



Test Report

AIR-CAP2601y-A-K9 AIR-SAP2601y-A-K9

Cisco Aironet 802.11n Dual Band Access Points

**FCC ID: LDK102081
IC: 2461B-102081**

AIR-CAP2602y-A-K9 AIR-SAP2602y-A-K9

Cisco Aironet 802.11n Dual Band Access Points

**FCC ID: LDK102080
IC: 2461B-102080**

Also covers:

AIR-CAP2602y-N-K9, AIR-SAP2602y-N-K9
AIR-CAP2602y-T-K9, AIR-SAP2602y-T-K9
AIR-CAP2602y-Z-K9, AIR-SAP2602y-Z-K9

y = E (External Antenna) or I (Internal Antenna)

2400-2483.5 MHz

Against the following Specifications:

**CFR47 Part 15.247
RSS210**

Cisco Systems
170 West Tasman Drive
San Jose, CA 95134



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Section 1: Overview

1.1 Test Summary

The samples were assessed against the tests detailed in section 3 under the requirements of the following specifications:

Emission	Immunity
CFR47 Part 15.247 RSS210	N/A

The specifications listed above represent actual tests performed to demonstrate compliance against the specifications and basic standards listed on the front cover of this report. This list is not a one to one match to the front cover for one or more of the following reasons.

1. Basic standards call up many different test phenomena specifications such as the 61000-4-X series. The basic standards define which elements and levels shall be applied from these specifications and as such it is not appropriate to list the individual specifications on the front cover.
2. A Standard listed on the front cover may be required in a particular country but is not appropriate for the particular technologies included in the equipment under test. E.g. You cannot test a DC product to the mains Harmonics requirements in EN61000-3-2. See section 3.2.
3. Test results against a particular standard or specification may be included in a different test report. See section 3.2 for an EDCS reference of this data.
4. Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
5. Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.
6. Testing may have been performed to an equivalent test that satisfies the requirements of the standards and specifications listed on the front cover of the report. See section 3.2.
7. Where radiated emissions testing has been performed to EN55022/CISPR22 the additional requirements of VCCI: V- 3/2006.04, EN55022: 1994 +A1/2 and CAN/CSA- CISPR 22-02 have also been evaluated unless otherwise stated.
8. Testing to the requirements of CFR47 Part 15 was performed against the CISPR22 limits. The results are therefore deemed satisfactory evidence of compliance with Industry Canada Interference Causing Equipment Standard ICES-003.
9. Where assessment has been performed to CISPR24, all the applicable test requirements may have not been covered. Refer to the results section for the tests performed.

Notes:

- 1) Where a specification listed on the front cover of this report has deviations from the basic standards listed above, the additional technical requirements of the specification were also assessed.
- 2) Where appropriate, Cisco may have substituted a later revision of a basic standard to those referenced in the specification on the front sheet of this test report. This decision was based upon improved test methodology and repeatability and/or where the newer revision represented a more stringent test.
- 3) Where relevant, testing has been carried out to the requirements of both EN and IEC Specifications. This was possible because of the similarities of the test methods involved and the Cisco EMC test procedures.



Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc:

With regard to this assessment, the following points should be noted:

- a) The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.
- b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.
- c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).
- d) All testing was performed under the following environmental conditions:

Temperature	15°C to 35°C (54°F to 95°F)
Atmospheric Pressure	860mbar to 1060mbar (25.4" to 31.3")
Humidity	10% to 75*%

*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.
- e) All AC testing was performed at one or more of the following supply voltages:

110V 60 Hz (+/-20%)
220V 50 Hz (+/-20%)

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2.2 Date of testing

06-February-2012 – 24-February-2012

2.3 Report Issue Date

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled

2.4 Testing facilities

This assessment was performed by:

Testing Laboratory

Cisco Systems, Inc.,	Cisco Systems, Inc.
4125 Highlander Parkway	170 West Tasman Drive
Richfield, OH 44286	San Jose, CA 95134
USA	USA

Test Engineers

James Nicholson

2.5 Equipment Assessed (EUT)

AIR-CAP2602E-A-K9 Cisco Aironet 802.11n Dual Band Access Point



2.6 EUT Description

The 2600 Series Cisco Aironet 802.11n Dual Band Access Points support the following modes of operation. The modes are further defined in the radio Theory of Operation. The modes included in this report represent the worst case data for all modes.

- Legacy CCK, One Antenna, 1 to 11 Mbps
- Legacy CCK, Two Antennas, 1 to 11 Mbps
- Legacy CCK, Three Antennas, 1 to 11 Mbps
- Legacy CCK, Four Antennas, 1 to 11 Mbps

- Non HT-20, One Antenna, 6 to 54 Mbps
- Non HT-20, Two Antennas, 6 to 54 Mbps
- Non HT-20, Three Antennas, 6 to 54 Mbps
- Non HT-20, Four Antennas, 6 to 54 Mbps

- Non HT-20 Beam Forming, Two Antennas, 6 to 54 Mbps
- Non HT-20 Beam Forming, Three Antennas, 6 to 54 Mbps
- Non HT-20 Beam Forming, Four Antennas, 6 to 54 Mbps

- HT-20, One Antenna, M0 to M7
- HT-20, Two Antennas, M0 to M15
- HT-20, Three Antennas, M0 to M23
- HT-20, Four Antennas, M0 to M23

- HT-20 STBC, Two Antennas, M0 to M7
- HT-20 STBC, Three Antennas, M0 to M7
- HT-20 STBC, Four Antennas, M0 to M7

- HT-20 Beam Forming, Two Antennas, M0 to M15
- HT-20 Beam Forming, Three Antennas, M0 to M23
- HT-20 Beam Forming, Four Antennas, M0 to M23



The following antennas are supported by this product series.

The data included in this report represent the worst case data for all antennas.

Frequency	Part Number	Antenna Type	Antenna Gain (dBi)
2.4/5 GHz	AIR-ANT2524DB-R	Dual-resonant black dipole	2 / 4
	AIR-ANT2524DW-R	Dual-resonant white dipole	2 / 4
	AIR-ANT2524DG-R	Dual-resonant gray dipole	2 / 4
	Internal	Dual-resonant Omni	4 / 4
	AIR-ANT2534V4C-R	Dual-resonant ceiling mount omni (4-pack)	3 / 4
	AIR-ANT2544V4M-R	Dual-resonant omni (4-pack)	4 / 4
	AIR-ANT2566P4W-R	Dual-resonant "directional" antenna (4-pack)	6 / 6



Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing. Please also refer to the "Justification for worst Case test Configuration" section of this report for further details on the selection of EUT samples.

4.1 Sample Details (Photographs of the test samples, where appropriate can be found in appendix H)

Sample No.	Equipment Details	Part Number	Manufacturer	Hardware Rev.	Firmware Rev.	Software Rev.	Serial Number
S01	AIR-CAP2602E-A-K9		Cisco Systems	NA	NA	NA	
S02	AIR-PWR-B	341-0306-01	Cisco Systems	NA	NA	NA	

4.2 System Details

System #	Description	Samples
1	EUT	S01, S02

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Continuous Transmitting	Continuous Transmitting



Appendix A: Emission Test Results

Testing Laboratory: Cisco Systems, Inc., 4125 Highlander Parkway, Richfield, OH, USA

Target Maximum Channel Power

The following table details the maximum supported Total Channel Power for all operating modes.

Operating Mode	Maximum Channel Power (dBm)		
	Frequency (MHz)		
	2412	2437	2462
Legacy CCK, 1 to 11 Mbps	22	23	23
Non HT-20, 6 to 54 Mbps	17	23	18
Non HT-20 Beam Forming, 6 to 54 Mbps	14	22	15
HT-20, M0 to M23	16	23	17
HT-20 STBC, M0 to M7	16	23	17
HT-20 Beam Forming, M0 to M23	18	22	18



6dB Bandwidth

15.247: Systems using digital modulation techniques may operate in the 2400-2483.5MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.

Connect the antenna port(s) to the spectrum analyzer input. Using the spectrum analyzer Channel Bandwidth mode, configure the spectrum analyzer as shown below (enter all losses between the transmitter output and the spectrum analyzer).

Center Frequency:	Frequency from table below
Span:	2 x Nominal Bandwidth (e.g. 40MHz for a 20MHz channel)
Reference Level:	20 dBm
Attenuation:	10 dB
Sweep Time:	5 s
Resolution Bandwidth:	100 kHz
Video Bandwidth:	100 kHz
X dB Bandwidth:	6 dB
Detector:	Peak
Trace:	Single

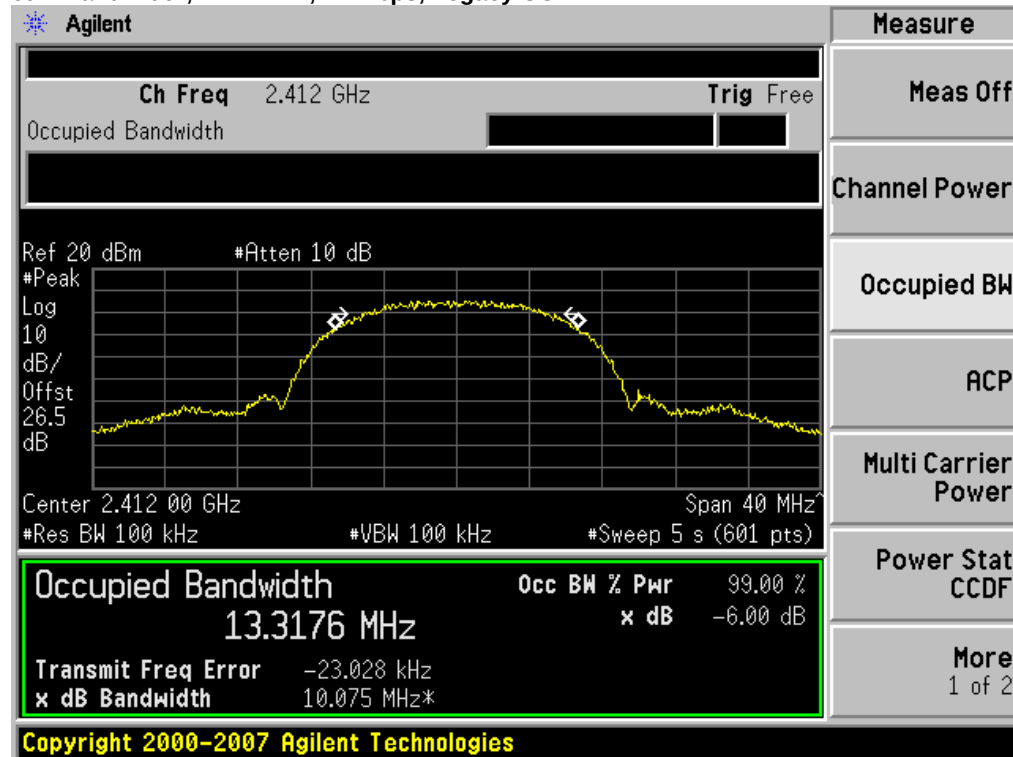
Place the radio in continuous transmit mode. View the transmitter waveform on the spectrum analyzer, and record the pertinent measurements:



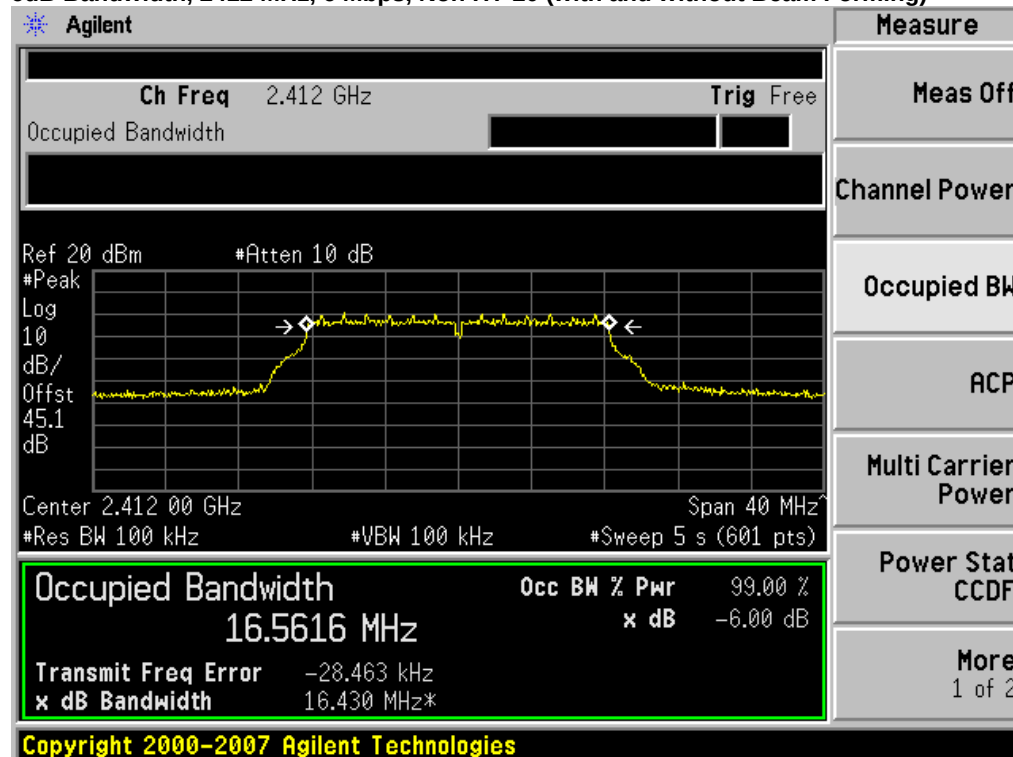
6dB Channel Bandwidth

Frequency (MHz)	Mode	Data Rate (Mbps)	6dB BW (MHz)	Limit (kHz)	Margin (MHz)
2412	Legacy CCK, 1 to 11 Mbps	11	10.1	>500	9.6
	Non HT-20, 6 to 54 Mbps	6	16.4	>500	15.9
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	16.4	>500	15.9
	HT-20, M0 to M23	m0	17.7	>500	17.2
	HT-20 STBC, M0 to M7	m0	17.7	>500	17.2
	HT-20 Beam Forming, M0 to M23	m0	17.7	>500	17.2
2437	Legacy CCK, 1 to 11 Mbps	11	10.8	>500	10.3
	Non HT-20, 6 to 54 Mbps	6	16.4	>500	15.9
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	16.4	>500	15.9
	HT-20, M0 to M23	m0	17.7	>500	17.2
	HT-20 STBC, M0 to M7	m0	17.7	>500	17.2
	HT-20 Beam Forming, M0 to M23	m0	17.7	>500	17.2
2462	Legacy CCK, 1 to 11 Mbps	11	10.9	>500	10.4
	Non HT-20, 6 to 54 Mbps	6	16.4	>500	15.9
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	16.4	>500	15.9
	HT-20, M0 to M23	m0	17.7	>500	17.2
	HT-20 STBC, M0 to M7	m0	17.7	>500	17.2
	HT-20 Beam Forming, M0 to M23	m0	17.7	>500	17.2

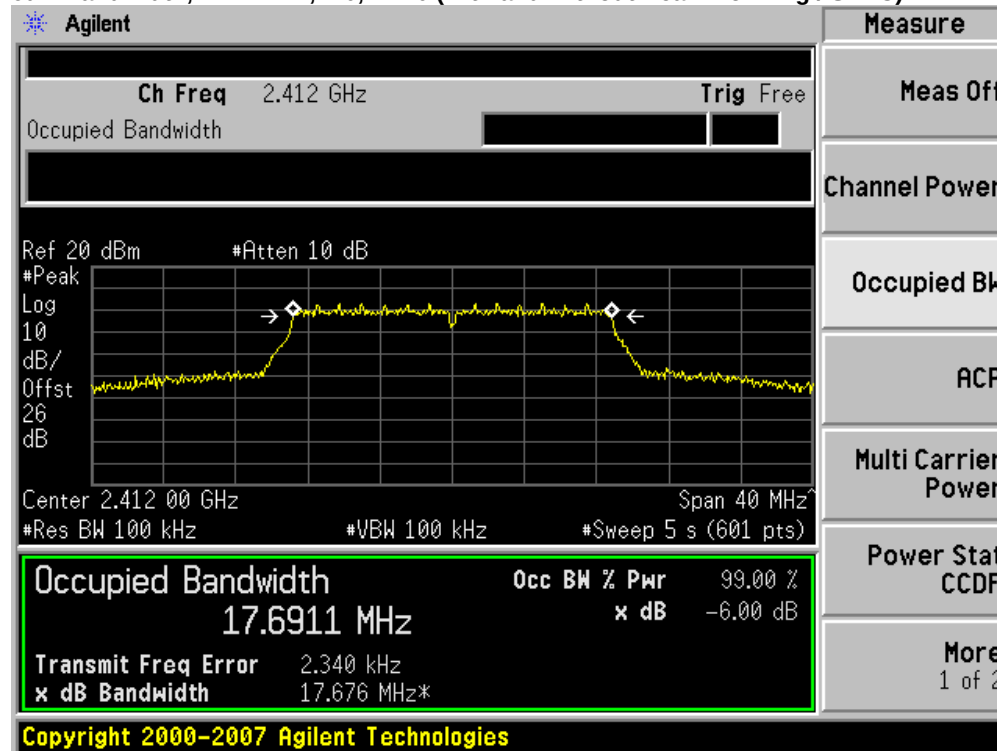
6dB Bandwidth, 2412 MHz, 11 Mbps, Legacy CCK



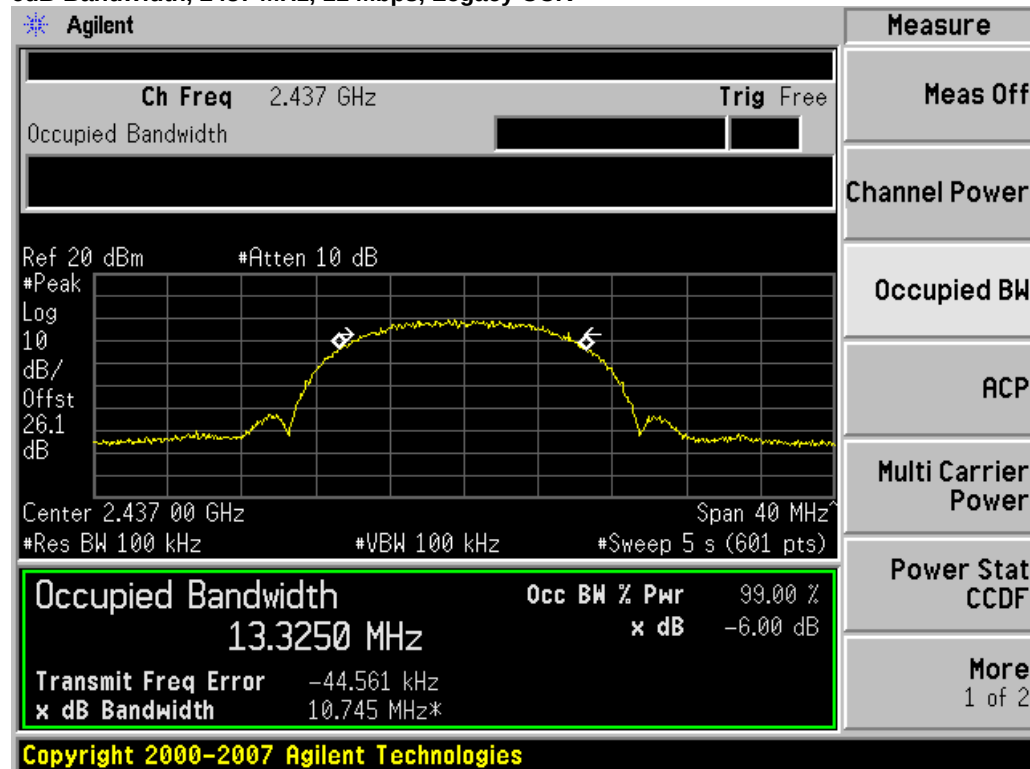
6dB Bandwidth, 2412 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



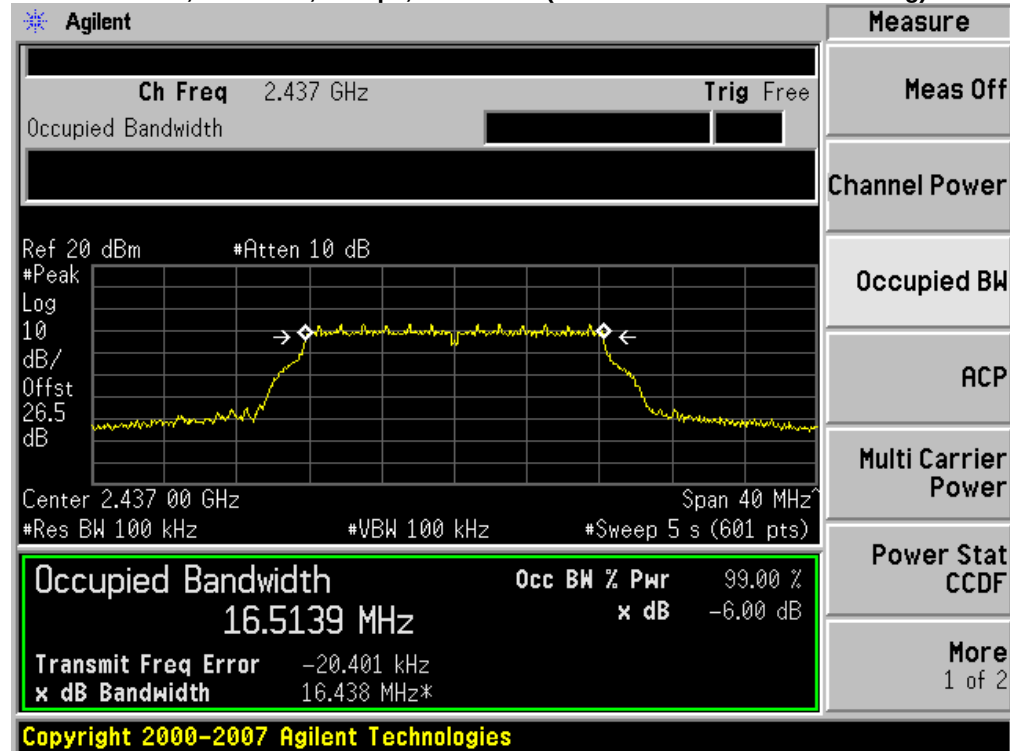
6dB Bandwidth, 2412 MHz, m0, HT20 (with and without Beam Forming / STBC)



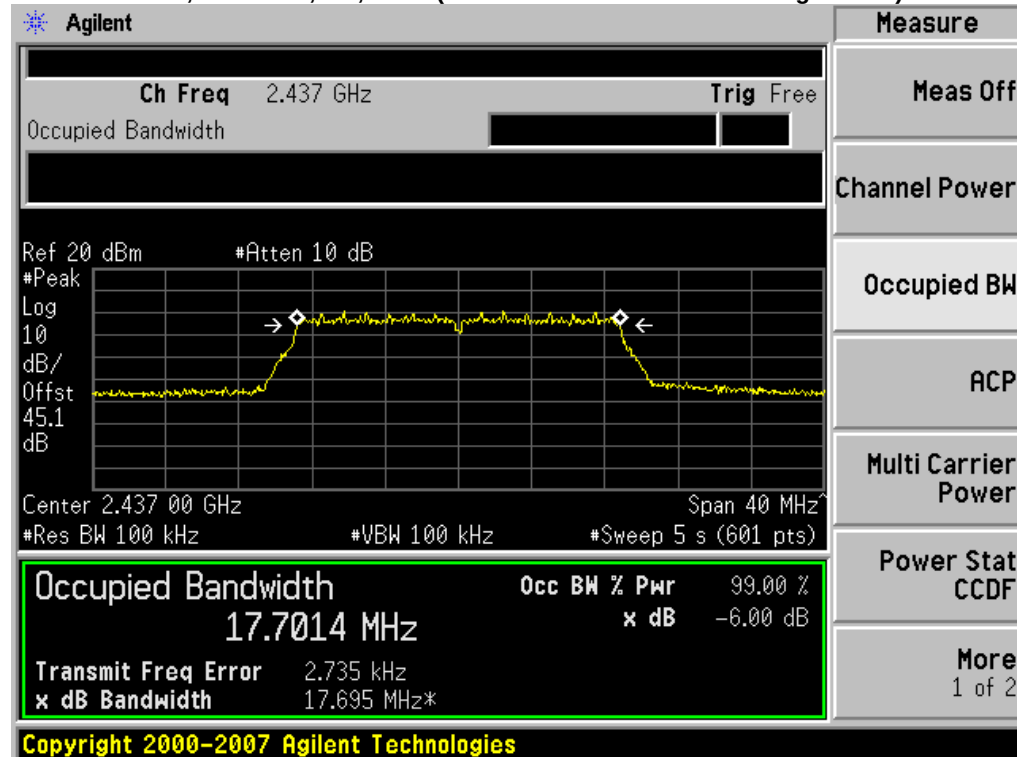
6dB Bandwidth, 2437 MHz, 11 Mbps, Legacy CCK



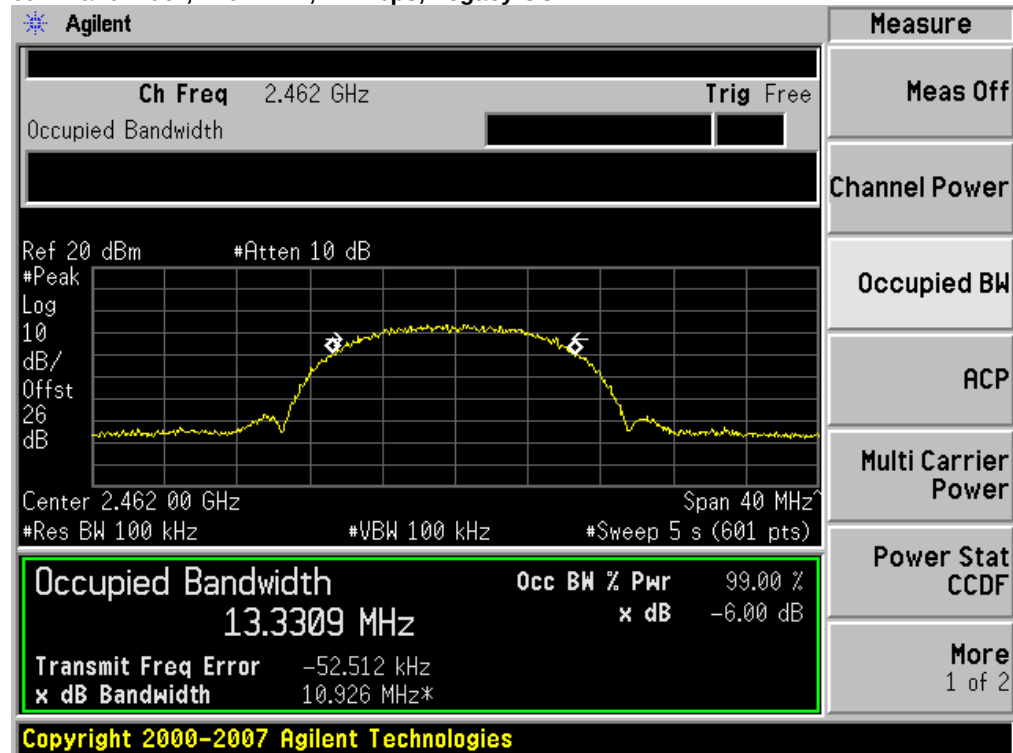
6dB Bandwidth, 2437 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



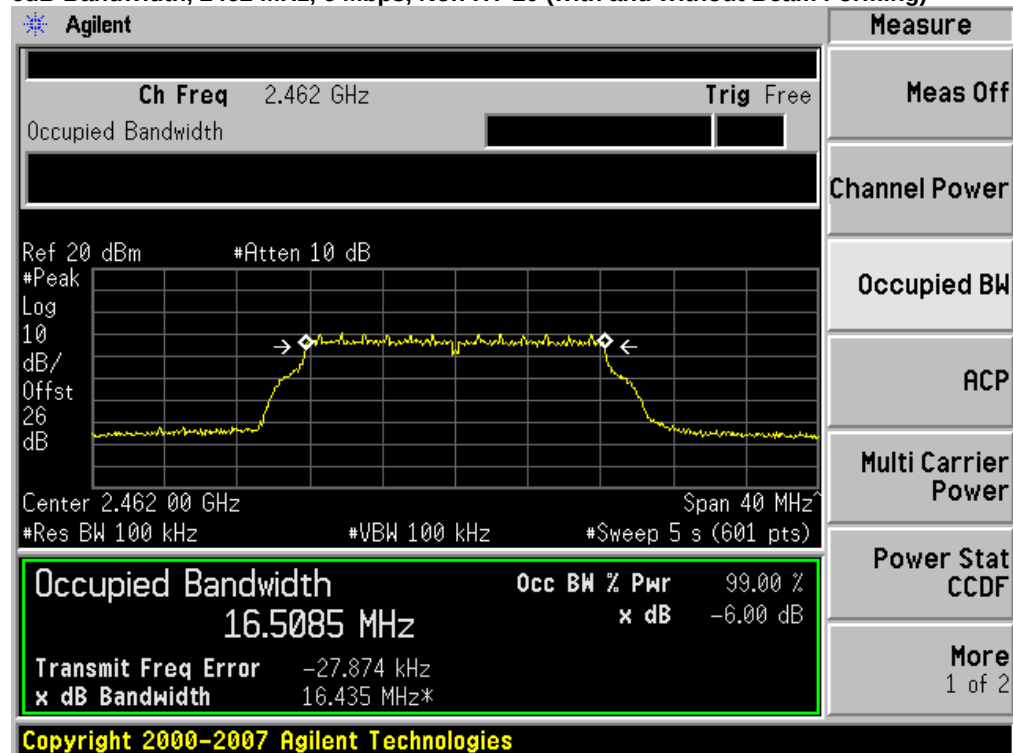
6dB Bandwidth, 2437 MHz, m0, HT20 (with and without Beam Forming / STBC)



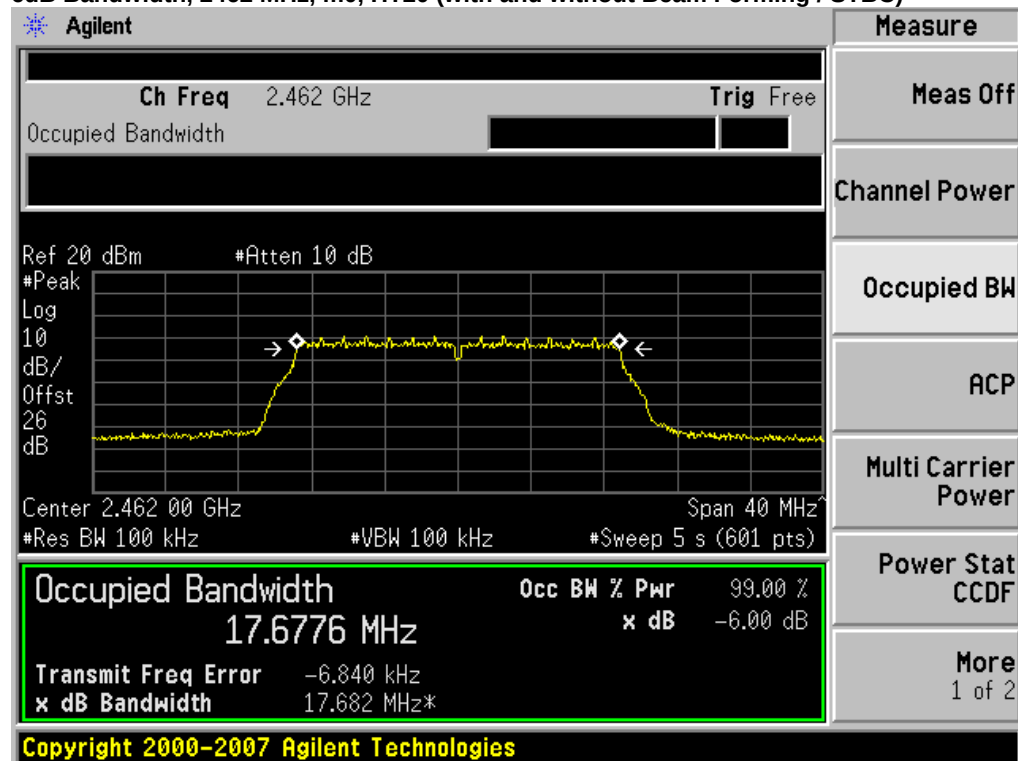
6dB Bandwidth, 2462 MHz, 11 Mbps, Legacy CCK



6dB Bandwidth, 2462 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



6dB Bandwidth, 2462 MHz, m0, HT20 (with and without Beam Forming / STBC)





99% and 26dB Bandwidth

Connect the antenna port(s) to the spectrum analyzer input. Using the spectrum analyzer Channel Bandwidth mode, configure the spectrum analyzer as shown below (enter all losses between the transmitter output and the spectrum analyzer).

