Tropos Test Report per FCC Rule Parts 2 and 90

I. General Overview

The Tropos FCC ID: P9J-BF4P9, model 9532, is a dual band/dual radio transceiver used in municipal wireless mesh network configurations. The transceivers, power supplies and associated electronics are housed in a single ruggedized weatherproof metal enclosure with two antennas, one for the 2.4 GHz radio, the other for the 4.9 GHz radio.

This product requires two FCC authorizations, one for the 2.4 GHz radio operating under Part 15 of FCC Rules, the second for the 4.9 GHz radio operating under Part 90 Subpart Y of the Rules. This report is limited to Part 90 test results.

Tropos is applying for limited modular approval for this product.

II. SPECIFICATIONS

Transmitter

TX operating frequency:	4945-4985 MHz
TX output power:	19.87 dBm maximum
Digital Modulation:	OFDM
Power requirements:	120 VAC
Antenna connector:	N- type
Frequency Tolerance	Remain in band: -30 to +50 C 85%-115% supply voltage at 20C

Block diagram and theory of operation is provided in a separate attachment.

III. Test Dates and Test Locations

Test Locations
Antenna port conducted emissions, including frequency stability, were performed at the Tropos Networks radio laboratory.

Radiated emissions testing was performed at

Compliance Certification Services
47173 Benicia Street
Fremont CA 94538

Test Dates
At Tropos Networks: 2/13, 2/14, 3/19, and 3/26/2007
At CCS Laboratory: 2/22/2007

IV. REVISION INFORMATION AND ATTESTATION OF RESULTS

Report No: 07PR010

REV No.	Description	Revised By:	Date
1.0	Original	T. Cokenias	4 April 2007

Test Requirement:	FCC Part 90 Subpart Y Limited modular certification
Manufacturer:	Tropos Networks Inc.
FCC ID:	P9J-BF4P9
Brand name:	Tropos
Model Nos.:	9532
IC:	4751A-BF4P9

FCC ID: P9J-BF4P9 meets all FCC requirements for a device of this type.

THOMAS N. COKENIAS 4 April 2007
Agent for Tropos Networks Inc.

FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Parts 1 and 2.

1.1307(b) RF exposure information is provided in a separate attachment in the form of maximum permissible exposure (MPE) data.

2.1033(c)1 Applicant: Tropos Networks Inc.
555 Del Ray Avenue
Sunnyvale CA 94085

2.1033(c)2 FCC ID: P9J-BF4P9

2.1033(c)3 Installation instructions are found in separate document.

2.1033(c)4 Emission types and emission designators

OFDM 5MHz Channels: 4M19W7D
10MHz Channels: 8M47W7D
20MHz Channels: 16M7W7D

2.1033(c)5 Frequency range

4945 – 4985 MHz

2.1033(c)6 Range of Operating Power

7 – 19.87 dBm in 0.5 dB steps

2.1033(c)7 Maximum Power Rating

Channel BW MHz	**Maximum Recorded Peak Power, dBm**	**Limit per 90.1215(a) Peak Power,dBm**
5	13.86	14
10	16.86	17
20	19.87	20

Maximum allowed per Section 90.1215: 20dBm Peak

2.1033(c)8 Applied voltages and currents into the final transistor elements

Refer to schematics, separate submission accompanying this application

2.1033(c)9 Tune-up procedure

Refer to installation instructions.

2.1033(c)10 Circuit and Functional Block Diagram, Description of Circuitry

Product schematics are provided in separate attachments.
Circuit description and theory of operation are found in separate attachment.

2.1033(c)11 FCC ID Label

Refer to separate attachment.

2.1033(c)12 Product Photographs

Refer to separate attachment.

2.1033(c)13 Description of Modulation System

OFDM per 802.11a

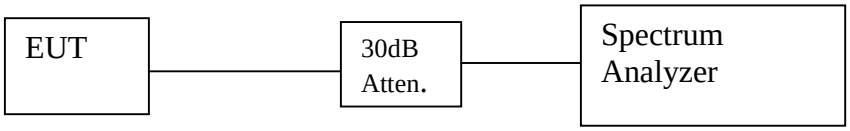
Test Equipment List

TEST EQUIPMENT LIST				
Name of Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Due Date**
Antenna, Horn 1 ~ 18 GHz	**ETS**	**3117**	**2238**	**4/22/07**
Preamplifier, 1 ~ 26.5 GHz	**Agilent / HP**	**8449B**	**3008A00931**	**8/01/07**
Spectrum Analyzer 3 Hz ~ 44 GHz	**Agilent / HP**	**E4446A**	**MY44460112**	**5/3/07**
Spectrum Analyzer 3 Hz ~ 26.5 GHz*	**Agilent**	**E4440A**	**US40420968**	**2/08/08**
Spectrum Analyzer *	**Anritsu**	**MS2721A**	**437032**	**9/10/07**
Temperature Chamber*	**TPS Tenney**	**TUJR**	**0611000091**	**12/1/07**
Variac*	**Elpac**	**n/a**	**n/a**	**NCR**
*** Tropos test equipment**				

Test Results

2.1049 Occupied Bandwidth

Test Set-up



Test Procedures

Using the spectrum analyzer Occupied Bandwidth measurement function, the 99% occupied bandwidth and -26 dB bandwidth were measured for the EUT at LOW, MID, and HIGH channels for each TX channel bandwidth mode with the EUT operating at full rated power.

Test Results: Refer to data plots below.

2.1046 RF Output Power Measurements

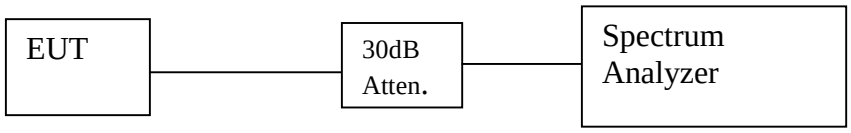
Requirement/Limit: 90.1215(a)

The transmitting power of stations operating in the 4940–4990 MHz band must not exceed the maximum limits in this section.

(a) The peak transmit power should not exceed:

Channel bandwidth (MHz)	**Low power peak** transmitter power (dBm)
5.....	14
10.....	17
20.....	20

Test Set-up



Test Procedures

Using the spectrum analyzer Channel Power measurement function, the Peak output power was measured for the EUT at LOW, MID, and HIGH channels for each TX channel bandwidth mode with the EUT operating at full rated power.

Test Results: Refer to data plots below.

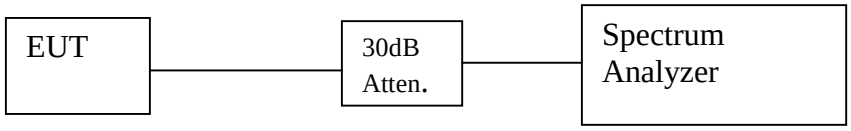
Power Spectral Density Measurements

Requirement/Limit: 90.1215b, d

(b) **Low power** devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the peak transmit power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

(d) The peak power spectral density is measured as conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of one MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

Test Set-up



Test Procedures

1. Set spectrum analyzer RBW=1MHz, VBW>RBW
2. Set analyzer SPAN = 1.5x Channel Bandwidth
3. Use PEAK SEARCH function to determine maximum PSD.

Test Results

Refer to data plots below.

2.1051 Spurious and Harmonic Emissions at Antenna Terminals
Emissions Masks

Requirement: 90.210(l)

90.210 Emissions mask

(l) *Emission Mask L.* For low power transmitters (20 dBm or less) operating in the 4940–4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:

(1) On any frequency removed from the assigned frequency between 0–45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45–50% of the authorized bandwidth: 219 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50–55% of the authorized bandwidth: 10 + 242 log (% of (BW)/50) dB.

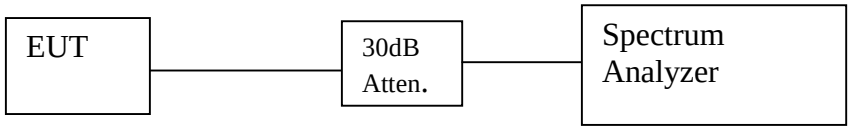
(4) On any frequency removed from the assigned frequency between 55–100% of the authorized bandwidth: 20 + 31 log (% of (BW)/55) dB attenuation.

(5) On any frequency removed from the assigned frequency between 100–150% of the authorized bandwidth: 28 + 68 log (% of (BW)/100) dB attenuation.

(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 40 dB.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

Test Set-up



Test Procedures

1. Set spectrum analyzer RBW to at least 1% emission bandwidth, VBW=30kHz.
2. Use settings in (1) to establish mask reference

Test Results

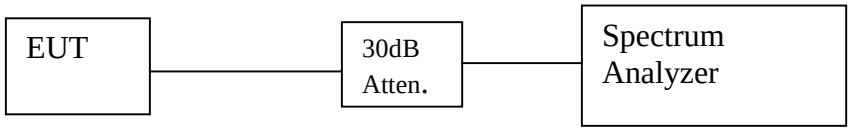
Refer to data plots below.

Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals

90.210 Emissions mask

(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 40 dB.
(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Test Set-up



Test Procedures

1. Set spectrum analyzer RBW and VBW to the same settings used for emissions masks.
2. Set limit line to: Mask Reference – 50 dB.

Test Results

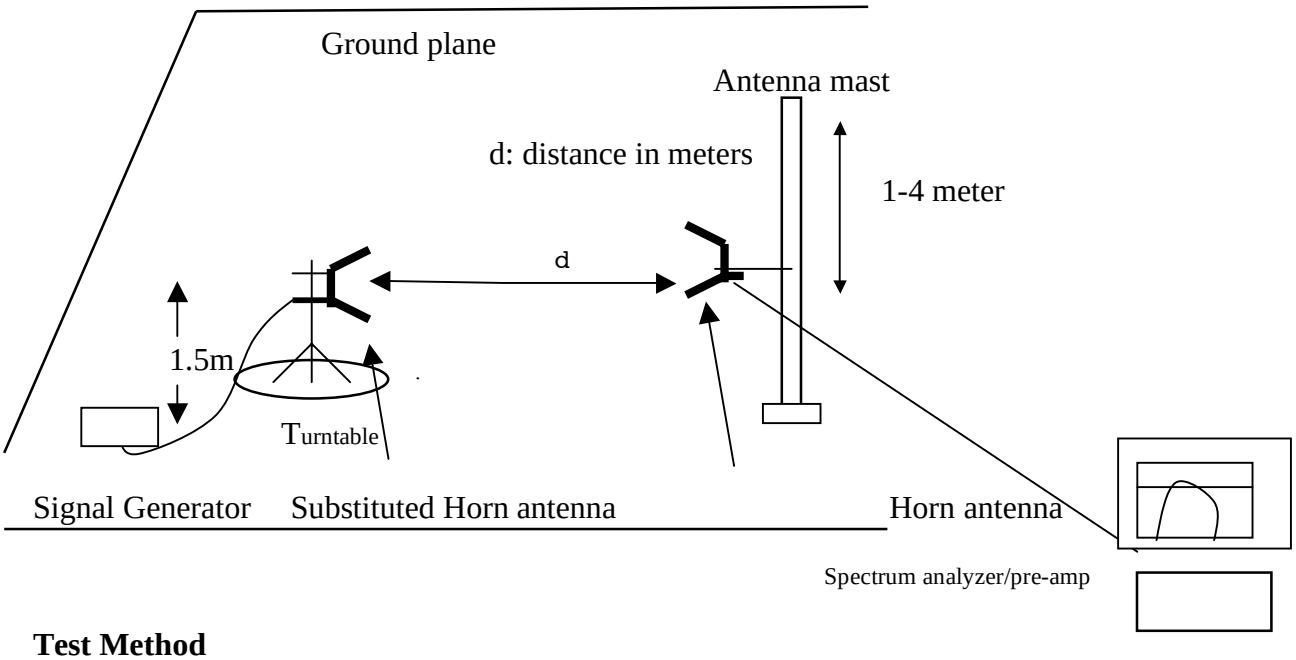
Refer to data plots below.

2.1053 Field Strength of Spurious and Harmonic Radiation

90.210 Emissions mask

(6) On any frequency removed from the assigned frequency above 150% of the authorized bandwidth: 40 dB.
(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Test Setup: Substitution antenna and signal generator



Test Method

The antenna output port of the EUT was terminated with a 50 ohm load. With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was raised and lowered in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 10 fo.

The EUT was removed and was replaced by a substitution antenna connected via coax to a signal generator. The generator output was set to each emission frequency detected, the search antenna was raised and lowered, the turntable was rotated, until the maximum emission level was obtained. The signal generator output level was adjusted to match the radiated emission level from the EUT. After correcting for substitution antenna factor and generator cable loss, output power level is compared to the limit.

Test Results

Pass. All emissions detected were below –40dBc. Refer to test data below.

Radiated Emissions Data

Note: EUT was tested at higher levels than EUT operates but EUT continues to meet radiated emissions limits.

