



**FCC Part 15, Subpart E, UNII (Part 15.401)
Certification Application**

**Industrie Canada RSS-210
Certification Application**

**EMI Test Report
on
IEEE 802.11 Access Point.
Models: 2230 & 2230INT**

FCC ID: RVW2230W

IC ID: 332R-2230W

Prepared by:

David Waitt
202 Calvert Drive #217
Cupertino, Ca. 95014
david@waitt.us
(408) 832 7053

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General Information

Unit(s) Under Test: Nortel Networks access point
Model: 2230 & 2230INT
Product Description: IEEE 802.11A / B / G Access point

FCC ID: RVW2230W
IC ID: 337R-2230W

Tested For: Nortel Networks
4655 Great America Parkway
Santa Clara, CA 95054

Tested At: Elliott Laboratories
684 West Maude Ave
Sunnyvale, CA 94086

Tested By: M Faustino, Test Engineer, Elliott Laboratories
David Waitt, (Independent Consultant)

Test Specifications: FCC CFR 47, Part Subpart E, (15 401 UNII)
IC RSS-210 6.2.2.(O)

Test Date: May 2004

Requested Certification: FCC Part 15 Subpart E Certification
Industrie Canada RSS-210

Detailed Product Information / Operational Description

The access point radio is an IEEE 802.11 A / B / G Access point is intended to be professionally installed and configured in corporate and industrial environments.

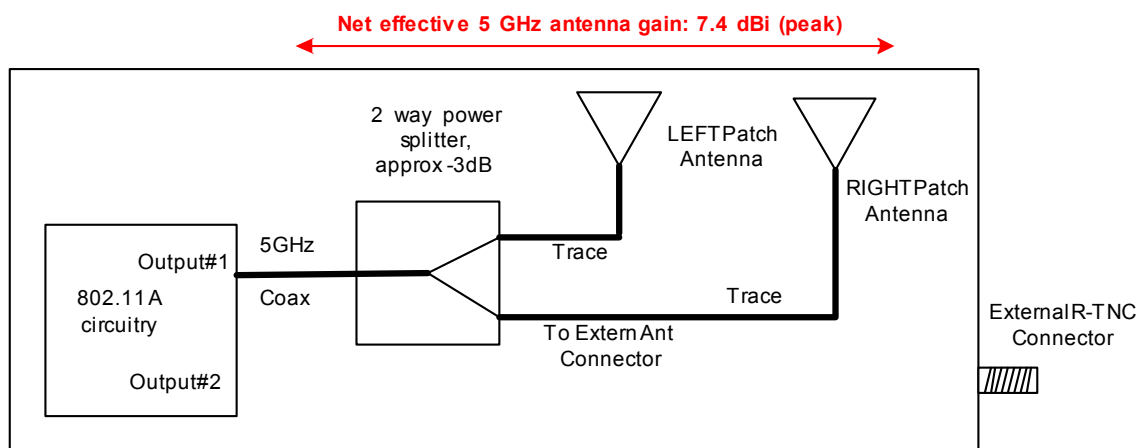
The device does not include a “Turbo” mode.

The access point is powered either by an external 48V power supply or via power over Ethernet (POE)

Additionally, the device has been tested for compliance to the FCC Part 15 Class B limits. A report has been prepared and is on with the manufacturer.

Internal Antenna Version

The access point utilizes integral antennas on the 802.11 A / B / G bands. The access point includes two integral 5 GHz patch antennas pointing 180° from each other to create a somewhat omni directional 5 GHz pattern. The access point effectively includes only a single 2.4GHz patch antenna (the 2.4 GHz antenna is discussed in the 802.11 B report). The effective gain of the 5 GHz antenna path (the power divider and the antenna itself) is 7.4dBi. The diagrams below outline the RF path from the output of the mini PCI module within the access point to the integral antennas within the access point (Note that only the Subpart E, 15.401 UNII 5 GHz portion is covered by this particular report)



5 GHz RF Path Block Diagram (Internal Antenna Version)

Internal / External Antenna Version

The second version of the access point allows the connection of an external 5 GHz antenna. This option can be selected by the configuration software. If an external 5 GHz antenna is used, it is permanently attached to the access point to meet FCC “Integral” antenna requirements. The maximum gain of the external antenna is below 7.4 dBi net effective gain (antenna gain - cable loss)

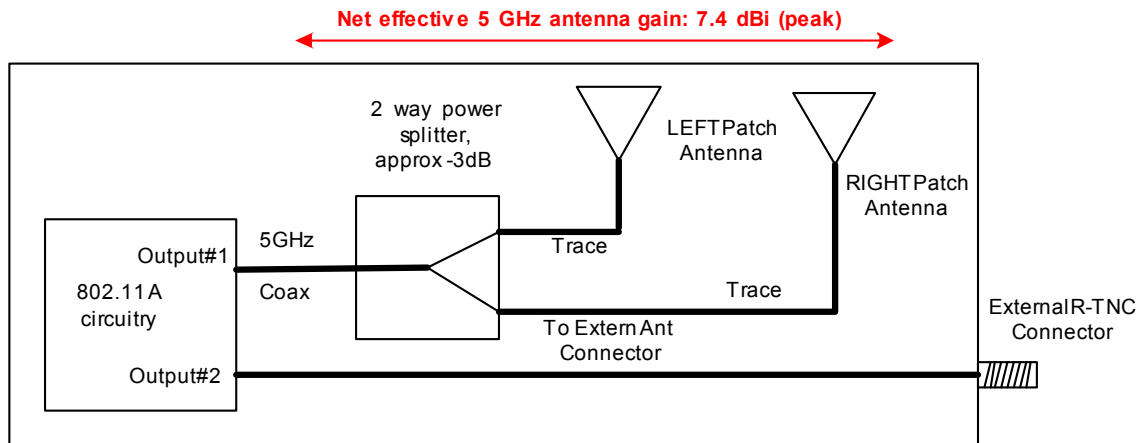
Note that in contrast to the internal antennas; only ONE external 5 GHz antenna can be used. The configuration software cannot be configured to rapidly switch between the internal and external antenna.

The only difference between the two versions is the inclusion of a short coax and external connector in the housing.

The access point was NOT tested with external antennas because:

- 1: The internal and external antennas will be of the same type (Patch antenna)
- 2: The external antennas will be of equal or lower net effective gain than the internal antennas.

This test methodology adheres to the current policy of testing the product with the highest gain antenna of each type that will be used with the product.



5 GHz RF Path Block Diagram (Internal / External Antenna Version)

Report Organization and Results Summary

This report presents the results of the tests that verify compliance with FCC Part 15.401 and Industrie Canada RSS-210. Though this product must comply with FCC Part 15.247 (for 802.11 B/G) as well, only the 15.401 (UNII) results are contained in this report. The compliance information for Part 15.247 is contained in a separate report.

A brief results summary of all the in this report is below.

Part 15 Paragraph	Test	Results
15.407(a) (5)	Power Spectral Density (5.15 - 5.25)	-.259 dBm/1MHz
15.407(a) (5)	Power Spectral Density (5.25 - 5.35)	9.15 dBm/1MHz
15.407(a) (5)	Power Spectral Density (5.725 - 5.825)	14.33 dBm/1MHz
15.407(b) (1)	Out of Band Emissions (5.15 - 5.25)	-37.95 dBm MAX
15.407(b) (1)	Out of Band Emissions (5.25 - 5.35)	-38.87 dBm MAX
15.407(b) (1)	Out of Band Emissions (5.725 - 5.825)	-37.06 dBm MAX
15.407(a)	26dB Bandwidth	45.58 MHz
15.407(a) (1)	Transmit Power (5.15 - 5.25)	34.12 mW MAX 187.5 mW EIRP
15.407(a) (1)	Transmit Power (5.25 - 5.35)	120.5 mW MAX 662.22 mW EIRP
15.407(a) (3)	Transmit Power (5.275 - 5.825)	93.11 mW MAX 511.68 mW EIRP
15.407(a) (6)	Peak Excursion	2.26 MAX
15.205	Radiated Emissions in Restricted bands	.52 dB in spec @5.15 GHz
CISPR 22	AC Line Conducted Emissions	10.1 dB in Spec

Test Facilities

All of the certification tests were performed at:

Elliott Labs
684 West Maude Ave
Sunnyvale, CA 94086

General:

Final radiated test measurements were taken in May 2004 at Elliott Laboratories Chamber #5

The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

OATS:

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated emissions are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 Guidelines.

Antenna, Antenna Mast and Turntable

The Horn antennas that are used to measure radiated emissions above 1000MHz are mounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

ANSI C63.4 specifies that the test height above the ground plane shall be 80cm unless the equipment is intended to be floor mounted. During the radiated emissions tests the equipment is positioned on a motorized turntable in conformance with the ANSI requirement.

Equipment Lists

Instrument Calibration

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

The following test equipment was used to perform the testing

Elliott Test Equipment

<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263	09-Jan-05
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	868	20-Apr-06
Hewlett Packard	Microwave EMI test system (SA40, 9kHz - 40GHz) Fremont	84125C	1410	26-Mar-05
Hewlett Packard	EMC Spectrum Analyzer 9KHz-26.5GHz, non programmable	8563E	284	15-Mar-05
Rohde & Schwarz	Power Meter, Single Channel	NRVS	1290	22-Apr-05
Rohde & Schwarz	Peak Power Sensor 100uW - 2 Watts	NRV-Z32	1536	22-Apr-05

Additional Test Equipment

<u>Item</u>	<u>Desc.</u>	<u>Manufacturer</u>	<u>Model</u>	<u>S/N</u>	<u>Cal due date</u>
Spectrum Analyzer		Agilent	E4440A	MY43362314	16 Jan 2005

Test Methods

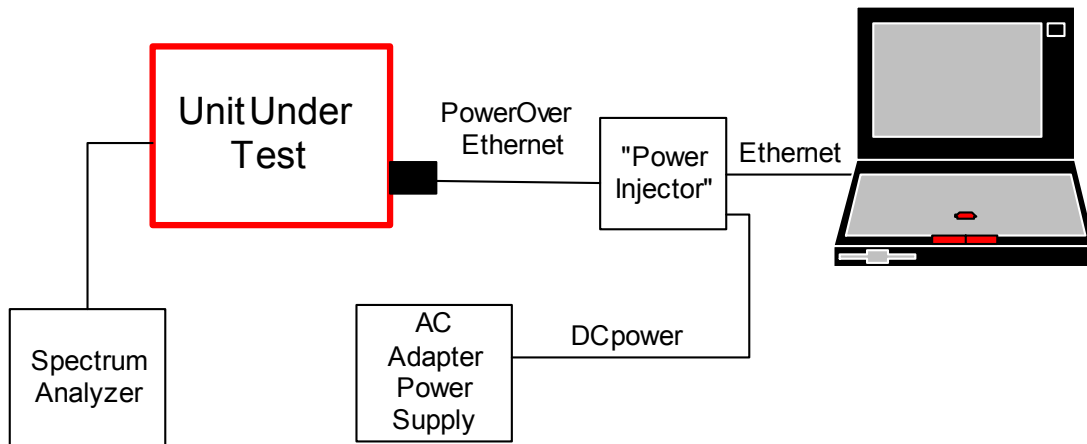
Many of the tests are performed at a low, middle and high channel of the applicable band. The typical frequencies used for the test for each band are listed below.

UNII 802.11 A		UNII / 802.11 A	
5.15 – 5.25 GHz & 5.25 – 5.35 GHz		5.725 5.825 GHz	
Channel	Freq(MHz)	Channel	Freq(MHz)
Low	5180	Low	5745
Mid	5260	Mid	5765
High	5320	High	5805

In order to comply with the maximum allowable RF power requirement in the 5.15 - 5.25 GHz band, the power setting (and thus the transmit power) is lower in this band then in the other two UNII bands. The maximum power setting that yielded compliance will be programmed into the configuration firmware of the access point to ensure the maximum possible power setting will be correct for each band.

The following tests are performed using the basic test setup shown below. In several cases, the EUT was running special diagnostic firmware to allow it to transmit random data on a particular channel indefinitely.

Part 15	Test
15.407(a)(5)	Power Spectral Density
15.407(b)(1)	Out of Band Emissions (5.15 - 5.25)
15.407(b)(1)	Out of Band Emissions (5.25 - 5.35)
15.407(b)(1)	Out of Band Emissions (5.725 - 5.825)
15.407(a)	26dB Bandwidth
15.407(a)(1)	Transmit Power (5.15 - 5.25)
15.407(a)(2)	Transmit Power (5.25 - 5.35)
15.407(a)(3)	Transmit Power (5.275 - 5.825)
15.407(a)(6)	Peak Excursion



Basic Conducted RF Bench Test Setup

Unless otherwise noted, the support equipment for the bench tests is listed below.

Support Equipment				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	Armada E 500	P31000T4X20DC12N2	Compaq	Laptop PS
Test Software	Atheros Radio Test		Atheros	
48VDC AC adapter	Generic		Generic	Standard Twin lead DC wire

Test Results

Detailed test procedures and test results are contained in the following sections. In cases where the test setup differs from the Conducted RF test setup shown above, the test setup is also presented.

Test Conditions			
Temperature	22 C	Humidity:	41%
ATM pressure	1021 mBar	Grounding:	None
Tested By	David Waitt	Date of Test:	May 2004
Test Reference	Refer to individual test results		
Tested Range	Test Dependent		
Test Voltage	48 VDC to the access point		
Modifications	No modifications were made to the unit during the tests		

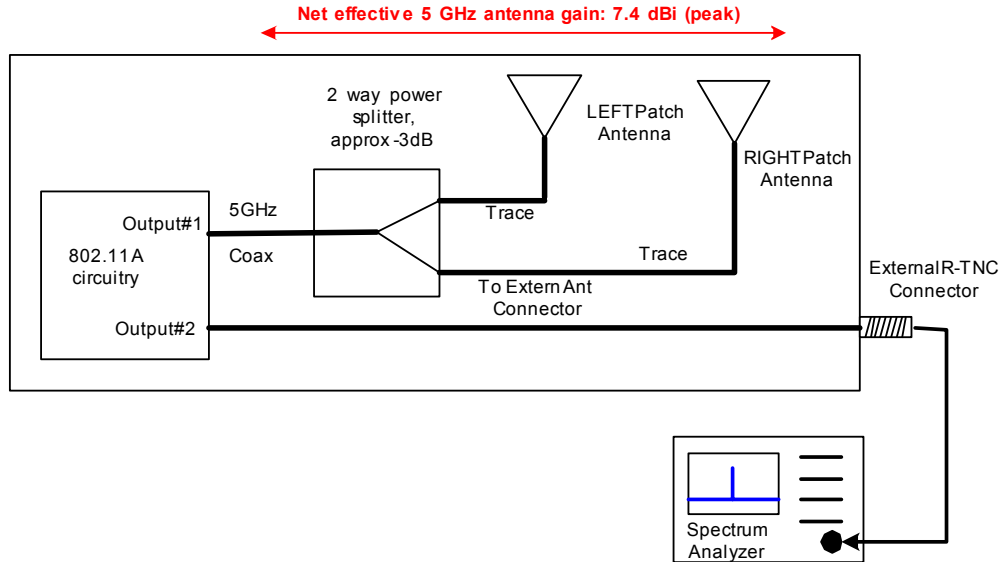
802.11 A Maximum RF Power Output at Antenna Terminals

Specifications:

FCC Specification: Paragraph(s): 15.401(a)(1), 15.401(a)(2), 15.401(a)(3)

IC Specification: 6.2.2.(q1)i

Procedure:



The test was conducted by connecting the external antenna output of the AP directly to a spectrum analyzer. This measured power is therefore equal to the power into the power splitter when using the internal antennas and the same as the power into the external antenna if applicable.

The settings that were used during this certification testing will be entered into the firmware of the access point. These firmware configuration limits will ensure that the power levels are not exceeded.

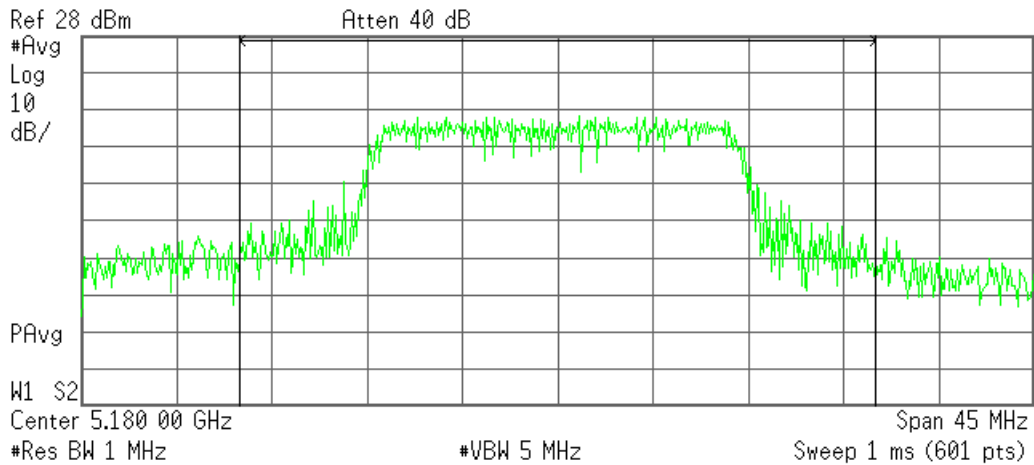
Power measurements were performed with a spectrum analyzer using channel power integration over the 26 dB bandwidth. This was achieved by selecting trace "max hold". The measurements were made per FCC "Method 1" outlined in public notice DA 02-2138 dated 30 Aug 2002.

RF Transmit Power Summary Results:

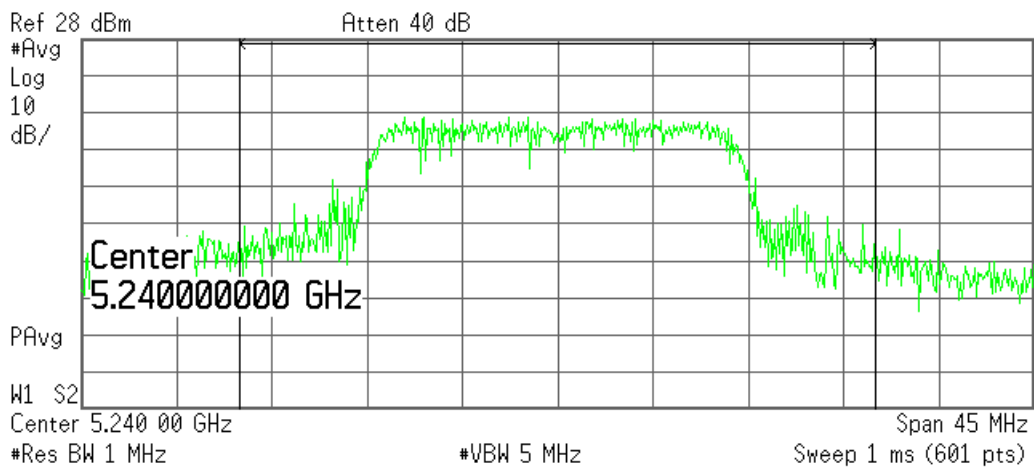
INTERNAL or EXTERNAL ANTENNA								
Frequency MHz	Measured 26 dB Channel Power at Ext Ant connector		Power Spec	Delta	Maximum EIRP (Ant gain = 7.4dBi MAX)		Maximum EIRP Spec Pout+6dBi	Delta
	dBm	mW	dBm	dBm	dBm	mW	dBm EIRP	dB
5180	15.01	31.70	17.00	1.99	22.41	174.18	23.00	0.59
5240	15.33	34.12	17.00	1.67	22.73	187.50	23.00	0.27
5260	20.81	120.50	24.00	3.19	28.21	662.22	30.00	1.79
5320	20.74	118.58	24.00	3.26	28.14	651.63	30.00	1.86
5745	19.55	90.16	30.00	10.45	26.95	495.45	36.00	9.05
5765	19.69	93.11	30.00	10.31	27.09	511.68	36.00	8.91
5805	19.35	86.10	30.00	10.65	26.75	473.15	36.00	9.25

26 dB Channel Power, 5180 MHz

* Agilent 18:50:19 Jun 16, 2004

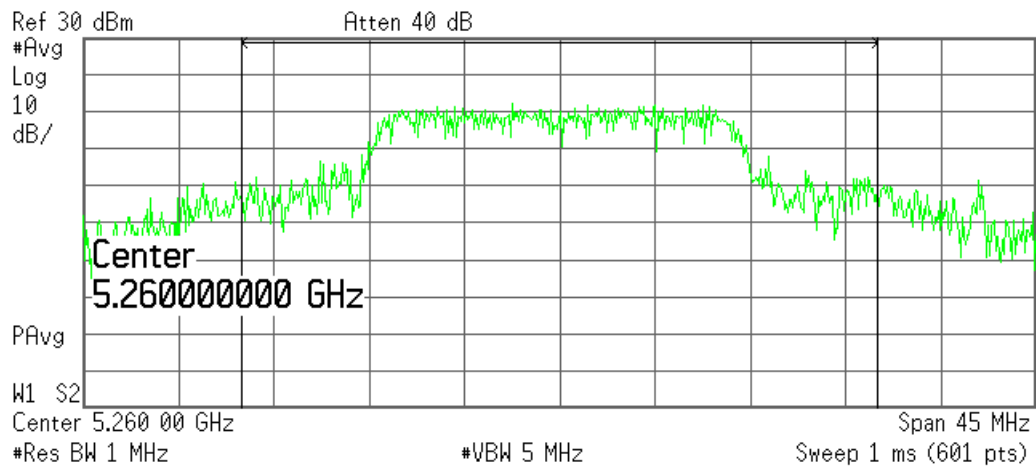
**Channel Power****15.01 dBm /30.0000 MHz****Power Spectral Density****-59.76 dBm/Hz****26 dB Channel Power, 5240 MHz**

* Agilent 18:52:33 Jun 16, 2004

**Channel Power****15.33 dBm /30.0000 MHz****Power Spectral Density****-59.45 dBm/Hz**

26 dB Channel Power, 5260 MHz

* Agilent 12:09:31 Jun 6, 2004



Channel Power

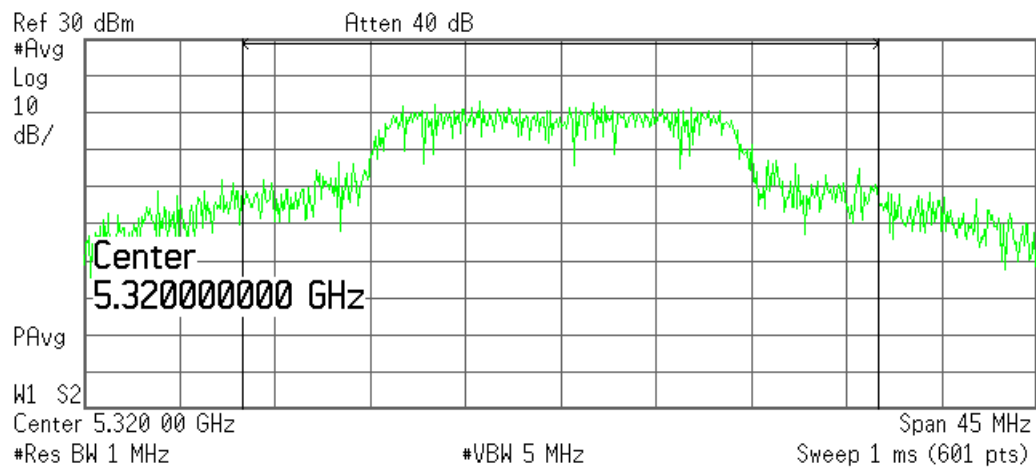
20.81 dBm /30.0000 MHz

Power Spectral Density

-53.97 dBm/Hz

26 dB Channel Power, 5320 MHz

* Agilent 12:10:55 Jun 6, 2004



Channel Power

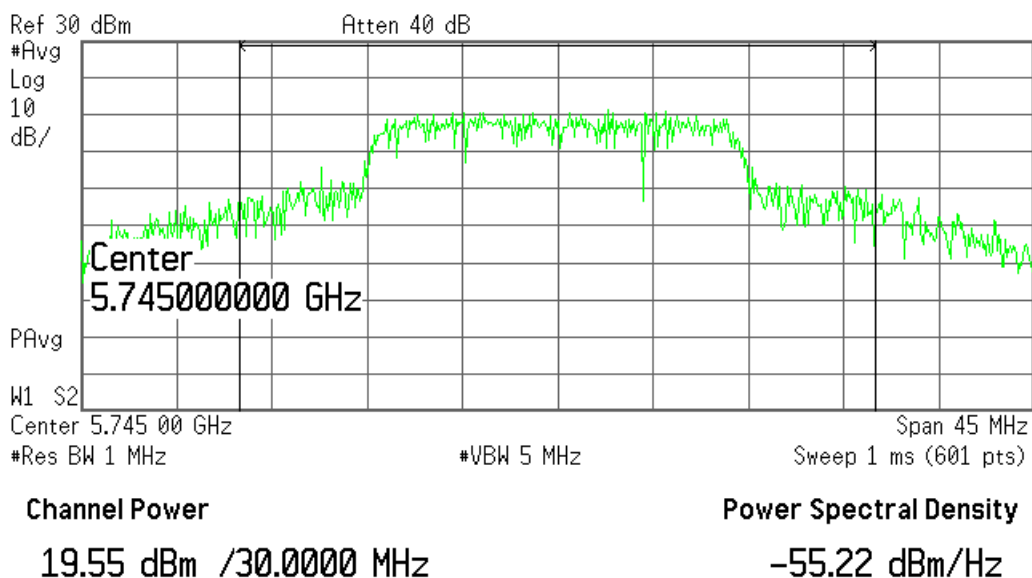
20.74 dBm /30.0000 MHz

Power Spectral Density

-54.03 dBm/Hz

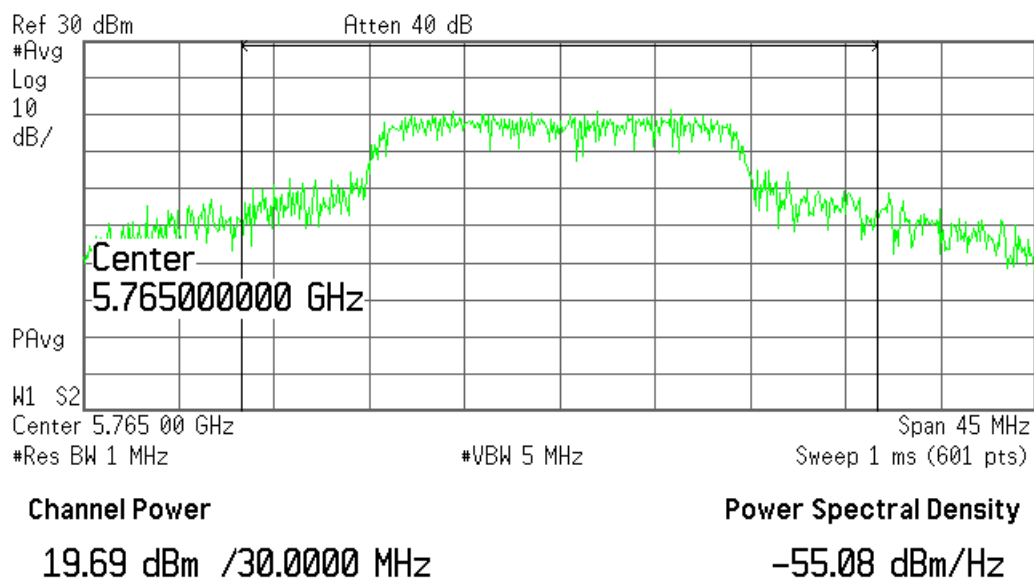
26 dB Channel Power, 5745 MHz

* Agilent 12:12:08 Jun 6, 2004



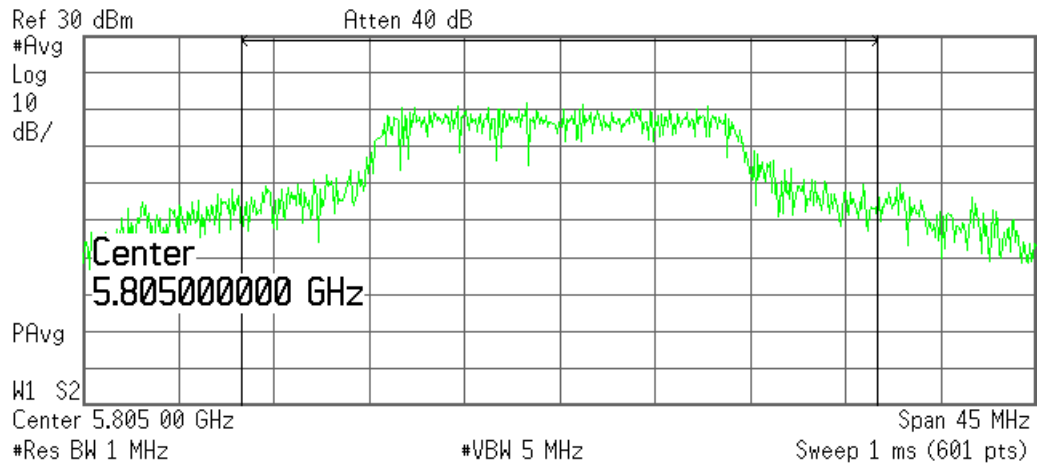
26 dB Channel Power, 5765 MHz

* Agilent 12:12:53 Jun 6, 2004



26 dB Channel Power, 5805 MHz

* Agilent 12:14:01 Jun 6, 2004



Channel Power

19.35 dBm /30.0000 MHz

Power Spectral Density

-55.42 dBm/Hz

20 dB / 26 dB bandwidth**Specification**

FCC Specification: Paragraph 15.407(a)

IC Specification: 6.2.2.(O)

The access point operates on the standard IEEE 802.11 'A' channels. The 20 dB and 26dB bandwidth was measured on the low middle and high channel of the 5 GHz UNII bands (5.15 - 5.35 GHz and 5.725-5.825GHz) using the conducted RF test setup.

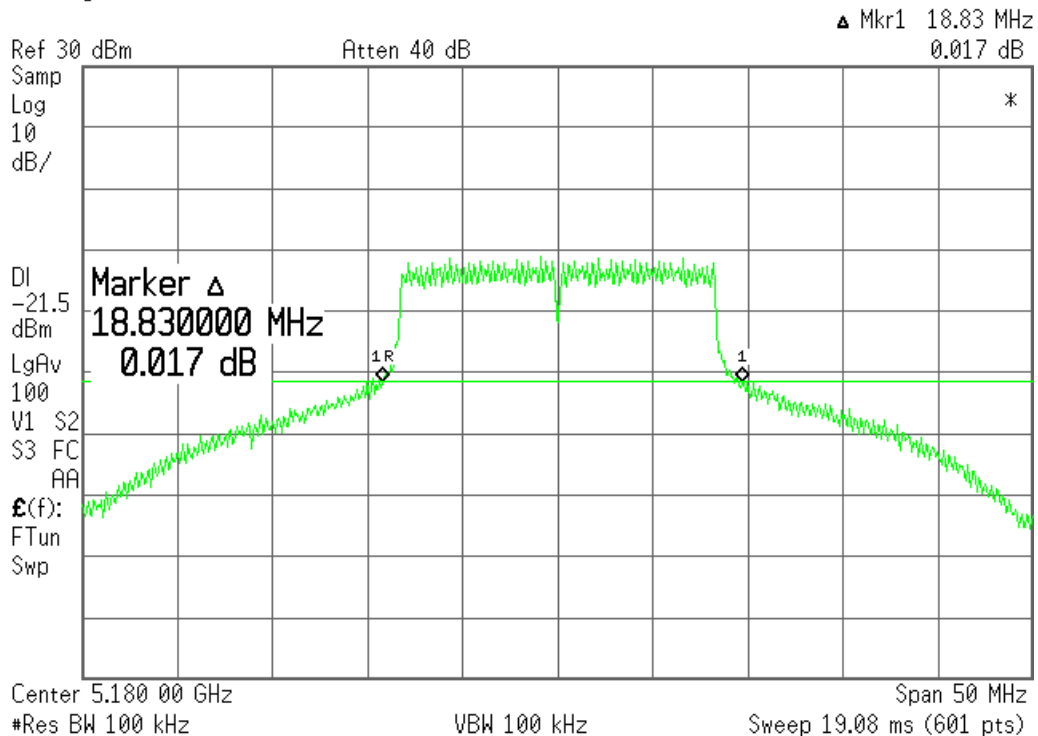
Once the trace had stabilized, a peak search was performed and a marker placed 20dB (or 26dB as applicable) below the peak. This marker was then used as a reference for a "marker-delta" measurement. The delta marker was adjusted as close as possible to the same level as the reference marker.

