FCC 47 CFR PART 15 SUBPART E

CERTIFICATION TEST REPORT
CLASS II PERMISSIVE CHANGE

FOR

3X3 MIMO BASE STATION

MODEL NUMBER: A1470

FCC ID: BCGA1470

REPORT NUMBER: 15U21850-E5V1

ISSUE DATE: DECEMBER 08, 2015

Prepared for
APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

Prepared by
UL VERIFICATION SERVICES INC.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	12/08/2015	Initial Issue	M. Mekuria

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: 3X3 MIMO BASE STATION

MODEL: A1470

SERIAL NUMBER: MODEL: A1521:C86KXE50F9H6(conducted);C86K5031FGCR (radiated)
MODEL: A1470: C86LCE5GFJ1R (DFS)

DATE TESTED: OCTOBER 09, 2015 –DECEMBER 08, 2015

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart E	Pass

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 any government.

Approved & Released For
UL Verification Services Inc. By:

Mengistu Mekuria

MENGISTU MEKURIA
SENIOR ENGINEER
UL VERIFICATION SERVICES INC.

Tested By:

ERIC YU
EMC LAB ENGINEER
UL VERIFICATION SERVICES INC.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v01r02/D03 v01r01/D06 v01, FCC KDB 789033 D02 v01, FCC KDB 644545 D03 v01, ANSI C63.10-2013.

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	☒ Chamber D
☐ Chamber B	☒ Chamber E
☐ Chamber C	☒ Chamber F
	☐ Chamber G
	☐ Chamber H

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through H are covered under Industry Canada company address code 2324B with site numbers 2324B -1 through 2324B-8, respectively.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

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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
Conducted Disturbance, 0.15 to 30 MHz	± 3.52 dB
Radiated Disturbance, 30 to 1000 MHz	± 4.94 dB
Radiated Disturbance, 1 to 6 GHz	± 3.86 dB
Radiated Disturbance, 6 to 18 GHz	± 4.23 dB
Radiated Disturbance, 18 to 26 GHz	± 5.30 dB
Radiated Disturbance, 26 to 40 GHz	± 5.23 dB

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

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a 3x3 802.11a/g/n/ac MIMO base station. The EUT also supports transmit beam forming on 11n and 11ac modes.

5.2. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

Upgrade EUT to 5.8GHz band new rule per KDB 789033 D02, v01 and upgrade 5.3GHz/5.6GHz band new rule per KDB 905462 D02 v01r02.

5.3. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5745 - 5825	802.11a	Covered by 802.11n HT20 SISO	
5745 - 5825	802.11a 2TX CDD	Covered by 802.11n HT20 2TX CDD	
5745 - 5825	802.11a 3TX CDD	Covered by 802.11n HT20 3TX CDD	
5745 - 5825	802.11n HT20 SISO	19.30	85.11
5745 - 5825	802.11n HT20 CDD 2TX	21.06	127.64
5745 - 5825	802.11n HT20 STBC/SDM 2TX	Covered by 802.11n HT20 2TX CDD	
5745 - 5825	802.11n HT20 BF 2TX	19.25	84.14
5745 - 5825	802.11n HT20 CDD 3TX	20.66	116.41
5745 - 5825	802.11n HT20 STBC/SDM 3TX	Covered by 802.11n HT20 3TX CDD	
5745 - 5825	802.11n HT20 BF 3TX	19.99	99.77
5755 - 5795	802.11n HT40 SISO	19.20	83.18
5755 - 5795	802.11n HT40 CDD 2TX	21.00	125.89
5755 - 5795	802.11n HT40 STBC/SDM 2TX	Covered by 802.11n HT40 2TX CDD	
5755 - 5795	802.11n HT40 BF 2TX	20.22	105.20
5755 - 5795	802.11n HT40 CDD 3TX	21.07	127.94
5755 - 5795	802.11n HT40 STBC/SDM 3TX	Covered by 802.11n HT40 3TX CDD	
5755 - 5795	802.11n HT40 BF 3TX	19.99	99.77
5775	802.11ac VHT80 SISO	15.50	35.48
5775	802.11ac VHT80 CDD 2TX	18.00	63.10
5775	802.11ac VHT80 STBC/SDM 2TX	Covered by 802.11ac HT80 2TX CDD	
5775	802.11ac VHT80 BF 2TX	14.74	29.79
5775	802.11ac VHT80 CDD 3TX	18.61	72.61
5775	802.11ac VHT80 STBC/SDM 3TX	Covered by 802.11ac HT80 3TX CDD	
5775	802.11ac VHT80 BF 3TX	15.38	34.51

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5.4. DESCRIPTION OF AVAILABLE ANTENNAS

Band (GHz)	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
5.8	2.70	1.90	4.40	3.13

Band (GHz)	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
5.8	2.70	1.90	4.40	7.83

5.5. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 6.10.56.166.

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5.6. WORST-CASE CONFIGURATION AND MODE

FCC ID: BCGA1470 is eletrically identical to FCC ID: BCGA1521 except harddrive. Conducted and radiated test data in this report was generated using FCC ID: BCGA1521 since RF characteristic for FCC ID: BCGA1521 are representative of FCC ID: BCGA1470. DFS test data is performed on FCC ID: BCGA1470.

Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The fundamental of the EUT was investigated in three orthogonal orientations X (Flatbed), Y (Landscape), Z (Portrait), it was determined that Y (Landscapre) was worst-case orientations. Therefore, all final radiated testing was performed with the EUT in Y (Landscapre) orientation.

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

802.11a mode: 6 Mbps
802.11n HT20 mode: MCS0
802.11n HT40 mode: MCS0
802.11ac VHT20 mode: MCS0
802.11ac VHT40 mode: MCS0
802.11ac VHT80 mode: MCS0

802.11ac VHT20 and VHT40 mode are different from 802.11nHT20 and HT40 only in control messages and have the same power settings.

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

For simultaneous transmission of multiple channels from the same antenna in BT/BLE and WLAN 5 GHz bands. Baseline testing was performed on various configurations to determine the worst case on radiated emissions.

The following configuration was investigated on AC line conducted test.

Configuration	Descriptions
1	EUT powered by AC adapter

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5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	MacBook Pro	C02FD1TDDF8V	N/A
Laptop AC/DC adapter	Apple	A1172	MV7211FJAX4XA	N/A
EUT AC adapter	Apple	N/A	A3 258 12SV	N/A

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	Ethernet cable	1	RJ45	Un-Shielded	1	EUT to Laptop
3	AC	1	2P	Un-shielded	1.8	N/A
4	AC/DC	1	AC	Shielded	3	N/A

I/O CABLES (RADIATED BELOW/ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
3	AC	1	2P	Un-shielded	1.8	N/A

I/O CABLES (AC LINE CONDUCTED: AC ADAPTER)

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	2P	Un-shielded	1.8	N/A
2	Antenna	1	SMA	Un-Shielded	0.2	N/A
3	AC/DC	1	AC	Shielded	1	N/A

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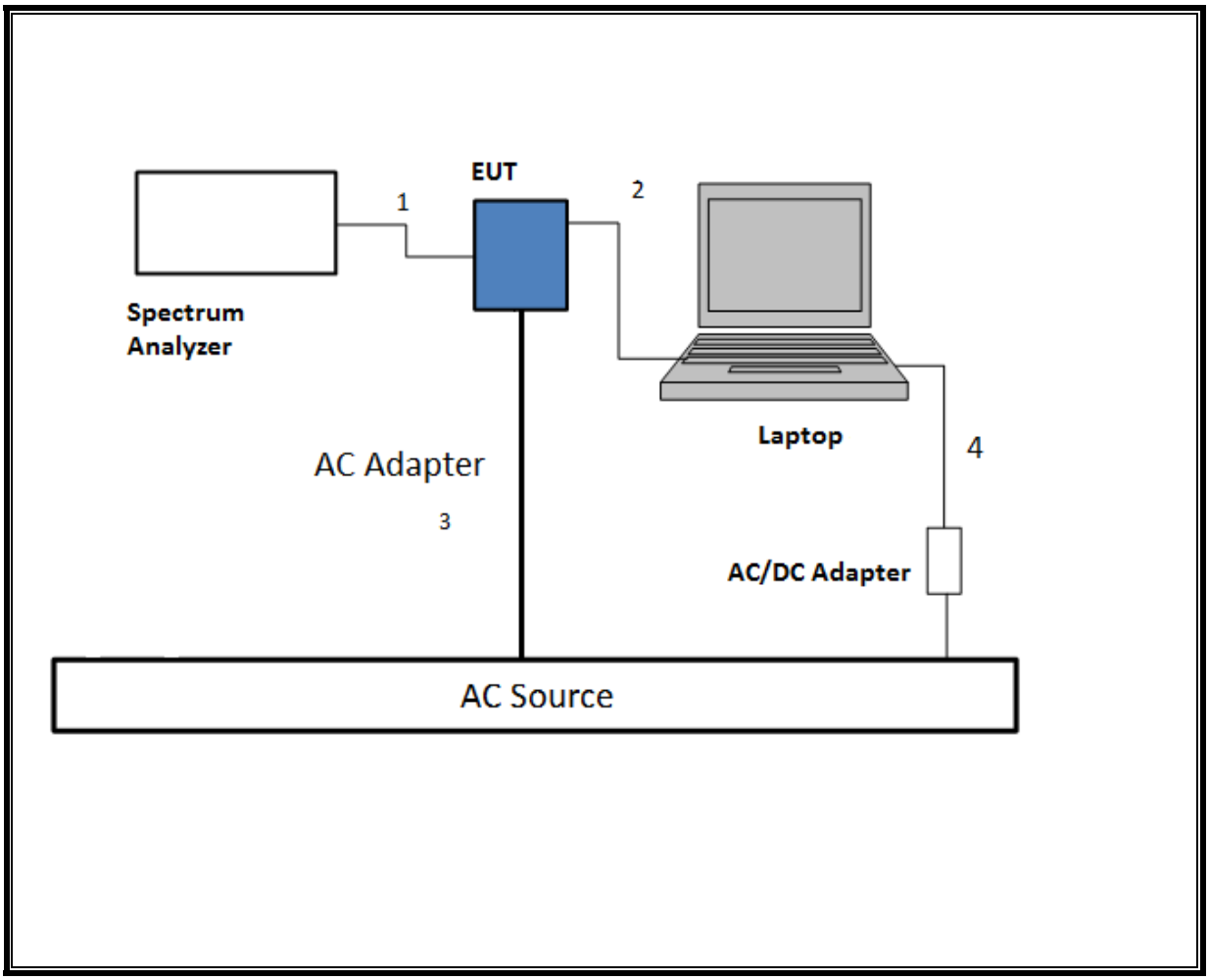
TEST SETUP - CONDUCTED TESTS

The EUT was tested connected to a host Laptop via ethernet cable and spectrum analyzer to antenna port. Test software exercised the EUT.

SETUP DIAGRAM



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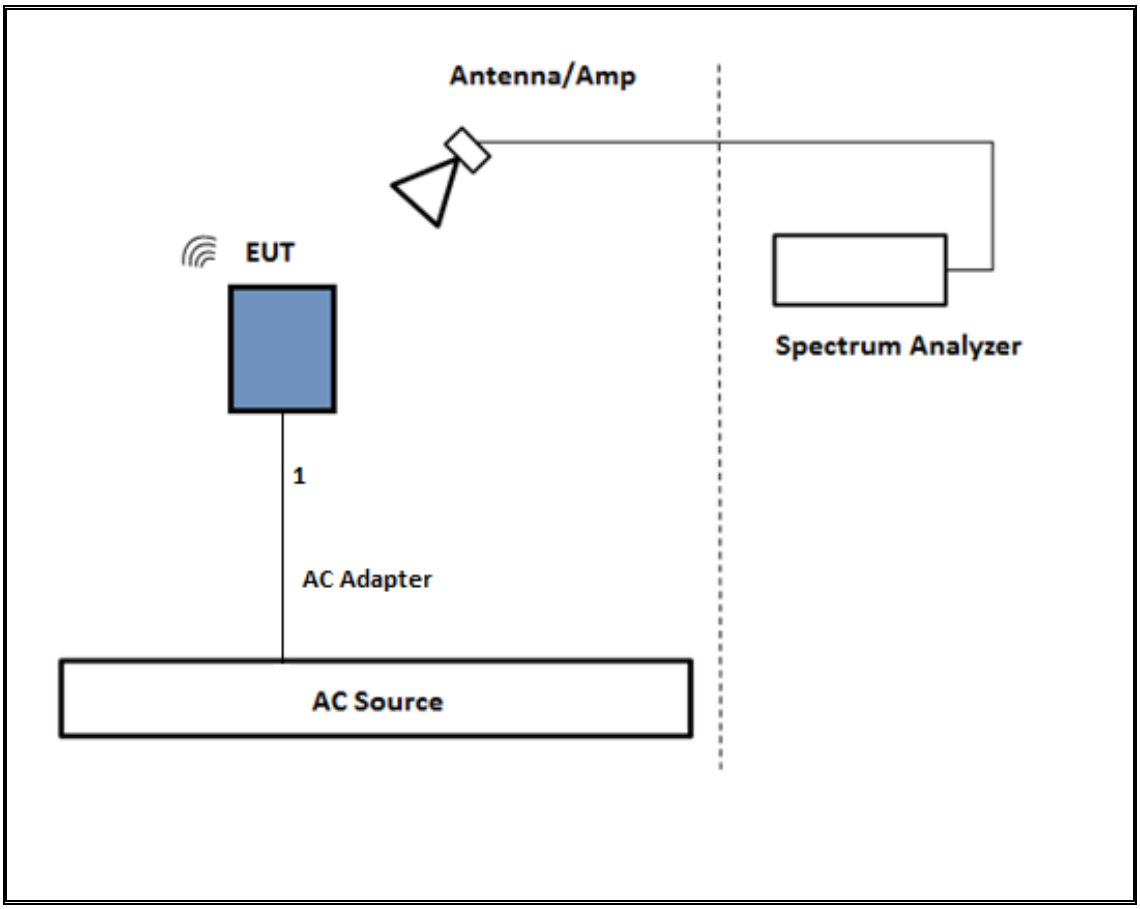
TEST SETUP- RADIATED-BELOW / ABOVE 1 GHZ

The EUT was tested battery powered. Test software exercised the EUT.

SETUP DIAGRAM



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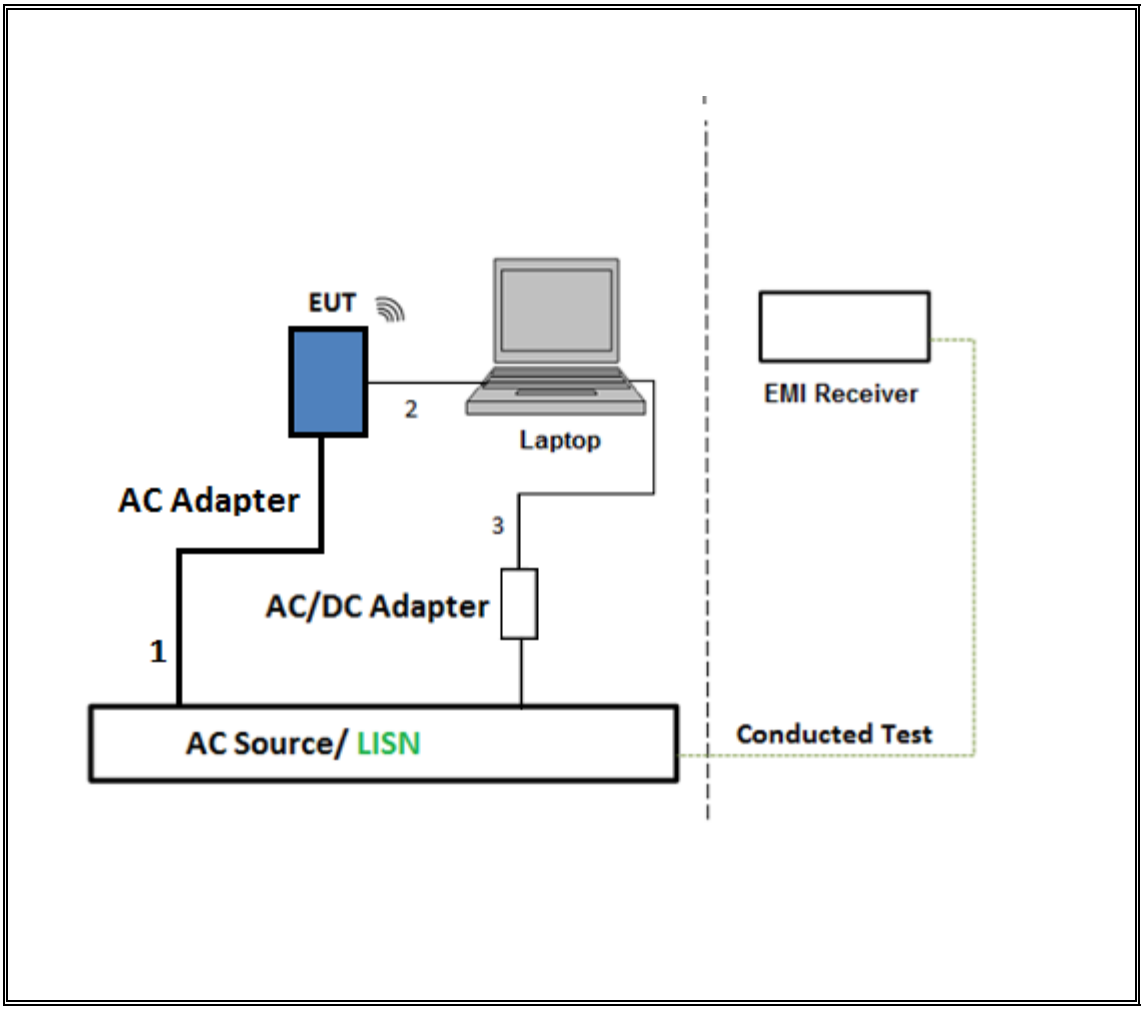
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION

The EUT was powered by AC adapter. Test software exercised the EUT.

SETUP DIAGRAM



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6. 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**	**Asset**	**Cal Due**
Antenna, Horn 1-18GHz	ETS Lindgren	3117	00143448	2/10/2016
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	A022813-2	3/5/2016
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	1782158	1/26/2016
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	323562	5/7/2016
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	MY52350675	11/12/2015
Antenna, Horn 1-18GHz	ETS Lindgren	3117	00143449	2/10/2016
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	A022813-1	1/14/2016
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	323561	6/8/2016
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	MY54490254	12/10/2015
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight	N1921A	MY55200002	3/6/2016
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight	N1921A	MY55200004	5/6/2016
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826	1049	12/17/2015
Horn Antenna, 40GHz	ARA	MWH-2640/B	1029	7/28/2016
Spectrum Analyzer, 40 GHz	Agilent	8564E	3943A01643	8/6/2016
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Keysight	8449B	3008A04710	6/29/2016
Amplifier, 26 - 40GHz	Miteq	NSP4000-SP2	924343	4/7/2016
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	100773	8/7/2016
LISN for Conducted Emissions CISPR-16	FCC	50/250-25-2	114	1/16/2016
Power Cable, Line Conducted Emissions ANSI 63.4	UL	PG1	N/A	7/28/2016
UL SOFTWARE				
*Radiated Software	UL	UL EMC	Ver 9.5, July 22, 2014	
*Conducted Software	UL	UL EMC	Ver 2.2, March 31, 2015	
*AC Line Conducted Software	UL	UL EMC	Ver 9.5, April 3, 2015	

Note: * indicates automation software version used in the compliance certification testing

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7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

7.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a 1TX	2.064	2.082	0.991	99.14%	0.00	0.010
802.11n HT20 1TX	1.920	1.935	0.992	99.22%	0.00	0.010
802.11n HT20 2TX CDD	1.920	1.935	0.992	99.22%	0.00	0.010
802.11n HT20 2TX STBC	1.920	1.938	0.991	99.07%	0.00	0.010
802.11n HT20 2TX BF	3.829	3.941	0.972	97.16%	0.13	0.261
802.11n HT20 3TX CDD	1.920	1.938	0.991	99.07%	0.00	0.010
802.11n HT20 3TX STBC	1.919	1.936	0.991	99.12%	0.00	0.010
802.11n HT20 3TX BF	3.832	3.936	0.974	97.36%	0.12	0.261
802.11n HT40 1TX	0.944	0.960	0.983	98.33%	0.00	0.010
802.11n HT40 2TX CDD	0.944	0.962	0.981	98.13%	0.00	0.010
802.11n HT40 2TX STBC	0.944	0.960	0.983	98.33%	0.00	0.010
802.11n HT40 2TX BF	4.570	4.700	0.972	97.23%	0.12	0.219
802.11n HT40 3TX CDD	0.942	0.958	0.983	98.33%	0.00	0.010
802.11n HT40 3TX STBC	0.944	0.960	0.983	98.33%	0.00	0.010
802.11n HT40 3TX BF	4.592	4.712	0.975	97.45%	0.11	0.218
802.11ac VHT80 1TX	0.599	0.616	0.972	97.24%	0.12	1.669
802.11ac VHT80 2TX CDD	0.600	0.616	0.974	97.40%	0.11	1.667
802.11ac VHT80 2TX STBC	0.599	0.616	0.972	97.24%	0.12	1.669
*802.11ac VHT80 2TX BF	5.100	5.470	0.932	93.24%	0.30	0.196
802.11ac VHT80 3TX CDD	0.460	0.478	0.962	96.23%	0.17	2.174
802.11ac VHT80 3TX STBC	0.460	0.478	0.962	96.17%	0.17	2.176
*802.11ac VHT80 3TX BF	5.060	5.390	0.939	93.88%	0.27	0.198

*802.11ac VHT80 2TX BF and *802.11ac VHT80 3TX BF were measured as worst case scenario.

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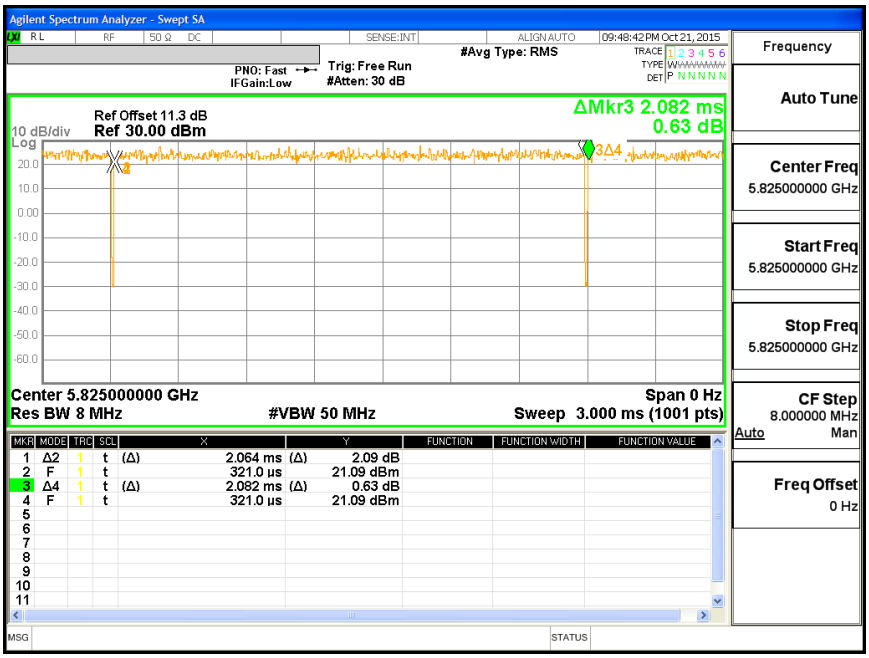
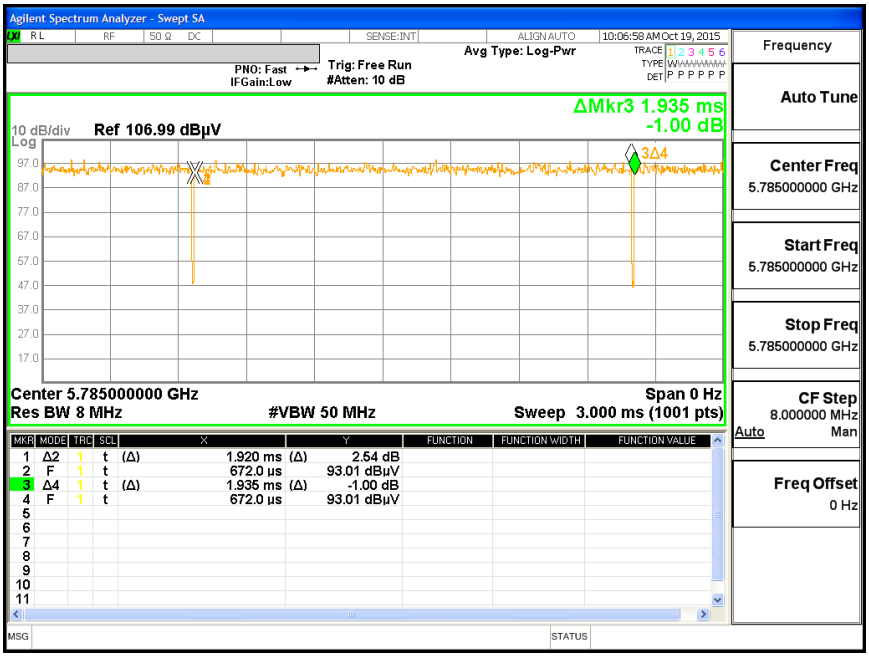
DUTY CYCLE PLOTS