Center Frequency:	Frequency from table below
Span:	2 x Nominal Bandwidth (e.g. 40MHz for a 20MHz channel)
Reference Level:	20 dBm
Attenuation:	10 dB
Sweep Time:	5 s
Resolution Bandwidth:	1%-3% of 26 dB Bandwidth
Video Bandwidth:	≥Resolution Bandwidth
X dB Bandwidth:	26 dB
Detector:	Peak
Trace:	Single

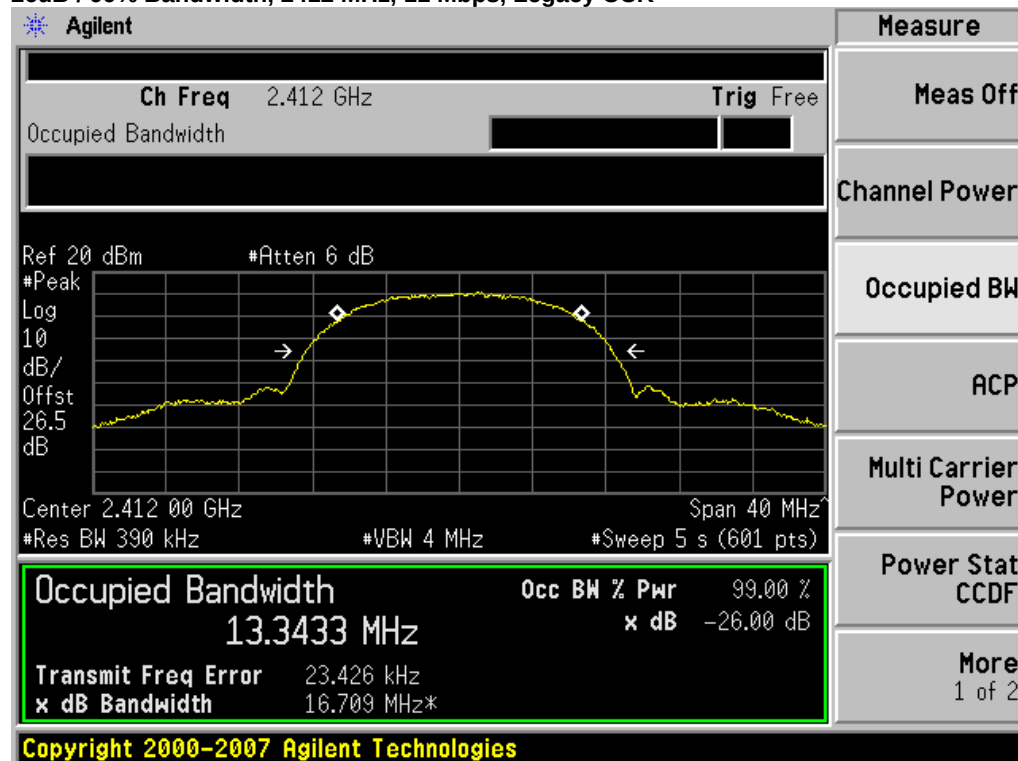
Place the radio in continuous transmit mode. View the transmitter waveform on the spectrum analyzer, and record the pertinent measurements:



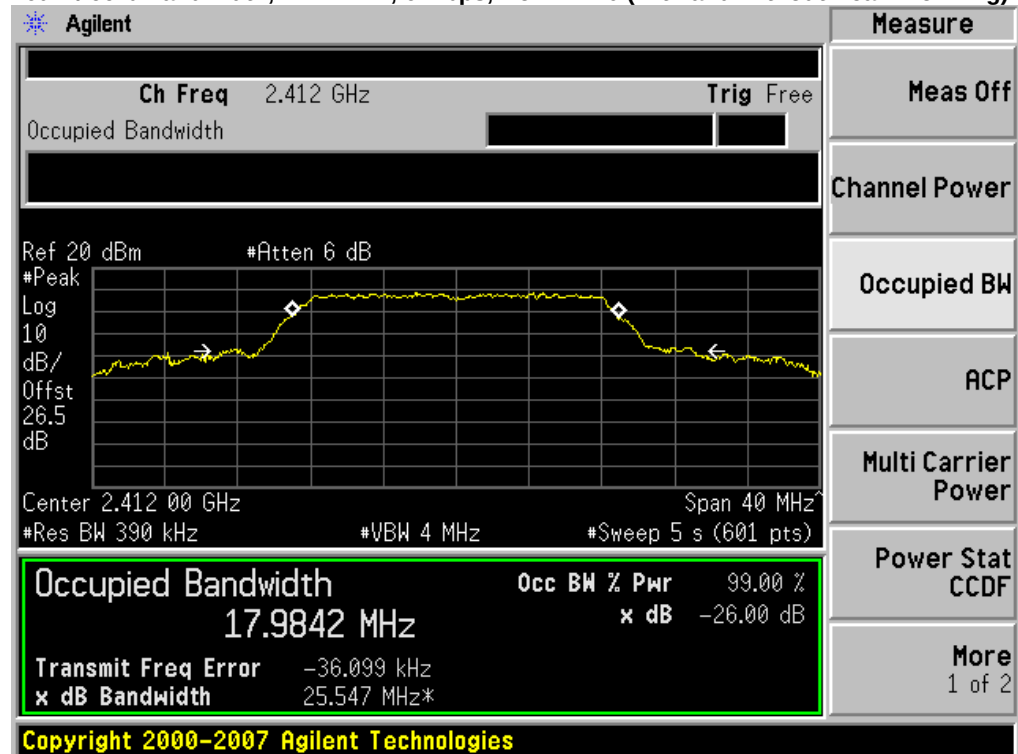
99% and 26dB Bandwidth

Frequency (MHz)	Mode	Data Rate (Mbps)	26dB BW (MHz)	99% BW (MHz)
2412	Legacy CCK, 1 to 11 Mbps	11	16.7	13.3
	Non HT-20, 6 to 54 Mbps	6	25.5	18.0
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	25.5	18.0
	HT-20, M0 to M23	m0	30.0	18.3
	HT-20 STBC, M0 to M7	m0	30.0	18.3
	HT-20 Beam Forming, M0 to M23	m0	30.0	18.3
2437	Legacy CCK, 1 to 11 Mbps	11	16.7	13.4
	Non HT-20, 6 to 54 Mbps	6	26.2	18.0
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	26.2	18.0
	HT-20, M0 to M23	m0	28.2	18.5
	HT-20 STBC, M0 to M7	m0	28.2	18.5
	HT-20 Beam Forming, M0 to M23	m0	28.2	18.5
2462	Legacy CCK, 1 to 11 Mbps	11	16.7	13.4
	Non HT-20, 6 to 54 Mbps	6	25.7	18.0
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	25.7	18.0
	HT-20, M0 to M23	m0	31.4	18.4
	HT-20 STBC, M0 to M7	m0	31.4	18.4
	HT-20 Beam Forming, M0 to M23	m0	31.4	18.4

26dB / 99% Bandwidth, 2412 MHz, 11 Mbps, Legacy CCK

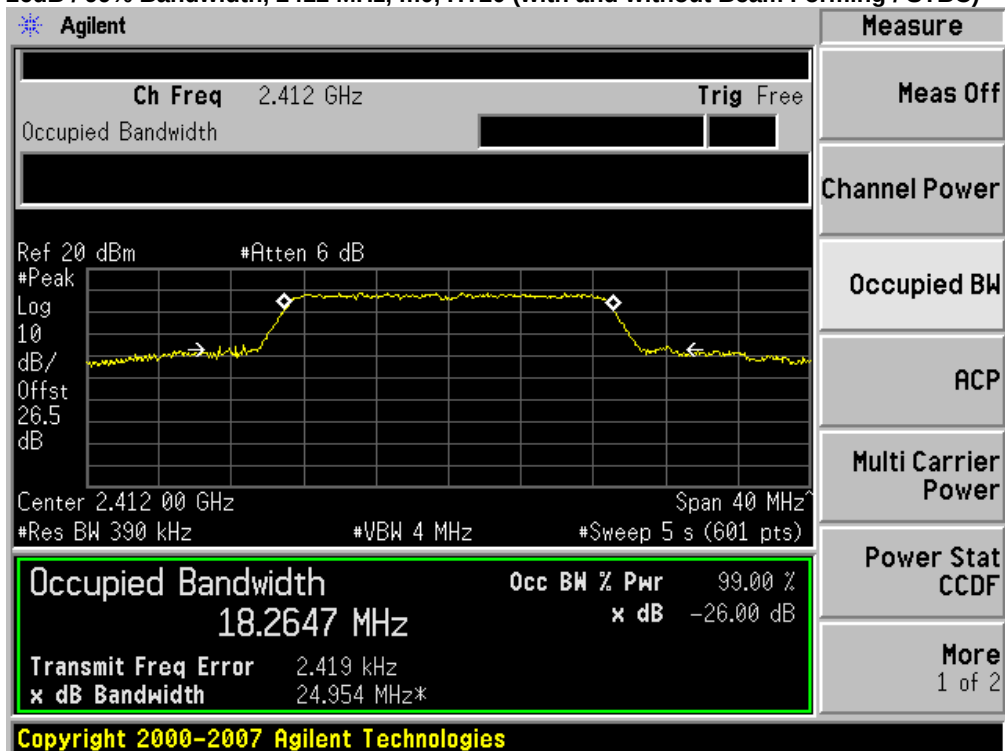


26dB / 99% Bandwidth, 2412 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)

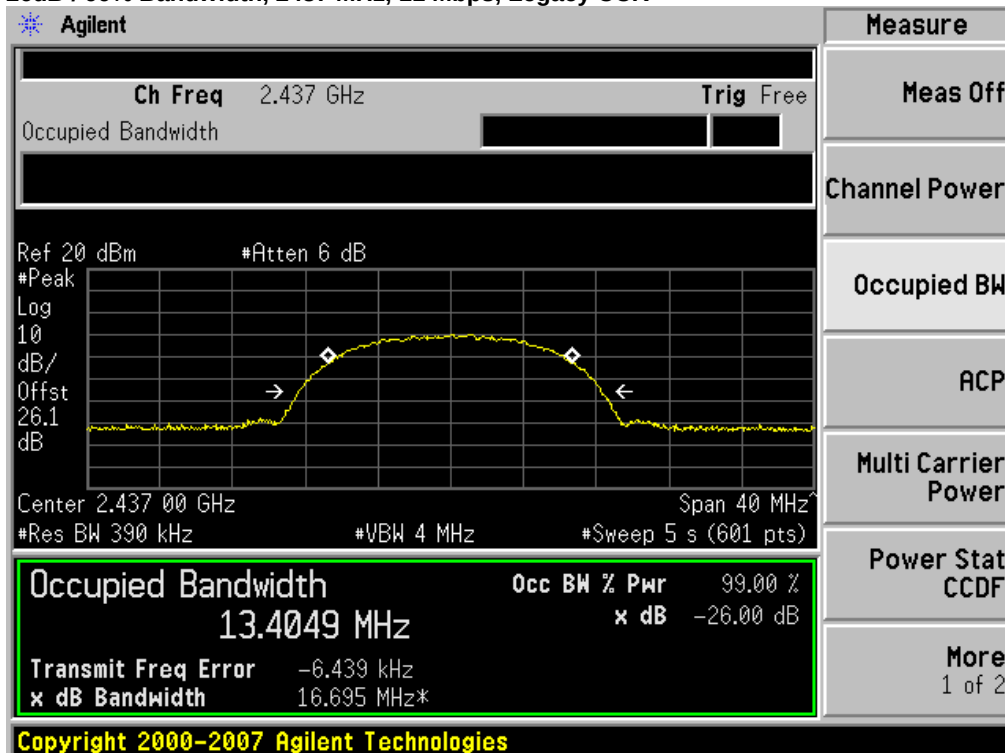




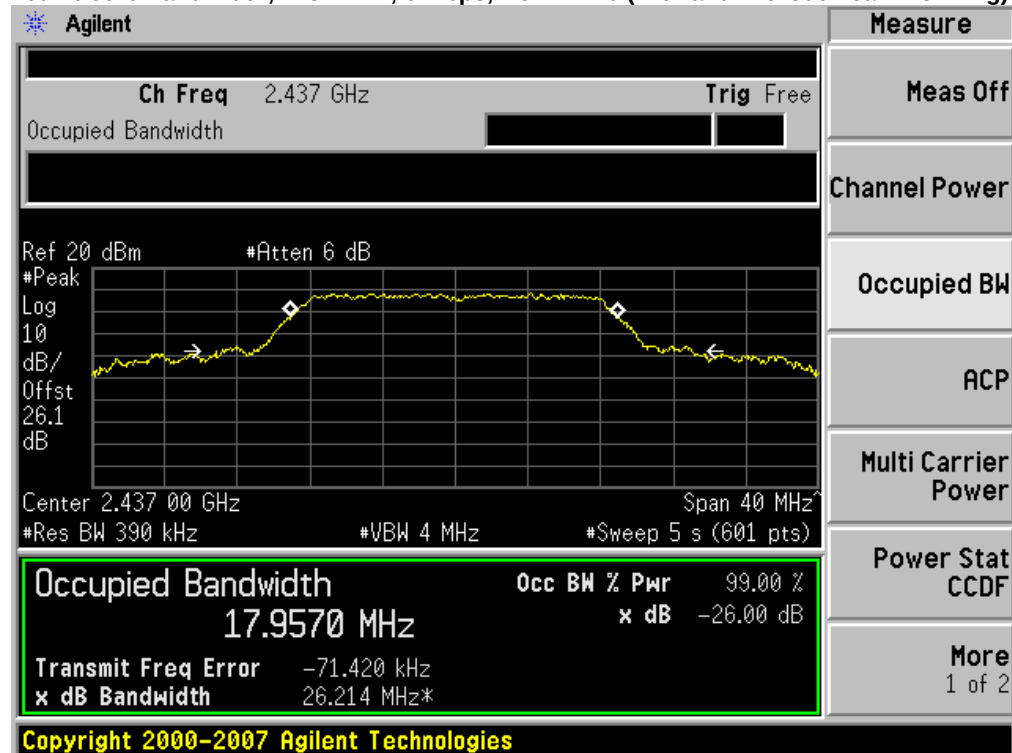
26dB / 99% Bandwidth, 2412 MHz, m0, HT20 (with and without Beam Forming / STBC)



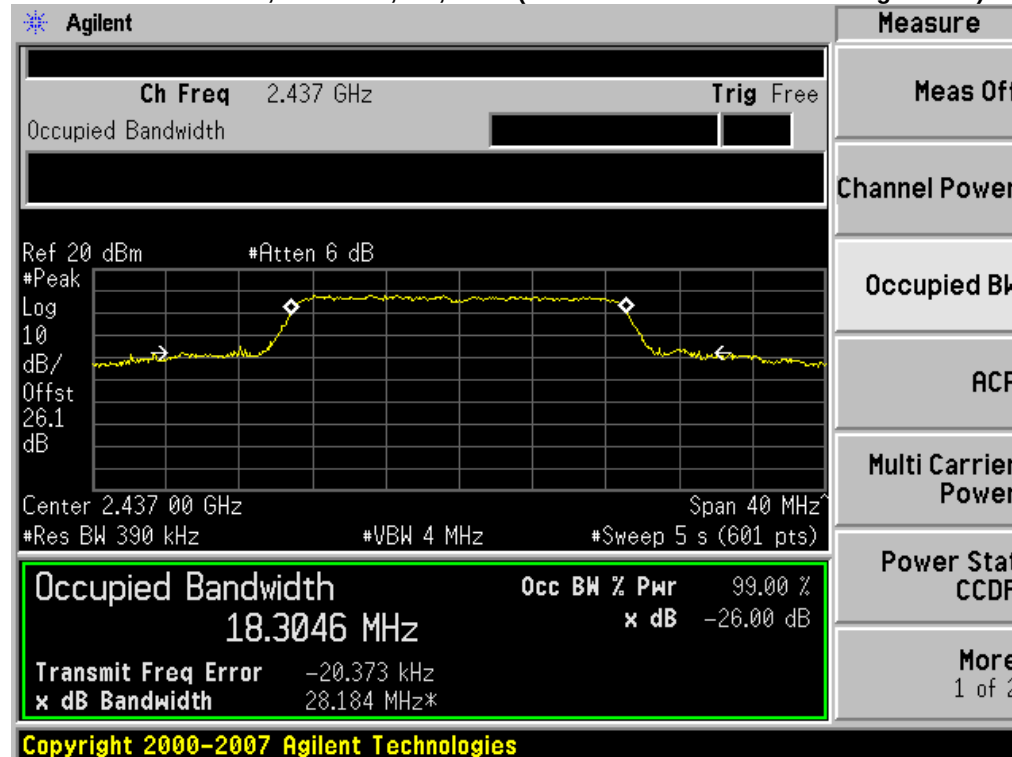
26dB / 99% Bandwidth, 2437 MHz, 11 Mbps, Legacy CCK



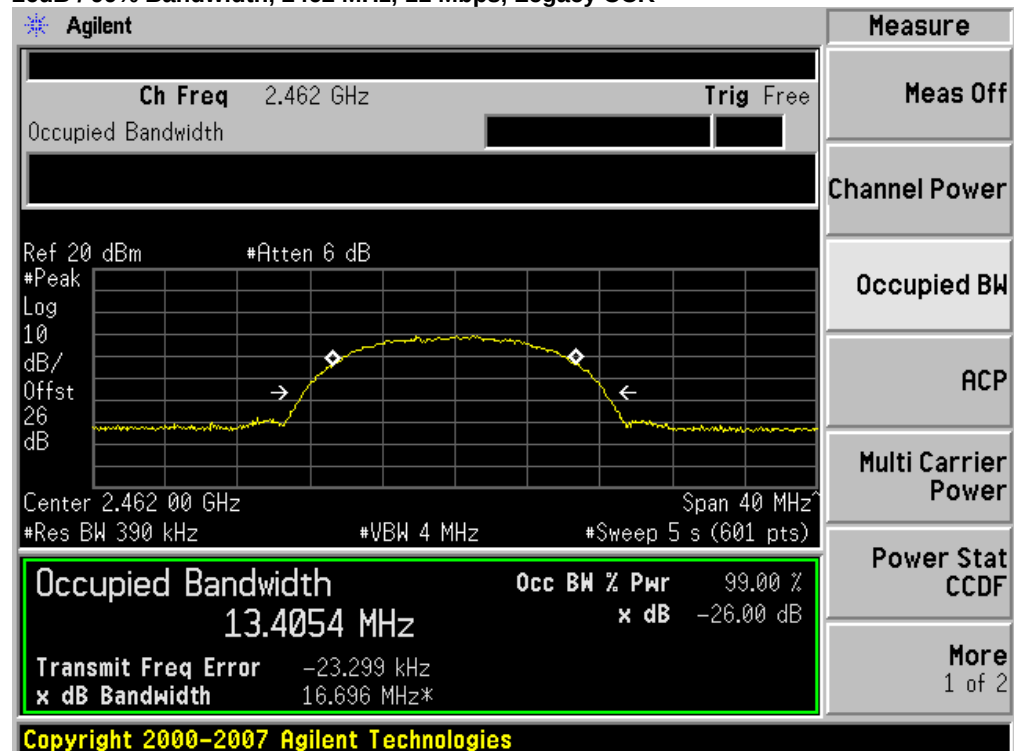
26dB / 99% Bandwidth, 2437 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



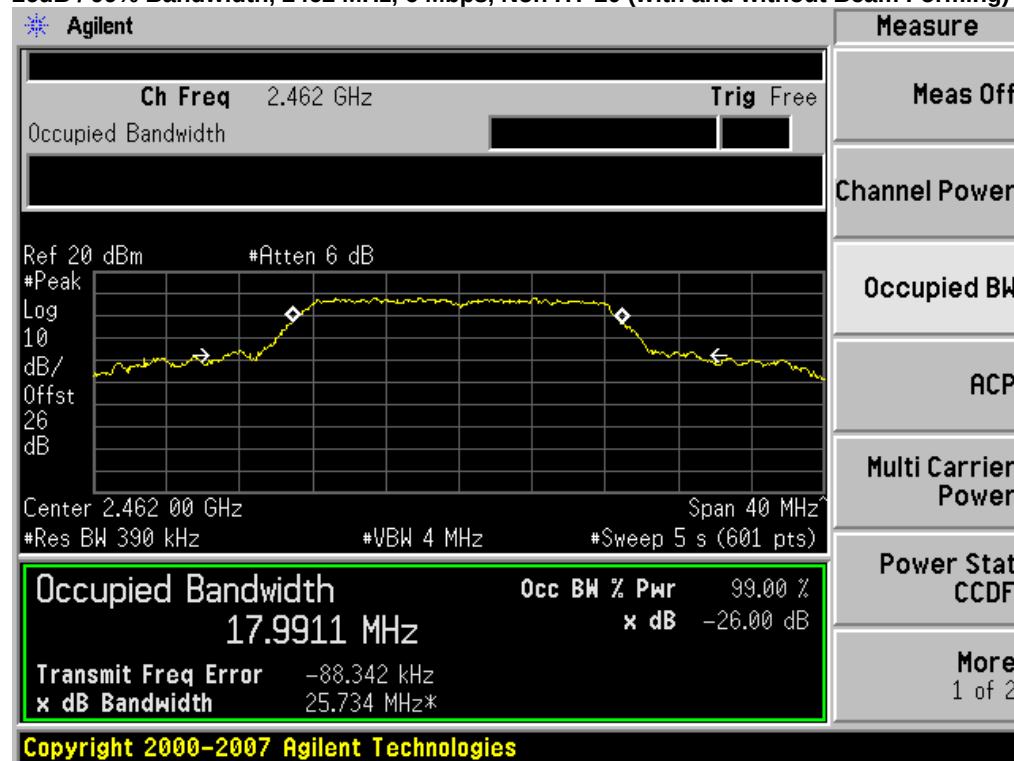
26dB / 99% Bandwidth, 2437 MHz, m0, HT20 (with and without Beam Forming / STBC)



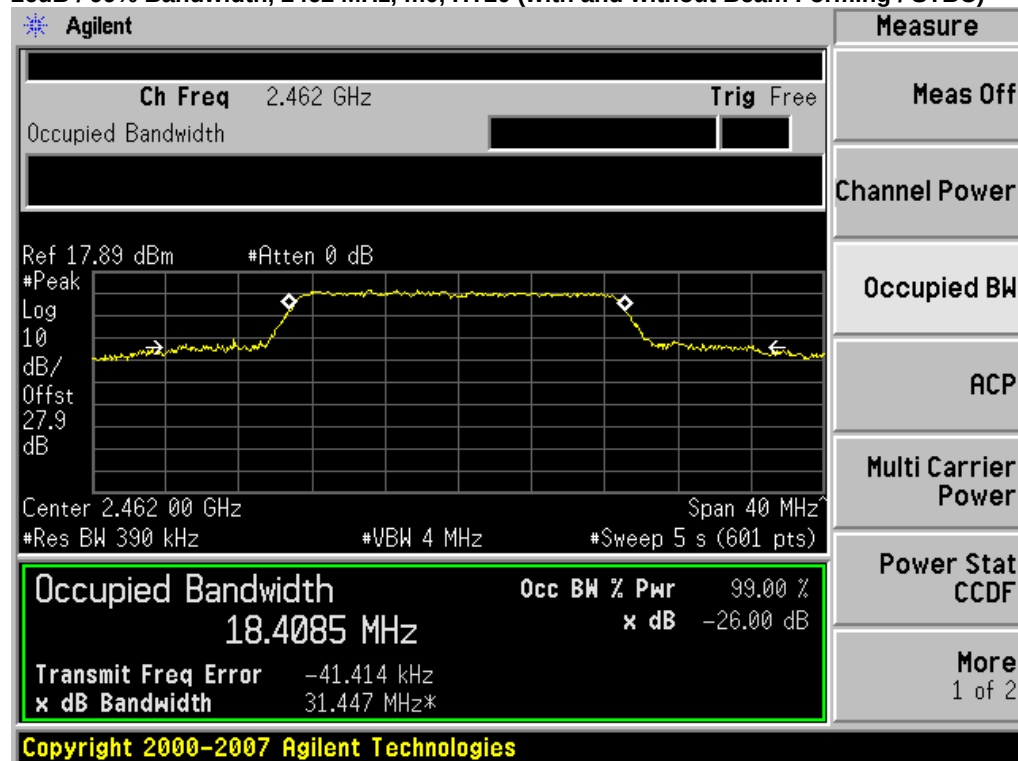
26dB / 99% Bandwidth, 2462 MHz, 11 Mbps, Legacy CCK



26dB / 99% Bandwidth, 2462 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



26dB / 99% Bandwidth, 2462 MHz, m0, HT20 (with and without Beam Forming / STBC)





Peak Output Power

15.247: The maximum conducted output power of the intentional radiator for systems using digital modulation in the 2400-2483.5 MHz band shall not exceed 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum supported antenna gain is 6dBi. The peak correlated gain for each mode is listed in the table below. See the Theory of Operation for details on the correlated gain for each mode.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Configure the spectrum analyzer as shown below.

Enable "Channel Power" function of analyzer	
Center Frequency:	Frequency from table below
Span:	20 MHz (must be greater than 26dB bandwidth, adjust as necessary)
Ref Level Offset:	Correct for attenuator and cable loss.
Reference Level:	20 dBm
Attenuation:	20 dB
Sweep Time:	100ms, Single sweep
Resolution Bandwidth:	1 MHz
Video Bandwidth:	3 MHz
Detector:	Sample
Trace:	Trace Average 100 traces in Power Averaging Mode
Integration BW:	=26 dB BW from 26 dB Bandwidth Data

After averaging 100 traces of the transmitter waveform on the spectrum analyzer, record the spectrum analyzer Channel Power.

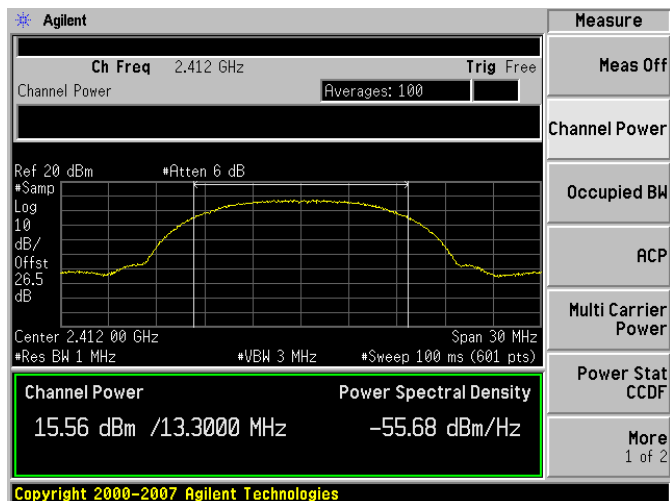
The "measure-and-sum technique" is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units.



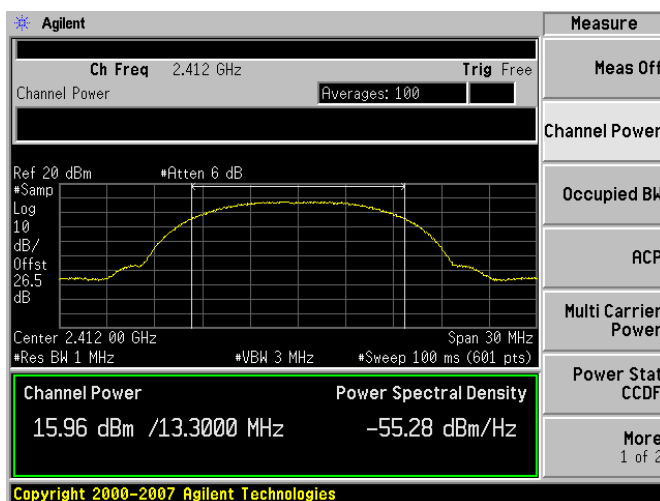
Frequency (MHz)	Operating Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Peak Power (dBm)	Tx 2 Peak Power (dBm)	Tx 3 Peak Power (dBm)	Tx 4 Peak Power (dBm)	Total Tx Channel Power (dBm)	Limit (dBm)	Margin (dB)
2412	Legacy CCK, 1 to 11 Mbps	4	6	15.6	16.0	15.6	15.7	21.7	30	8.3
	Non HT-20, 6 to 54 Mbps	4	6	9.8	10.9	8.9	10.0	16.0	30	14.0
	Non HT-20 Beam Forming, 6 to 54 Mbps	4	12	6.9	8.4	5.7	7.5	13.3	24	10.7
	HT-20, M0 to M23	4	6	8.8	9.9	7.6	8.9	14.9	30	15.1
	HT-20 STBC, M0 to M7	4	6	8.8	9.9	7.6	8.9	14.9	30	15.1
	HT-20 Beam Forming, M0 to M7	4	12	8.8	9.9	7.6	8.9	14.9	24	9.1
	HT-20 Beam Forming, M8 to M15	4	9	10.8	11.5	10.0	10.8	16.8	27	10.2
	HT-20 Beam Forming, M16 to M23	4	7	10.8	11.5	10.0	10.8	16.8	29	11.9
2437	Legacy CCK, 1 to 11 Mbps	4	6	15.5	15.2	15.0	15.1	21.2	30	8.8
	Non HT-20, 6 to 54 Mbps	4	6	15.6	15.3	14.9	15.4	21.3	30	8.7
	Non HT-20 Beam Forming, 6 to 54 Mbps	4	12	14.6	14.3	13.9	14.2	20.3	24	3.7
	HT-20, M0 to M23	4	6	15.6	15.4	15.0	15.3	21.3	30	8.7
	HT-20 STBC, M0 to M7	4	6	15.6	15.4	15.0	15.3	21.4	30	8.6
	HT-20 Beam Forming, M0 to M7	4	12	14.5	14.5	13.8	14.3	20.3	24	3.7
	HT-20 Beam Forming, M8 to M15	4	9	14.5	14.5	13.8	14.3	20.3	27	6.7
	HT-20 Beam Forming, M16 to M23	4	7	14.5	14.5	13.8	14.3	20.3	29	8.4
2462	Legacy CCK, 1 to 11 Mbps	4	6	14.9	14.7	14.5	14.7	20.7	30	9.3
	Non HT-20, 6 to 54 Mbps	4	6	10.3	10.5	9.0	9.8	15.9	30	14.1
	Non HT-20 Beam Forming, 6 to 54 Mbps	4	12	7.0	8.0	5.8	7.3	13.1	24	10.9
	HT-20, M0 to M23	4	6	9.3	9.7	8.0	9.0	15.1	30	14.9
	HT-20 STBC, M0 to M7	4	6	9.3	9.7	8.0	9.0	15.1	30	14.9
	HT-20 Beam Forming, M0 to M7	4	12	7.2	7.8	5.4	7.1	13.0	24	11.0
	HT-20 Beam Forming, M8 to M15	4	9	10.2	10.5	8.9	9.7	15.9	27	11.1
	HT-20 Beam Forming, M16 to M23	4	7	12.3	12.3	11.4	11.6	18.0	29	10.8



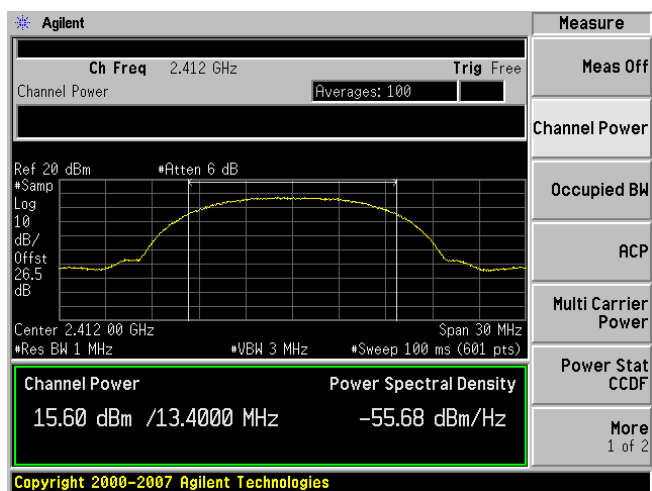
Peak Output Power, 2412 MHz, 11 Mbps, Legacy CCK



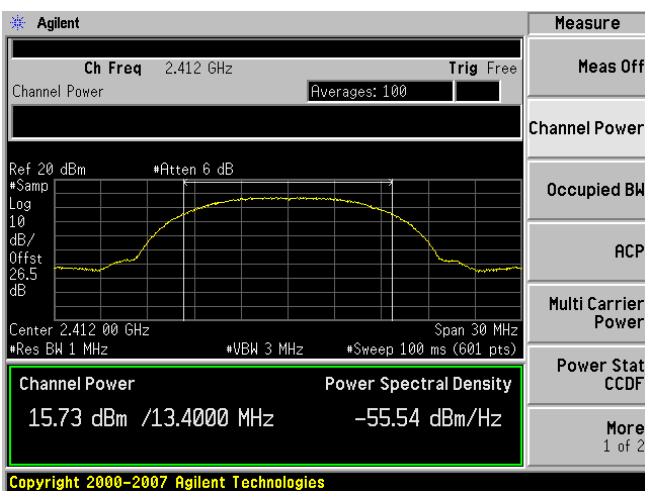
Antenna A



Antenna B

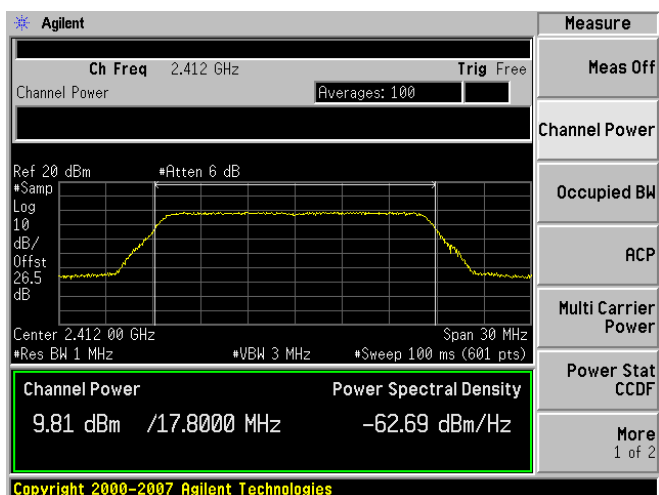


Antenna C

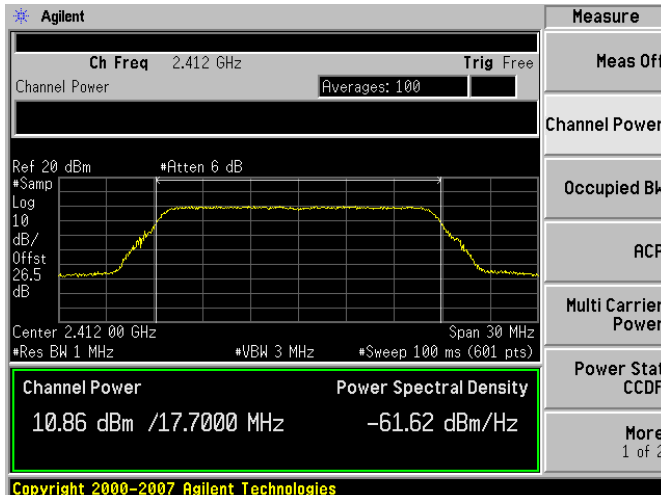


Antenna D

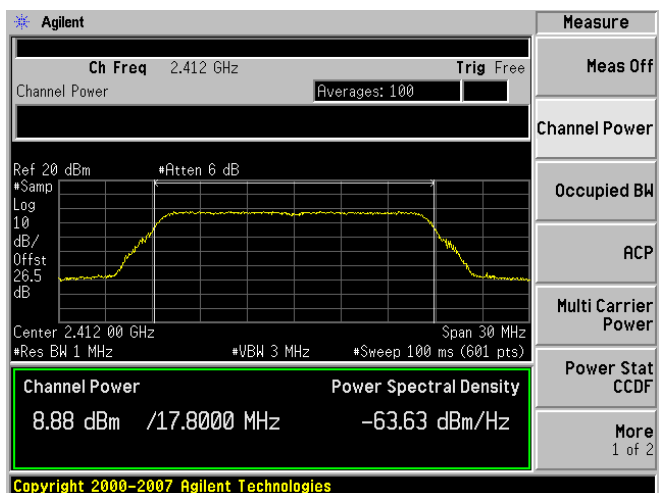
Peak Output Power, 2412 MHz, 6 Mbps, Non HT-20



