CERTIFICATION TEST REPORT

Report Number. : 12696945-E3V2

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A
Model	:	A2221
FCC ID	:	BCG-E3304A
IC	:	579C-E3304A
EUT Description	:	SMARTPHONE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2 ISED RSS-GEN ISSUE 5

Date Of Issue:
July 31, 2019

Prepared by:
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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	7/19/2019	Initial Issue	Francisco Guarnero
V2	7/31/2019	Addressed TCB questions	Francisco Guarnero

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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 8

5.4. SOFTWARE AND FIRMWARE 8

5.5. WORST-CASE CONFIGURATION AND MODE 9

5.6. DESCRIPTION OF TEST SETUP 10

6. MEASUREMENT METHOD 15

7. TEST AND MEASUREMENT EQUIPMENT 16

8. ANTENNA PORT TEST RESULTS 17

8.1. ON TIME AND DUTY CYCLE 17

8.2. 99% BANDWIDTH 19

8.2.1. 802.11b MODE 19

8.2.2. 802.11n HT20 MODE 23

8.2.3. 802.11n HT20 CDD MODE 2TX 29

8.2.4. 802.11ax HE20 MODE 33

8.2.5. 802.11ax HE20 OFDMA MODE 2TX 59

8.3. 6 dB BANDWIDTH 76

8.3.1. 802.11b MODE 76

8.3.2. 802.11n HT20 MODE 80

8.3.3. 802.11n HT20 CDD MODE 2TX 86

8.3.4. 802.11ax HE20 MODE 90

8.3.5. 802.11ax HE20 OFDMA MODE 2TX 116

8.4. OUTPUT POWER 133

8.4.1. 802.11b MODE 135

8.4.2. 802.11n HT20 MODE 137

8.4.3. 802.11n HT20 CDD MODE 2TX 139

8.4.4. 802.11ax HE20 MODE 140

8.4.5. 802.11ax HE20 OFDMA MODE 2TX 150

8.5. POWER SPECTRAL DENSITY 155

8.5.1. 802.11b MODE 156

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8.5.2. 802.11n HT20 MODE 160
8.5.3. 802.11n HT20 CDD MODE 2TX 166
8.5.4. 802.11ax HE20 MODE 170
8.5.5. 802.11ax HE20 OFDMA MODE 2TX 196

8.6. CONDUCTED SPURIOUS EMISSIONS 213
8.6.1. 802.11b MODE 214
8.6.2. 802.11n HT20 MODE 218
8.6.3. 2TX 802.11n HT20 CDD MODE 2TX 224
8.6.4. 802.11ax HE20 MODE 229
8.6.5. 802.11ax HE20 OFDMA MODE 2TX 255

9. RADIATED TEST RESULTS 280

9.1. TRANSMITTER ABOVE 1 GHz 282
9.1.1. TX ABOVE 1 GHz 802.11b MODE IN THE 2.4 GHz BAND 282
9.1.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 2.4 GHz BAND 310
9.1.3. TX ABOVE 1 GHz 802.11 HT20 CDD MODE IN THE 2.4 GHz BAND 342
9.1.4. TX ABOVE 1 GHz 802.11ax HE20 MODE IN THE 2.4 GHz BAND 360
9.1.5. TX ABOVE 1 GHz 802.11ax HE20 OFDMA MODE IN THE 2.4 GHz BAND 428

9.2. WORST CASE BELOW 1 GHz 472

9.3. WORST CASE 18-26 GHz 474

10. AC POWER LINE CONDUCTED EMISSIONS 476

10.1.1. AC Power Line Host 477
10.1.2. AC Power Line Norm 479

11. SETUP PHOTOS 481

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE INC.
1 APPLE PARK WAY
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: SMARTPHONE

MODEL: A2221

SERIAL NUMBER: C7CYQ00BMTCF; C7CYG01XMCHV

DATE TESTED: FEBRUARY 19, 2019 – JULY 31, 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
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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, ANSI C63.10-2013, 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
☒ Chamber A (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)	☐ Chamber I (ISED:2324A-5)
☒ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)	☐ Chamber J (ISED:2324A-6)
☐ Chamber C (ISED:2324B-3)	☐ Chamber F (ISED:22541-3)	☒ Chamber K (ISED:2324A-1)
	☐ Chamber G (ISED:22541-4)	☐ Chamber L (ISED:2324A-3)
	☐ Chamber H (ISED:22541-5)	

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

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

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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%.

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

EUT is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wide band, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based pSIM (physical SIM) or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible

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)
1Tx			
2412 - 2472	802.11b	21.43	139.00
2412 - 2472	802.11g	Covered by 802.11n HT20 1TX	
2412 - 2472	802.11n HT20	21.45	139.64
2412 - 2472	802.11ax HE20, 242-Tones	21.48	140.60
2412 - 2472	802.11ax HE20, 26-Tones	21.49	140.93

2Tx			
2412 - 2472	802.11n HT20 CDD	24.43	277.33
2412 - 2472	802.11g SDM/STBC	Covered by 802.11n HT20 2TX CDD	
2412 - 2472	802.11ax HE20, 242-Tones	24.49	281.19
2412 - 2472	802.11ax HE20, 26-Tones	22.91	195.43

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range	Antenna 2(Core 0)	Antenna Ant 5 (Core 1)
2400-2480	-4.5	-2.6

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was WiFi FW Version: 18_20_56_1.

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5.5. WORST-CASE CONFIGURATION AND MODE

EUT was investigated in three orthogonal orientations X, Y and Z on Ant 2 (Core 0), Ant 5 (Core 1) and 2TX. It was determined that Y (Landscape) orientation was worst-case orientation for both Ant 2 and 2TX and X (Flatbed) orientation for Antenna 5.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 30MHz, below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario.

For radiated harmonics spurious below 1GHz, 1-18GHz L/M/H channels, 18-26GHz, and power line conducted emissions were performed with the EUT set at the 2TX CDD mode among the CDD/SDM modes and 2TX HE mode with power setting equal or higher than SISO modes as worst-case scenario. G mode covered by HT20 mode since it has the same power as HT20.

Below 1GHz tests were performed with EUT connected to AC power adapter as the worst case; and for above 1GHz tests, the worst-case configuration reported was with EUT only. For AC line conducted emission, test was investigated with AC power adapter and with laptop. There were no emissions found below 30MHz within 20dB of the limit.

The output power and psd for the 802.11 ax mode were investigated between all different tones, and we found that the highest tone had equal or higher output power and widest bandwidth, the lowest tone had the highest PSD reading from the target power table. Therefore, full testing was performed on both the highest and lowest tones. In addition, RU52 was investigated on channel 13 1TX and 2TX on power, PSD and band edge to show compliance.

The peak PSD were performed as worst case mode.

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

802.11b mode: 1 Mbps
802.11n HT20mode: MCS0
802.11ax HE20mode: MCS0

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

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5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
laptop	Apple	A1398	C02PM012G3QD	QDS-BRCM1069
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
EUT AC Adapter	Apple	A1385	D29325SM03XDHLHC9	NA

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

I/O Cable List						
Cable No	**Port**	**# of identical**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

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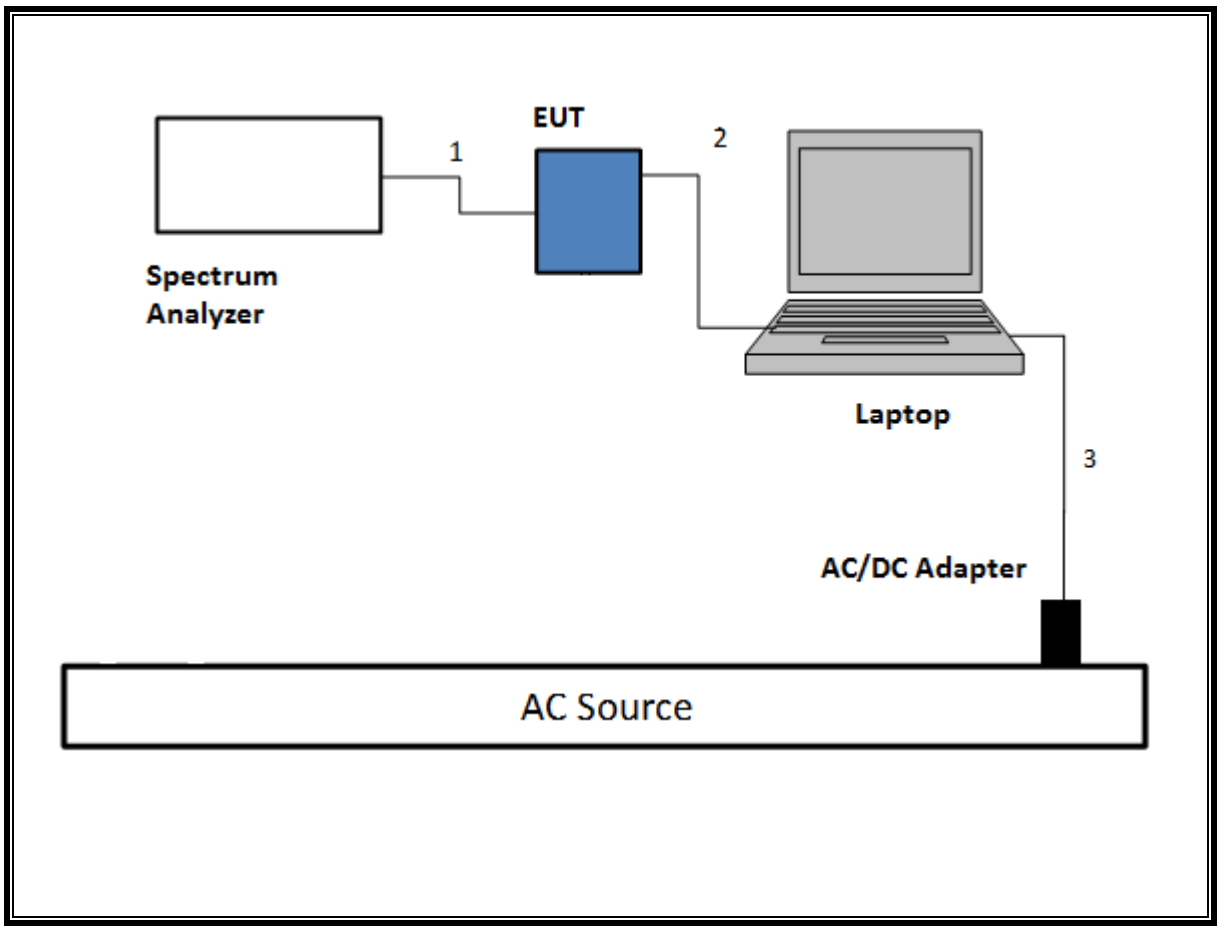
SETUP DIAGRAM FOR CONDUCTED TESTS



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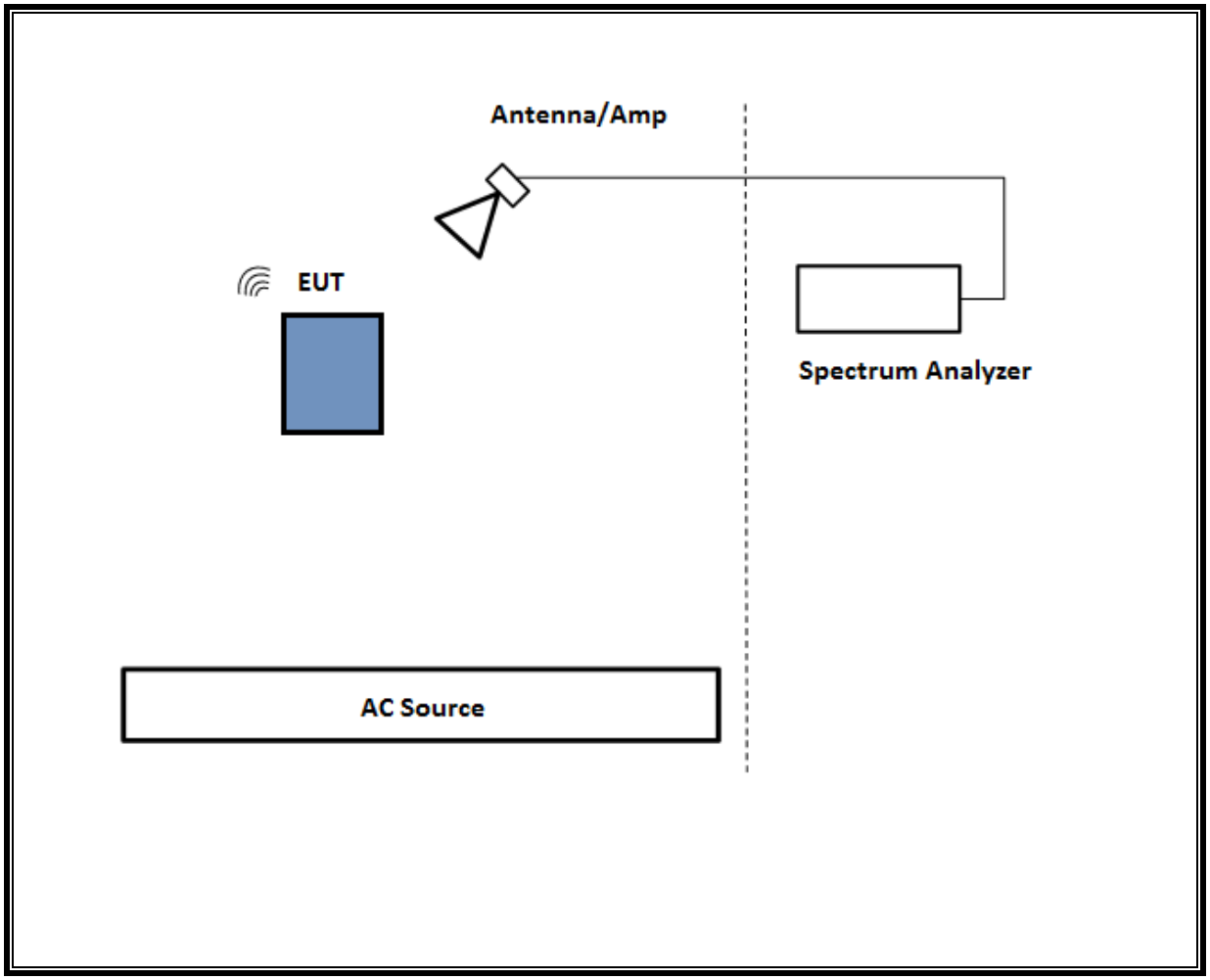
SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz



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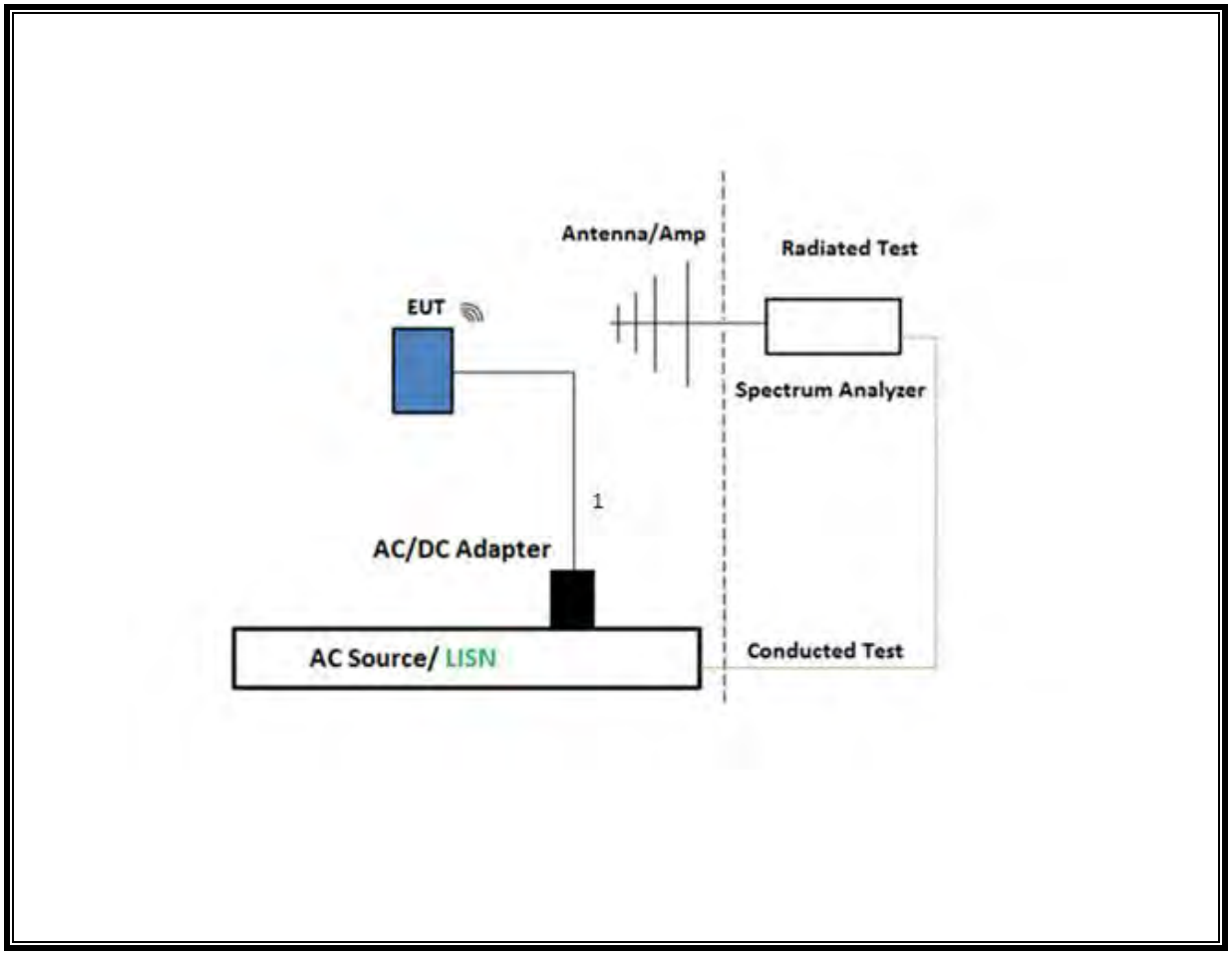
SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST



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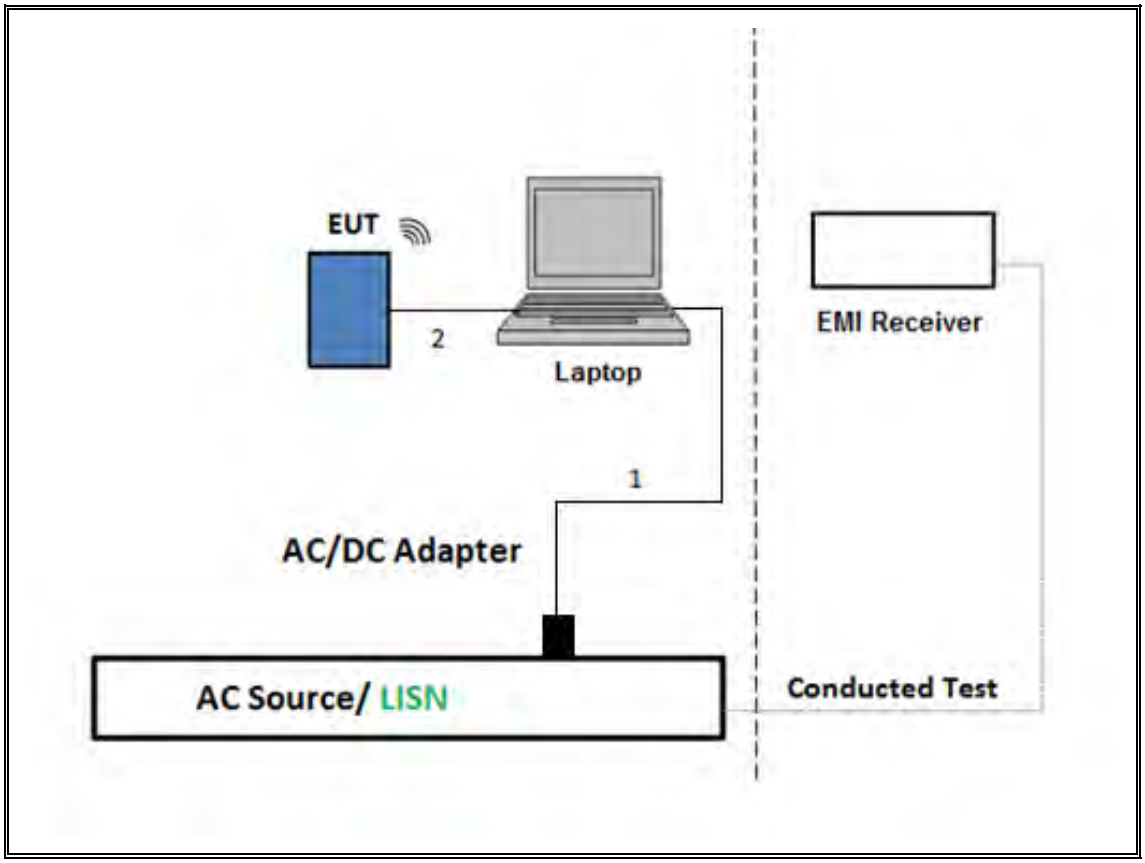
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



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6. MEASUREMENT METHOD

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW ≥ DTS BW

99% BW: ANSI C63.10-2013, Section 6.9.3.

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

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

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

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

Band-edge: ANSI C63.10 Subclause -11.13.3.2 Integration method -Peak detection

Band-edge: ANSI C63.10 Subclause -11.13.3.3 Integration method -Trace averaging with continuous transmission at full power

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

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

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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, 10KHz to 1GHz, 32dB	Sonoma Instrument Co.	310N	T286	06/06/2020	07/06/2019
Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T740	10/06/2019	10/06/2018
*Antenna Horn, 18 to 26GHz	ARA	MWH-1826	T447	06/16/2019	06/16/2018
*Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	03/23/2020	03/23/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T459	01/24/2020	01/24/2019
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T346	05/14/2020	05/14/2019
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T345	04/20/2020	04/20/2019
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T344	05/07/2020	05/07/2019
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T712	02/26/2020	02/26/2019
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T136	07/02/2019	07/02/2018
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T119	03/22/2020	03/22/2019
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	05/30/2020	05/30/2020
*Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T1165	06/12/2019	06/12/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T493	08/30/2019	08/30/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T740	10/062019	10/062018
Amplifier, 1 to 18GHz	Amplical	AFS42-00101800-25-S-42	T1567	01/26/2020	01/26/2019
*Amplifier, 1 to 18GHz	Amplical	AFS42-00101800-25-S-42	T1568	06/21/2019	06/21/2018
*Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB1	T122	03/21/2020	03/21/2019
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T835	01/02/2020	01/02/2019
Power Meter, P-series single channel	Keysight	N1912A	T1244	01/30/2020	01/30/2019
*Power Sensor	Keysight	N1921A	T1224	02/22/2020	02/22/2019
*Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T491	05/30/2020	05/30/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T906	01/22/2020	01/22/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T908	01/24/2020	01/24/2019
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/25/2019	09/25/2018

AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	02/14/2020
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2019
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/19/2019
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

*Testing is completed before equipment expiration date

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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	10.250	10.250	1.000	100.00%	0.00	0.010
802.11n HT20	1.920	1.945	0.987	98.71%	0.00	0.010
802.11ax HE20 26T-RU0	4.128	4.204	0.982	98.19%	0.00	0.010
802.11ax HE20 242T-RU61	1.575	1.596	0.987	98.68%	0.00	0.010

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DUTY CYCLE PLOTS

DUTY CYCLE 802.11b MODE

DUTY CYCLE 802.11n HT20

DUTY CYCLE 802.11ax HE20 26T-RU0

DUTY CYCLE 802.11ax HE20 242T-RU61

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8.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

RESULTS

8.2.1. 802.11b MODE

1TX Antenna 2 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	13.1678
Mid 6	2437	13.5377
High 11	2462	13.2259
High 12	2467	13.2890
High 13	2472	13.3282

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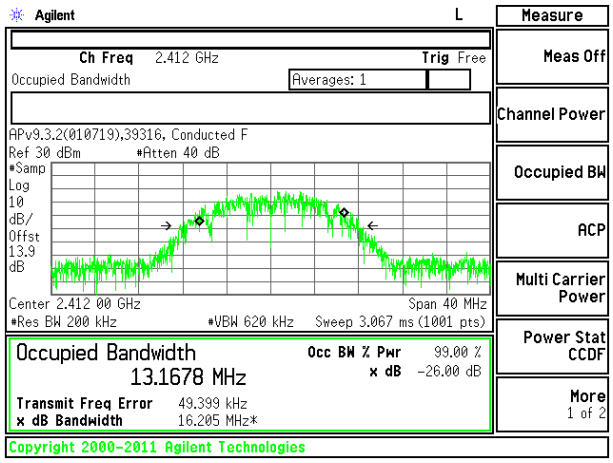
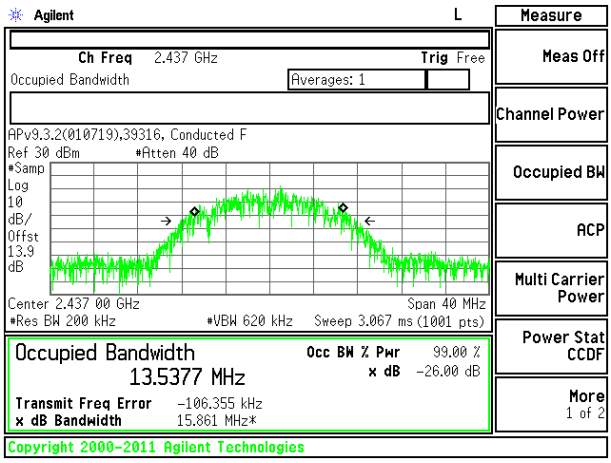
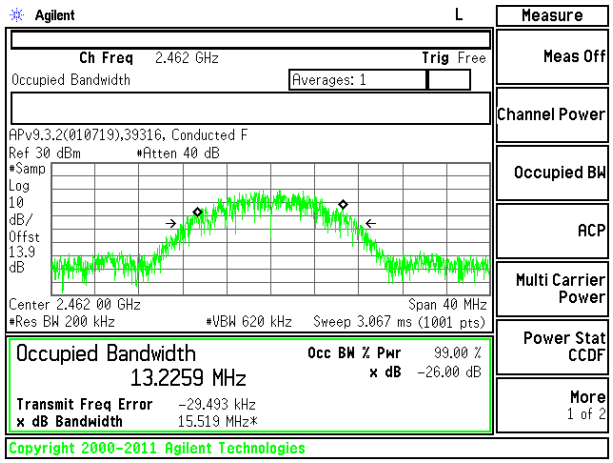


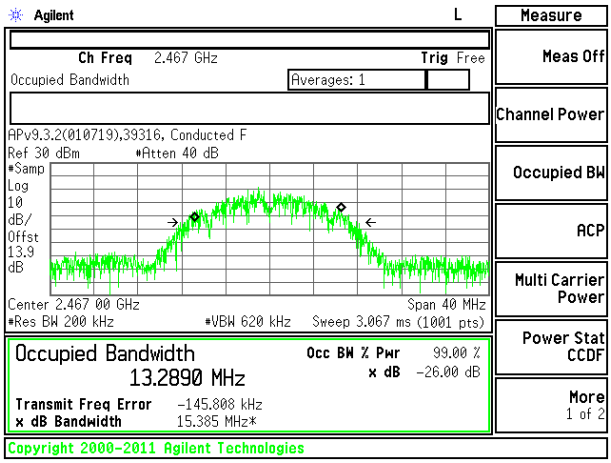
LOW CHANNEL 1



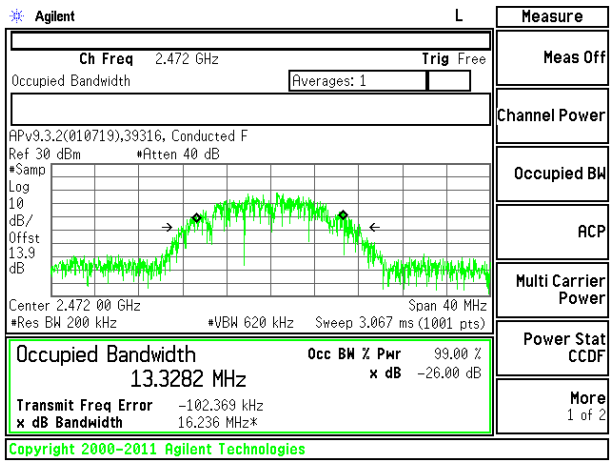
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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1TX Antenna 5 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	13.4431
Mid 6	2437	13.5222
High 11	2462	13.6662
High 12	2467	13.1119
High 13	2472	13.2410

