CERTIFICATION TEST REPORT

Report Number. : 12204447-E3V3

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	:	A2097
FCC ID	:	BCG-E3232A
ISED ID	:	579C-E3232A
EUT Description	:	SMARTPHONE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART C ISED RSS-247 ISSUE 2

Date Of Issue:
August 10, 2018

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538, U.S.A.
TEL: (510) 771-1000
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NVLAP LAB CODE 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	7/13/2018	Initial Issue	Chin Pang
V2	7/17/2018	Update equipment list and update Section 5.5	Chin Pang
V3	8/10/2018	Addressed TCB Questions	Jingang Li

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UL VERIFICATION SERVICES INC.
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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: A2097

SERIAL NUMBER: C39WP04UK95F

DATE TESTED: JANUARY 26, 2018 – JULY 14, 2018

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

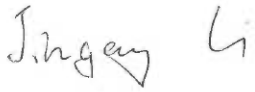
UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. 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:

Chin Pang
CONSUMER TECHNOLOGY DIVISION
Senior Engineer
UL Verification Services Inc.

Prepared By:



Jingang Li
CONSUMER TECHNOLOGY DIVISION
TEST ENGINEER
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, KDB 558074 D01 v04, ANSI C63.10-2013, 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, 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
☐ Chamber A (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)
☐ Chamber B (ISED:2324B-2)	☐ Chamber E (ISED:22541-2)
☐ Chamber C (ISED:2324B-3)	☒ Chamber F (ISED:22541-3)
	☒ Chamber G (ISED:22541-4)
	☐ Chamber H (ISED:22541-5)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through C is covered under ISED company address code 2324B with site numbers 2324B -1 through 2324B-3, respectively. Chambers D through H are covered under ISED Canada company address code 22541 with site numbers 22541 -1 through 22541-5, respectively.

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at NVLAP Lab Search.

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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

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

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	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 dB

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

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The Apple iPhone, 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, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM is either UICC based, electronic SIM (e-SIM), or second SIM is not present. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is not user accessible.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

2.4GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
1Tx			
2412 - 2472	802.11b	21.93	155.96
2412 - 2472	802.11g	Covered by 11n HT20	
2412 - 2472	802.11n HT20	21.89	154.53

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2Tx			
2412 - 2472	802.11n HT20 CDD	23.81	240.44

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	Ant. 4 (dBi)	Ant. 3 (dBi)
2.4	-2.8	-4.1

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v16.30.67.7

5.5. WORST-CASE CONFIGURATION AND MODE

EUT was investigated in three orthogonal orientations X, Y and Z on Ant 4 (Antenna 4) and Ant 3 (Antenna 3), it was determined that X (Flatbed) orientation was worst-case orientation for Ant 4 and Ant 3.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was 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 HT20 modes, radiated harmonics spurious were performed with the EUT set at the 2TX CDD mode with power setting equal or higher than SISO modes as the 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, the worst-case configuration reported was tested 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.

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

802.11b mode: 1 Mbps
802.11n HT20mode: 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.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	MacBook Pro	HRP007154	FCC DoC
AC/DC adapter	Delta Electronic	A1343	ADP-85EBT V85	NA
AC/DC Adapter	Apple	A1385	D293062F3WVDHLHCF	NA

I/O CABLES (CONDUCTED TEST)

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 (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
None Used						

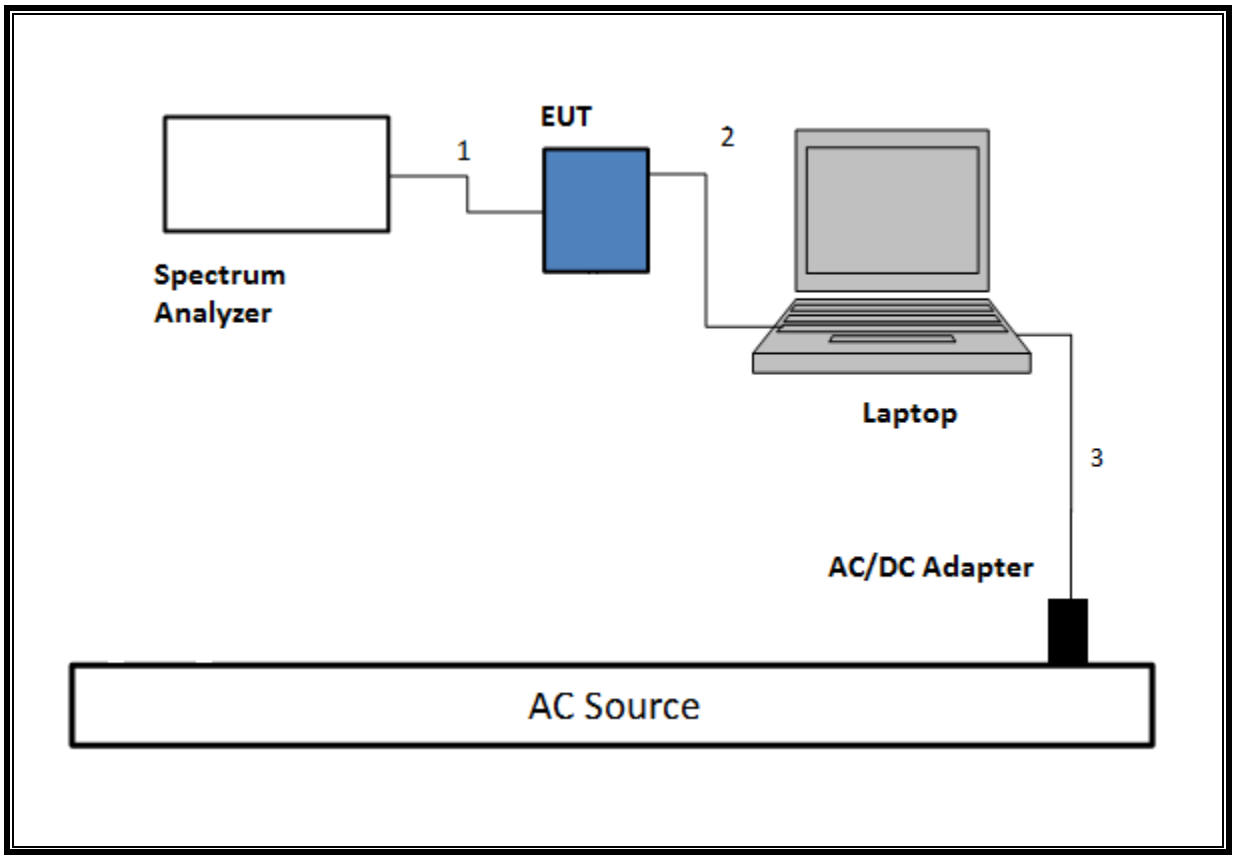
I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP

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	Shielded	1	N/A

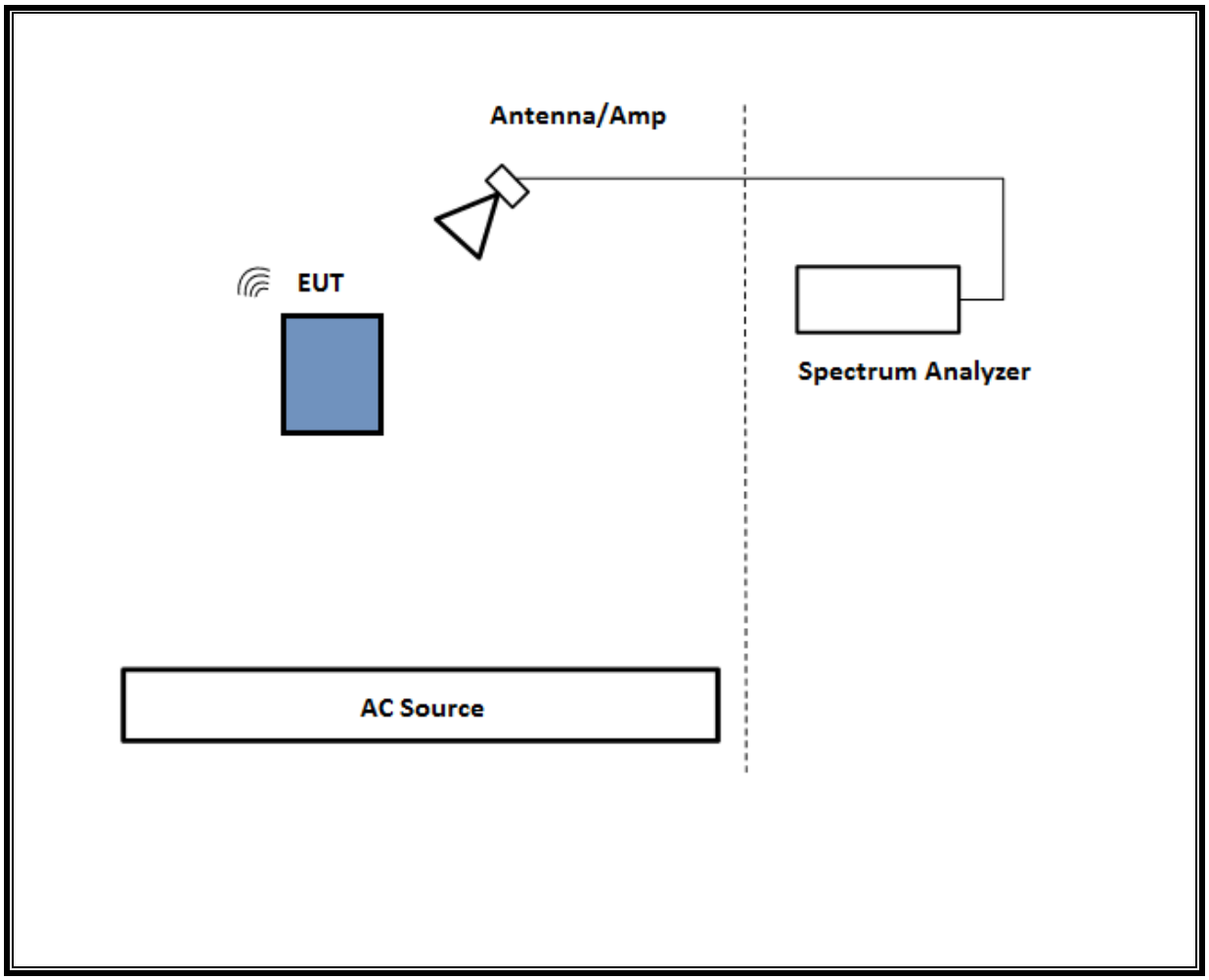
TEST SETUP

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

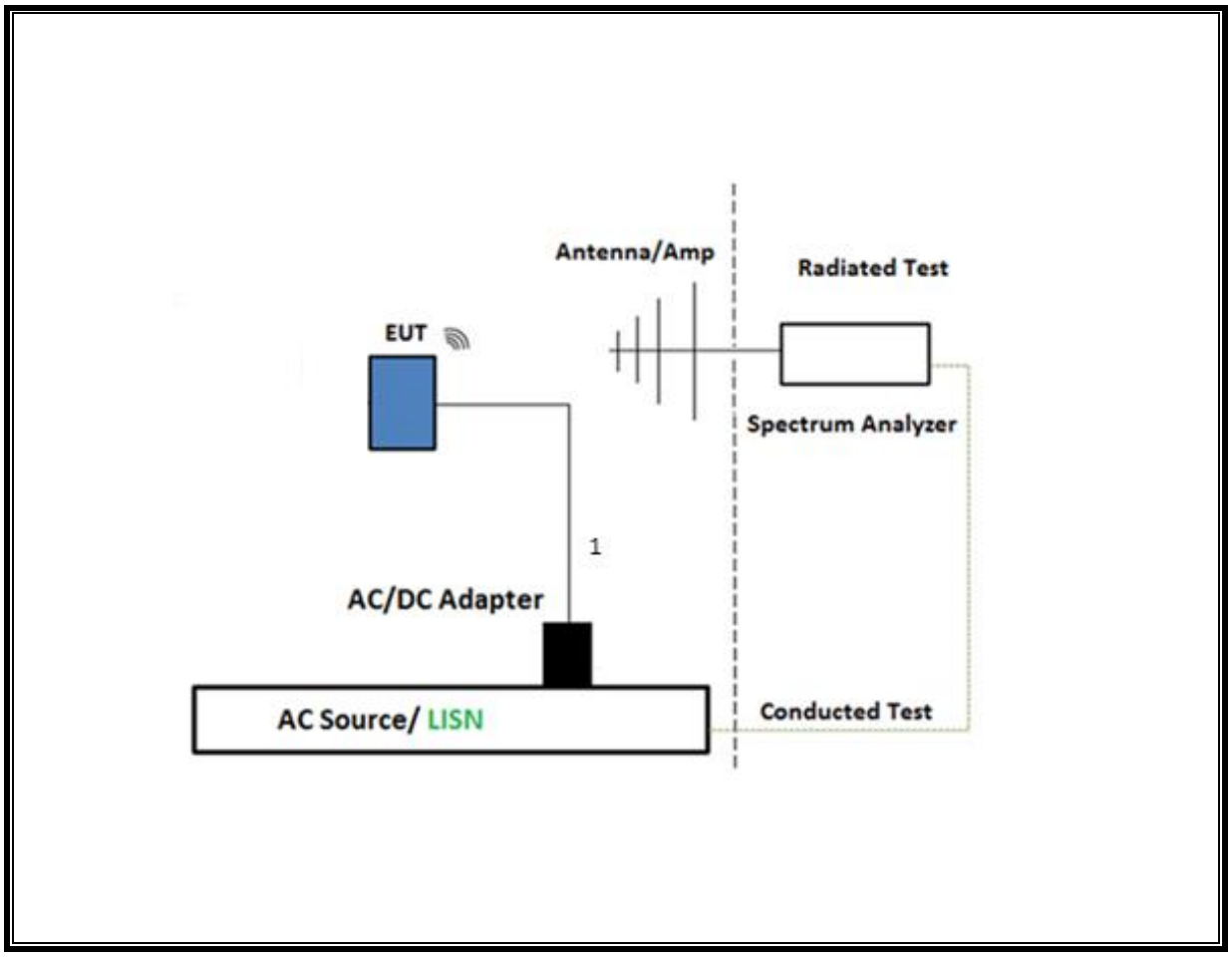
SETUP DIAGRAM FOR CONDUCTED TESTS



SETUP DIAGRAM FOR RADIATED TESTS Above 1GHz



SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST



6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 558074 D01 v04, Section 6.

6 dB BW: KDB 558074 D01 v04, Section 8.1.

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

Output Power: KDB 558074 D01 v04, Section 9.2.3.2.

Power Spectral Density: KDB 558074 D01 v04, Section 10.2.

Out-of-band emissions in non-restricted bands: KDB 558074 D01 v04, Section 11.1 (b).

Out-of-band emissions in restricted bands: KDB 558074 D01 v04, Section 12.1.

Band-edge: KDB 558074 D01 v04, Section 12.1.

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

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7. TEST AND MEASUREMENT EQUIPMENT

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

Description	Manufacturer	Model	ID Num	Cal Due
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T136	06/26/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T740	12/30/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T907	02/07/2019
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T119	04/03/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T742	12/04/2018
Spectrum Analyzer, PSA, 3Hz to 44GHz	Agilent (Keysight) Technologies	E4446A	T177	04/12/2019
*Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T407	04/14/2018
*Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T834	06/01/2018
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T862	05/24/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T1165	06/12/2019
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A-544	T341	11/12/2018
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T227	10/27/2018
Power Sensor	Keysight	N1921A	T750	10/27/2018
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/14/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T342	02/22/2019
*Antenna Horn, 18 to 26GHz	ARA	MWH-1826	T447	06/24/2018
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	07/23/2018
*Antenna Horn 18 to 26.5GHz	ARA	MWH-1826/B	T449	06/12/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1454	01/08/2019
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	01/25/2019
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2018
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018
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	

Note: *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.

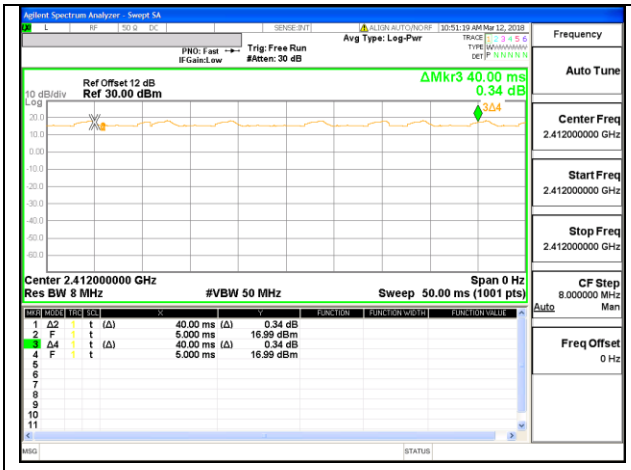
PROCEDURE

KDB 558074 D01 v04, Section 6.

ON TIME AND DUTY CYCLE RESULTS

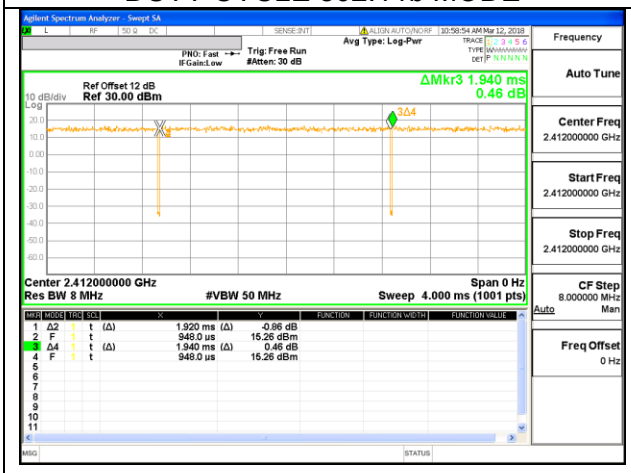
Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
2.4GHz Band						
802.11b 1TX	100.0	100.0	1.000	100.00%	0.00	0.010
802.11n HT20 1TX	1.920	1.940	0.990	98.97%	0.00	0.010
802.11n HT20 2TX	1.920	1.940	0.990	98.97%	0.00	0.010

DUTY CYCLE PLOTS



DUTY CYCLE 802.11b MODE

DUTY CYCLE 802.11n HT20 MODE



DUTY CYCLE 802.11n 2TX MODE

8.2. 99% BANDWIDTH

LIMITS

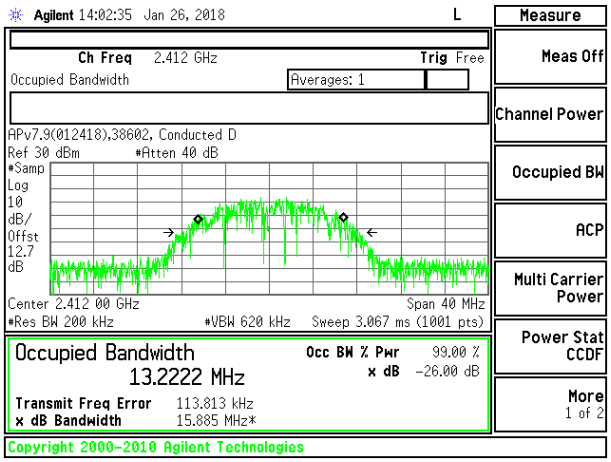
None; for reporting purposes only.

