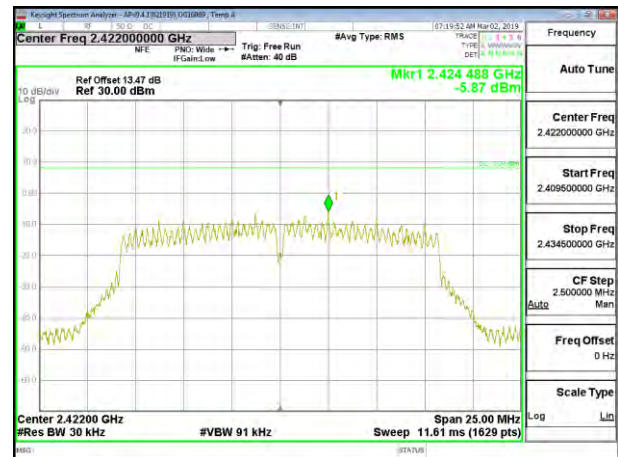
LOW CHANNEL 2



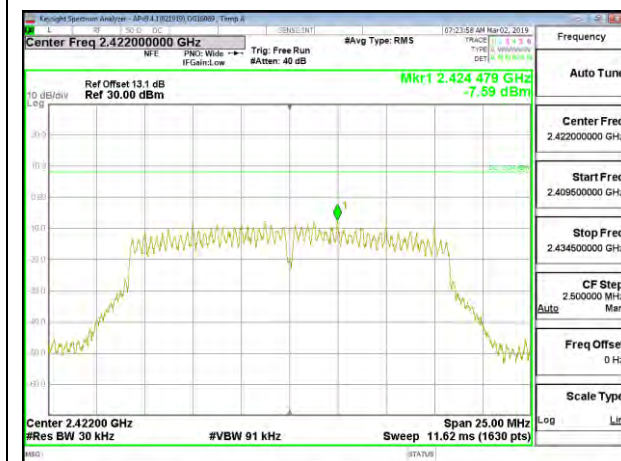
LOW CHANNEL 3



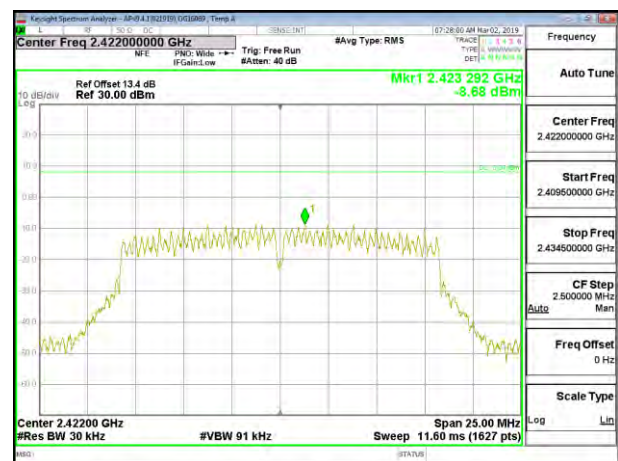
LOW CHANNEL 3 CHAIN 0



LOW CHANNEL 3 CHAIN 1



LOW CHANNEL 3 CHAIN 2



LOW CHANNEL 3 CHAIN 3