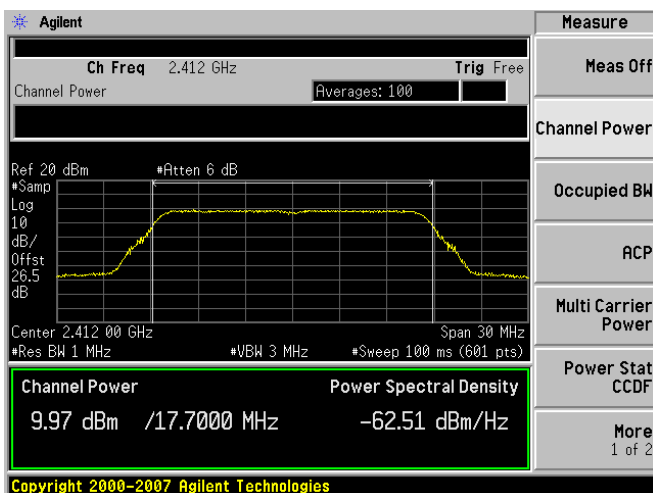
Antenna A



Antenna B



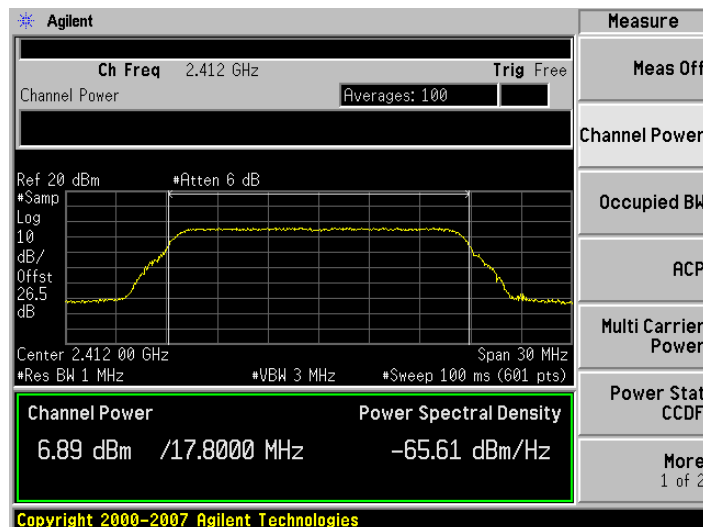
Antenna C



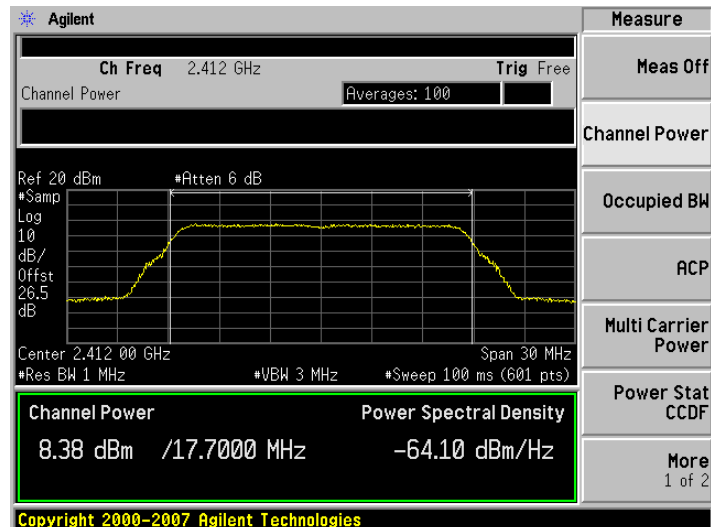
Antenna D



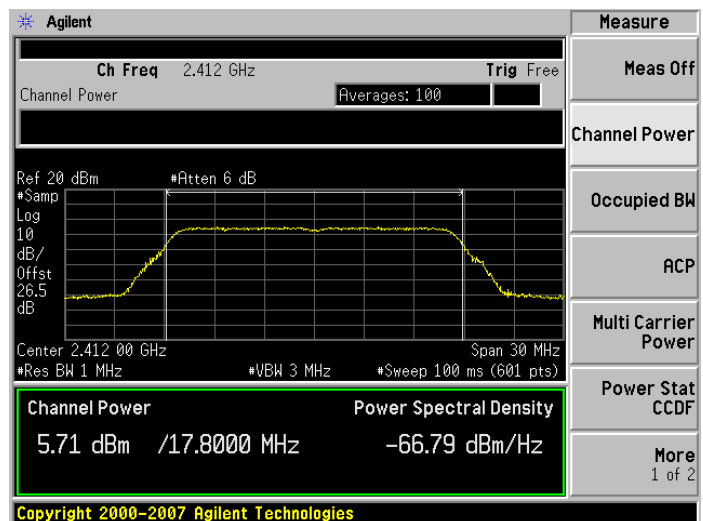
Peak Output Power, 2412 MHz, 6 Mbps, Non HT-20 Beam Forming



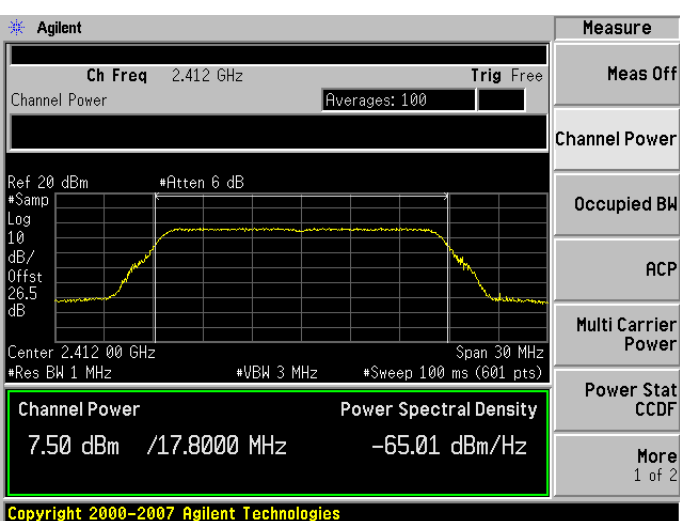
Antenna A



Antenna B



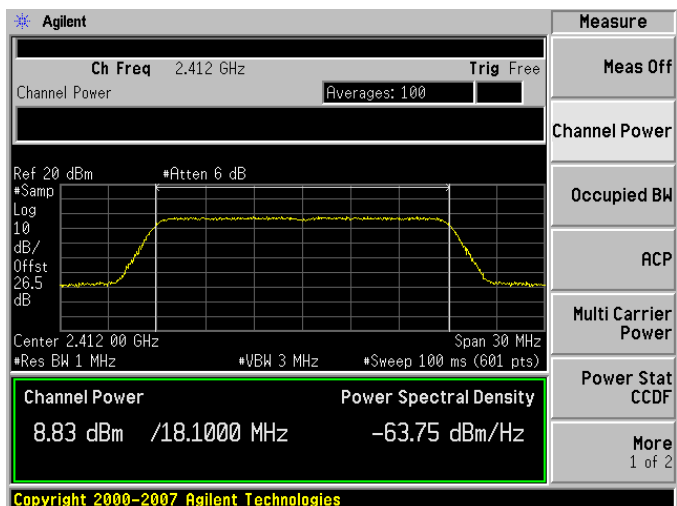
Antenna C



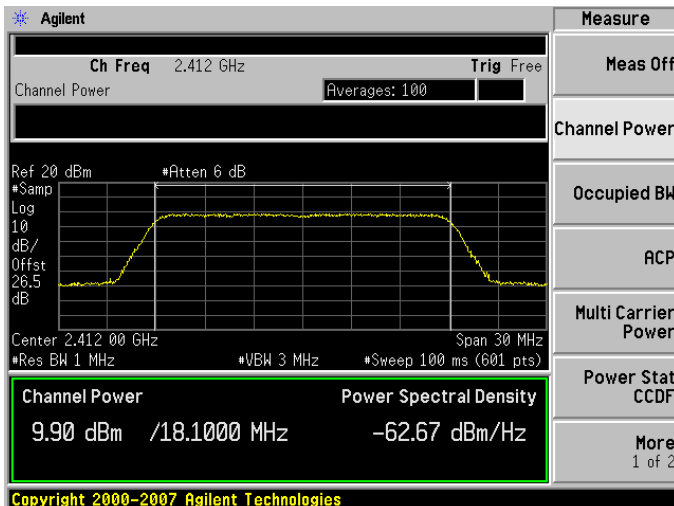
Antenna D



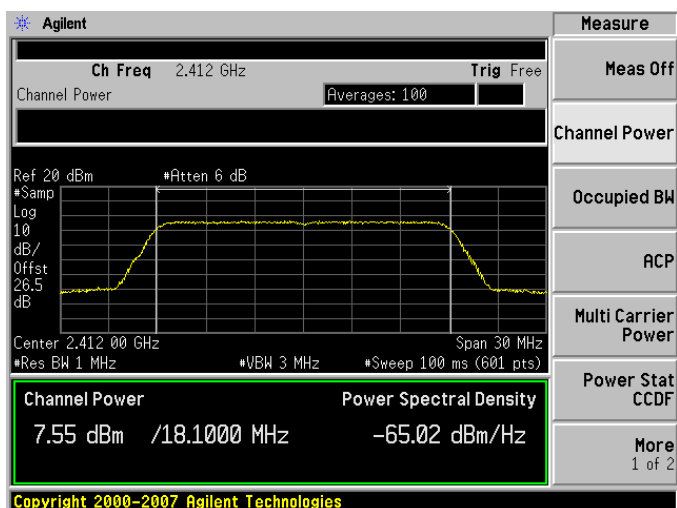
Peak Output Power, 2412 MHz, m0, HT20 Beam Forming, with and without STBC



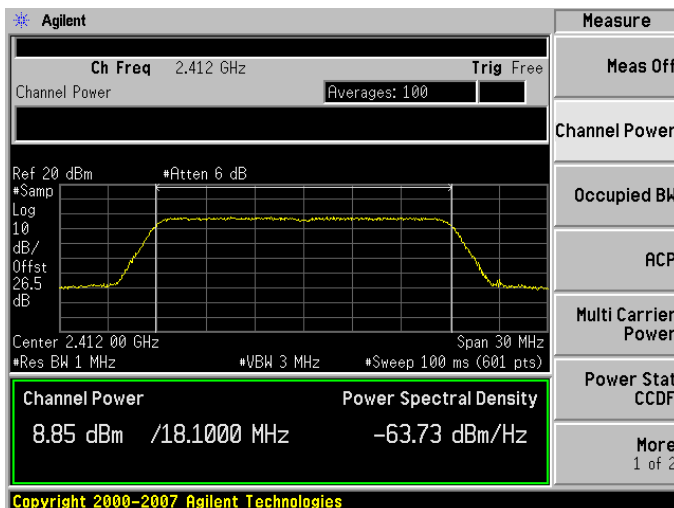
Antenna A



Antenna B



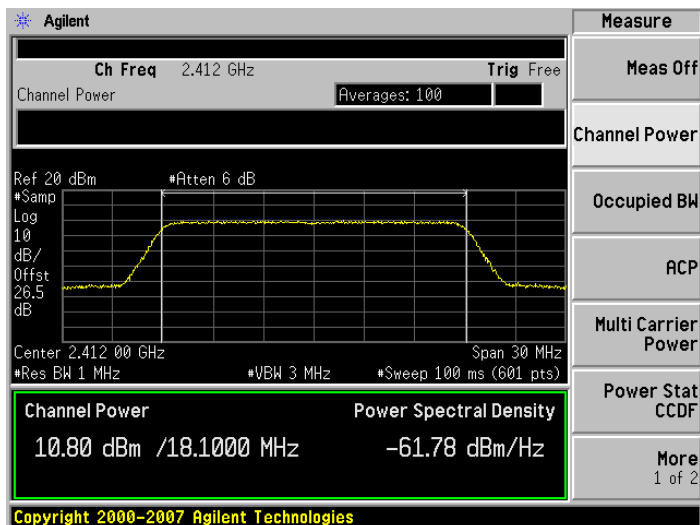
Antenna C



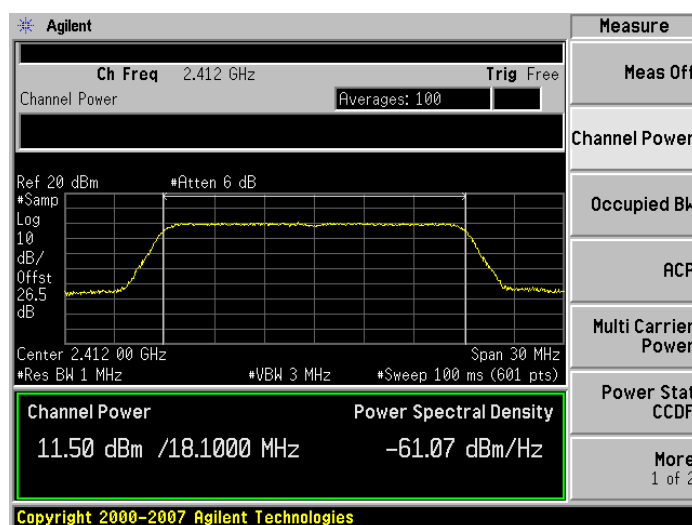
Antenna D



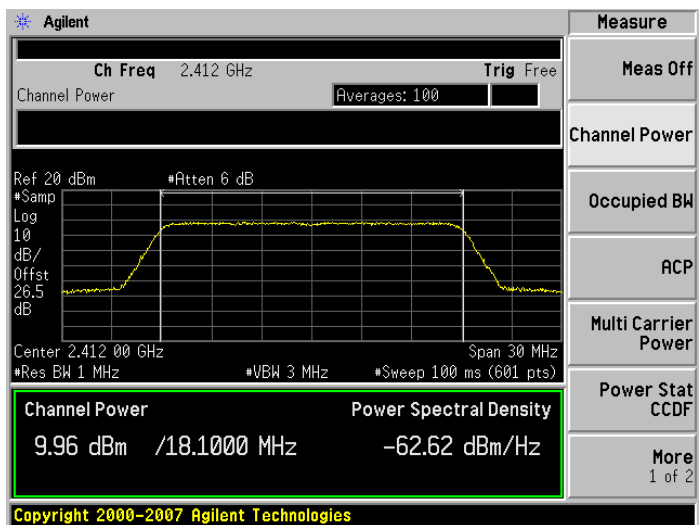
Peak Output Power, 2412 MHz, m8, m16, HT20 Beam Forming



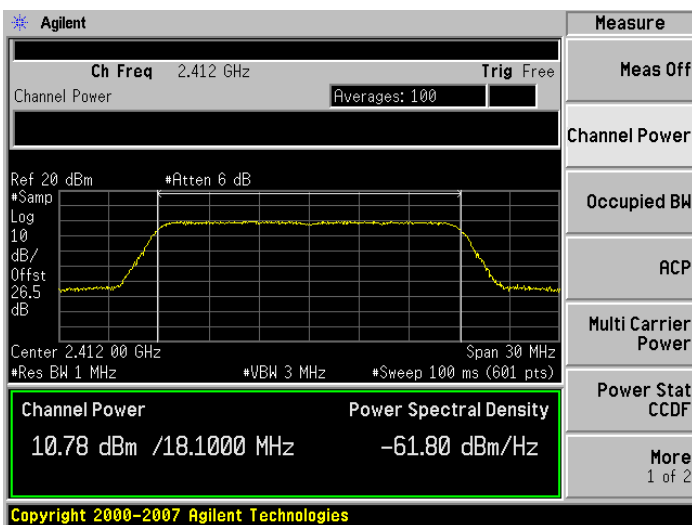
Antenna A



Antenna B



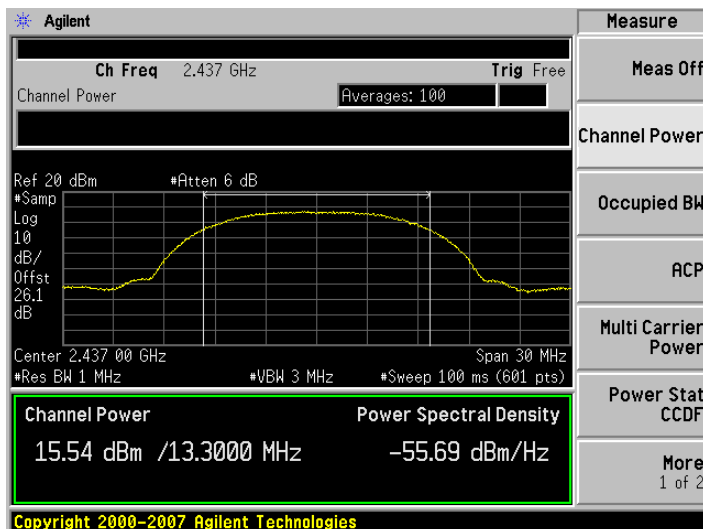
Antenna C



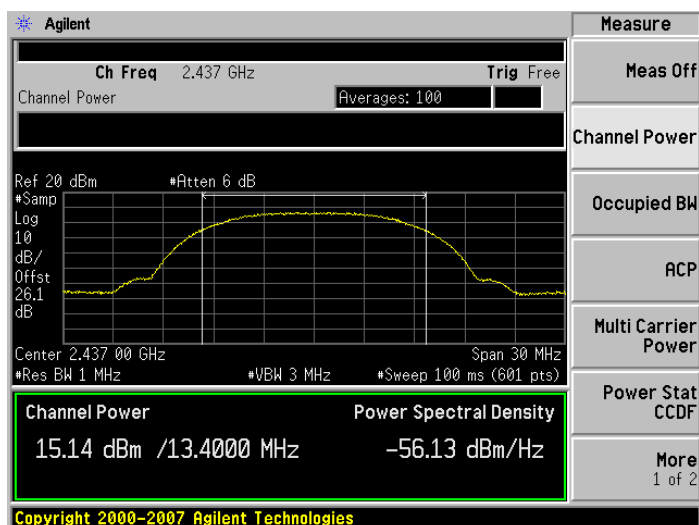
Antenna D



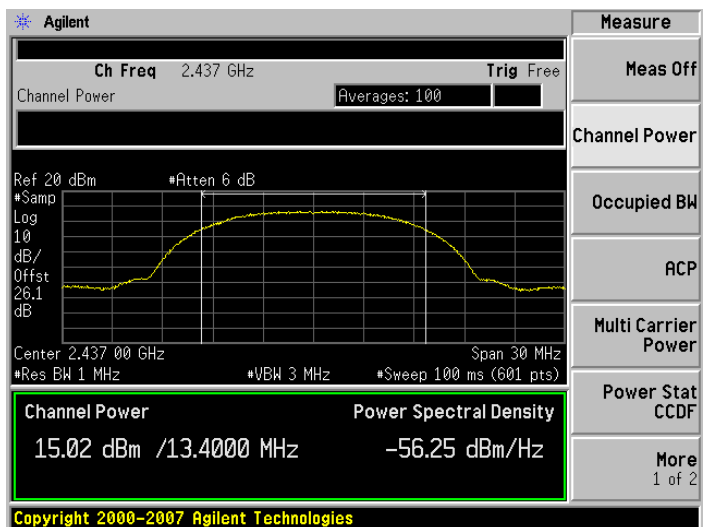
Peak Output Power, 2437 MHz, 11 Mbps, Legacy CCK



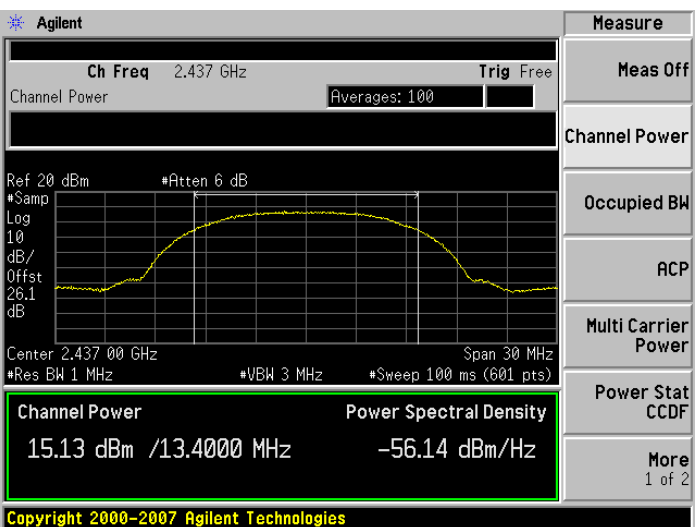
Antenna A



Antenna B



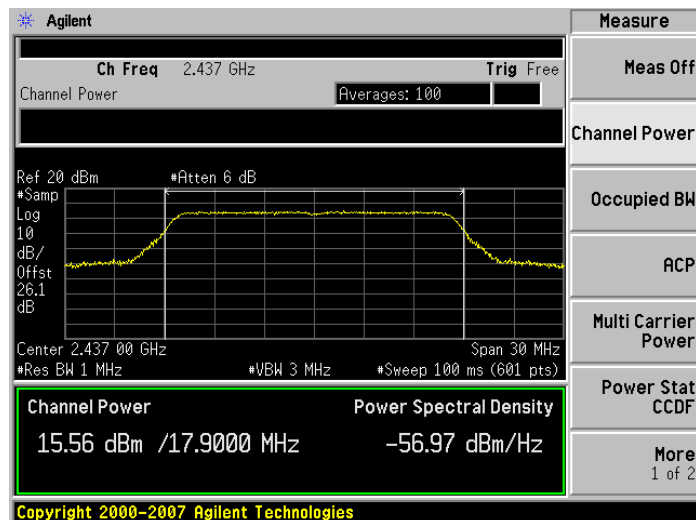
Antenna C



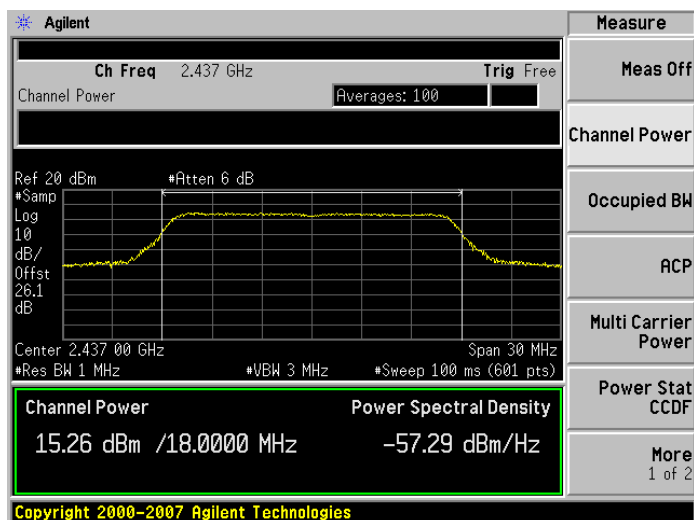
Antenna D



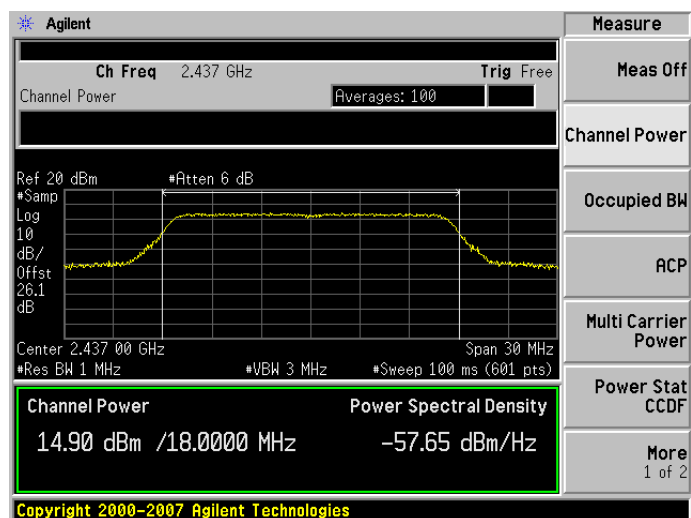
Peak Output Power, 2437 MHz, 6 Mbps, Non HT-20



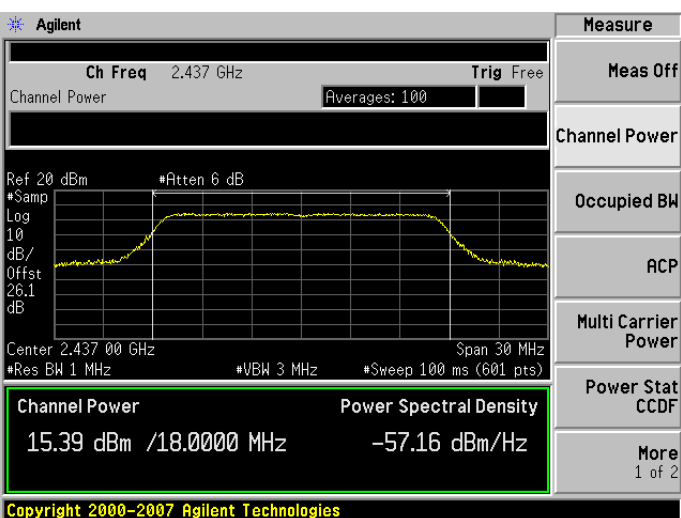
Antenna A



Antenna B



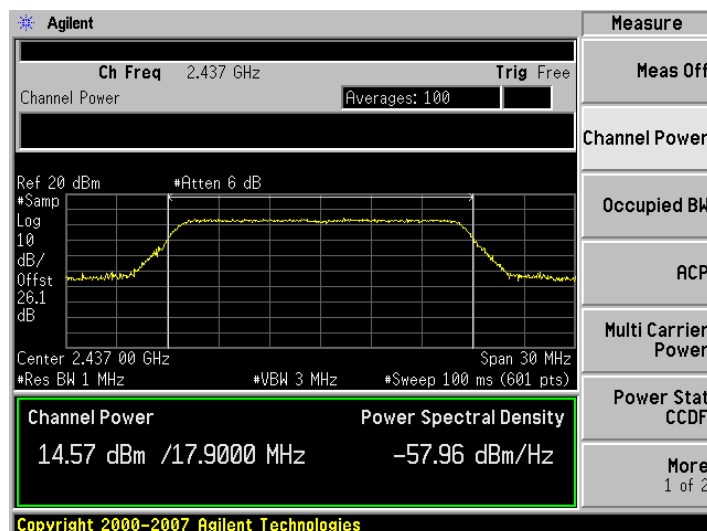
Antenna C



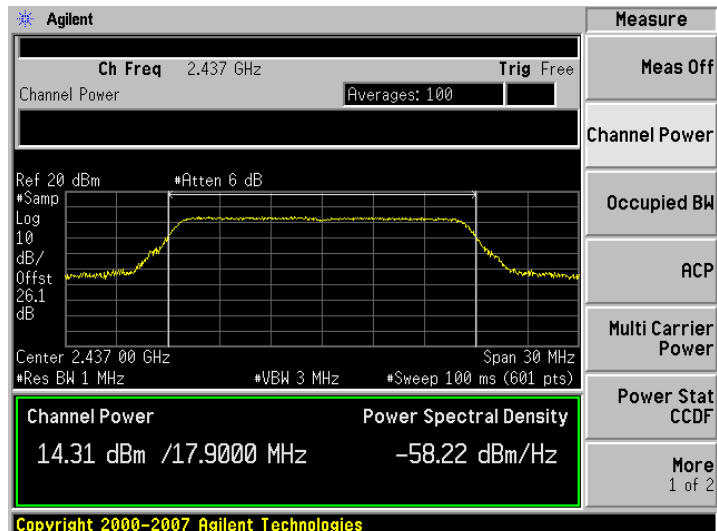
Antenna D



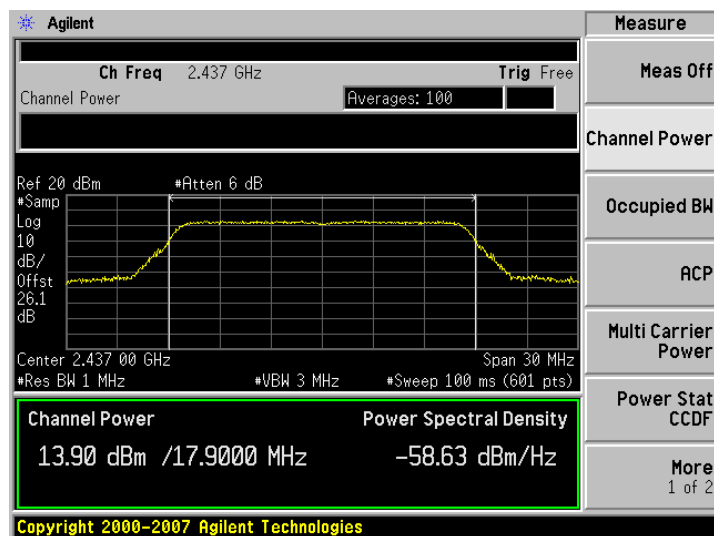
Peak Output Power, 2437 MHz, 6 Mbps, Non HT-20 Beam Forming



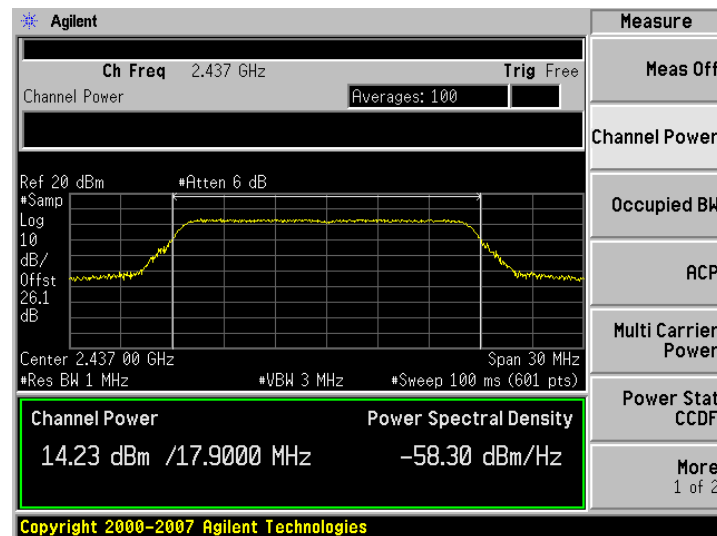
Antenna A



Antenna B



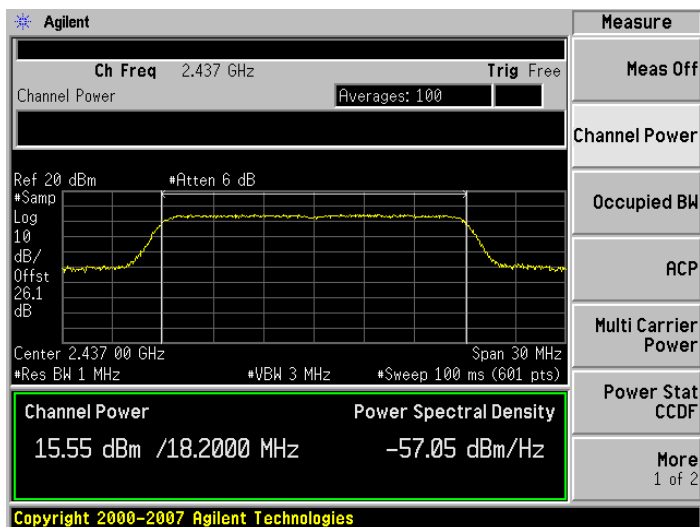
Antenna C



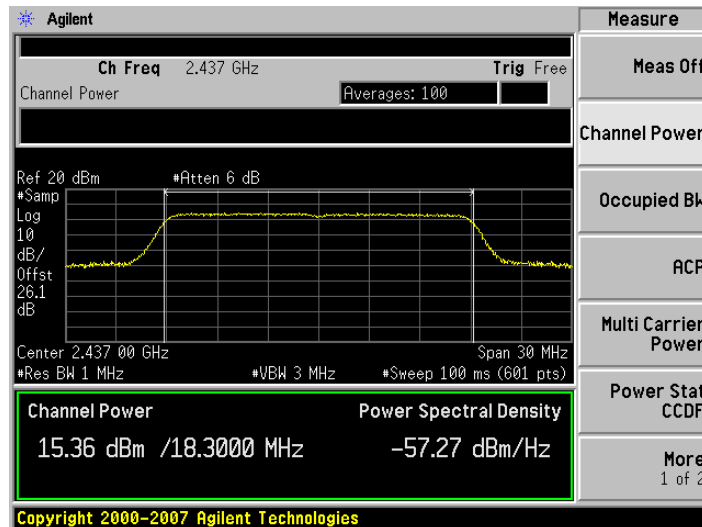
Antenna D



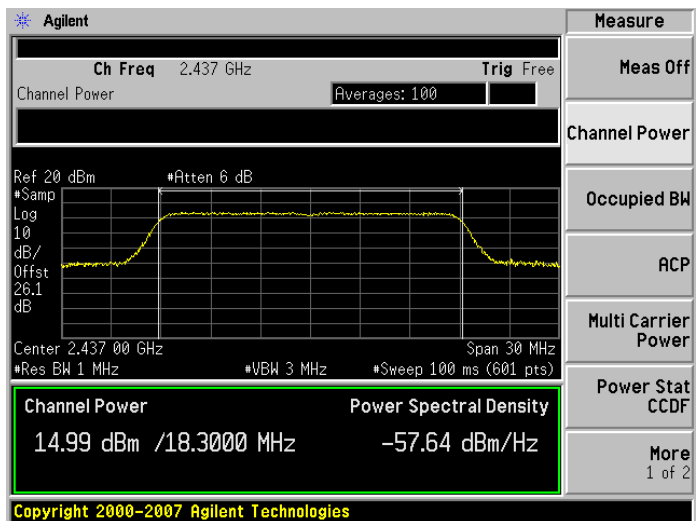
Peak Output Power, 2437 MHz, m0, HT20 with and without STBC