DUTY CYCLE 802.11a 1TX MODE



DUTY CYCLE 802.11n HT20 1TX MODE



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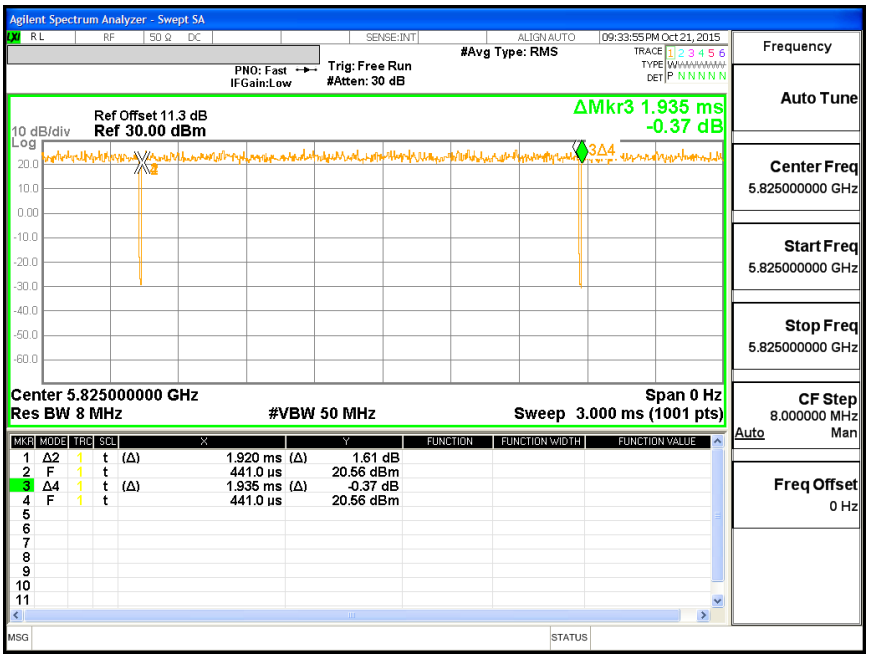
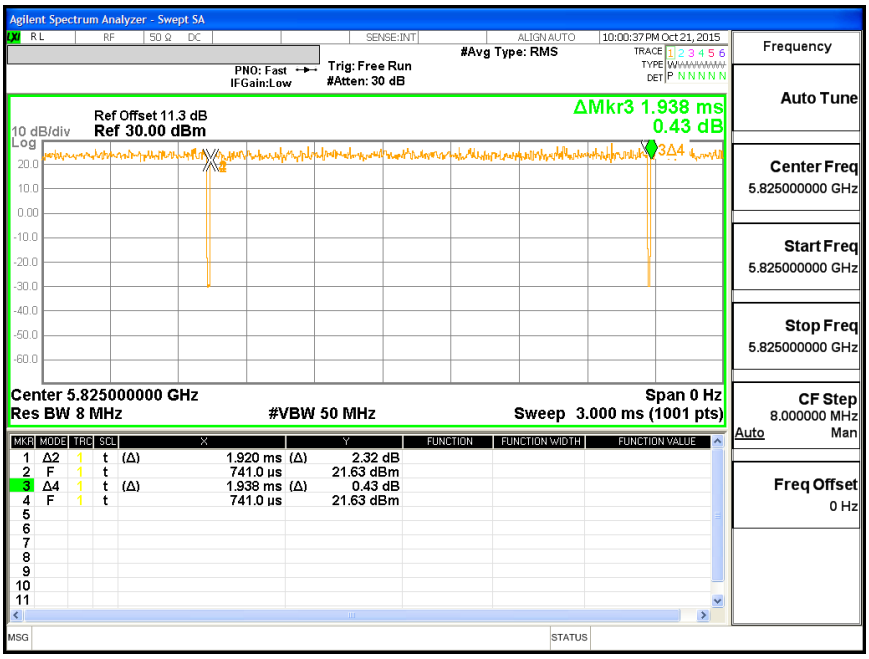
DUTY CYCLE 802.11n HT20 2TX CDD MODE



DUTY CYCLE 802.11n HT20 2TX STBC MODE



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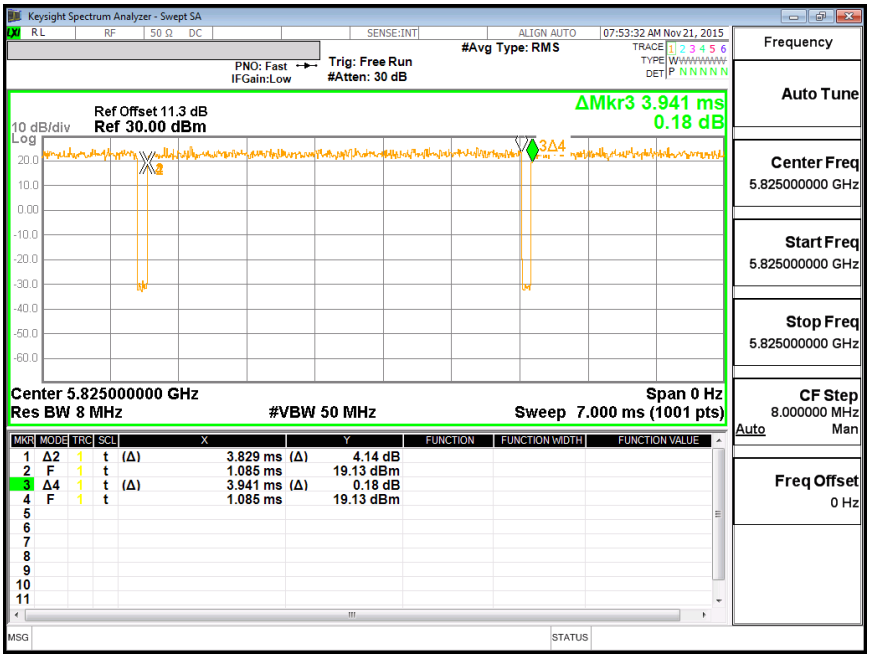
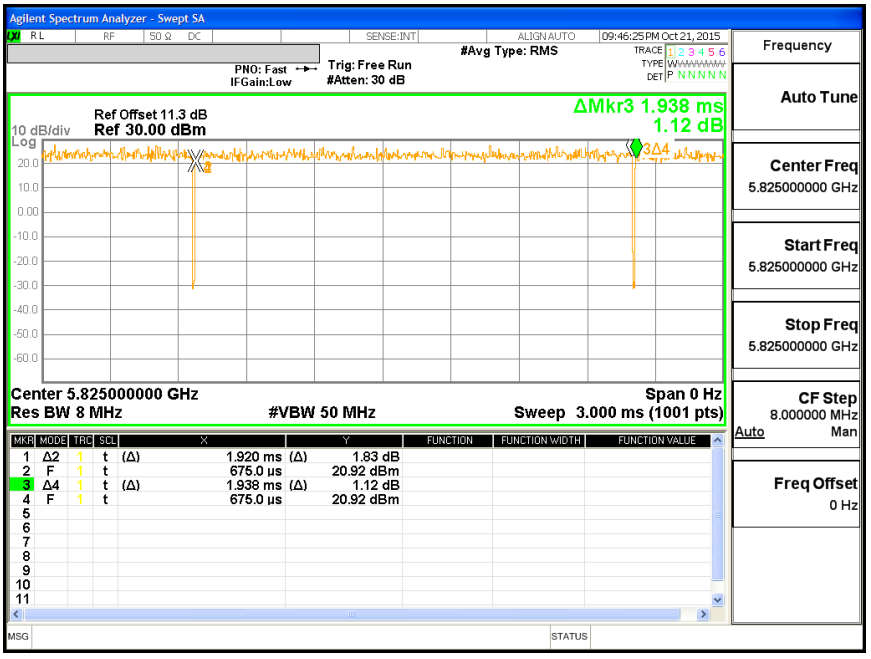
DUTY CYCLE 802.11n HT20 2TX BF MODE



DUTY CYCLE 802.11n HT20 3TX CDD MODE



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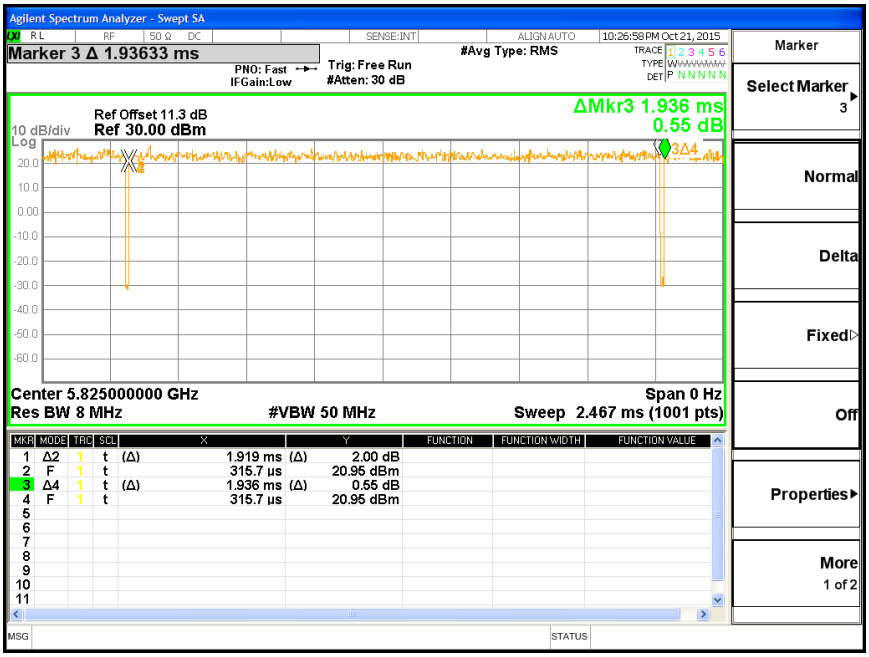
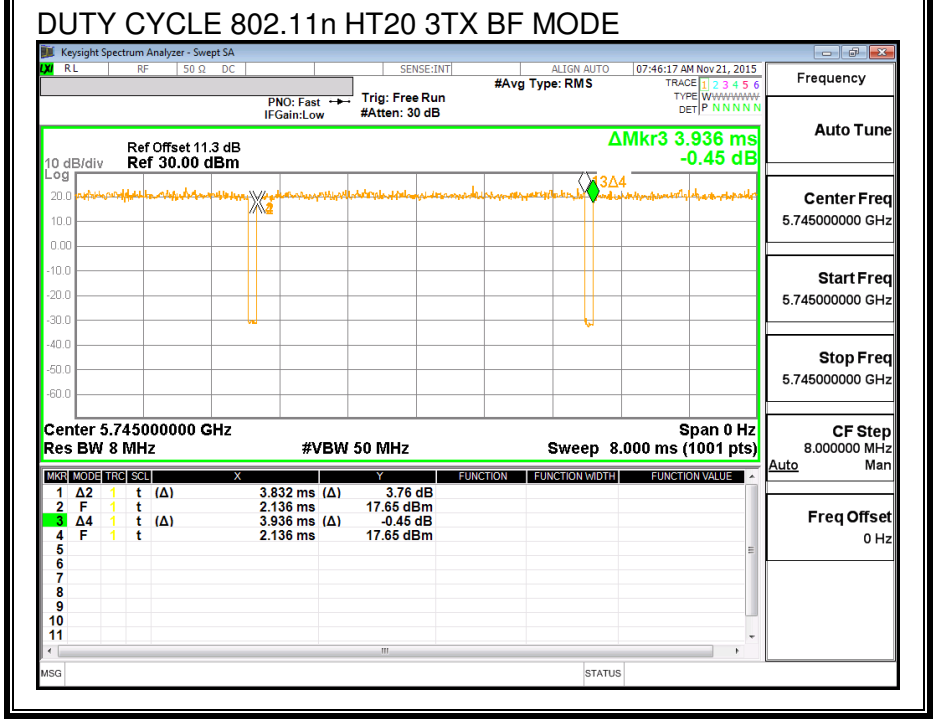
DUTY CYCLE 802.11n HT20 3TX STBC MODE



DUTY CYCLE 802.11n HT20 3TX BF MODE



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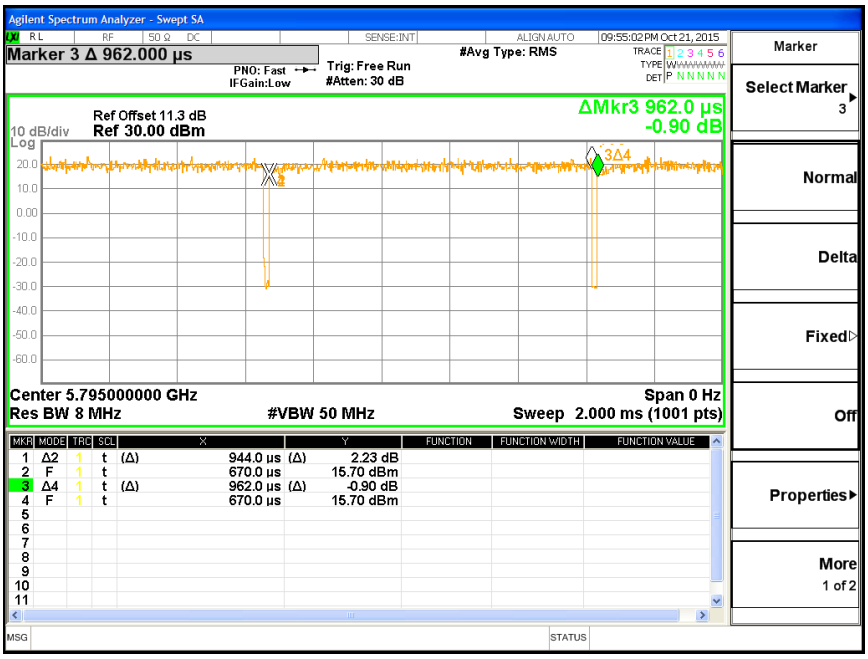
DUTY CYCLE 802.11n HT40 1TX MODE

DUTY CYCLE 802.11n HT40 2TX CDD MODE



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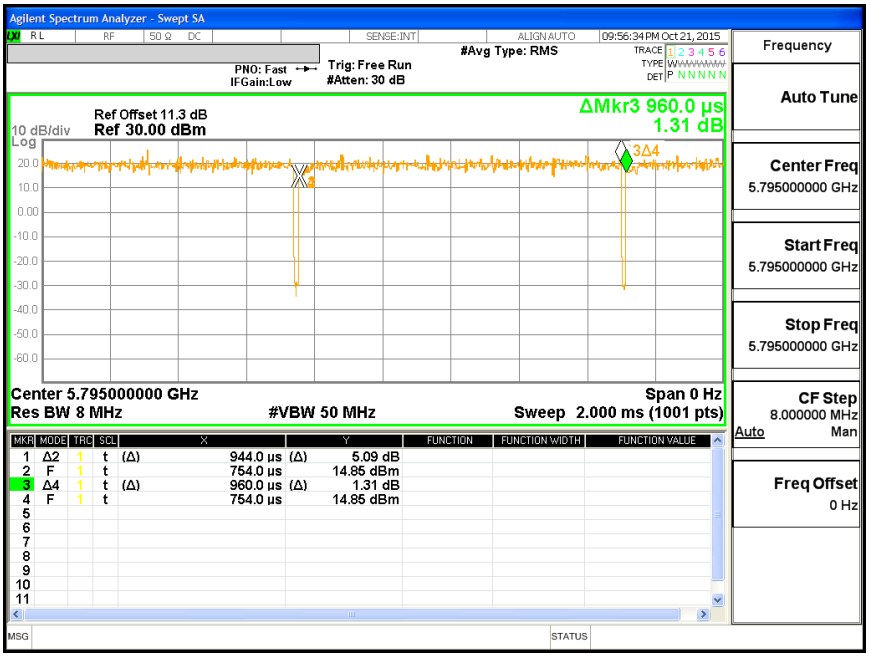
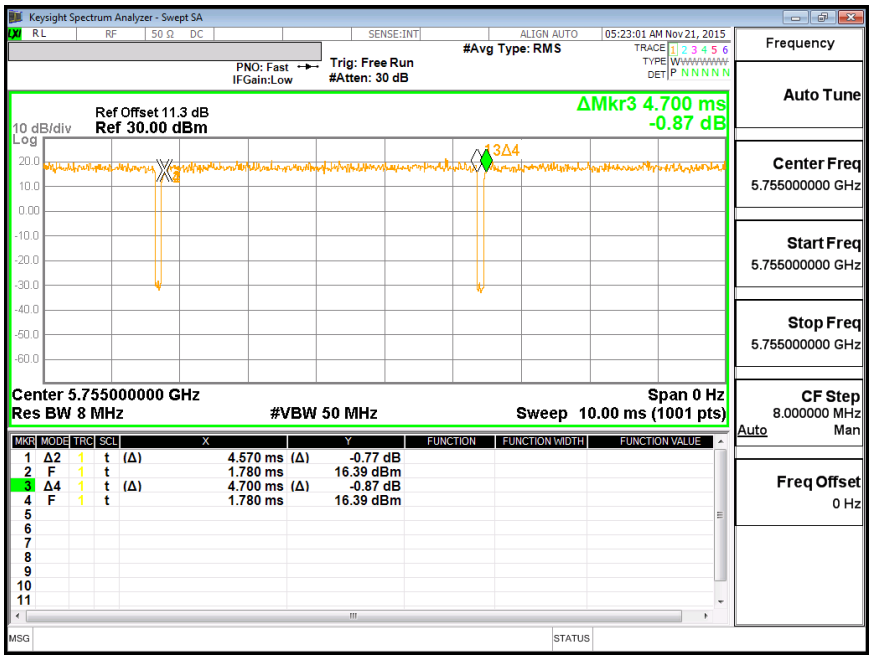
DUTY CYCLE 802.11n HT40 2TX STBC MODE



DUTY CYCLE 802.11n HT40 2TX BF MODE



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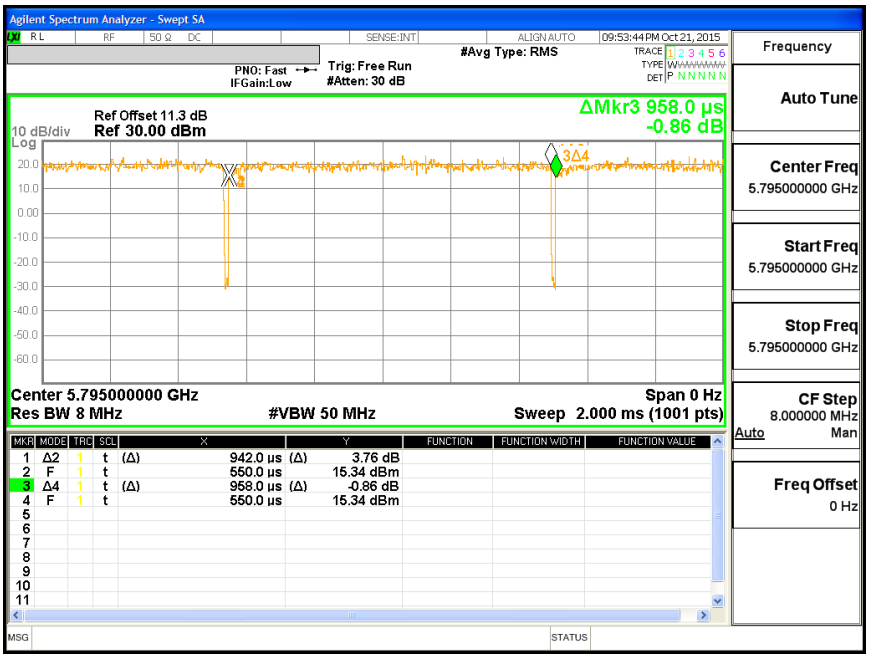
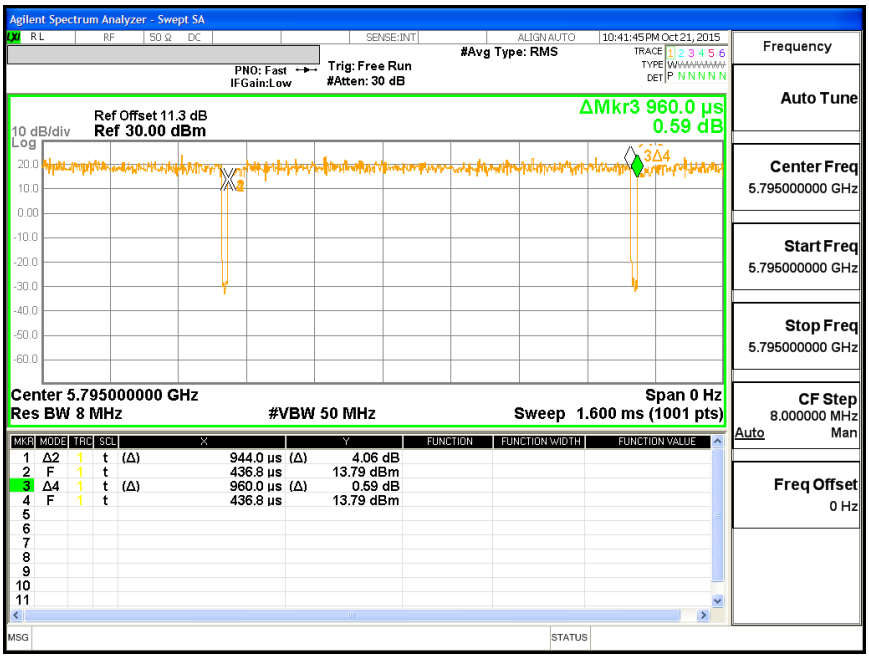
DUTY CYCLE 802.11n HT40 3TX CDD MODE



DUTY CYCLE 802.11n HT40 3TX STBC MODE



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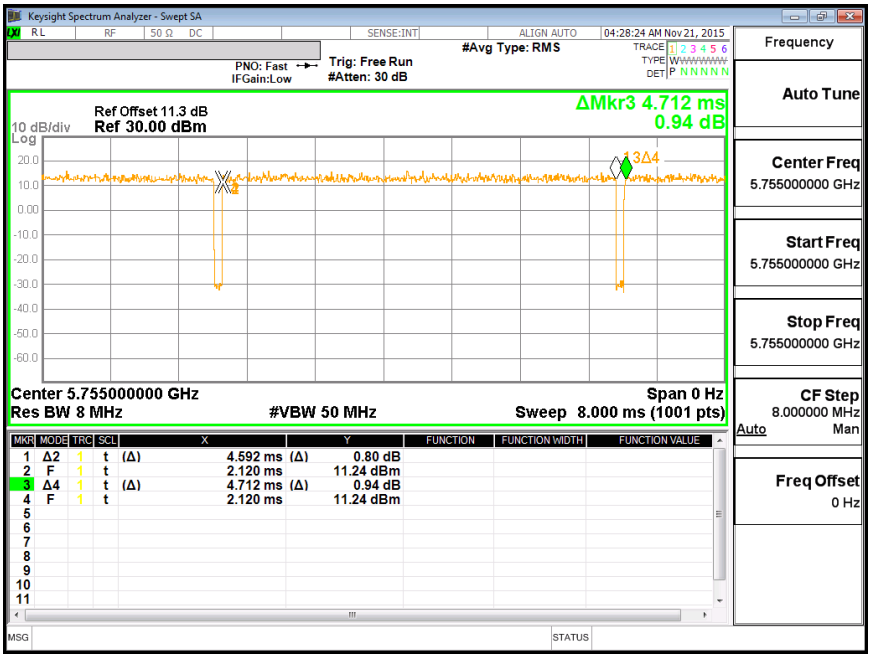
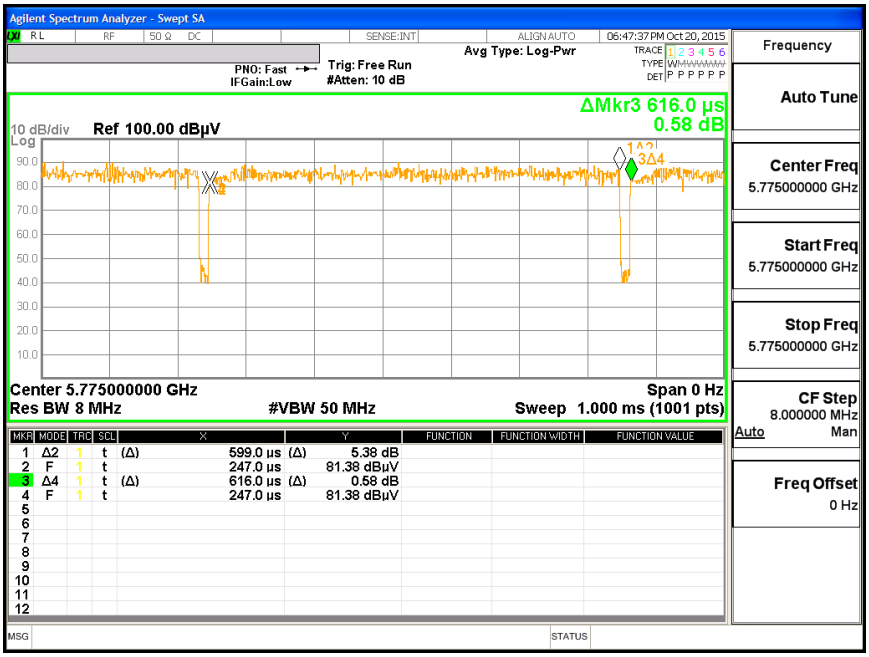
DUTY CYCLE 802.11n HT40 3TX BF MODE



DUTY CYCLE 802.11ac VHT80 1TX MODE



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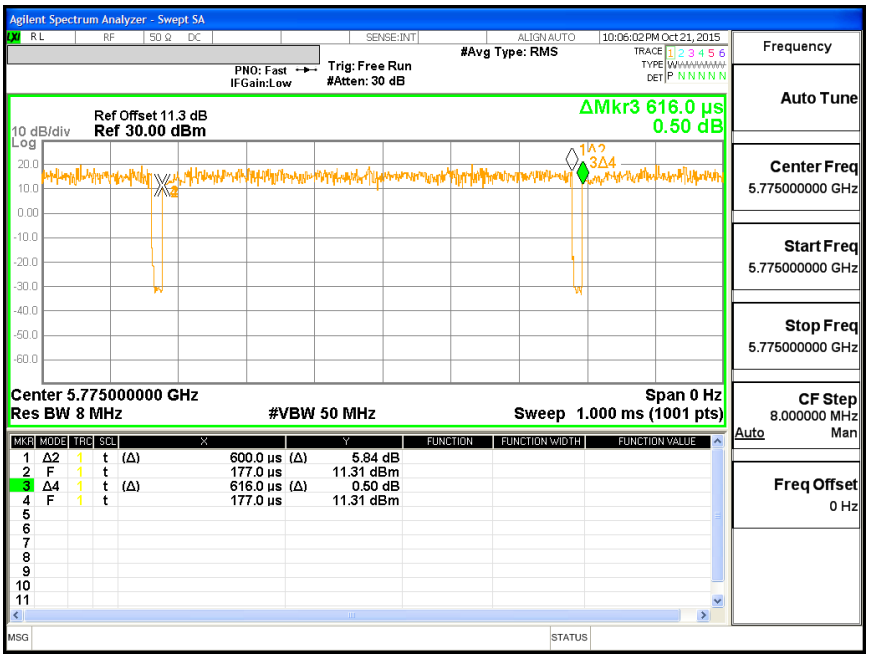
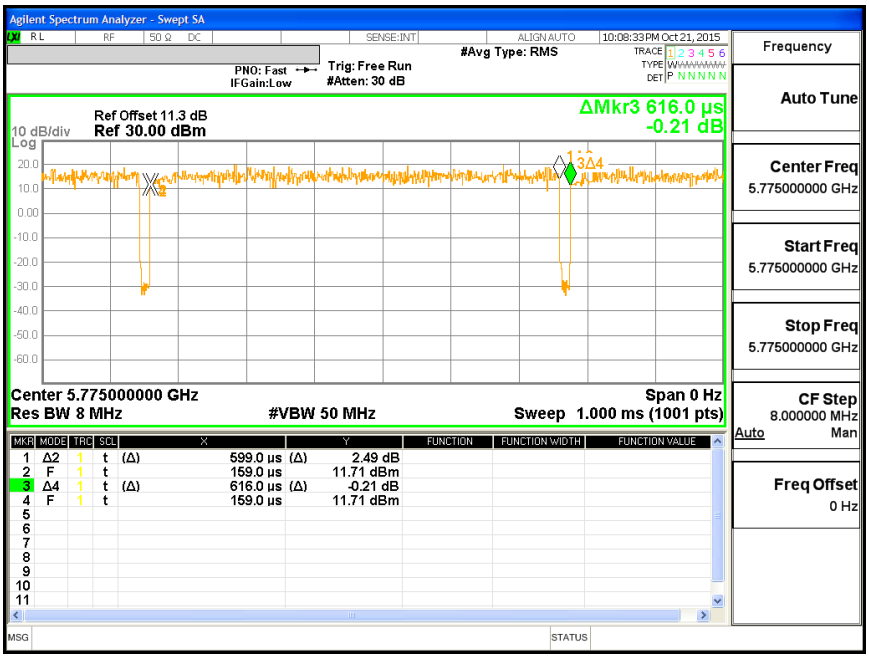
DUTY CYCLE 802.11ac VHT80 2TX CDD MODE



