FCC CFR47 PART 15 SUBPART E

CERTIFICATION TEST REPORT
CLASS II PERMISSIVE CHANGE

FOR

THE APPLE IPAD IS A TABLET DEVICE WITH MULTIMEDIA FUNCTIONS (MUSIC, APPLICATION SUPPORT, AND VIDEO), 802.11A/B/G/N RADIO, AND BLUETOOTH RADIO FUNCTIONS

MODEL NUMBER: A1432, A1454, & A1455*

FCC ID: BCGA1432 (A1432)
FCC ID: BCGA1454 (A1454)
FCC ID: BCGA1455 (A1455)

REPORT NUMBER: 15U21850-E34V3

ISSUE DATE: DECEMBER 07, 2015

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

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

*Models differences are detailed within the body of this report

NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	11/16/2015	Initial issue. Upgrade 12U14526-2 Revision A report to 5.2/5.3/5.6GHz band to new rule per KDB 789033 D02 v01.	T. Chu
V2	12/02/2015	Inserting Additional FCC IDs to cover page & header	M. Mekuria
V3	12/07/2015	Revised report to address TCB's questions	T. Chu

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS 6

2. TEST METHODOLOGY 7

3. FACILITIES AND ACCREDITATION 7

4. CALIBRATION AND UNCERTAINTY 7

4.1. MEASURING INSTRUMENT CALIBRATION 7

4.2. SAMPLE CALCULATION 7

4.3. MEASUREMENT UNCERTAINTY 7

5. EQUIPMENT UNDER TEST 8

5.1. DESCRIPTION OF EUT 8

5.2. DESCRIPTION OF CLASS II PERMISSIVE CHANGE 8

5.3. DESCRIPTION OF MODELS DIFFERENCES 8

5.4. MAXIMUM OUTPUT POWER 9

5.5. DESCRIPTION OF AVAILABLE ANTENNAS 9

5.6. SOFTWARE AND FIRMWARE 10

5.7. WORST-CASE CONFIGURATION AND MODE 10

5.8. DESCRIPTION OF TEST SETUP 11

6. TEST AND MEASUREMENT EQUIPMENT 14

7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS 15

7.1. ON TIME AND DUTY CYCLE RESULTS 15

7.2. MEASUREMENT METHOD FOR POWER AND PPSD 15

7.3. MEASUREMENT METHOD FOR AVG SPURIOUS EMISSIONS ABOVE 1 GHz 15

7.4. DUTY CYCLE PLOTS 16

8. ANTENNA PORT TEST RESULTS 18

8.1. 802.11a MODE IN THE 5.2 GHz BAND 18

8.1.1. 26 dB BANDWIDTH 18
8.1.2. 99% BANDWIDTH 21
8.1.3. AVERAGE POWER 24
8.1.4. OUTPUT POWER AND PPSD 25

8.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND 29

8.2.1. 26 dB BANDWIDTH 29
8.2.2. 99% BANDWIDTH 32
8.2.3. AVERAGE POWER 35
8.2.4. OUTPUT POWER AND PPSD 36

8.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND 40

8.3.1. 26 dB BANDWIDTH 40
8.3.2. 99% BANDWIDTH 42

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.3. AVERAGE POWER 44
8.3.4. OUTPUT POWER AND PPSD 45

8.4. 802.11a MODE IN THE 5.3 GHz BAND 48
8.4.1. 26 dB BANDWIDTH 48
8.4.2. 99% BANDWIDTH 51
8.4.3. AVERAGE POWER 54
8.4.4. OUTPUT POWER AND PPSD 55

8.5. 802.11n HT20 MODE IN THE 5.3 GHz BAND 59
8.5.1. 26 dB BANDWIDTH 59
8.5.2. 99% BANDWIDTH 62
8.5.3. AVERAGE POWER 65
8.5.4. OUTPUT POWER AND PPSD 66

8.6. 802.11n HT40 MODE IN THE 5.3 GHz BAND 70
8.6.1. 26 dB BANDWIDTH 70
8.6.2. 99% BANDWIDTH 72
8.6.3. AVERAGE POWER 74
8.6.4. OUTPUT POWER AND PPSD 75

8.7. 802.11a MODE IN THE 5.6 GHz BAND 78
8.7.1. 26 dB BANDWIDTH 78
8.7.2. 99% BANDWIDTH 82
8.7.3. AVERAGE POWER 86
8.7.4. OUTPUT POWER AND PPSD 87

8.8. 802.11n HT20 MODE IN THE 5.6 GHz BAND 92
8.8.1. 26 dB BANDWIDTH 92
8.8.2. 99% BANDWIDTH 96
8.8.3. AVERAGE POWER 100
8.8.4. OUTPUT POWER AND PPSD 101

8.9. 802.11n HT40 MODE IN THE 5.6 GHz BAND 106
8.9.1. 26 dB BANDWIDTH 106
8.9.2. 99% BANDWIDTH 109
8.9.3. AVERAGE POWER 112
8.9.4. OUTPUT POWER AND PPSD 113

9. RADIATED TEST RESULTS 117

9.1. LIMITS AND PROCEDURE 117

9.2. TRANSMITTER ABOVE 1 GHz 118
9.2.1. TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND 118
9.2.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND 121
9.2.3. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND 124
9.2.4. TX ABOVE 1 GHz 802.11a MODE IN THE 5.3 GHz BAND 127
9.2.5. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND 130
9.2.6. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.3 GHz BAND 133
9.2.7. TX ABOVE 1 GHz 802.11a MODE IN THE 5.6 GHz BAND 136
9.2.8. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND 140
9.2.9. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.6 GHz BAND 144
9.2.10. 2.4 GHz and 5GHz band Colocation 148

9.3. WORST-CASE BELOW 1 GHz 151

10. AC POWER LINE CONDUCTED EMISSIONS 154

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11. DYNAMIC FREQUENCY SELECTION 158

11.1. OVERVIEW 158
11.1.1. LIMITS 158
11.1.2. TEST AND MEASUREMENT SYSTEM 161
11.1.3. SETUP OF EUT 164
11.1.4. DESCRIPTION OF EUT 166

11.2. CLIENT MODE RESULTS FOR 20 MHz BANDWIDTH 168
11.2.1. TEST CHANNEL 168
11.2.2. RADAR WAVEFORM AND TRAFFIC 168
11.2.3. OVERLAPPING CHANNEL TESTS 170
11.2.4. MOVE AND CLOSING TIME 170

11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH 175
11.3.1. TEST CHANNEL 175
11.3.2. RADAR WAVEFORM AND TRAFFIC 175
11.3.3. OVERLAPPING CHANNEL TESTS 177
11.3.4. MOVE AND CLOSING TIME 177
11.3.5. NON-OCCUPANCY PERIOD 182

11.4. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 20 MHz BANDWIDTH 183
11.4.1. TEST CHANNEL 183
11.4.2. RADAR WAVEFORM AND TRAFFIC 183
11.4.3. OVERLAPPING CHANNEL TESTS 185
11.4.4. MOVE AND CLOSING TIME 185

12. SETUP PHOTOS 190

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: The Apple iPad is a tablet device with multimedia functions (music, application support, and video), 802.11a/b/g/n radio, and Bluetooth radio functions

MODEL: A1432, A1454, & A1455

SERIAL NUMBER: PT758824

DATE TESTED: JULY 15 - AUGUST 22, 2012

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:

FRANK IBRAHIM
WiSE PROJECT LEADER
UL Verification Services Inc.

Tested By:

TOM CHEN
EMC ENGINEER
UL Verification Services Inc.

This report shall not be reproduced except in full, without the written approval of 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, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v01r02/D03 v01r01/D06 v01, FCC KDB 789033 D02 v01, ANSI C63.10-2009.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

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.

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

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

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a iPad tablet device with iPod functions (music, application support, and video), 802.11a/b/g/n radio, and Bluetooth radio functions.

5.2. DESCRIPTION OF CLASS II PERMISSIVE CHANGE

Upgrade 5.2/5.3/5.6GHz band to new rule per KDB 789033 D02 v01.

We have reviewed the original test report for UNII-1, UNII-2A and UNII-2C bands and are hereby attesting that all current technical requirements are still met and all applicable test procedures remain the same. Therefore, the original report is still applicable and no additional testing is done.

We updated the following on this report:

- Updated report to latest KDB 789033 D02 v01.
- 5.2G output power table limit/PPSD limit.
- Removed IC related information.
- Removed Peak Excursion.

5.3. DESCRIPTION OF MODELS DIFFERENCES

FCC ID: BCGA1432
Model #: A1432

Model A1432, is a tablet with multimedia functions (music, application support, and video)IEEE 802.11a/b/g/n radio and Bluetooth radio. The rechargeable battery is not user accessible.

FCC ID: BCGA1454
Model #: A1454

Model A1454 is a tablet with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/LTE radio, IEEE 802.11a/b/g/n and Bluetooth radio. The rechargeable battery is not user accessible.

FCC ID: BCGA1455
Model #: A1455

Model A1455, is a tablet with multimedia functions (music, application support, and video), cellular GSM/GPRS/EGPRS/WCDMA/HSPA+/DC-HSDPA/CDMA1xRTT/ EV-DO Rev 0, A, B / LTE radio, IEEE 802.11a/b/g/n radio and Bluetooth radio. The rechargeable battery is not user accessible.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.4. MAXIMUM OUTPUT POWER

The transmitter has a maximum conducted output power as follows:

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11a	14.257	26.650
5180 - 5240	802.11n HT20	14.354	27.252
5190 - 5230	802.11n HT40	15.780	37.844
5260 - 5320	802.11a	17.176	52.192
5260 - 5320	802.11n HT20	17.278	53.432
5270 - 5310	802.11n HT40	17.260	53.211
5500 - 5700	802.11a	16.585	45.551
5500 - 5700	802.11n HT20	16.421	43.863
5510 - 5670	802.11n HT40	16.491	44.576

5.5. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a PIFA antenna, with a maximum gain as shown below:

Frequency Band (GHz)	*Antenna Gain (dBi)*
2.4-2.4835	1.41
5.15-5.25	4.70
5.25-5.35	5.08
5.5-5.7	5.42
5.725-5.85	5.27

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.6. SOFTWARE AND FIRMWARE

The firmware installed in the EUT during testing was 10A378

The EUT driver software installed during testing was Broadcom_Rel_6_10_56_166

The EUT is connected to the power meter.

5.7. WORST-CASE CONFIGURATION AND MODE

For the fundamental investigation, since the EUT is a portable device that has three orientations; X, Y and Z orientations have been investigated, also with AC/DC adapter, and earphone, and the worst case was found to be at Y orientation without AC adapter and earphone for both 2.4GHz and 5GHz band.

For Radiated Emissions below 1 GHz and Power line Conducted Emissions, the channel with the highest conducted output power was selected as a worst-case scenario.

Worst-case data rates as provided by the manufacturer are:

For 802.11a mode: 6Mbps
For 802.11n HT20: MCS0
For 802.11n HT40: MCS0

For 2.4 GHz band, an investigation of the fundamental frequency on both Ant0 and Ant1 ports showed that Ant0 is worst-case; therefore, all final radiated testing was performed using Ant0.

For 5 GHz bands, an investigation of the fundamental frequency on both Ant0 and Ant1 ports showed that Ant1 is worst-case; therefore, all final radiated testing was performed using Ant1.

Low channel for both 11a and 11n HT20 in the 5.6 GHz band, was tested for harmonics and BE at the power level of Low1 channel (5520 MHz) as worst-case scenario.

High channel for both 11a and 11n HT20 in the 5.6 GHz band, was tested for harmonics and BE at the power level of High1 channel (5680 MHz) as worst-case scenario.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.8. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	Apple	A1401	D060812	DoC
Power Splitter	Krytar	158010	99250	N/A
Dc Power Supply	Agilent	E3610A	KR24104150	N/A
Laptop PC	Apple	MacBook Pro	AOU269116	N/A

I/O CABLES (CONDUCTED SETUP)

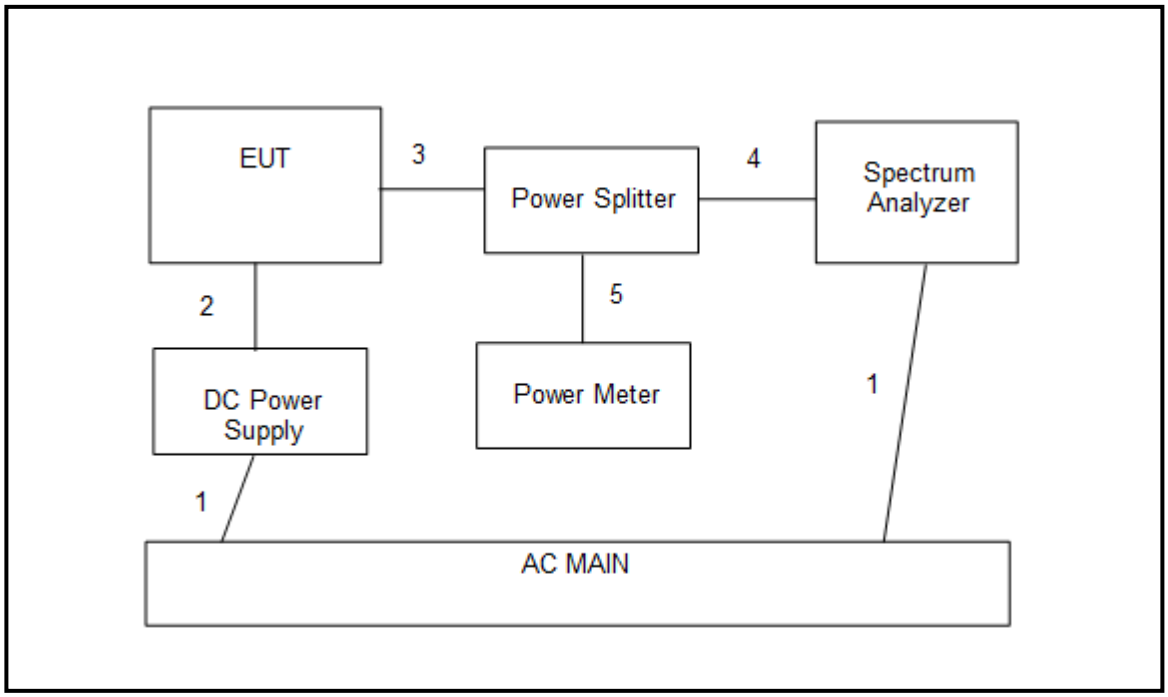
I/O CABLE LIST						
Cable No.	**Port**	**#of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length**	**Remarks**
1	AC	2	AC	Un-shielded	2.0m	N/A
2	DC	1	DC	Un-shielded	1.0m	N/A
3	Antenna Port	1	Splitter	Un-shielded	0.1m	N/A
4	RF out	1	Spectrum Analyzer	Un-Shielded	None	N/A
5	RF out	1	Power Meter	Shielded	None	NA

I/O CABLES (RADIATED SETUP)

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC	1	MINI USB	UN-SHELDED	1.0m	N/A
2	AUDIO	1	MINI JACK	UN-SHELDED	1.0m	N/A

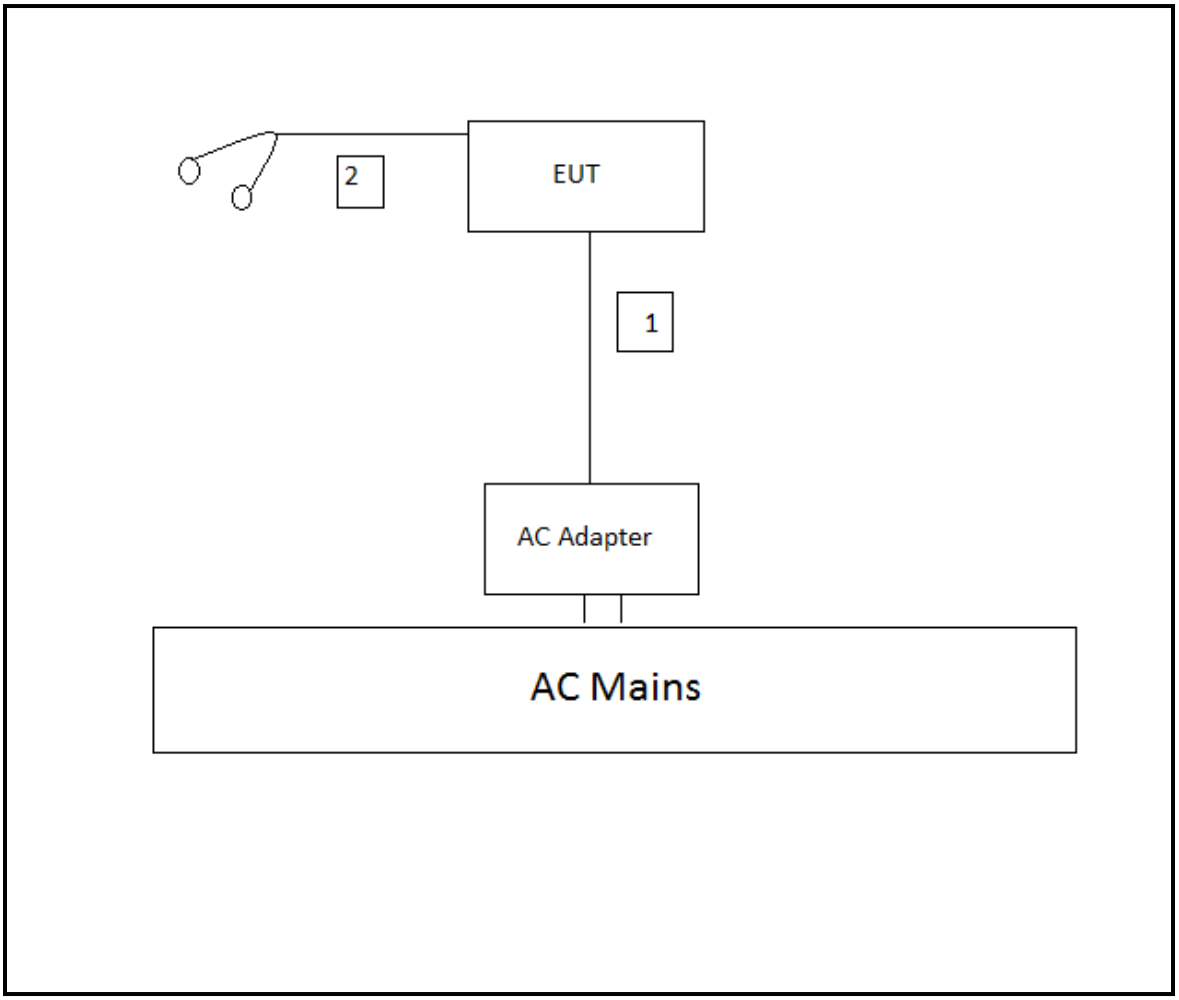
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

SETUP DIAGRAM FOR CONDUCTED TEST



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

SETUP DIAGRAM FOR RADIATED TEST



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

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**
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	11/11/12
Antenna, Horn, 18 GHz	EMCO	3115	C00945	10/06/12
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	11/11/12
Antenna, Bilog, 2 GHz	Sunol Sciences	JB1		02/07/13
Horn Antenna, 26.5 GHz	ARA	MWH-1826/B	C00589	04/23/13
Horn Antenna, 40 GHz	ARA	MWH-2640/B	C00981	06/14/13
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	03/14/13
Reject Filter, 2.0-2.9 GHz	Micro-Tronics	BRM50702	N02684	CNR
High Pass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01069	12/15/12
E-Series Power Sensor 9 kHg~18 GHz	Agilent	E9304A	1260847C	05/23/13
P-Series single channel Power Meter	Agilent / HP	N1911A		07/27/13
Reject Filter, 5.725-5.825 GHz	Micro-Tronics	BRC13192	N02676	CNR
Reject Filter, 2.4-2.5 GHz	Micro-Tronics	BRM50702	N02685	CNR
Highpass Filter, 7.6 GHz	Micro-Tronics	HPM13195	N02682	CNR
EMI Test Receiver, 30MHz	R & S	ESHS 20	N02396	08/19/13
LISN, 30 MHz	FCC	LISN-50/250-25-2	N02625	12/13/12

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

7.1. ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11a 20 MHz	2.055	2.094	0.981	98.1%	0.08	0.487
802.11n HT20	1.917	1.947	0.985	98.5%	0.07	0.522
802.11n HT40	0.9445	0.9599	0.984	98.4%	0.07	1.059

7.2. MEASUREMENT METHOD FOR POWER AND PPSD

The Duty Cycle is greater than or equal to 98% therefore KDB 789033 Method SA-1 is used.

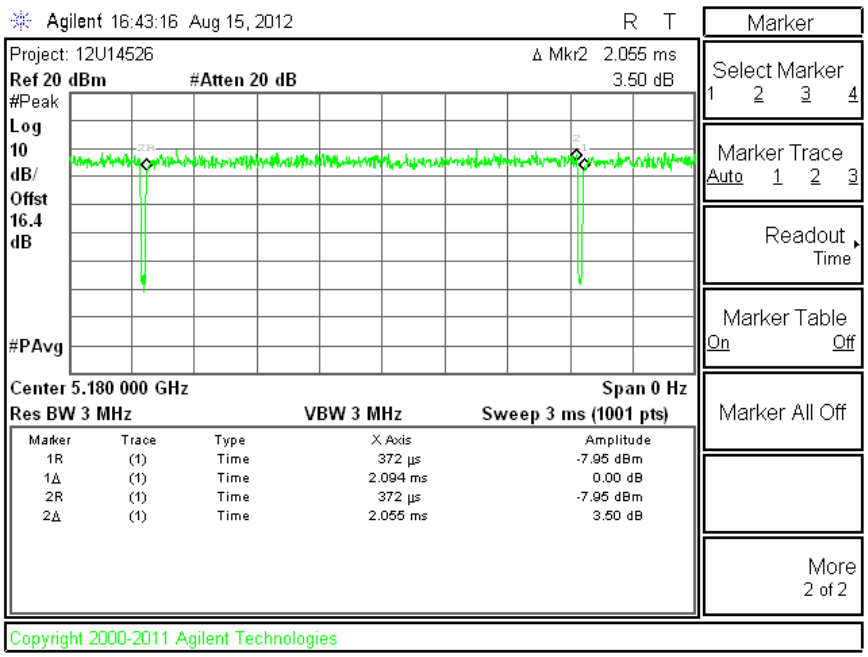
7.3. MEASUREMENT METHOD FOR AVG SPURIOUS EMISSIONS ABOVE 1 GHz

The Duty Cycle is greater than or equal to 98%, KDB 789033 Method VB with Power RMS Averaging is used.

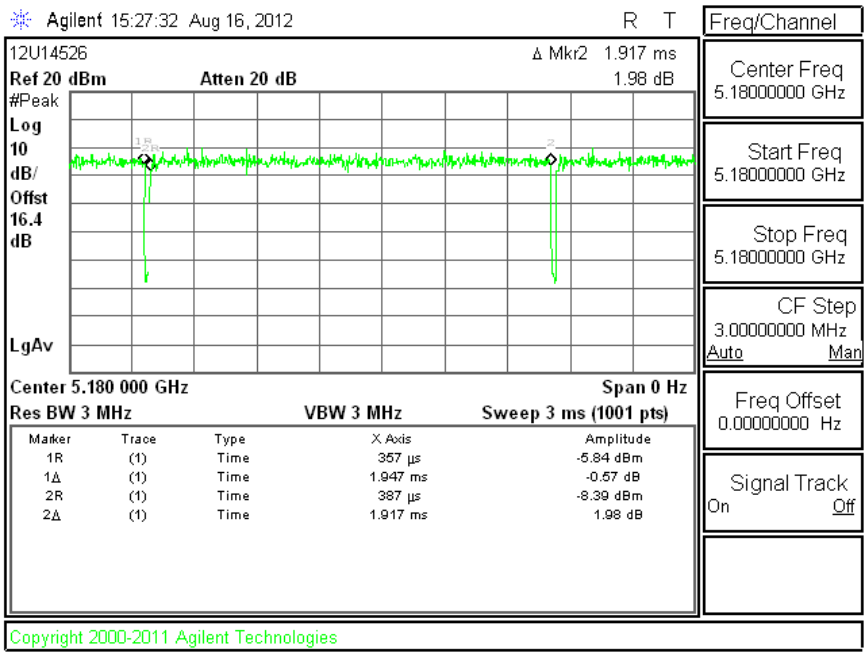
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

7.4. DUTY CYCLE PLOTS

DUTY CYCLE 802.11a MODE

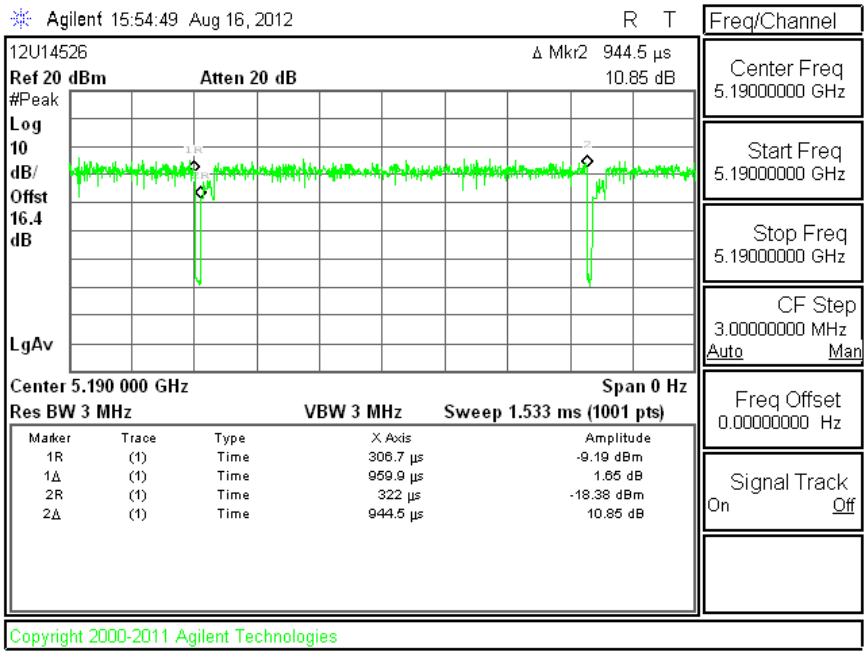


DUTY CYCLE 802.11n HT20 MODE



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

DUTY CYCLE 802.11n HT40 MODE



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8. ANTENNA PORT TEST RESULTS

8.1. 802.11a MODE IN THE 5.2 GHz BAND

8.1.1. 26 dB BANDWIDTH

LIMITS

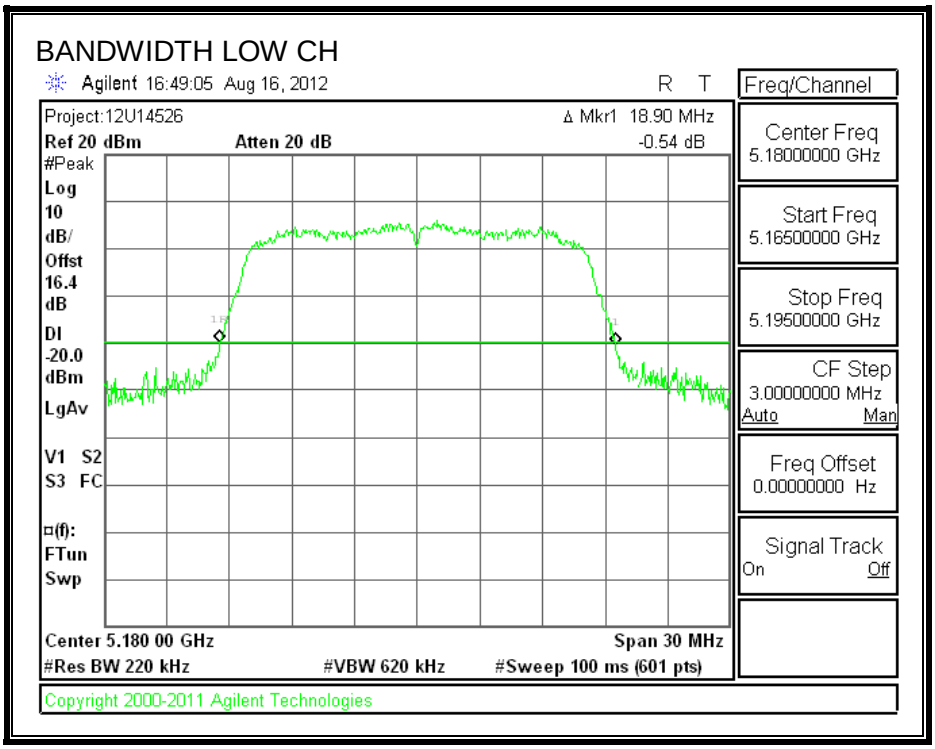
None; for reporting purposes only.

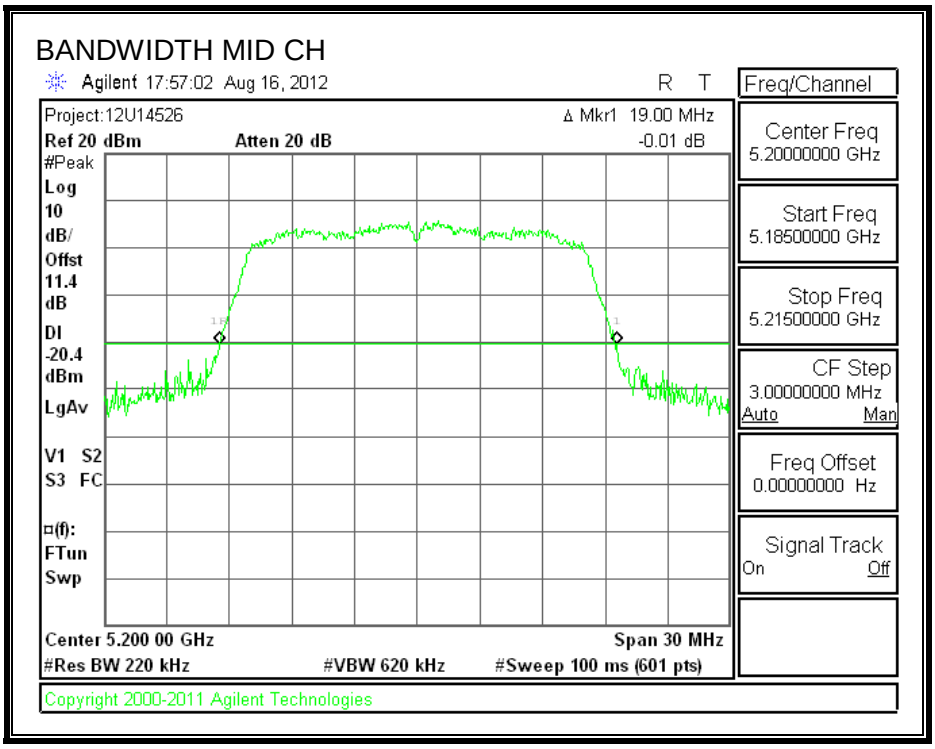
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	18.90
Mid	5200	19.00
High	5240	18.95

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

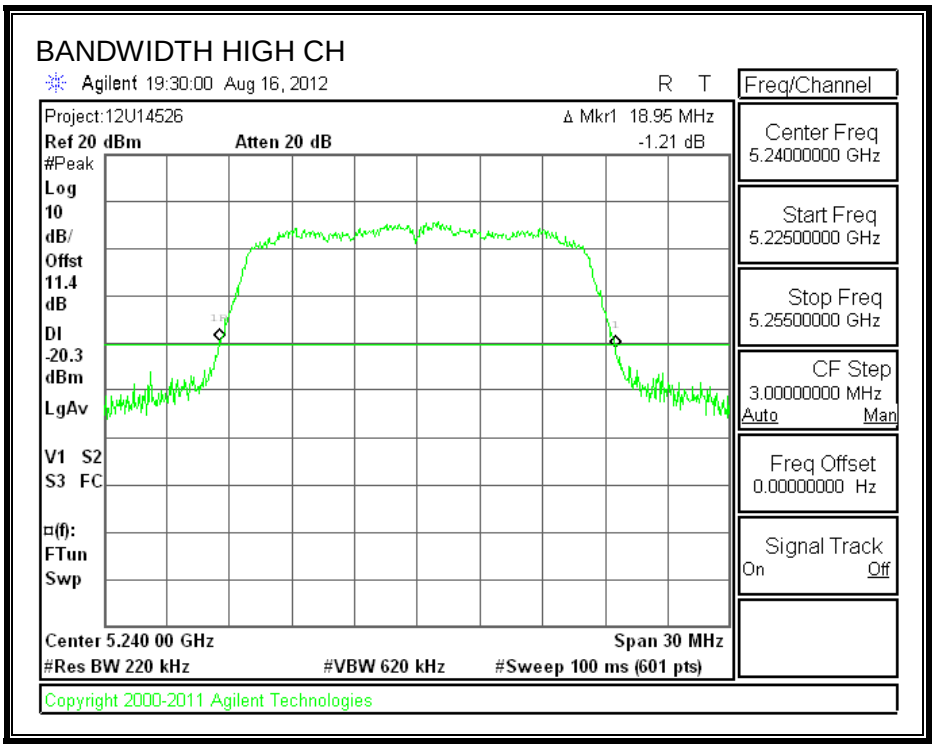
26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.2. 99% BANDWIDTH

LIMITS

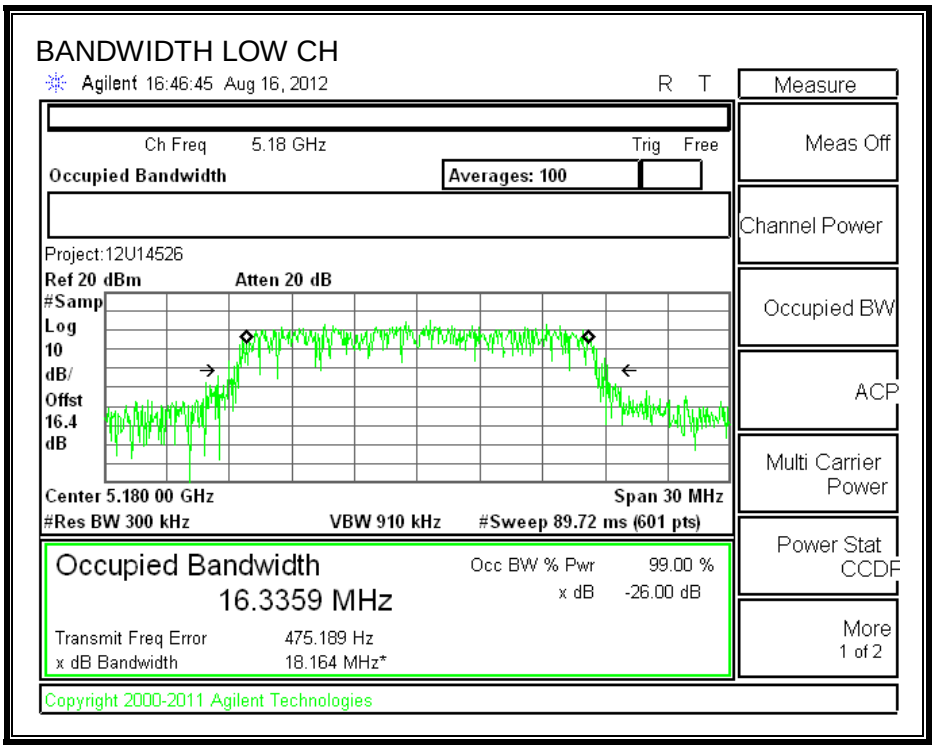
None; for reporting purposes only.

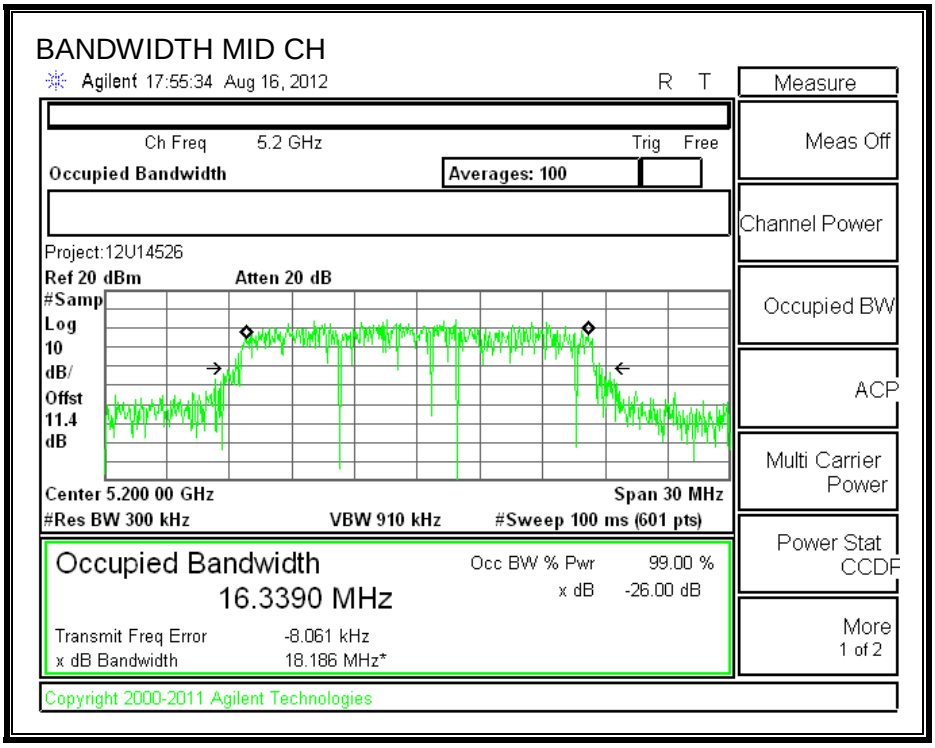
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	16.3359
Mid	5200	16.3390
High	5240	16.3392

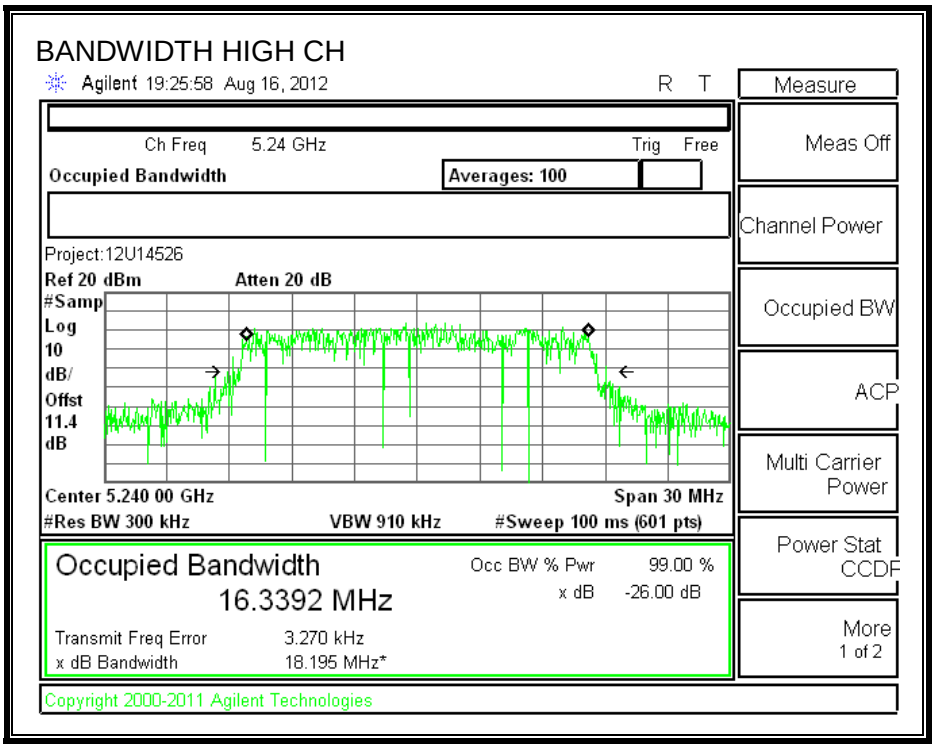
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5180	13.98
Mid	5200	13.93
High	5240	13.85

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits FCC 15.407

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	4.70	24.00	11.00
Mid	5200	4.70	24.00	11.00
High	5240	4.70	24.00	11.00

Output Power Results

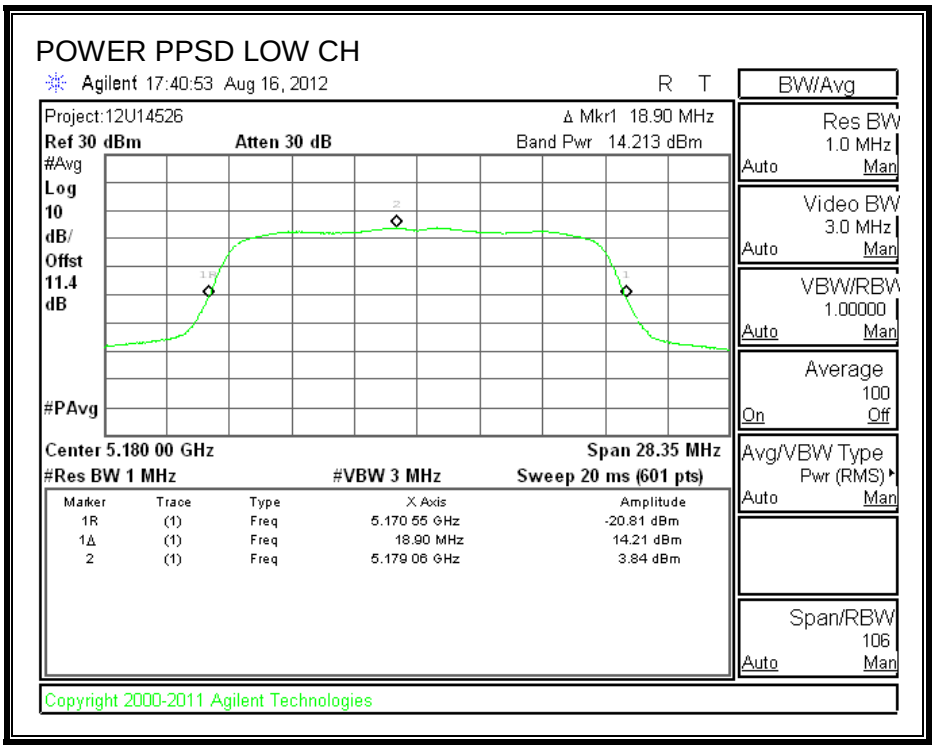
Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.213	14.213	24.00	-9.787
Mid	5200	14.257	14.257	24.00	-9.743
High	5240	14.124	14.124	24.00	-9.876

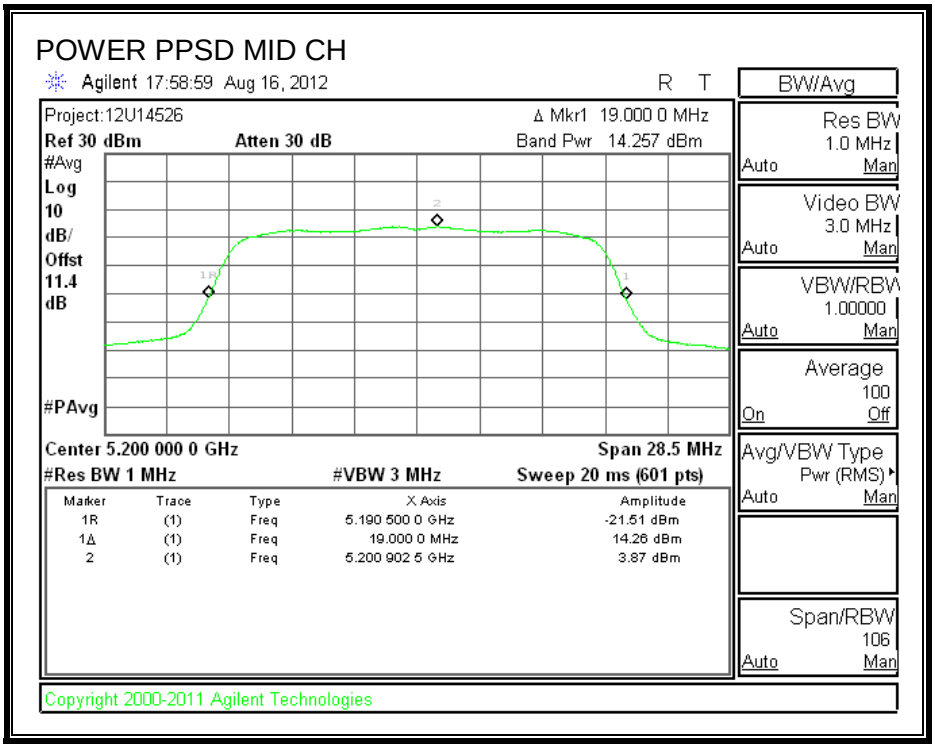
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	3.84	3.84	11.00	-7.16
Mid	5200	3.87	3.87	11.00	-7.13
High	5240	3.70	3.70	11.00	-7.30

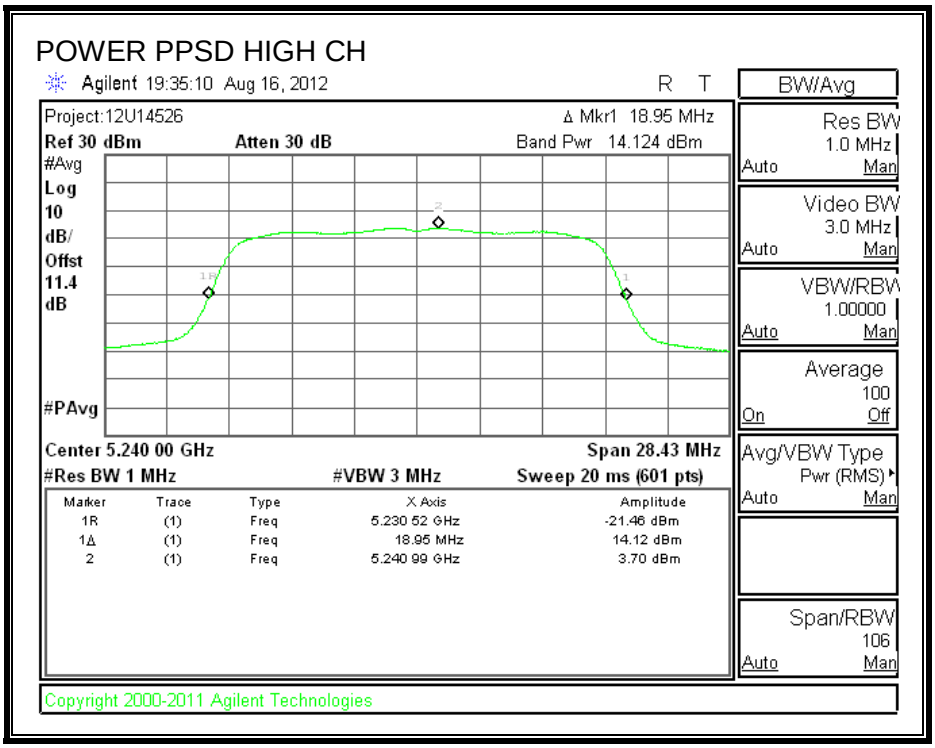
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2. 802.11n HT20 MODE IN THE 5.2 GHz BAND

8.2.1. 26 dB BANDWIDTH

LIMITS

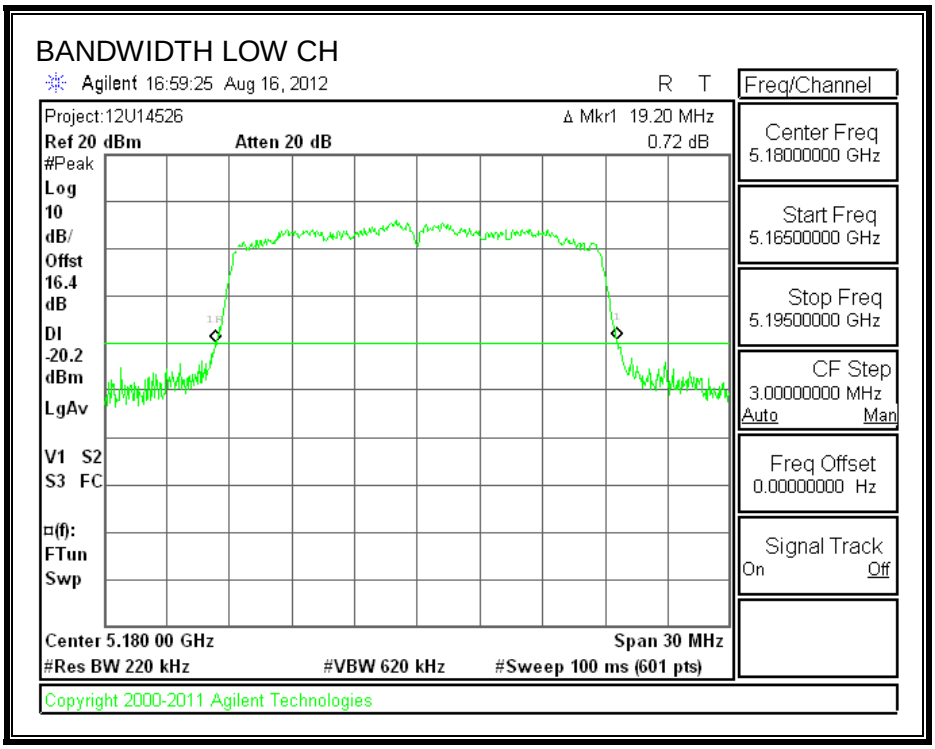
None; for reporting purposes only.