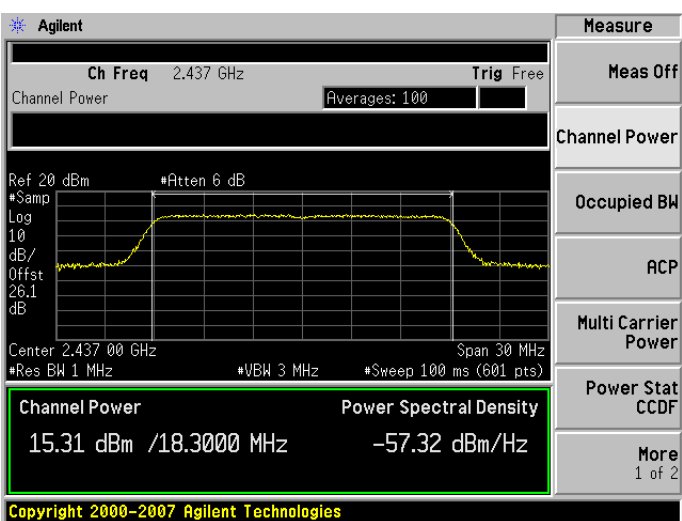
Antenna A



Antenna B



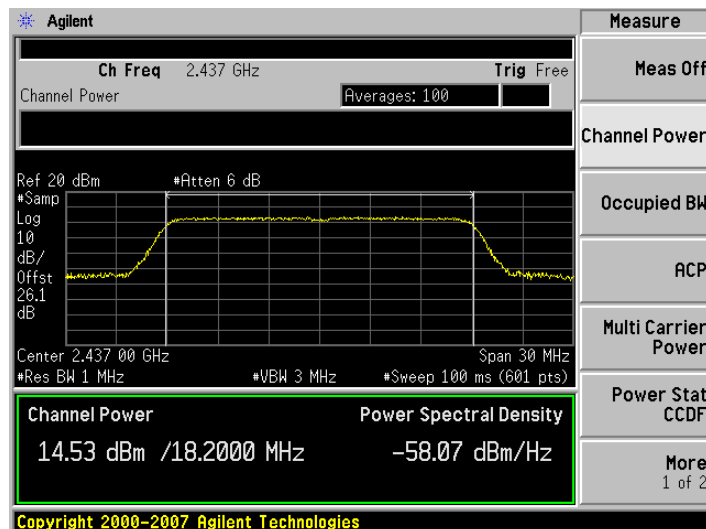
Antenna C



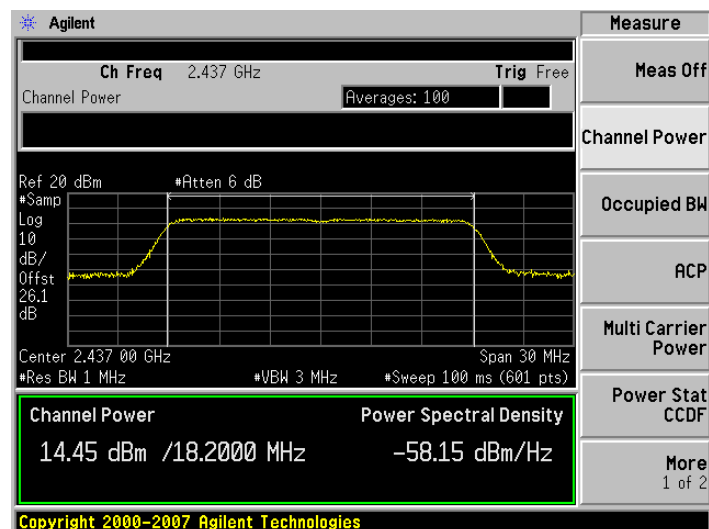
Antenna D



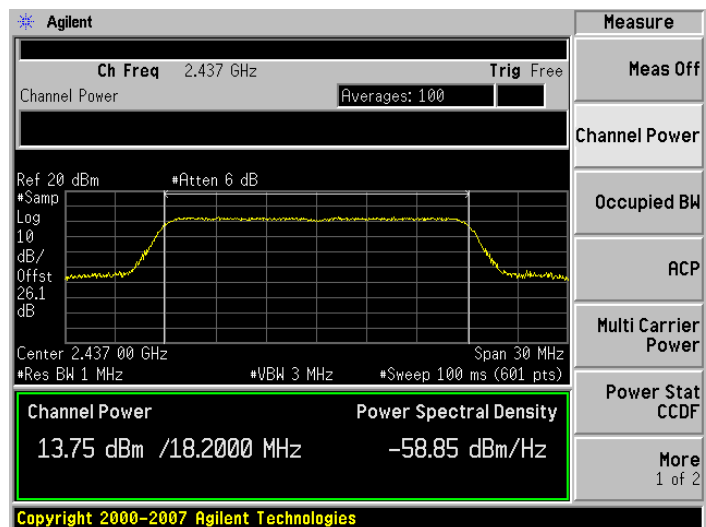
Peak Output Power, 2437 MHz, m0, HT20 Beam Forming



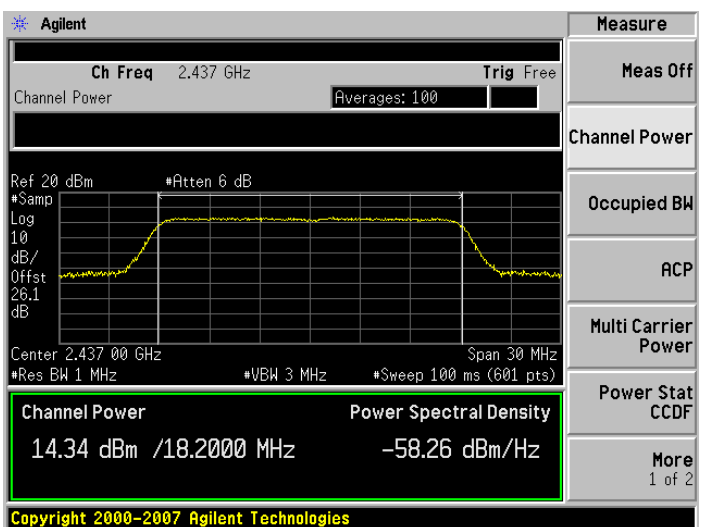
Antenna A



Antenna B



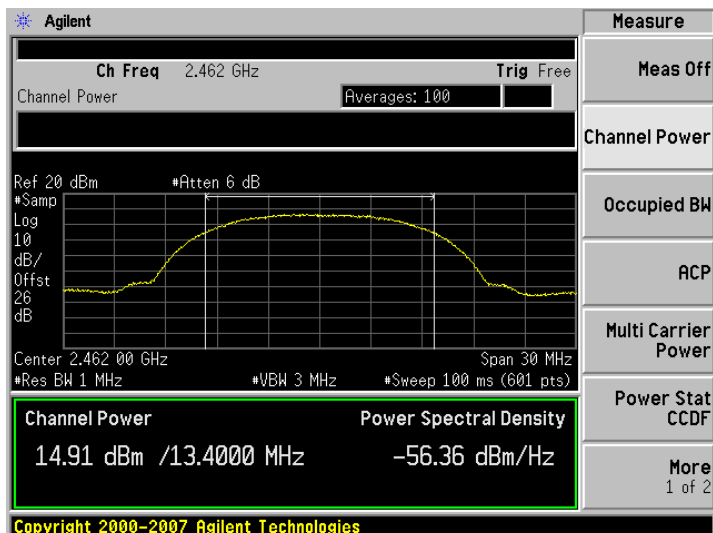
Antenna C



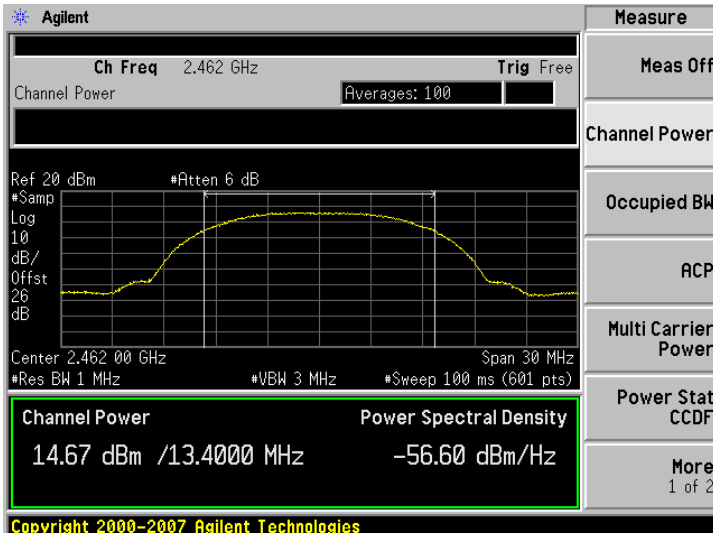
Antenna D



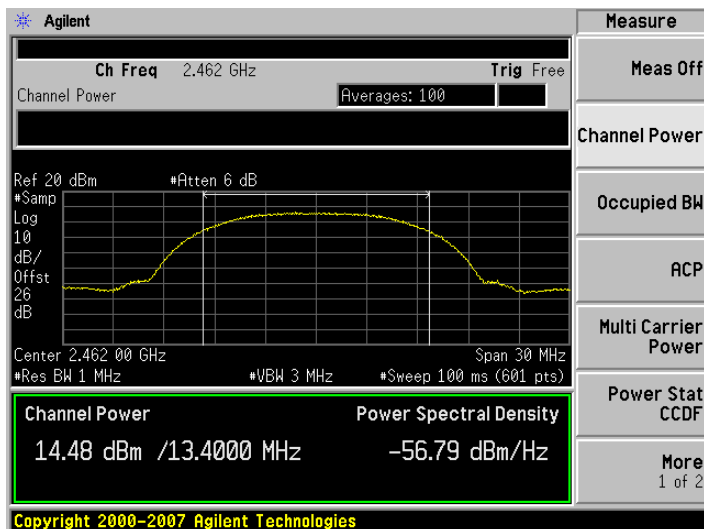
Peak Output Power, 2462 MHz, 11 Mbps, Legacy CCK



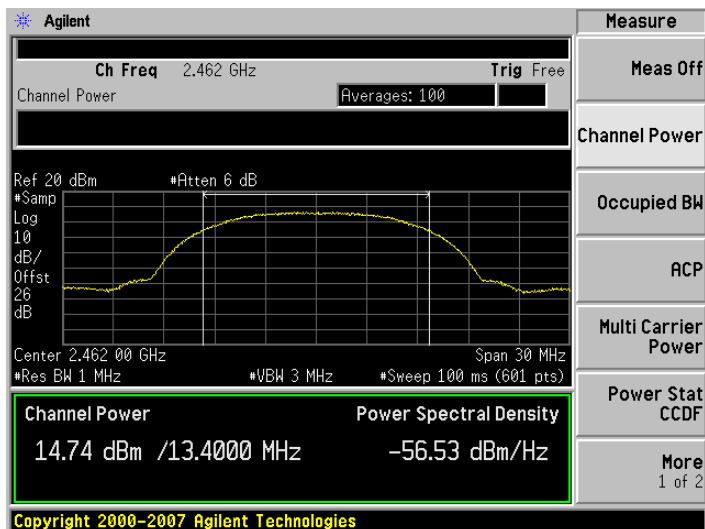
Antenna A



Antenna B



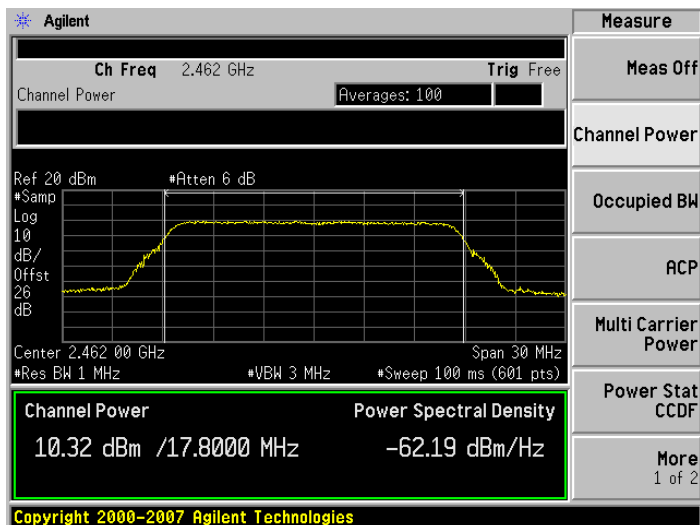
Antenna C



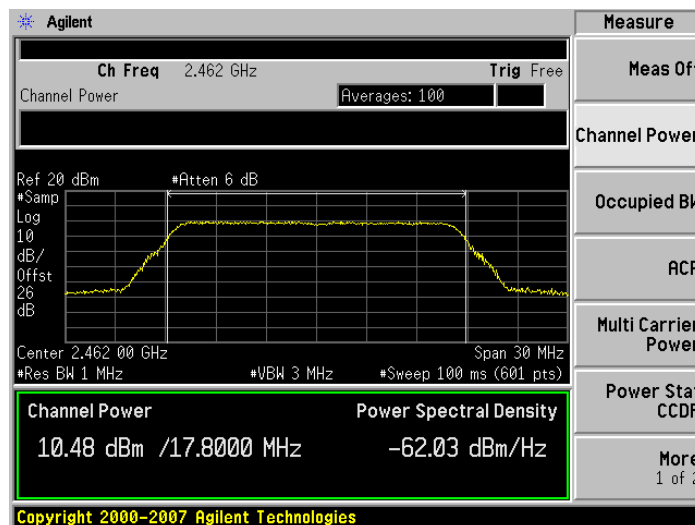
Antenna D



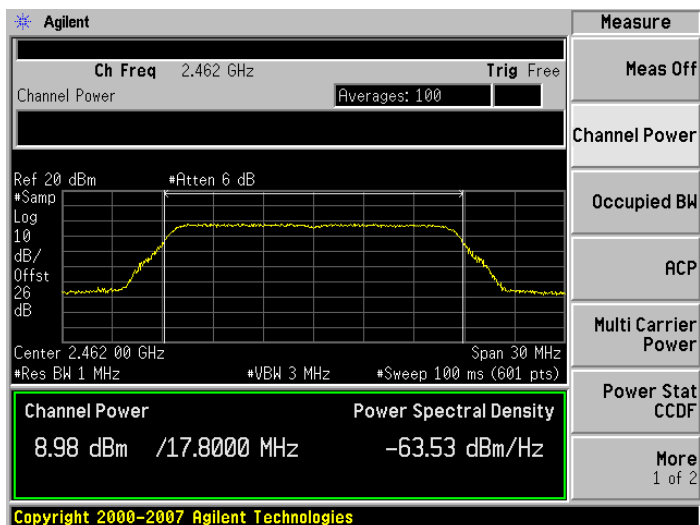
Peak Output Power, 2462 MHz, 6 Mbps, Non HT-20



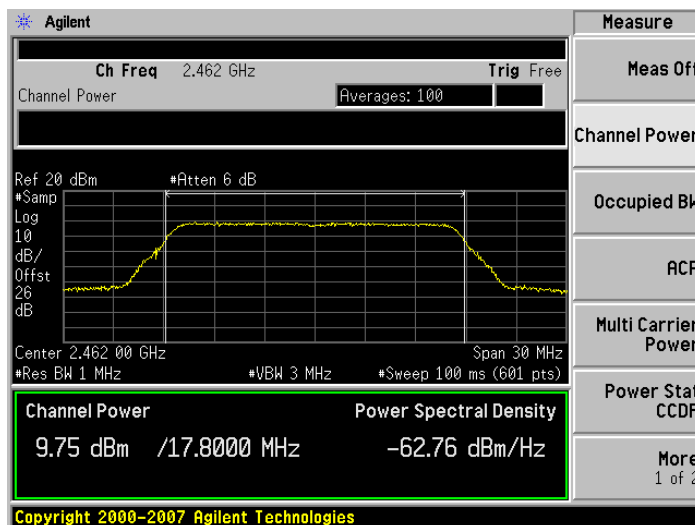
Antenna A



Antenna B



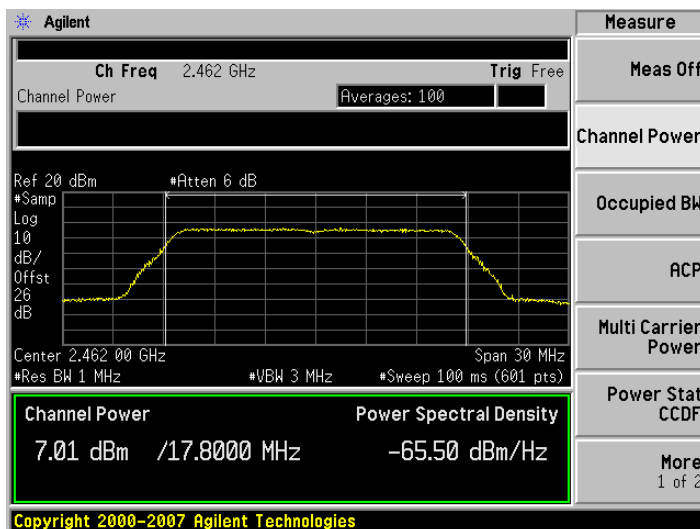
Antenna C



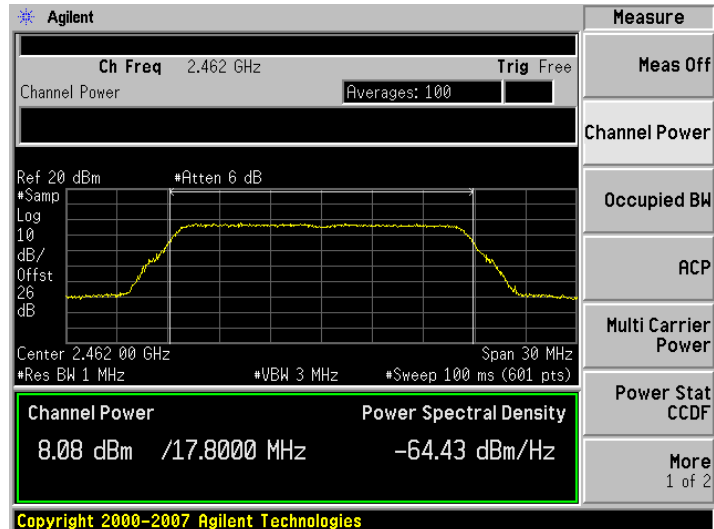
Antenna D



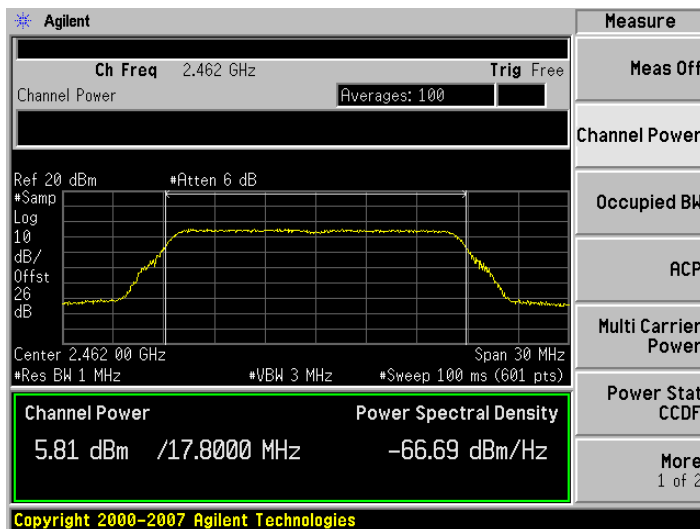
Peak Output Power, 2462 MHz, 6 Mbps, Non HT-20 Beam Forming



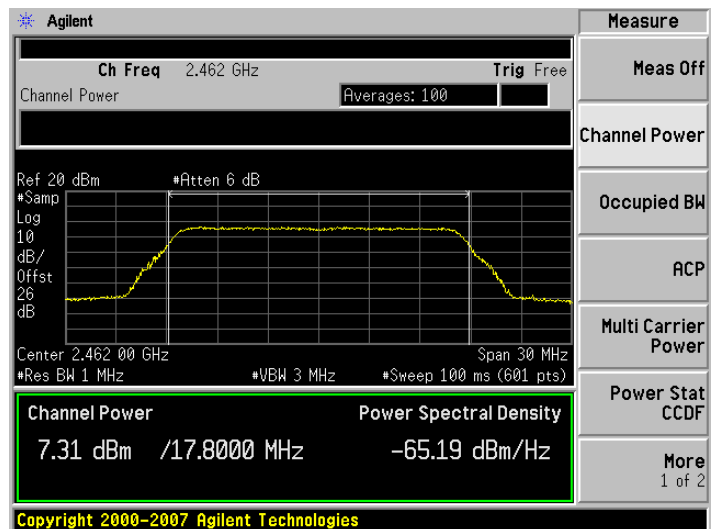
Antenna A



Antenna B



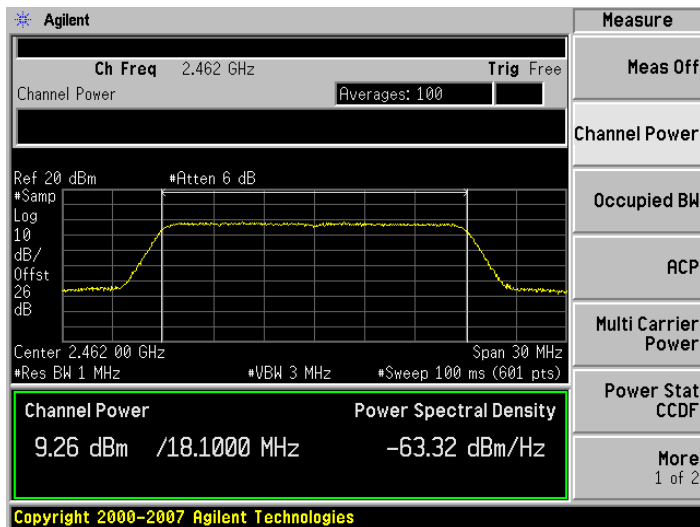
Antenna C



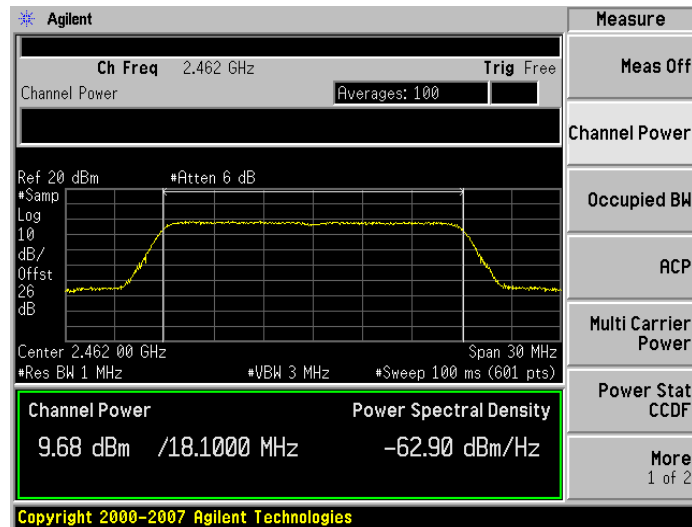
Antenna D



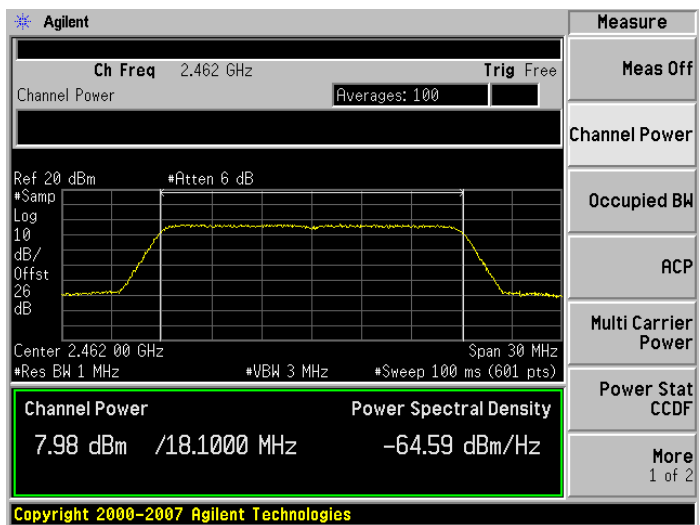
Peak Output Power, 2462 MHz, m0, HT20 with and without STBC



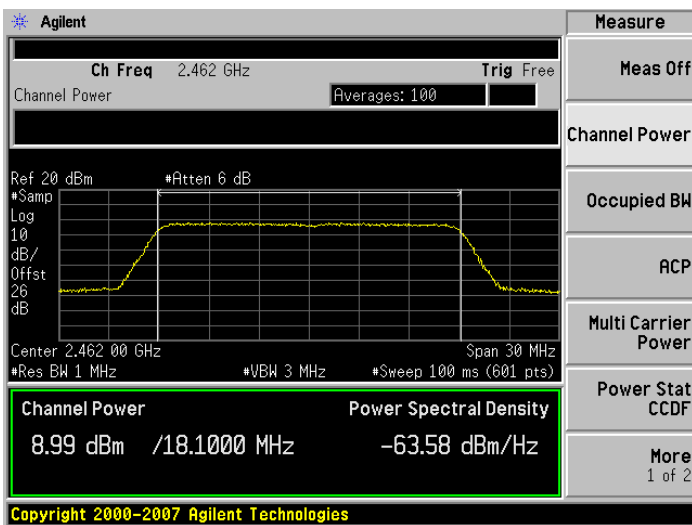
Antenna A



Antenna B



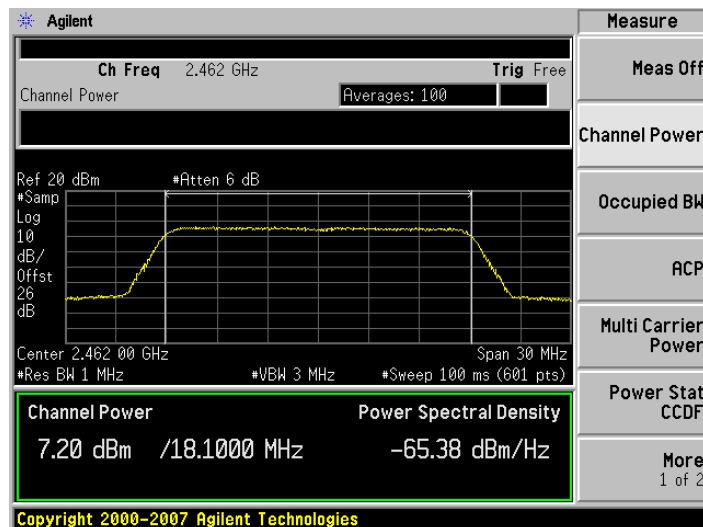
Antenna C



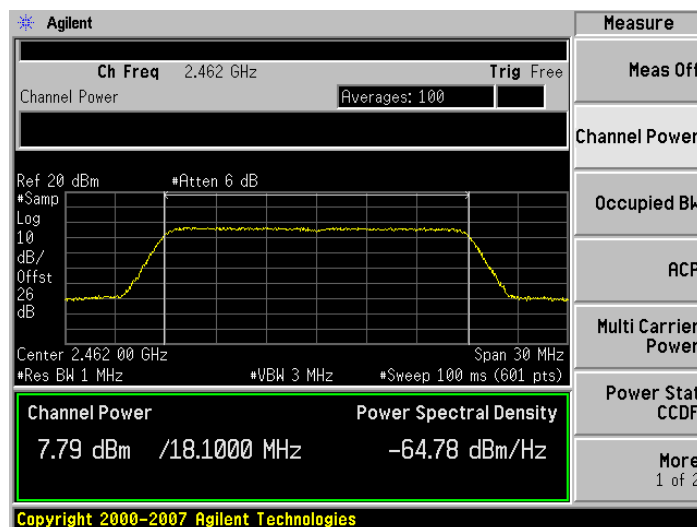
Antenna D



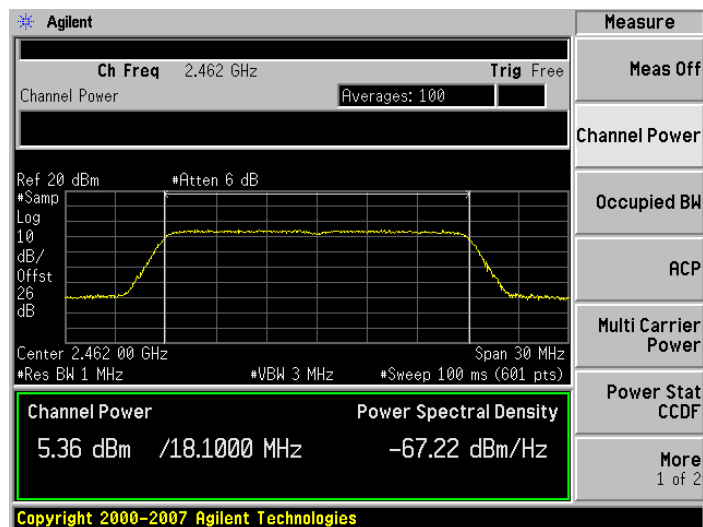
Peak Output Power, 2462 MHz, m0, HT20 Beam Forming



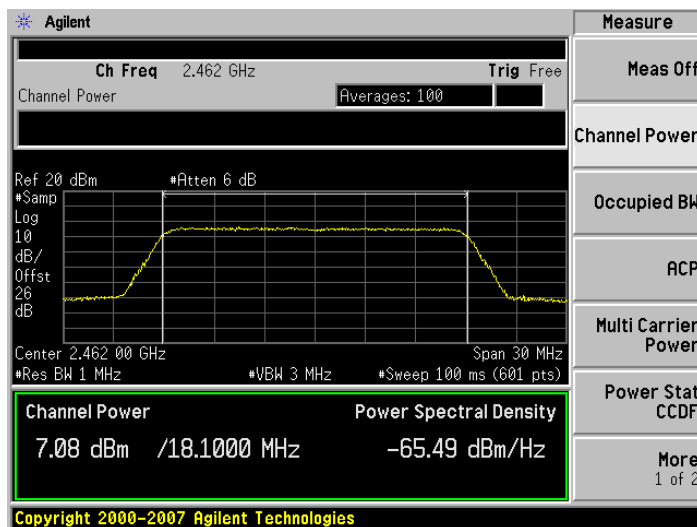
Antenna A



Antenna B



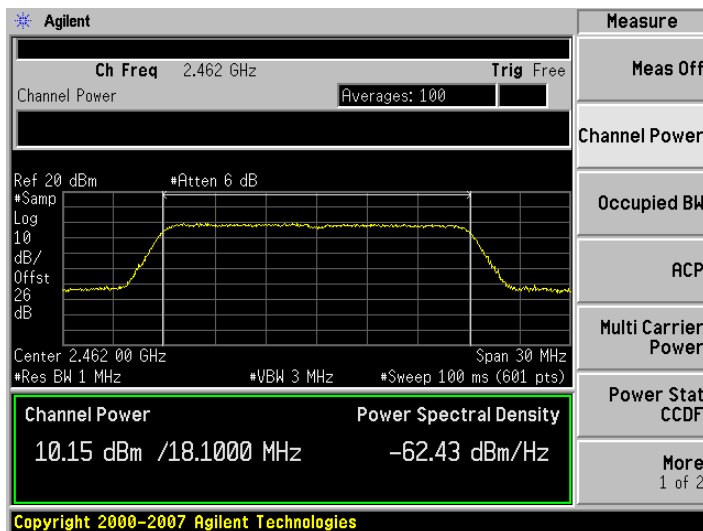
Antenna C



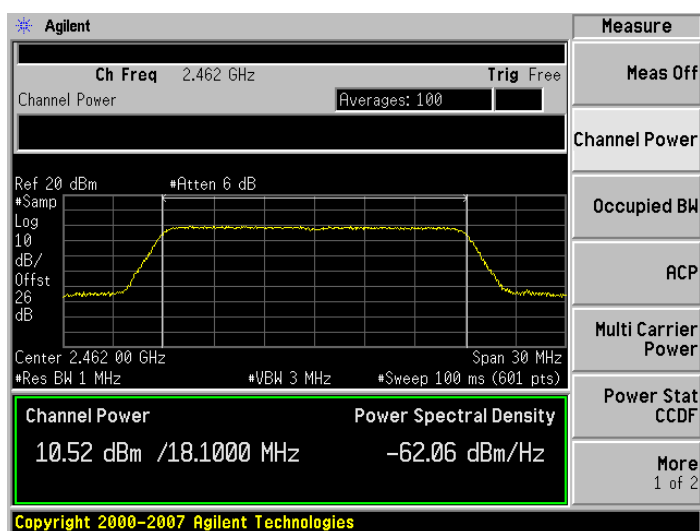
Antenna D



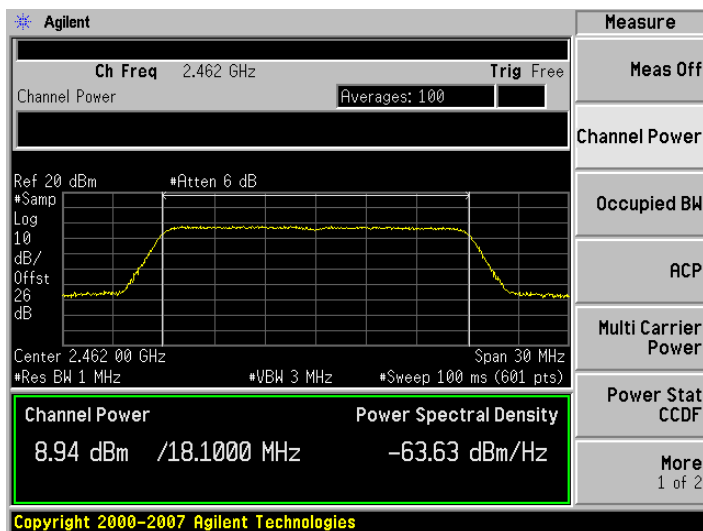
Peak Output Power, 2462 MHz, m8,HT20 Beam Forming