20 dB / 26 dB bandwidth Summary Results

Frequency (MHz)	26 dB Signal Bandwidth (MHz)	20 dB Signal Bandwidth (MHz)	99% Signal Bandwidth (MHz)
5180	29.90	18.83	16.45
5260	29.58	18.92	16.34
5320	28.60	18.33	16.48
5745	31.08	20.00	16.44
5765	29.17	19.08	16.47
5805	30.33	19.67	16.45

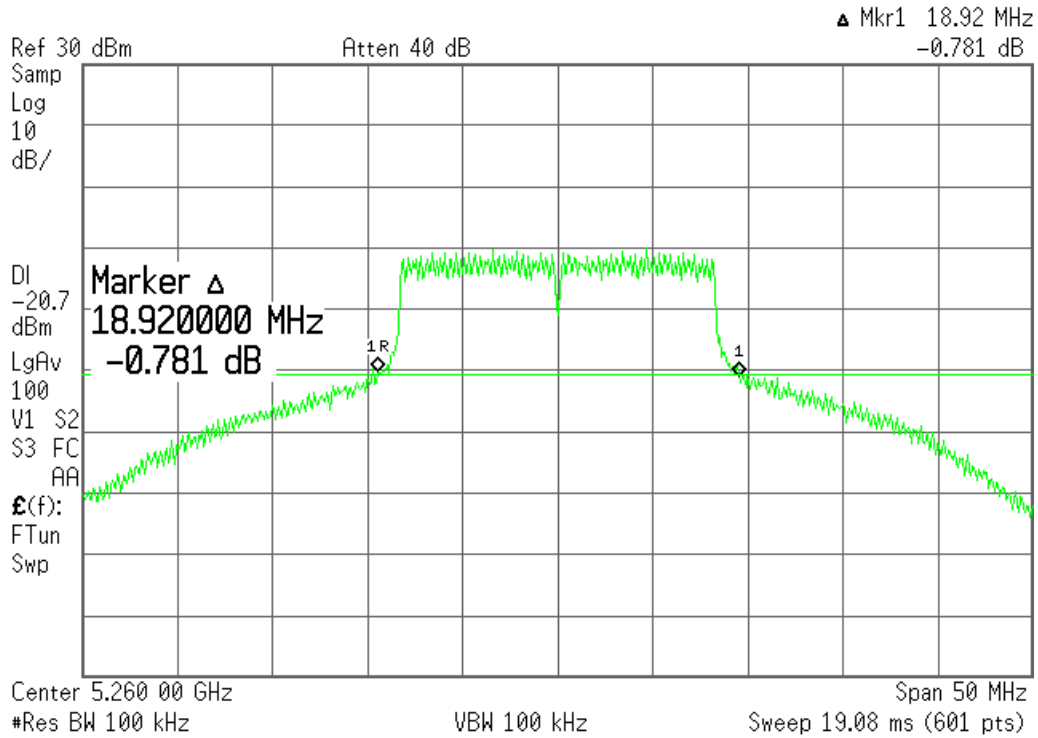
20 dB Bandwidth Plots**5180MHz 20dB BW**

Agilent 00:21:37 May 11, 2004



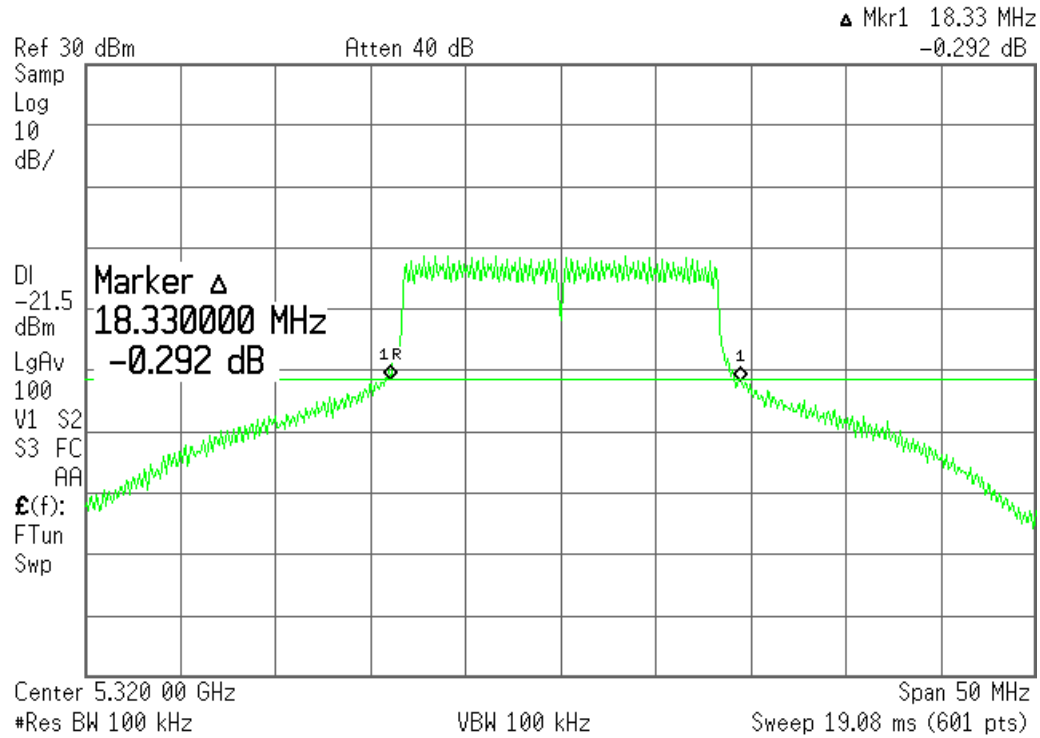
5260MHz 20dB BW

* Agilent 00:23:42 May 11, 2004



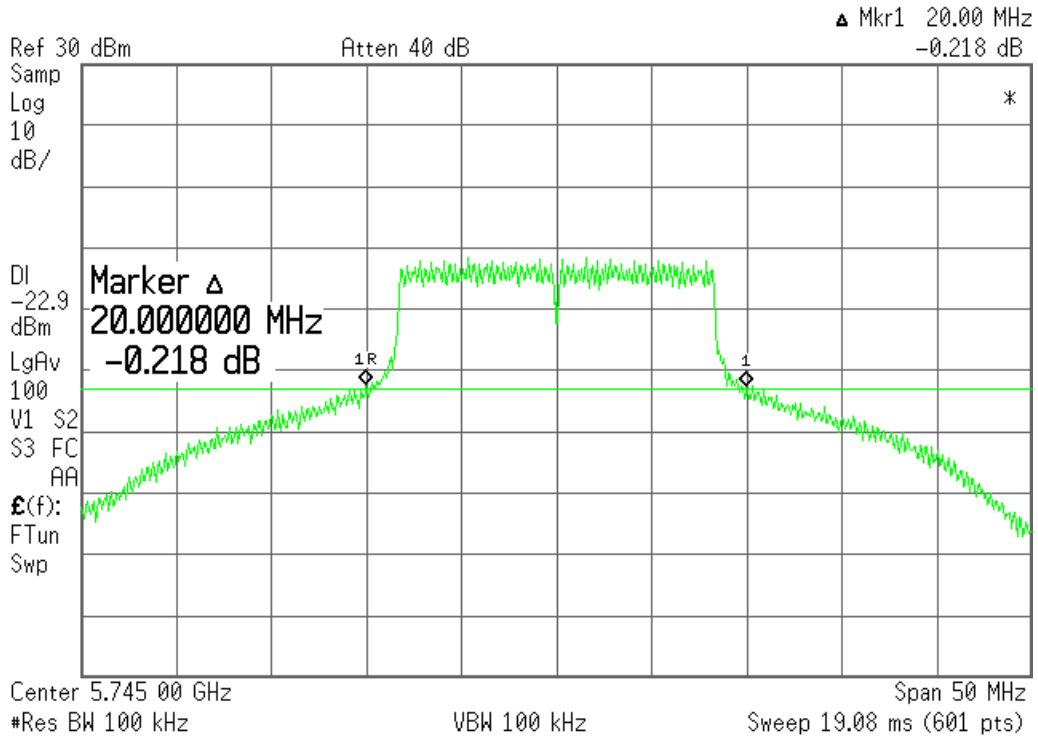
5320MHz 20dB BW

* Agilent 00:26:27 May 11, 2004



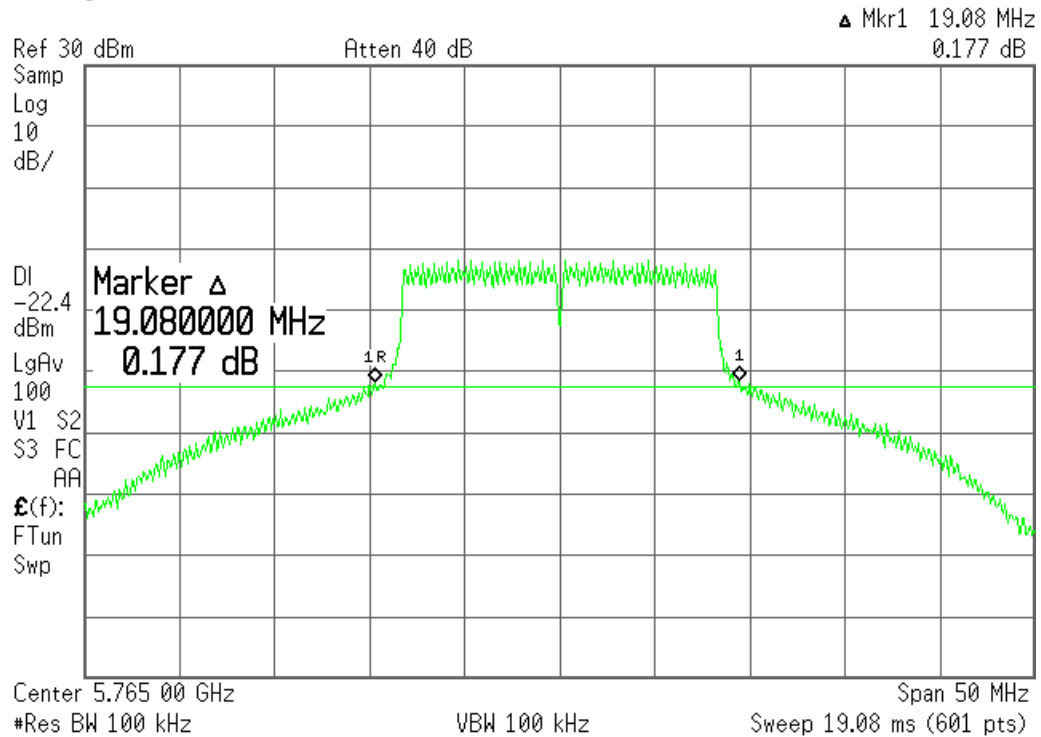
5745MHz 20dB BW

Agilent 00:30:34 May 11, 2004

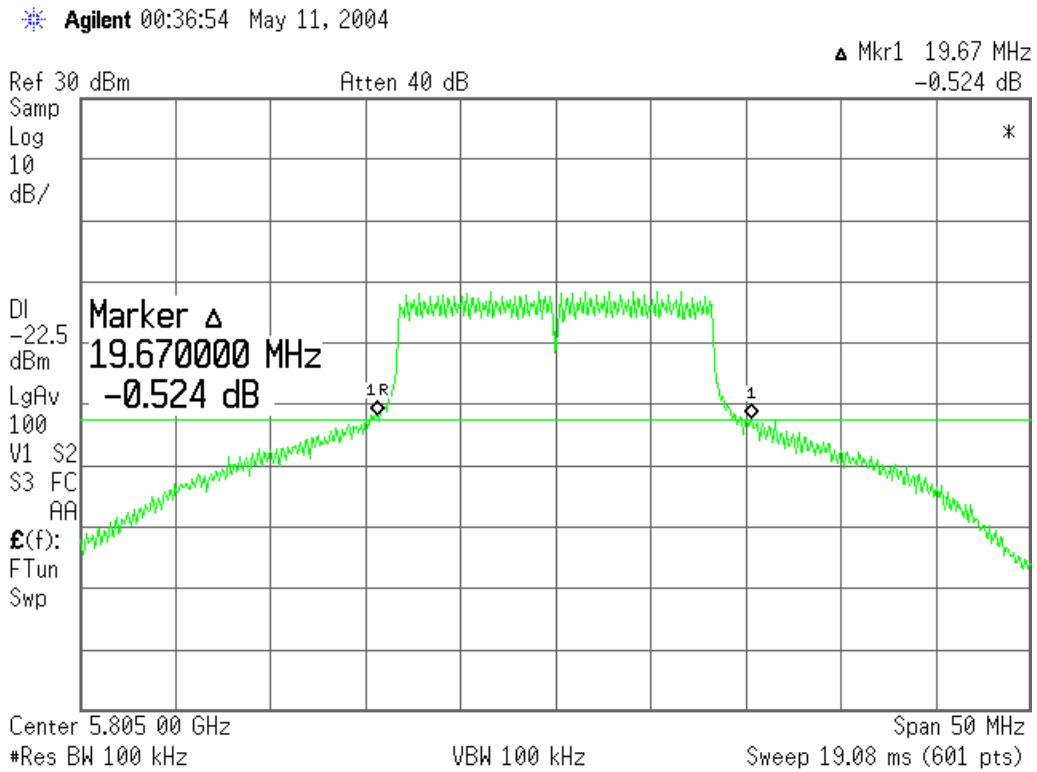


5765MHz 20dB BW

Agilent 00:31:49 May 11, 2004

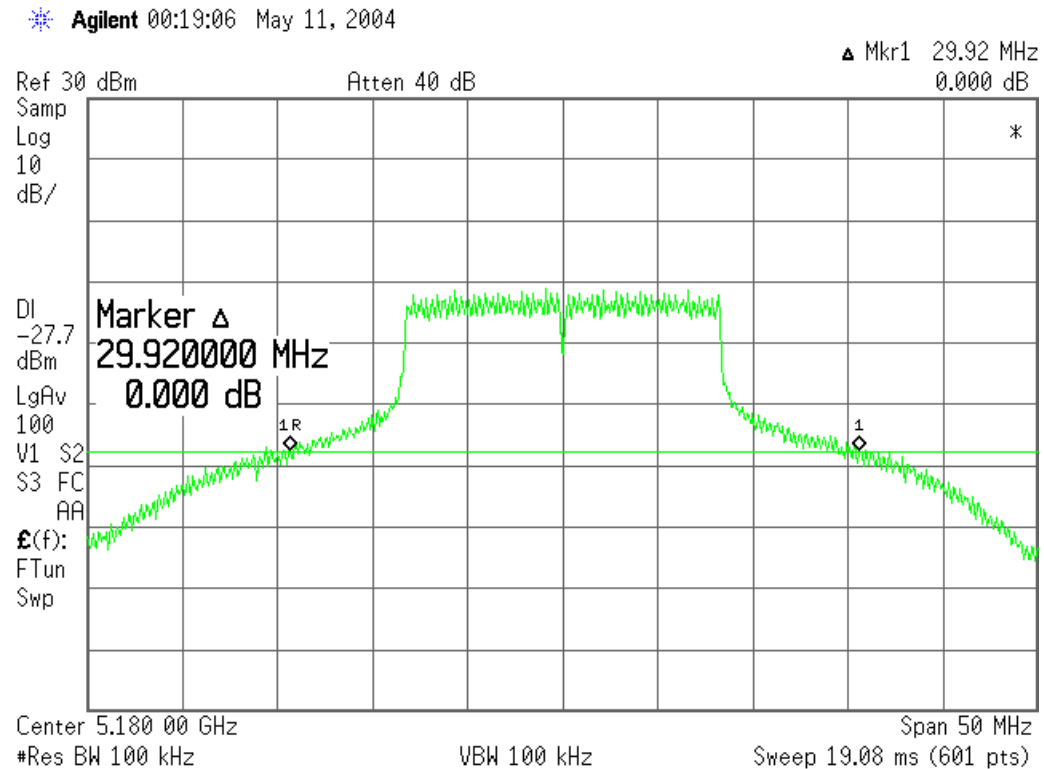


5805MHz 20dB BW



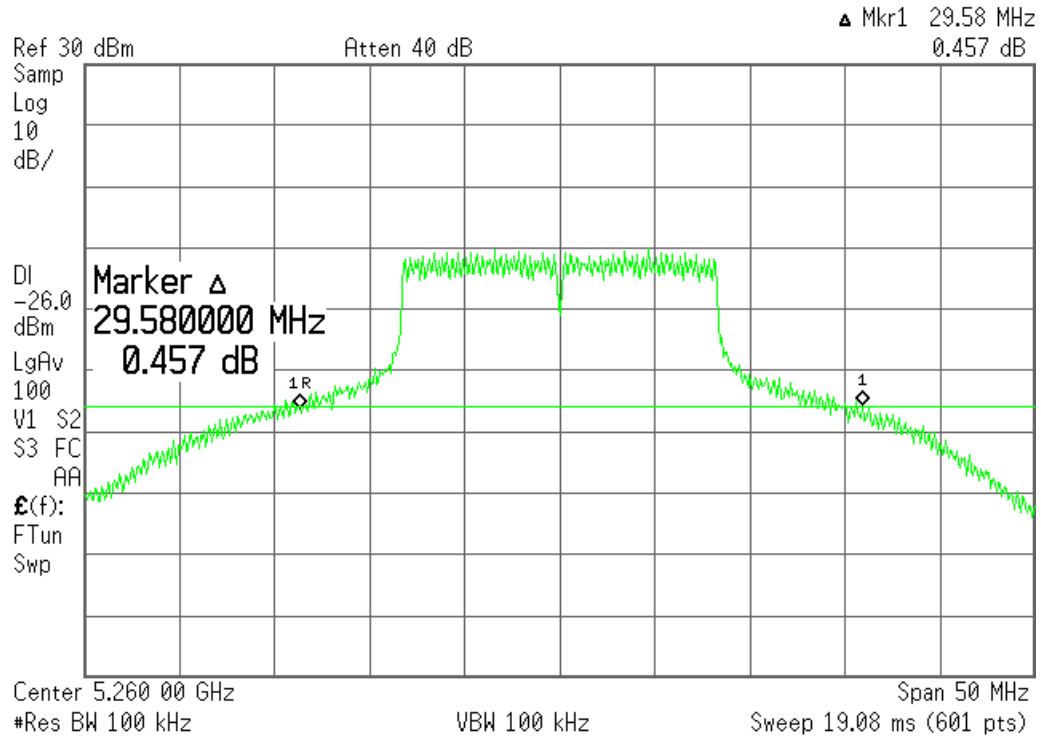
26 dB Bandwidth Plots

5180MHz 26dB BW



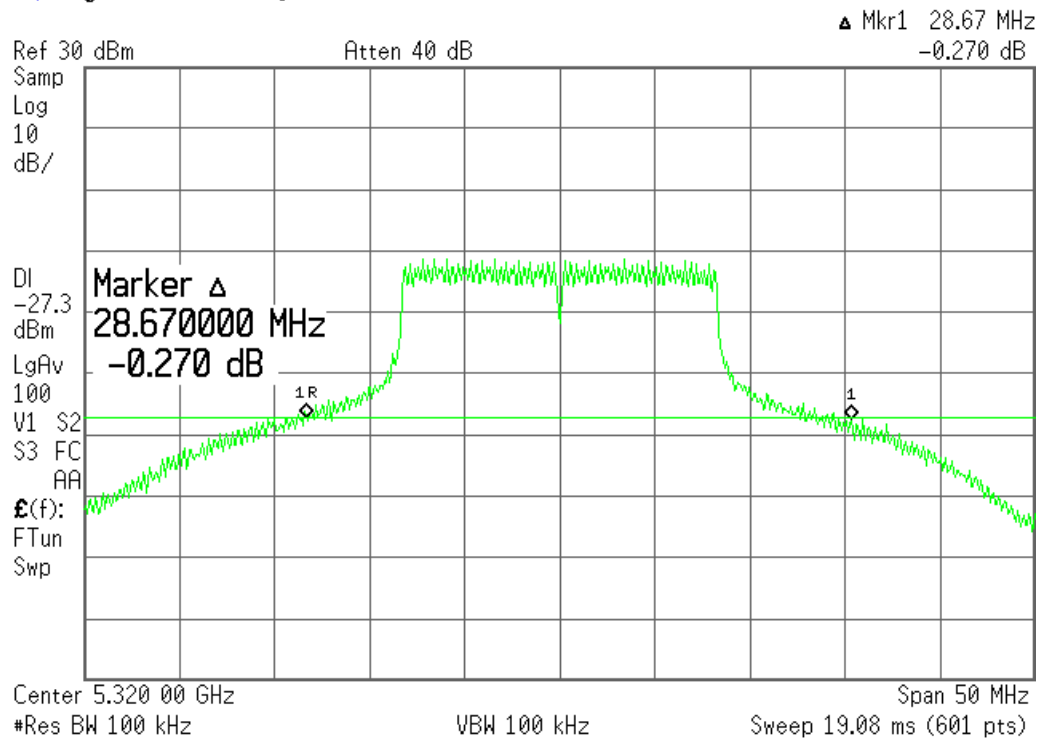
5260MHz 26dB BW

Agilent 00:24:46 May 11, 2004

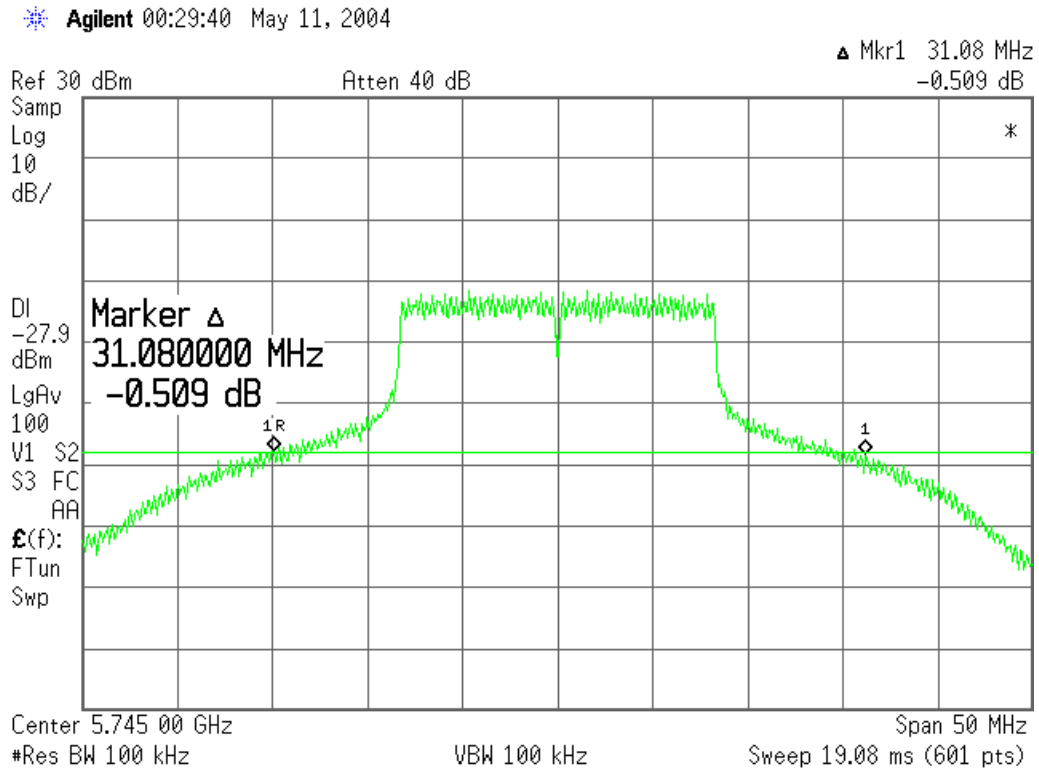


5320MHz 26dB BW

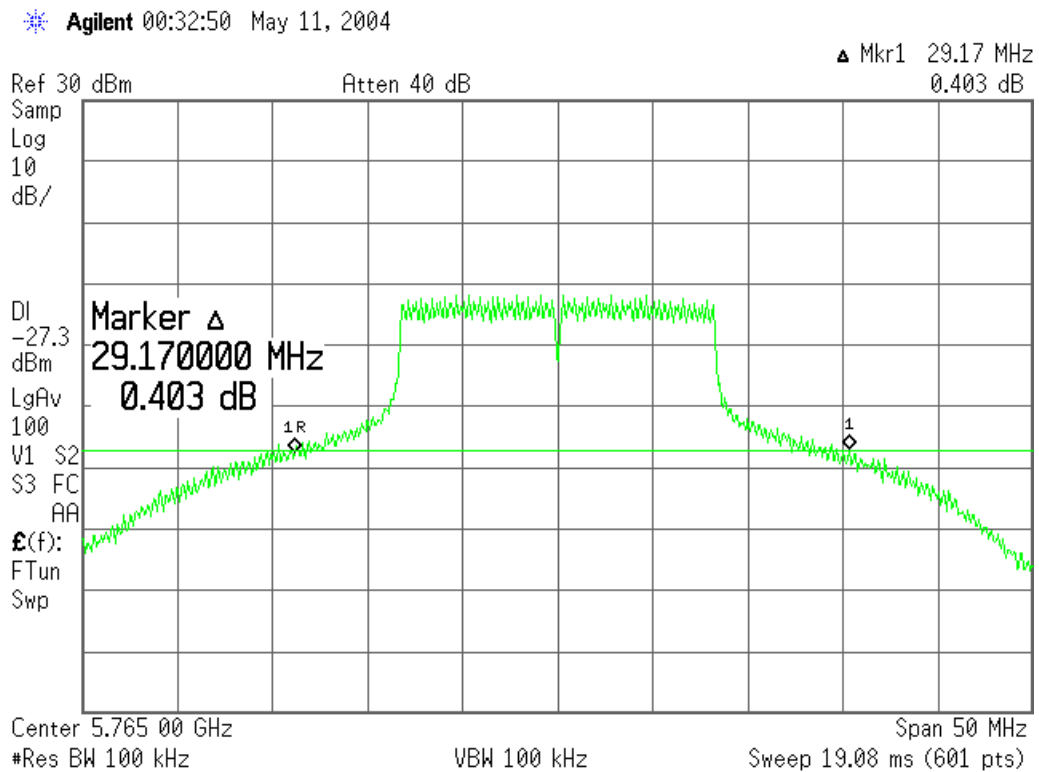
Agilent 00:27:43 May 11, 2004



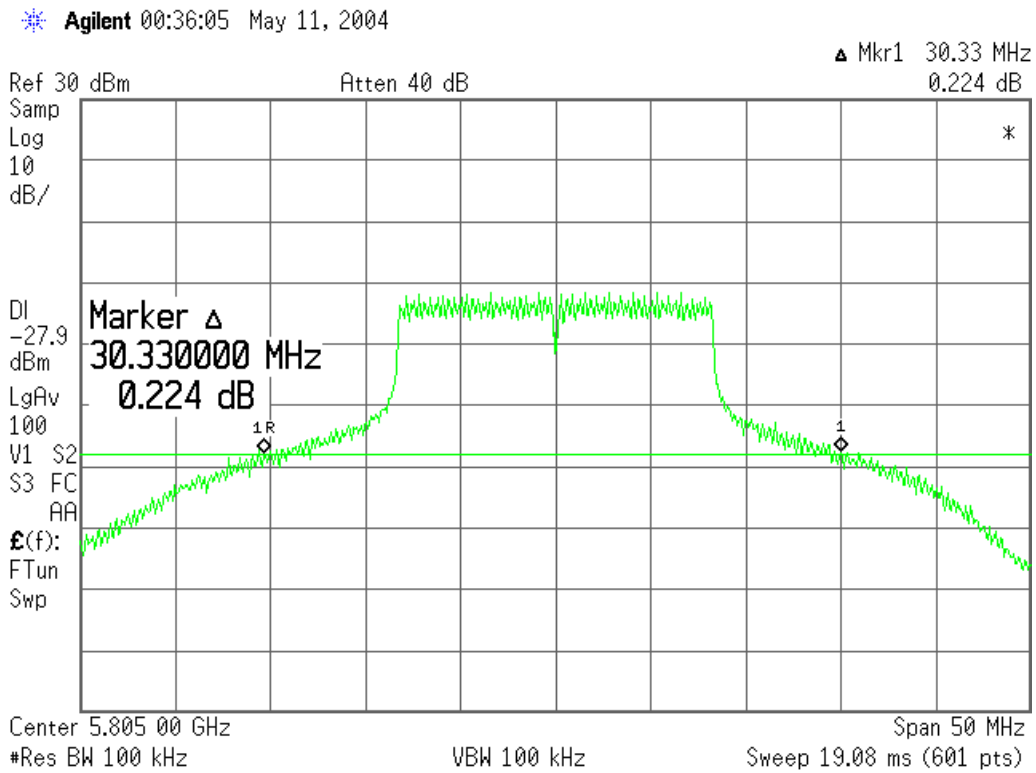
5745MHz 26dB BW



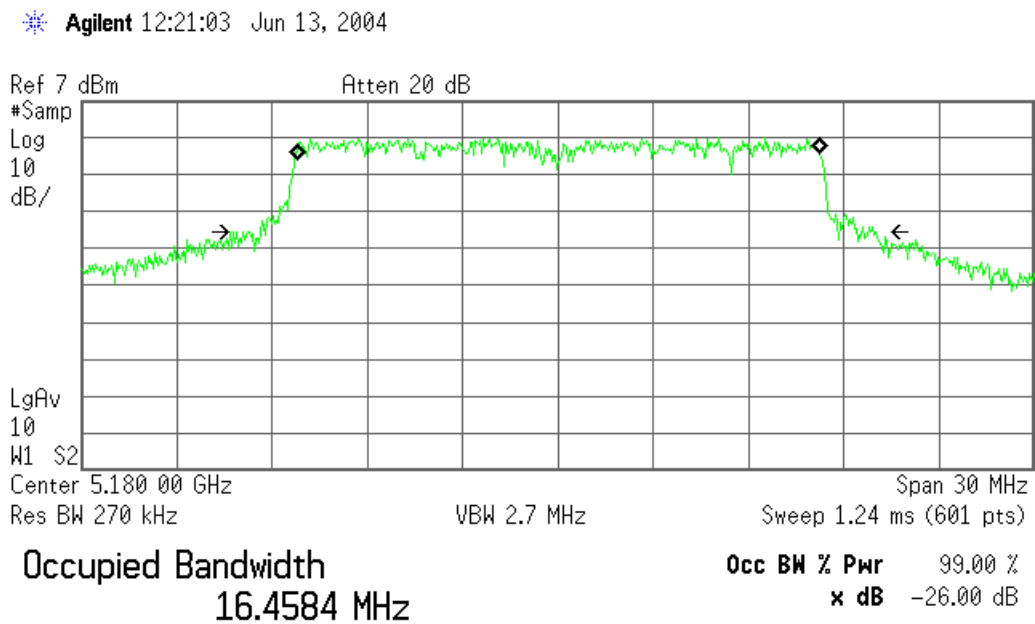
5765MHz 26dB BW



5805MHz 26dB BW



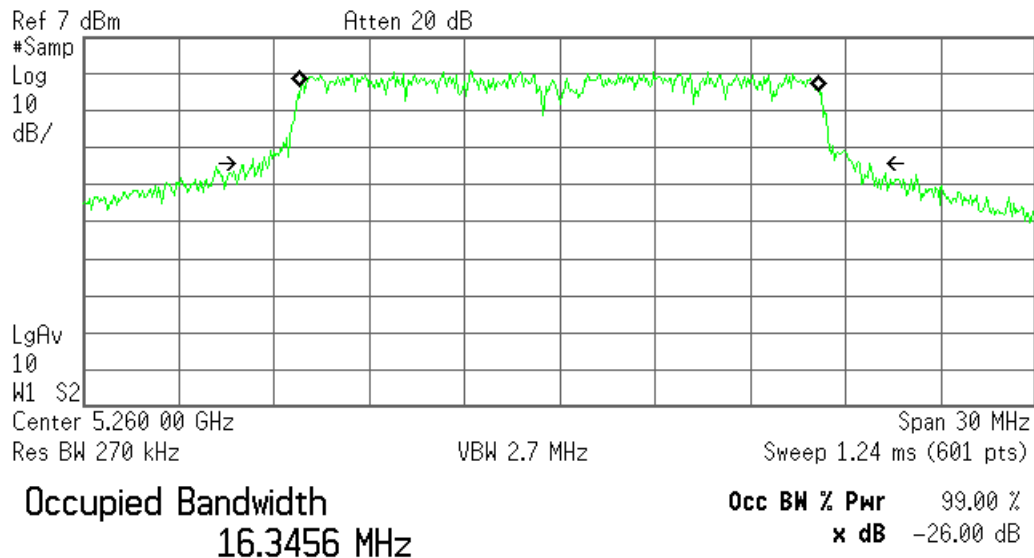
99% Bandwidth Plots 5180MHz 99% BW



Transmit Freq Error 23.891 kHz
x dB Bandwidth 19.833 MHz*

5260MHz 99% BW

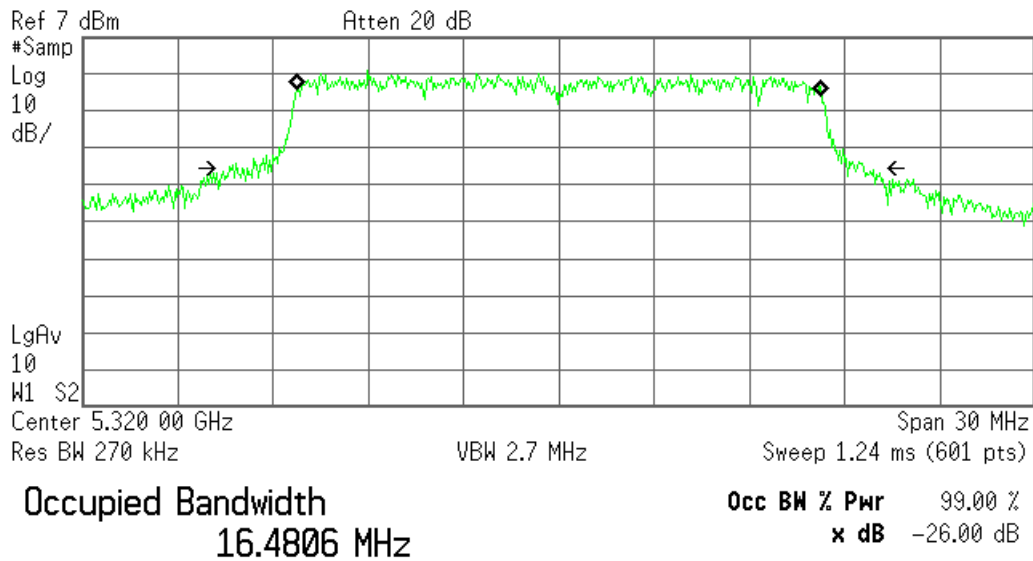
Agilent 12:21:47 Jun 13, 2004



Transmit Freq Error -7.641 kHz
x dB Bandwidth 19.503 MHz*

5320MHz 99% BW

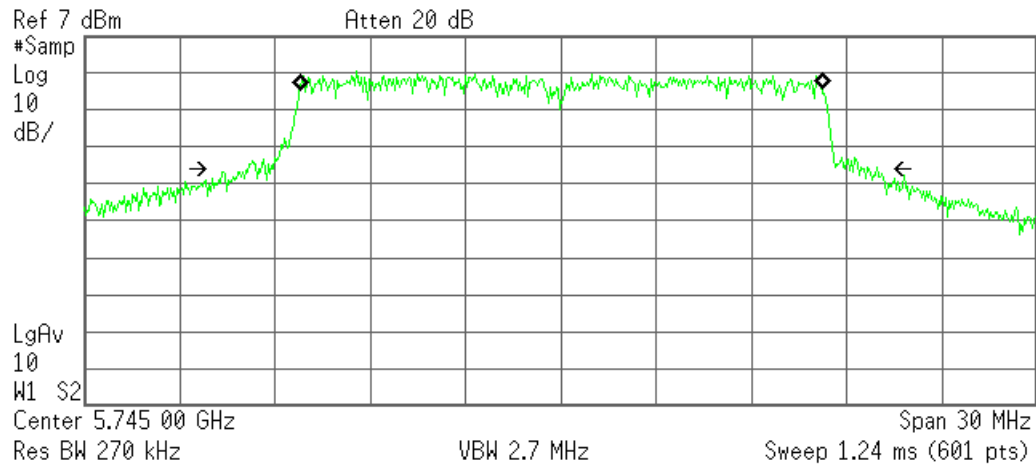
Agilent 12:22:21 Jun 13, 2004



Transmit Freq Error -12.174 kHz
x dB Bandwidth 20.187 MHz*

5745MHz 99% BW

Agilent 12:23:02 Jun 13, 2004



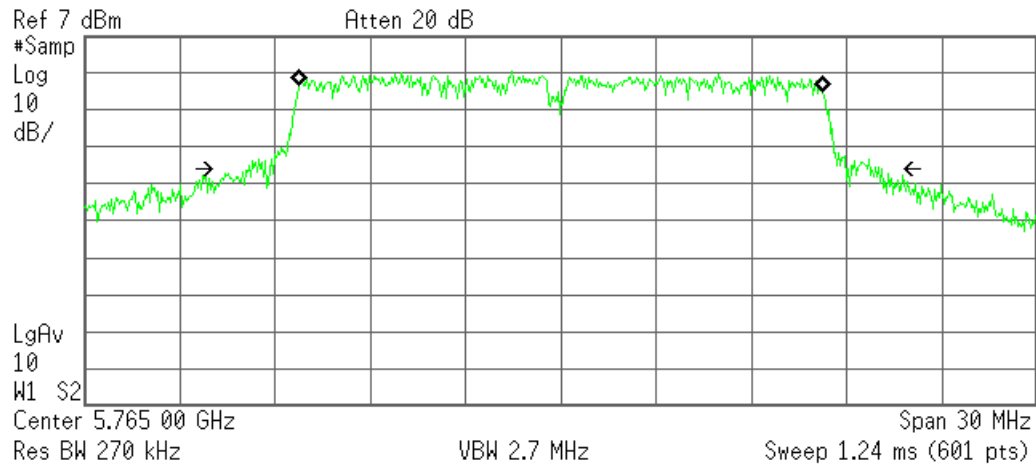
Occupied Bandwidth
16.4459 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error 18.169 kHz
x dB Bandwidth 20.673 MHz*