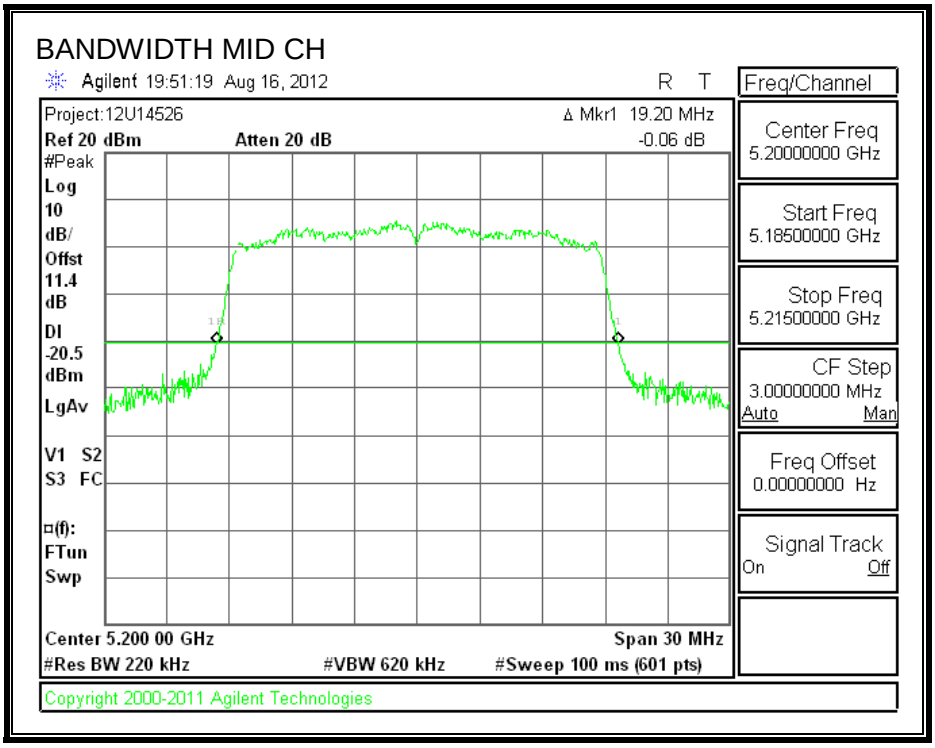
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	19.20
Mid	5200	19.20
High	5240	19.25

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

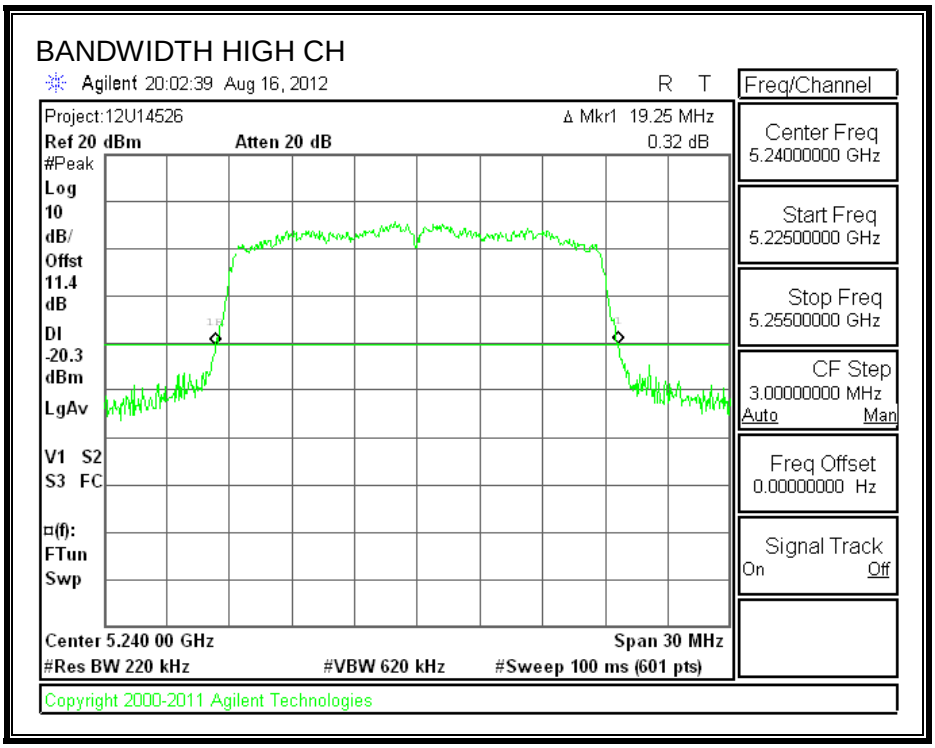
26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.2. 99% BANDWIDTH

LIMITS

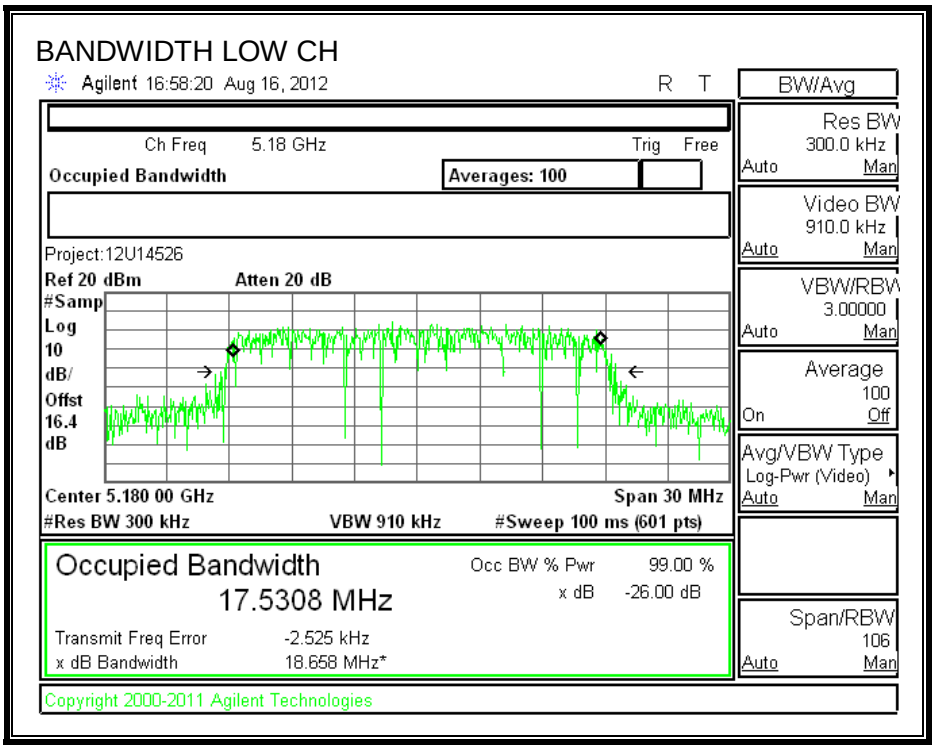
None; for reporting purposes only.

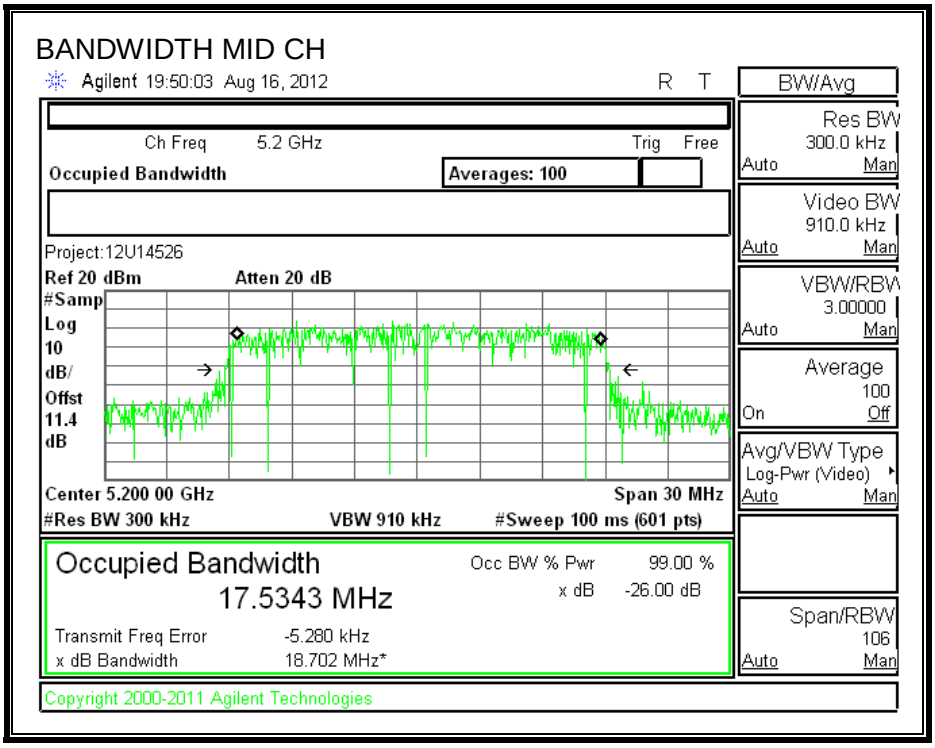
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5180	17.5308
Mid	5200	17.5343
High	5240	17.5313

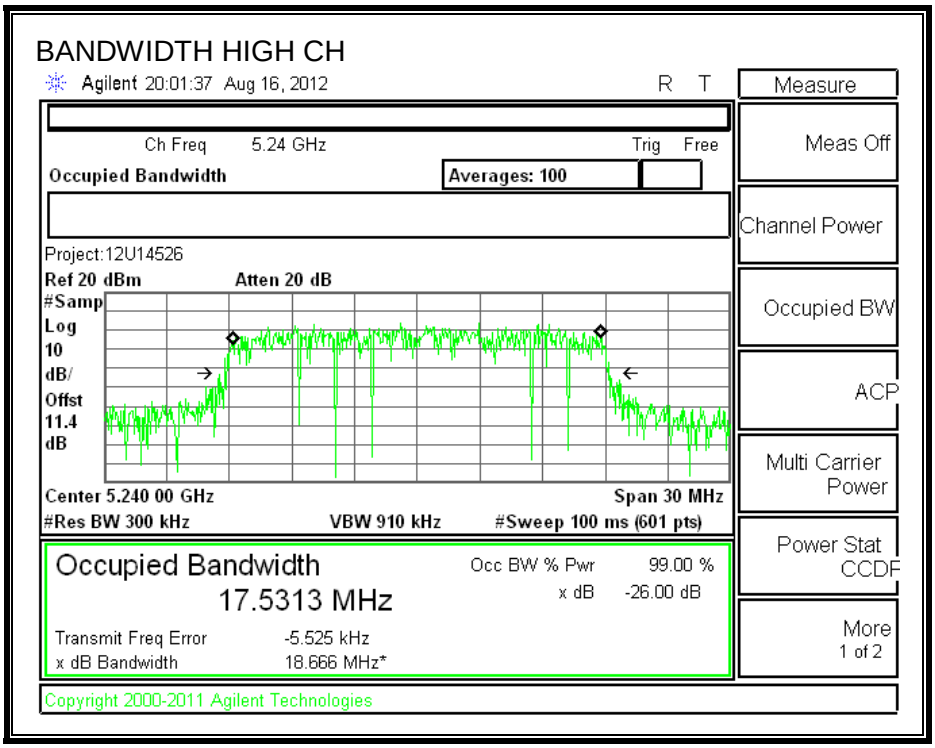
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5180	13.94
Mid	5200	13.94
High	5240	13.87

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits FCC 15.407

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5180	4.70	24.00	11.00
Mid	5200	4.70	24.00	11.00
High	5240	4.70	24.00	11.00

Output Power Results

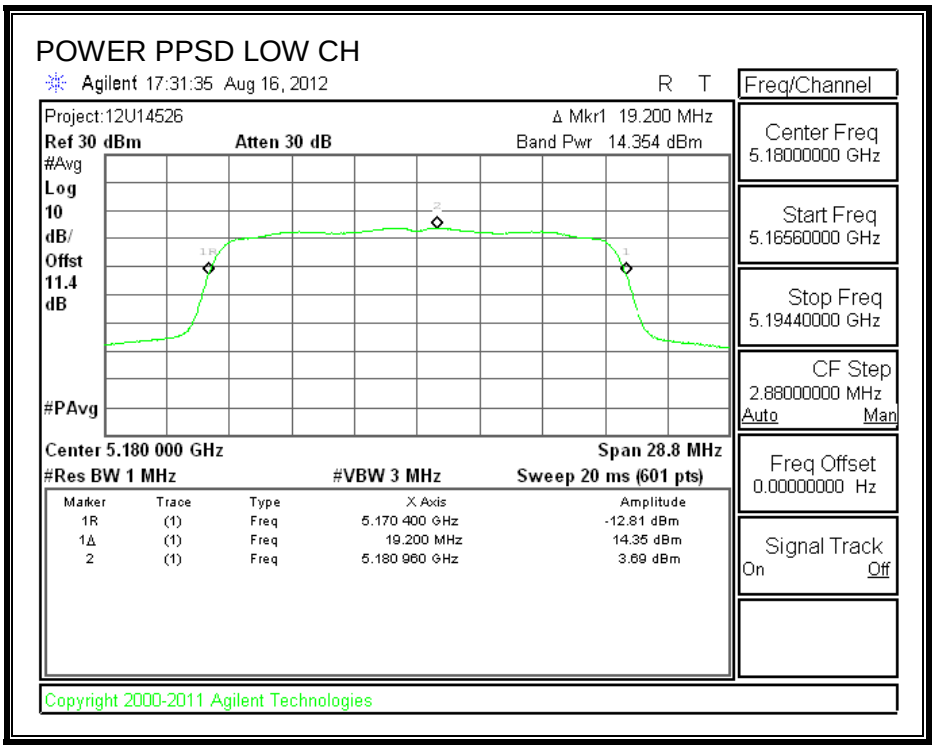
Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.354	14.354	24.00	-9.646
Mid	5200	14.155	14.155	24.00	-9.845
High	5240	14.298	14.298	24.00	-9.702

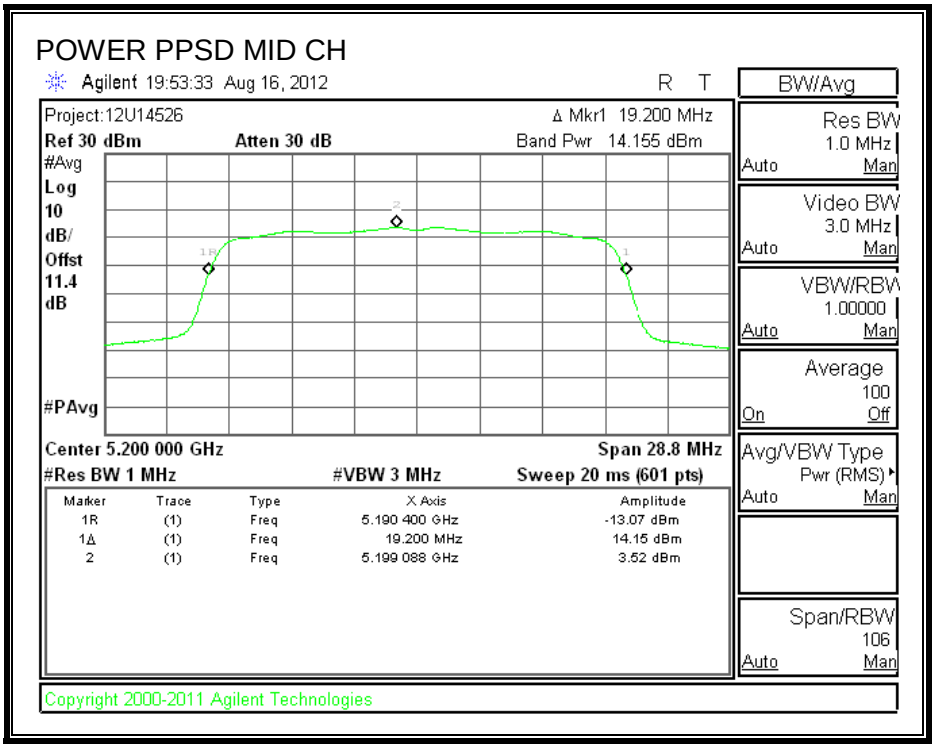
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5180	3.69	3.69	11.00	-7.31
Mid	5200	3.52	3.52	11.00	-7.48
High	5240	3.67	3.67	11.00	-7.33

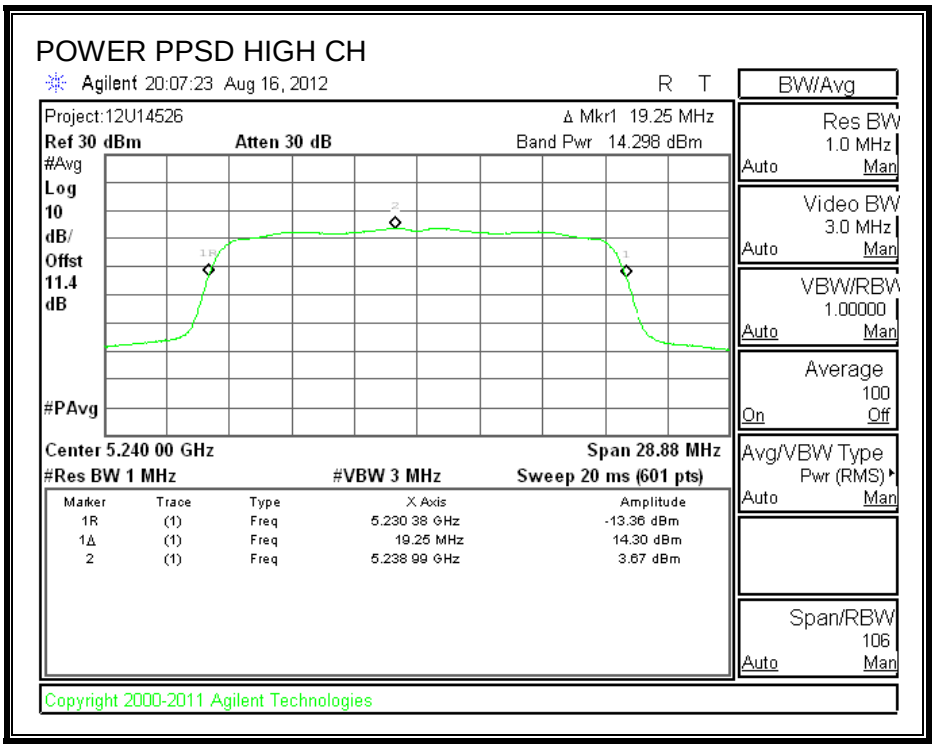
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3. 802.11n HT40 MODE IN THE 5.2 GHz BAND

8.3.1. 26 dB BANDWIDTH

LIMITS

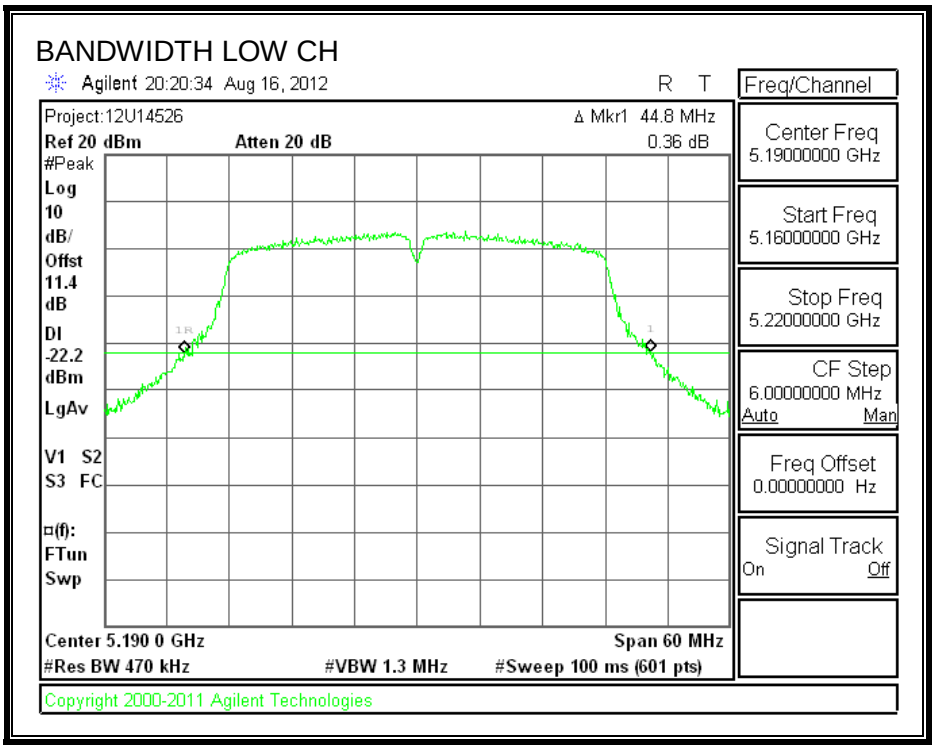
None; for reporting purposes only.

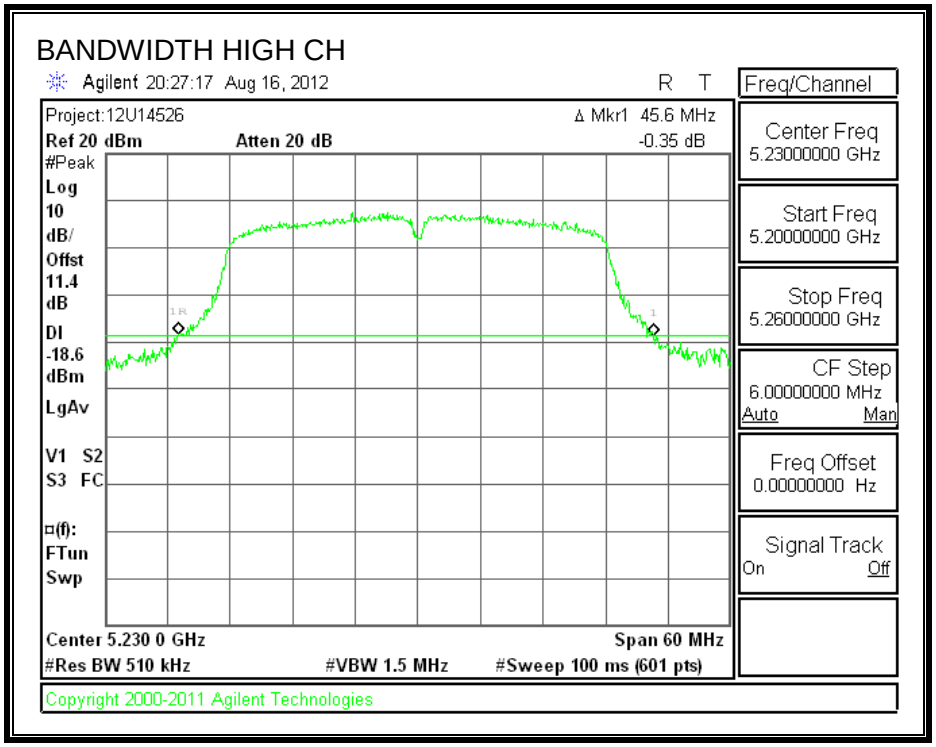
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5190	44.8
High	5230	45.6

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.2. 99% BANDWIDTH

LIMITS

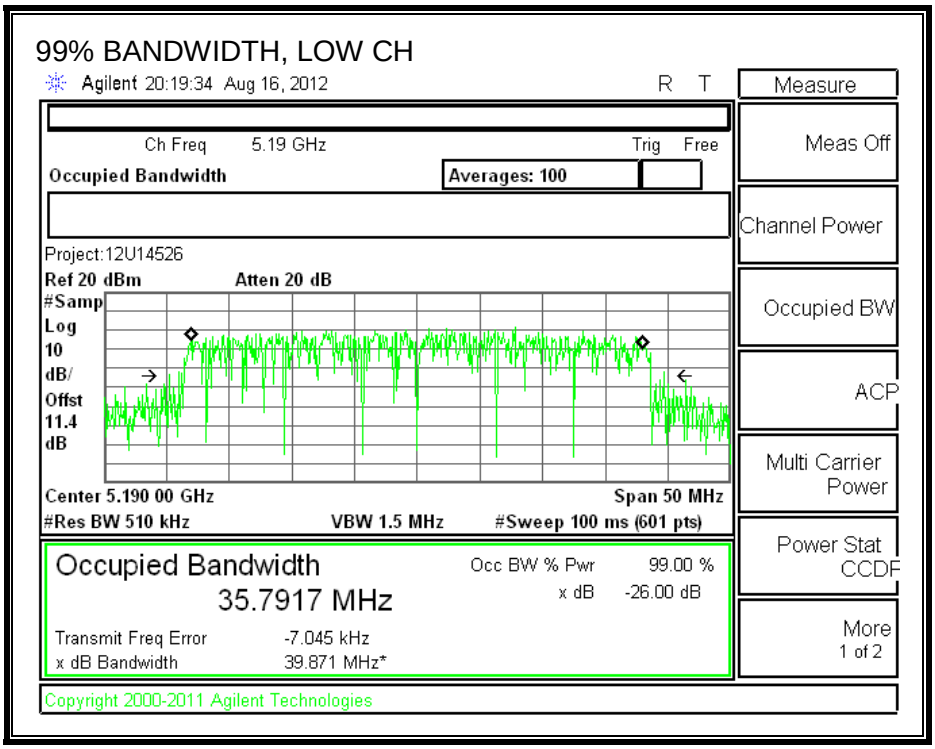
None; for reporting purposes only.

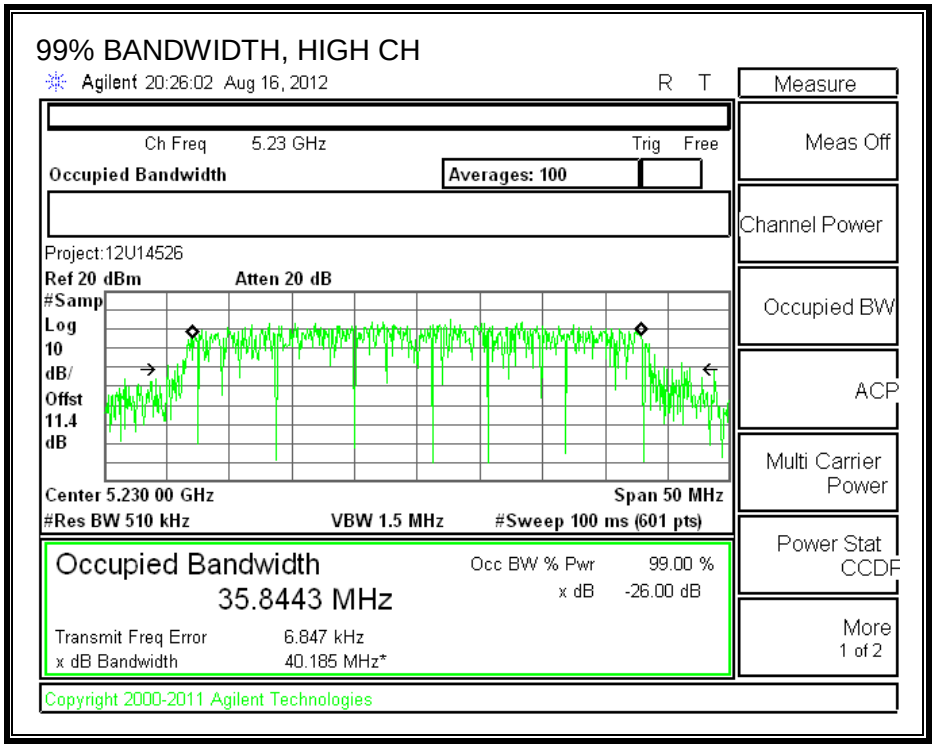
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5190	35.7917
High	5230	35.8443

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5190	11.95
High	5230	15.45

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz 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.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5190	4.70	24.00	11.00
High	5230	4.70	24.00	11.00

Output Power Results

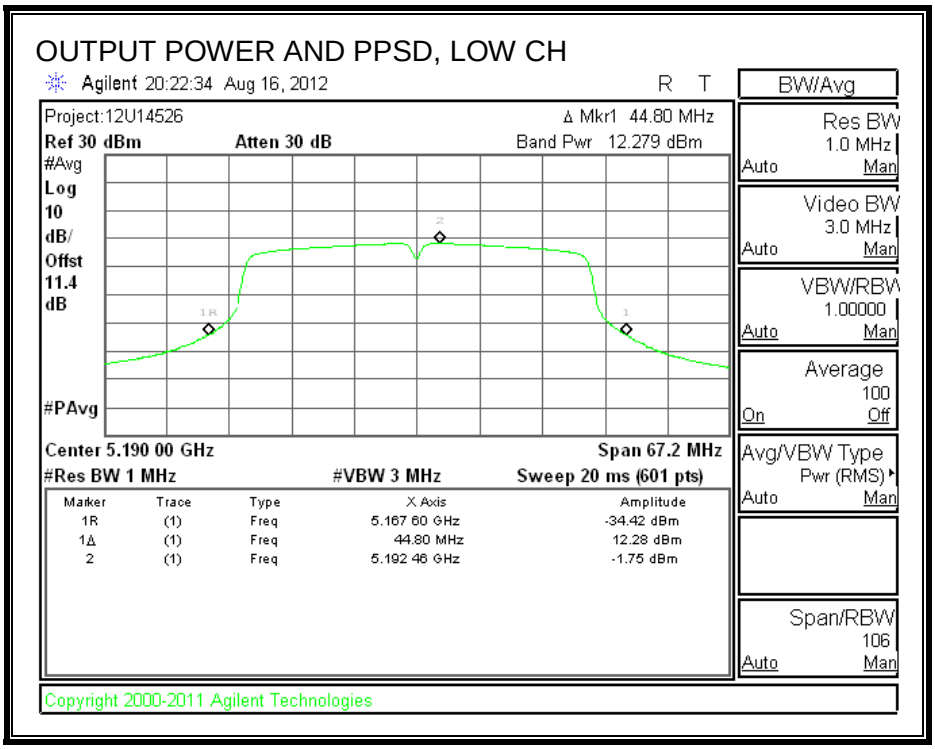
Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5190	12.279	12.279	24.00	-11.721
High	5230	15.780	15.780	24.00	-8.220

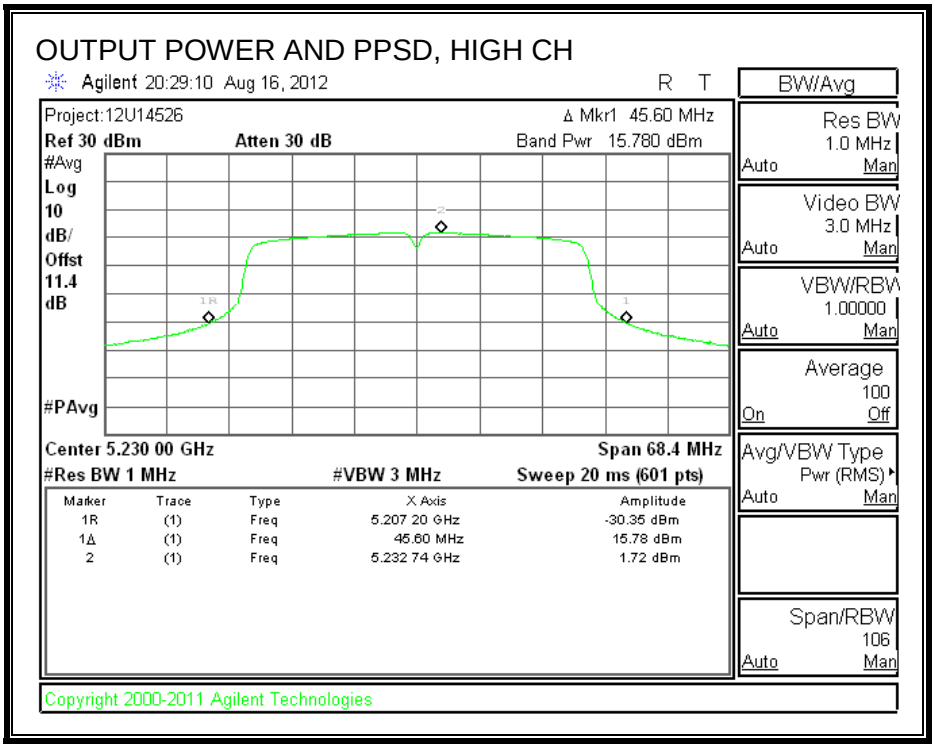
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5190	-1.75	-1.75	11.00	-12.75
High	5230	1.72	1.72	11.00	-9.28

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4. 802.11a MODE IN THE 5.3 GHz BAND

8.4.1. 26 dB BANDWIDTH

LIMITS

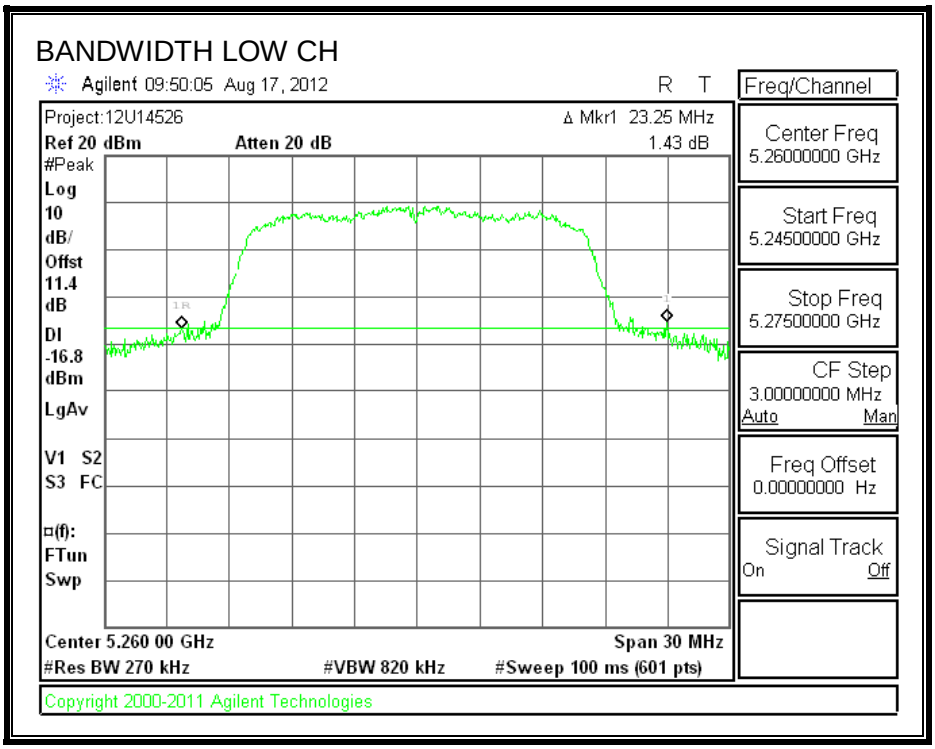
None; for reporting purposes only.

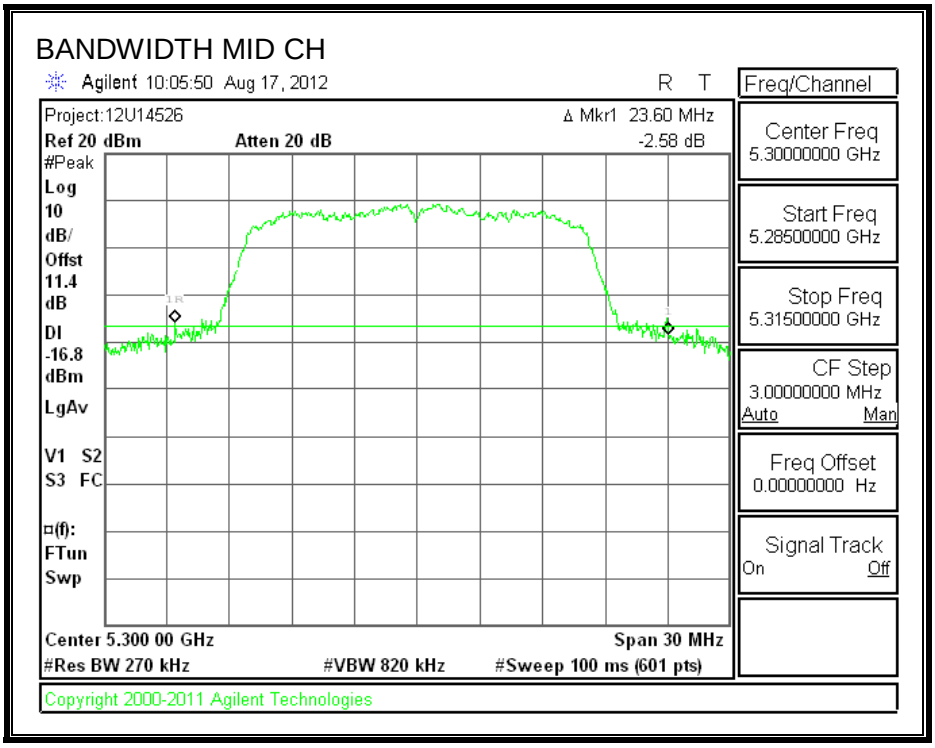
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	23.25
Mid	5300	23.60
High	5320	19.00

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

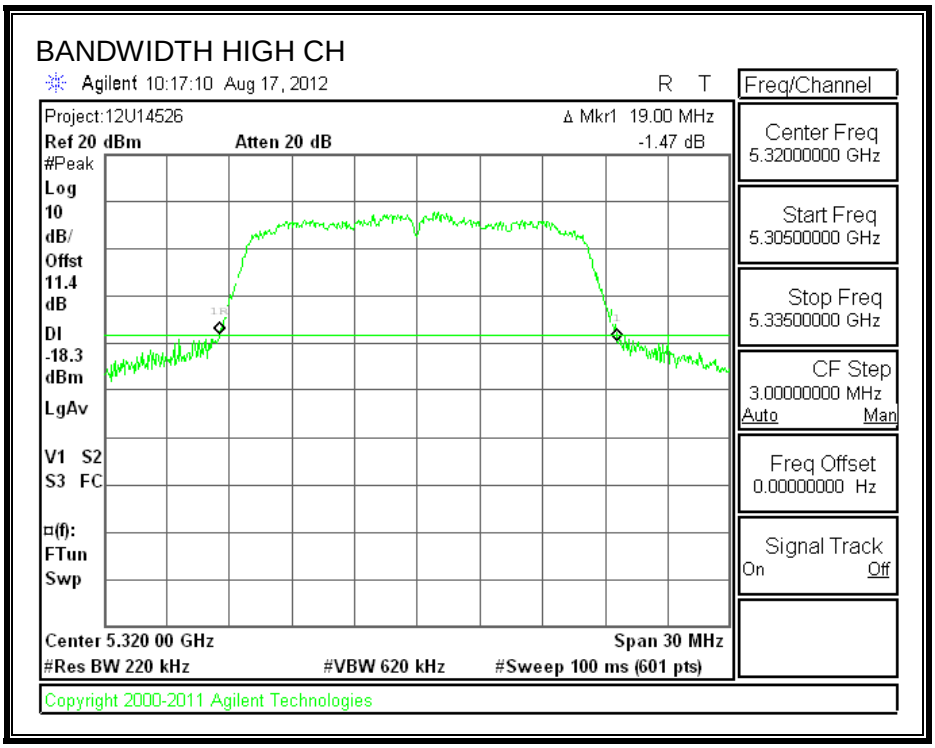
26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.2. 99% BANDWIDTH

LIMITS

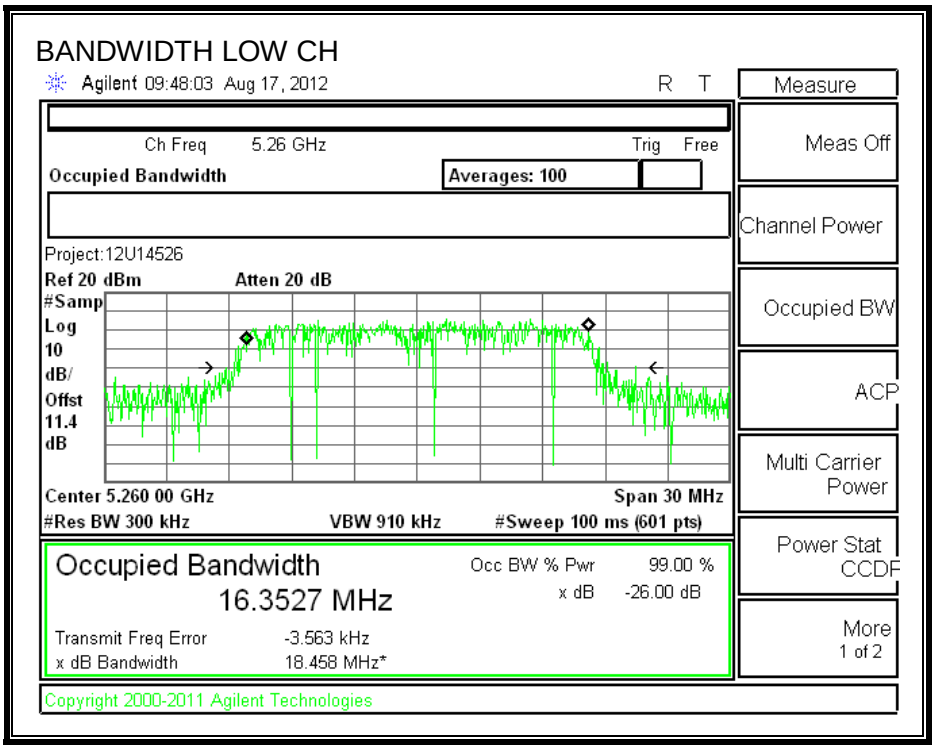
None; for reporting purposes only.

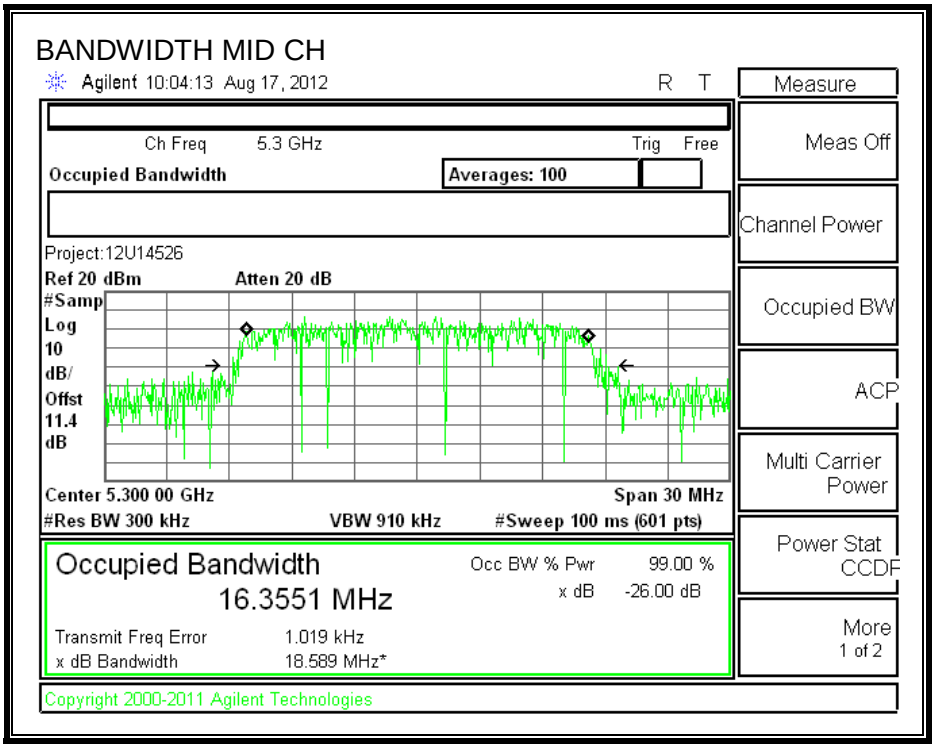
RESULTS

Frequency (MHz)	99% Bandwidth (MHz)
5260	16.3527
5300	16.3551
5320	16.3541

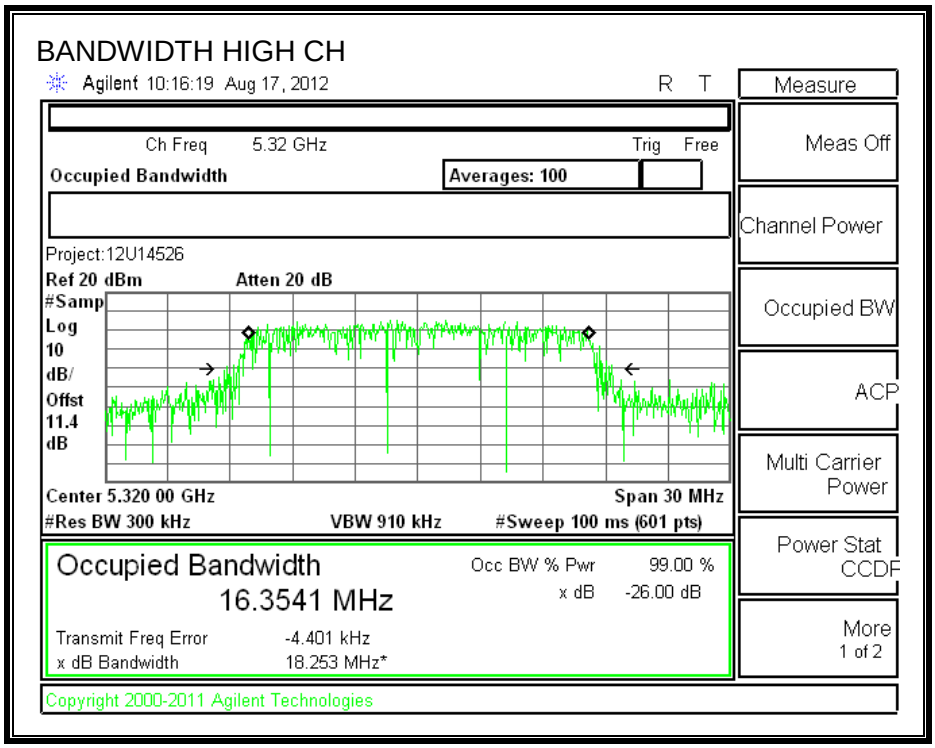
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5260	16.90
Mid	5300	16.87
High	5320	15.97

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5260	24	16.3527	23.14	5.08	23.14	11.00
Mid	5300	24	16.3551	23.14	5.08	23.14	11.00
High	5320	24	16.3541	23.14	5.08	23.14	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5260	17.164	17.164	23.14	-5.972
Mid	5300	17.176	17.176	23.14	-5.961
High	5320	16.451	16.451	23.14	-6.685

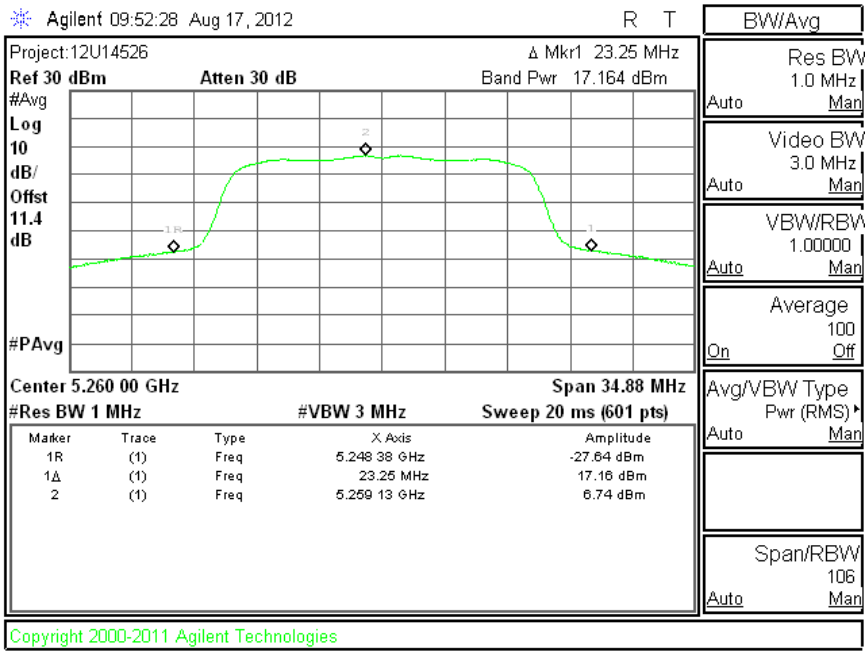
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5260	6.74	6.74	11.00	-4.26
Mid	5300	6.76	6.76	11.00	-4.24
High	5320	6.03	6.03	11.00	-4.97

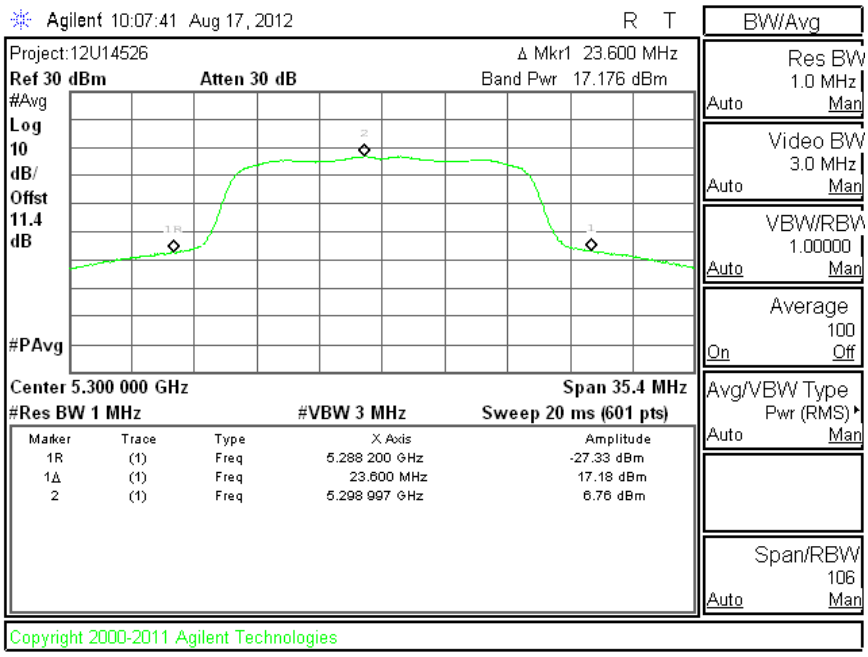
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

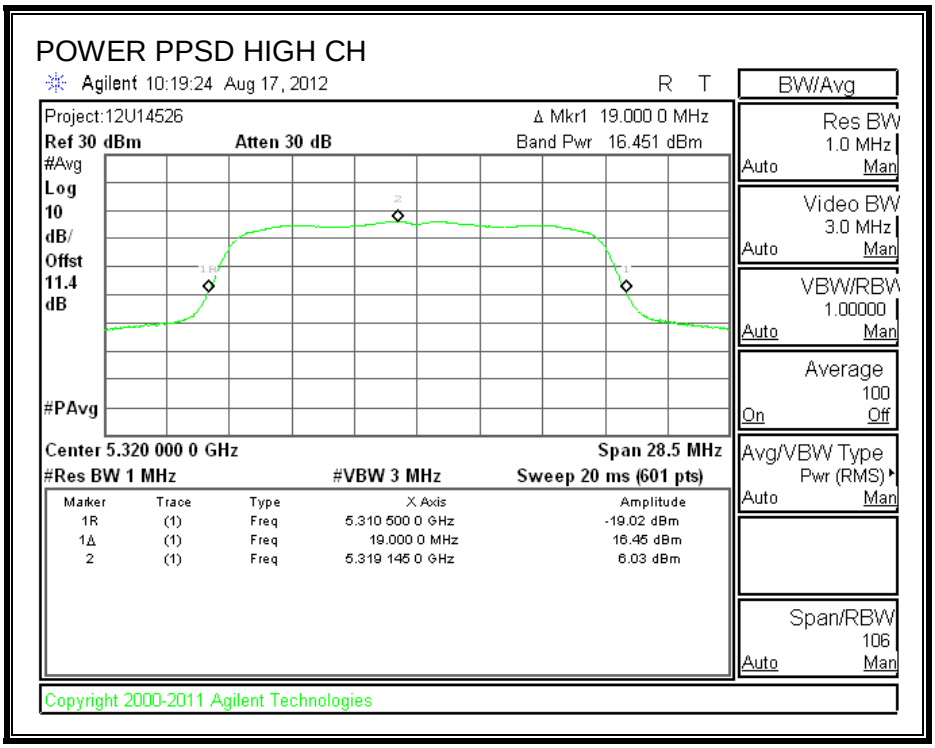
POWER PPSD LOW CH



POWER PPSD MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5. 802.11n HT20 MODE IN THE 5.3 GHz BAND

8.5.1. 26 dB BANDWIDTH

LIMITS

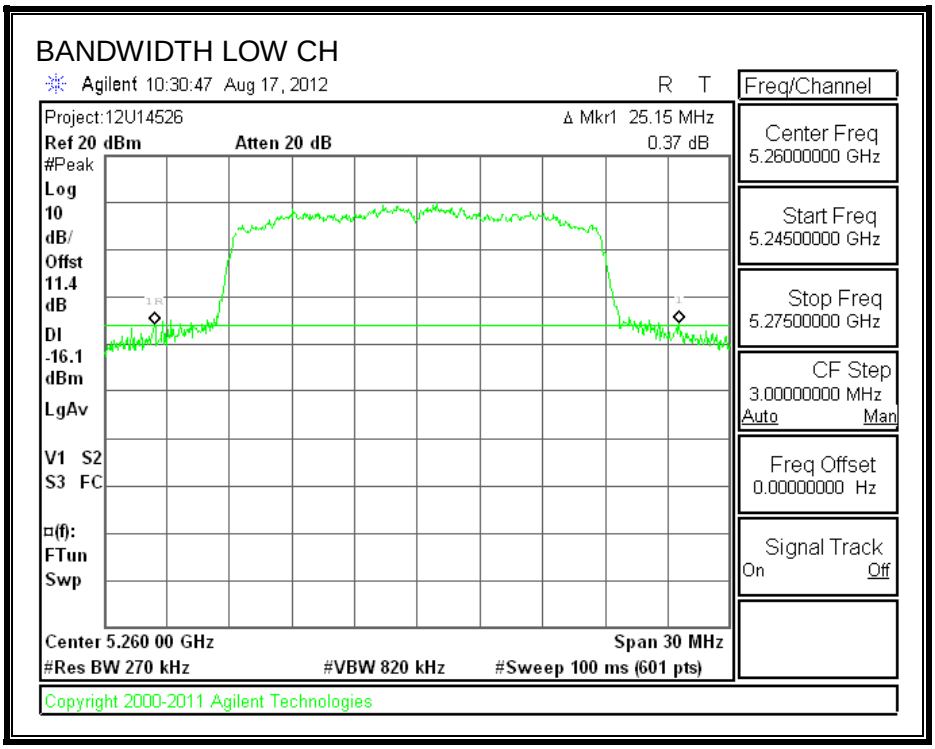
None; for reporting purposes only.