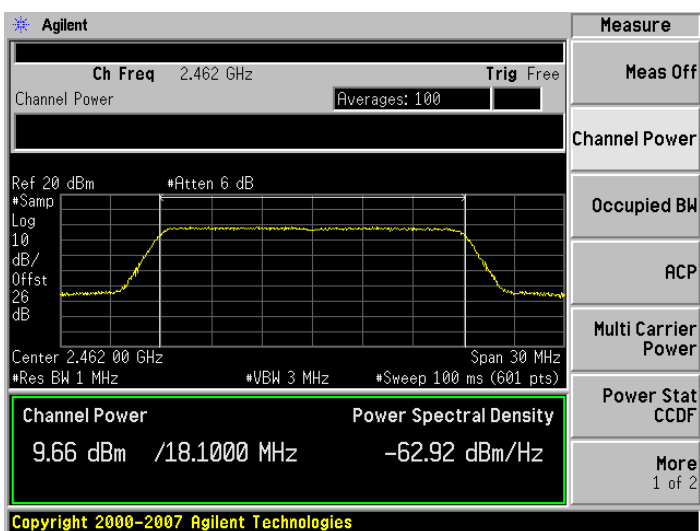
Antenna A



Antenna B



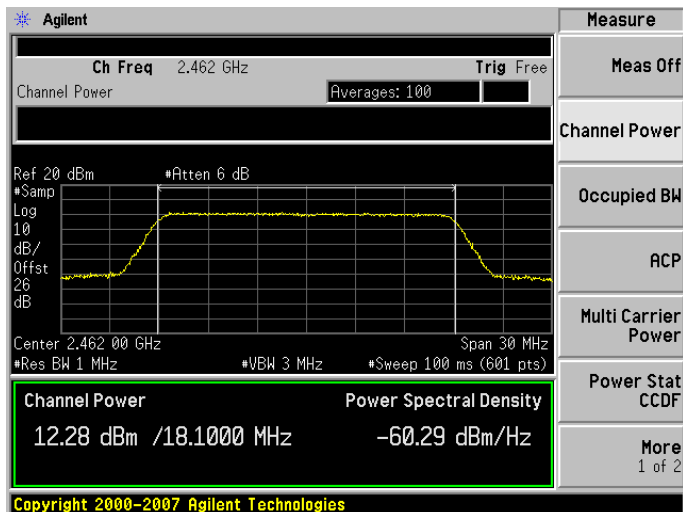
Antenna C



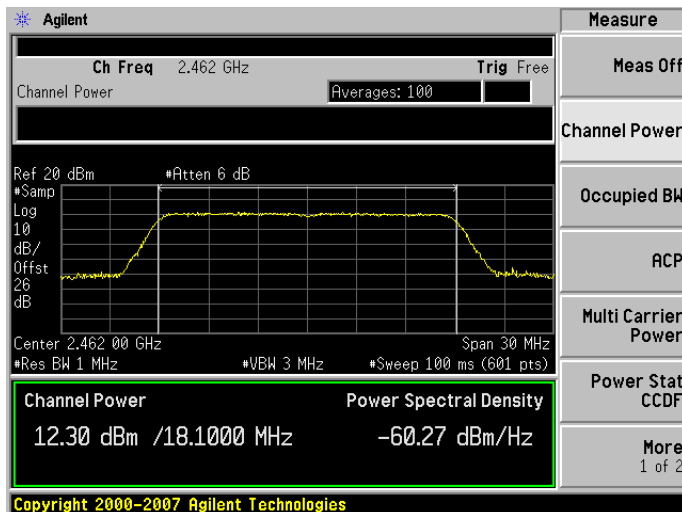
Antenna D



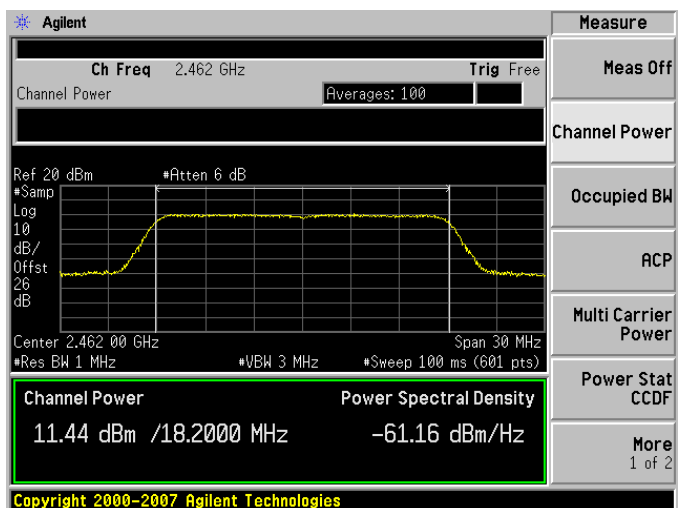
Peak Output Power, 2462 MHz, m16, HT20 Beam Forming



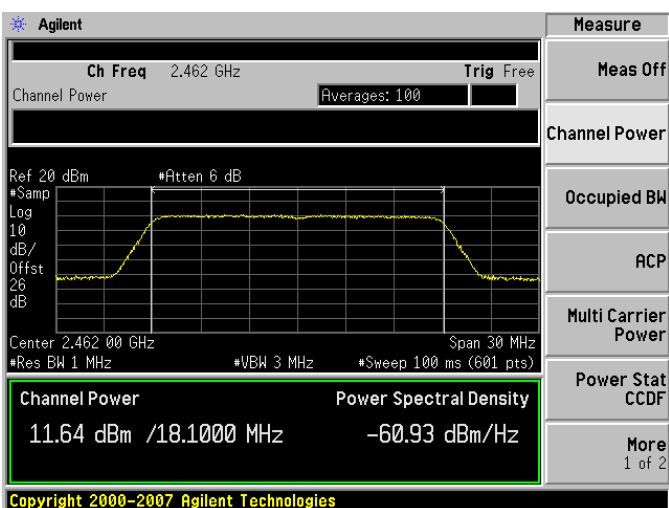
Antenna A



Antenna B



Antenna C



Antenna D



Power Spectral Density

15.247: For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Configure the spectrum analyzer as shown below.

Center Frequency:	Frequency from table below
Span:	20 MHz
Ref Level Offset:	Correct for attenuator and cable loss.
Reference Level:	20 dBm
Attenuation:	20 dB
Sweep Time:	10s
Resolution Bandwidth:	3 kHz
Video Bandwidth:	10 kHz
Detector:	Peak
Trace:	Single
Marker:	Peak Search

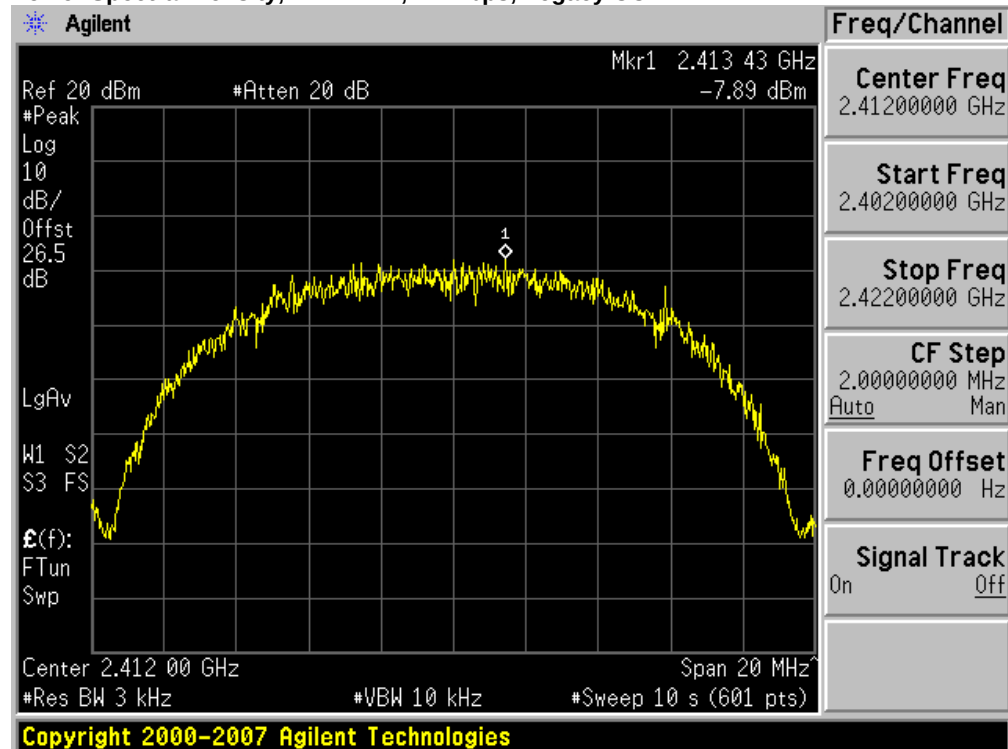
Record the Marker value.

The “Measure and add $10 \log(N)$ dB technique”, where N is the number of outputs, is used for measuring in-band Power Spectral Density. With this technique, spectrum measurements are performed at each output of the device, and the quantity $10 \log(4)$ (or 6dB) is added to the worst case spectrum value before comparing to the emission limit.

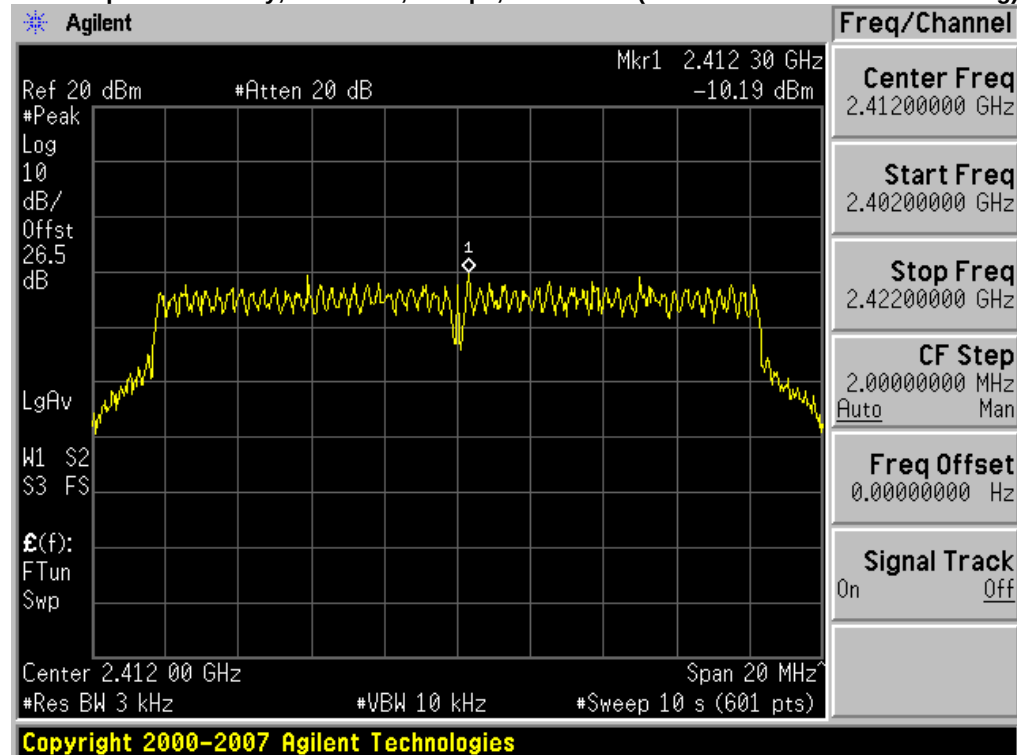


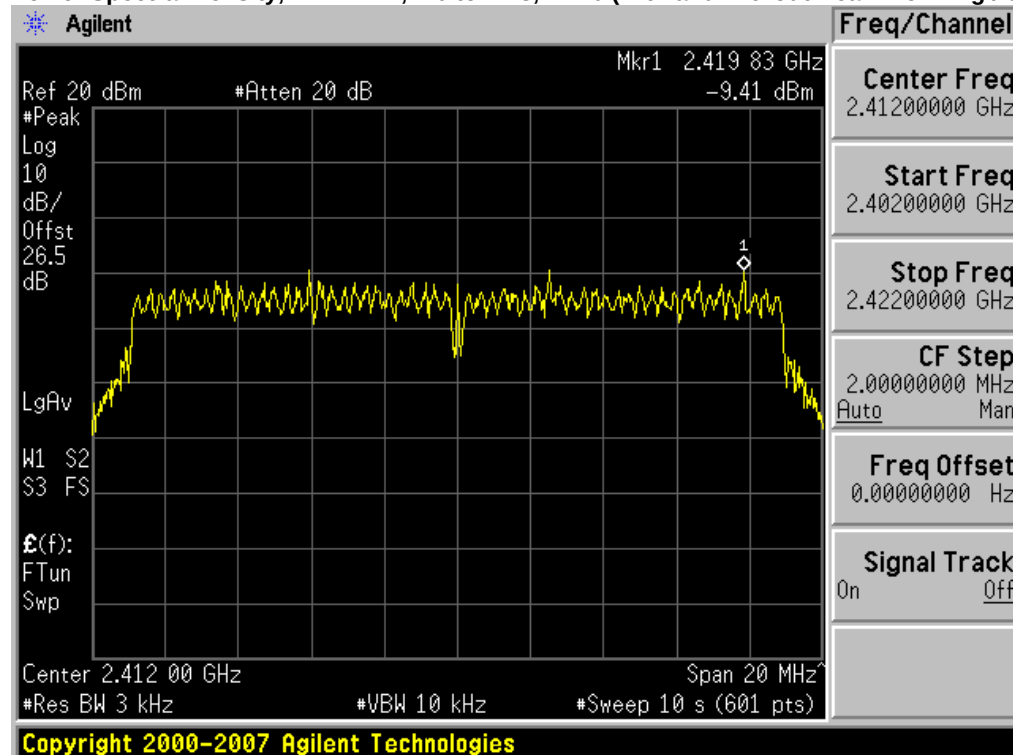
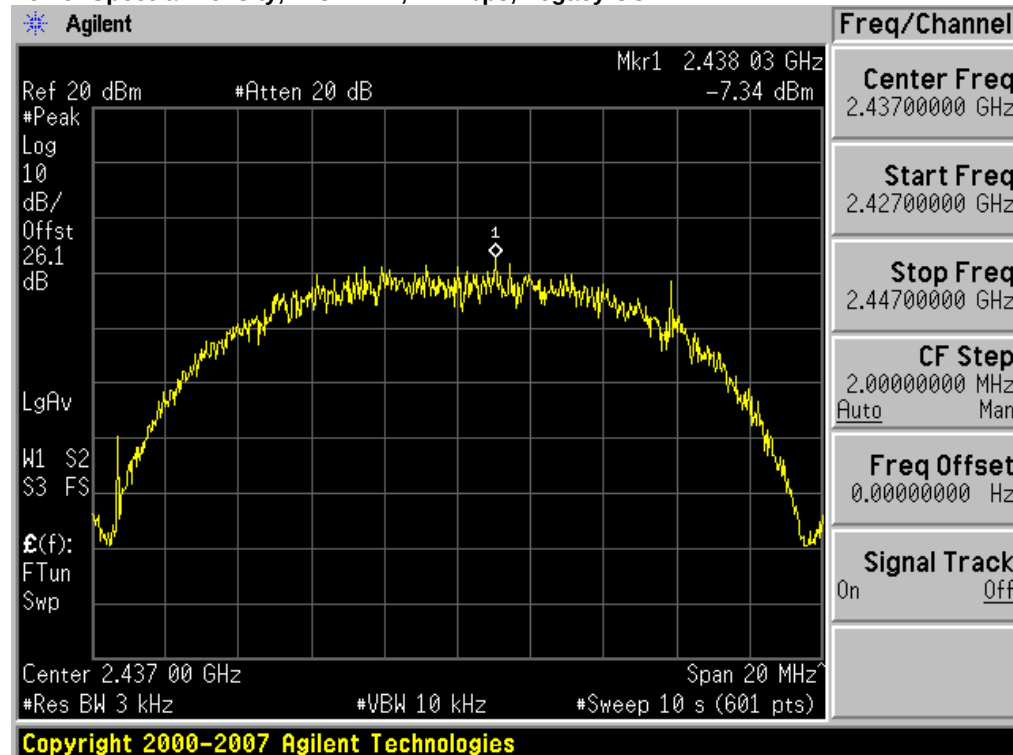
Frequency (MHz)	Mode	Data Rate (Mbps)	PSD / Antenna (dBm/3kHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
2412	Legacy CCK, 1 to 11 Mbps	11	-6.9	-0.9	8	8.9
	Non HT-20, 6 to 54 Mbps	6	-10.2	-4.2	8	12.2
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	-10.2	-4.2	8	12.2
	HT-20, M0 to M23	m0	-9.4	-3.4	8	11.4
	HT-20 STBC, M0 to M7	m0	-9.4	-3.4	8	11.4
	HT-20 Beam Forming, M0 to M23	m0	-9.4	-3.4	8	11.4
2437	Legacy CCK, 1 to 11 Mbps	11	-7.3	-1.3	8	9.3
	Non HT-20, 6 to 54 Mbps	6	-11.1	-5.1	8	13.1
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	-11.1	-5.1	8	13.1
	HT-20, M0 to M23	m0	-10.3	-4.3	8	12.3
	HT-20 STBC, M0 to M7	m0	-10.3	-4.3	8	12.3
	HT-20 Beam Forming, M0 to M23	m0	-10.3	-4.3	8	12.3
2462	Legacy CCK, 1 to 11 Mbps	11	-8.6	-2.6	8	10.6
	Non HT-20, 6 to 54 Mbps	6	-10.5	-4.4	8	12.4
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	-10.5	-4.4	8	12.4
	HT-20, M0 to M23	m0	-8.9	-2.9	8	10.9
	HT-20 STBC, M0 to M7	m0	-8.9	-2.9	8	10.9
	HT-20 Beam Forming, M0 to M23	m0	-8.9	-2.9	8	10.9

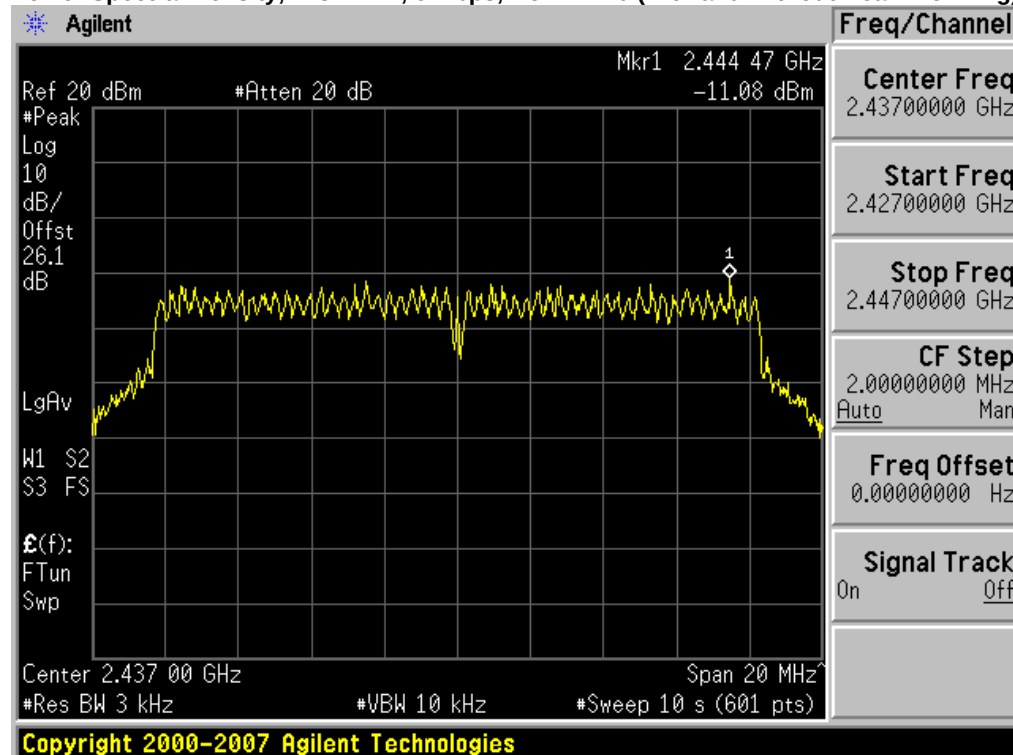
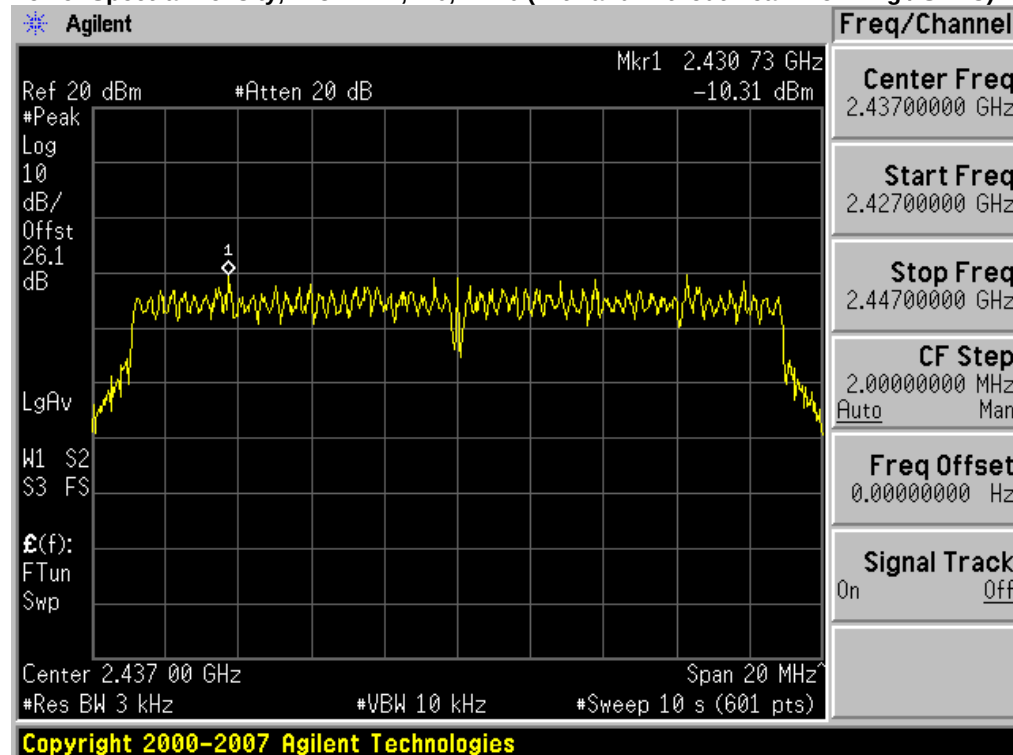
Power Spectral Density, 2412 MHz, 11 Mbps, Legacy CCK



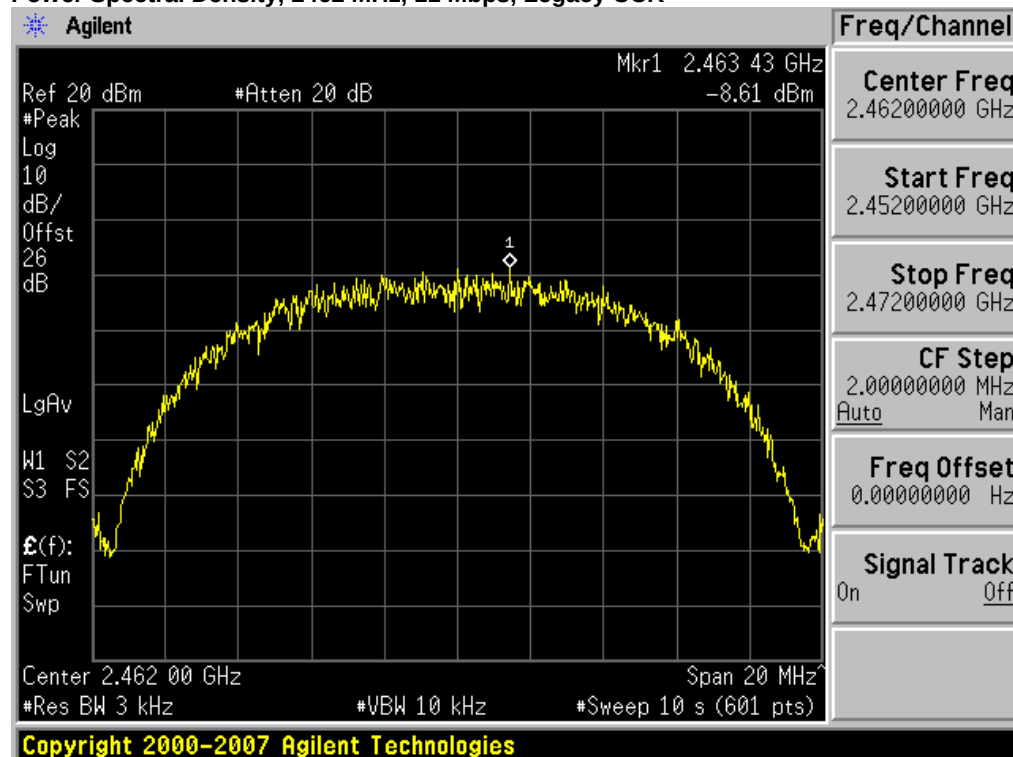
Power Spectral Density, 2412 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



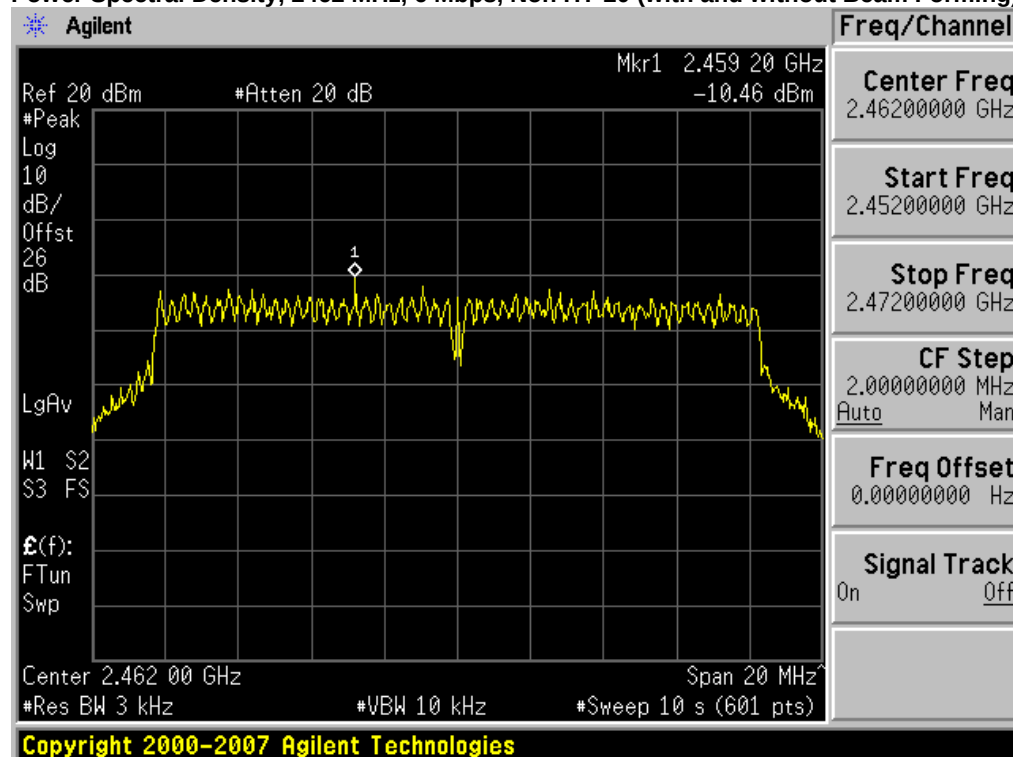
Power Spectral Density, 2412 MHz, m0 to m23, HT20 (with and without Beam Forming / STBC)**Power Spectral Density, 2437 MHz, 11 Mbps, Legacy CCK**

Power Spectral Density, 2437 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)**Power Spectral Density, 2437 MHz, m0, HT20 (with and without Beam Forming / STBC)**

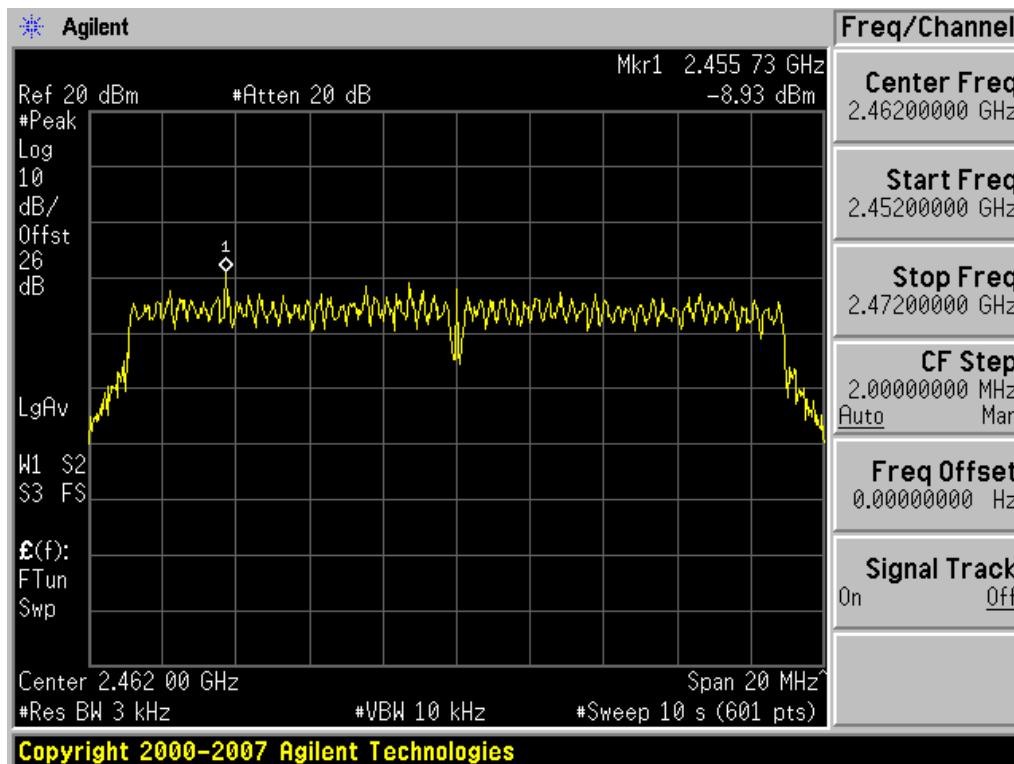
Power Spectral Density, 2462 MHz, 11 Mbps, Legacy CCK



Power Spectral Density, 2462 MHz, 6 Mbps, Non HT-20 (with and without Beam Forming)



Power Spectral Density, 2462 MHz, m0, HT20 (with and without Beam Forming / STBC)





Appendix B: Emission Test Results

Testing Laboratory: Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134, USA

Conducted Bandedge

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Use the procedures in 718828 D01 DTS Meas Guidance v01 to substitute conducted measurements in place of radiated measurements.

Connect the antenna port(s) to the spectrum analyzer input. Place the radio in continuous transmit mode. Be sure to enter all losses between the transmitter output and the spectrum analyzer.

Reference Level:	10 dBm
Attenuation:	4 dB
Sweep Time:	Coupled
Resolution Bandwidth:	1MHz
Video Bandwidth:	1 MHz for peak, 100 Hz for average
Detector:	Peak

Save 2 plots: 1) Average Plot (Vertical and Horizontal), Limit= -41.25 dBm eirp (54dBuV @3m)
 2) Peak plot (Vertical and Horizontal), Limit = -21.25 dBm eirp (74dBuV @3m)

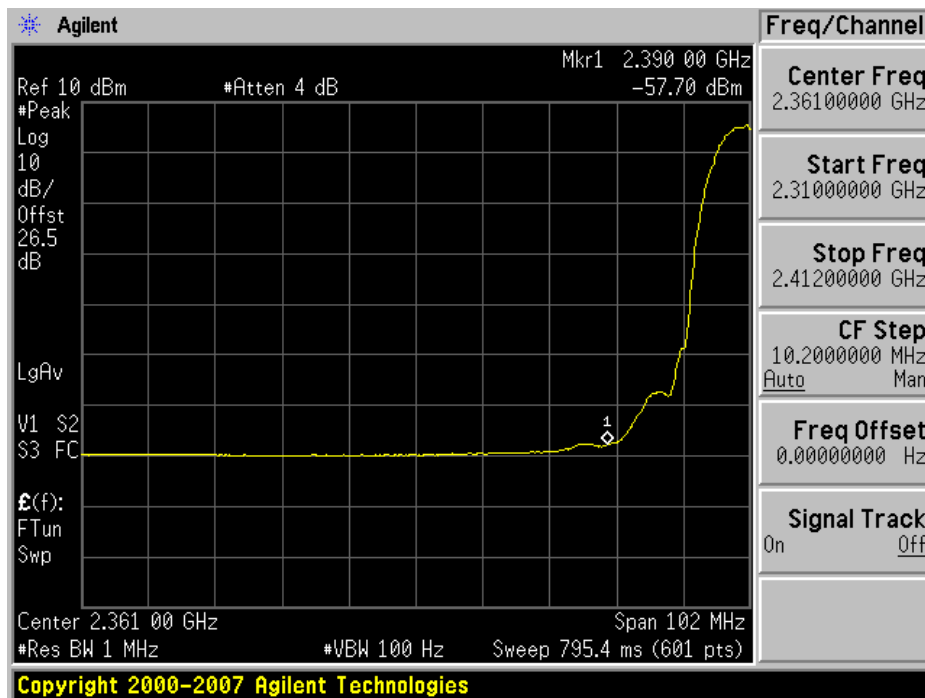
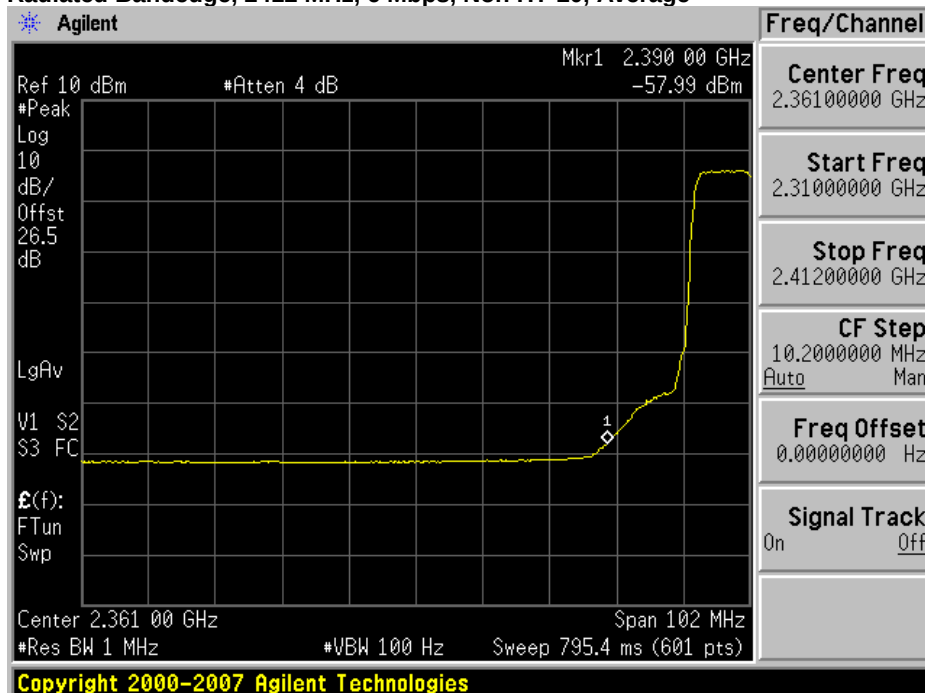
Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands.

