

## Product Description and Operation Overview

### General Overview

The Aperto Networks MMDS band radio consists of a indoor unit (IDU) network interface and an outdoor unit (ODU) radio head. The IDU connects to the digital network via CAT5 cable. The IDU is connected to the ODU via shielded CAT5 cable for control and an RG6 with F connector for signal/data. (from user manual):

**Table 3-A Subscriber Site Cable Requirements**

| Connection — Qty                                                              | Cable Type          | Max. Length      | Connectors  |
|-------------------------------------------------------------------------------|---------------------|------------------|-------------|
| Ethernet (1)                                                                  | Cat 5               | 330 ft (100 m)   | RJ45 male   |
| Radio Signal (1)                                                              | Quad Shield Coaxial | 165 ft. (50 m) * | Male F type |
| Radio Control (1)                                                             | Shielded Cat 5      | 165 ft. (50 m) * | RJ45 male   |
| * These two cables run over the same path, and so will be of the same length. |                     |                  |             |

The outdoor radio can be configured as either customer premises equipment (CPE) or as a base station unit (BSU). The radios are identical, except that the CPE uses an integral antenna, and the BSU has an antenna connector for separately mounted antennas.

The base station IDU and subscriber IDU are different, but the output signals are the same and the radio heads used with them are the same except as outlined above.

A description of the theory of operation and product configuration is found in an attachment to this application and report.

## SPECIFICATIONS

### ODU RF Head

Frequency range: 2503 - 2683 MHz  
 Channelization: 6 MHz channels, 1 MHz spacings  
 Power output: 17 dBm  
 Modulation type: QPSK, 16QAM

### IDU IF Head

Frequency range: 44 MHz IF  
 10 MHz reference clock

Data transfer rate, air link: Up to 20 MBAs in a 6 MHz channel

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

## FCC CERTIFICATION INFORMATION

The following information is in accordance with FCC Rules, 47CFR Part 2.

**2.1033(c)1**      Applicant:    Aperto Networks  
                                        1635 S. Main Street  
                                        Milpitas CA 95037

2.1033(c)2 FCC ID: PS6SR1000-A1

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

**2.1033(c)4** Emission type: QPSK and 16QAM  
Up to 20 MBPS

Emission designator: 5M70G7W

**2.1033(c)5** Frequency range: 2503 - 2683 MHz (6 MHz channel, 1 MHz spacings)

### 2.1033(c)6 Range of Operating Power

0 - 17 dBm

### 2.1033(c)7 Maximum Power Rating

17 dBm

Maximum allowed per 21.909(g)2: 2 watts (33 dBm)

### 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 in separate attachment. RF channel selection is achieved via control and set-up PC software via GUI.

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

Complete 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**

Refer to theory of operation, separate attachment

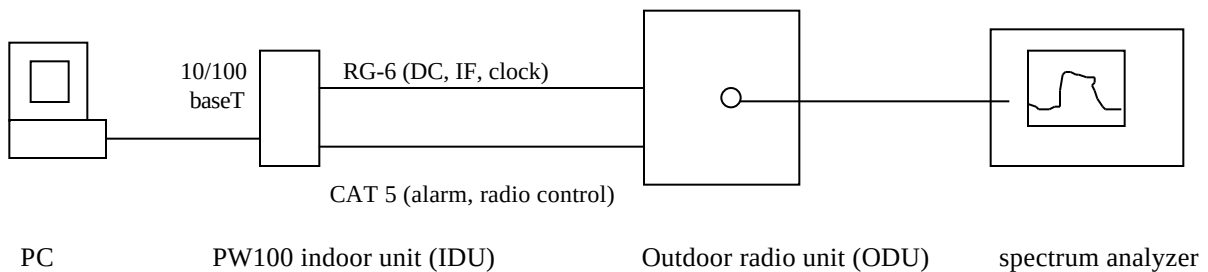
**2.1033(c)14 Test Data per 2.1046 – 2.1057****(2) RF Output Power Measurements****Measurement equipment used:**

Agilent E4440A Spectrum Analyzer

Coaxial cable (worst case 1.9 dB attenuation at 26 GHz )

**Test set-up:**

**Figure 1**

**Test Procedures**

1. Set the IDU channel bandwidth parameters and output level to desired values. Output level is chosen to maximize RF output level from ODU.
2. Connect cable between E4440A and ODU antenna output port. Activate Channel Power subroutine via E4440A soft keys, plot and record results.