High Frequency Substitution Measurement
Compliance Certification Services, B- 5m Chamber Fremont Site

Company: Tropos
Project #: 07U10862
Date: 02/22/2007
Test Engineer: Vien Tran
Configuration: EUT (Terminated at antennas ports) & laptop (config channels & powers)
Mode: Tx 5 MHz BANDWIDTH
Average Power Meter: Low = 17 dBm, Mid = 17 dBm, High = 17 dBm

Test Equipment:

EMCO Horn 1-18GHz: T60; S/N: 2238 @3m
Horn > 18GHz:
Limit: EIRP
Hi Frequency Cables: (2 ft) (2 ~ 3 ft) (4 ~ 6 ft) (12 ft)
Pre-amplifer 1-26GHz: T144 Miteq 3008A00
Pre-amplifer:

f GHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	EIRP (dBm)	Limit (dBm)	Margin (dB)
LOW CHAN, 4945 MHz									
1.130	58.9	V	-50.2	3.5	5.2	3.1	-48.4	-37.5	-11.0
2.400	55.8	V	-49.2	5.1	9.3	7.1	-45.1	-37.5	-7.7
2.494	51.2	V	-53.3	5.2	9.3	7.1	-49.3	-37.5	-11.8
1.130	54.1	H	-54.3	3.5	5.2	3.1	-52.5	-37.5	-15.1
2.400	52.0	H	-52.8	5.1	9.3	7.1	-48.7	-37.5	-11.3
2.494	50.0	H	-54.3	5.2	9.3	7.1	-50.3	-37.5	-12.8
MID CH, 4965 MHz									
1.130	56.9	V	-52.2	3.5	5.2	3.1	-50.4	-37.2	-13.2
2.400	53.8	V	-51.2	5.1	9.3	7.1	-47.1	-37.2	-9.9
2.494	50.1	V	-54.4	5.2	9.3	7.1	-50.4	-37.2	-13.2
1.130	52.2	V	-56.9	3.5	5.2	3.1	-55.1	-37.2	-17.9
2.400	51.1	V	-53.9	5.1	9.3	7.1	-49.8	-37.2	-12.6
2.494	49.0	V	-55.5	5.2	9.3	7.1	-51.5	-37.2	-14.3
HI CH, 4985 MHz									
1.130	55.2	V	-53.9	3.5	5.2	3.1	-52.1	-37.5	-14.6
2.400	53.4	V	-51.6	5.1	9.3	7.1	-47.5	-37.5	-10.0
2.494	48.9	V	-55.6	5.2	9.3	7.1	-51.6	-37.5	-14.1
1.130	53.8	H	-54.6	3.5	5.2	3.1	-52.8	-37.5	-15.3
2.400	50.6	H	-54.2	5.1	9.3	7.1	-50.1	-37.5	-12.6
2.494	47.9	H	-56.4	5.2	9.3	7.1	-52.4	-37.5	-14.9
		No other emission were detected up to 40 GHz							

High Frequency Substitution Measurement
Compliance Certification Services, B- 5m Chamber Fremont Site

Company: Tropos
Project #: 07U10862
Date: 02/22/2007
Test Engineer: Vien Tran
Configuration: EUT (Terminated at antennas ports) & laptop (Config channels & powers)
Mode: Tx 10 MHz BANDWIDTH
Average Power Meter: Low = 21 dBm, Mid = 21 dBm, High = 21 dBm

Test Equipment:

EMCO Horn 1-18GHz: T60; S/N: 2238 @3m
Horn > 18GHz:
Limit: EIRP
Hi Frequency Cables: (2 ft) ☑ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☐ (12 ft) ☑
Pre-amplifer 1-26GHz: T144 Miteq 3008A00
Pre-amplifer:

f GHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	EIRP (dBm)	Limit (dBm)	Margin (dB)
LOW CHAN, 4945 MHz									
1.130	59.9	V	-49.2	3.5	5.2	3.1	-47.4	-37.9	-9.5
2.400	55.4	V	-49.6	5.1	9.3	7.1	-45.5	-37.9	-7.6
1.130	56.8	H	-51.6	3.5	5.2	3.1	-49.8	-37.9	-11.9
2.400	52.3	H	-52.5	5.1	9.3	7.1	-48.4	-37.9	-10.5
MID CH, 4965 MHz									
1.130	57.2	V	-51.9	3.5	5.2	3.1	-50.1	-37.5	-12.6
2.400	54.5	V	-50.5	5.1	9.3	7.1	-46.4	-37.5	-8.9
1.130	54.1	H	-54.3	3.5	5.2	3.1	-52.5	-37.5	-15.0
HI CH, 4985 MHz									
1.130	56.5	V	-52.6	3.5	5.2	3.1	-50.8	-37.5	-13.3
2.400	54.8	V	-50.2	5.1	9.3	7.1	-46.1	-37.5	-8.6
2.494	52.4	V	-52.1	5.2	9.3	7.1	-48.1	-37.5	-10.6
1.130	53.7	H	-54.7	3.5	5.2	3.1	-52.9	-37.5	-15.4
2.400	52.6	H	-52.2	5.1	9.3	7.1	-48.1	-37.5	-10.6
2.494	51.3	H	-53.0	5.2	9.3	7.1	-49.0	-37.5	-11.5
		No other emission were detected up to 40 GHz							

High Frequency Substitution Measurement
Compliance Certification Services, B- 5m Chamber Fremont Site

Company: Tropos
Project #: 07U10862
Date: 02/22/2007
Test Engineer: Vien Tran
Configuration: EUT (Terminated at antennas ports) & laptop (config channels & powers)
Mode: Tx 20 MHz BANDWIDTH
Average Power Meter: Low = 24 dBm, Mid = 24 dBm, High = 24 dBm

Test Equipment:

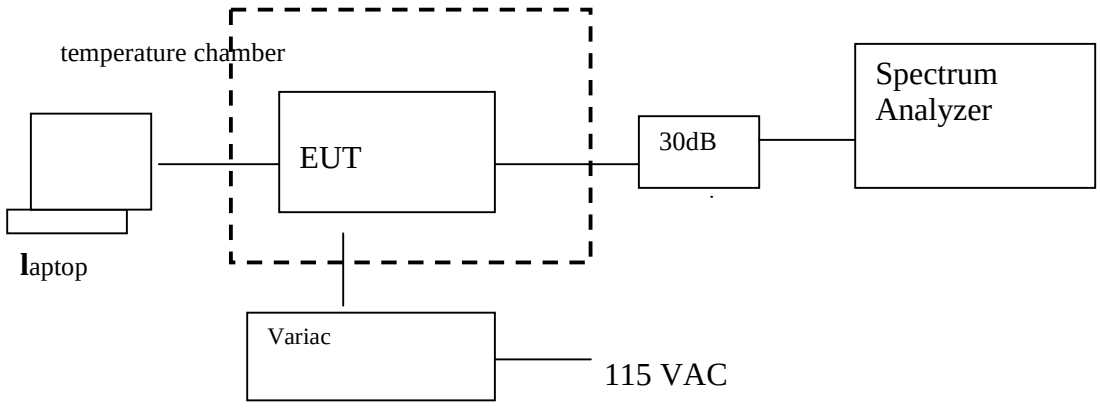
EMCO Horn 1-18GHz: T60; S/N: 2238 @3m
Horn > 18GHz:
Limit: EIRP
Hi Frequency Cables: (2 ft) ☑ (2 ~ 3 ft) ☐ (4 ~ 6 ft) ☐ (12 ft) ☑
Pre-amplifer 1-26GHz: T144 Miteq 3008A00
Pre-amplifer:

f GHz	SA reading (dBuV/m)	Ant. Pol. (H/V)	SG reading (dBm)	CL (dB)	Gain (dBi)	Gain (dBd)	EIRP (dBm)	Limit (dBm)	Margin (dB)
LOW CH, 4950 MHz									
1.130	58.9	V	-50.2	3.5	5.2	3.1	-48.4	-33.7	-14.7
1.130	54.9	H	-53.5	3.5	5.2	3.1	-51.7	-33.7	-18.0
MID CH, 4965 MHz									
1.130	59.3	V	-49.8	3.5	5.2	3.1	-48.0	-33.6	-14.4
1.130	54.0	H	-54.4	3.5	5.2	3.1	-52.6	-33.6	-19.0
HI CH, 4980 MHz									
1.130	58.2	V	-50.9	3.5	5.2	3.1	-49.1	-33.7	-15.4
1.130	56.1	H	-52.3	3.5	5.2	3.1	-50.5	-33.7	-16.8
		No other emission were detected up to 40 GHz							

2.1055 Frequency Stability

Requirement/Limit: Emissions remain in-band.

Test Setup



Test Procedures

1. Set the temperature chamber to normal temperature and input voltage: 20C and 115VAC. Record frequency.
2. At 20C record frequency at 85% and 115% of normal voltage.
3. At normal voltage, allow temperature to stabilize at every 10 degrees C from –30C to +50C.

Test Results

Temp (°C)	Freq. (Hz)
50	4 970 025 850
40	4 970 025 310
30	4 970 030 850
20	**4 970 034 200**
10	4 970 036 380
0	4 970 039 040
-10	4 970 034 250
-20	4 970 018 660
-30	4 969 990 840

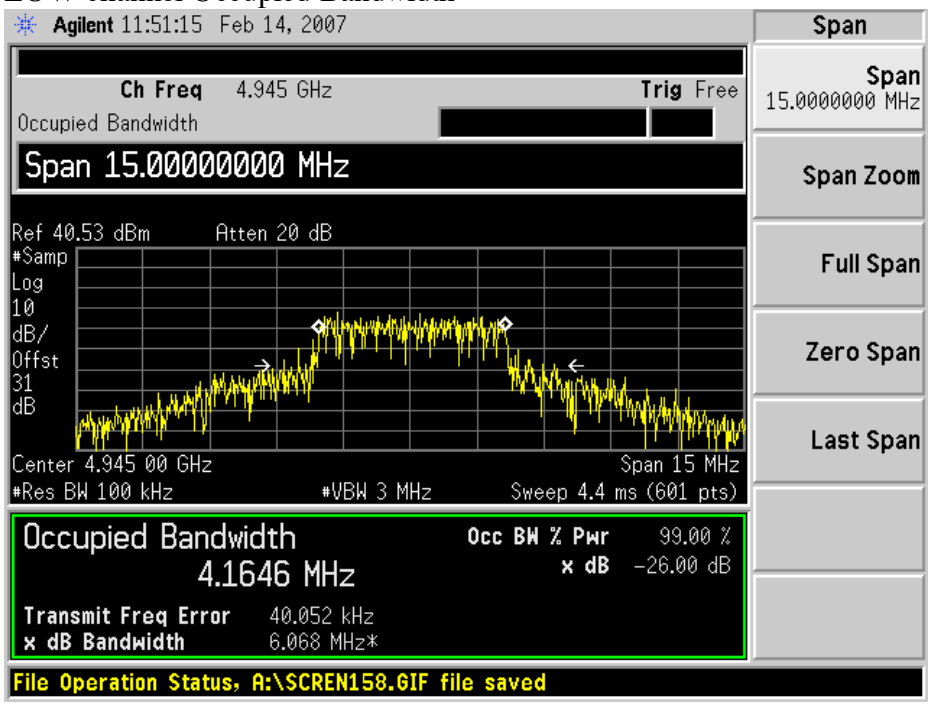
Maximum deviation: 43360 Hz (8.7 ppm)

Input Voltage	Freq. (Hz)
115 VAC (100%)	4 970 034 200
133 VAC (115%)	4 970 034 200
98 VAC (85%)	4 970 034 200