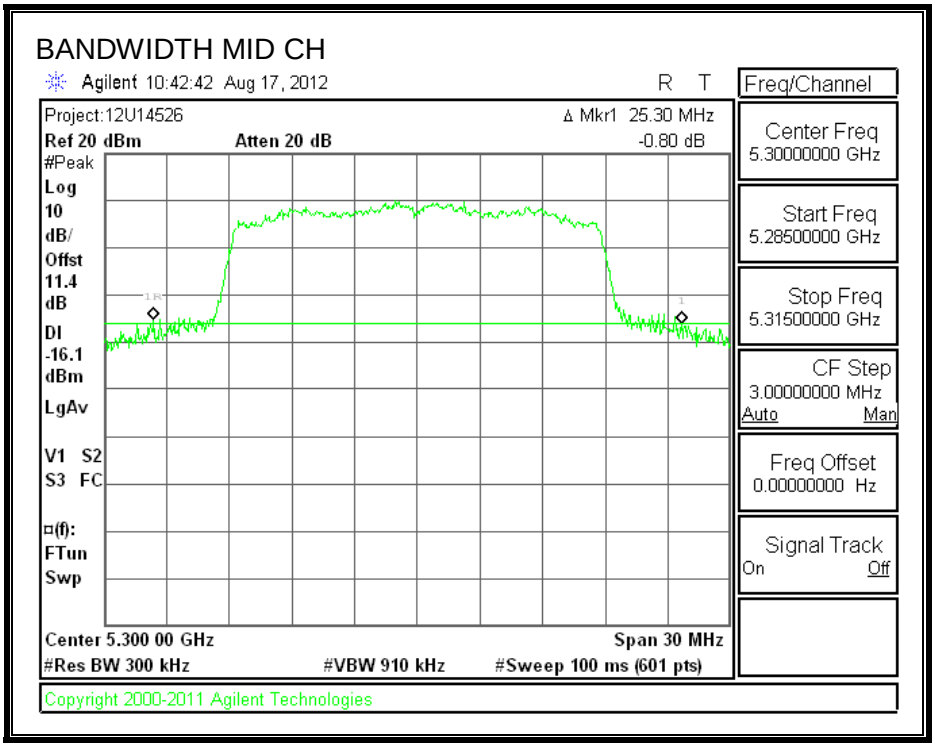
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5260	25.15
Mid	5300	25.30
High	5320	19.60

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

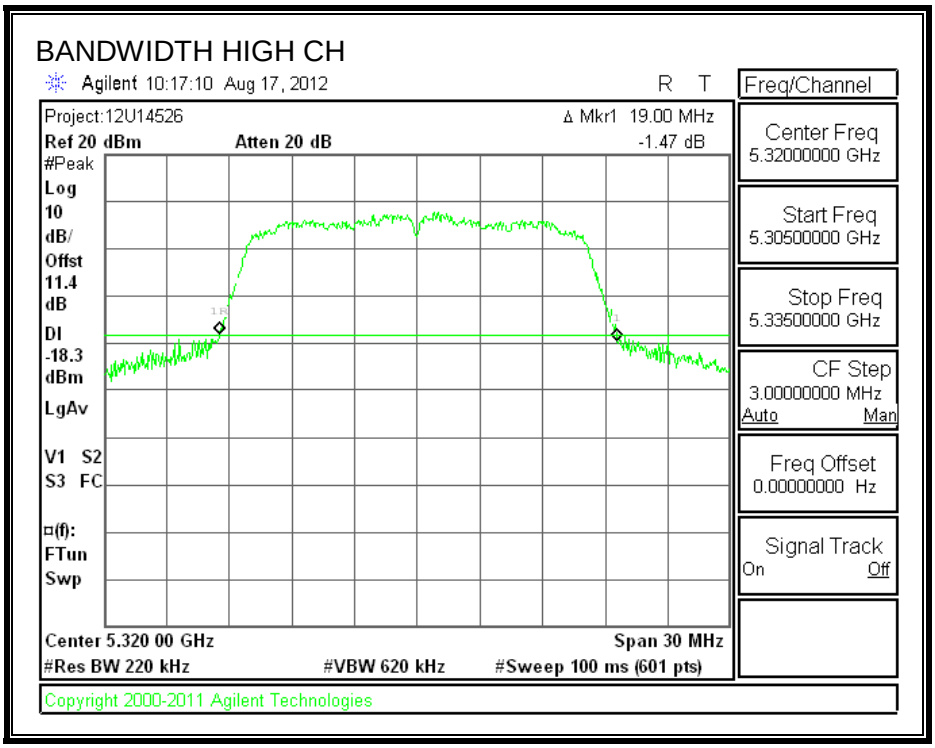
26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.2. 99% BANDWIDTH

LIMITS

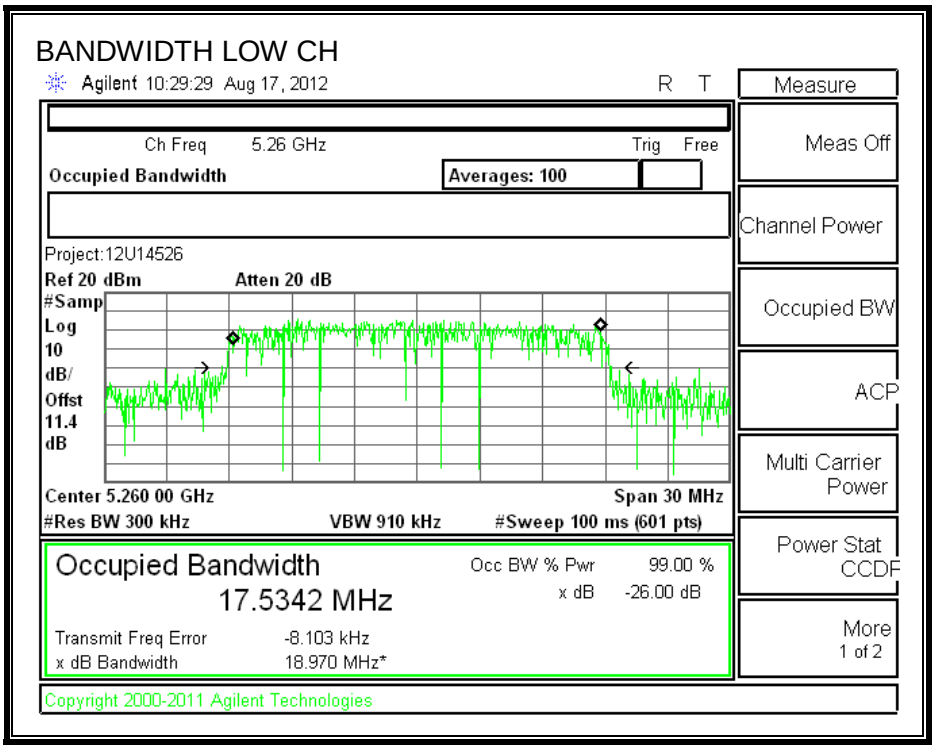
None; for reporting purposes only.

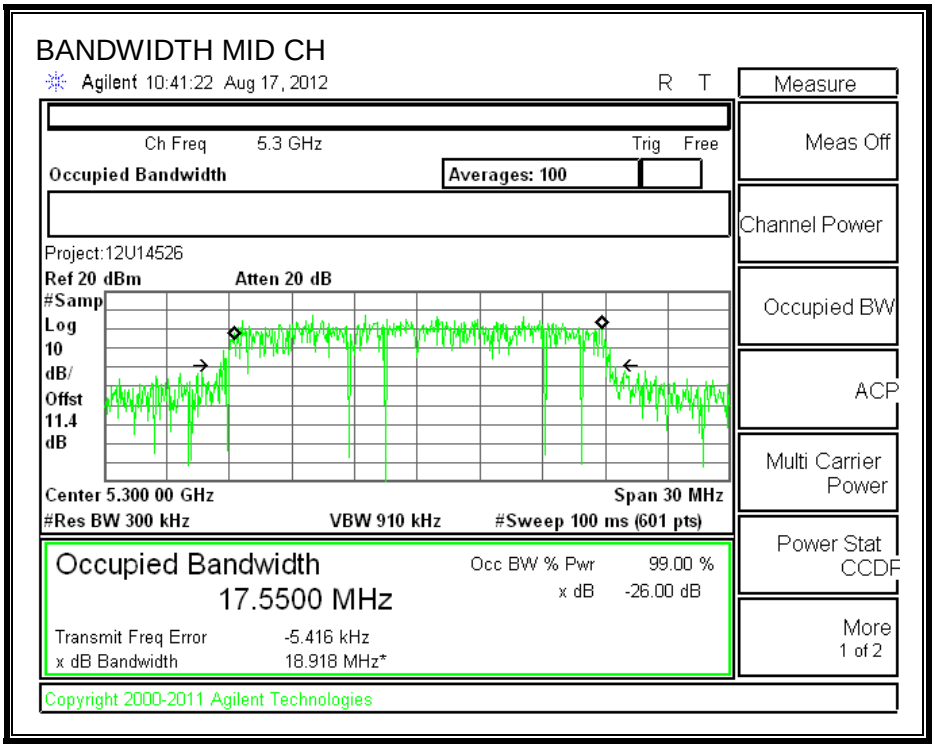
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5260	17.5342
Mid	5300	17.5500
High	5320	17.5299

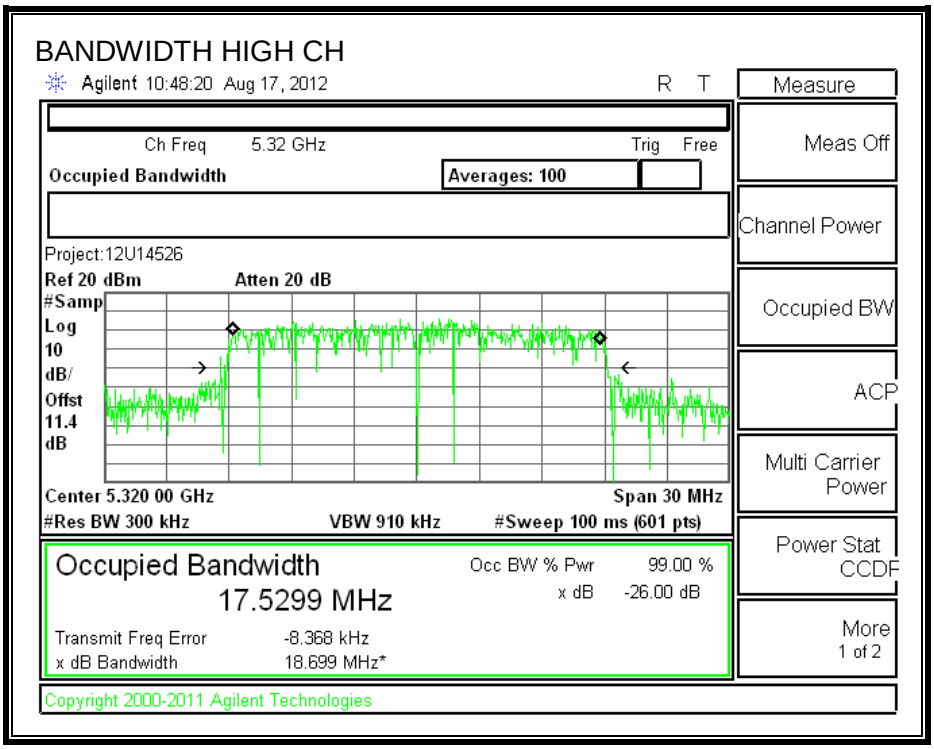
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5260	16.91
Mid	5300	16.90
High	5320	15.91

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5260	24	17.5342	23.44	5.08	23.44	11.00
Mid	5300	24	17.5500	23.44	5.08	23.44	11.00
High	5320	24	17.5299	23.44	5.08	23.44	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5260	17.278	17.278	23.44	-6.161
Mid	5300	17.251	17.251	23.44	-6.192
High	5320	16.357	16.357	23.44	-7.081

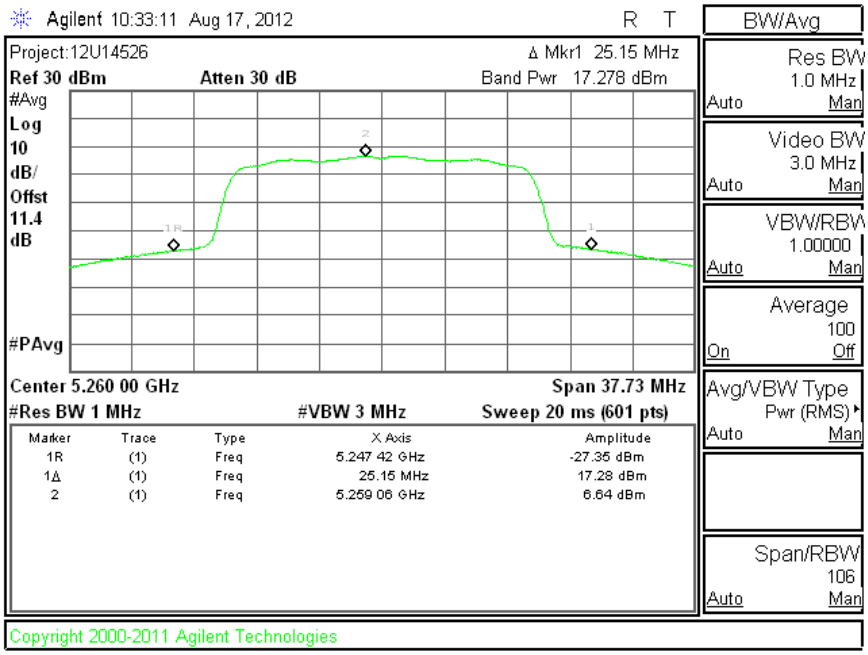
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5260	6.64	6.64	11.00	-4.36
Mid	5300	6.62	6.62	11.00	-4.38
High	5320	5.74	5.74	11.00	-5.26

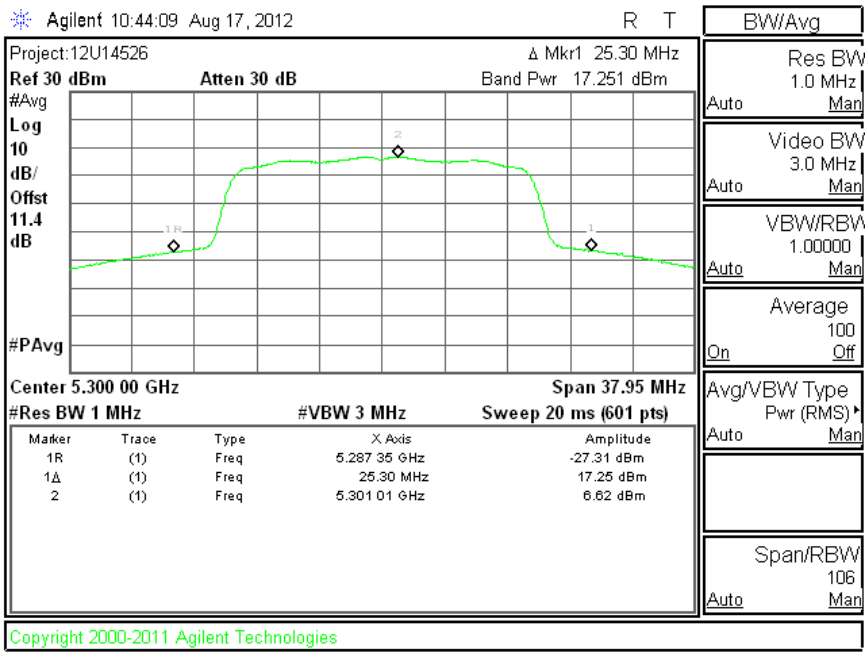
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

POWER PPSD LOW CH

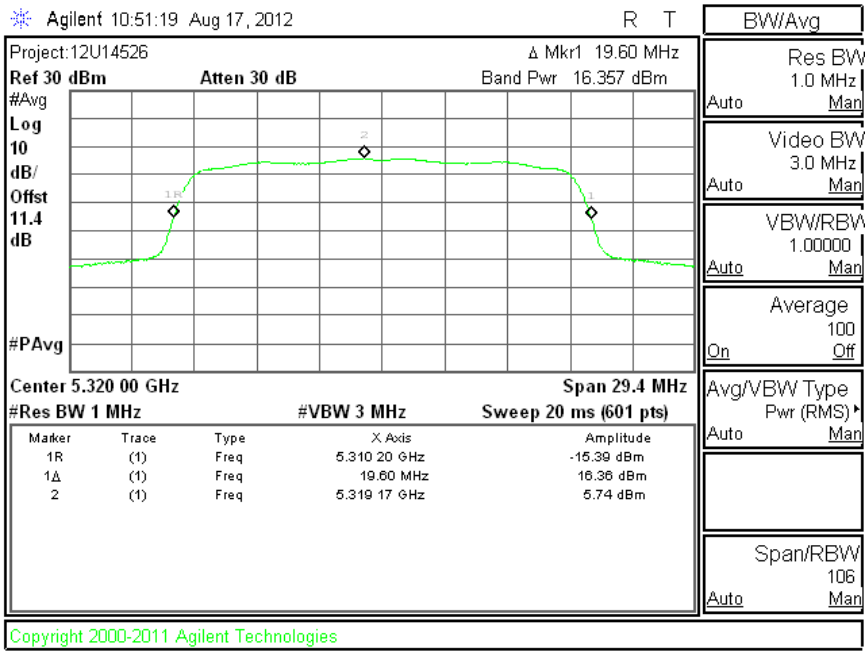


POWER PPSD MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD HIGH CH



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Freq	5.310 20 GHz	-15.39 dBm
1Δ	(1)	Freq	19.60 MHz	16.36 dBm
2	(1)	Freq	5.319 17 GHz	5.74 dBm

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6. 802.11n HT40 MODE IN THE 5.3 GHz BAND

8.6.1. 26 dB BANDWIDTH

LIMITS

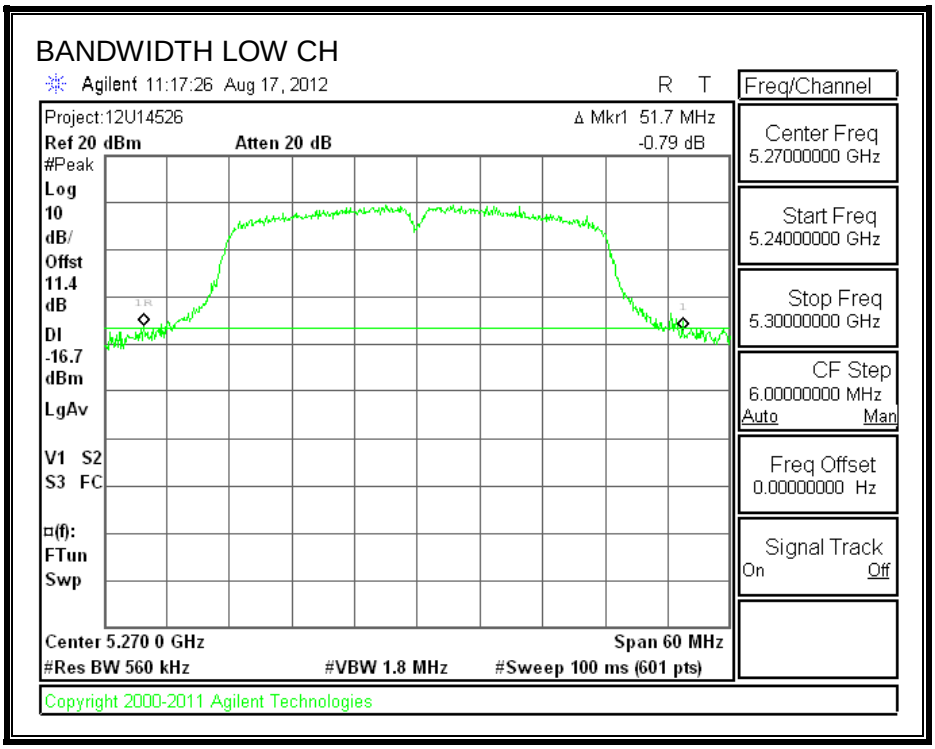
None; for reporting purposes only.

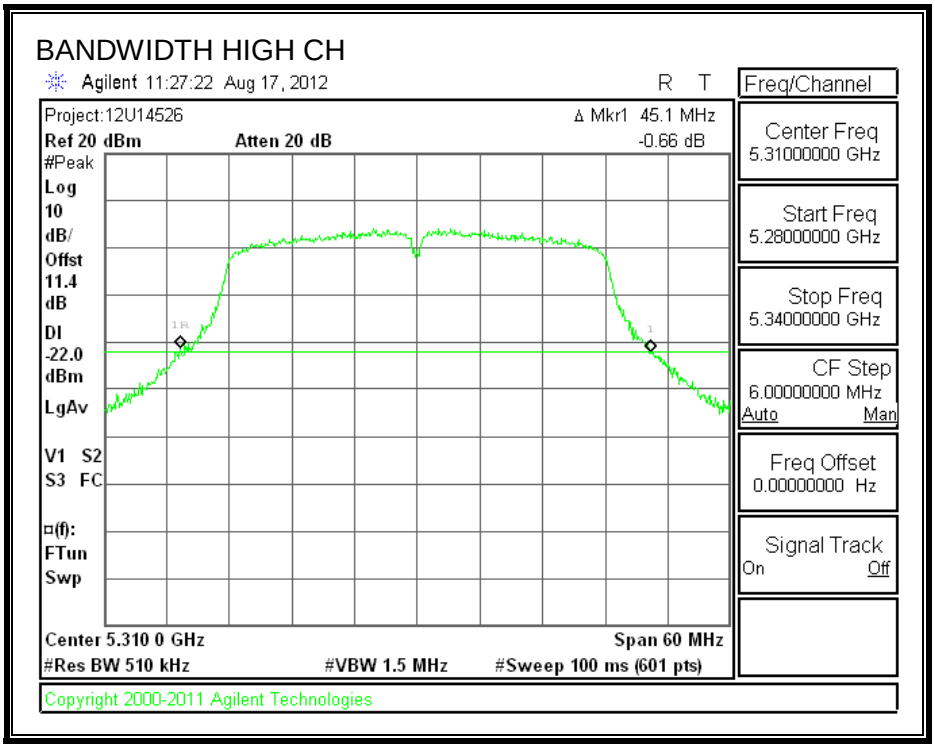
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5270	51.70
High	5310	45.10

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701H
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.2. 99% BANDWIDTH

LIMITS

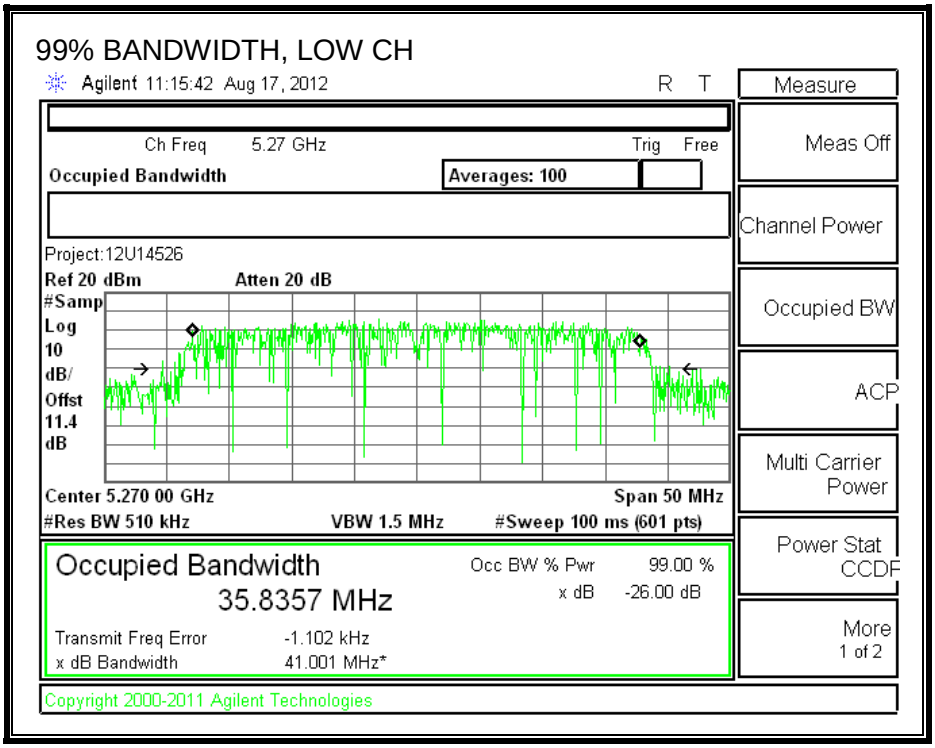
None; for reporting purposes only.

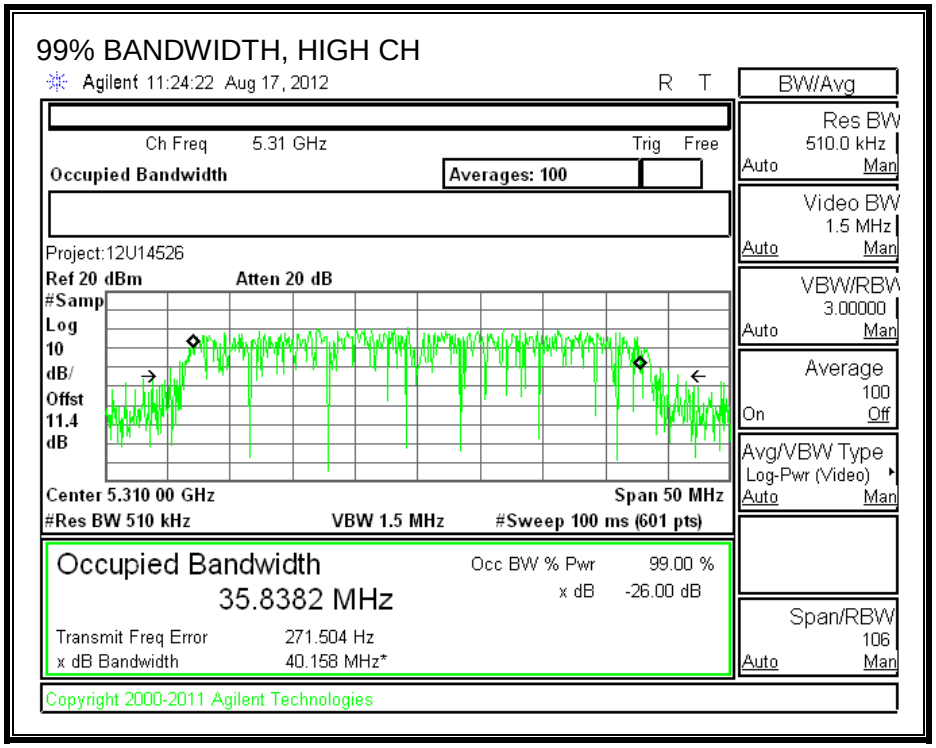
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5270	35.8357
High	5310	35.8382

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.4 dB (including 10 dB pad and 1.4 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5270	17.0
High	5310	11.9

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.25–5.35 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5270	24	35.8357	26.54	5.08	24.00	11.00
High	5310	24	35.8380	26.54	5.08	24.00	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5270	17.260	17.260	24.00	-6.740
High	5310	12.380	12.380	24.00	-11.620

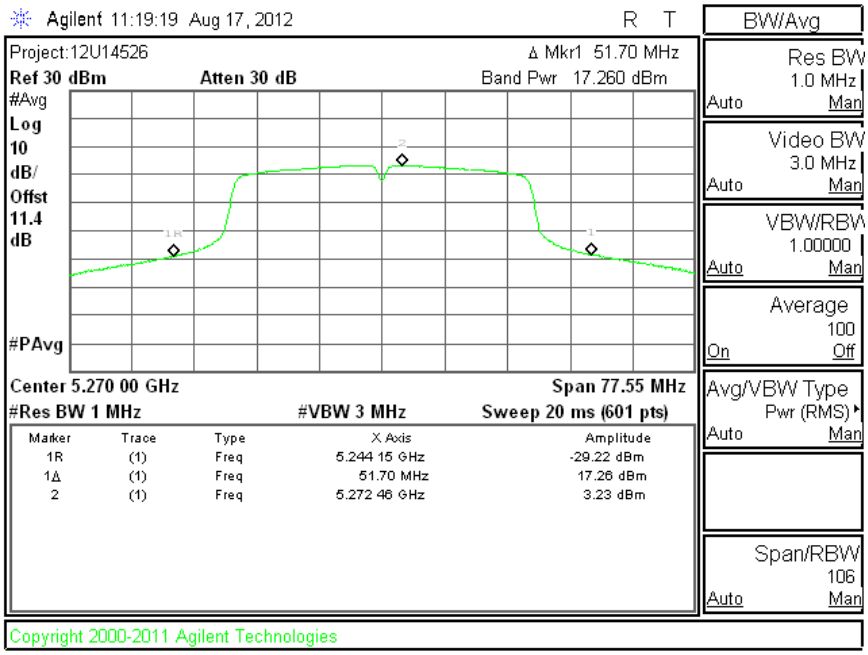
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5270	3.29	3.29	11.00	-7.71
High	5310	-1.64	-1.64	11.00	-12.64

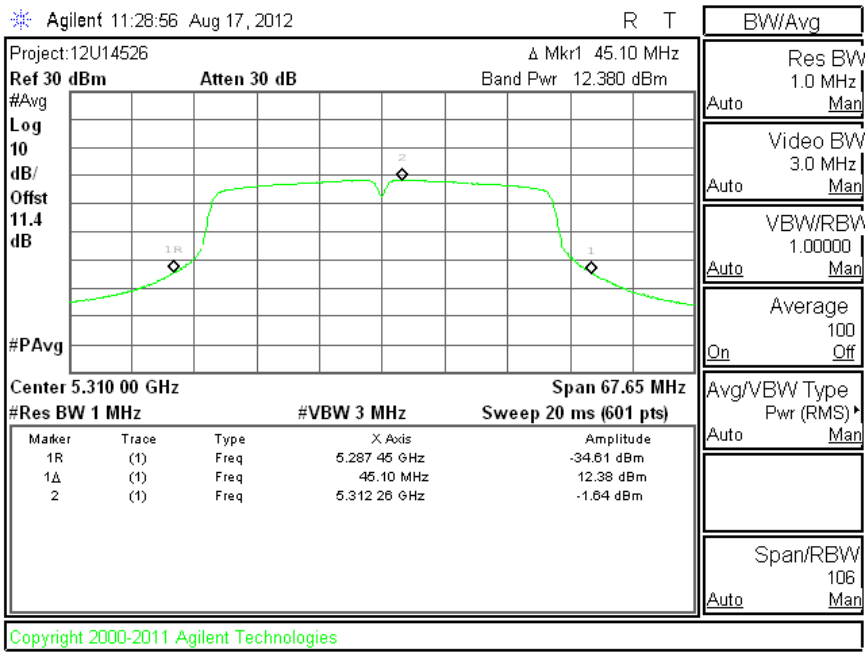
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

POWER PPSD LOW CH



POWER PPSD HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.7. 802.11a MODE IN THE 5.6 GHz BAND

8.7.1. 26 dB BANDWIDTH

LIMITS

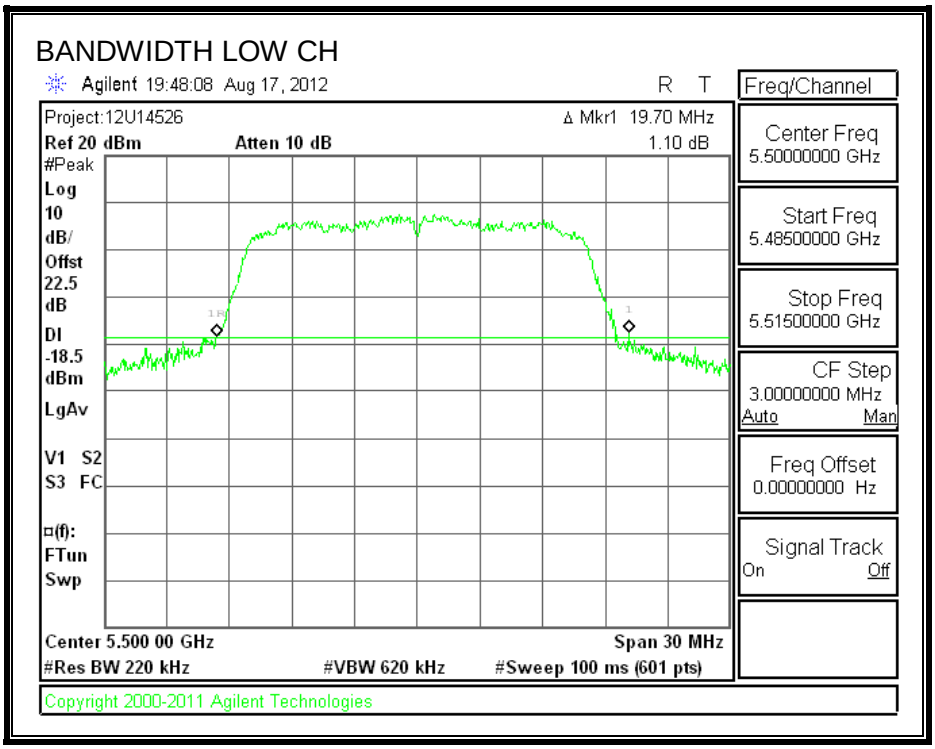
None; for reporting purposes only.

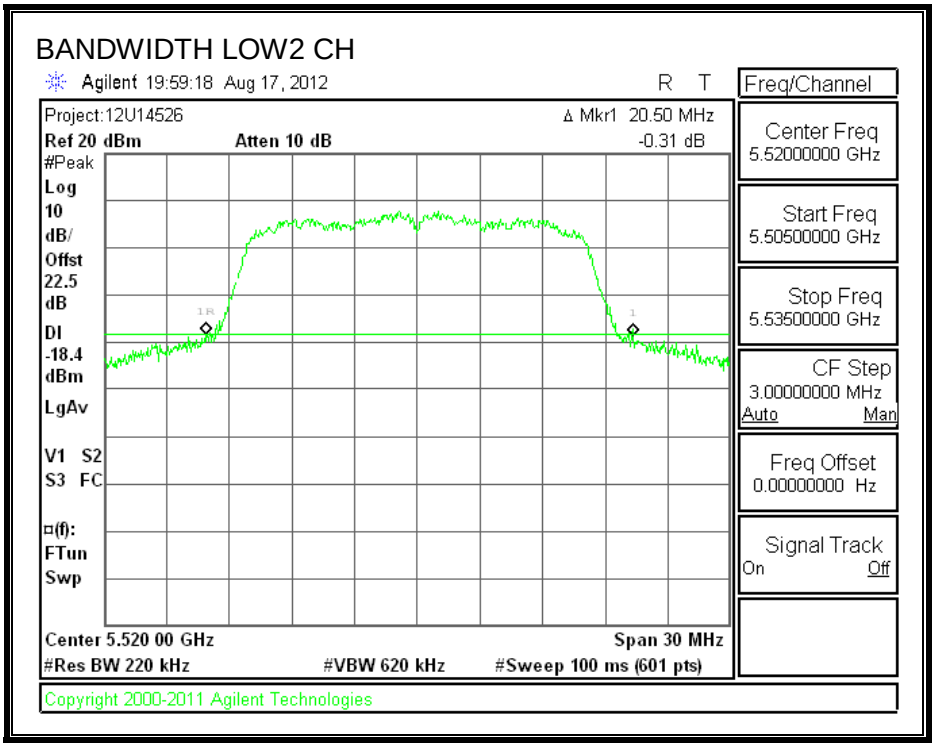
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	19.70
Low2	5520	20.50
Mid	5580	20.00
High2	5680	19.60
High	5700	19.10

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

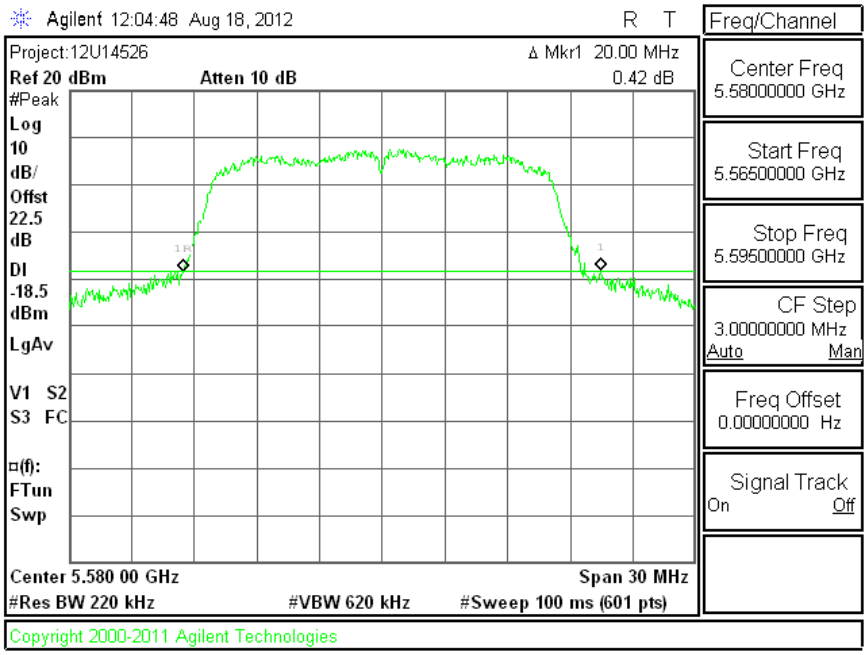
26 dB BANDWIDTH



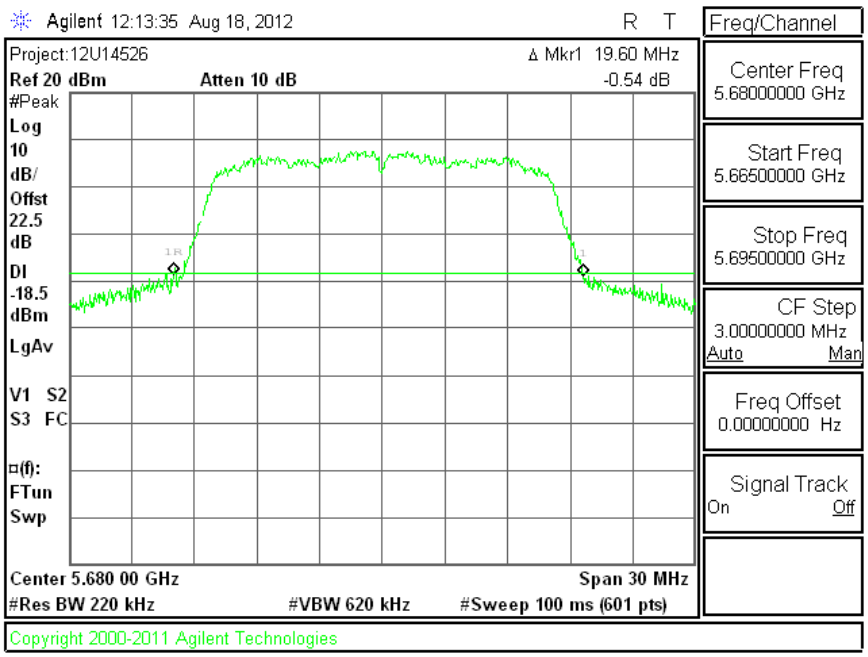


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH MID CH

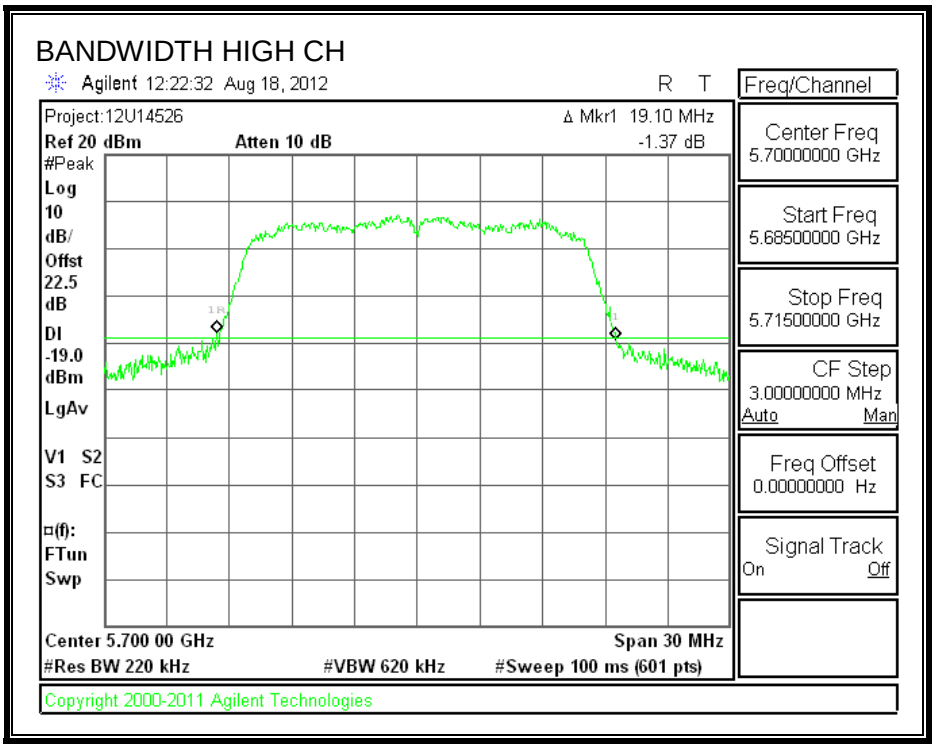


BANDWIDTH HIGH2 CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.7.2. 99% BANDWIDTH

LIMITS

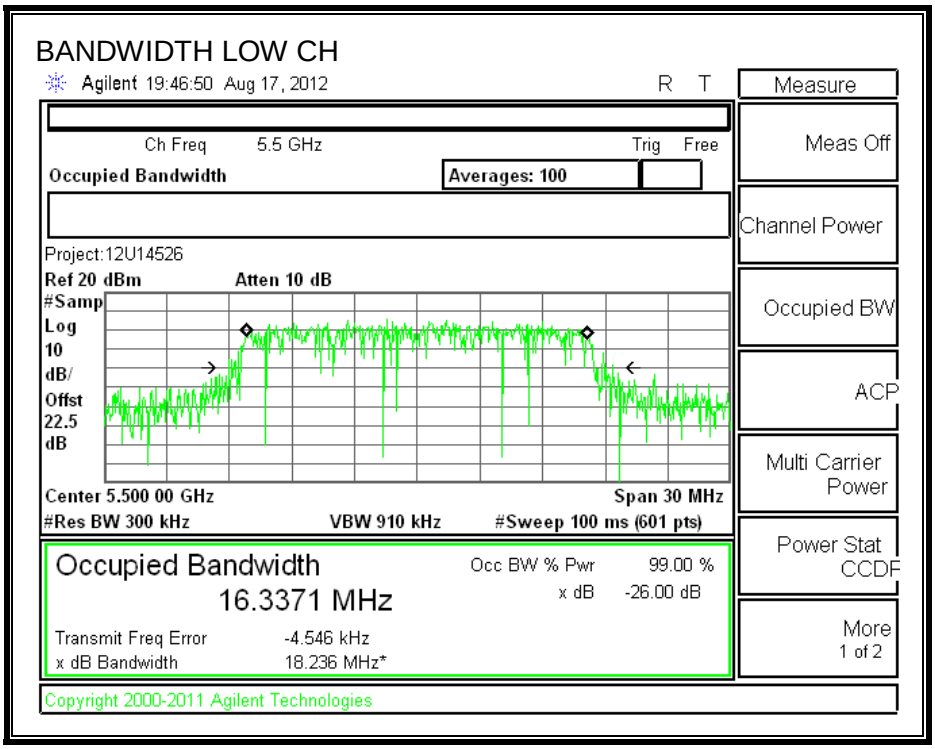
None; for reporting purposes only.