5765MHz 99% BW

Agilent 12:23:23 Jun 13, 2004



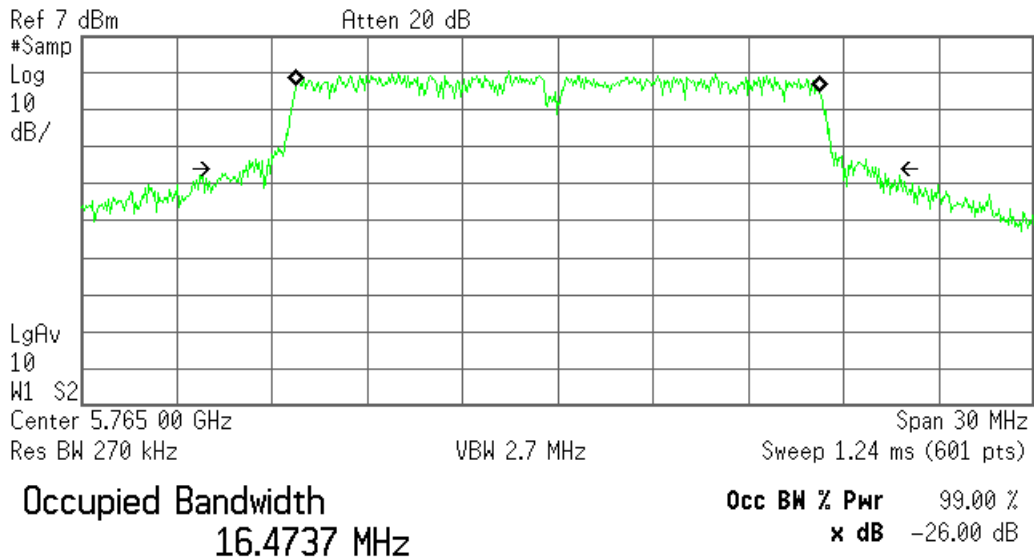
Occupied Bandwidth
16.4737 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error 6.607 kHz
x dB Bandwidth 20.758 MHz*

5765MHz 99% BW

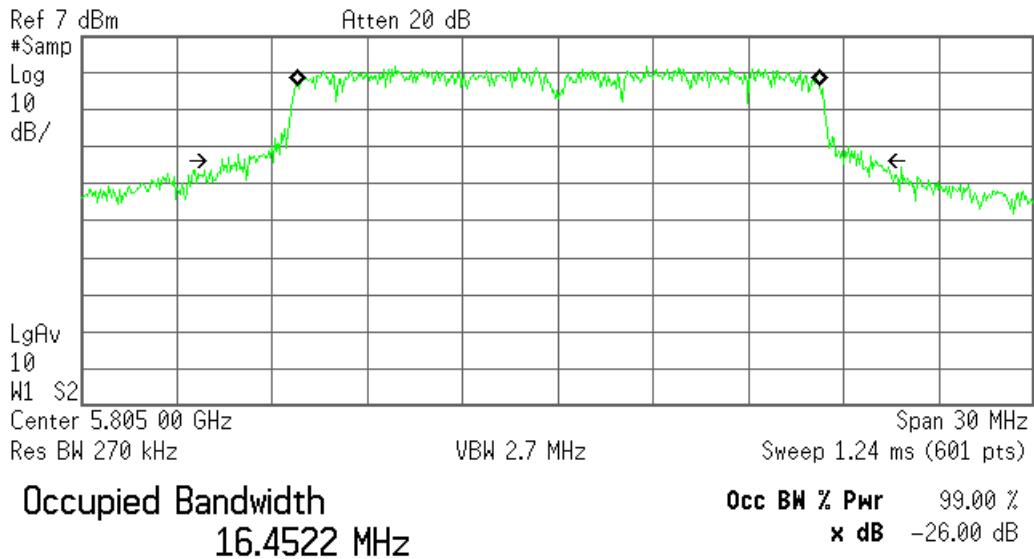
* Agilent 12:23:23 Jun 13, 2004



Transmit Freq Error 6.607 kHz
x dB Bandwidth 20.758 MHz*

5805MHz 99% BW

* Agilent 12:41:40 Jun 13, 2004



Transmit Freq Error 22.815 kHz
x dB Bandwidth 20.441 MHz*

Power Spectral Density

Specification

FCC Specification: Paragraph 15.407(a)(5)

IC Specification: 6.2.2(q1)i

Procedure:

The test setup was configured as shown in the conducted test setup. The UUT was configured to continuously transmit random data packets. Initially the bandwidth of the entire channel was examined. Using MAX HOLD and peak search, the frequency with the maximum power was determined. The measurements were made using RBW = 1MHz, VBW >= 1MHz

The Power spectral density limits are shown below:

5.15-5.25GHz: 4dBm/MHz

5.25-5.35GHz 11dBm/MHz

5.725-5.825GHz: 17dBm/MHz

However, these limits must be reduced 1 dB for every dB that the maximum antenna gain exceeds 6.0dBi. Since the maximum antenna gain used with the access point is 7.4 dBi. These PSD limits must be reduced by 1.4 dB. This reduced limit is shown in the table below.

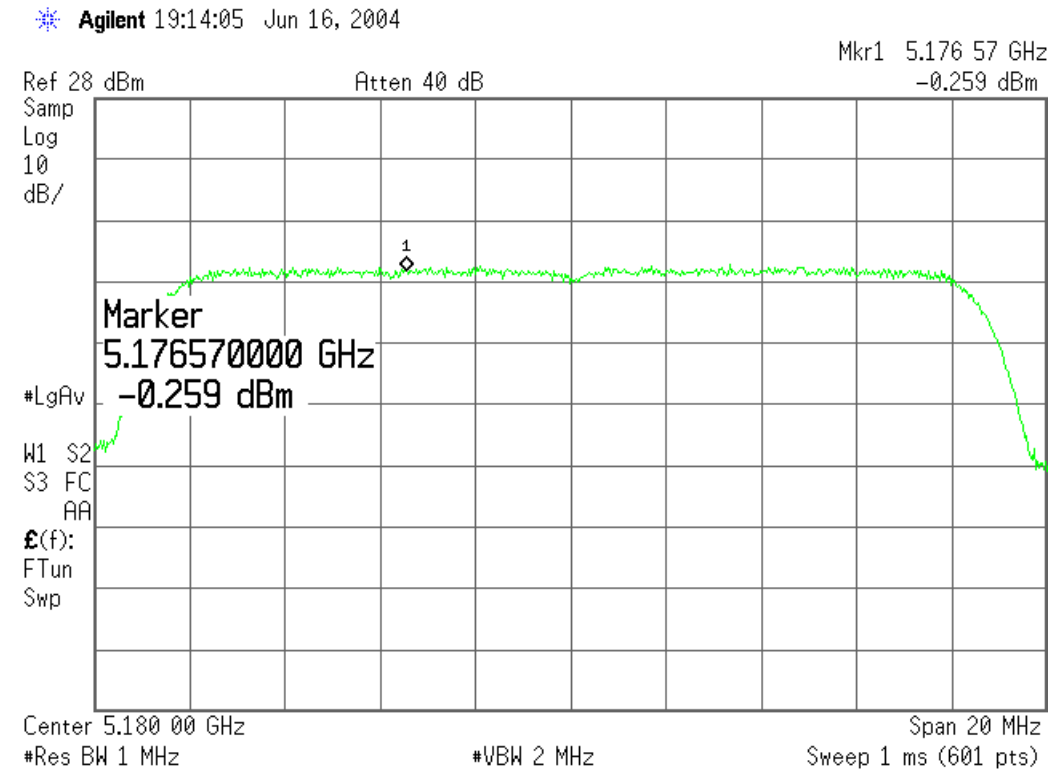
The power spectral density was measured at the designated test channels with the appropriate power level (as determined in the for the given test channel.

Power Spectral Density Summary Results:

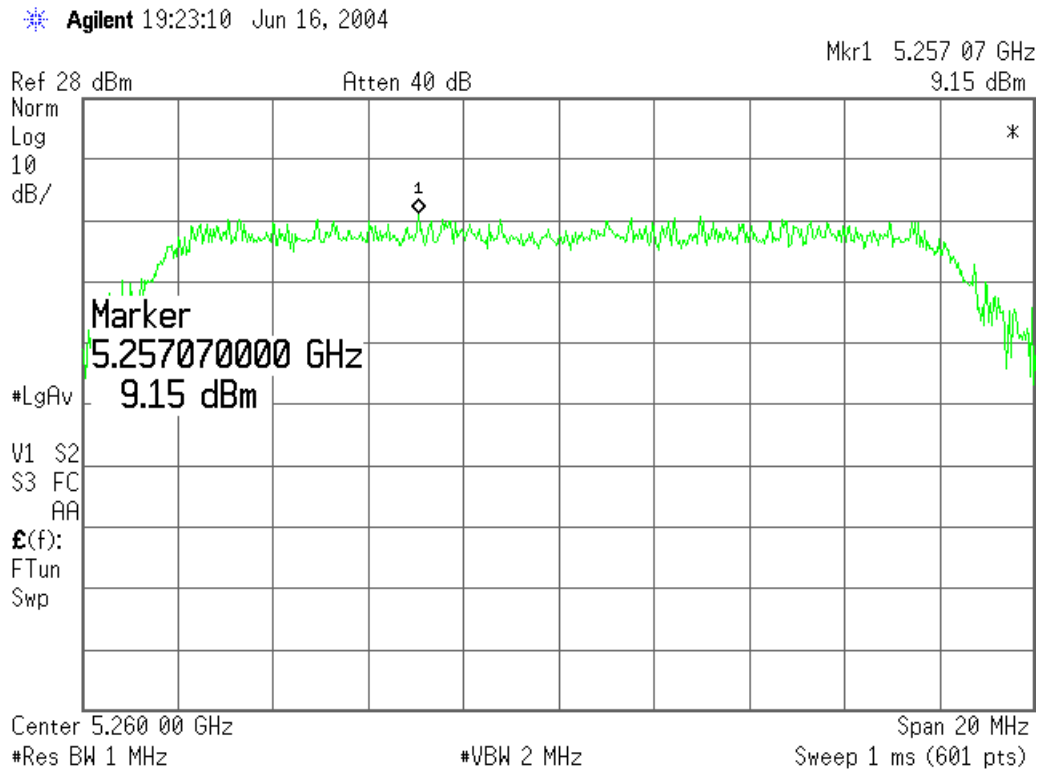
Frequency (MHz)	P.S.D. (dBm/MHz)	FCC Limit (dBm/MHz) Corrected for excess gain over 6 dBi	Delta (dB)
5180	-0.259	2.60	2.859
5260	9.150	9.60	0.450
5320	8.910	9.60	0.690
5745	13.570	15.60	2.030
5765	14.320	15.60	1.280
5805	14.330	15.60	1.270

Power Spectral Density Plots

5180MHz PSD

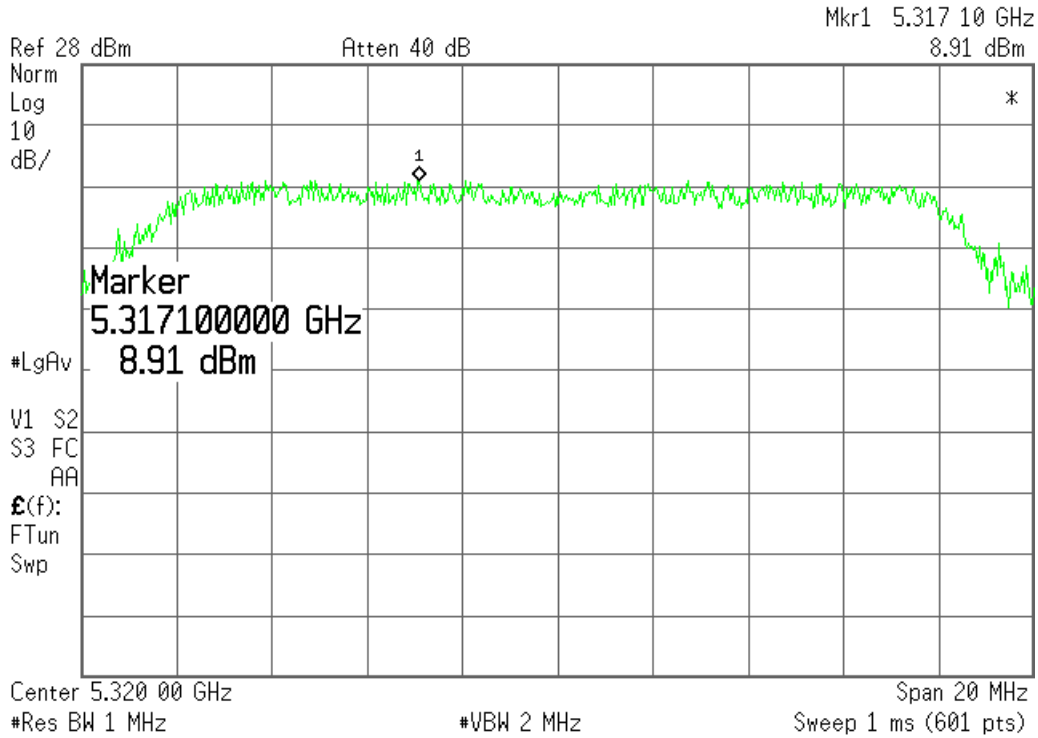


5260MHz PSD



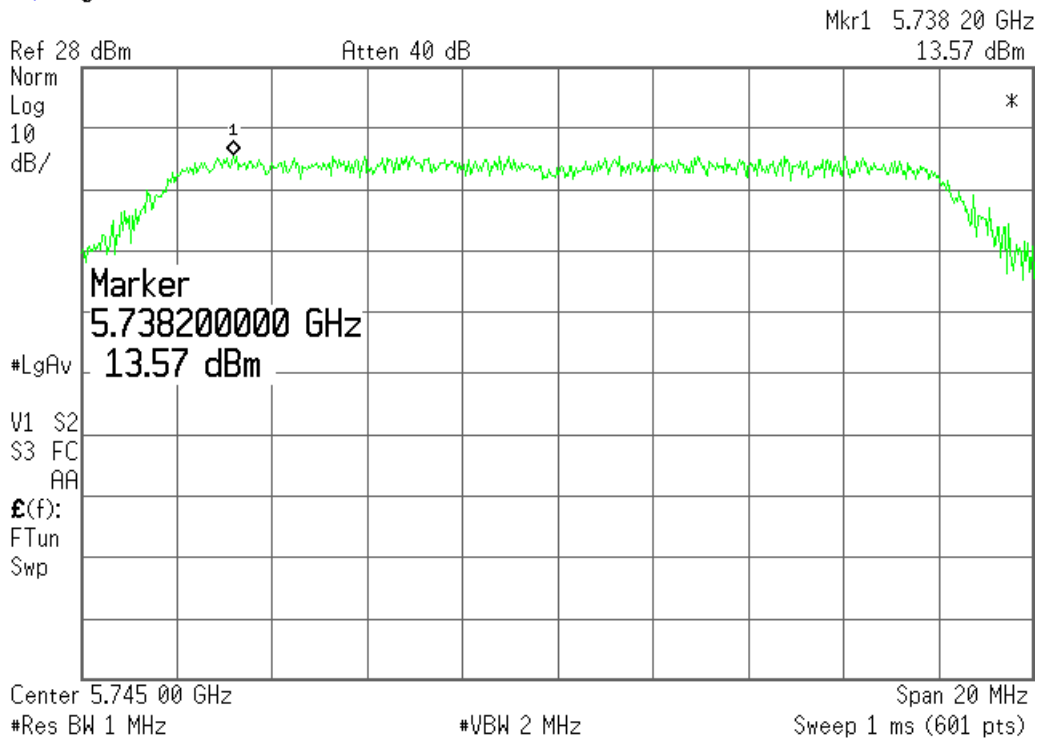
5320MHz PSD

* Agilent 19:25:03 Jun 16, 2004

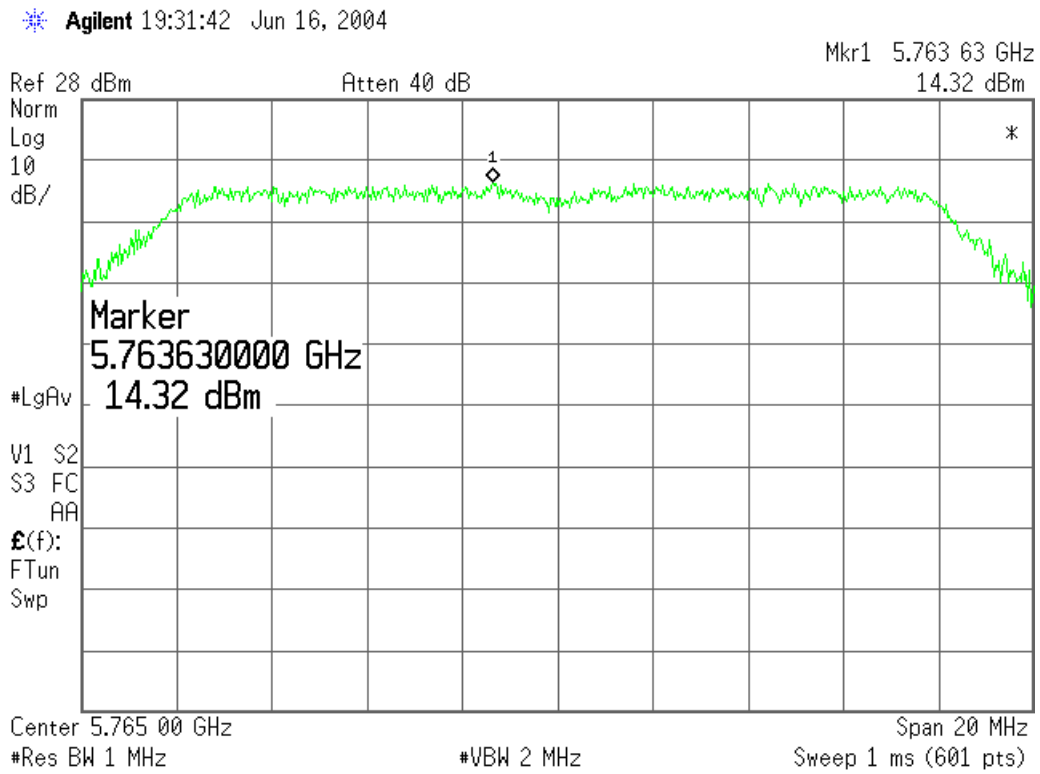


5745MHz PSD

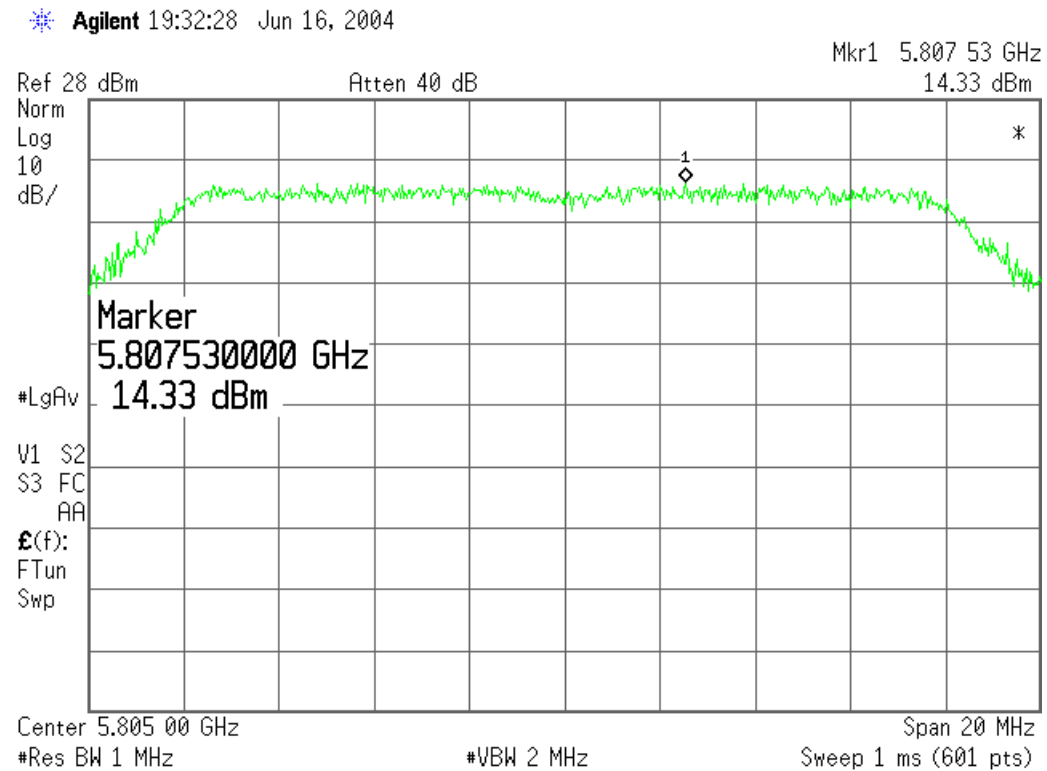
* Agilent 19:28:03 Jun 16, 2004



5765MHz PSD



5805MHz PSD



Out of band Spurious Emissions

Specification

FCC Specifications: Paragraphs 15.407(b)(1), 15.407(b)(2), 15.407(b)(3),

IC Specification: 6.2.2.(q1)i

Procedure:

The test was configured as shown in the conducted RF test setup. The band from 1 GHz to 25 GHz was examined spurious emissions. This test was conducted with the unit transmitting at the appropriate power setting for the channel being examined and configured to transmit continuous random data.

Limit Calculation:

Antenna Gain: 7.4 dBi

Out of band signal limit: -27dBm/MHz EIRP (for signals not in a restricted band)

Conducted limit: -27dBm/MHz - 7.4 dBi = **-34.4 dBm/MHz EIRP**

This assumes a maximum external antenna gain of 7.4 dBi and a net equivalent internal antenna gain (antenna + power splitter) of 7.4 dBi

In the some instances, the measured emission is a harmonic of the fundamental and is examined in detail in the Radiated Emissions Is Restricted Bands Test.

Out of band Spurious Emissions Results Summary:

Tabular results below are followed by plots of the conducted emissions. In each of the plots below, the display line is placed at -34.4 dBm to graphically illustrate the limit.

*Note: The emissions indicated in **RED** below are harmonics of the fundamental transmit frequency and are examined in detail during the "Radiated Emissions in Restricted Bands" test.*

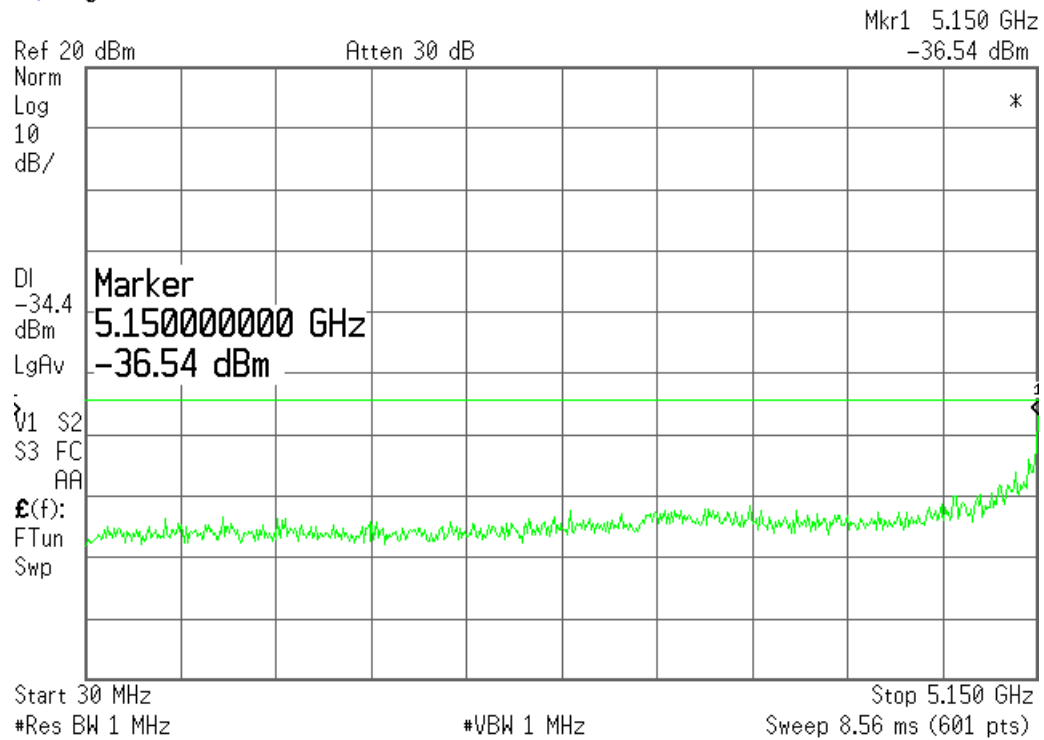
*The emission in **BLUE** is not an out of band emission. It is measurement error due to the measurement span of the spectrum analyzer and the proximity of the fundamental to the band edge.*

These level are NOT used to calculate the specification delta in the table below

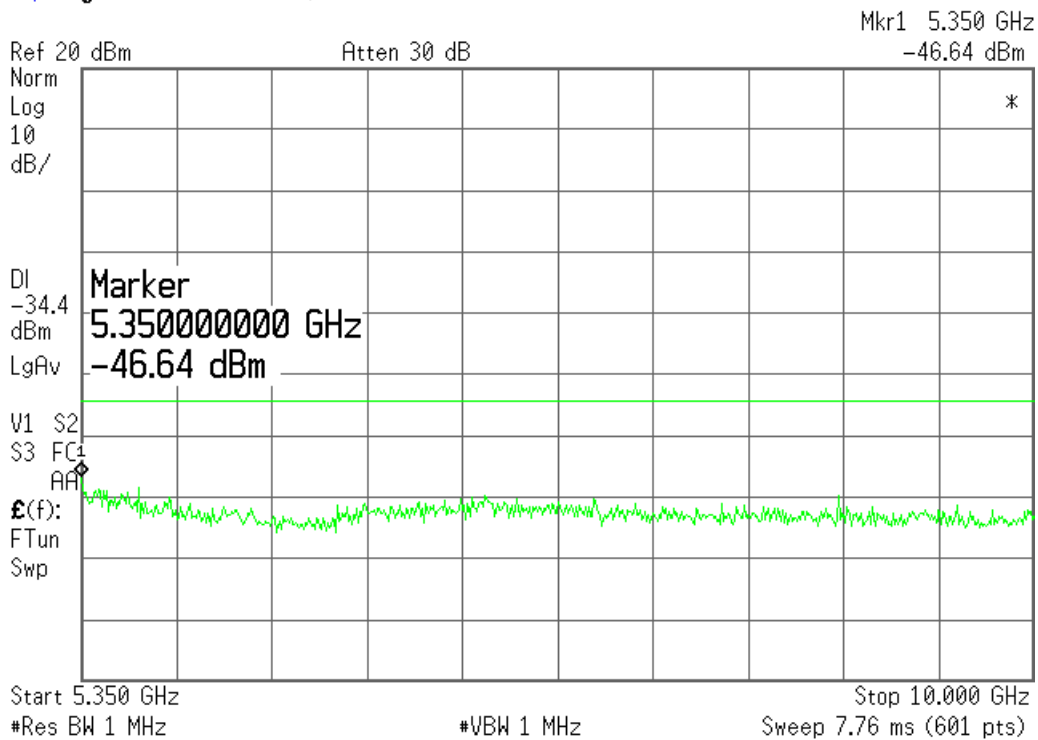
Xmit Freq (MHz)	Highest Measured Emission Within The Band					Specification	Delta (dB) (from highest NON-Rband level)
	1.0 - 5.15	5.35 - 10.0	10.0 - 15.0	15.0 - 20.0	20.0 - 25.0		
5180	-36.54	-46.64	-37.95	-47.61	-45.81	-34.4	12.24
5260	-45.58	-47.07	-44.82	-46.79	-45.97	-34.4	12.67
5320	-46.45	-38.87	-47.26	-47.18	-46.02	-34.4	12.05
	1.0 - 5.725	5.805 - 10.0	10.0 - 15.0	15.0 - 20.0	20.0 - 25.0		
5745	-41.59	-48.67	-47.73	-46.99	-45.86	-34.4	7.19
5765	-37.06	-47.09	-47.65	-45.67	-45.63	-34.4	2.66
5805	-38.17	-43.12	-48.26	-48.00	-46.33	-34.4	3.77