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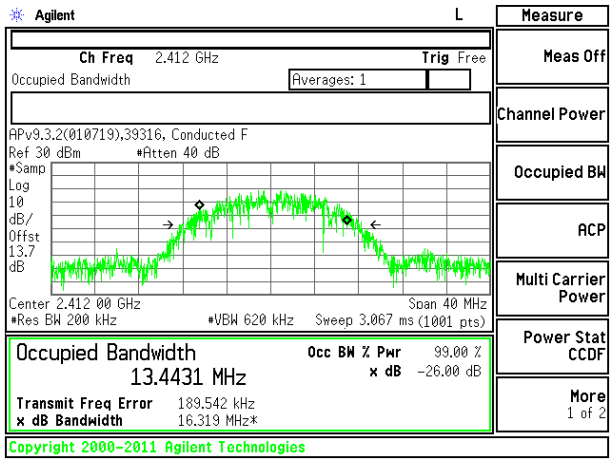
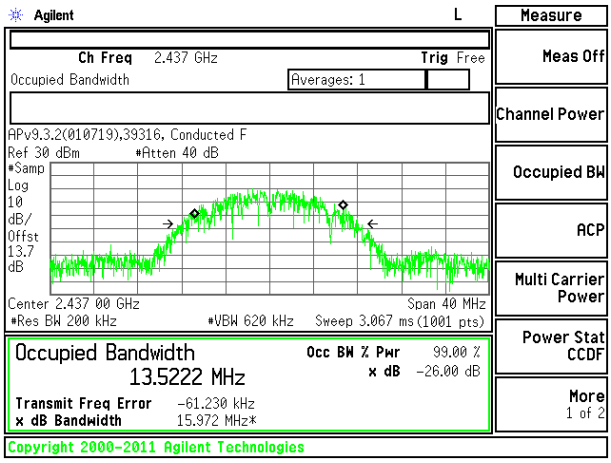
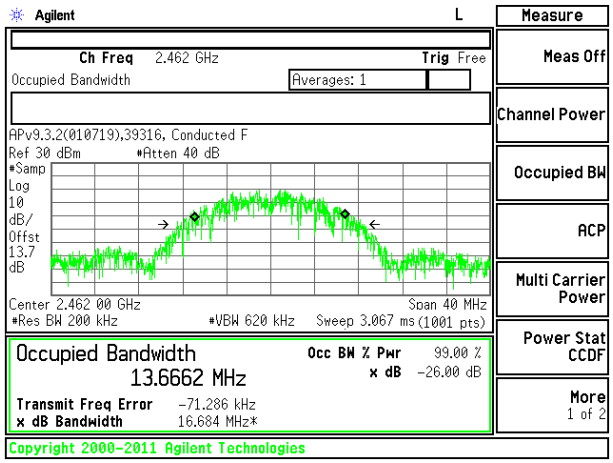


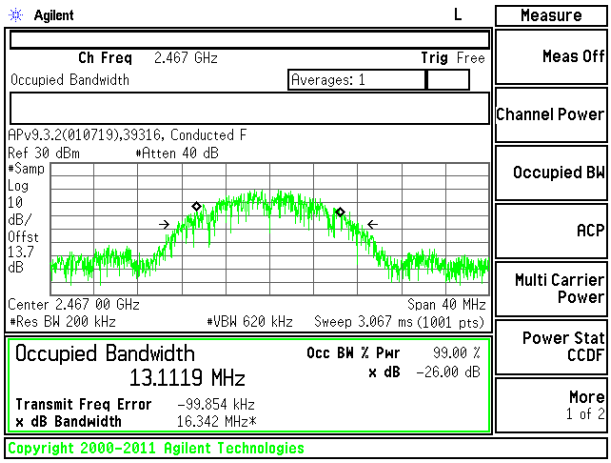
LOW CHANNEL 1



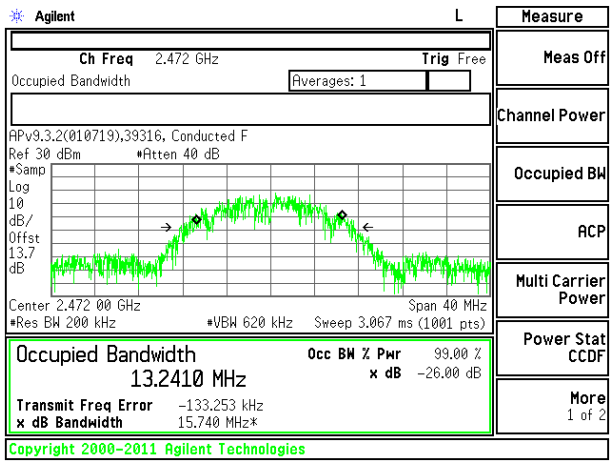
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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8.2.2. 802.11n HT20 MODE

1TX Antenna 2 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	17.5886
Low 2	2417	17.5955
Low 3	2422	17.6750
Mid 6	2437	17.5511
High 9	2452	17.0820
High 10	2457	17.5179
High 11	2462	17.6375
High 12	2467	17.5309
High 13	2472	17.6115

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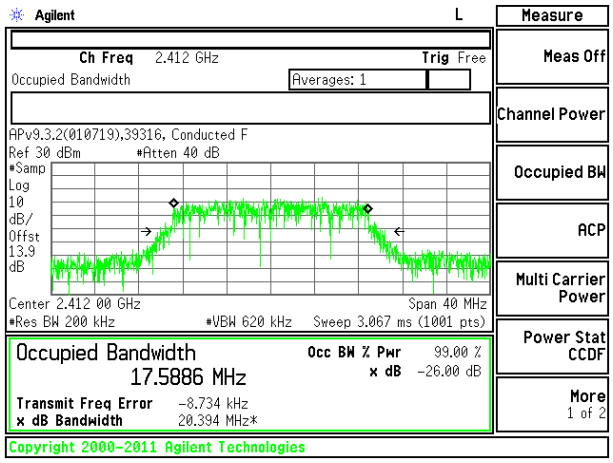
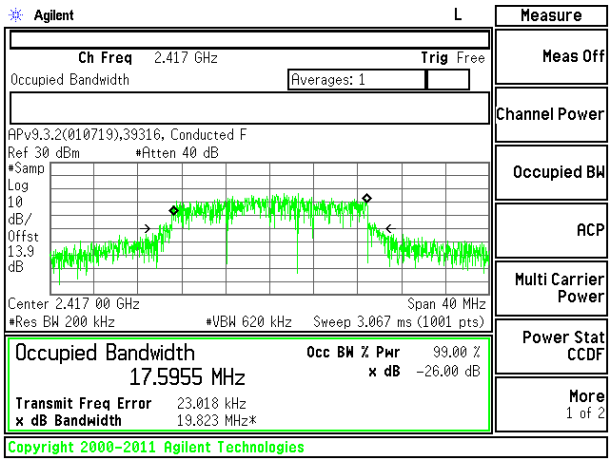
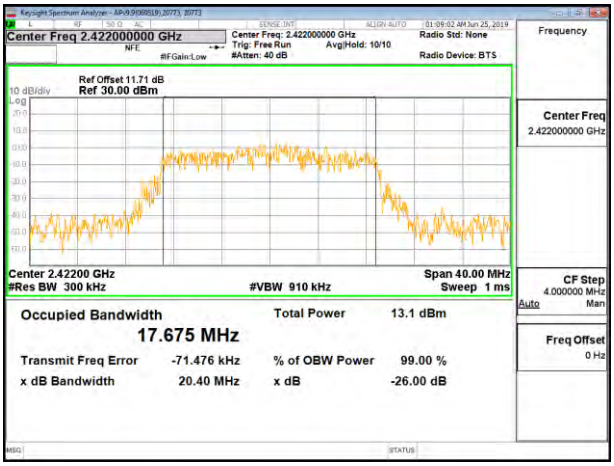


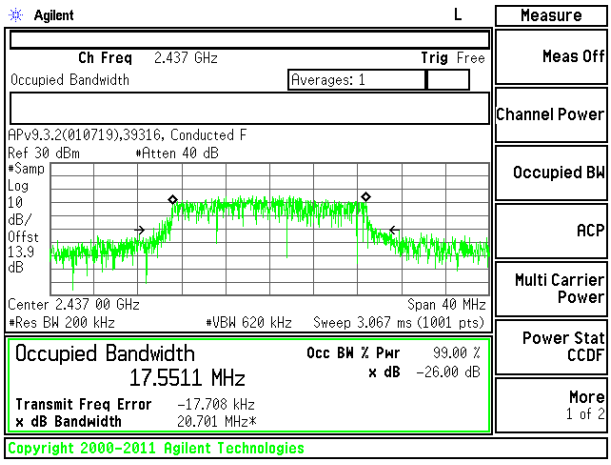
LOW CHANNEL 1



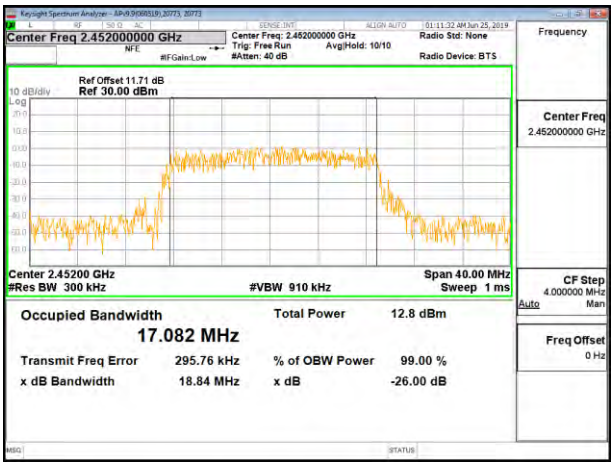
LOW CHANNEL 2



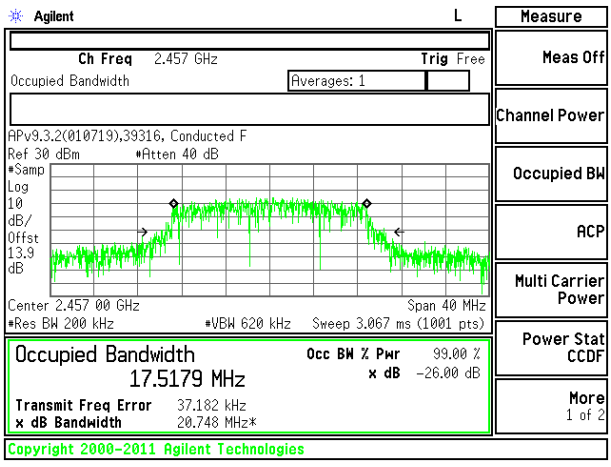
LOW CHANNEL 3



MID CHANNEL 6



HIGH CHANNEL 9



HIGH CHANNEL 10

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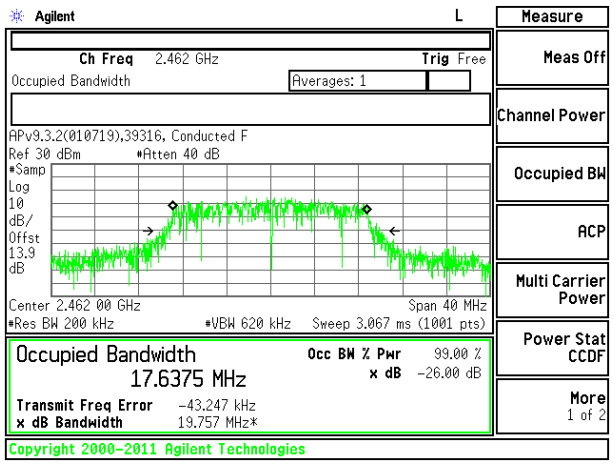
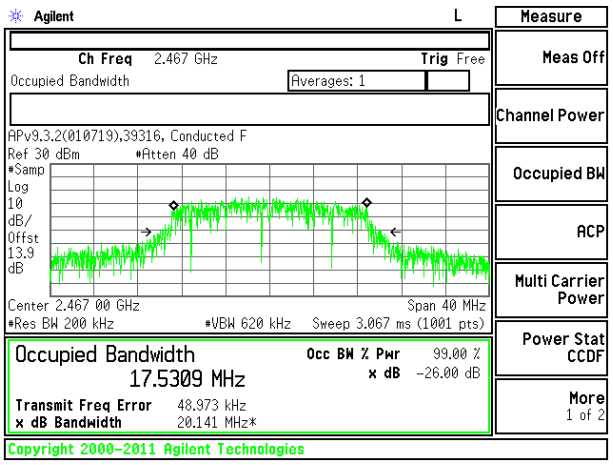
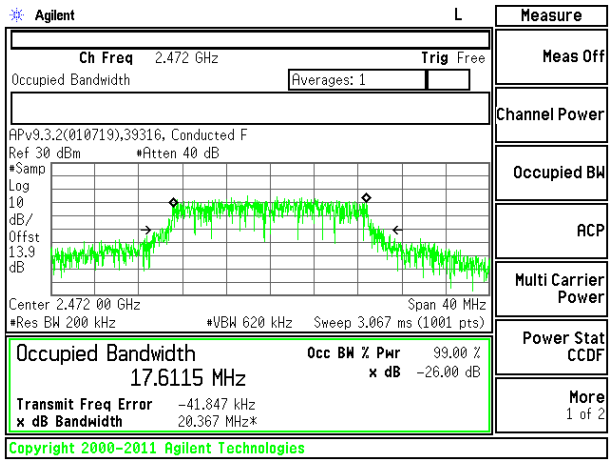


HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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1TX Antenna 5 MODE

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	17.5411
Low 2	2417	17.6289
Low 3	2422	17.6040
Mid 6	2437	17.5378
High 9	2452	17.6260
High 10	2457	17.5431
High 11	2462	17.5439
High 12	2467	17.4935
High 13	2472	17.6445

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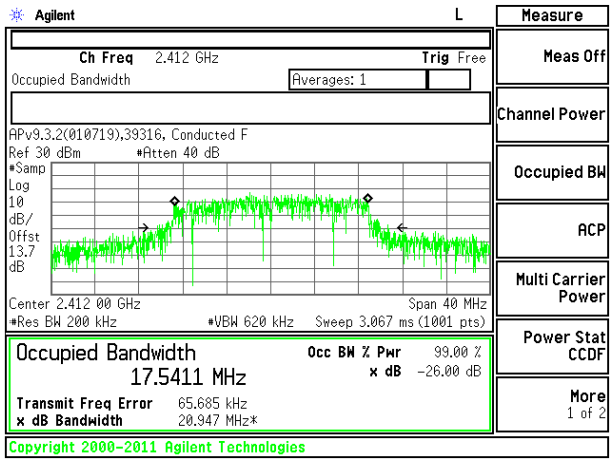
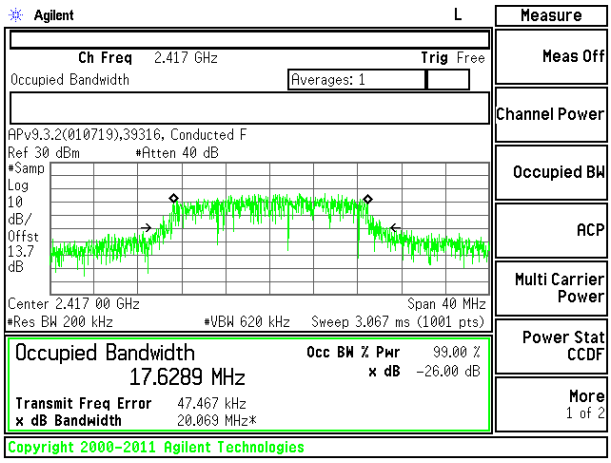
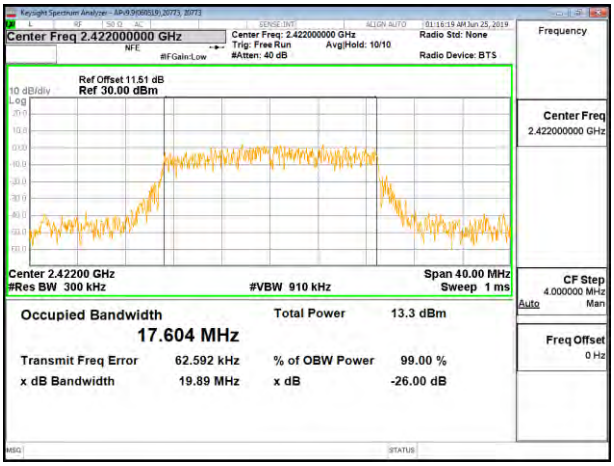


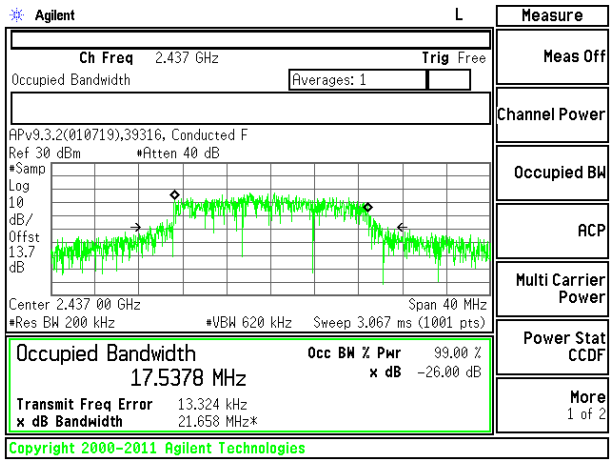
LOW CHANNEL 1



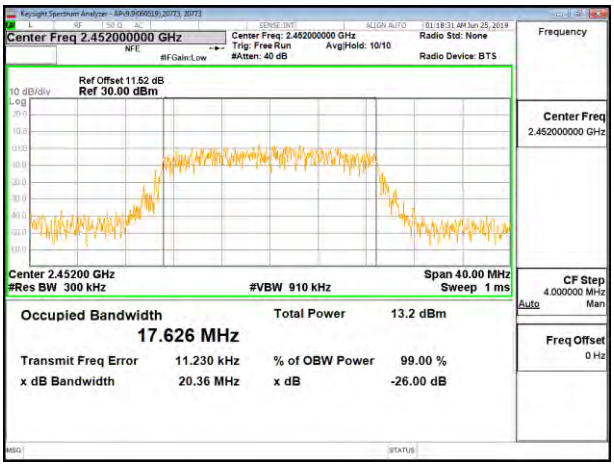
LOW CHANNEL 2



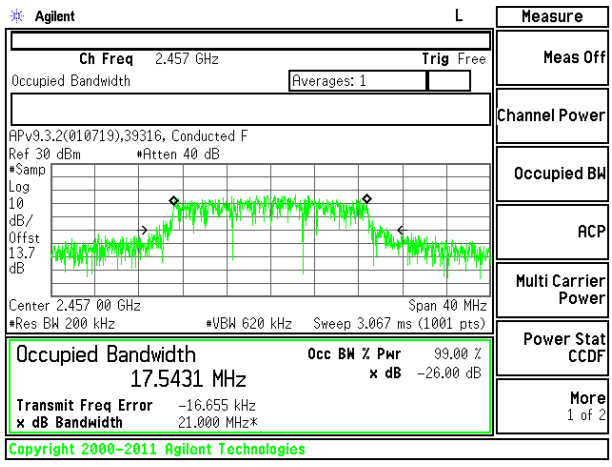
LOW CHANNEL 3



MID CHANNEL 6



HIGH CHANNEL 9



HIGH CHANNEL 10

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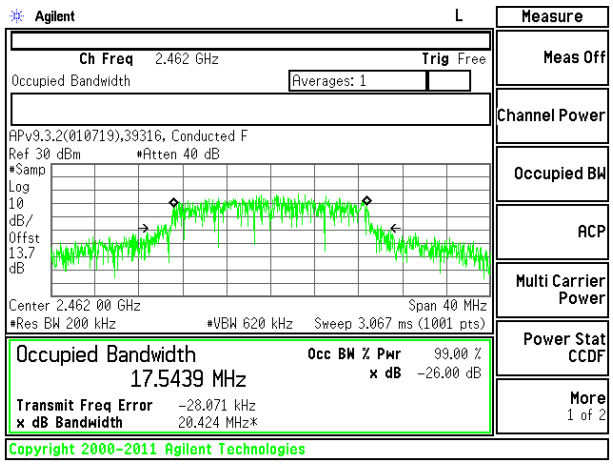
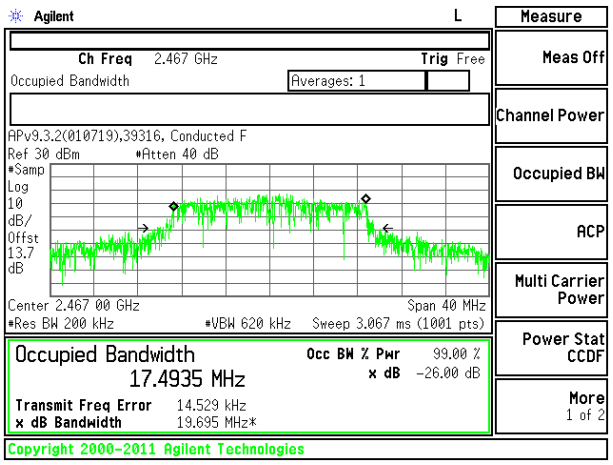
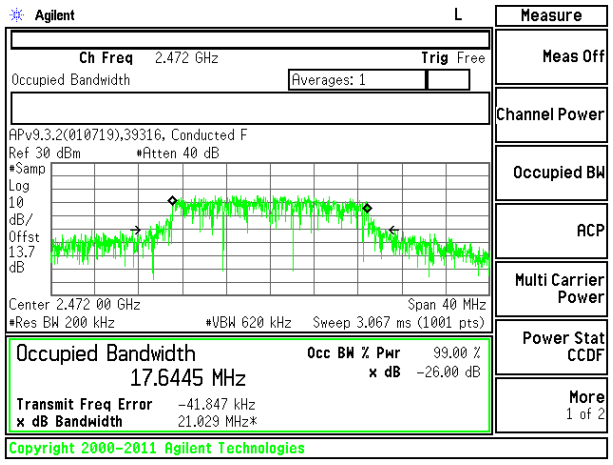


HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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8.2.3. 802.11n HT20 CDD MODE 2TX

Antenna 2 + Antenna 5 2TX MODE

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
Low 1	2412	17.652	17.566
Low 2	2417	17.535	17.563
Mid 6	2437	17.640	17.564
High 10	2457	17.500	17.565
High 11	2462	17.594	17.582
High 12	2467	17.606	17.550
High 13	2472	17.630	17.600

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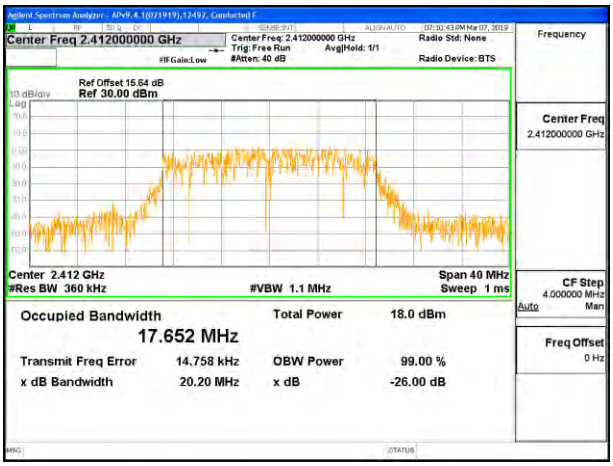
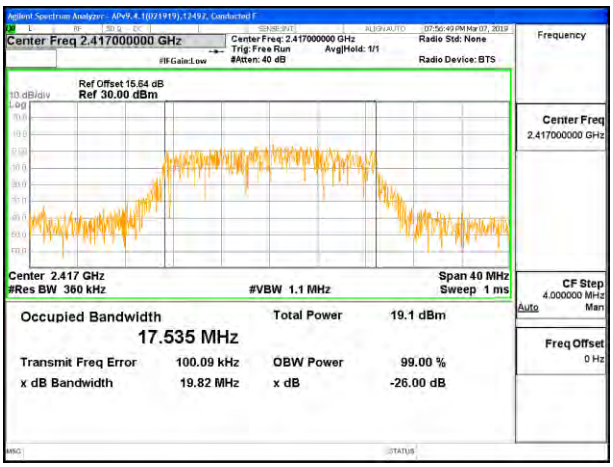


LOW CHANNEL 1 ANT 2

LOW CHANNEL 1 ANT 5



LOW CHANNEL 2 ANT 2

LOW CHANNEL 2 ANT 5

MID CHANNEL 6 ANT 2

MID CHANNEL 6 ANT 5

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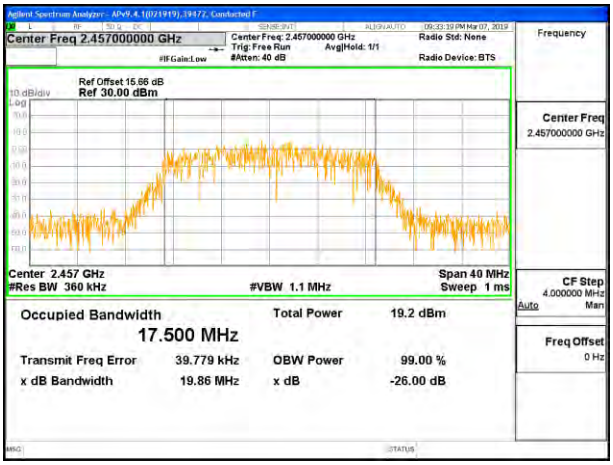
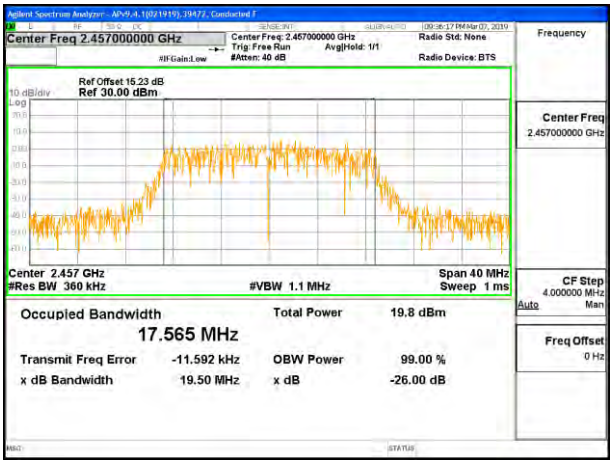
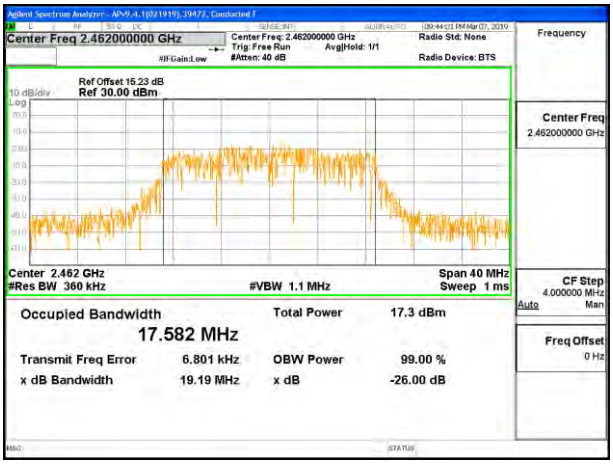


HIGH CHANNEL 10 ANT 2

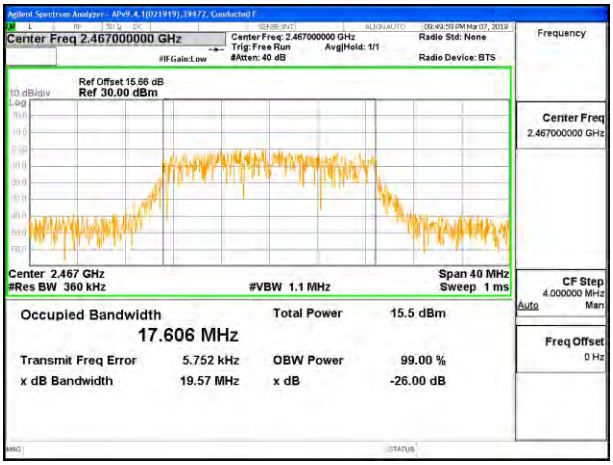


HIGH CHANNEL 10 ANT 5

HIGH CHANNEL 11 ANT 2



HIGH CHANNEL 11 ANT 5



HIGH CHANNEL 12 ANT 2

HIGH CHANNEL 12 ANT 5

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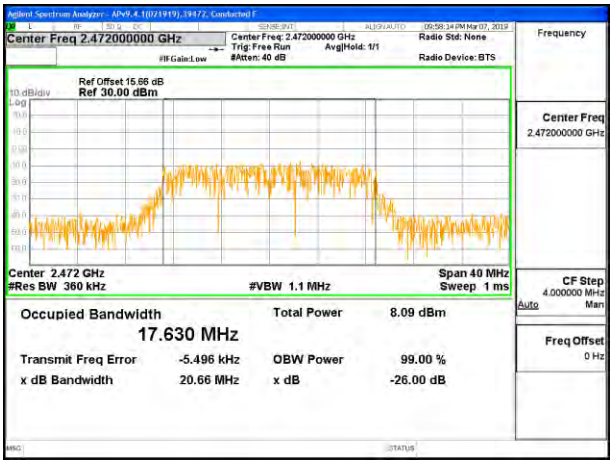