DUTY CYCLE 802.11ac VHT80 2TX STBC MODE



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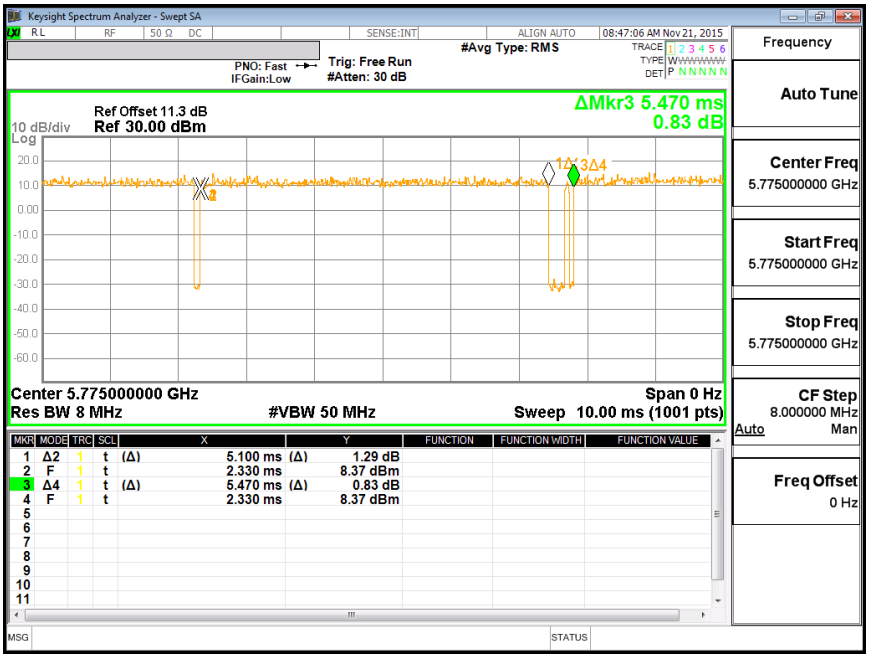
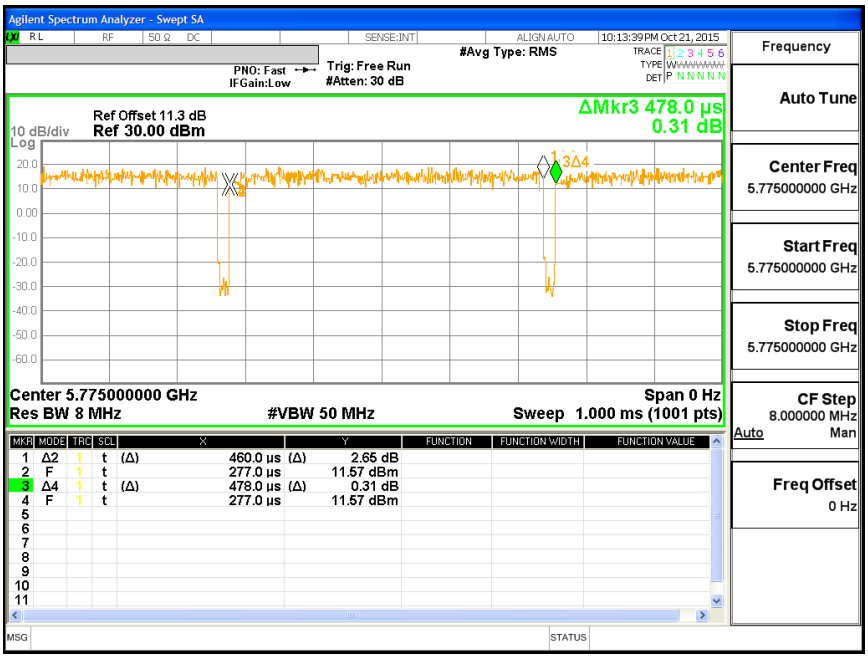
DUTY CYCLE 802.11ac VHT80 2TX BF MODE



DUTY CYCLE 802.11ac VHT80 3TX CDD MODE



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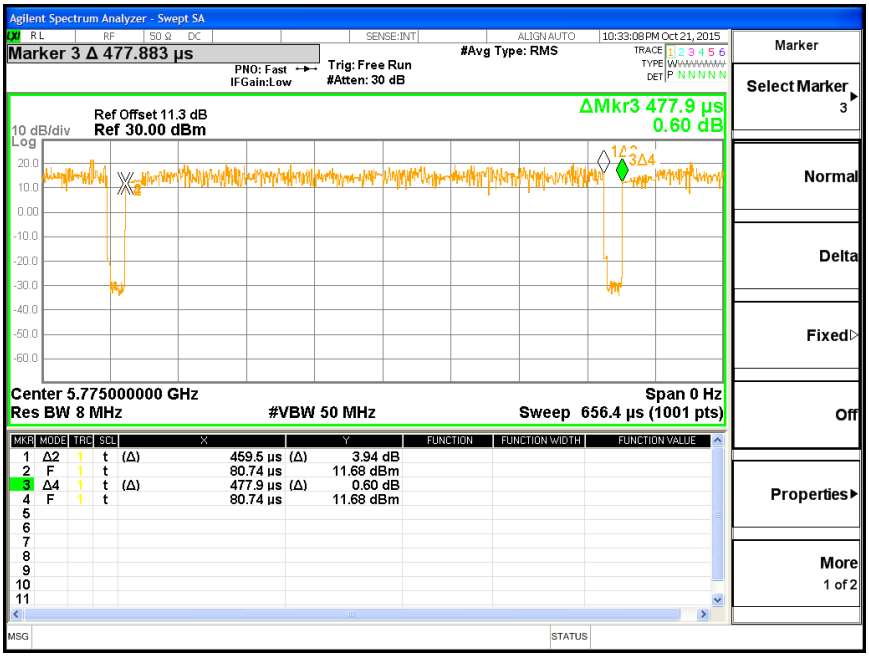
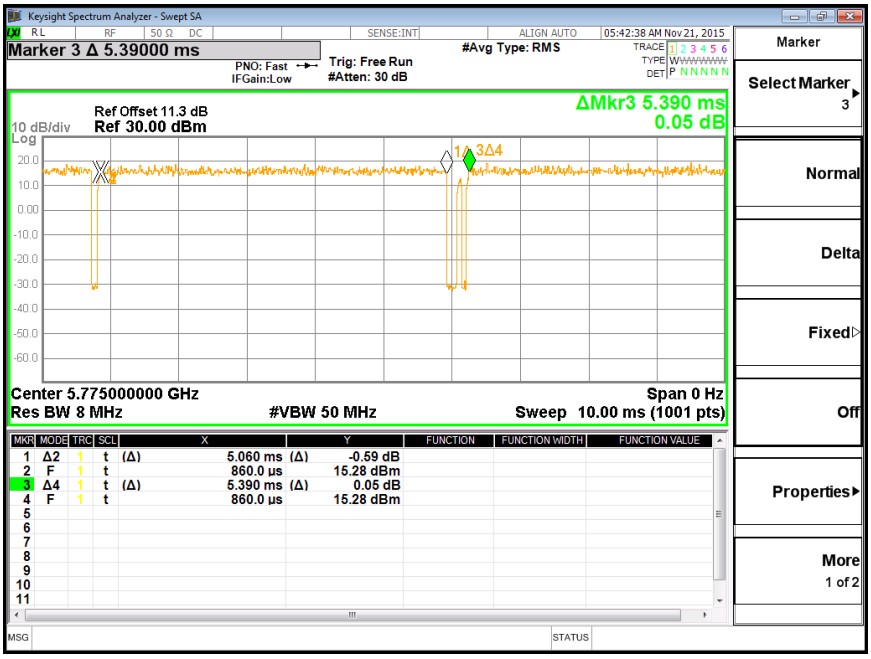
DUTY CYCLE 802.11ac VHT80 3TX STBC MODE



DUTY CYCLE 802.11ac VHT80 3TX BF MODE



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7.2. MEASUREMENT METHODS

26 dB Emission BW & 6 dB Emission BW: KDB 789033 D02 v01, Section C.

99% Occupied BW: KDB 789033 D02 v01, Section D.

Conducted Output Power: KDB 789033 D02 v01, Section E.3.b (Method PM-G).

Power Spectral Density: KDB 789033 D02 v01, Section F.

Unwanted emissions in restricted bands: KDB 789033 D02 v01, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v01, Sections G.3, G.4, and G.5.

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8. ANTENNA PORT TEST RESULTS

8.1. 802.11a 1TX MODE IN THE 5.8 GHz BAND

NOTE: Covered by 802.11n HT20 1TX.

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8.2. 802.11n HT20 1TX MODE IN THE 5.8 GHz BAND

8.2.1. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

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

RESULTS

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	5745	17.82	0.5
Mid	5785	17.77	0.5
High	5825	17.60	0.5

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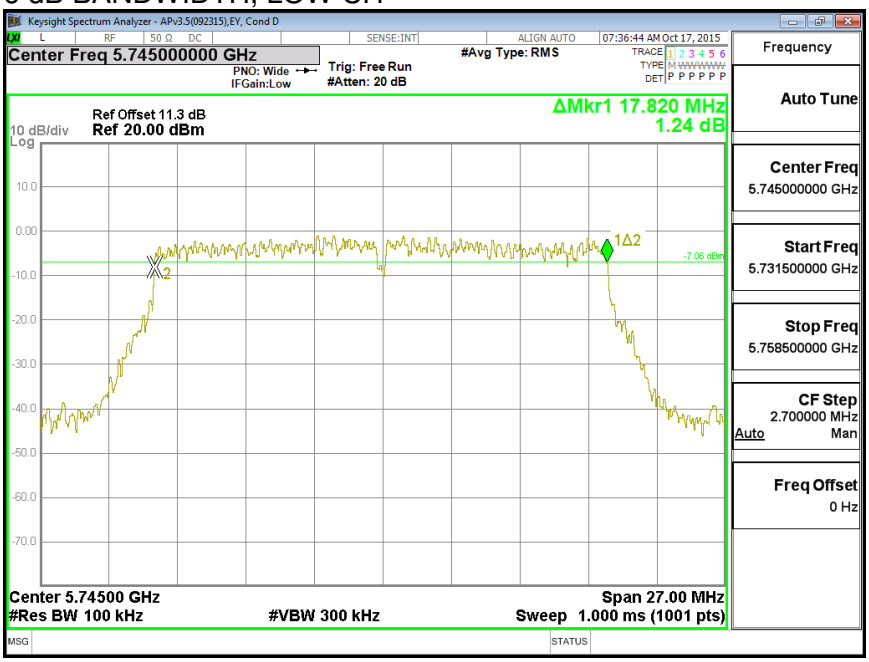
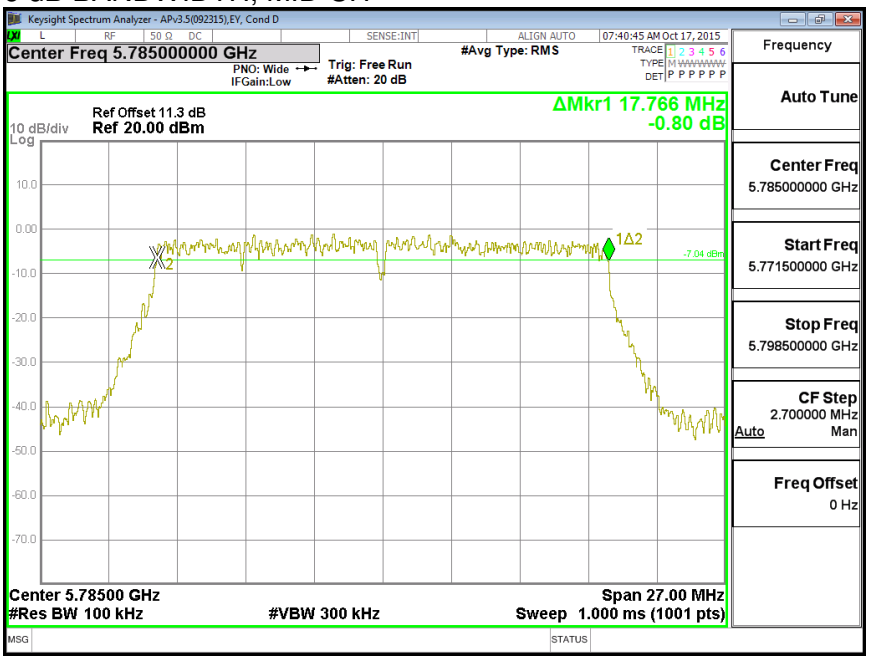
6 dB BANDWIDTH

6 dB BANDWIDTH, LOW CH



6 dB BANDWIDTH, MID CH



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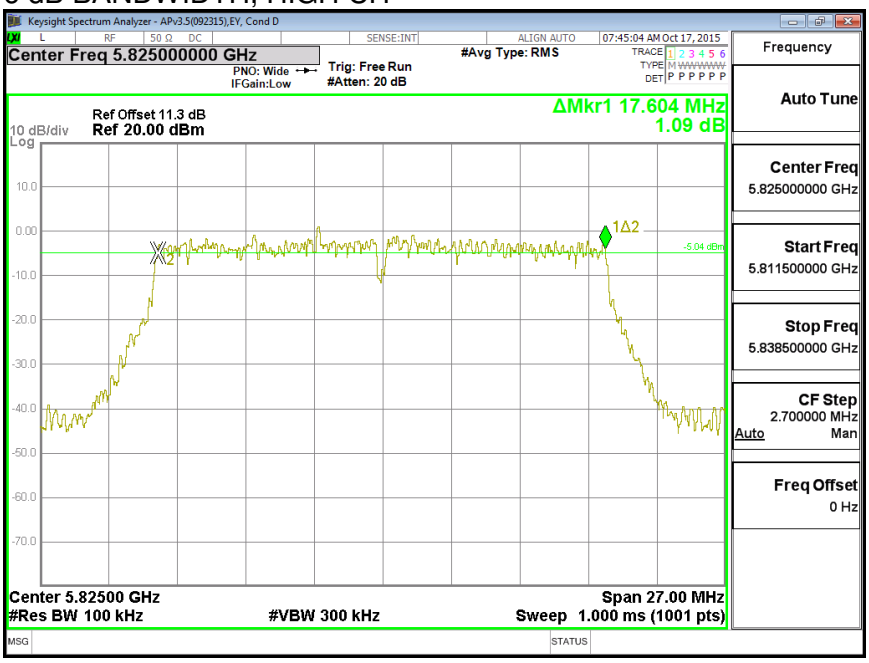
6 dB BANDWIDTH, HIGH CH



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8.2.2. **26 dB BANDWIDTH**

LIMITS

None, for reporting purposes only

RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5745	20.06
Mid	5785	19.95
High	5825	20.21

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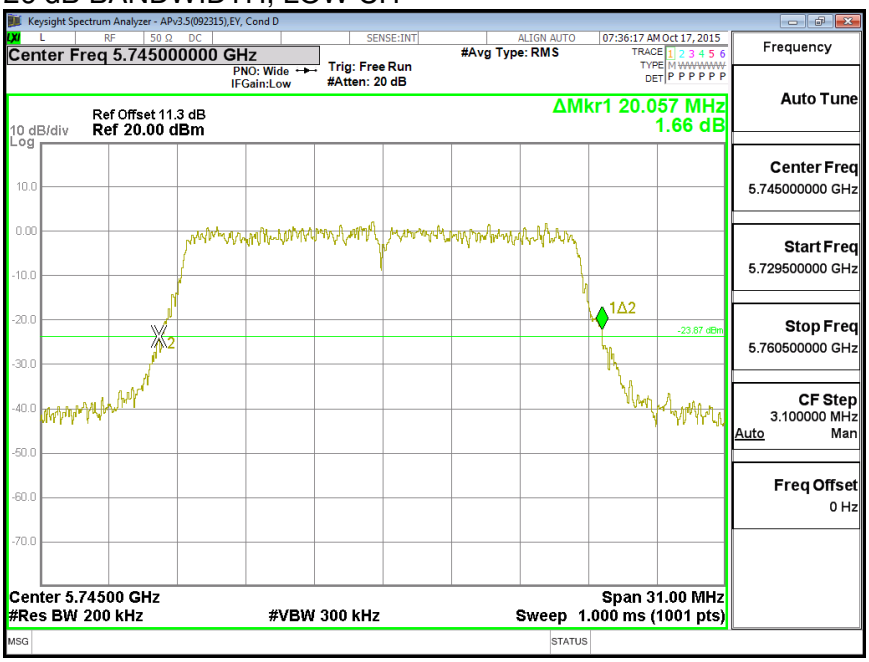
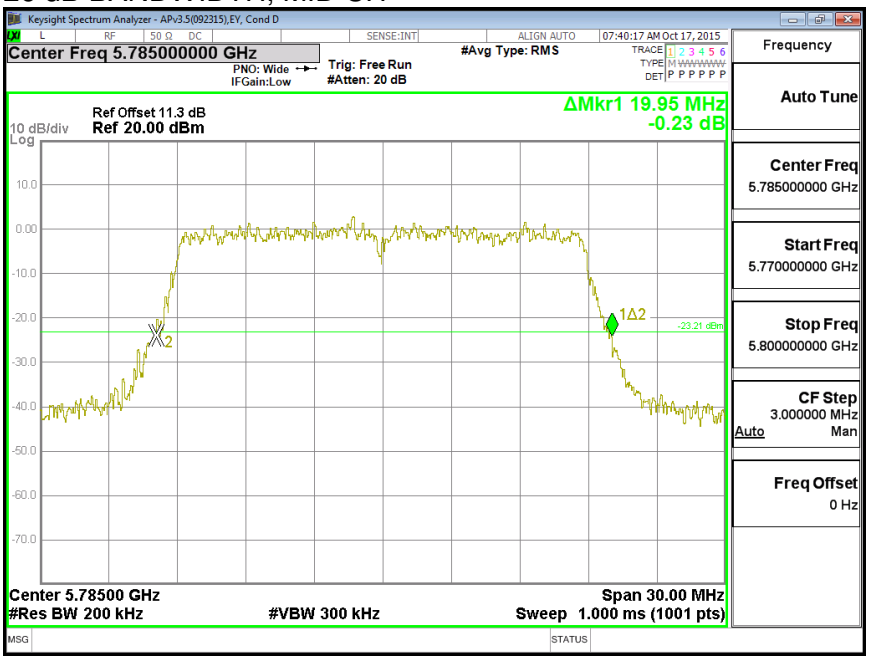
26 dB BANDWIDTH

26 dB BANDWIDTH, LOW CH



26 dB BANDWIDTH, MID CH



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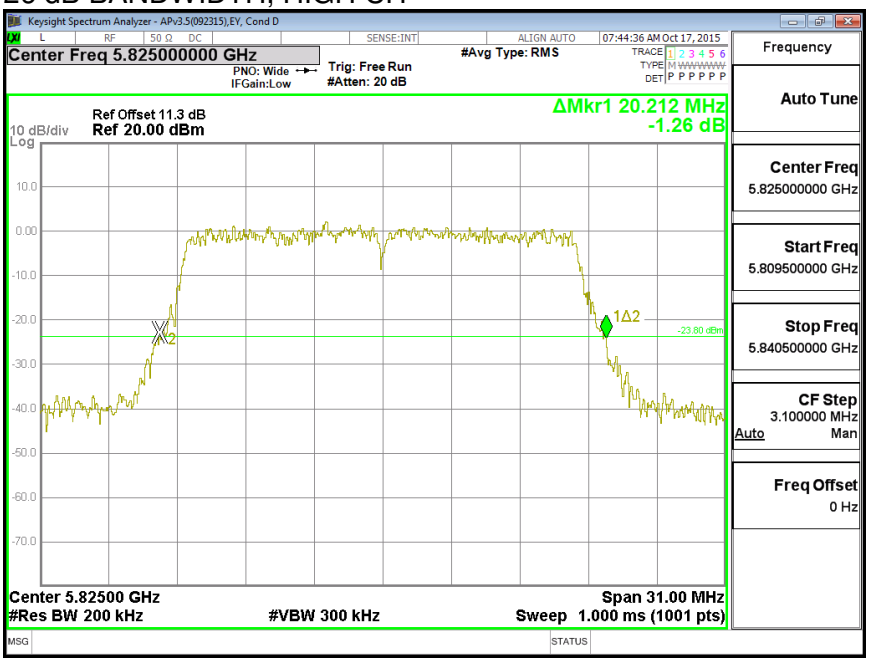
26 dB BANDWIDTH, HIGH CH



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8.2.3. **99% BANDWIDTH**

LIMITS

None; for reporting purposes only.

RESULTS

Frequency (MHz)	99% Bandwidth (MHz)
5745	17.775
5785	17.725
5825	17.872

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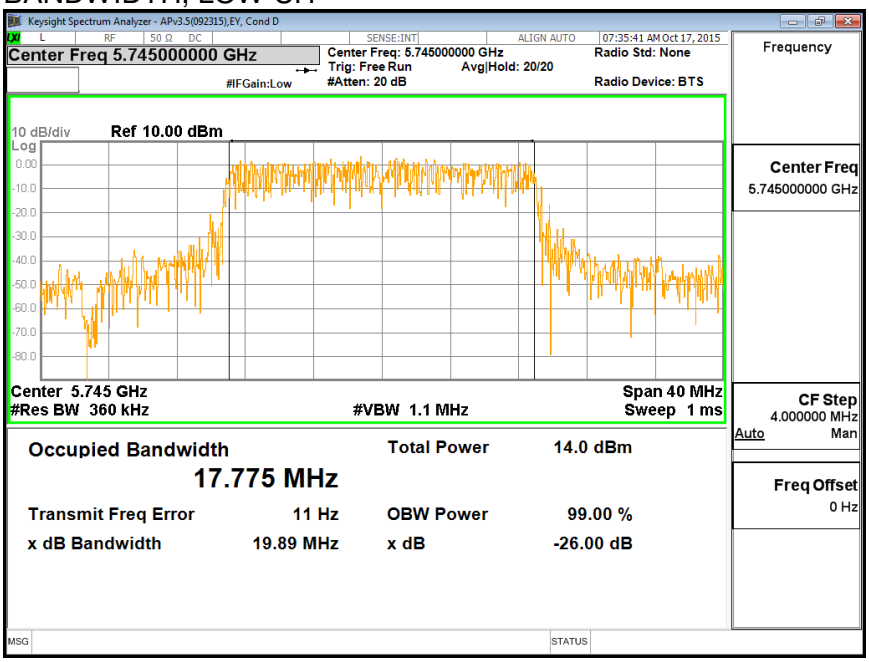
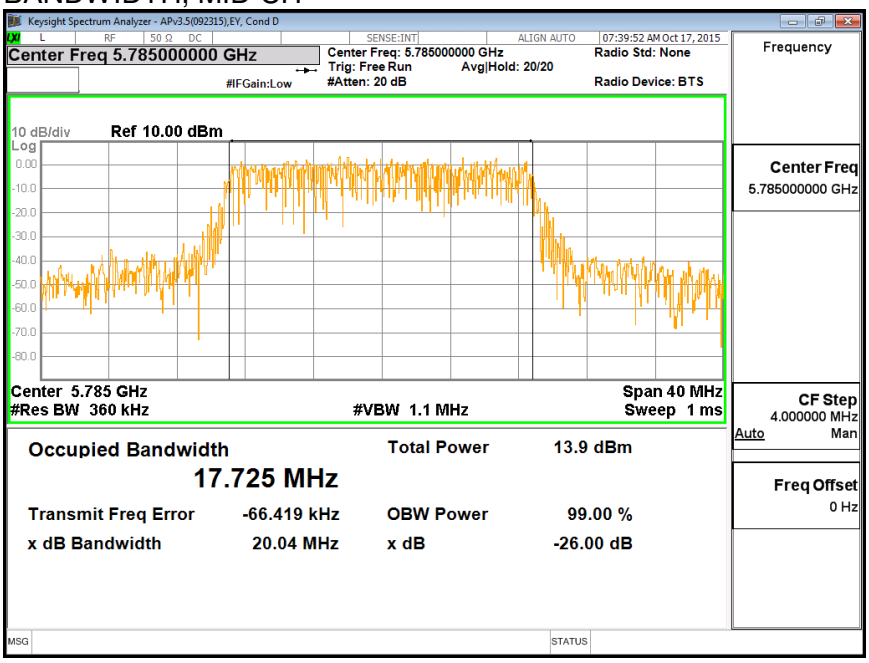
99% BANDWIDTH

BANDWIDTH, LOW CH



BANDWIDTH, MID CH



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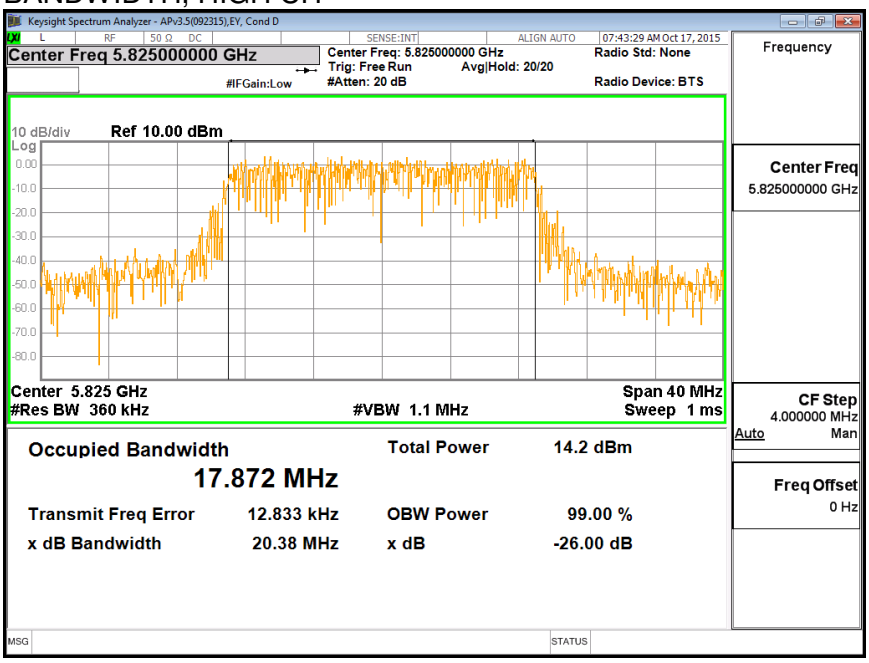
BANDWIDTH, HIGH CH