RESULTS

8.2.1. 802.11b MODE

1TX ANTENNA 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	13.222
Low 2	2417	13.323
Mid 6	2437	13.199
High 11	2462	13.080
High 12	2467	13.146
High 13	2472	12.785



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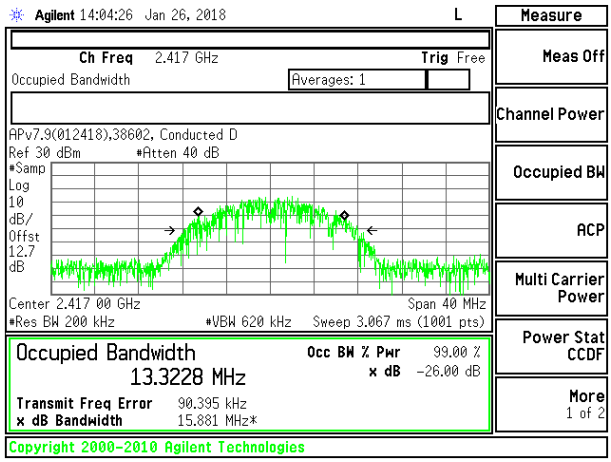

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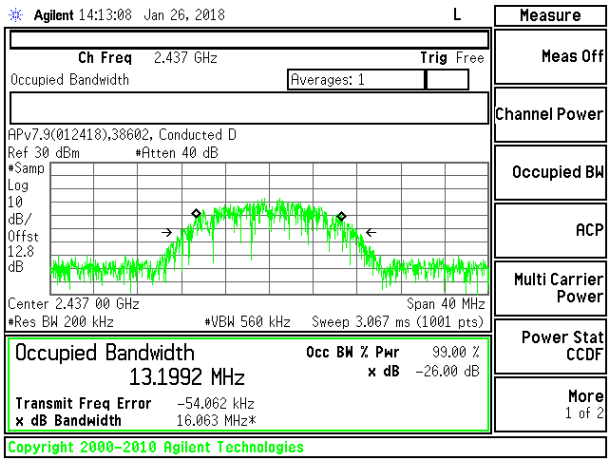
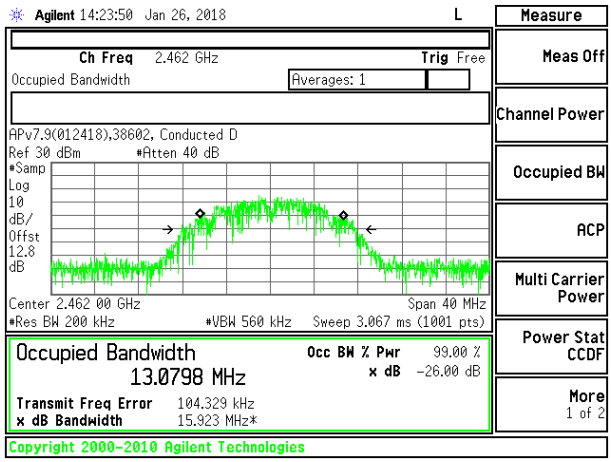
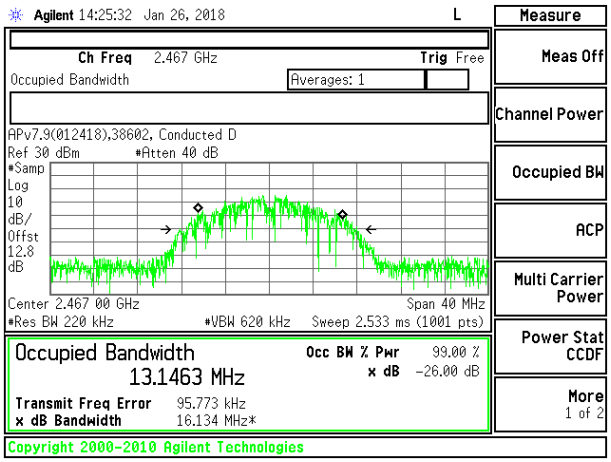


MID CHANNEL 6



HIGH CHANNEL 11



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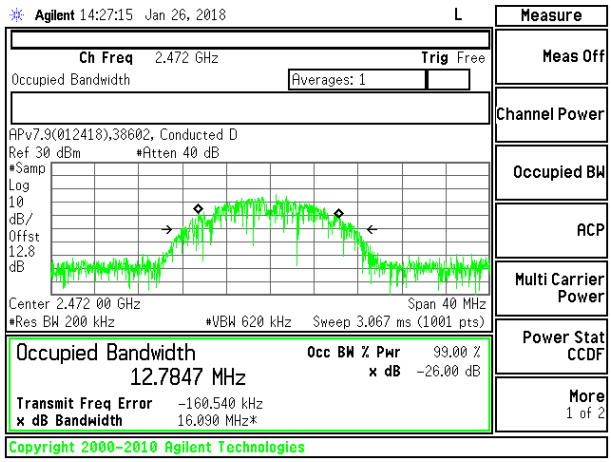
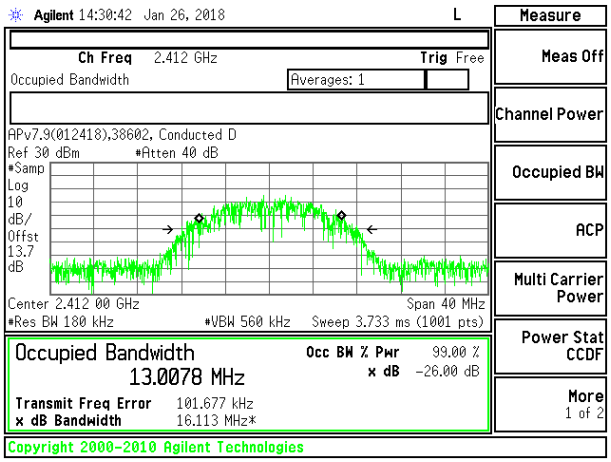


HIGH CHANNEL 13

1TX ANTENNA 3

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	13.008
Low 2	2417	13.252
Mid 6	2437	13.055
High 11	2462	12.748
High 12	2467	13.104
High 13	2472	12.936



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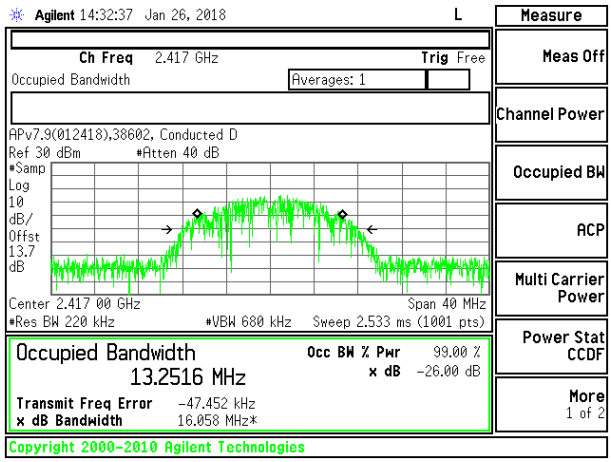

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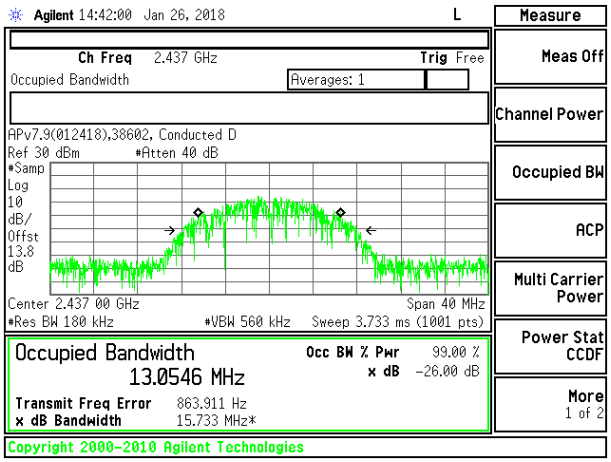

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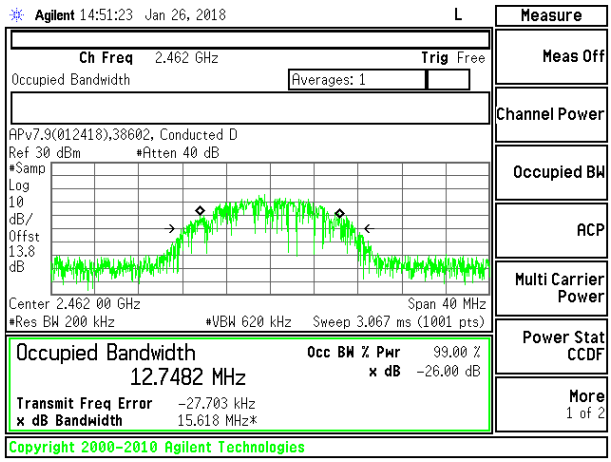

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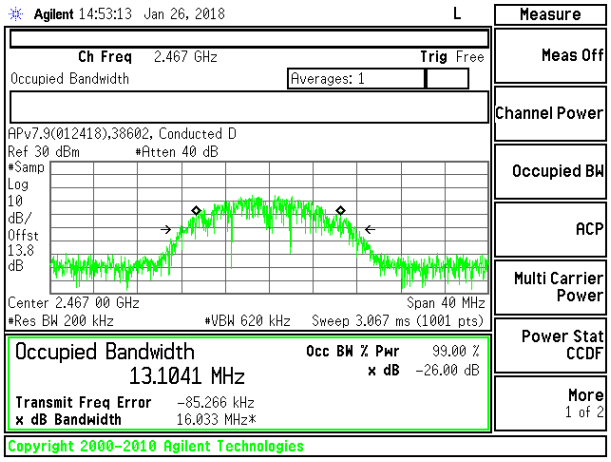

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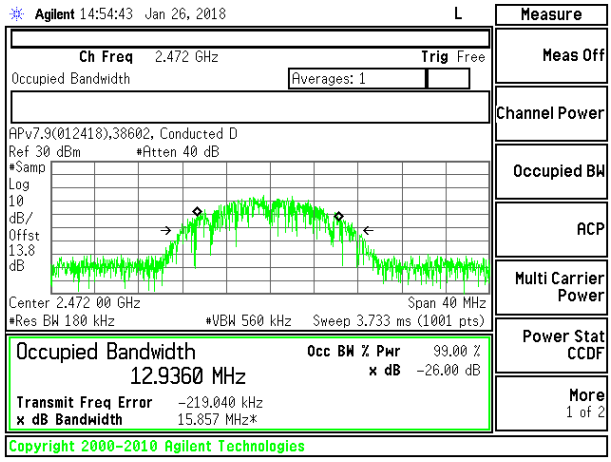
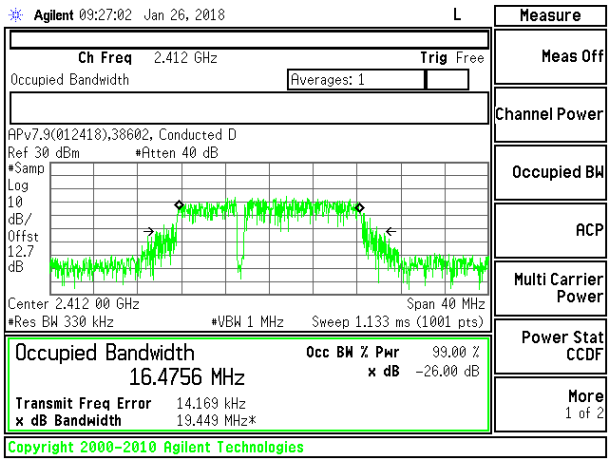


HIGH CHANNEL 13

8.2.2. 802.11n HT20 MODE

1TX ANTENNA 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	16.476
Low 2	2417	16.464
Low 3	2422	16.478
Mid 6	2437	16.508
High 9	2452	16.446
High 10	2457	16.396
High 11	2462	16.402
High 12	2467	16.495
High 13	2472	16.417



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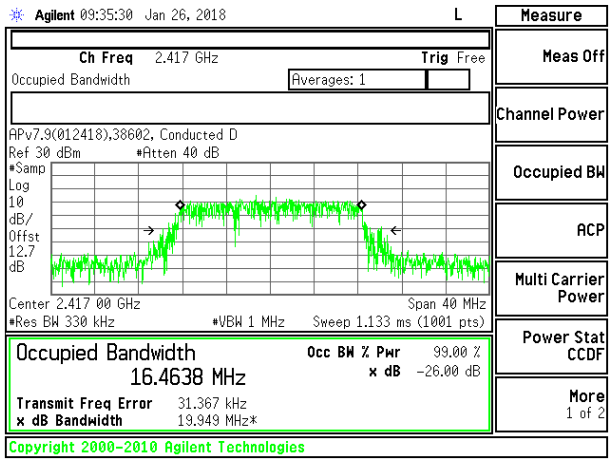

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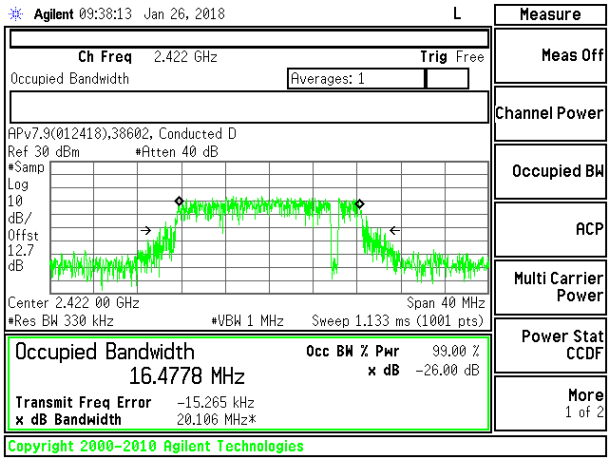

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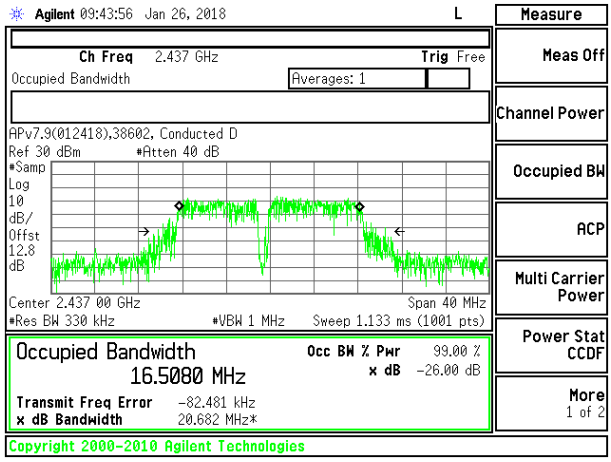

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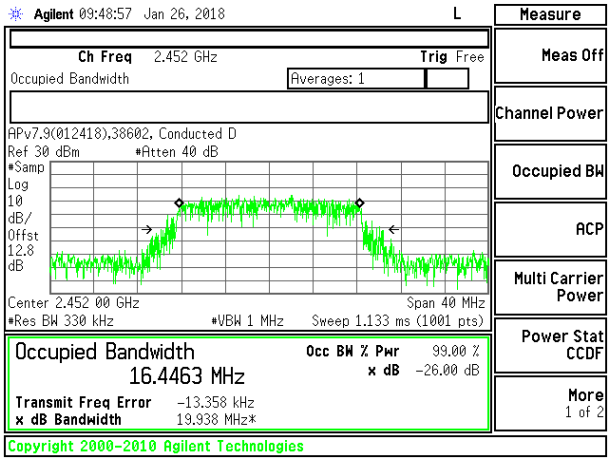
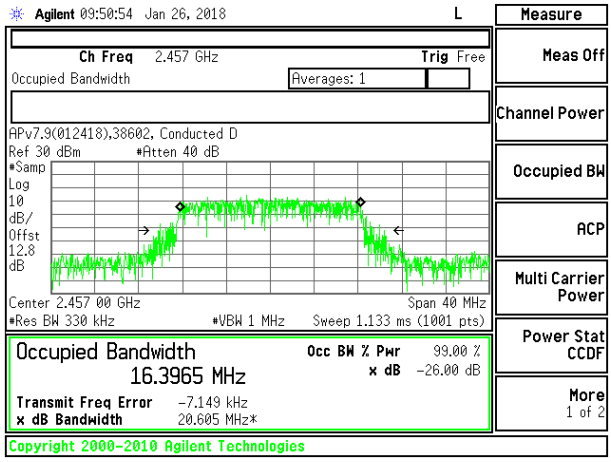
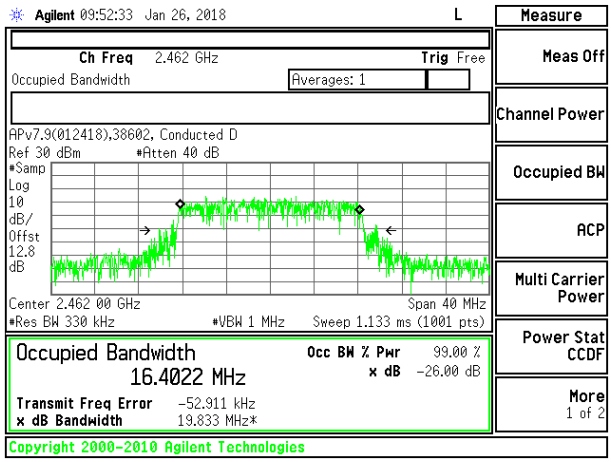