HIGH CHANNEL 13 ANT 2

HIGH CHANNEL 13 ANT 5

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8.2.4. 802.11ax HE20 MODE

Antenna 2 LEGACY SISO MODE: 26-Tones, RU index 0

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.555
Low 2	2417	18.500
Low 3	2422	18.470
Mid 6	2437	18.484
High 9	2452	18.506
High 10	2457	18.494
High 11	2462	18.466
High 12	2467	18.457
High 13	2472	18.395

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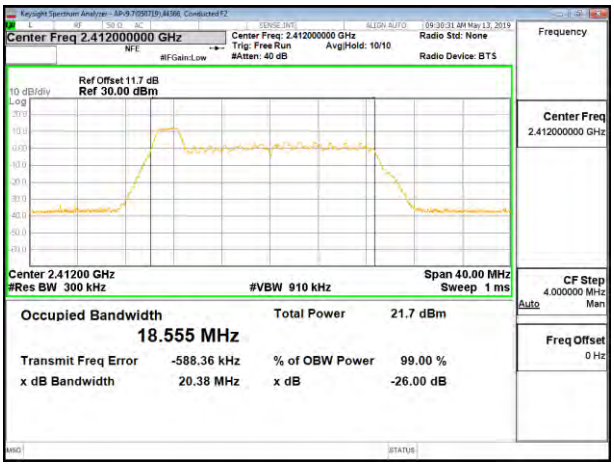
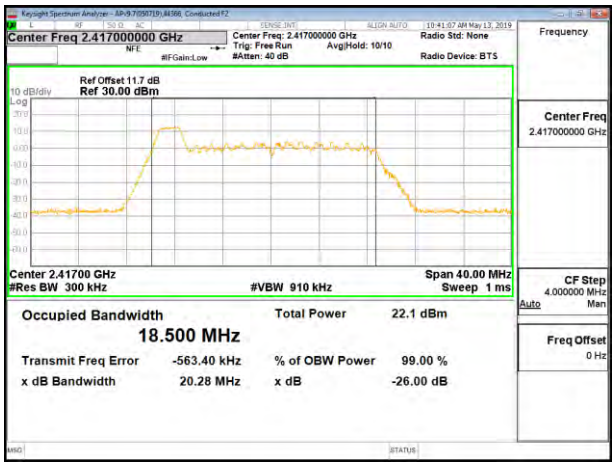
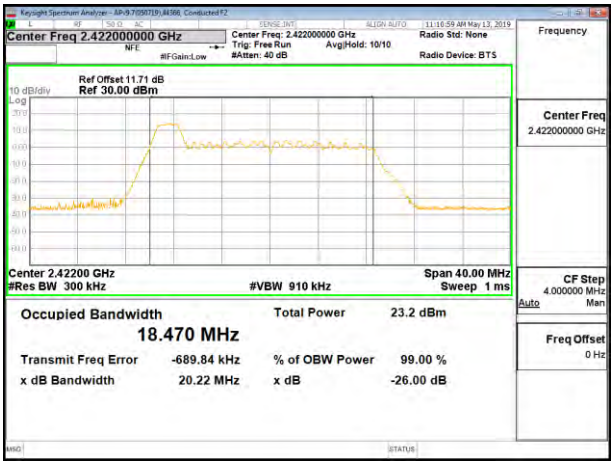


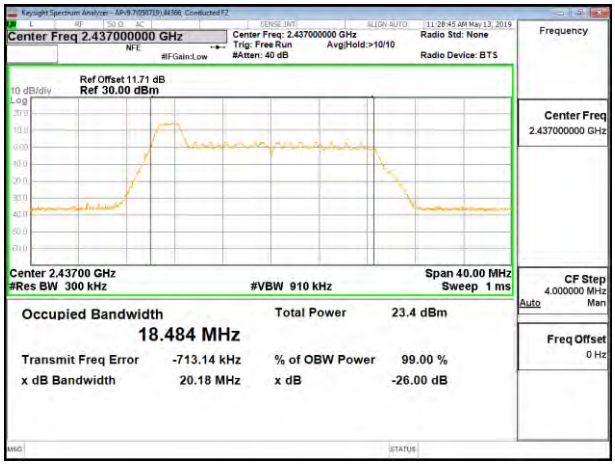
LOW CHANNEL 1



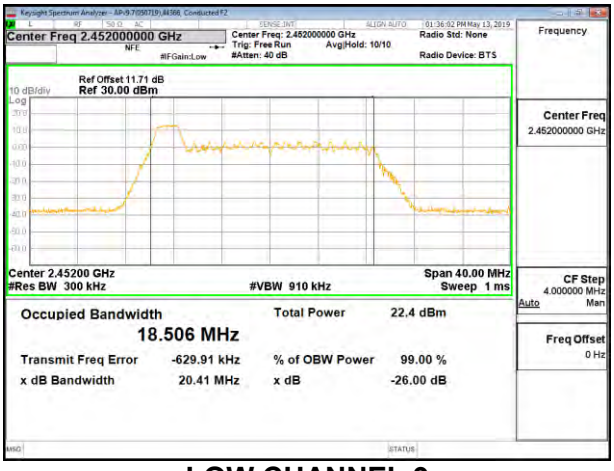
LOW CHANNEL 2



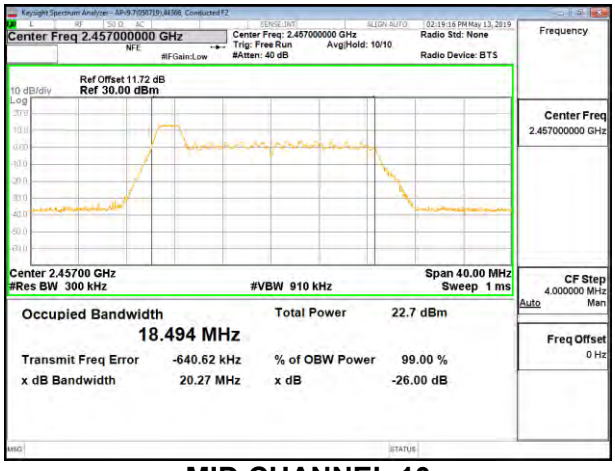
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



MID CHANNEL 10

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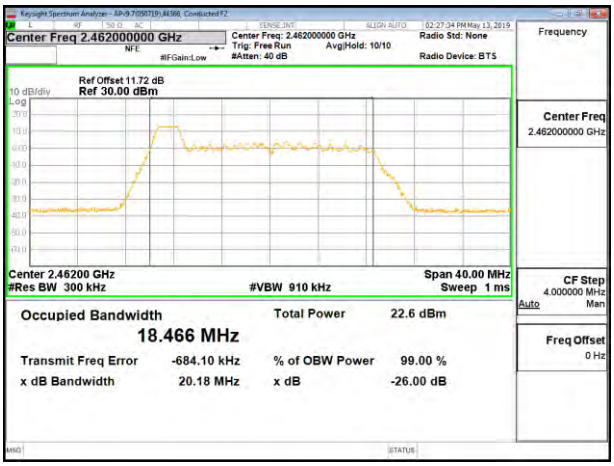
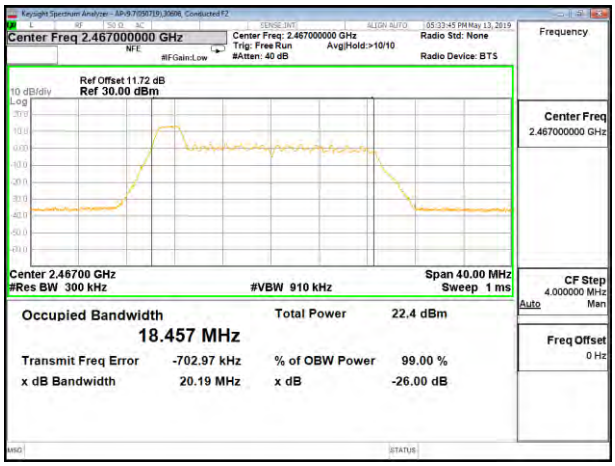
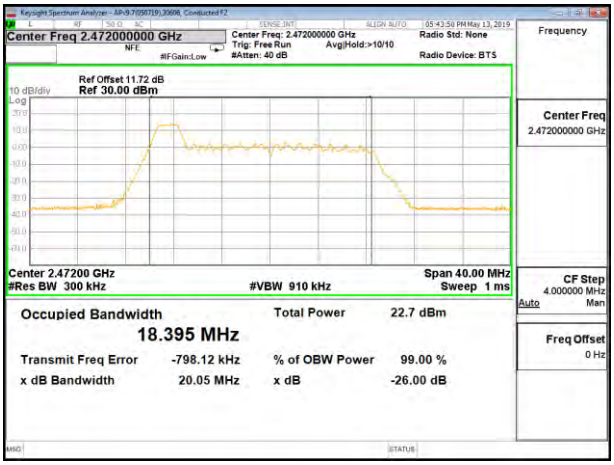


LOW CHANNEL 11



MID CHANNEL 12



HIGH CHANNEL 13

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Antenna 2 LEGACY SISO MODE: 26-Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	17.001
Low 2	2417	17.004
Low 3	2422	17.014
Mid 6	2437	17.215
High 9	2452	17.168
High 10	2457	17.045
High 11	2462	17.061
High 12	2467	17.207
High 13	2472	17.148

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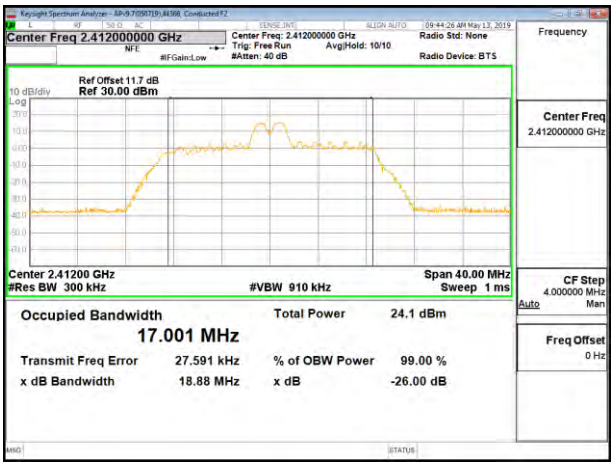
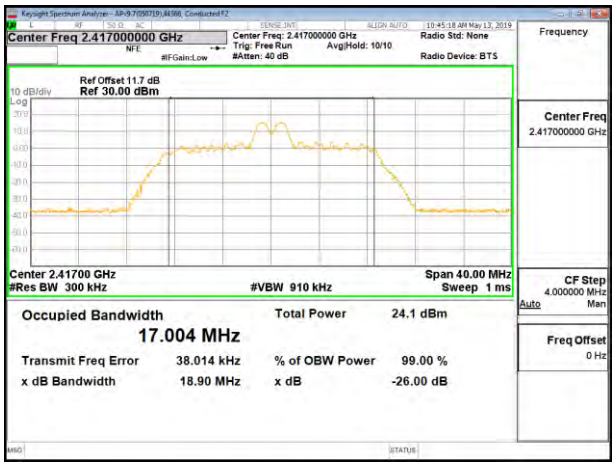
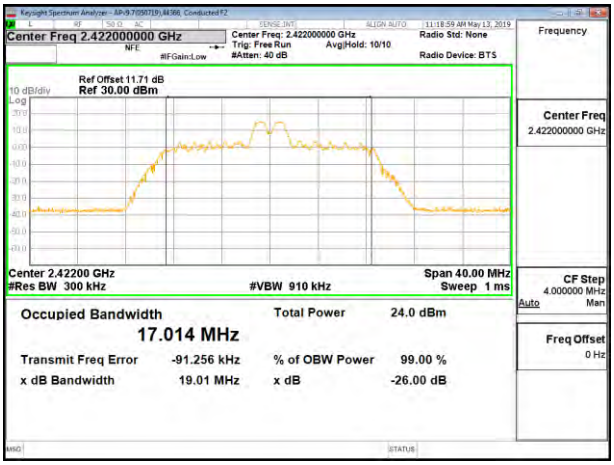


LOW CHANNEL 1



LOW CHANNEL 2



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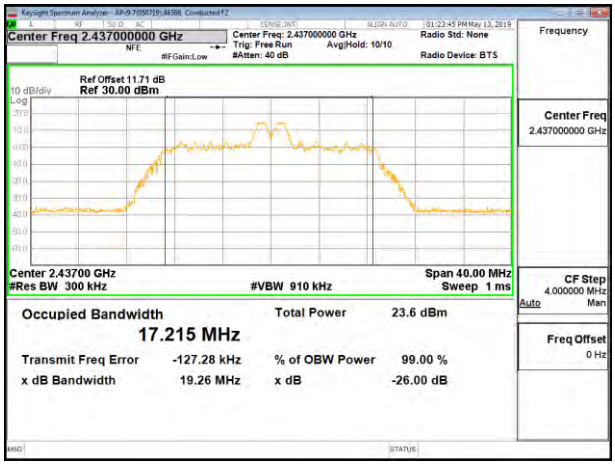

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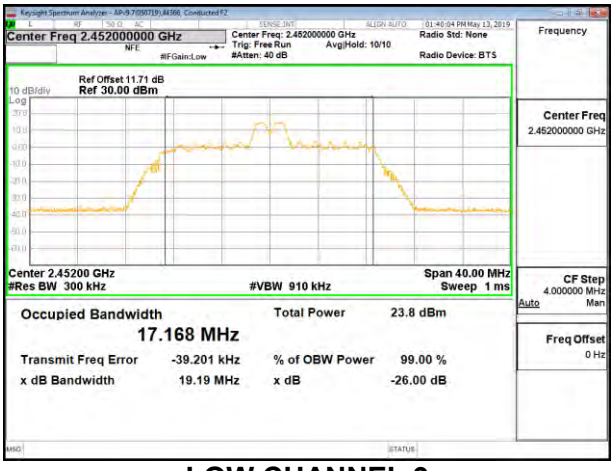
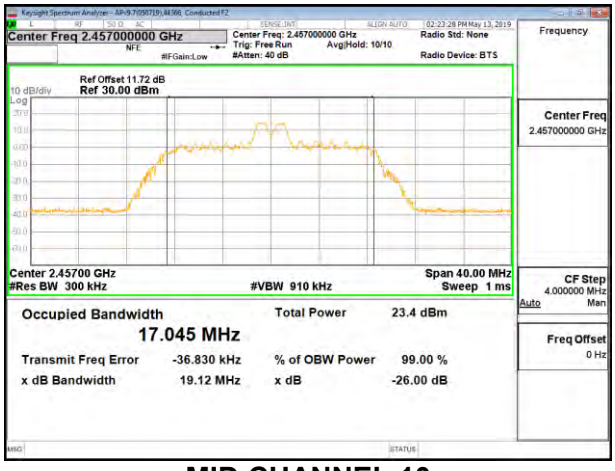


LOW CHANNEL 9



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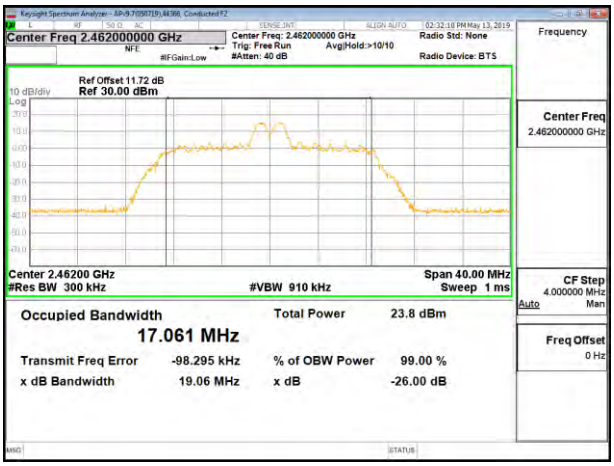

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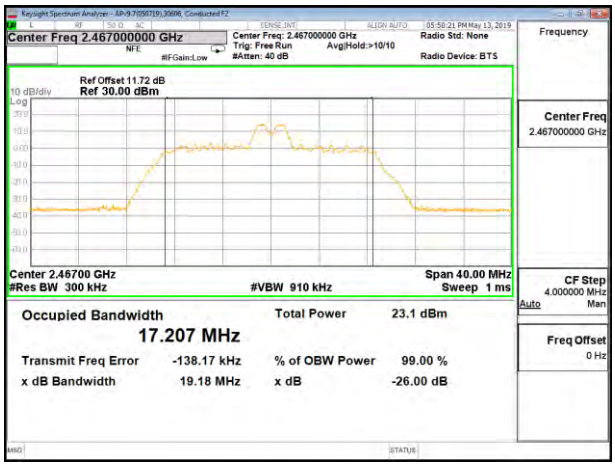

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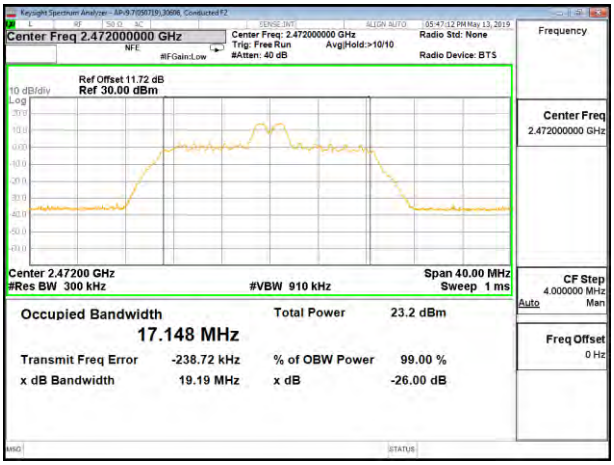

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Antenna 2 LEGACY SISO MODE: 26-Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.495
Low 2	2417	18.519
Low 3	2422	18.624
Mid 6	2437	18.545
High 9	2452	18.663
High 10	2457	18.601
High 11	2462	18.590
High 12	2467	18.803
High 13	2472	18.915

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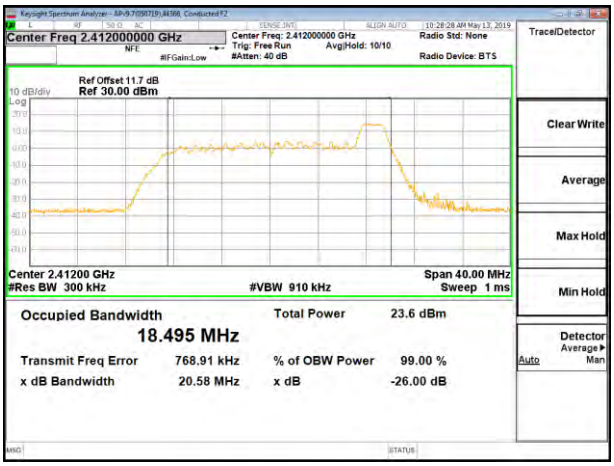

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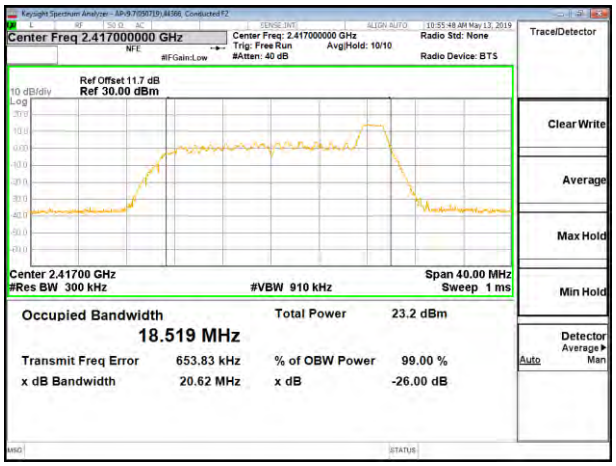
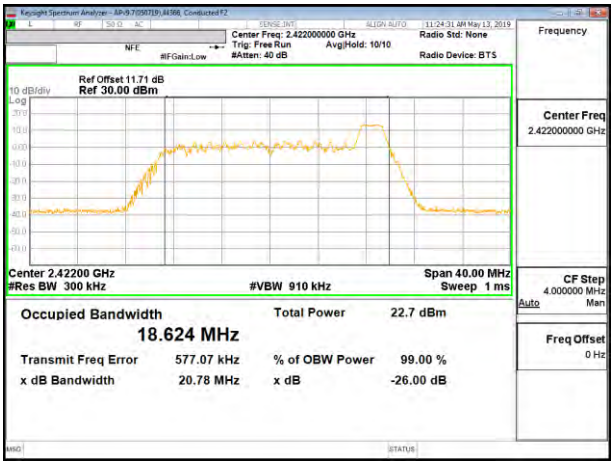
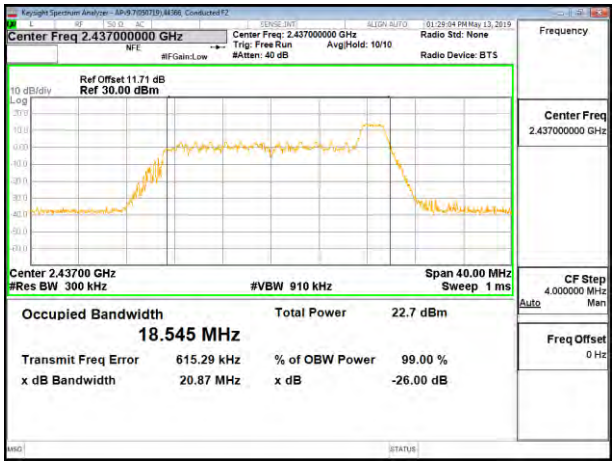


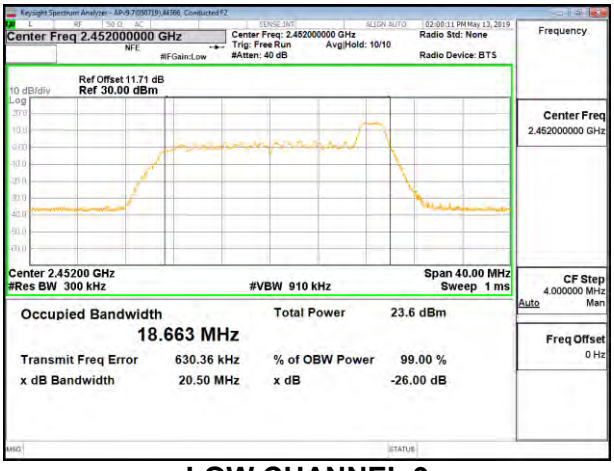
LOW CHANNEL 2



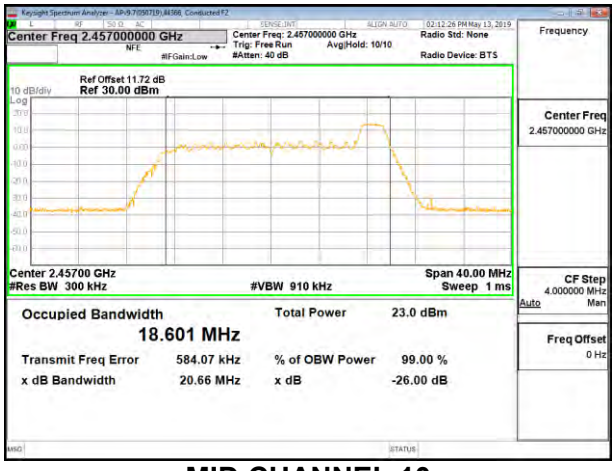
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



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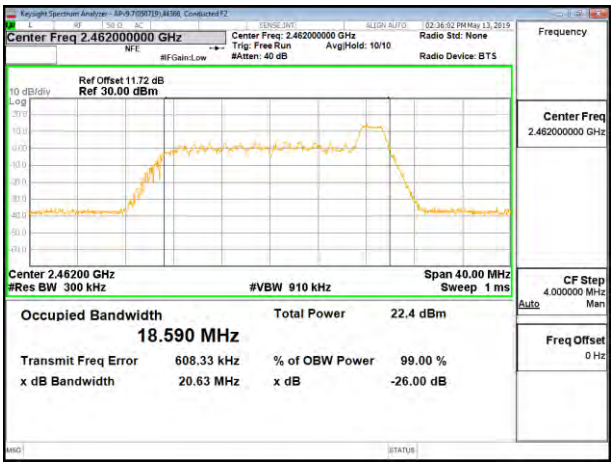
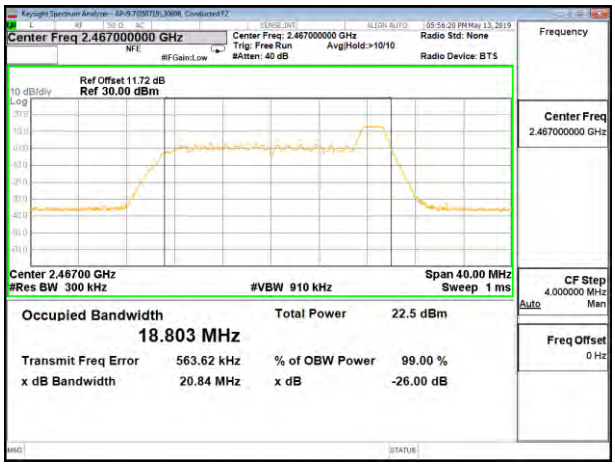


LOW CHANNEL 11



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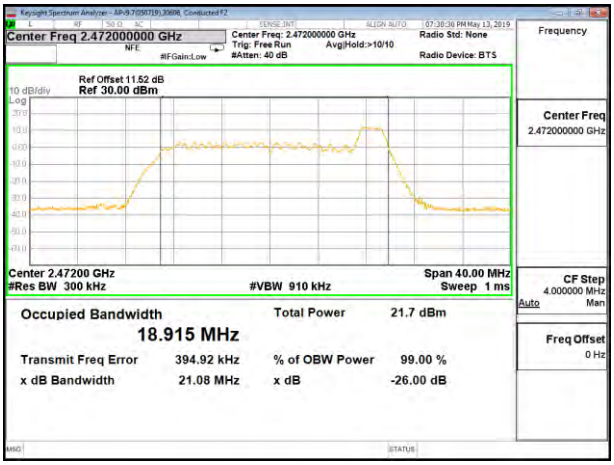

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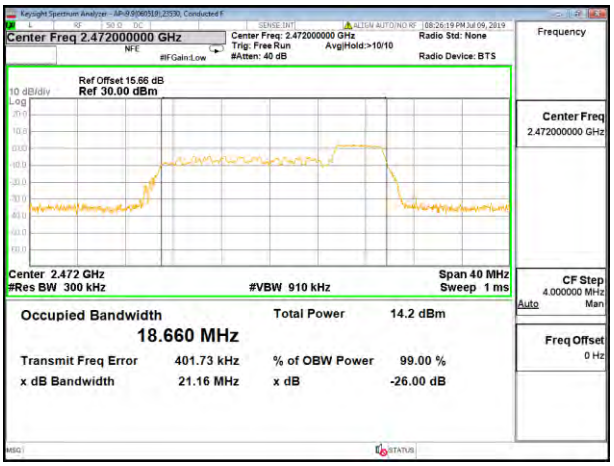
Antenna 2 LEGACY SISO MODE: 52-Tones, RU Index 40

Channel	Frequency (MHz)	99% Bandwidth (MHz)
High 13	2472	18.660



HIGH CHANNEL 13

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Antenna 2 LEGACY SISO MODE: 242-Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.891
Low 2	2417	18.989
Low 3	2422	19.002
Mid 6	2437	19.118
High 9	2452	19.064
High 10	2457	18.997
High 11	2462	19.036
High 12	2467	19.055
High 13	2472	18.906