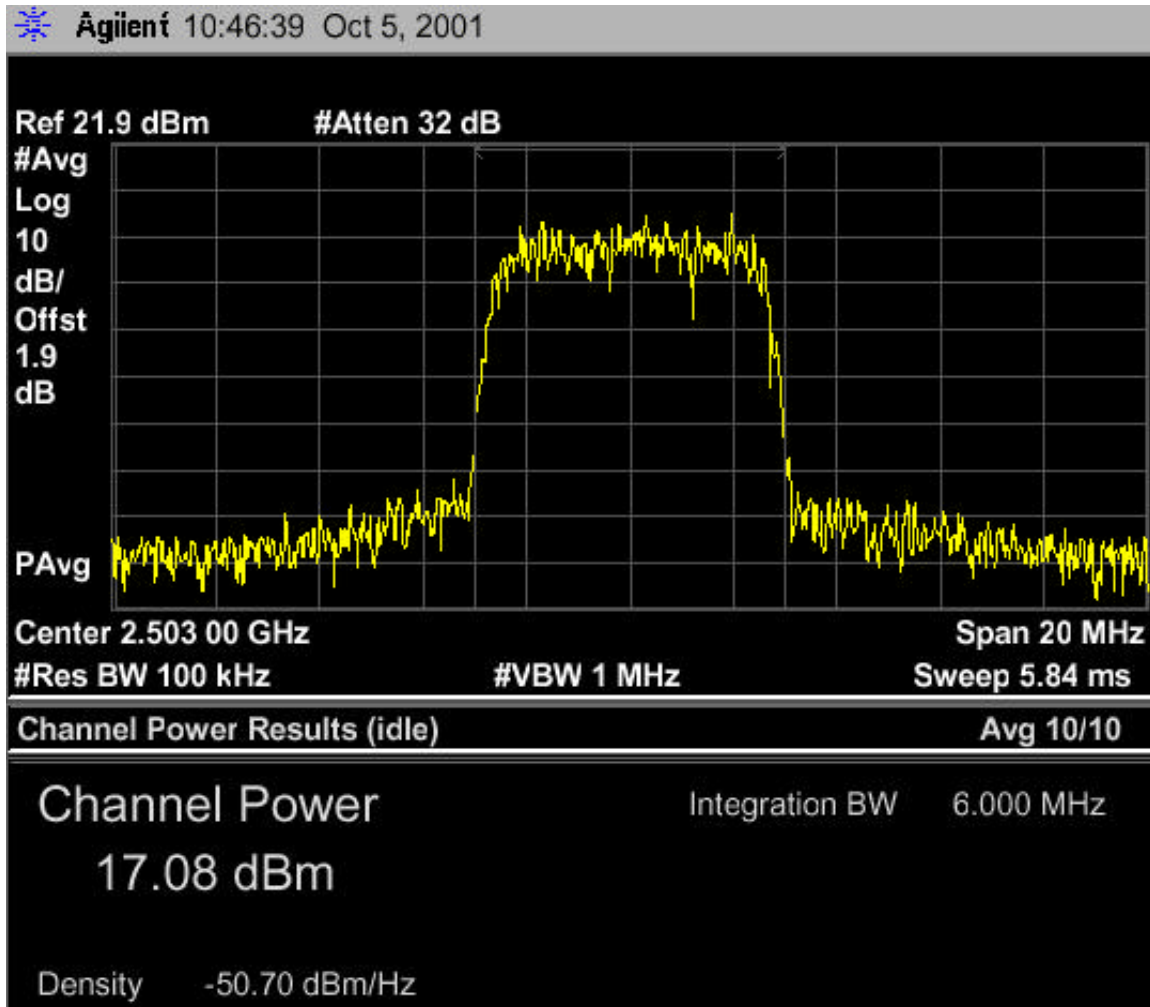
**Test Results**

| F(MHz) | P requested | P delivered |
|--------|-------------|-------------|
| 2503   | 17 dBm      | 17.08 dBm   |
| 2593   | 17 dBm      | 17.03 dBm   |
| 2683   | 17 dBm      | 17.05 dBm   |

IDU output signal to ODU input port is shown below also.

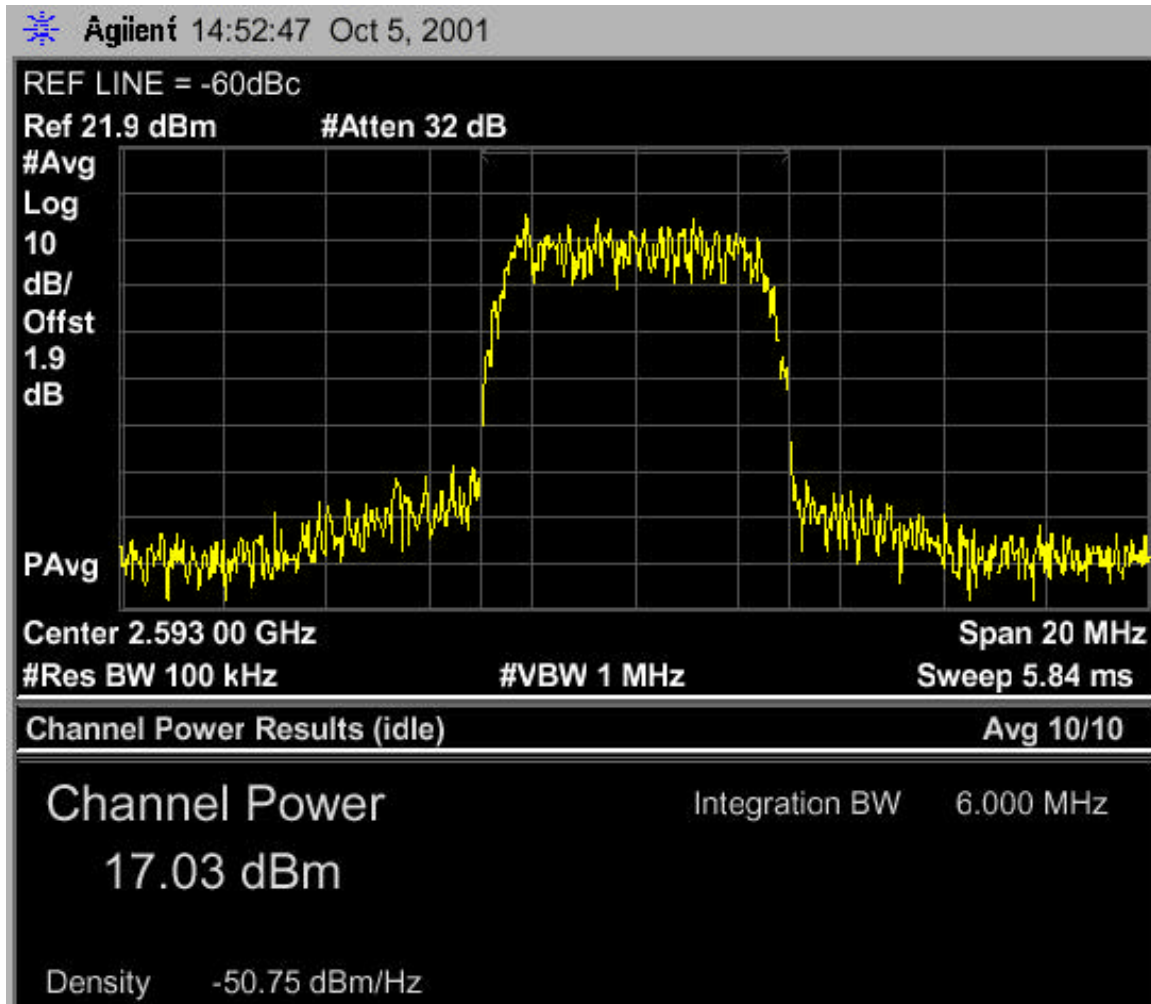
# Power Output Spectrum Analyzer Graphs

fo = 2503 MHz (low channel)