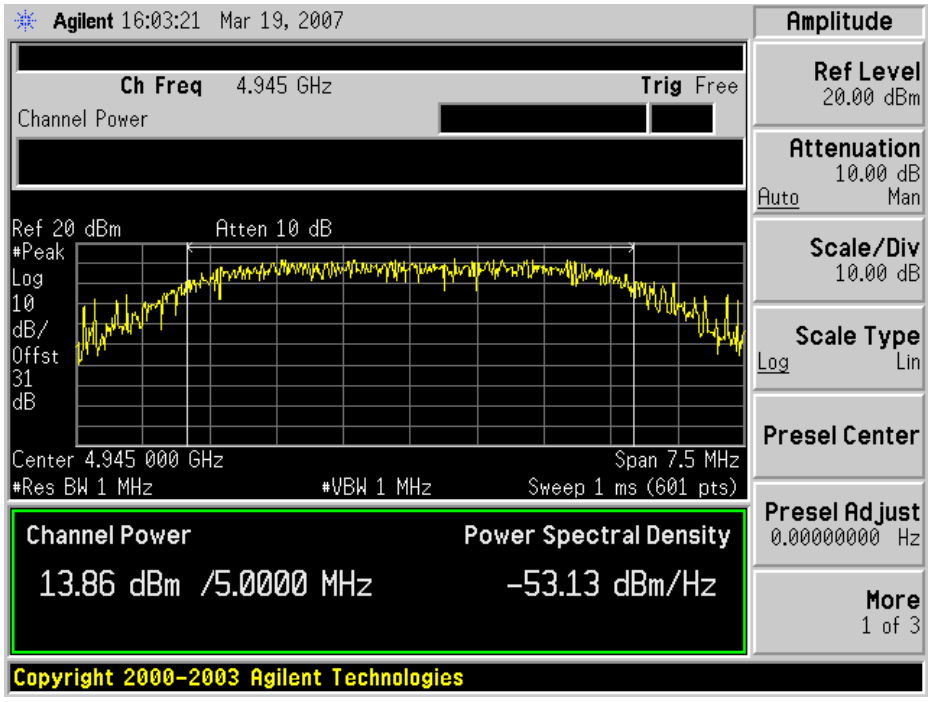
DATA PLOTS and CHARTS

5 MHz Channel Bandwidth Antenna Port Conducted Data

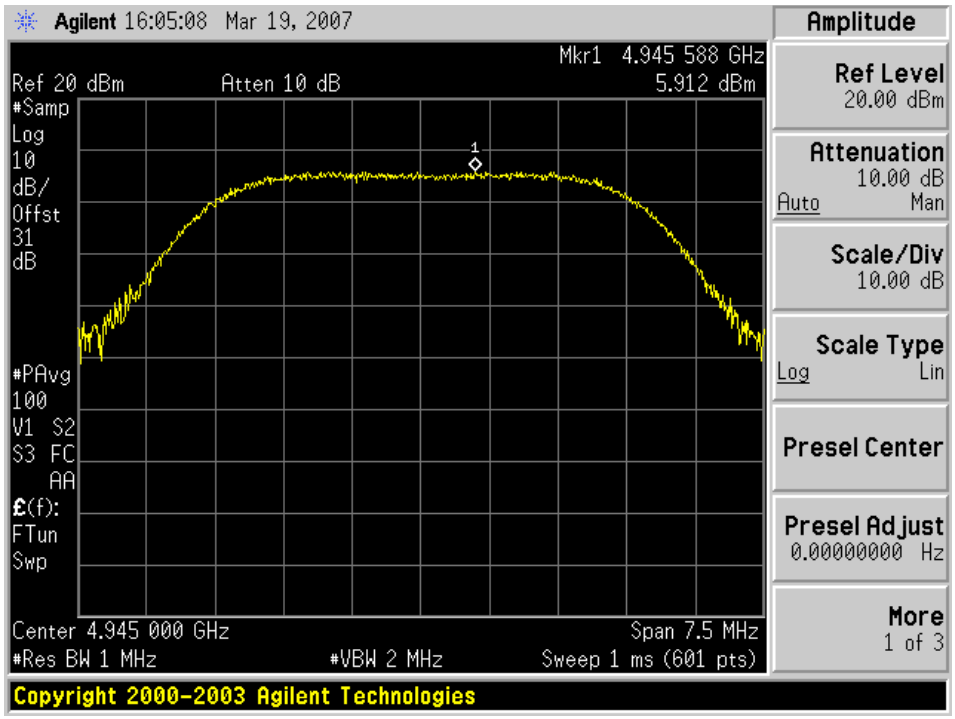
LOW channel Occupied Bandwidth



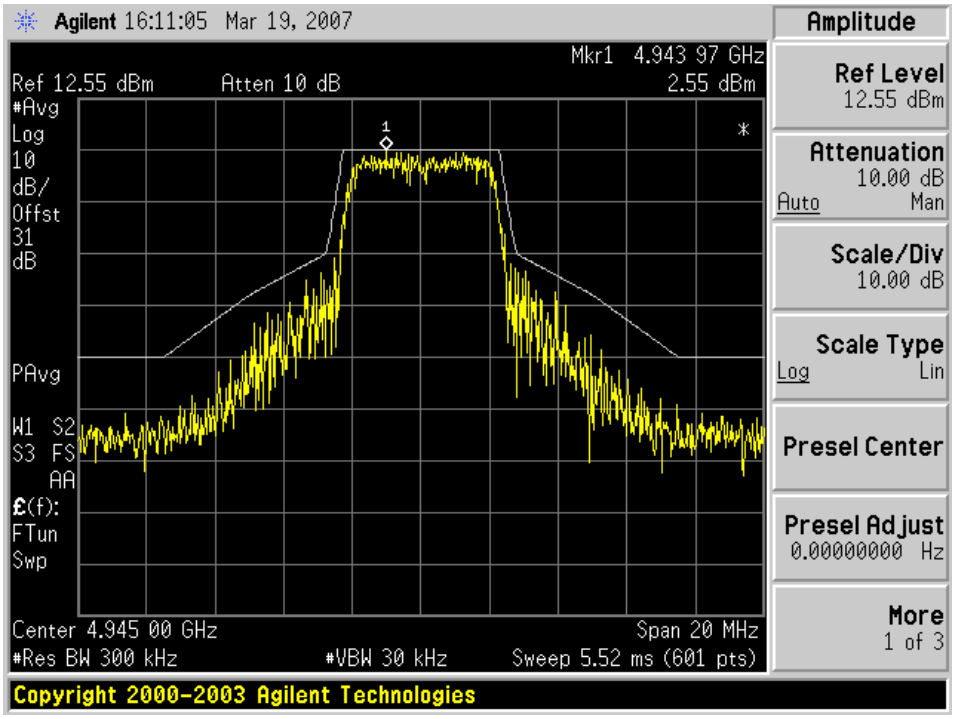
LOW 5MHz Channel Peak Output Power



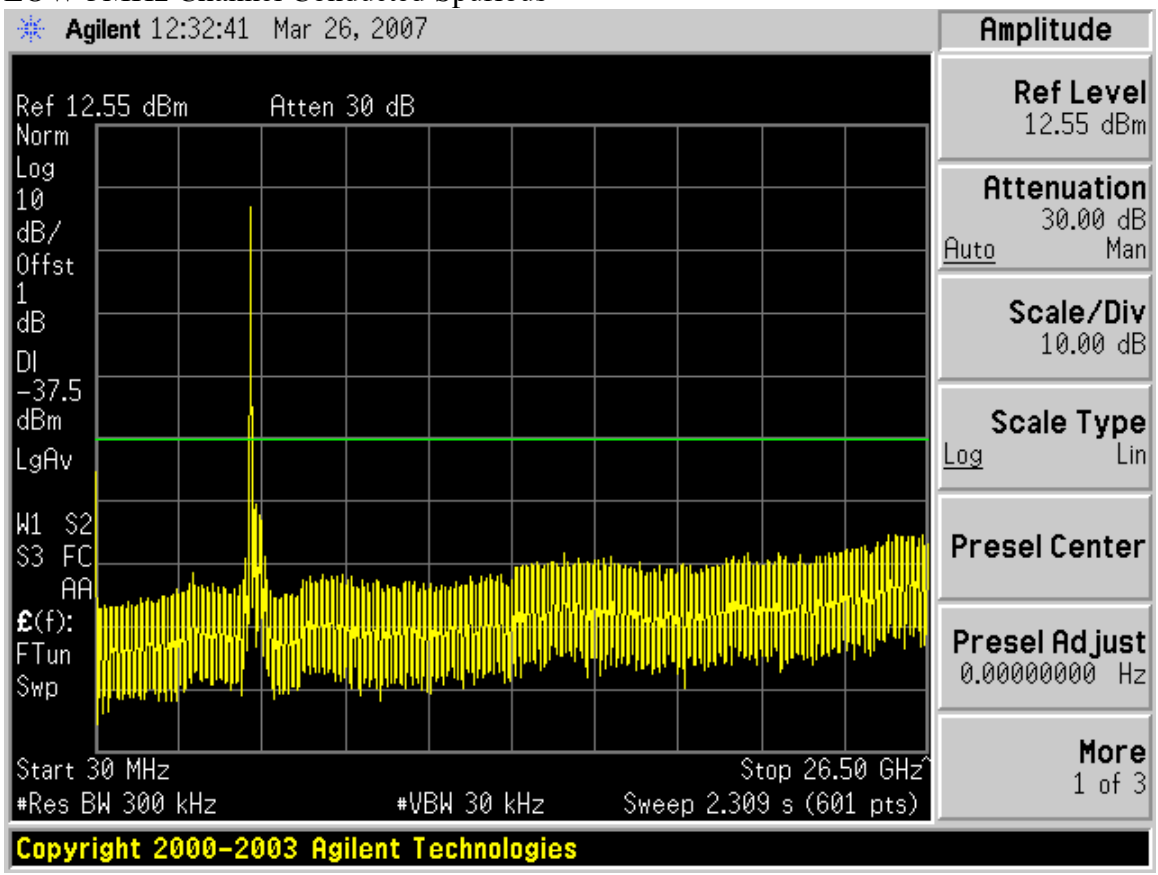
LOW 5MHz Channel PSD



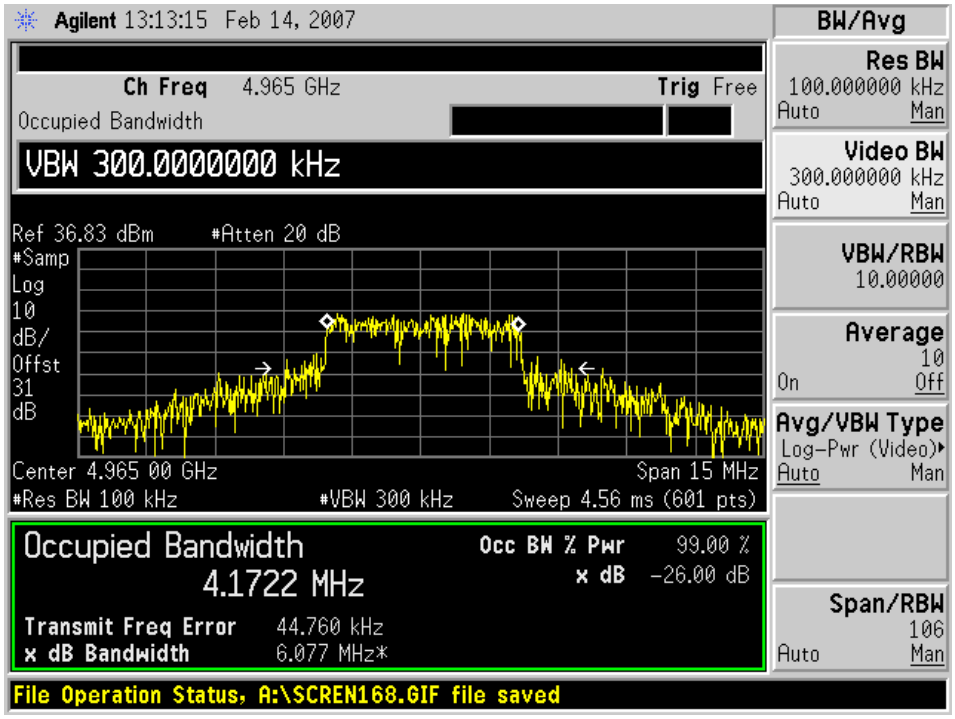
LOW 5MHz Channel Mask



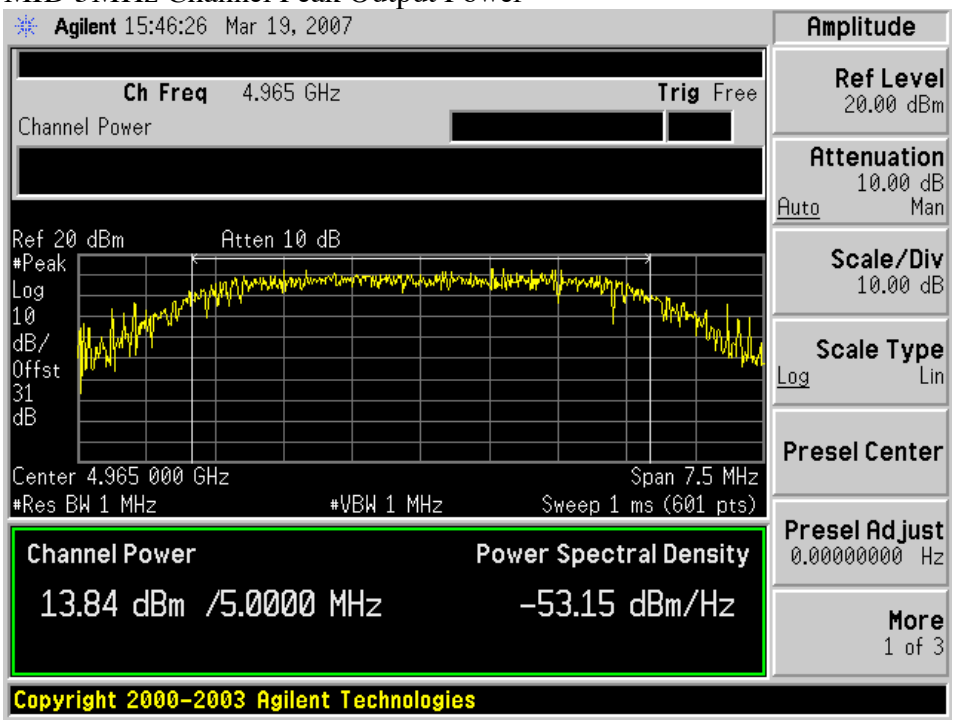
LOW 5MHz Channel Conducted Spurious



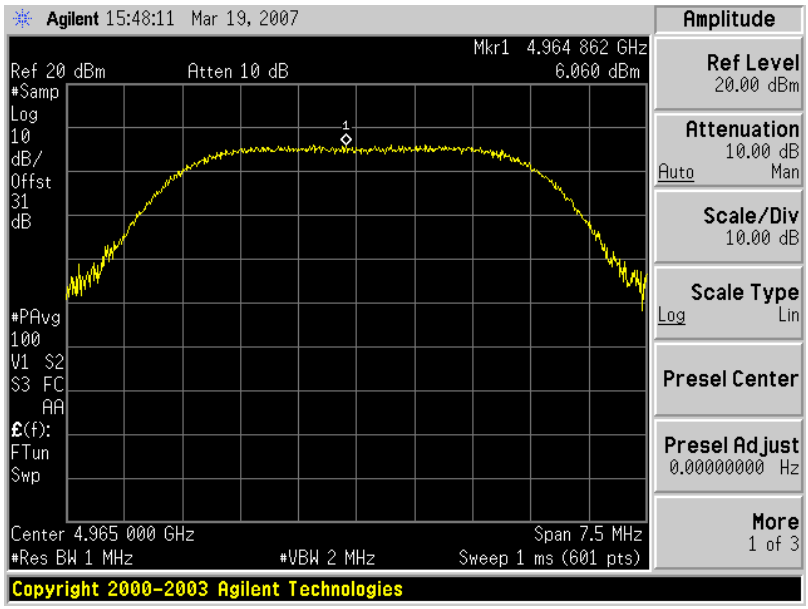
MID 5MHz Channel Occupied Bandwidth