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8.2.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

Test Procedure

Measurements perform using a wideband gated RF power meter.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5745	17.40
Mid	5785	19.30
High	5825	18.38

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8.2.5. OUTPUT POWER

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

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RESULTS

Antenna Gain and Limit

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Power Limit (dBm)
Low	5745	4.40	30.00
Mid	5785	4.40	30.00
High	5825	4.40	30.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5745	17.40	17.40	30.00	-12.60
Mid	5785	19.30	19.30	30.00	-10.70
High	5825	18.38	18.38	30.00	-11.62

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8.2.6. **PSD**

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

RESULTS

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	PSD Limit (dBm)
Low	5745	4.40	30.00
Mid	5785	4.40	30.00
High	5825	4.40	30.00

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

PSD Results

Channel	Frequency (MHz)	Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5745	4.74	4.74	30.00	-25.26
Mid	5785	6.56	6.56	30.00	-23.44
High	5825	6.64	6.64	30.00	-23.36

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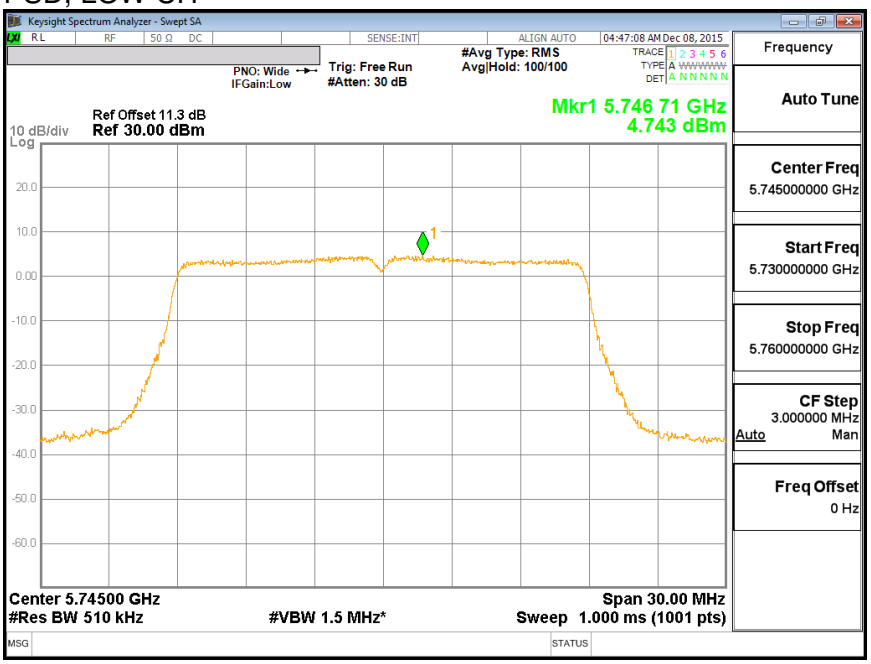
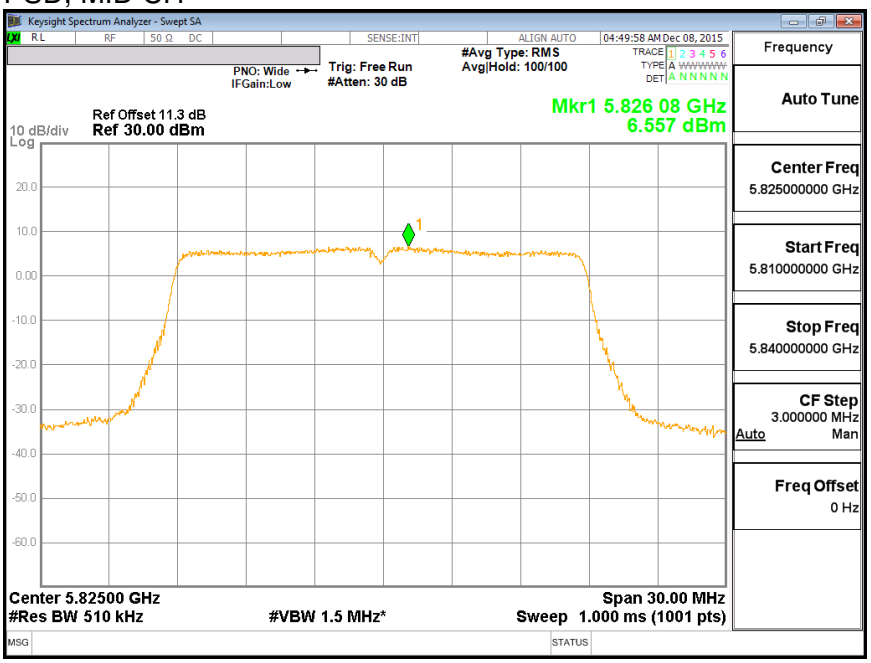
PSD

PSD, LOW CH



PSD, MID CH



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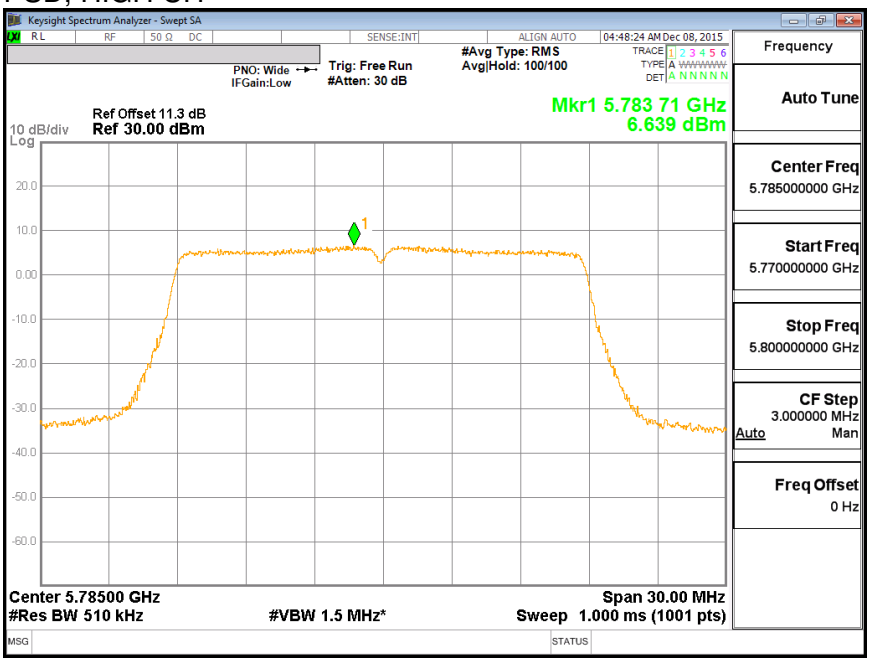
PSD, HIGH CH



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8.3. 802.11n HT20 2TX CDD MODE IN THE 5.8 GHz BAND

8.3.1. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

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

RESULTS

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 2 (MHz)	Minimum Limit (MHz)
Low	5745	17.60	17.63	0.5
Mid	5785	17.66	17.52	0.5
High	5825	17.55	17.82	0.5

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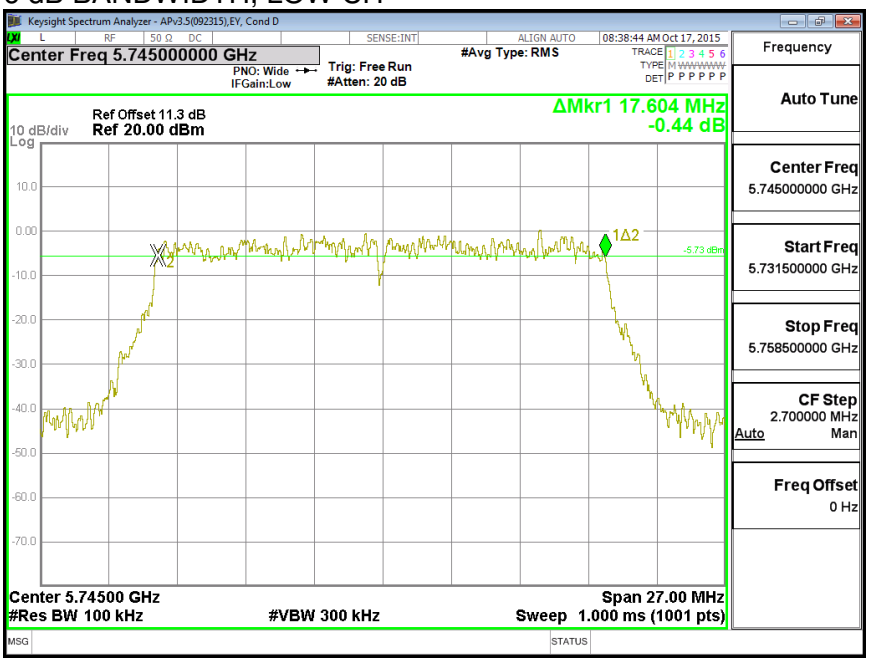
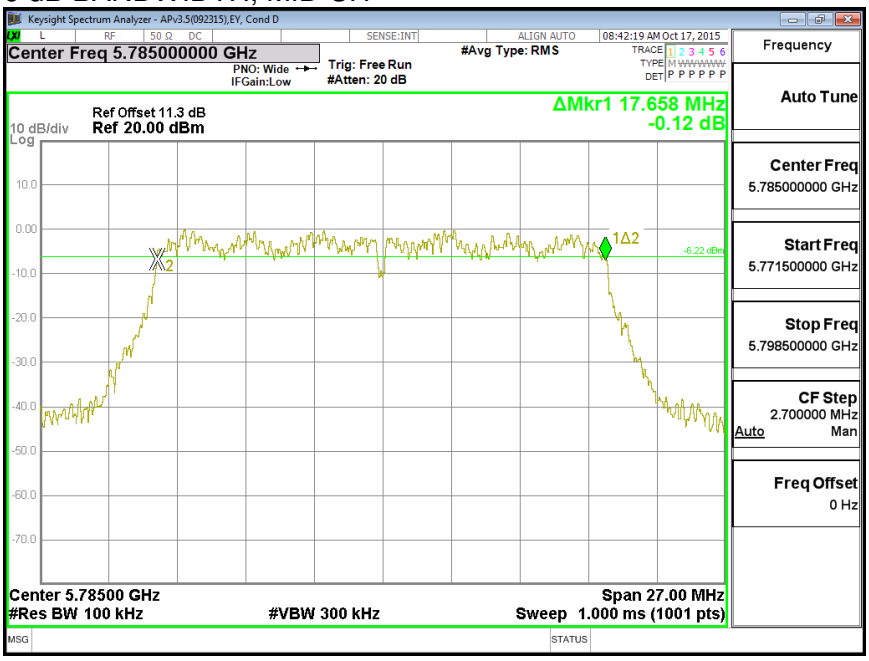
6 dB BANDWIDTH, CHAIN 0

6 dB BANDWIDTH, LOW CH



6 dB BANDWIDTH, MID CH



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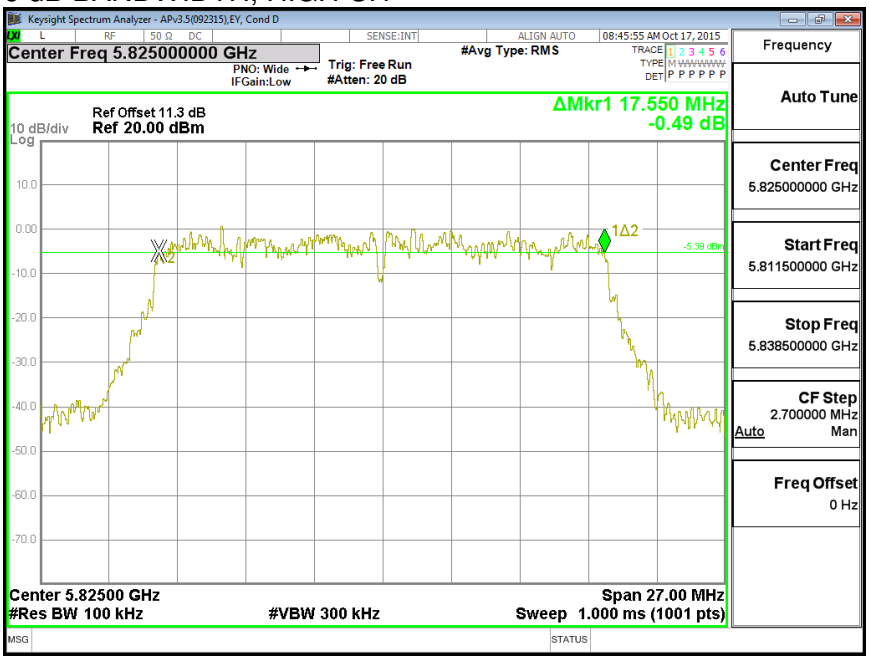
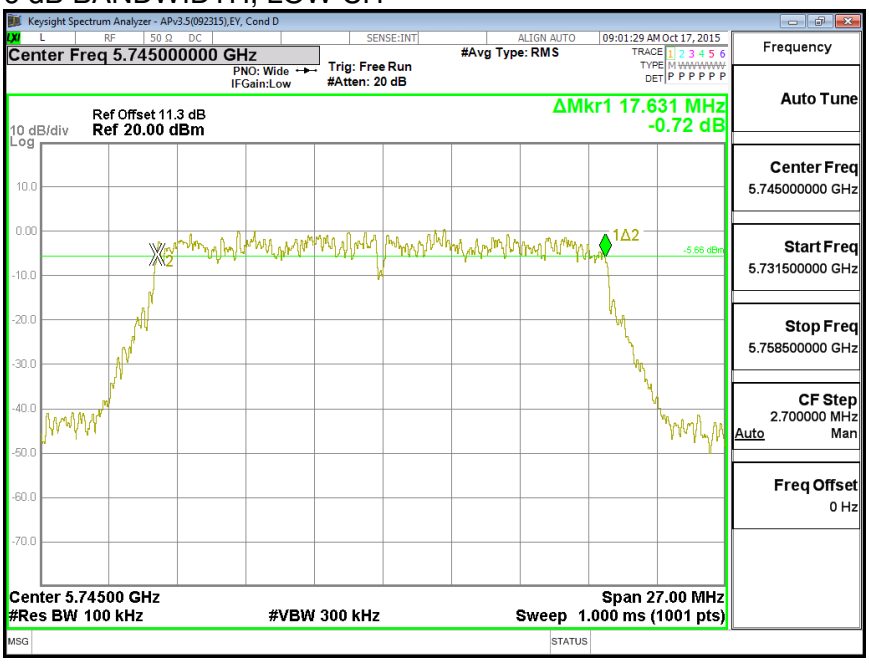
6 dB BANDWIDTH, HIGH CH



6 dB BANDWIDTH, CHAIN 2

6 dB BANDWIDTH, LOW CH



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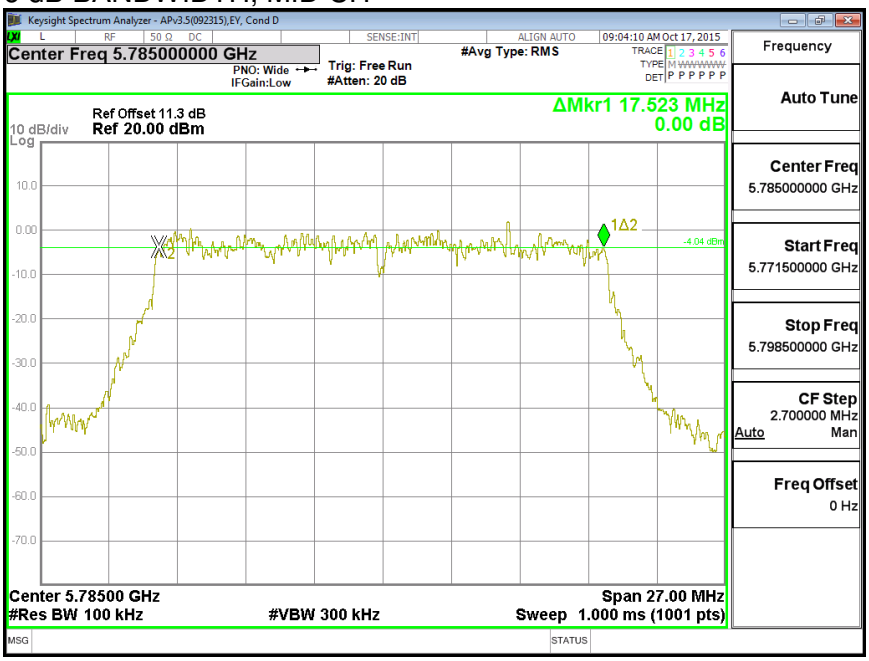
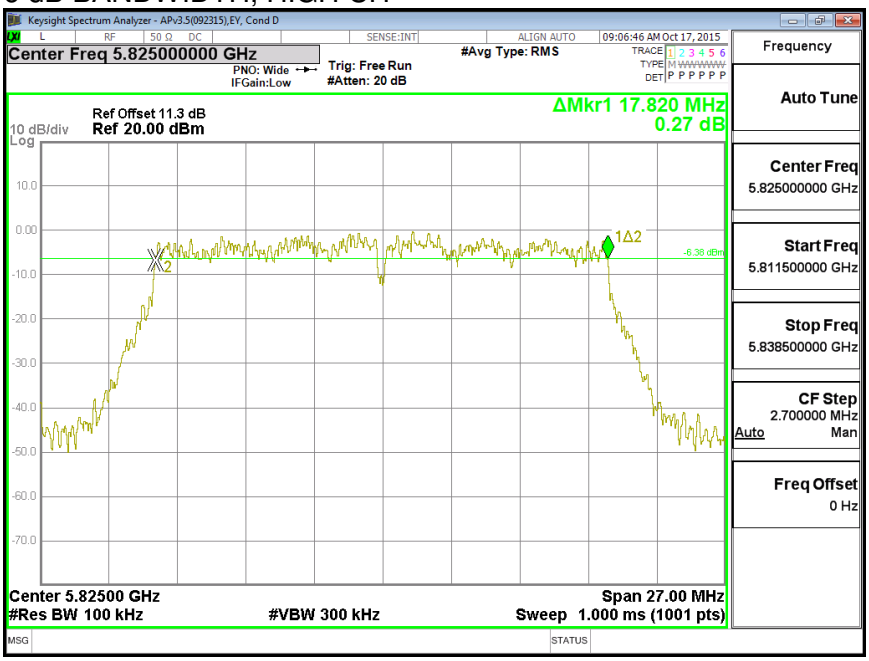
6 dB BANDWIDTH, MID CH



6 dB BANDWIDTH, HIGH CH



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8.3.2. **26 dB BANDWIDTH**

LIMITS

None, for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 0 (MHz)	26 dB BW Chain 2 (MHz)
Low	5745	20.01	19.98
Mid	5785	20.03	20.37
High	5825	20.06	19.95

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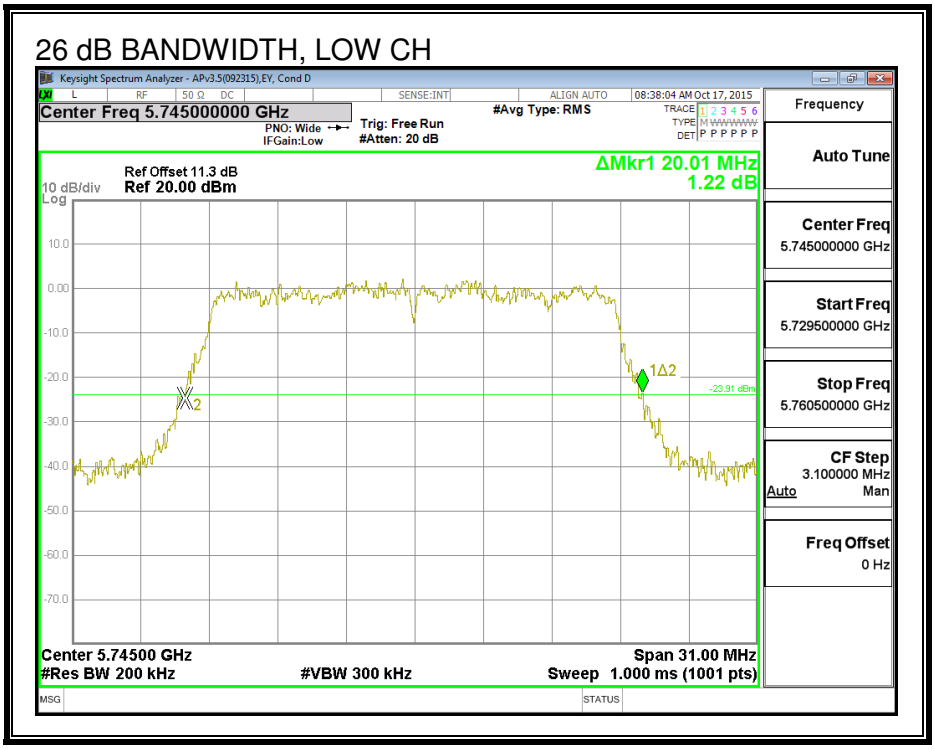
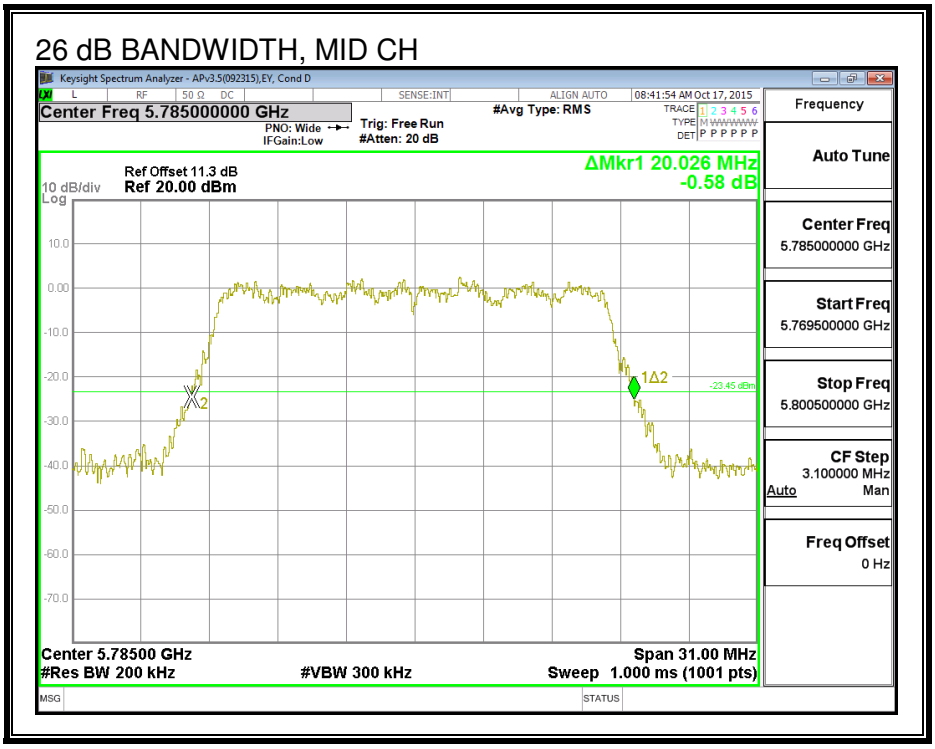
26 dB BANDWIDTH, CHAIN 0





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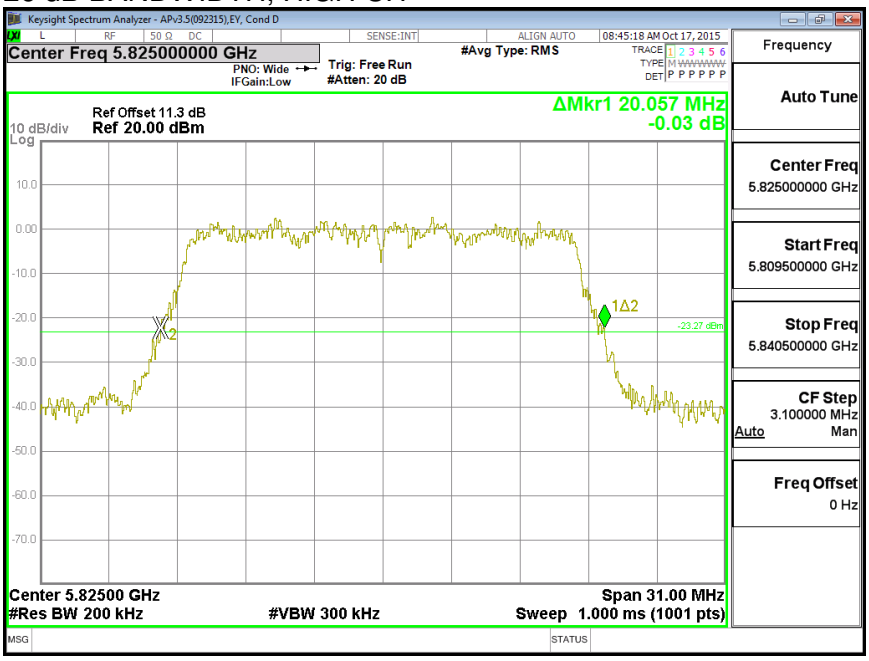
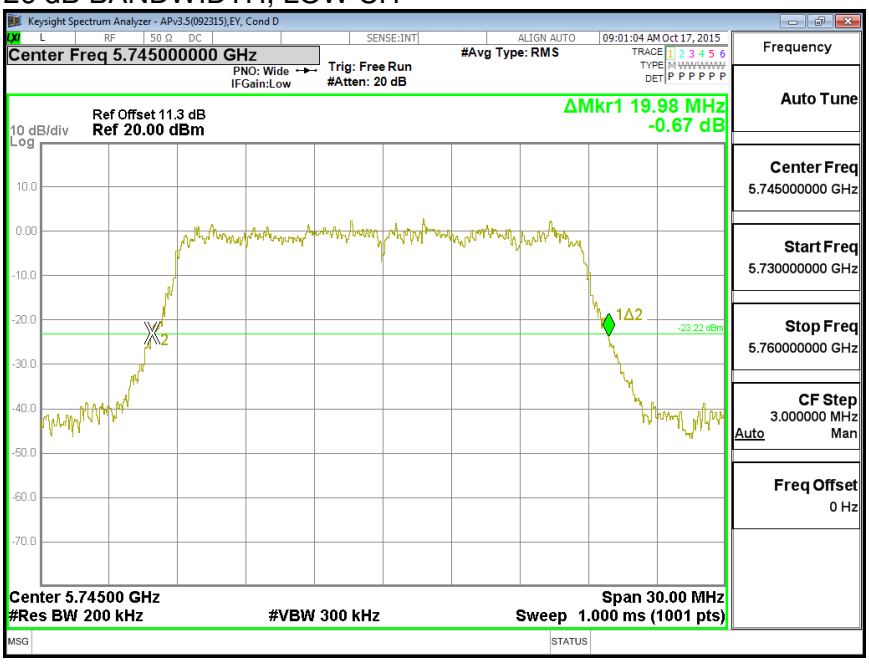
26 dB BANDWIDTH, HIGH CH