The “measure-and-sum technique” is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units.

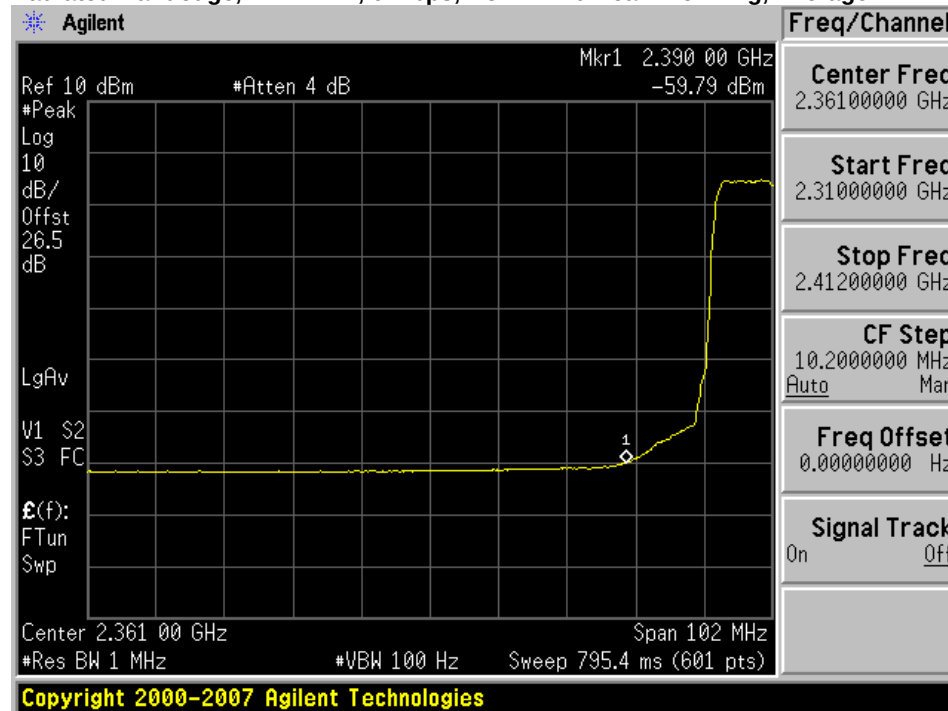
This report represents the worst case data for all supported operating modes and antennas.



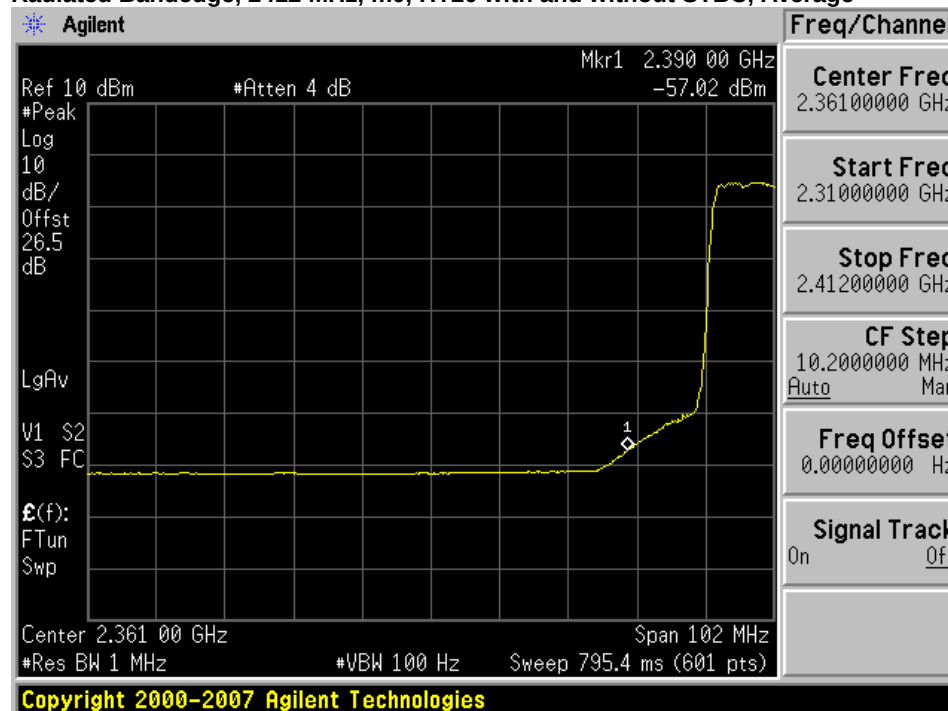
Frequency (MHz)	Operating Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Banded Level (dBm)	Tx 2 Banded Level (dBm)	Tx 3 Banded Level (dBm)	Tx 4 Banded Level (dBm)	Total Tx Banded Level (dBm)	Limit (dBm)	Margin (dB)
2412	Legacy CCK, 1 to 11 Mbps	4	6	-58.8	-57.7	-58.2	-58.2	-46.2	-41.25	4.9
	Non HT-20, 6 to 54 Mbps	4	6	-54.1	-54.1	-54.0	-54.2	-42.1	-41.25	0.8
	Non HT-20 Beam Forming, 6 to 54 Mbps	4	12	-60.1	-59.8	-60.1	-59.9	-41.9	-41.25	0.7
	HT-20, M0 to M23	4	6	-53.8	-53.3	-53.9	-53.4	-41.6	-41.25	0.3
	HT-20 STBC, M0 to M7	4	6	-57.1	-57.6	-59.0	-57.7	-45.8	-41.25	4.5
	HT-20 Beam Forming, M0 to M7	4	12	-59.6	-58.7	-59.5	-59.3	-41.2	-41.25	0.0
	HT-20 Beam Forming, M8 to M15	4	9	-58.7	-58.5	-58.5	-58.6	-43.5	-41.25	2.3
	HT-20 Beam Forming, M16 to M23	4	7	-53.6	-55.4	-56.1	-55.2	-41.7	-41.25	0.5
2462	Legacy CCK, 1 to 11 Mbps	4	6	-60.0	-59.9	-59.8	-59.9	-47.9	-41.25	6.6
	Non HT-20, 6 to 54 Mbps	4	6	-53.8	-55.0	-53.5	-54.8	-42.2	-41.25	0.9
	Non HT-20 Beam Forming, 6 to 54 Mbps	4	12	-60.3	-59.6	-61.0	-60.3	-42.2	-41.25	1.0
	HT-20, M0 to M23	4	6	-54.5	-53.9	-53.6	-52.4	-41.5	-41.25	0.2
	HT-20 STBC, M0 to M7	4	6	-54.5	-53.9	-53.6	-52.4	-41.5	-41.25	0.2
	HT-20 Beam Forming, M0 to M7	4	12	-60.1	-59.3	-60.0	-60.0	-41.8	-41.25	0.5
	HT-20 Beam Forming, M8 to M15	4	9	-57.4	-57.0	-60.0	-58.1	-42.9	-41.25	1.7
	HT-20 Beam Forming, M16 to M23	4	7	-53.5	-54.6	-54.9	-56.2	-41.5	-41.25	0.2

Conducted Bandedge, 2412 MHz, 11 Mbps, Legacy CCK, Average**Radiated Bandedge, 2412 MHz, 6 Mbps, Non HT-20, Average**

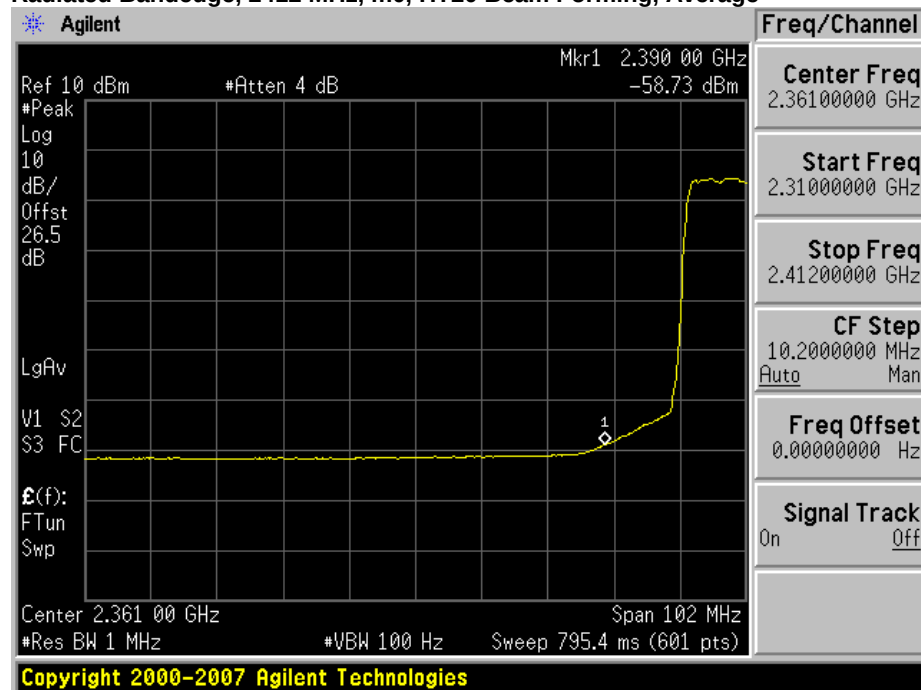
Radiated Bandedge, 2412 MHz, 6 Mbps, Non HT-20 Beam Forming, Average



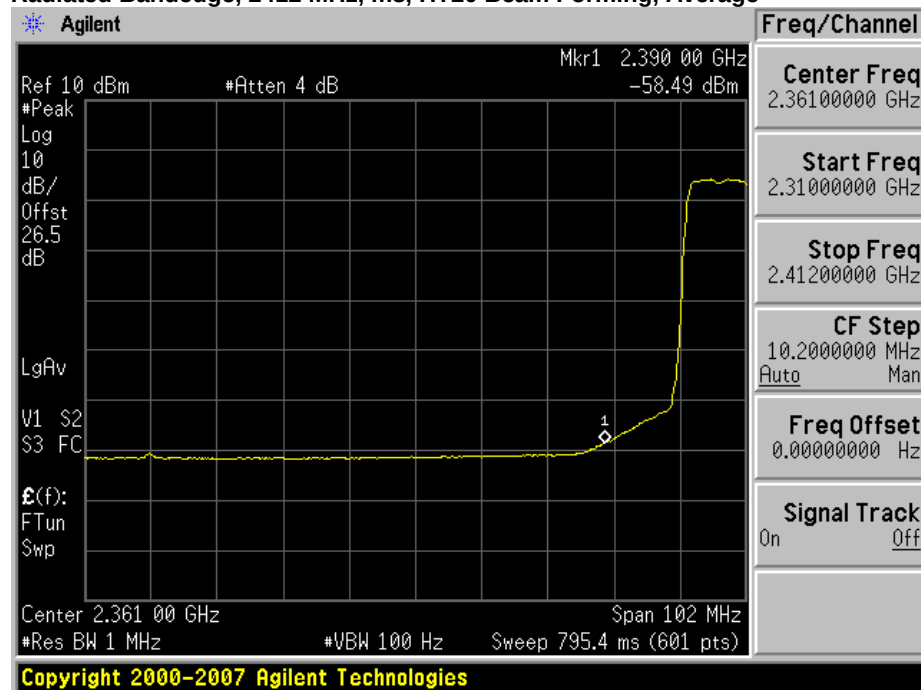
Radiated Bandedge, 2412 MHz, m0, HT20 with and without STBC, Average



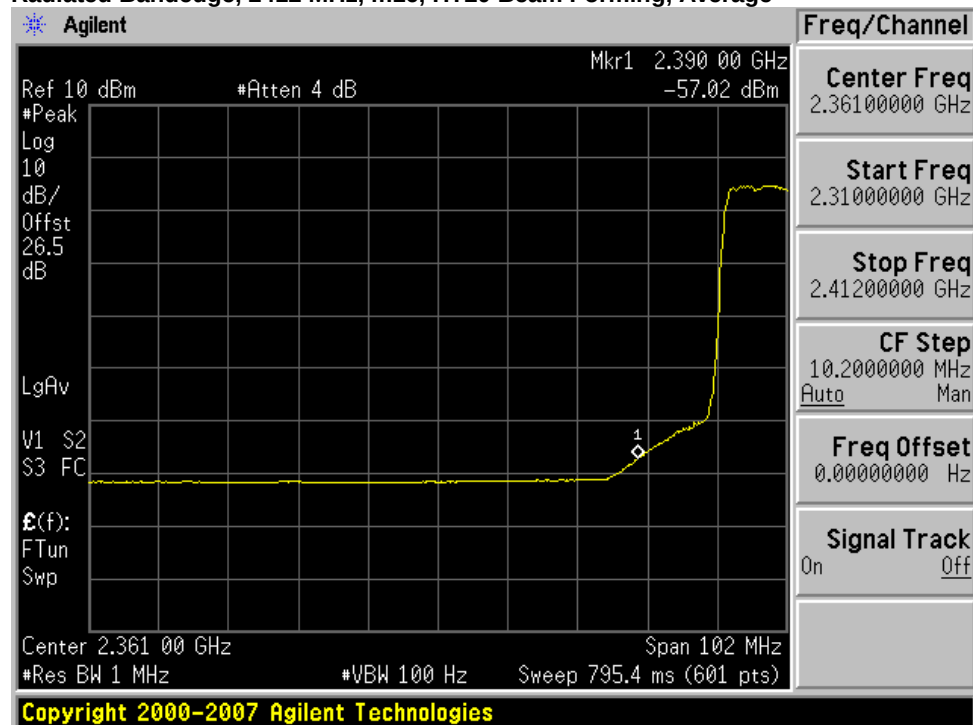
Radiated Bandedge, 2412 MHz, m0, HT20 Beam Forming, Average



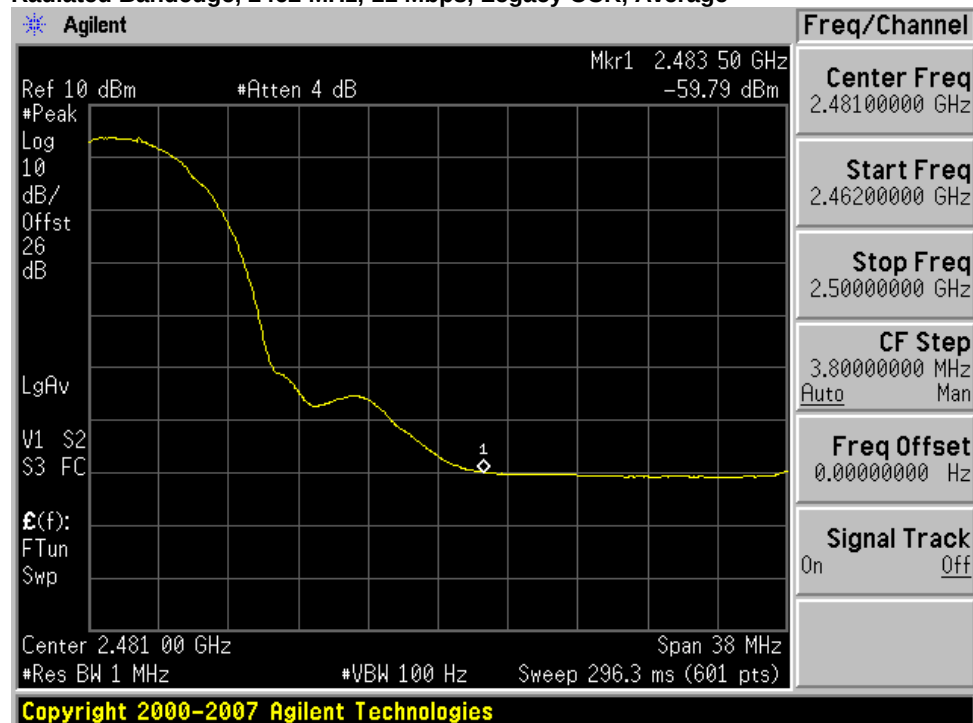
Radiated Bandedge, 2412 MHz, m8, HT20 Beam Forming, Average



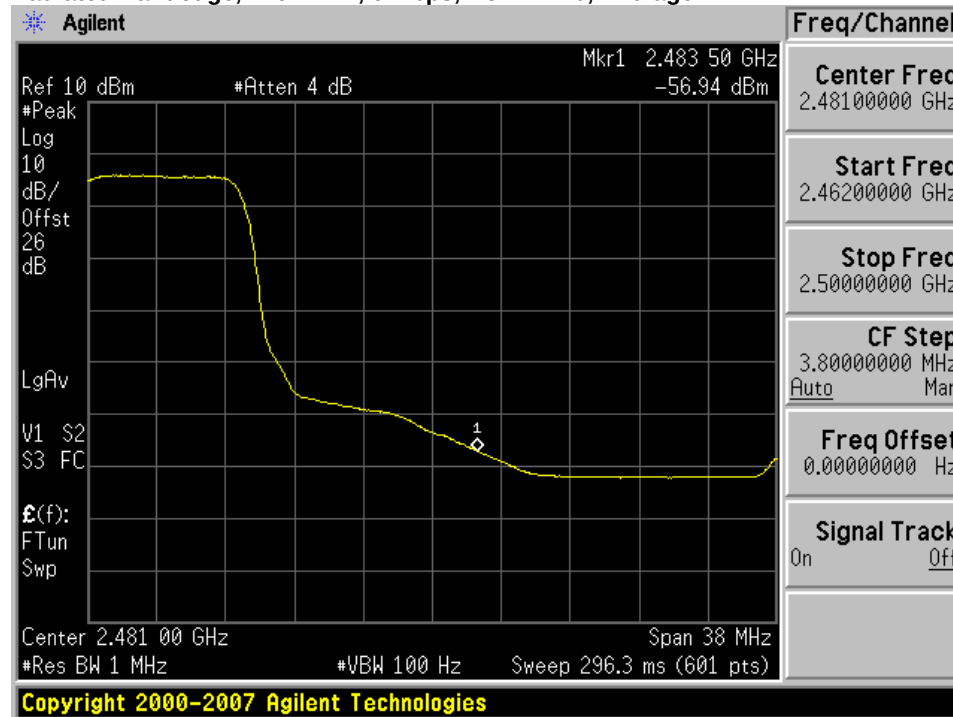
Radiated Bandedge, 2412 MHz, m16, HT20 Beam Forming, Average



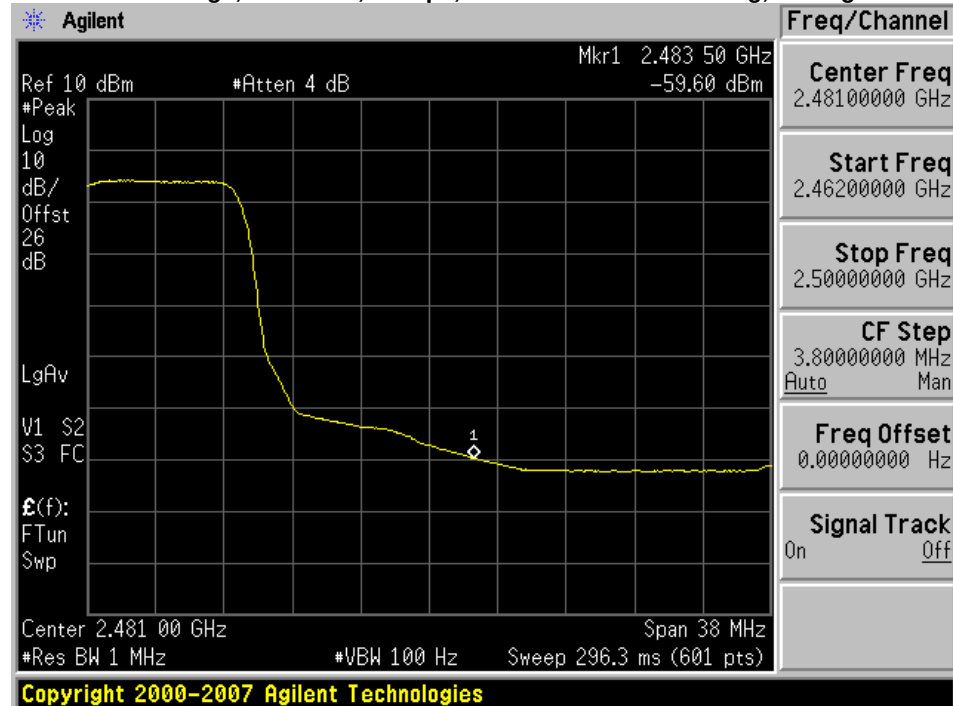
Radiated Bandedge, 2462 MHz, 11 Mbps, Legacy CCK, Average



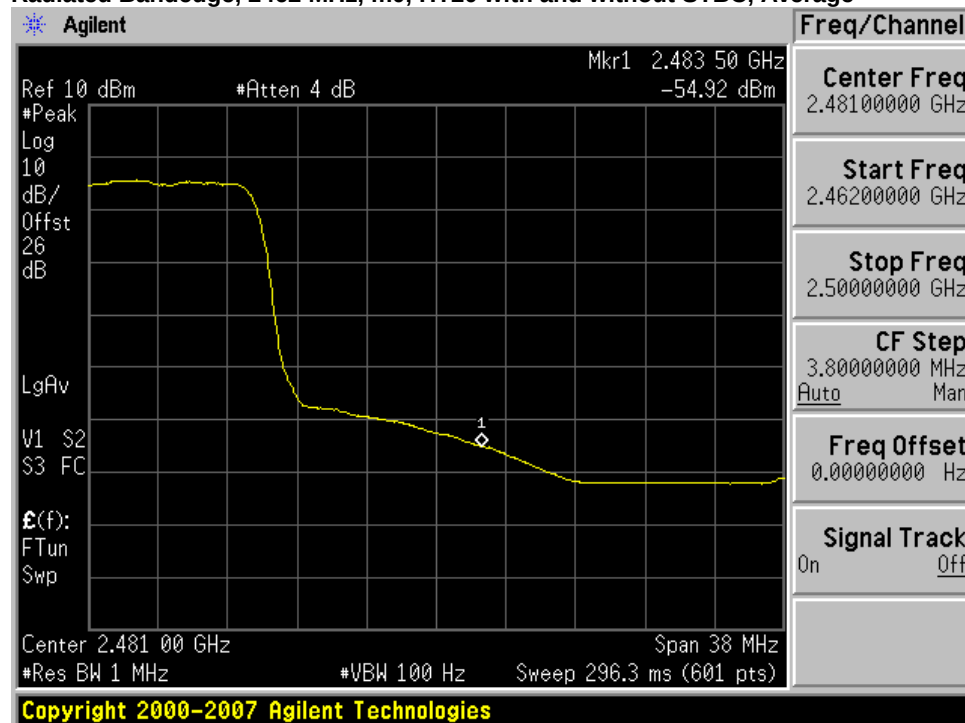
Radiated Bandedge, 2462 MHz, 6 Mbps, Non HT-20, Average



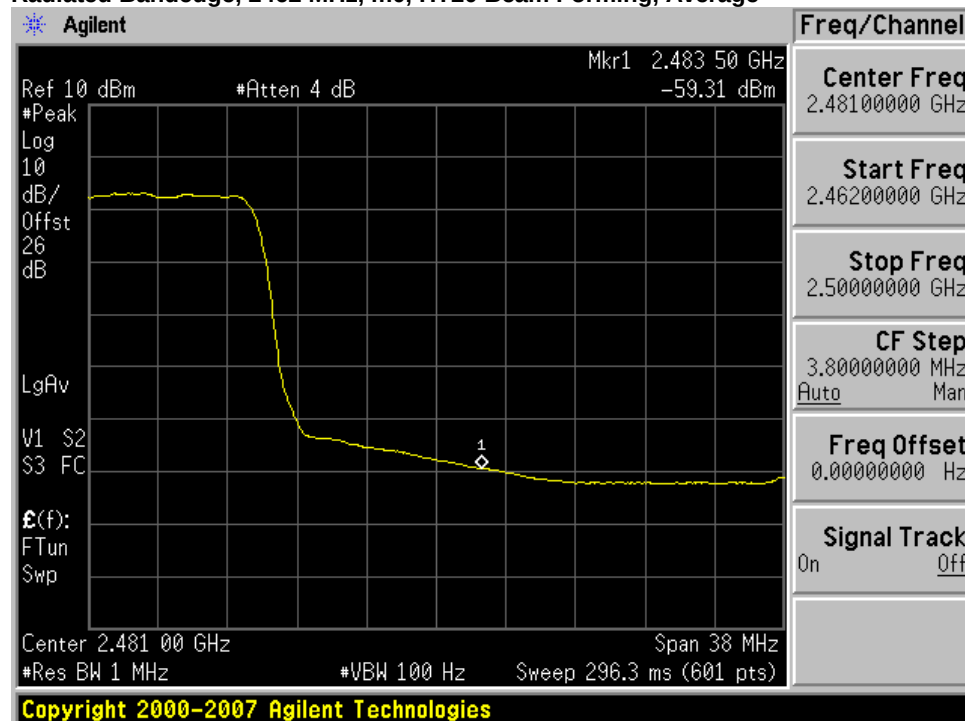
Radiated Bandedge, 2462 MHz, 6 Mbps, Non HT-20 Beam Forming, Average



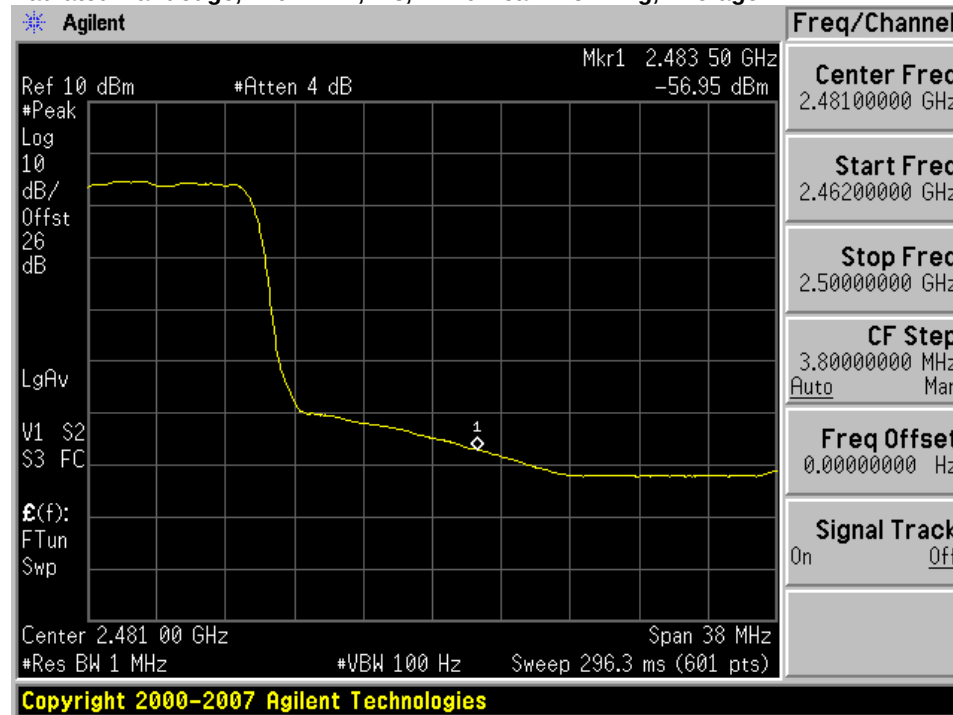
Radiated Bandedge, 2462 MHz, m0, HT20 with and without STBC, Average



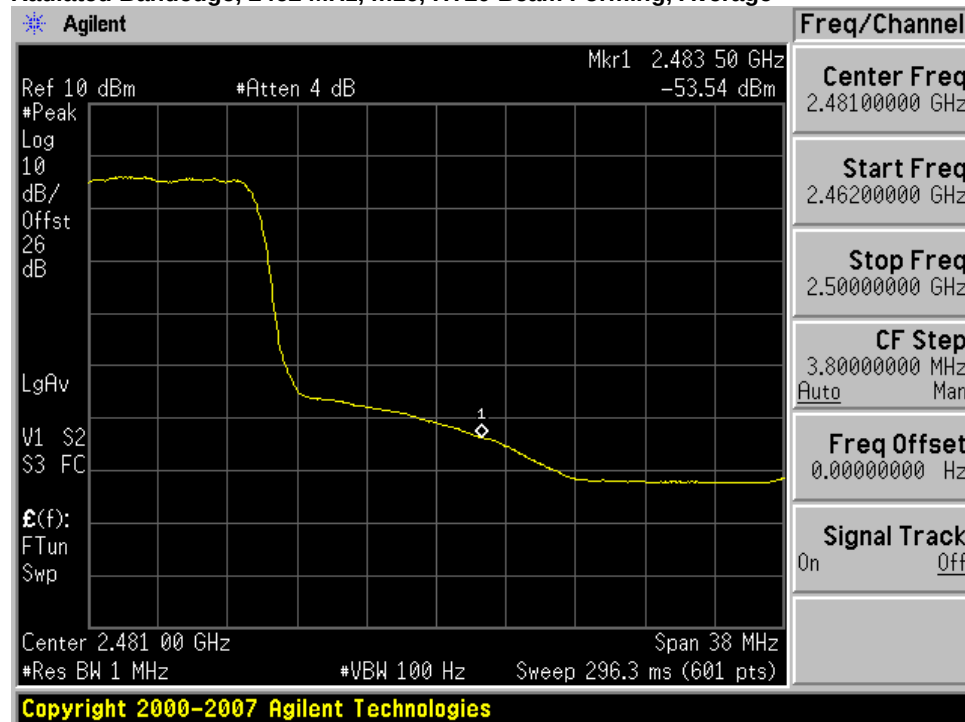
Radiated Bandedge, 2462 MHz, m0, HT20 Beam Forming, Average



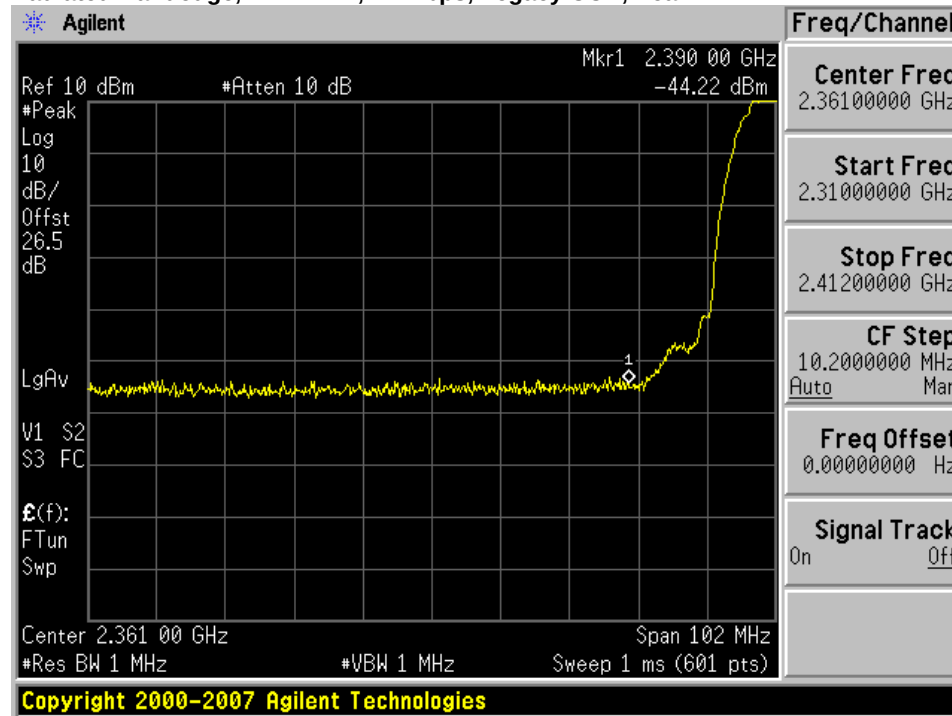
Radiated Bandedge, 2462 MHz, m8, HT20 Beam Forming, Average



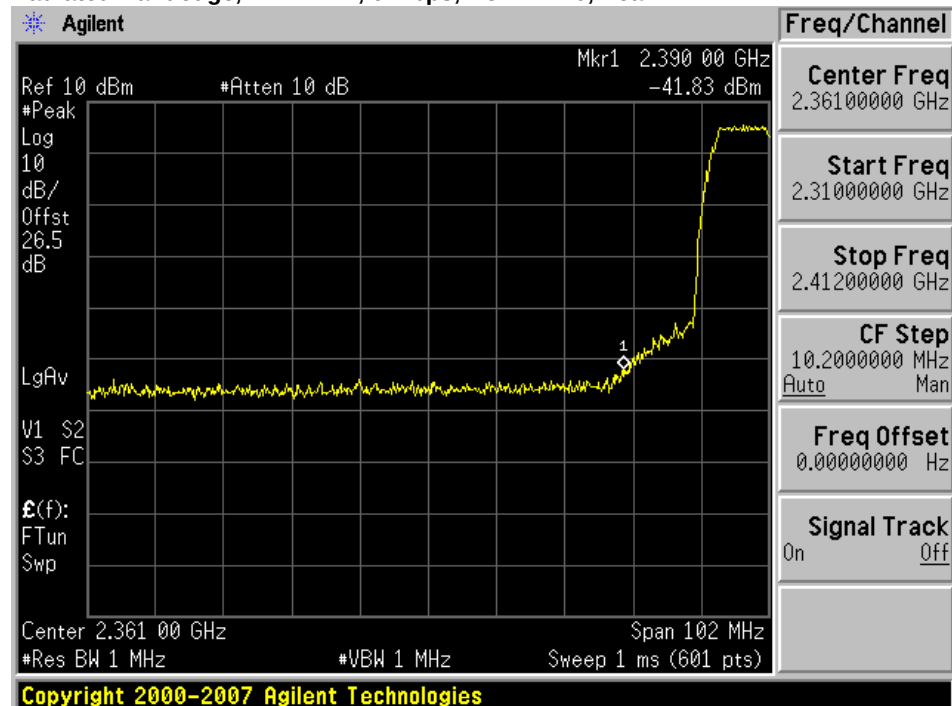
Radiated Bandedge, 2462 MHz, m16, HT20 Beam Forming, Average