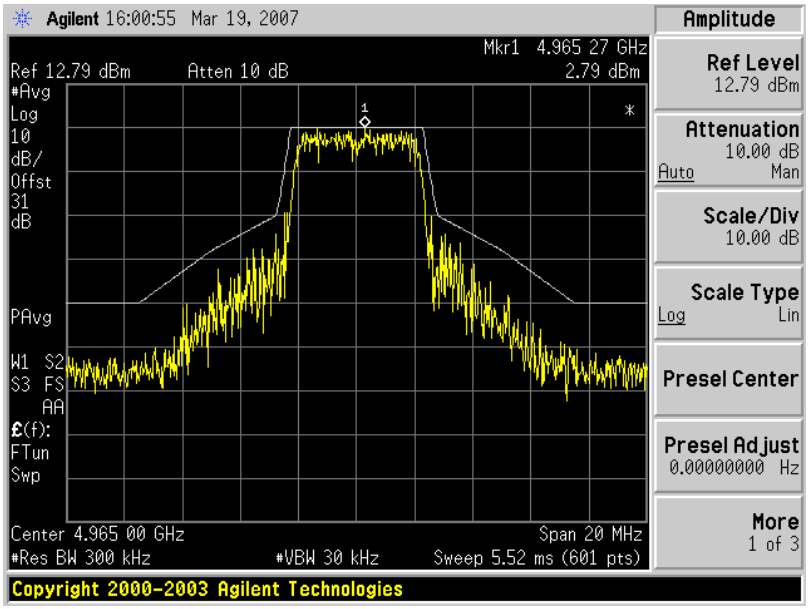
MID 5MHz Channel Peak Output Power



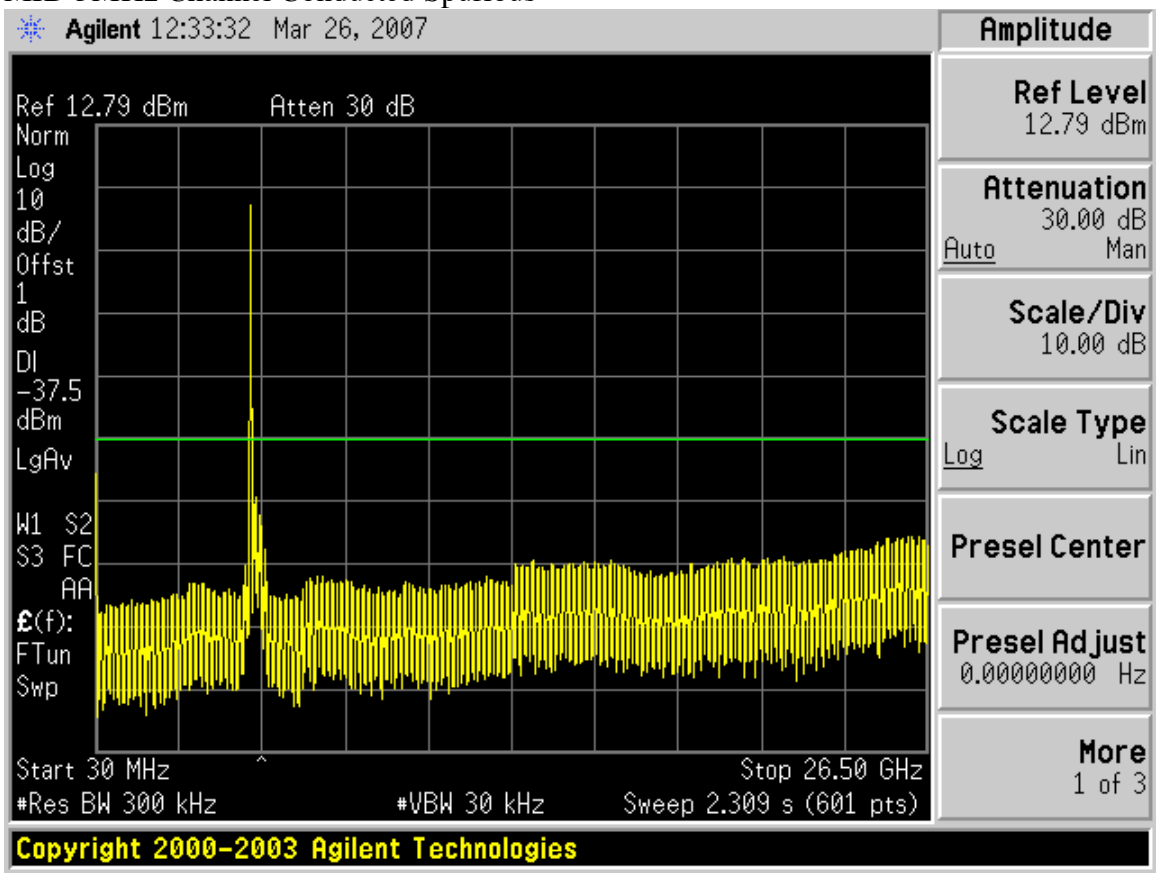
MID 5MHz Channel PSD



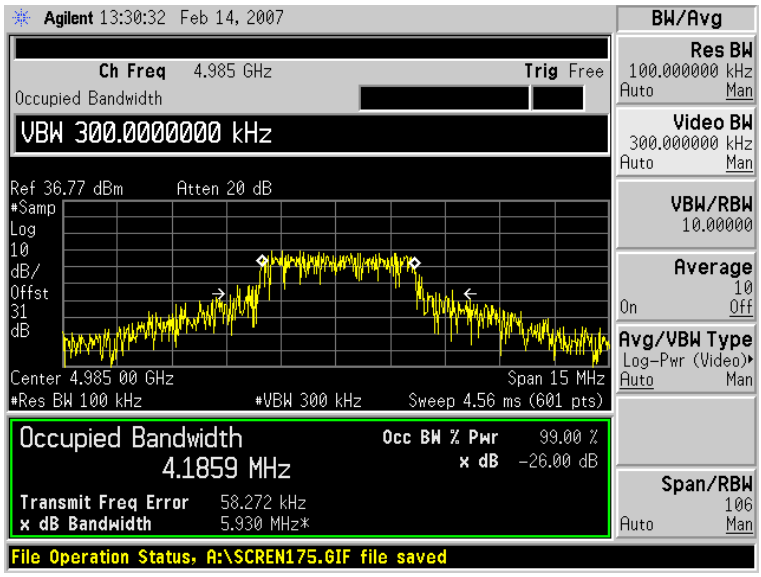
MID 5MHz Channel Mask



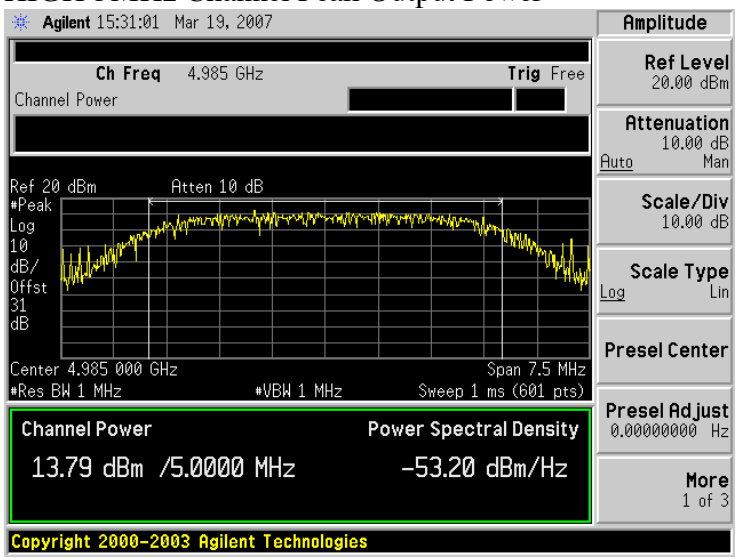
MID 5MHz Channel Conducted Spurious



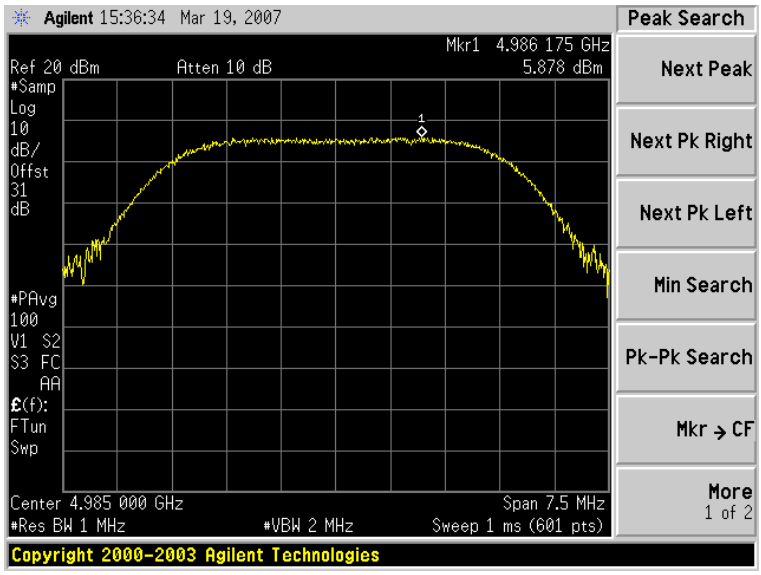
HIGH 5MHz Channel Occupied Bandwidth



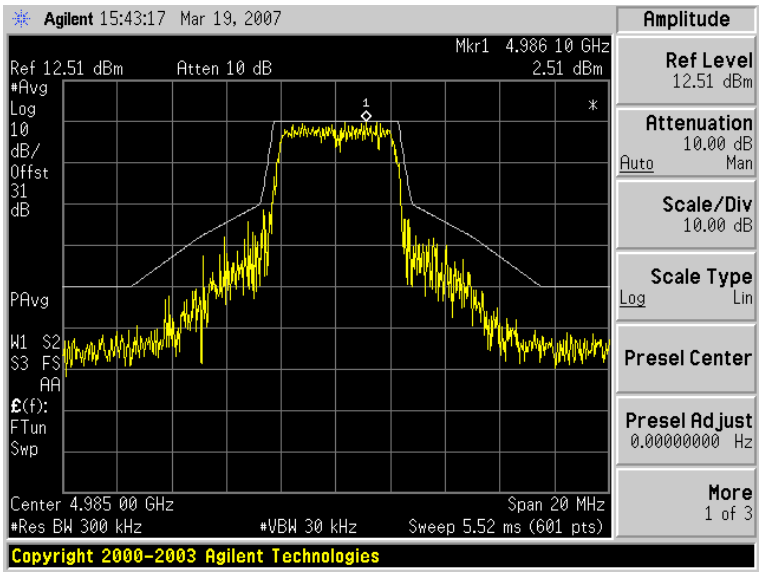
HIGH 5MHz Channel Peak Output Power



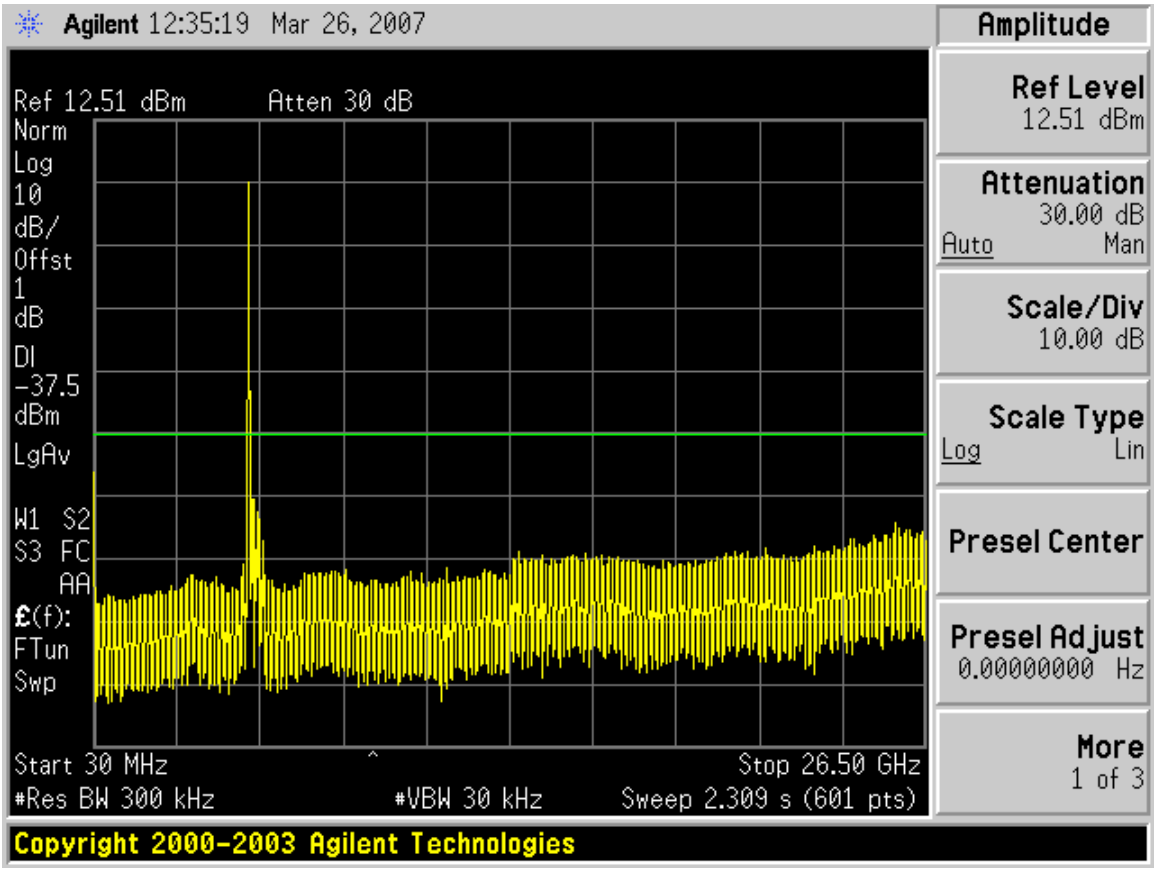
HIGH 5MHz Channel PSD



HIGH 5MHz Channel Mask

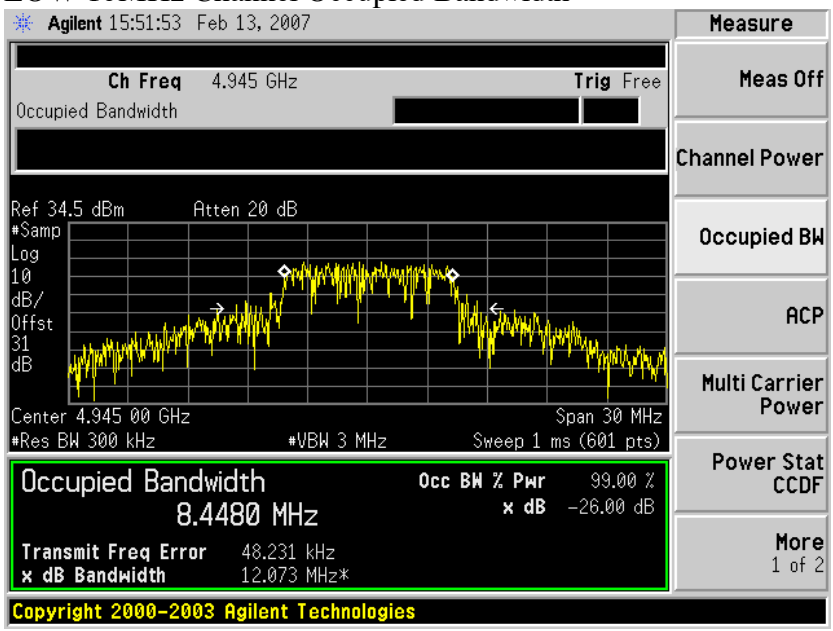