UUT Transmitting on 5180MHz

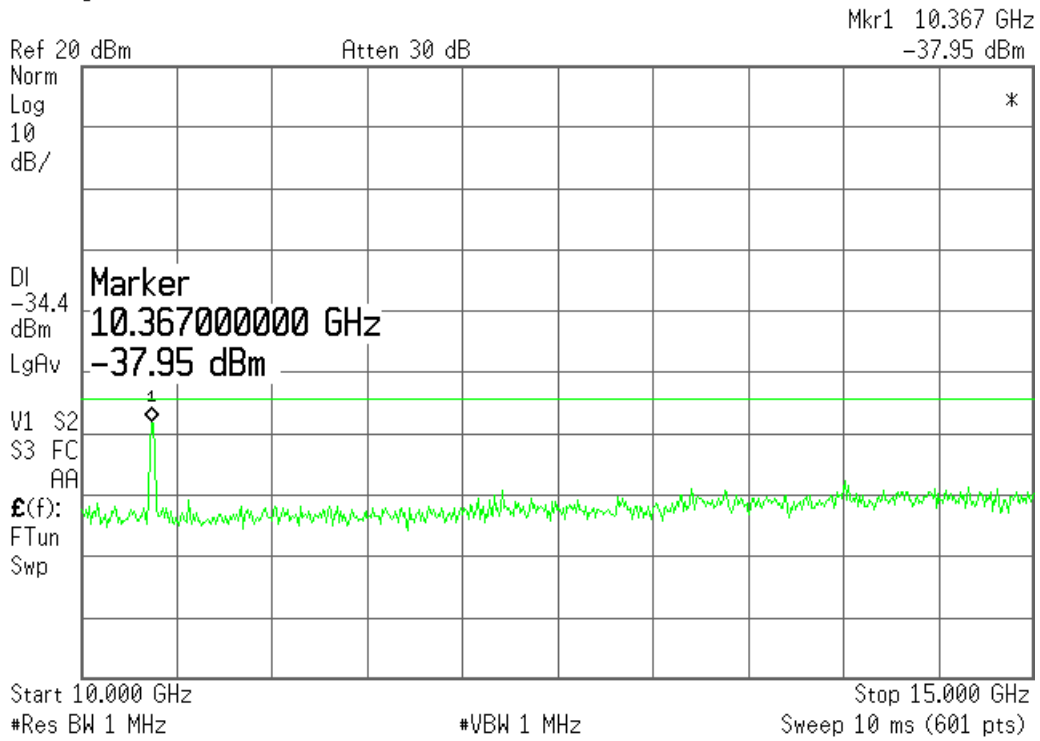
Agilent 13:35:35 Jun 6, 2004



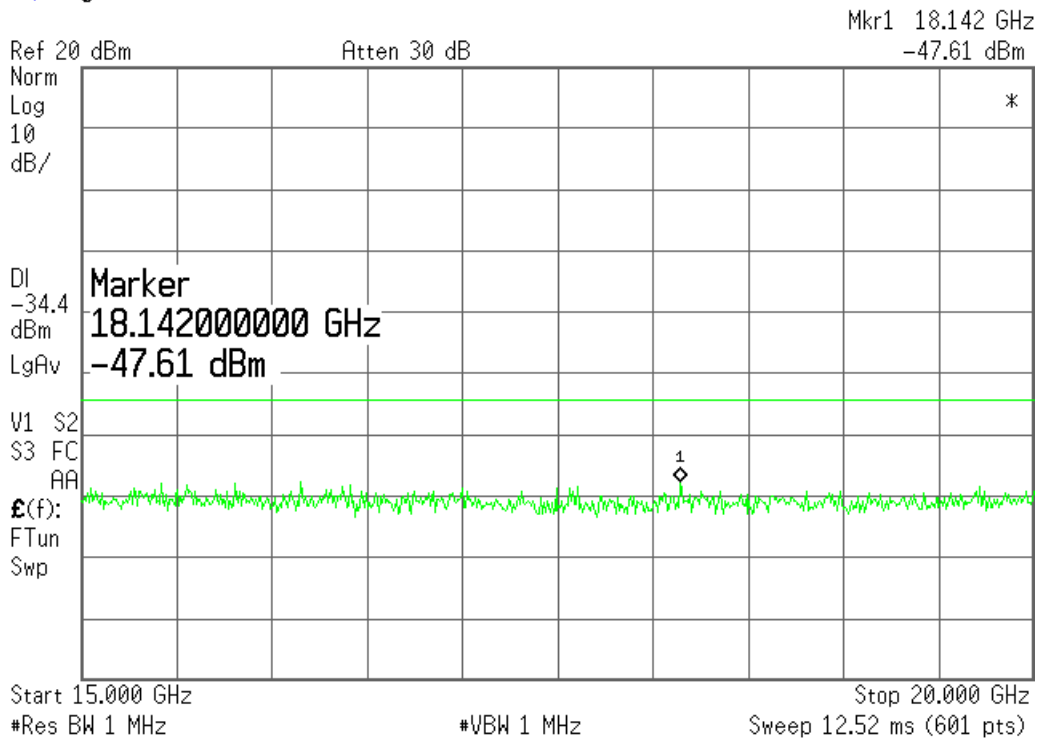
Agilent 13:36:40 Jun 6, 2004



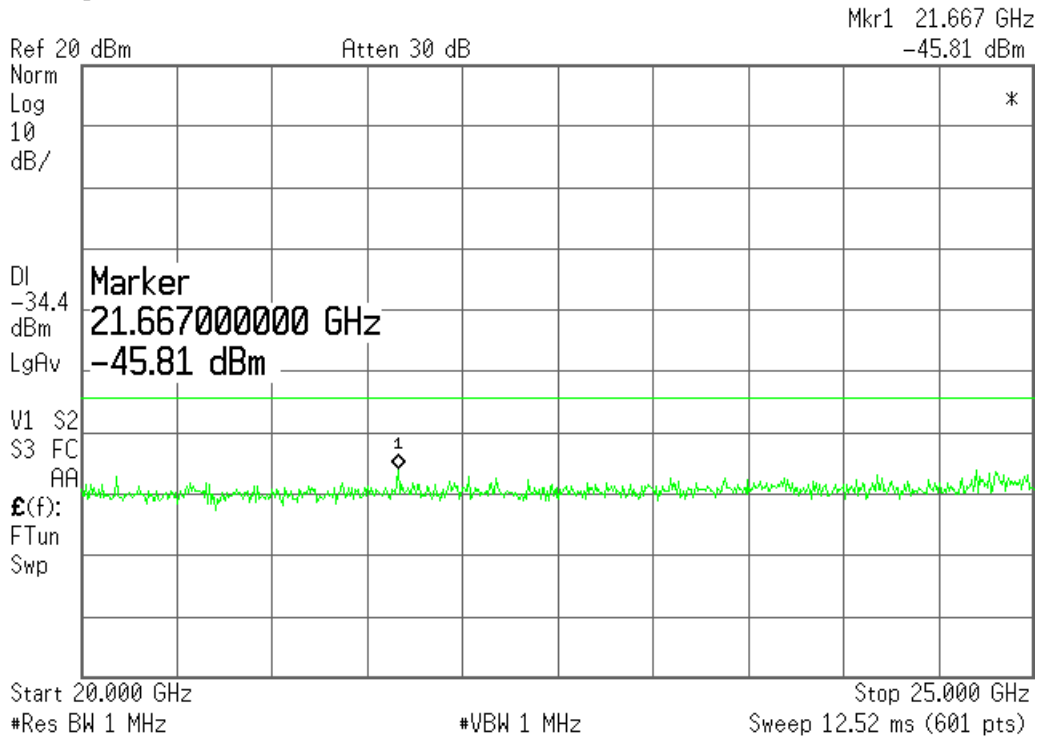
✱ Agilent 13:37:50 Jun 6, 2004



✱ Agilent 13:39:12 Jun 6, 2004

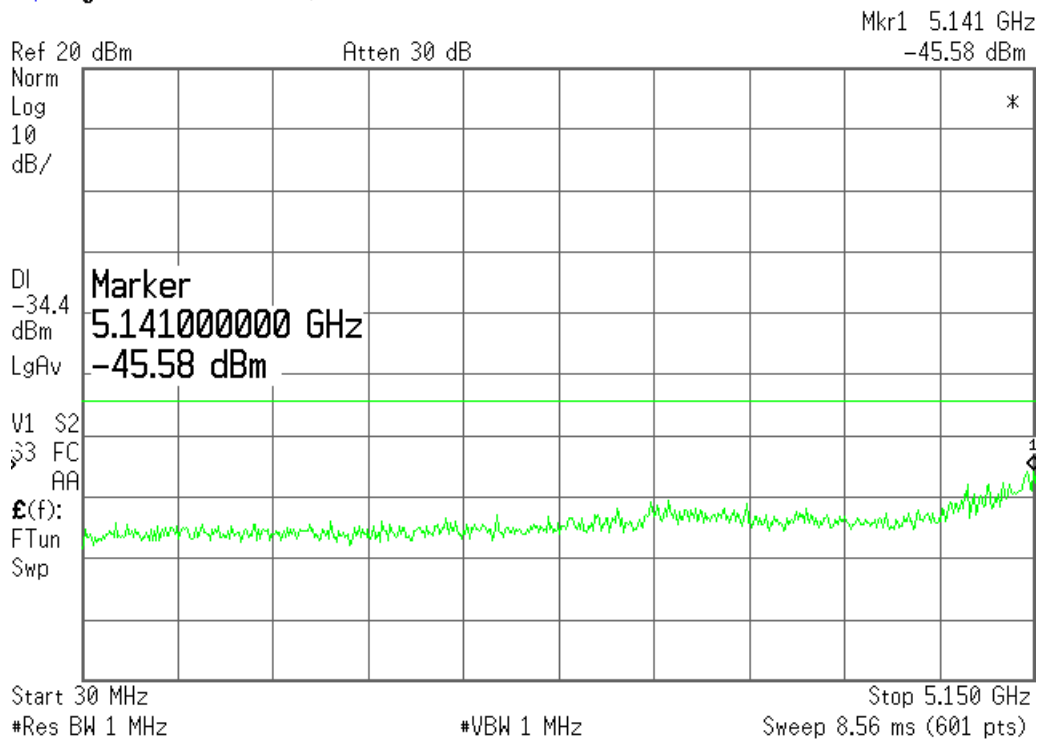


✱ Agilent 13:39:57 Jun 6, 2004

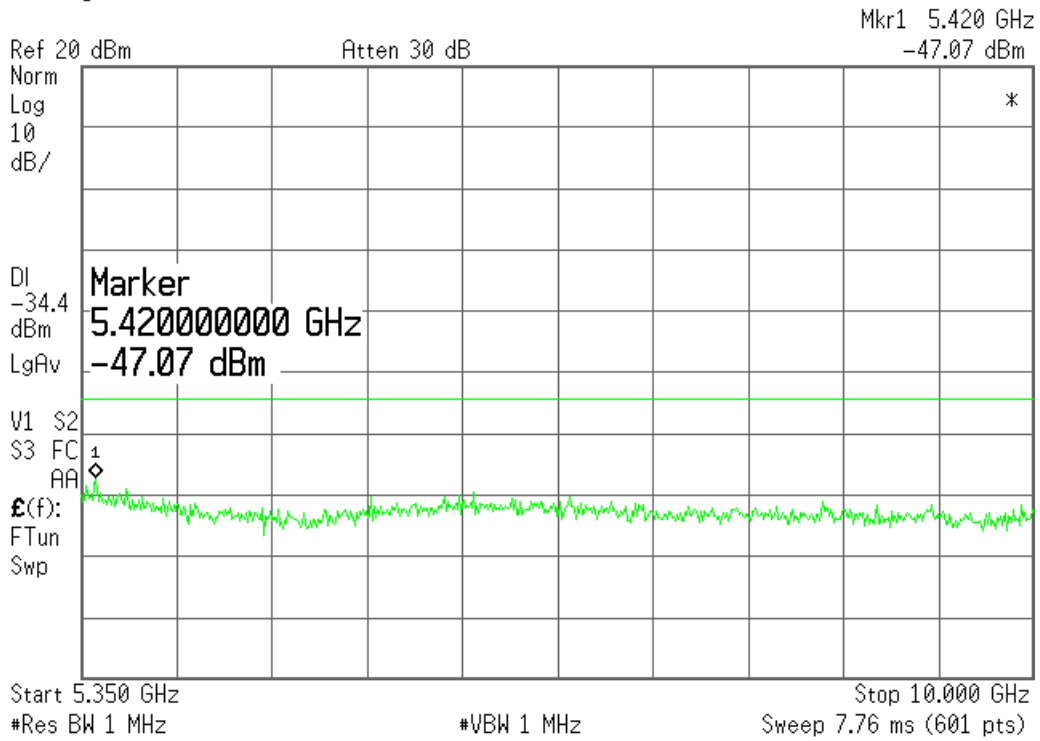


UUT Transmitting on 5260MHz

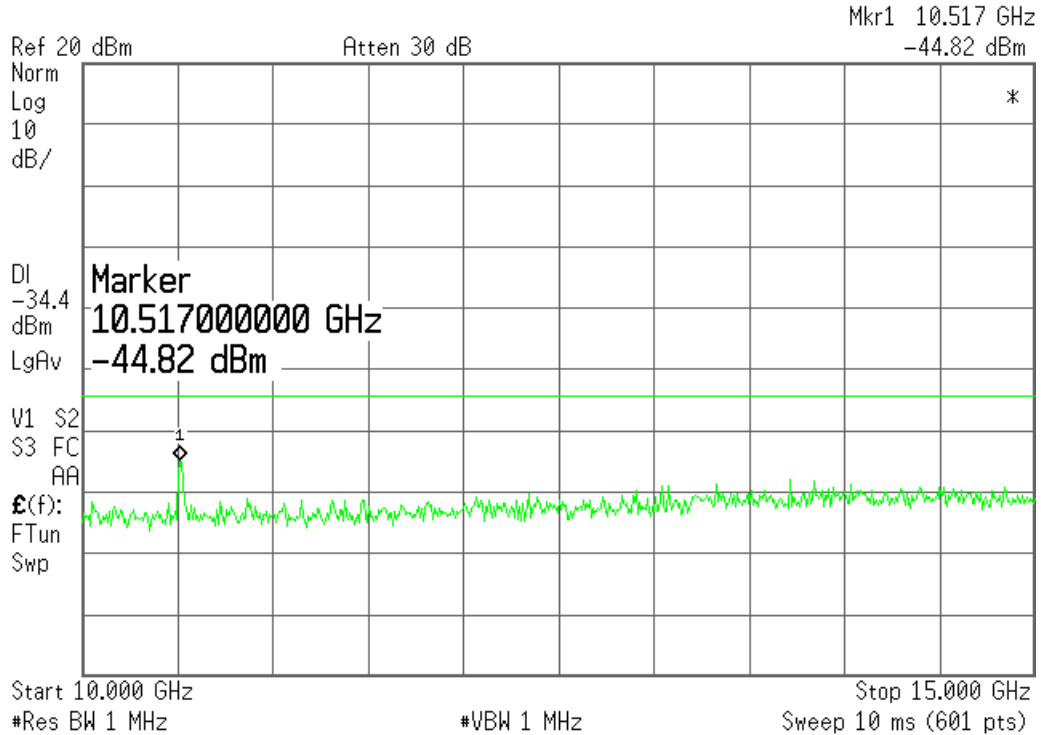
✱ Agilent 13:42:14 Jun 6, 2004



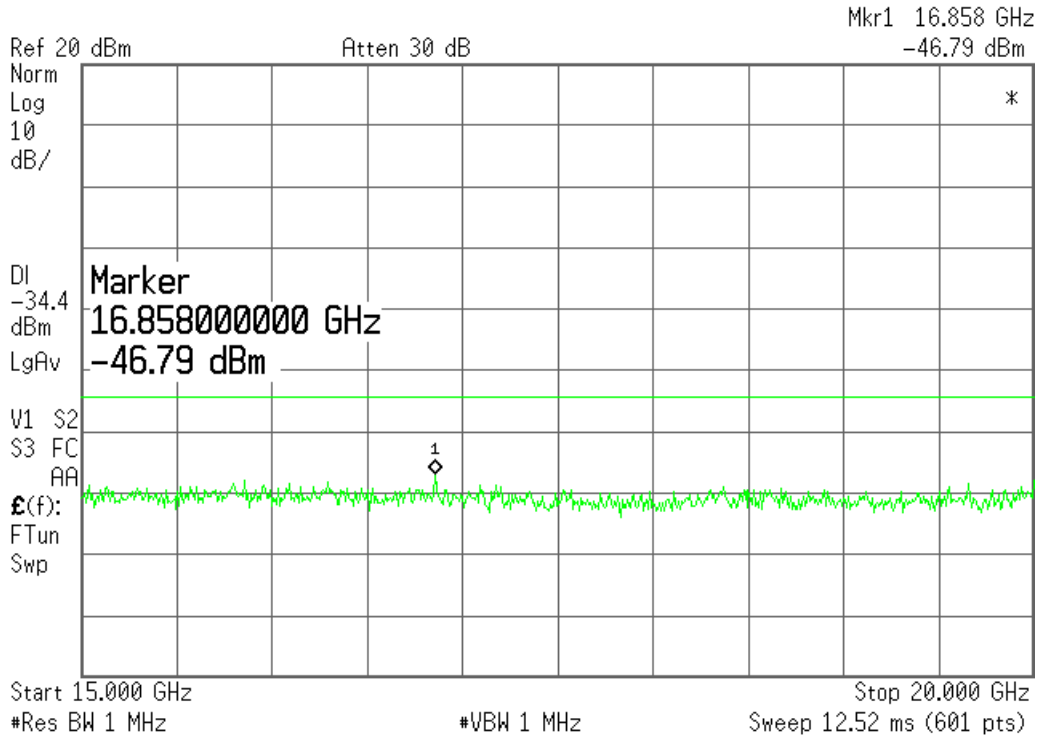
Agilent 13:43:04 Jun 6, 2004



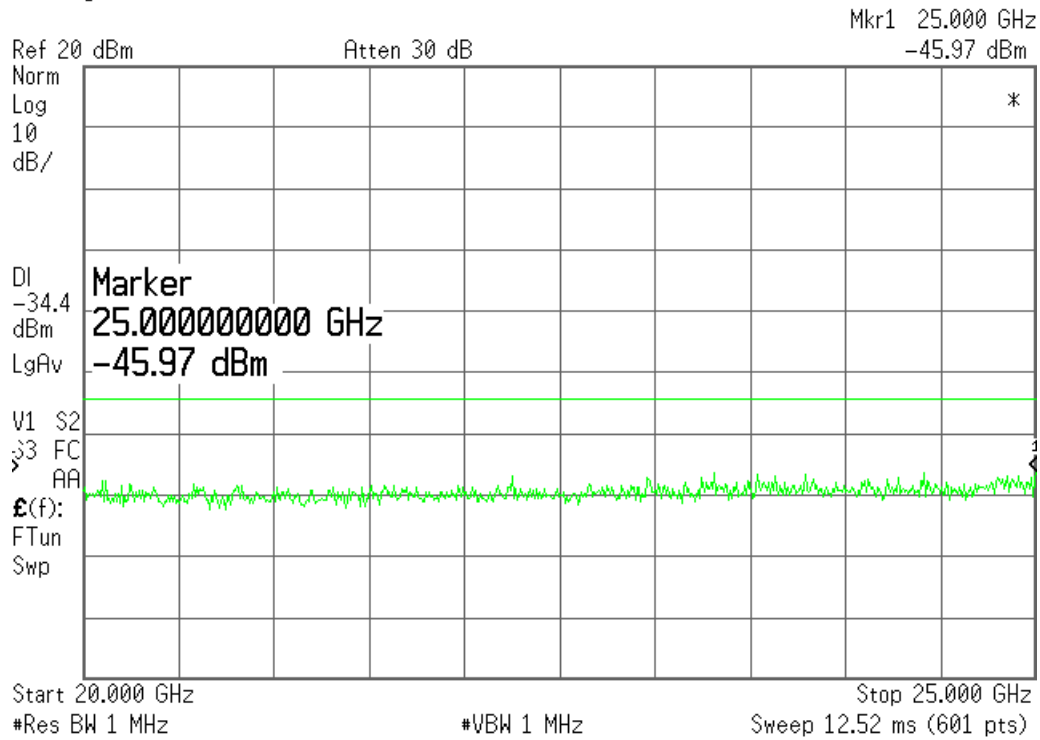
Agilent 13:43:32 Jun 6, 2004



Agilent 13:44:04 Jun 6, 2004

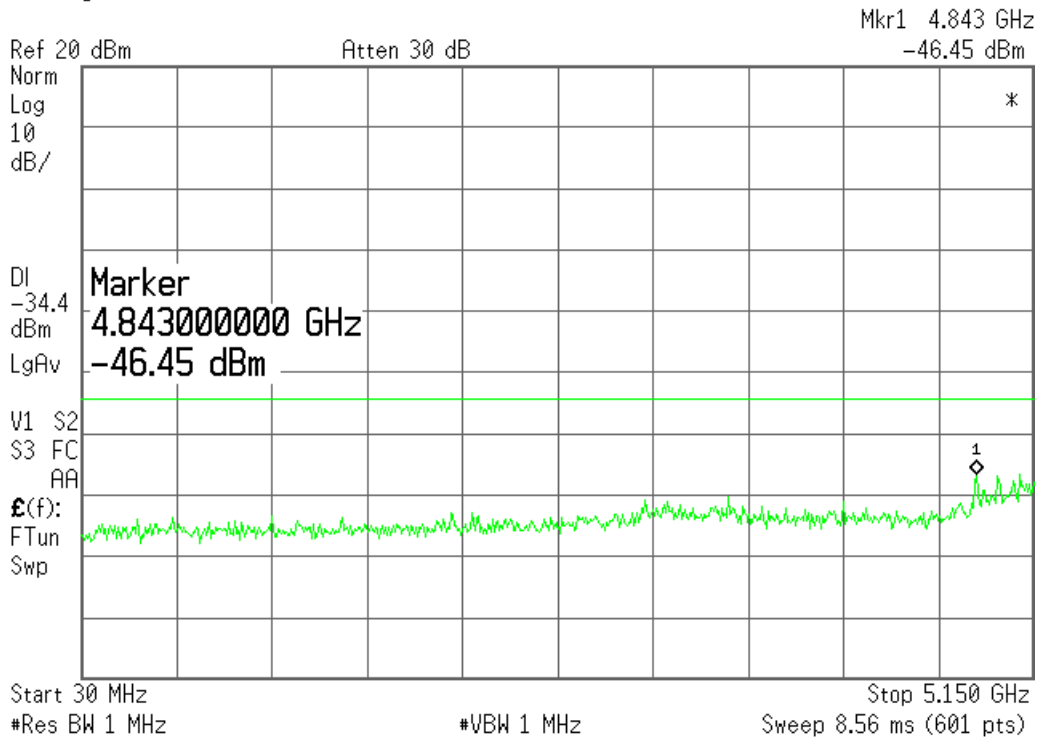


Agilent 13:44:37 Jun 6, 2004

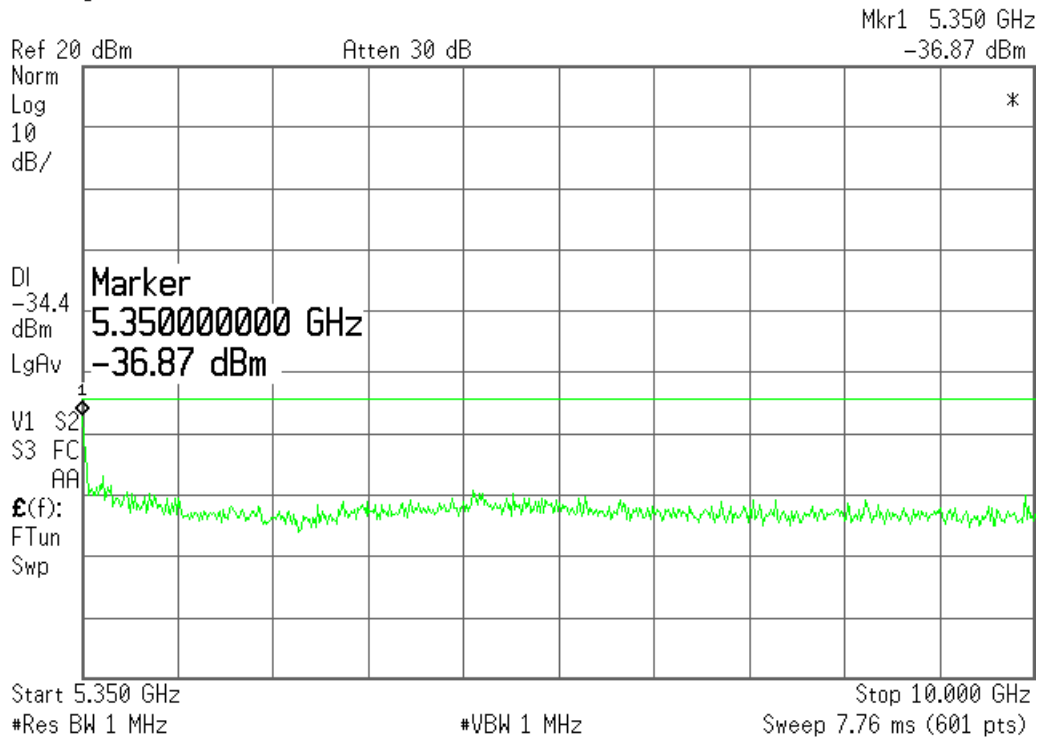


UUT Transmitting on 5320MHz

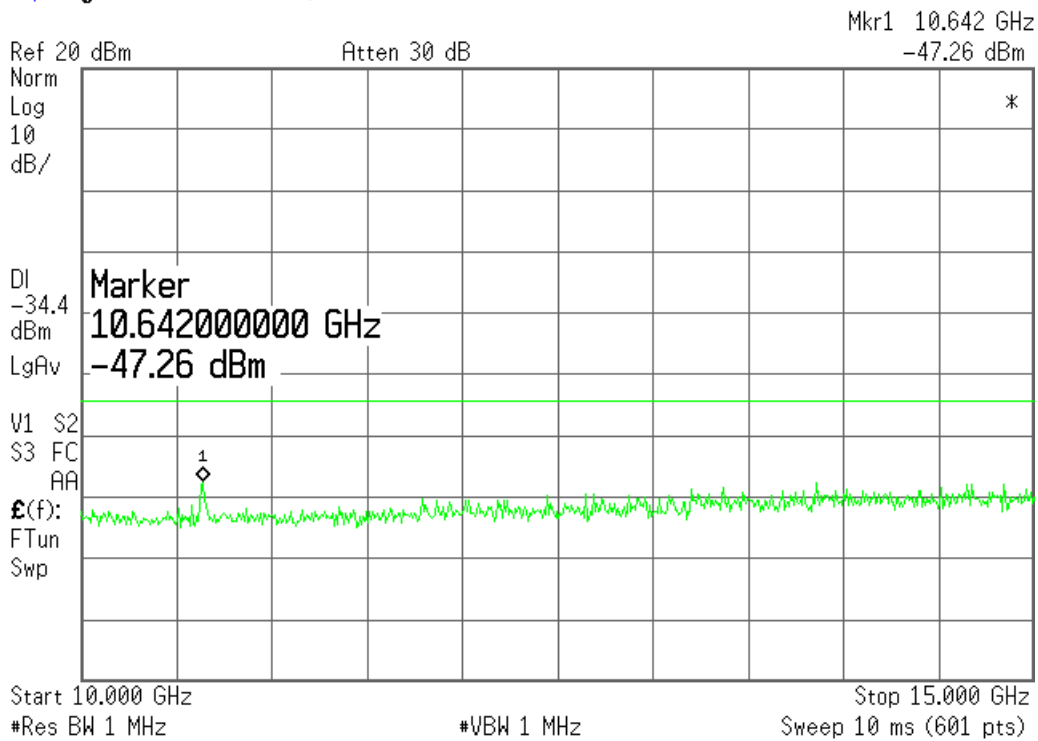
✱ Agilent 13:46:48 Jun 6, 2004



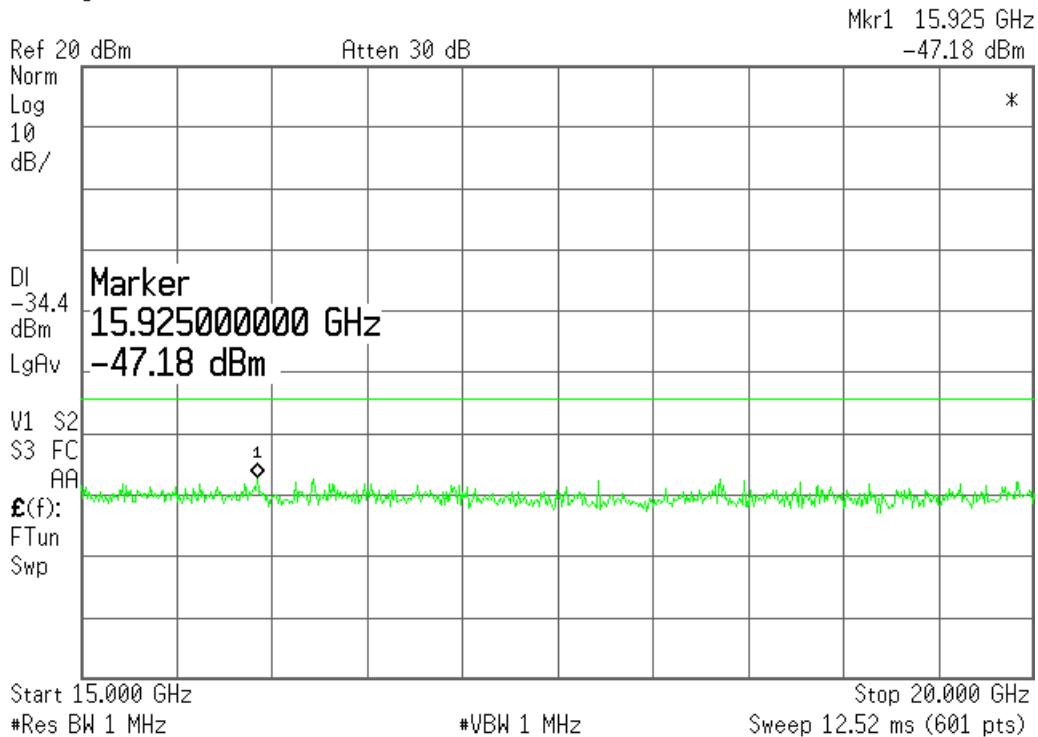
✱ Agilent 13:47:26 Jun 6, 2004



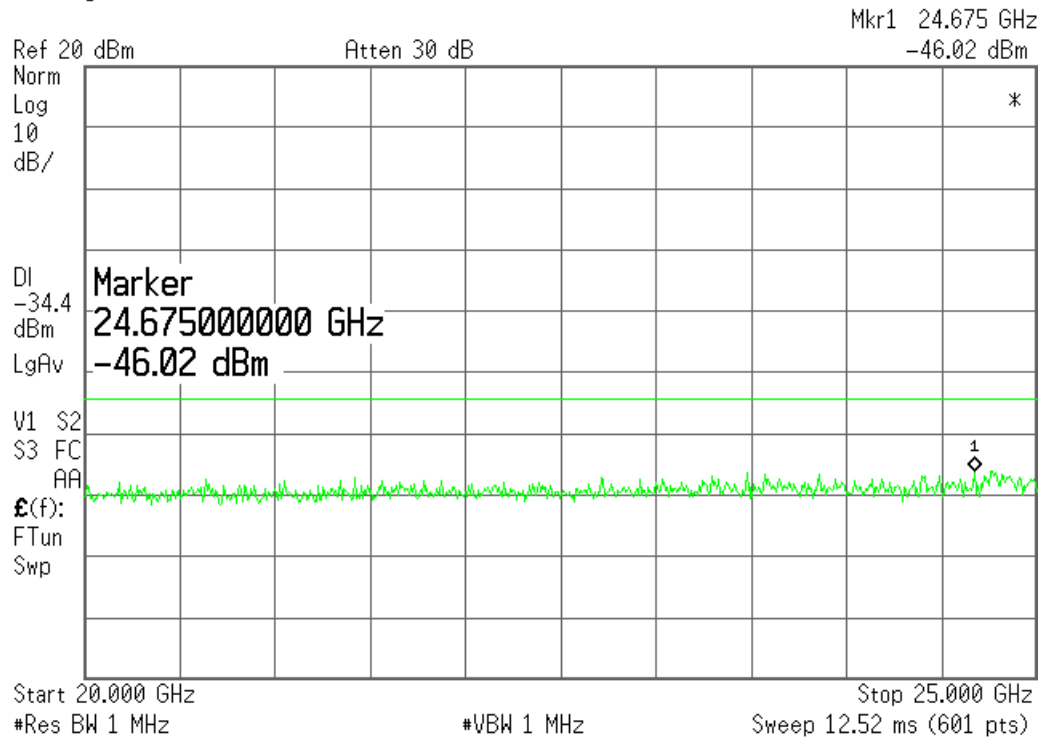
* Agilent 13:47:56 Jun 6, 2004



* Agilent 13:48:28 Jun 6, 2004

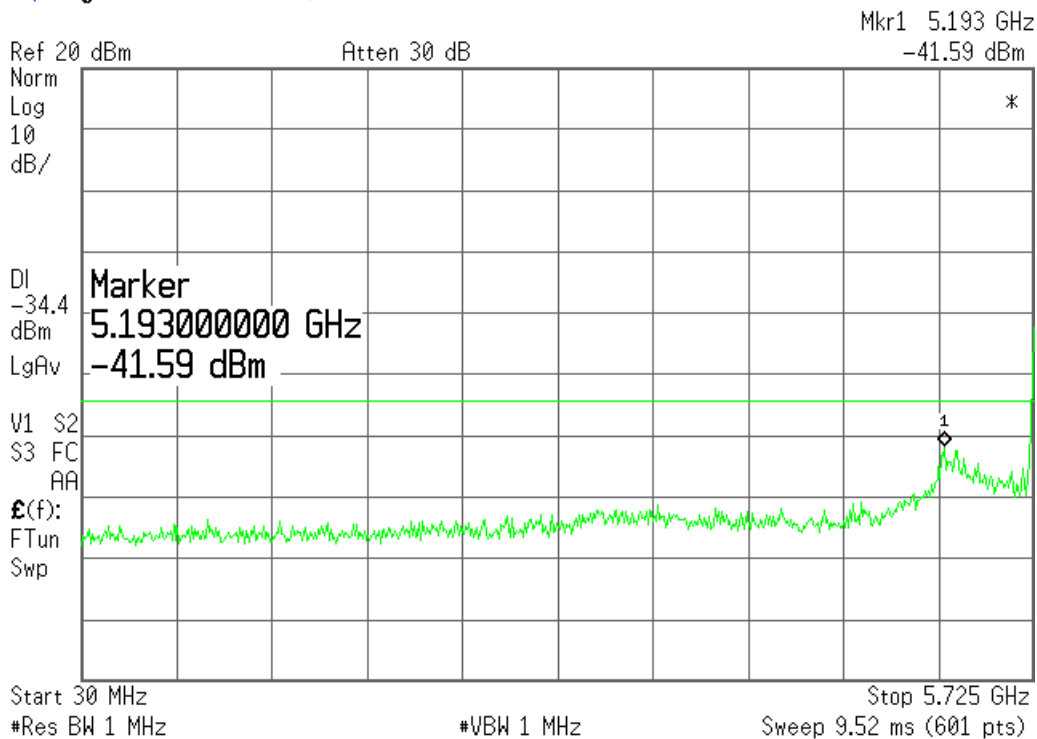


Agilent 13:49:00 Jun 6, 2004

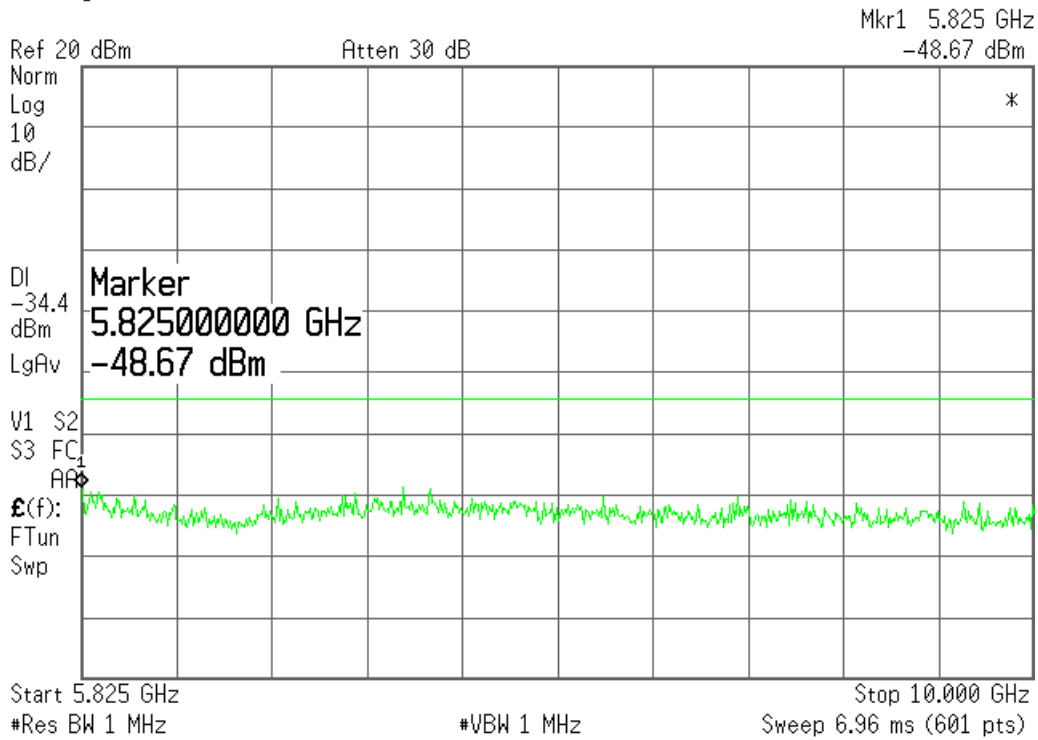


UUT Transmitting on 5745MHz

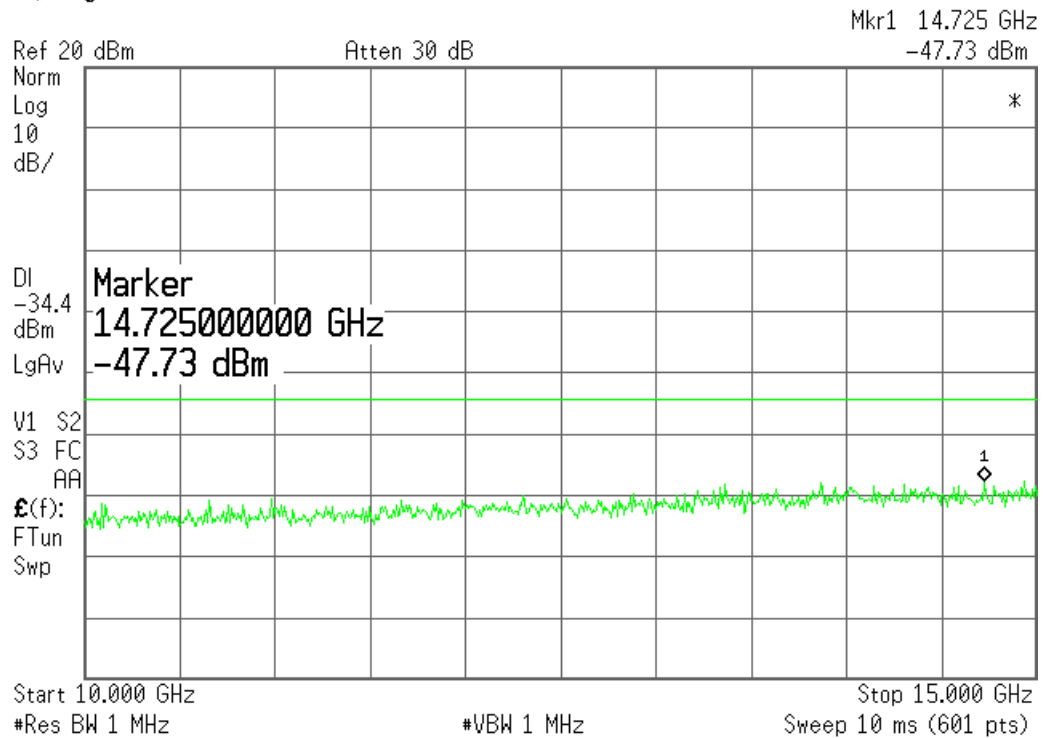
Agilent 13:52:51 Jun 6, 2004



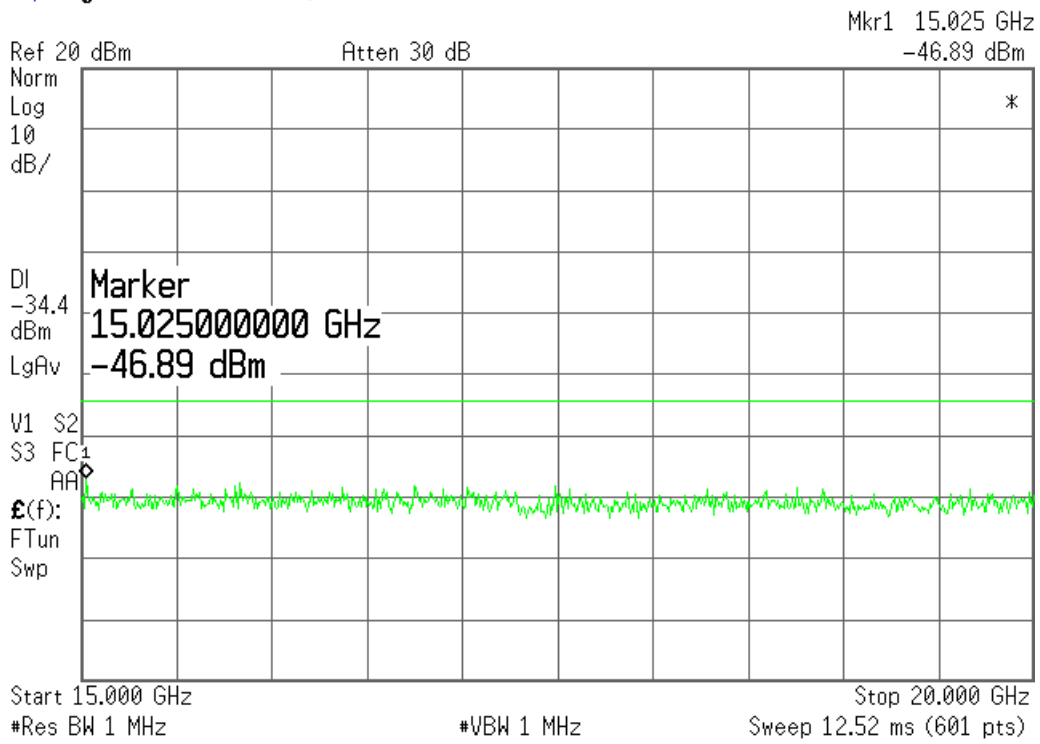
✱ Agilent 13:53:32 Jun 6, 2004



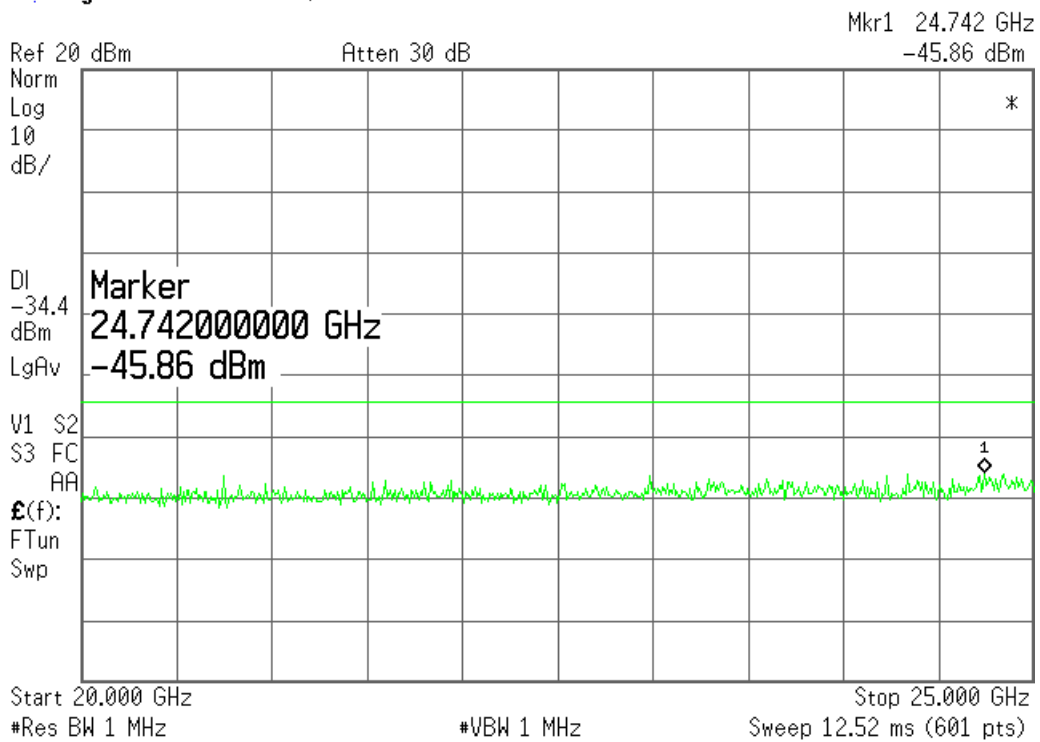
✱ Agilent 13:54:00 Jun 6, 2004



✱ Agilent 13:54:52 Jun 6, 2004

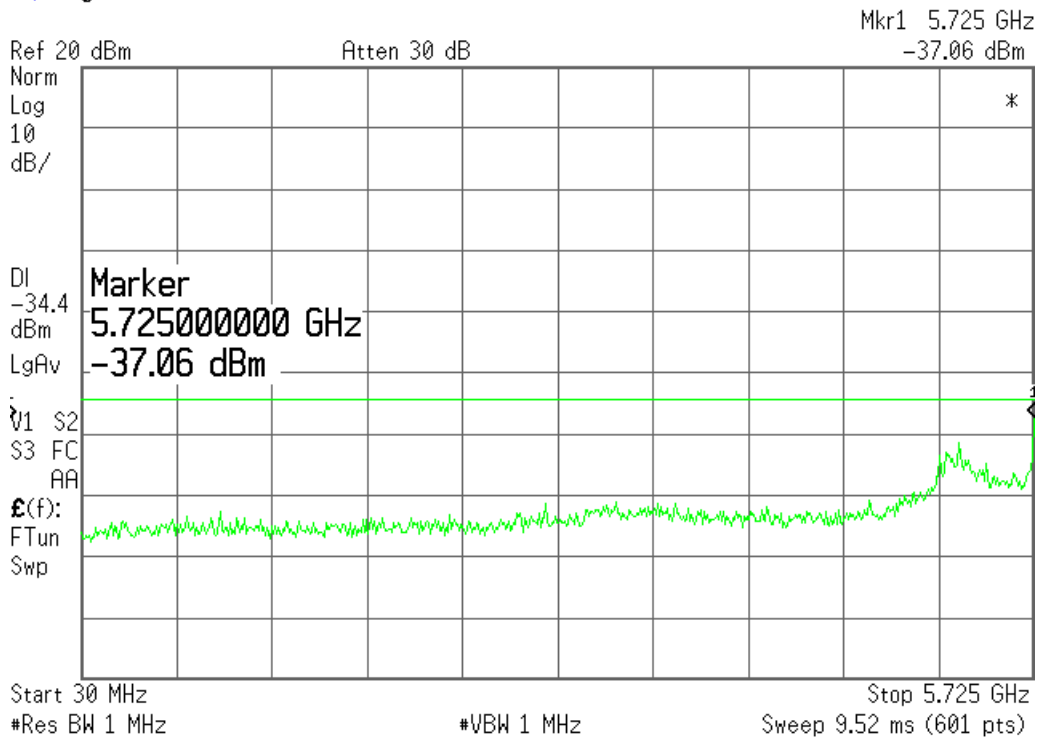


✱ Agilent 13:55:26 Jun 6, 2004

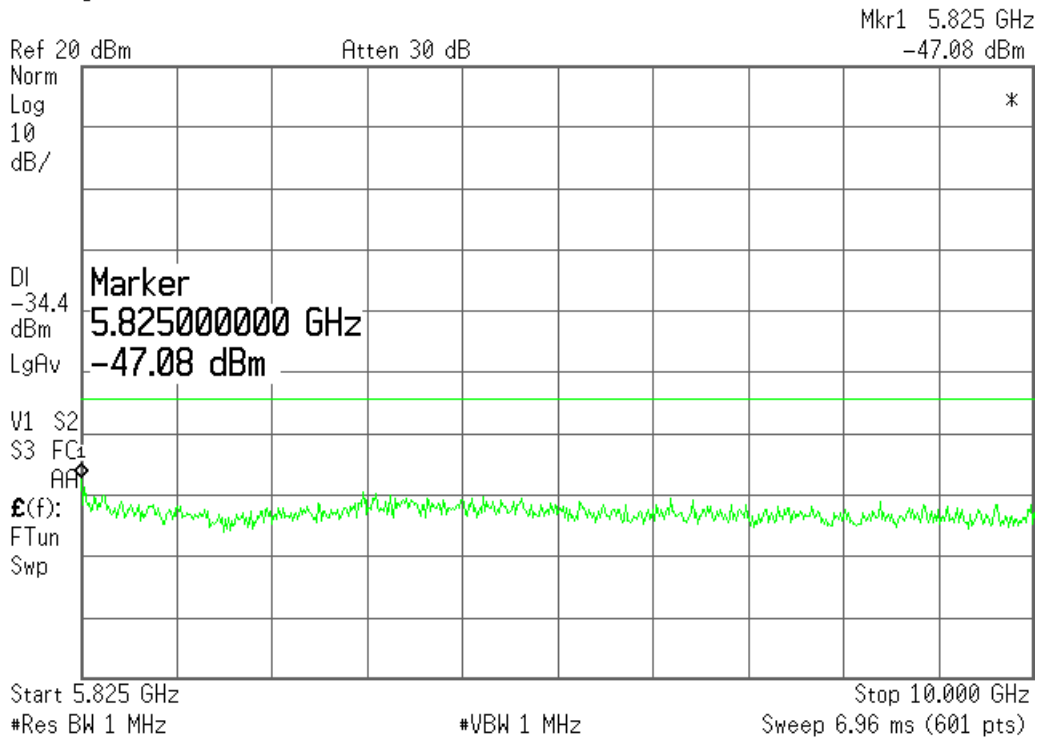


UUT Transmitting on 5765MHz

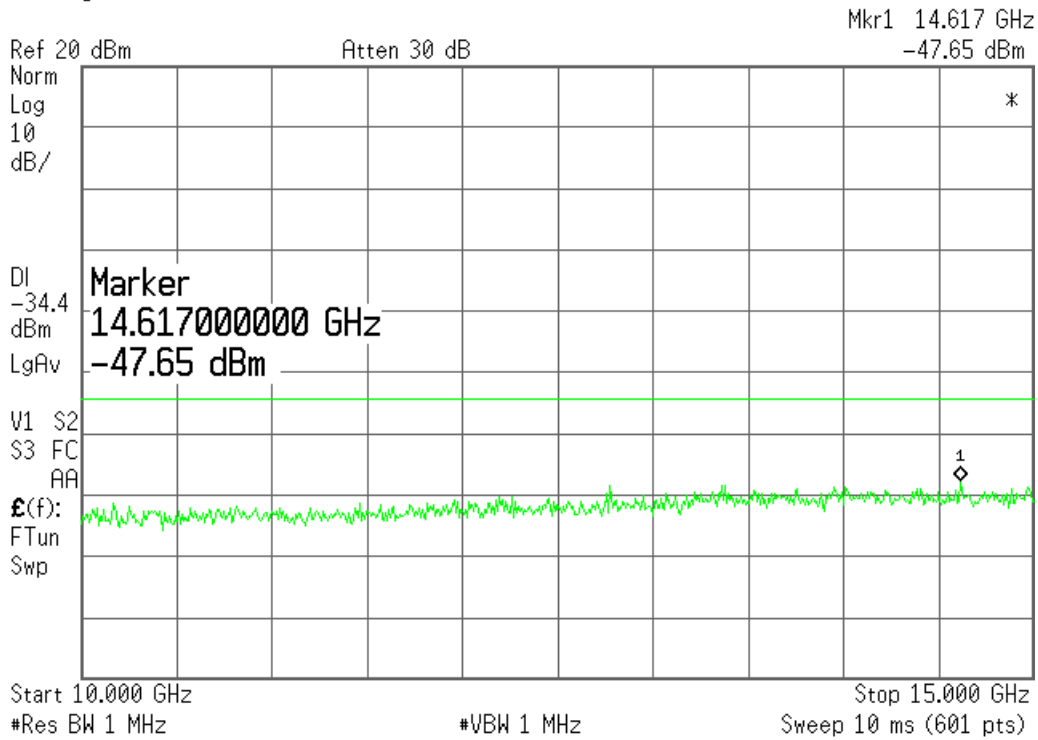
* Agilent 13:56:32 Jun 6, 2004



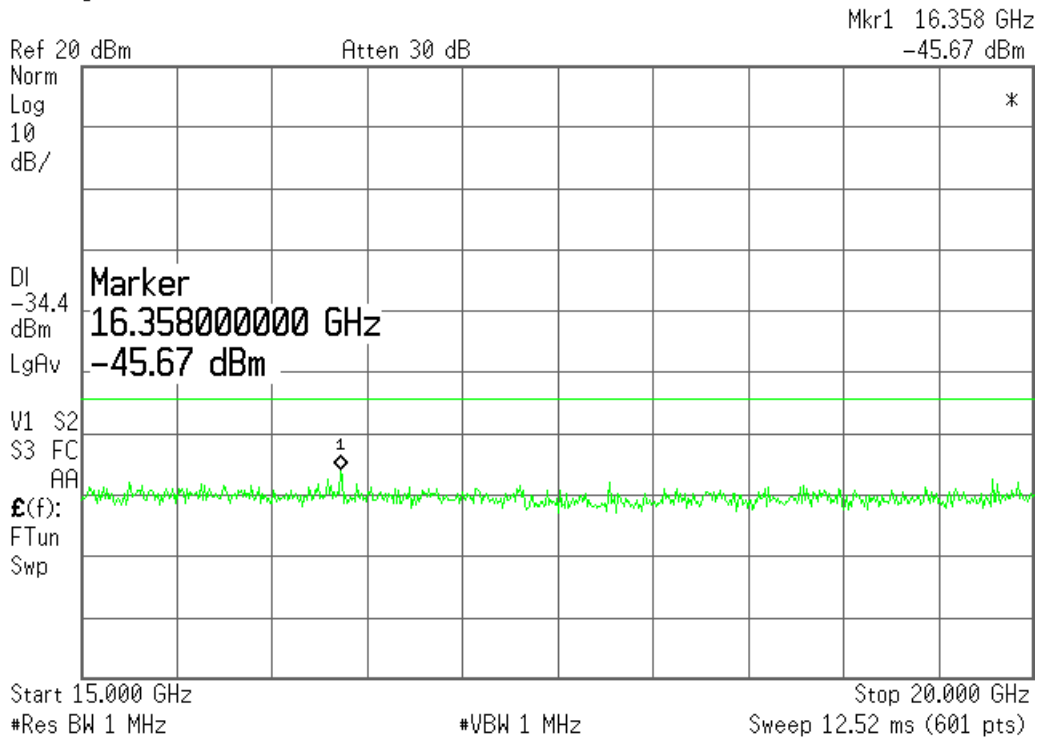
* Agilent 13:56:58 Jun 6, 2004