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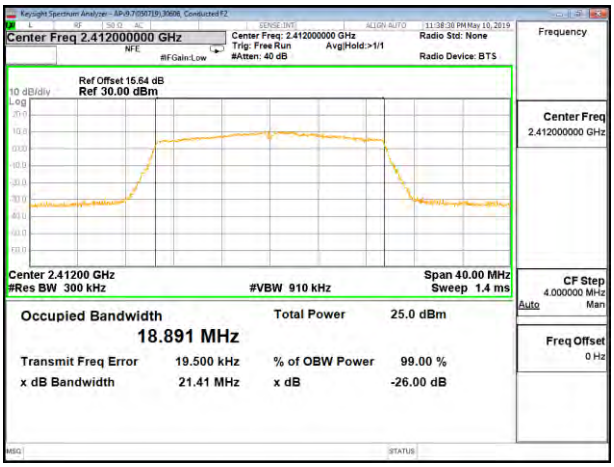
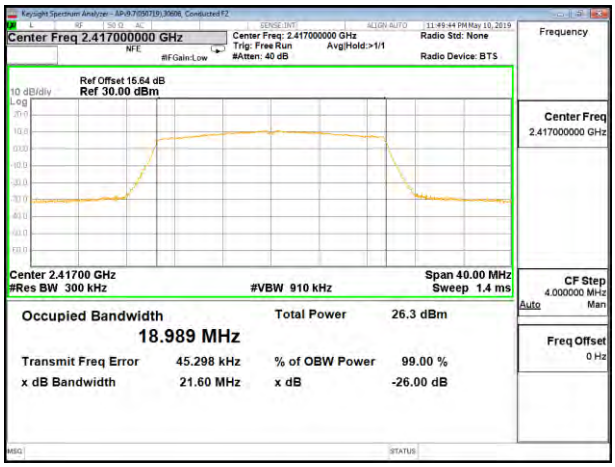
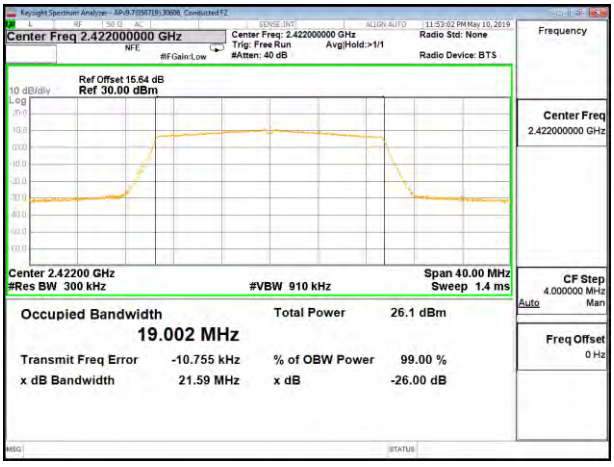


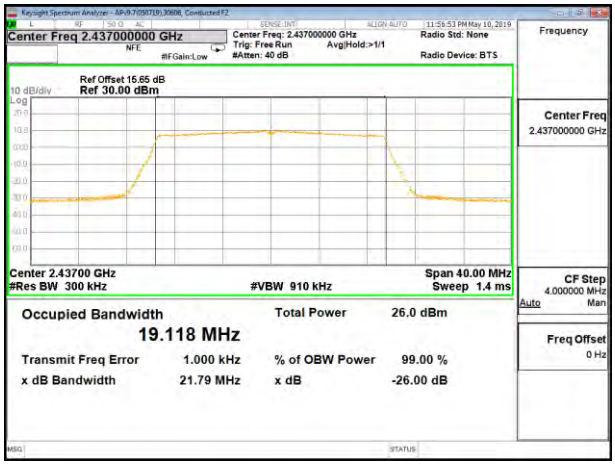
LOW CHANNEL 1



LOW CHANNEL 2



LOW CHANNEL 3



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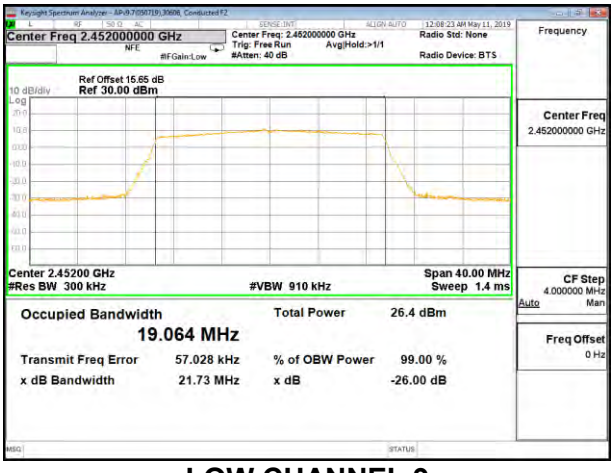
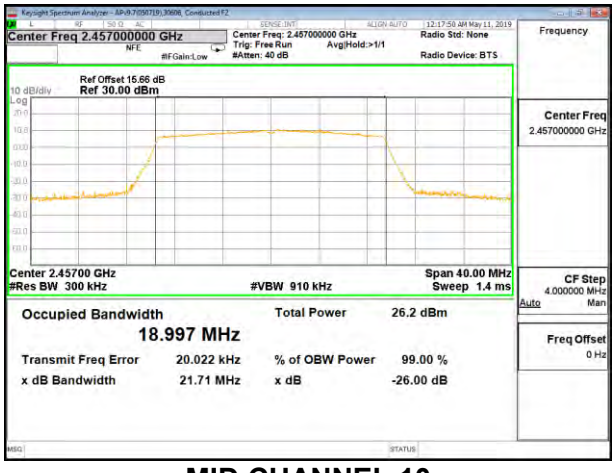


LOW CHANNEL 9



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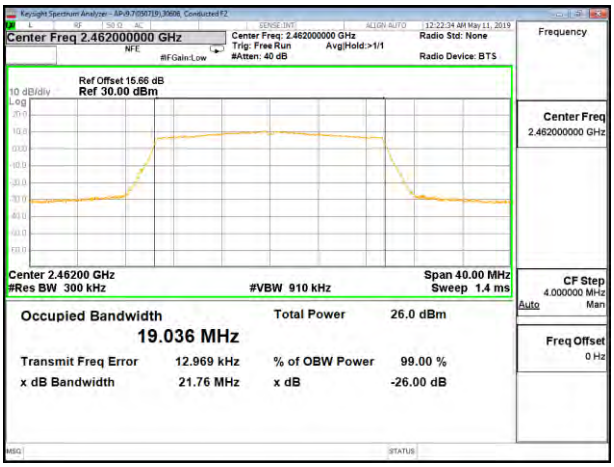
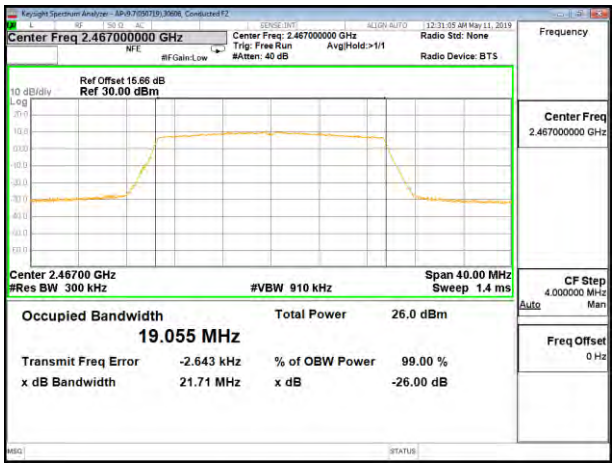


LOW CHANNEL 11



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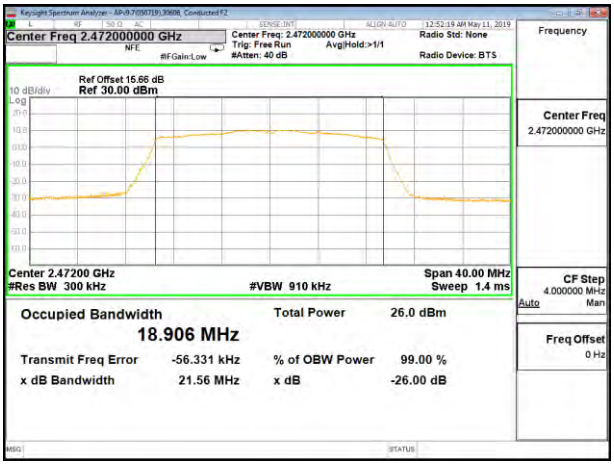

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Antenna 5 LEGACY SISO MODE: 26-Tones, RU Index 0

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.523
Low 2	2417	18.501
Low 3	2422	18.498
Mid 6	2437	18.467
High 9	2452	18.538
High 10	2457	18.507
High 11	2462	18.480
High 12	2467	18.356
High 13	2472	18.200

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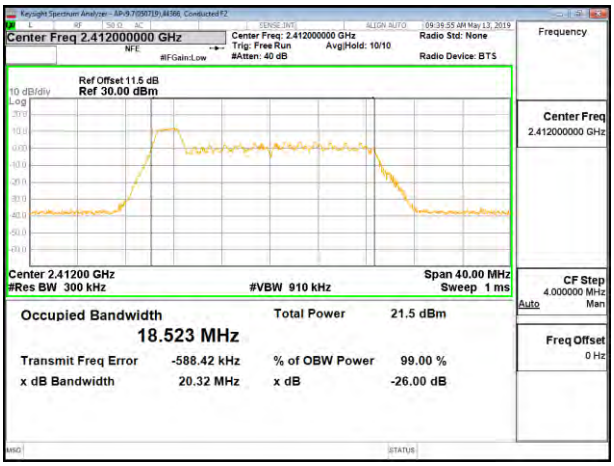

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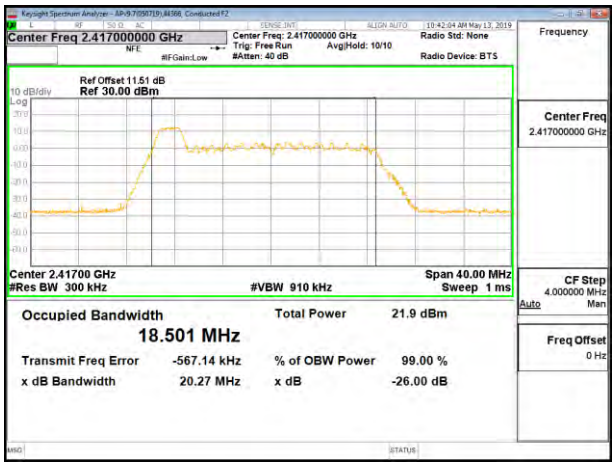
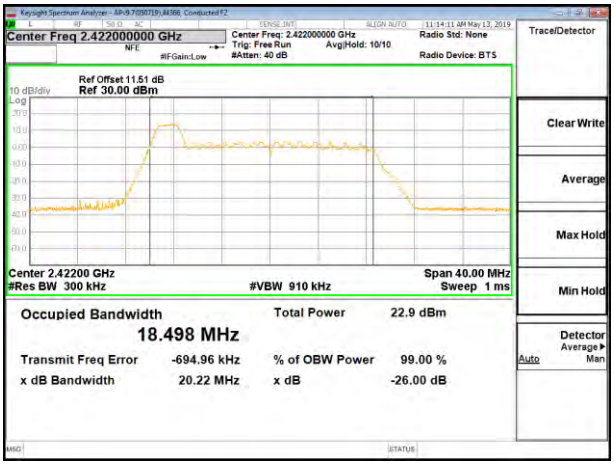
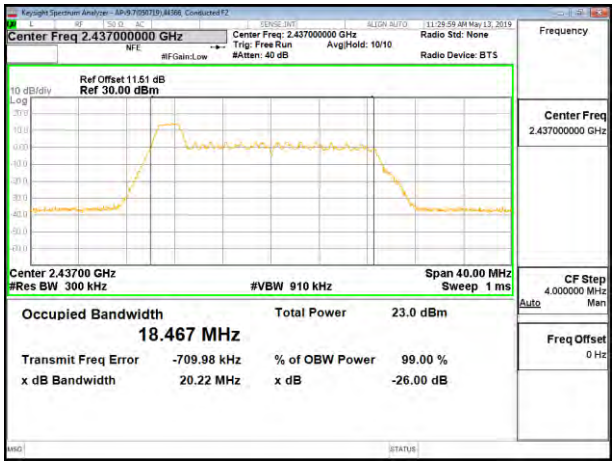


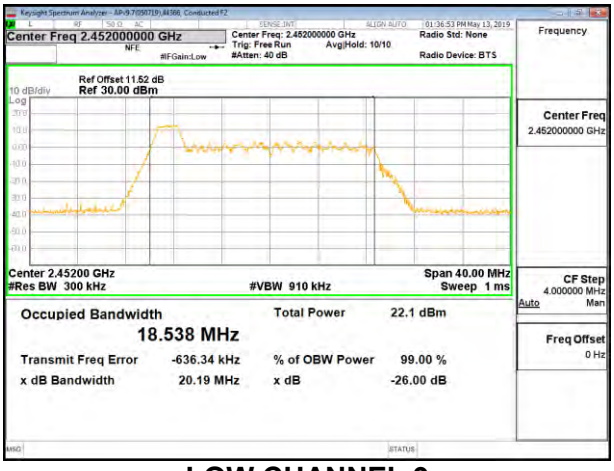
LOW CHANNEL 2



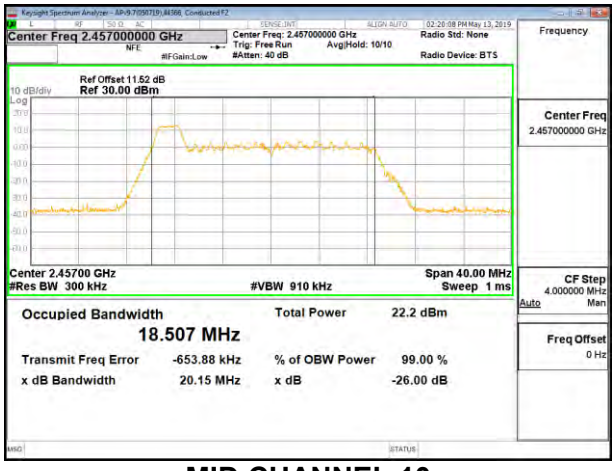
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



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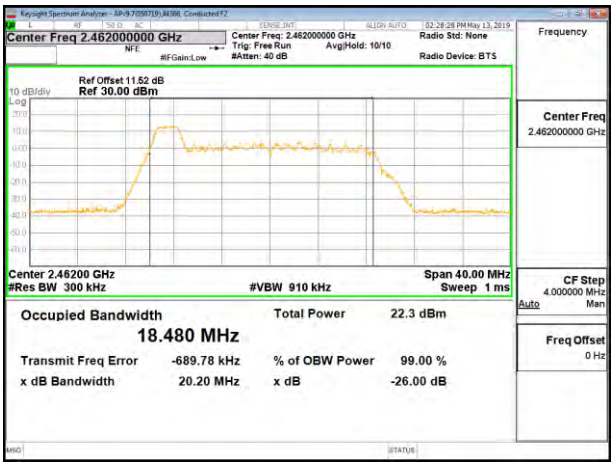
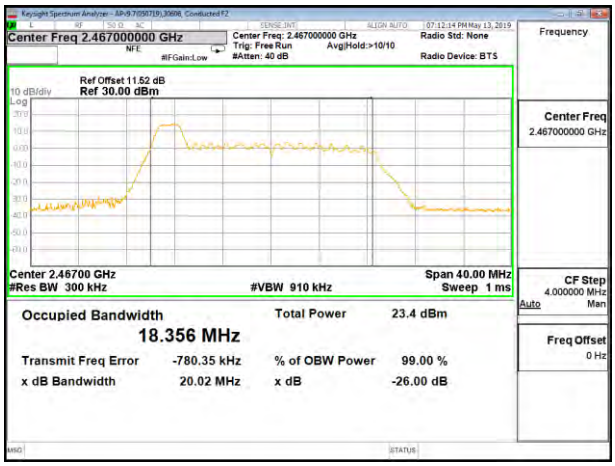


LOW CHANNEL 11



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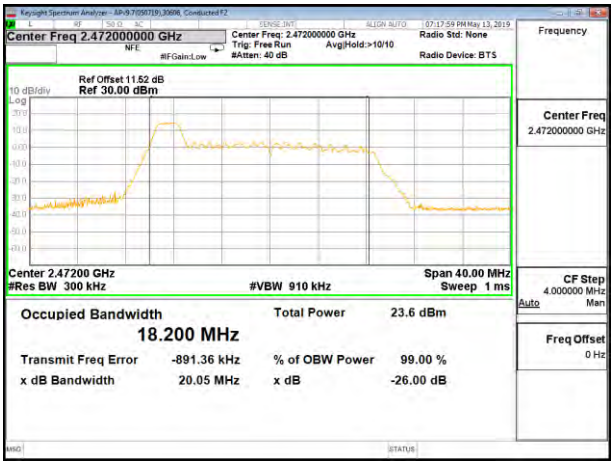

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Antenna 5 LEGACY SISO MODE: 26-Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	17.014
Low 2	2417	17.010
Low 3	2422	17.283
Mid 6	2437	17.045
High 9	2452	17.122
High 10	2457	17.008
High 11	2462	17.036
High 12	2467	17.113
High 13	2472	17.024

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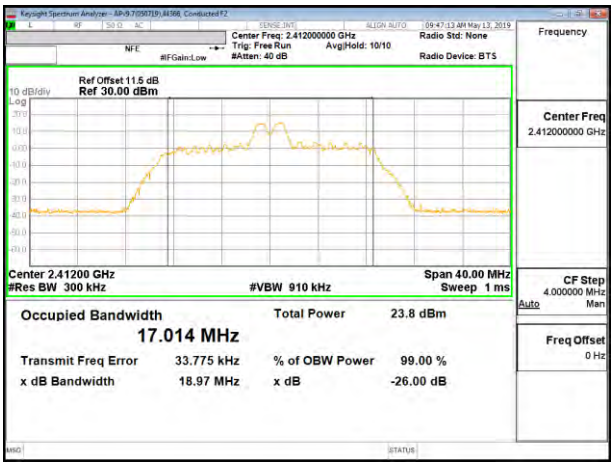
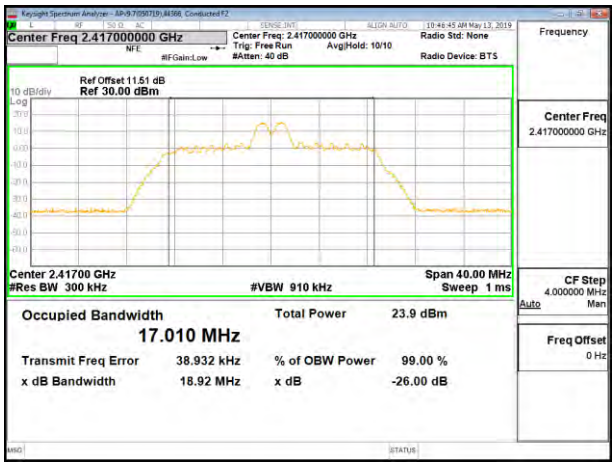
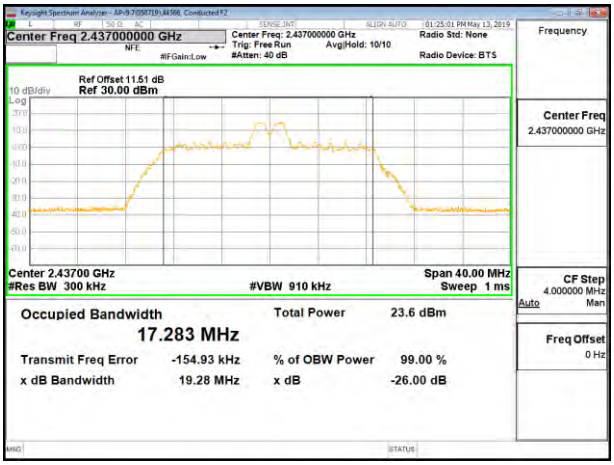


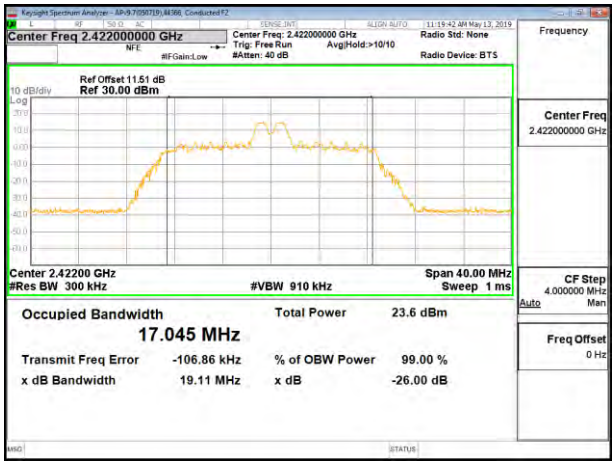
LOW CHANNEL 1



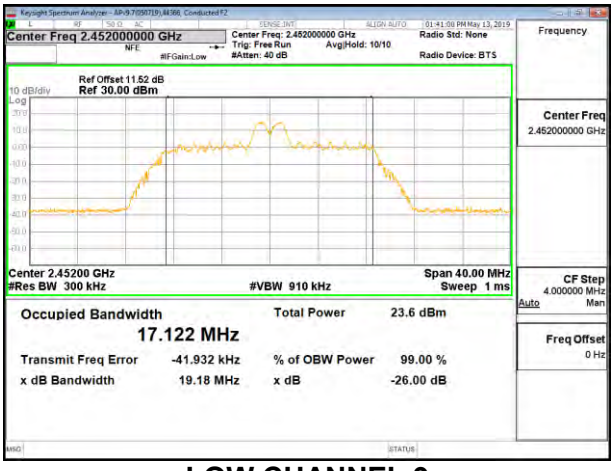
LOW CHANNEL 2



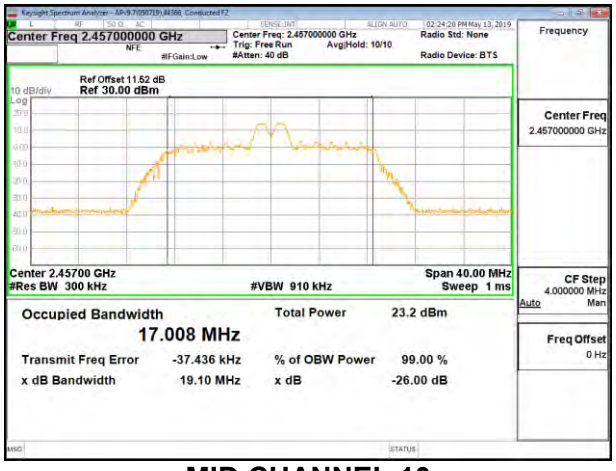
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



MID CHANNEL 10

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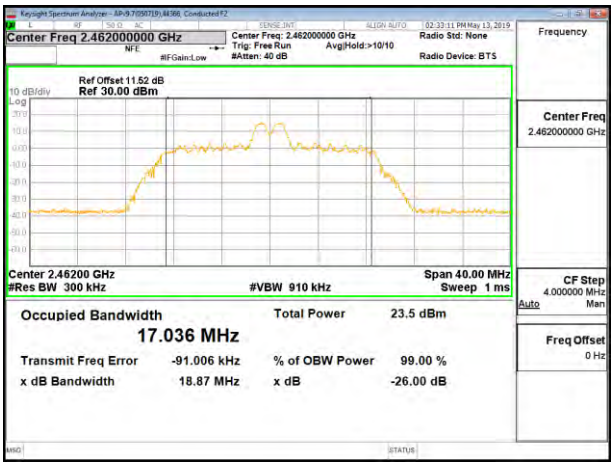
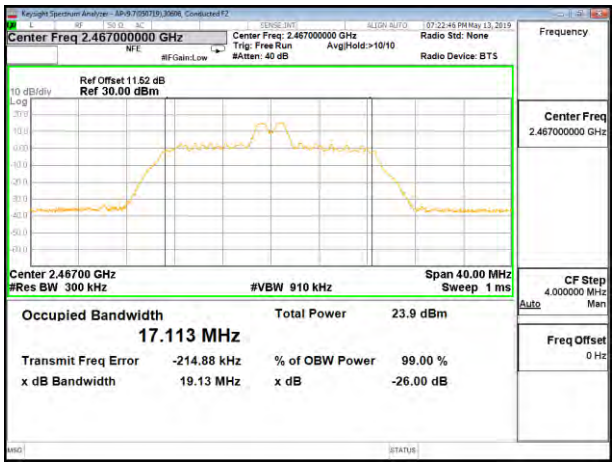
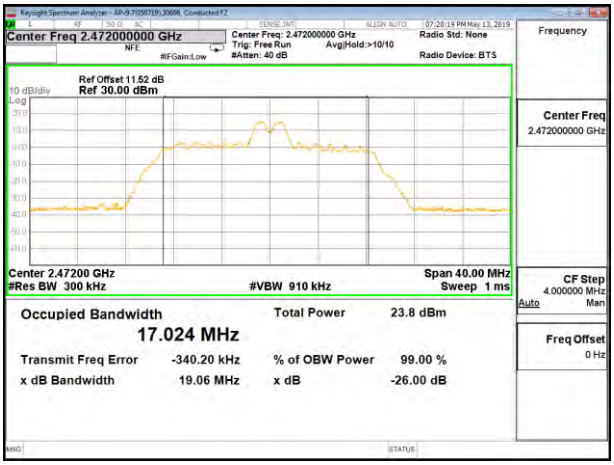


LOW CHANNEL 11



MID CHANNEL 12



HIGH CHANNEL 13

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Antenna 5 LEGACY SISO MODE: 26-Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.506
Low 2	2417	18.542
Low 3	2422	18.648
Mid 6	2437	18.584
High 9	2452	18.628
High 10	2457	18.575
High 11	2462	18.521
High 12	2467	18.853
High 13	2472	18.915

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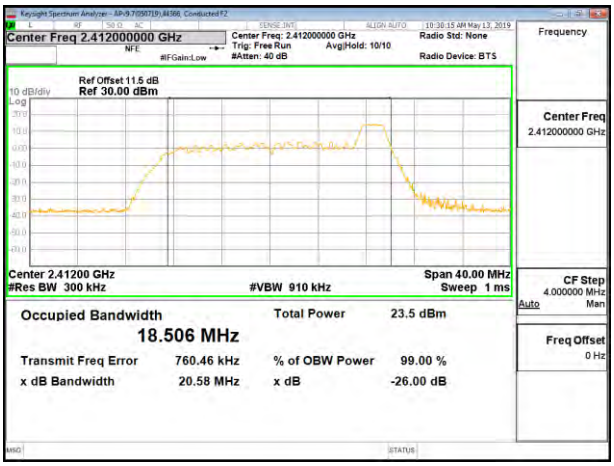
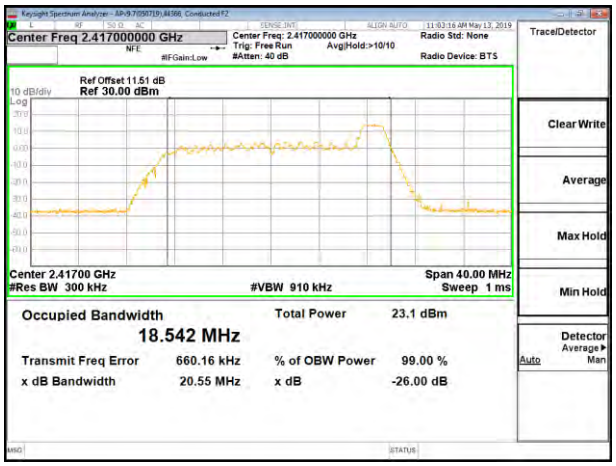