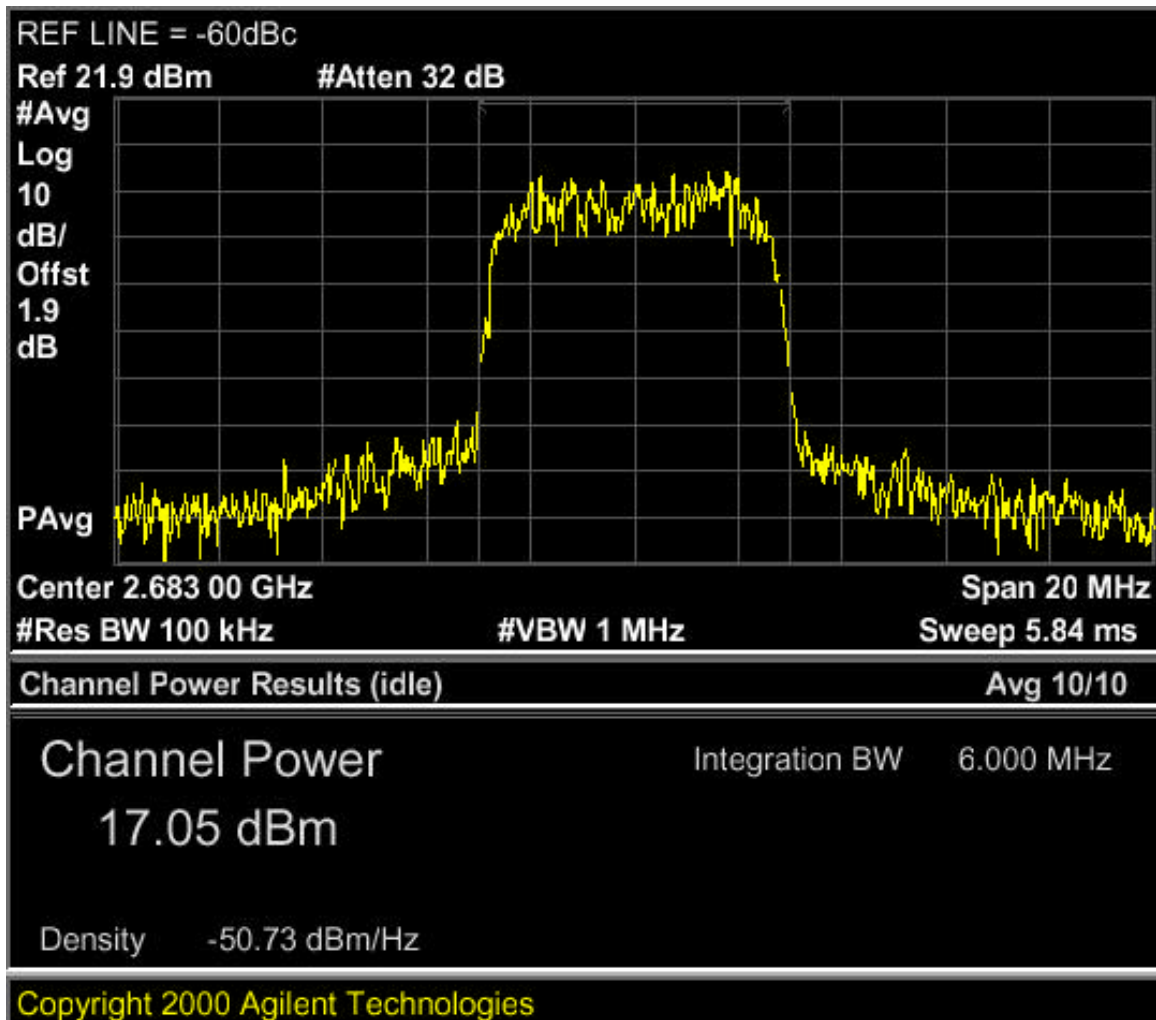


# Power Output Spectrum Analyzer Graphs

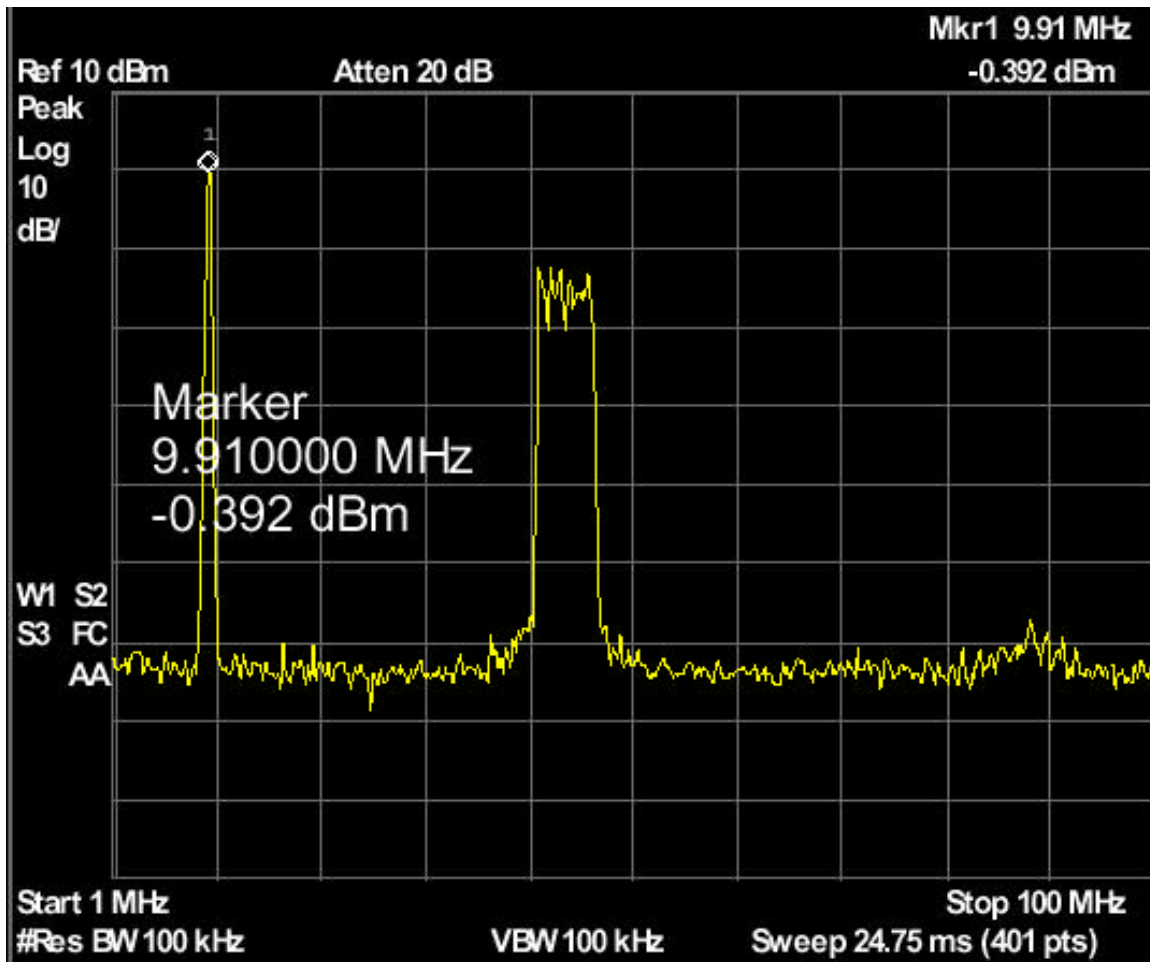
fo = 2593 MHz (middle channel)