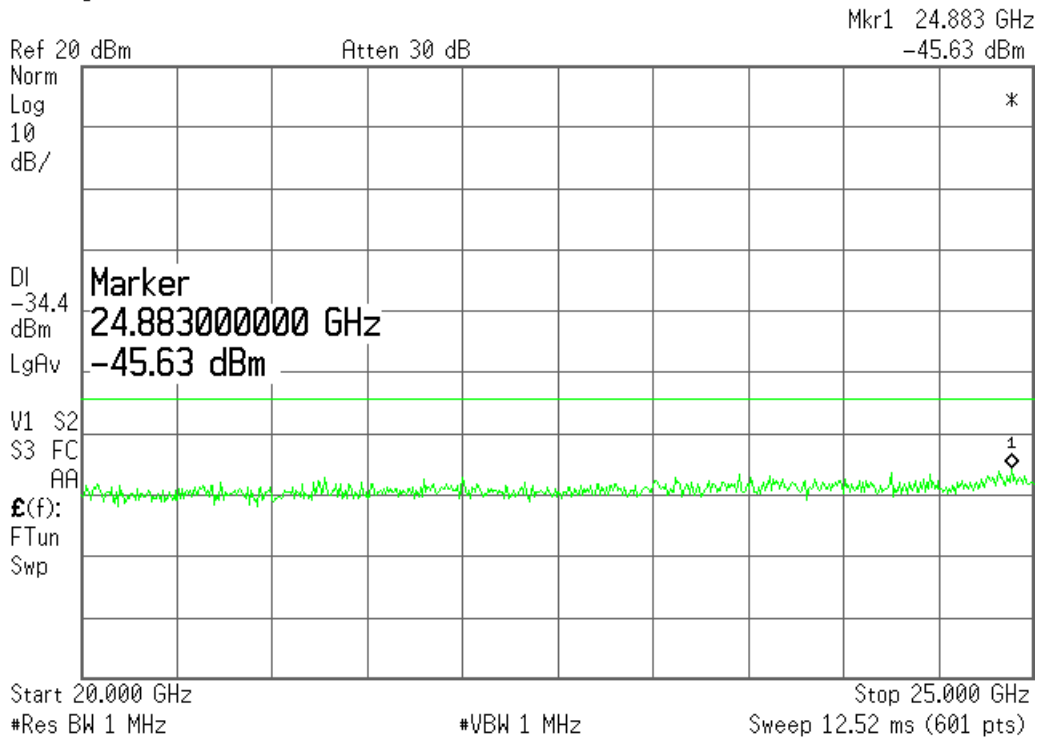
✱ Agilent 13:57:22 Jun 6, 2004



✱ Agilent 13:57:51 Jun 6, 2004

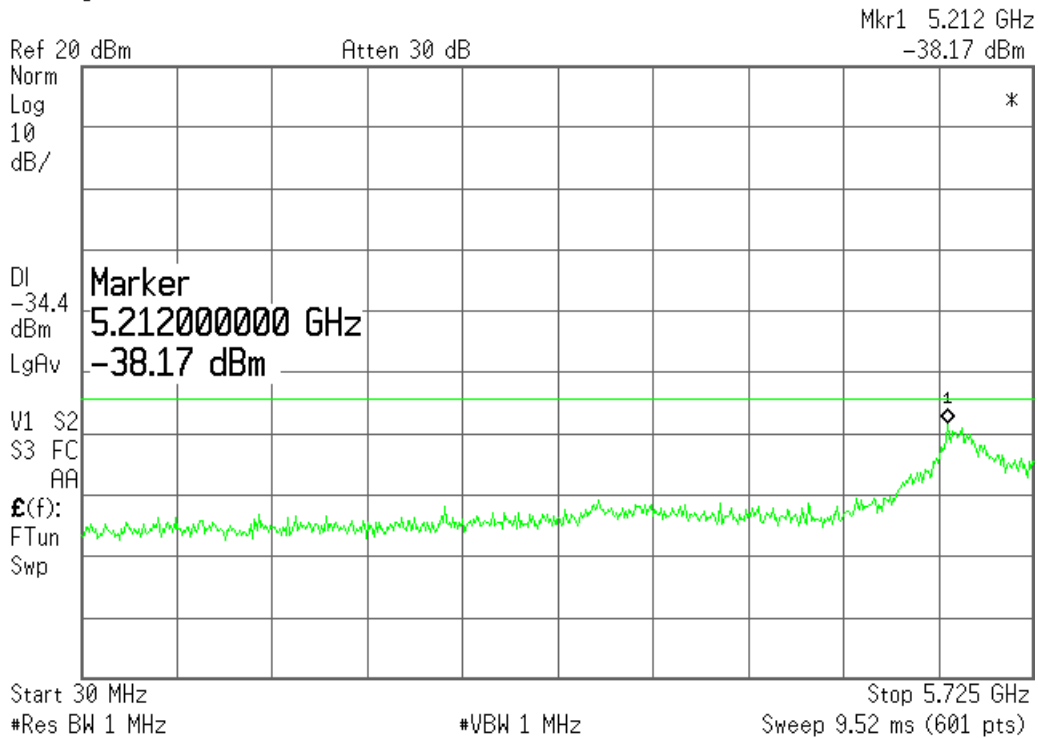


* Agilent 13:58:42 Jun 6, 2004

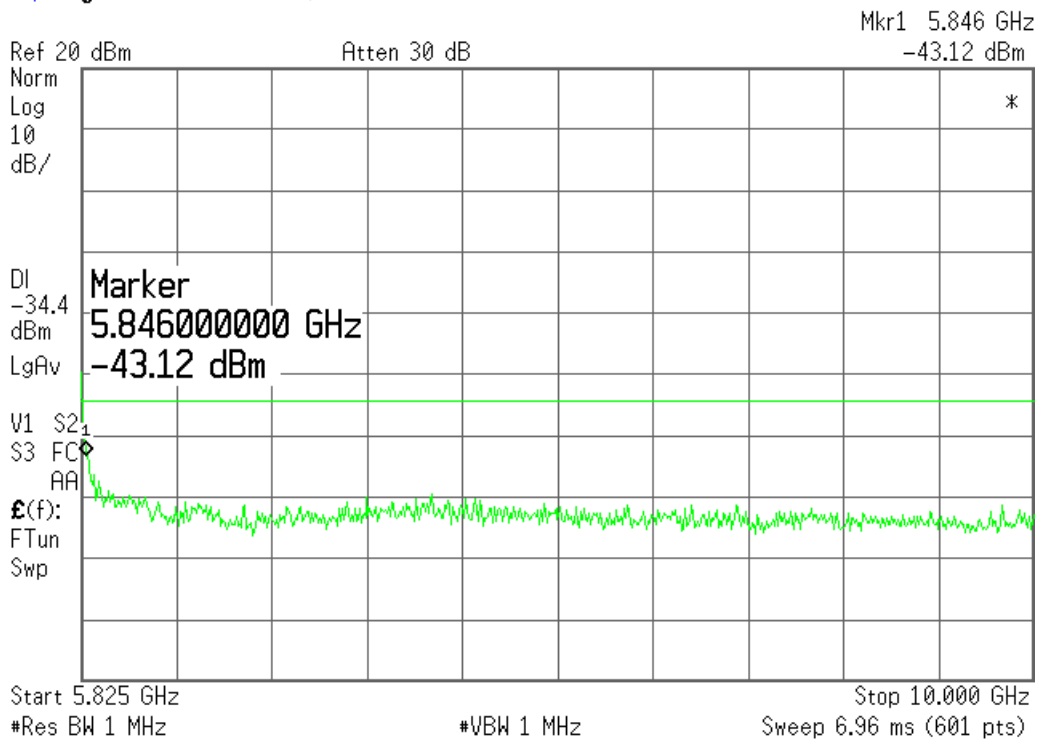


UUT Transmitting on 5805MHz

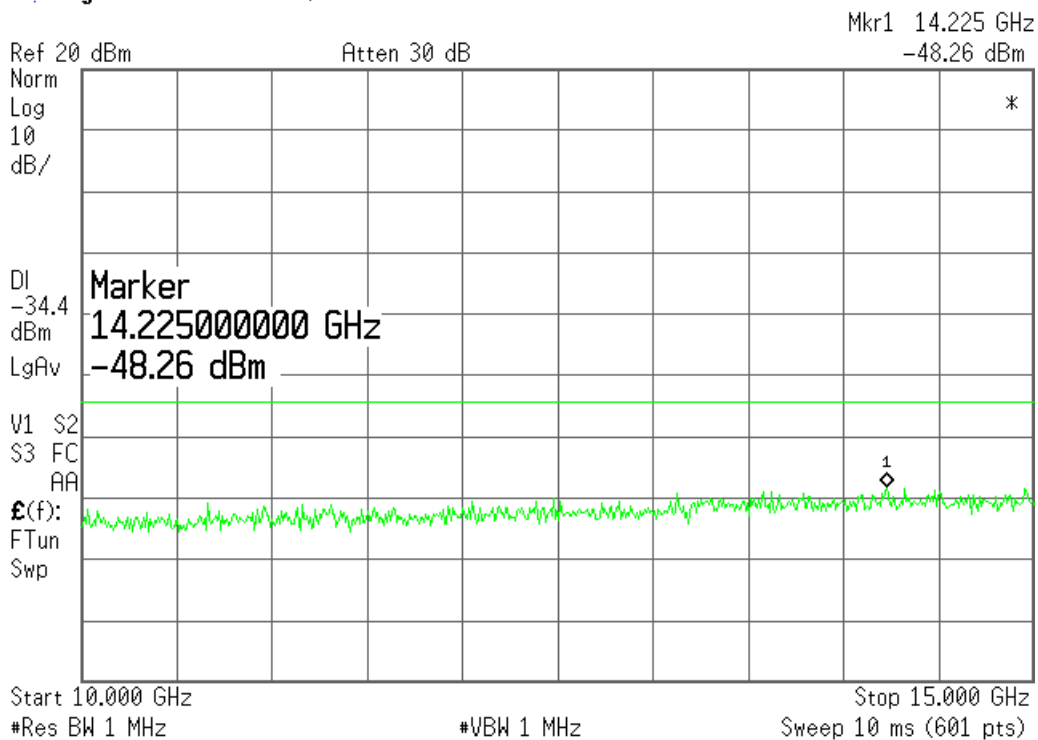
* Agilent 14:00:46 Jun 6, 2004



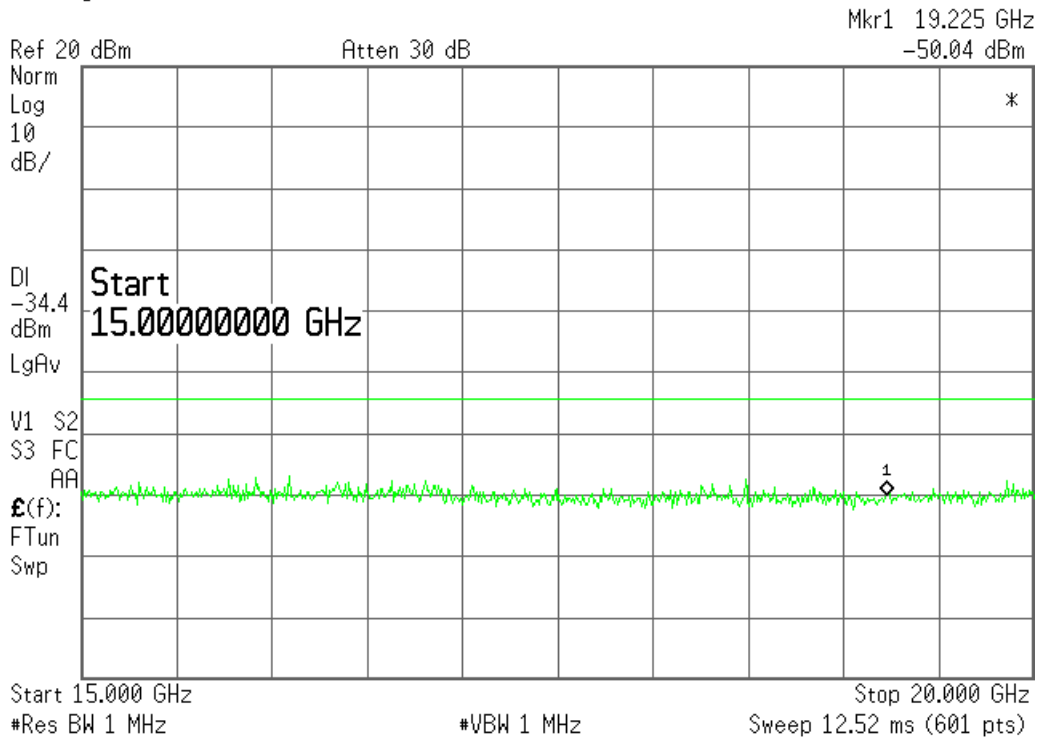
* Agilent 14:14:22 Jun 6, 2004



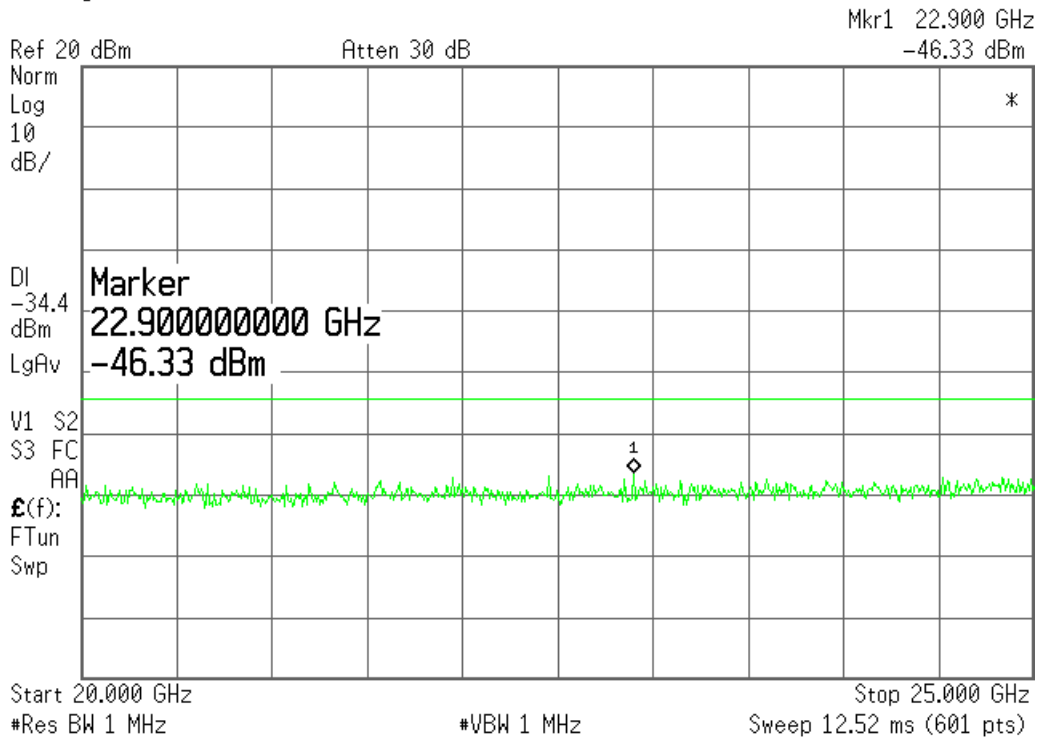
* Agilent 14:14:54 Jun 6, 2004



✱ Agilent 14:15:23 Jun 6, 2004



✱ Agilent 14:15:48 Jun 6, 2004



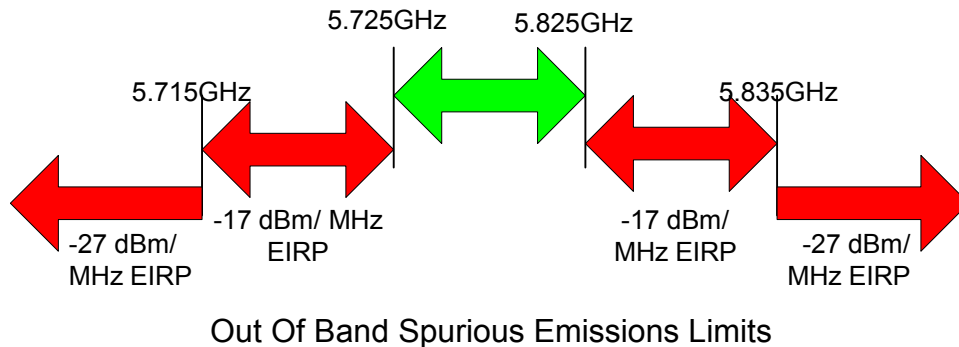
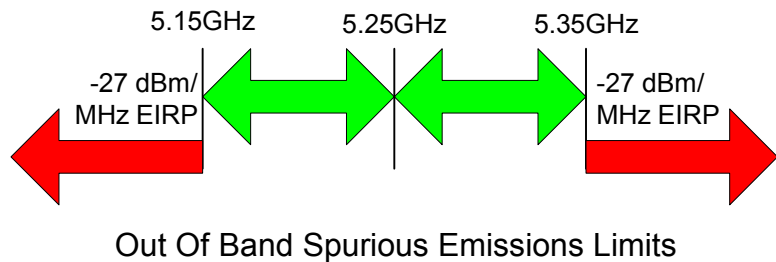
5.15 - 5.35 GHZ & 5.725 – 5.825 GHz Bandedge**Specification**

FCC Specifications: Paragraphs 15.407(b)(3)

Procedure:

For signals in the bands immediately above and below the 5.15 - 5.35GHz and 5.725 - 5.825 GHz band, conducted measurements were made at the external antenna connector. The test was configured as shown in the Conducted RF test setup. The UUT was configured to transmit continuous random data packets on the standard channel closest to the band edge being examined. The UUT was configured to the appropriate power setting depending on the test channel.

Since the specification is in EIRP, the appropriate specification limit was adjusted account for the maximum allowable antenna gain. The band edges and their appropriate limits (unadjusted for antenna gain) are shown below.

**5.15 - 5.35 GHZ & 5.725 – 5.825 GHz Bandedge Results:**

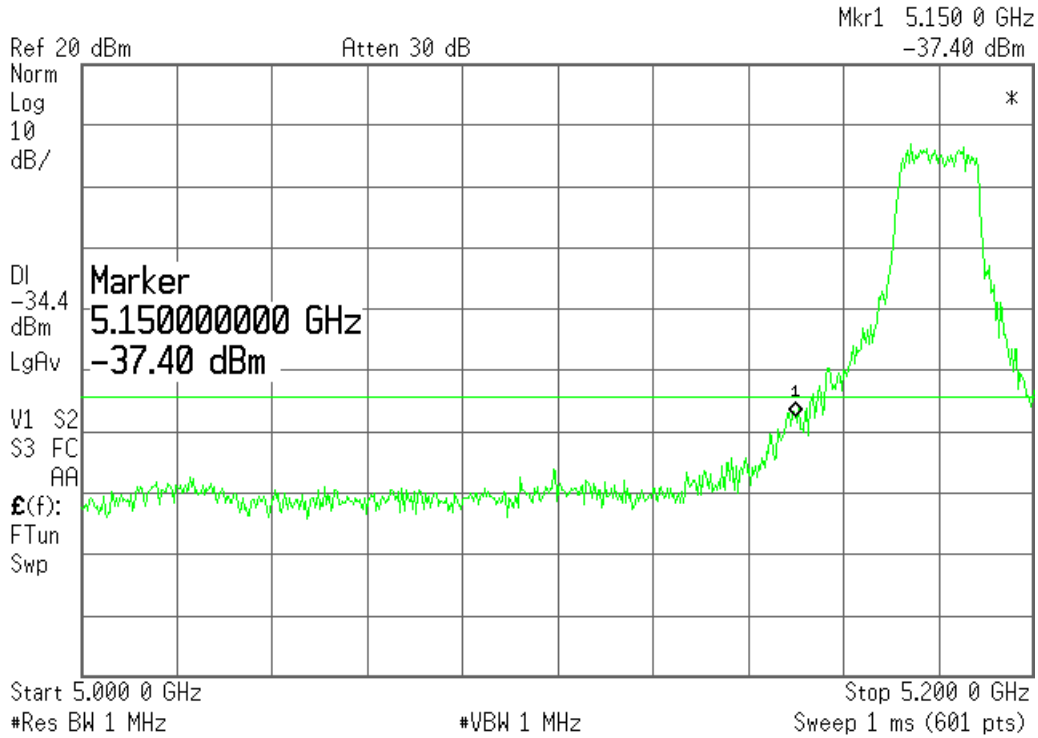
UNII band edge emissions summary. The adjusted conducted limit reflects a maximum allowable antenna gain of 7.4 dBi. The measurements were made with RBW = 1MHz, VBW = 100kHz, video averaging on.

Plots of the out of band emissions at the band edges are shown on the following page.