26 dB BANDWIDTH, CHAIN 2

26 dB BANDWIDTH, LOW CH



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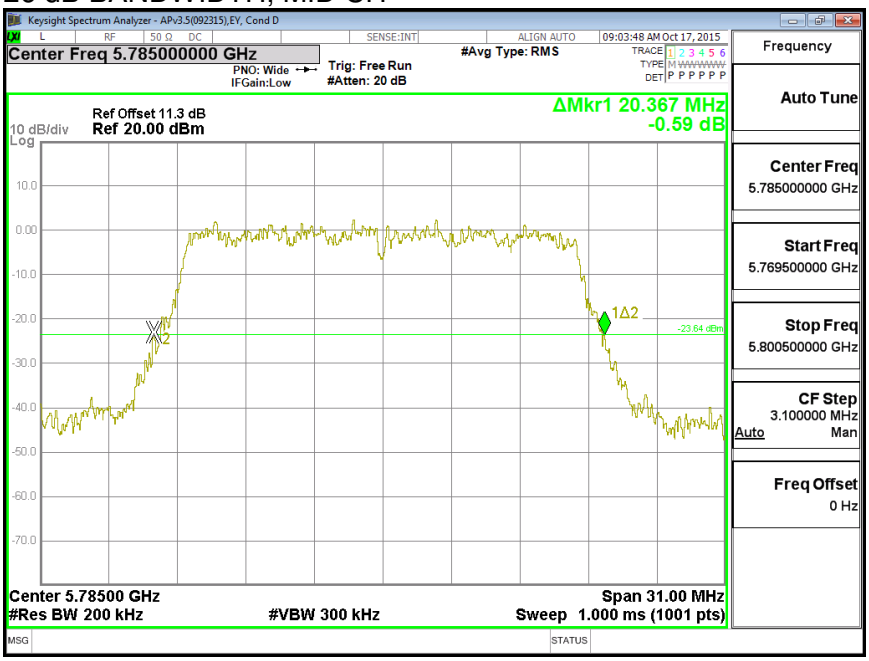
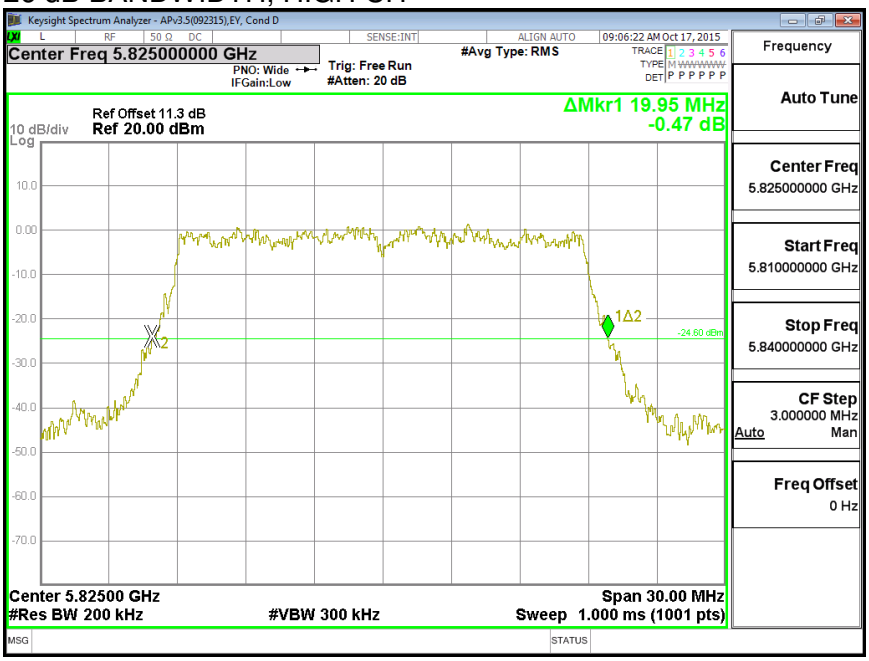
26 dB BANDWIDTH, MID CH



26 dB BANDWIDTH, HIGH CH



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8.3.3. **99% BANDWIDTH**

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% BW Chain 0 (MHz)	99% BW Chain 2 (MHz)
Low	5745	17.673	17.670
Mid	5785	17.703	17.811
High	5825	17.540	17.820

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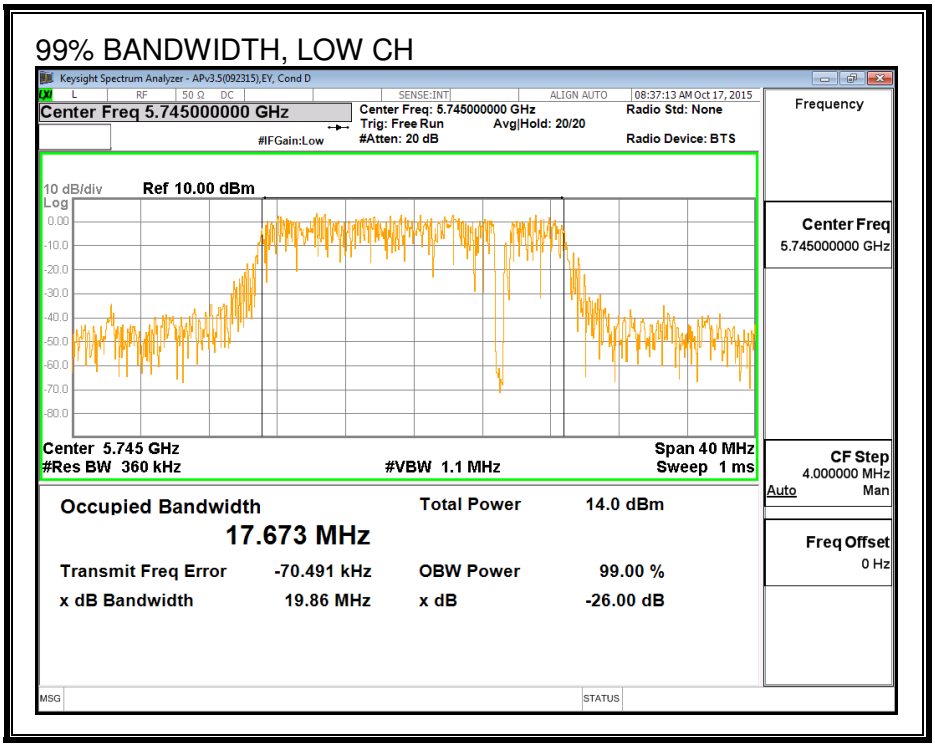
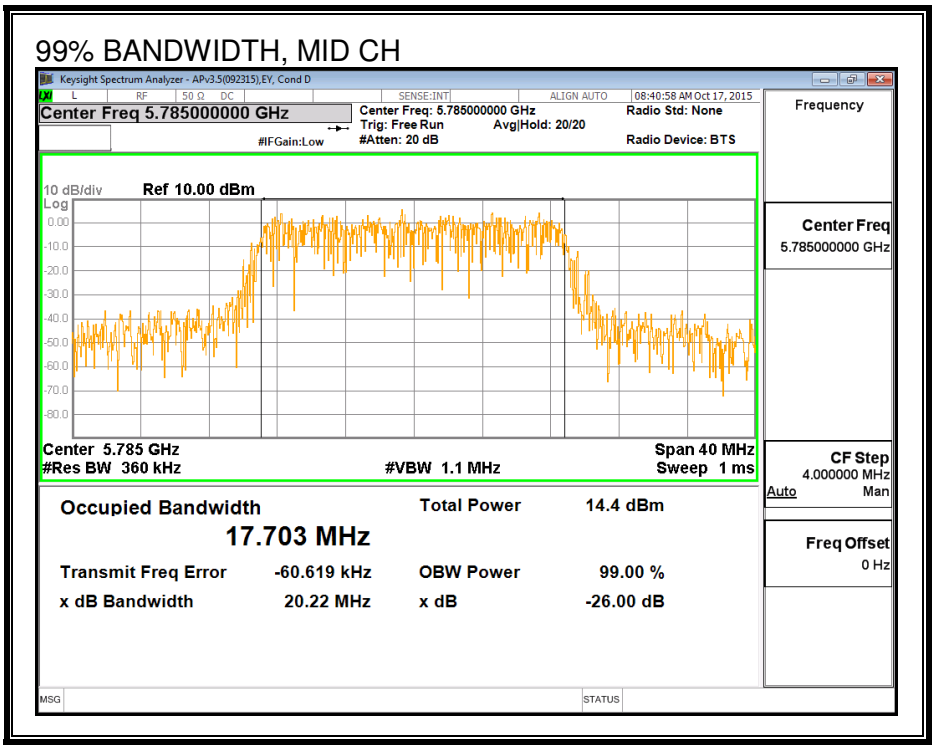
99% BANDWIDTH, CHAIN 0





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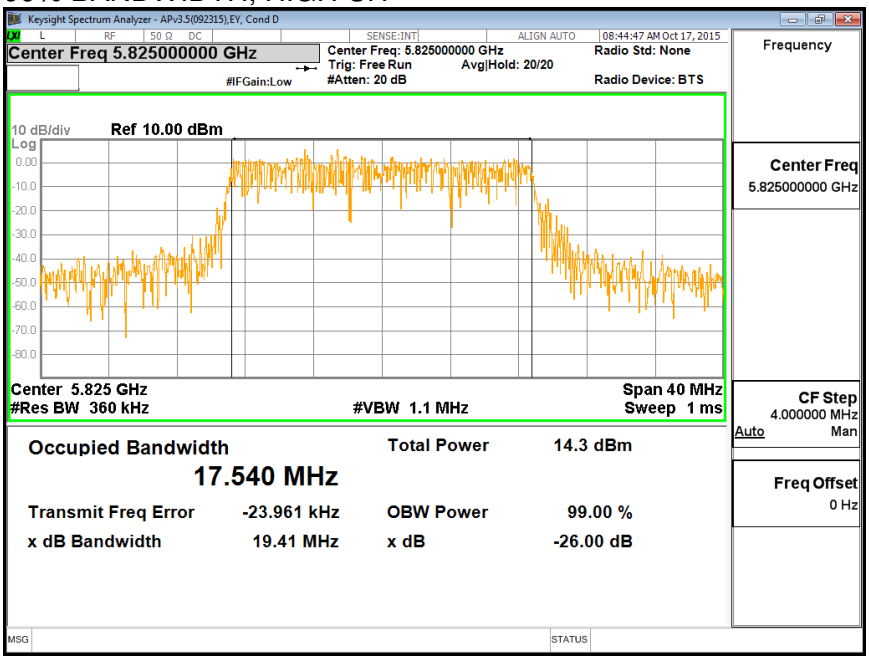
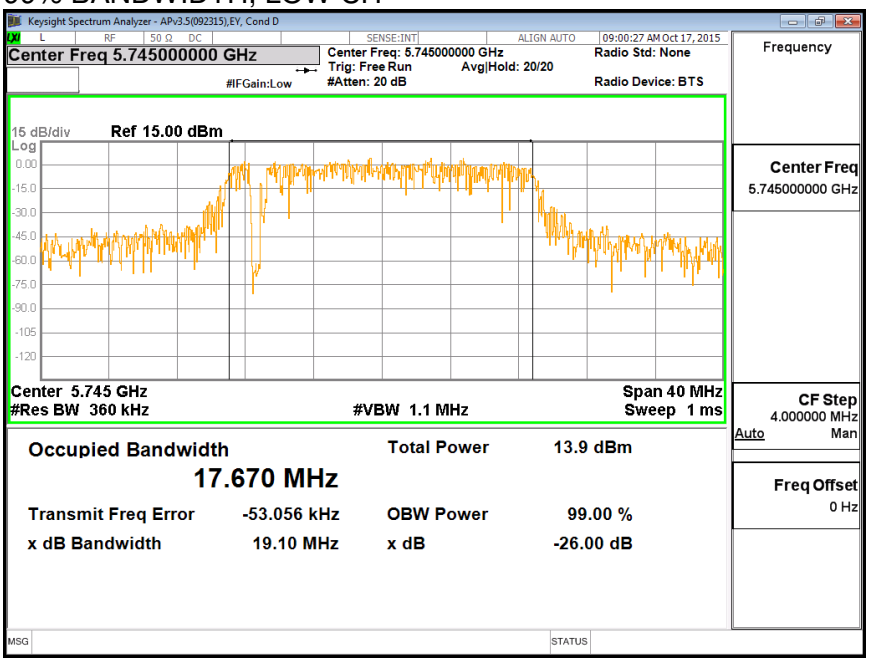
99% BANDWIDTH, HIGH CH



99% BANDWIDTH, CHAIN 2

99% BANDWIDTH, LOW CH



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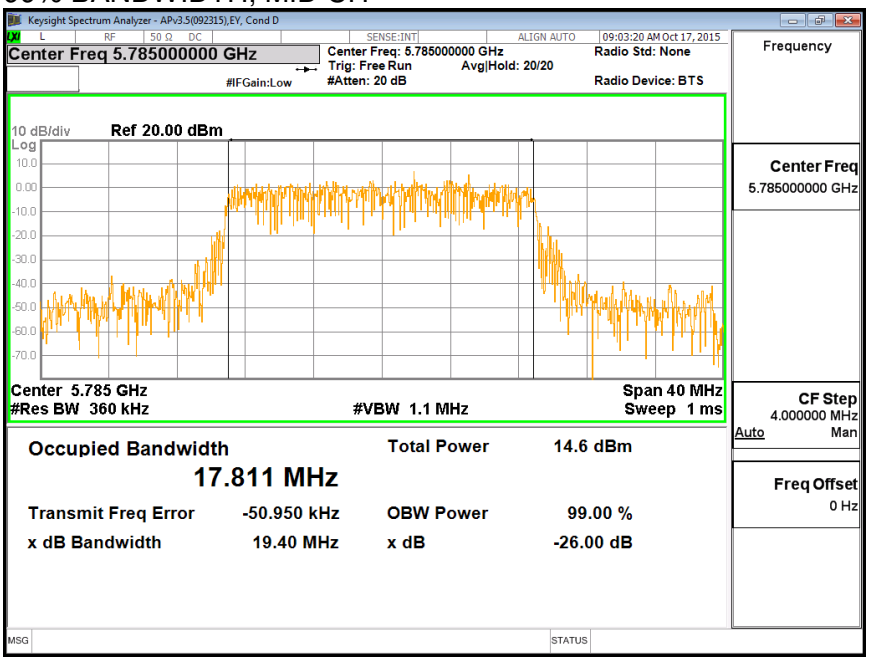
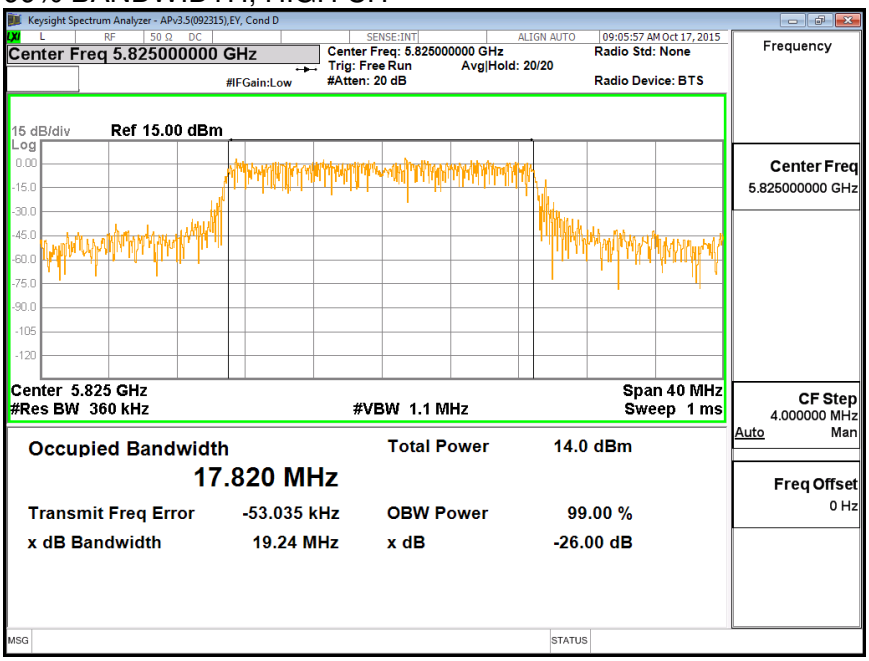
99% BANDWIDTH, MID CH



99% BANDWIDTH, HIGH CH



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8.3.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

Test Procedure

Measurements perform using a wideband gated RF power meter.

RESULTS

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5745	16.55	16.23	19.40
Mid	5785	18.11	17.99	21.06
High	5825	16.32	15.97	19.16

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8.3.5. OUTPUT POWER

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
2.70	4.40	3.63

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RESULTS

Antenna Gain and Limit

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Power Limit (dBm)
Low	5745	3.63	30.00
Mid	5785	3.63	30.00
High	5825	3.63	30.00

Output Power Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5745	16.55	16.23	19.40	30.00	-10.60
Mid	5785	18.11	17.99	21.06	30.00	-8.94
High	5825	16.32	15.97	19.16	30.00	-10.84

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8.3.6. **PSD**

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.70	4.40	6.60

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RESULTS

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	PSD Limit (dBm)
Low	5745	6.60	29.40
Mid	5785	6.60	29.40
High	5825	6.60	29.40

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

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas PSD (dBm)	Chain 2 Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5745	4.92	4.85	7.90	29.40	-21.50
Mid	5785	6.89	6.78	9.84	29.40	-19.56
High	5825	4.46	4.29	7.38	29.40	-22.02

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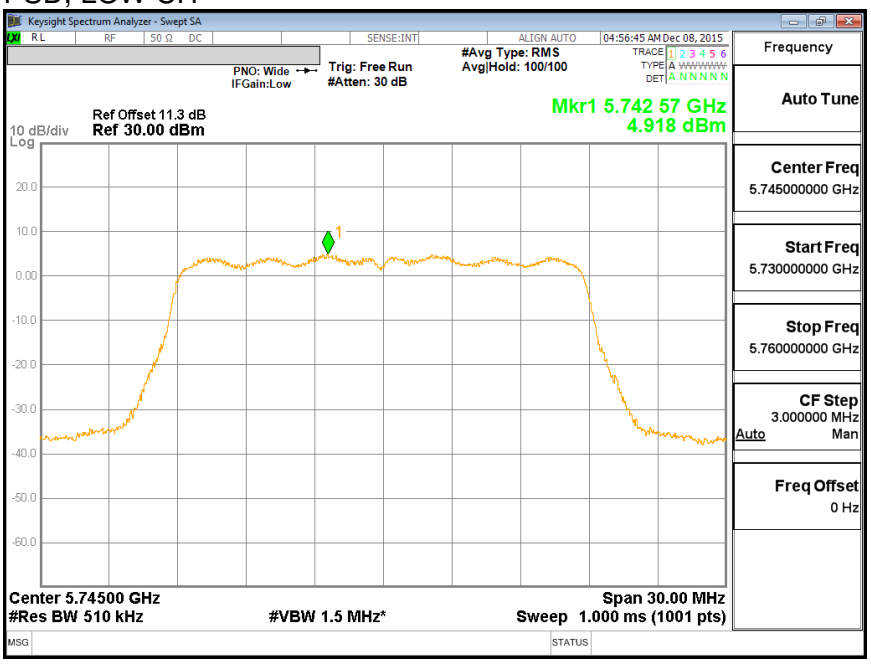
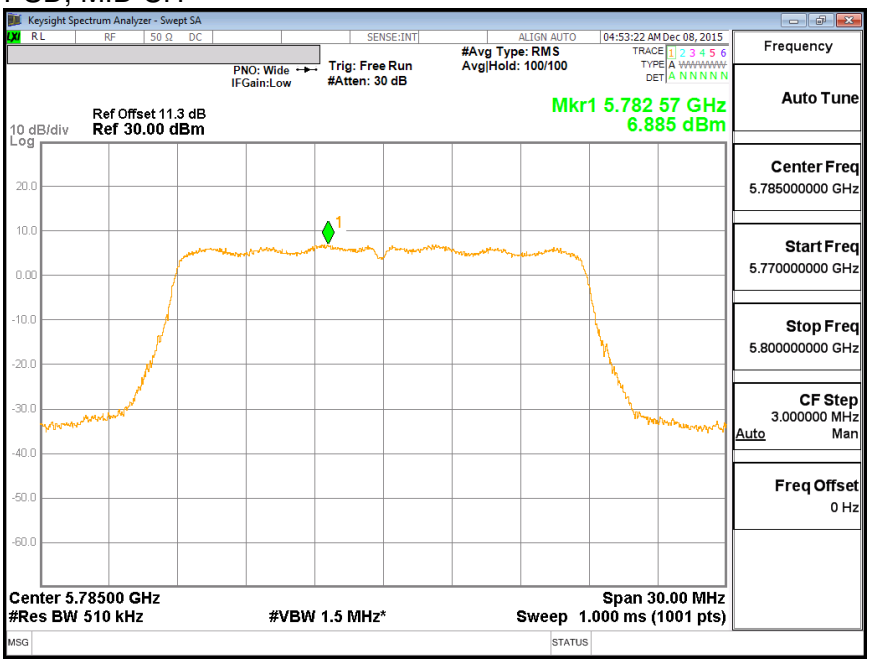
PSD, CHAIN 0

PSD, LOW CH



PSD, MID CH



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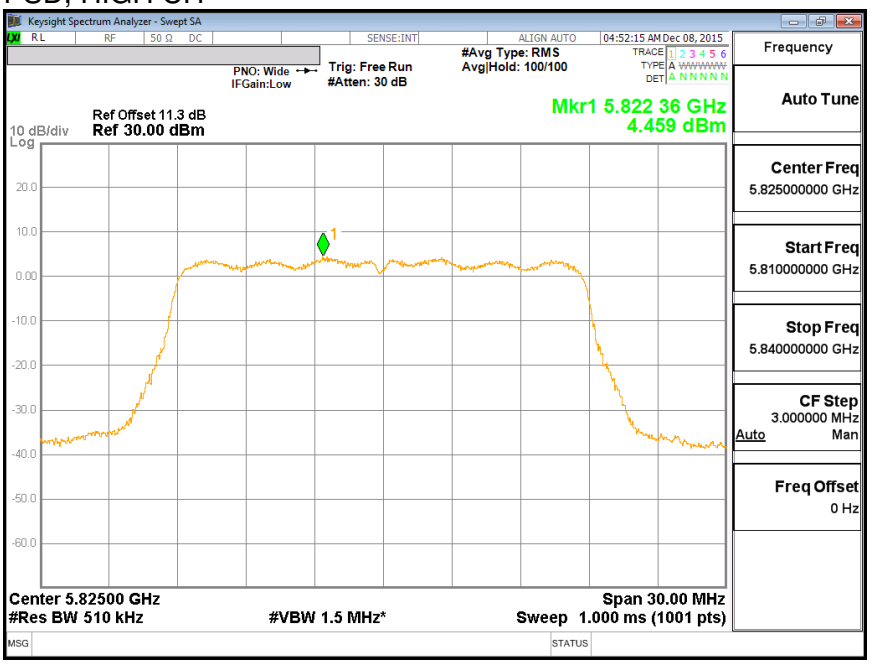
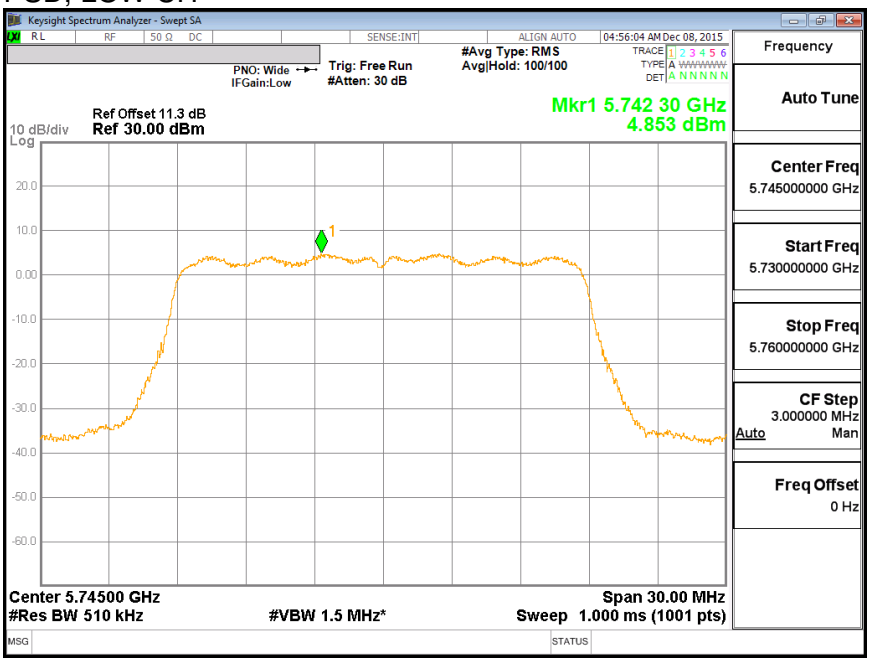
PSD, HIGH CH



PSD, CHAIN 2

PSD, LOW CH



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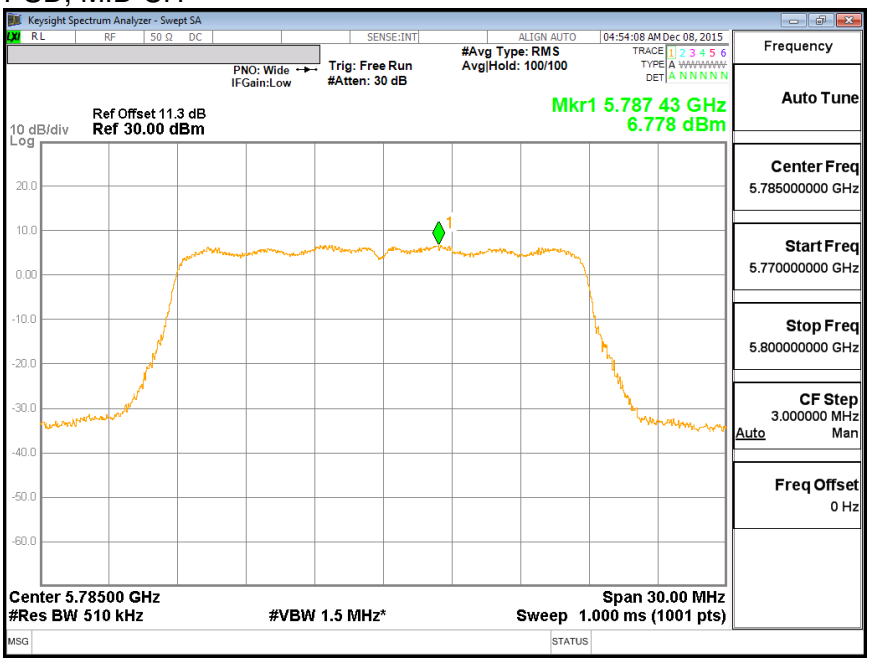
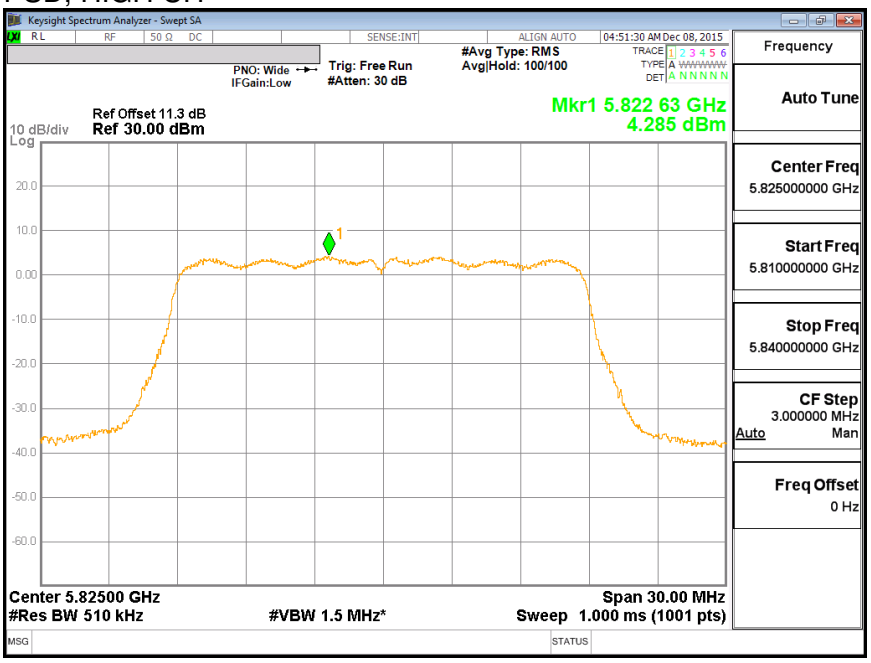
PSD, MID CH



PSD, HIGH CH



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8.4. 802.11n HT20 2TX STBC MODE IN THE 5.8 GHz BAND

NOTE: Covered by 802.11n HT20 2TX CDD.