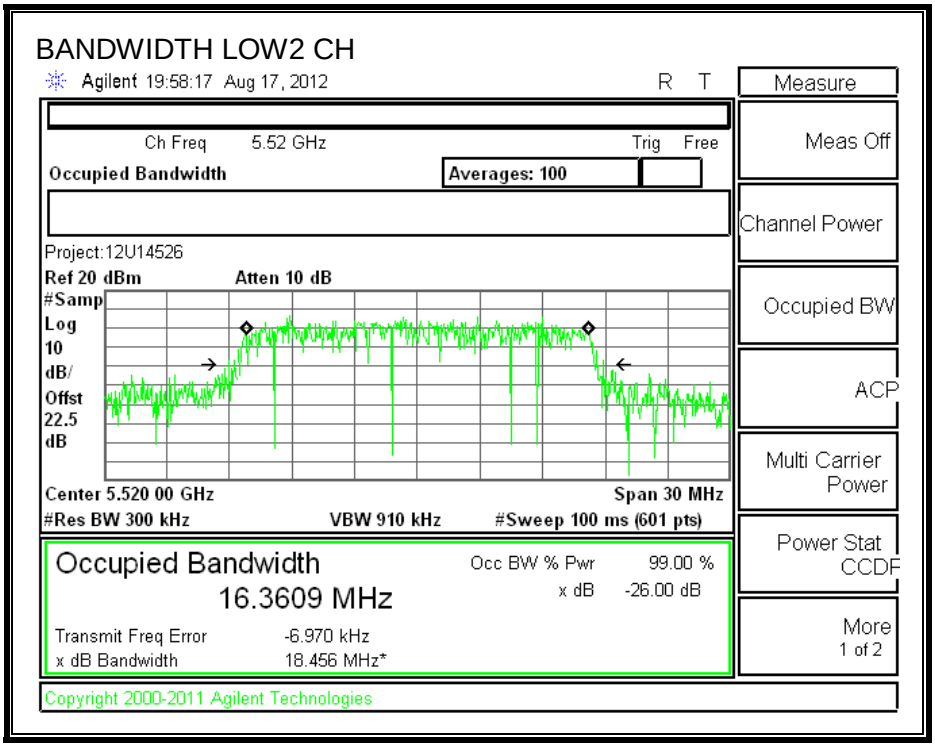
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5500	16.3371
Low2	5520	16.3609
Mid	5580	16.3586
High2	5680	16.3476
High	5700	16.3529

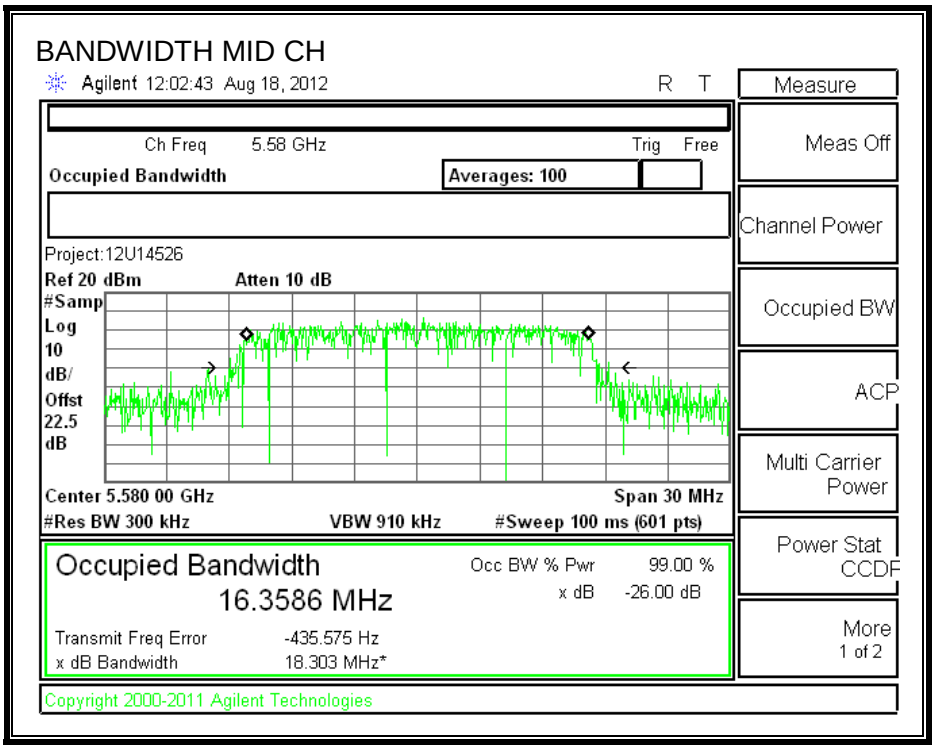
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

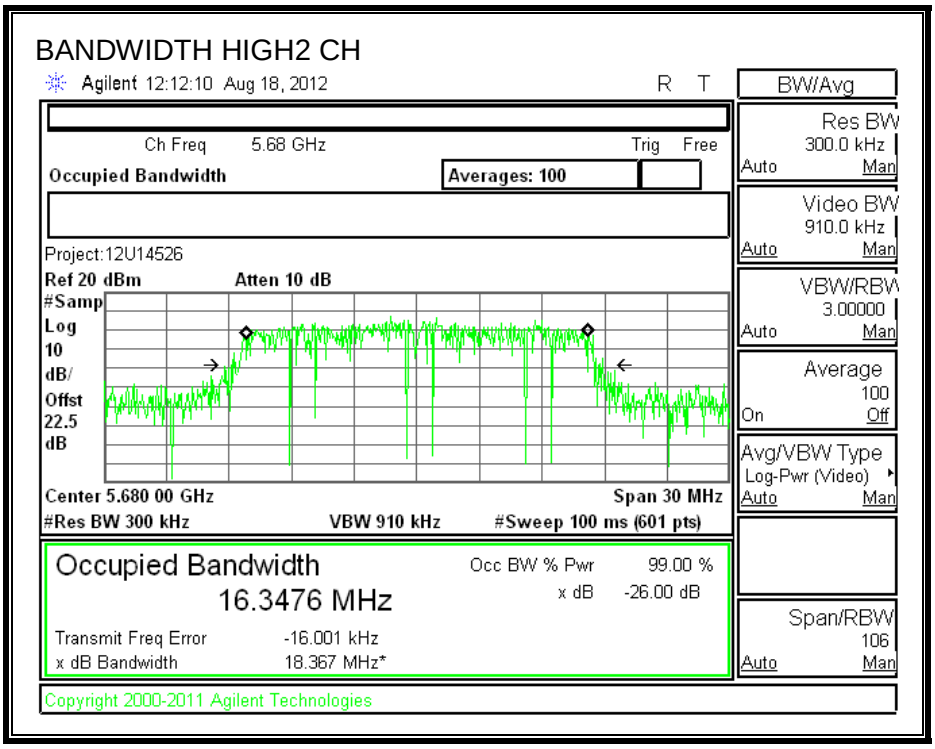
99% BANDWIDTH



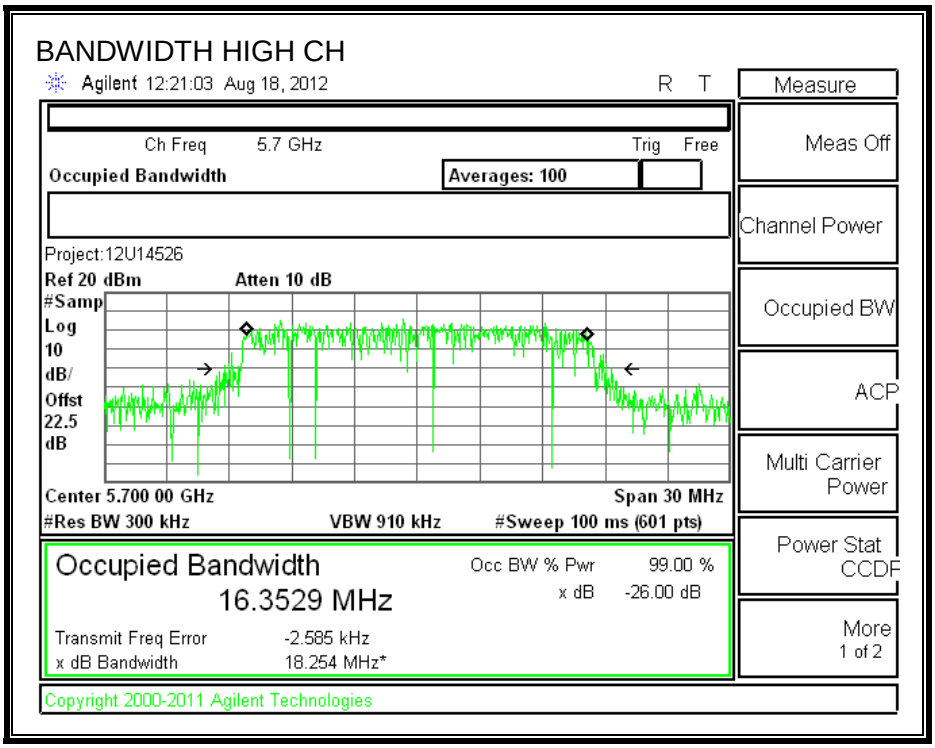


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.7.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.5 dB (including 10 dB pad and 1.5 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5500	15.49
Low2	5520	15.97
Mid	5580	15.94
High2	5680	15.97
High	5700	15.50

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.7.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701H
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5500	24	16.3371	23.13	5.42	23.13	11.00
Low2	5520	24	16.3609	23.14	5.42	23.14	11.00
Mid	5580	24	16.3586	23.14	5.42	23.14	11.00
High2	5680	24	16.3476	23.13	5.42	23.13	11.00
High	5700	24	16.3529	23.14	5.42	23.14	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	16.422	16.422	23.13	-6.710
Low2	5520	16.585	16.585	23.14	-6.552
Mid	5580	16.397	16.397	23.14	-6.740
High2	5680	16.574	16.574	23.13	-6.561
High	5700	16.089	16.089	23.14	-7.047

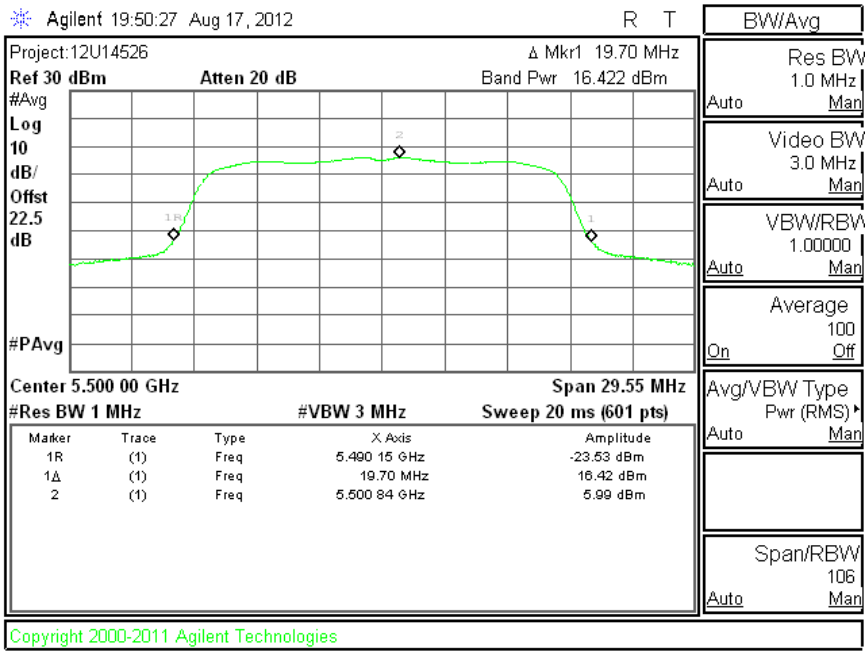
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5500	5.99	5.99	11.00	-5.01
Low2	5520	6.16	6.16	11.00	-4.84
Mid	5580	5.98	5.98	11.00	-5.02
High2	5680	6.16	6.16	11.00	-4.84
High	5700	5.68	5.68	11.00	-5.32

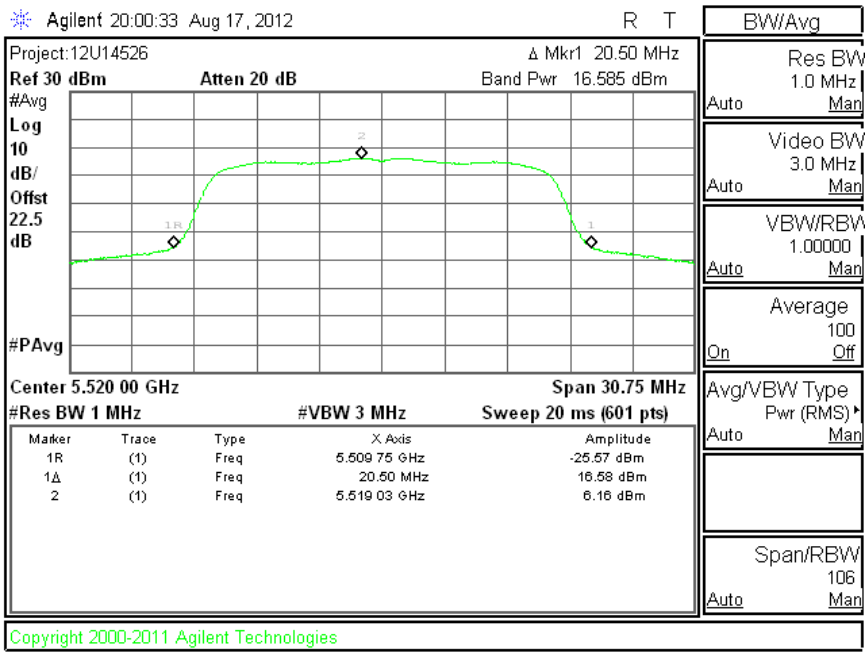
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

POWER PPSD LOW CH

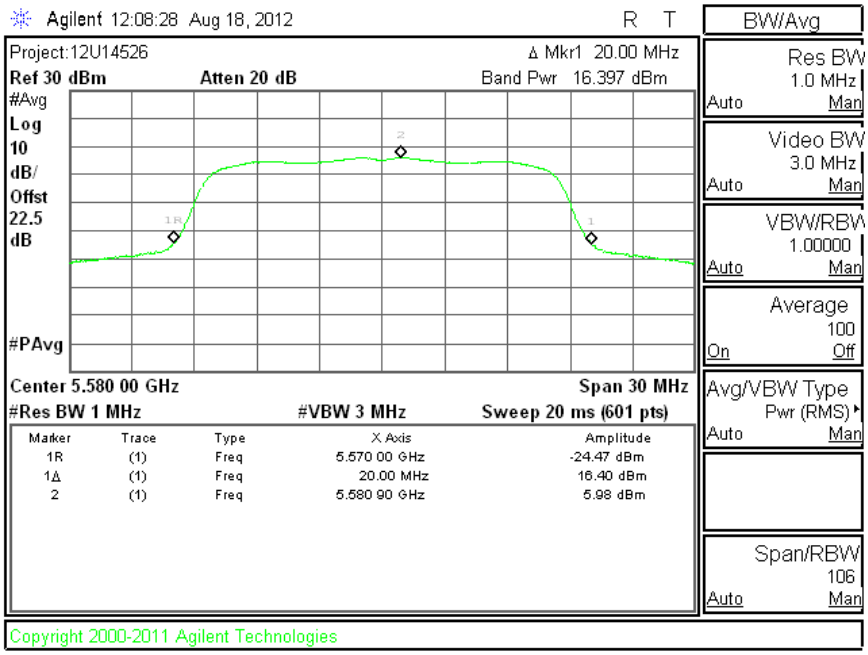


POWER PPSD LOW2 CH

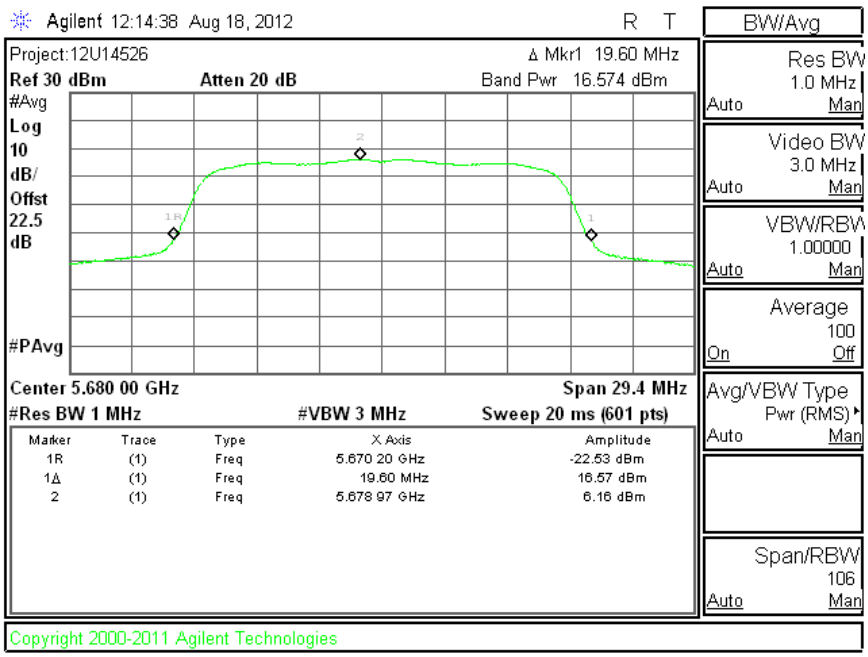


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD MID CH

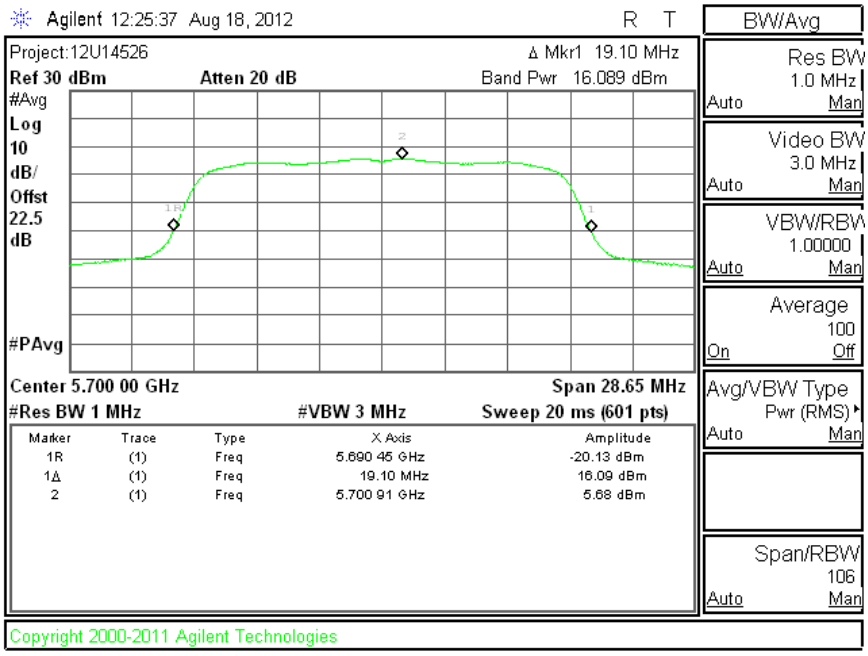


POWER PPSD HIGH2 CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.8. 802.11n HT20 MODE IN THE 5.6 GHz BAND

8.8.1. 26 dB BANDWIDTH

LIMITS

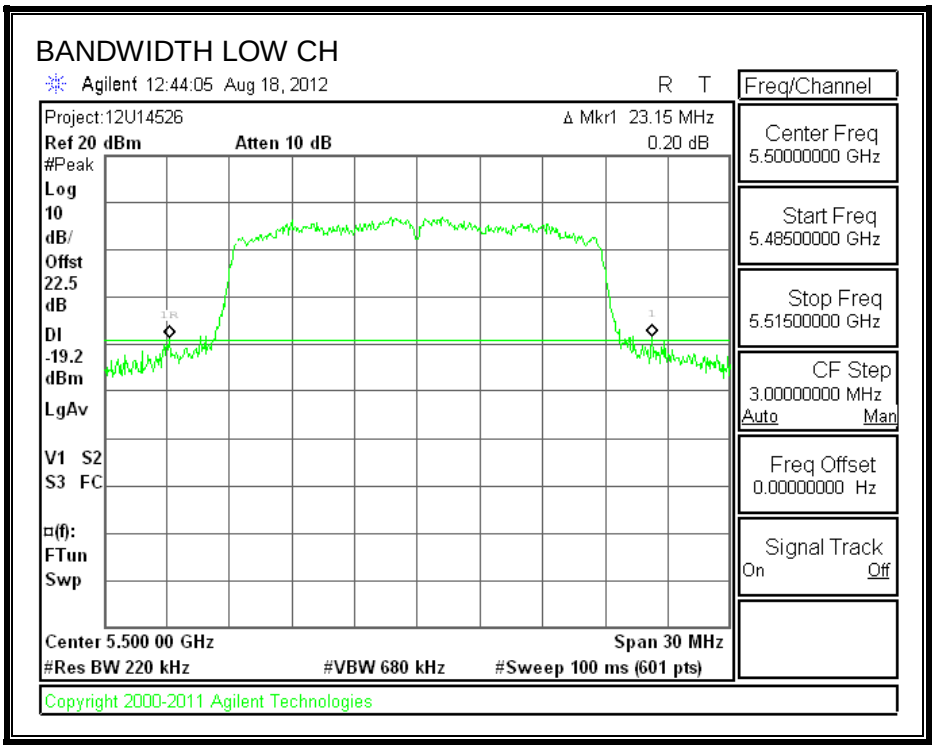
None; for reporting purposes only.

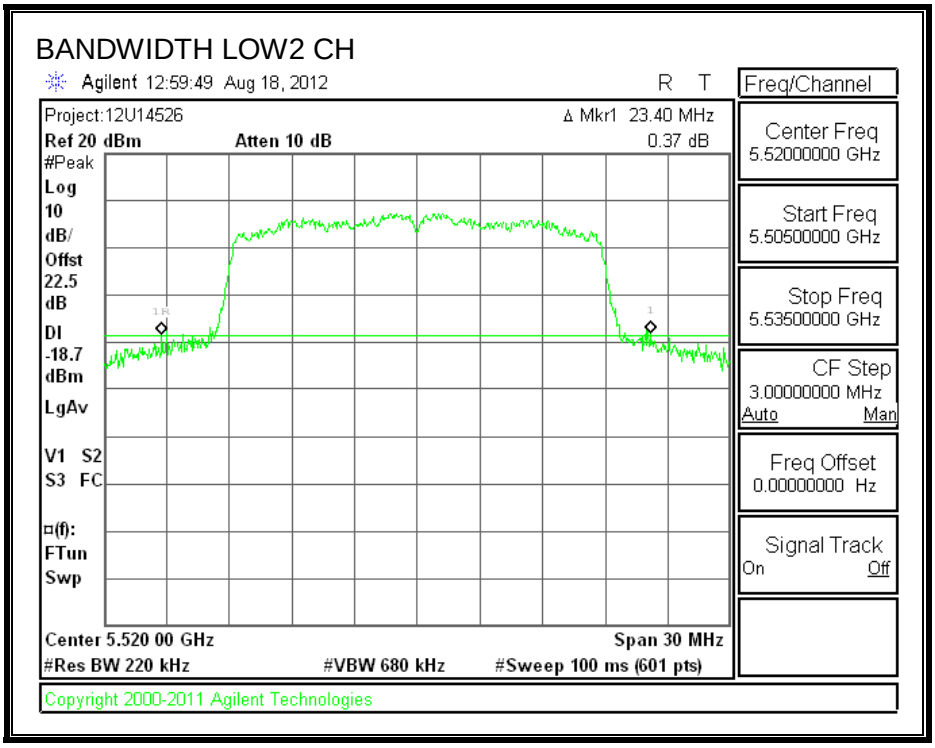
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5500	23.15
Low2	5520	23.40
Mid	5580	20.45
High2	5680	19.35
High	5700	19.25

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

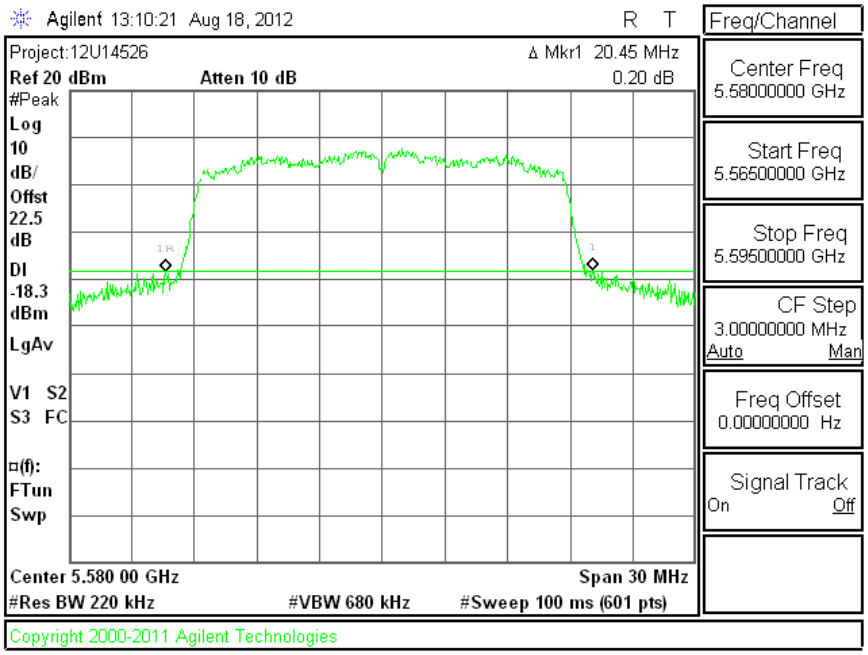
26 dB BANDWIDTH



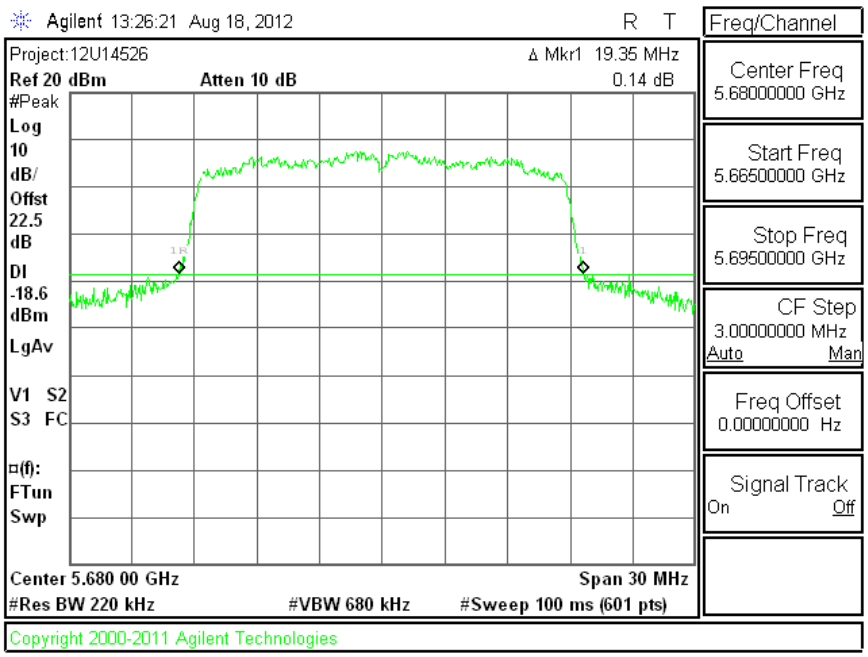


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH MID CH

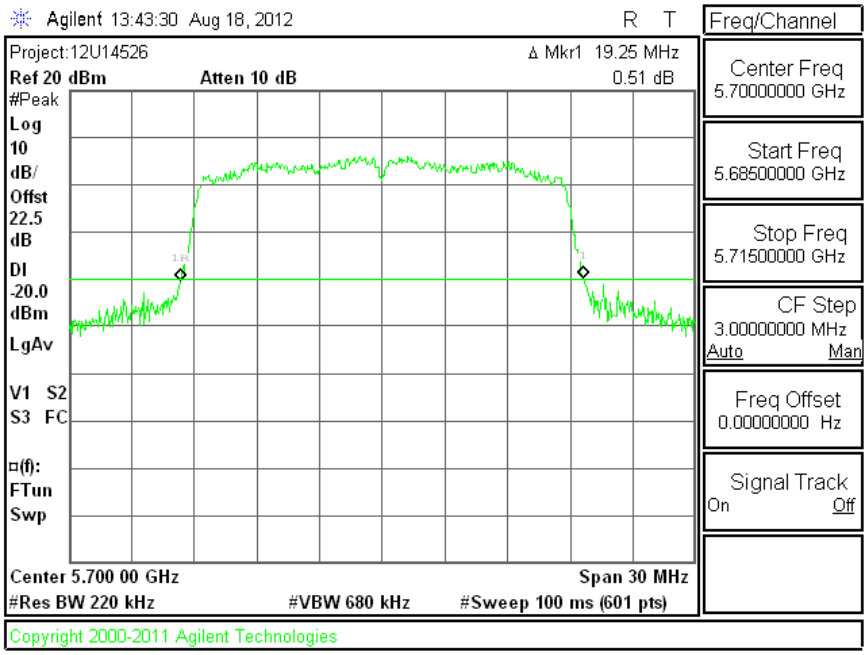


BANDWIDTH HIGH2 CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.8.2. 99% BANDWIDTH

LIMITS

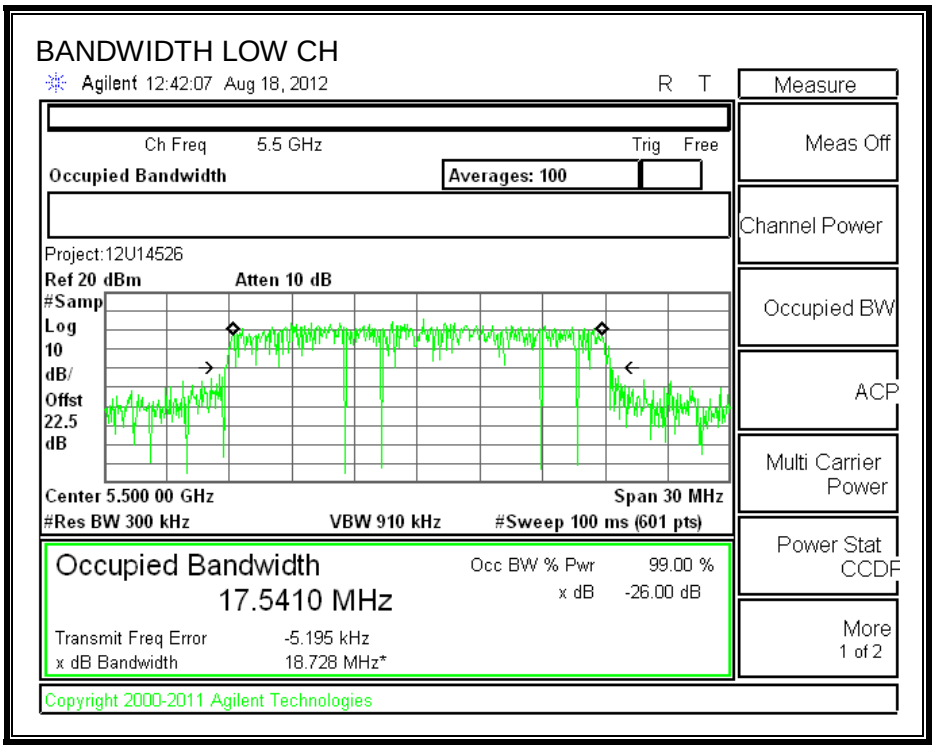
None; for reporting purposes only.

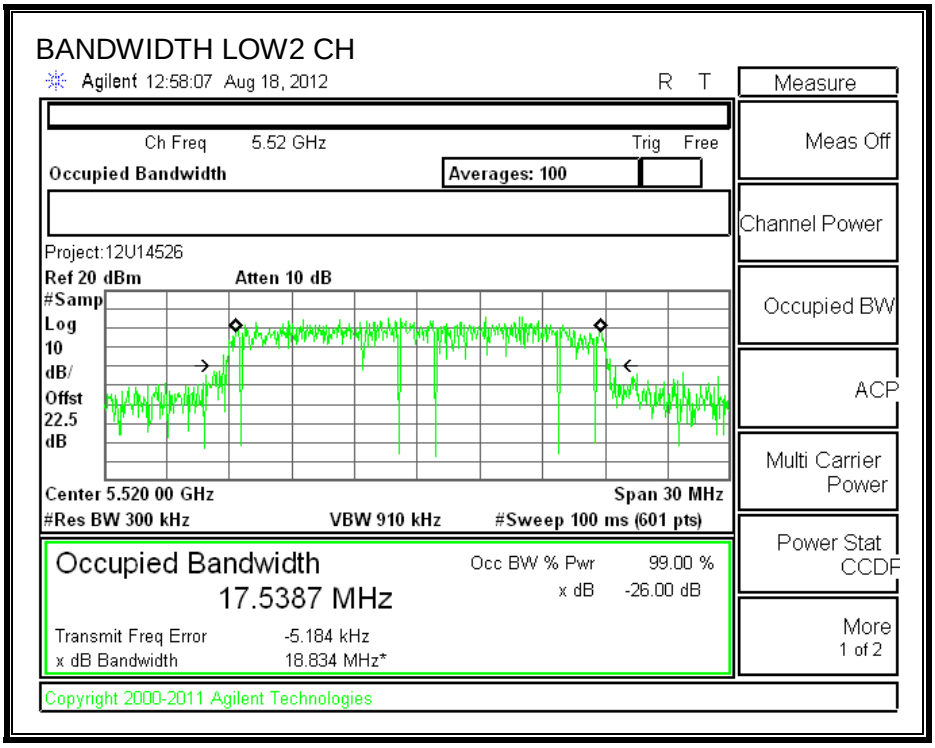
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5500	17.5410
Low2	5520	17.5387
Mid	5580	17.5274
High2	5680	17.5362
High	5700	17.5205

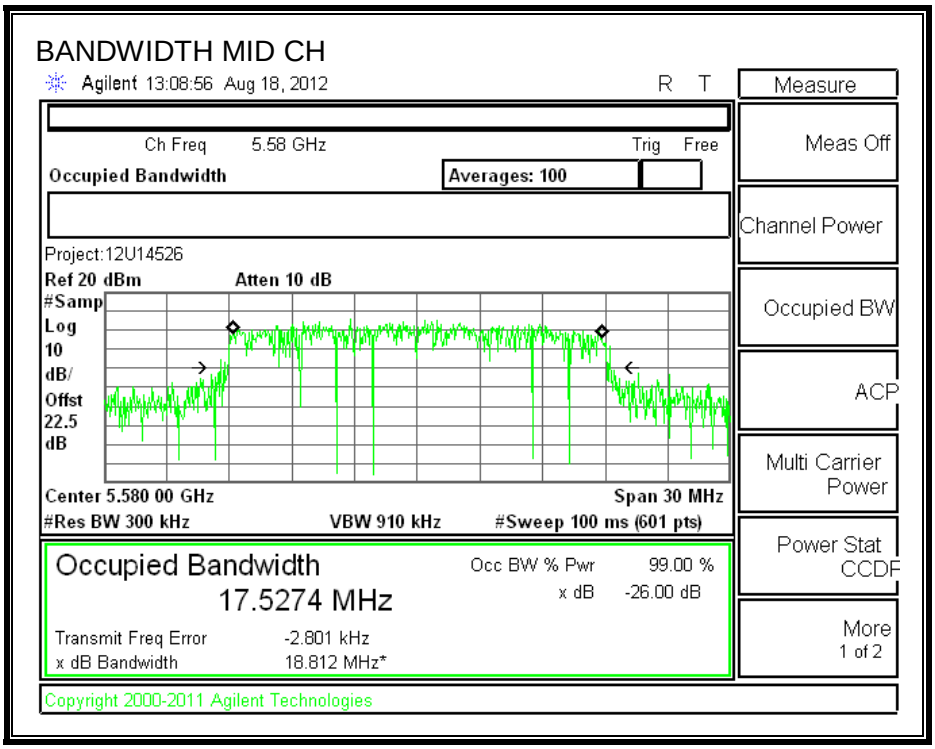
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

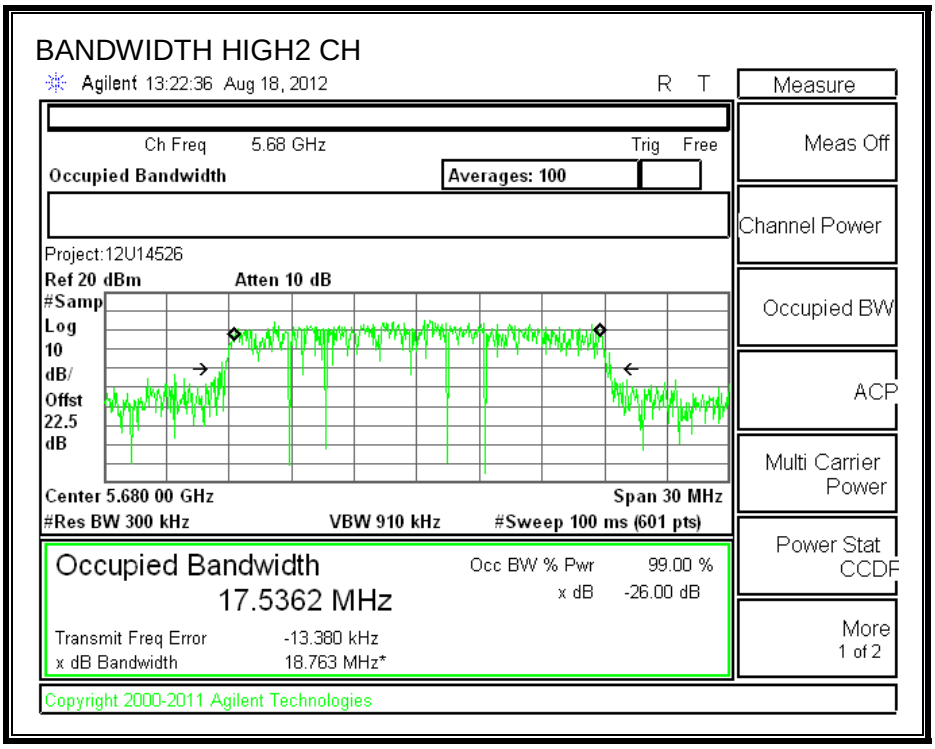
99% BANDWIDTH



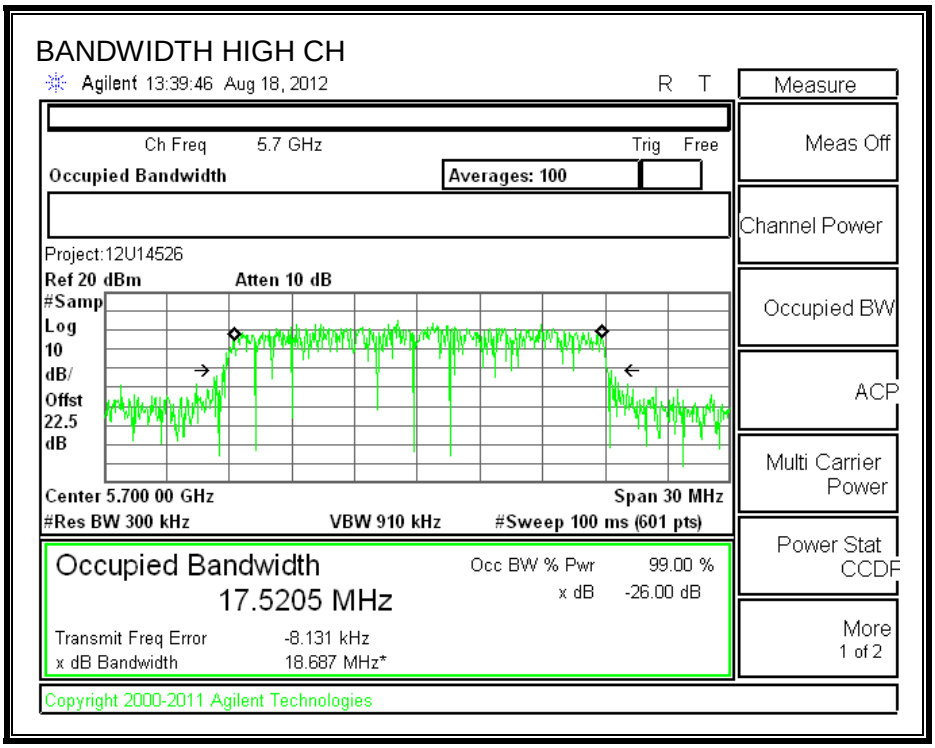


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.8.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.5 dB (including 10 dB pad and 1.5 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5500	15.48
Low2	5520	15.95
Mid	5580	15.93
High2	5680	15.97
High	5700	14.46

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.8.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5500	24	17.5410	23.44	5.42	23.44	11.00
Low2	5520	24	17.5387	23.44	5.42	23.44	11.00
Mid	5580	24	17.5274	23.44	5.42	23.44	11.00
High2	5680	24	17.5362	23.44	5.42	23.44	11.00
High	5700	24	17.5205	23.44	5.42	23.44	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5500	15.971	15.971	23.44	-7.470
Low2	5520	16.407	16.407	23.44	-7.030
Mid	5580	16.392	16.392	23.44	-7.045
High2	5680	16.421	16.421	23.44	-7.018
High	5700	15.009	15.009	23.44	-8.426

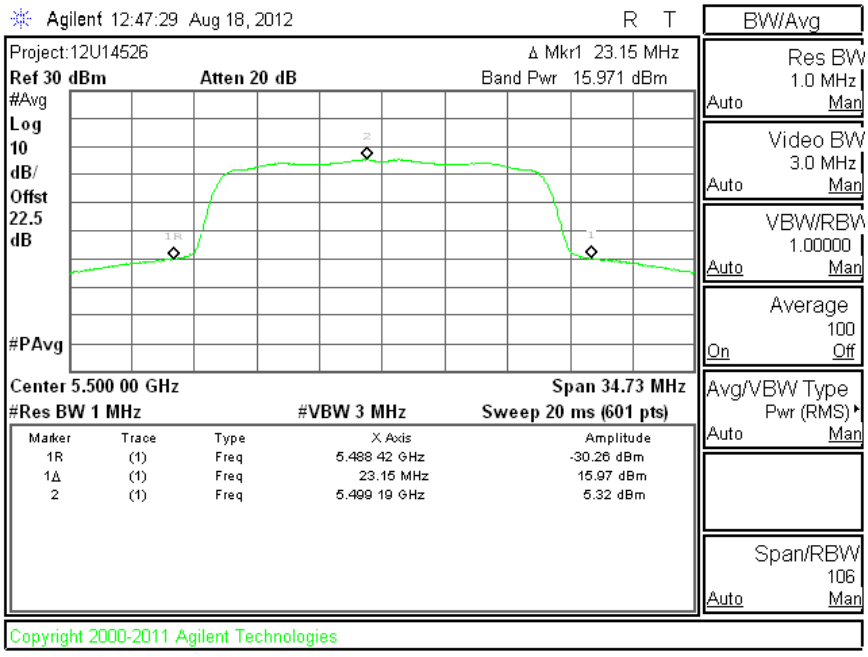
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5500	5.32	5.32	11.00	-5.68
Low2	5520	5.80	5.80	11.00	-5.20
Mid	5580	5.75	5.75	11.00	-5.25
High2	5680	5.80	5.80	11.00	-5.20
High	5700	4.34	4.34	11.00	-6.66

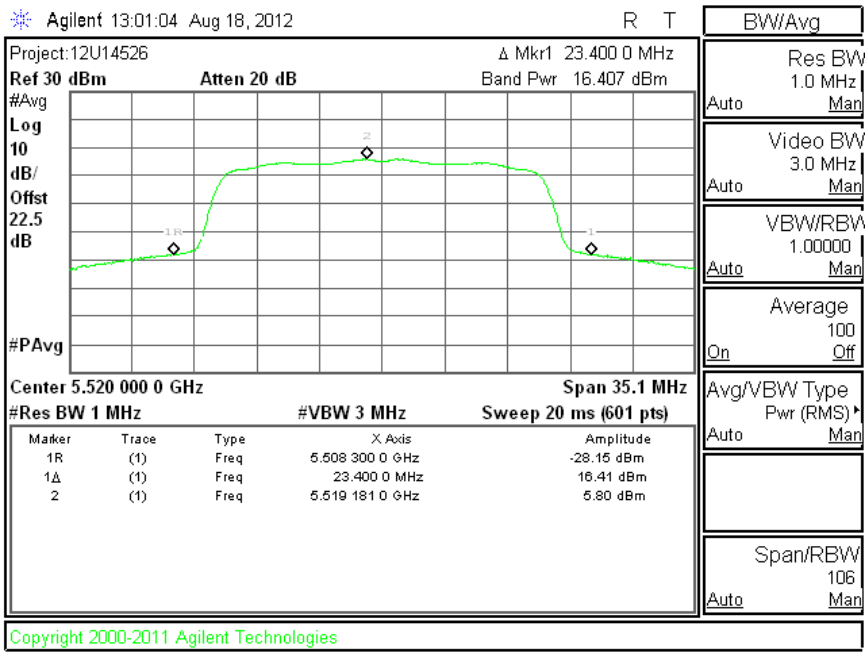
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

POWER PPSD LOW CH

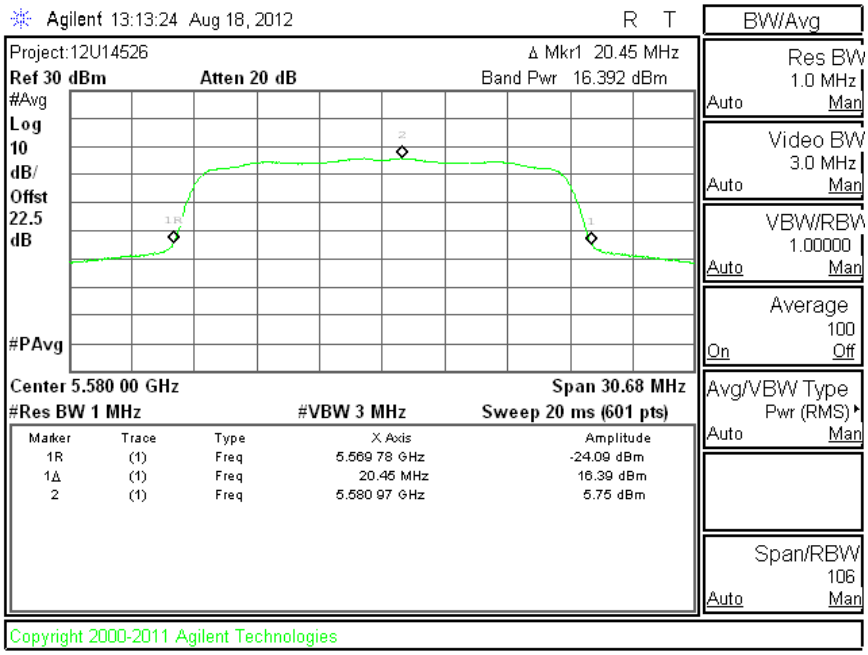


POWER PPSD LOW2 CH

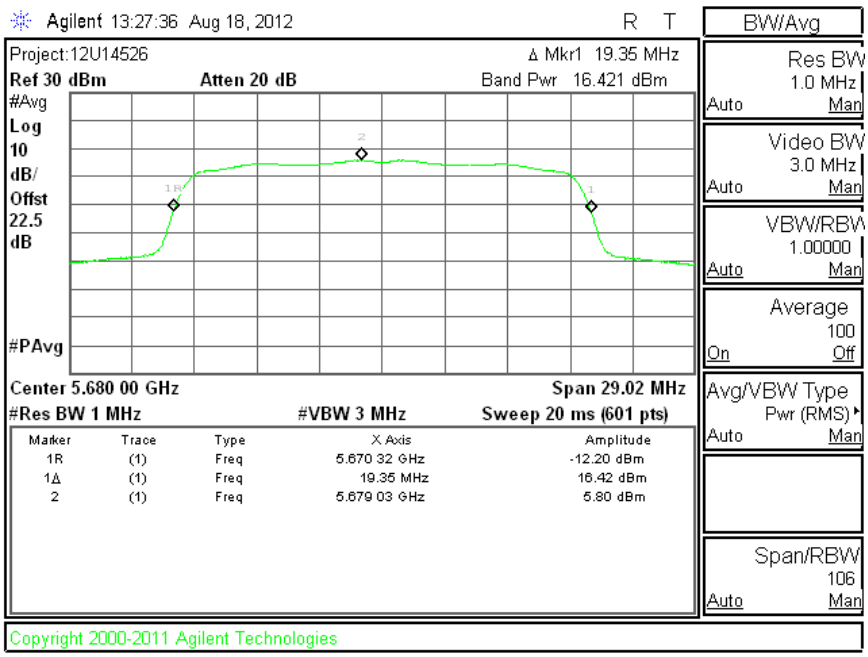


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD MID CH

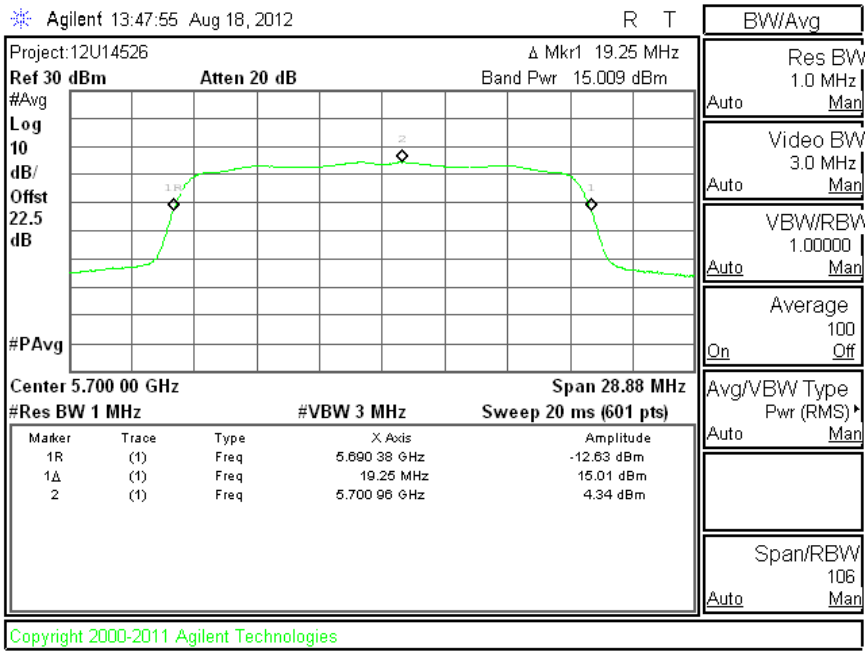


POWER PPSD HIGH2 CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

POWER PPSD HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.9. 802.11n HT40 MODE IN THE 5.6 GHz BAND

8.9.1. 26 dB BANDWIDTH

LIMITS

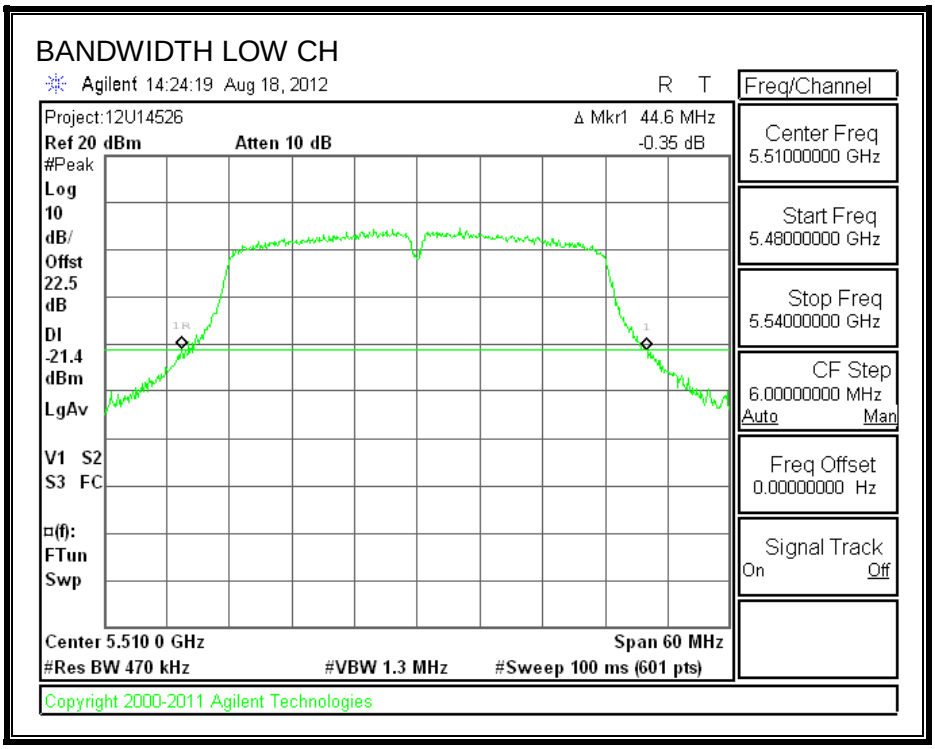
None; for reporting purposes only.

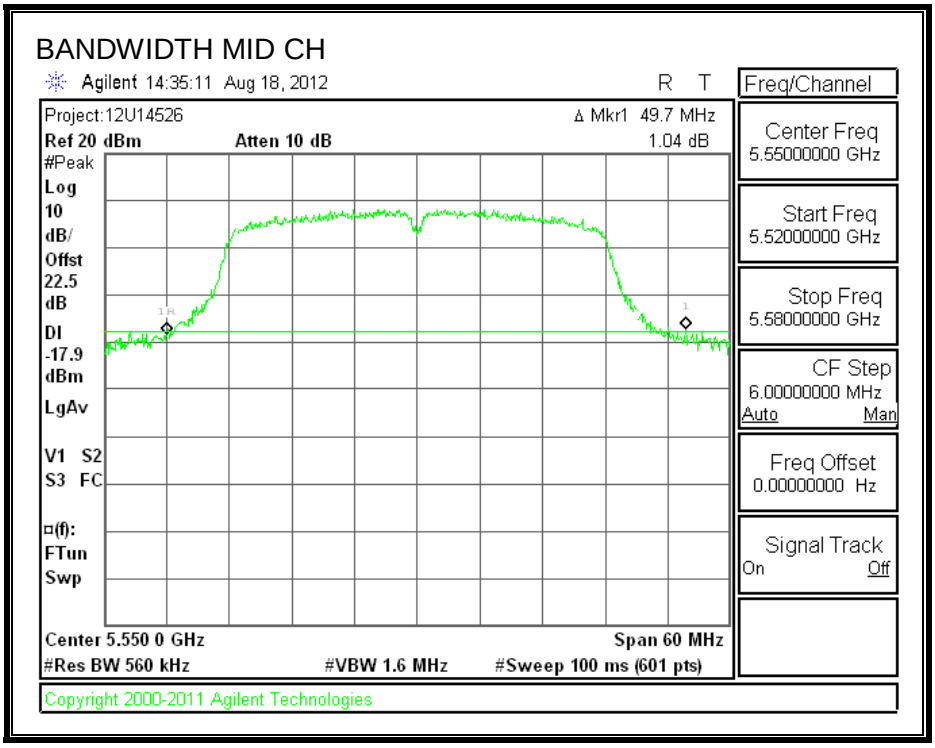
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5510	44.60
Mid	5550	49.70
High	5670	45.40

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

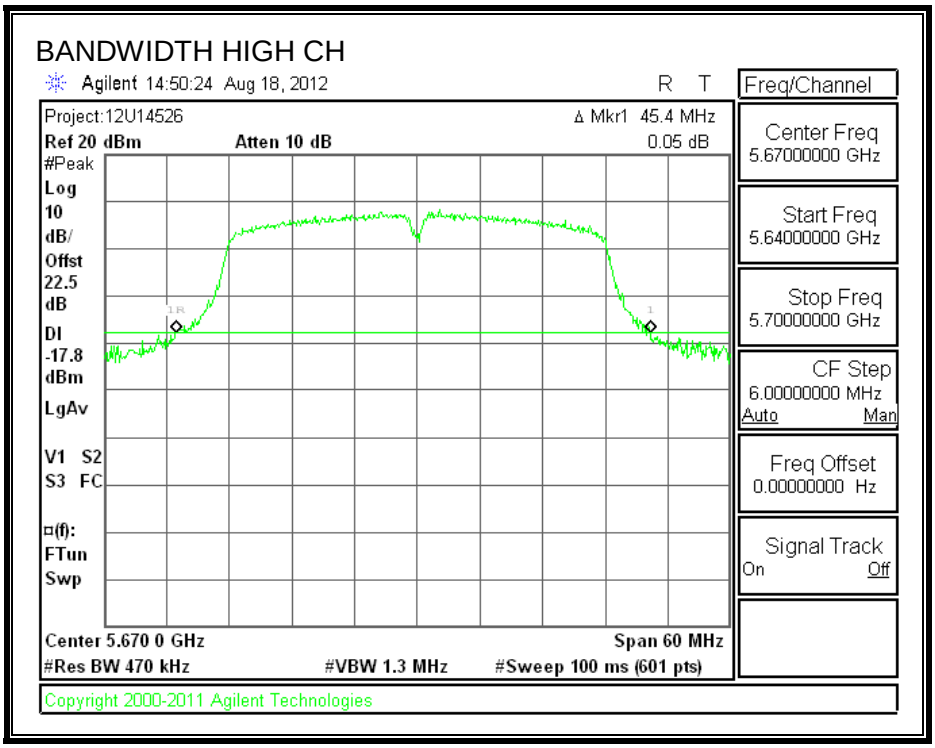
26 dB BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.9.2. 99% BANDWIDTH

LIMITS

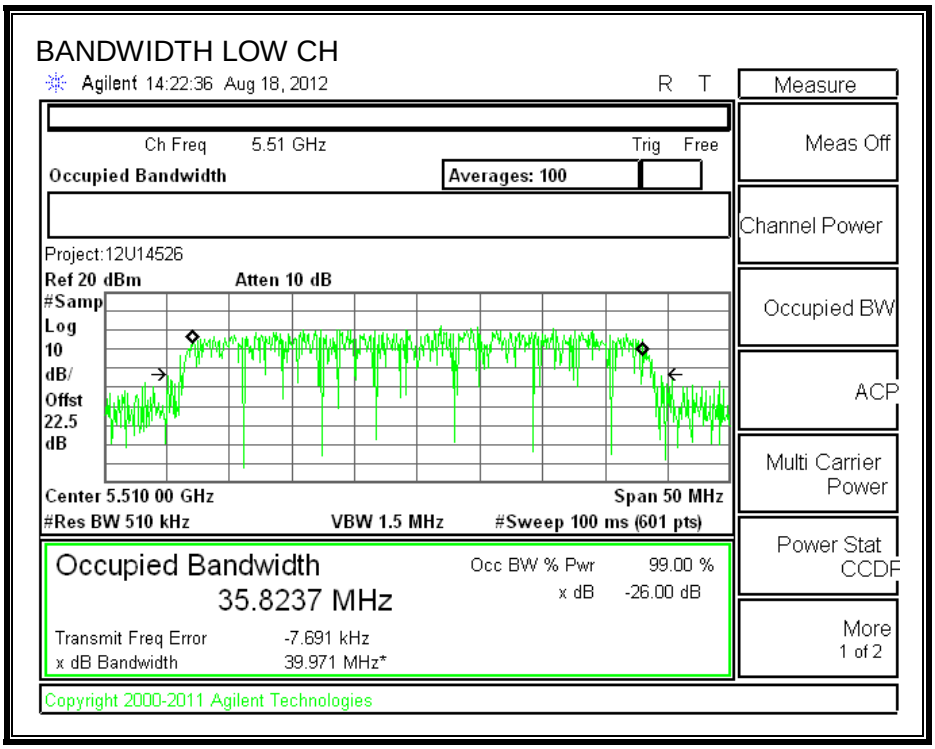
None; for reporting purposes only.