HIGH 5MHz Conducted Spurious

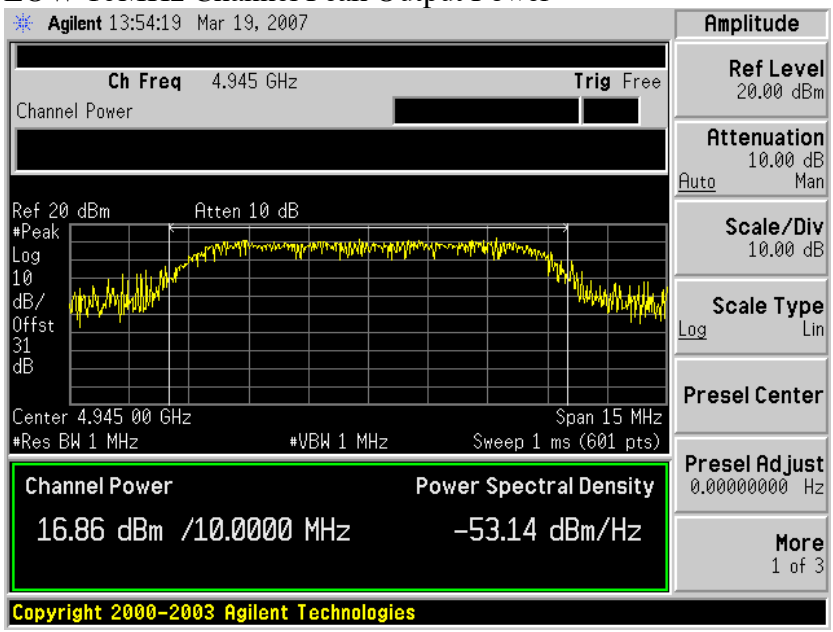


10 MHz Channels

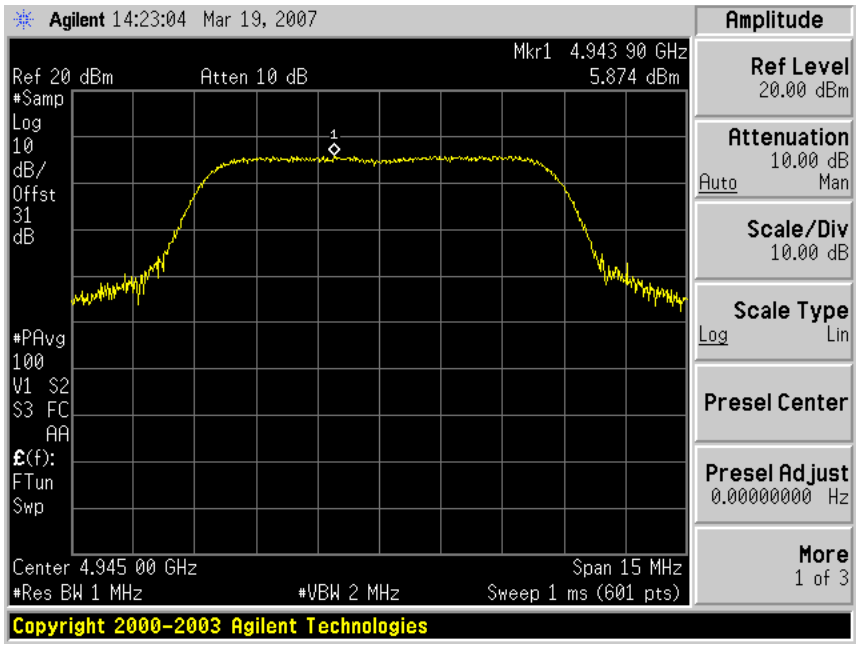
LOW 10MHz Channel Occupied Bandwidth



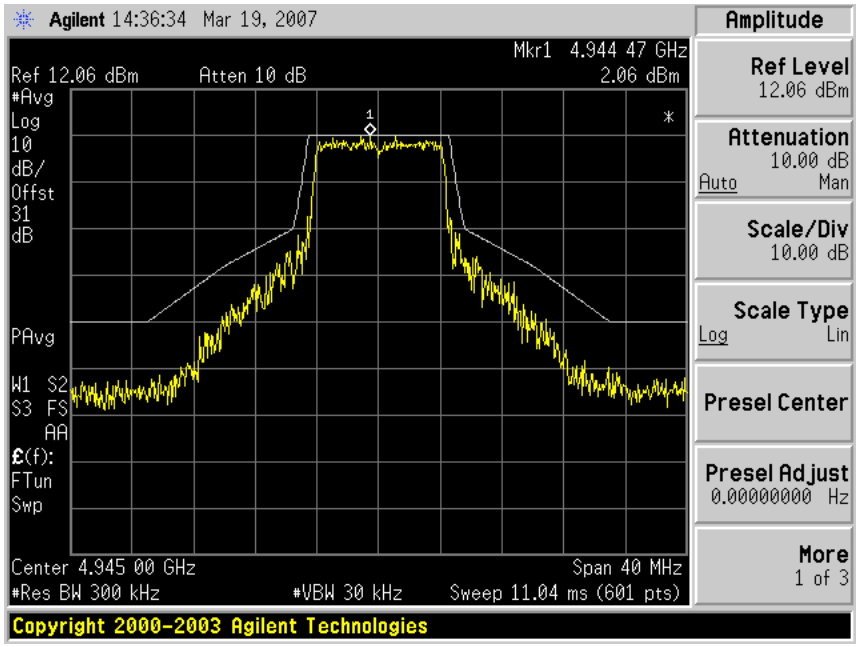
LOW 10MHz Channel Peak Output Power



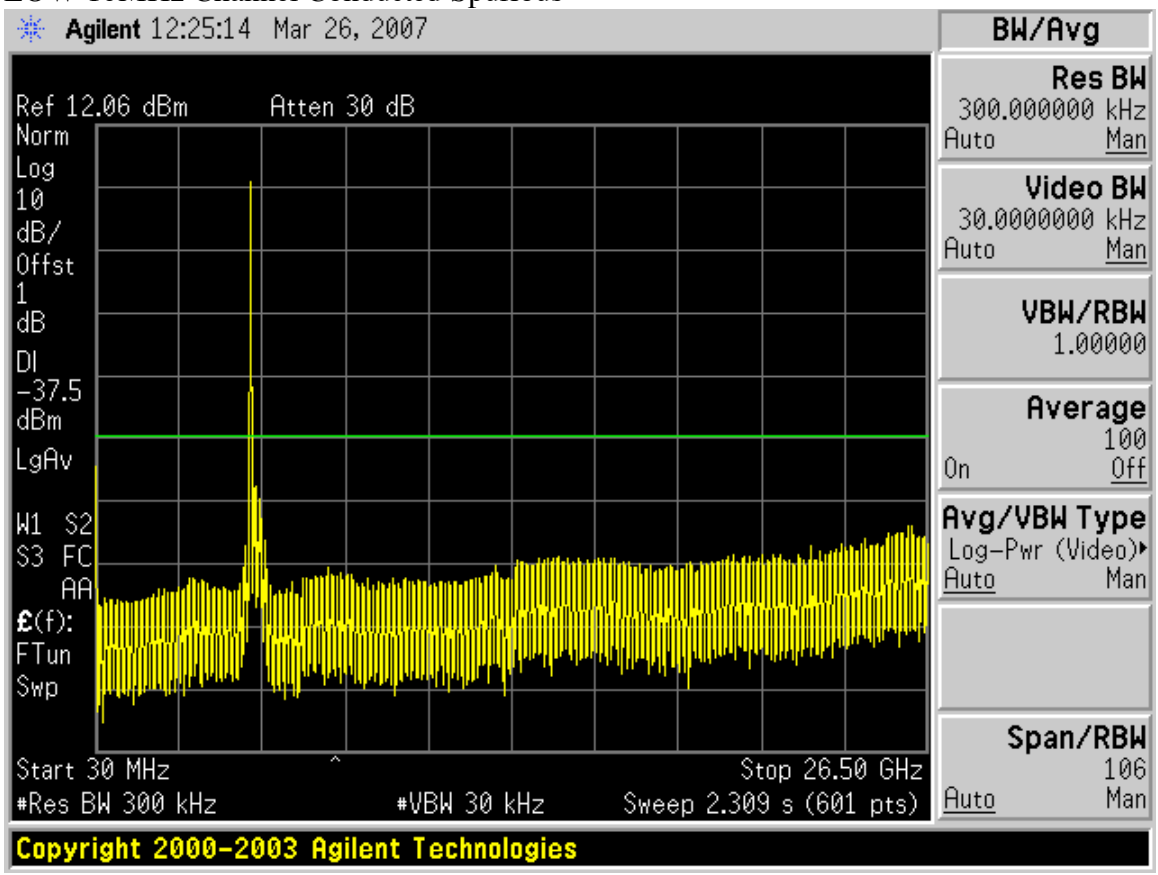
LOW 10MHz Channel PSD



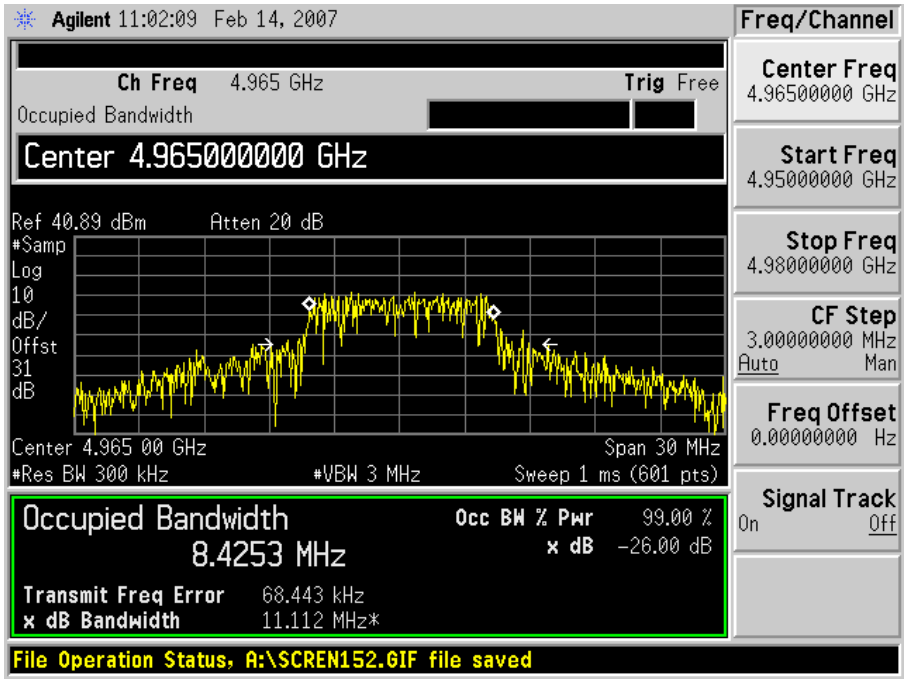
LOW 10MHz Channel Mask



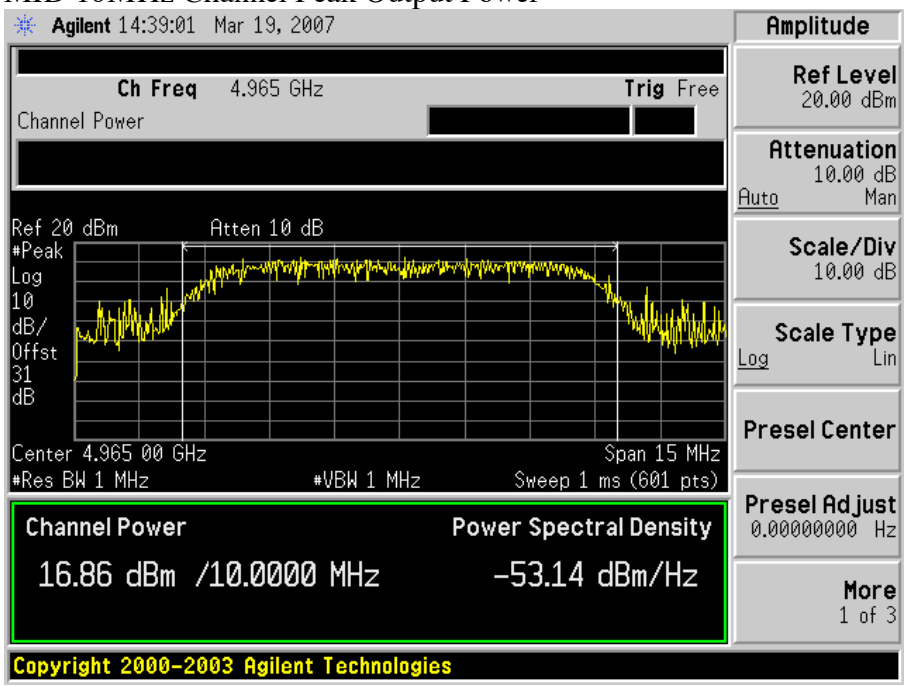
LOW 10MHz Channel Conducted Spurious



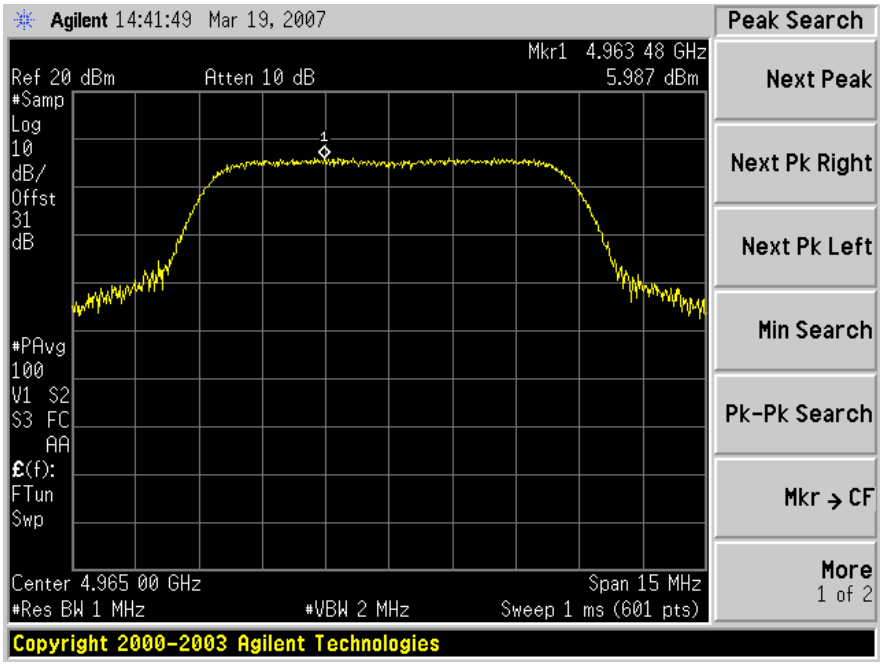
MID 10MHz Channel Occupied Bandwidth