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8.5. 802.11n HT20 2TX BF MODE IN THE 5.8 GHz BAND

8.5.1. AVERAGE POWER

LIMITS

None; for reporting purposes only.

Test Procedure

Measurements perform using a wideband gated RF power meter.

RESULTS

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5745	15.16	15.41	18.30
Mid	5785	16.05	16.42	19.25
High	5825	15.07	15.30	18.20

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8.5.2. OUTPUT POWER

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.70	4.40	6.60

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RESULTS

Antenna Gain and Limit

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Power Limit (dBm)
Low	5745	6.60	29.40
Mid	5785	6.60	29.40
High	5825	6.60	29.40

Output Power Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5745	15.16	15.41	18.30	29.40	-11.10
Mid	5785	16.05	16.42	19.25	29.40	-10.15
High	5825	15.07	15.30	18.20	29.40	-11.20

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8.5.3. **PSD**

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.70	4.40	6.60

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RESULTS

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	PSD Limit (dBm)
Low	5745	6.60	29.40
Mid	5785	6.60	29.40
High	5825	6.60	29.40

Duty Cycle CF (dB)	0.13	**Included in Calculations of Corr'd PSD**

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas PSD (dBm)	Chain 2 Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5745	2.43	2.46	5.58	29.40	-23.82
Mid	5785	3.07	3.44	6.40	29.40	-23.00
High	5825	2.46	2.65	5.69	29.40	-23.71

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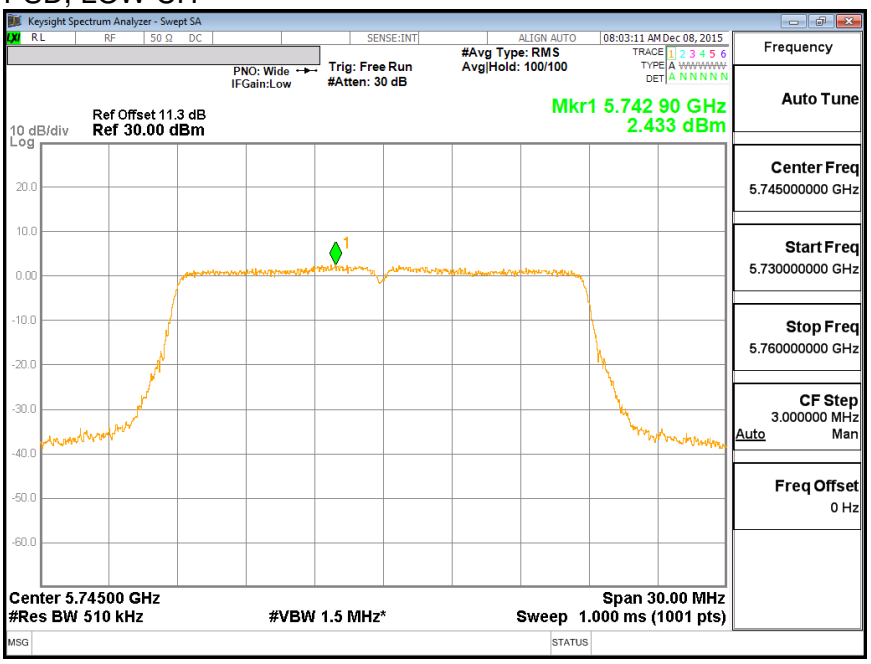
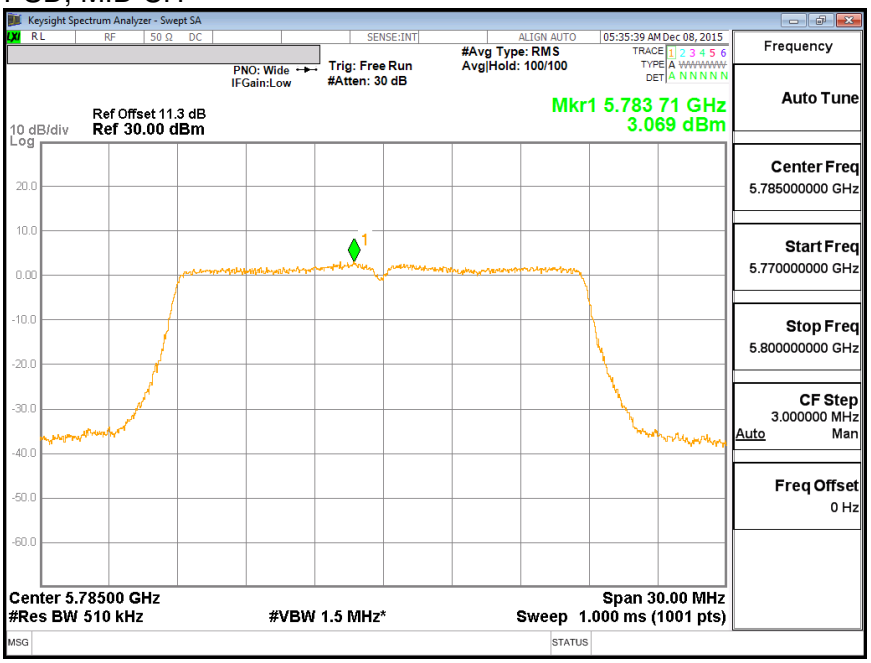
PSD, CHAIN 0

PSD, LOW CH



PSD, MID CH



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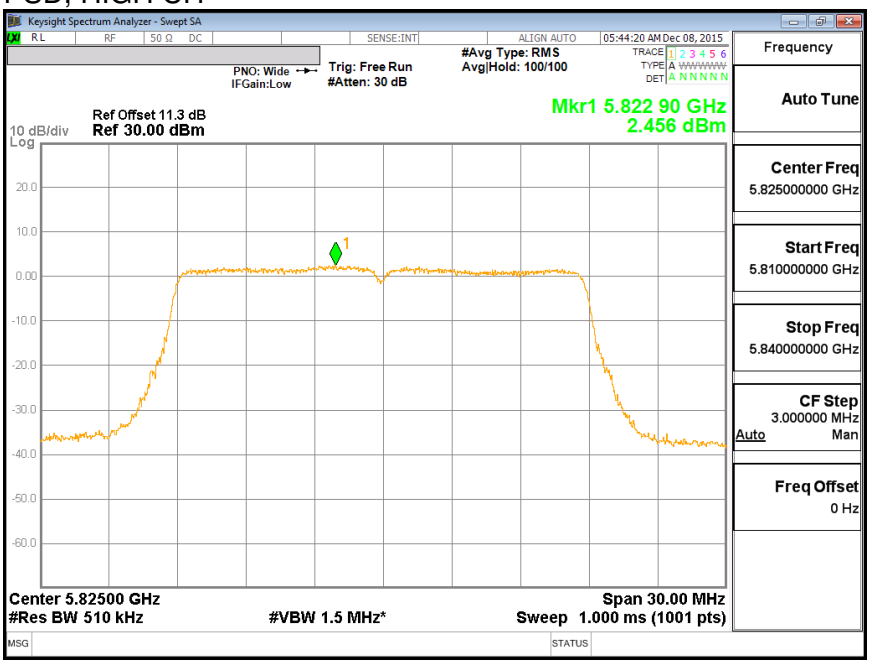
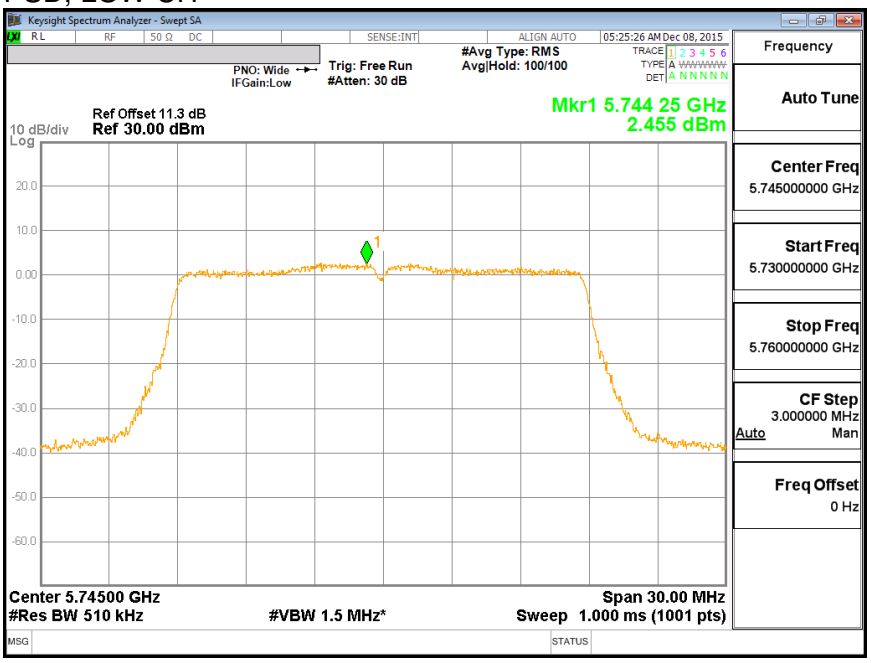
PSD, HIGH CH



PSD, CHAIN 2

PSD, LOW CH



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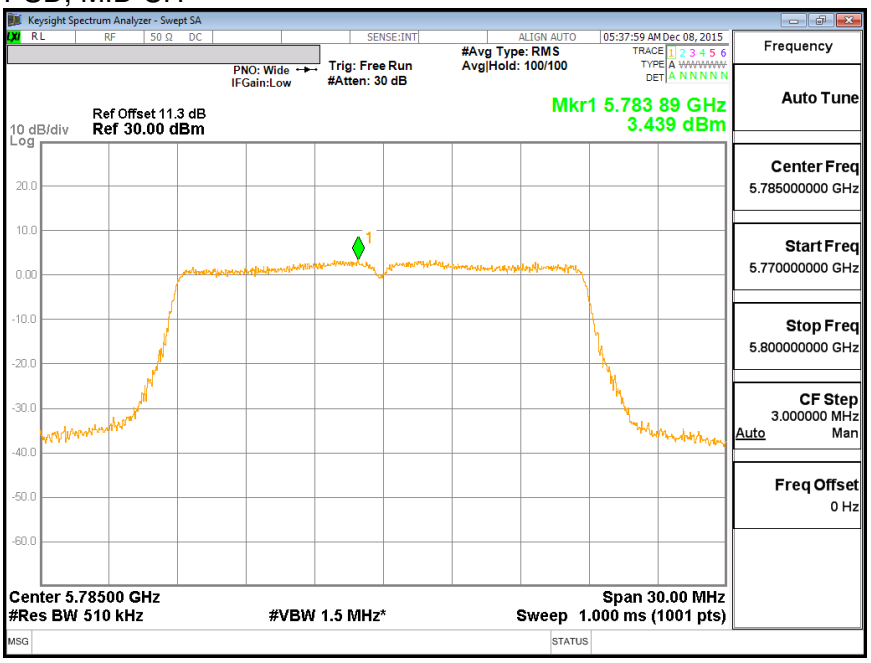
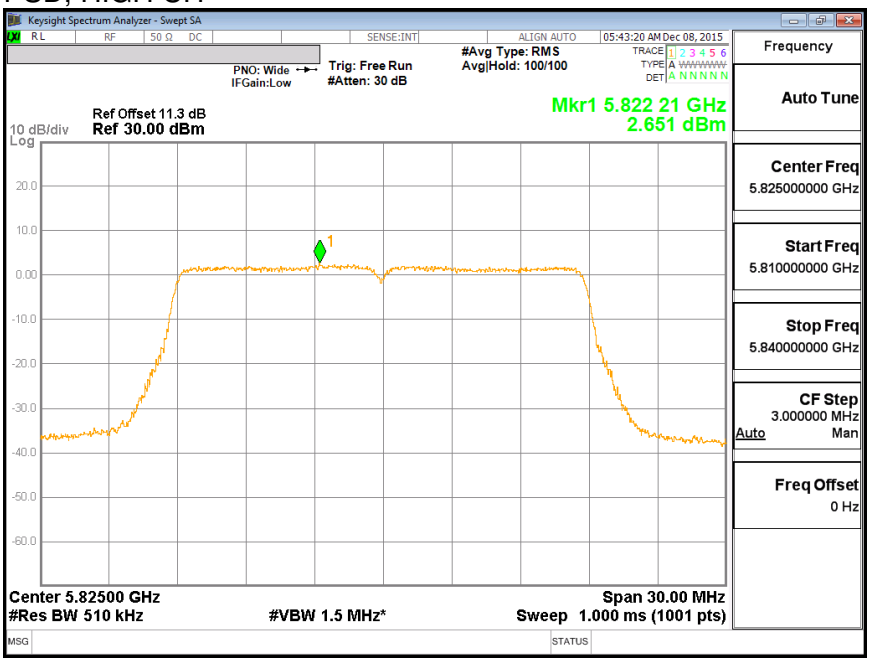
PSD, MID CH



PSD, HIGH CH



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8.6. 802.11n HT20 3TX CDD MODE IN THE 5.8 GHz BAND

8.6.1. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

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

RESULTS

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	6 dB BW Chain 2 (MHz)	Minimum Limit (MHz)
Low	5745	17.58	17.00	16.98	0.5
Mid	5785	17.63	17.36	17.26	0.5
High	5825	17.60	16.30	17.33	0.5

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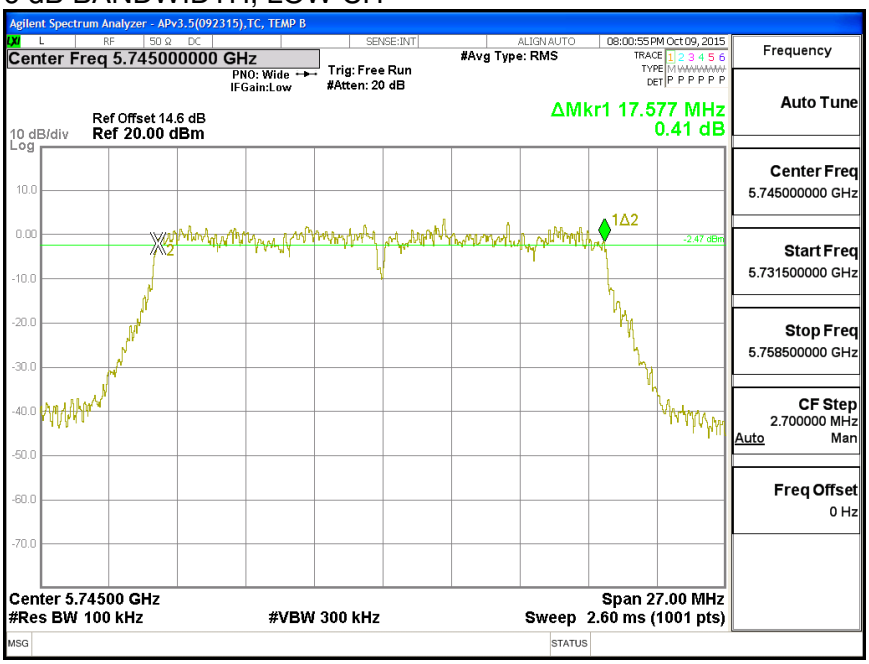
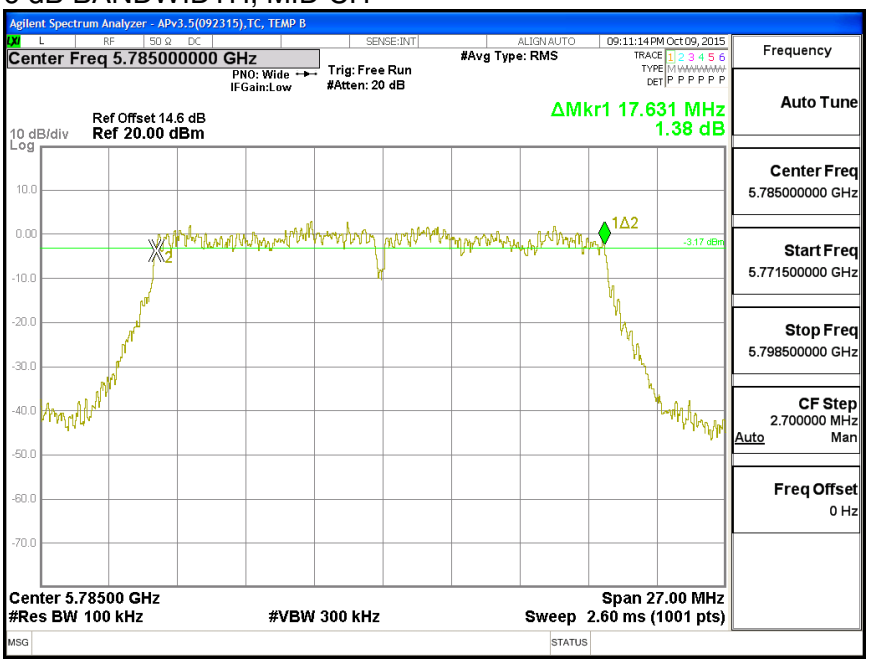
6 dB BANDWIDTH, CHAIN 0

6 dB BANDWIDTH, LOW CH



6 dB BANDWIDTH, MID CH



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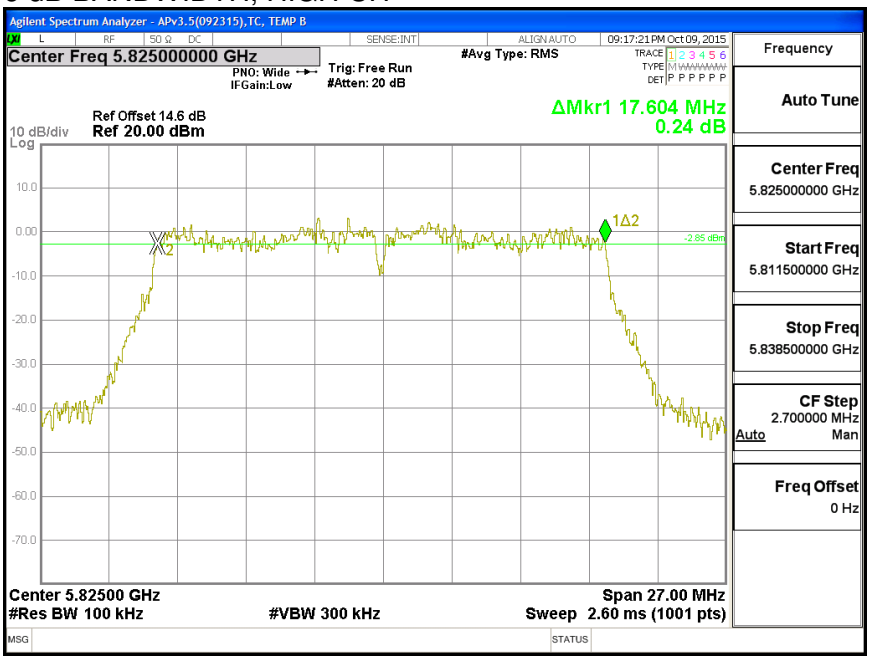
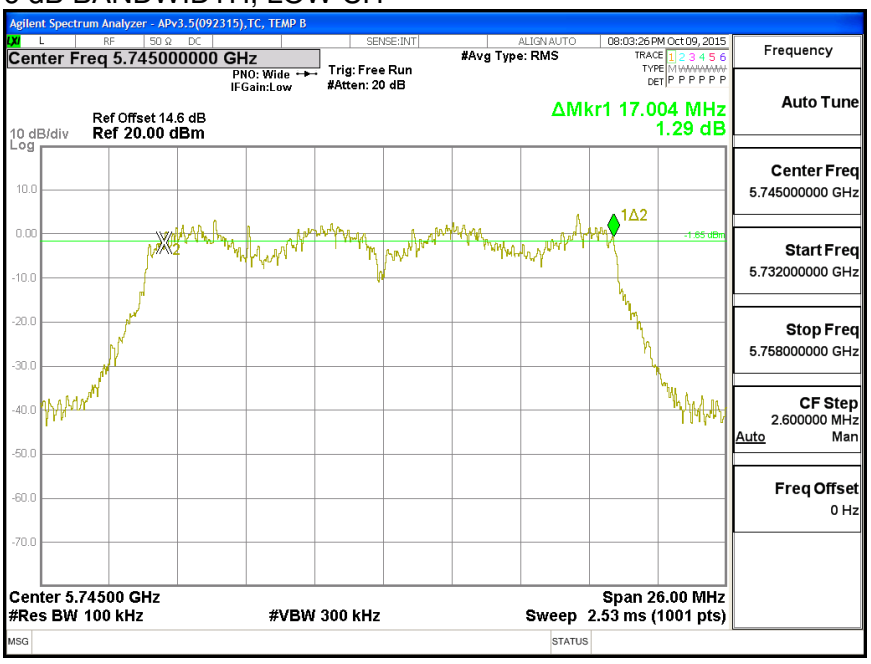
6 dB BANDWIDTH, HIGH CH



6 dB BANDWIDTH, CHAIN 1

6 dB BANDWIDTH, LOW CH



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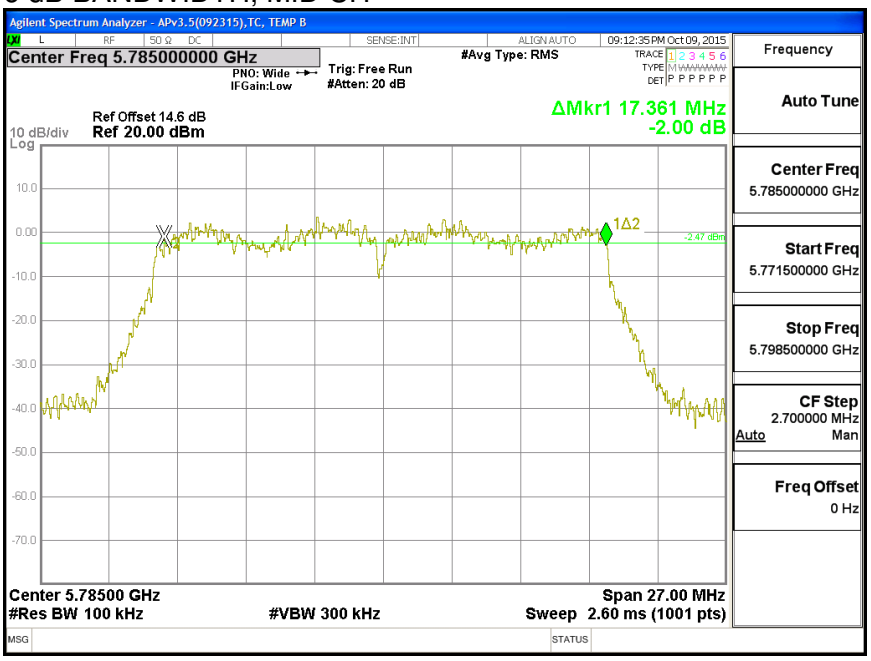
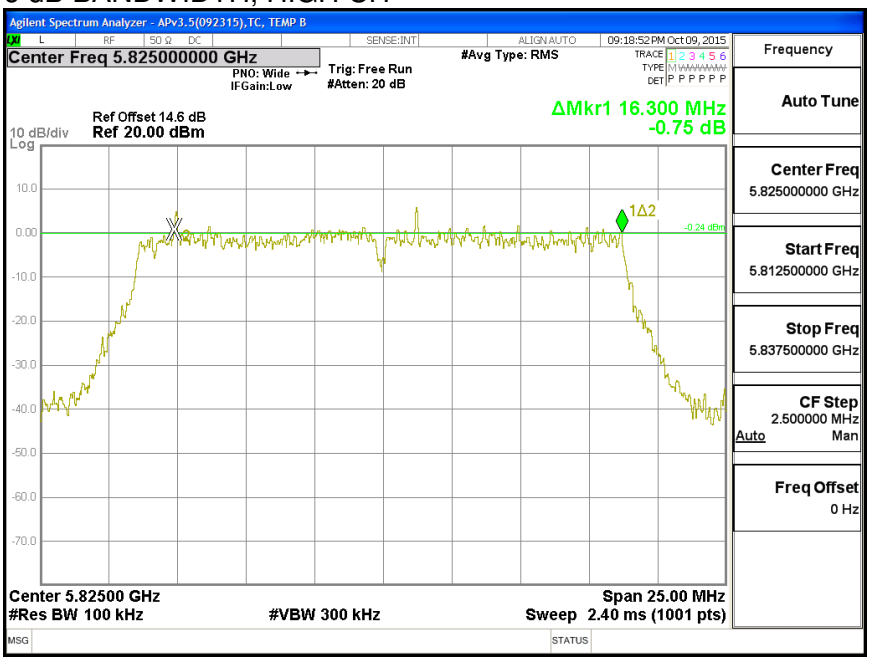
6 dB BANDWIDTH, MID CH