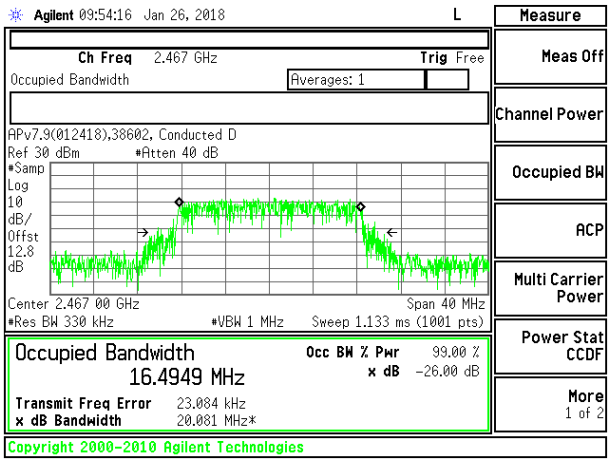
HIGH CHANNEL 9



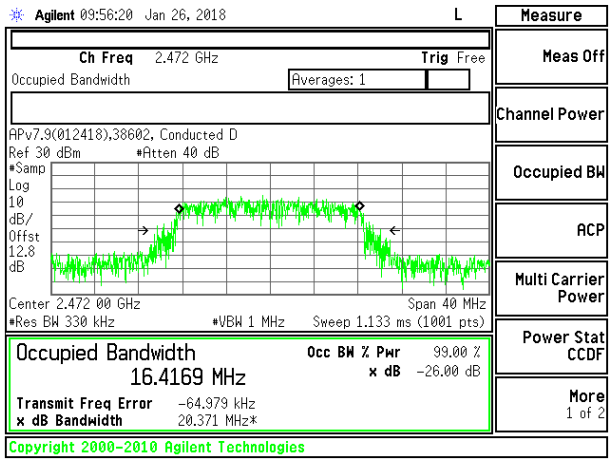
HIGH CHANNEL 10



HIGH CHANNEL 11



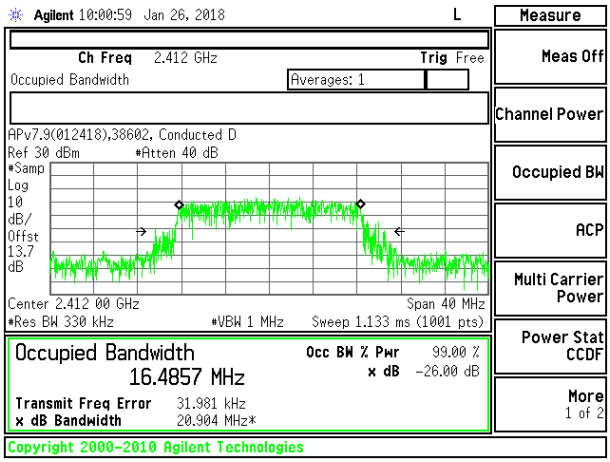
HIGH CHANNEL 12



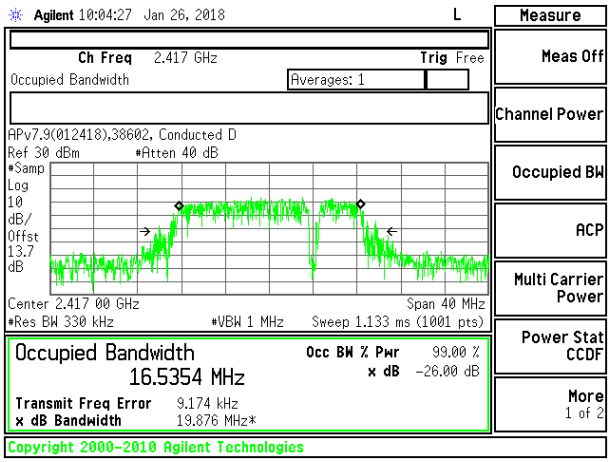
HIGH CHANNEL 13

1TX ANTENNA 3

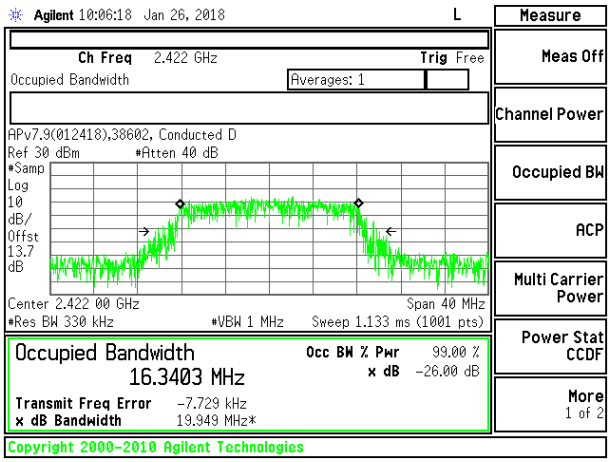
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low 1	2412	16.486
Low 2	2417	16.535
Low 3	2422	16.340
Mid 6	2437	16.584
High 9	2452	16.444
High 10	2457	16.456
High 11	2462	16.438
High 12	2467	16.434
High 13	2472	16.467



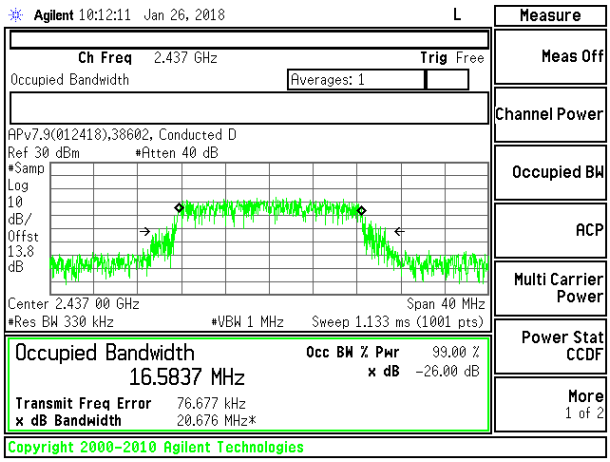
LOW CHANNEL 1



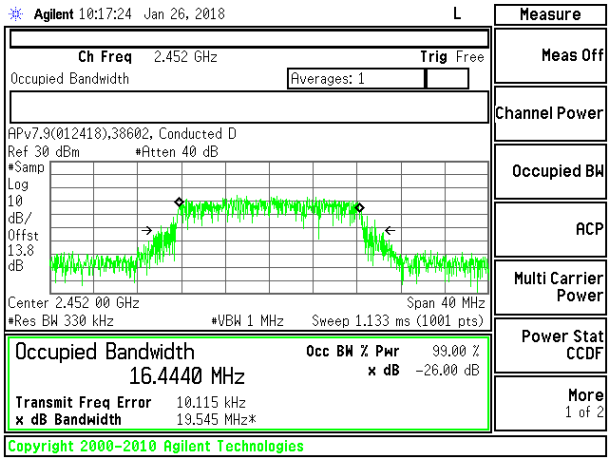
LOW CHANNEL 2



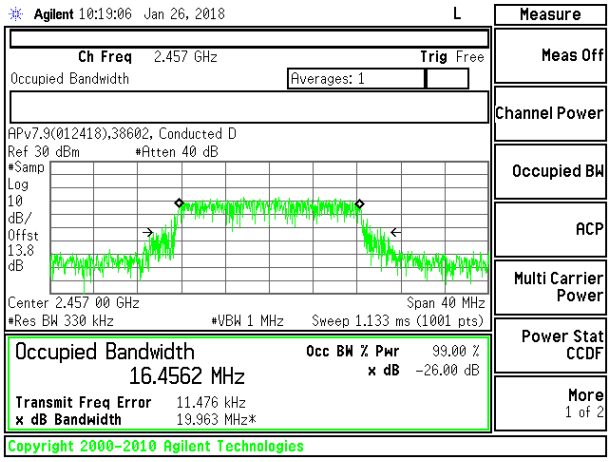
LOW CHANNEL 3



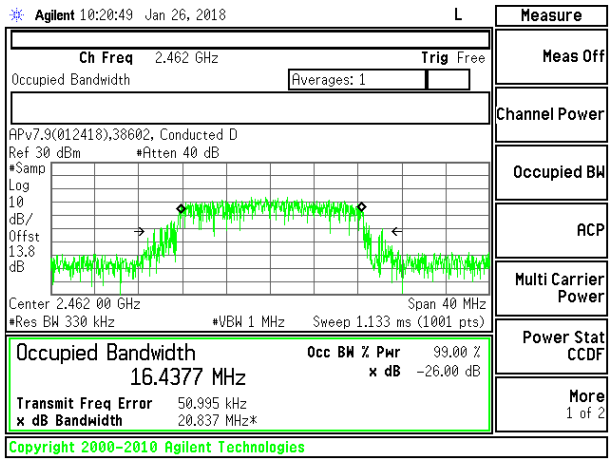
MID CHANNEL 6



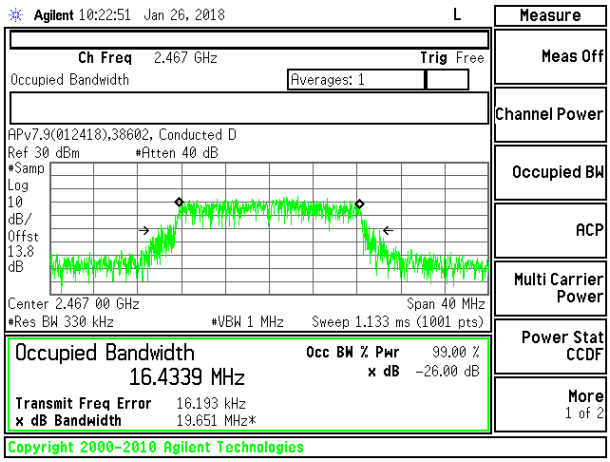
HIGH CHANNEL 9



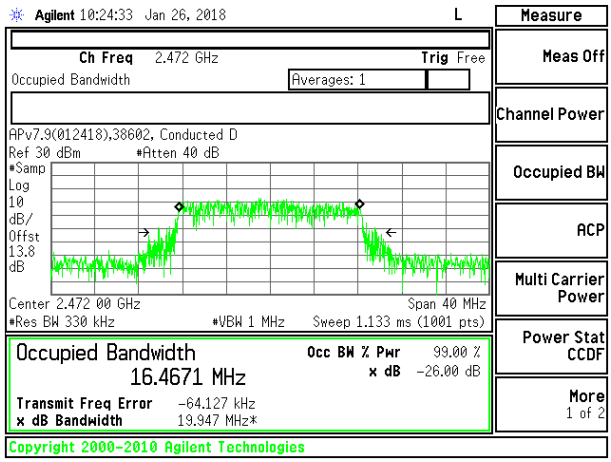
HIGH CHANNEL 10



HIGH CHANNEL 11



HIGH CHANNEL 12

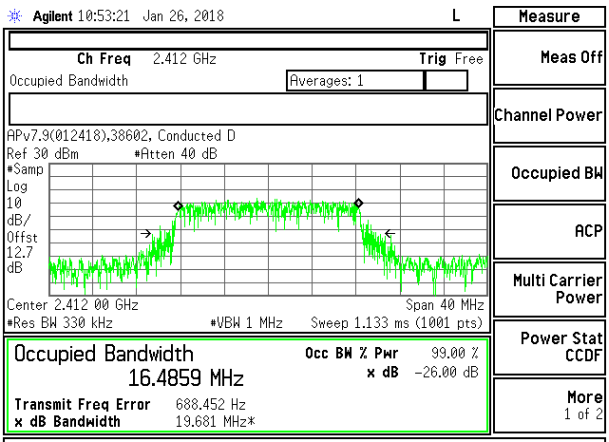


HIGH CHANNEL 13

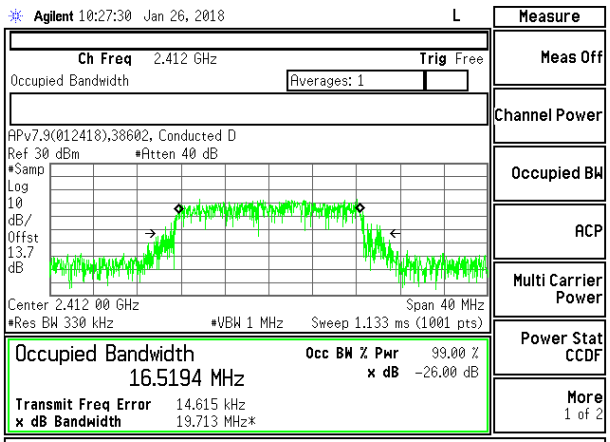
8.2.3. 2TX ANTENNA 4 + ANTENNA 3 CDD MODE

Channel	Frequency (MHz)	99% Bandwidth Ant 4 (MHz)	99% Bandwidth Ant 3 (MHz)
Low 1	2412	16.486	16.519
Low 2	2417	16.533	16.375
Low 3	2422	16.423	16.355
Low 4	2427	16.543	16.393
Mid 6	2437	16.525	16.400
High 8	2447	16.440	16.400
High 9	2452	16.506	16.529
High 10	2457	16.609	16.540
High 11	2462	16.479	16.474
High 12	2467	16.431	16.358
High 13	2472	16.460	16.445