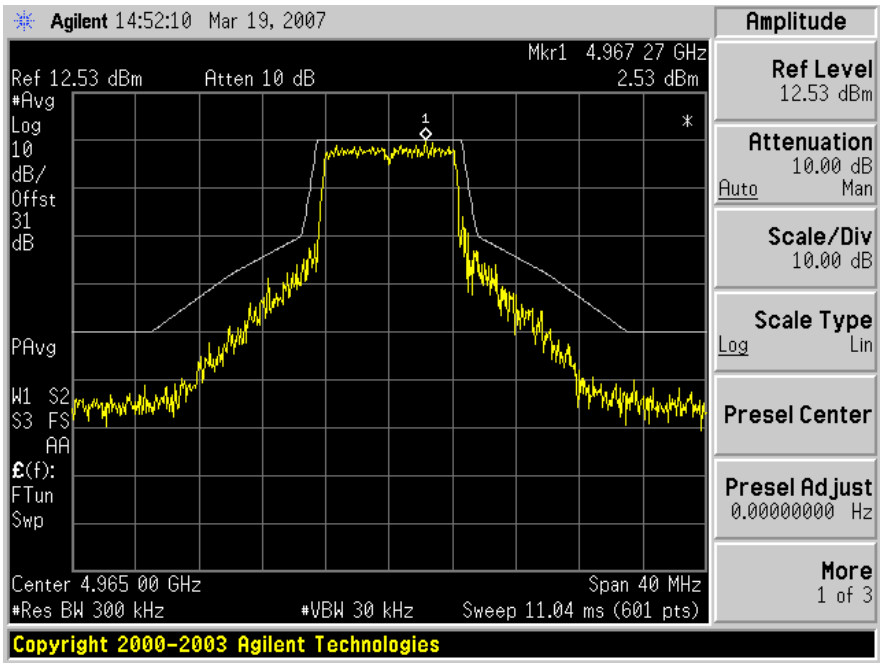
MID 10MHz Channel Peak Output Power



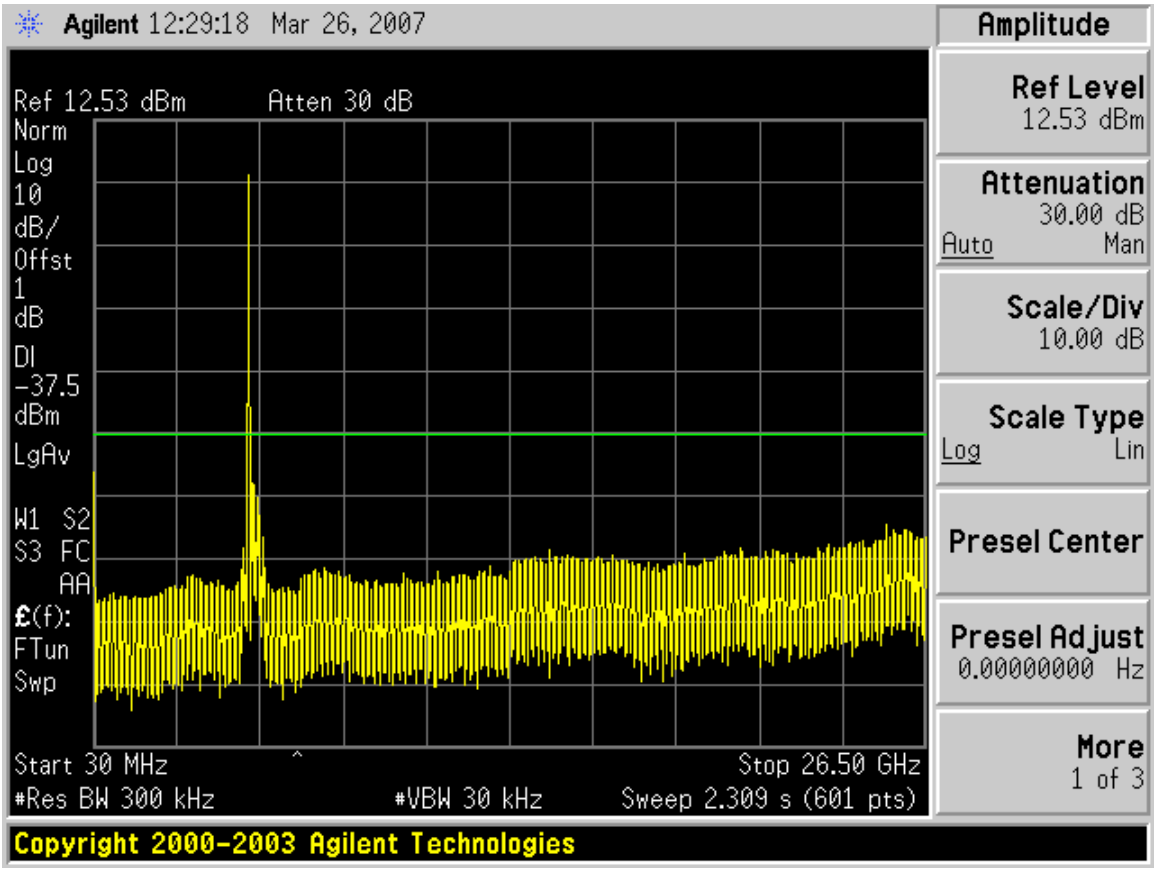
MID 10MHz Channel PSD



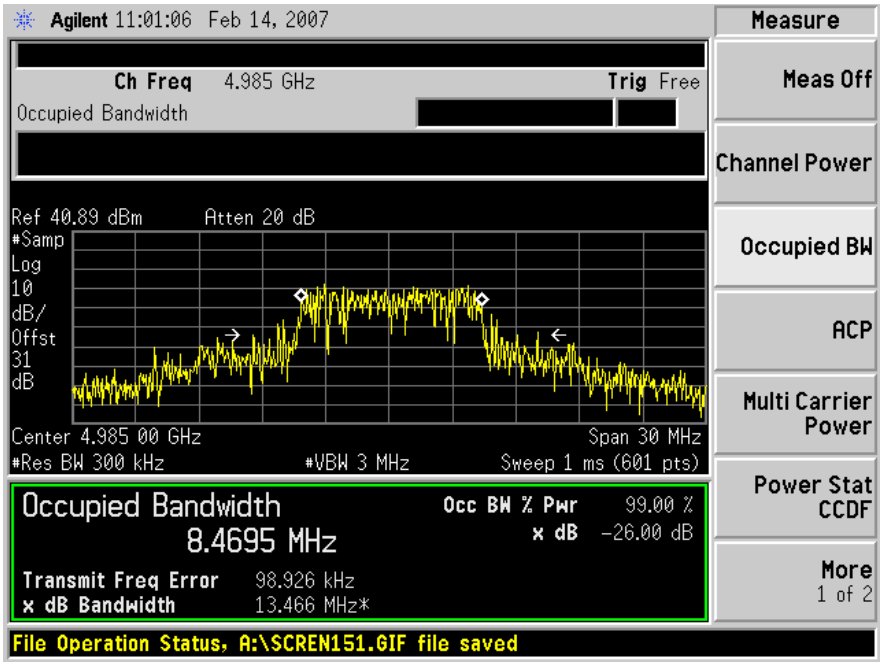
MID 10MHz Channel Mask



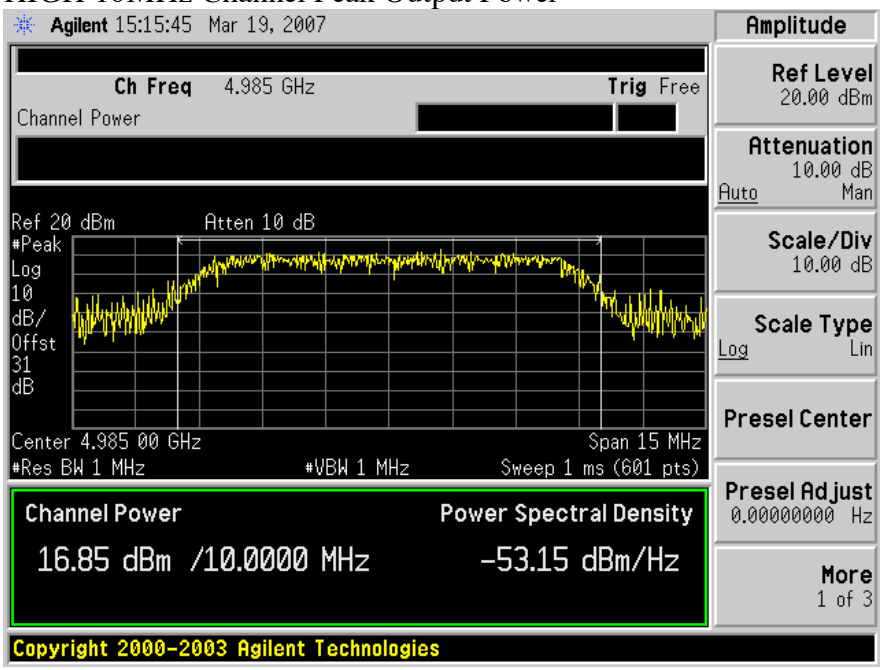
MID 10MHz Channel Conducted Spurious



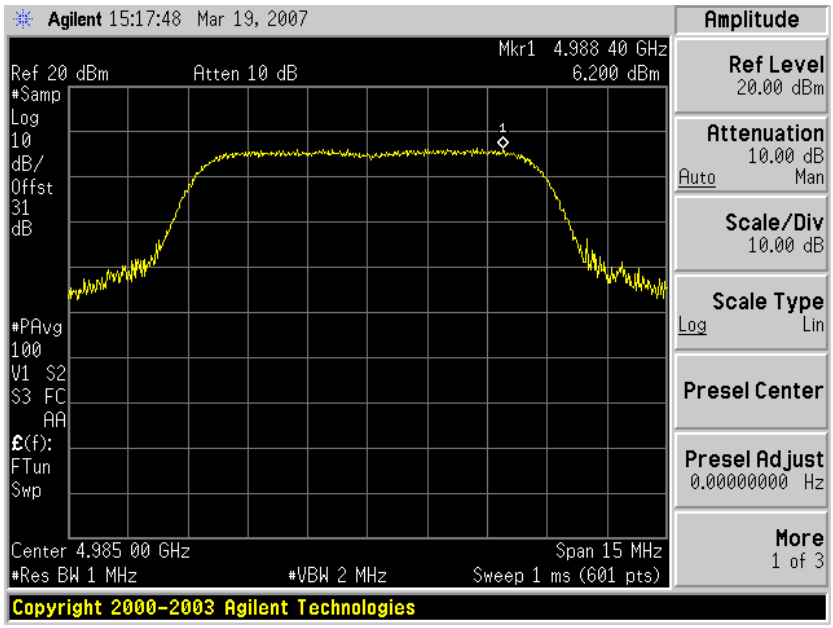
HIGH 10MHz Channel Occupied Bandwidth



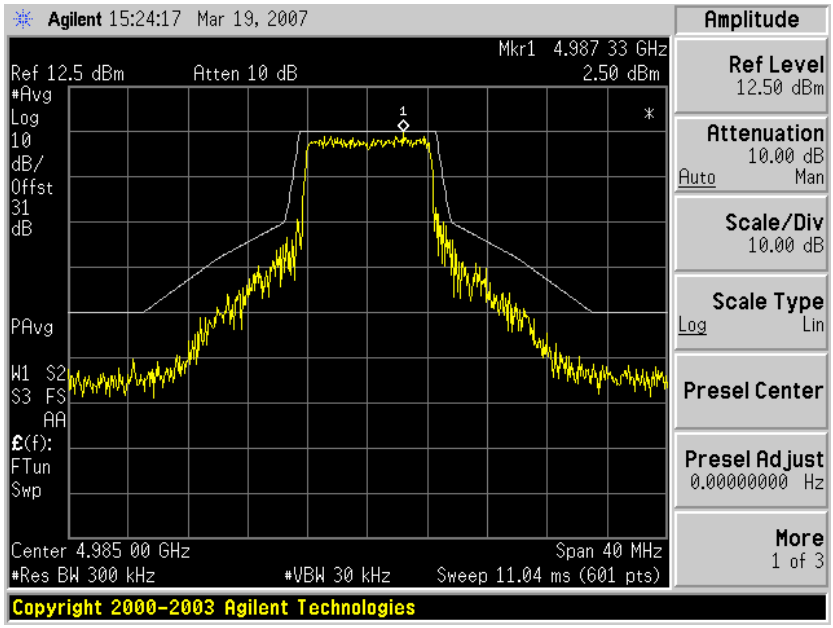
HIGH 10MHz Channel Peak Output Power



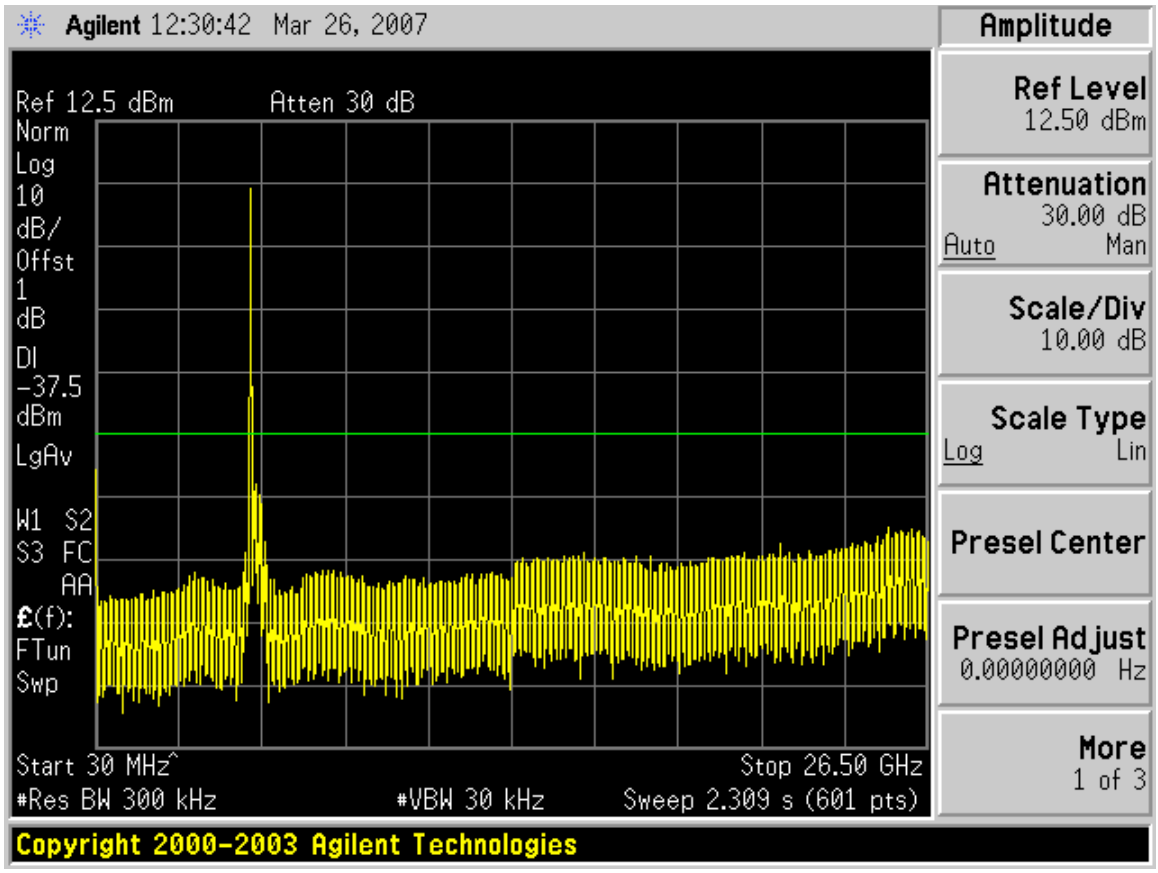
HIGH 10MHz Channel PSD



HIGH 10MHz Channel Mask