Transmit Frequency (MHz)	Frequency Range	Unadjusted Radiated Limit -dBm/MHz EIRP	Adjusted Conducted Limit -dBm/MHz	Measured Level at Band Edge (dBm)	Delta dB Below Limit
5180	F < 5.15 GHz	-27	-34.4	-37.40	3.00
5320	F > 5.35 GHz	-27	-34.4	-34.87	0.47
5745	F < 5.715 GHz	-27	-34.4	-39.15	4.75
5745	5.715 - 5.725 GHz	-17	-24.4	-28.13	3.73
5805	5.825 - 5.835 GHz	-17	-24.4	-30.00	5.60
5805	F > 5.835	-27	-34.4	-38.89	4.49

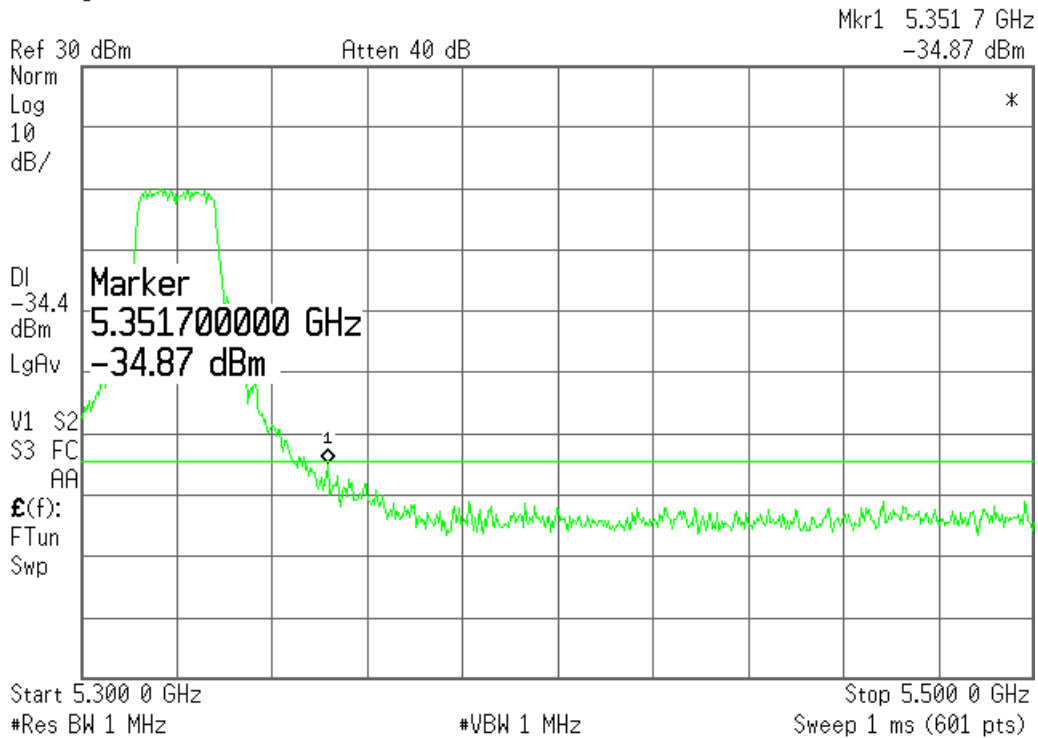
5.15 GHz bandedge

* Agilent 14:29:23 Jun 6, 2004



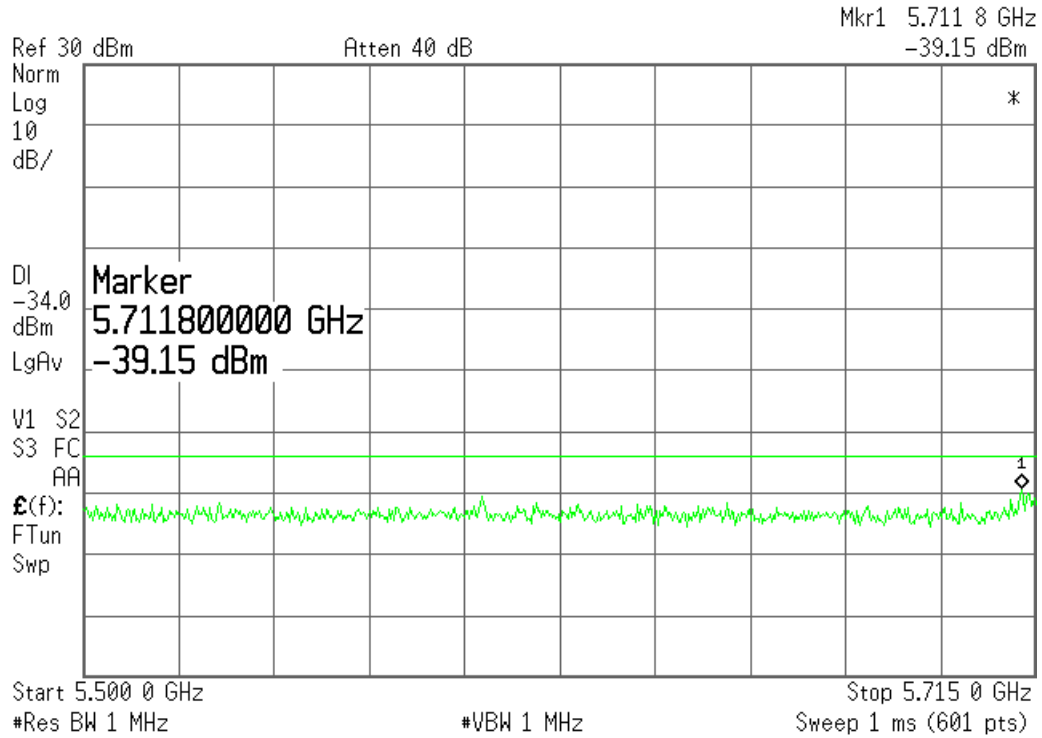
5.35 GHz bandedge

* Agilent 14:33:06 Jun 6, 2004

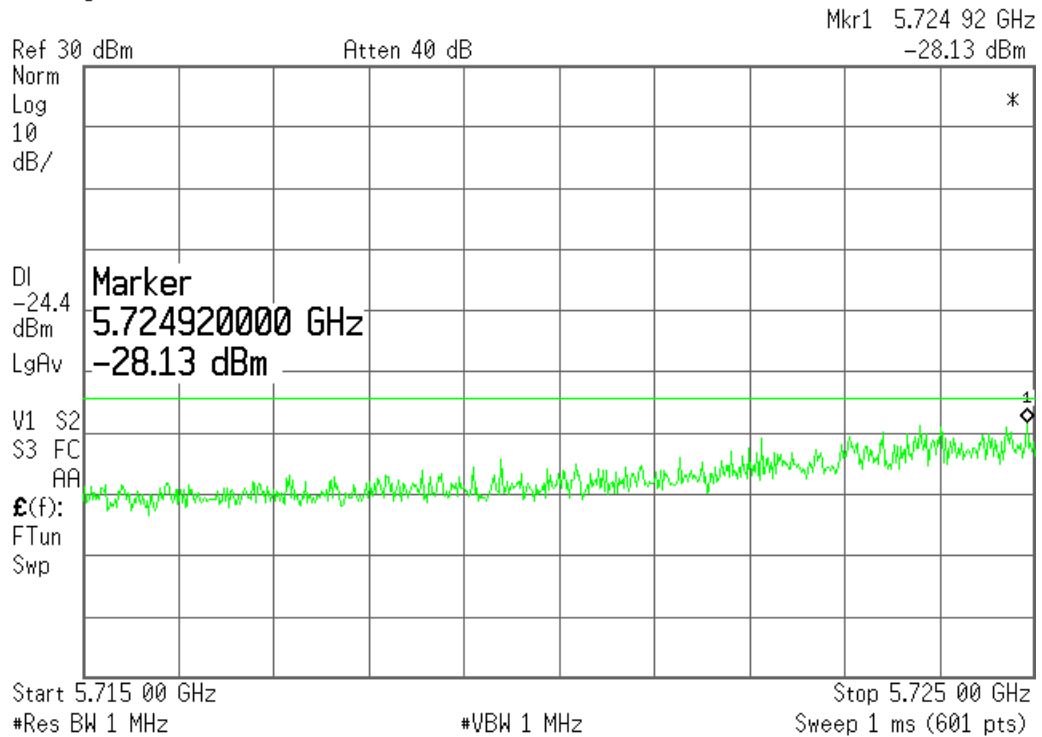


5.725 GHz bandedge

* Agilent 14:42:23 Jun 6, 2004

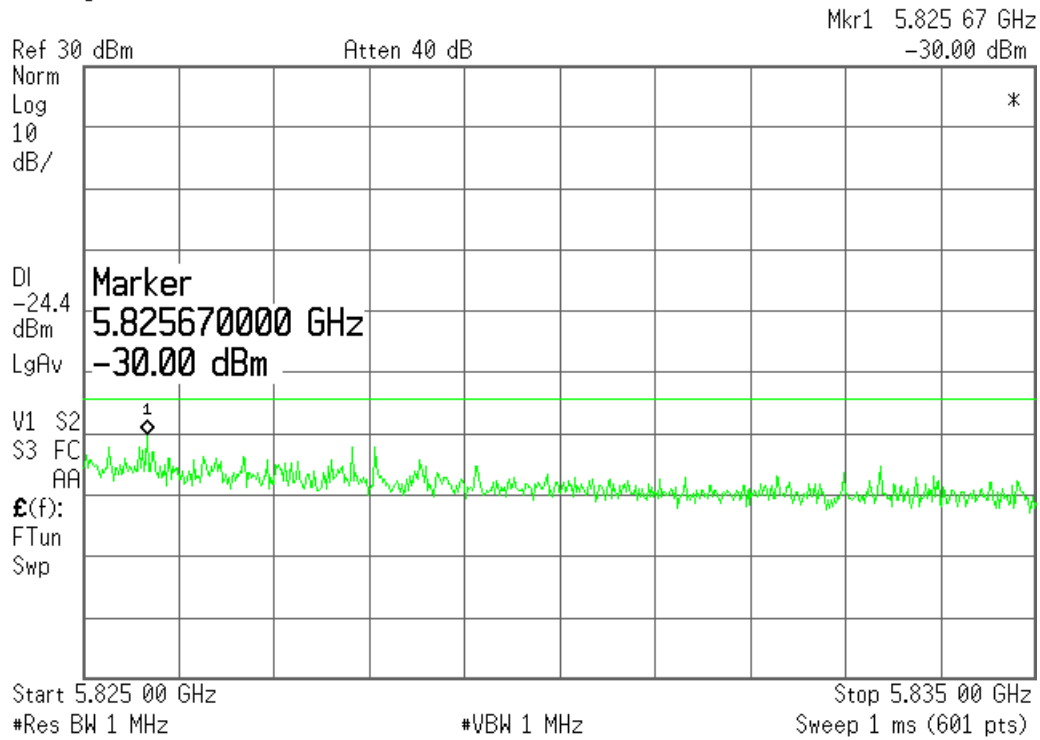


* Agilent 14:37:48 Jun 6, 2004

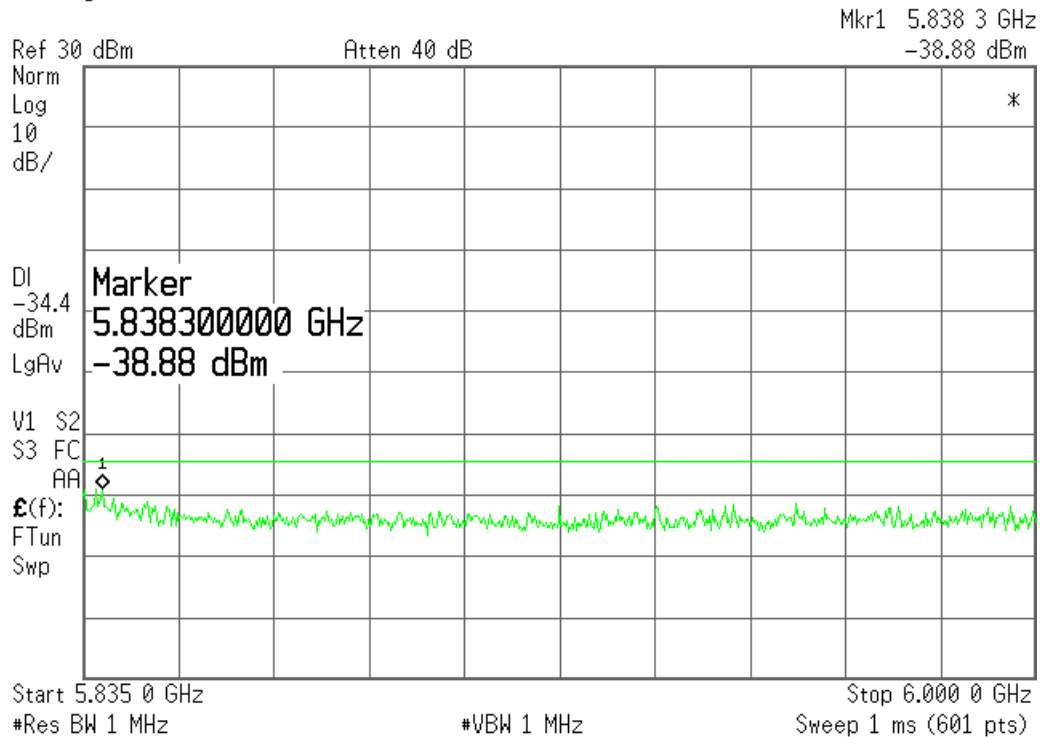


5.825 GHz bandedge

* Agilent 14:44:06 Jun 6, 2004



* Agilent 14:45:13 Jun 6, 2004



Peak Excursion**Specification**

FCC Specifications: Paragraphs 15.407(a)(5)

IC Specification: 6.2.2.(O)

Procedure:

The test equipment was configured as shown in the RF Conducted bench setup.

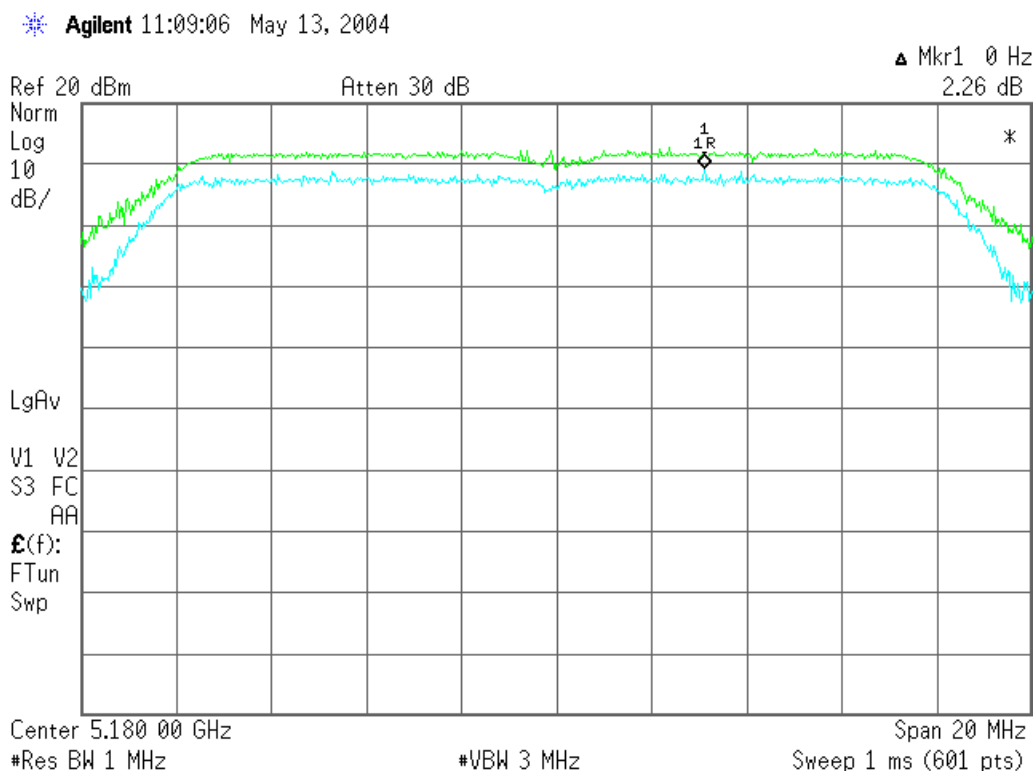
The analyzer was set to an appropriate span to view the entire emission bandwidth. There were two traces made in order to determine the peak excursion. The following settings were used for the two traces.

Trace 1: RBW = 1 MHz, VBW = 3 MHz with peak detector and max-hold settings.

Trace 2: RBW = 1 MHz. Set VBW = 300 kHz, set to Max Hold and allowed to settle for 60 seconds.

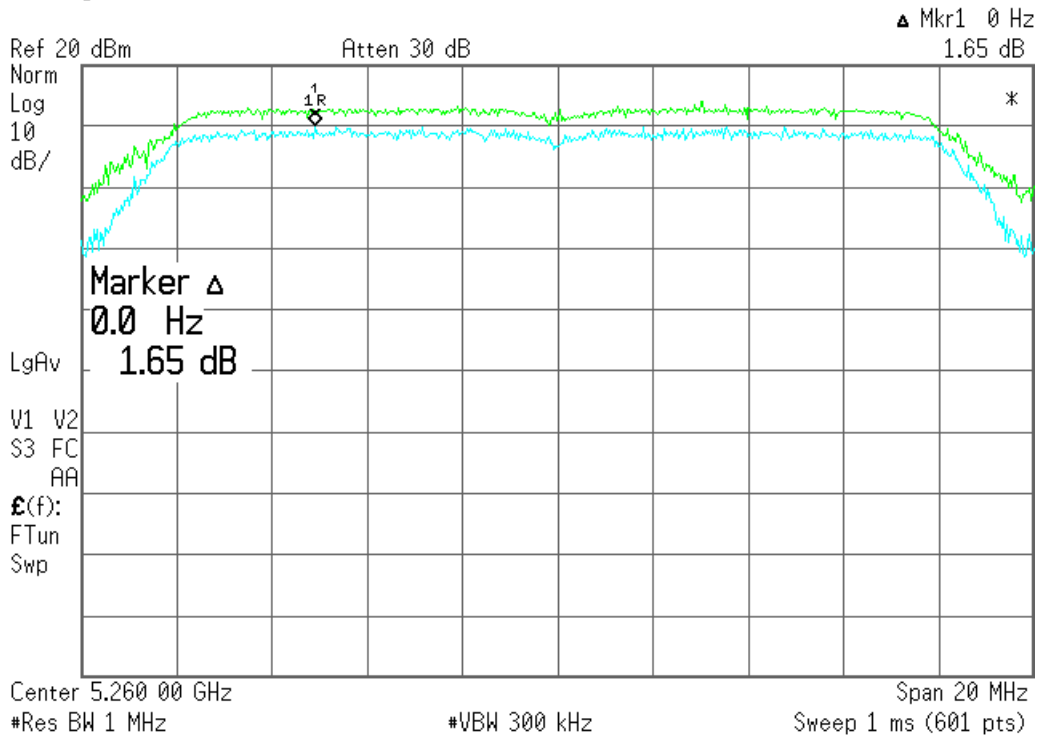
Peak Excursion Summary Results:

Frequency (MHz)	Peak Excursion (dB)	FCC Limit (dB)	Delta (dB)
5180	2.26	13	10.74
5260	1.65	13	11.35
5320	0.82	13	12.18
5745	0.82	13	12.18
5765	1.27	13	11.73
5805	0.68	13	12.32

Peak Excursion: 5180 MHz

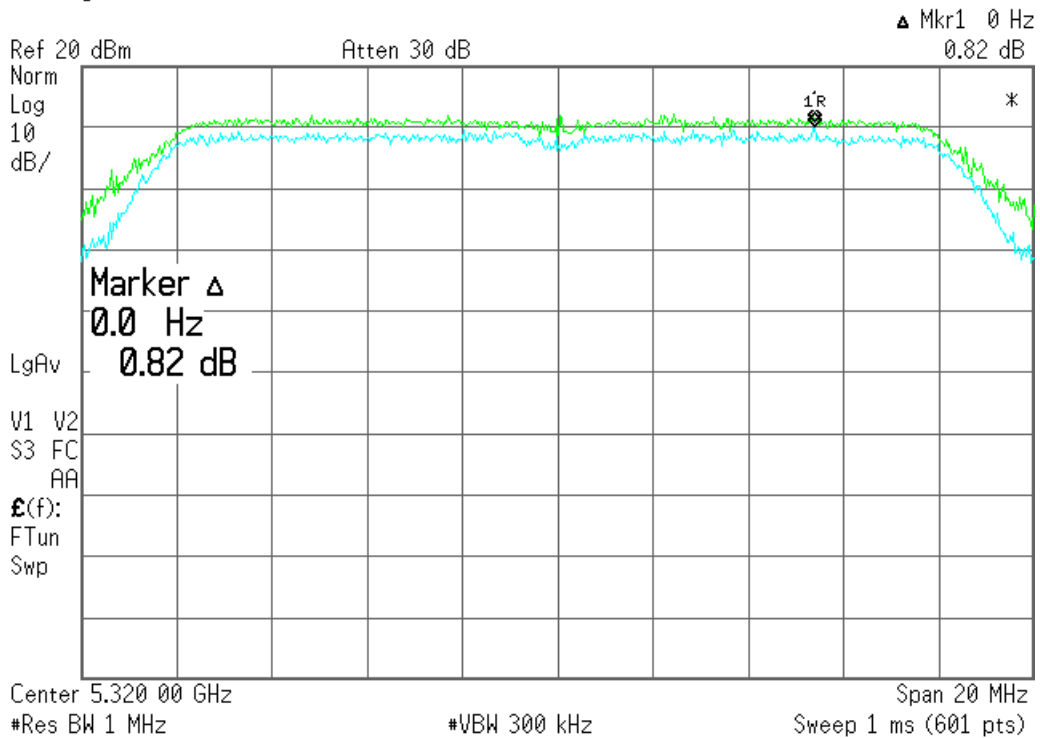
Peak Excursion: 5260 MHz

Agilent 11:13:10 May 13, 2004



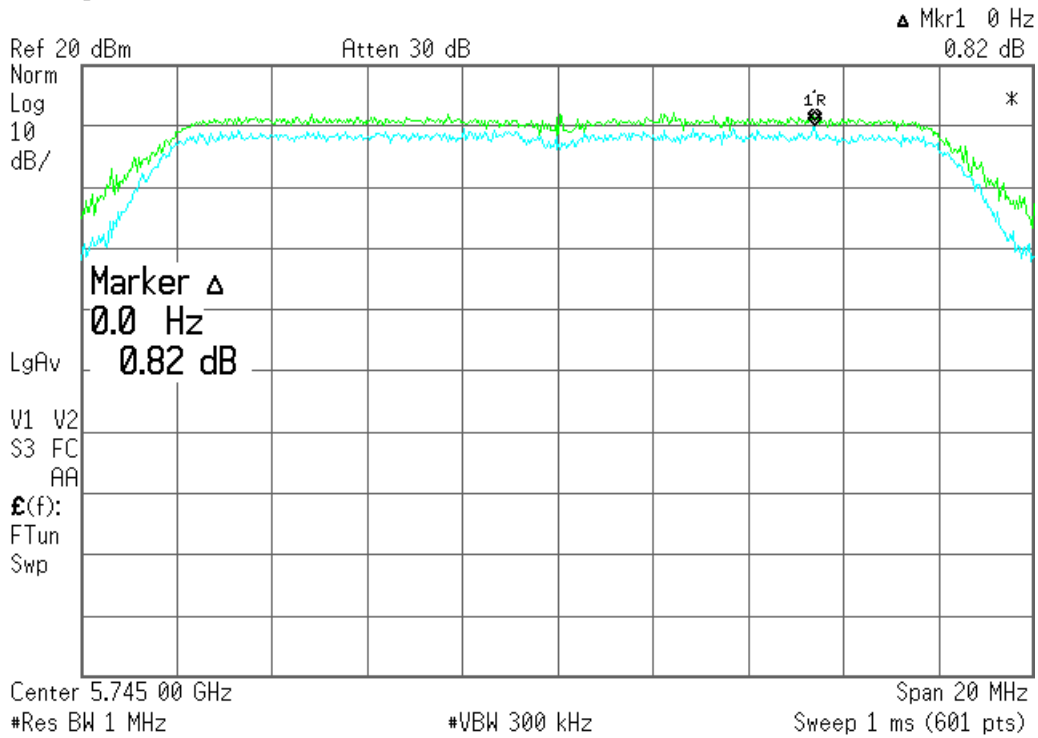
Peak Excursion: 5320 MHz

Agilent 11:15:11 May 13, 2004



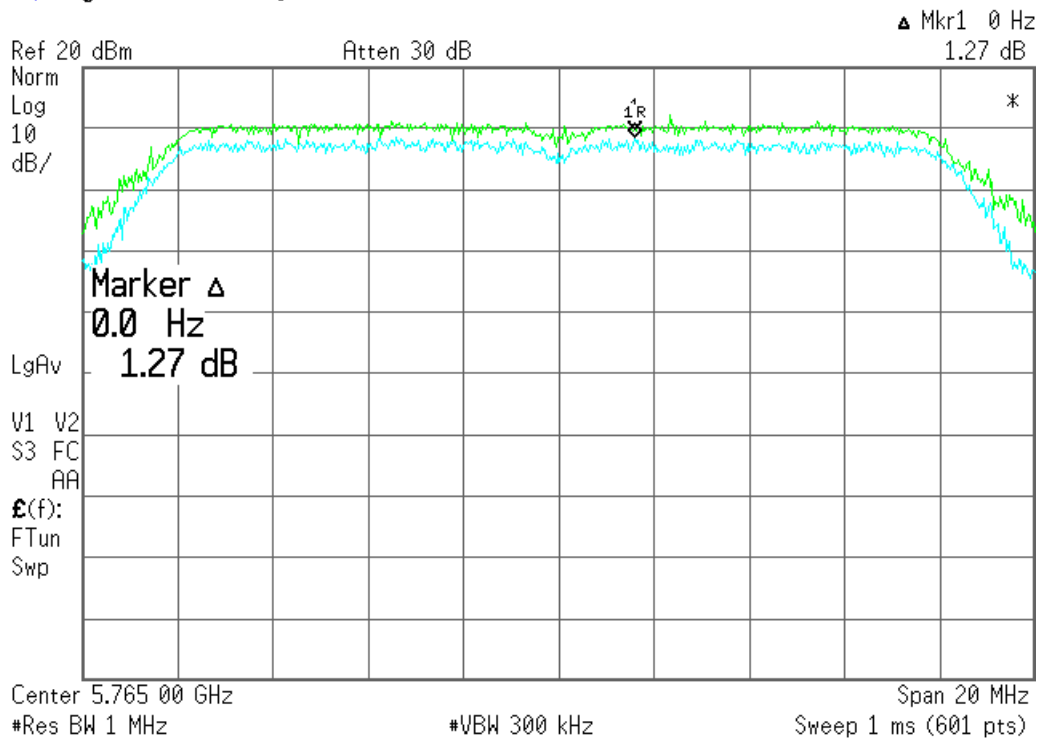
Peak Excursion: 5745 MHz

Agilent 11:31:46 May 13, 2004



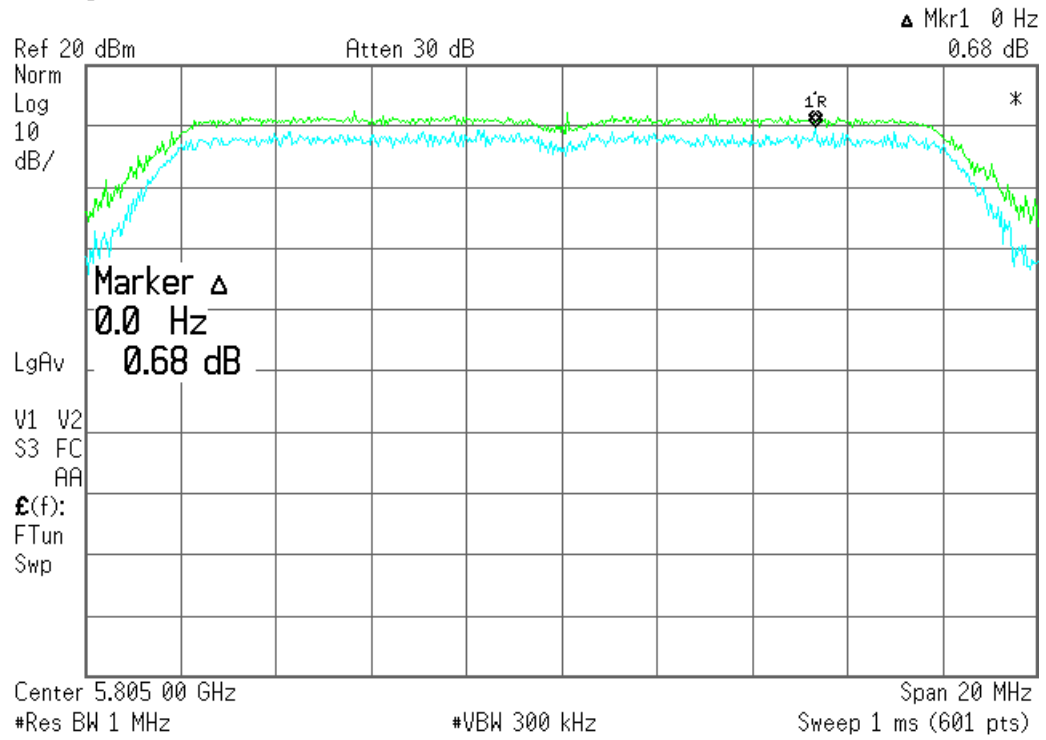
Peak Excursion: 5765 MHz

Agilent 11:33:15 May 13, 2004



Peak Excursion: 5805 MHz

Agilent 11:34:47 May 13, 2004



Radiated Emissions in Restricted bands

Specification:

FCC Specification: Paragraph 15.407(b)(6)

IC Specification: 6.2.2.(q1)i 6.2.2.(q1)ii 6.2.2.(q1) iii

Procedure:

This test was conducted on a 10-meter semi anechoic chamber at Elliott Laboratories. The unit was placed on a rotating wooden table 80cm above the ground plane. A Horn antenna(s) were secured to a mast 3 meters away. The unit was tested at a low, mid and high channel within the 5.15-5.35GHz and the 5.725 - 5.825GHz bands. The UUT was configured to transmit random data. The transmit power was set to the settings outlined in the power setting table in this report. The test equipment was configured as shown below.

The band from 1 to 40 GHz was scanned (40 GHz is the limit of the available test equipment). A high pass filter prior to the pre-amplifier was required to prevent the signal level of the fundamental frequency from overloading the front end of the spectrum analyzer and creating harmonics within the analyzer.

The EUT was rotated 360 degrees and the height of the antenna adjusted from 1 to 4 meters above the ground plane to determine the maximum level of the emission. The level of the harmonic emission was measured in two modes, "Peak" and "Average".

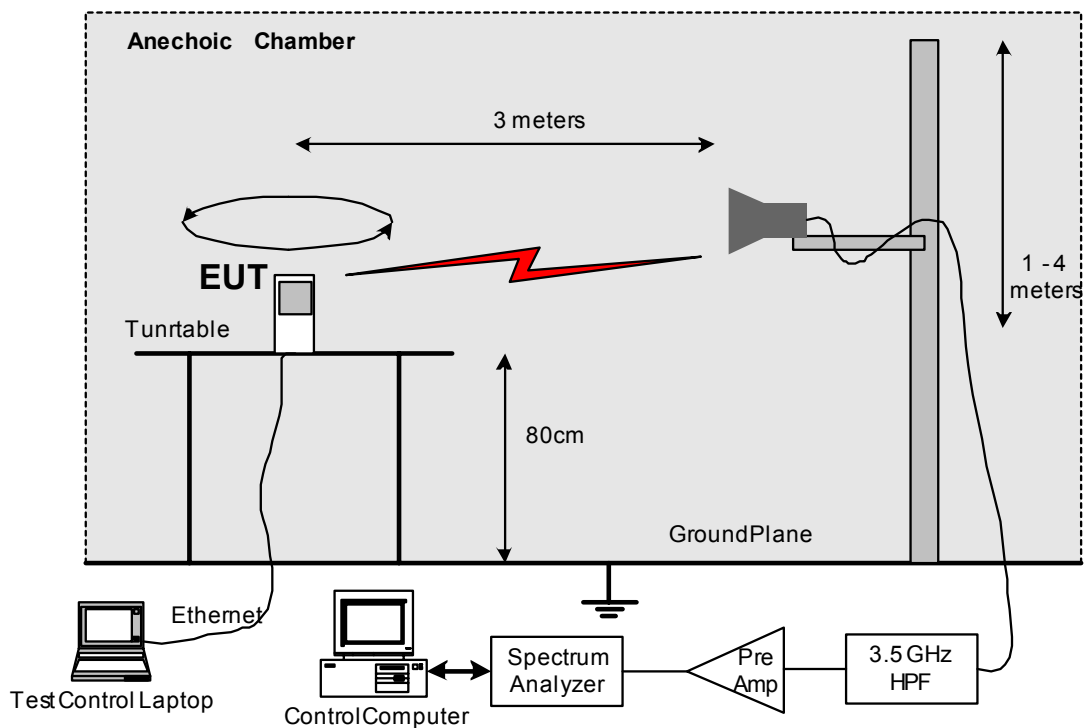
The maximum spectrum analyzer reading was captured by the automated test software where correction factors (antenna factor, cable loss, pre-amplifier gain, HPF loss...) were then applied to obtain a final corrected measurement.

Fund	2	3	4	5	6	7	8	9	10
5180	10360	15540	20720	25900	31080	36260	41440	46620	51800
5260	10520	15780	21040	26300	31560	36820	42080	47340	52600
5320	10640	15960	21280	26600	31920	37240	42560	47880	53200
5745	11490	17235	22980	28725	34470	40215	45960	51705	57450
5765	11530	17295	23060	28825	34590	40355	46120	51885	57650
5805	11610	17415	23220	29025	34830	40635	46440	52245	58050

15.407(b)(6) Harmonic test table

NOTE: RED indicates a harmonic that falls within a restricted band, the harmonics in gray are NOT in restricted bands.

Radiated Emissions in Restricted Bands Test Setup



Support Equipment

Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	Armada E 500	P31000T4X20DC12N2	Compaq	Laptop PS
Test Software	Atheros Radio Test		Atheros	

Test Conditions

Temperature	19.8 C	Humidity:	41%
ATM pressure	1020 mBar	Grounding:	None
Tested By	M. Faustino, Elliott Labs	Date of Test:	May 2004
Test Reference	FCC Part 15.205 IC Paragraph RSS210, 6.2.3 (c)		
Setup Method	ANSI C63.4		
Tested Range	1 GHz to 40 GHz		
Test Voltage	48 VDC		
Modifications	No modifications were made to the unit		

Radiated Emissions in Restricted Bands Test Results

There were some emissions detected during the test. The results are below. In cases where the emission was not within a restricted band the Out Of Band Emission limit is applied. No emissions above approximately the third harmonic (16 GHz) were detected. The band up to 40 GHz was examined.