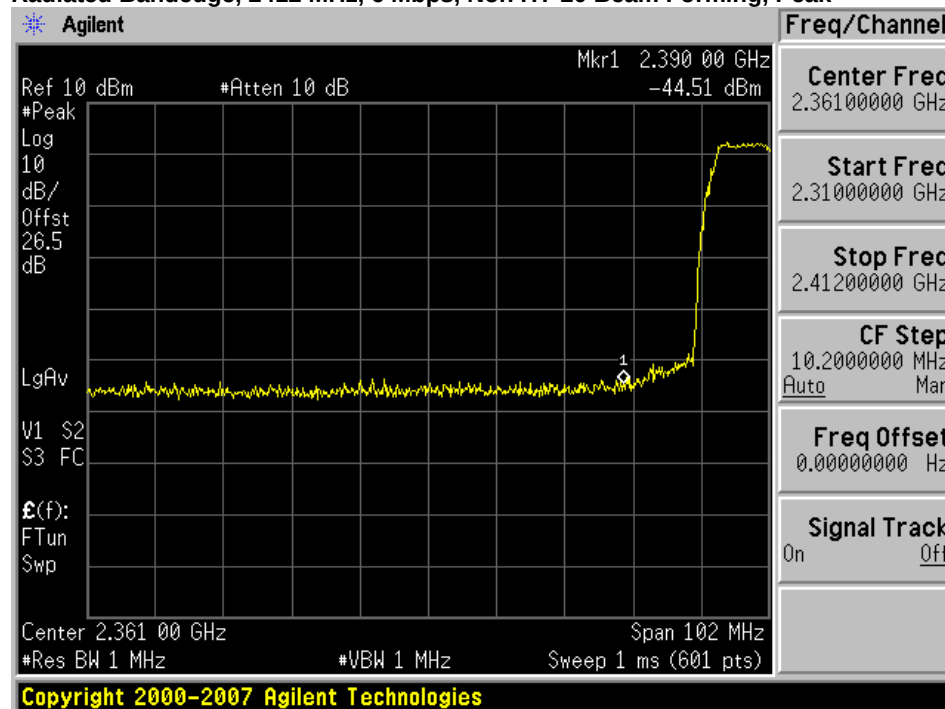
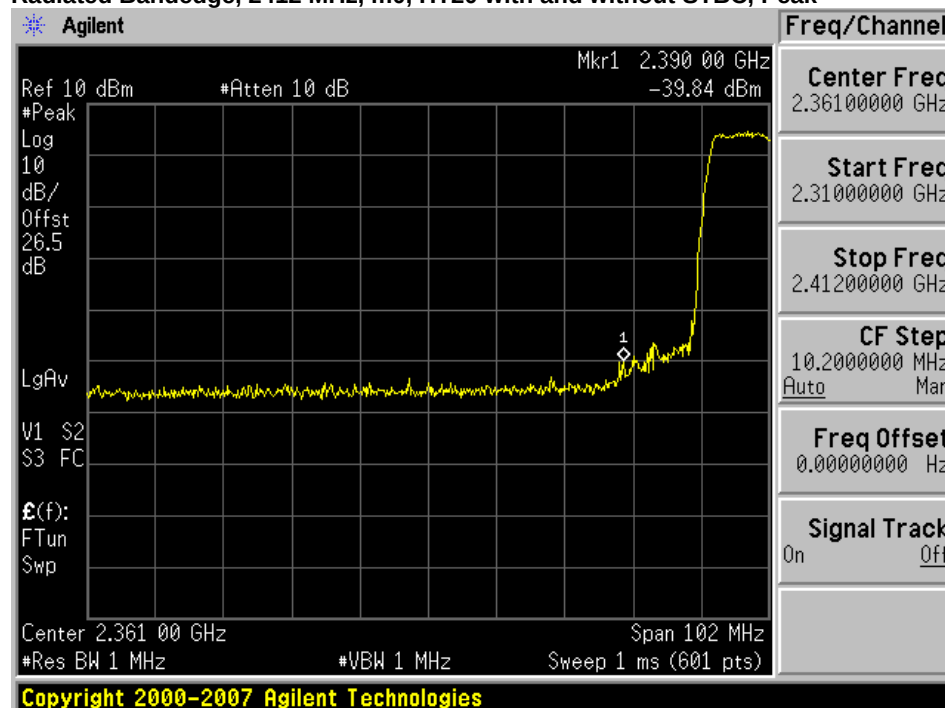


Radiated Bandedge, 2412 MHz, 11 Mbps, Legacy CCK, Peak

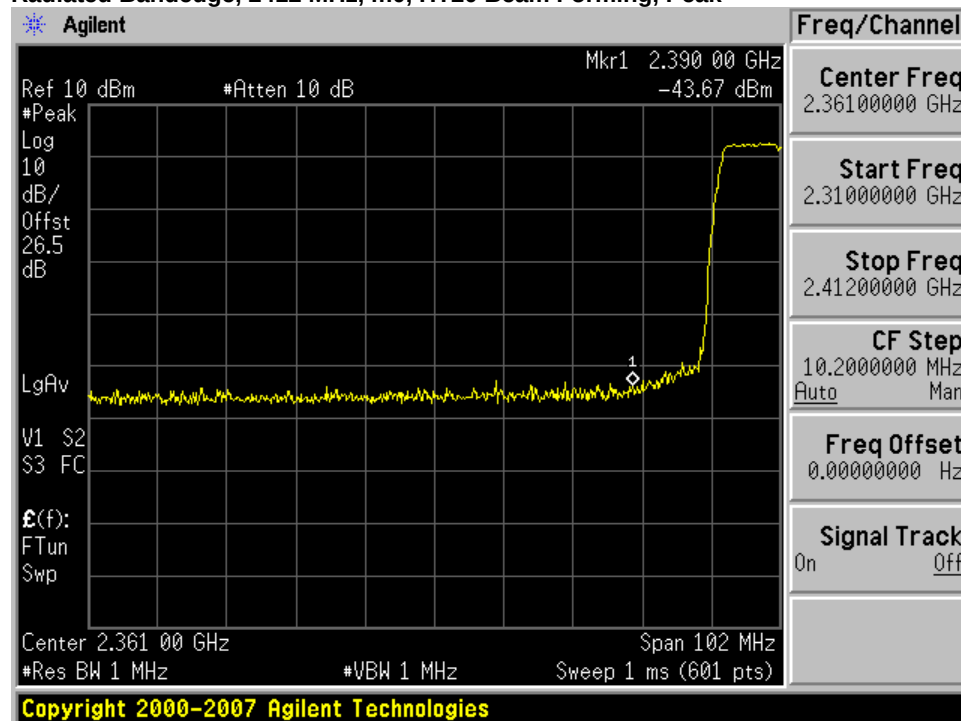


Radiated Bandedge, 2412 MHz, 6 Mbps, Non HT-20, Peak

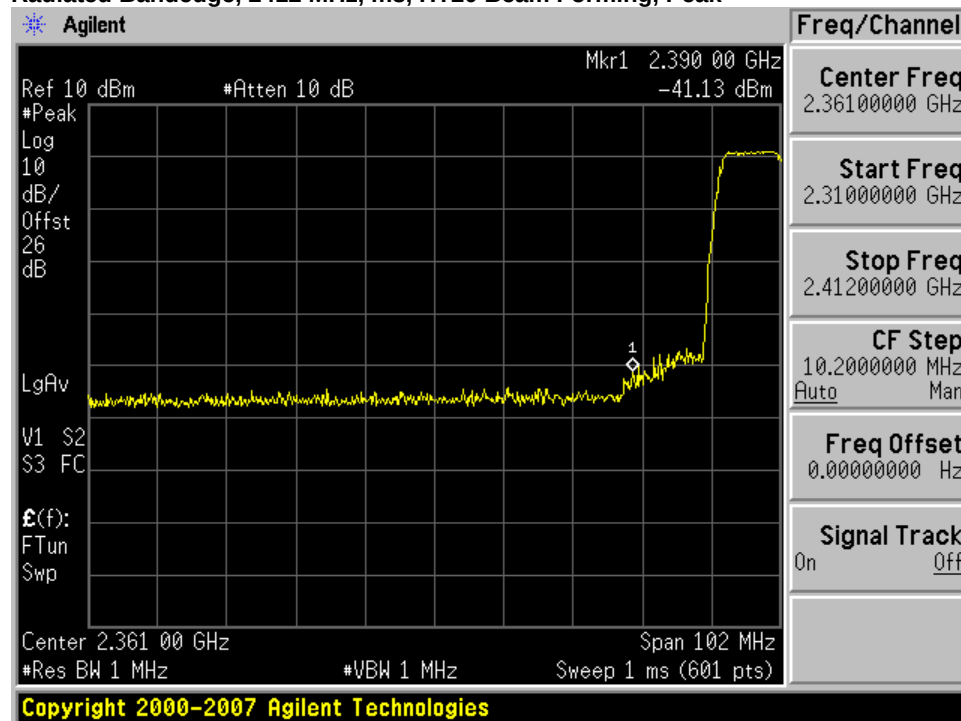


Radiated Bandedge, 2412 MHz, 6 Mbps, Non HT-20 Beam Forming, Peak**Radiated Bandedge, 2412 MHz, m0, HT20 with and without STBC, Peak**

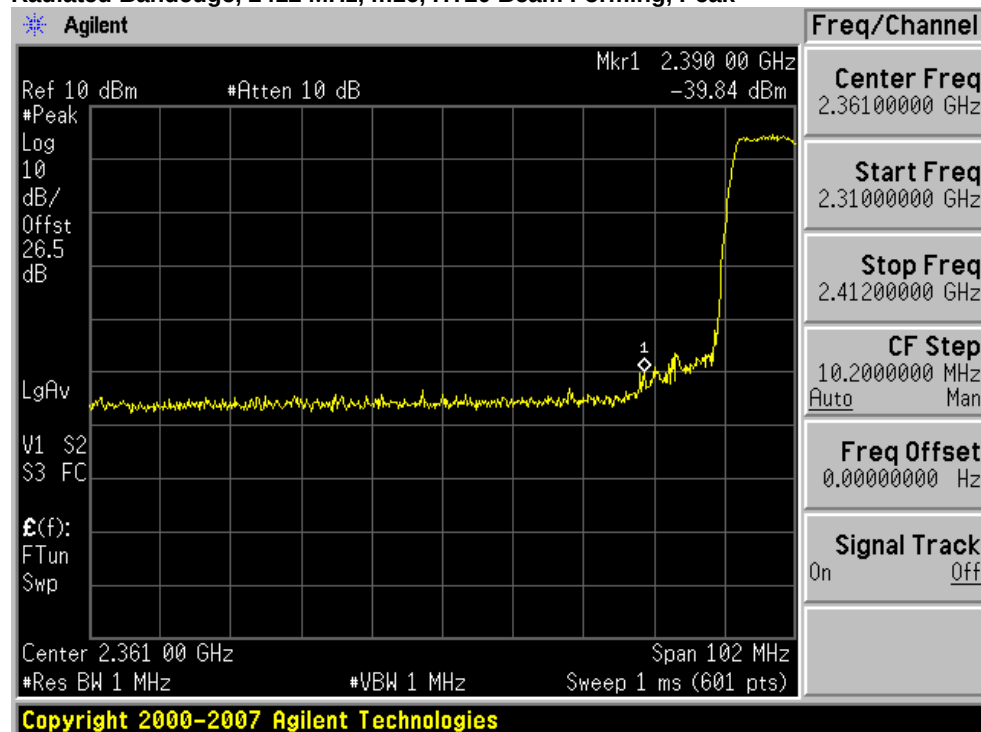
Radiated Bandedge, 2412 MHz, m0, HT20 Beam Forming, Peak



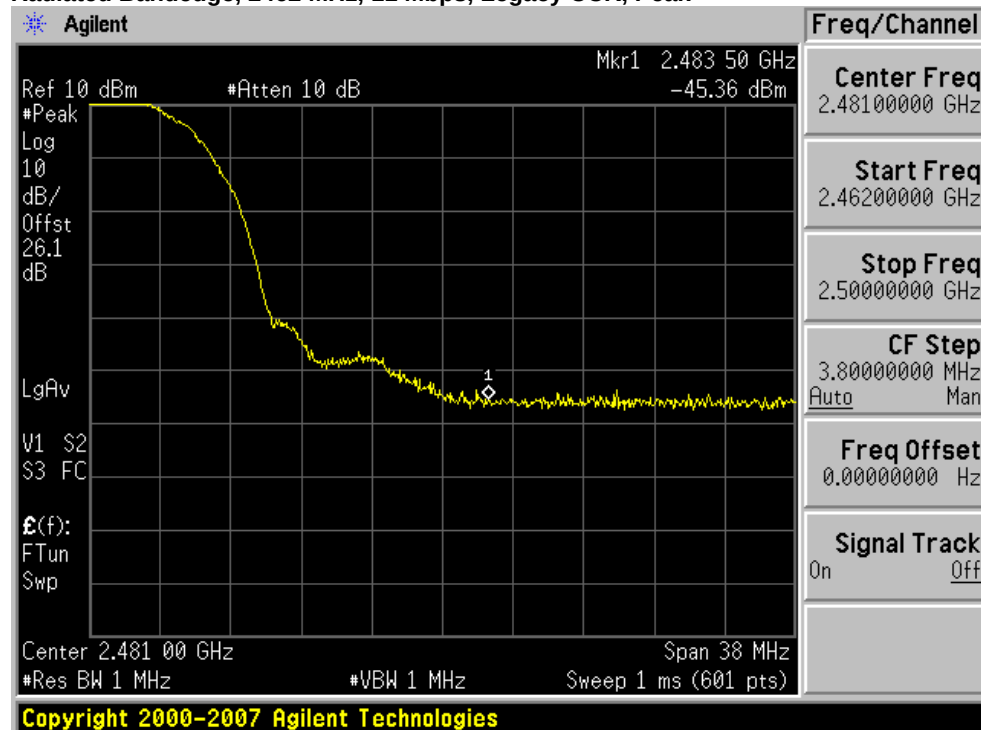
Radiated Bandedge, 2412 MHz, m8, HT20 Beam Forming, Peak



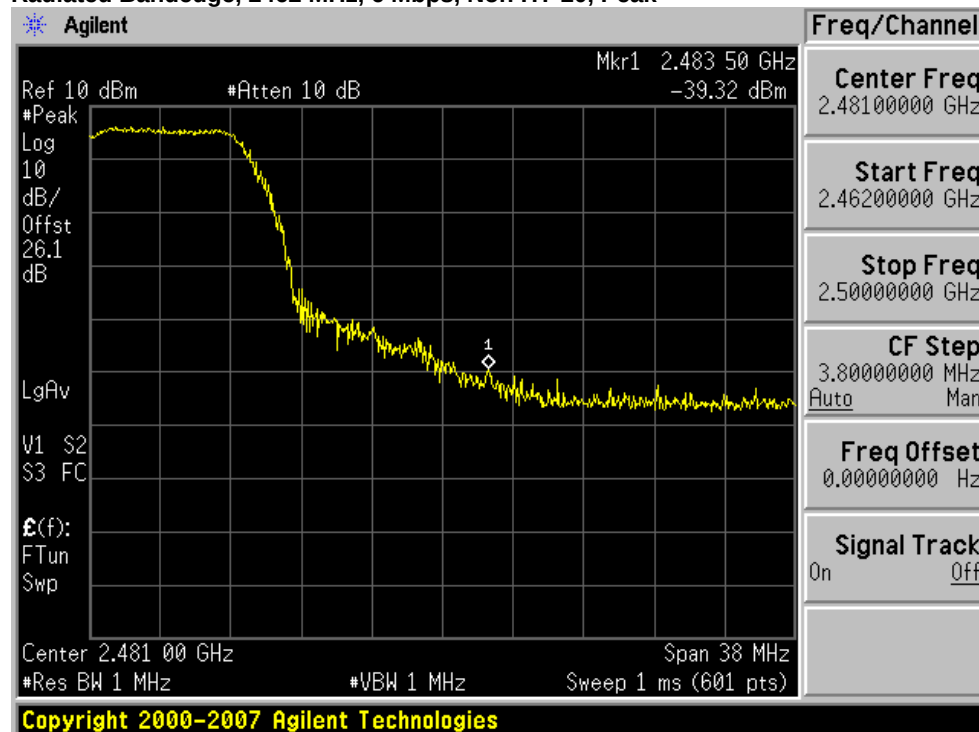
Radiated Bandedge, 2412 MHz, m16, HT20 Beam Forming, Peak



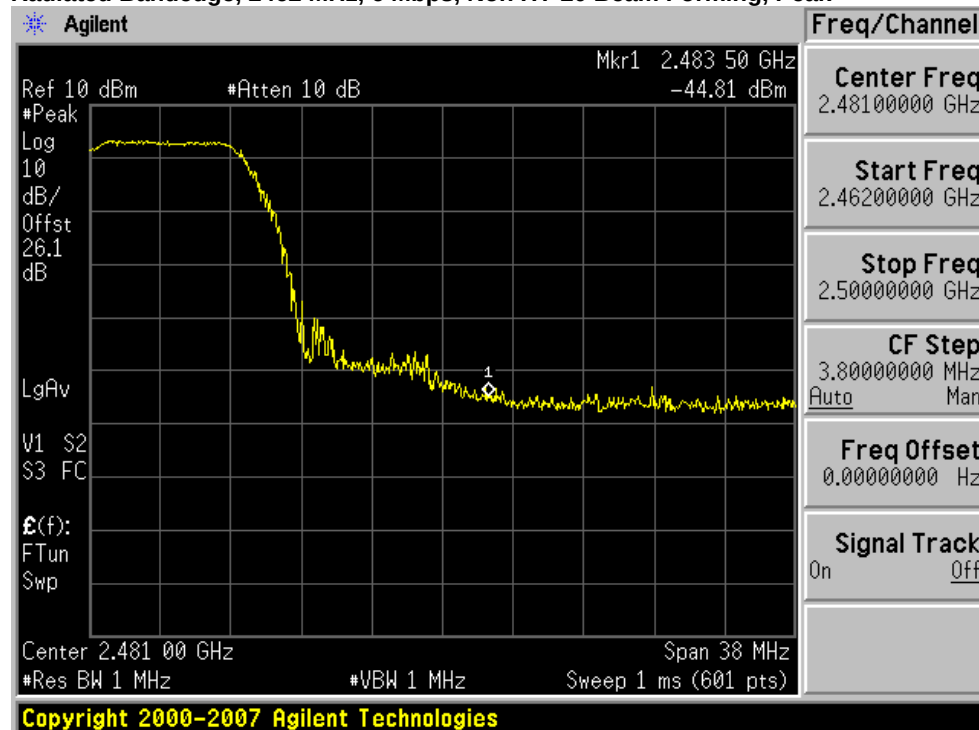
Radiated Bandedge, 2462 MHz, 11 Mbps, Legacy CCK, Peak



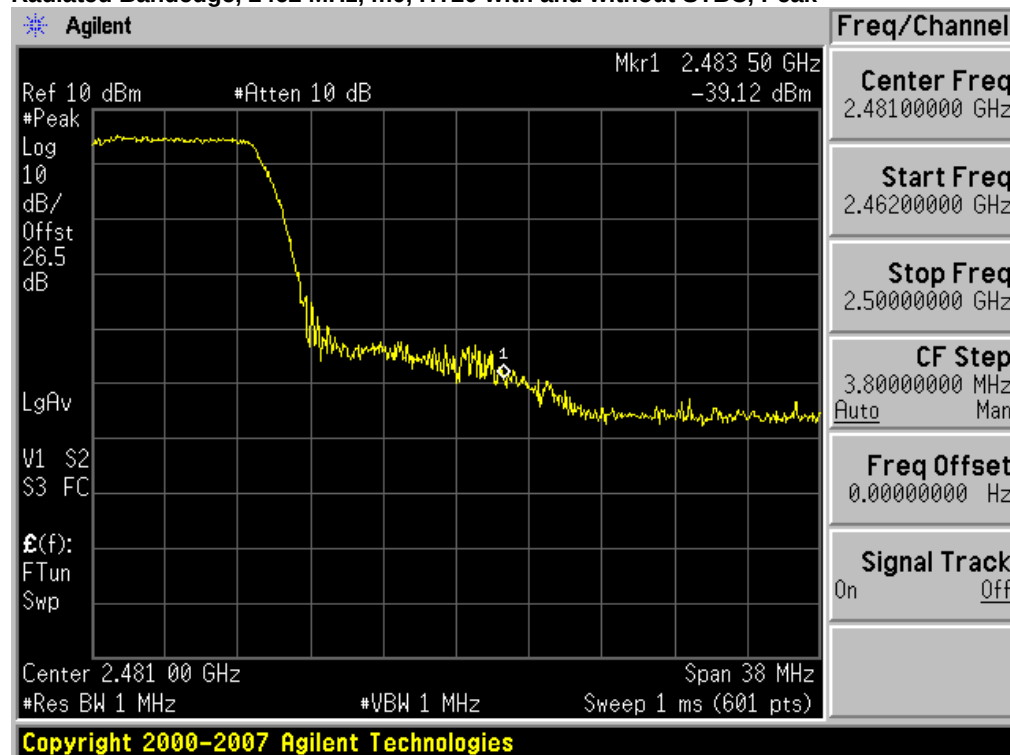
Radiated Bandedge, 2462 MHz, 6 Mbps, Non HT-20, Peak



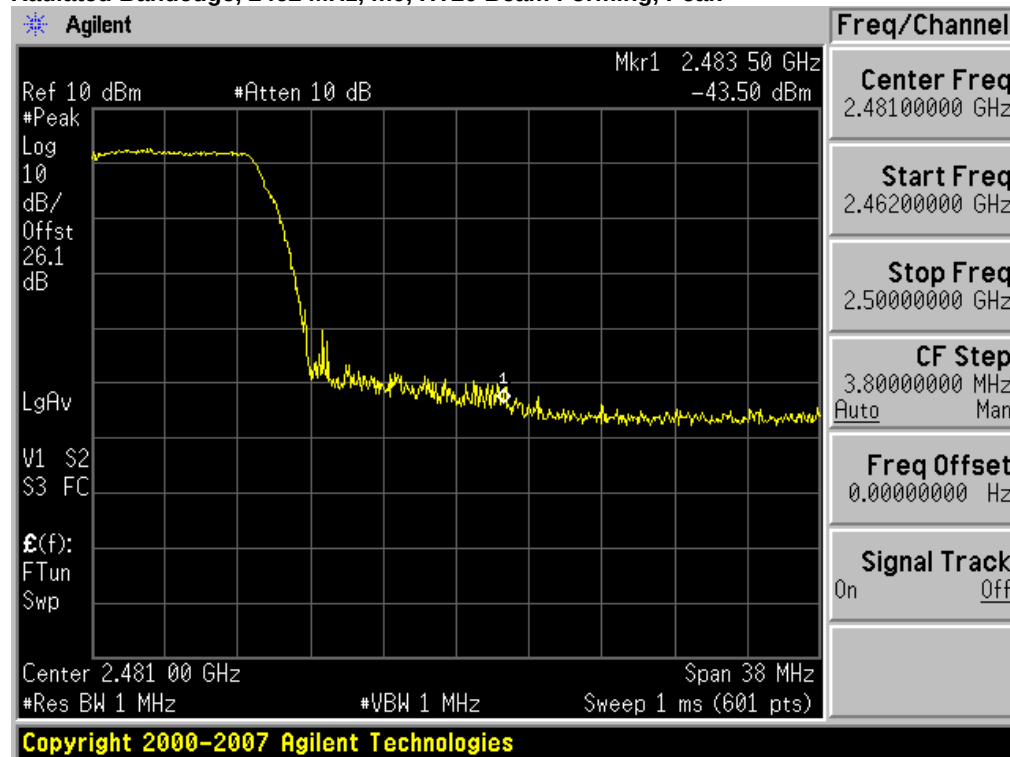
Radiated Bandedge, 2462 MHz, 6 Mbps, Non HT-20 Beam Forming, Peak



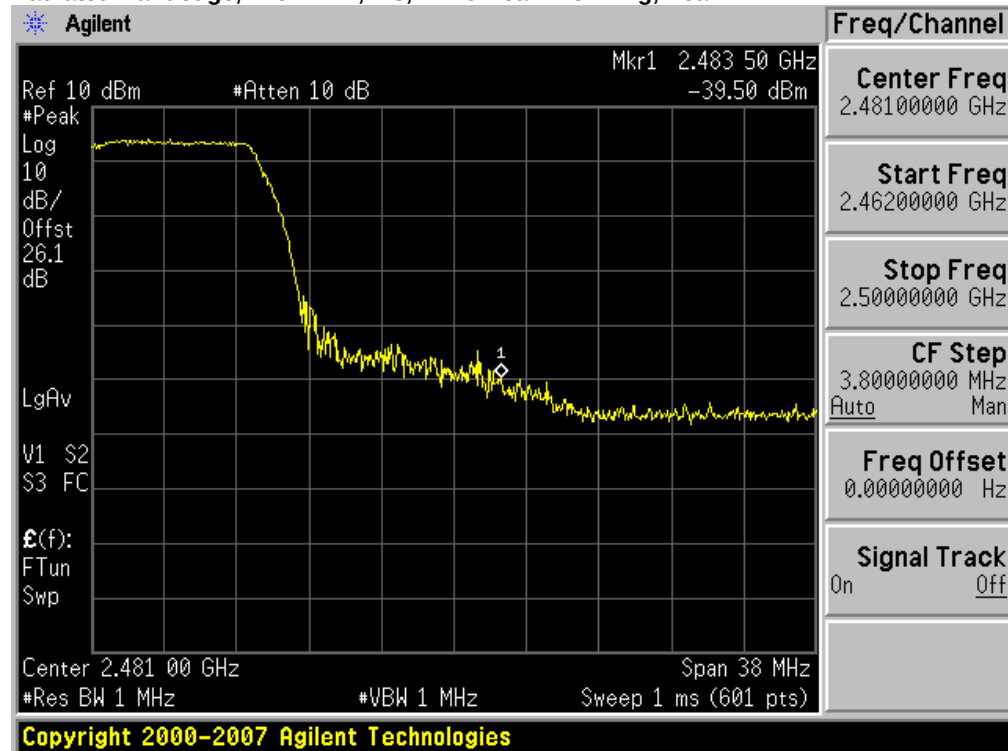
Radiated Bandedge, 2462 MHz, m0, HT20 with and without STBC, Peak



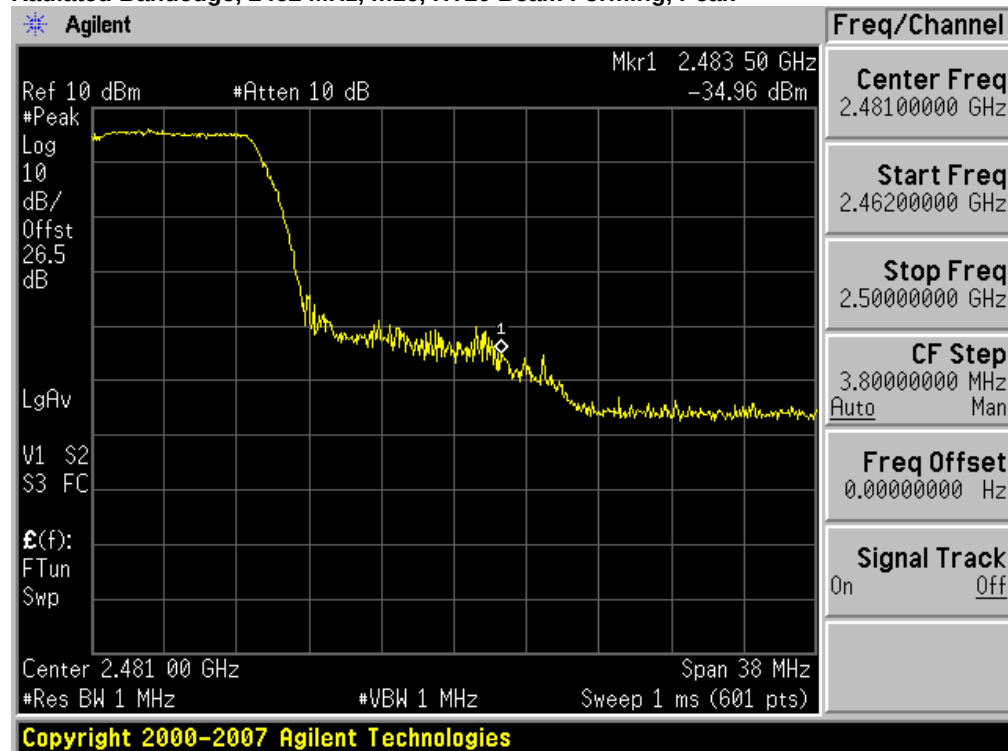
Radiated Bandedge, 2462 MHz, m0, HT20 Beam Forming, Peak



Radiated Bandedge, 2462 MHz, m8, HT20 Beam Forming, Peak



Radiated Bandedge, 2462 MHz, m16, HT20 Beam Forming, Peak





Radiated Spurious Emissions

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Using Vasona, configure the spectrum analyzer as shown below (be sure to enter all losses between the transmitter output and the spectrum analyzer). Place the radio in continuous transmit mode.

Span:	1GHz – 18 GHz
Reference Level:	80 dBuV
Attenuation:	10 dB
Sweep Time:	Coupled
Resolution Bandwidth:	1MHz
Video Bandwidth:	1 MHz for peak, 10 Hz for average
Detector:	Peak

Maximize Turntable (find worst case table angle), Maximize Antenna (find worst case height)

Save 2 plots: 1) Average Plot (Vertical and Horizontal), Limit= 54dBuV @3m
 2) Peak plot (Vertical and Horizontal), Limit = 74dBuV @3m

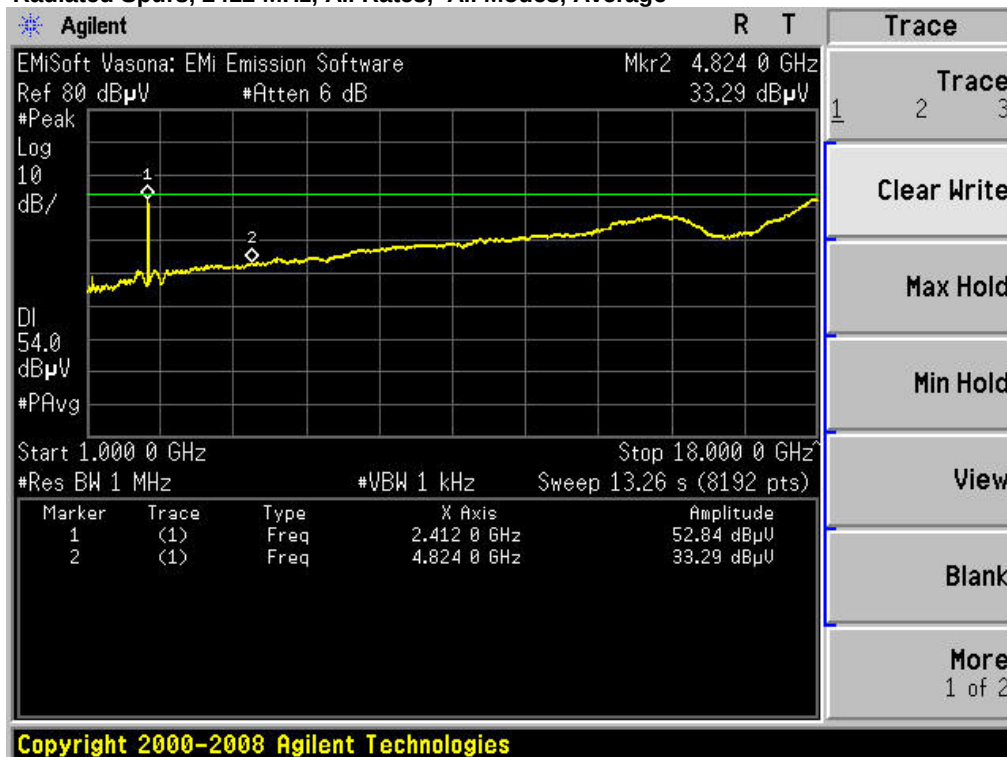
Place a marker at the end of the restricted band closest to the transmit frequency to show compliance.
Also measure any emissions in the restricted bands.

This report represents the worst case data for all supported operating modes and antennas.
There are no measurable emissions above 18 GHz.