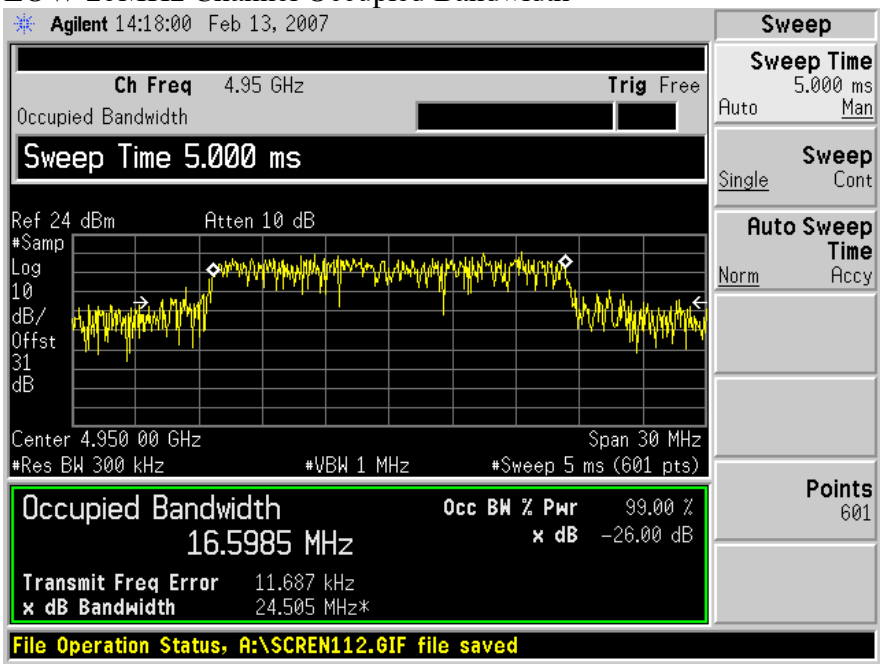


HIGH 10MHz Channel Conducted Spurious

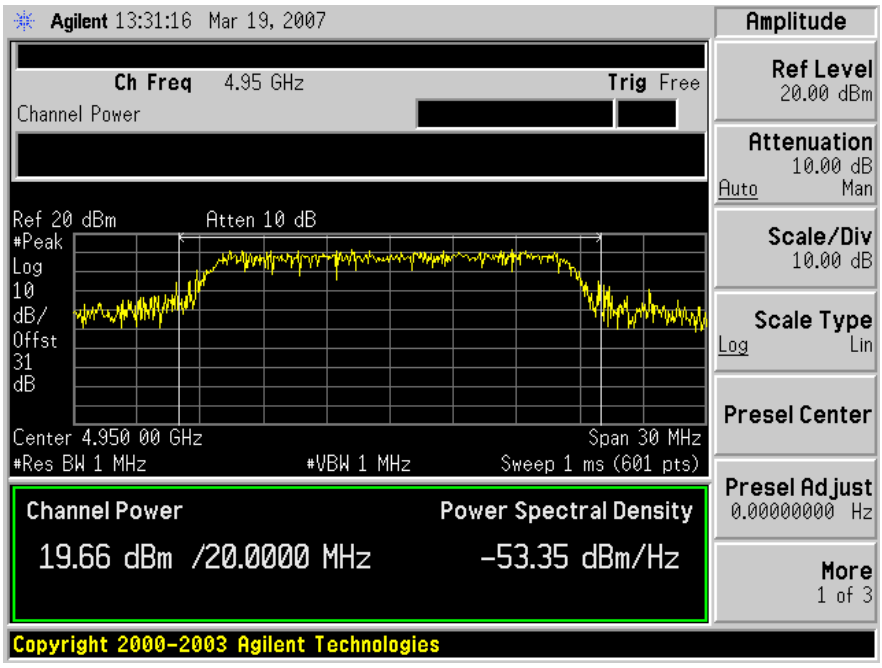


20 MHz channel data

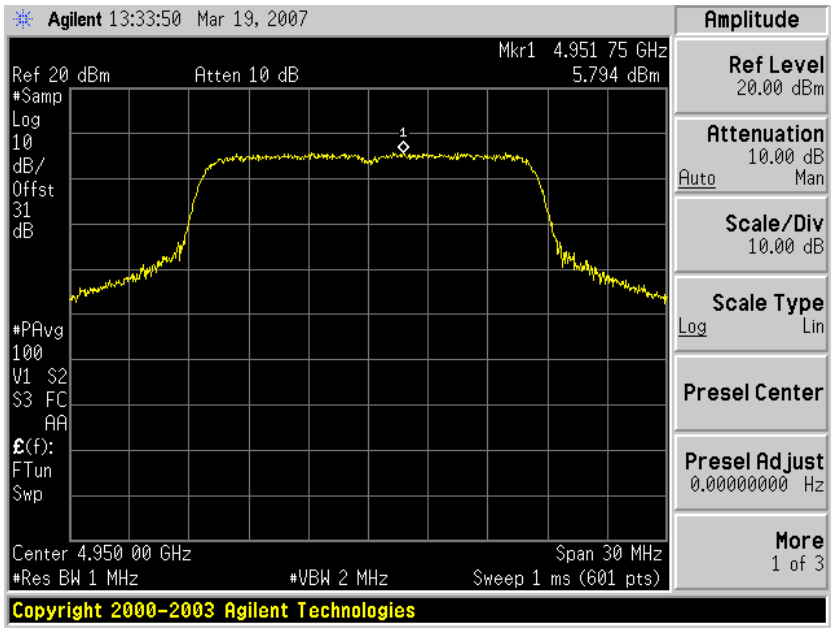
LOW 20MHz Channel Occupied Bandwidth



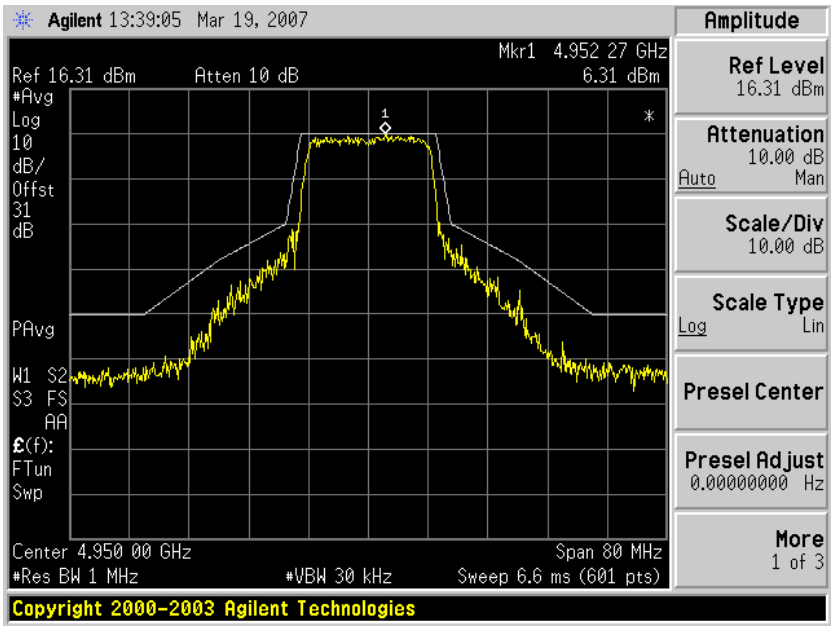
LOW 20MHz Channel Peak Output Power



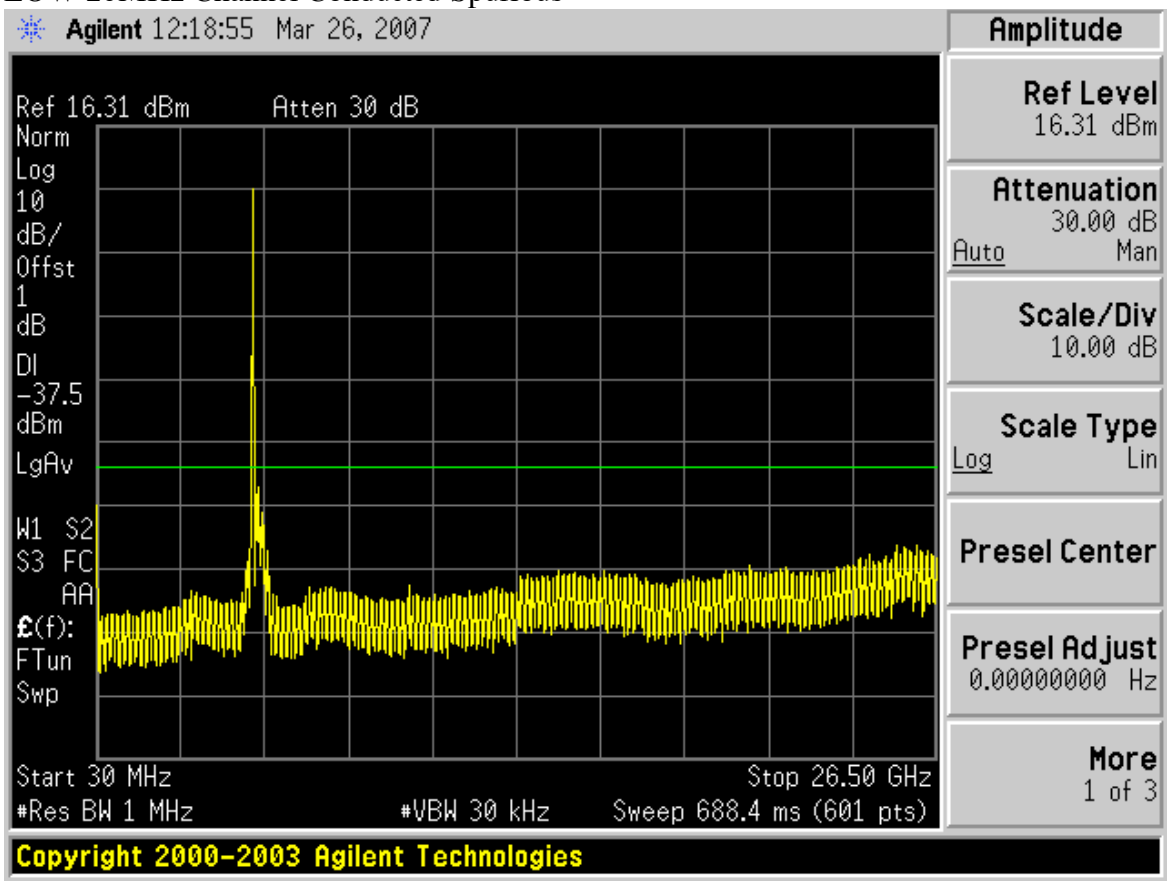
LOW 20MHz Channel PSD



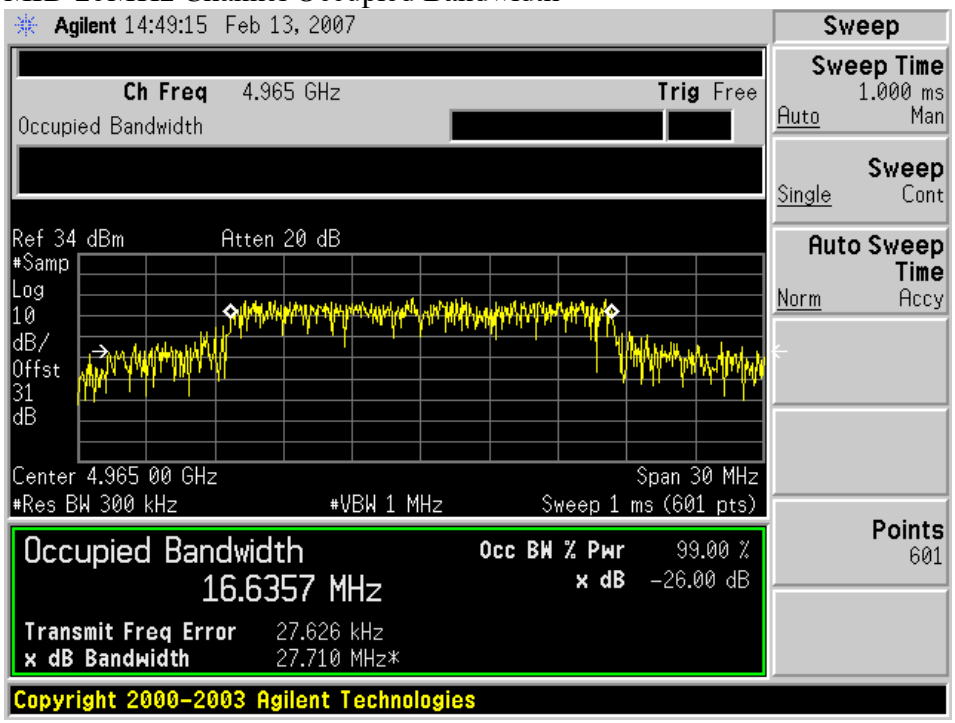
LOW 20MHz Channel Mask



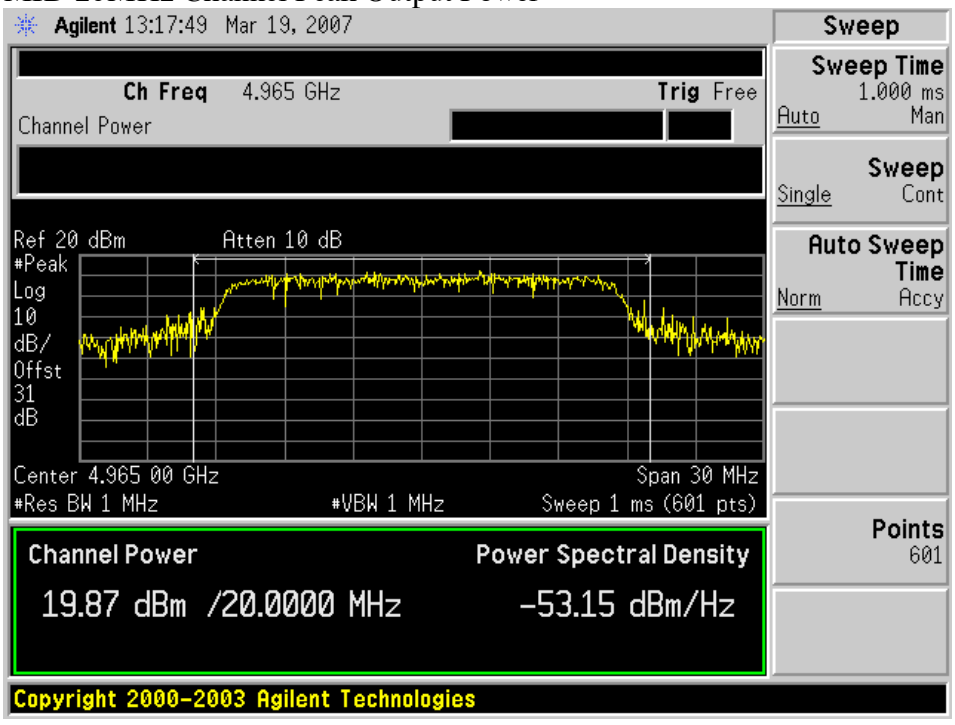
LOW 20MHz Channel Conducted Spurious



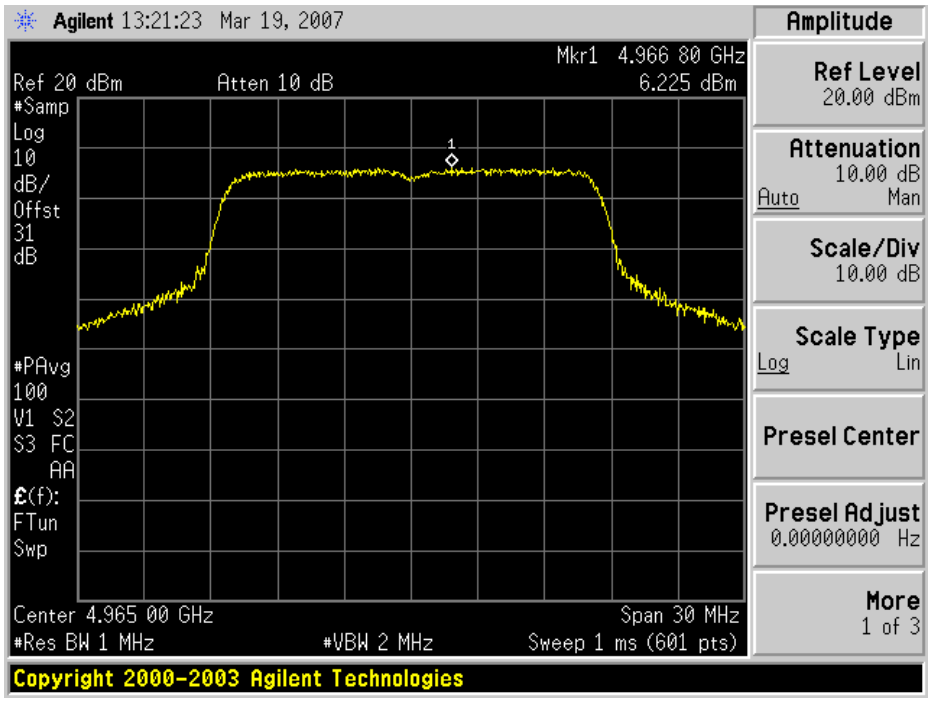
MID 20MHz Channel Occupied Bandwidth