Transmit Freq (MHz)	802.11 Mode	Emission Frequency (MHz)	Level dBmV/m	Pol V/H	15.209 / 15.407 Limit Margin		Detector Pk/QP/Avg	Azimuth Deg	Height Meters
5180	A	10378.59	36.0	V	54.0	18.0	AVG	165	1.0
5180	A	10378.59	47.9	V	74.0	26.1	PK	165	1.0
5260	A	15810.00	39.7	H	54.0	14.3	Peak	118	1.0
5260	A	10539.46	42.1	V	54.0	11.9	AVG	11	1.3
5260	A	10539.46	55.5	V	74.0	18.5	PK	11	1.3
5320	A	15980.00	40.3	H	54.0	13.7	Peak	115	1.0
5320	A	10661.29	31.0	H	54.0	23.0	AVG	203	1.3
5320	A	10661.29	43.6	H	74.0	30.4	PK	203	1.3
5745	A	11509.02	44.7	V	54.0	9.3	AVG	330	1.3
5745	A	11509.02	56.2	V	74.0	17.8	PK	330	1.3
5785	A	11589.11	44.5	V	54.0	9.5	AVG	174	1.0
5785	A	11589.11	56.3	V	74.0	17.7	PK	174	1.0
5805	A	11628.95	43.1	V	54.0	10.9	AVG	34	1.3
5805	A	11628.95	54.3	V	74.0	19.7	PK	34	1.3

Notes:

#2 Emission is within a restricted band.

Peak measurements: Resolution and Video BW: 1 MHz, 74 dBuV Limit

Average Measurements: Resolution BW: 1MHz and Video BW: 10 Hz, 54 dBuV Limit

Peak measurements: 74 dBuV Limit

Average Measurements: 54 dBuV Limit

#3 Emission is NOT within a restricted band.

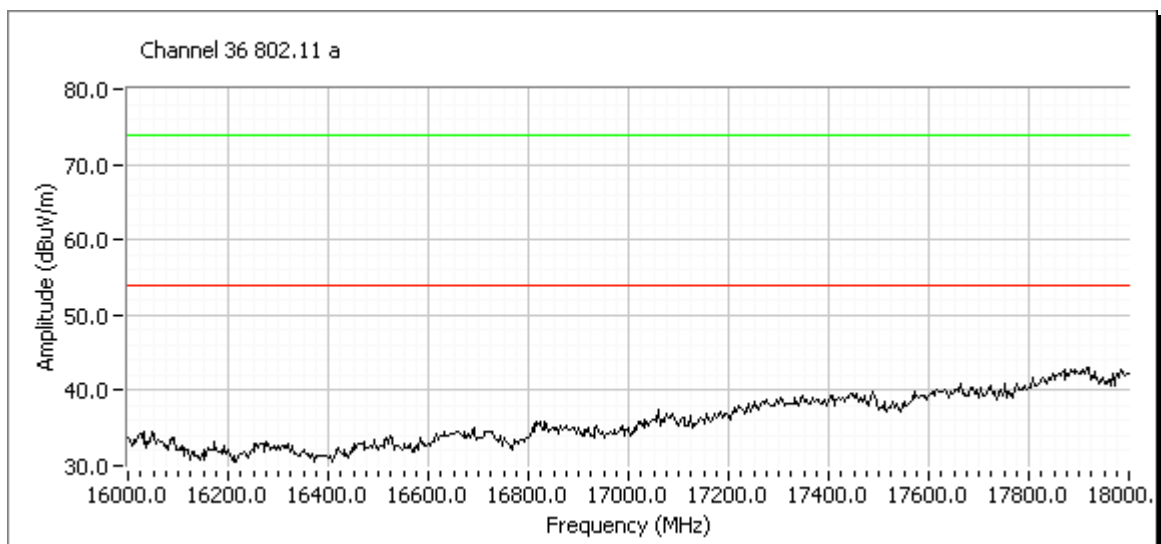
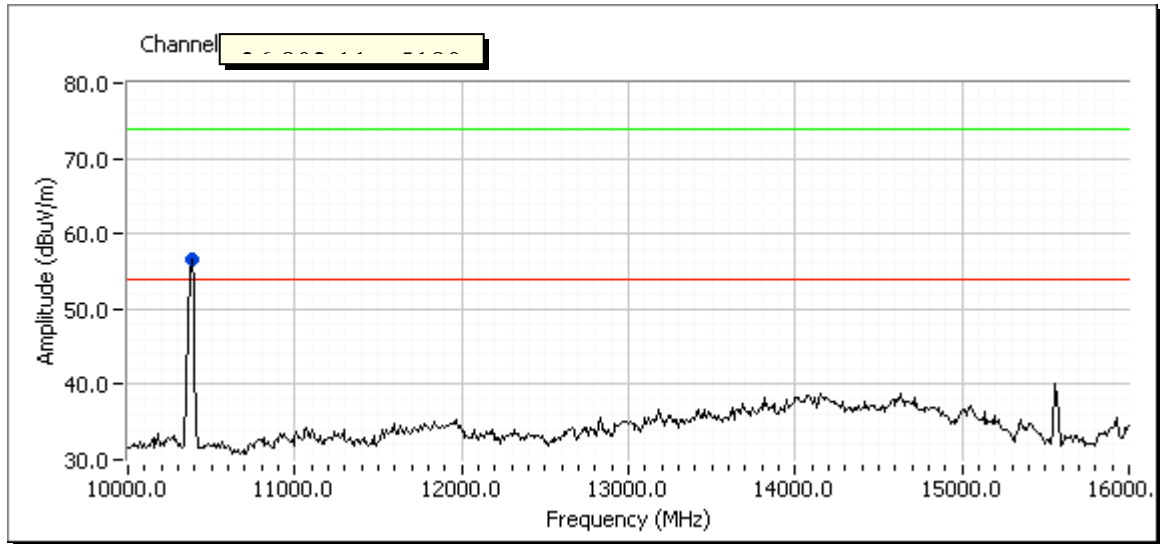
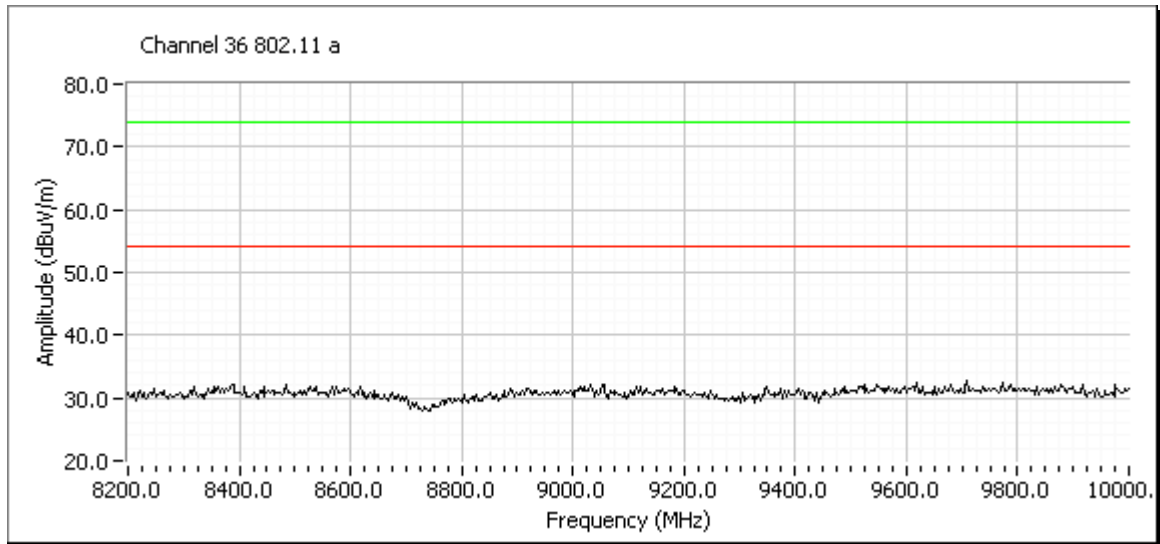
Measurement settings: Resolution BW = 1MHz and VBW = 3MHz.

Video averaging on (100 samples).

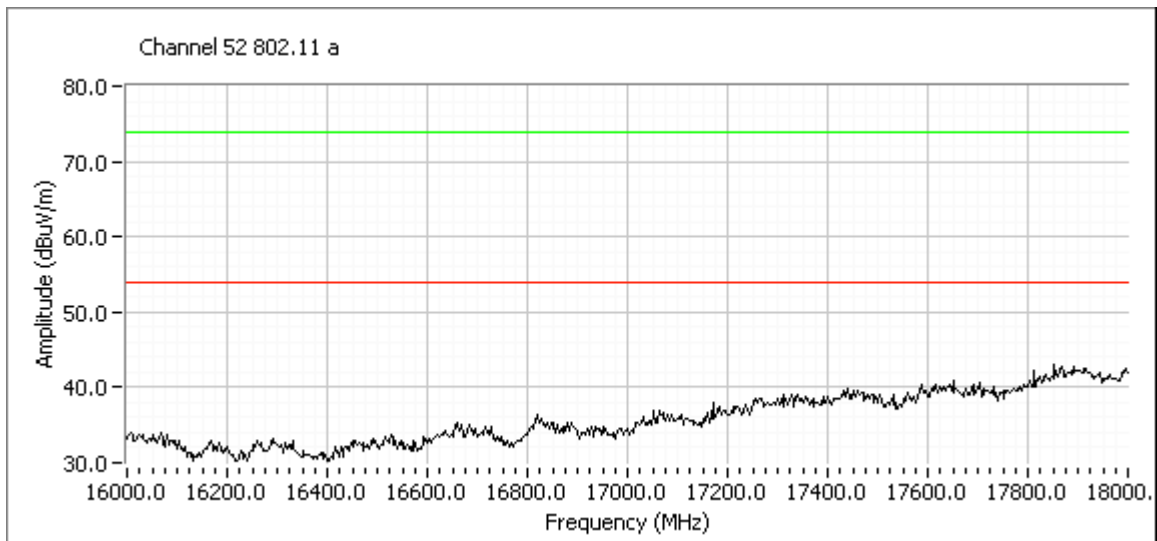
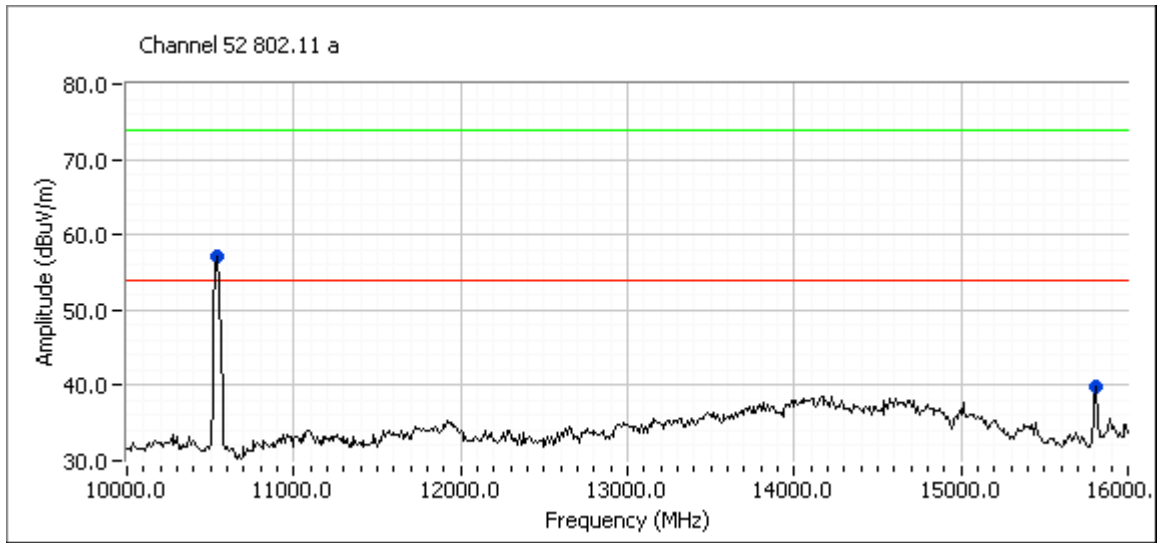
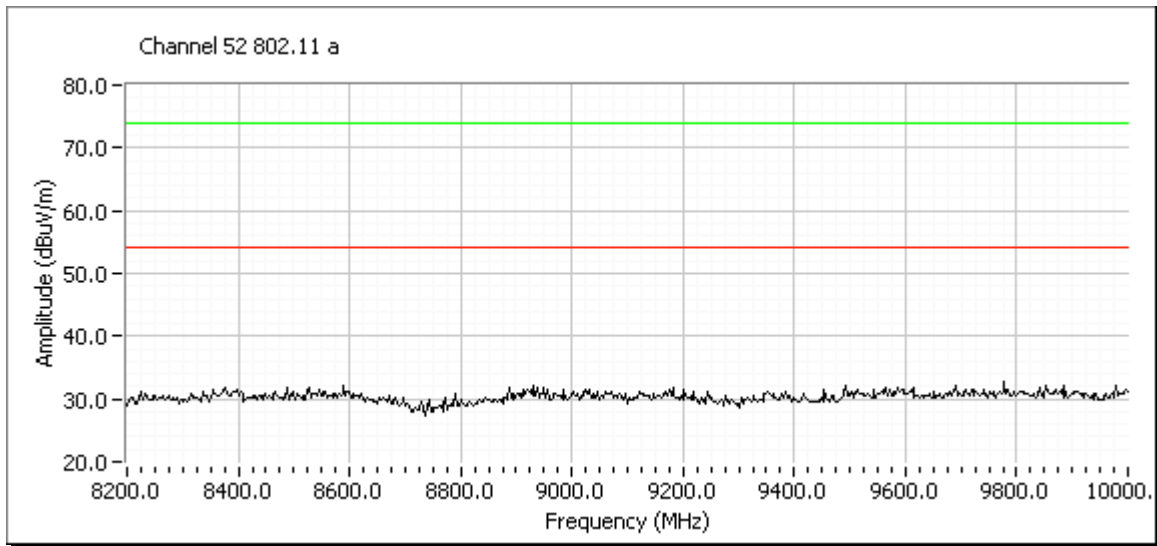
Limit -27 dBm / MHz EIRP, adjusted to 3M field strength: 68.3 dBuV

For emissions falling in the restricted bands detailed in 15.205 the general limits of 15.209 apply. For all other emissions the limit is EIRP < -27dBm (equivalent to a field strength at 3m of 68.3 dBuV/m)

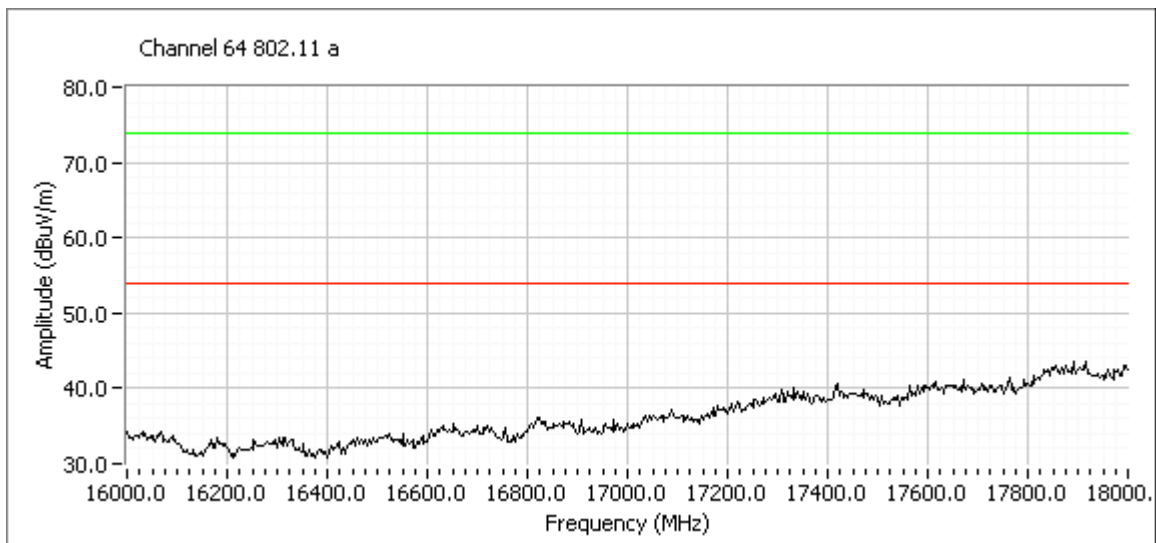
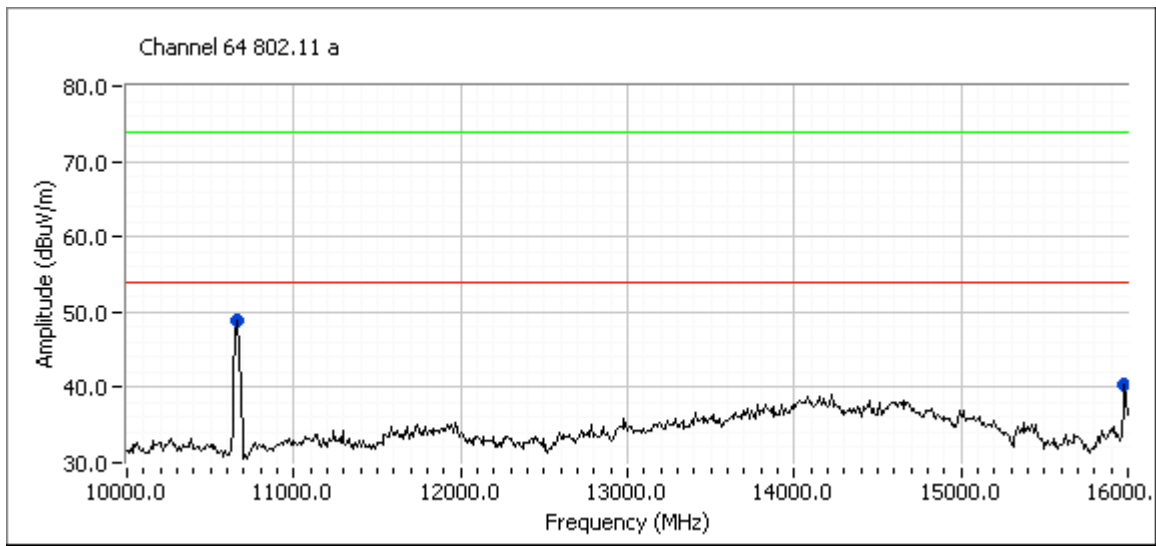
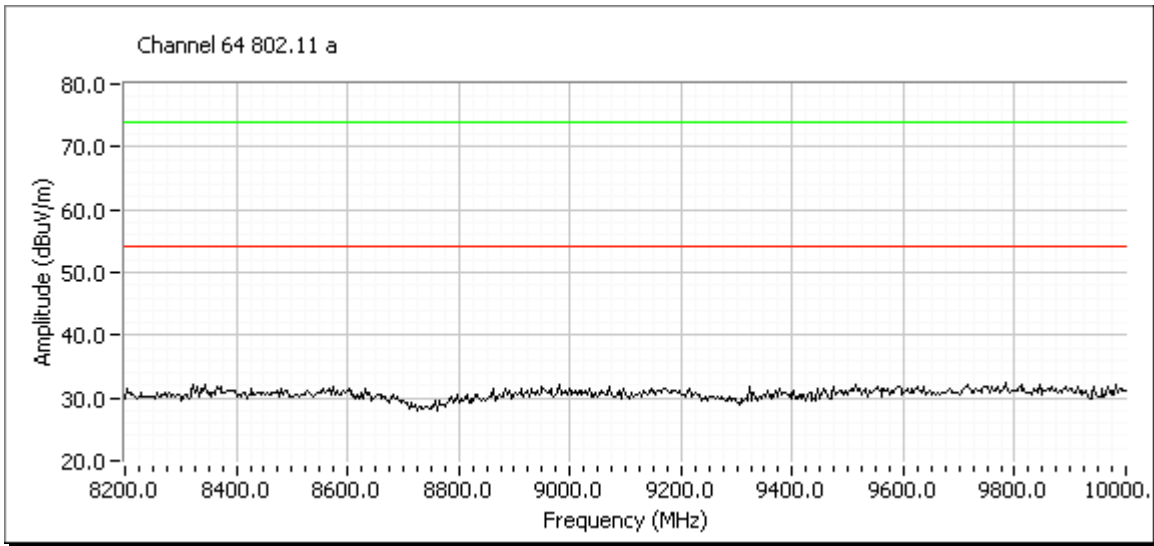
Restricted Band Emissions, UUT Transmitting on 5180 MHz



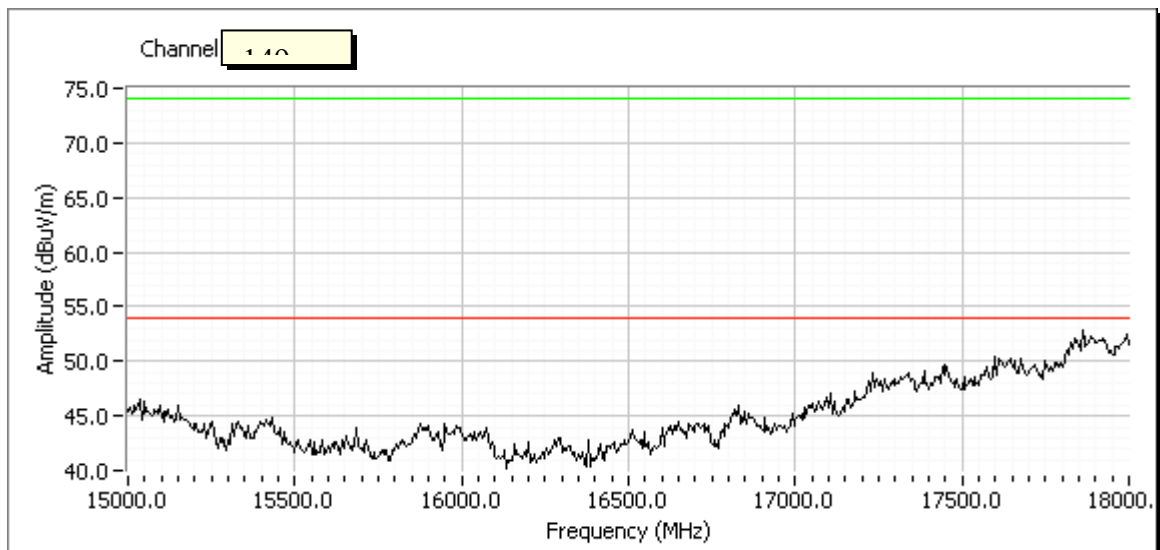
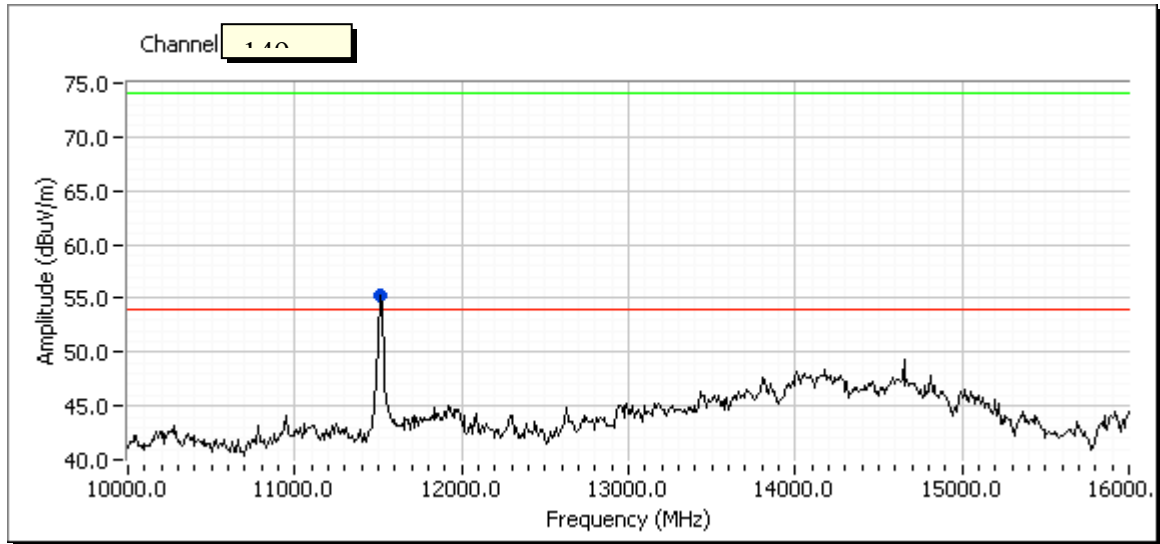
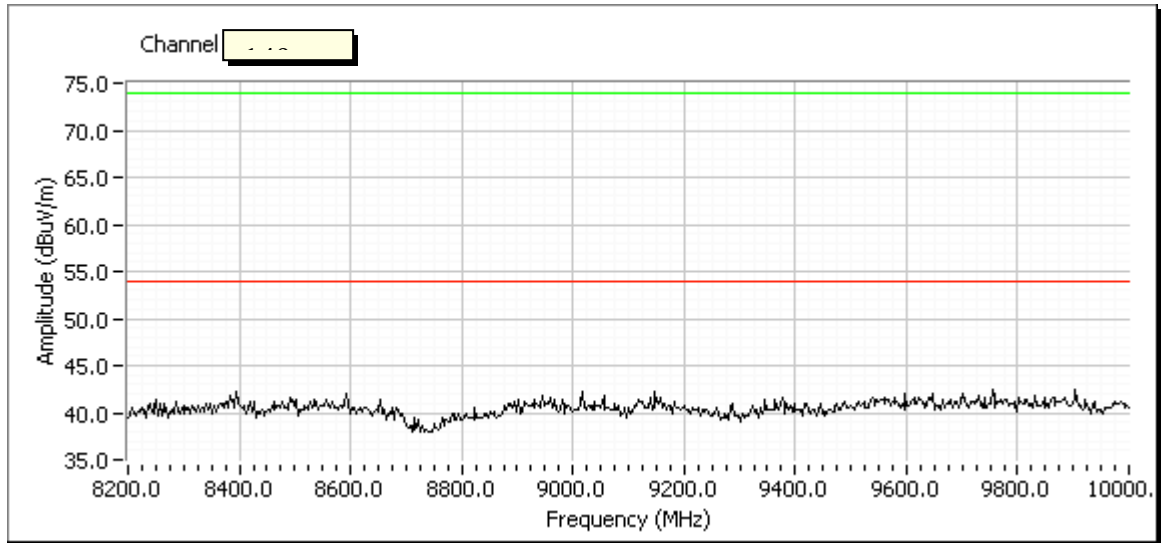
Restricted Band Emissions, UUT Transmitting on 5260 MHz



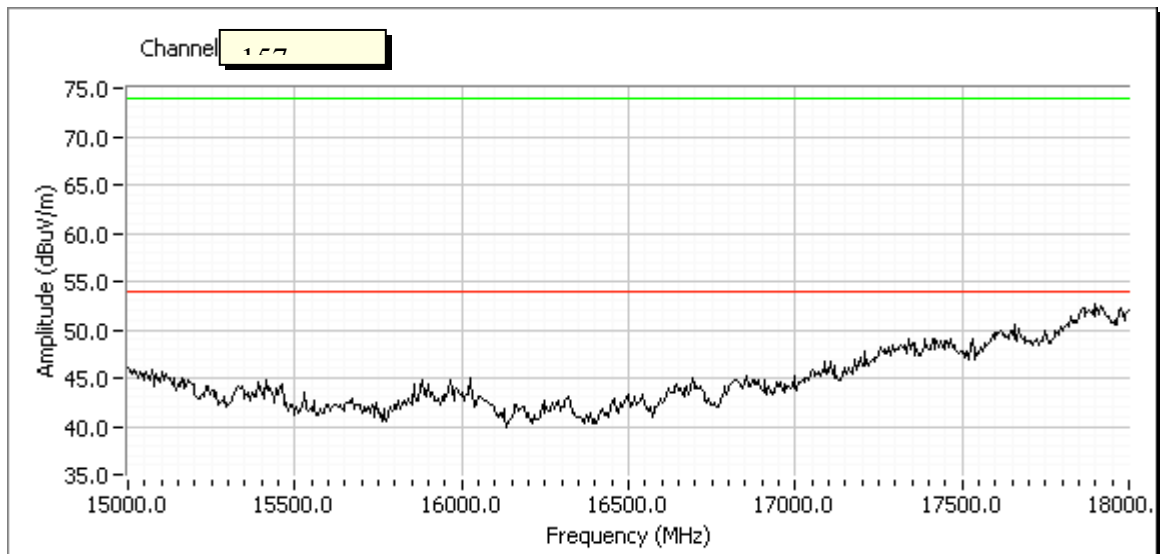
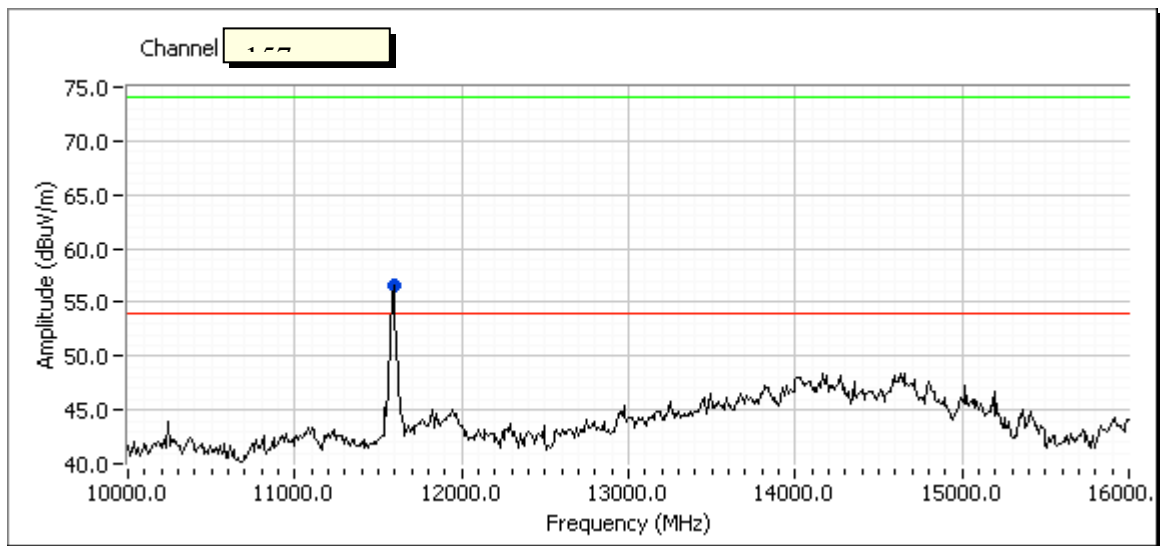
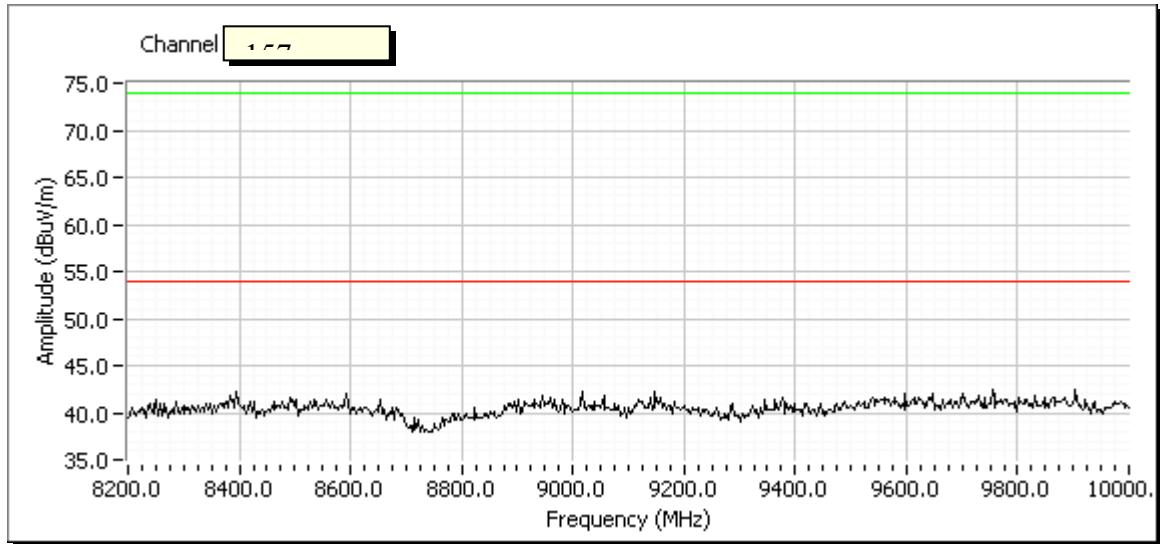
Restricted Band Emissions, UUT Transmitting on 5320 MHz



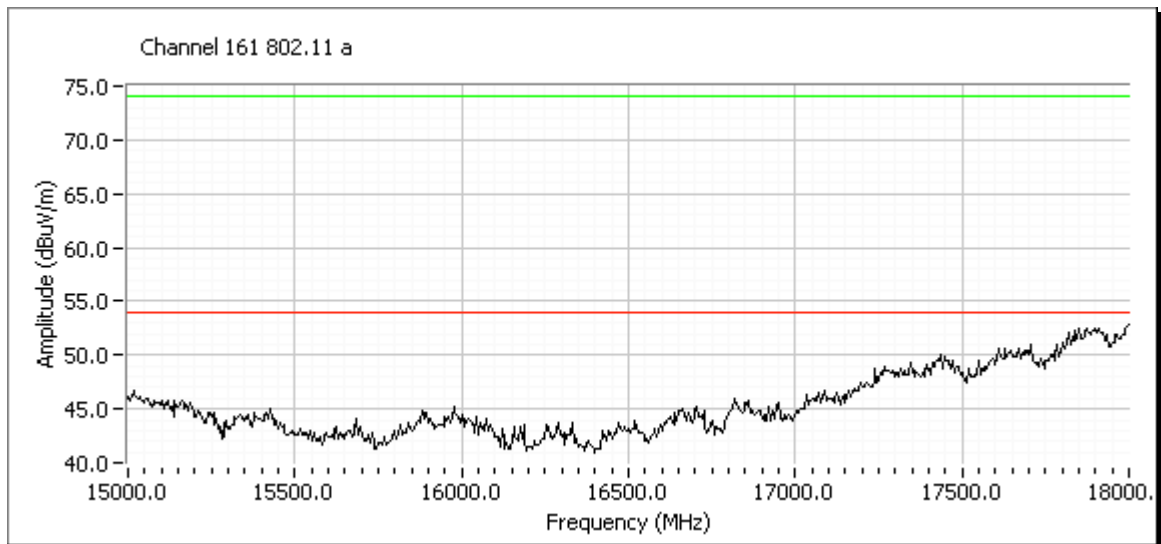
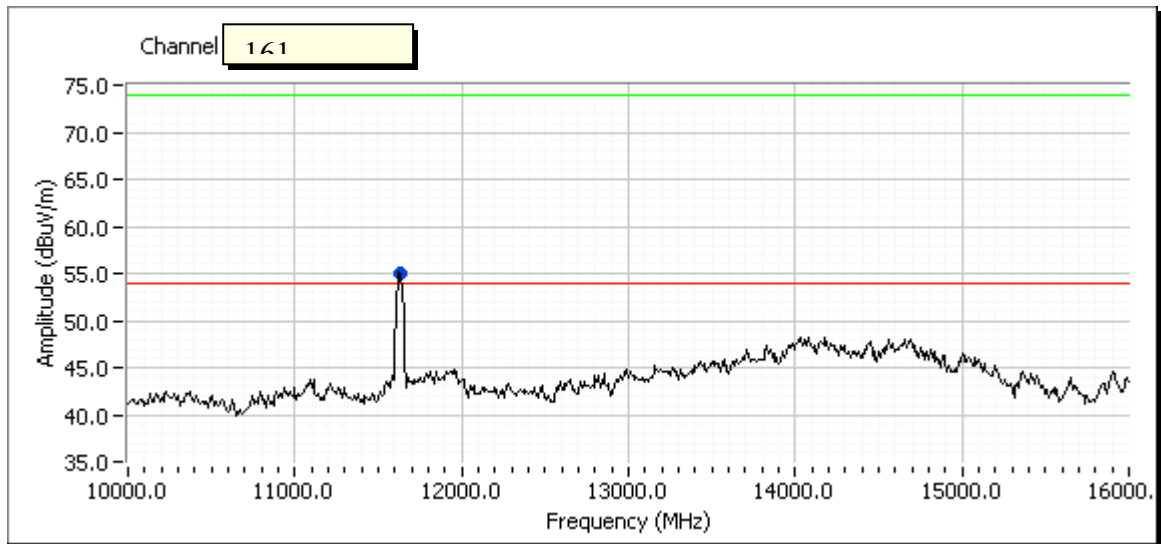
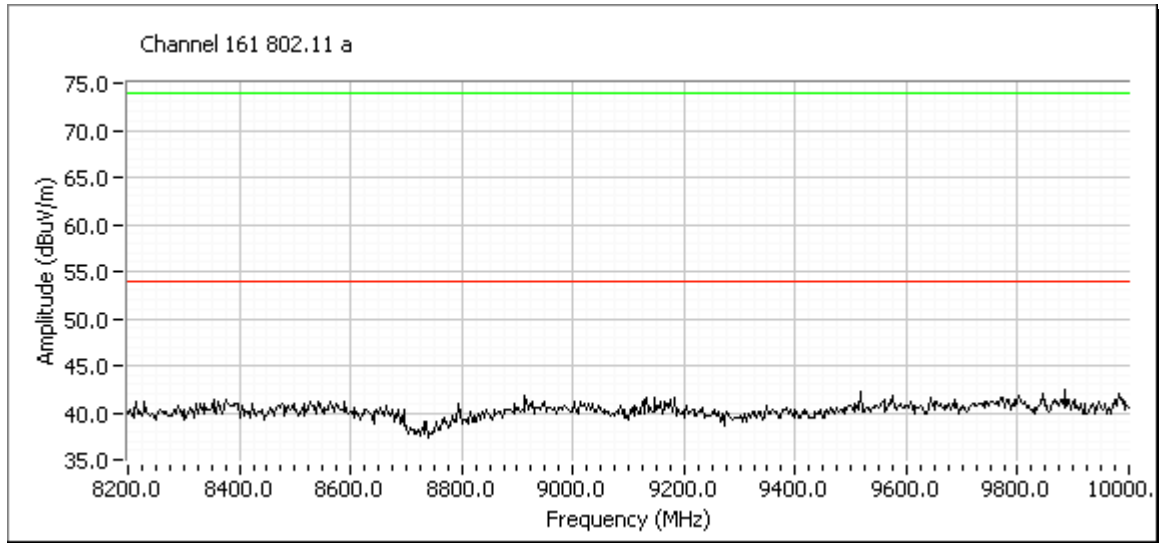
Restricted Band Emissions, UUT Transmitting on 5745 MHz



Restricted Band Emissions, UUT Transmitting on 5785 MHz



Restricted Band Emissions, UUT Transmitting on 5805 MHz



Radiated Emissions in Restricted Bands at the Band Edges.