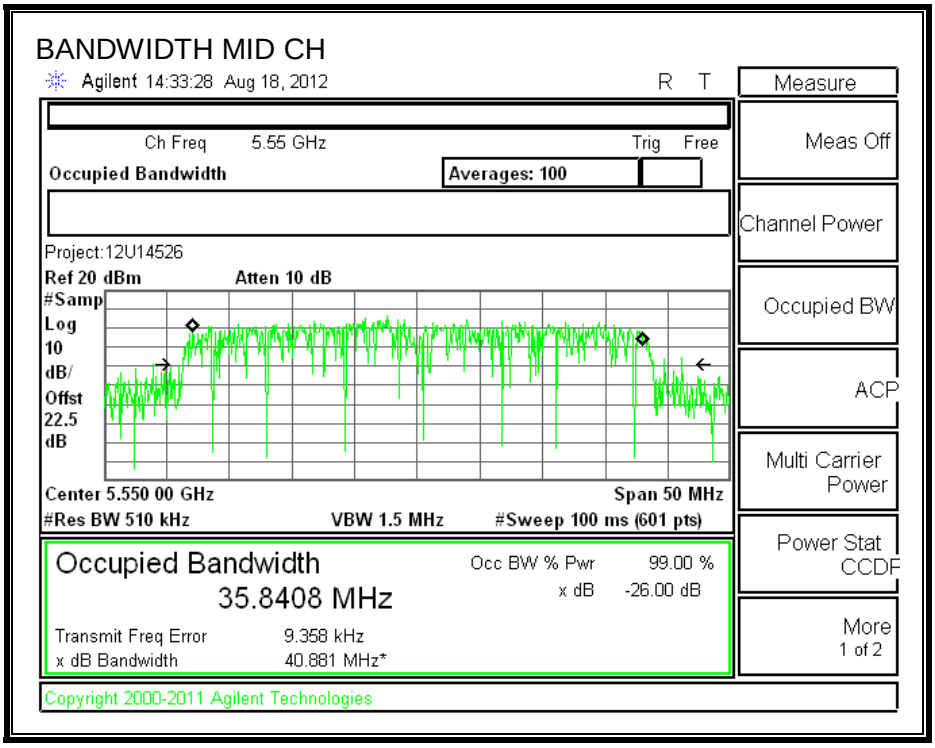
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5510	35.8237
Mid	5550	35.8408
High	5670	35.8519

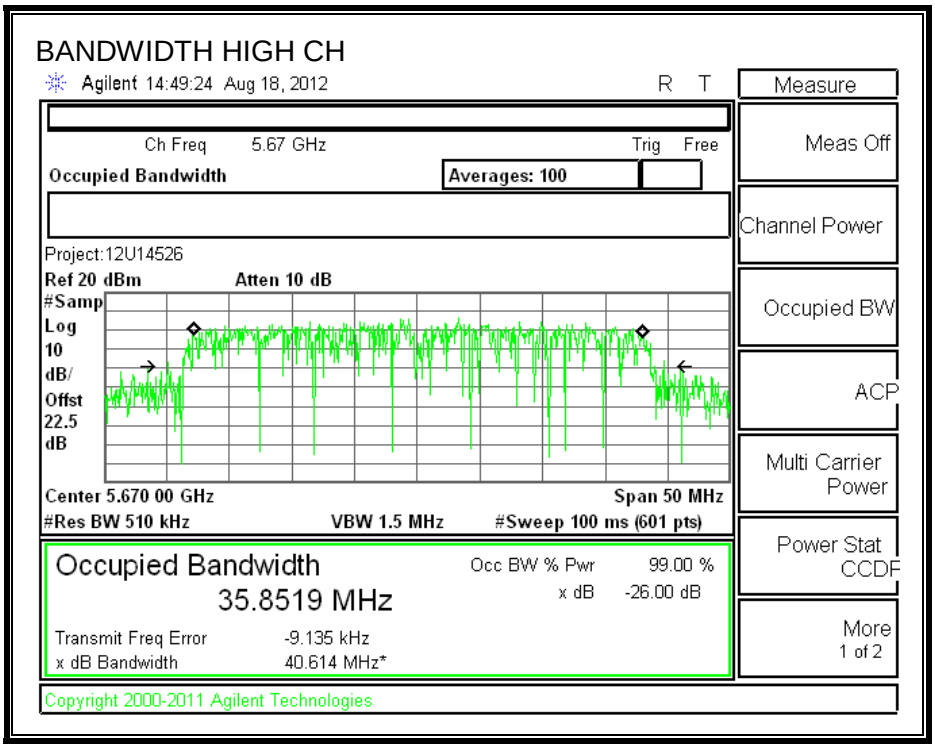
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.9.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

The cable assembly insertion loss of 11.5 dB (including 10 dB pad and 1.5 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

RESULTS

Channel	Frequency (MHz)	Power (dBm)
Low	5510	12.47
Mid	5550	15.99
High	5670	15.96

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.9.4. OUTPUT POWER AND PPSD

LIMITS

FCC §15.407 (a) (2)

For the band 5.47–5.725 GHz, the maximum conducted output power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10 log B, where B is the 26–dB emission bandwidth in MHz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1–MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the peak 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.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

Limits

Channel	Frequency (MHz)	Fixed Limit (dBm)	B (MHz)	11 + 10 Log B Limit (dBm)	Directional Gain (dBi)	Power Limit (dBm)	PPSD Limit (dBm)
Low	5510	24	35.8237	26.54	5.42	24.00	11.00
Mid	5550	24	35.8408	26.54	5.42	24.00	11.00
High	5670	24	35.8519	26.55	5.42	24.00	11.00

Output Power Results

Channel	Frequency (MHz)	Meas Power (dBm)	Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5510	13.042	13.042	24.00	-10.958
Mid	5550	16.325	16.325	24.00	-7.675
High	5670	16.491	16.491	24.00	-7.509

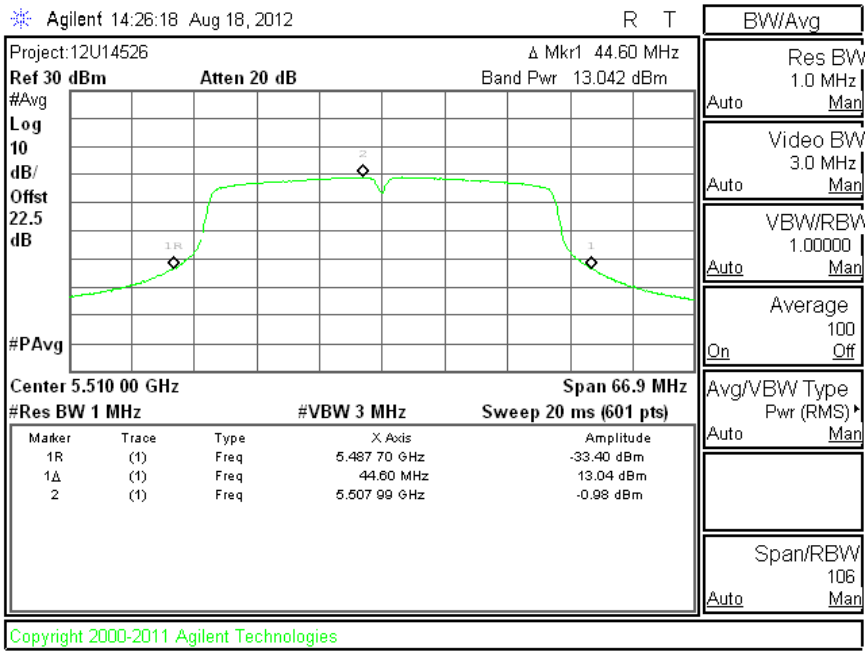
PPSD Results

Channel	Frequency (MHz)	Meas PPSD (dBm)	Corr'd PPSD (dBm)	PPSD Limit (dBm)	PPSD Margin (dB)
Low	5510	-0.98	-0.98	11.00	-11.98
Mid	5550	2.27	2.27	11.00	-8.73
High	5670	2.48	2.48	11.00	-8.52

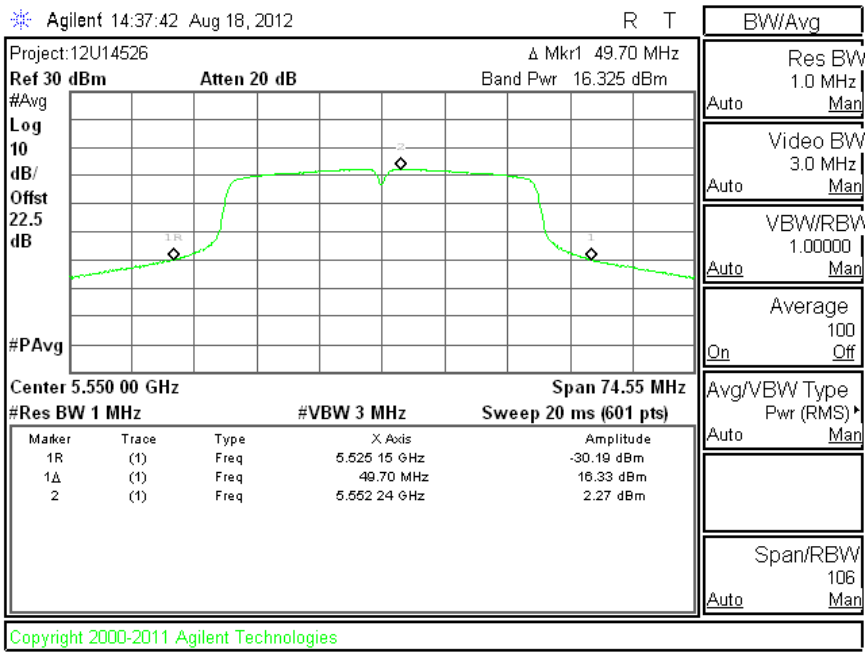
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OUTPUT POWER AND PPSD

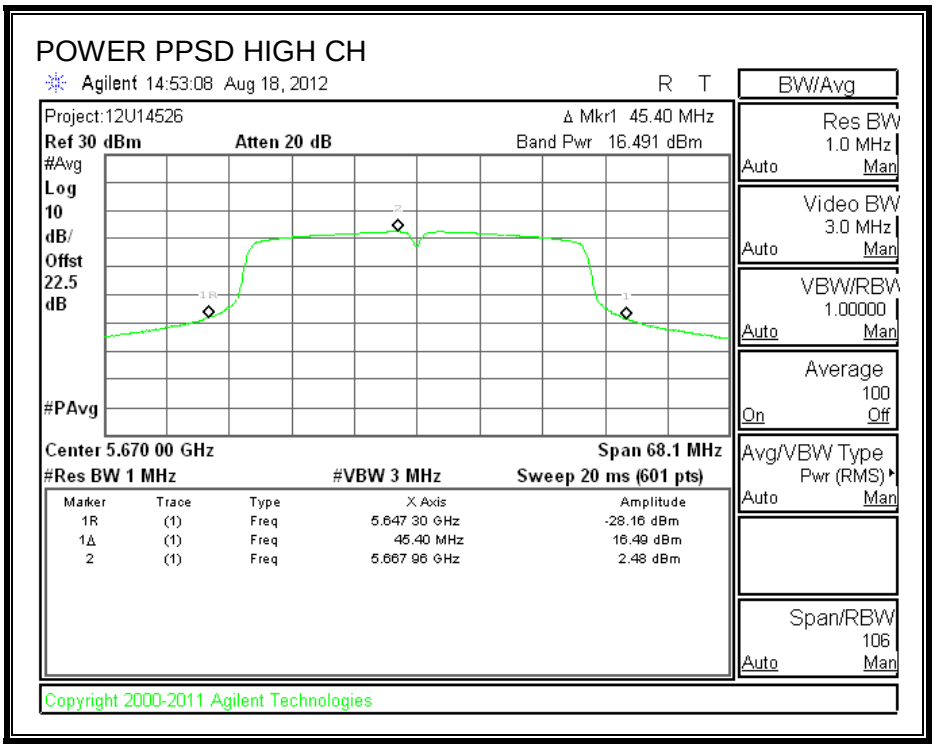
POWER PPSD LOW CH



POWER PPSD MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9. RADIATED TEST RESULTS

9.1. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 1 MHz for peak measurements and as applicable for average measurements.

The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

TEST RESULT

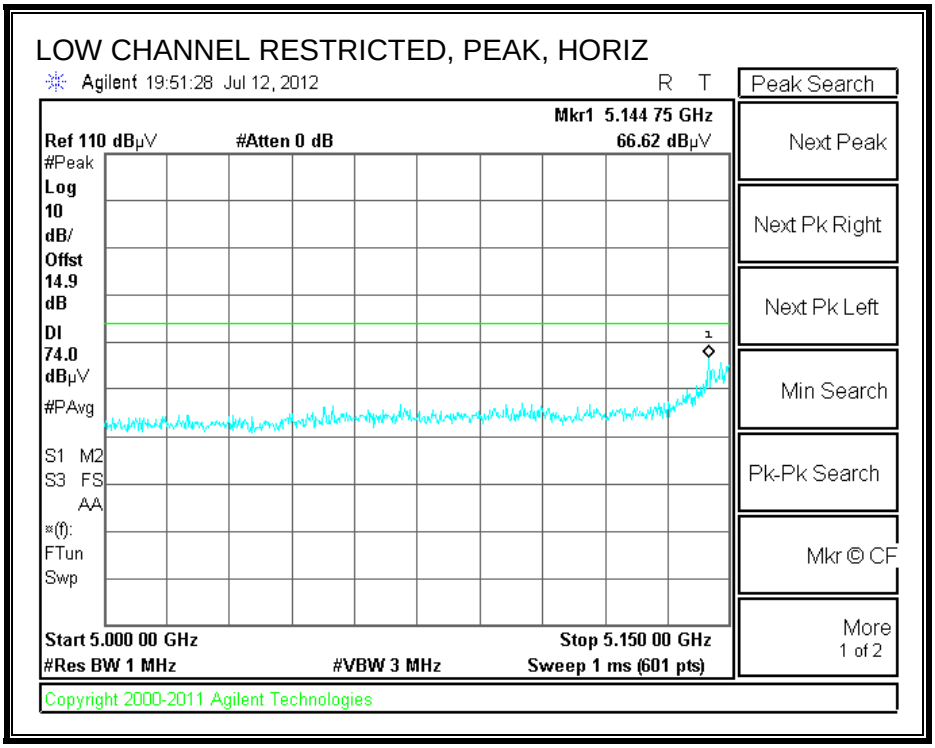
No other spurious emissions were found above 18G.

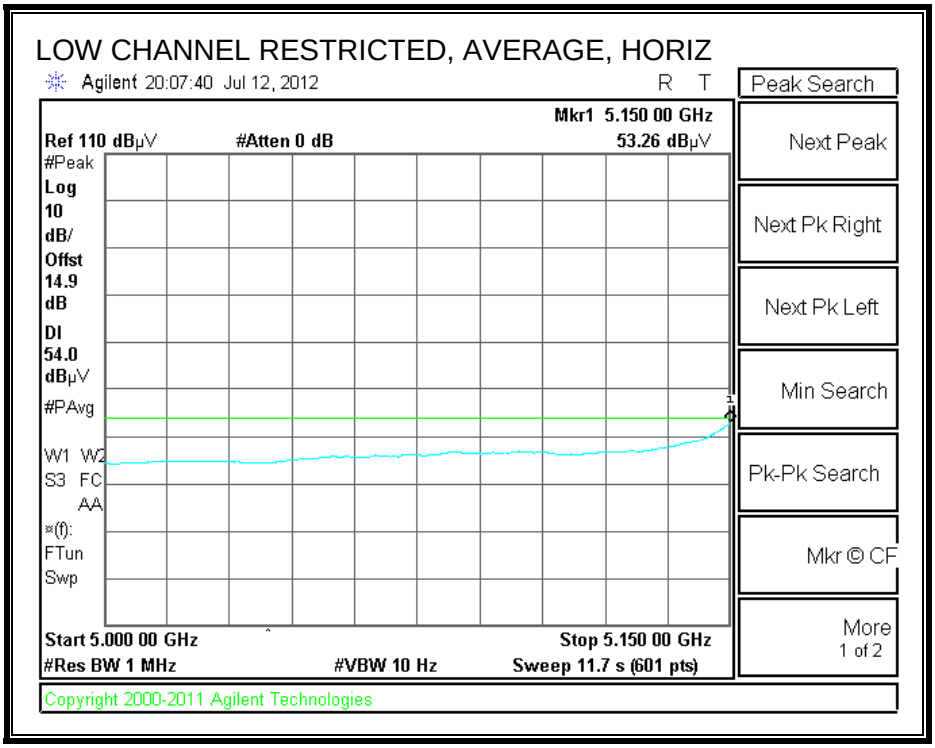
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2. TRANSMITTER ABOVE 1 GHz

9.2.1. TX ABOVE 1 GHz 802.11a MODE IN THE 5.2 GHz BAND

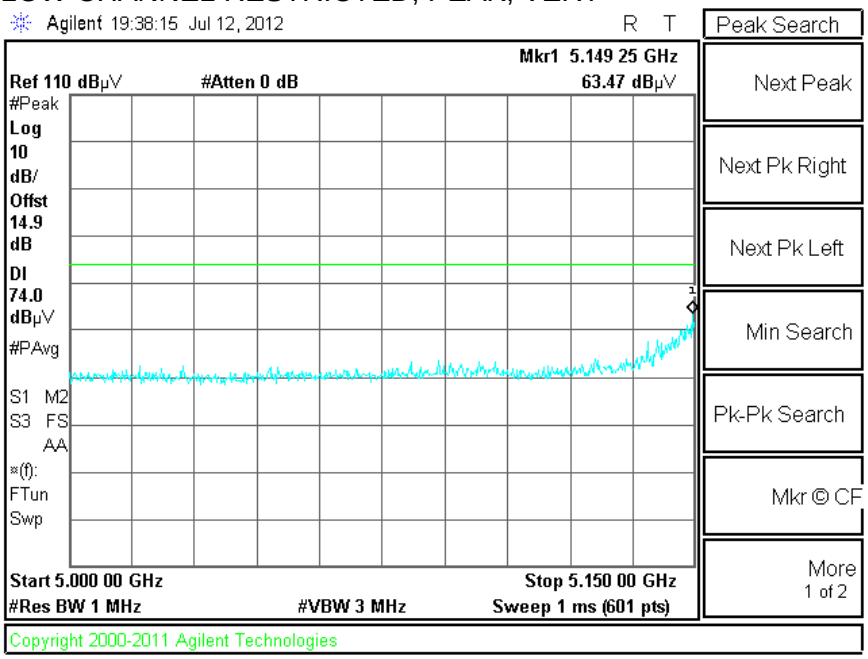
RESTRICTED BANDEDGE (LOW CHANNEL)



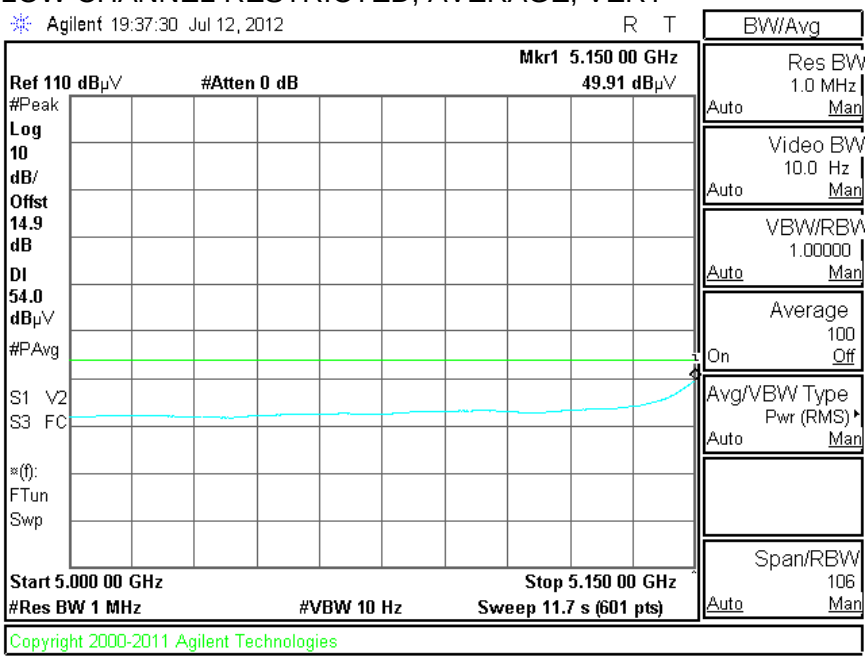


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: a mode, 5.2GHz (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

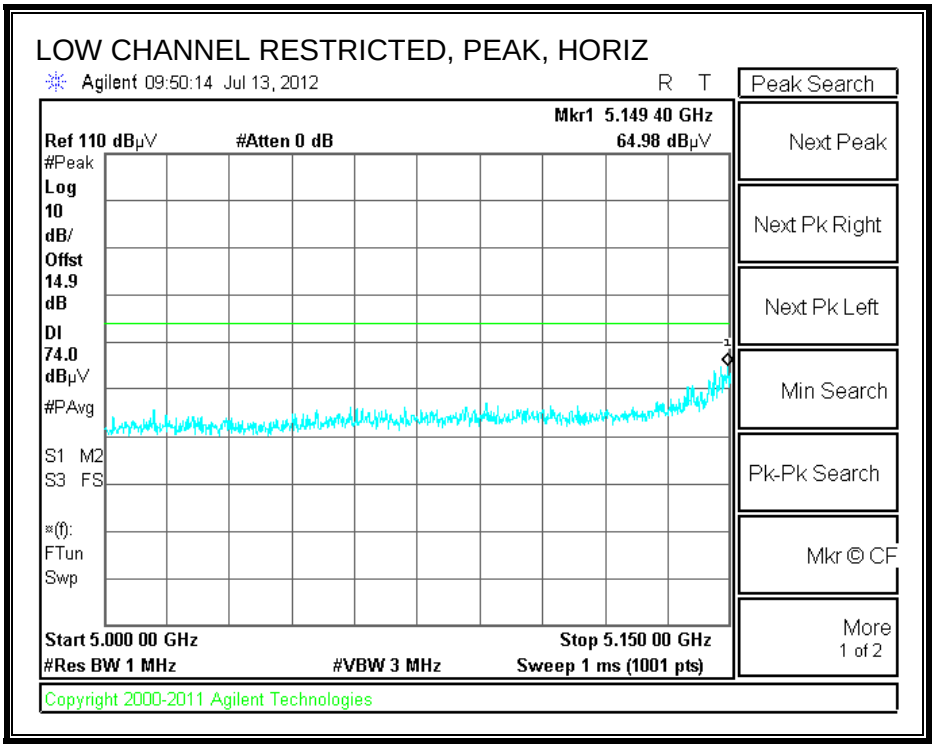
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5180MHz													
15.540	3.0	34.3	39.0	12.5	-34.0	0.0	0.0	51.8	74.0	-22.2	V	P	
15.540	3.0	22.4	39.0	12.5	-34.0	0.0	0.0	39.8	54.0	-14.2	V	A	
15.540	3.0	34.7	39.0	12.5	-34.0	0.0	0.0	52.2	74.0	-21.8	H	P	
15.540	3.0	22.8	39.0	12.5	-34.0	0.0	0.0	40.3	54.0	-13.7	H	A	
Mid Ch, 5200MHz													
15.600	3.0	34.5	38.8	12.5	-34.0	0.0	0.0	51.8	74.0	-22.2	V	P	
15.600	3.0	22.3	38.8	12.5	-34.0	0.0	0.0	39.7	54.0	-14.3	V	A	
15.600	3.0	35.0	38.8	12.5	-34.0	0.0	0.0	52.3	74.0	-21.7	H	P	
15.600	3.0	22.3	38.8	12.5	-34.0	0.0	0.0	39.7	54.0	-14.3	H	A	
High Ch, 5240mhZ													
15.720	3.0	33.5	38.4	12.6	-34.0	0.0	0.0	50.6	74.0	-23.4	V	P	
15.720	3.0	22.0	38.4	12.6	-34.0	0.0	0.0	39.0	54.0	-15.0	V	A	
15.720	3.0	34.0	38.4	12.6	-34.0	0.0	0.0	51.0	74.0	-23.0	H	P	
15.720	3.0	22.0	38.4	12.6	-34.0	0.0	0.0	39.0	54.0	-15.0	H	A	

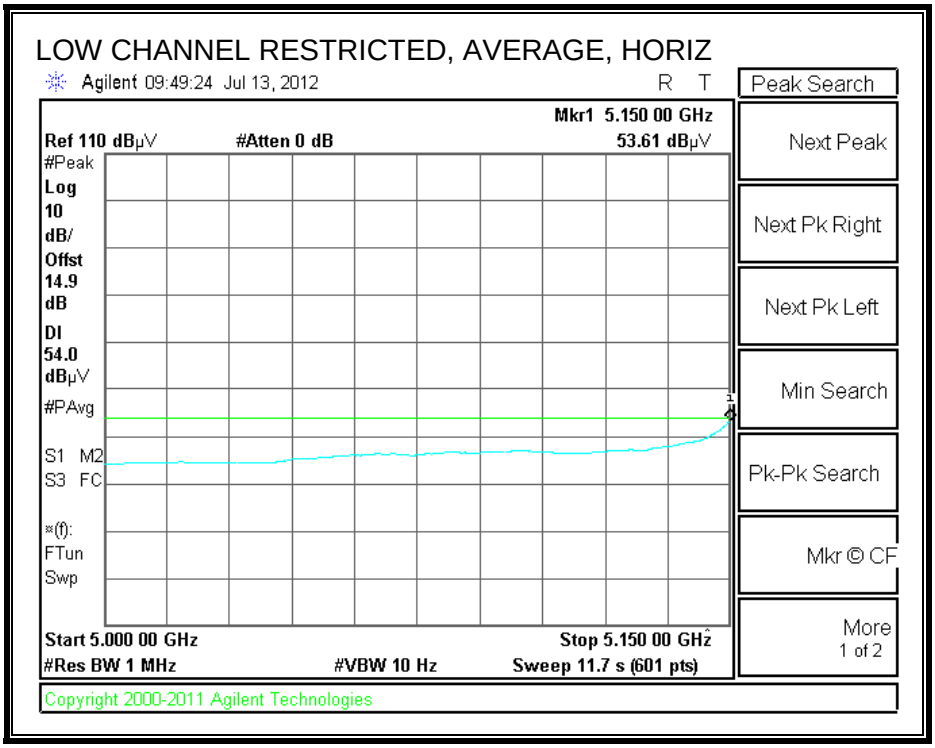
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.2. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.2 GHz BAND

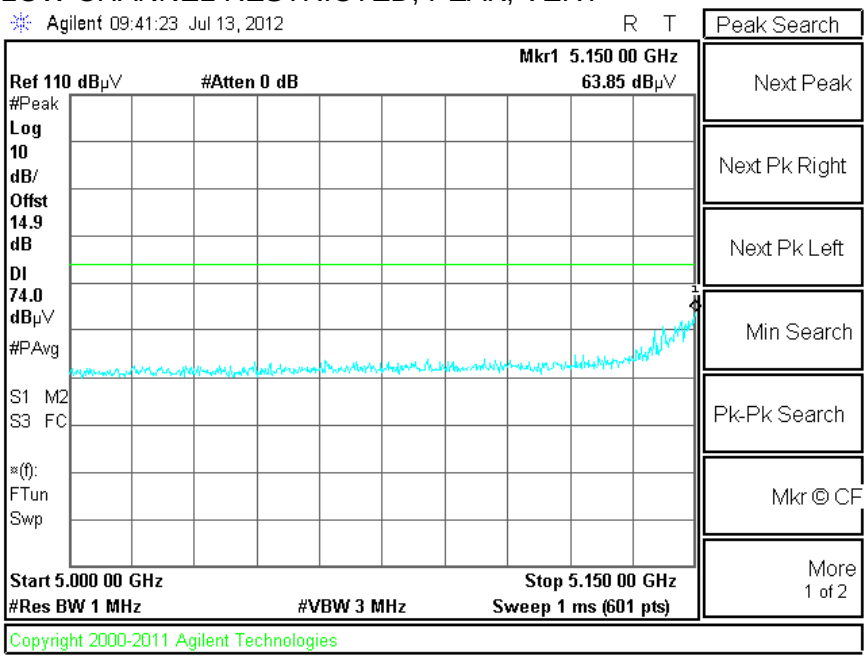
RESTRICTED BANDEDGE (LOW CHANNEL)



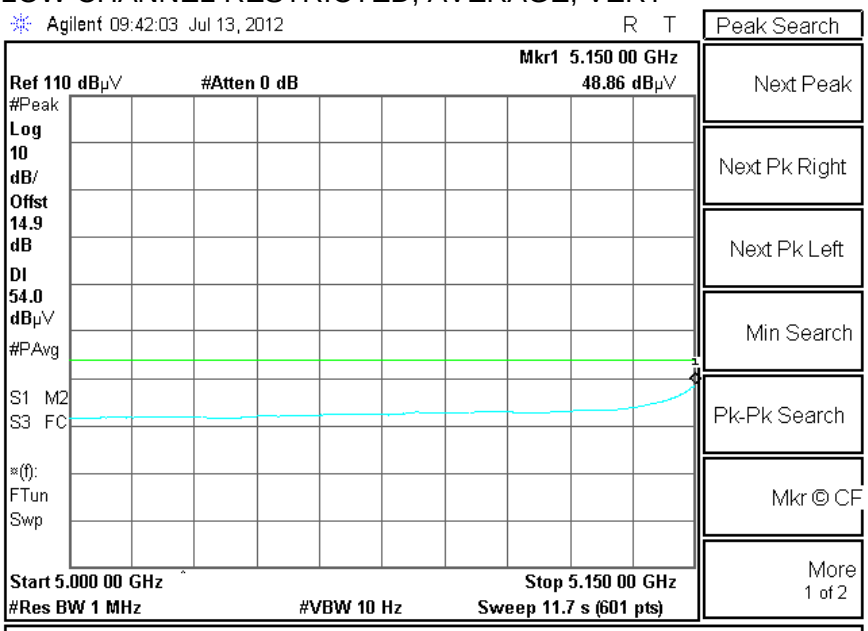


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: HT20, 5.2GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

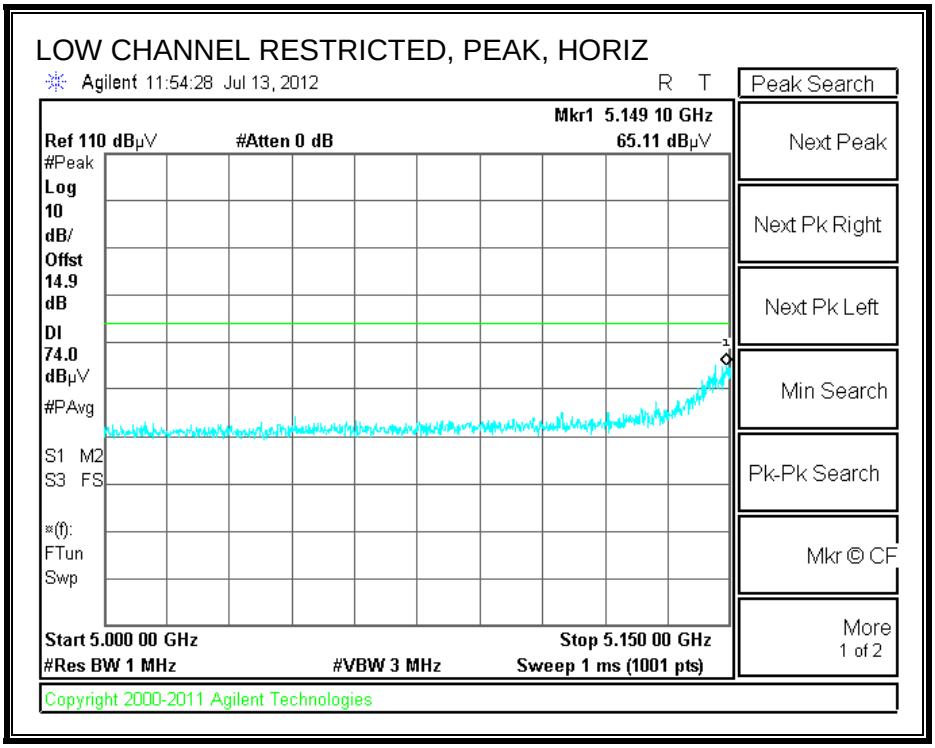
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5180MHz													
15.540	3.0	35.0	39.0	12.5	-34.0	0.0	0.0	52.4	74.0	-21.6	V	P	
15.540	3.0	22.4	39.0	12.5	-34.0	0.0	0.0	39.9	54.0	-14.1	V	A	
15.540	3.0	34.6	39.0	12.5	-34.0	0.0	0.0	52.1	74.0	-21.9	H	P	
15.540	3.0	22.4	39.0	12.5	-34.0	0.0	0.0	39.9	54.0	-14.1	H	A	
Mid Ch, 5200MHz													
15.600	3.0	34.9	38.8	12.5	-34.0	0.0	0.0	52.2	74.0	-21.8	V	P	
15.600	3.0	22.4	38.8	12.5	-34.0	0.0	0.0	39.7	54.0	-14.3	V	A	
15.600	3.0	34.7	38.8	12.5	-34.0	0.0	0.0	52.0	74.0	-22.0	H	P	
15.600	3.0	22.4	38.8	12.5	-34.0	0.0	0.0	39.7	54.0	-14.3	H	A	
High Ch, 5240MHz													
15.720	3.0	34.7	38.4	12.6	-34.0	0.0	0.0	51.8	74.0	-22.2	V	P	
15.720	3.0	22.0	38.4	12.6	-34.0	0.0	0.0	39.0	54.0	-15.0	V	A	
15.720	3.0	34.2	38.4	12.6	-34.0	0.0	0.0	51.2	74.0	-22.8	H	P	
15.720	3.0	22.0	38.4	12.6	-34.0	0.0	0.0	39.0	54.0	-15.0	H	A	

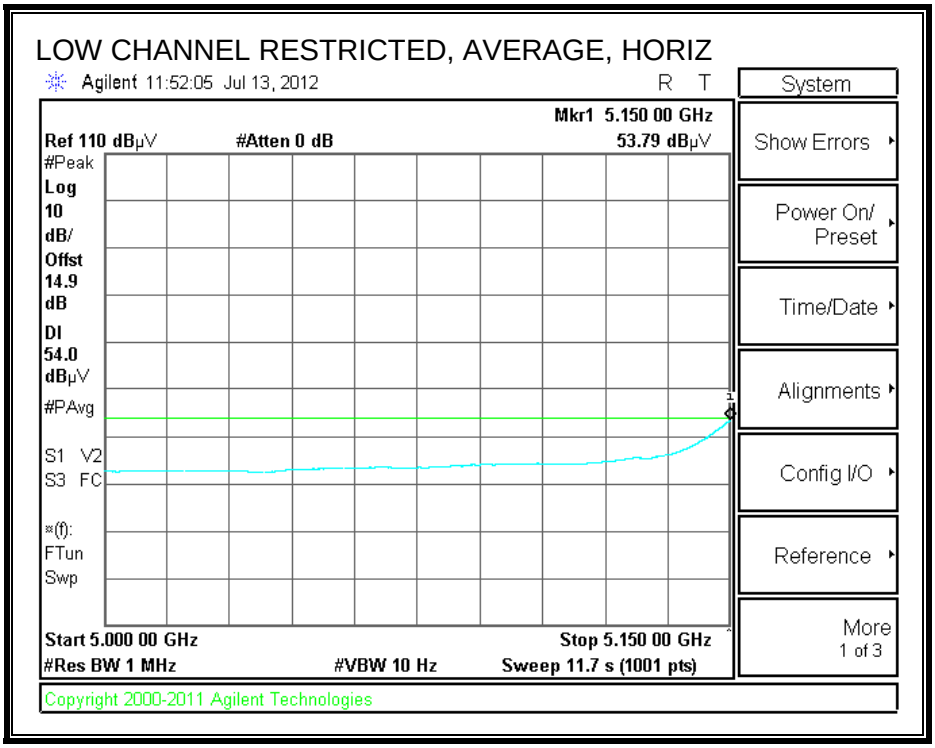
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.3. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.2 GHz BAND

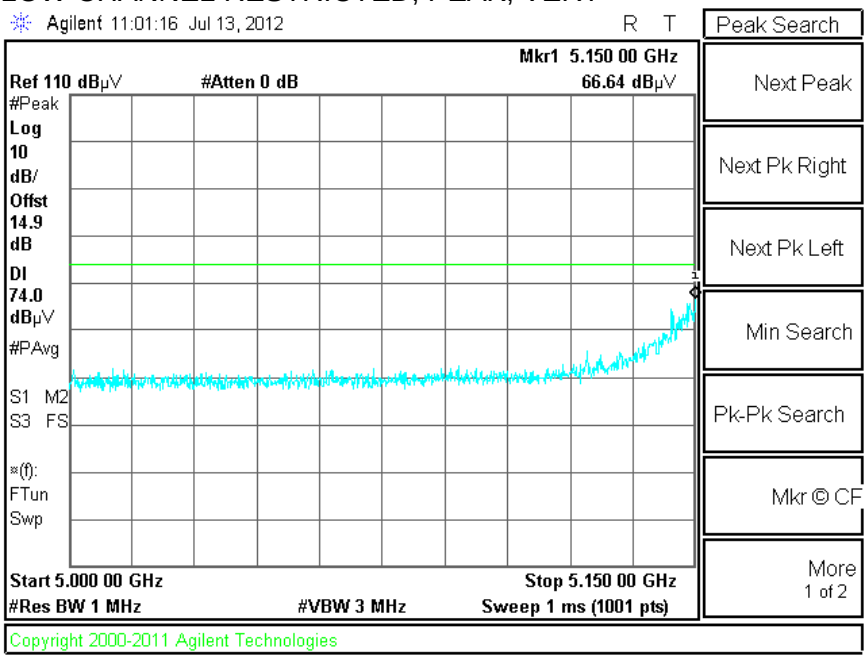
RESTRICTED BANDEDGE (LOW CHANNEL)



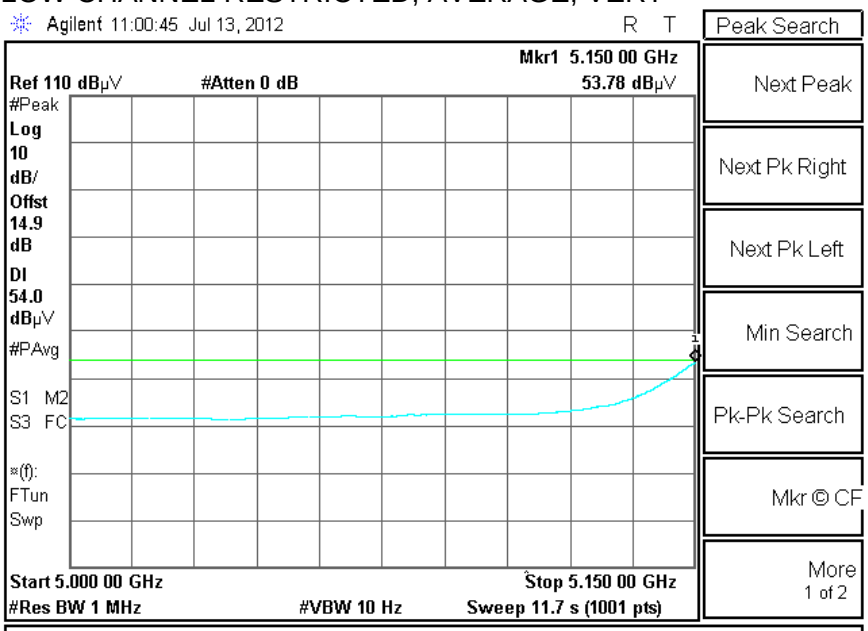


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: HT40, 5.2GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

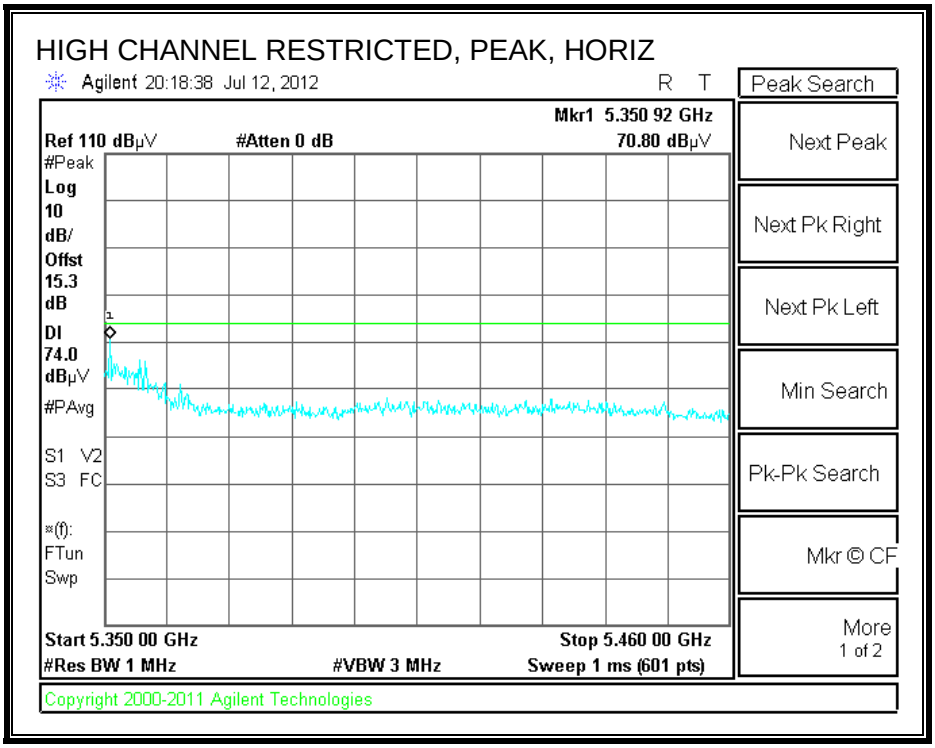
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5190MHz													
15.570	3.0	35.3	38.9	12.5	-34.0	0.0	0.0	52.7	74.0	-21.3	H	P	
15.570	3.0	22.5	38.9	12.5	-34.0	0.0	0.0	39.9	54.0	-14.1	H	A	
15.570	3.0	35.2	38.9	12.5	-34.0	0.0	0.0	52.6	74.0	-21.4	V	P	
15.570	3.0	22.4	38.9	12.5	-34.0	0.0	0.0	39.9	54.0	-14.1	V	A	
High Ch, 5230MHz													
15.690	3.0	34.3	38.5	12.6	-34.0	0.0	0.0	51.4	74.0	-22.6	H	P	
15.690	3.0	22.3	38.5	12.6	-34.0	0.0	0.0	39.4	54.0	-14.6	H	A	
15.690	3.0	34.6	38.5	12.6	-34.0	0.0	0.0	51.7	74.0	-22.3	V	P	
15.690	3.0	22.2	38.5	12.6	-34.0	0.0	0.0	39.3	54.0	-14.7	V	A	

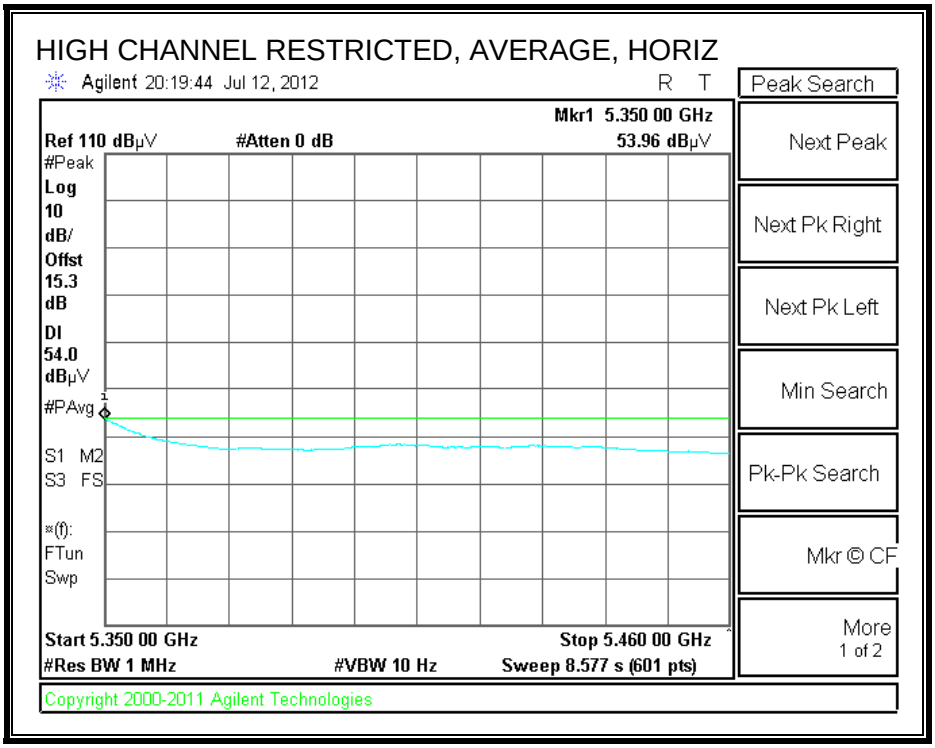
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.4. TX ABOVE 1 GHz 802.11a MODE IN THE 5.3 GHz BAND

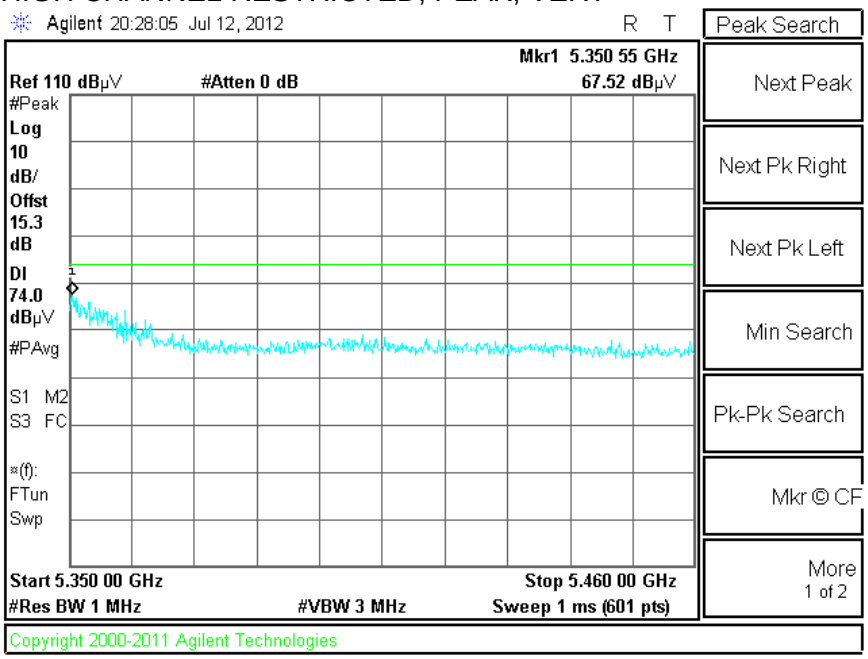
RESTRICTED BANDEDGE (HIGH CHANNEL)



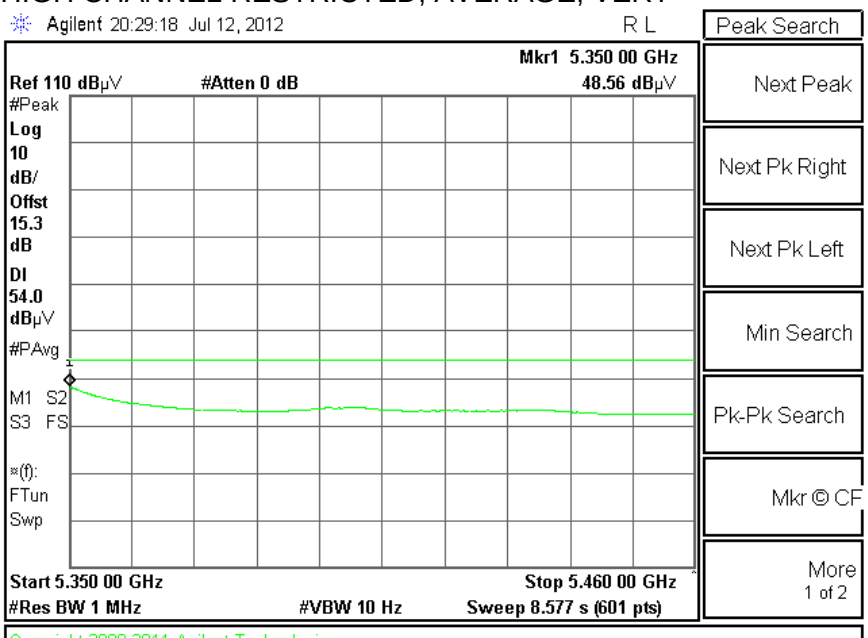


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: a mode 5.3GHz TX(Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