LOW CHANNEL 1

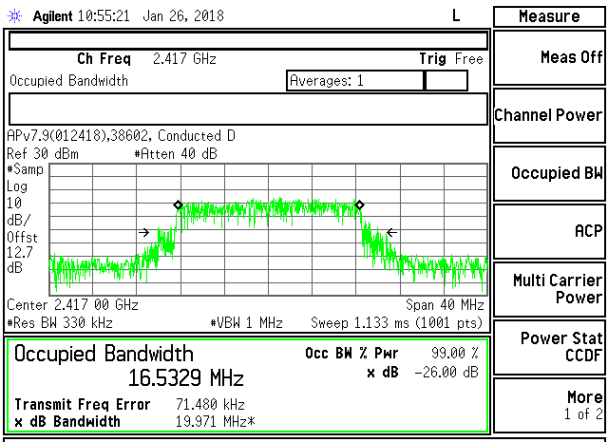


LOW CHANNEL 1 ANTENNA 4

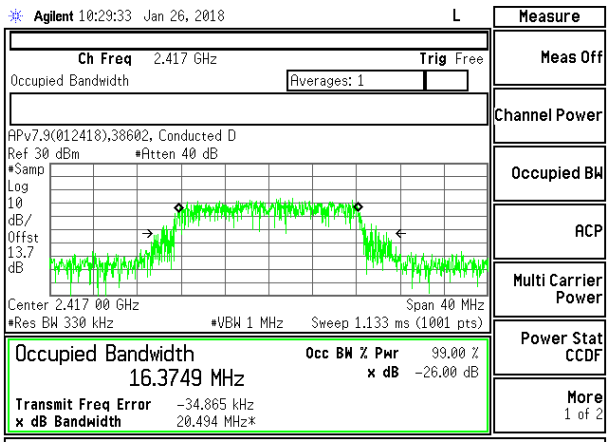


LOW CHANNEL 1 ANTENNA 3

LOW CHANNEL 2

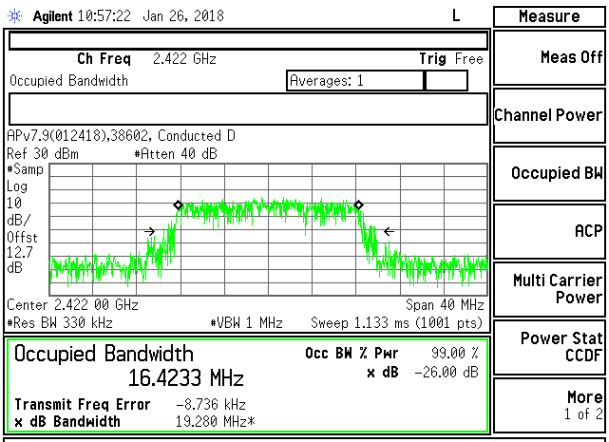


LOW CHANNEL 2 ANTENNA 4

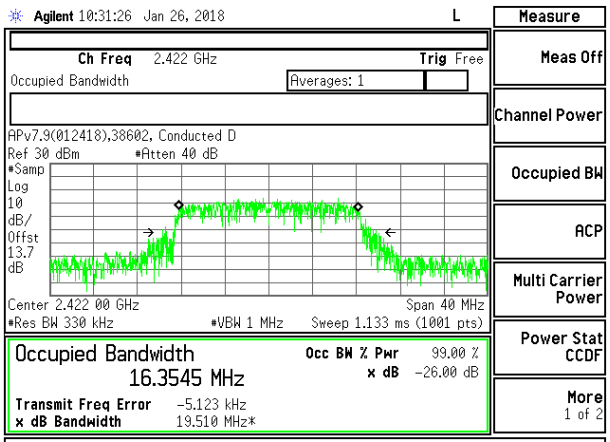


LOW CHANNEL 2 ANTENNA 3

LOW CHANNEL 3

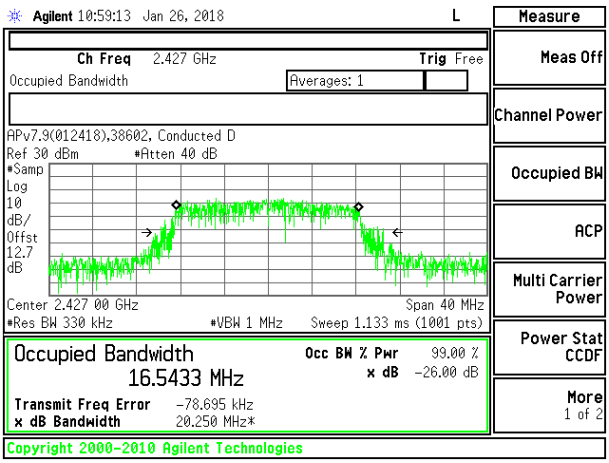


LOW CHANNEL 3 ANTENNA 4

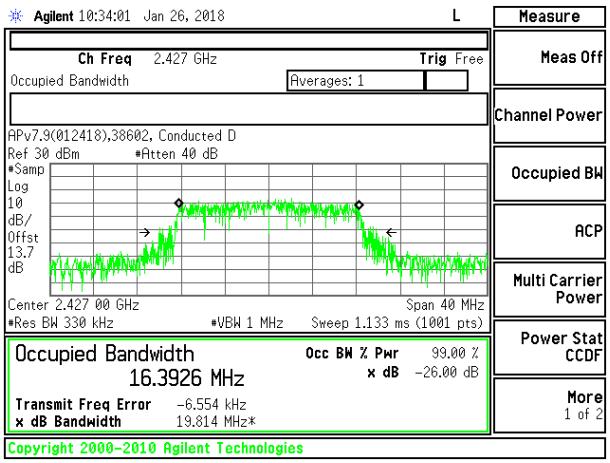


LOW CHANNEL 3 ANTENNA 3

LOW CHANNEL 4

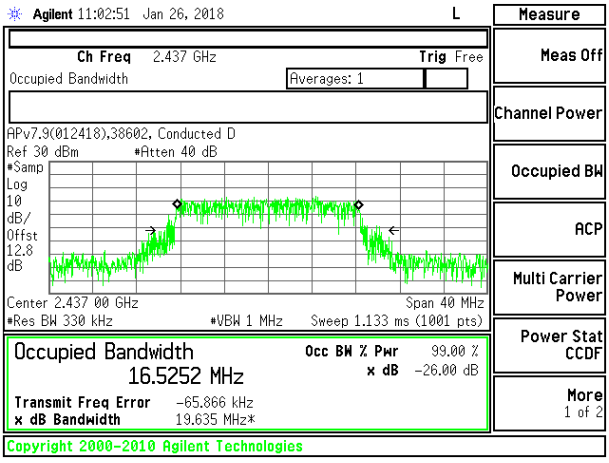


LOW CHANNEL 4 ANTENNA 4

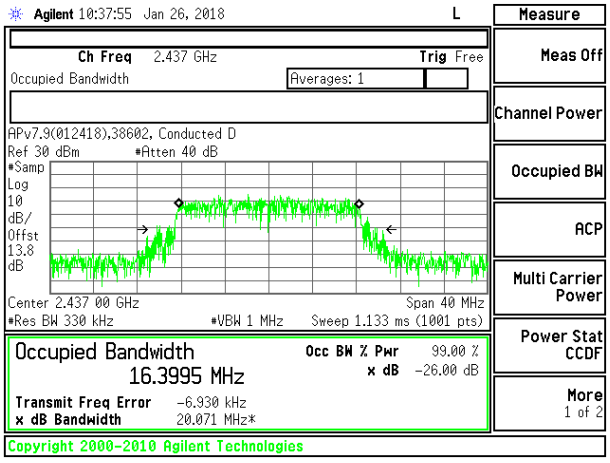


LOW CHANNEL 4 ANTENNA 3

MID CHANNEL 6

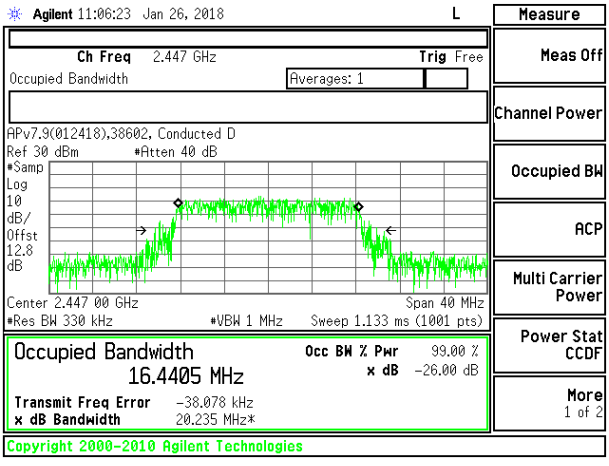


MID CHANNEL 6 ANTENNA 4

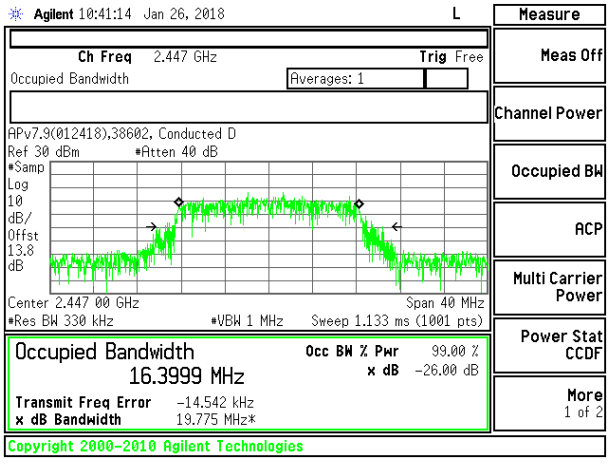


MID CHANNEL 6 ANTENNA 3

HIGH CHANNEL 8

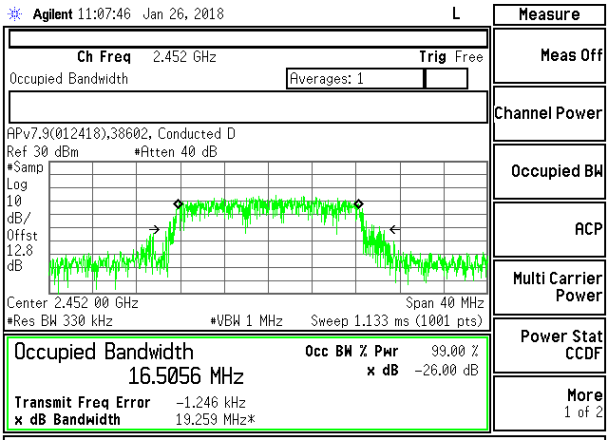


HIGH CHANNEL 8 ANTENNA 4

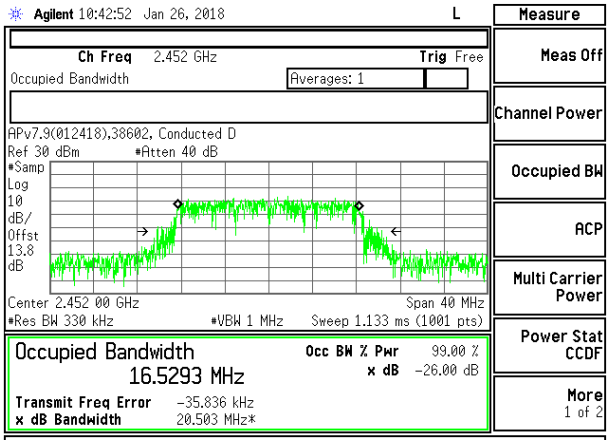


HIGH CHANNEL 8 ANTENNA 3

HIGH CHANNEL 9

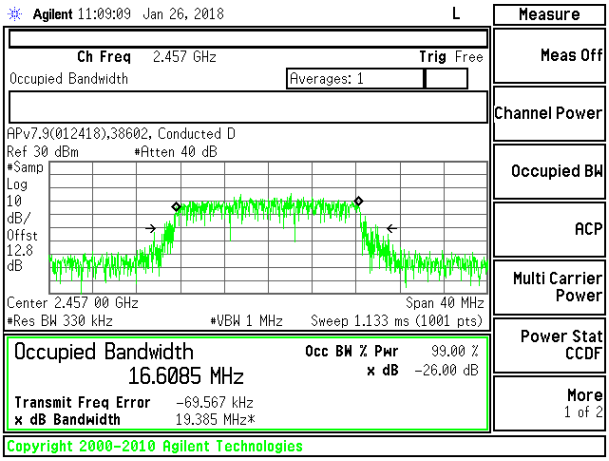


HIGH CHANNEL 9 ANTENNA 4

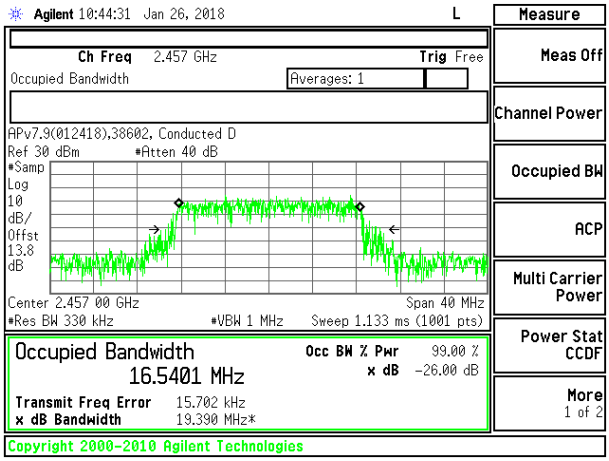


HIGH CHANNEL 9 ANTENNA 3

HIGH CHANNEL 10

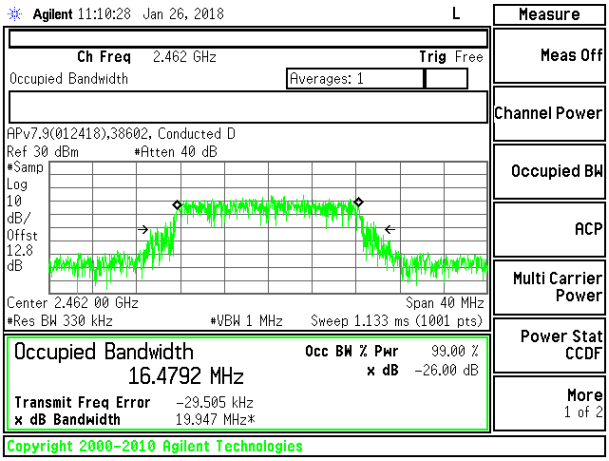


HIGH CHANNEL 10 ANTENNA 4

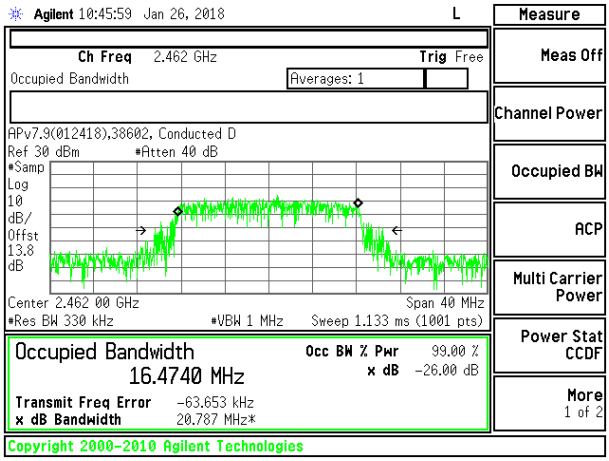


HIGH CHANNEL 10 ANTENNA 3

HIGH CHANNEL 11

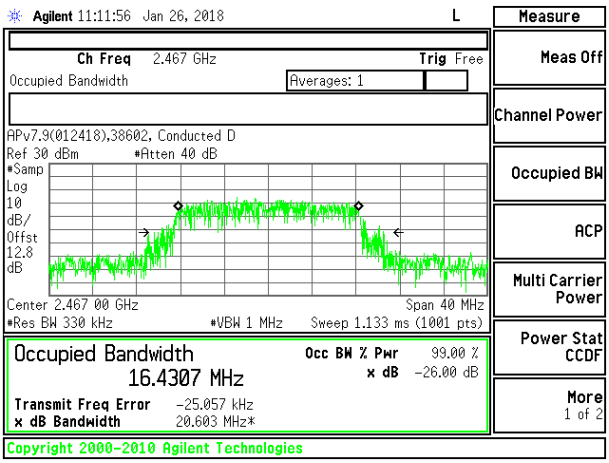


HIGH CHANNEL 11 ANTENNA 4

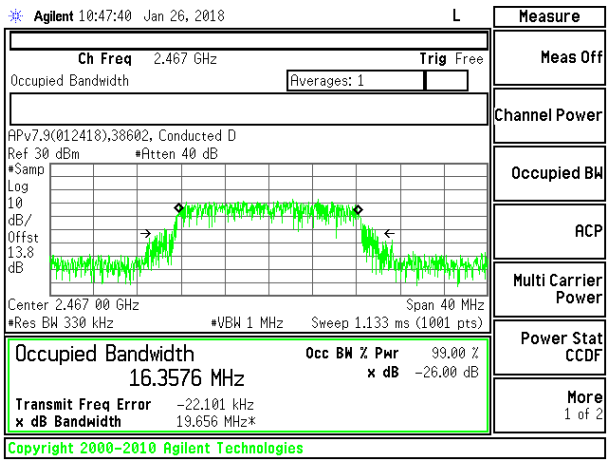


HIGH CHANNEL 11 ANTENNA 3

HIGH CHANNEL 12

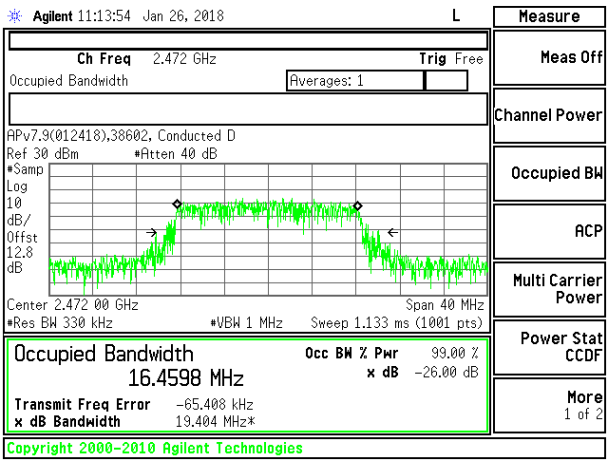


HIGH CHANNEL 12 ANTENNA 4

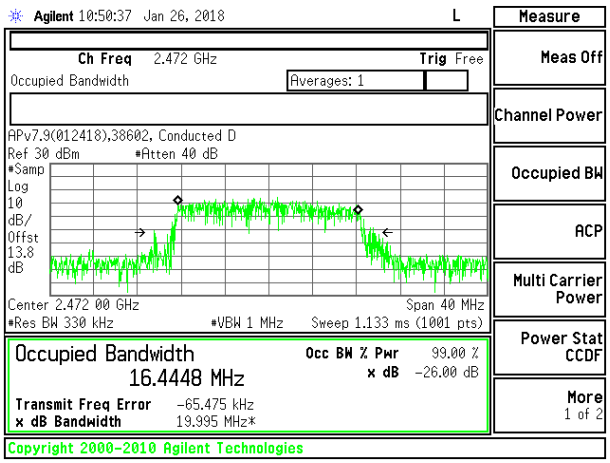


HIGH CHANNEL 12 ANTENNA 3

HIGH CHANNEL 13



HIGH CHANNEL 13 ANTENNA 4



HIGH CHANNEL 13 ANTENNA 3

8.3. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

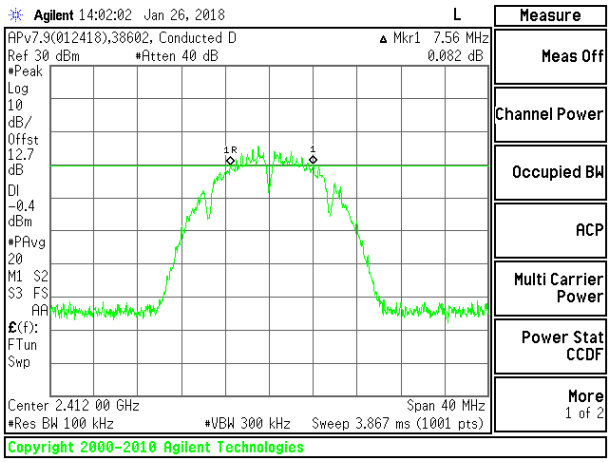
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

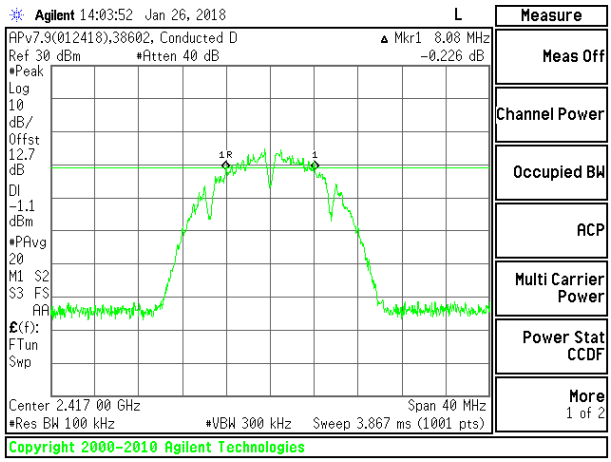
8.3.1. 802.11b MODE

1TX ANTENNA 4

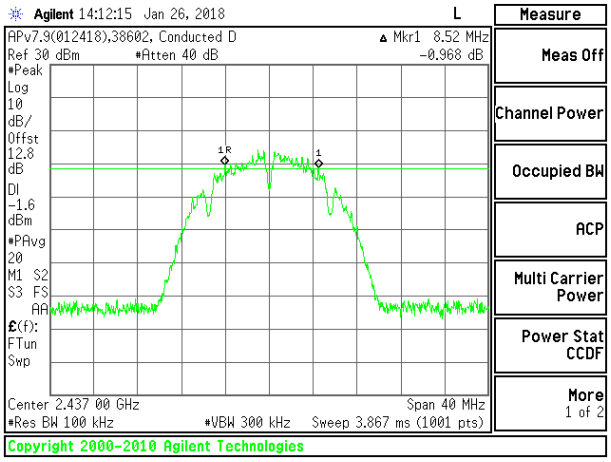
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	7.560	0.5
Low 2	2417	8.080	0.5
Mid 6	2437	8.520	0.5
High 11	2462	8.040	0.5
High 12	2467	8.080	0.5
High 13	2472	7.600	0.5