**Power Output Spectrum Analyzer Graphs**  
**fo = 2683 MHz (highest channel)**



## IDU Output (10 MHz reference and 44 MHz IF)



**Section 2.1047 Modulation Characteristics****Measurement equipment used:**

Agilent E4440A Spectrum Analyzer  
Coaxial cable (worst case 1.9 dB attenuation at 26 GHz )

**Test set-up:**

Refer to Fig. 1.

**Test Procedures**

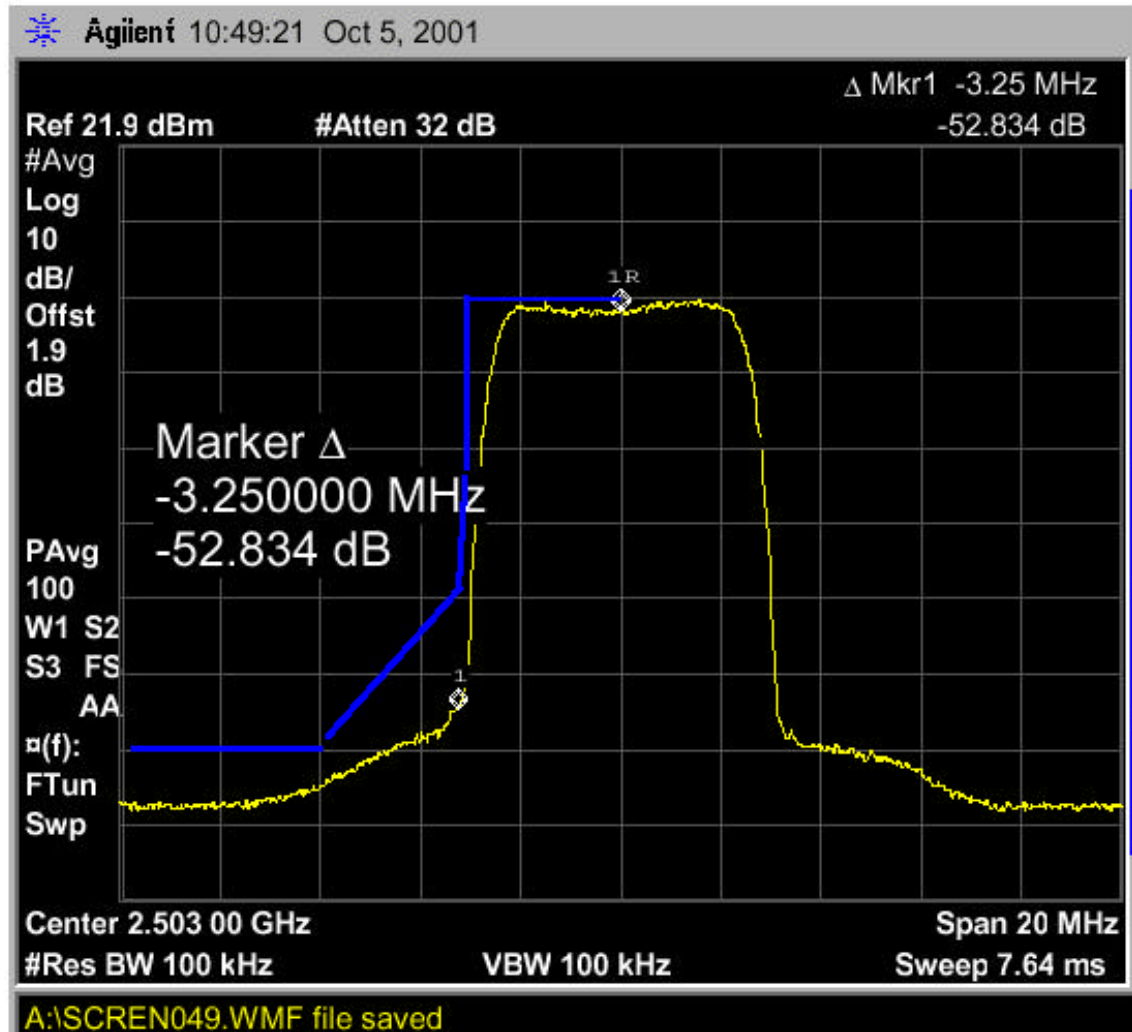
Software was run to produce a continuous pseudo random bit stream (prbs). Parameters were set to produce maximum IF output at the IDU.