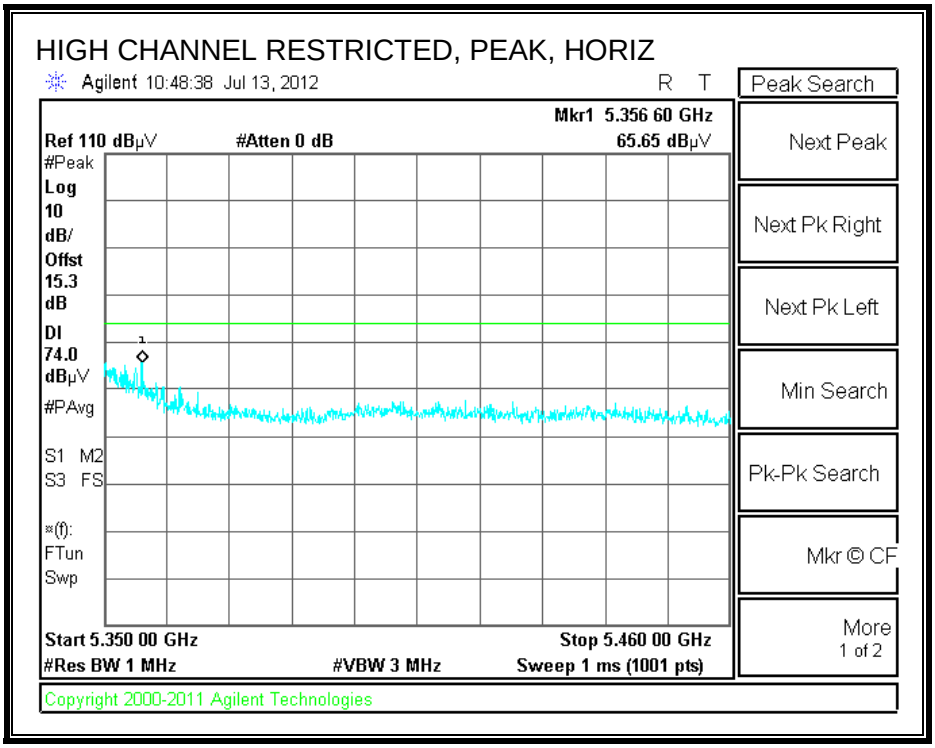
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5260MHz													
15.780	3.0	34.3	38.2	12.6	-33.9	0.0	0.0	51.2	74.0	-22.8	V	P	
15.780	3.0	22.2	38.2	12.6	-33.9	0.0	0.0	39.1	54.0	-14.9	V	A	
15.780	3.0	34.1	38.2	12.6	-33.9	0.0	0.0	51.0	74.0	-23.0	H	P	
15.780	3.0	22.1	38.2	12.6	-33.9	0.0	0.0	39.0	54.0	-15.0	H	A	
Mid Ch, 5300MHz													
10.600	3.0	36.6	38.3	9.7	-35.7	0.0	0.0	48.8	74.0	-25.2	V	P	
10.600	3.0	24.5	38.3	9.7	-35.7	0.0	0.0	36.7	54.0	-17.3	V	A	
15.900	3.0	34.3	37.8	12.7	-33.9	0.0	0.0	50.8	74.0	-23.2	V	P	
15.900	3.0	22.3	37.8	12.7	-33.9	0.0	0.0	38.9	54.0	-15.1	V	A	
10.600	3.0	34.2	38.3	9.7	-35.7	0.0	0.0	46.4	74.0	-27.6	H	P	
10.600	3.0	21.9	38.3	9.7	-35.7	0.0	0.0	34.0	54.0	-20.0	H	A	
15.900	3.0	34.0	37.8	12.7	-33.9	0.0	0.0	50.6	74.0	-23.4	H	P	
15.900	3.0	22.3	37.8	12.7	-33.9	0.0	0.0	38.8	54.0	-15.2	H	A	
High Ch, 5320MHz													
10.640	3.0	35.1	38.3	9.7	-35.7	0.0	0.0	47.3	74.0	-26.7	V	P	
10.640	3.0	22.8	38.3	9.7	-35.7	0.0	0.0	35.0	54.0	-19.0	V	A	
15.960	3.0	34.9	37.6	12.7	-33.9	0.0	0.0	51.3	74.0	-22.7	V	P	
15.960	3.0	22.4	37.6	12.7	-33.9	0.0	0.0	38.8	54.0	-15.2	V	A	
10.640	3.0	34.0	38.3	9.7	-35.7	0.0	0.0	46.3	74.0	-27.7	H	P	
10.640	3.0	21.9	38.3	9.7	-35.7	0.0	0.0	34.2	54.0	-19.8	H	A	
15.960	3.0	34.4	37.6	12.7	-33.9	0.0	0.0	50.9	74.0	-23.1	H	P	
15.960	3.0	22.3	37.6	12.7	-33.9	0.0	0.0	38.7	54.0	-15.3	H	A	

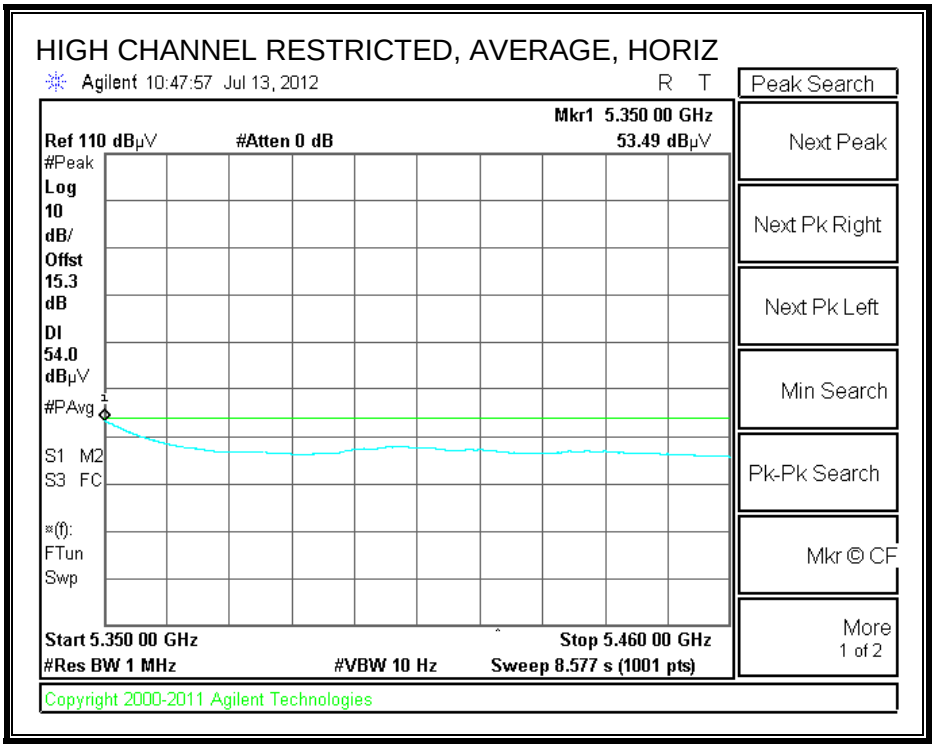
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.5. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.3 GHz BAND

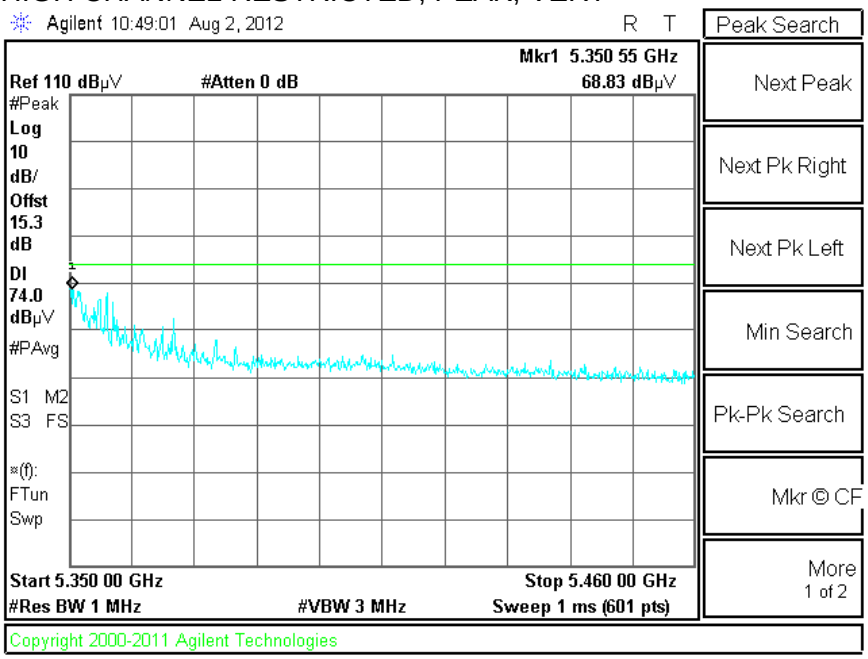
RESTRICTED BANDEDGE (HIGH CHANNEL)



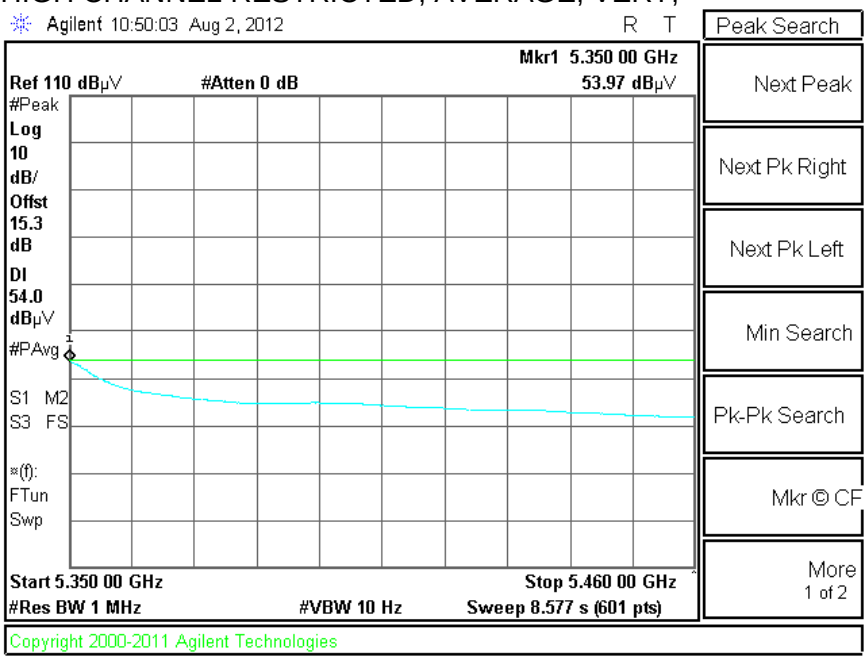


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT,



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC15.407
Mode Oper: HT20, 5.3GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

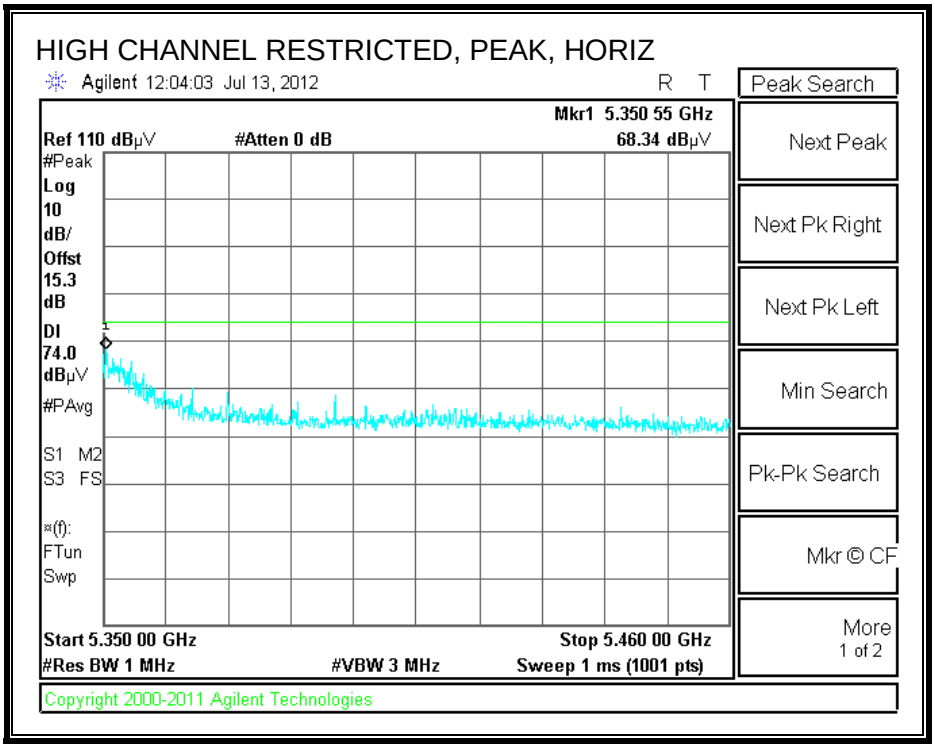
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5260MHz													
15.780	3.0	34.6	38.2	12.6	-33.9	0.0	0.0	51.5	74.0	-22.5	V	P	
15.780	3.0	22.1	38.2	12.6	-33.9	0.0	0.0	39.0	54.0	-15.0	V	A	
15.780	3.0	35.2	38.2	12.6	-33.9	0.0	0.0	52.0	74.0	-22.0	H	P	
15.780	3.0	22.1	38.2	12.6	-33.9	0.0	0.0	38.9	54.0	-15.1	H	A	
Mid Ch, 5300MHz													
10.600	3.0	37.1	38.3	9.7	-35.7	0.0	0.0	49.3	74.0	-24.7	V	P	
10.600	3.0	24.1	38.3	9.7	-35.7	0.0	0.0	36.3	54.0	-17.7	V	A	
15.900	3.0	35.0	37.8	12.7	-33.9	0.0	0.0	51.6	74.0	-22.4	V	P	
15.900	3.0	22.2	37.8	12.7	-33.9	0.0	0.0	38.8	54.0	-15.2	V	A	
10.600	3.0	33.4	38.3	9.7	-35.7	0.0	0.0	45.5	74.0	-28.5	H	P	
10.600	3.0	21.5	38.3	9.7	-35.7	0.0	0.0	33.7	54.0	-20.3	H	A	
15.900	3.0	34.2	37.8	12.7	-33.9	0.0	0.0	50.8	74.0	-23.2	H	P	
15.900	3.0	22.2	37.8	12.7	-33.9	0.0	0.0	38.8	54.0	-15.2	H	A	
High Ch, 5320MHz													
10.640	3.0	33.8	38.3	9.7	-35.7	0.0	0.0	46.0	74.0	-28.0	V	P	
10.640	3.0	21.3	38.3	9.7	-35.7	0.0	0.0	33.5	54.0	-20.5	V	A	
15.960	3.0	34.5	37.6	12.7	-33.9	0.0	0.0	50.9	74.0	-23.1	V	P	
15.960	3.0	22.3	37.6	12.7	-33.9	0.0	0.0	38.7	54.0	-15.3	V	A	
10.640	3.0	33.8	38.3	9.7	-35.7	0.0	0.0	46.0	74.0	-28.0	H	P	
10.640	3.0	21.3	38.3	9.7	-35.7	0.0	0.0	33.5	54.0	-20.5	H	A	
15.960	3.0	35.3	37.6	12.7	-33.9	0.0	0.0	51.7	74.0	-22.3	H	P	
15.960	3.0	22.3	37.6	12.7	-33.9	0.0	0.0	38.7	54.0	-15.3	H	A	

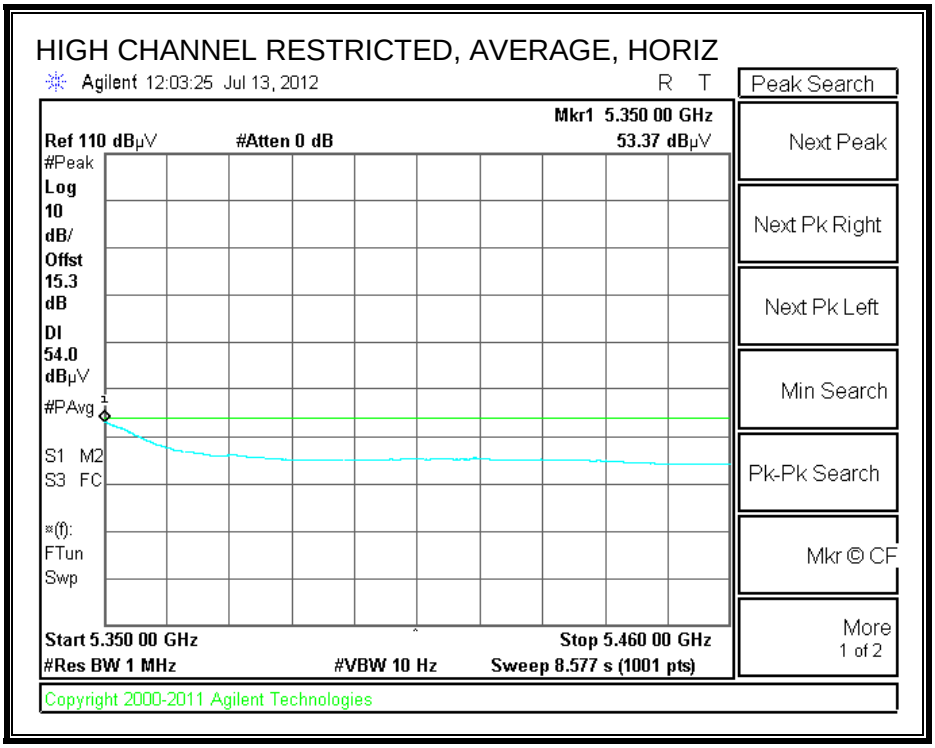
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.6. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.3 GHz BAND

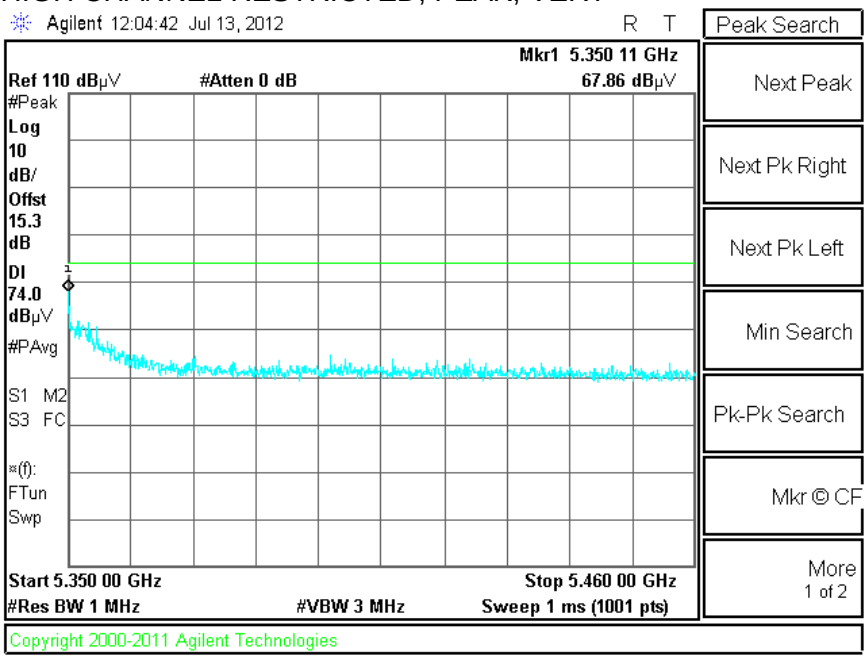
RESTRICTED BANDEDGE (HIGH CHANNEL)



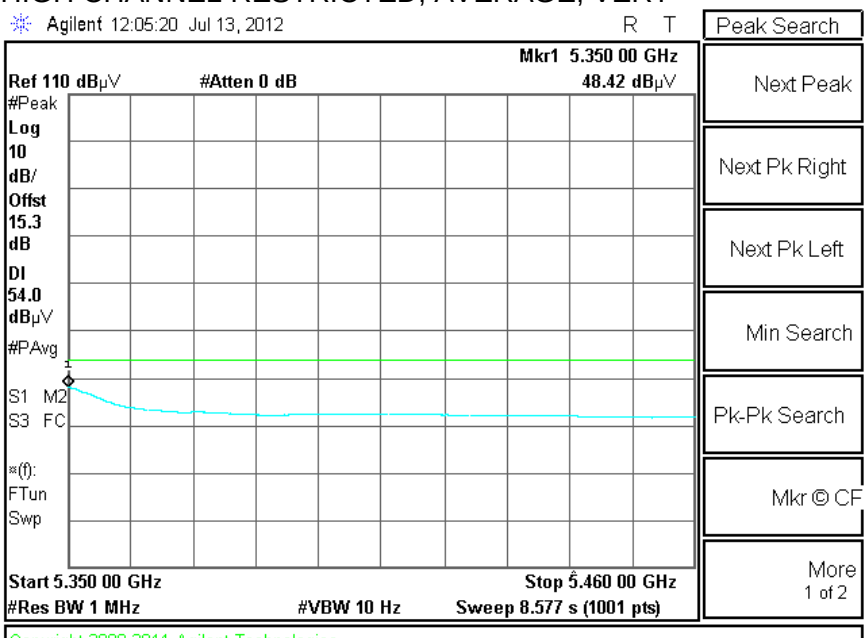


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HIGH CHANNEL RESTRICTED, PEAK, VERT



HIGH CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: HT40, 5.3GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

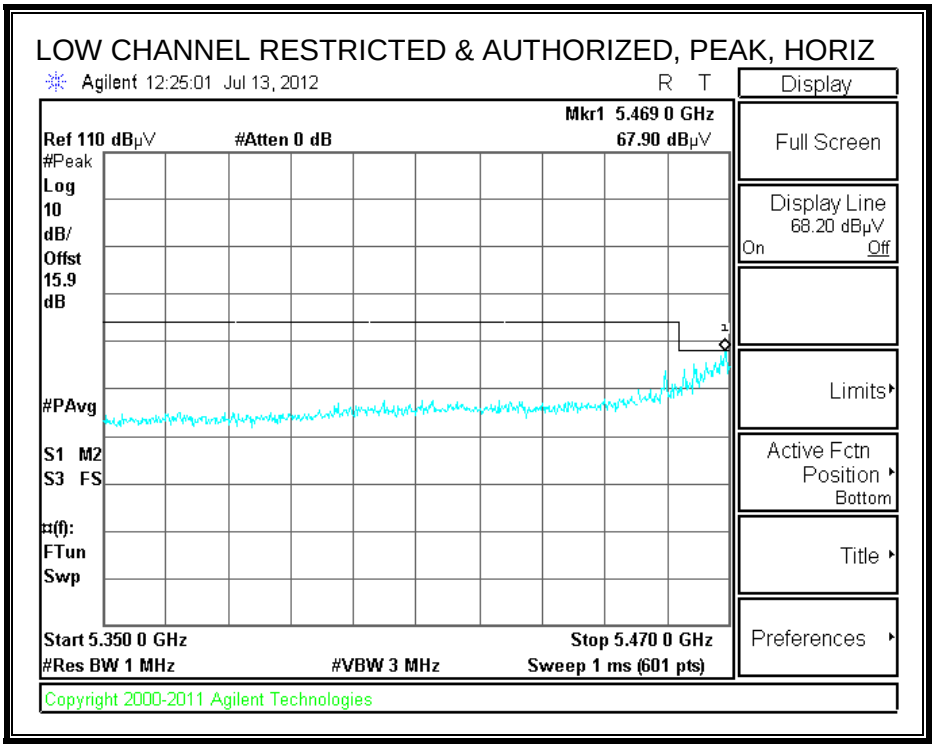
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5270MHz													
15.810	3.0	34.6	38.1	12.6	-33.9	0.0	0.0	51.4	74.0	-22.6	V	P	
15.810	3.0	22.3	38.1	12.6	-33.9	0.0	0.0	39.1	54.0	-14.9	V	A	
15.810	3.0	34.9	38.1	12.6	-33.9	0.0	0.0	51.6	74.0	-22.4	H	P	
15.810	3.0	22.3	38.1	12.6	-33.9	0.0	0.0	39.1	54.0	-14.9	H	A	
High Ch, 5310													
10.620	3.0	33.8	38.3	9.7	-35.7	0.0	0.0	46.0	74.0	-28.0	V	P	
10.620	3.0	21.3	38.3	9.7	-35.7	0.0	0.0	33.5	54.0	-20.5	V	A	
15.930	3.0	34.3	37.7	12.7	-33.9	0.0	0.0	50.8	74.0	-23.2	V	P	
15.930	3.0	22.3	37.7	12.7	-33.9	0.0	0.0	38.8	54.0	-15.2	V	A	
10.620	3.0	33.7	38.3	9.7	-35.7	0.0	0.0	45.9	74.0	-28.1	H	P	
10.620	3.0	21.4	38.3	9.7	-35.7	0.0	0.0	33.7	54.0	-20.3	H	A	
15.930	3.0	35.0	37.7	12.7	-33.9	0.0	0.0	51.5	74.0	-22.5	H	P	
15.930	3.0	22.5	37.7	12.7	-33.9	0.0	0.0	39.0	54.0	-15.0	H	A	

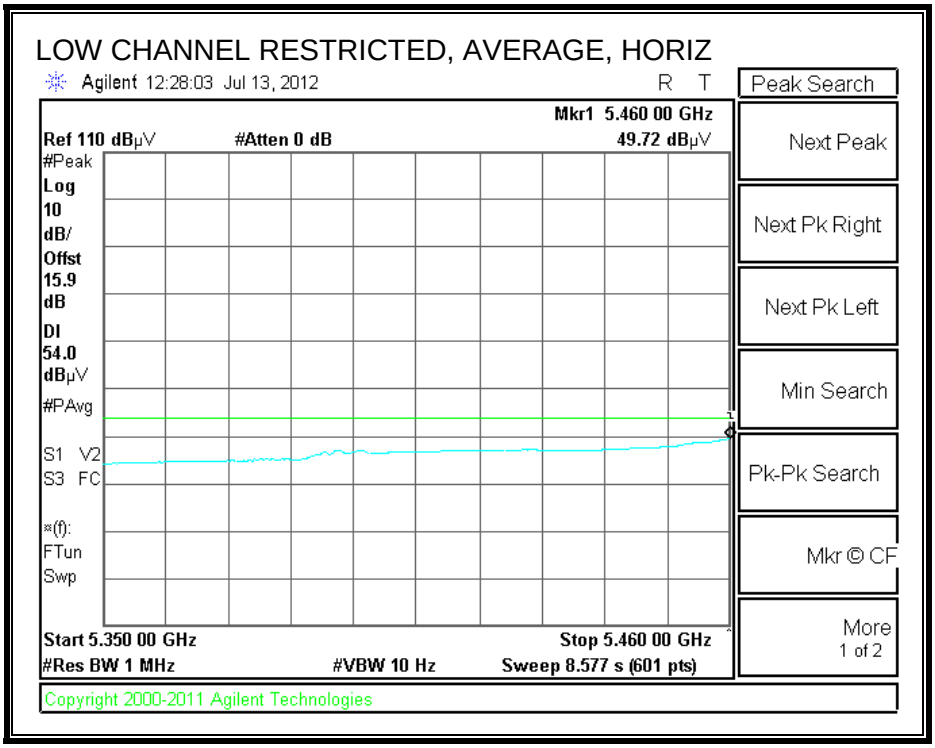
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.7. TX ABOVE 1 GHz 802.11a MODE IN THE 5.6 GHz BAND

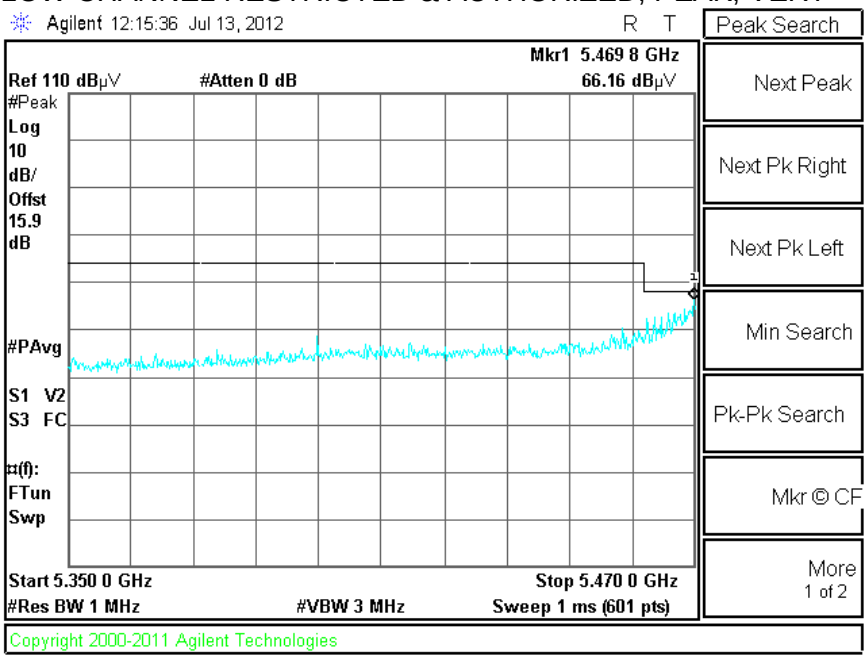
RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)



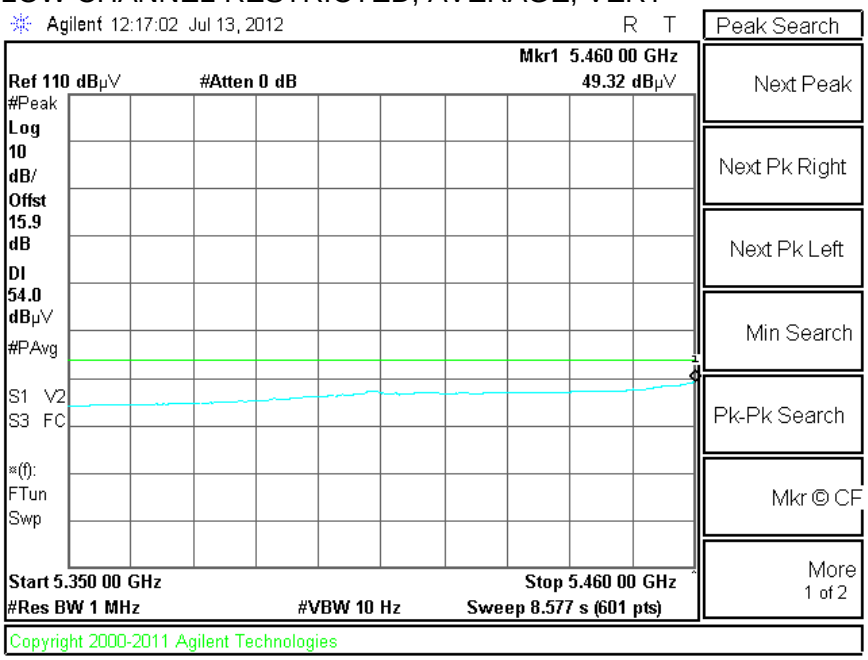


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT

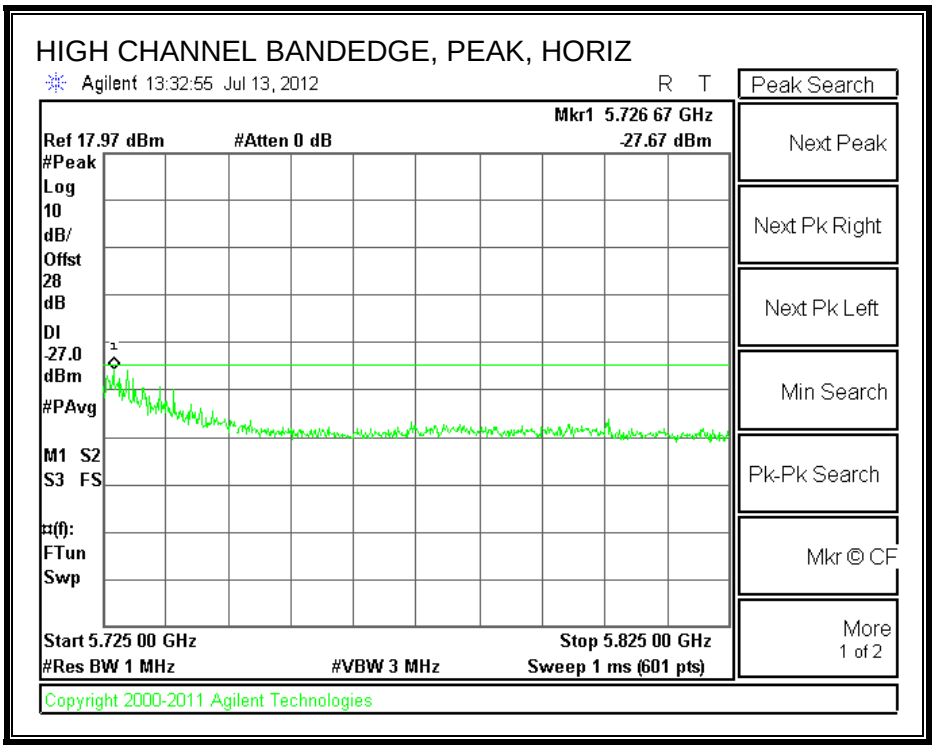


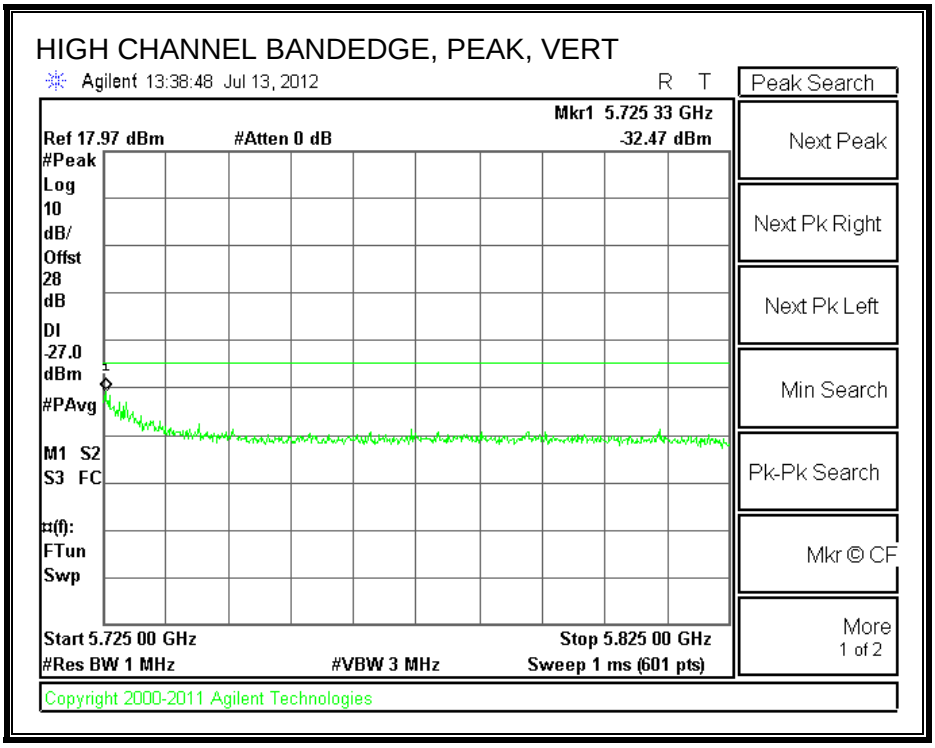
LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AUTHORIZED BANDEDGE (HIGH CHANNEL)





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: a mode, 5.6GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

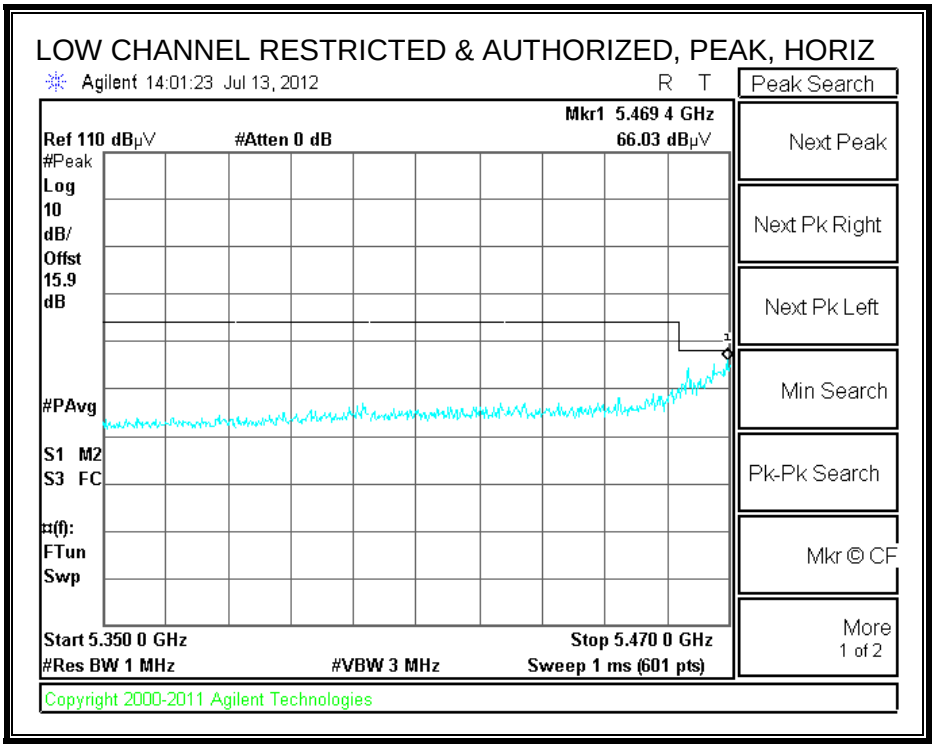
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5500MHz													
11.000	3.0	33.0	38.4	10.1	-35.6	0.0	0.0	45.7	74.0	-28.3	V	P	
11.000	3.0	21.0	38.4	10.1	-35.6	0.0	0.0	33.7	54.0	-20.3	V	A	
11.000	3.0	33.3	38.4	10.1	-35.6	0.0	0.0	46.1	74.0	-27.9	H	P	
11.000	3.0	21.0	38.4	10.1	-35.6	0.0	0.0	33.8	54.0	-20.2	H	A	
Mid Ch, 5580MHz													
11.160	3.0	35.0	38.5	10.2	-35.6	0.0	0.0	48.2	74.0	-25.8	V	P	
11.160	3.0	22.4	38.5	10.2	-35.6	0.0	0.0	35.6	54.0	-18.4	V	A	
11.160	3.0	35.5	38.5	10.2	-35.6	0.0	0.0	48.7	74.0	-25.3	H	P	
11.160	3.0	22.3	38.5	10.2	-35.6	0.0	0.0	35.5	54.0	-18.5	H	A	
High Ch, 5700MHz													
11.400	3.0	33.9	38.7	10.4	-35.6	0.0	0.0	47.6	74.0	-26.4	V	P	
11.400	3.0	21.8	38.7	10.4	-35.6	0.0	0.0	35.4	54.0	-18.6	V	A	
11.400	3.0	33.9	38.7	10.4	-35.6	0.0	0.0	47.5	74.0	-26.5	H	P	
11.400	3.0	21.8	38.7	10.4	-35.6	0.0	0.0	35.4	54.0	-18.6	H	A	

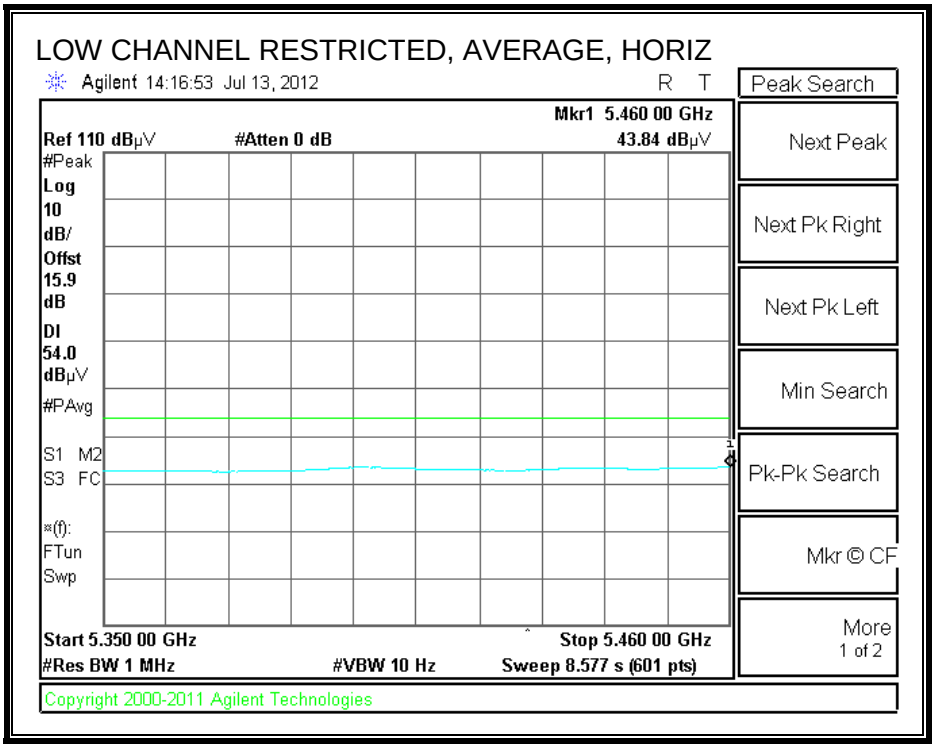
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.8. TX ABOVE 1 GHz 802.11n HT20 MODE IN THE 5.6 GHz BAND

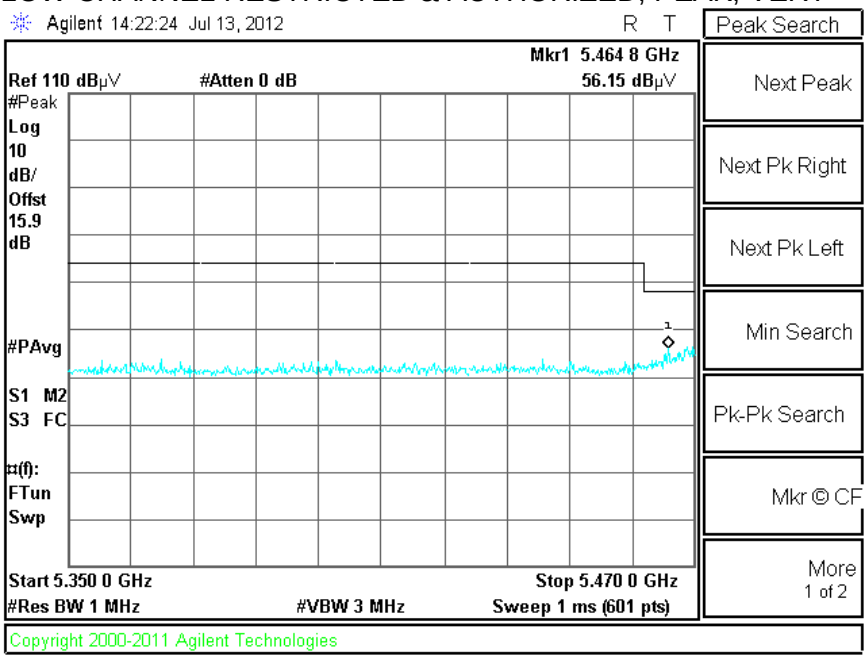
RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)



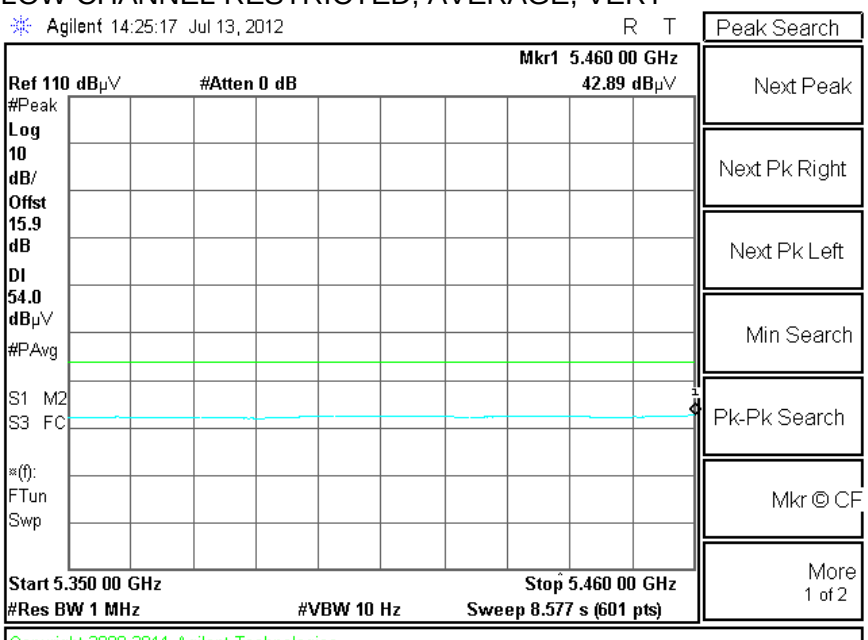


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT

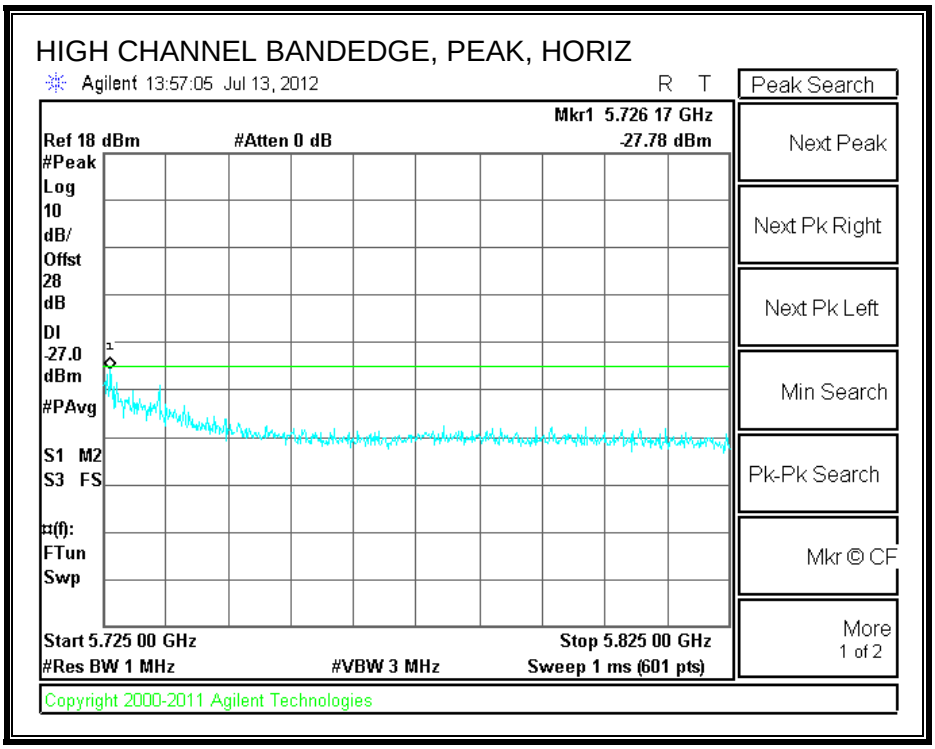


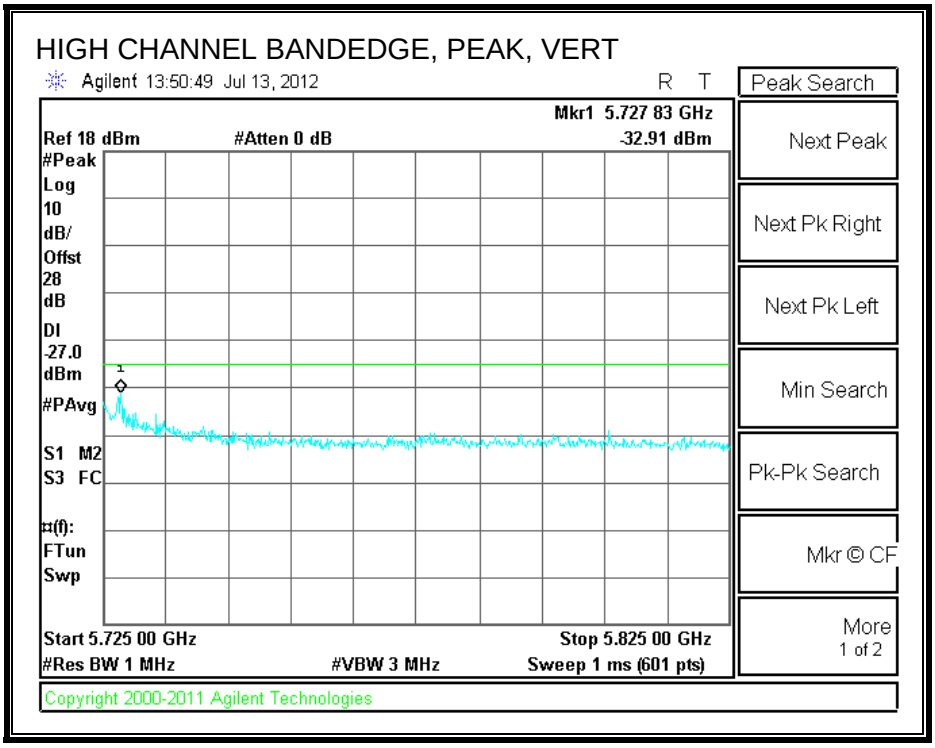
LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AUTHORIZED BANDEDGE (HIGH CHANNEL)





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: HT20 mode, 5.6GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

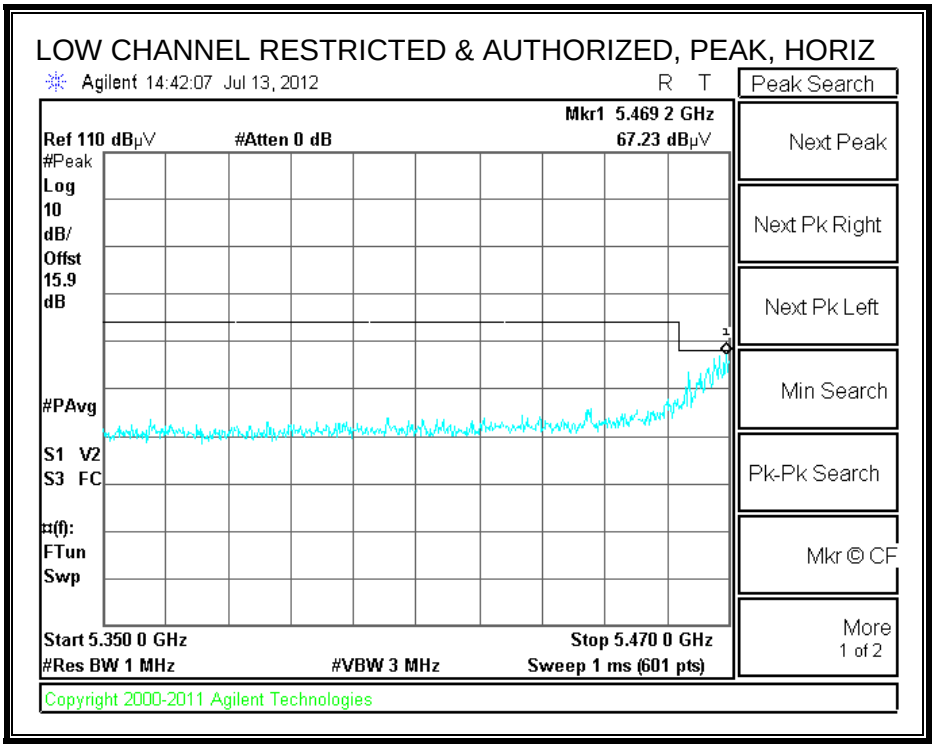
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5500MHz													
11.000	3.0	32.9	38.4	10.1	-35.6	0.0	0.0	45.6	74.0	-28.4	V	P	
11.000	3.0	21.0	38.4	10.1	-35.6	0.0	0.0	33.8	54.0	-20.2	V	A	
11.000	3.0	33.4	38.4	10.1	-35.6	0.0	0.0	46.2	74.0	-27.8	H	P	
11.000	3.0	21.0	38.4	10.1	-35.6	0.0	0.0	33.8	54.0	-20.2	H	A	
Mid Ch, 5600MHz													
11.160	3.0	34.3	38.5	10.2	-35.6	0.0	0.0	47.5	74.0	-26.5	V	P	
11.160	3.0	22.5	38.5	10.2	-35.6	0.0	0.0	35.7	54.0	-18.3	V	A	
11.160	3.0	34.3	38.5	10.2	-35.6	0.0	0.0	47.5	74.0	-26.5	H	P	
11.160	3.0	21.8	38.5	10.2	-35.6	0.0	0.0	35.0	54.0	-19.0	H	A	
High Ch, 5700MHz													
11.400	3.0	33.7	38.7	10.4	-35.6	0.0	0.0	47.4	74.0	-26.6	V	P	
11.400	3.0	21.6	38.7	10.4	-35.6	0.0	0.0	35.3	54.0	-18.7	V	A	
11.400	3.0	34.5	38.7	10.4	-35.6	0.0	0.0	48.1	74.0	-25.9	H	P	
11.400	3.0	21.6	38.7	10.4	-35.6	0.0	0.0	35.3	54.0	-18.7	H	A	