LOW CHANNEL 1



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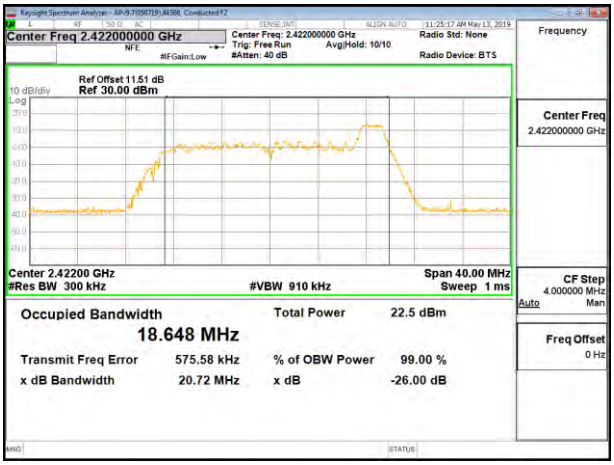
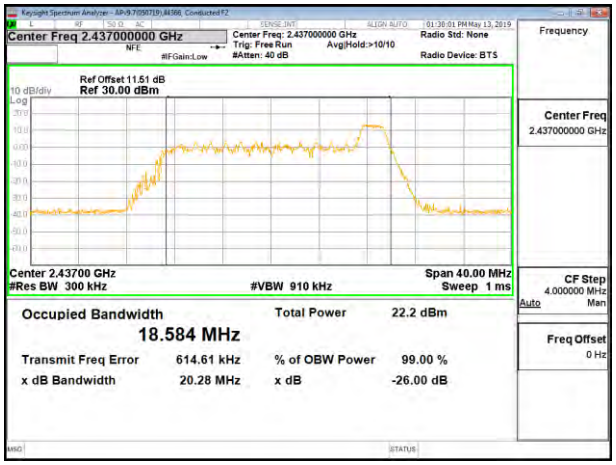
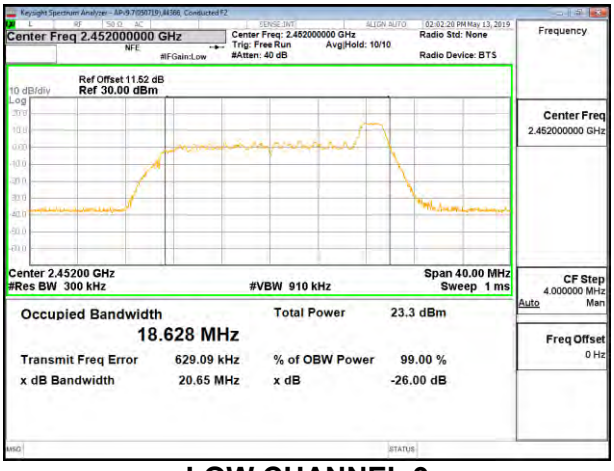


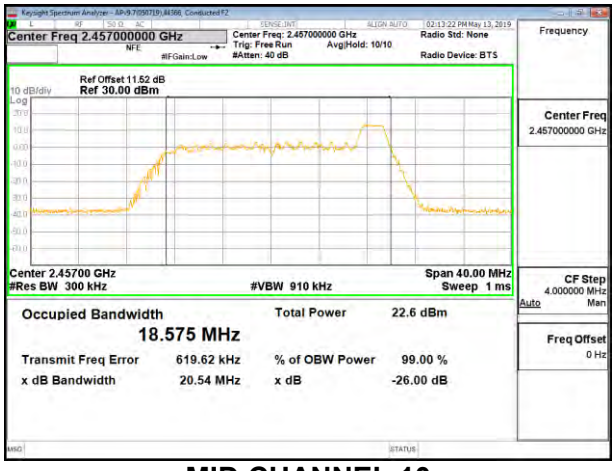
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



MID CHANNEL 10

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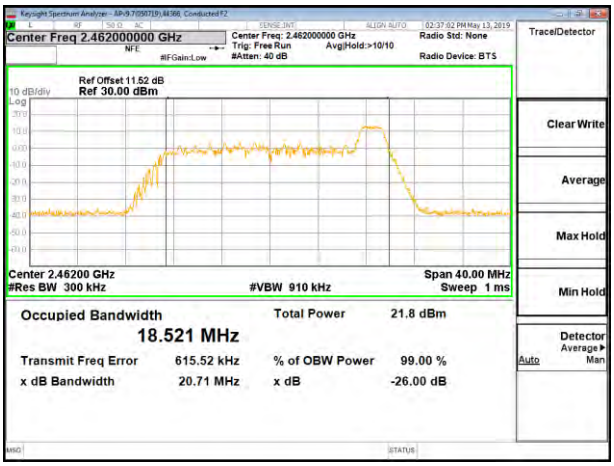
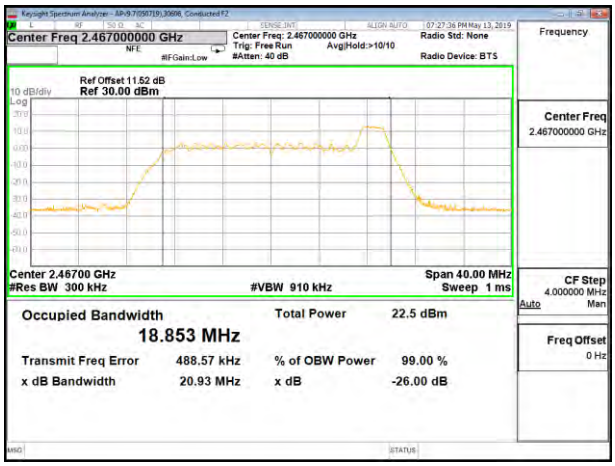
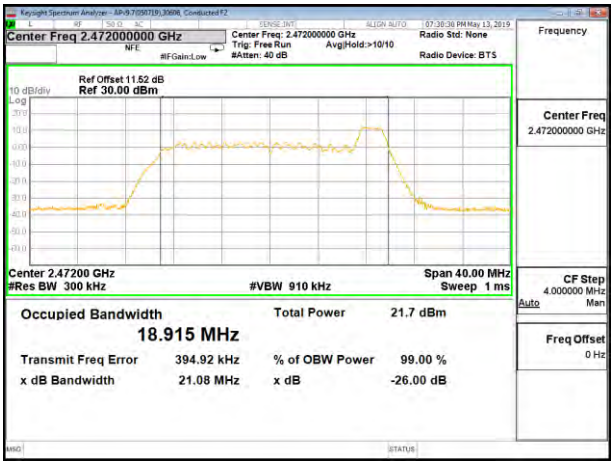


LOW CHANNEL 11



MID CHANNEL 12



HIGH CHANNEL 13

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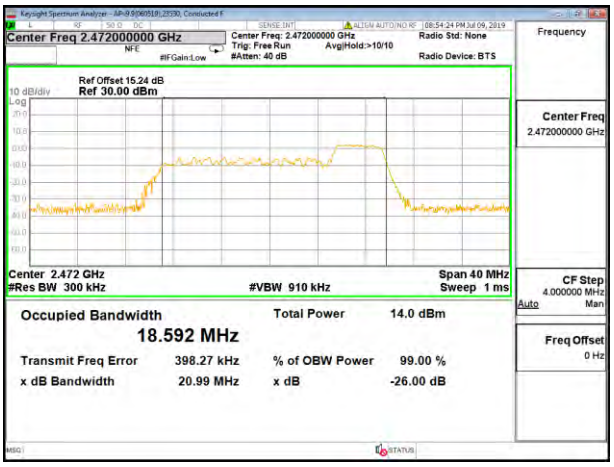
Antenna 5 LEGACY SISO MODE: 52-Tones, RU Index 40

Channel	Frequency (MHz)	99% Bandwidth (MHz)
High 13	2472	18.592



HIGH CHANNEL 13

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Antenna 5 LEGACY SISO MODE: 242-Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	18.938
Low 2	2417	18.996
Low 3	2422	18.994
Mid 6	2437	19.090
High 9	2452	19.050
High 10	2457	19.025
High 11	2462	19.004
High 12	2467	18.981
High 13	2472	18.908

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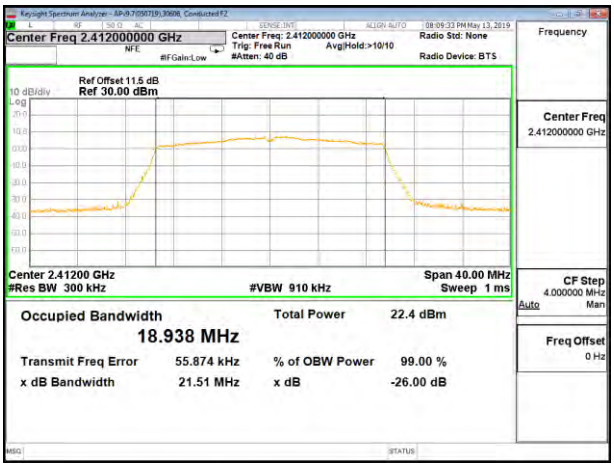
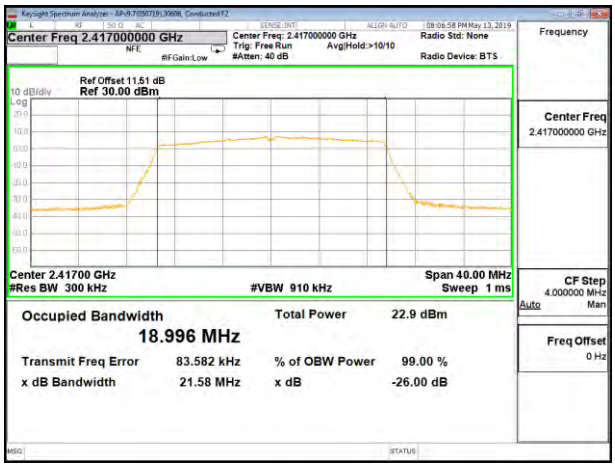
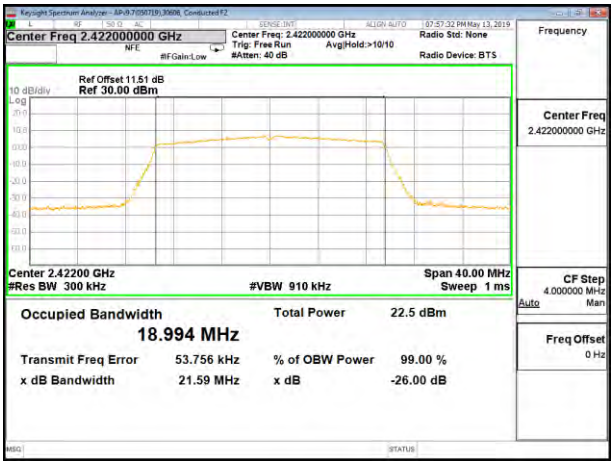


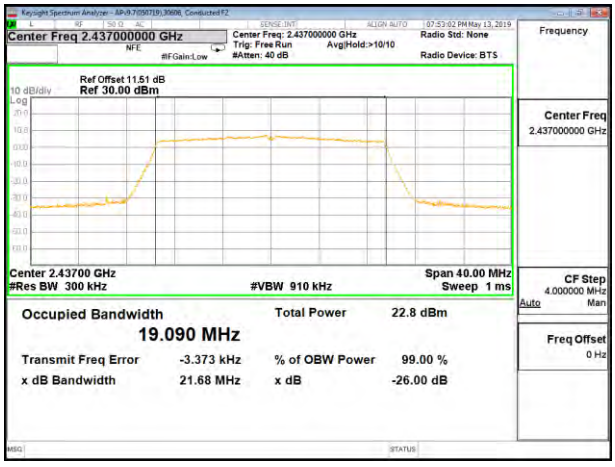
LOW CHANNEL 1



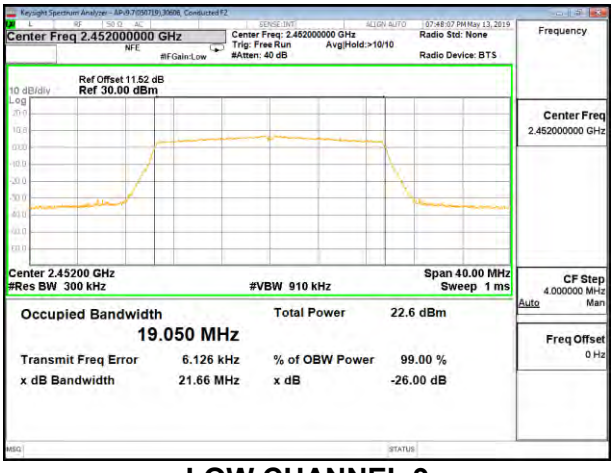
LOW CHANNEL 2



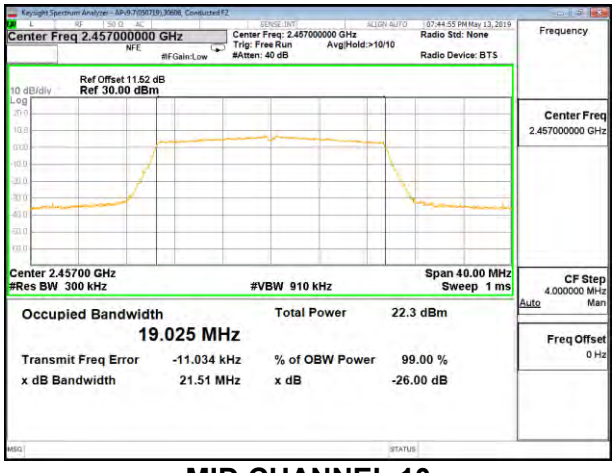
LOW CHANNEL 3



MID CHANNEL 6



LOW CHANNEL 9



MID CHANNEL 10

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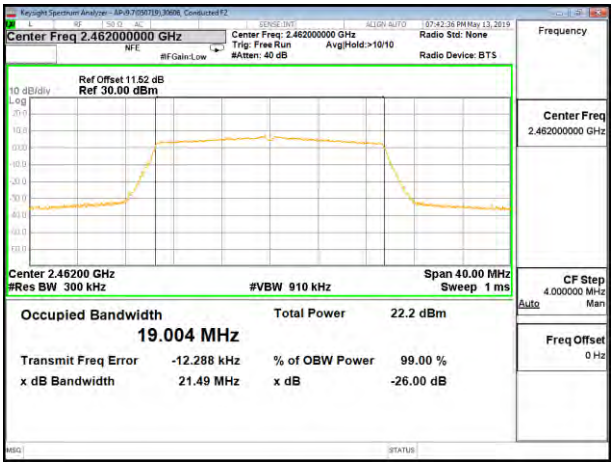
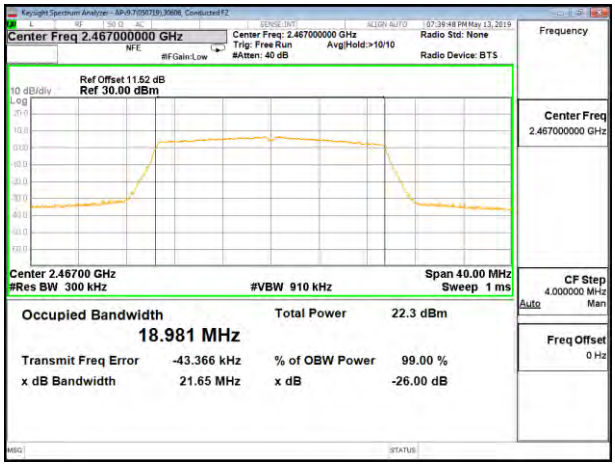
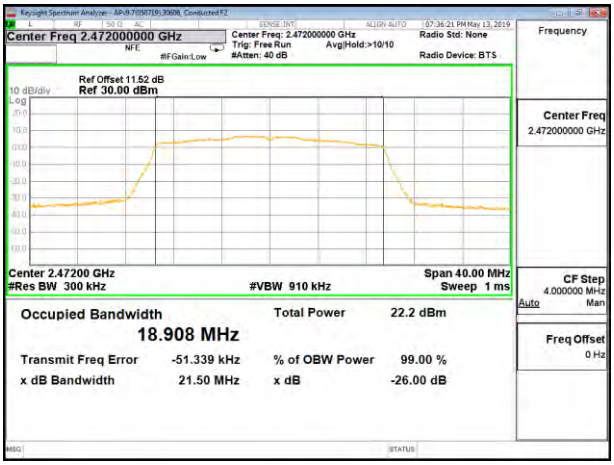


LOW CHANNEL 11



MID CHANNEL 12



HIGH CHANNEL 13

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8.2.5. 802.11ax HE20 OFDMA MODE 2TX

Antenna 2 + Antenna 5 2TX MODE: 26-Tones, RU Index 0

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
Low 1	2412	18.526	18.506
Low 2	2417	18.510	18.507
Low 3	2422	18.473	18.451
Mid 6	2437	18.476	18.471
High 10	2457	18.491	18.494
High 11	2462	18.473	18.481
High 12	2467	18.468	18.096
High 13	2472	18.078	17.866

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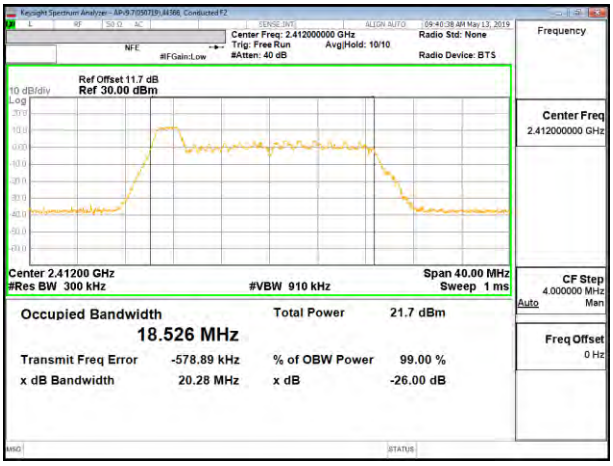
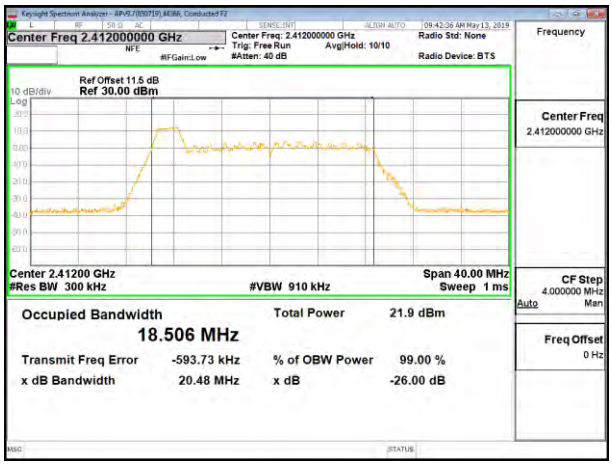
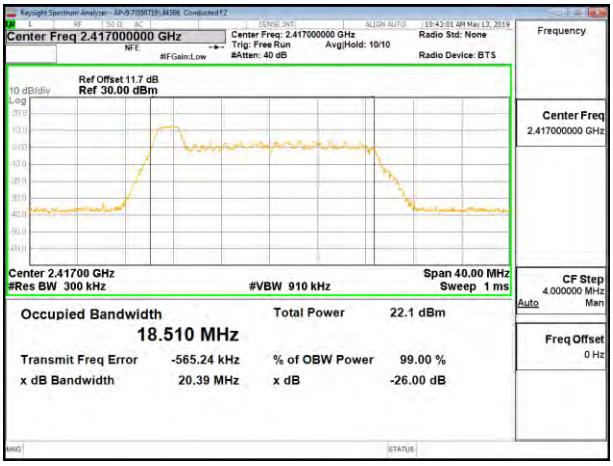


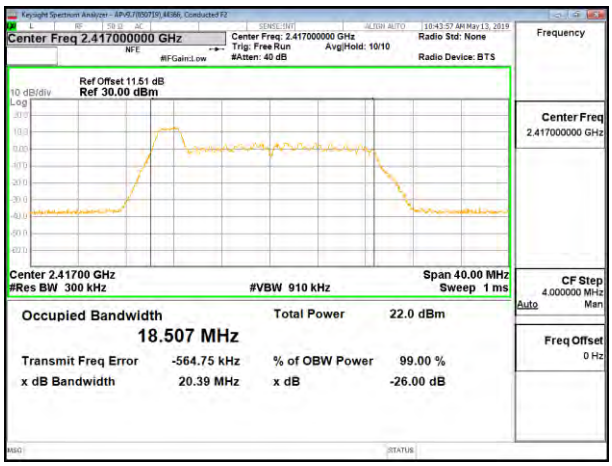
LOW CHANNEL 1 ANT 2



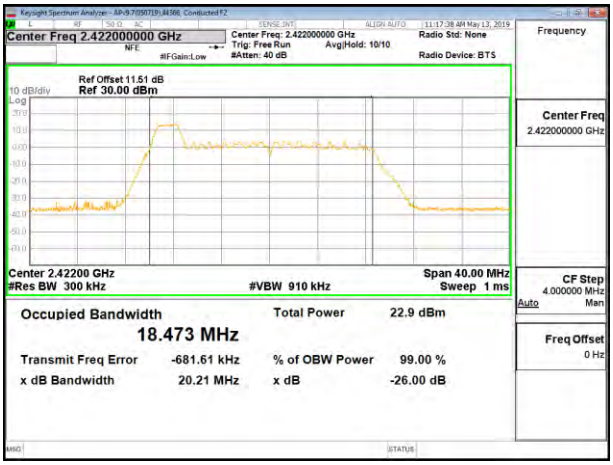
LOW CHANNEL 1 ANT 5



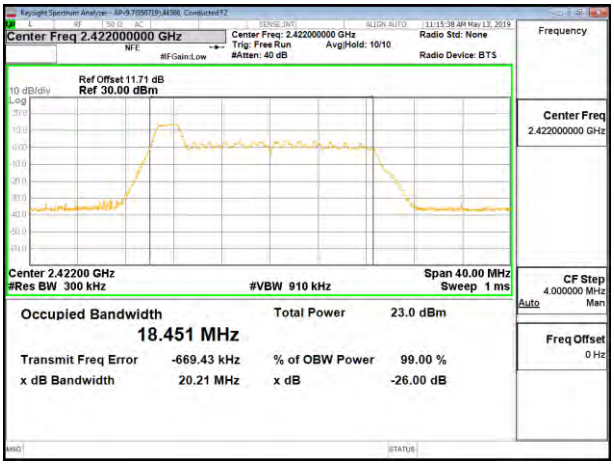
LOW CHANNEL 2 ANT 2



LOW CHANNEL 2 ANT 5



LOW CHANNEL 3 ANT 2



LOW CHANNEL 3 ANT 5

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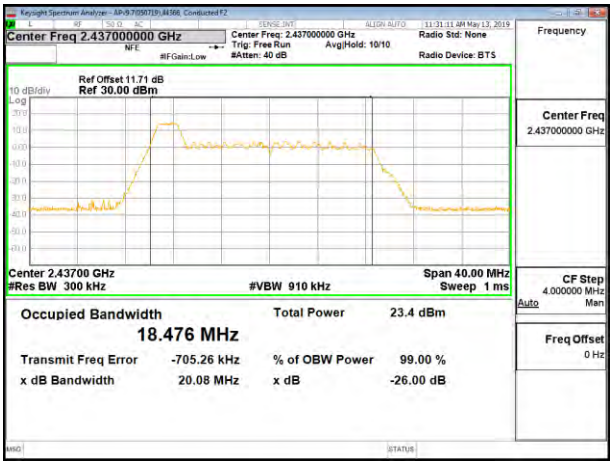
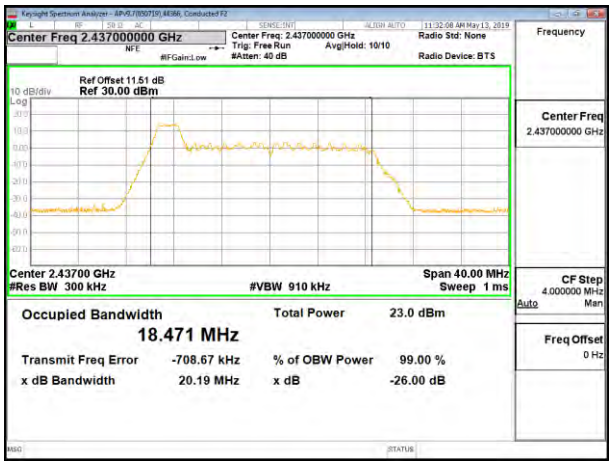
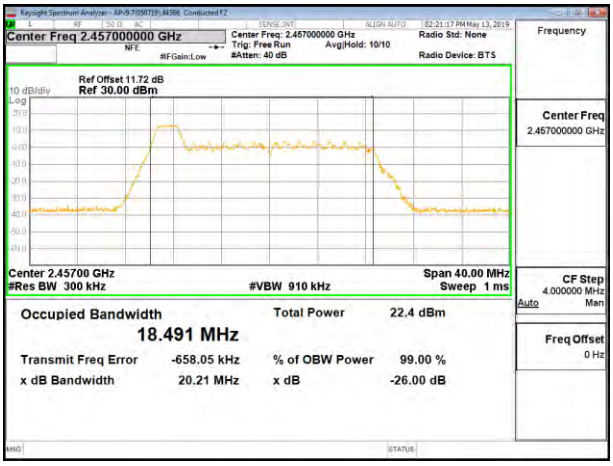


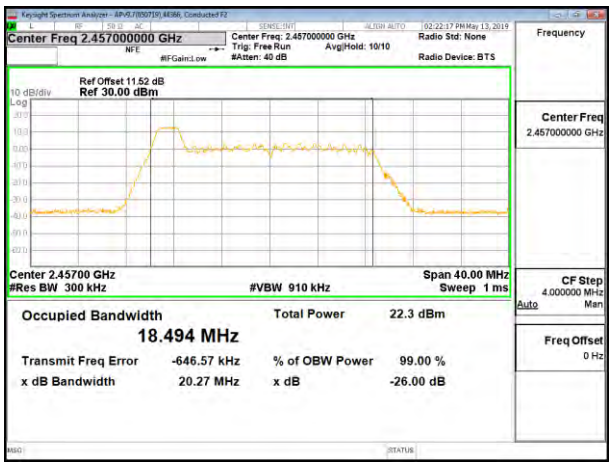
MID CHANNEL 6 ANT 2



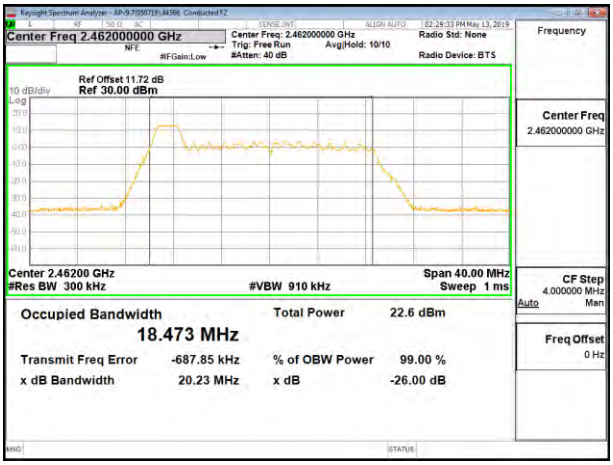
MID CHANNEL 6 ANT 5



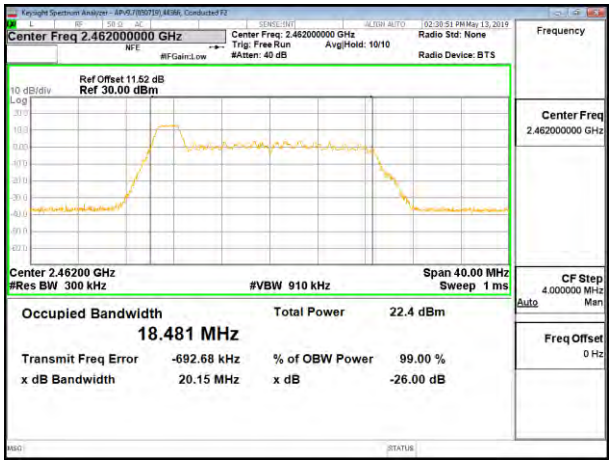
HIGH CHANNEL 10 ANT 2



HIGH CHANNEL 10 ANT 5



HIGH CHANNEL 11 ANT 2



HIGH CHANNEL 11 ANT 5

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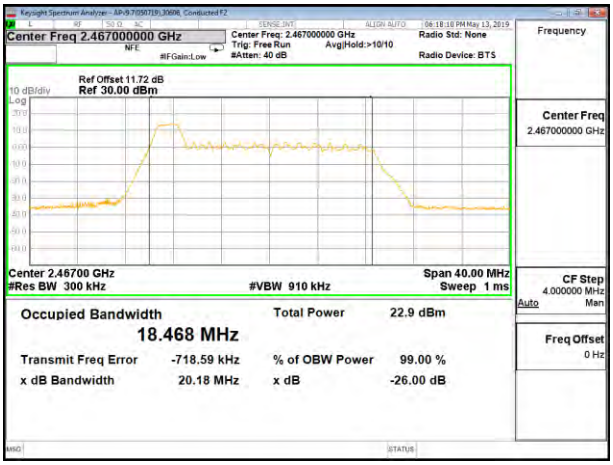
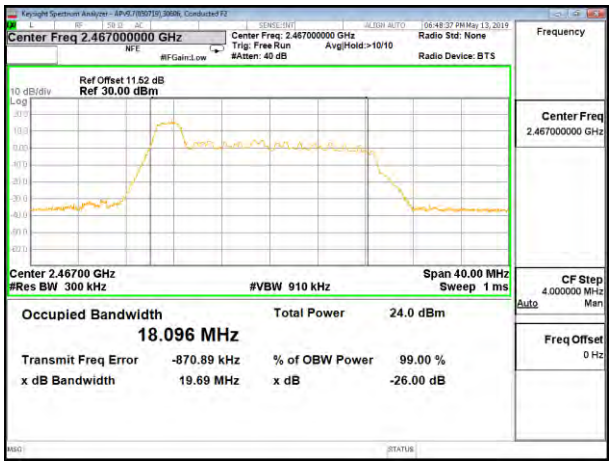
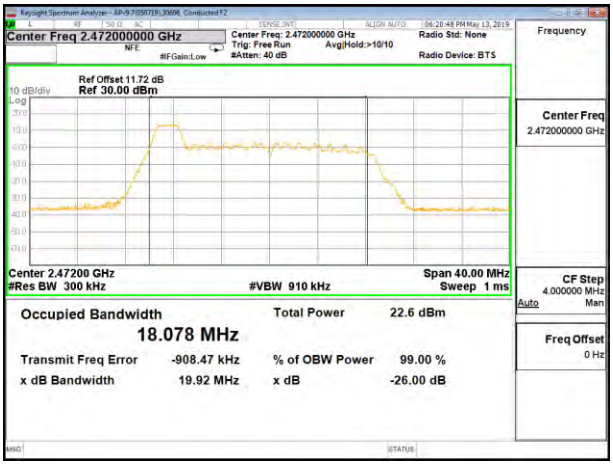