Ending at 5.15 GHz and beginning at 5.35 GHz

Procedure

There are three steps to performing this test.

STEP 1: Make a radiated measurement of the fundamental signal with the UUT on the highest channel. This measurement is used using the peak and average RBW and VBW of 1MHz/1MHz and 1MHz/10Hz. This measured radiated level is then used as a reference and is referred to as the Fundamental Reference Measurement in the table below

STEP 2: Additional conducted measurements are made for Peak and Average -dBc values. The peak and average bandwidths are:

PEAK: RBW = 1 MHz VBW = 1 MHz

AVG: RBW = 1 MHz VBW = 10 Hz

These measurements determine a –dBc (delta dB) level between the fundamental reference level (in a 1 MHz BW) and the actual level at highest point within the restricted band. This dBc level is then subtracted from the associated (peak or avg) radiated field strength reference measurement made earlier.

STEP 3 A third measurement is made to determine the apparent drop in fundamental carrier power when the RBW is narrowed from 1MHz (in the reference measurement) to 100kHz (the actual specification BW) This is referred to below as the “BW Delta”. This correction factor is only allowed in the highest emission in the restricted band is less than 2 “standard bandwidths” from the edge of the restricted band.

This measurement is made at the highest emission within the restricted band and is the apparent drop in level when the RBW is narrowed from 1 MHz to 100 kHz.

This procedure is outline in FCC Public Notice DA 00-705, released on 30 March 2000 and is referred to as the “Marker-Delta Method”

The restricted bands that are of concern in the test are 4.5 – 5.15 GHz and 5.35 – 5.46 GHz because these restricted bands are adjacent to the operating bands of the AP.



The power setting of the access point during this test was as shown in the power settings table earlier in this report.

Radiated Emissions at the Band Edges Summary Table

802.11 A Band Edge (Restricted band @ 5.15GHz)												
Pol	Fundamental Radiated Ref Msmt		-dBc Delta Msmt		BW Delta Msmt		Radiated Level at Band Edge		Specification		Delta (dB below Limit)	
	Peak dbuv/m	Avg dbuv/m	Peak dBc	Avg dBc	Pk dB	Avg dB	Peak dBuv/m	Avg dBuv/m	Peak dBuv/m	Avg dBuv/m	Peak dBuv/m	Avg dBuv/m
Vert	114.2	105.4	42.83	42.59	9.03	9.33	62.34	53.48	74	54	11.66	0.52
Horz	100.7	92.6					48.84	40.68			25.16	13.32
802.11 A Band Edge (Restricted band @ 5.35GHz)												
Pol	Fundamental Radiated Ref Msmt		-dBc Delta Msmt		BW Delta Msmt		Radiated Level at Band Edge		Specification		Delta (dB below Limit)	
	Peak dbuv/m	Avg dbuv/m	Peak dBc	Avg dBc	Pk dB	Avg dB	Peak dBuv/m	Avg dBuv/m	Peak dBuv/m	Avg dBuv/m	Peak dBuv/m	Avg dBuv/m
Vert	110.7	102.3	43.617	43.853	7.69	8.282	59.389	50.165	74	54	14.61	3.84
Horz	101.3	93					49.989	40.865			24.01	13.14

Restricted band level (AVG) = AVG reference level - AVG delta dB - BW Delta dB
Restricted band level (Peak) = Peak reference level - Peak delta dB - BW Delta dB

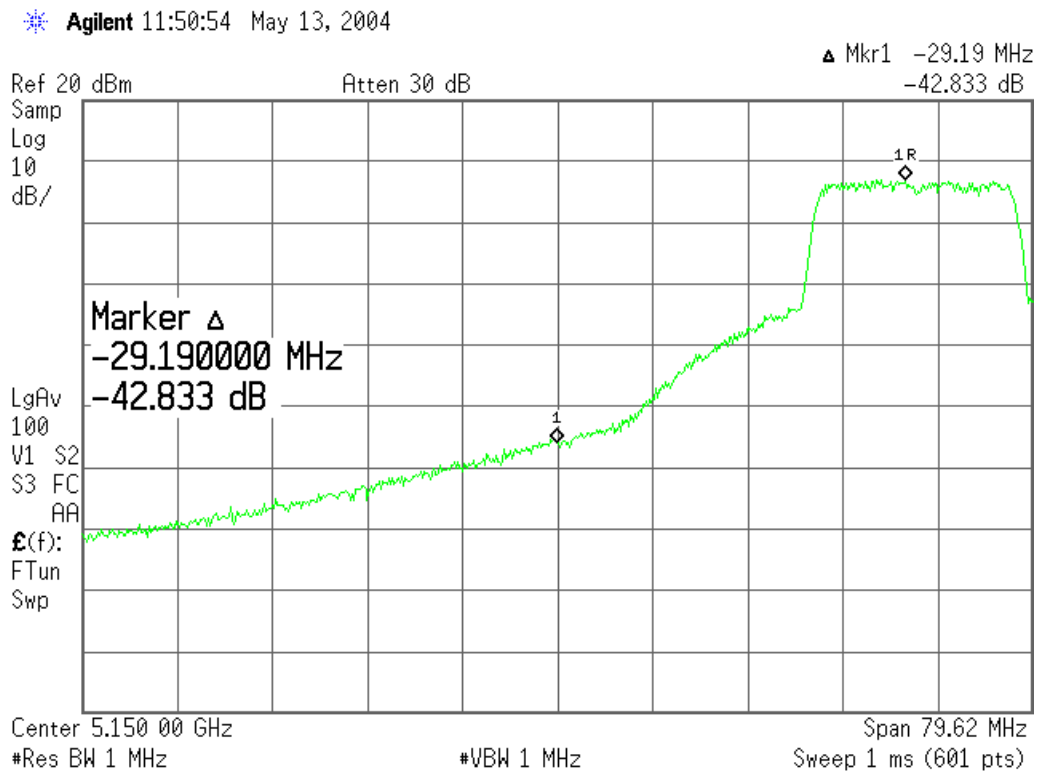
Radiated Emissions Sample Calculations

Bandedge @ 5.15 GHz, AVG

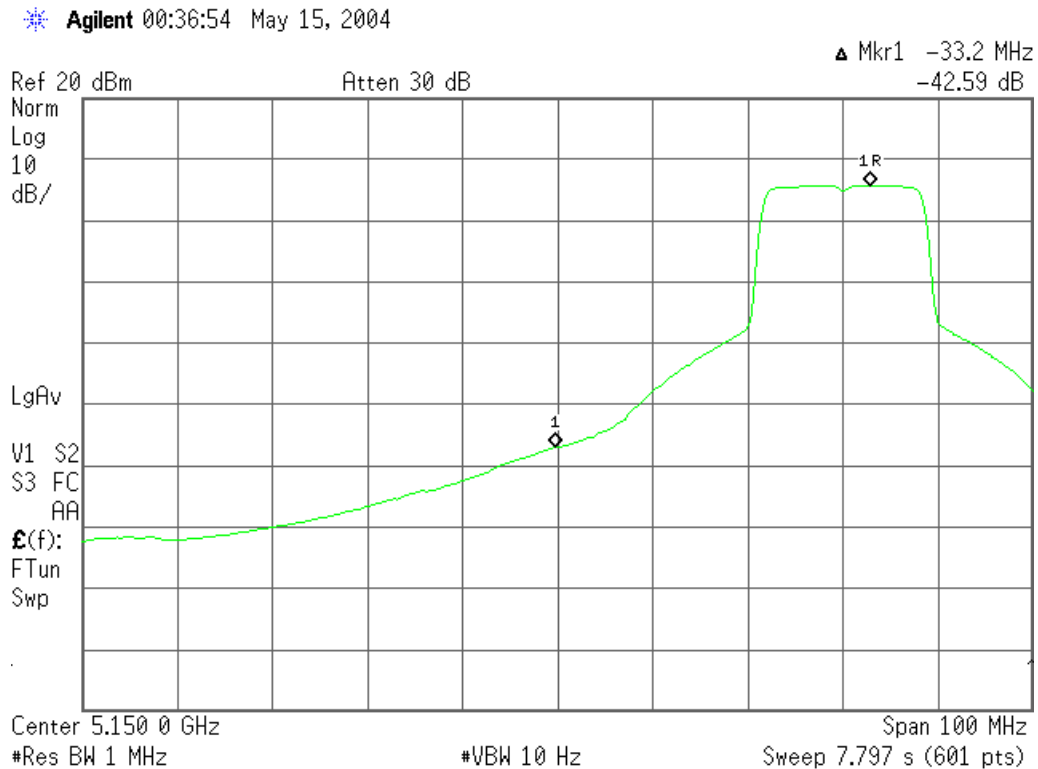
$$105.4 \text{ dBuV/m} - 42.59\text{dB} - 9.33\text{dB} = 53.48$$

$$54 - 53.48 = .52 \text{ dB below limit}$$

5.15GHz Bandedge, -dBc (Peak)

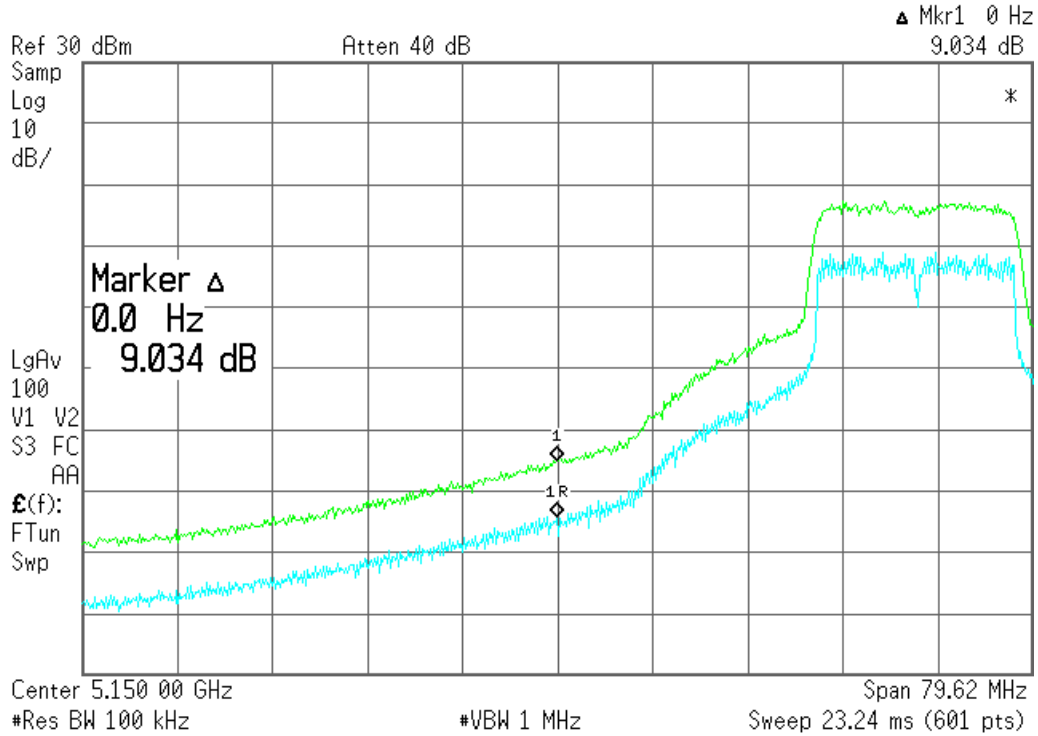


5.15GHz Bandedge, -dBc (Avg)



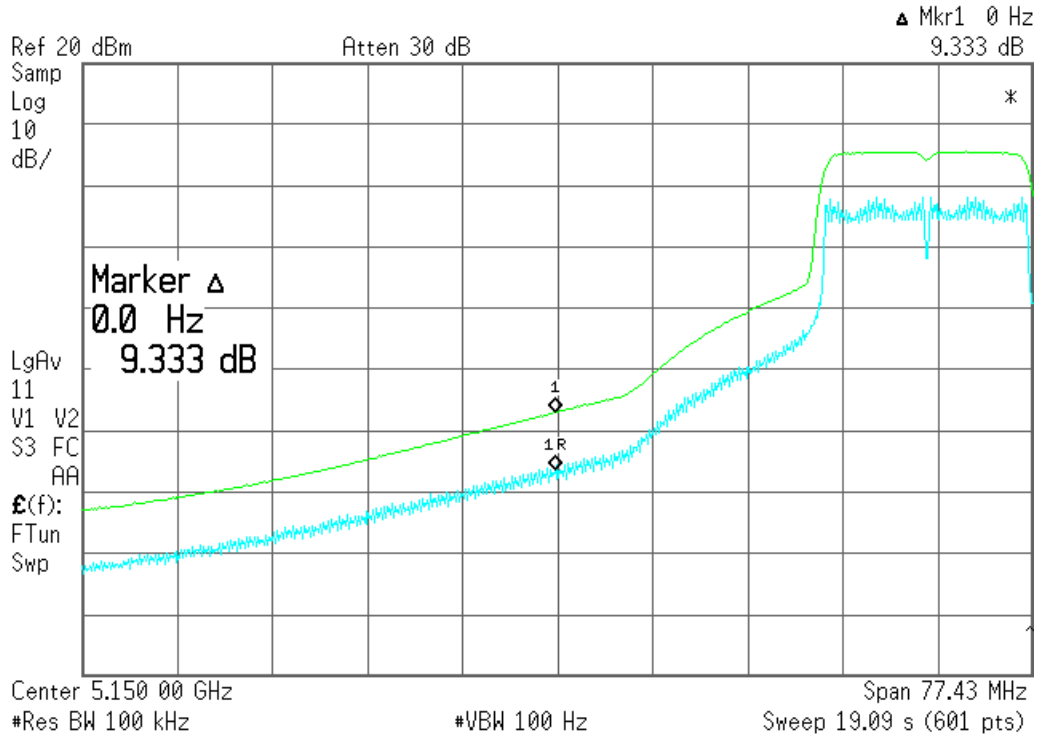
5.15GHz Bandedge, BW Delta (Peak)

* Agilent 11:58:31 May 13, 2004



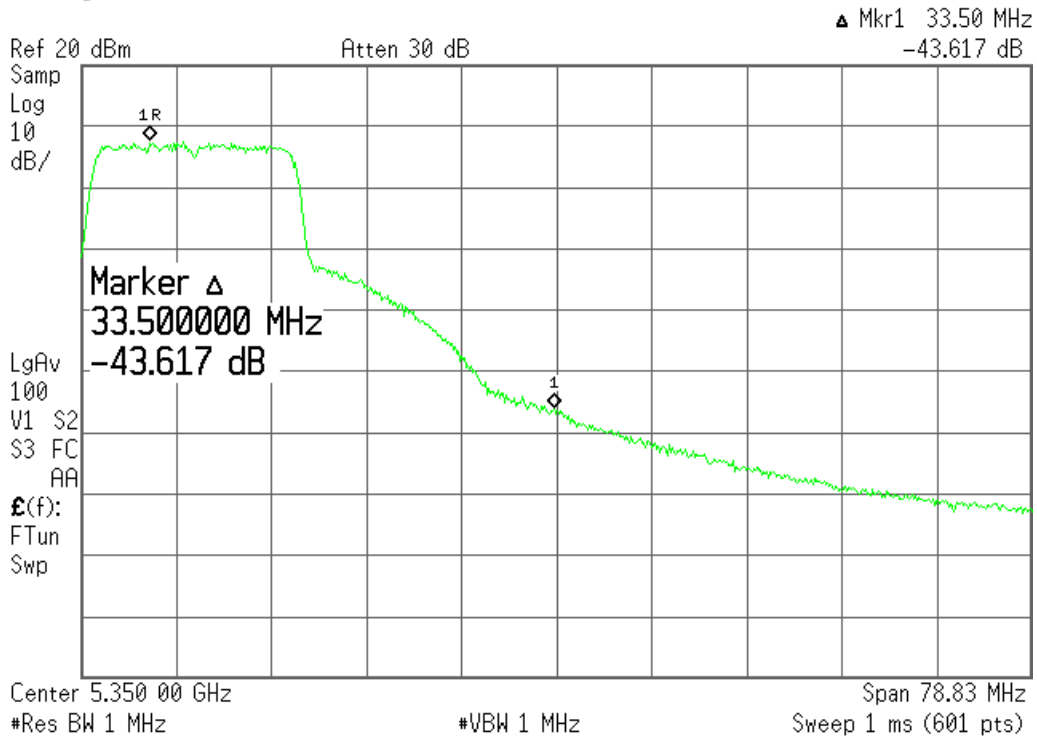
5.15GHz Bandedge, BW Delta (Avg)

* Agilent 00:54:00 May 15, 2004



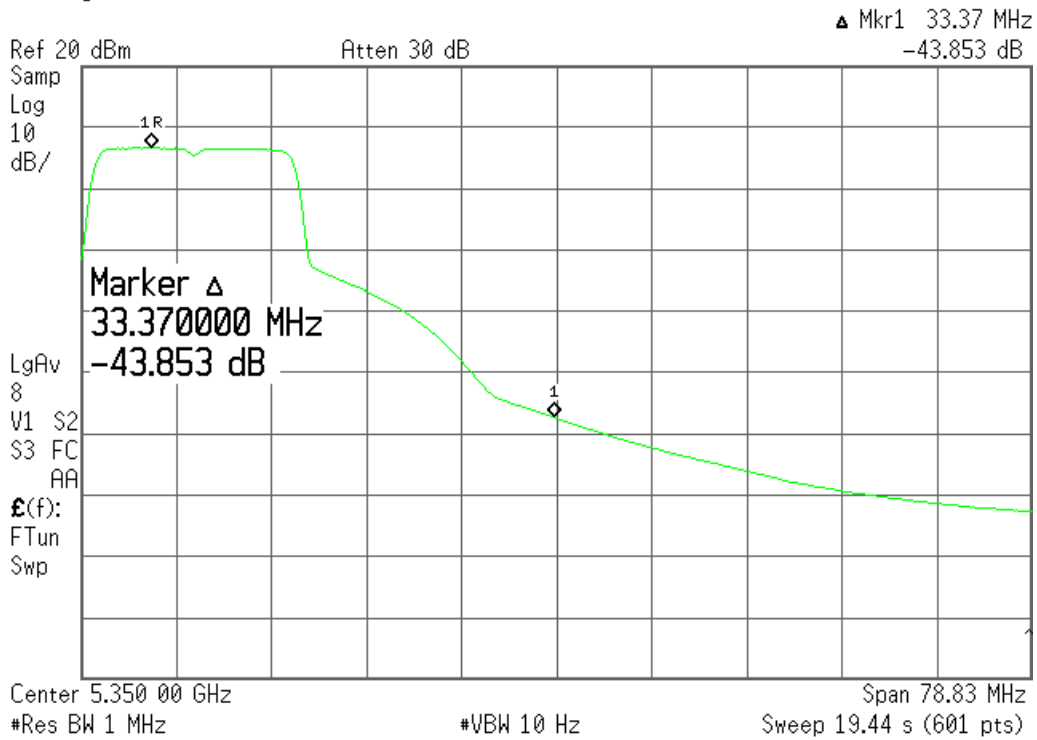
5.35GHz Bandedge, -dBc (Peak)

✱ Agilent 12:02:50 May 13, 2004

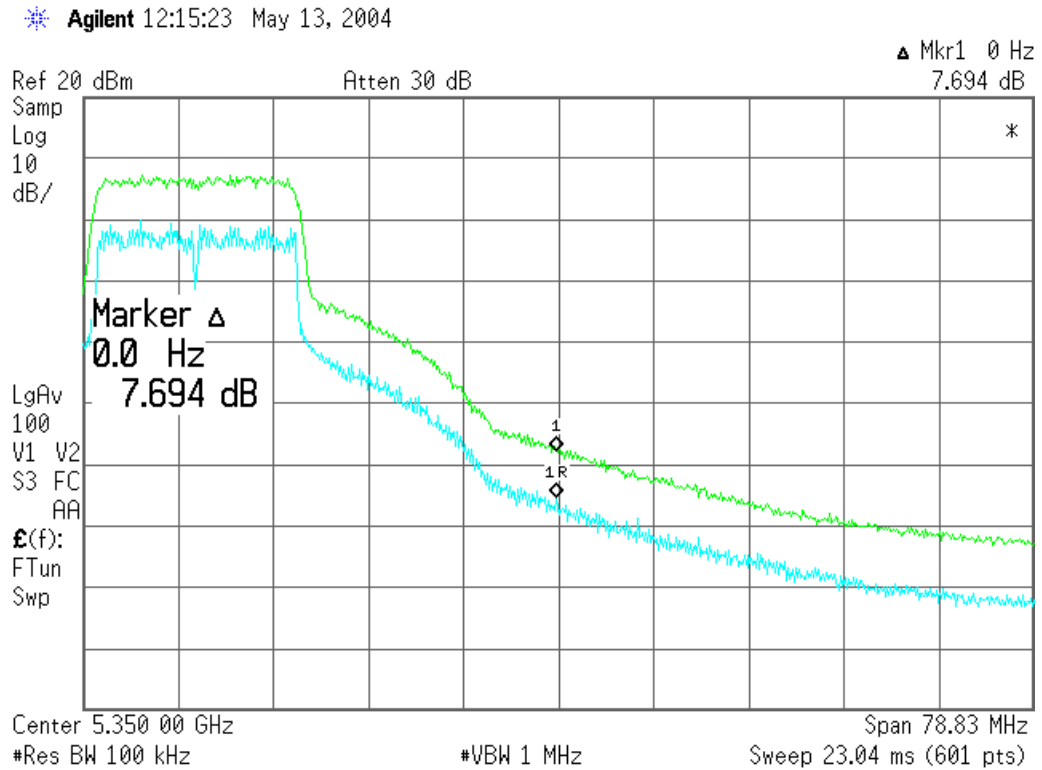


5.35GHz Bandedge, -dBc (Avg)

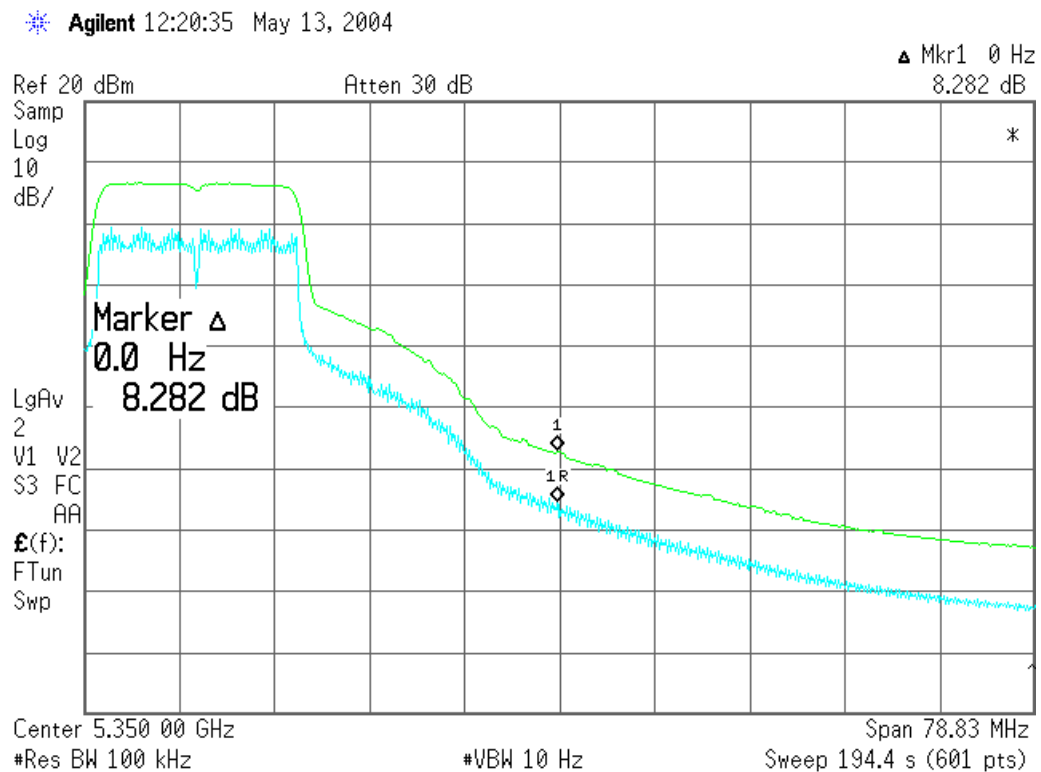
✱ Agilent 12:08:44 May 13, 2004



5.35GHz Bandedge, BW Delta (Peak)



5.35GHz Bandedge, BW Delta (Avg)



AC Line Conducted Emissions

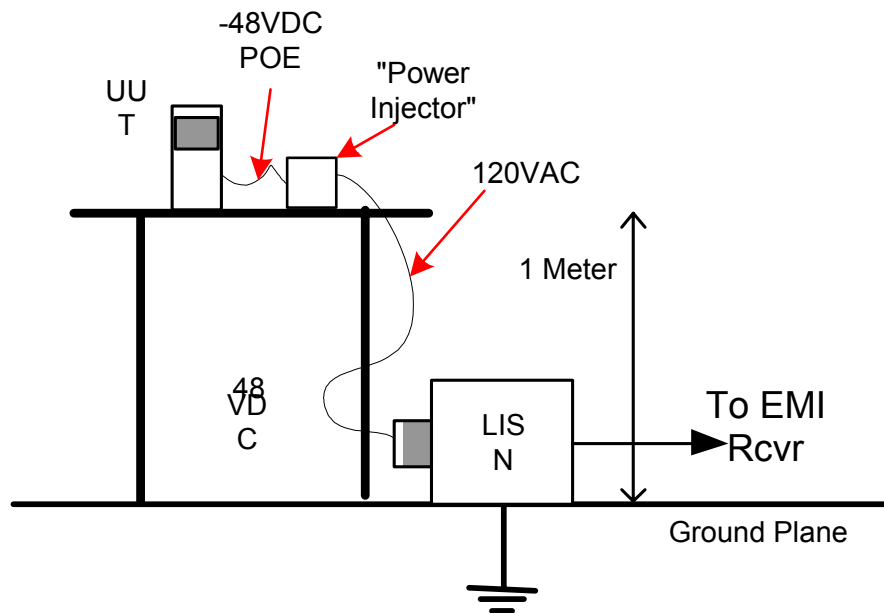
Specification:

Specification: CISPR 22

Procedure:

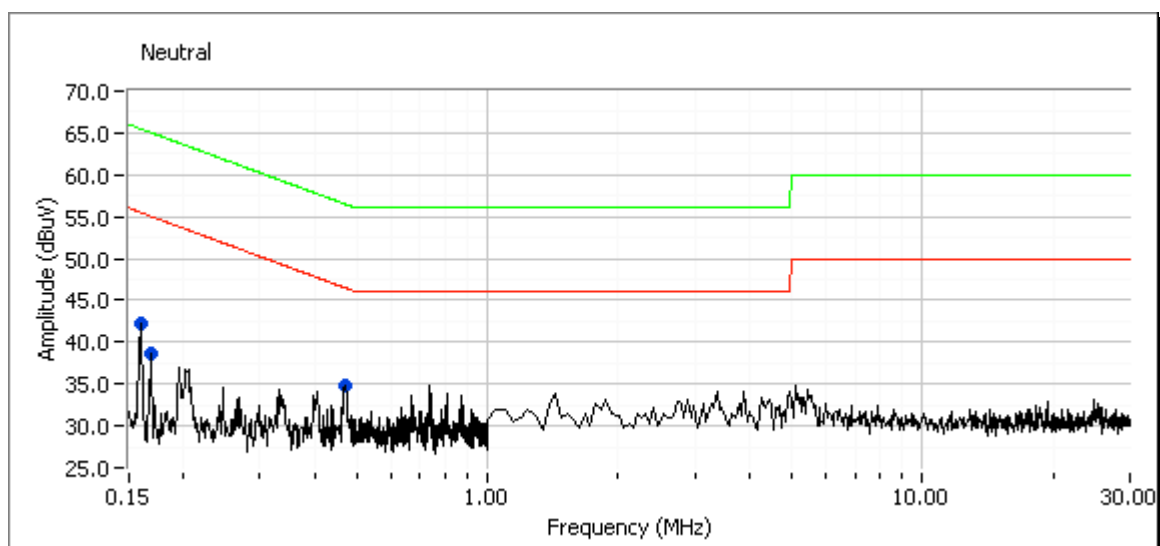
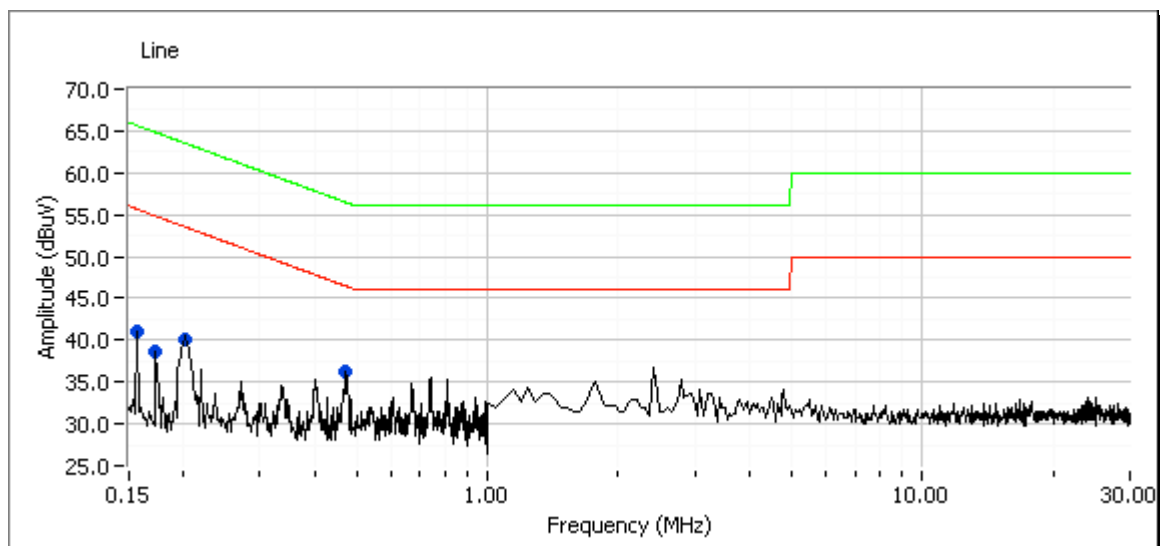
The test was set up according to the guidelines set forth in EN55022:1998 and FCC Part 2 for AC Line Conducted Emissions. The measurement used a LISN line on each AC line and an EMI receiver. A peak scan was made over the measurement frequency range (150 kHz to 30 MHz). The highest peaks were then marked and re-measured and quasi-peaked and averaged.

The test was configured as shown below. The product was tested with “power injector” running on 120 VAC @ 60 Hz. The power injector provides -48VDC onto an Ethernet cable to power the access point.



Results:

The “Quasi-peak” and the AVG results for the unit transmitting packets are contained in the table below



Frequency	Level	AC	EN55022 Class B		Detector
MHz	dB μ V	Line	Limit	Margin	QP/Ave
Preliminary peak readings captured during pre-scan (peak readings vs. average limit)					
0.470	36.4	Line 1	46.5	-10.1	Peak
0.473	34.9	Neutral	46.5	-11.6	Peak
0.160	42.4	Neutral	55.5	-13.1	Peak
0.201	40.0	Line 1	53.6	-13.6	Peak
0.156	41.0	Line 1	55.6	-14.6	Peak
0.172	38.7	Line 1	54.8	-16.2	Peak
0.168	38.7	Neutral	55.0	-16.4	Peak