6 dB BANDWIDTH, HIGH CH



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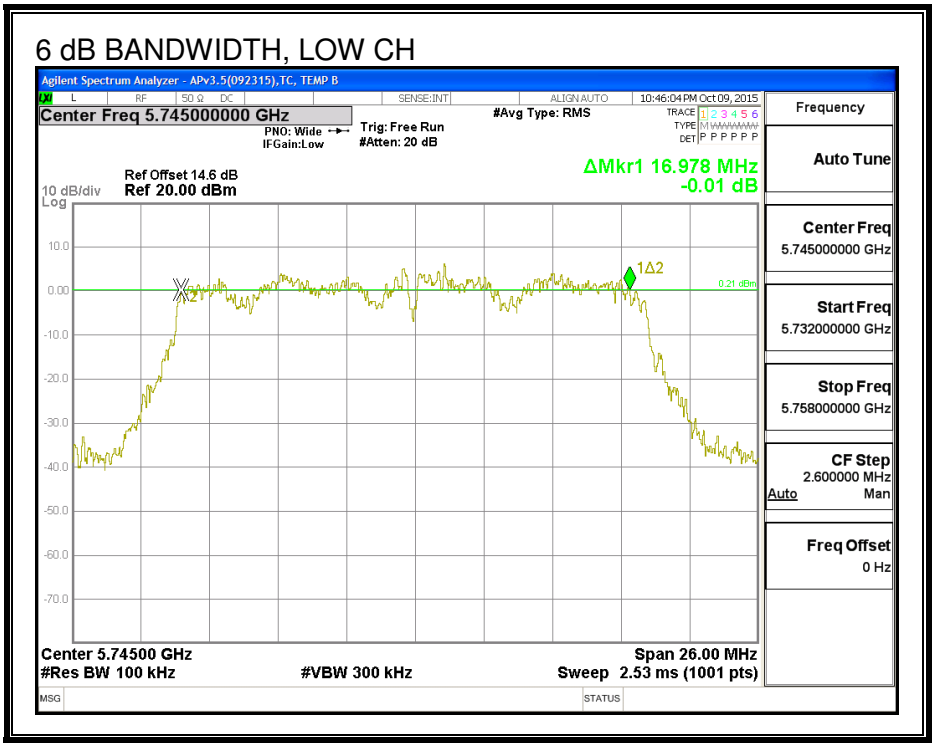
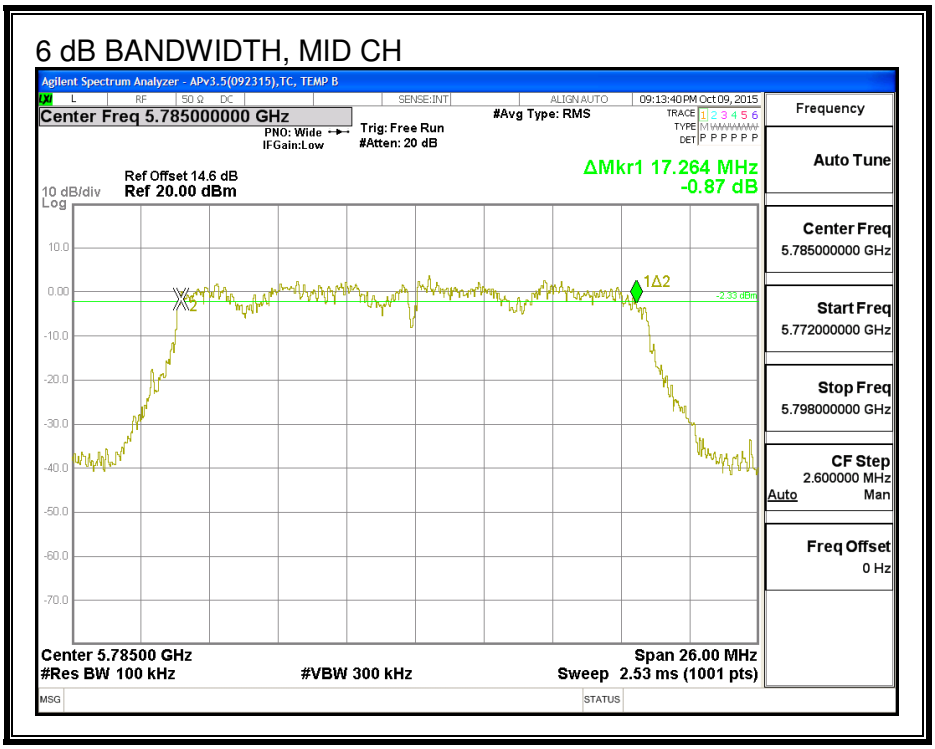
6 dB BANDWIDTH, CHAIN 2





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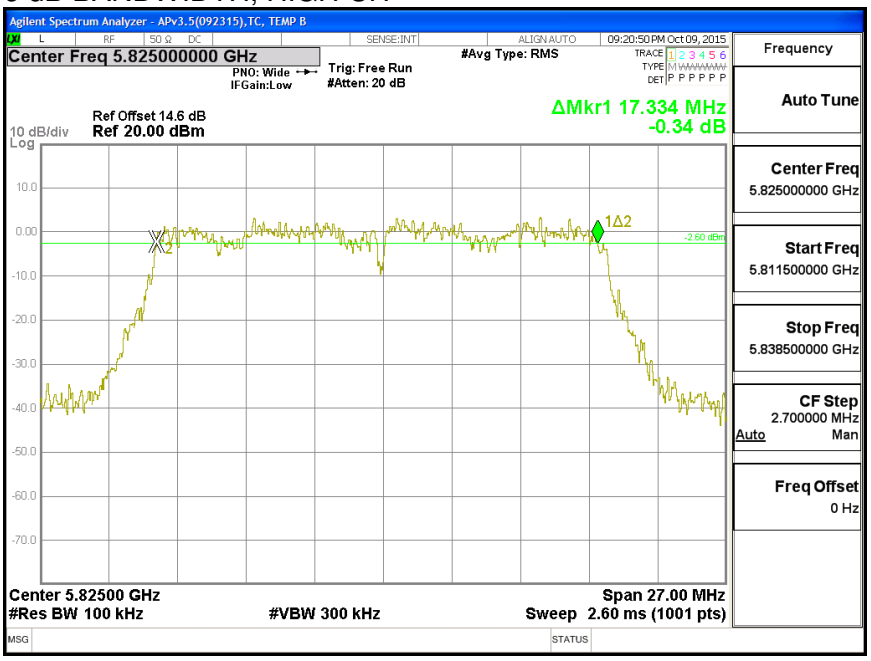
6 dB BANDWIDTH, HIGH CH



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8.6.2. **26 dB BANDWIDTH**

LIMITS

None, for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	26 dB BW Chain 0 (MHz)	26 dB BW Chain 1 (MHz)	26 dB BW Chain 2 (MHz)
Low	5745	19.77	19.74	19.98
Mid	5785	19.86	19.77	19.86
High	5825	19.98	19.77	19.50

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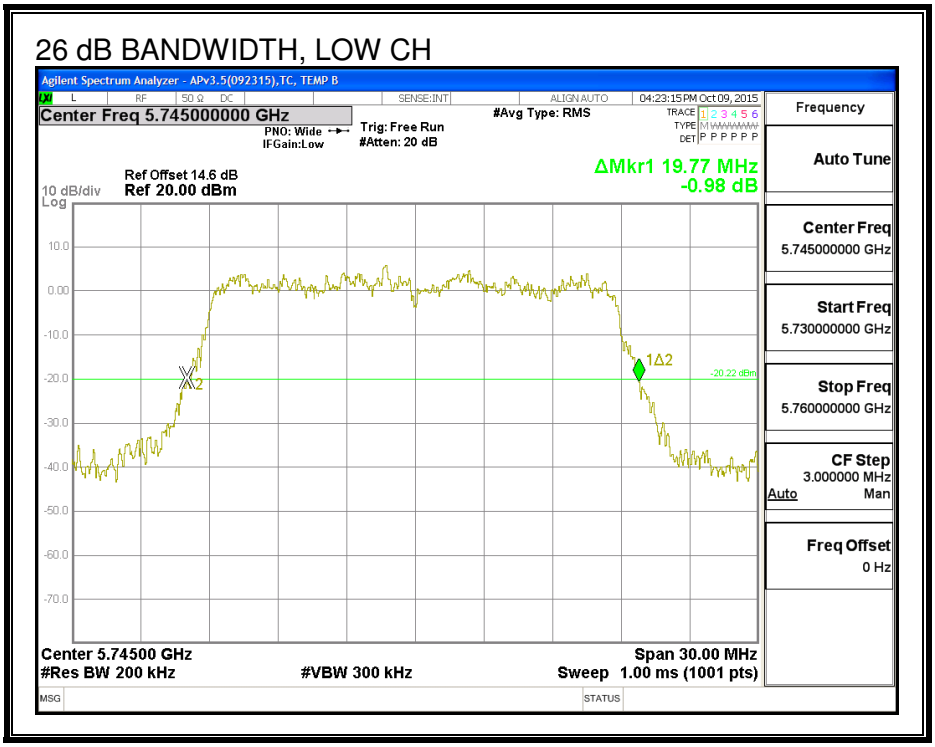
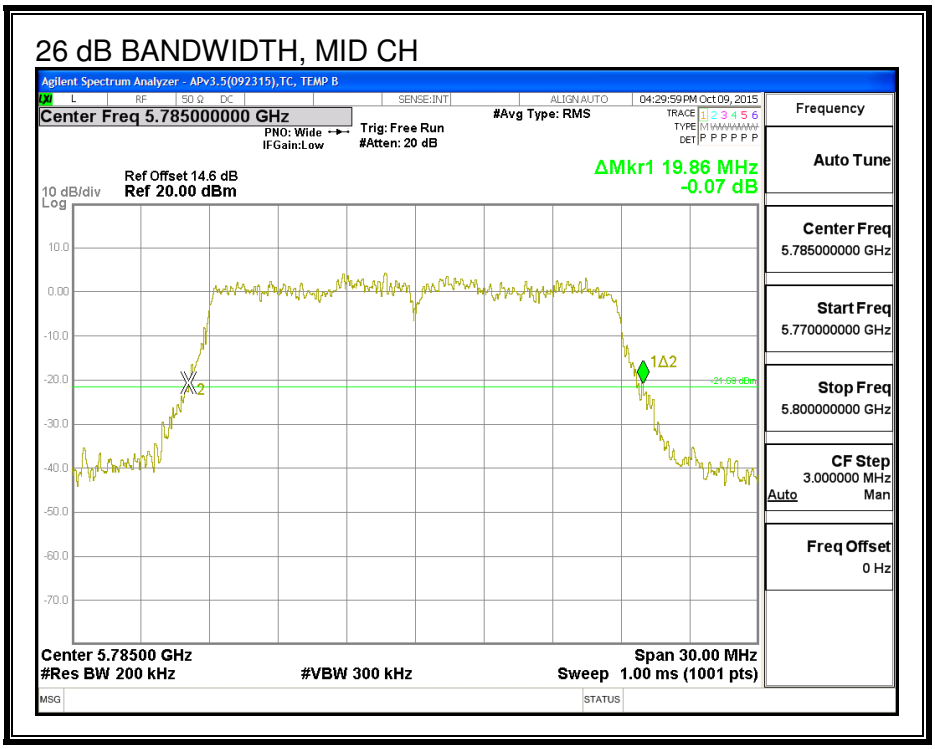
26 dB BANDWIDTH, CHAIN 0





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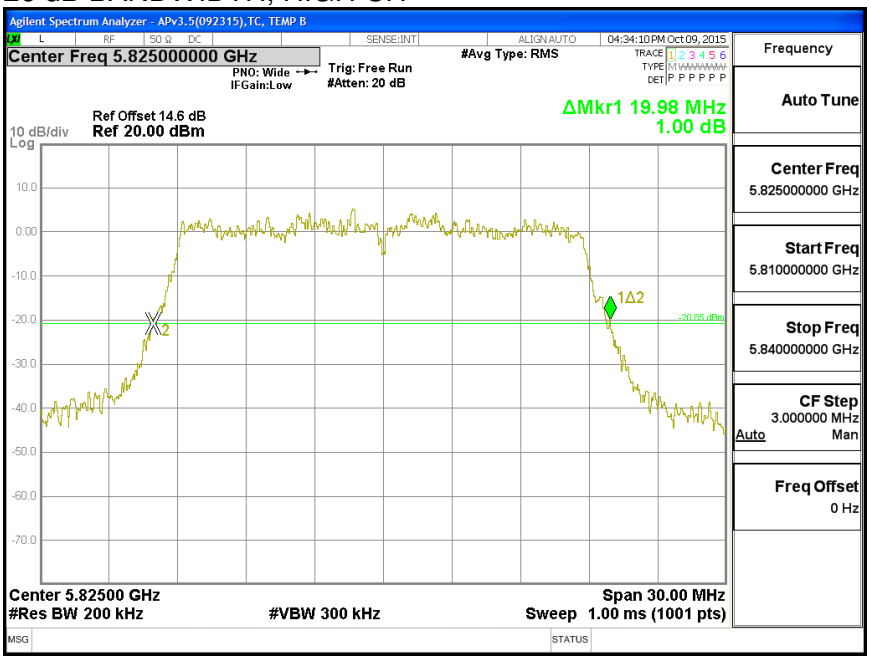
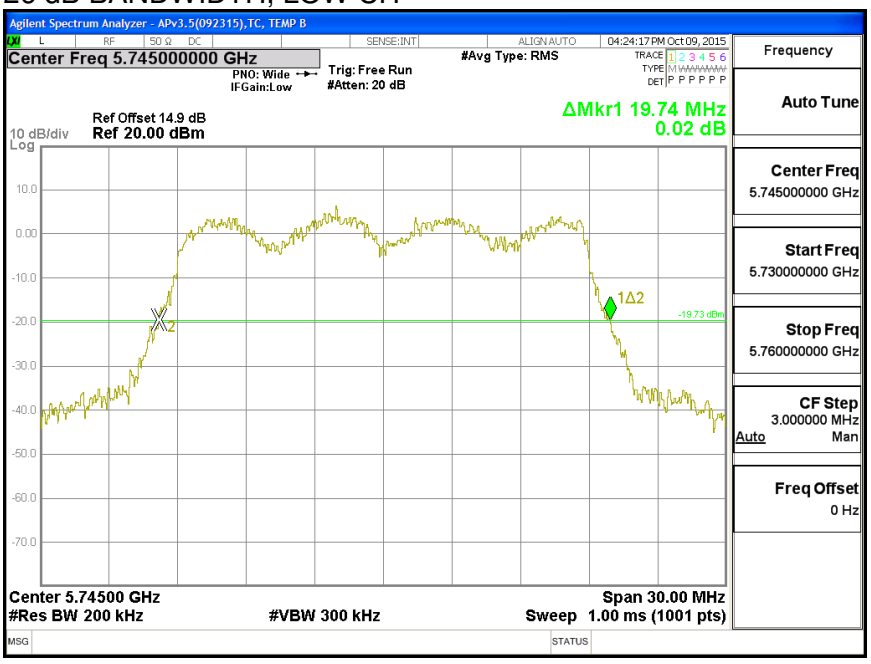
26 dB BANDWIDTH, HIGH CH



26 dB BANDWIDTH, CHAIN 1

26 dB BANDWIDTH, LOW CH



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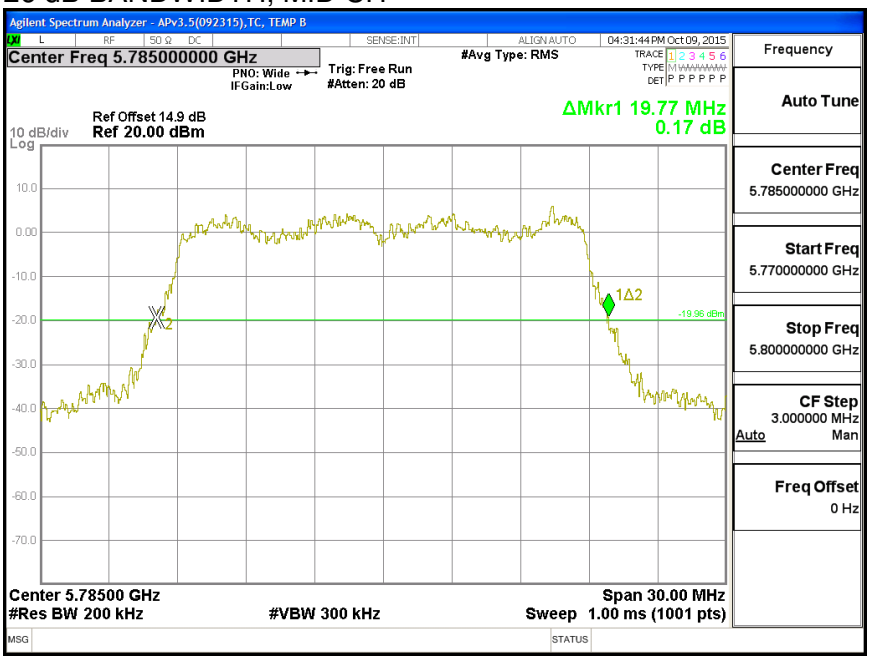
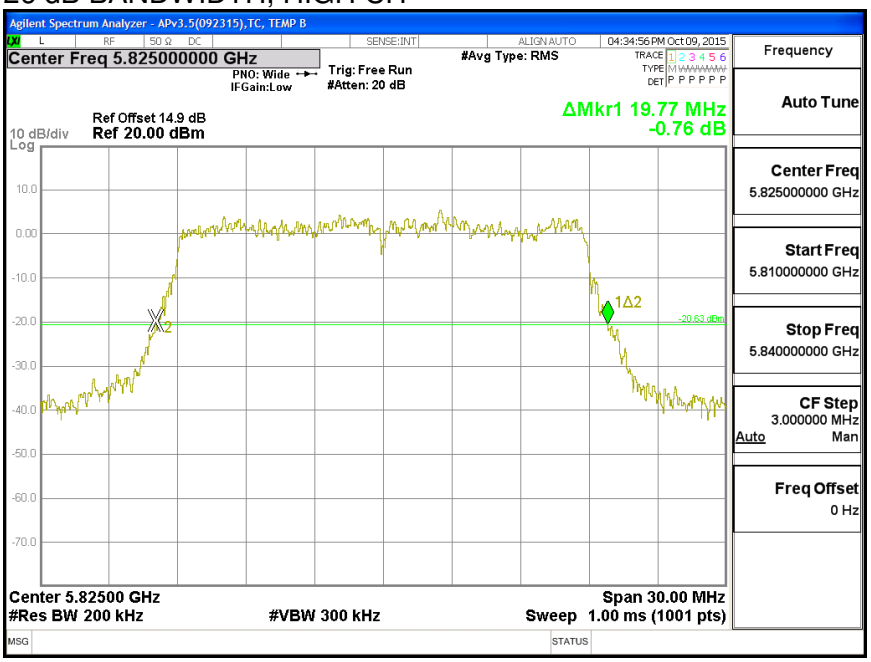
26 dB BANDWIDTH, MID CH



26 dB BANDWIDTH, HIGH CH



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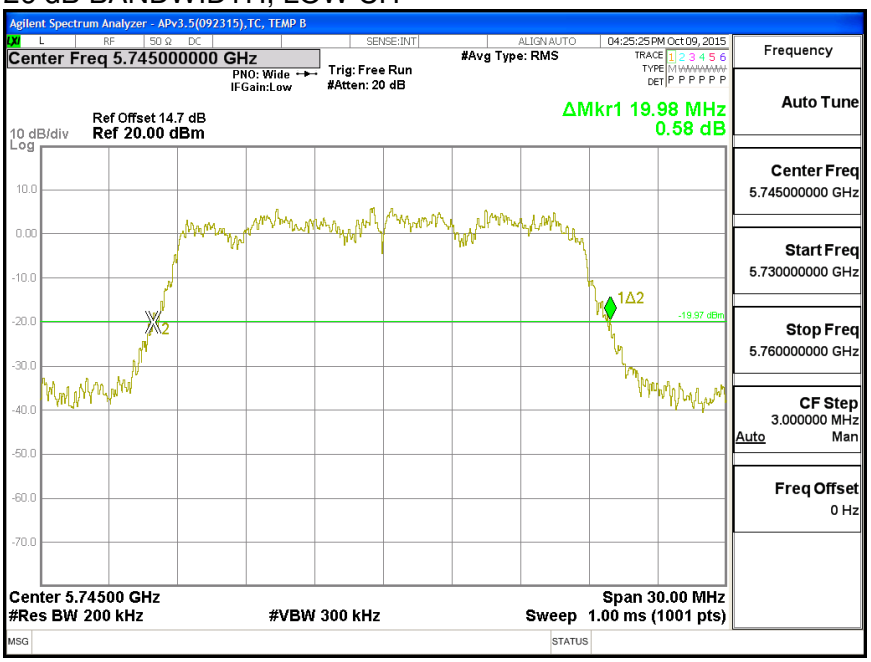
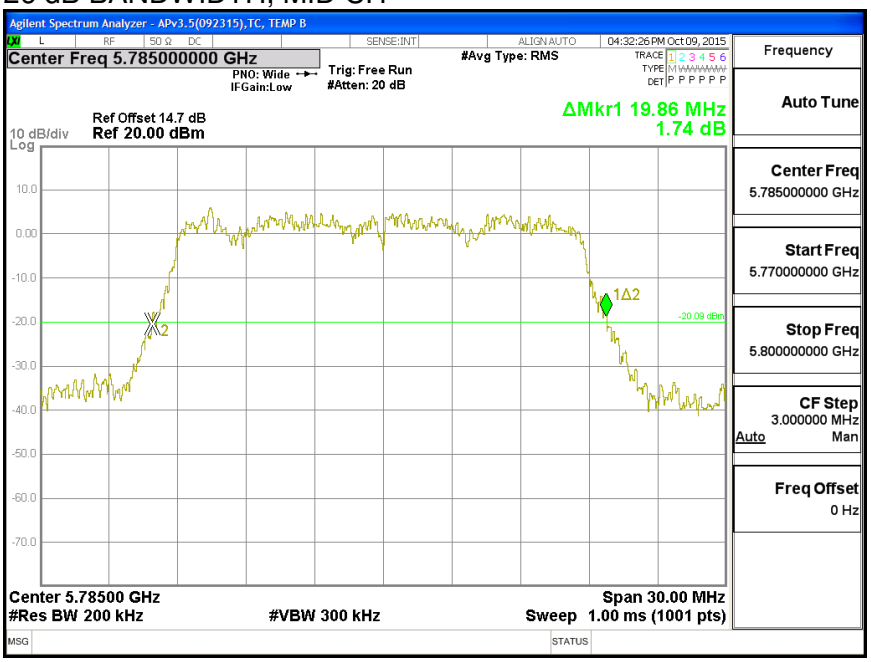
26 dB BANDWIDTH, CHAIN 2

26 dB BANDWIDTH, LOW CH



26 dB BANDWIDTH, MID CH



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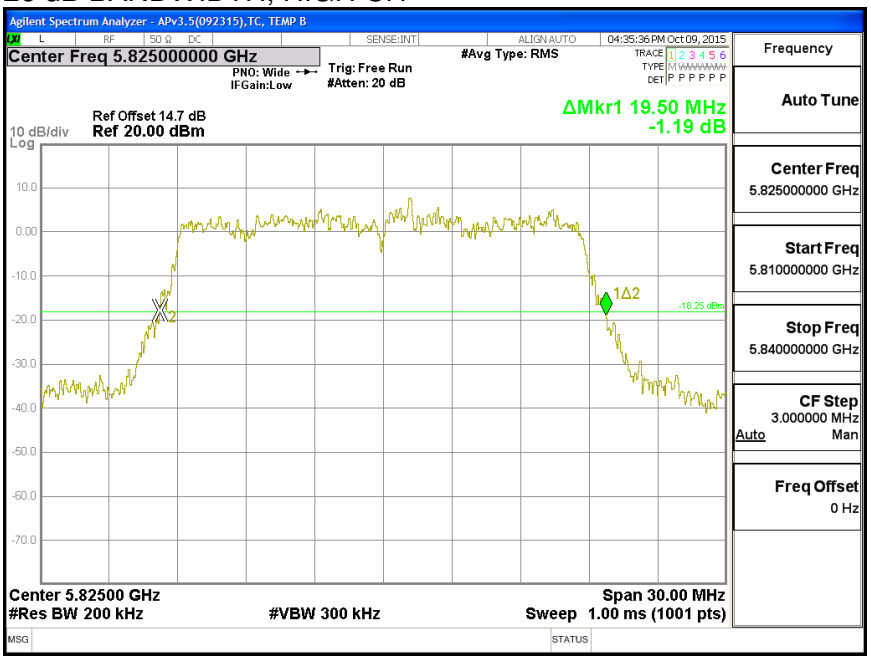
26 dB BANDWIDTH, HIGH CH



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8.6.3. **99% BANDWIDTH**

LIMITS

None; for reporting purposes only.