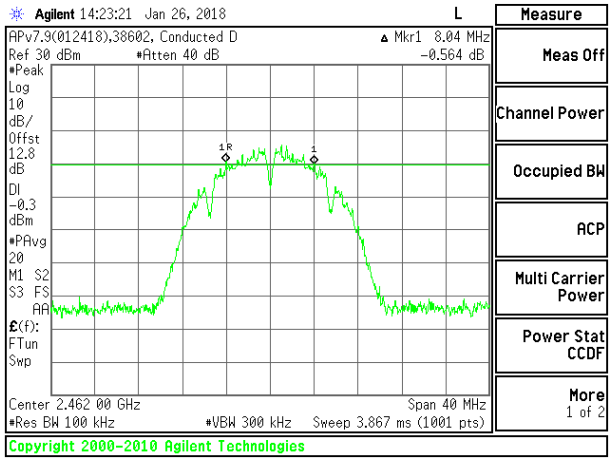
LOW CHANNEL 1



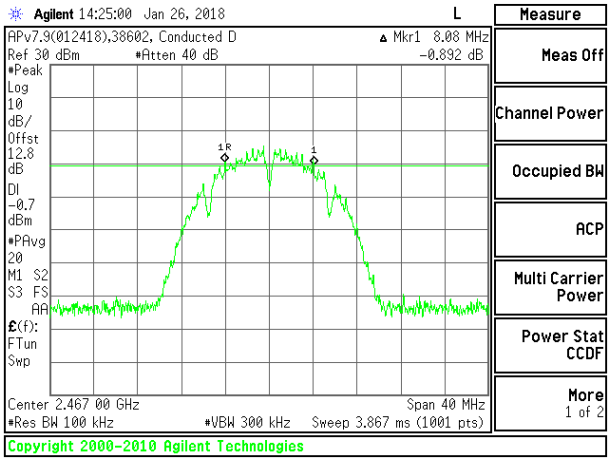
LOW CHANNEL 2



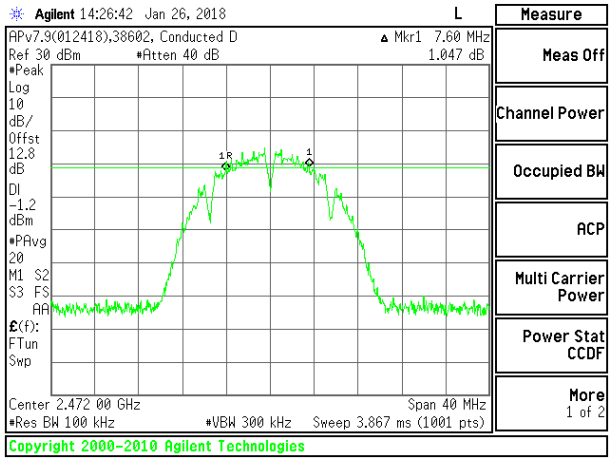
MID CHANNEL 6



HIGH CHANNEL 11



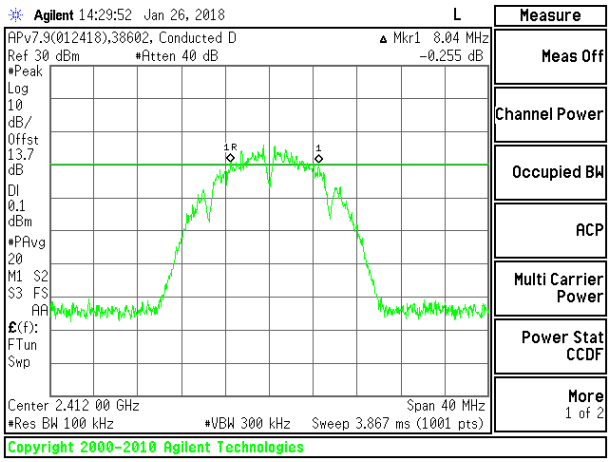
HIGH CHANNEL 12



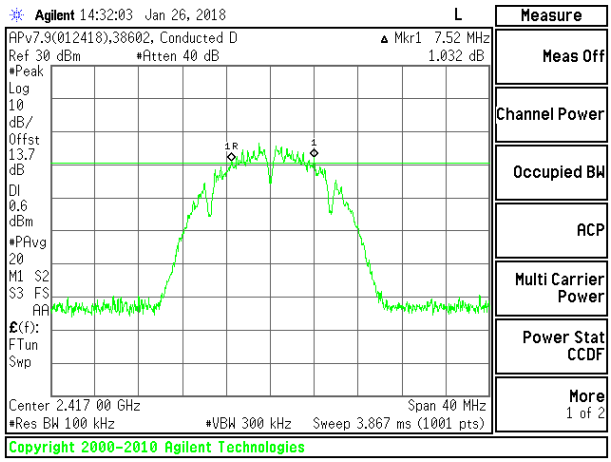
HIGH CHANNEL 13

1TX ANTENNA 3

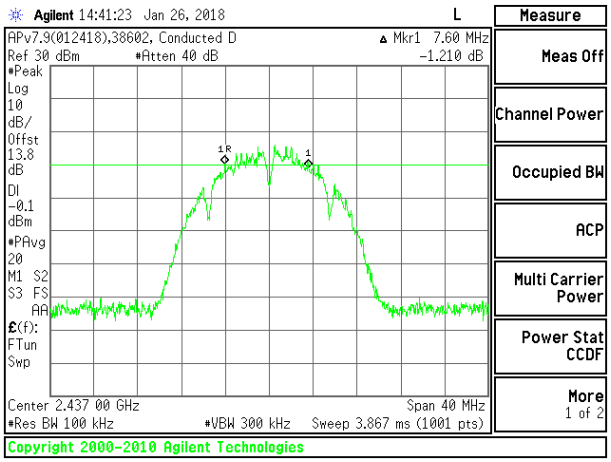
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	8.040	0.5
Low 2	2417	7.520	0.5
Mid 6	2437	7.600	0.5
High 11	2462	8.120	0.5
High 12	2467	8.080	0.5
High 13	2472	8.040	0.5



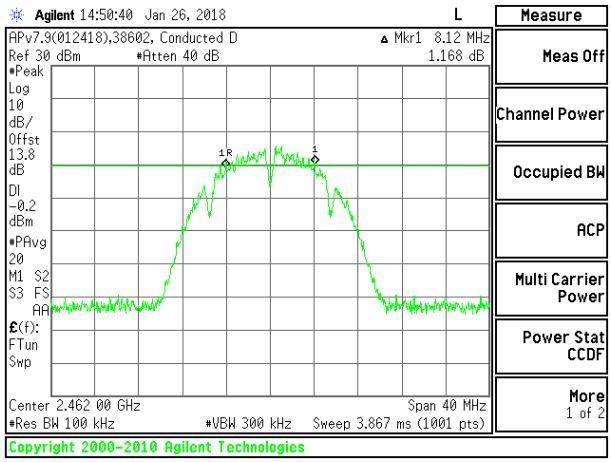
LOW CHANNEL 1



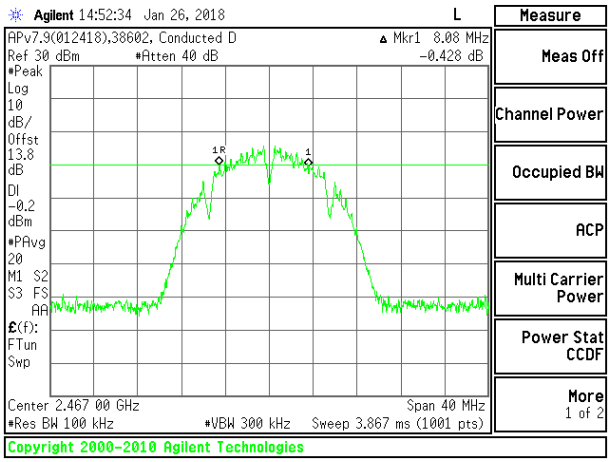
LOW CHANNEL 2



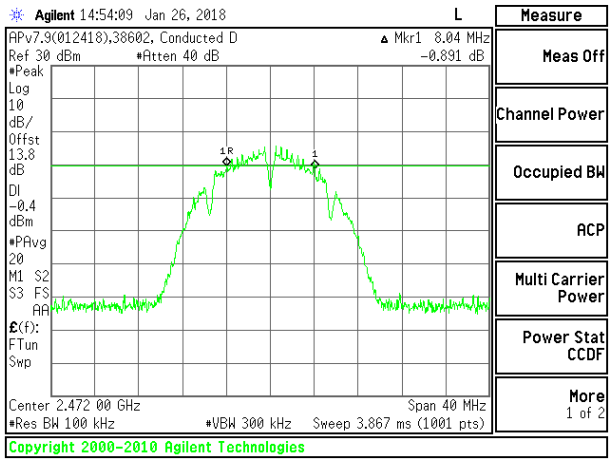
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

8.3.2. 802.11n HT20 MODE

1TX ANTENNA 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	17.68	0.5
Low 2	2417	16.32	0.5
Low 3	2422	17.68	0.5
Mid 6	2437	15.64	0.5
High 9	2452	16.40	0.5
High 10	2457	16.28	0.5
High 11	2462	15.56	0.5
High 12	2467	16.36	0.5
High 13	2472	15.88	0.5

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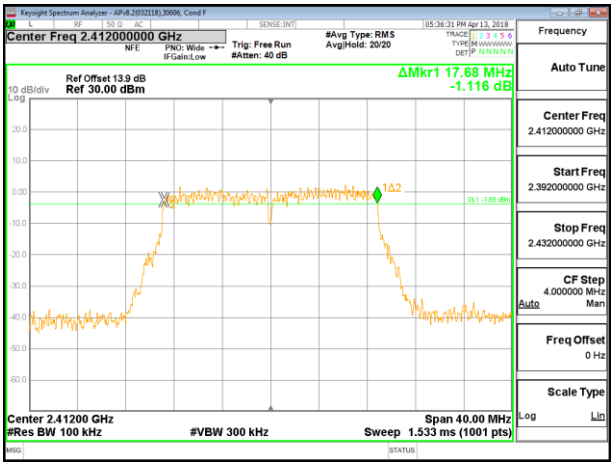
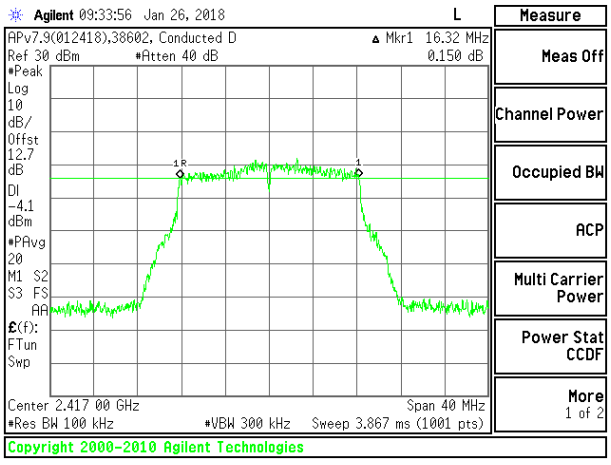
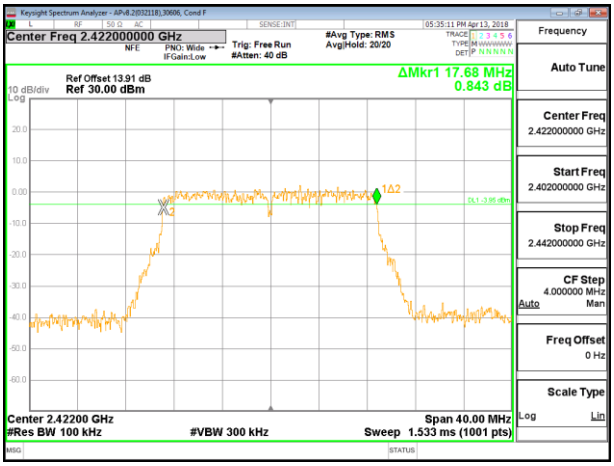


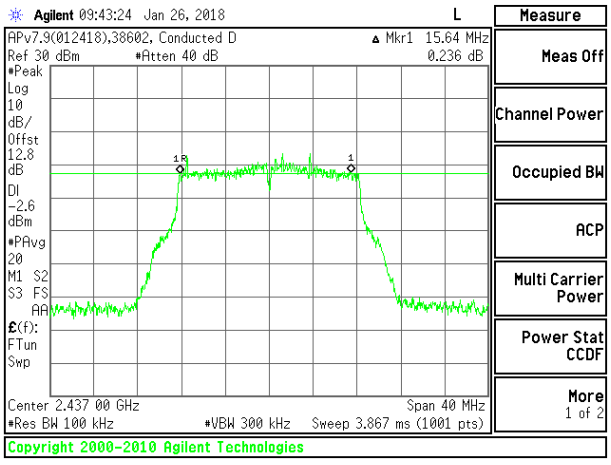
LOW CHANNEL 1



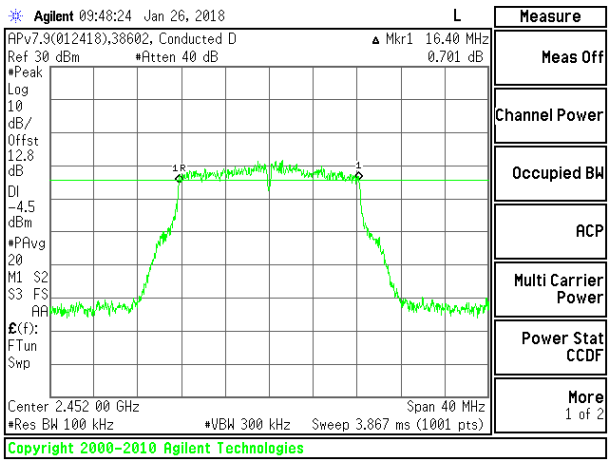
LOW CHANNEL 2



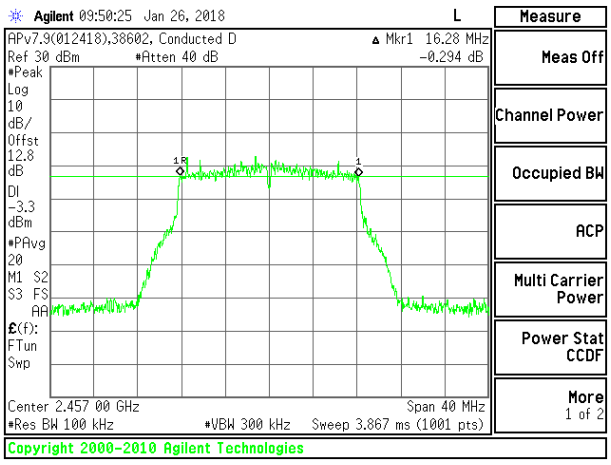
LOW CHANNEL 3



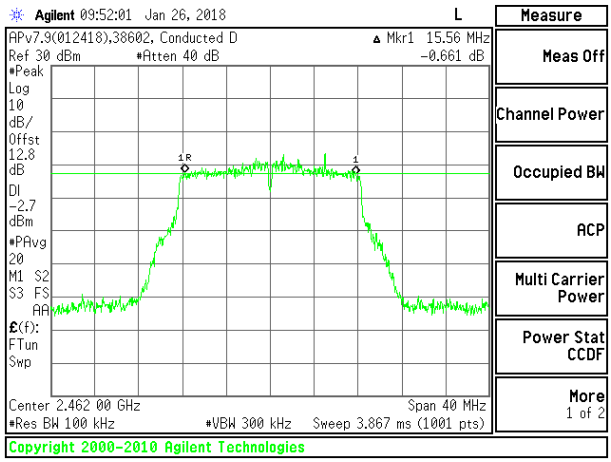
MID CHANNEL 6



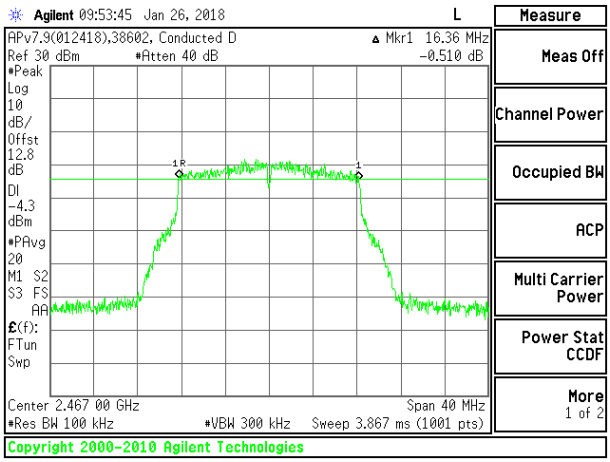
HIGH CHANNEL 9



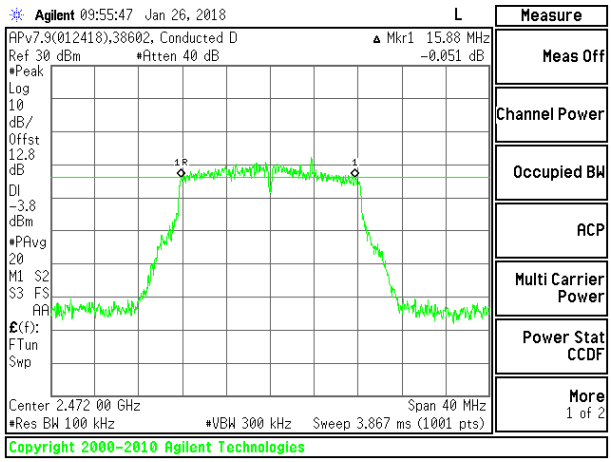
HIGH CHANNEL 10



HIGH CHANNEL 11



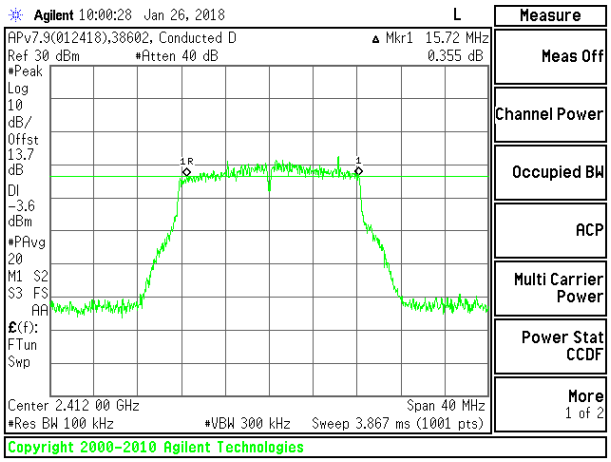
HIGH CHANNEL 12



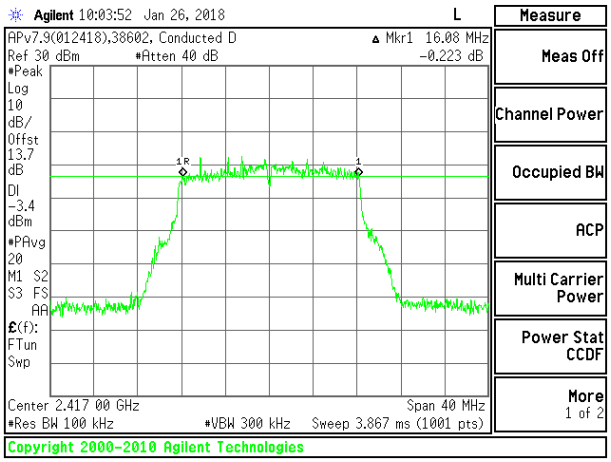
HIGH CHANNEL 13

1TX ANTENNA 3

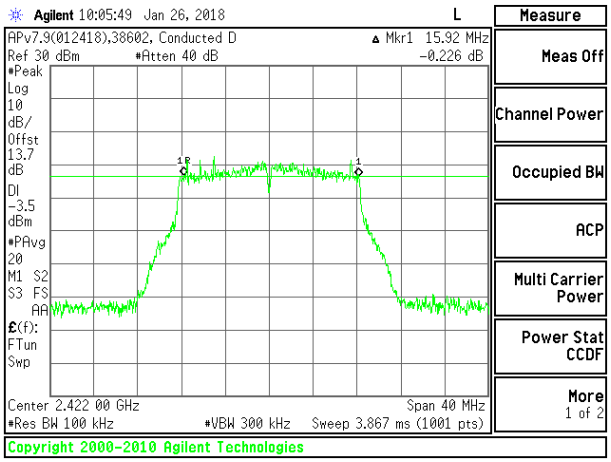
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low 1	2412	15.720	0.5
Low 2	2417	16.080	0.5
Low 3	2422	15.920	0.5
Mid 6	2437	15.920	0.5
High 9	2452	16.280	0.5
High 10	2457	16.320	0.5
High 11	2462	15.320	0.5
High 12	2467	16.360	0.5
High 13	2472	15.760	0.5