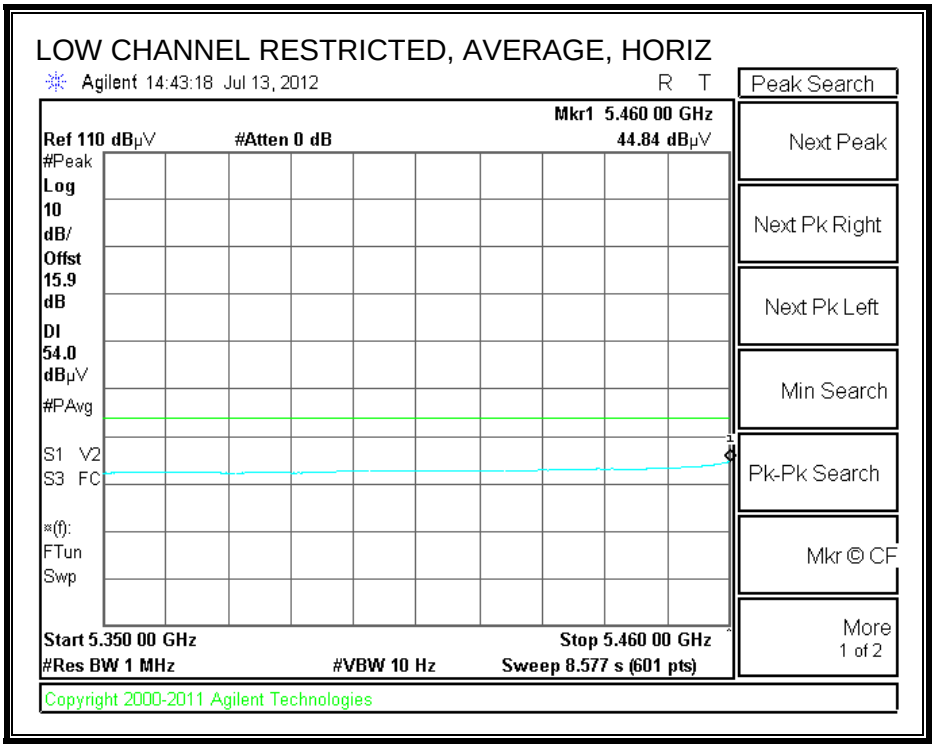
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.9. TX ABOVE 1 GHz 802.11n HT40 MODE IN THE 5.6 GHz BAND

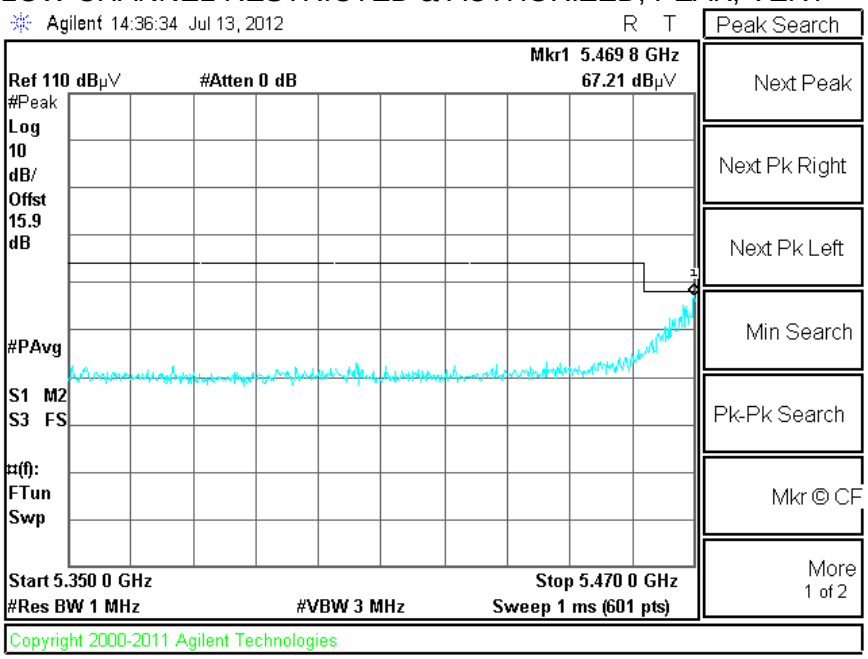
RESTRICTED & AUTHORIZED BANDEDGE (LOW CHANNEL)



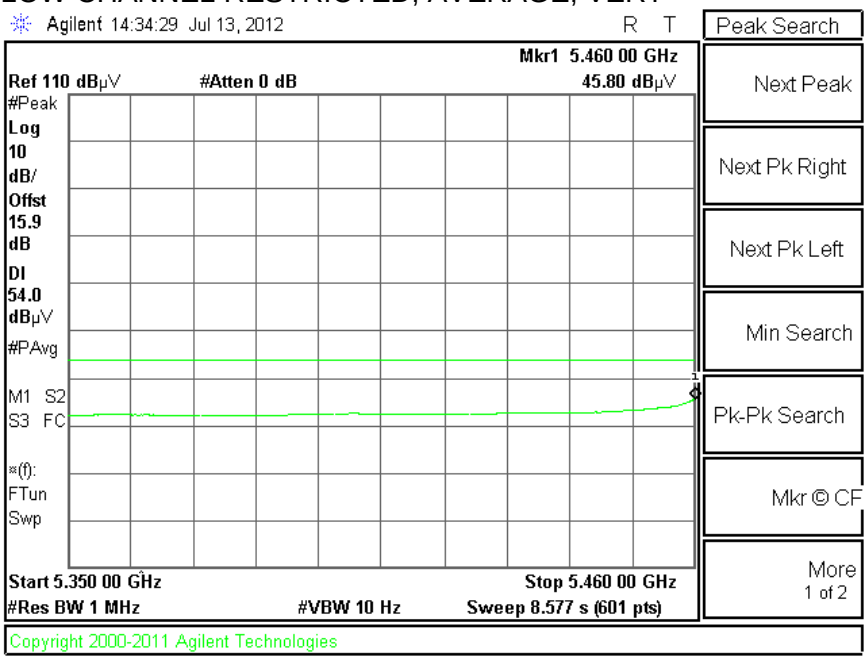


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED & AUTHORIZED, PEAK, VERT

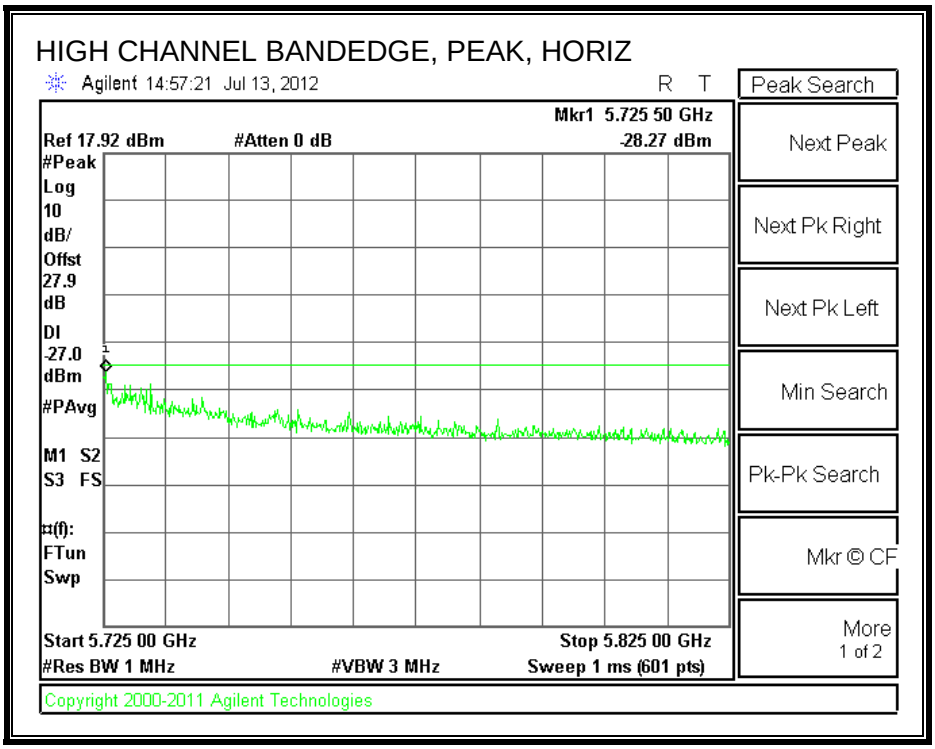


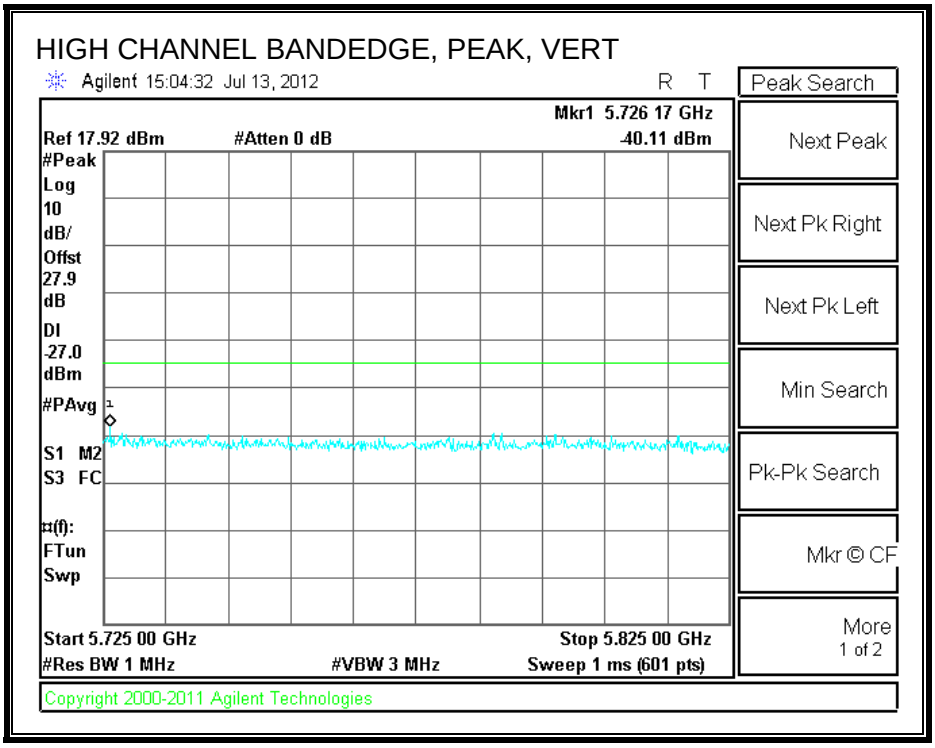
LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AUTHORIZED BANDEDGE (HIGH CHANNEL)





This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin Pang
Date: 08/13/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: HT40, 5.6GHz, TX (Worst Case)

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

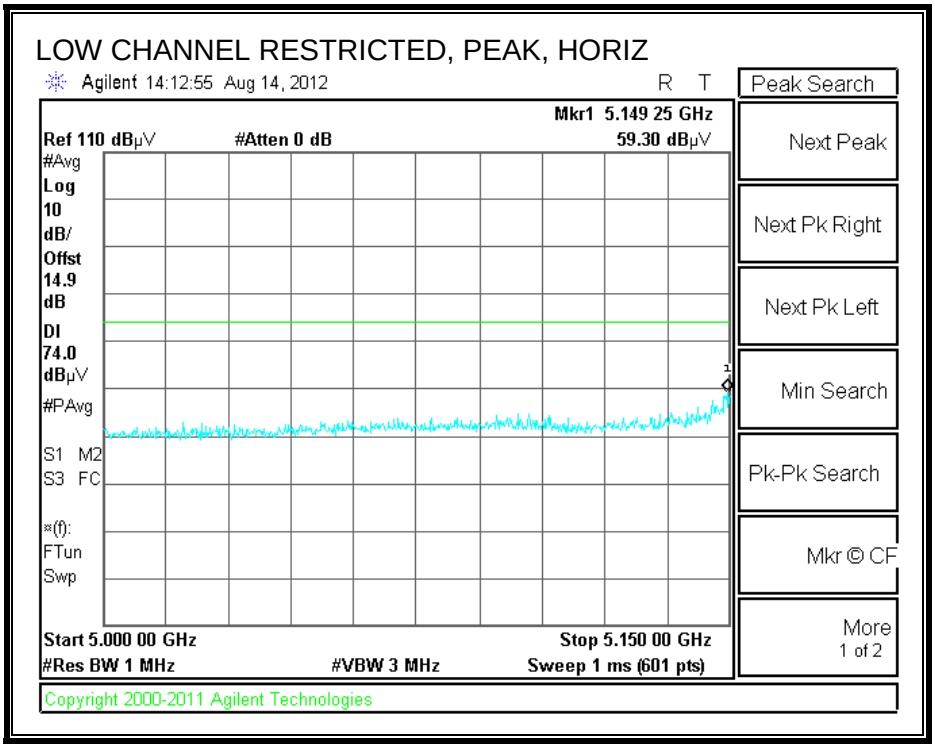
f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5510MHz													
11.020	3.0	32.4	38.4	10.1	-35.6	0.0	0.0	45.2	74.0	-28.8	V	P	
11.020	3.0	20.8	38.4	10.1	-35.6	0.0	0.0	33.6	54.0	-20.4	V	A	
11.020	3.0	32.9	38.4	10.1	-35.6	0.0	0.0	45.7	74.0	-28.3	H	P	
11.020	3.0	20.8	38.4	10.1	-35.6	0.0	0.0	33.6	54.0	-20.4	H	A	
Mid Ch, 5550MHz													
11.100	3.0	34.6	38.5	10.2	-35.6	0.0	0.0	47.7	74.0	-26.3	V	P	
11.100	3.0	22.4	38.5	10.2	-35.6	0.0	0.0	35.5	54.0	-18.5	V	A	
11.100	3.0	34.6	38.5	10.2	-35.6	0.0	0.0	47.7	74.0	-26.3	H	P	
11.100	3.0	22.5	38.5	10.2	-35.6	0.0	0.0	35.6	54.0	-18.4	H	A	
High Ch, 5670MHz													
11.340	3.0	33.5	38.7	10.4	-35.6	0.0	0.0	47.0	74.0	-27.0	V	P	
11.340	3.0	21.5	38.7	10.4	-35.6	0.0	0.0	35.0	54.0	-19.0	V	A	
11.340	3.0	33.8	38.7	10.4	-35.6	0.0	0.0	47.3	74.0	-26.7	H	P	
11.340	3.0	21.6	38.7	10.4	-35.6	0.0	0.0	35.1	54.0	-18.9	H	A	

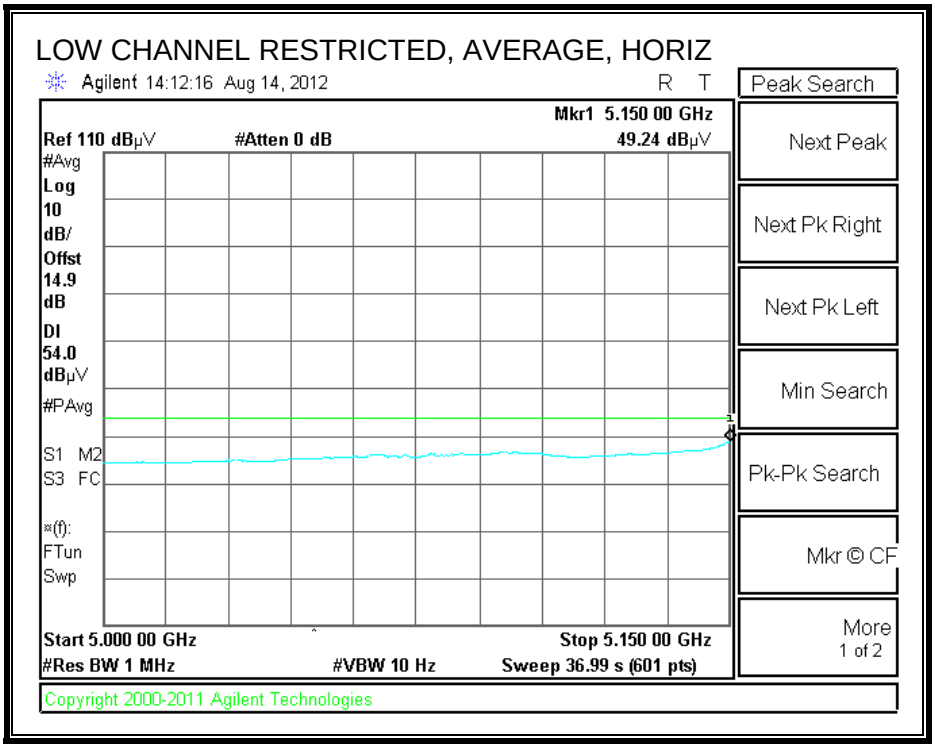
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.10. 2.4 GHz and 5GHz band Colocation

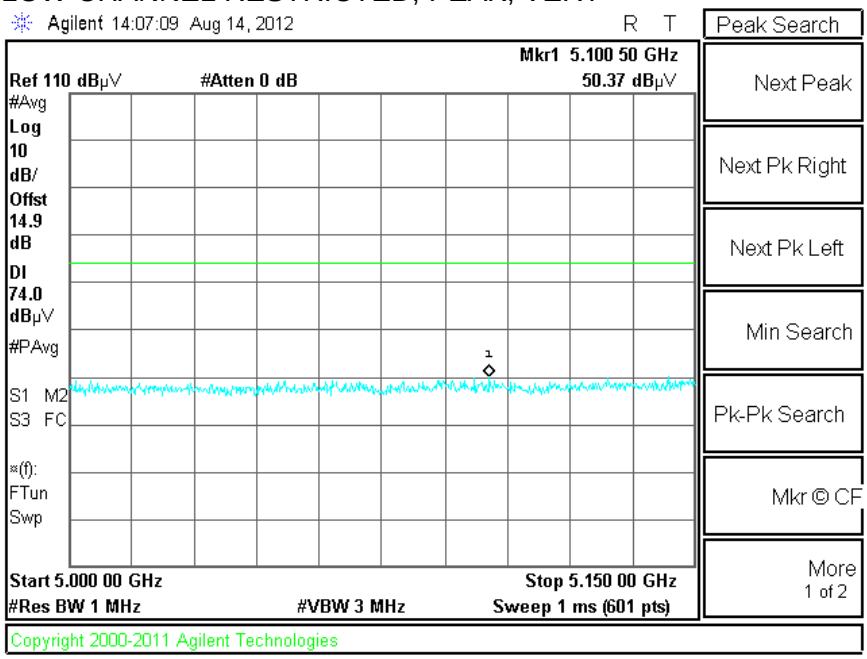
BANDEDGE (CHANNEL 36 and Bluetooth High CHANNEL)



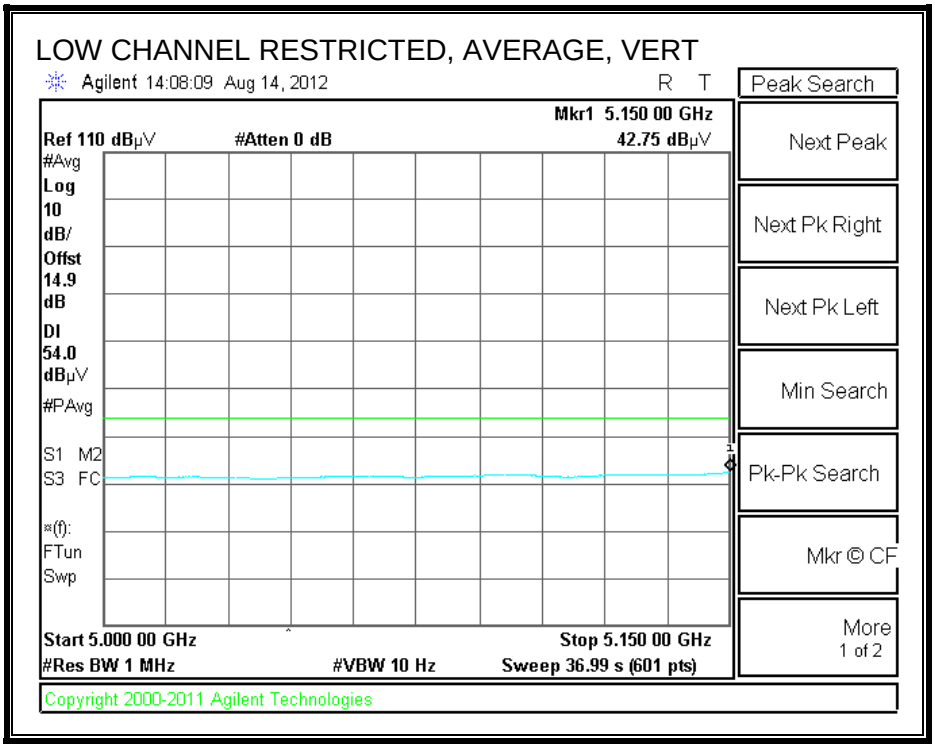


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LOW CHANNEL RESTRICTED, PEAK, VERT



LOW CHANNEL RESTRICTED, AVERAGE, VERT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HARMONICS AND SPURIOUS EMISSIONS

High Frequency Measurement
Compliance Certification Services, Fremont 5m Chamber

Test Engr: Chin pang
Date: 08/14/12
Project #: 12U14526
Company: Apple
Test Target: FCC 15.407
Mode Oper: Co-location, 5GHz and BT TX.

f	Measurement Frequency	Amp	Preamp Gain	Average Field Strength Limit
Dist	Distance to Antenna	D Corr	Distance Correct to 3 meters	Peak Field Strength Limit
Read	Analyzer Reading	Avg	Average Field Strength @ 3 m	Margin vs. Average Limit
AF	Antenna Factor	Peak	Calculated Peak Field Strength	Margin vs. Peak Limit
CL	Cable Loss	HPF	High Pass Filter	

f GHz	Dist (m)	Read dBuV	AF dB/m	CL dB	Amp dB	D Corr dB	Fltr dB	Corr. dBuV/m	Limit dBuV/m	Margin dB	Ant. Pol. V/H	Det. P/A/QP	Notes
Low Ch, 5180MHz													
10.360	3.0	34.9	38.2	9.4	-35.8	0.0	0.0	46.8	74.0	-27.2	V	P	
10.360	3.0	22.4	38.2	9.4	-35.8	0.0	0.0	34.3	54.0	-19.7	V	A	
15.540	3.0	35.5	39.0	12.5	-34.0	0.0	0.0	53.0	74.0	-21.0	V	P	
15.540	3.0	22.3	39.0	12.5	-34.0	0.0	0.0	39.7	54.0	-14.3	V	A	
10.360	3.0	35.3	38.2	9.4	-35.8	0.0	0.0	47.1	74.0	-26.9	H	P	
10.360	3.0	22.4	38.2	9.4	-35.8	0.0	0.0	34.3	54.0	-19.7	H	A	
15.540	3.0	35.2	39.0	12.5	-34.0	0.0	0.0	52.7	74.0	-21.3	H	P	
15.540	3.0	22.3	39.0	12.5	-34.0	0.0	0.0	39.8	54.0	-14.2	H	A	
BT High ch, 2480MHz													
4.960	3.0	55.6	33.6	6.4	-35.5	0.0	0.0	60.0	74.0	-14.0	H	P	
4.960	3.0	40.2	33.6	6.4	-35.5	0.0	0.0	44.6	54.0	-9.4	H	A	
7.440	3.0	50.4	35.9	8.5	-35.5	0.0	0.0	59.4	74.0	-14.6	H	P	
7.440	3.0	36.1	35.9	8.5	-35.5	0.0	0.0	45.2	54.0	-8.9	H	A	
9.920	3.0	35.9	38.1	9.1	-35.9	0.0	0.0	47.2	74.0	-26.8	H	P	
9.920	3.0	23.1	38.1	9.1	-35.9	0.0	0.0	34.4	54.0	-19.6	H	A	
4.960	3.0	48.5	33.6	6.4	-35.5	0.0	0.0	53.0	74.0	-21.0	V	P	
4.960	3.0	36.4	33.6	6.4	-35.5	0.0	0.0	40.8	54.0	-13.2	V	A	
7.440	3.0	41.3	35.9	8.5	-35.5	0.0	0.0	50.3	74.0	-23.7	V	P	
7.440	3.0	30.1	35.9	8.5	-35.5	0.0	0.0	39.1	54.0	-14.9	V	A	

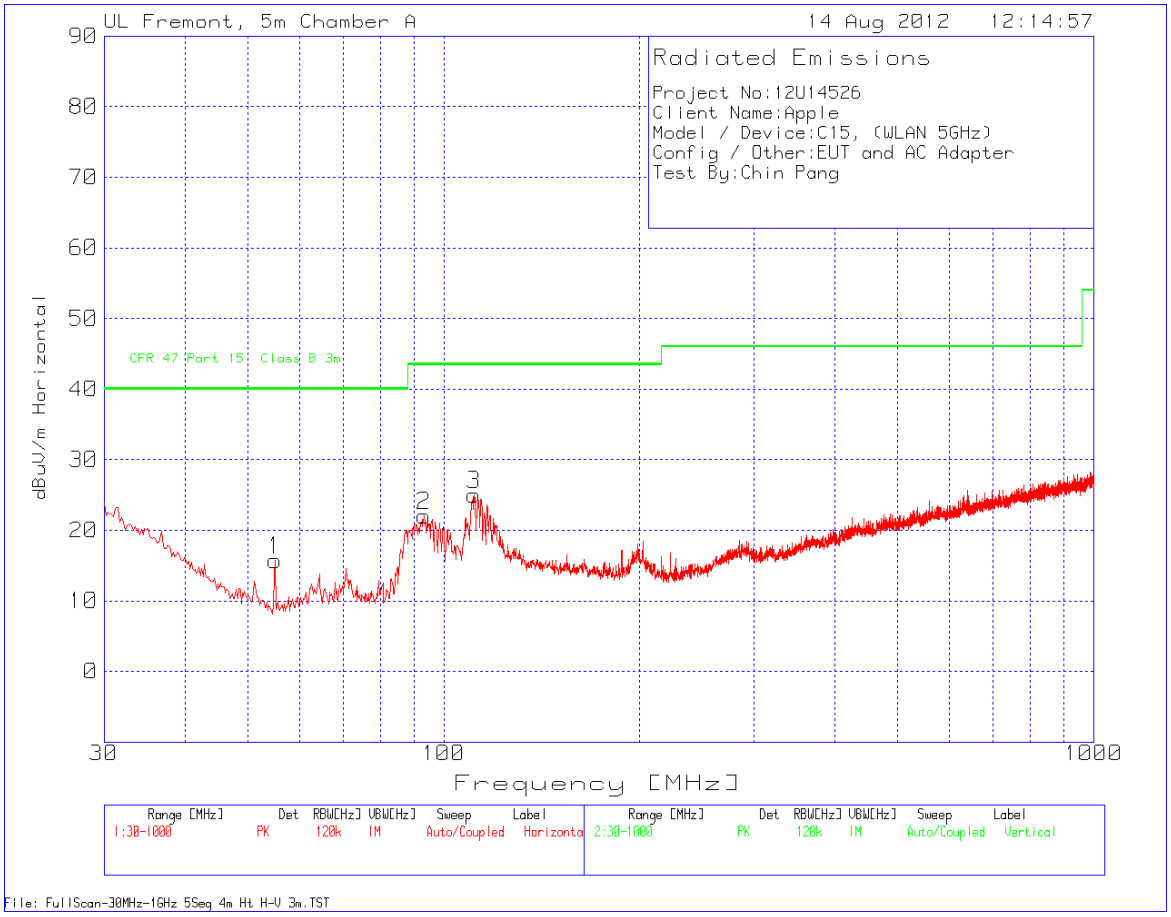
Rev. 4.1.2.7
Note: No other emissions were detected above the system noise floor.

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701H
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.3. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, HORIZONTAL)

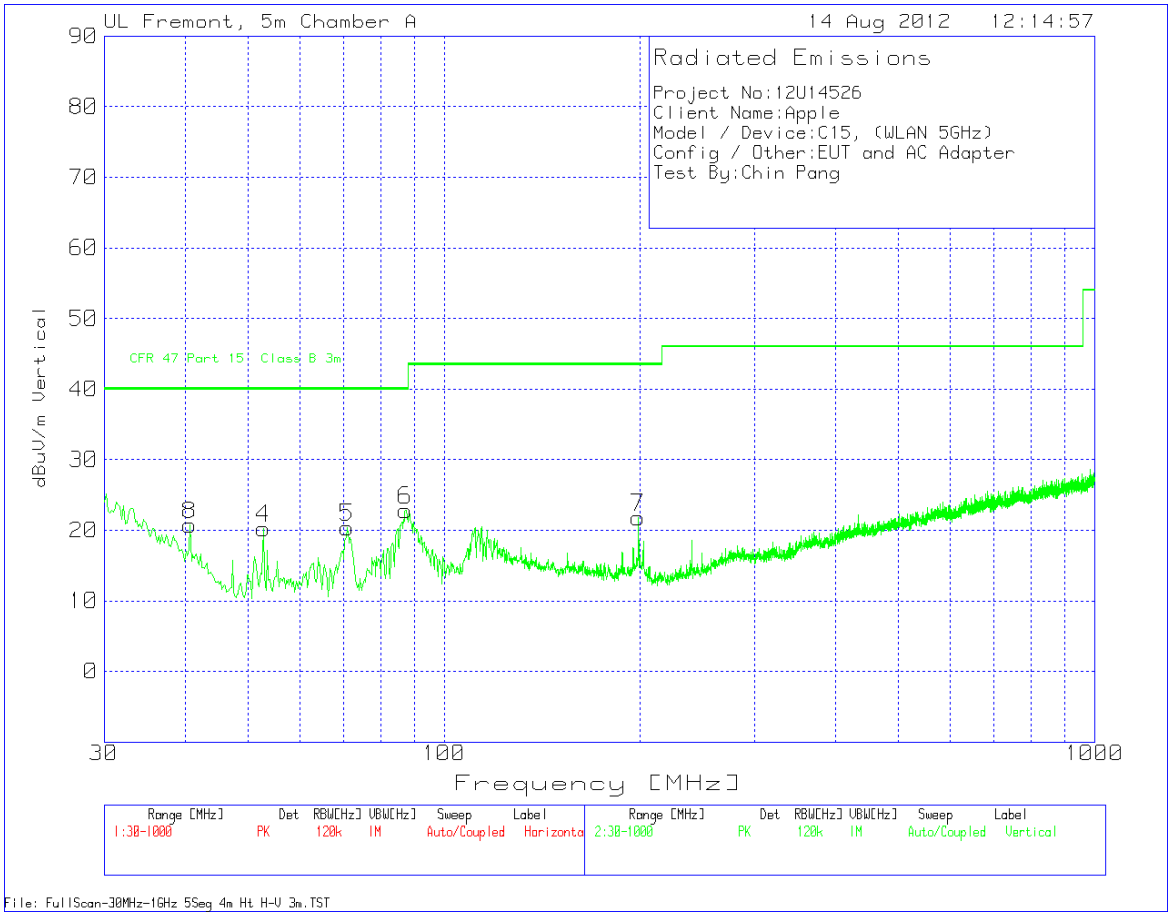
HORIZONTAL PLOT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION, VERTICAL)

VERTICAL PLOT



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

HORIZONTAL AND VERTICAL DATA

Project No:12U14526
Client Name:Apple
Model / Device:C15, (WLAN 5GHz)
Config / Other:EUT and AC Adapter
Test By:Chin Pang

Horizontal 30 - 1000MHz

Frequency	Reading	Detector	25MHz-1GHz ChmbrA Amplified.TX (dB)	T243 Sunol Bilog.TXT (dB)	dBuV/m	CFR 47 Part 15B 3m	Margin	Polarity
55.006	35.91	PK	-27.3	7.1	15.71	40	-24.29	Horz
93.3873	40.68	PK	-27	8.4	22.08	43.5	-21.42	Horz
111.221	38.86	PK	-26.7	12.9	25.06	43.5	-18.44	Horz

Vertical 30 - 1000MHz

Frequency	Reading	Detector	25MHz-1GHz ChmbrA Amplified.TX (dB)	T243 Sunol Bilog.TXT (dB)	dBuV/m	CFR 47 Part 15B 3m	Margin	Polarity
52.6799	40.15	PK	-27.3	7.4	20.25	40	-19.75	Vert
70.9013	39.37	PK	-27.1	8.1	20.37	40	-19.63	Vert
87.1843	42.43	PK	-27	7.4	22.83	40	-17.17	Vert
198.8389	35.85	PK	-26.2	12.2	21.85	43.5	-21.65	Vert
40.6615	34.51	PK	-27.3	13.5	20.71	40	-19.29	Vert

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

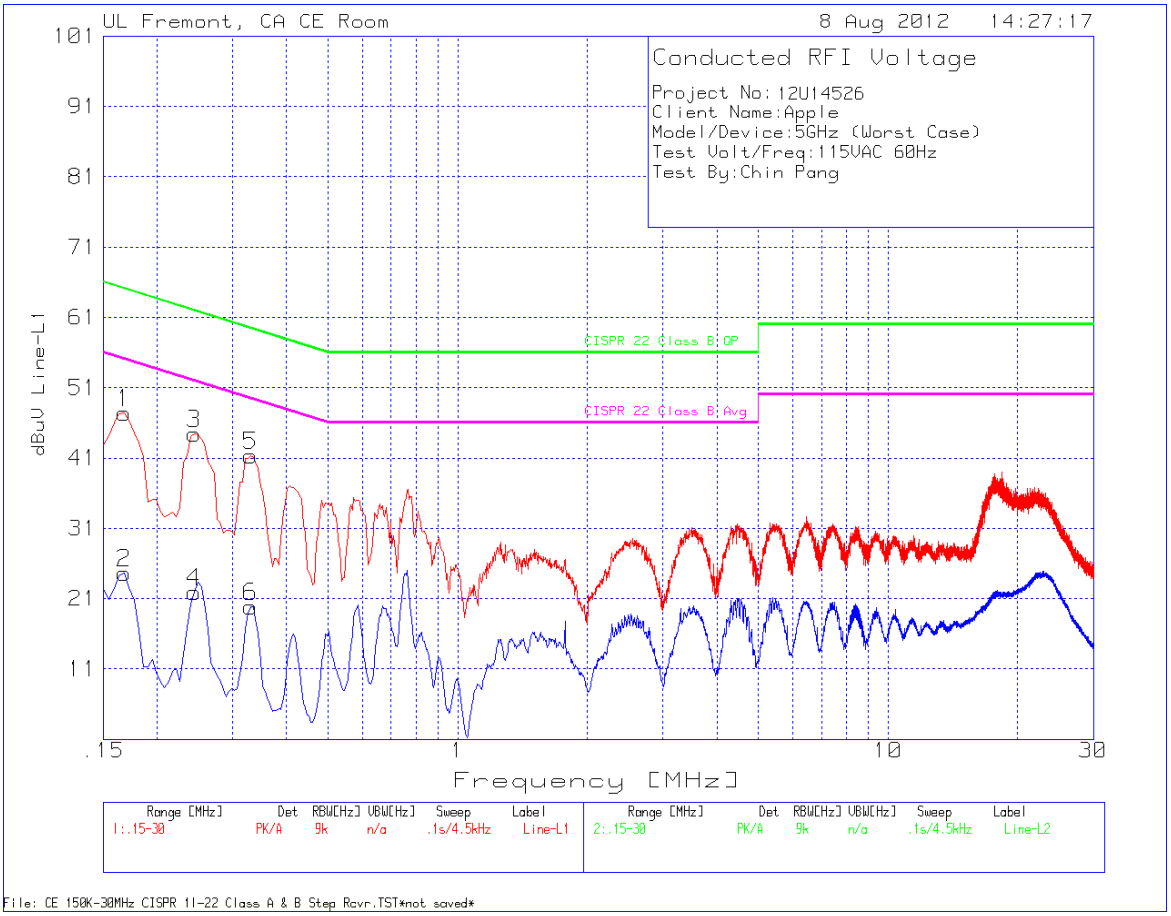
RESULTS

6 WORST EMISSIONS

Project No:12U14526									
Client Name:Apple									
Model/Device:5GHz (Worst Case)									
Test Volt/Freq:115VAC 60Hz									
Test By:Chin Pang									
Line-L1 .15 - 30MHz									
Frequency	Reading	Detector	T24 IL L1	LC Cables	dBuV	CISPR 22B	Margin	CISPR 22B	Margin
0.168	47.28	PK	0.1	0	47.38	65.1	-17.72	-	-
0.168	24.53	Av	0.1	0	24.63	-	-	55.1	-30.47
0.2445	44.34	PK	0.1	0	44.44	61.9	-17.46	-	-
0.2445	21.81	Av	0.1	0	21.91	-	-	51.9	-29.99
0.33	41.21	PK	0.1	0	41.31	59.5	-18.19	-	-
0.33	19.79	Av	0.1	0	19.89	-	-	49.5	-29.61
Line-L2 .15 - 30MHz									
Frequency	Reading	Detector	T24 IL L1	LC Cables	dBuV	CISPR 22B	Margin	CISPR 22B	Margin
0.168	47.94	PK	0.1	0	48.04	65.1	-17.06	-	-
0.168	25.97	Av	0.1	0	26.07	-	-	55.1	-29.03
0.2445	45.18	PK	0.1	0	45.28	61.9	-16.62	-	-
0.2445	22.76	Av	0.1	0	22.86	-	-	51.9	-29.04
0.33	41.78	PK	0.1	0	41.88	59.5	-17.62	-	-
0.33	20.89	Av	0.1	0	20.99	-	-	49.5	-28.51

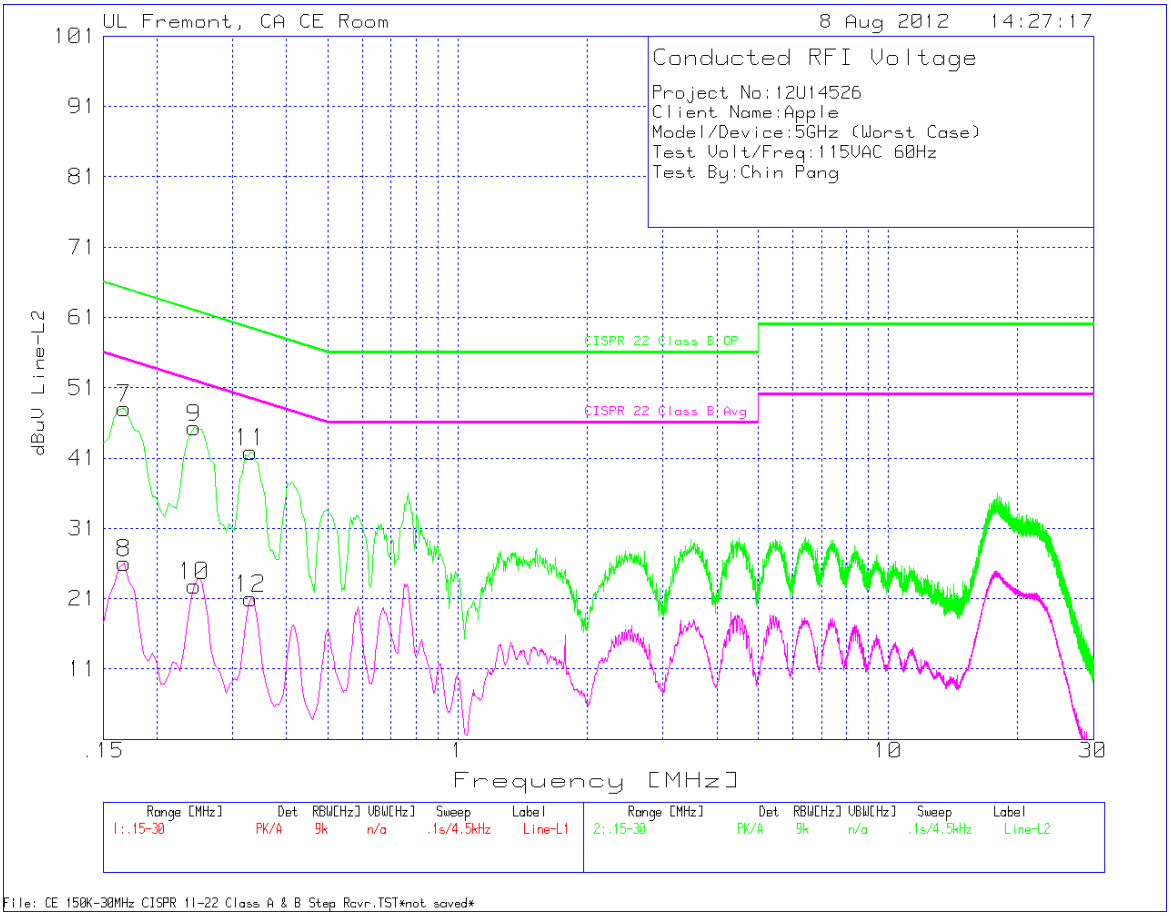
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LINE 1 RESULTS



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

LINE 2 RESULTS



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11. DYNAMIC FREQUENCY SELECTION

11.1. OVERVIEW

11.1.1. LIMITS

FCC

§15.407 (h) and FCC 06-96 APPENDIX “COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVCIES OPERATING IN THE 5250-5350 MHz AND 5470-5725 MHz BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION”.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (without radar detection)	Client (with radar detection)
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master	Client **(without DFS)**	Client **(with DFS)**
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see note)
≥ 200 milliwatt	-64 dBm
< 200 milliwatt	-62 dBm
Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
Channel Closing Transmission Time	200 milliseconds + approx. 60 milliseconds over remaining 10 second period
The instant that the *Channel Move Time* and the *Channel Closing Transmission Time* begins is as follows: For the Short pulse radar Test Signals this instant is the end of the *Burst*. For the Frequency Hopping radar Test Signal, this instant is the end of the last radar burst generated. For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission. The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate channel changes (an aggregate of approximately 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (Microseconds)	PRI (Microseconds)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Table 6 – Long Pulse Radar Test Signal

Radar Waveform	Bursts	Pulses per Burst	Pulse Width (µsec)	Chirp Width (MHz)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	80%	30

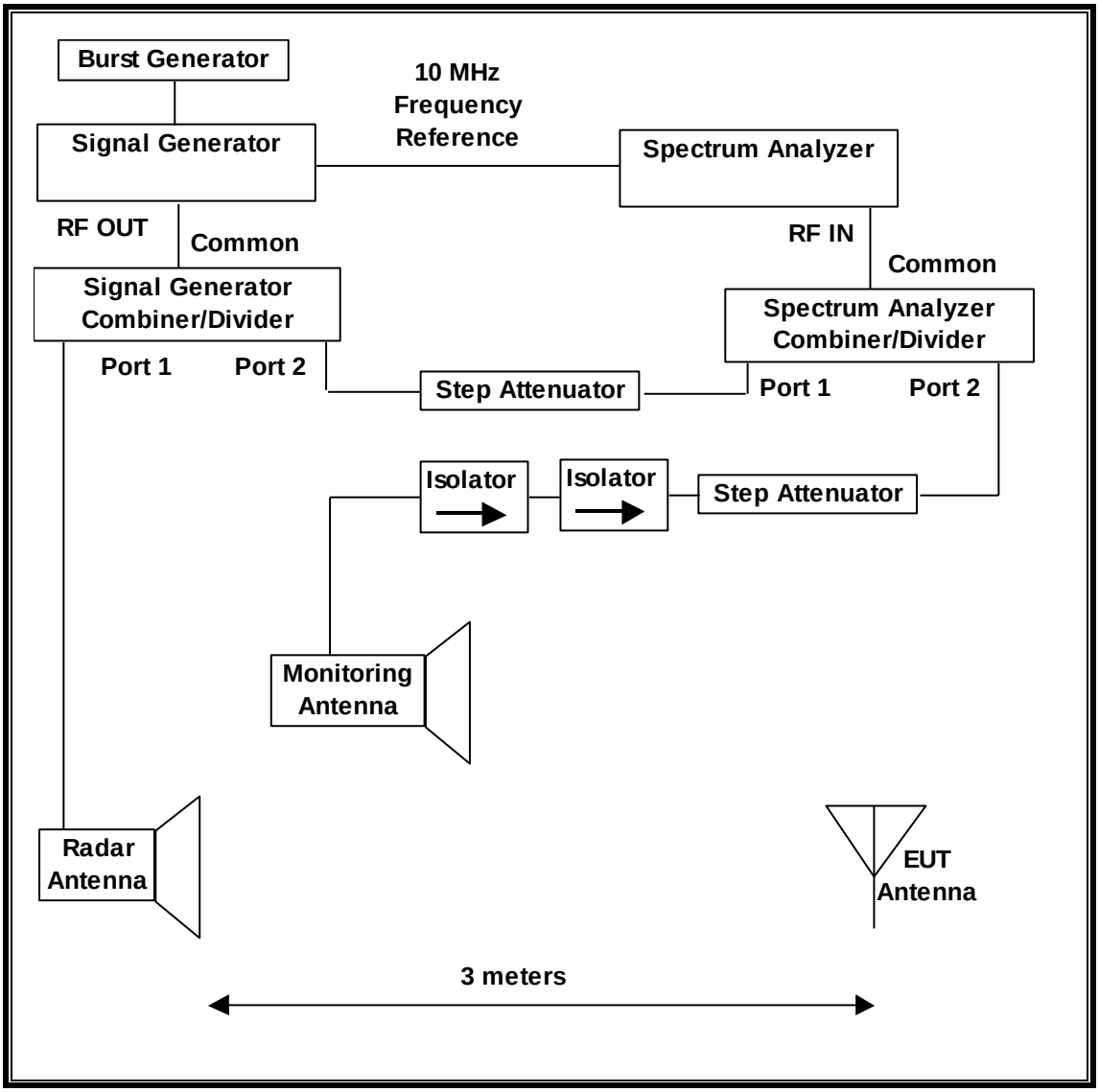
Table 7 – Frequency Hopping Radar Test Signal

Radar Waveform	Pulse Width (µsec)	PRI (µsec)	Burst Length (ms)	Pulses per Hop	Hopping Rate (kHz)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	300	9	.333	70%	30

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.1.2. TEST AND MEASUREMENT SYSTEM

RADIATED METHOD SYSTEM BLOCK DIAGRAM



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

SYSTEM OVERVIEW

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

The short pulse types 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of FCC 06-96 APPENDIX. The frequency of the signal generator is incremented in 1 MHz steps from F_L to F_H for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

SYSTEM CALIBRATION

A 50-ohm load is connected in place of the spectrum analyzer, and the spectrum analyzer is connected to a horn antenna via a coaxial cable, with the reference level offset set to (horn antenna gain – coaxial cable loss). The signal generator is set to CW mode. The amplitude of the signal generator is adjusted to yield a level of –64 dBm as measured on the spectrum analyzer.

Without changing any of the instrument settings, the spectrum analyzer is reconnected to the Common port of the Spectrum Analyzer Combiner/Divider. The Reference Level Offset of the spectrum analyzer is adjusted so that the displayed amplitude of the signal is –64 dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of –64 dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

ADJUSTMENT OF DISPLAYED TRAFFIC LEVEL

A link is established between the Master and Slave and the distance between the units is adjusted as needed to provide a suitable received level at the Master and Slave devices. The video test file is streamed to generate WLAN traffic. The monitoring antenna is adjusted so that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold.