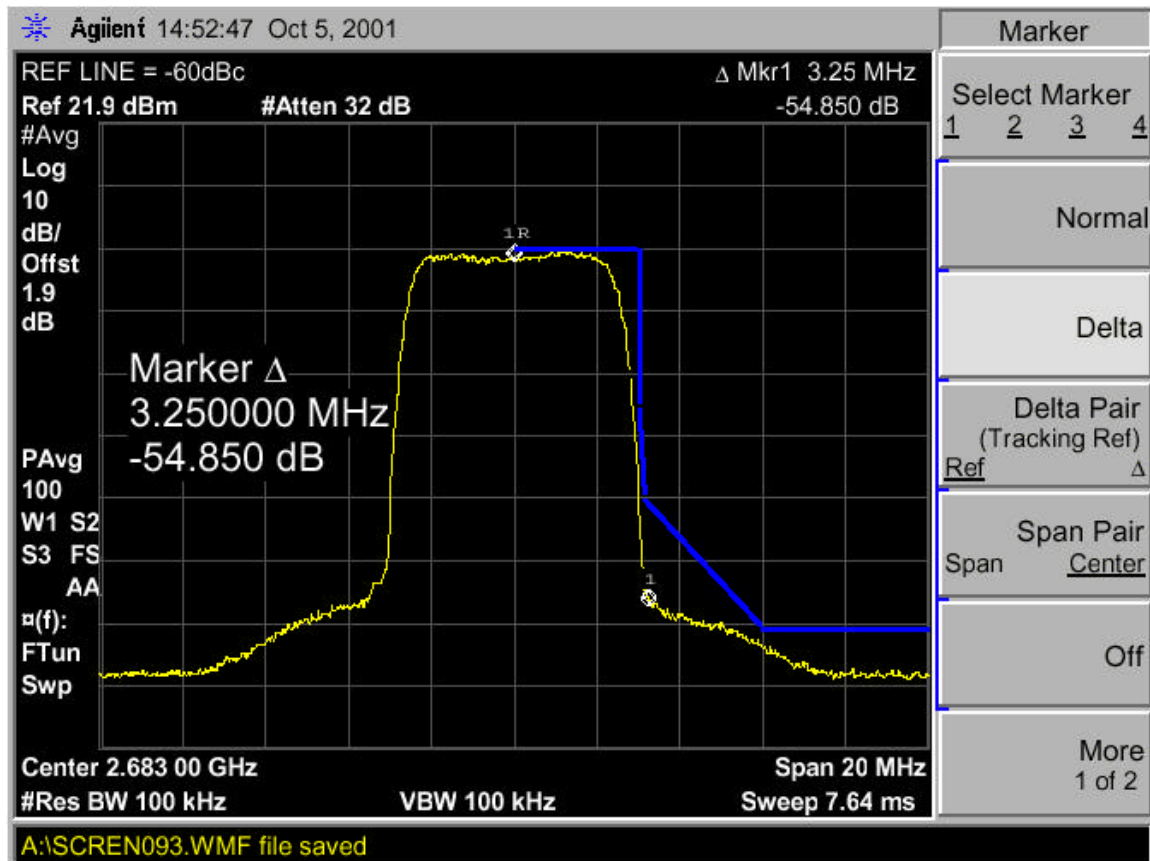
**Test Results**

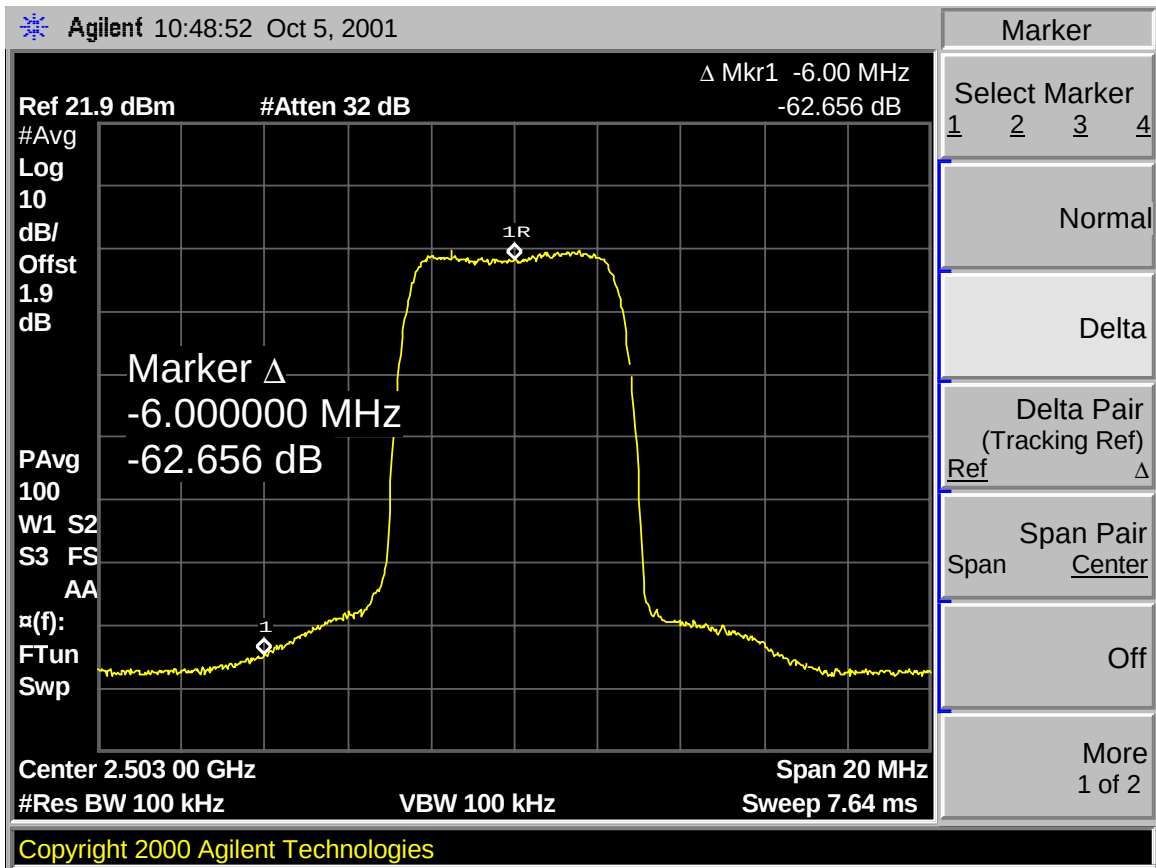
**PASS.** Refer to attached spectrum analyzer charts for three channels:

Lowest: 2503 MHz  
Middle: 2593 MHz  
Highest: 2683 MHz

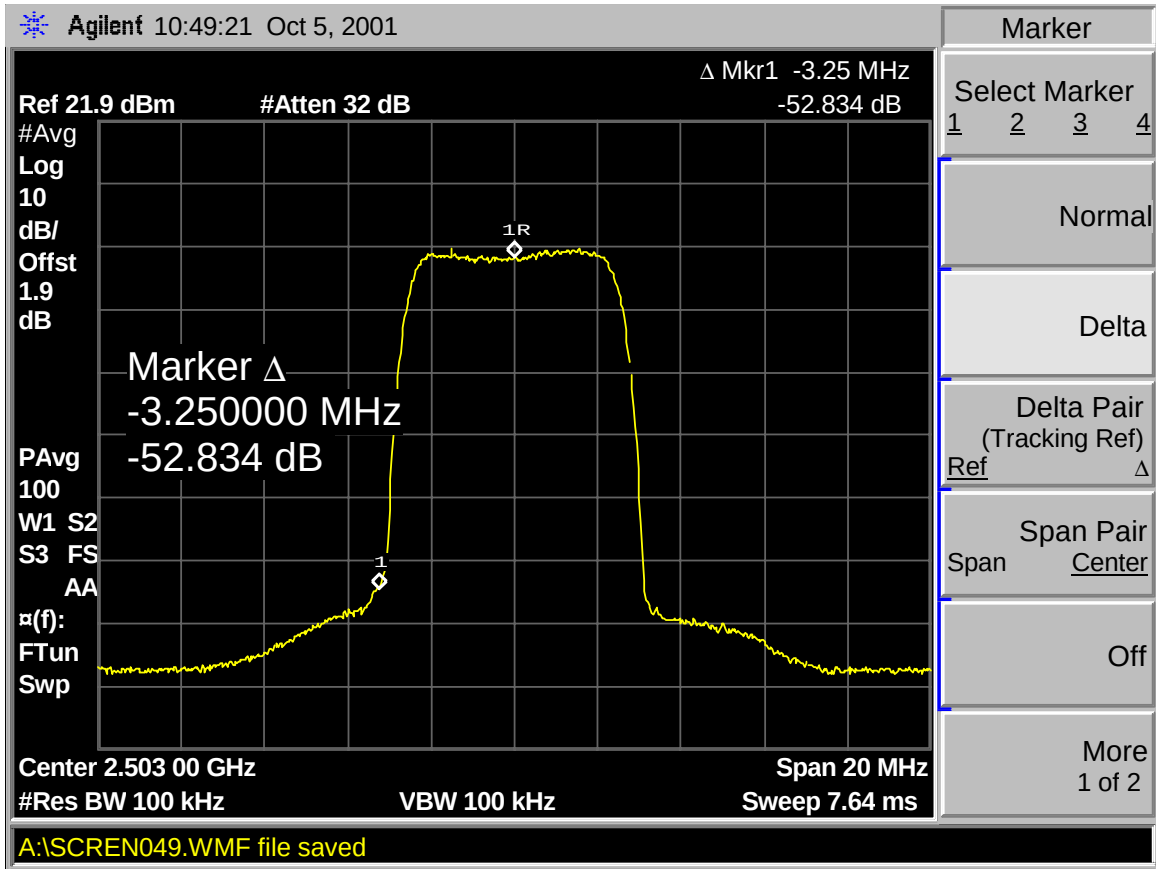
Emissions masks at Lowest and Highest channels are shown with blue mask lines superimposed on spectrum analyzer charts.

Channel Mask for  $f_0 = 2503$  MHz (lowest channel)

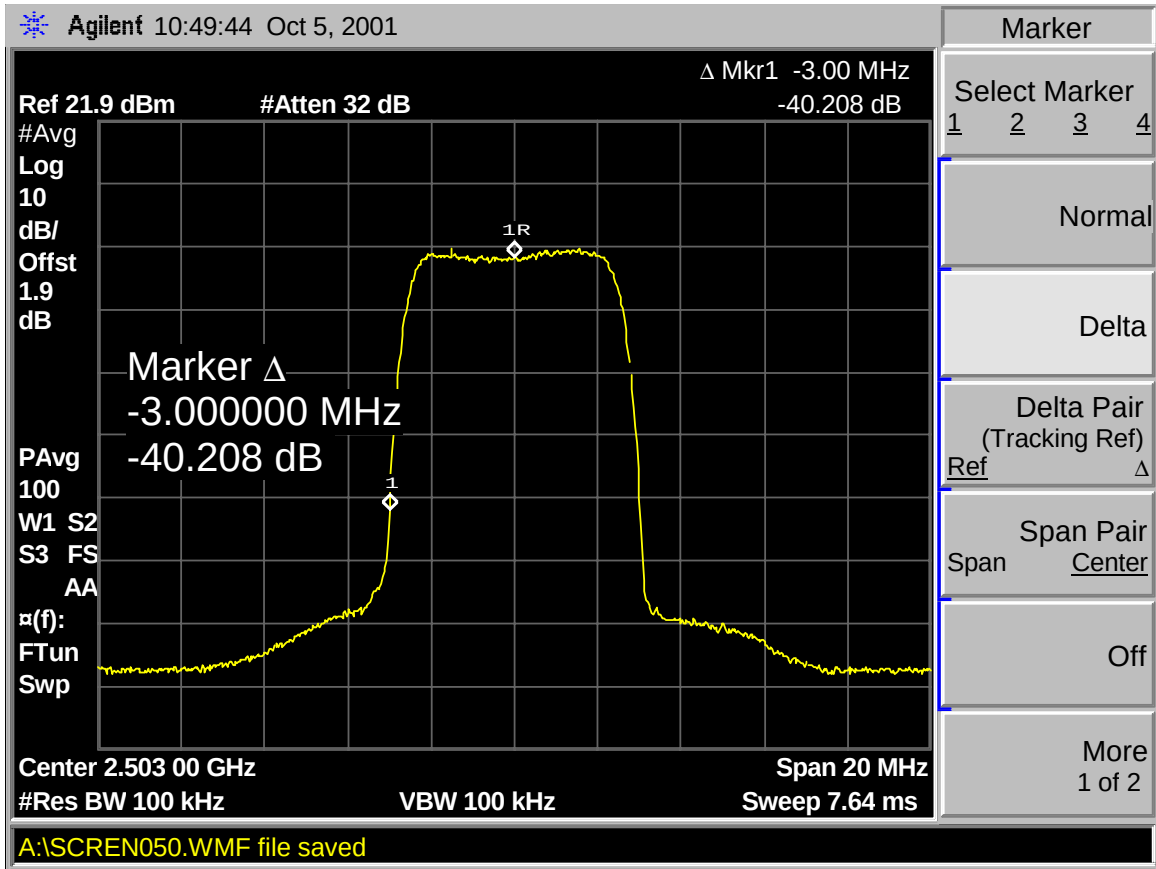
**Channel mask for  $f_0 = 2683$  MHz (highest channel)**