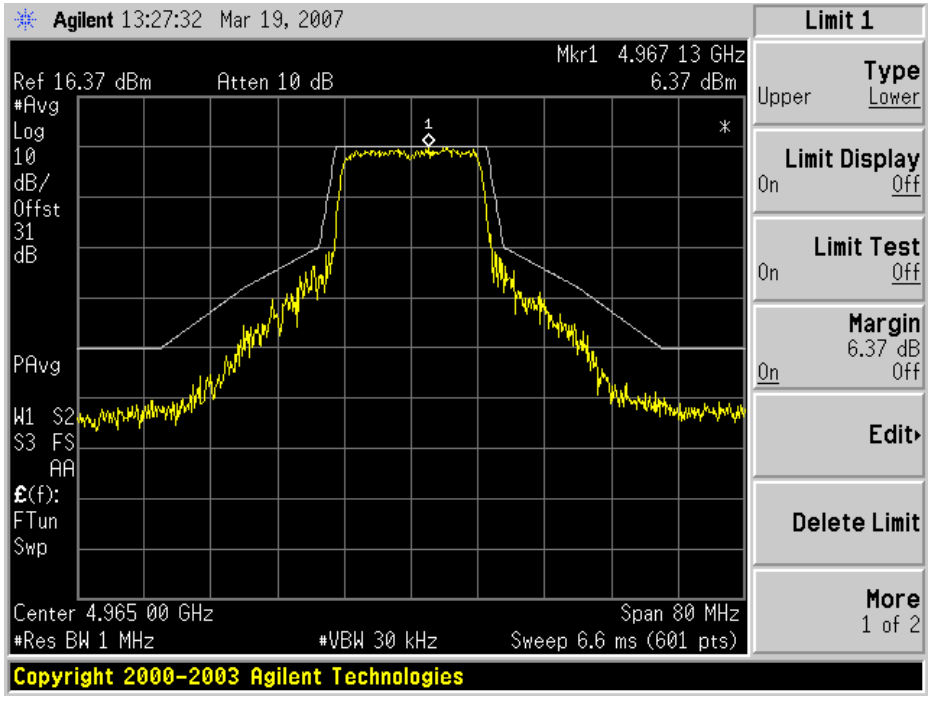
MID 20MHz Channel Peak Output Power



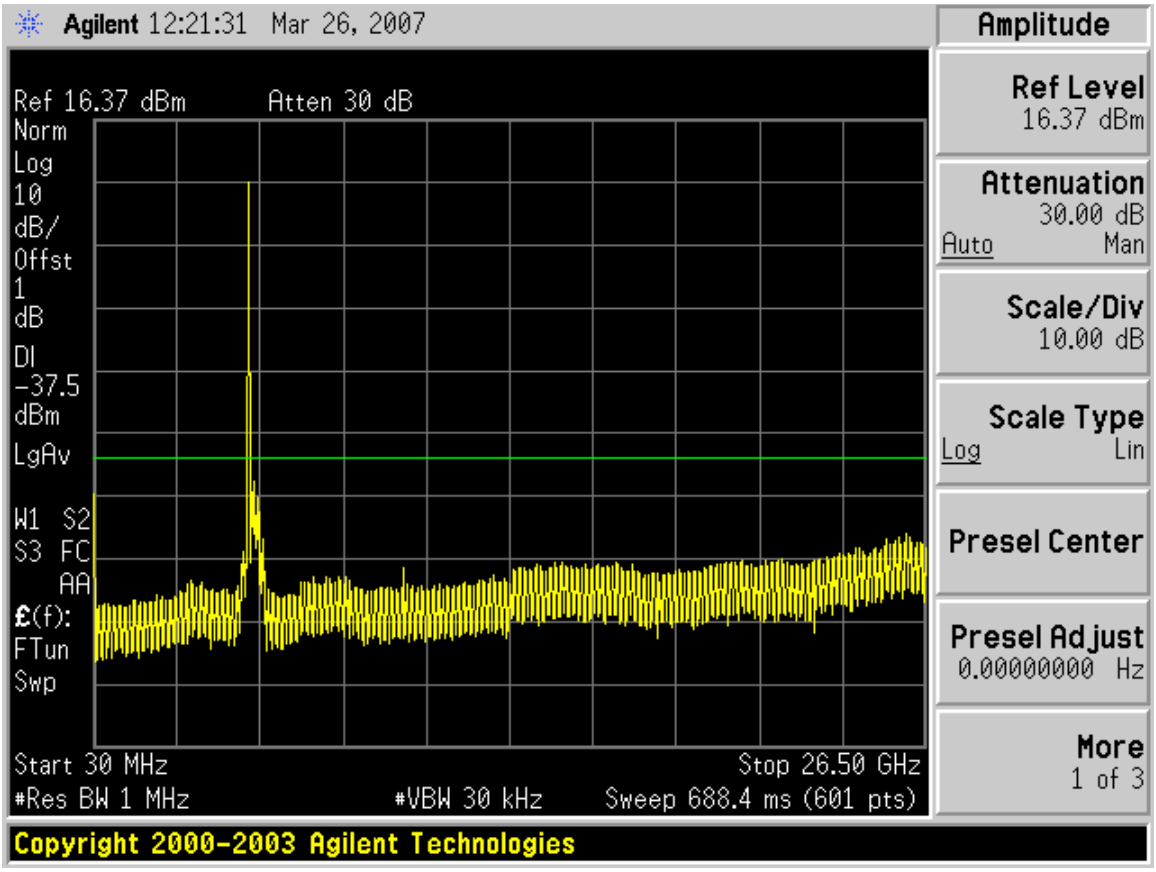
MID 20MHz Channel PSD



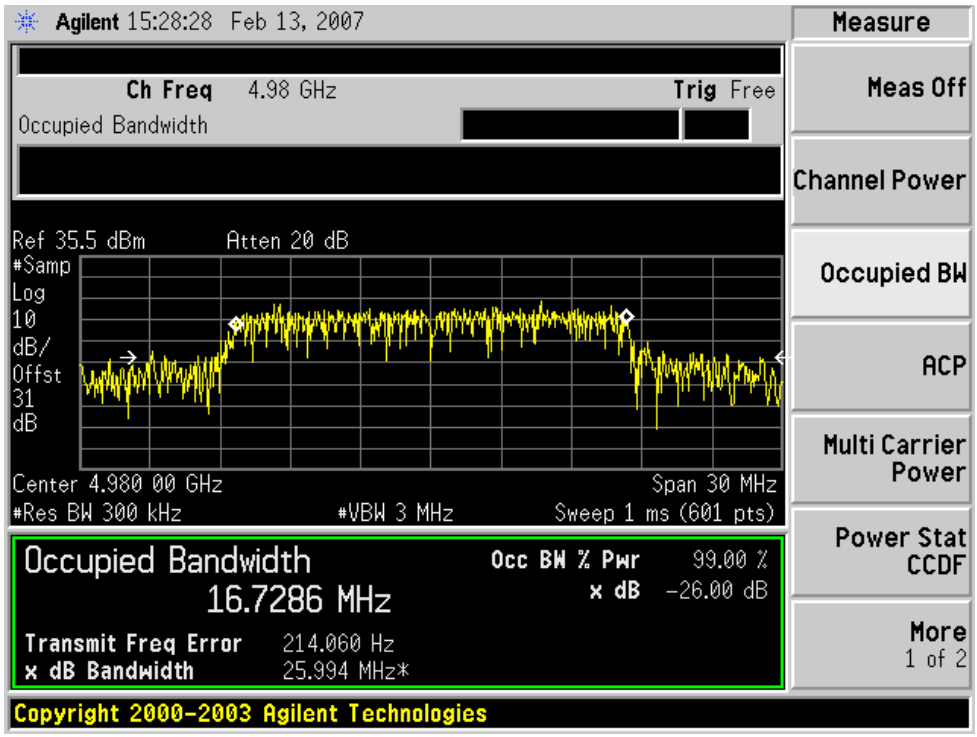
MID 20MHz Channel Mask



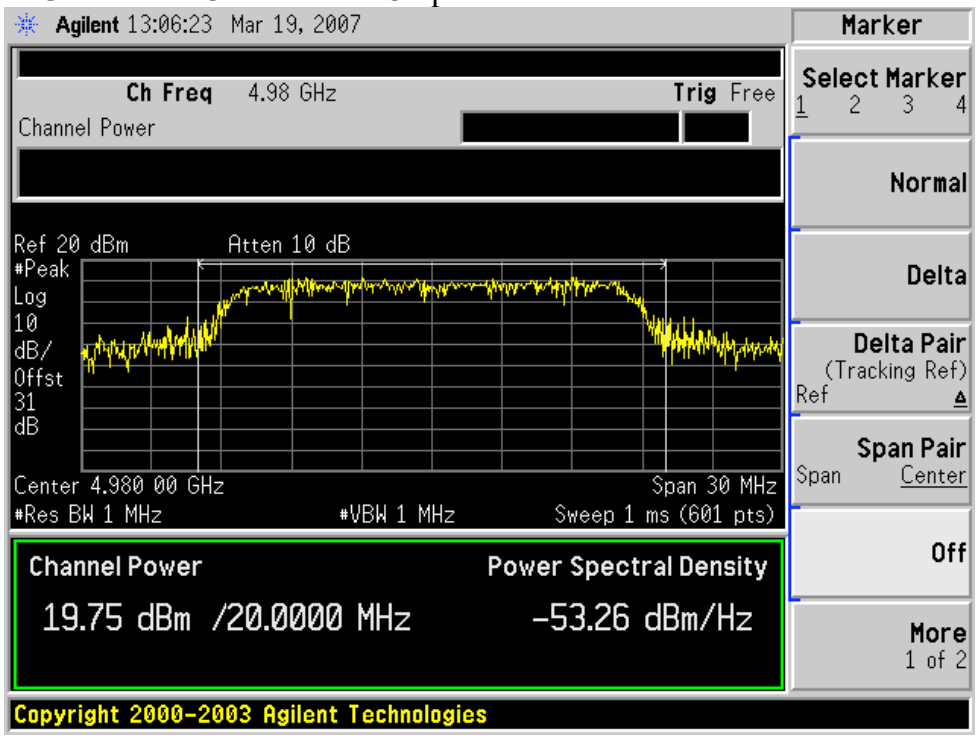
MID 20MHz Channel Conducted Spurious



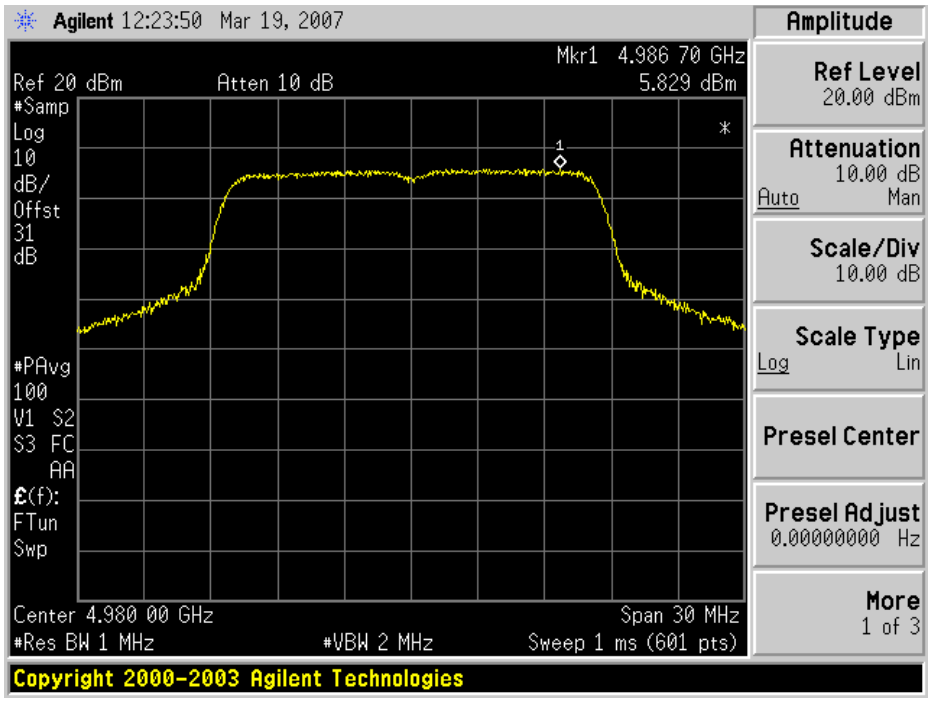
HIGH 20MHz Channel Occupied Bandwidth



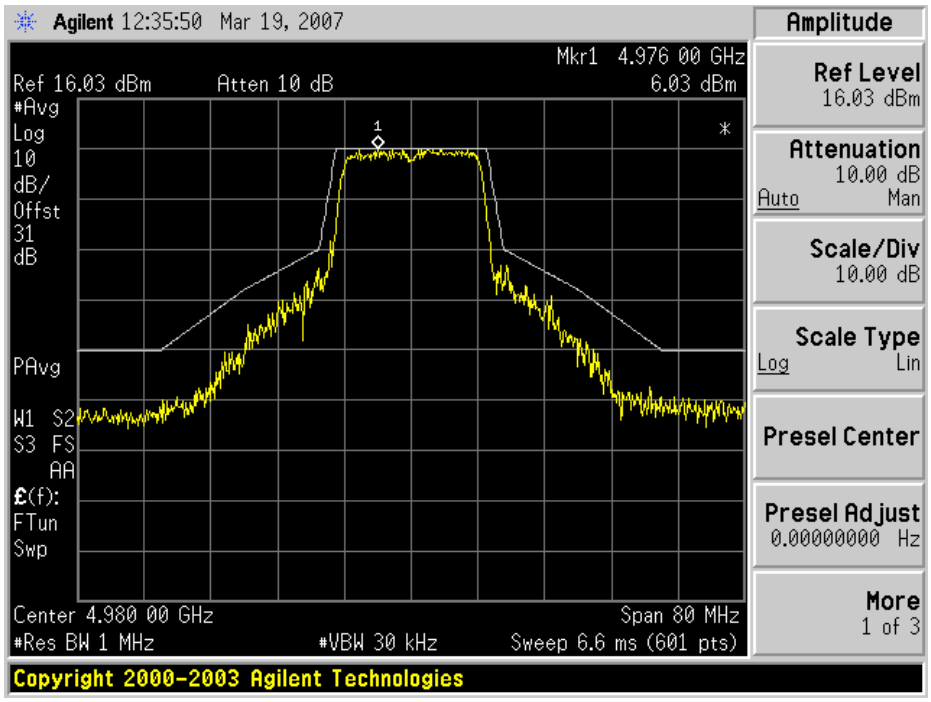
HIGH 20MHz Channel Peak Output Power



HIGH 20MHz Channel PSD



HIGH 20MHz Channel Mask



HIGH 20MHz Channel Conducted Spurious