RESULTS

Channel	Frequency (MHz)	99% BW Chain 0 (MHz)	99% BW Chain 1 (MHz)	99% BW Chain 2 (MHz)
Low	5745	17.646	17.777	17.546
Mid	5785	17.766	17.729	17.664
High	5825	17.671	17.683	17.614

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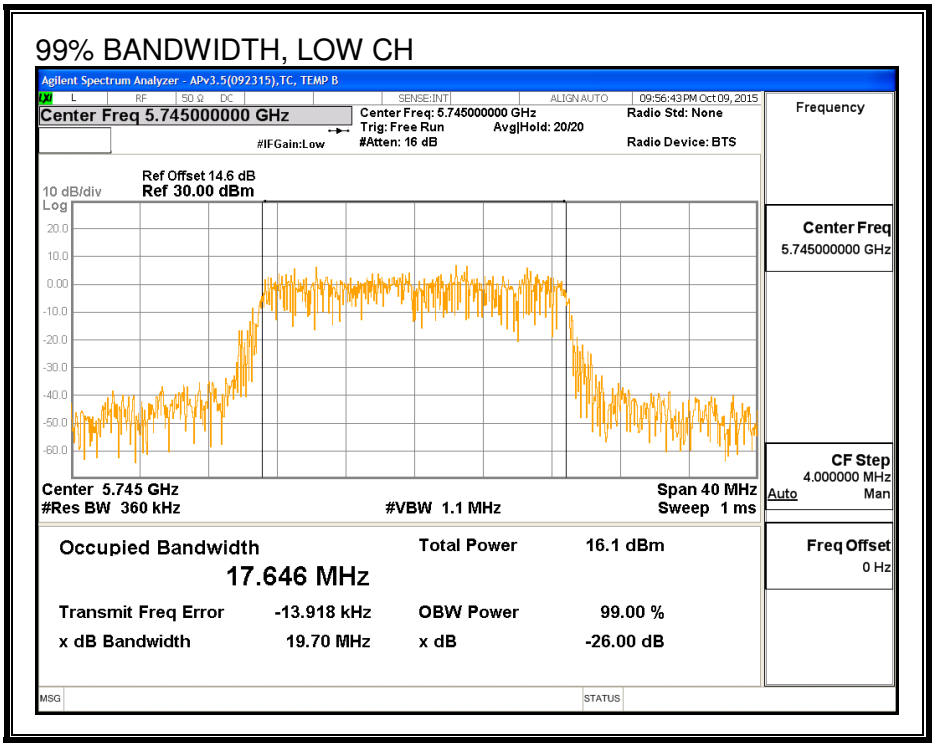
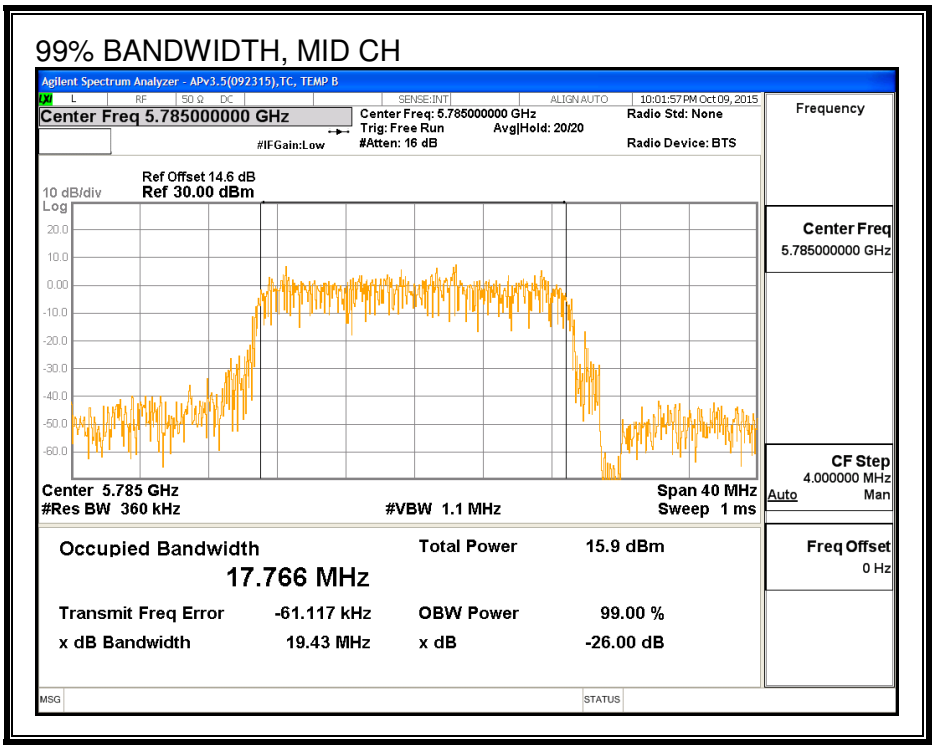
99% BANDWIDTH, CHAIN 0





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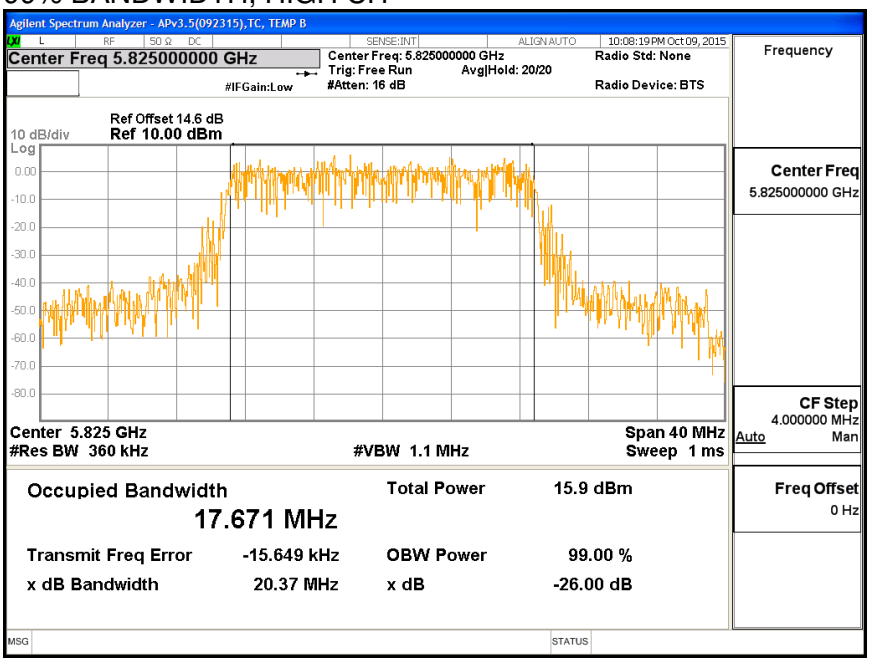
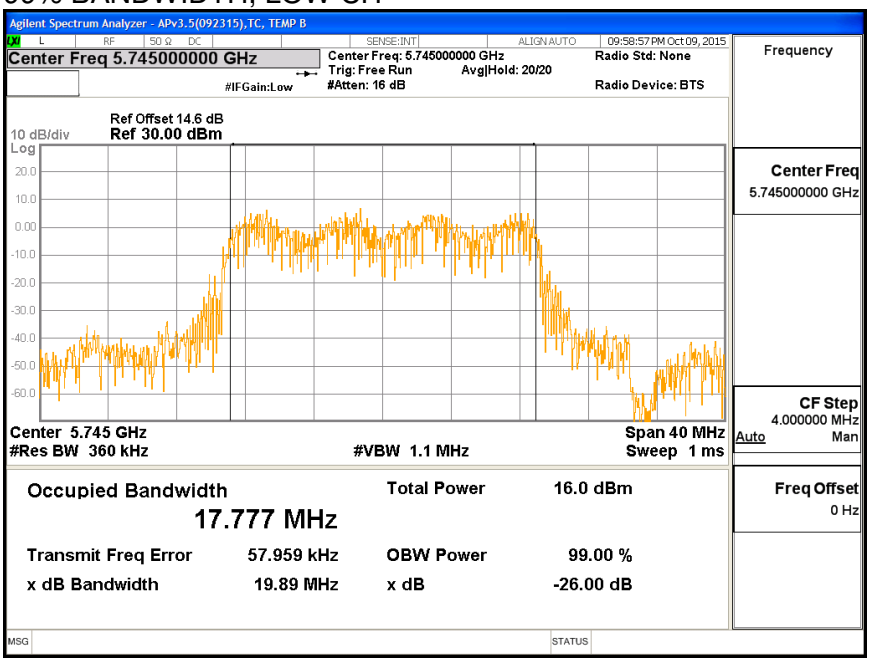
99% BANDWIDTH, HIGH CH



99% BANDWIDTH, CHAIN 1

99% BANDWIDTH, LOW CH



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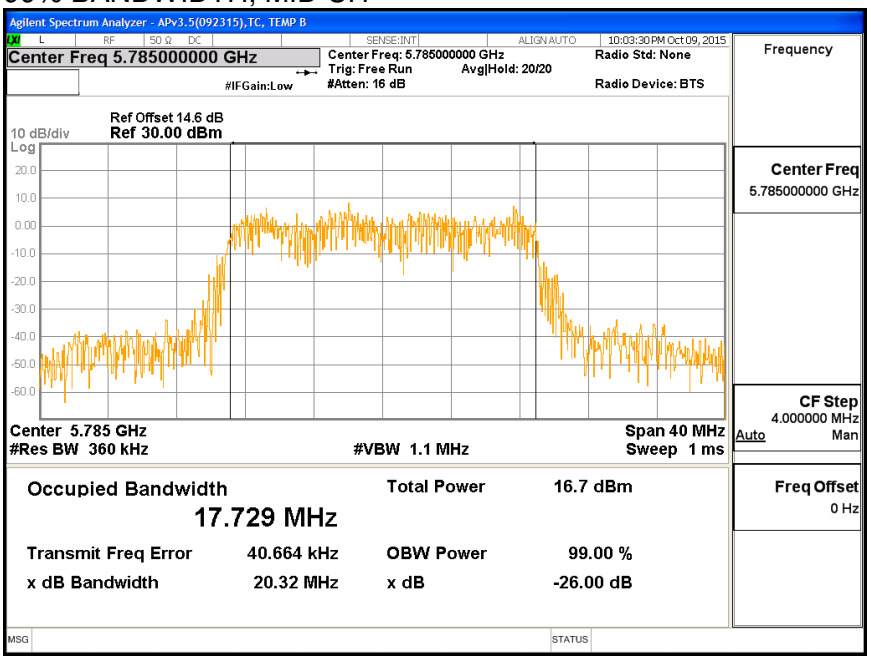
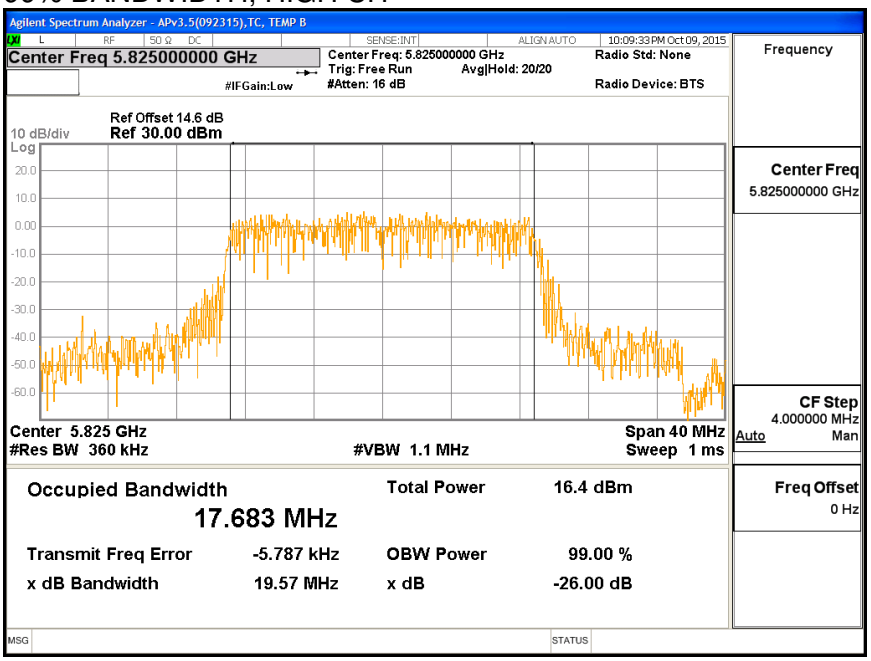
99% BANDWIDTH, MID CH



99% BANDWIDTH, HIGH CH



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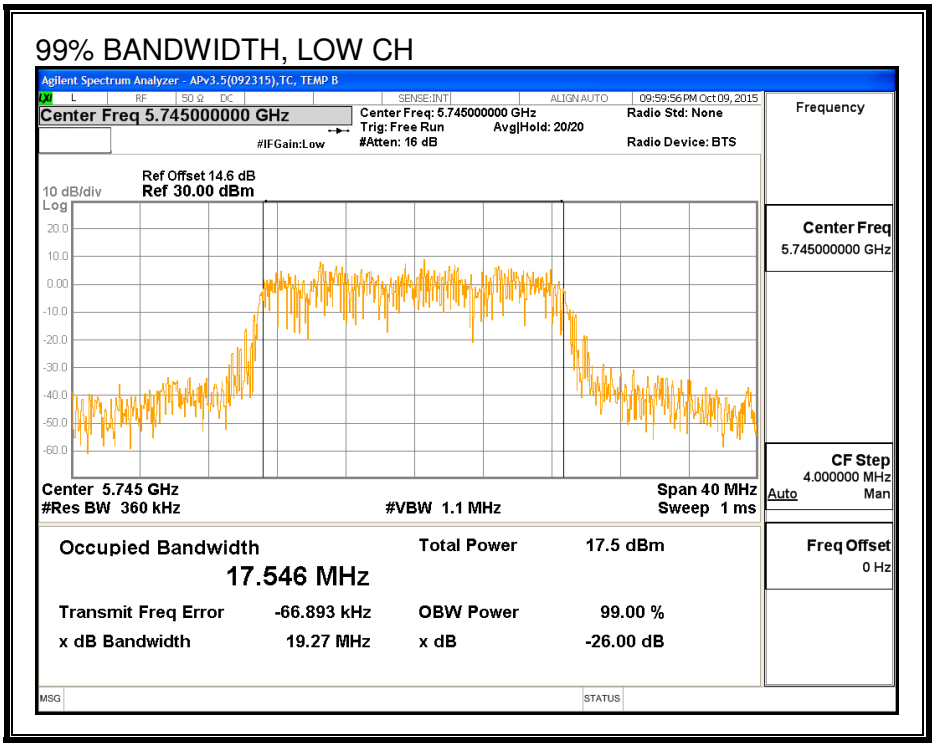
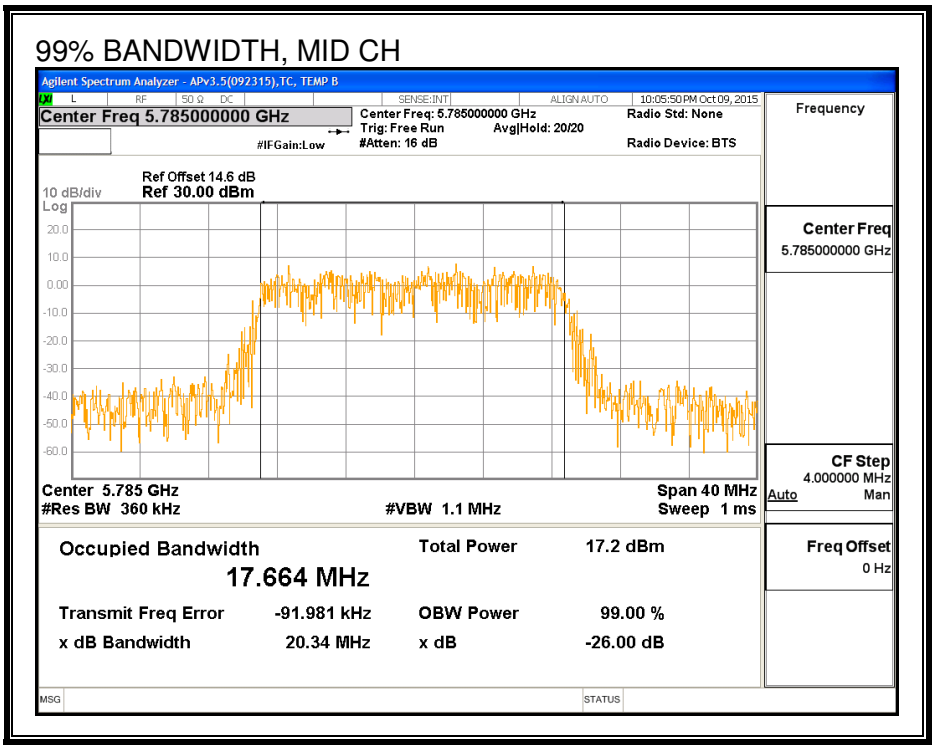
99% BANDWIDTH, CHAIN 2





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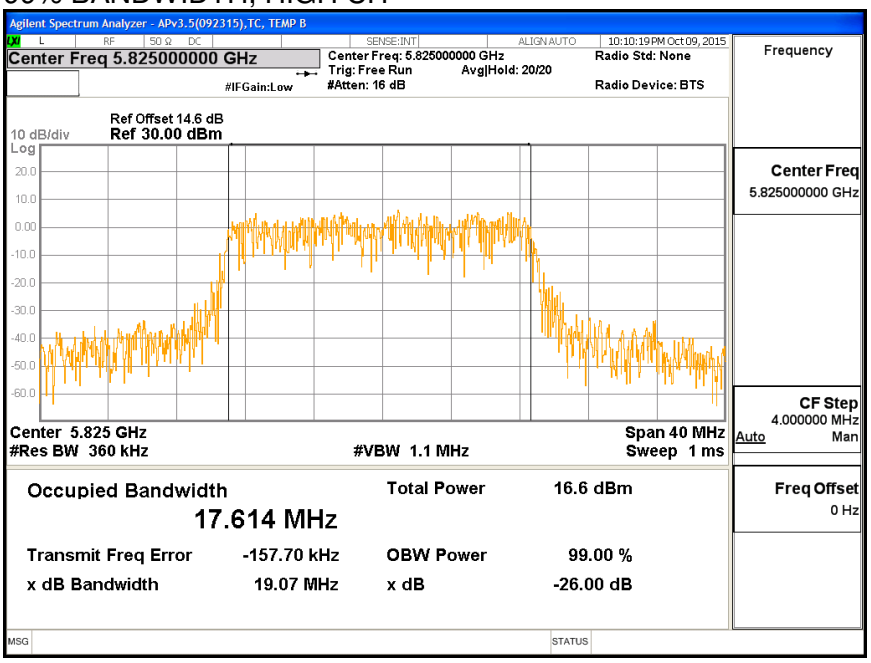
99% BANDWIDTH, HIGH CH



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8.6.4. AVERAGE POWER

LIMITS

None; for reporting purposes only.

Test Procedure

Measurements perform using a wideband gated RF power meter.

RESULTS

Channel	Frequency (MHz)	Chain 0 Power (dBm)	Chain 1 Power (dBm)	Chain 2 Power (dBm)	Total Power (dBm)
Low	5745	15.19	15.19	15.07	19.92
Mid	5785	15.97	15.85	15.86	20.66
High	5825	15.23	14.91	14.94	19.80

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8.6.5. OUTPUT POWER

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
2.70	1.90	4.40	3.13

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RESULTS

Antenna Gain and Limit

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)
Low	5745	7.83	28.17
Mid	5785	7.83	28.17
High	5825	7.83	28.17

Output Power Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5745	15.19	15.19	15.07	19.92	28.17	-8.25
Mid	5785	15.97	15.85	15.86	20.66	28.17	-7.51
High	5825	15.23	14.91	14.94	19.80	28.17	-8.37

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8.6.6. **PSD**

LIMITS

FCC §15.407 (a) (3)

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

DIRECTIONAL ANTENNA GAIN

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Chain 2 Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.70	1.90	4.40	7.83

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RESULTS

Antenna Gain and Limit

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)
Low	5745	7.83	28.17
Mid	5785	7.83	28.17
High	5825	7.83	28.17

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

Output Power Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Chain 2 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5745	5.98	5.78	5.68	10.58	28.17	-17.59
Mid	5785	5.35	5.53	5.30	10.17	28.17	-18.00
High	5825	5.37	5.05	5.07	9.93	28.17	-18.24

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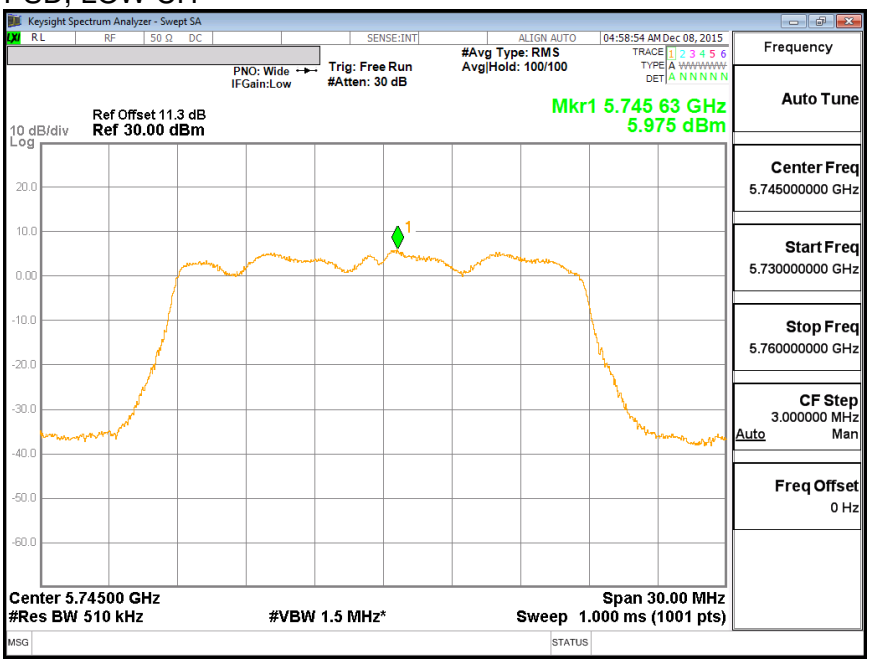
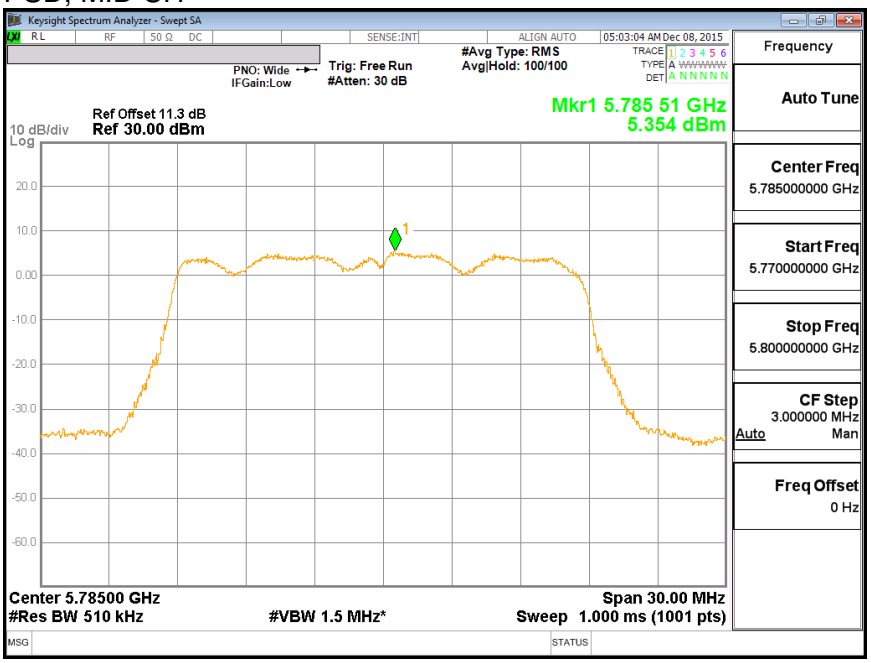
PSD, CHAIN 0

PSD, LOW CH



PSD, MID CH



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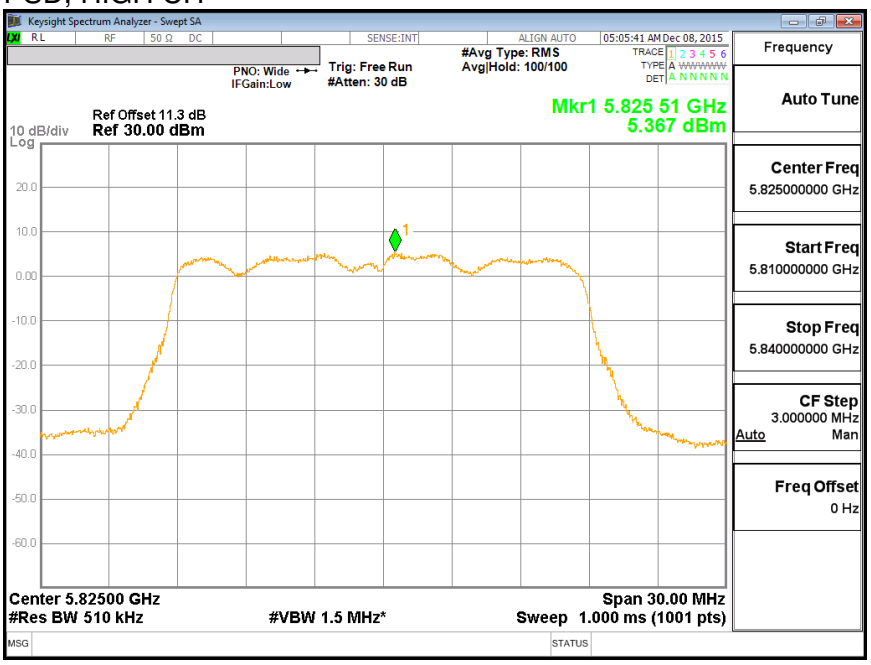
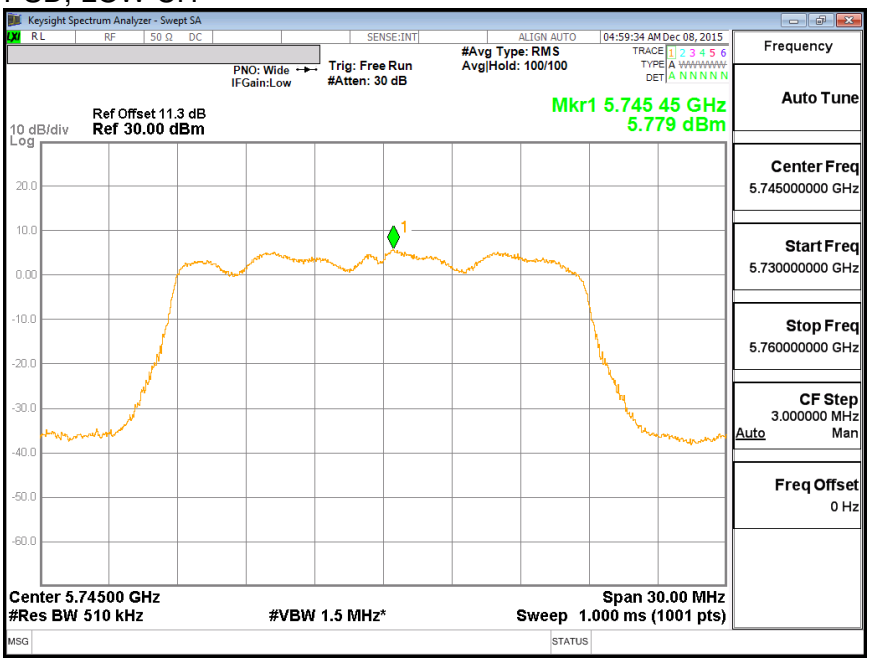
PSD, HIGH CH



PSD, CHAIN 1

PSD, LOW CH



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