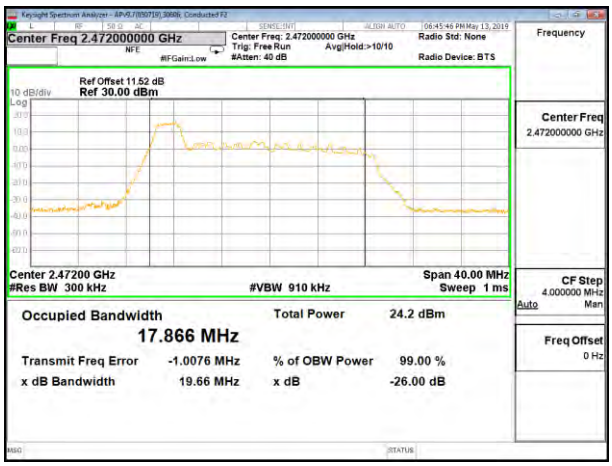
HIGH CHANNEL 12 ANT 2



HIGH CHANNEL 12 ANT 5



HIGH CHANNEL 13 ANT 2



HIGH CHANNEL 13 ANT 5

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Antenna 2 + Antenna 5 2TX MODE: 26-Tones, RU Index 4

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
Low 1	2412	17.009	17.020
Low 2	2417	16.990	17.003
Low 3	2422	17.010	17.044
Mid 6	2437	17.198	17.238
High 10	2457	17.008	17.130
High 11	2462	17.004	17.002
High 12	2467	18.809	17.222
High 13	2472	16.785	16.181

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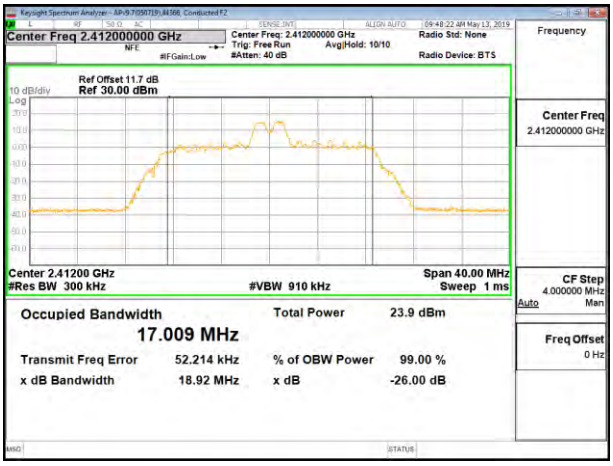
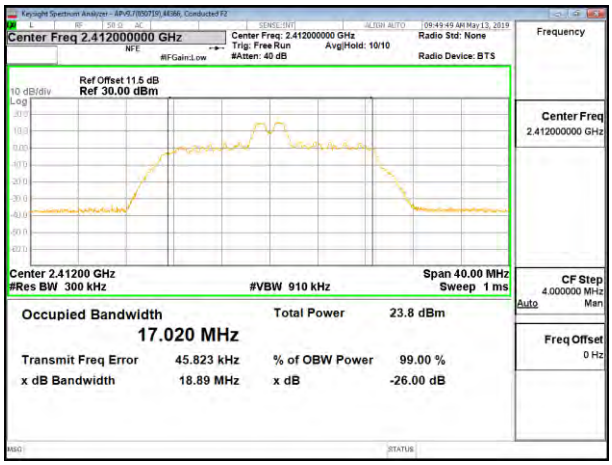
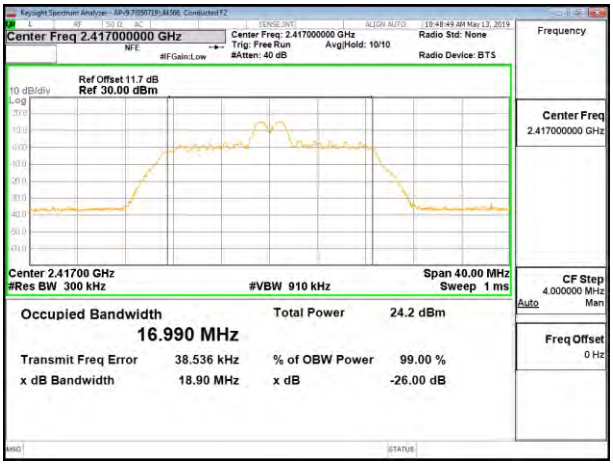


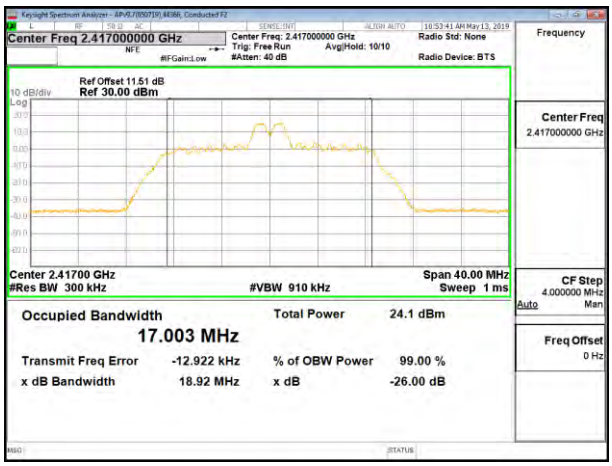
LOW CHANNEL 1 ANT 2



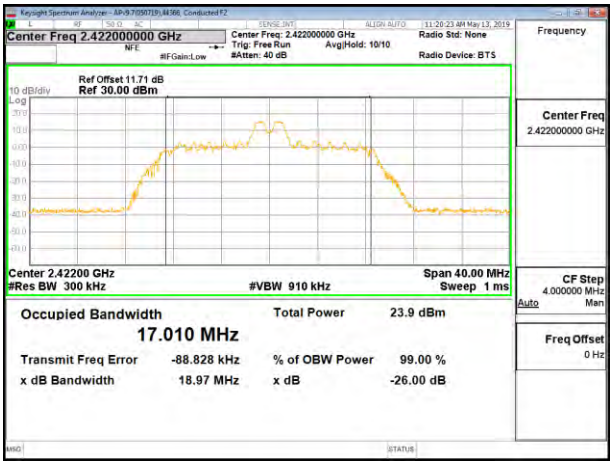
LOW CHANNEL 1 ANT 5



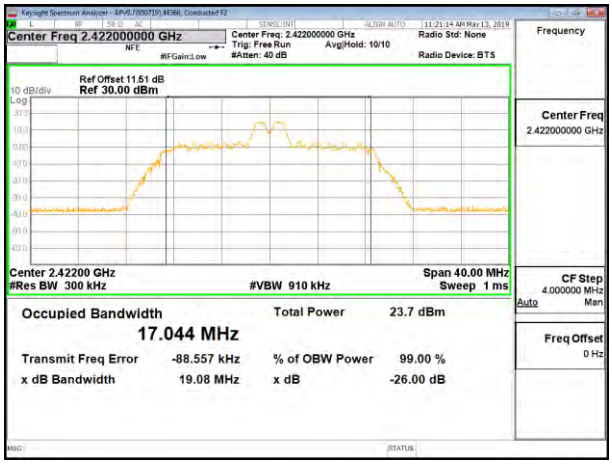
LOW CHANNEL 2 ANT 2



LOW CHANNEL 2 ANT 5



LOW CHANNEL 3 ANT 2



LOW CHANNEL 3 ANT 5

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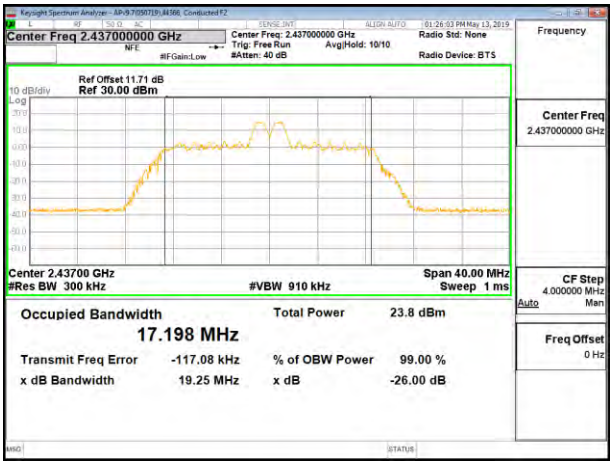
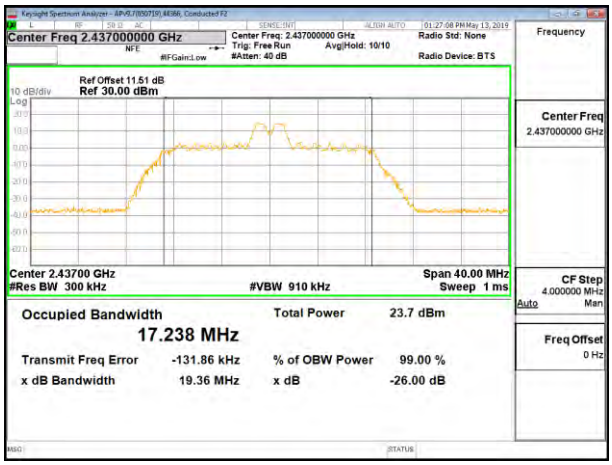
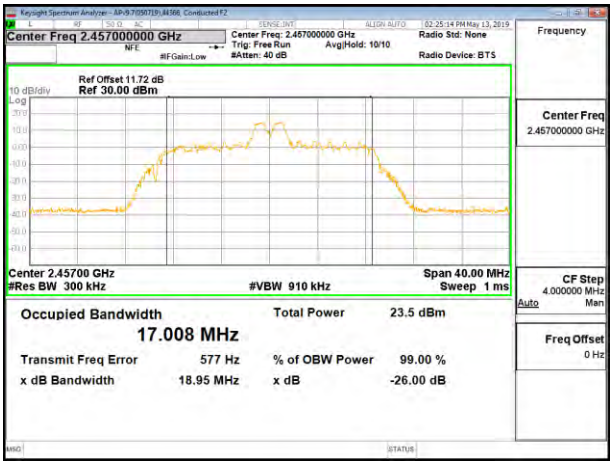


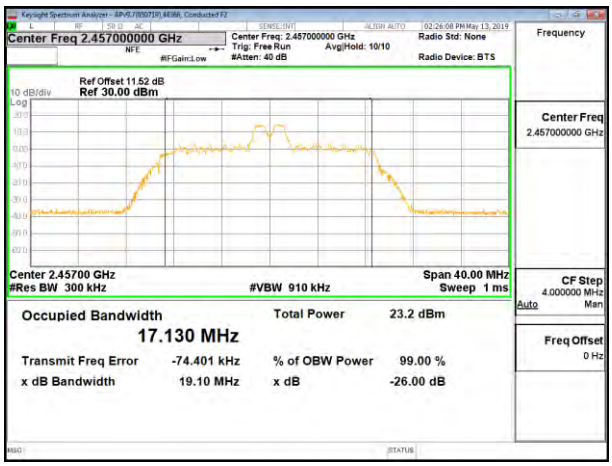
MID CHANNEL 6 ANT 2



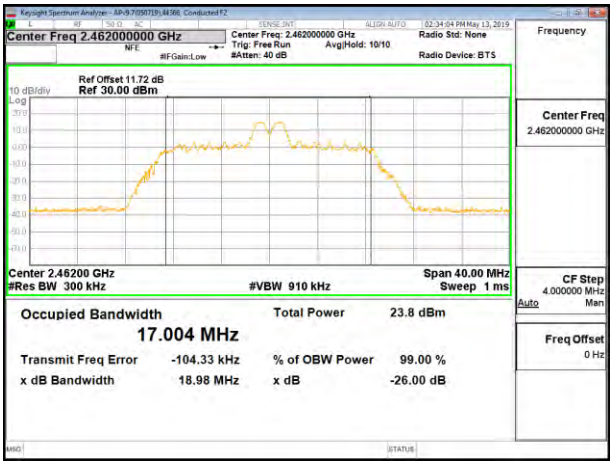
MID CHANNEL 6 ANT 5



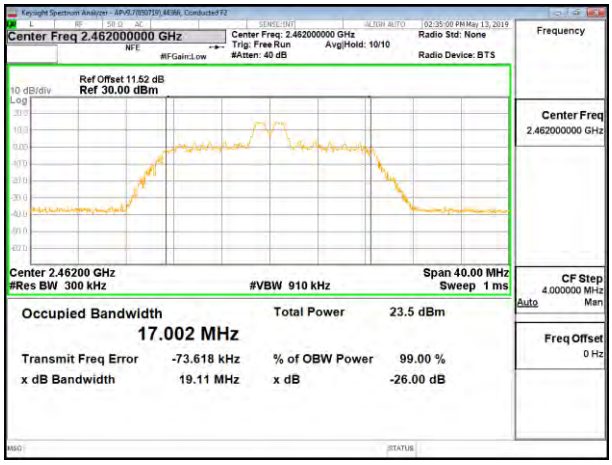
HIGH CHANNEL 10 ANT 2



HIGH CHANNEL 10 ANT 5



HIGH CHANNEL 11 ANT 2



HIGH CHANNEL 11 ANT 5

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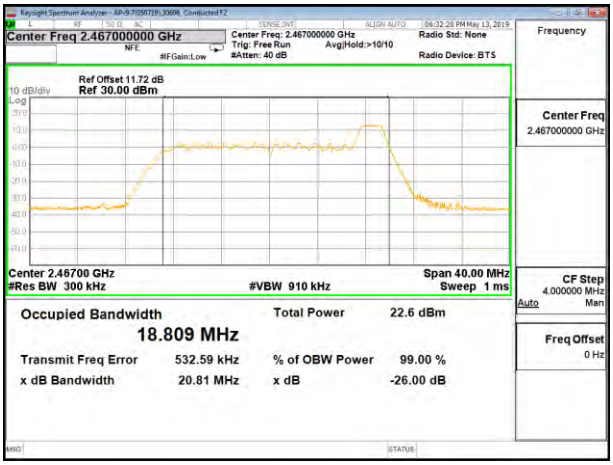
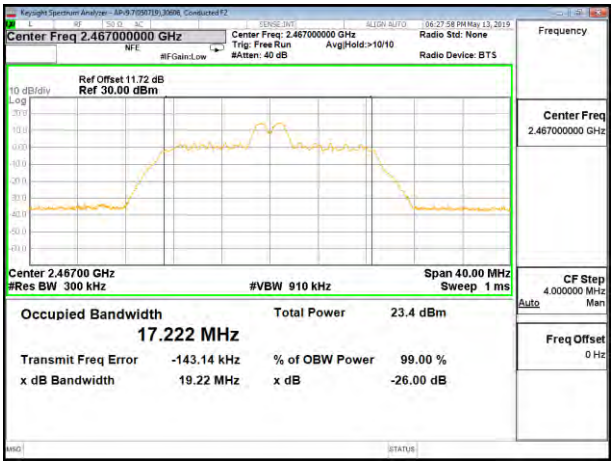
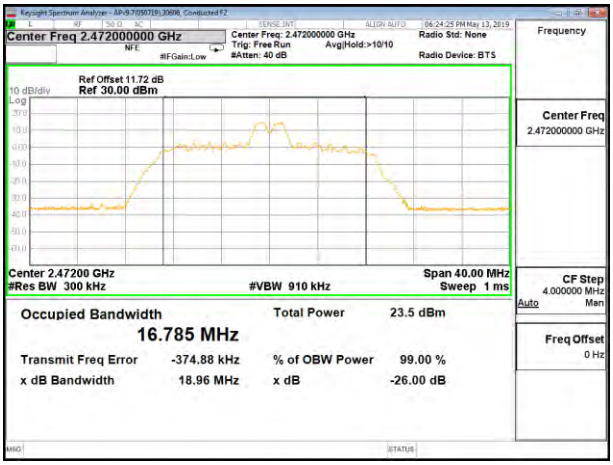


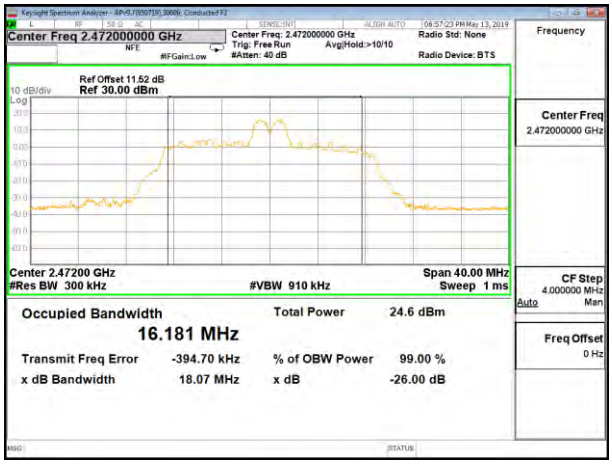
HIGH CHANNEL 12 ANT 2



HIGH CHANNEL 12 ANT 5



HIGH CHANNEL 13 ANT 2



HIGH CHANNEL 13 ANT 5

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Antenna 2 + Antenna 5 2TX MODE: 26-Tones, RU Index 8

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
Low 1	2412	18.516	18.517
Low 2	2417	18.509	18.511
Low 3	2422	18.656	18.614
Mid 6	2437	18.514	18.596
High 10	2457	18.562	18.617
High 11	2462	18.533	18.545
High 12	2467	18.809	18.482
High 13	2472	18.837	18.452

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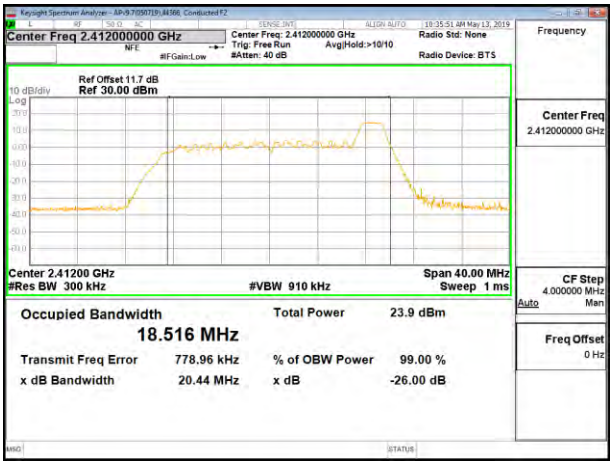
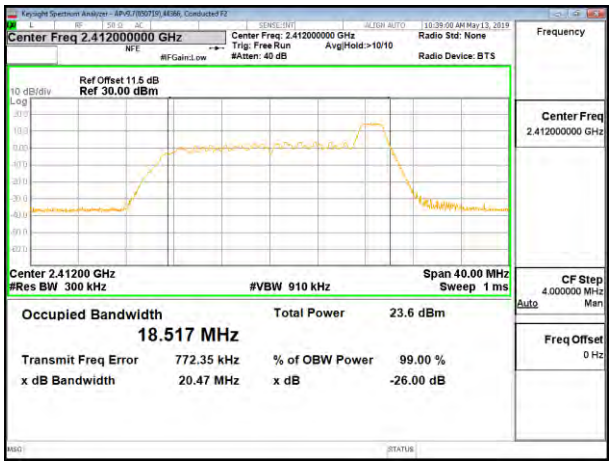
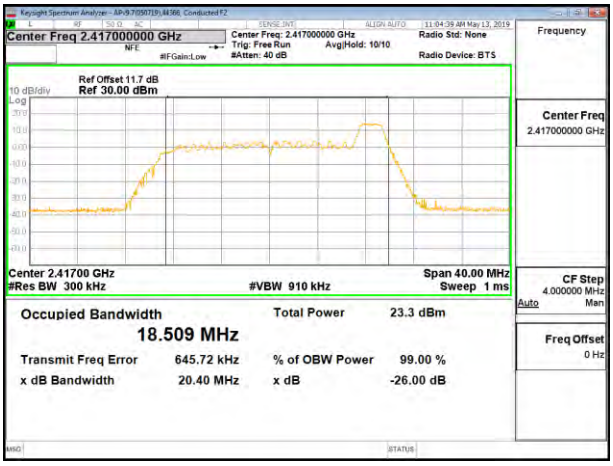


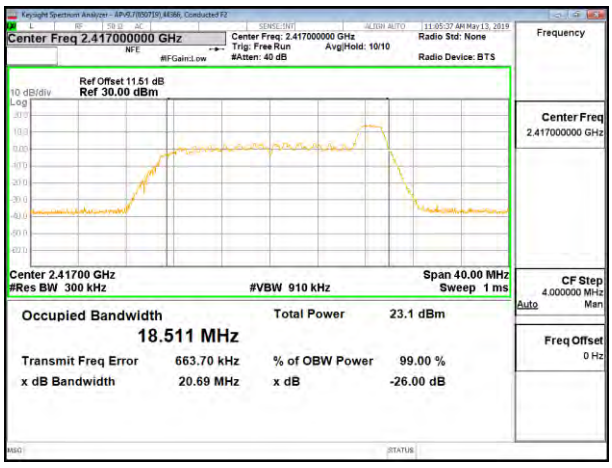
LOW CHANNEL 1 ANT 2



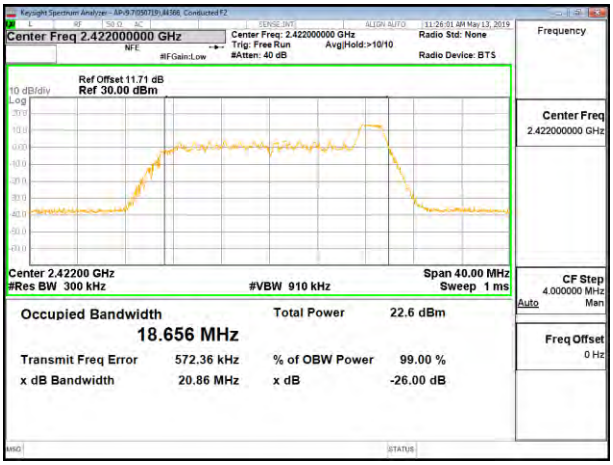
LOW CHANNEL 1 ANT 5



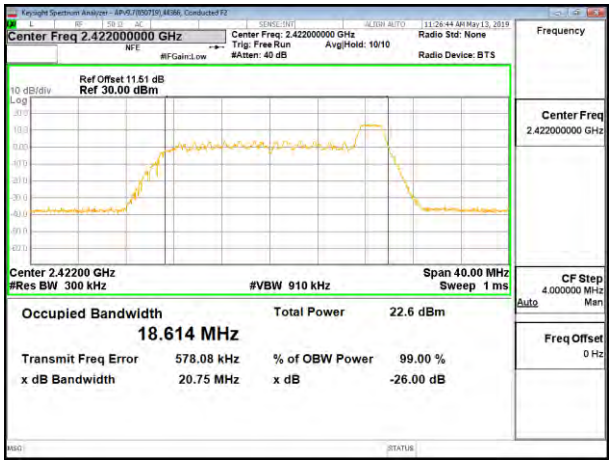
LOW CHANNEL 2 ANT 2



LOW CHANNEL 2 ANT 5



LOW CHANNEL 3 ANT 2



LOW CHANNEL 3 ANT 5

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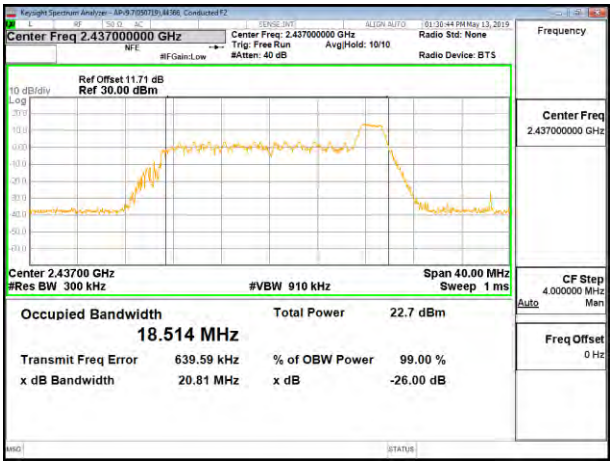
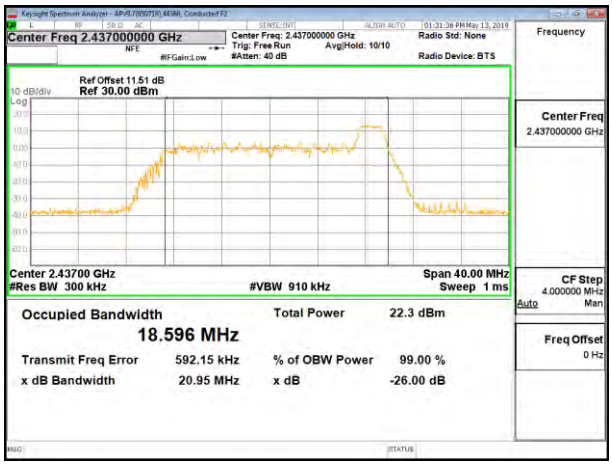
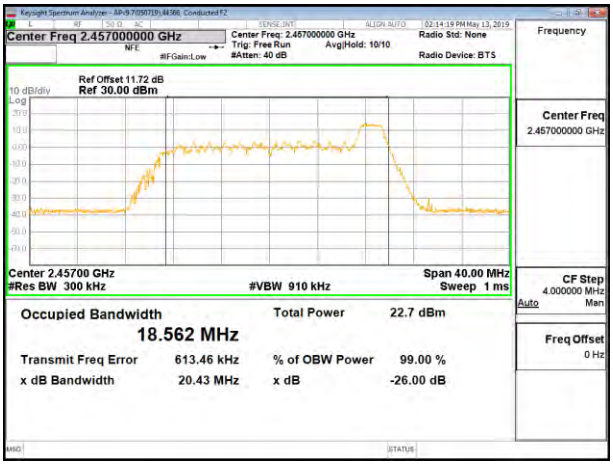