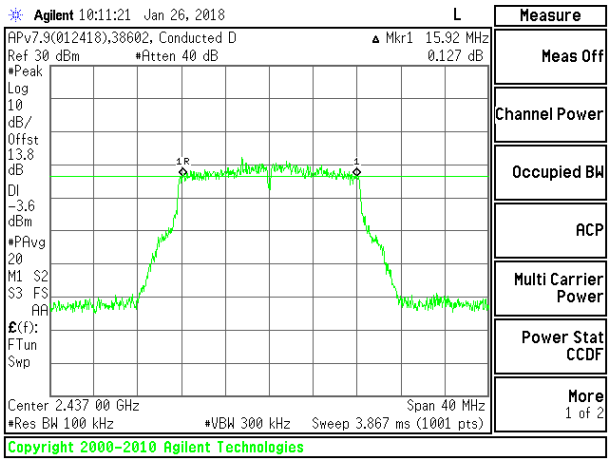
LOW CHANNEL 1



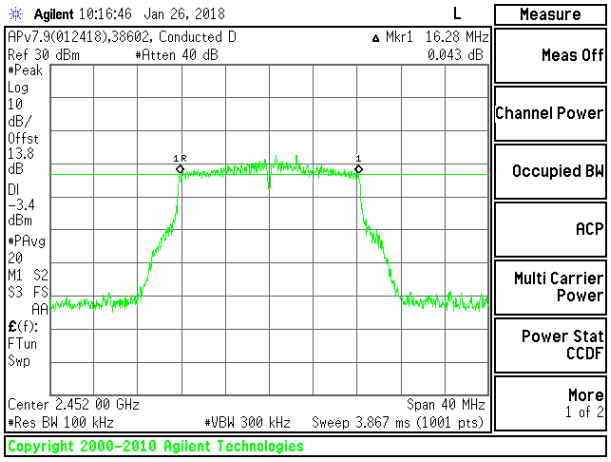
LOW CHANNEL 2



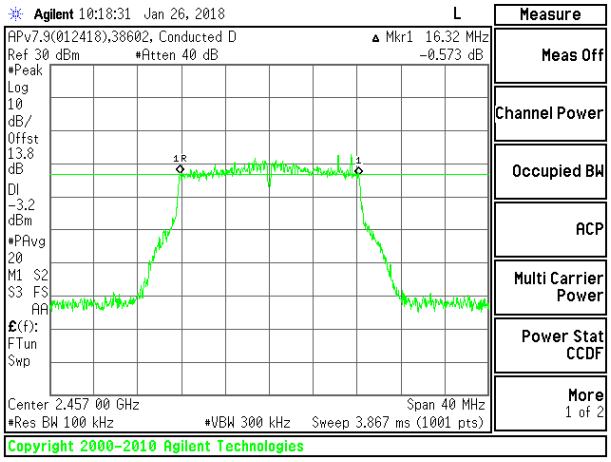
LOW CHANNEL 3



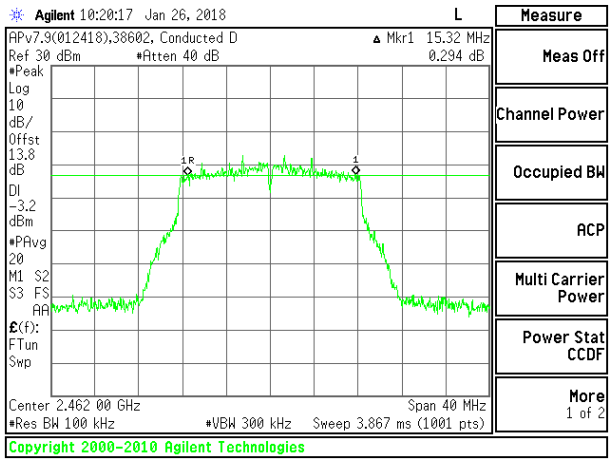
MID CHANNEL 6



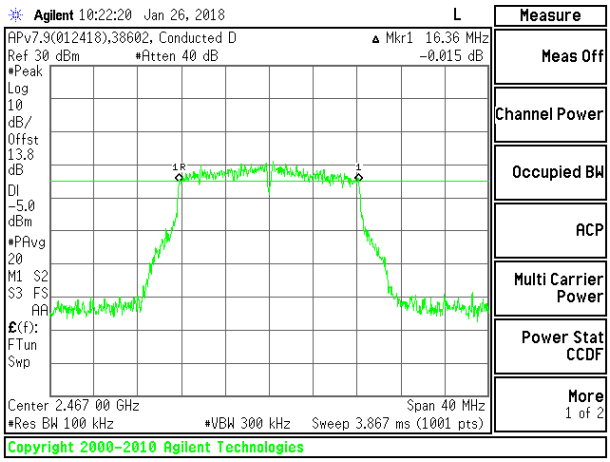
HIGH CHANNEL 9



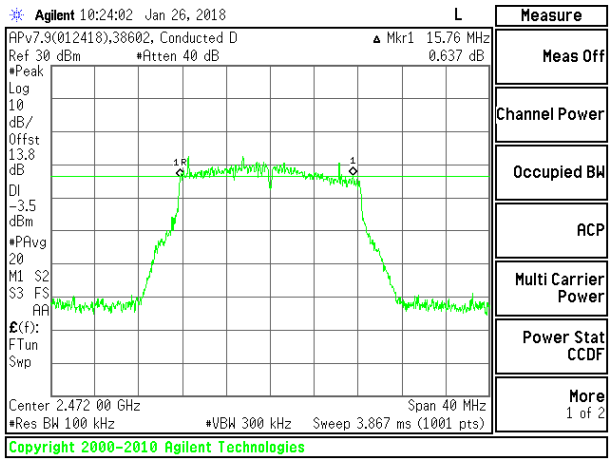
HIGH CHANNEL 10



HIGH CHANNEL 11



HIGH CHANNEL 12

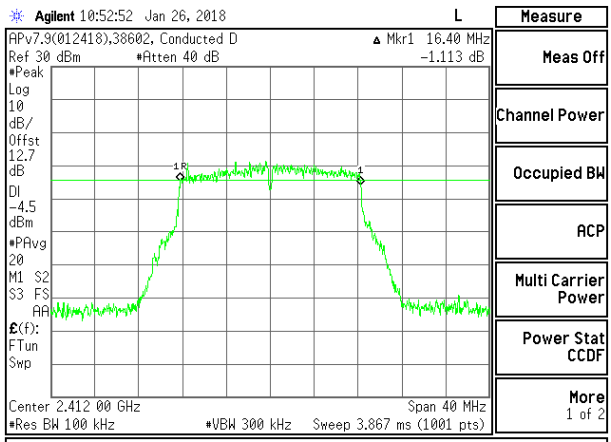


HIGH CHANNEL 13

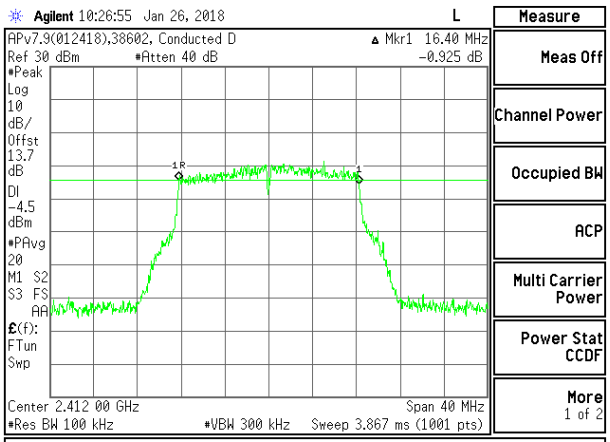
8.3.3. 2TX ANTENNA 4 + ANTENNA 3 CDD MODE

Channel	Frequency (MHz)	6 dB BW Ant 4 (MHz)	6 dB BW Ant 3 (MHz)	Minimum Limit (MHz)
Low 1	2412	16.400	16.400	0.5
Low 2	2417	16.320	15.800	0.5
Low 3	2422	16.320	16.560	0.5
Low 4	2427	16.360	16.080	0.5
Mid 6	2437	15.640	16.360	0.5
High 8	2447	16.280	16.360	0.5
High 9	2452	15.680	16.320	0.5
High 10	2457	16.280	16.040	0.5
High 11	2462	16.360	16.120	0.5
High 12	2467	16.000	15.720	0.5
High 13	2472	15.960	16.400	0.5