TEST AND MEASUREMENT EQUIPMENT

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

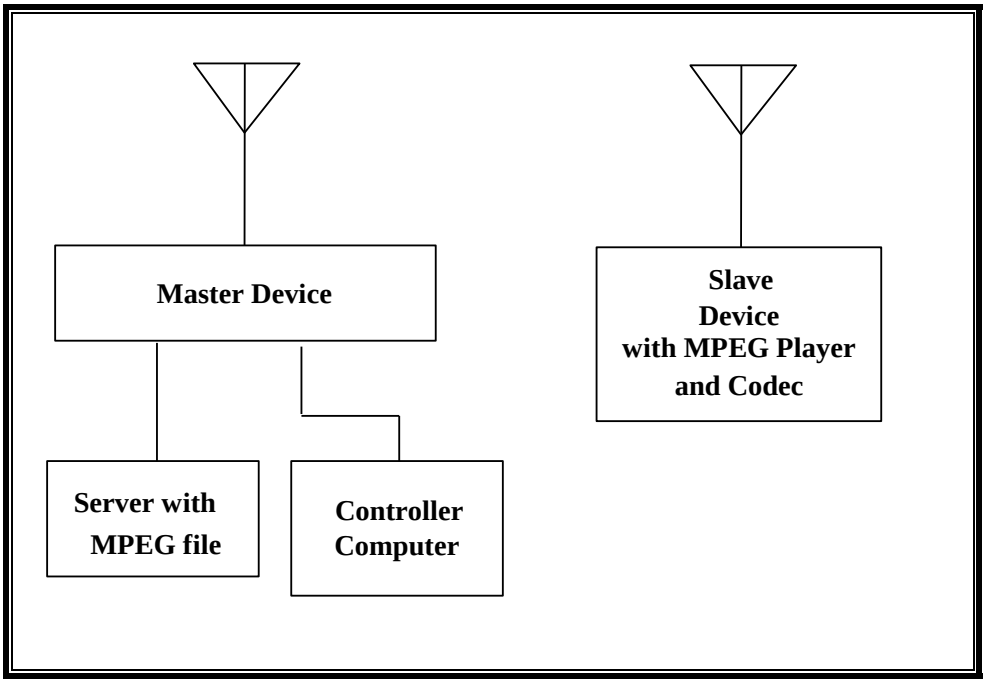
TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset Number**	**Cal Due**
Spectrum Analyzer, 26.5 GHz	Agilent / HP	E4440A	C01178	08/15/12
Vector Signal Generator, 20GHz	Agilent / HP	E8267C	C01066	11/17/12

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.1.3. SETUP OF EUT

CLIENT MODE:

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

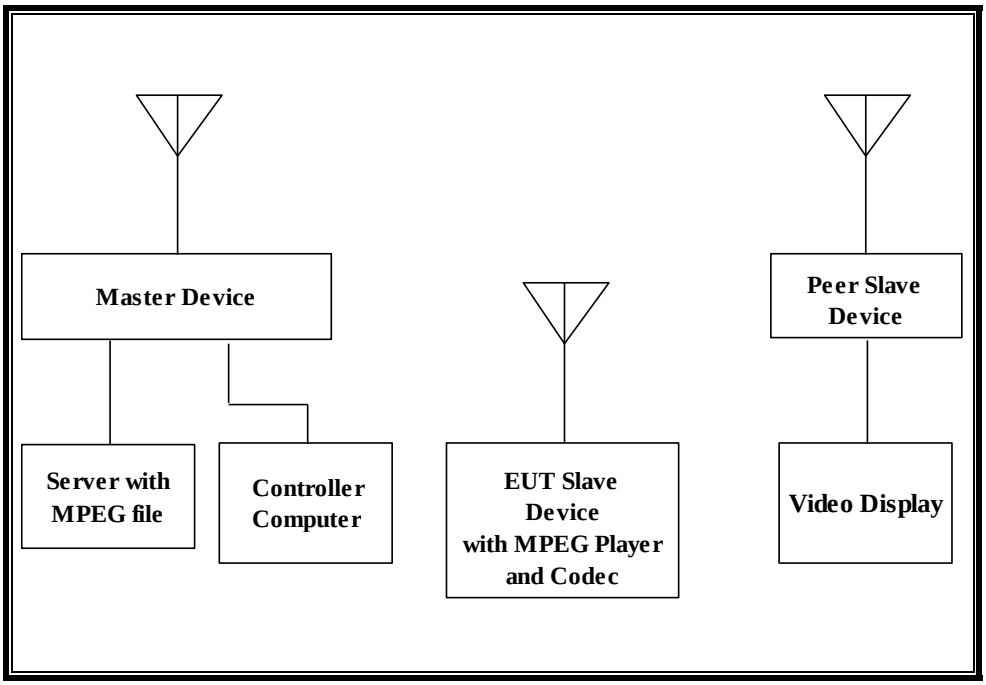
The following support equipment was utilized for the DFS tests documented in this report:

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Wireless Access Point (Master Device)	Cisco	AIR-AP1252AG-A-K9	FTX130390D9	LDK102061
AC Adapter (AP)	Delta Electronics	EADP-45BB B	DTH1049902N	DoC
Notebook PC (Server)	Apple	MacBook Pro A1150	AOU257941	DoC
AC Adapter (Server)	Delta Electronics	A1344	MV05104CNAL1A	DoC
Notebook PC (Controller)	Dell	PP18L	10657517725	DoC
AC Adapter (Controller PC)	Dell	LA65SN0-00	CN-ODF263-71615-6AU-1019	DoC

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AIRPLAY MODE:

RADIATED METHOD EUT TEST SETUP



SUPPORT EQUIPMENT

The following support equipment was utilized for the DFS tests documented in this report:

PERIPHERAL SUPPORT EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Wireless Access Point (Master Device)	Cisco	AIR-AP1252AG-A-K9	FTX130390D9	LDK102061
AC Adapter (AP)	Delta Electronics	EADP-45BB B	DTH1049902N	DoC
Notebook PC (Server)	Apple	MacBook Pro A1150	AOU257941	DoC
AC Adapter (Server)	Delta Electronics	A1344	MV05104CNAL1A	DoC
Notebook PC (Controller)	Dell	PP18L	10657517725	DoC
AC Adapter (Controller PC)	Dell	LA65SN0-00	CN-ODF263-71615-6AU-1019	DoC
Apple TV (Peer Slave Device)	Apple	A1427	C07GY040F14P	BCGA1427
LCD Monitor	Dell	Prototype	6279	N/A

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.1.4. DESCRIPTION OF EUT

The EUT operates over the 5250-5350 MHz and 5470-5725 MHz ranges.

The EUT is a Slave Device without Radar Detection.

The highest power level within these bands is 21.6 dBm EIRP in the 5250-5350 MHz band and 21.18 dBm EIRP in the 5470-5725 MHz band.

The only antenna assembly utilized with the EUT has a gain of 4.25 dBi in the 5250-5350 MHz band and 4.51 dBi in the 5470-5725 MHz band.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides margin to the limit.

The EUT uses one transmitter/receiver chain connected to an antenna to perform radiated tests.

In the client mode, WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master to the Slave in full motion video mode using Safari web browser. In the Client-to-Client Communications mode, WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master, to the Slave, and mirror to the peer slave device in full motion video mode using Safari web browser.

TPC is not required since the maximum EIRP is less than 500 mW (27 dBm).

The EUT utilizes the 802.11a/n architecture. Two nominal channel bandwidths of 20 MHz and 40 MHz are implemented in standard client mode. One nominal channel bandwidth of 20 MHz is implemented in Client-to-Client Communications mode.

The software installed in the EUT is IOS (Build 10A371).

UNIFORM CHANNEL SPREADING

This requirement is not applicable to Slave radio devices.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

OVERVIEW OF MASTER DEVICE WITH RESPECT TO §15.407 (h) REQUIREMENTS

The Master Device is a Cisco Access Point, FCC ID: LDK102061. The minimum antenna gain for the Master Device is 3.5 dBi.

The rated output power of the Master unit is > 23dBm (EIRP). Therefore the required interference threshold level is –64 dBm. After correction for procedural adjustments, the required radiated threshold at the antenna port is –64 + 1 = -63 dBm.

The calibrated radiated DFS Detection Threshold level is set to –64 dBm. The tested level is lower than the required level hence it provides margin to the limit.

The software installed in the access point is 12.4(25d)JA1.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

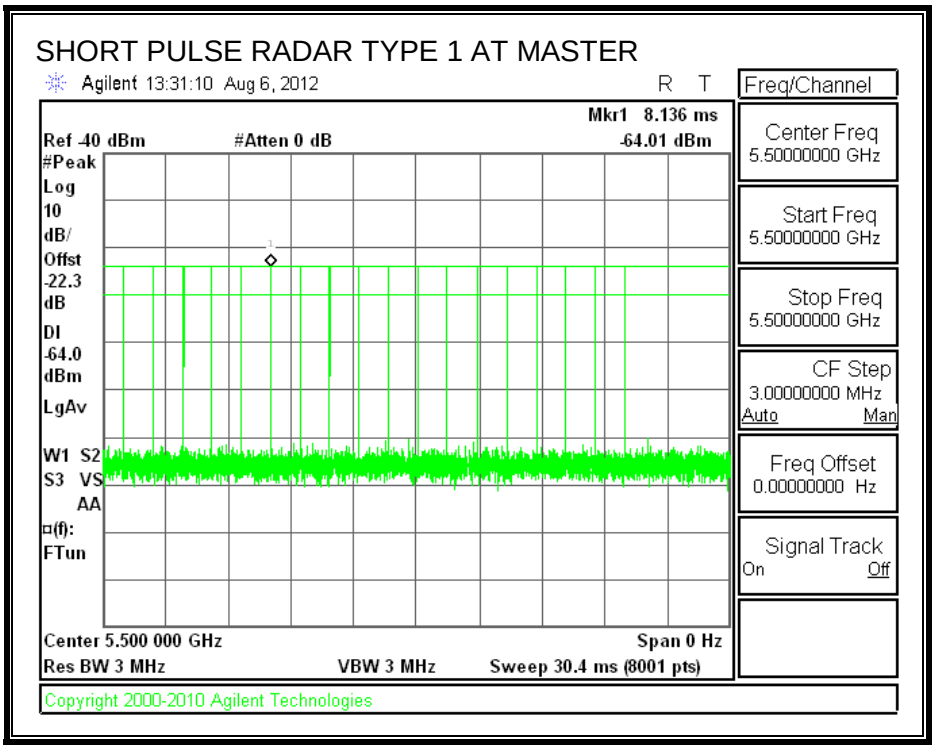
11.2. CLIENT MODE RESULTS FOR 20 MHz BANDWIDTH

11.2.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5500 MHz.

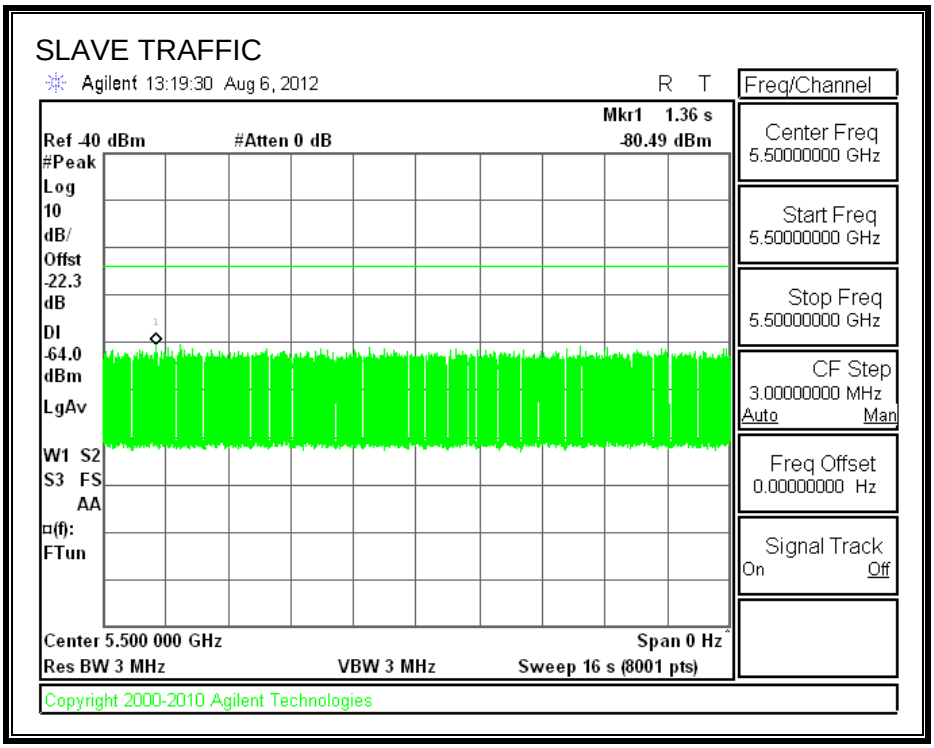
11.2.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TRAFFIC



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.2.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.2.4. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

The observation period over which the FCC aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

The observation period over which the IC aggregate time is calculated begins at (Reference Marker) and ends no earlier than (Reference Marker + 10 sec).

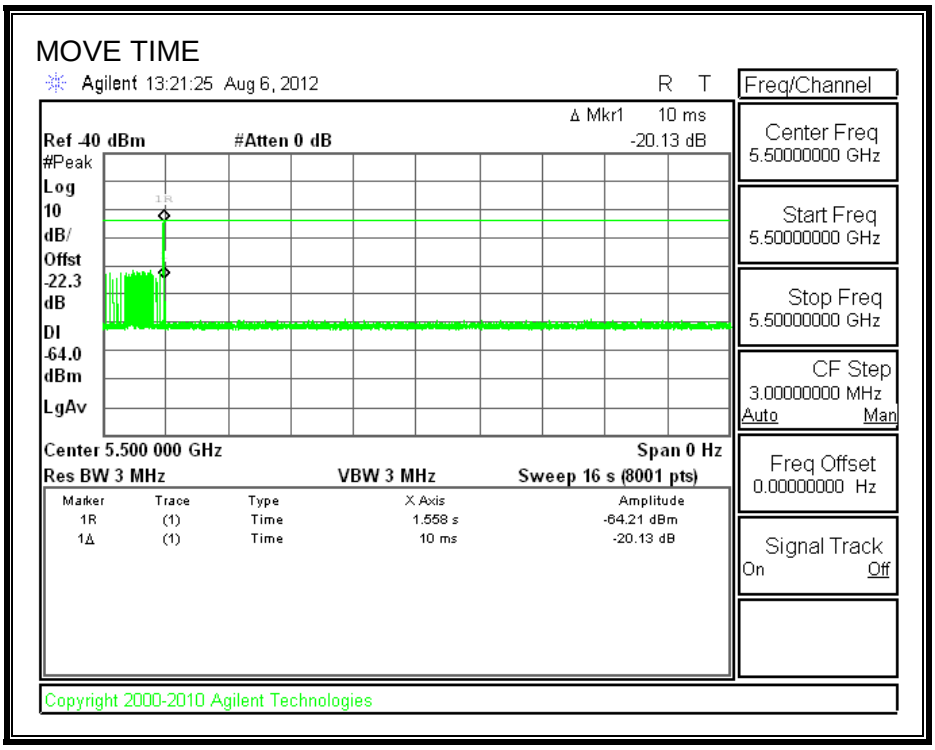
RESULTS

Agency	Channel Move Time (sec)	Limit (sec)
FCC / IC	0.010	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	4.0	260

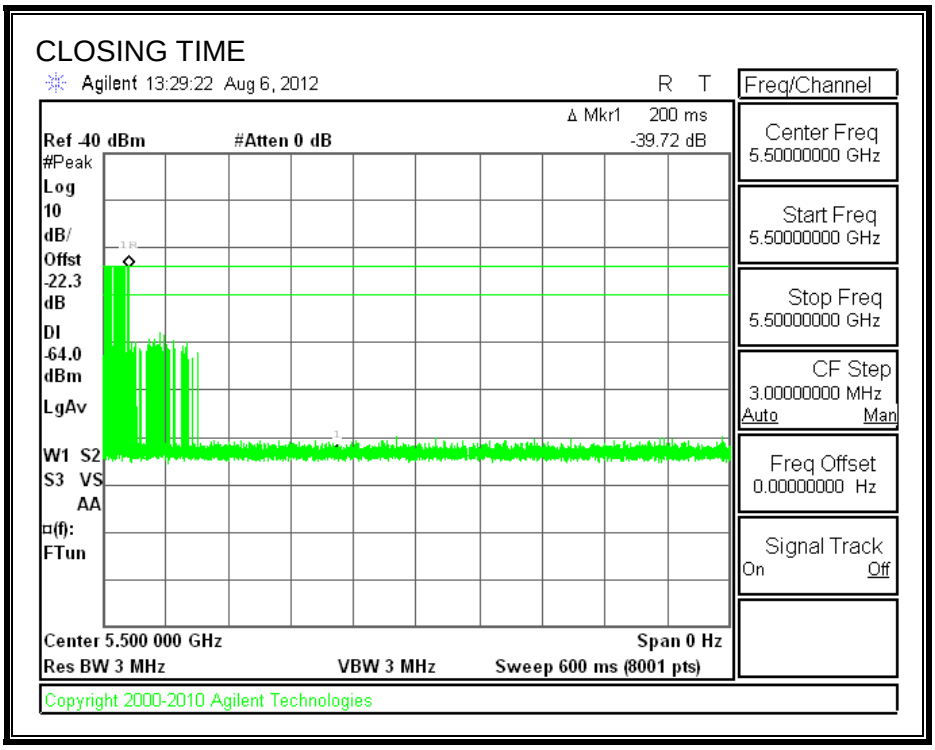
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

MOVE TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

CHANNEL CLOSING TIME

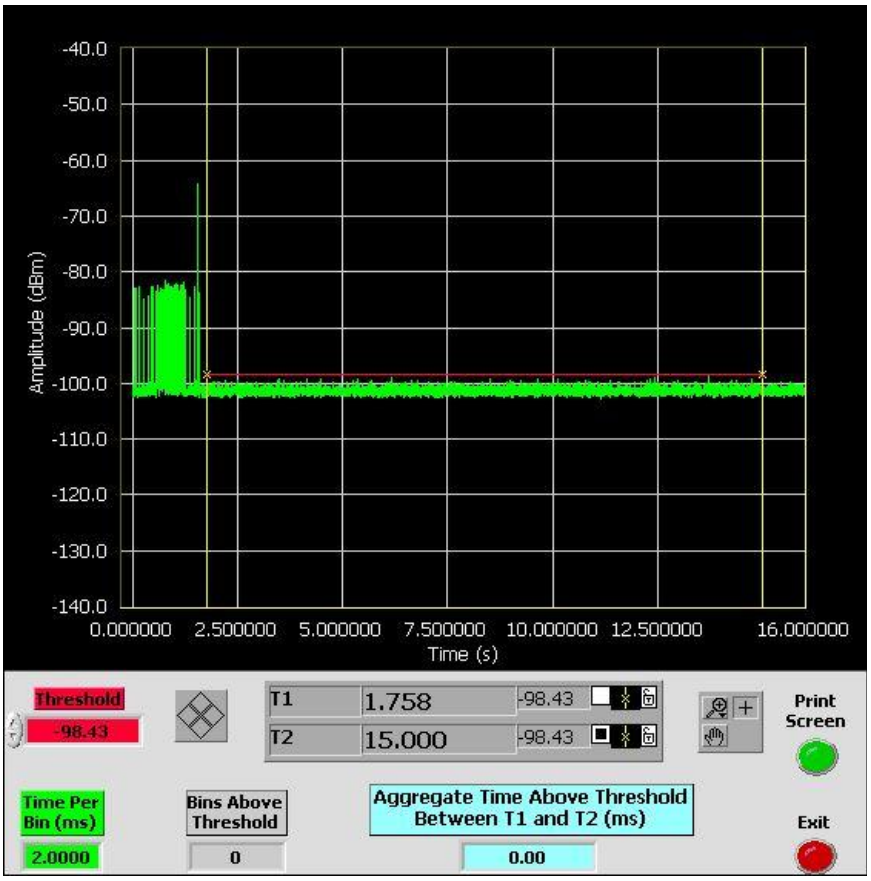


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

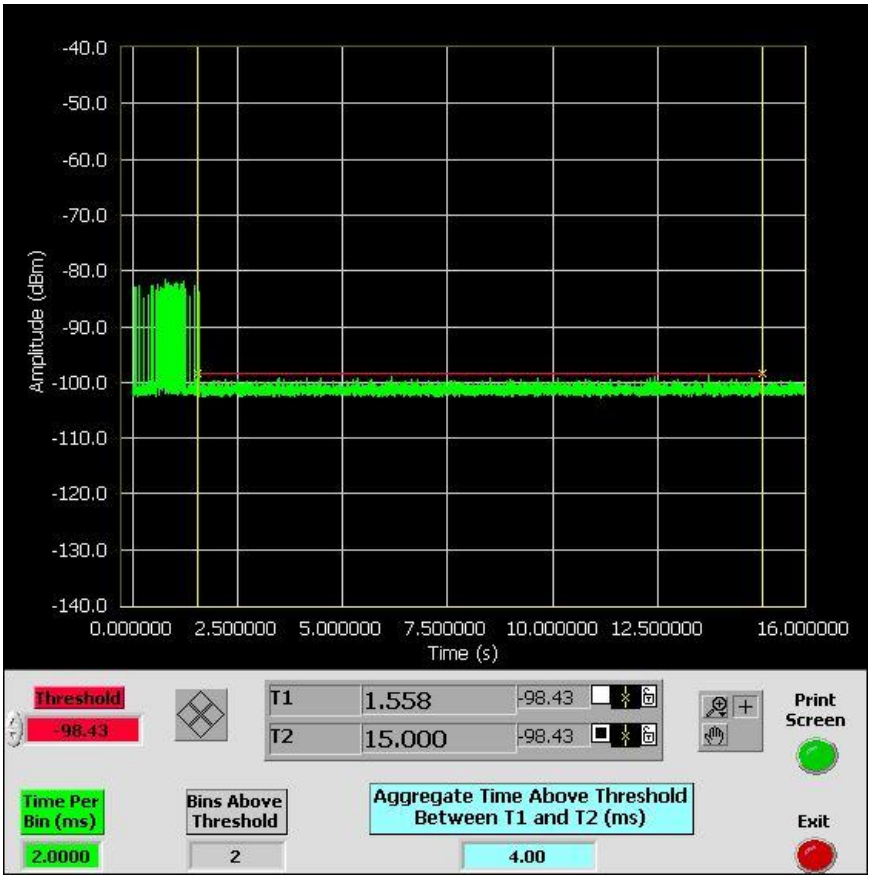
FCC AGGREGATE CLOSING TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Only intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

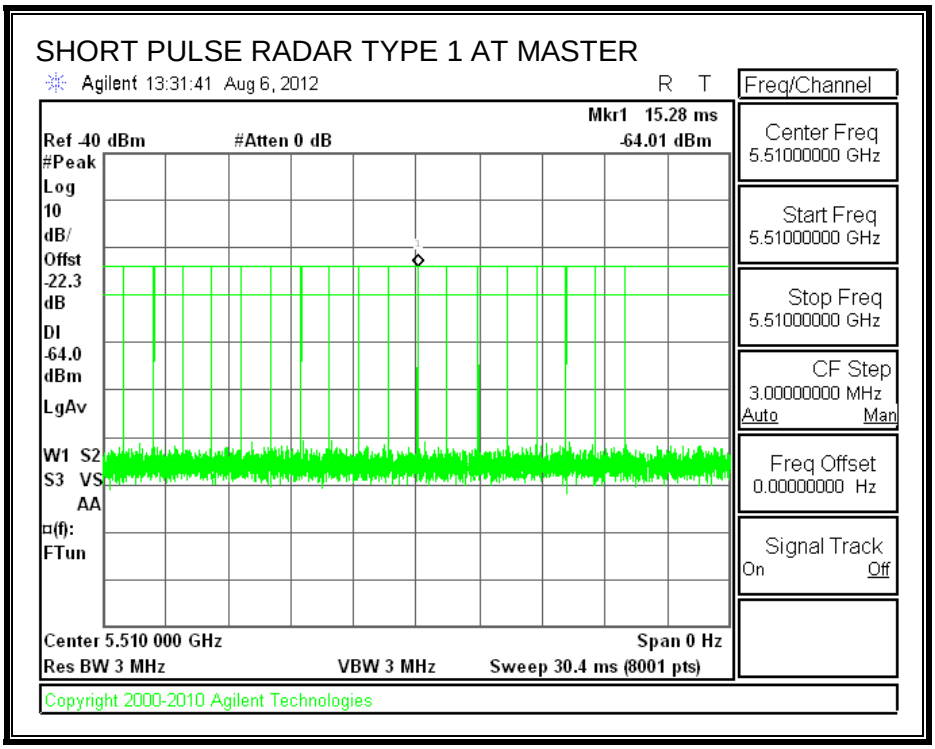
11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH

11.3.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5510 MHz.

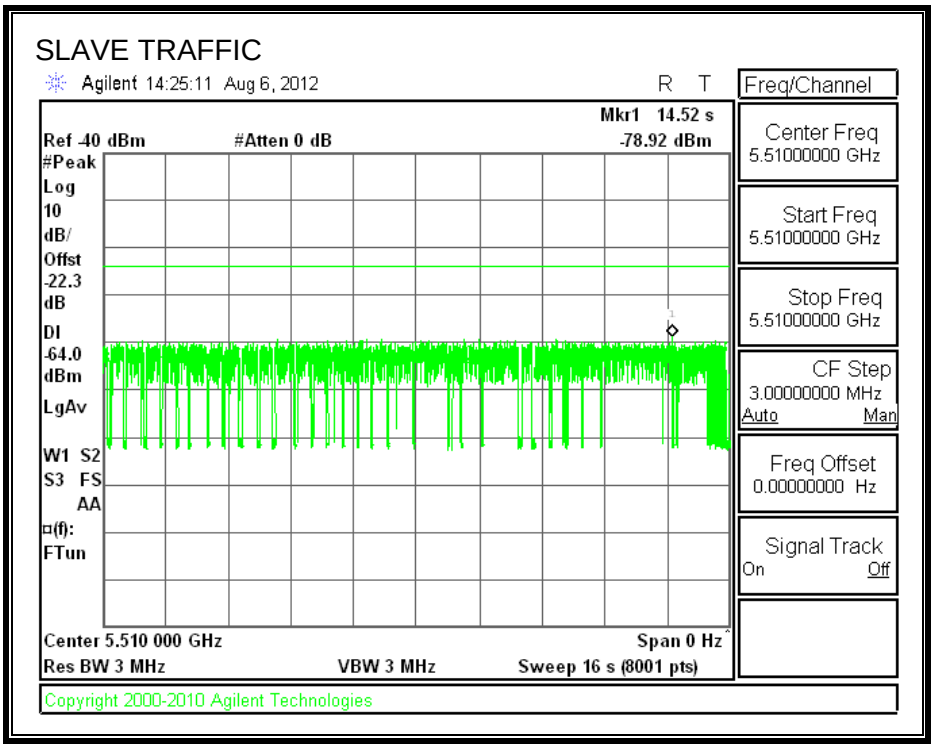
11.3.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TRAFFIC



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.3.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.3.4. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

The observation period over which the FCC aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

The observation period over which the IC aggregate time is calculated begins at (Reference Marker) and ends no earlier than (Reference Marker + 10 sec).

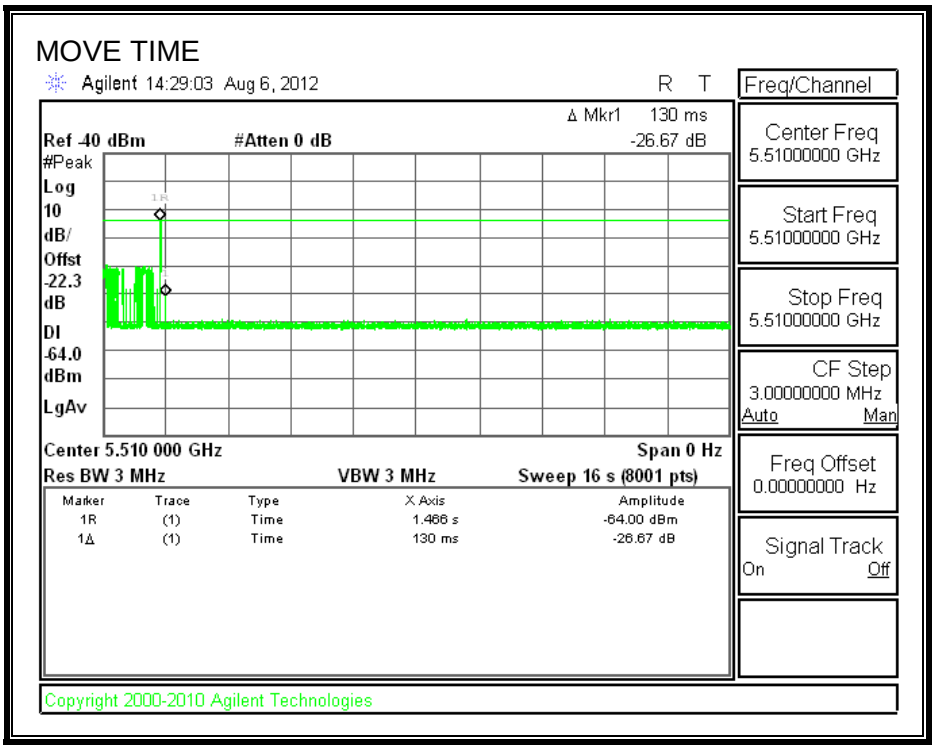
RESULTS

Agency	Channel Move Time (sec)	Limit (sec)
FCC / IC	0.130	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	2.0	260

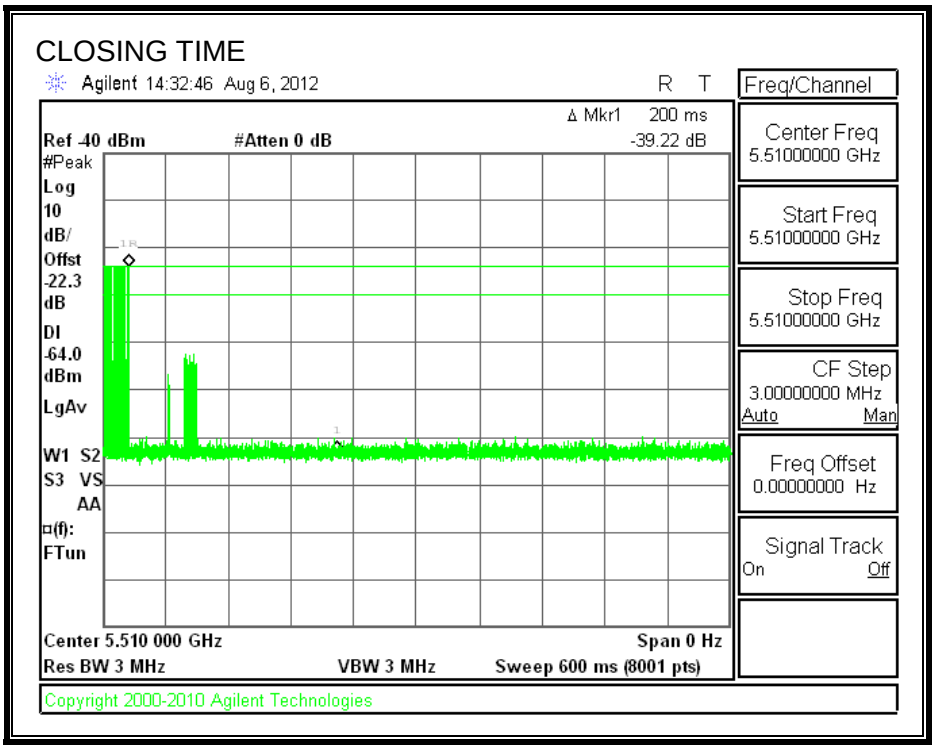
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

MOVE TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

CHANNEL CLOSING TIME

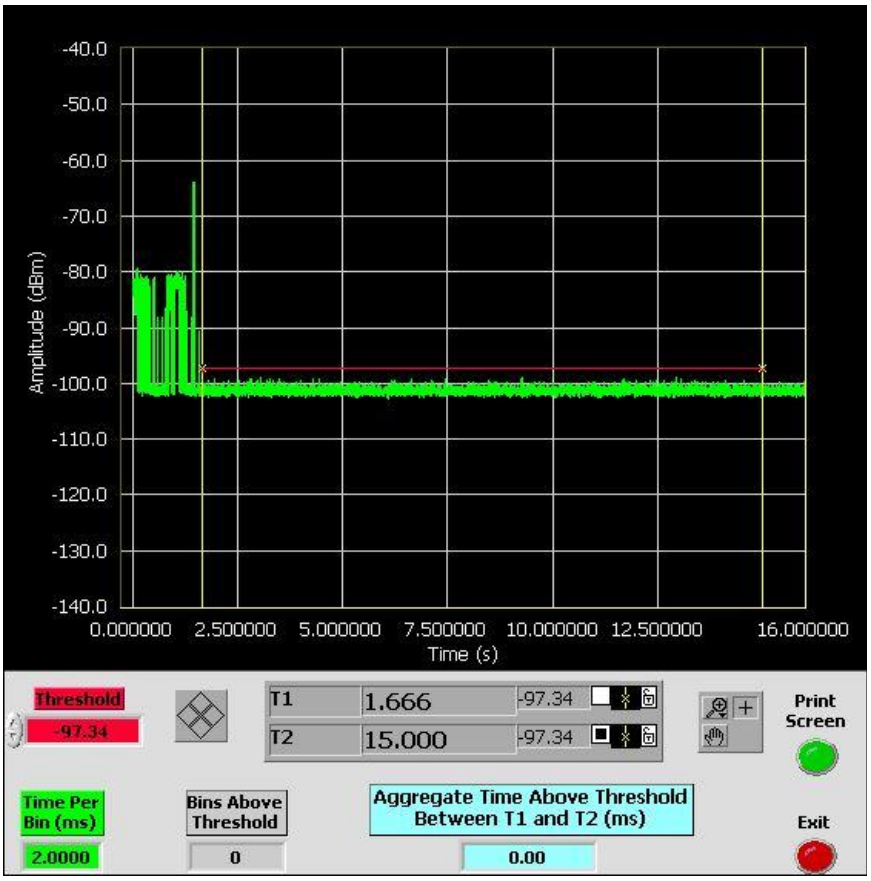


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

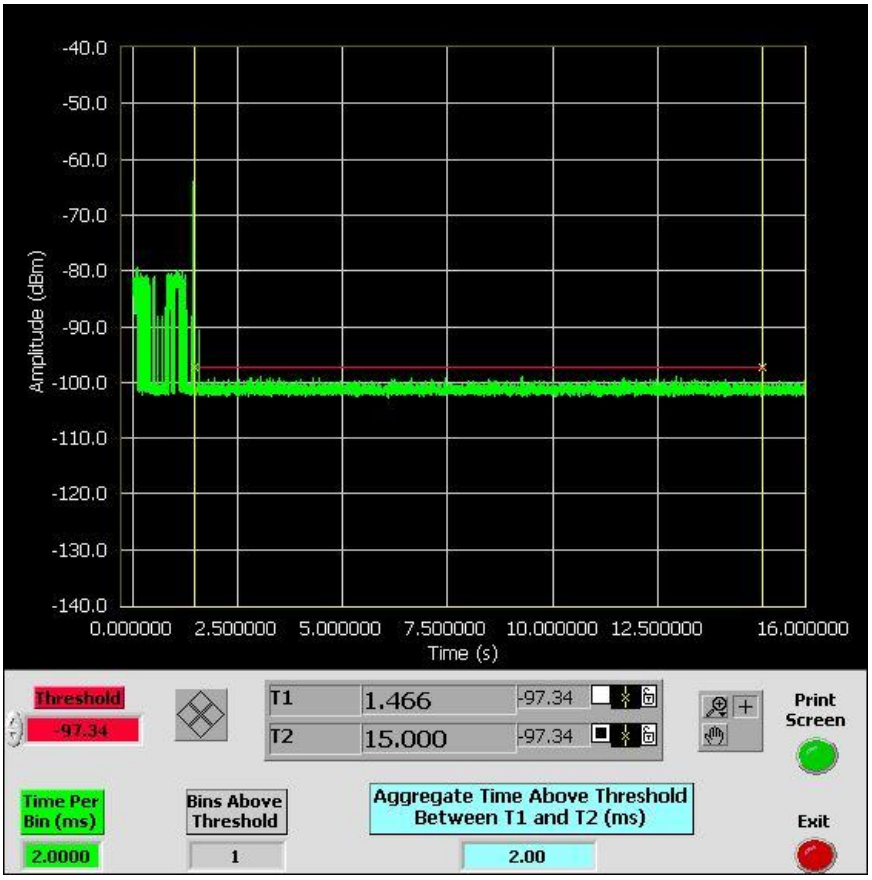
FCC AGGREGATE CLOSING TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Only intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME

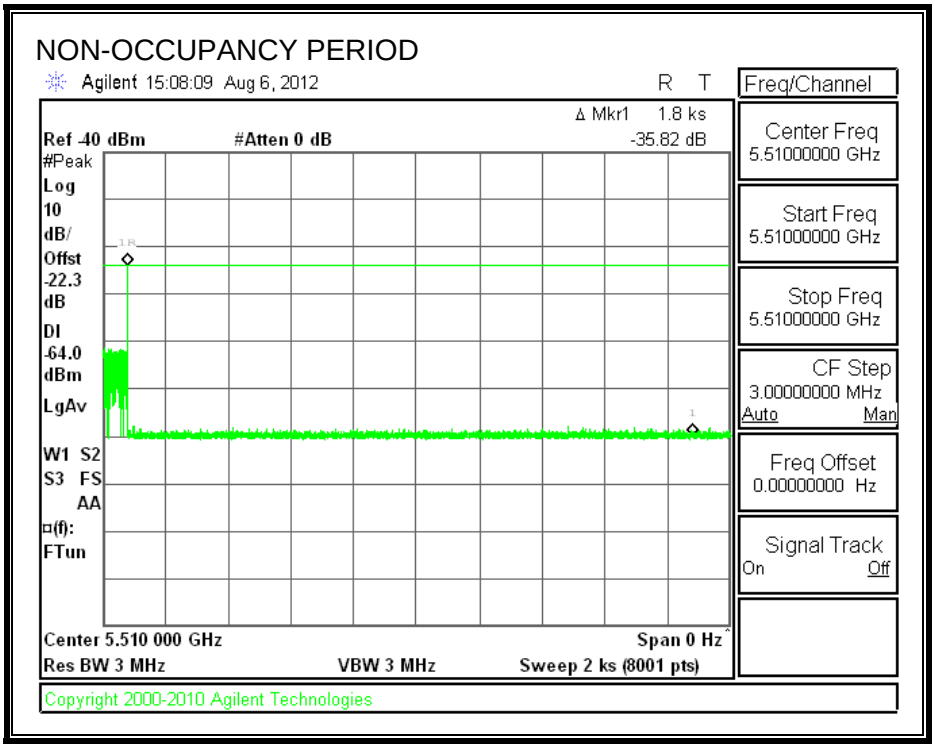


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.3.5. NON-OCCUPANCY PERIOD

RESULTS

No EUT transmissions were observed on the test channel during the 30-minute observation time.



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

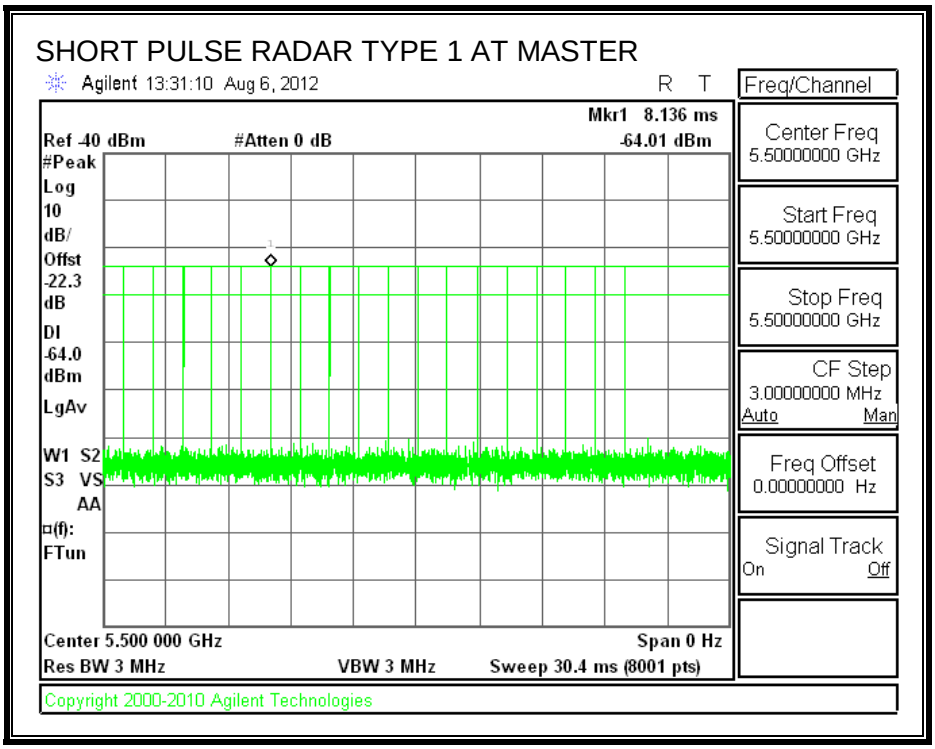
11.4. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 20 MHz BANDWIDTH

11.4.1. TEST CHANNEL

All tests were performed at a channel center frequency of 5500 MHz.

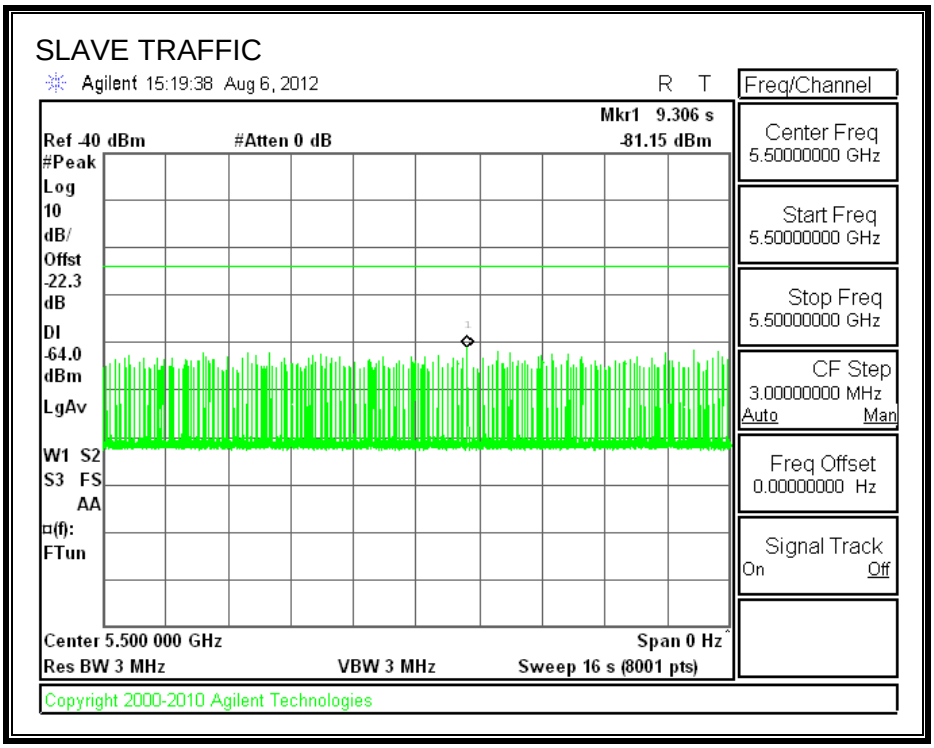
11.4.2. RADAR WAVEFORM AND TRAFFIC

RADAR WAVEFORM



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TRAFFIC



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

11.4.3. OVERLAPPING CHANNEL TESTS

RESULTS

These tests are not applicable.

11.4.4. MOVE AND CLOSING TIME

REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =
(Number of analyzer bins showing transmission) * (dwell time per bin)

The observation period over which the FCC aggregate time is calculated begins at (Reference Marker + 200 msec) and ends no earlier than (Reference Marker + 10 sec).

The observation period over which the IC aggregate time is calculated begins at (Reference Marker) and ends no earlier than (Reference Marker + 10 sec).

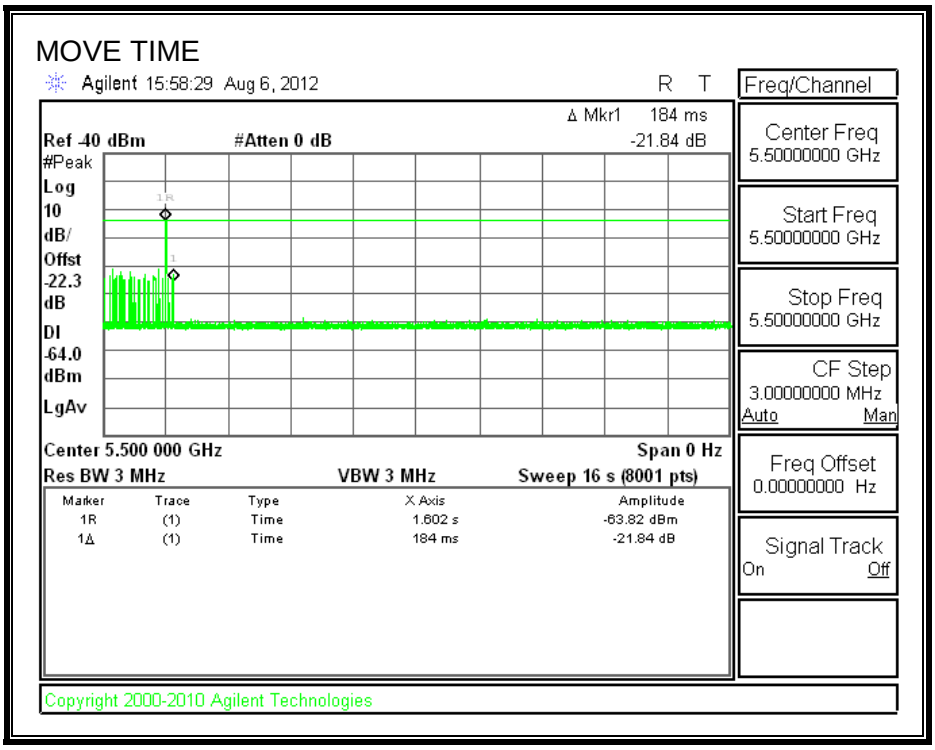
RESULTS

Agency	Channel Move Time (sec)	Limit (sec)
FCC / IC	0.184	10

Agency	Aggregate Channel Closing Transmission Time (msec)	Limit (msec)
FCC	0.0	60
IC	10.0	260

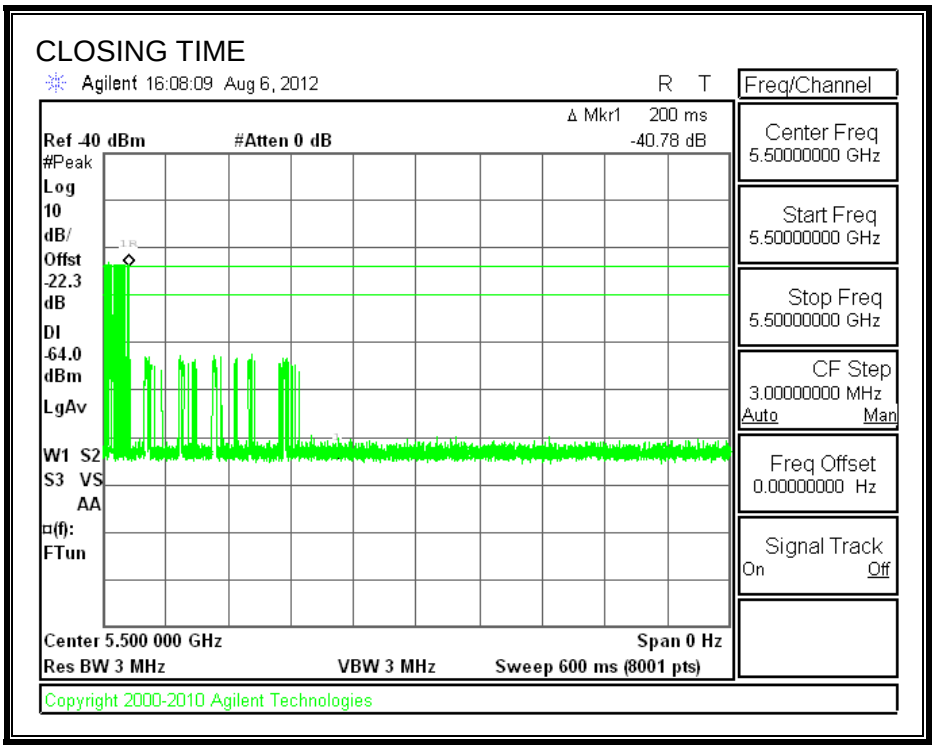
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

MOVE TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

CHANNEL CLOSING TIME

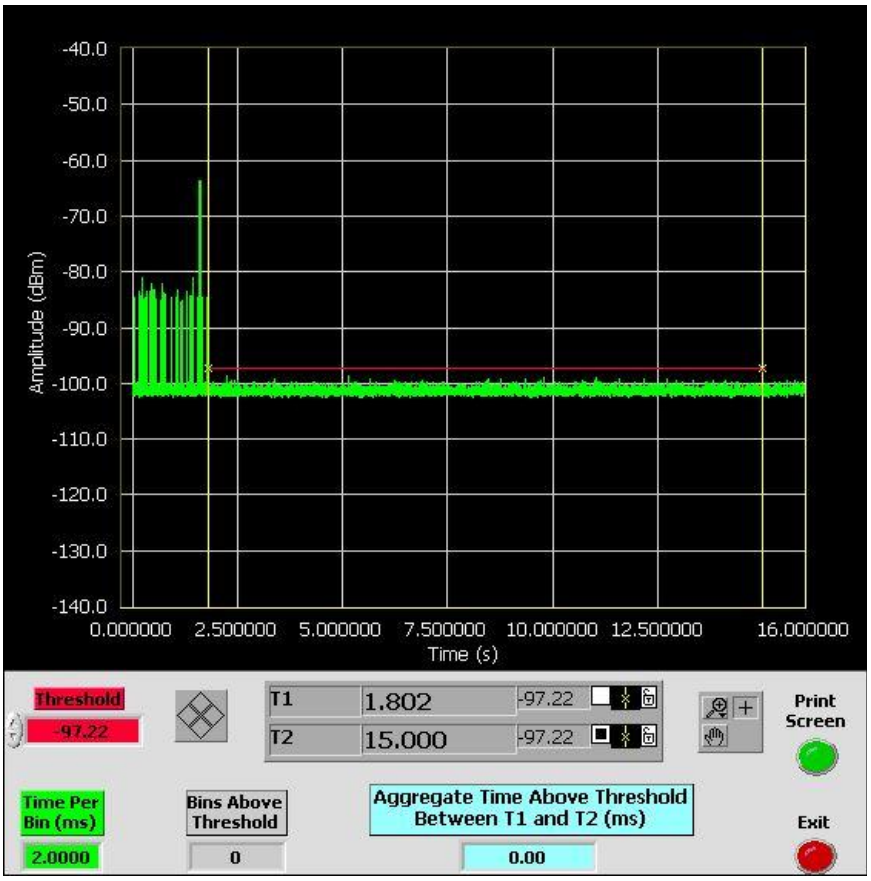


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

AGGREGATE CHANNEL CLOSING TRANSMISSION TIME

No transmissions are observed during the FCC aggregate monitoring period.

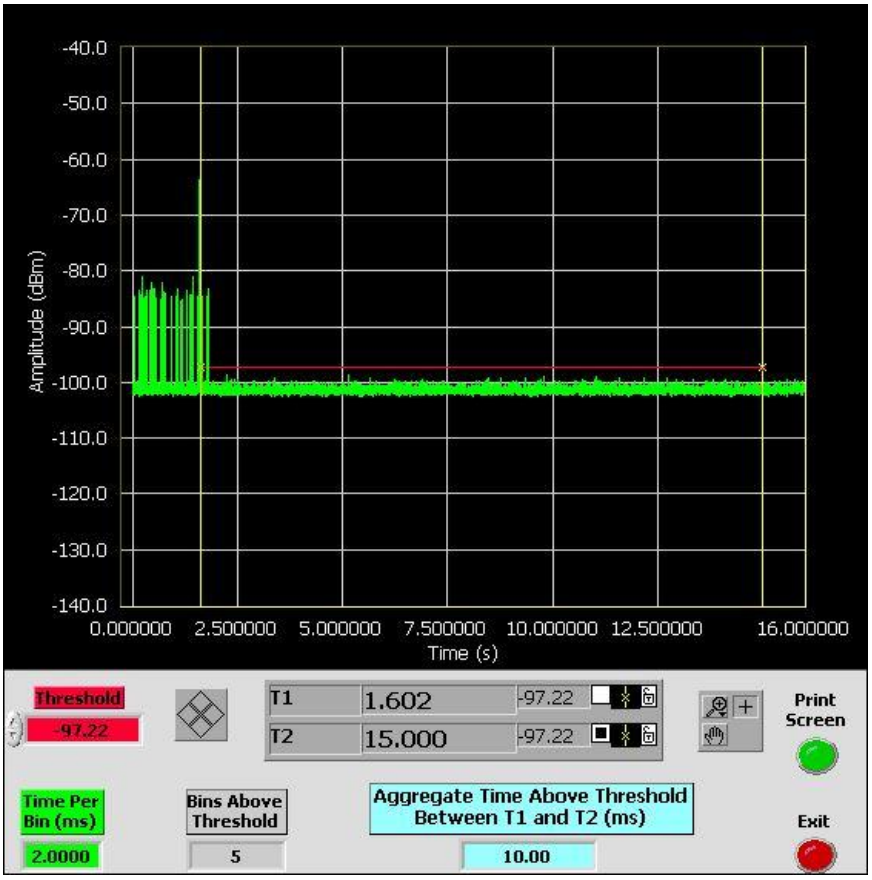
FCC AGGREGATE CLOSING TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

Only intermittent transmissions are observed during the IC aggregate monitoring period.

IC AGGREGATE CLOSING TIME



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.