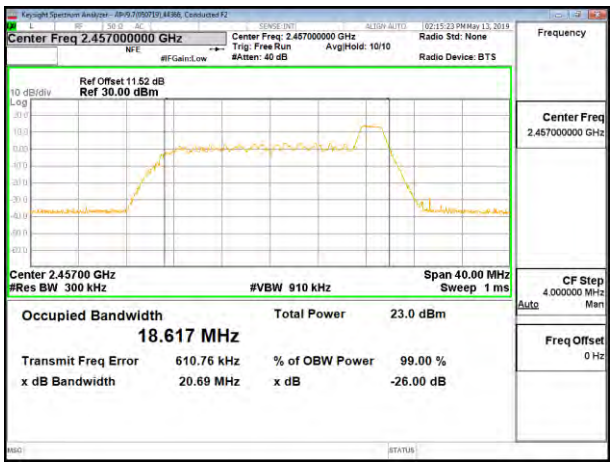
MID CHANNEL 6 ANT 2



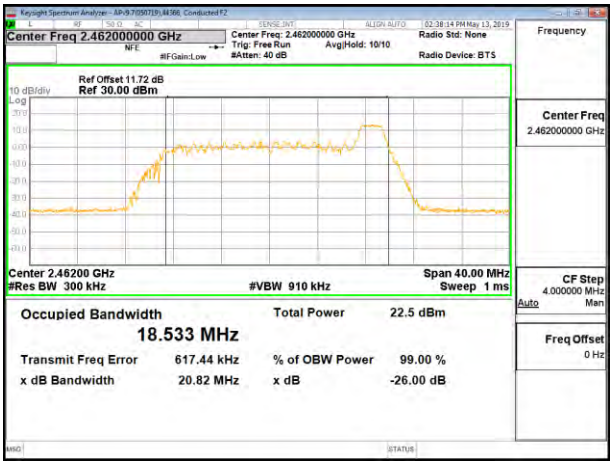
MID CHANNEL 6 ANT 5



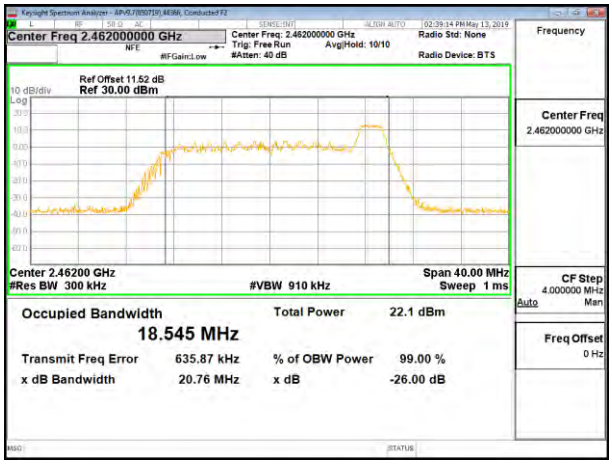
HIGH CHANNEL 10 ANT 2



HIGH CHANNEL 10 ANT 5



HIGH CHANNEL 11 ANT 2



HIGH CHANNEL 11 ANT 5

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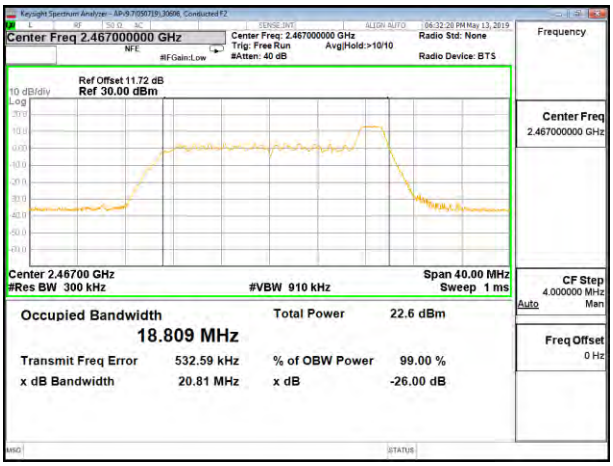
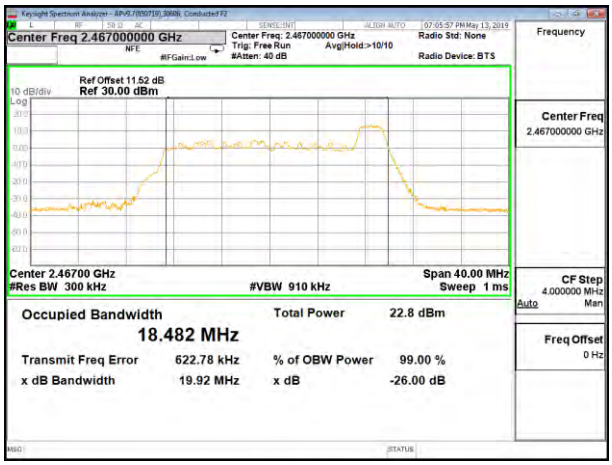
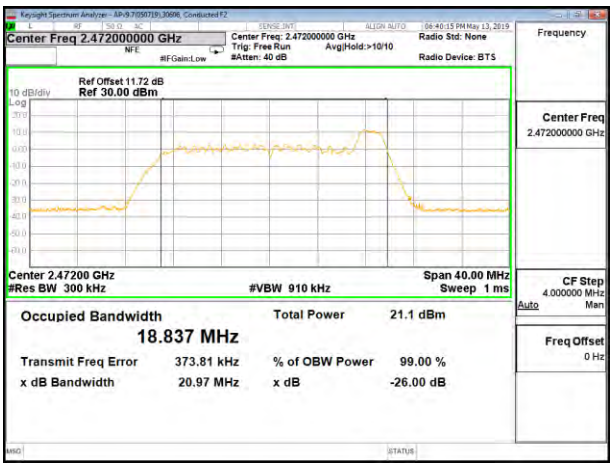


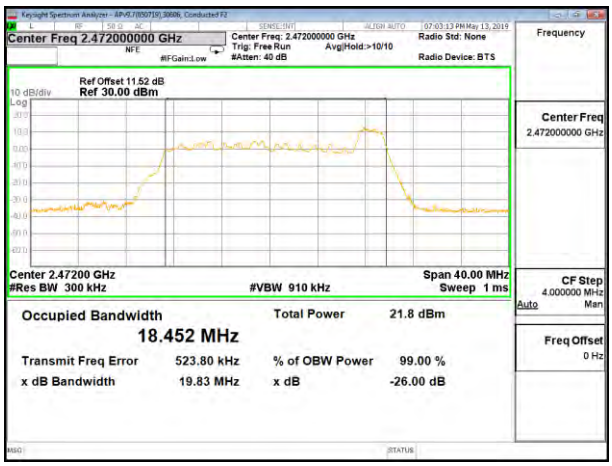
HIGH CHANNEL 12 ANT 2



HIGH CHANNEL 12 ANT 5



HIGH CHANNEL 13 ANT 2



HIGH CHANNEL 13 ANT 5

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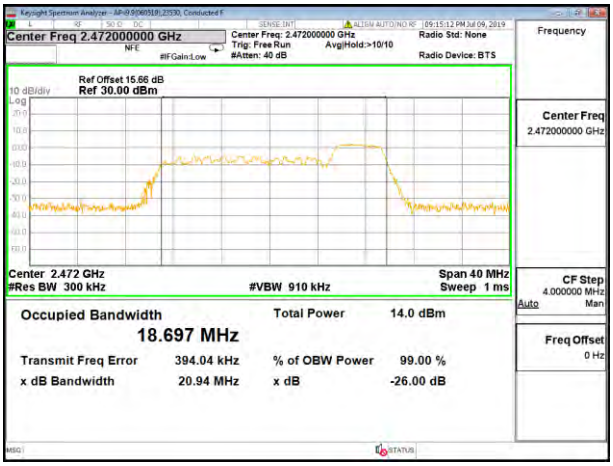
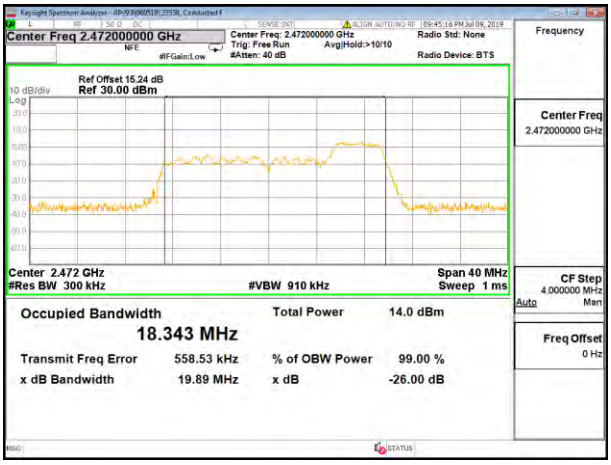
Antenna 2 + Antenna 5 2TX MODE: 52T-Tones, RU Index 40

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
High 13	2472	18.697	18.343



HIGH CHANNEL 13 ANT 2



HIGH CHANNEL 13 ANT 5

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Antenna 2 + Antenna 5 2TX MODE: 242T-Tones, RU Index 61

Channel	Frequency (MHz)	99% Bandwidth Antenna 2 (MHz)	99% Bandwidth Antenna 5 (MHz)
Low 1	2412	18.911	18.910
Low 2	2417	18.951	18.949
Low 3	2422	19.016	18.971
Low 4	2427	18.938	18.935
Mid 6	2437	19.107	19.051
High 10	2457	19.000	19.014
High 11	2462	19.024	18.987
High 12	2467	19.047	18.971
High 13	2472	18.689	18.731

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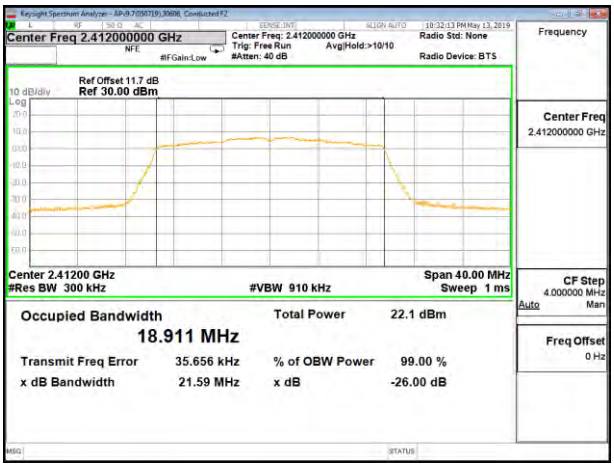
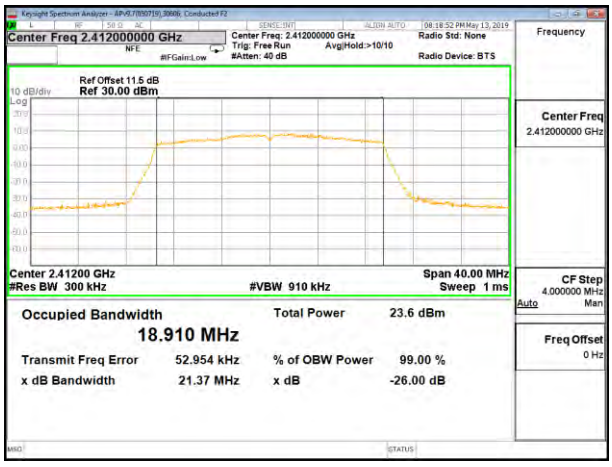
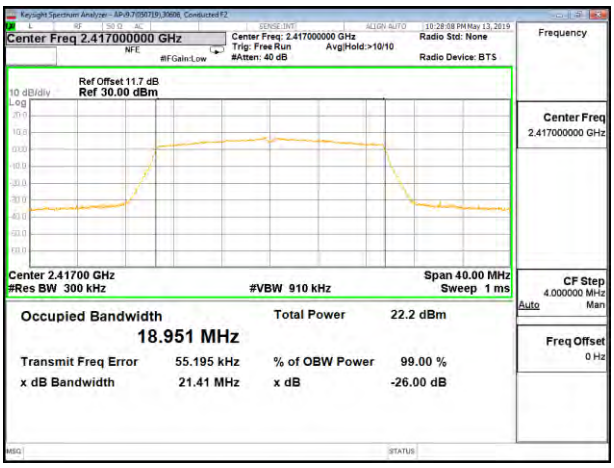


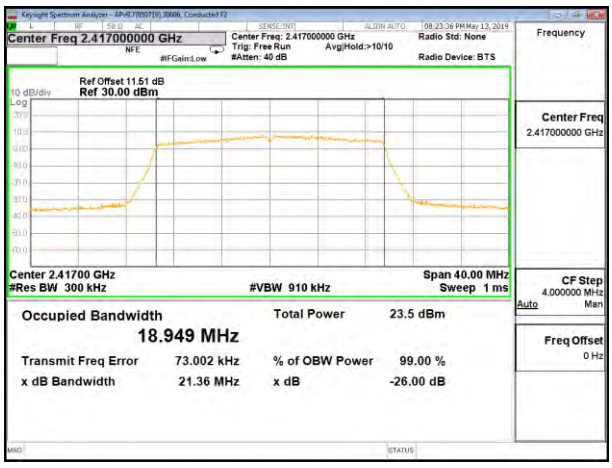
LOW CHANNEL 1 ANT 2



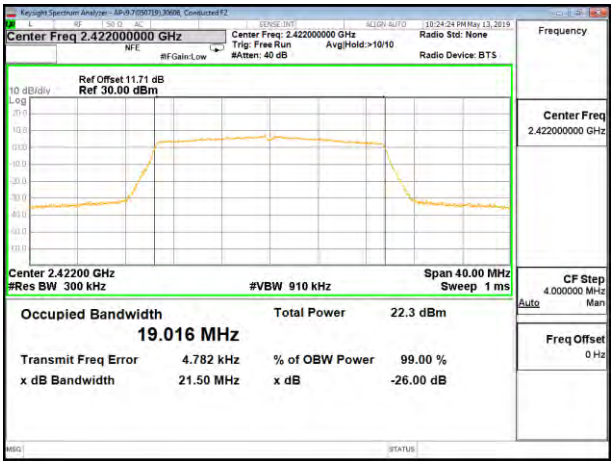
LOW CHANNEL 1 ANT 5



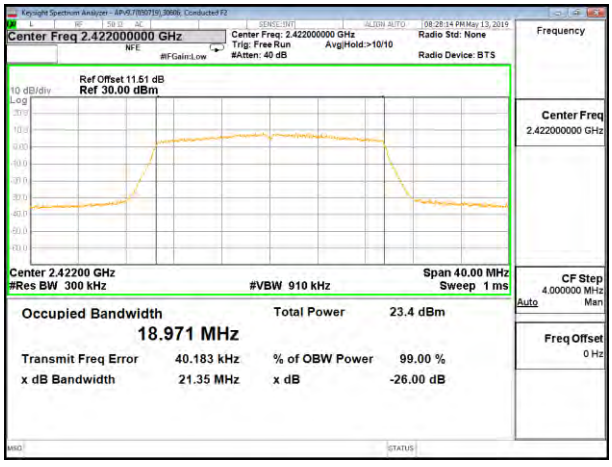
LOW CHANNEL 2 ANT 2



LOW CHANNEL 2 ANT 5



LOW CHANNEL 3 ANT 2



LOW CHANNEL 3 ANT 5

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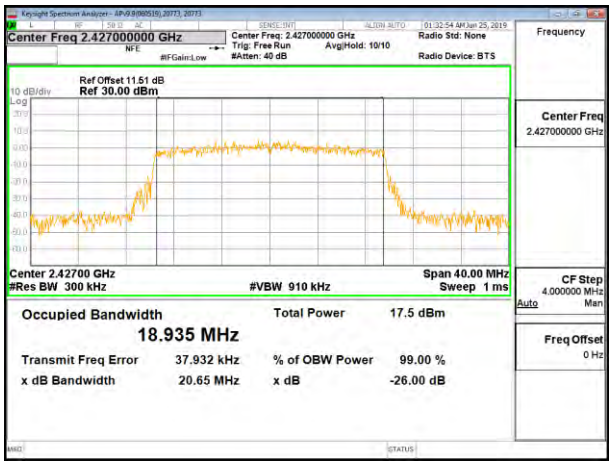
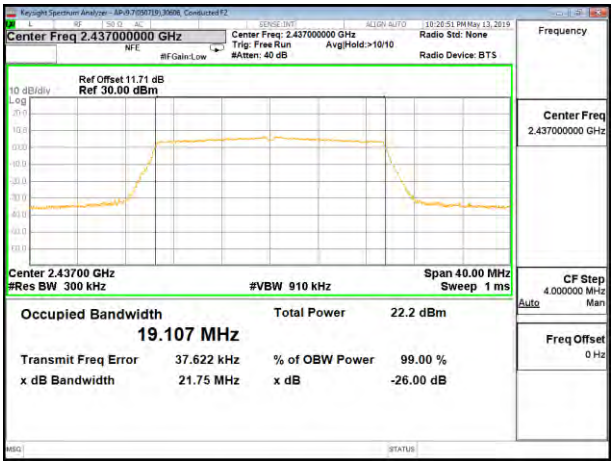
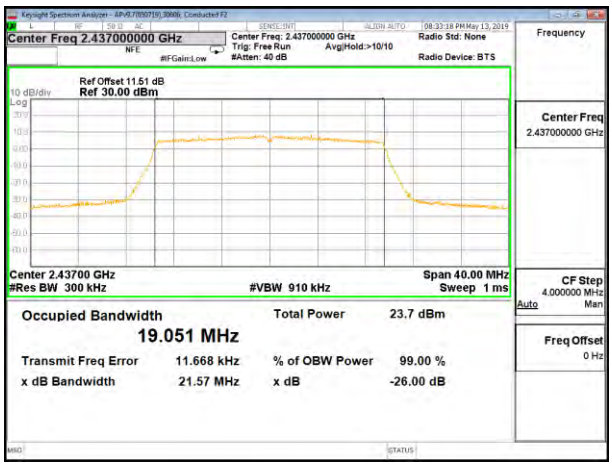
LOW CHANNEL 4 ANT 2



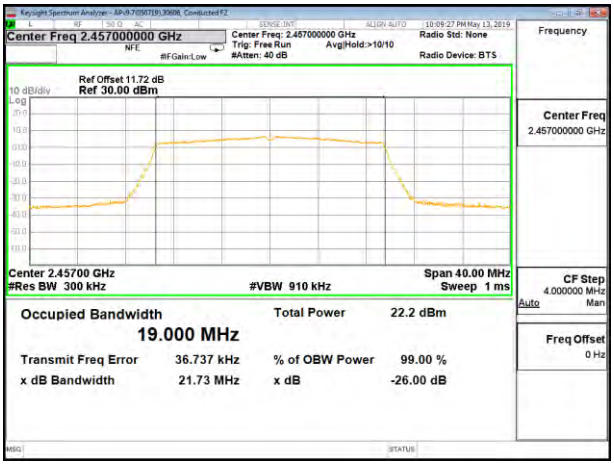
LOW CHANNEL 4 ANT 5



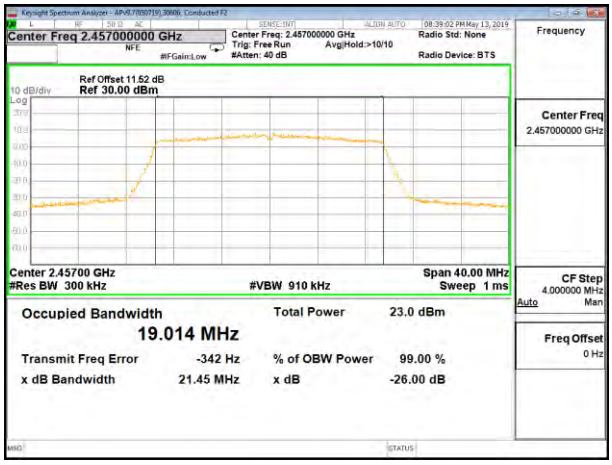
MID CHANNEL 6 ANT 2



MID CHANNEL 6 ANT 5



HIGH CHANNEL 10 ANT 2



HIGH CHANNEL 10 ANT 5

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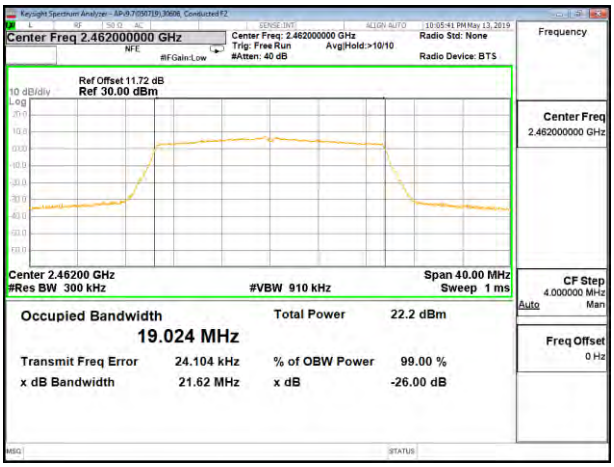
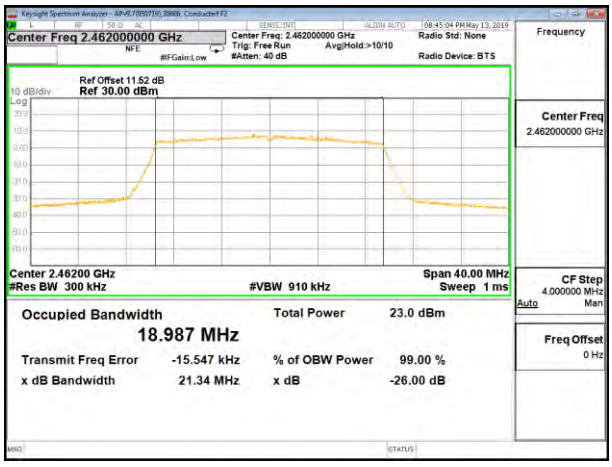
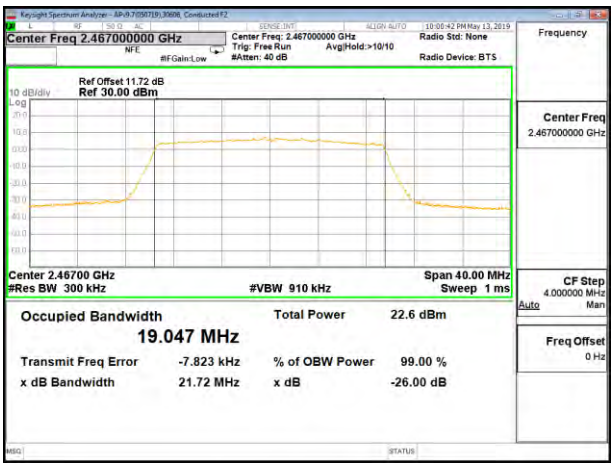


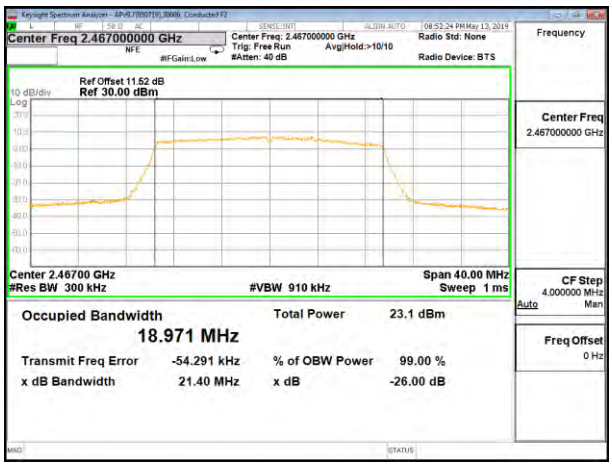
HIGH CHANNEL 11 ANT 2



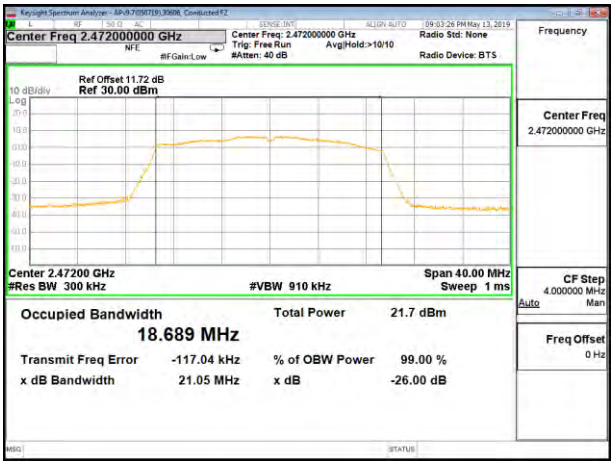
HIGH CHANNEL 11 ANT 5



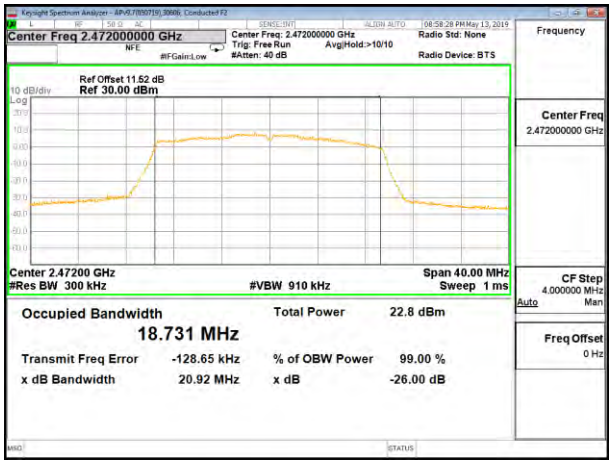
HIGH CHANNEL 12 ANT 2



HIGH CHANNEL 12 ANT 5



HIGH CHANNEL 13 ANT 2



HIGH CHANNEL 13 ANT 5

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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

1TX Antenna 2 MODE

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	6.80	0.5
Mid 6	2437	8.04	0.5
High 11	2462	7.60	0.5
High 12	2467	8.04	0.5
High 13	2472	7.56	0.5

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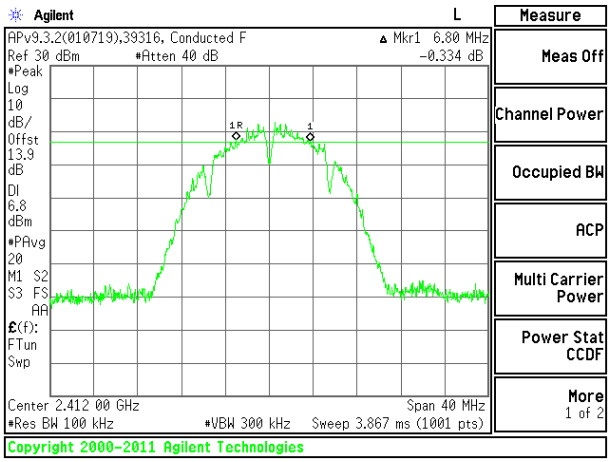
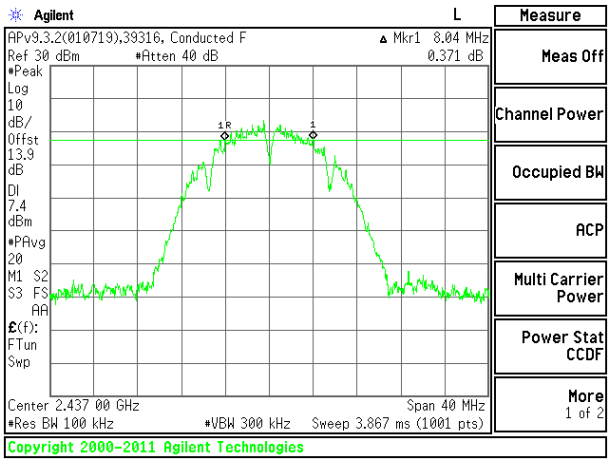
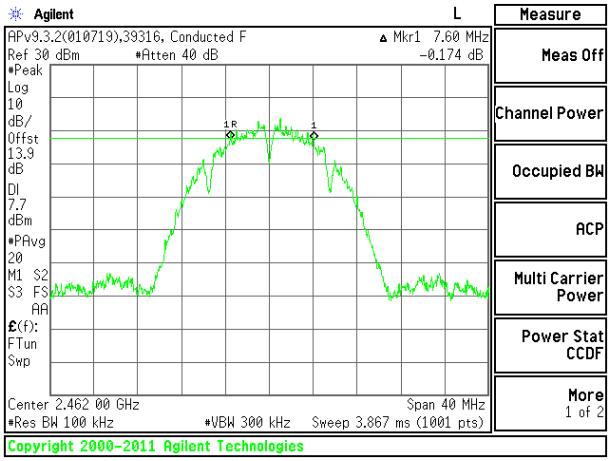


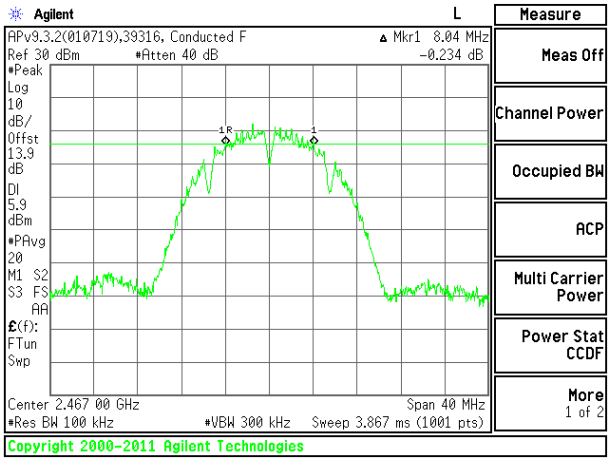
LOW CHANNEL 1



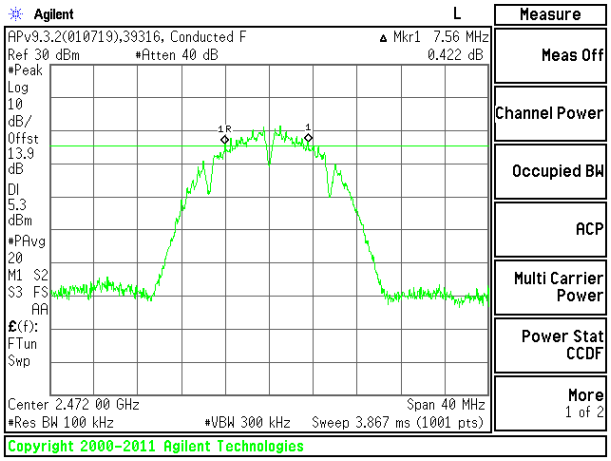
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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1TX Antenna 5 MODE