LOW CHANNEL 1

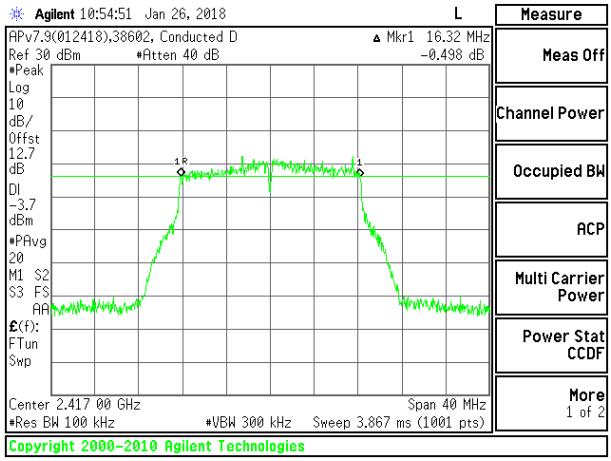


LOW CHANNEL 1 ANTENNA 4

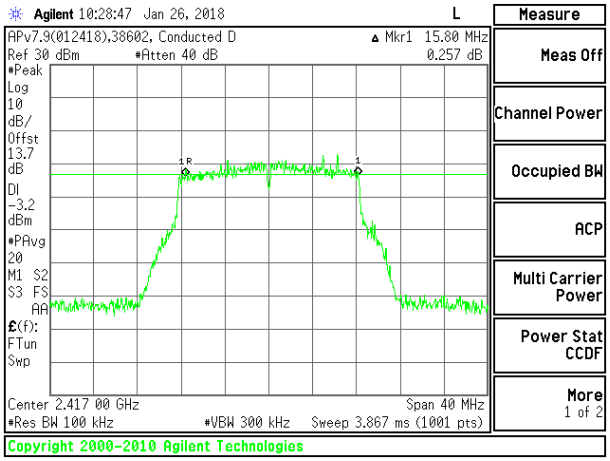


LOW CHANNEL 1 ANTENNA 3

LOW CHANNEL 2

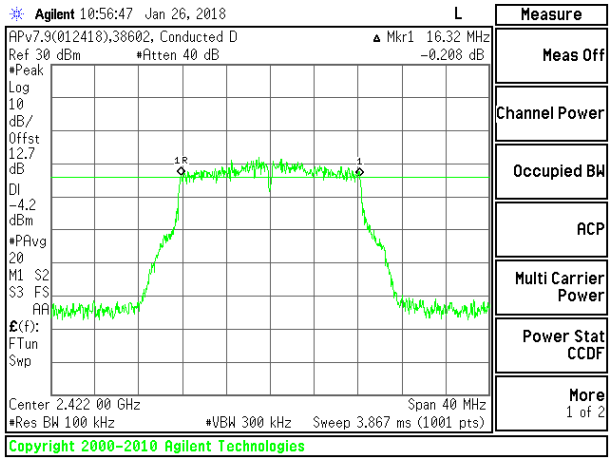


LOW CHANNEL 2 ANTENNA 4

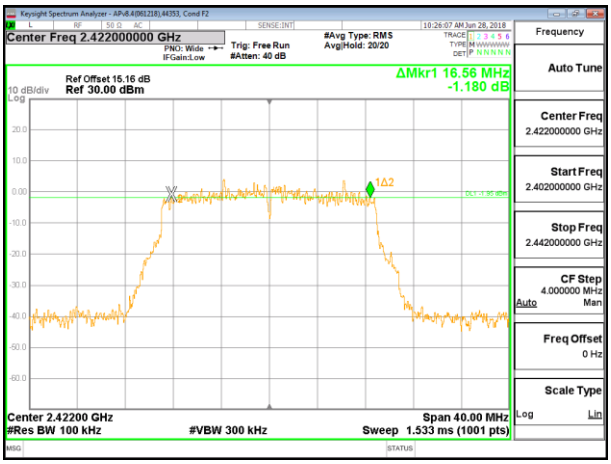


LOW CHANNEL 2 ANTENNA 3

LOW CHANNEL 3

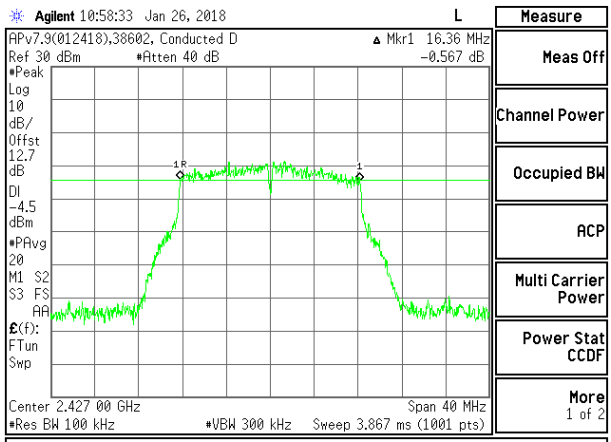


LOW CHANNEL 3 ANTENNA 4

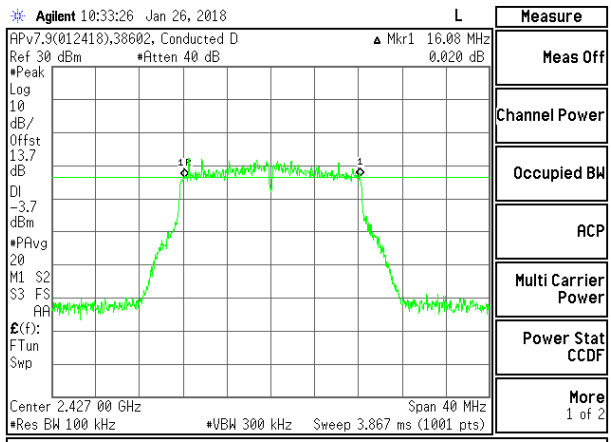


LOW CHANNEL 3 ANTENNA 3

LOW CHANNEL 4

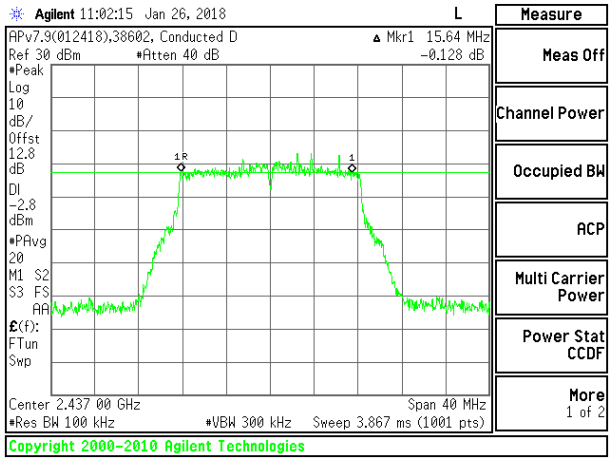


LOW CHANNEL 4 ANTENNA 4

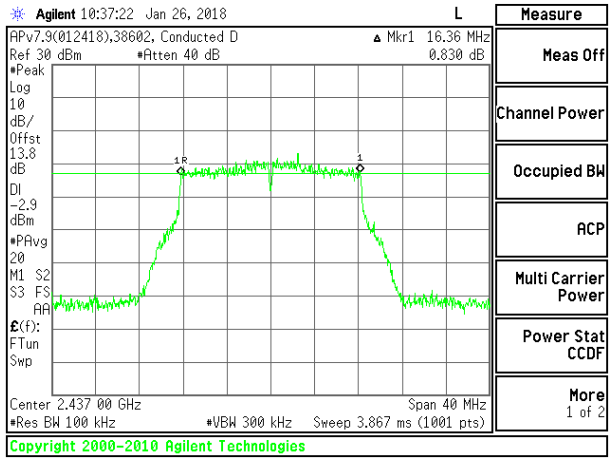


LOW CHANNEL 4 ANTENNA 3

MID CHANNEL 6

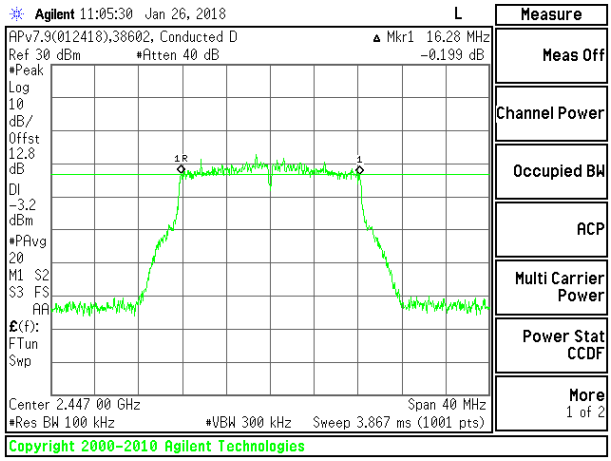


MID CHANNEL 6 ANTENNA 4

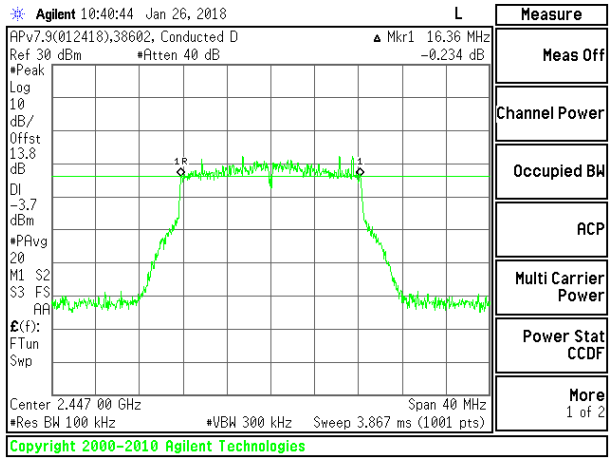


MID CHANNEL 6 ANTENNA 3

HIGH CHANNEL 8

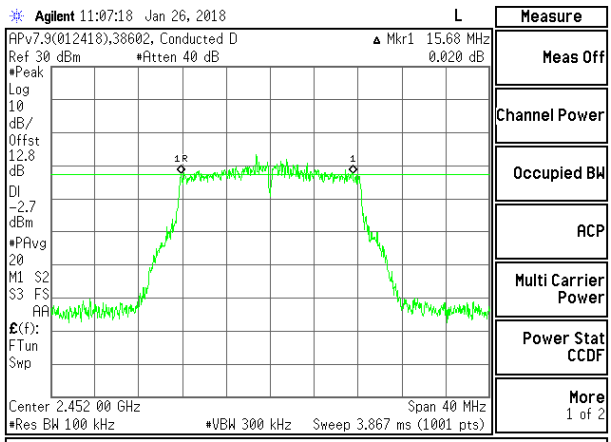


HIGH CHANNEL 8 ANTENNA 4

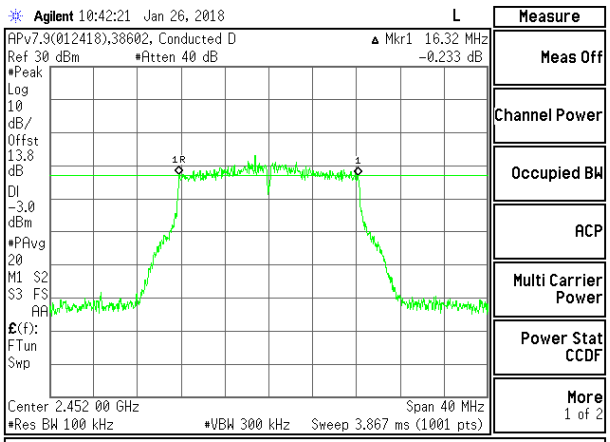


HIGH CHANNEL 8 ANTENNA 3

HIGH CHANNEL 9

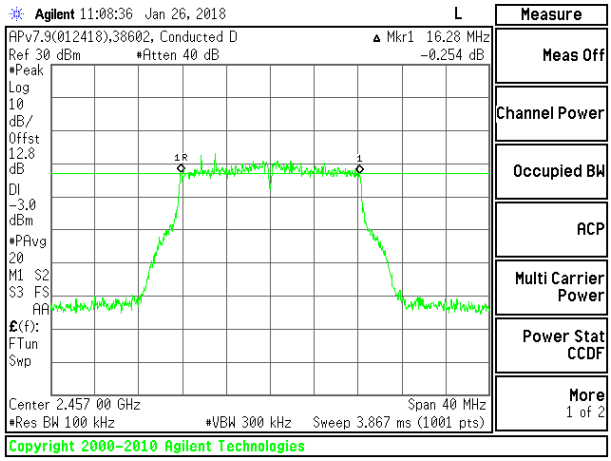


HIGH CHANNEL 9 ANTENNA 4

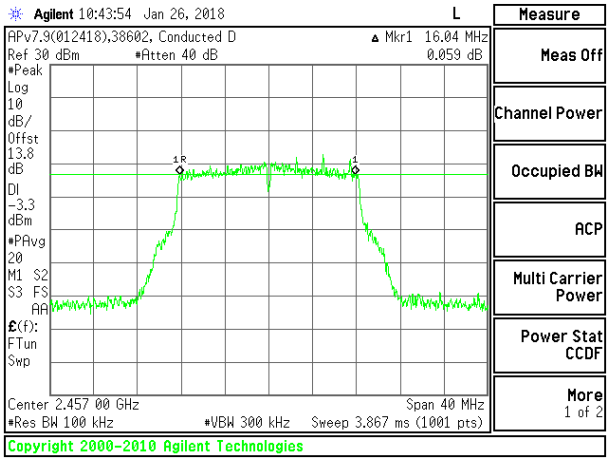


HIGH CHANNEL 9 ANTENNA 3

HIGH CHANNEL 10

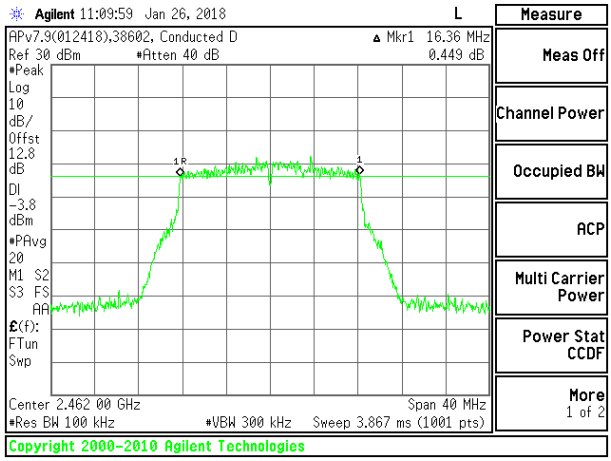


HIGH CHANNEL 10 ANTENNA 4

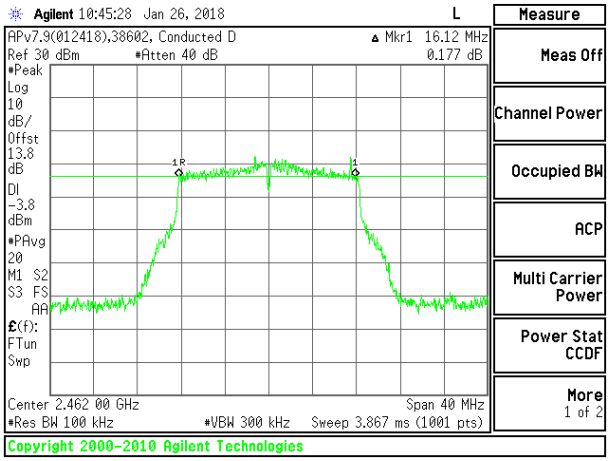


HIGH CHANNEL 10 ANTENNA 3

HIGH CHANNEL 11

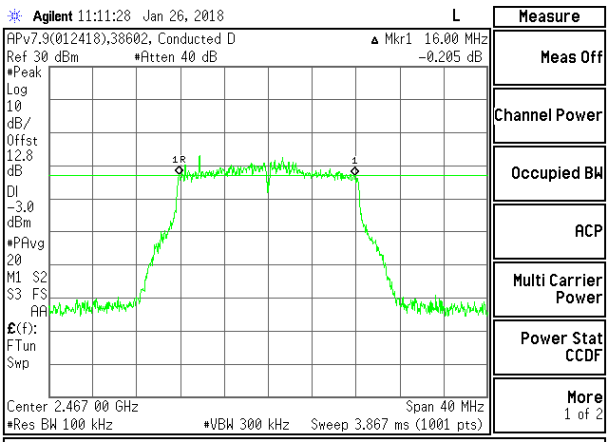


HIGH CHANNEL 11 ANTENNA 4

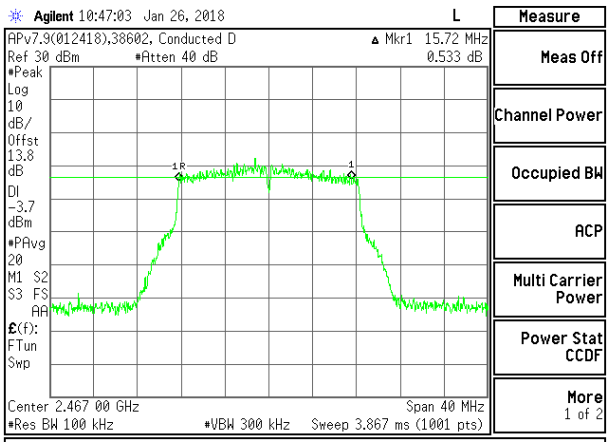


HIGH CHANNEL 11 ANTENNA 3

HIGH CHANNEL 12

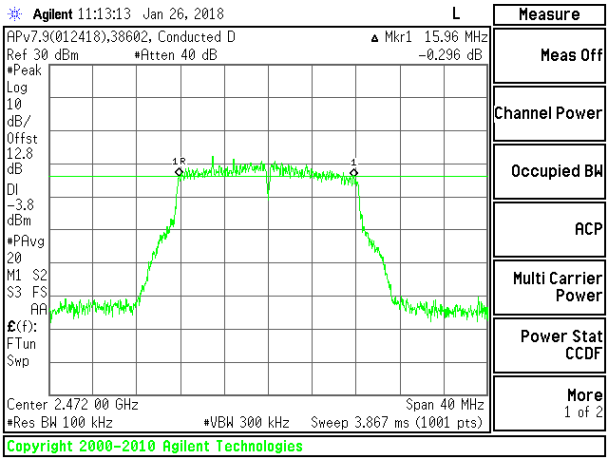


HIGH CHANNEL 12 ANTENNA 4

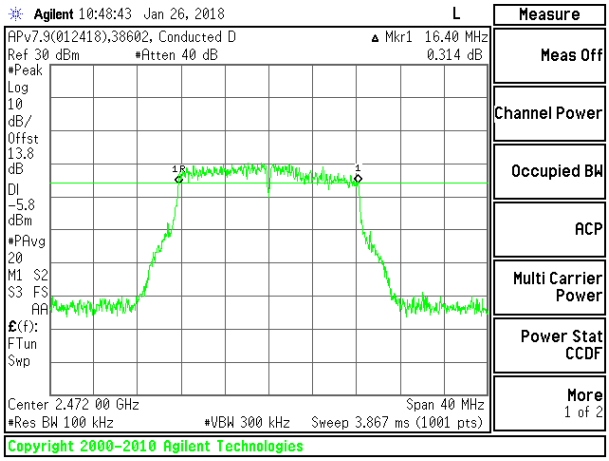


HIGH CHANNEL 12 ANTENNA 3

HIGH CHANNEL 13



HIGH CHANNEL 13 ANTENNA 4



HIGH CHANNEL 13 ANTENNA 3

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 broadband power meter

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

DIRECTIONAL ANTENNA GAIN

For 1 TX:
There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2 TX:

Tx chains are uncorrelated for power and correlated for PSD due to the device supporting CDD in all MIMO modes. The directional gains are as follows:

Band (GHz)	Antenna 4 Gain (dBi)	Antenna 3 Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.4	-2.80	-4.10	-3.40	-0.42

RESULTS

8.4.1. 802.11b MODE

ID:	30554	Date:	6/26/2018

1TX ANT. 4

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-2.80	30.00	30	36	30.00
Low_2	2417	-2.80	30.00	30	36	30.00
Mid	2437	-2.80	30.00	30	36	30.00
High_11	2462	-2.80	30.00	30	36	30.00
High_12	2467	-2.80	30.00	30	36	30.00
High_13	2472	-2.80	30.00	30	36	30.00

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

Results

Channel	Frequency (MHz)	Measured Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low_1	2412	19.29	19.29	30.00	-10.71
Low_2	2417	19.46	19.46	30.00	-10.54
Mid	2437	19.31	19.31	30.00	-10.69
High_10	2457	19.38	19.38	30.00	-10.62
High_11	2462	19.35	19.35	30.00	-10.65
High_12	2467	19.44	19.44	30.00	-10.56
High_13	2472	18.93	18.93	30.00	-11.07

ID:	30554	Date:	6/26/2018

1TX ANT. 3

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-4.10	30.00	30	36	30.00
Low_2	2417	-4.10	30.00	30	36	30.00
Mid	2437	-4.10	30.00	30	36	30.00
High_10	2457	-4.10	30.00	30	36	30.00
High_11	2462	-4.10	30.00	30	36	30.00
High_12	2467	-4.10	30.00	30	36	30.00
High_13	2472	-4.10	30.00	30	36	30.00

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

Results

Channel	Frequency (MHz)	Measured Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low_1	2412	20.33	20.33	30.00	-9.67
Low_2	2417	21.83	21.83	30.00	-8.17
Mid	2437	21.93	21.93	30.00	-8.07
High_10	2457	21.78	21.78	30.00	-8.22
High_11	2462	21.65	21.65	30.00	-8.35
High_12	2467	20.46	20.46	30.00	-9.54
High_13	2472	18.86	18.86	30.00	-11.14

8.4.2. 802.11n HT20 MODE

ID:	30554	Date:	6/26/2018

1TX ANT. 4

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-2.80	30.00	30	36	30.00
Low_2	2417	-2.80	30.00	30	36	30.00
Low_3	2422	-2.80	30.00	30	36	30.00
Mid_6	2437	-2.80	30.00	30	36	30.00
High_9	2452	-2.80	30.00	30	36	30.00
High_10	2457	-2.80	30.00	30	36	30.00
High_11	2462	-2.80	30.00	30	36	30.00
High_12	2467	-2.80	30.00	30	36	30.00
High_13	2472	-2.80	30.00	30	36	30.00

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

Results

Channel	Frequency (MHz)	Measured Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low_1	2412	17.30	17.30	30.00	-12.70
Low_2	2417	19.44	19.44	30.00	-10.56
Low_3	2422	19.39	19.39	30.00	-10.61
Mid_6	2437	19.32	19.32	30.00	-10.68
High_9	2452	19.44	19.44	30.00	-10.56
High_10	2457	19.35	19.35	30.00	-10.65
High_11	2462	17.43	17.43	30.00	-12.57
High_12	2467	15.20	15.20	30.00	-14.80
High_13	2472	7.95	7.95	30.00	-22.05

ID:	30554	Date:	6/26/2018

1TX ANT. 3

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-4.10	30.00	30	36	30.00
Low_2	2417	-4.10	30.00	30	36	30.00
Low_3	2422	-4.10	30.00	30	36	30.00
Mid_6	2437	-4.10	30.00	30	36	30.00
High_9	2452	-4.10	30.00	30	36	30.00
High_10	2457	-4.10	30.00	30	36	30.00
High_11	2462	-4.10	30.00	30	36	30.00
High_12	2467	-4.10	30.00	30	36	30.00
High_13	2472	-4.10	30.00	30	36	30.00

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

Results

Channel	Frequency (MHz)	Measured Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low_1	2412	17.41	17.41	30.00	-12.59
Low_2	2417	19.42	19.42	30.00	-10.58
Low_3	2422	21.75	21.75	30.00	-8.25
Mid_6	2437	21.89	21.89	30.00	-8.11
High-9	2452	21.83	21.83	30.00	-8.17
High-10	2457	19.35	19.35	30.00	-10.65
High_11	2462	17.29	17.29	30.00	-12.71
High_12	2467	15.44	15.44	30.00	-14.56
High_13	2472	7.87	7.87	30.00	-22.13

8.4.3. 2TX ANT. 4 + ANT. 3 CDD MODE

ID:	30554	Date:	6/26/2018

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC Power Limit (dBm)	IC Power Limit (dBm)	IC EIRP Limit (dBm)	Max Power (dBm)
Low_1	2412	-3.40	30.00	30	36	30.00
Low_2	2417	-3.40	30.00	30	36	30.00
Low_3	2422	-3.40	30.00	30	36	30.00
Low_4	2427	-3.40	30.00	30	36	30.00
Mid	2437	-3.40	30.00	30	36	30.00
High_8	2447	-3.40	30.00	30	36	30.00
High_9	2452	-3.40	30.00	30	36	30.00
High_10	2457	-3.40	30.00	30	36	30.00
High_11	2462	-3.40	30.00	30	36	30.00
High_12	2467	-3.40	30.00	30	36	30.00
High_13	2472	-3.40	30.00	30	36	30.00

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

Results

Channel	Frequency (MHz)	Ant 4 Measured Power (dBm)	Ant 3 Measured Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margi (dB)
Low_1	2412	16.38	16.31	19.36	30.00	-10.64
Low_2	2417	18.40	18.31	21.37	30.00	-8.63
Low_3	2422	19.39	19.83	22.63	30.00	-7.37
Low_4	2427	19.47	21.81	23.81	30.00	-6.19
Mid	2437	19.40	21.85	23.81	30.00	-6.19
High_8	2447	19.37	21.78	23.75	30.00	-6.25
High_9	2452	19.38	19.97	22.70	30.00	-7.30
High_10	2457	18.45	18.47	21.47	30.00	-8.53
High_11	2462	16.25	16.28	19.28	30.00	-10.72
High_12	2467	14.40	14.46	17.44	30.00	-12.56
High_13	2472	6.90	6.89	9.91	30.00	-20.09

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.

Note: for worst case, Peak detector was used to perform the test.