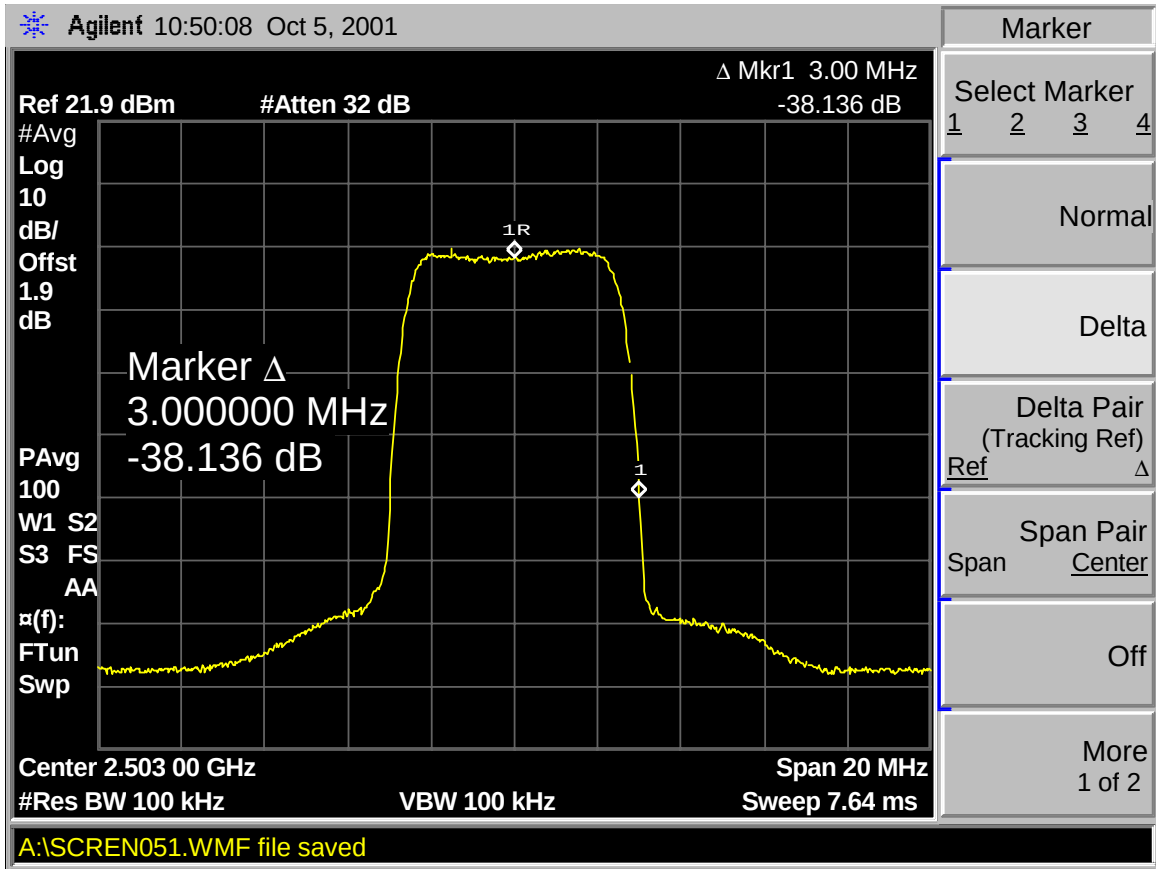
The adjacent channel power ratio (ACPR) measured at a 6 MHz offset to the lower sideband at a channel frequency of 2503 MHz.



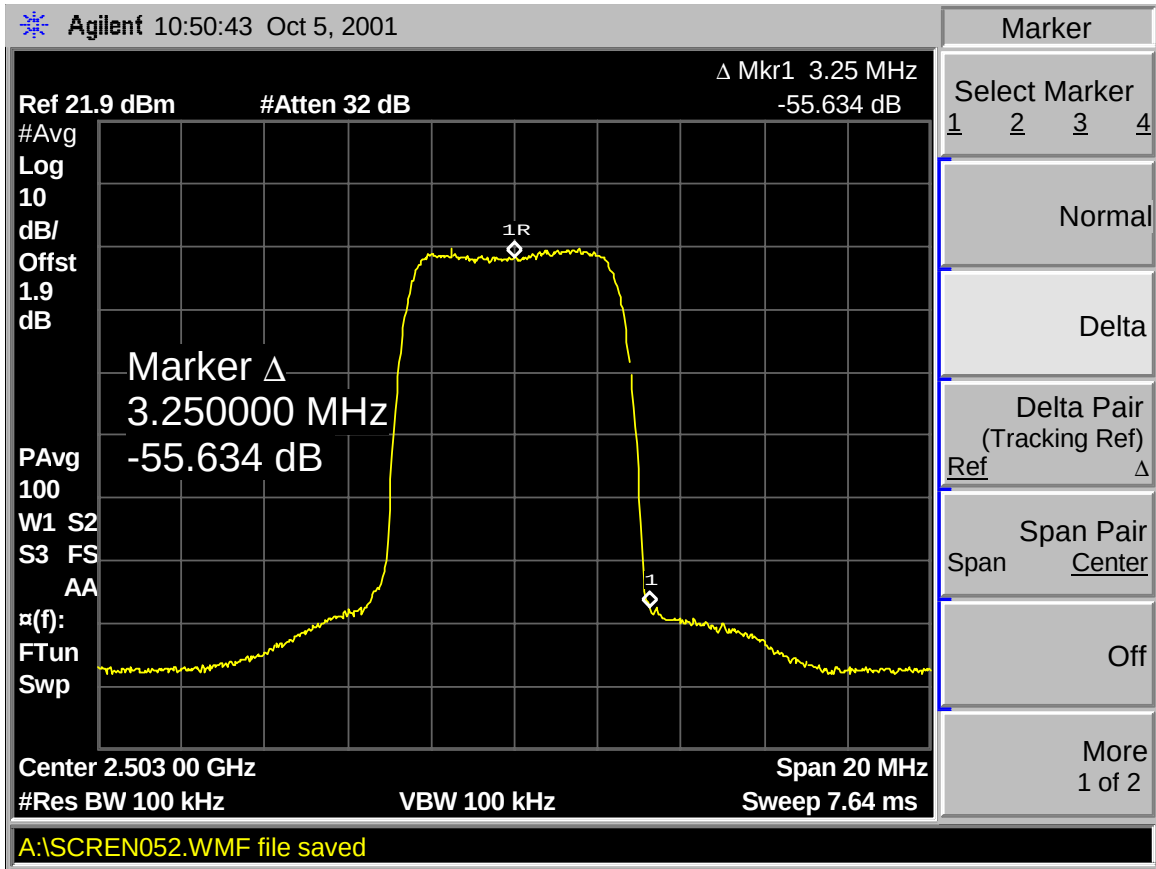
The ACPR at a 3.25 MHz offset to the lower side band at a channel frequency of 2503 MHz.