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	8.08	0.5
Mid 6	2437	7.56	0.5
High 11	2462	8.52	0.5
High 12	2467	8.04	0.5
High 13	2472	6.08	0.5

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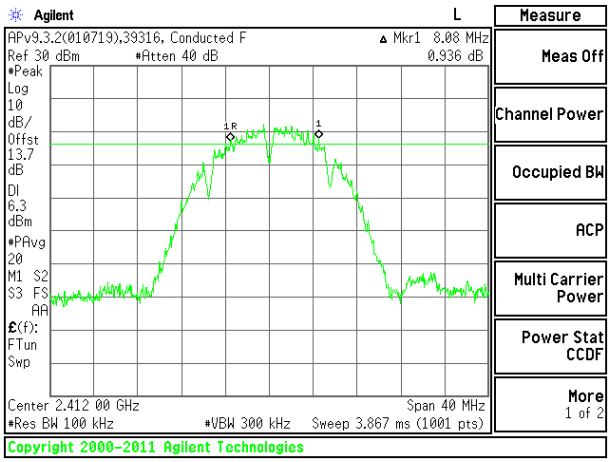
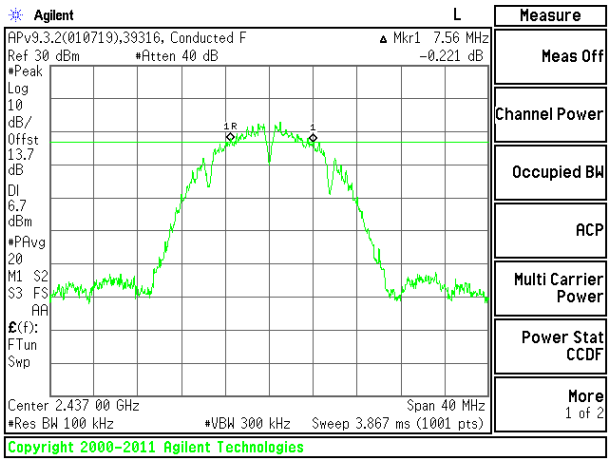
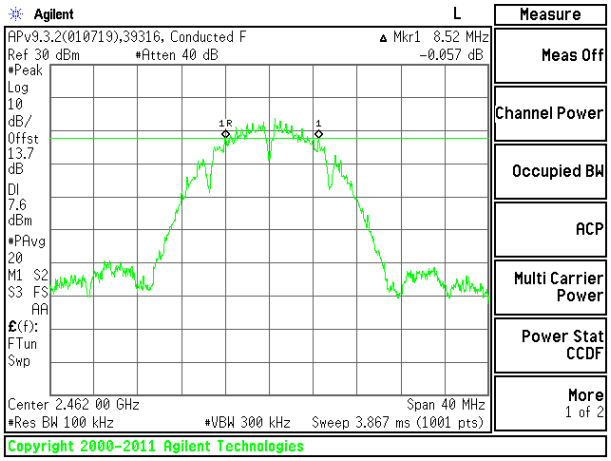


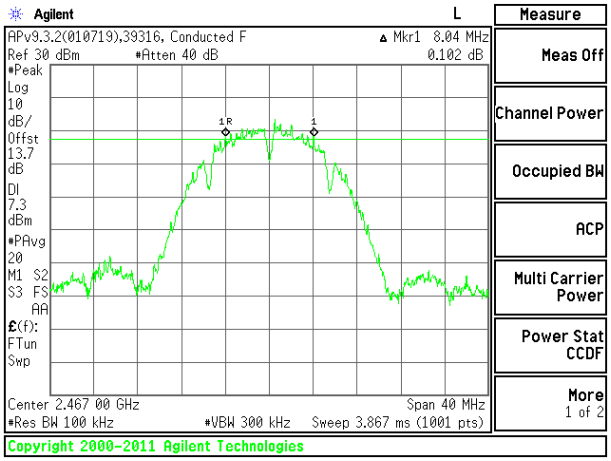
LOW CHANNEL 1



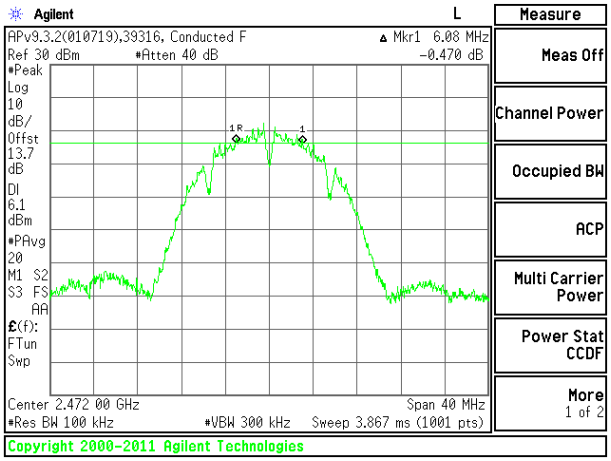
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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8.3.2. 802.11n HT20 MODE

1TX Antenna 2 MODE

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	17.64	0.5
Low 2	2417	17.32	0.5
Low 3	2422	17.36	0.5
Mid 6	2437	17.28	0.5
High 9	2452	17.68	0.5
High 10	2457	17.60	0.5
High 11	2462	17.68	0.5
High 12	2467	17.60	0.5
High 13	2472	17.60	0.5

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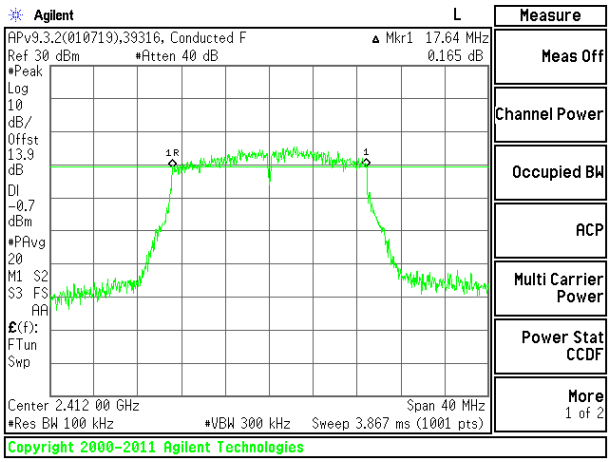
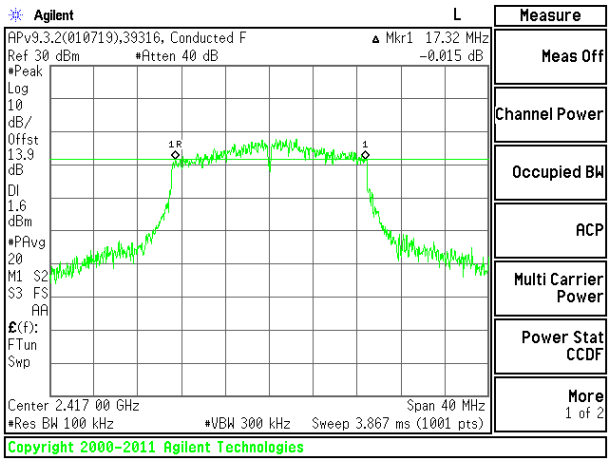
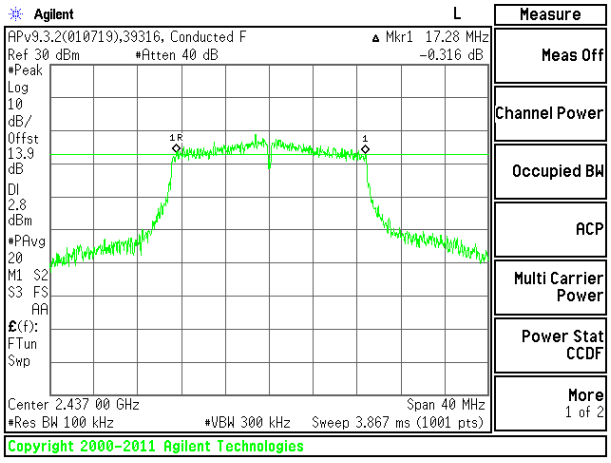


LOW CHANNEL 1

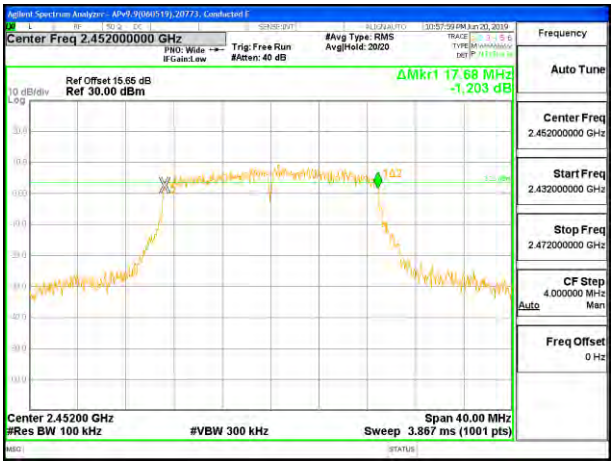


LOW CHANNEL 2

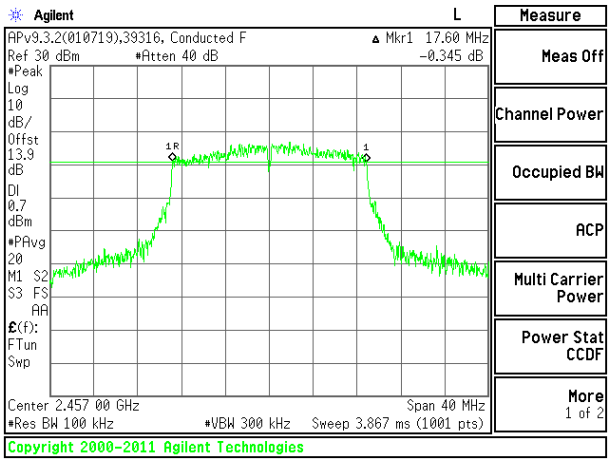
LOW CHANNEL 3



MID CHANNEL 6



HIGH CHANNEL 9



HIGH CHANNEL 10

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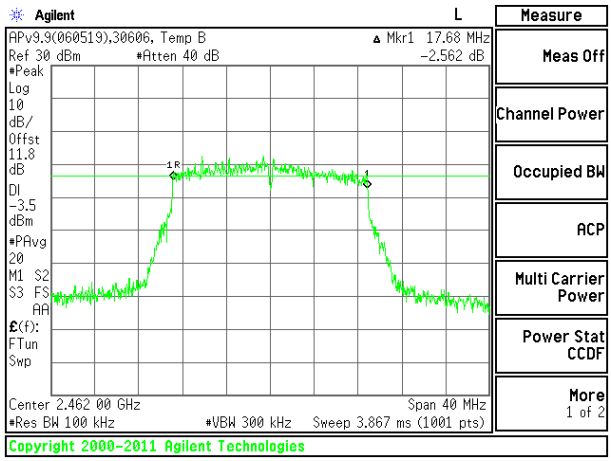
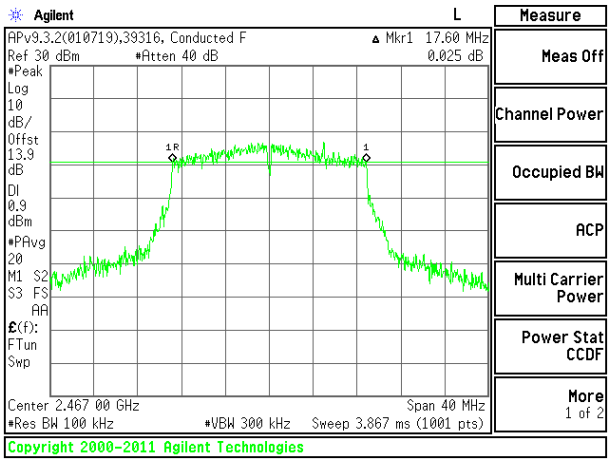
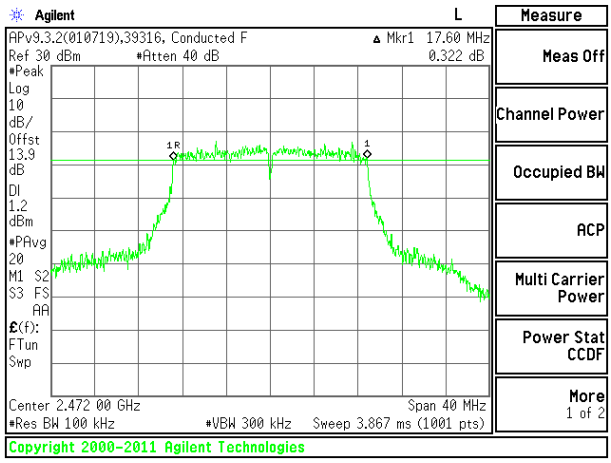


HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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1TX Antenna 5 MODE

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	17.44	0.5
Low 2	2417	17.04	0.5
Low 3	2422	17.76	0.5
Mid 6	2437	17.24	0.5
High 9	2452	17.68	0.5
High 10	2457	17.60	0.5
High 11	2462	17.60	0.5
High 12	2467	17.28	0.5
High 13	2472	17.20	0.5

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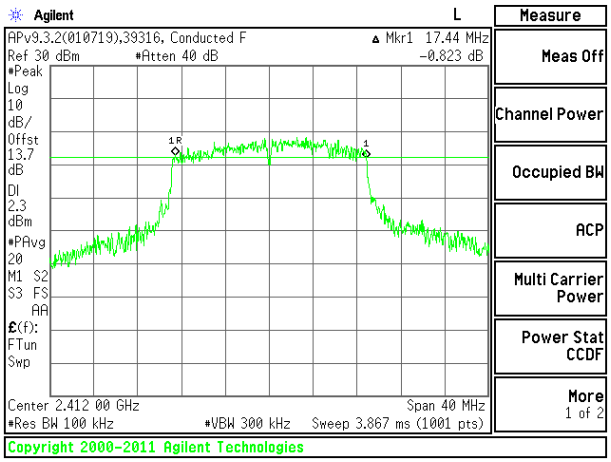
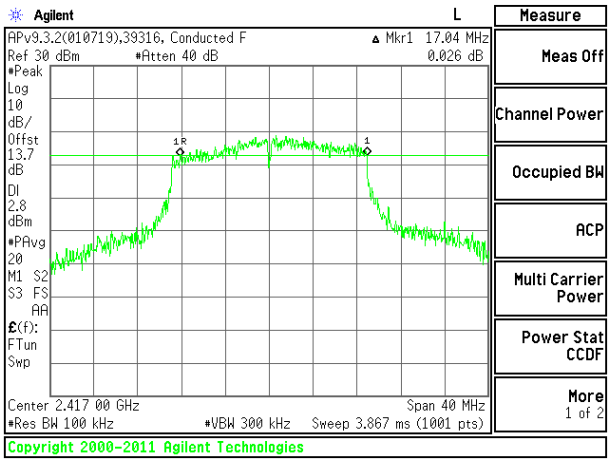
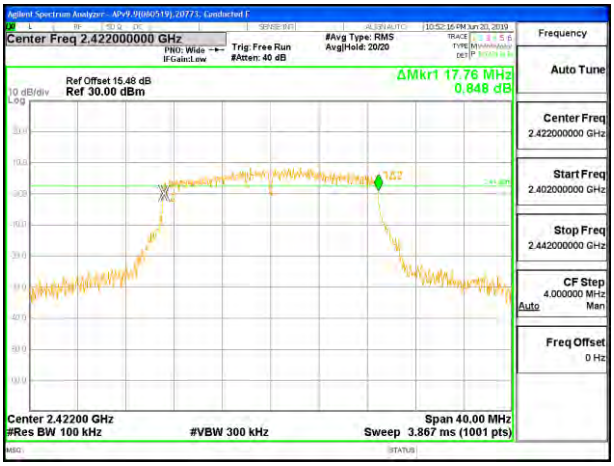


LOW CHANNEL 1



LOW CHANNEL 2



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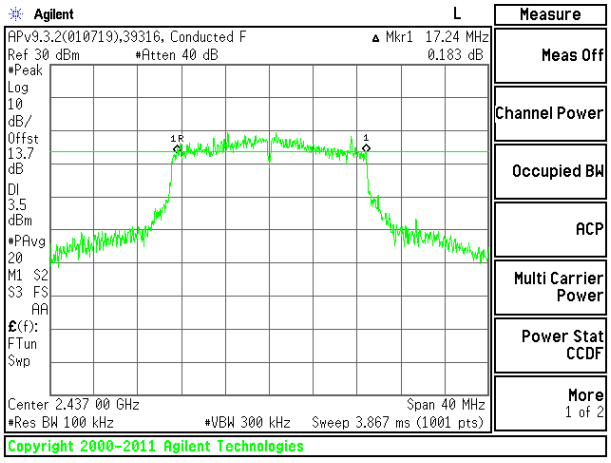
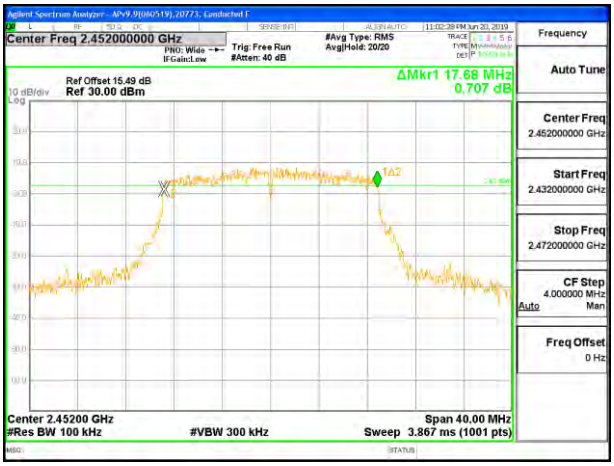
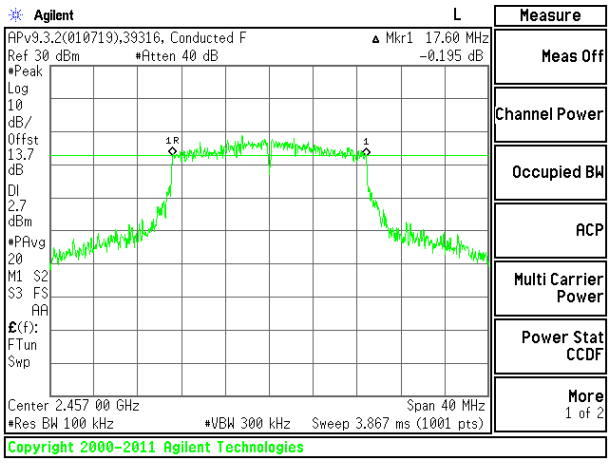


MID CHANNEL 6



HIGH CHANNEL 9



HIGH CHANNEL 10

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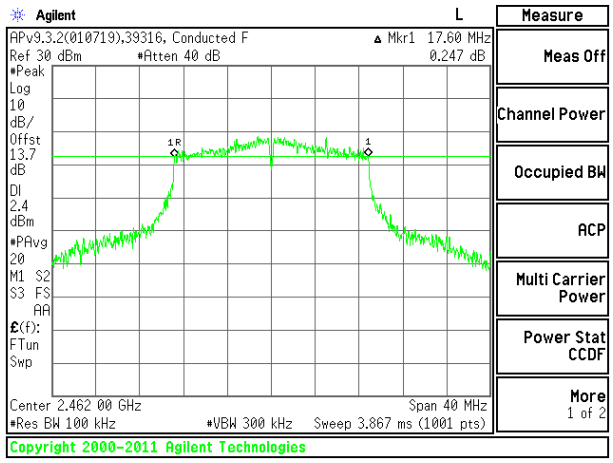
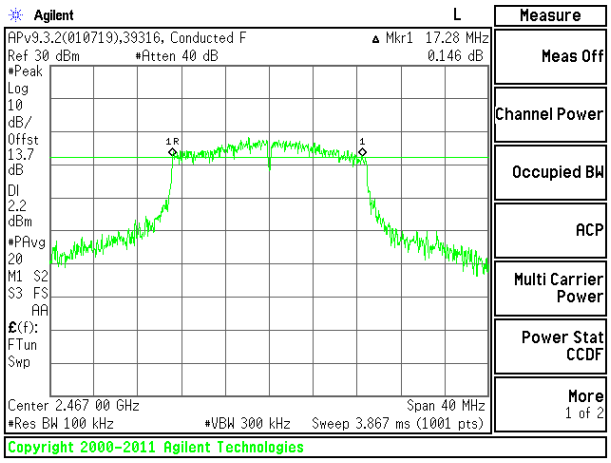
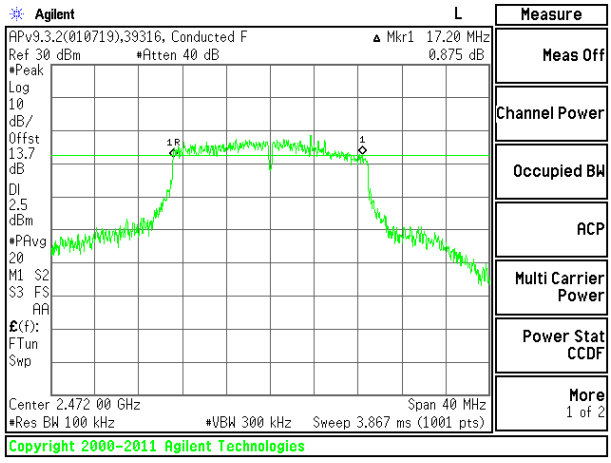


HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

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8.3.3. 802.11n HT20 CDD MODE 2TX

Antenna 2 + Antenna 5 2TX MODE

Channel	Frequency (MHz)	6 dB BW Antenna 2 (MHz)	6 dB BW Antenna 5 (MHz)	Minimum Limit (MHz)
Low 1	2412	17.40	17.68	0.5
Low 2	2417	17.24	17.24	0.5
Mid 6	2437	17.40	17.68	0.5
High 10	2457	17.40	17.00	0.5
High 11	2462	17.32	17.32	0.5
High 12	2467	17.00	17.08	0.5
High 13	2472	17.76	17.72	0.5

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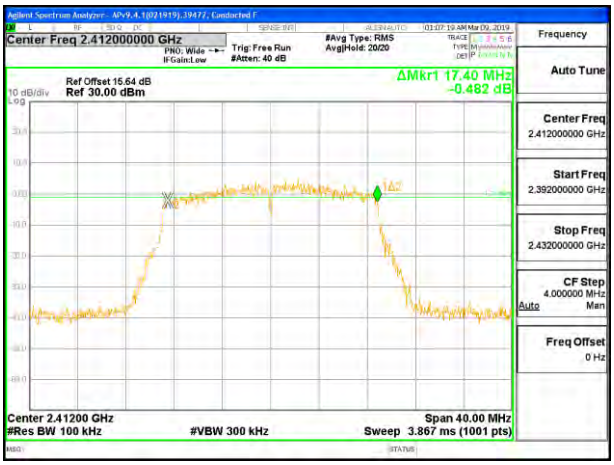
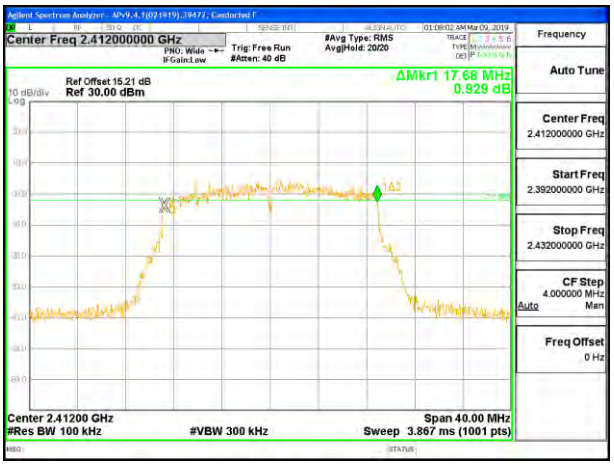
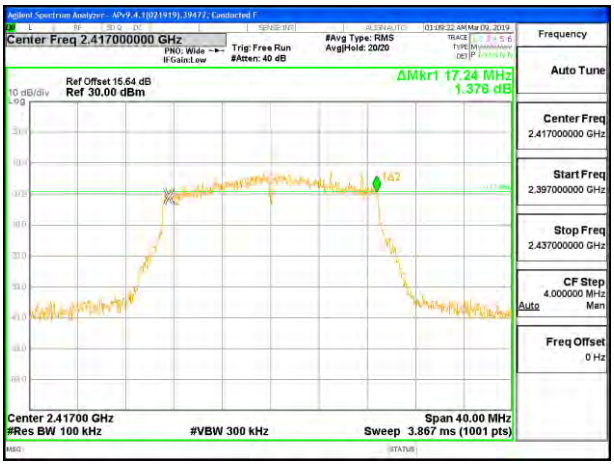


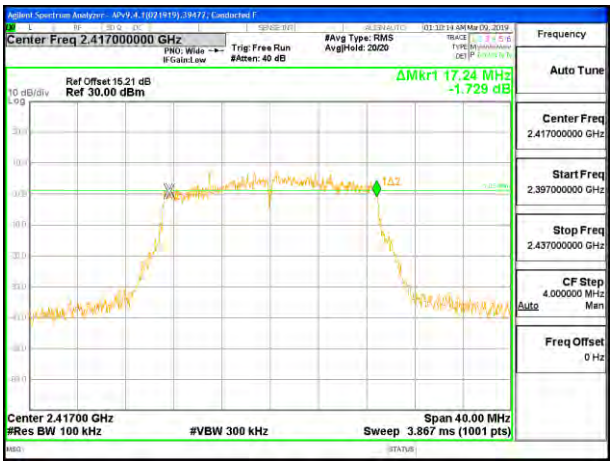
LOW CHANNEL 1 ANT 2



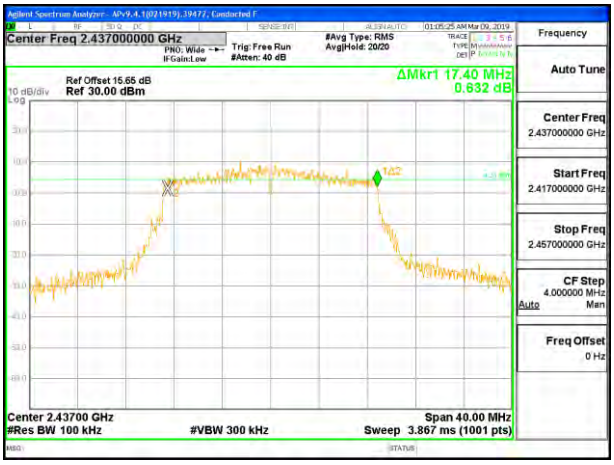
LOW CHANNEL 1 ANT 5



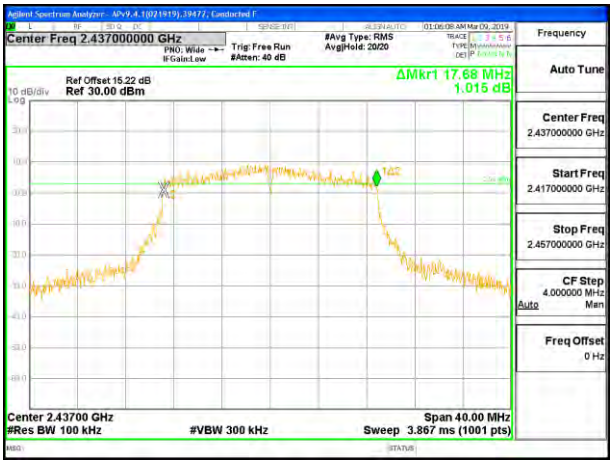
LOW CHANNEL 2 ANT 2



LOW CHANNEL 2 ANT 5



MID CHANNEL 6 ANT 2



MID CHANNEL 6 ANT 5

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