RESULTS

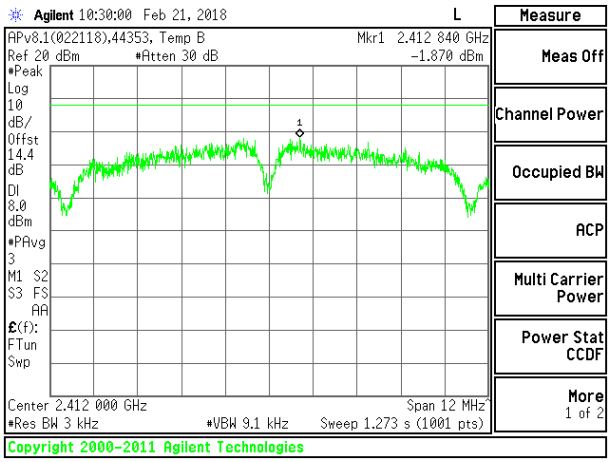
8.5.1. 802.11b MODE

1TX ANTENNA 4

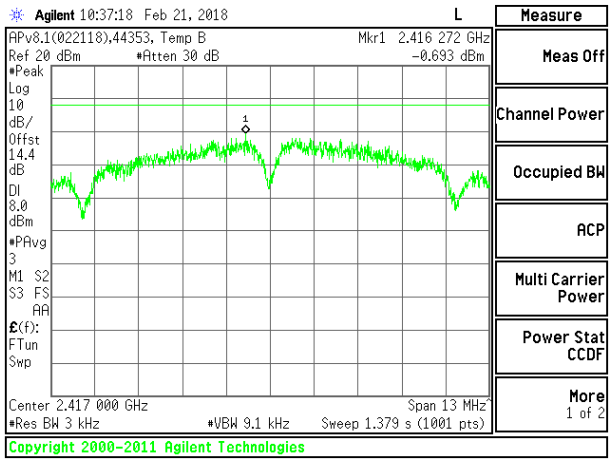
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

PSD Results

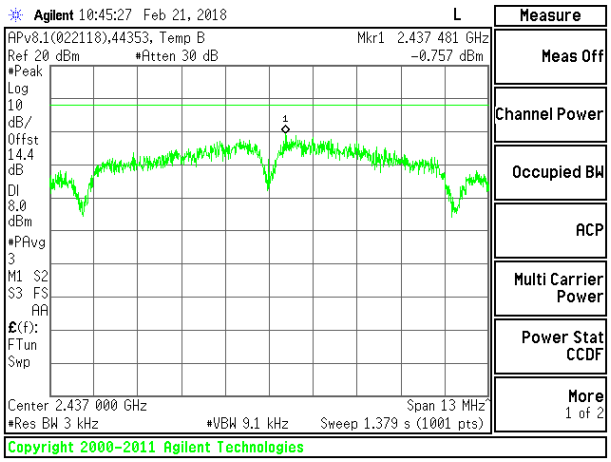
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-1.87	-1.87	8.0	-9.9
Low 2	2417	-0.69	-0.69	8.0	-8.7
Mid 6	2437	-0.76	-0.76	8.0	-8.8
High 11	2462	-0.29	-0.29	8.0	-8.3
High 12	2467	-0.91	-0.91	8.0	-8.9
High 13	2472	-2.42	-2.42	8.0	-10.4



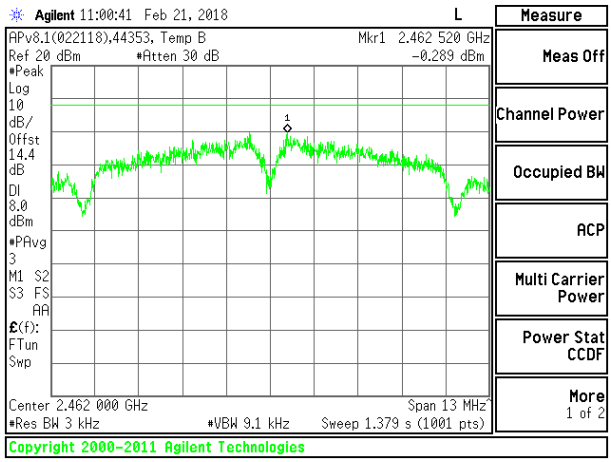
LOW CHANNEL 1



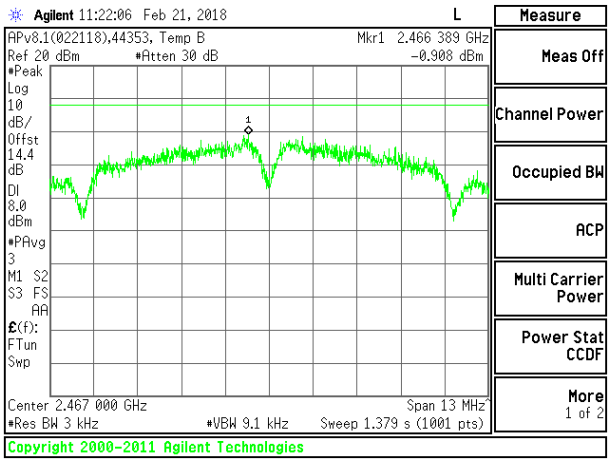
LOW CHANNEL 2



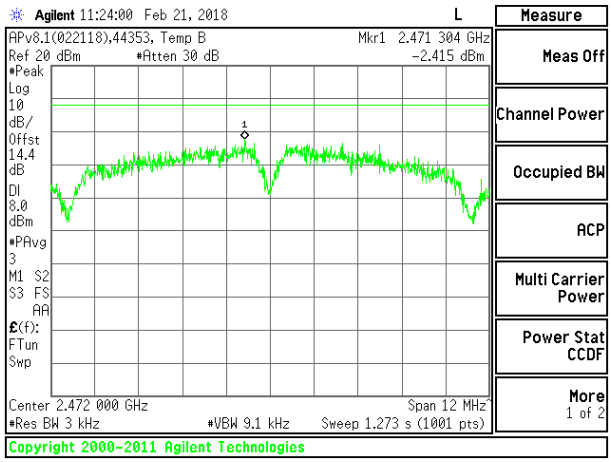
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



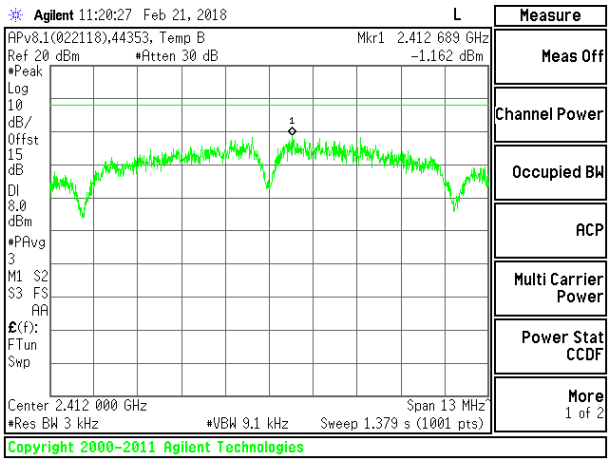
HIGH CHANNEL 13

1TX ANTENNA 3

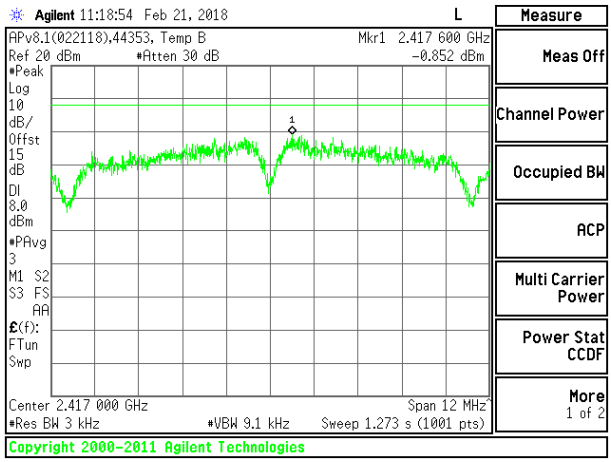
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

PSD Results

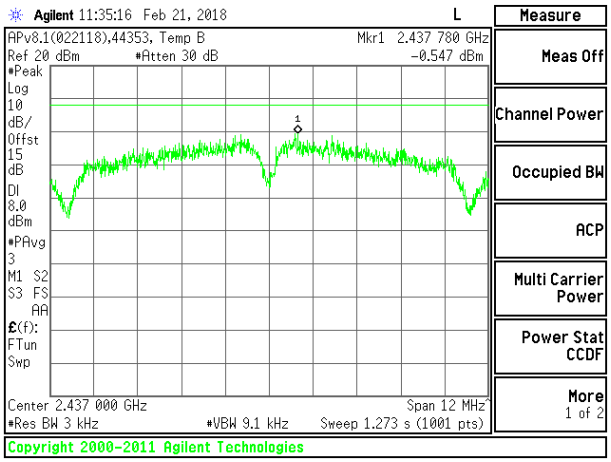
Channel	Frequency (MHz)	Ant 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-1.16	-1.16	8.0	-9.2
Low 2	2417	-0.85	-0.85	8.0	-8.9
Mid 6	2437	-0.55	-0.55	8.0	-8.6
High 11	2462	-0.51	-0.51	8.0	-8.5
High 12	2467	-1.14	-1.14	8.0	-9.1
High 13	2472	-2.50	-2.50	8.0	-10.5



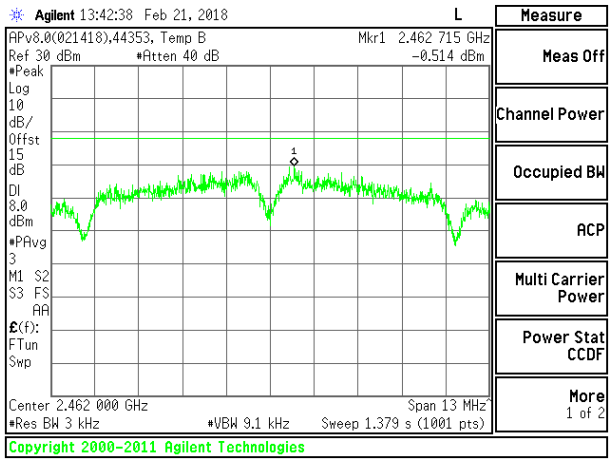
LOW CHANNEL 1



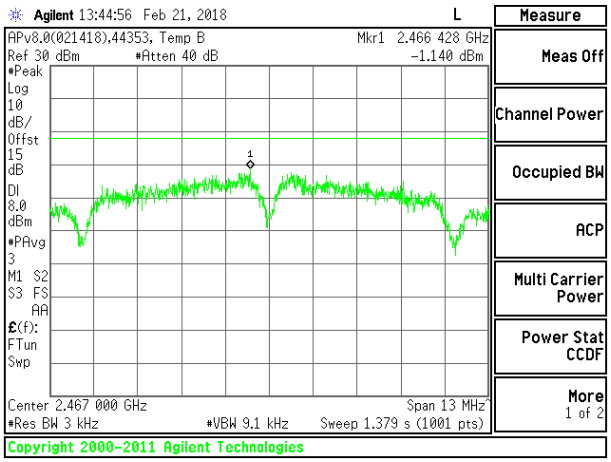
LOW CHANNEL 2



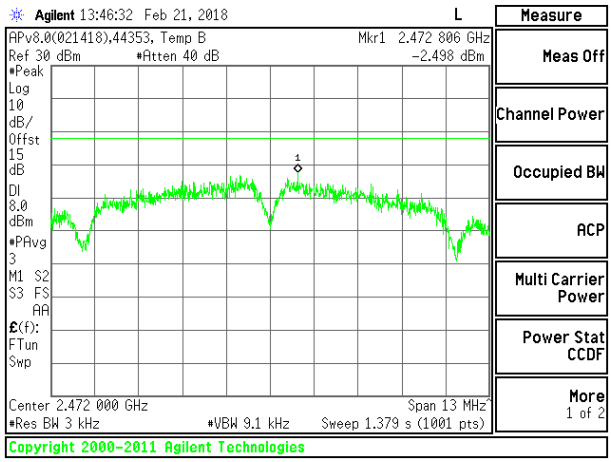
MID CHANNEL 6



HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13

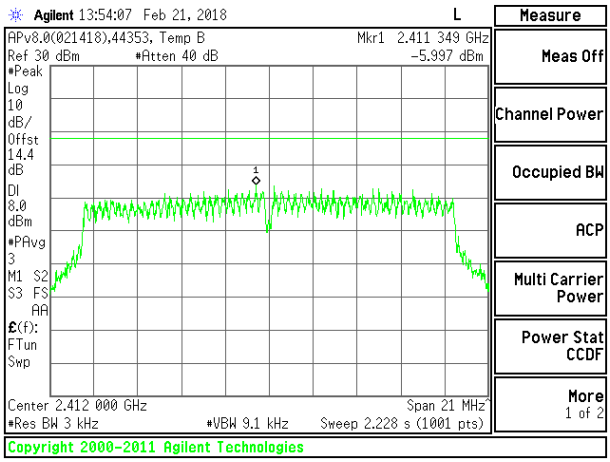
8.5.2. 802.11n HT20 MODE

1TX ANTENNA 4

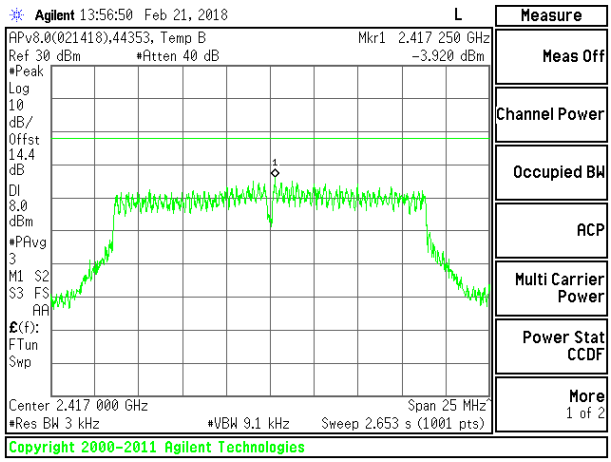
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

PSD Results

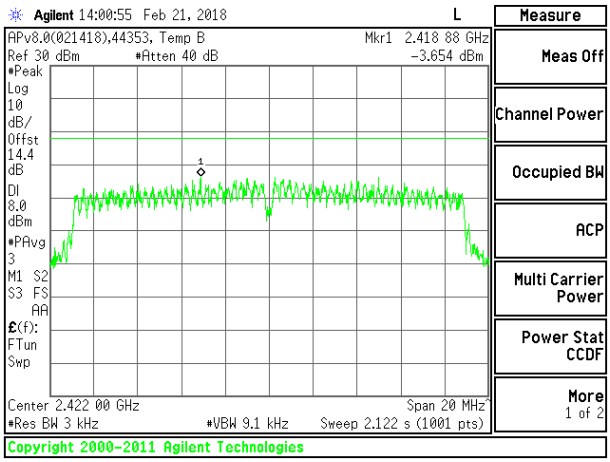
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-6.00	-6.00	8.0	-14.0
Low 2	2417	-3.92	-3.92	8.0	-11.9
Low 3	2422	-3.65	-3.65	8.0	-11.7
Mid 6	2437	-3.63	-3.63	8.0	-11.6
High 9	2452	-3.46	-3.46	8.0	-11.5
High 10	2457	-5.22	-5.22	8.0	-13.2
High 11	2462	-6.55	-6.55	8.0	-14.6
High 12	2467	-8.87	-8.87	8.0	-16.9
High 13	2472	-15.46	-15.46	8.0	-23.5



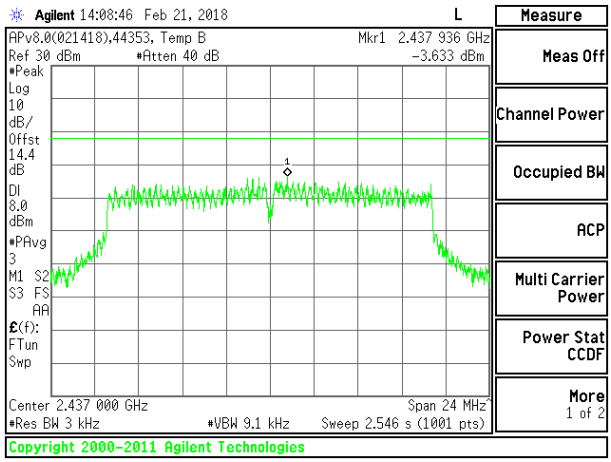
LOW CHANNEL 1



LOW CHANNEL 2



LOW CHANNEL 3



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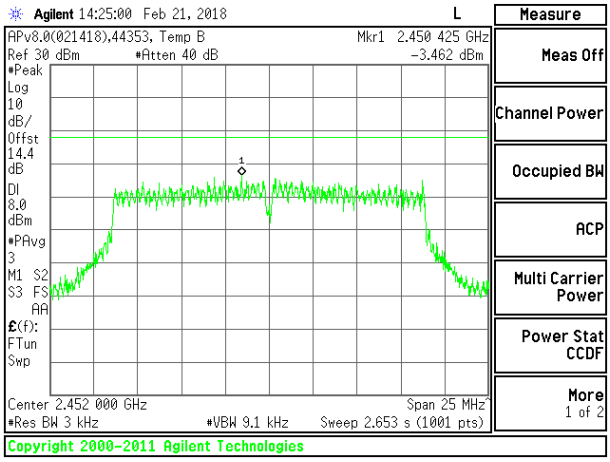

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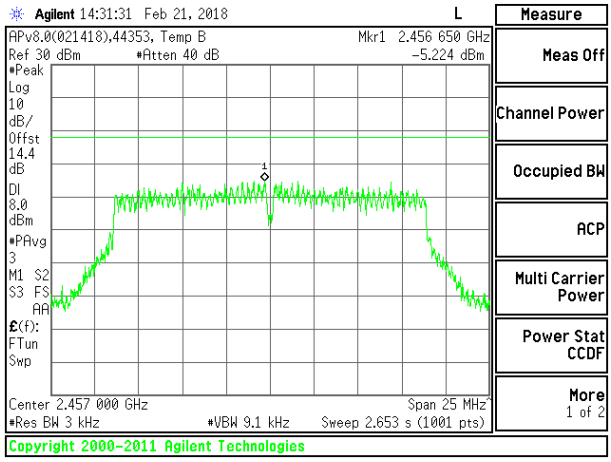

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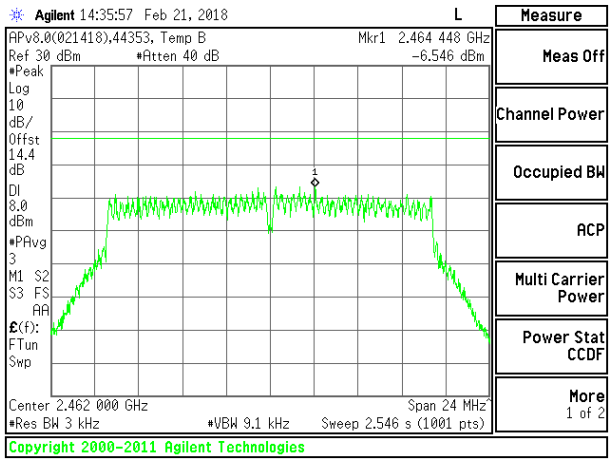
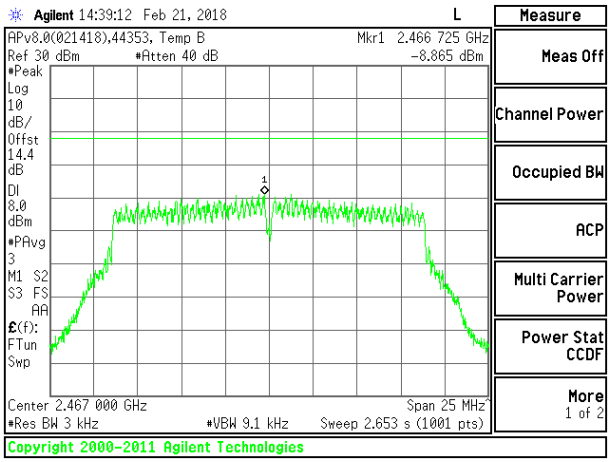
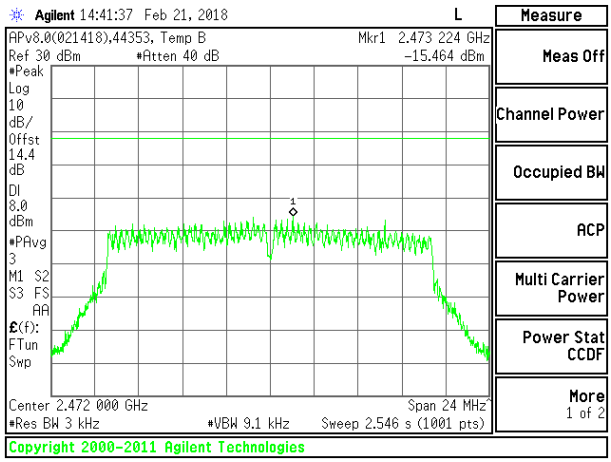


HIGH CHANNEL 11



HIGH CHANNEL 12



HIGH CHANNEL 13