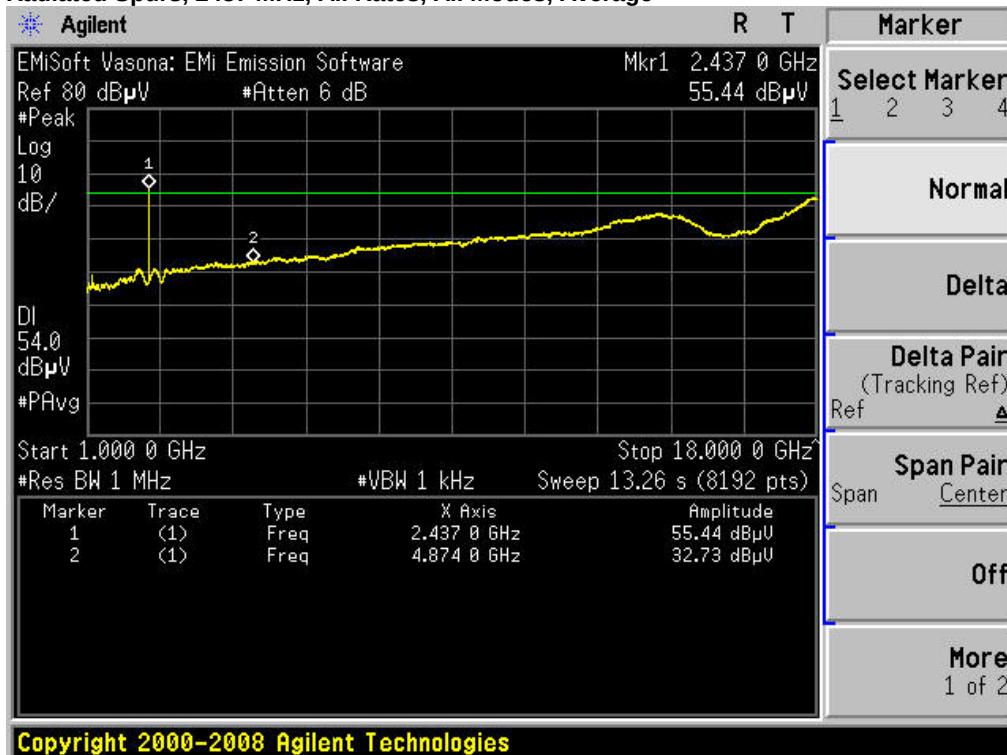


Frequency (MHz)	Mode	Data Rate (Mbps)	Spurious Emission Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)
2412	Legacy CCK, 1 to 11 Mbps	11	33.3	54.0	20.7
	Non HT-20, 6 to 54 Mbps	6	33.3	54.0	20.7
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	33.3	54.0	20.7
	HT-20, M0 to M23	m0	33.3	54.0	20.7
	HT-20 STBC, M0 to M7	m0	33.3	54.0	20.7
	HT-20 Beam Forming, M0 to M23	m0	33.3	54.0	20.7
2437	Legacy CCK, 1 to 11 Mbps	11	32.7	54.0	21.3
	Non HT-20, 6 to 54 Mbps	6	32.7	54.0	21.3
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	32.7	54.0	21.3
	HT-20, M0 to M23	m0	32.7	54.0	21.3
	HT-20 STBC, M0 to M7	m0	32.7	54.0	21.3
	HT-20 Beam Forming, M0 to M23	m0	32.7	54.0	21.3
2462	Legacy CCK, 1 to 11 Mbps	11	35.0	54.0	19.0
	Non HT-20, 6 to 54 Mbps	6	35.0	54.0	19.0
	Non HT-20 Beam Forming, 6 to 54 Mbps	6	35.0	54.0	19.0
	HT-20, M0 to M23	m0	35.0	54.0	19.0
	HT-20 STBC, M0 to M7	m0	35.0	54.0	19.0
	HT-20 Beam Forming, M0 to M23	m0	35.0	54.0	19.0

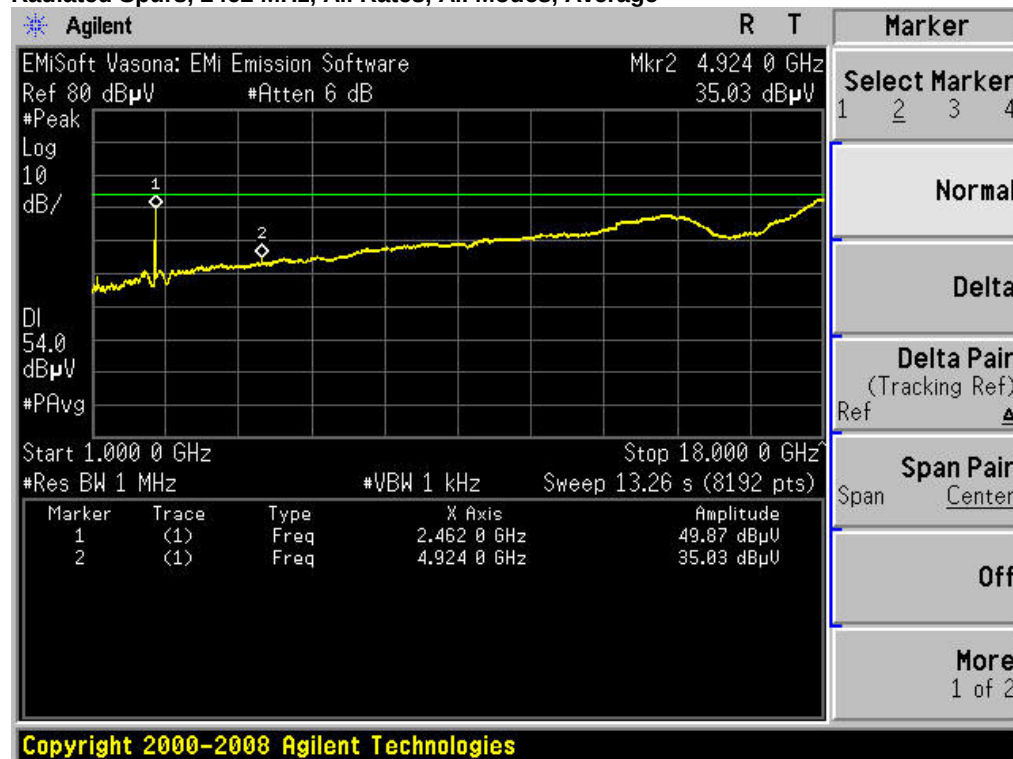
Radiated Spurs, 2412 MHz, All Rates, All Modes, Average



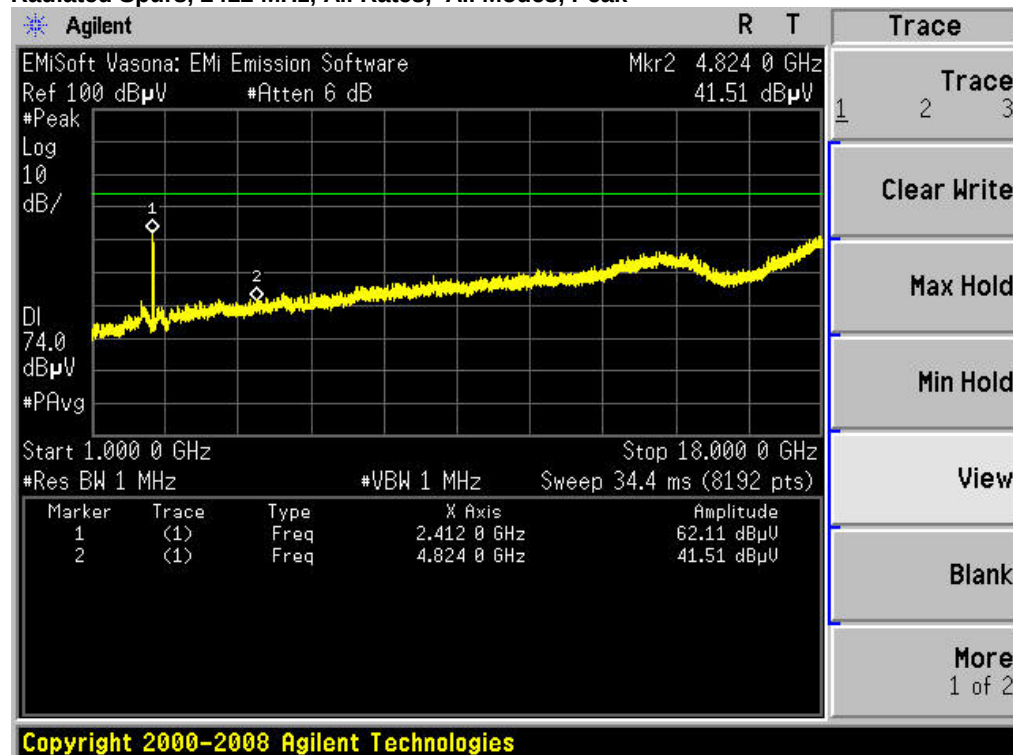
Radiated Spurs, 2437 MHz, All Rates, All Modes, Average



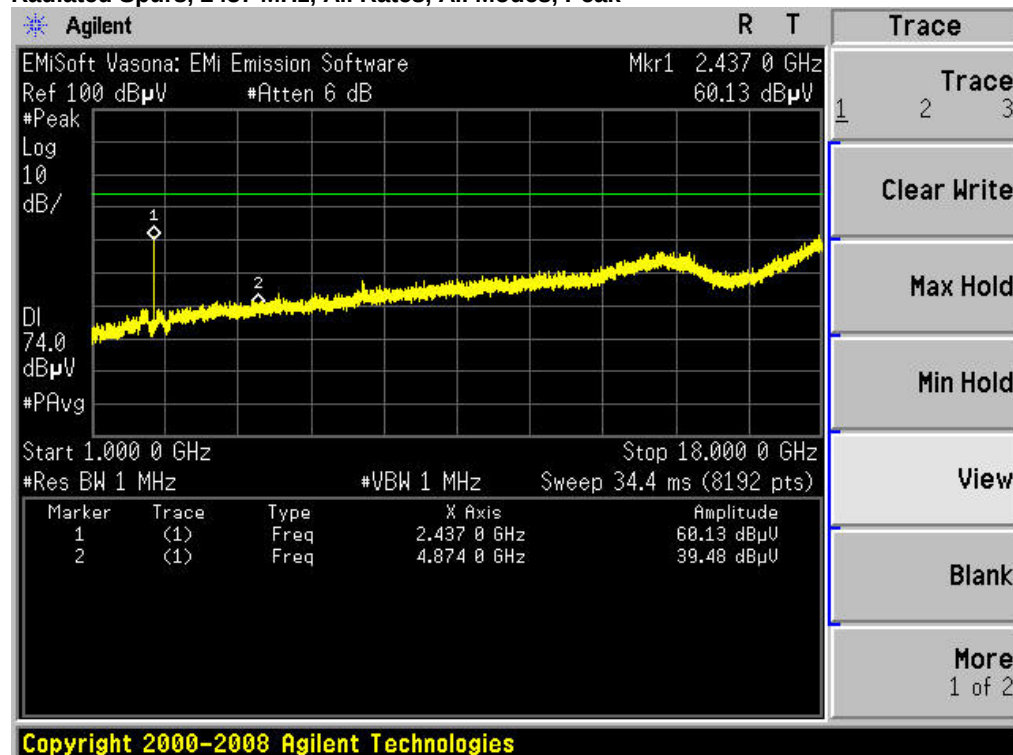
Radiated Spurs, 2462 MHz, All Rates, All Modes, Average



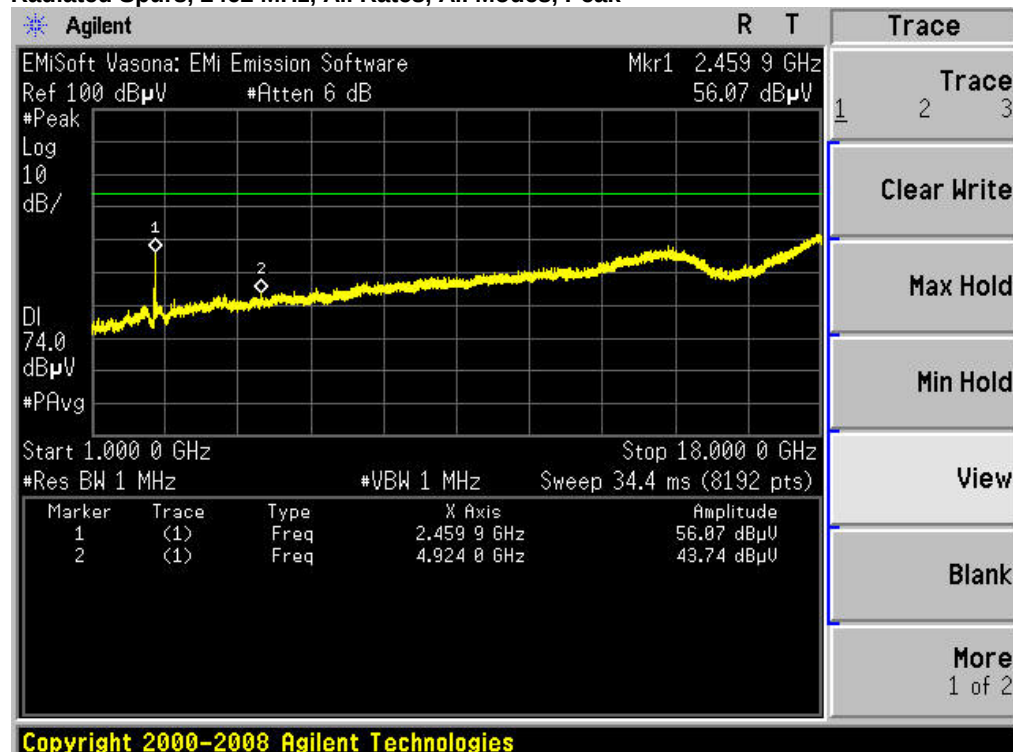
Radiated Spurs, 2412 MHz, All Rates, All Modes, Peak



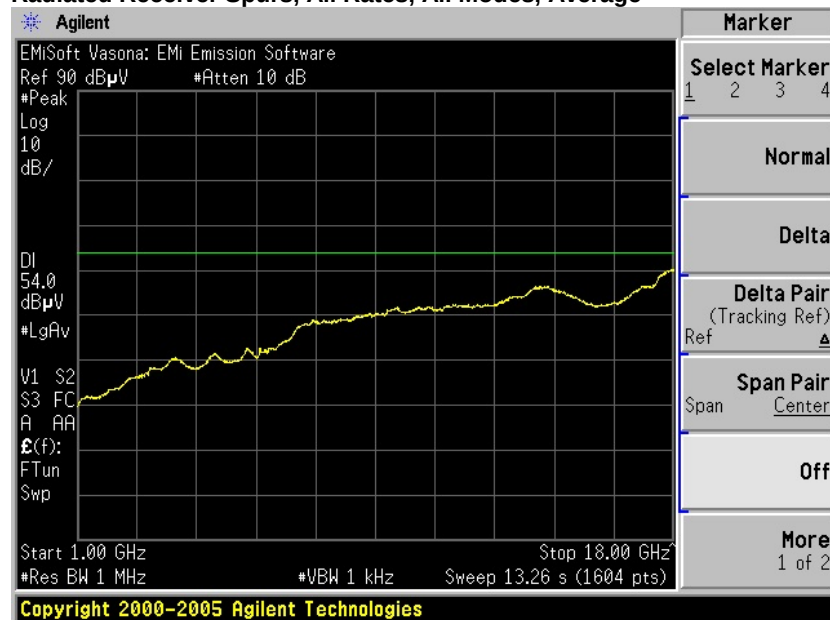
Radiated Spurs, 2437 MHz, All Rates, All Modes, Peak



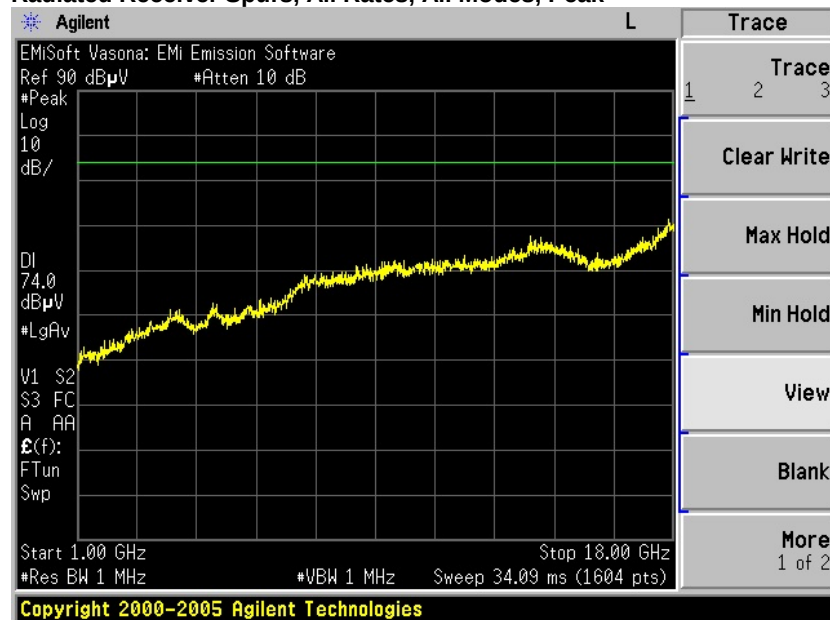
Radiated Spurs, 2462 MHz, All Rates, All Modes, Peak

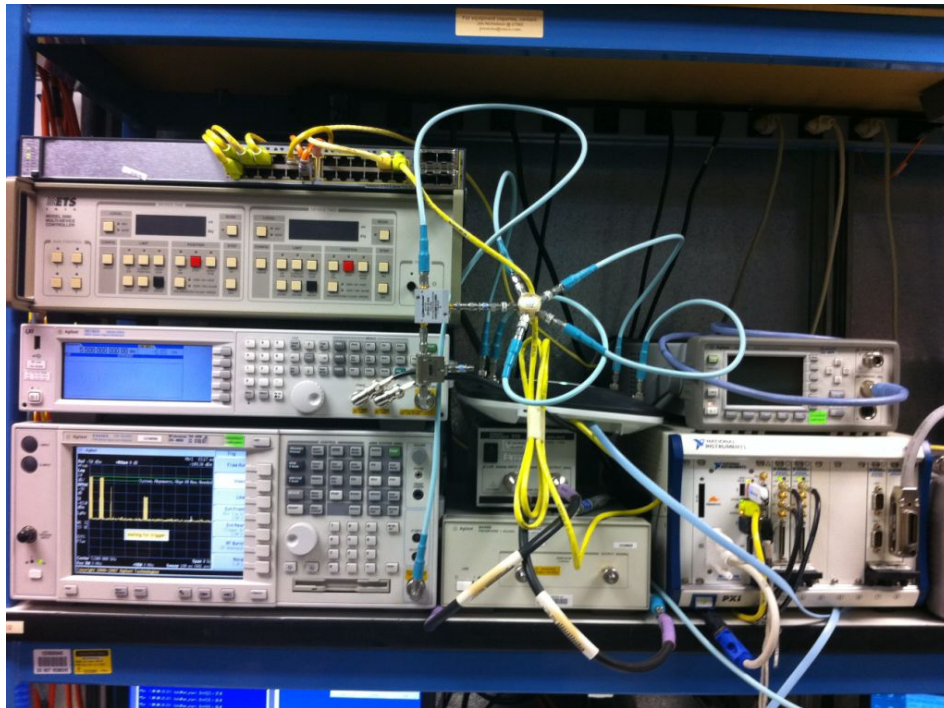


Radiated Receiver Spurs, All Rates, All Modes, Average

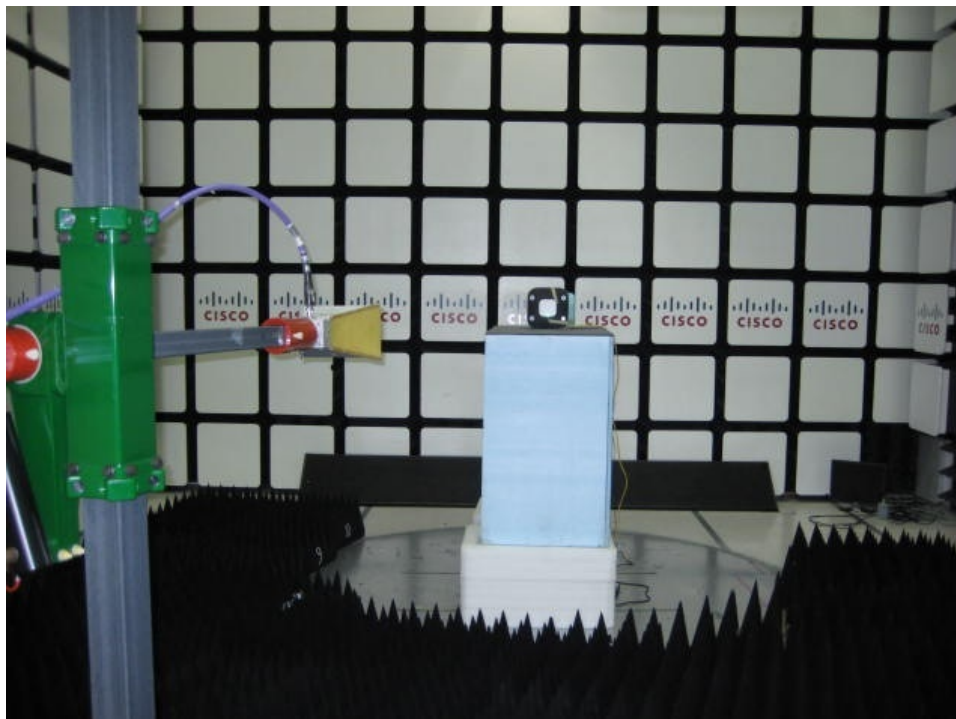


Radiated Receiver Spurs, All Rates, All Modes, Peak



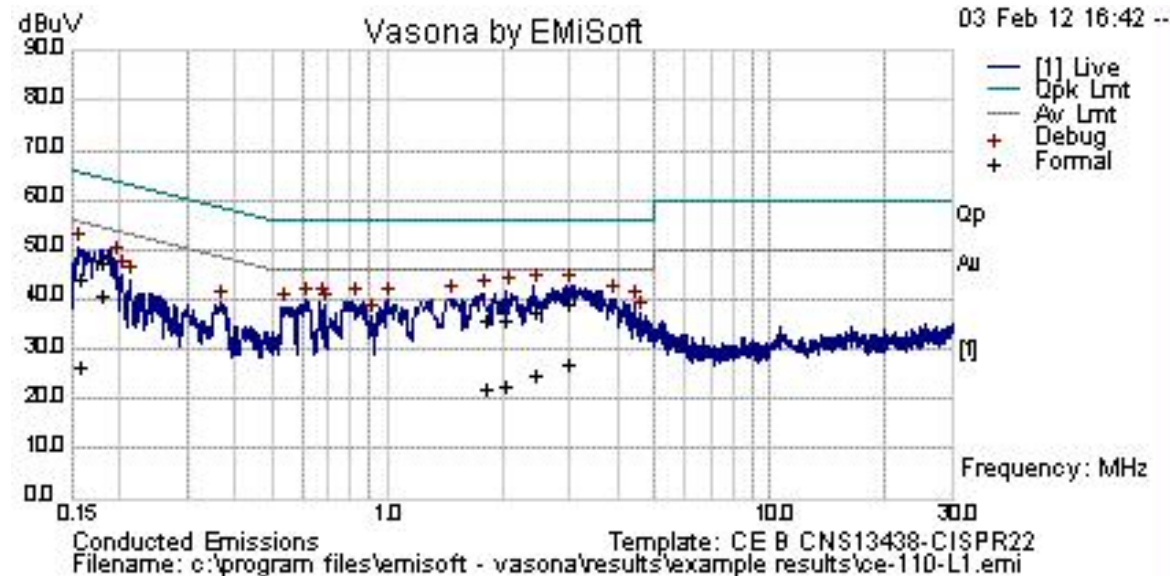


Test Setup for Conducted Measurements



Test Setup for Radiated Measurements

Conducted Emissions

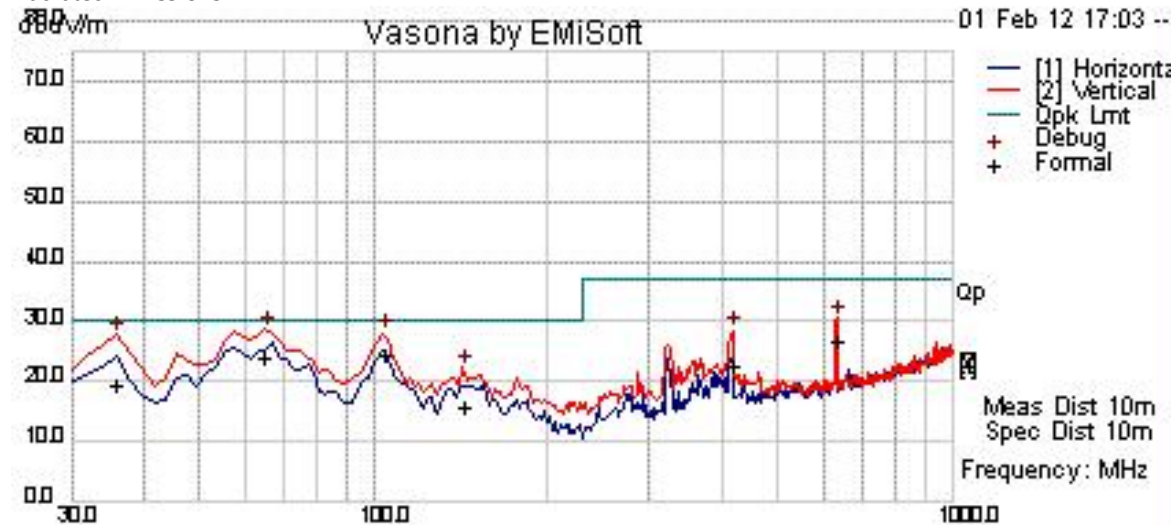


Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line	Limit dBuV	Margin dB	Pass /Fail	Comments
0.179435	19.6	20.2	1.1	40.9	Av	L	54.5	-13.6	Pass	
2.969	18.4	20.4	0.3	39.2	Qp	L	56	-16.8	Pass	
0.179435	26.1	20.2	1.1	47.5	Qp	L	64.5	-17	Pass	
2.421	16.7	20.4	0.3	37.4	Qp	L	56	-18.6	Pass	
2.969	6	20.4	0.3	26.8	Av	L	46	-19.2	Pass	
1.81	15.1	20.3	0.3	35.8	Qp	L	56	-20.2	Pass	
2.034	15	20.3	0.3	35.6	Qp	L	56	-20.4	Pass	
2.421	4.3	20.4	0.3	25	Av	L	46	-21	Pass	
0.157379	22.1	20.8	1.4	44.3	Qp	L	65.6	-21.3	Pass	
2.034	2.1	20.3	0.3	22.7	Av	L	46	-23.3	Pass	
1.81	1.7	20.3	0.3	22.3	Av	L	46	-23.7	Pass	
0.157379	4.4	20.8	1.4	26.5	Av	L	55.6	-29.1	Pass	



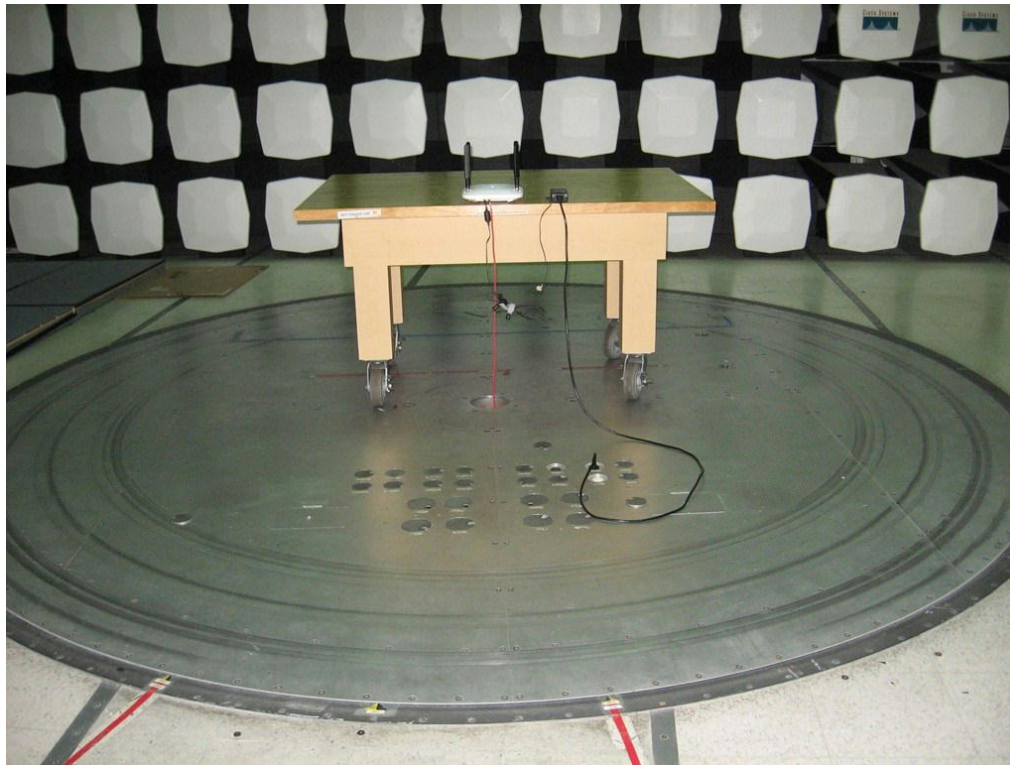


Radiated Emissions



Radiated Emissions Template: RE 30-1K 10m B CNS13438-CISPR22
 Filename: c:\program files\emisoft - vasona\results\example results\2-1-110-low.emi

Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measureme nt Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail	Comments
103.916	44.1	1.2	-20.8	24.5	Qp	V	137	204	30	-5.5	Pass	
64.728	47.2	1	-24.3	24	Qp	V	170	134	30	-6	Pass	
632.581	37.4	2.4	-13.4	26.5	Qp	V	126	0	37	-10.5	Pass	
35.673	34.1	0.9	-15.5	19.4	Qp	V	317	253	30	-10.6	Pass	
143.086	33.8	1.3	-19.6	15.6	Qp	V	282	44	30	-14.4	Pass	
416.829	36.6	2	-16.2	22.5	Qp	V	148	26	37	-14.5	Pass	



Maximum Permissible Exposure (MPE) Calculations

15.247: U-NII devices are subject to the radio frequency radiation exposure requirements specified in Sec. 1.1307(b), Sec. 2.1091 and Sec. 2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Given

$$E = \sqrt{(30 \cdot P \cdot G)/d} \text{ and } S = E^2/3770$$

where

E=Field Strength in Volts/meter

P=Power in Watts

G=Numeric Antenna Gain

d=Distance in meters

S=Power Density in mW/cm²

Combine equations and rearrange the terms to express the distance as a function of the remaining variables:

$$d = \sqrt{((30 \cdot P \cdot G)/(3770 \cdot S))}$$

Changing to units of power in mW and distance in cm, using:

$$P(\text{mW}) = P(\text{W})/1000 \quad d(\text{cm}) = 100 \cdot d(\text{m})$$

yields

$$d = 100 \cdot \sqrt{((30 \cdot (P/1000) \cdot G)/(3770 \cdot S))}$$

$$d = 0.282 \cdot \sqrt{(P \cdot G/S)}$$

where

d=Distance in cm

P=Power in mW

G=Numeric Antenna Gain

S=Power Density in mW/cm²

Substituting the logarithmic form of power and gain using:

$$P(\text{mW}) = 10^{(P(\text{dBm})/10)} \quad G(\text{numeric}) = 10^{(G(\text{dBi})/10)}$$

yields

$$d = 0.282 \cdot 10^{((P+G)/20)/\sqrt{S}} \quad \text{Equation (1)}$$

and

$$S = ((0.282 \cdot 10^{((P+G)/20)})/d)^2 \quad \text{Equation (2)}$$

where

d=MPE distance in cm

P=Power in dBm

G=Antenna Gain in dBi

S=Power Density in mW/cm²



Equation (1) and the measured peak power are used to calculate the MPE distance. Note that for mobile or fixed location transmitters such as an access point, the minimum separation distance is 20 cm even if the calculations indicate that the MPE distance may be less.

$S=1\text{mW/cm}^2$ maximum. The highest supported antenna gain is 6 dBi (9dBi with beamforming). Using the peak power levels recorded in the test report along with Equation 1 above, the MPE distances are calculated as follows.

Frequency (MHz)	Bit Rate (Mbps)	Power Density (mW/cm ²)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	MPE Distance (cm)	Limit (cm)	Margin (cm)
2412	11	1	23.0	6	7.95	20	12.05
2437	11	1	23.0	6	7.95	20	12.05
2462	11	1	23.0	6	7.95	20	12.05
2412	54	1	23.0	6	7.95	20	12.05
2437	54	1	23.0	6	7.95	20	12.05
2462	54	1	23.0	6	7.95	20	12.05

MPE Calculations

To maintain compliance, installations will assure a separation distance of at least 20cm.

Using Equation 2, the MPE levels (s) at 20 cm are calculated as follows:

Frequency (MHz)	Bit Rate (Mbps)	MPE Distance (cm)	Peak Transmit Power (dBm)	Antenna Gain (dBi)	Power Density (mW/cm ²)	Limit (mW/cm ²)	Margin (mW/cm ²)
2412	11	20	23.0	6	0.16	1	0.84
2437	11	20	23.0	6	0.16	1	0.84
2462	11	20	23.0	6	0.16	1	0.84
2412	54	20	23.0	6	0.16	1	0.84
2437	54	20	23.0	6	0.16	1	0.84
2462	54	20	23.0	6	0.16	1	0.84

**Appendix C: Test Equipment/Software Used to perform the test**

Equip #	Manufacturer	Model	Description	Last Cal	Next Due
CIS004882	EMC Test Systems	3115	Double Ridged Guide Horn Antenna	26-May-11	26-May-12
CIS005691	Miteq	NSP1800-25-S1	Broadband Preamplifier	31-Jan-12	31-Jan-13
COM000210	TTE	H785-150K-50-21378	Hi Pass Filter - 150KHz cutoff	17-Aug-11	17-Aug-12
COM000213	Fischer	FCC-LISN-50-50-2M	Turntable LISN (150KHz-30MHz)	5-Mar-11	5-Mar-12
CIS021117	Micro-Coax	UFB311A-0-2484-520520	RF Coaxial Cable, to 18GHz, 248.4 in	24-Aug-11	24-Aug-12
CIS030564	Micro-Coax	UFB311A-1-0950-504504	RF Coaxial Cable, to 18GHz, 95 in	24-Aug-11	24-Aug-12
COM000233	Sunol Sciences	JB1	Combination Antenna, 30MHz-2GHz	13-Jul-11	13-Jul-12
COM000239	Rohde & Schwarz	ESI40	EMI Test Receiver	21-Jun-11	21-Jun-12
COM000443	Sonoma Instrument	310N	Amplifier 9kHz-1GHz	8-Apr-11	8-Apr-12
CIS034972	Midwest Microwave	ATT-0640-20-29M-02	Attenuator, 20dB	17-May-11	16-May-12
CIS043116	Huber + Suhner	Sucoflex 104PE	N & SMA RF cable	14-Dec-11	14-Dec-12
CIS040603	Agilent	E4440A	Spectrum Analyzer	5-Aug-11	5-Aug-12
CIS040053	Agilent	E4448A	Spectrum Analyzer	29-Apr-11	28-Apr-12