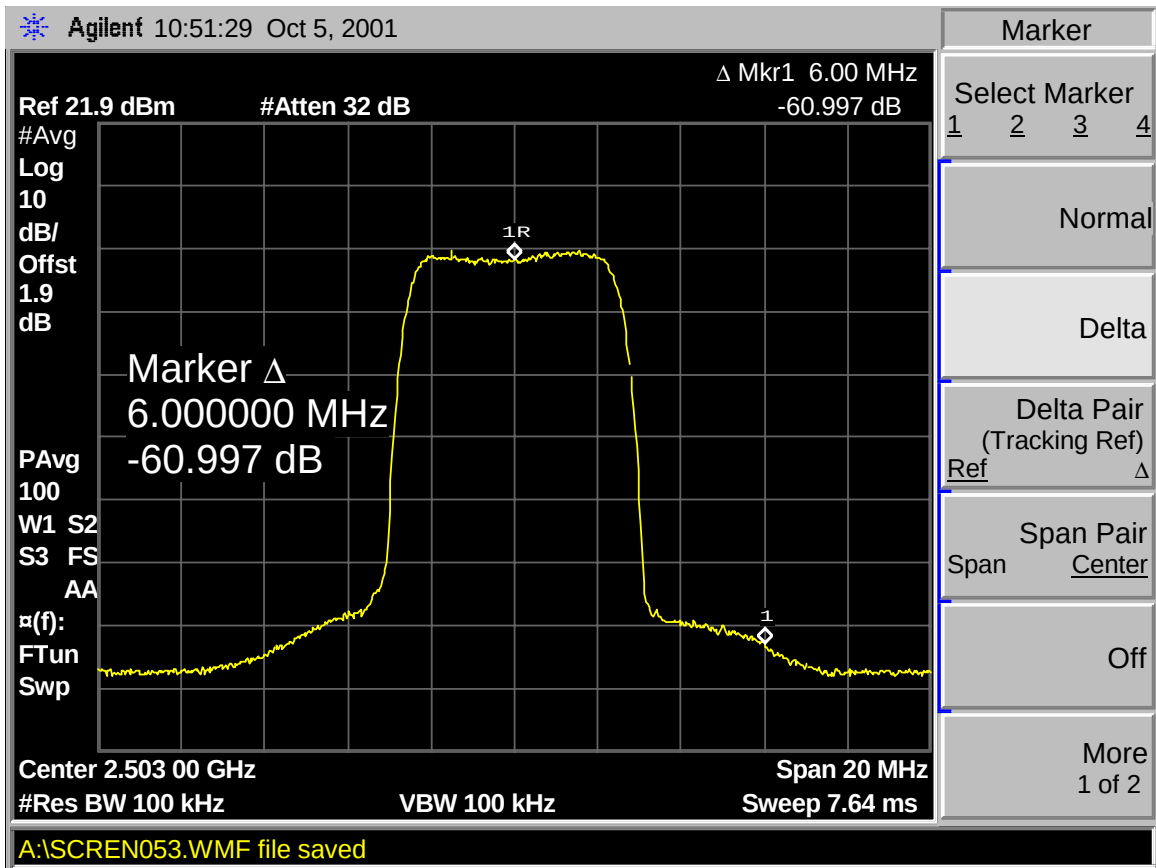
The ACPR at a 3 MHz offset to the lower side band at a channel frequency of 2503 MHz.



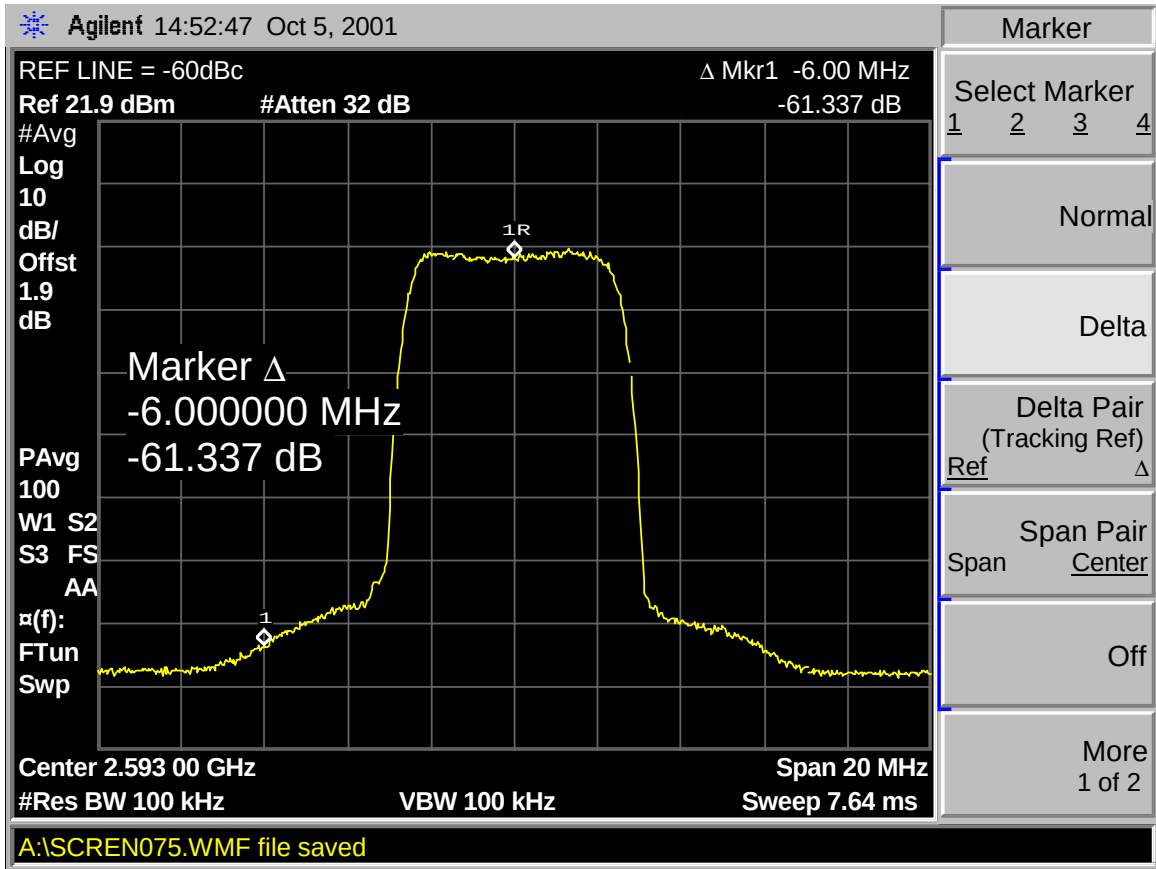
The ACPR at a 3 MHz offset to the upper side band at a channel frequency of 2503 MHz.



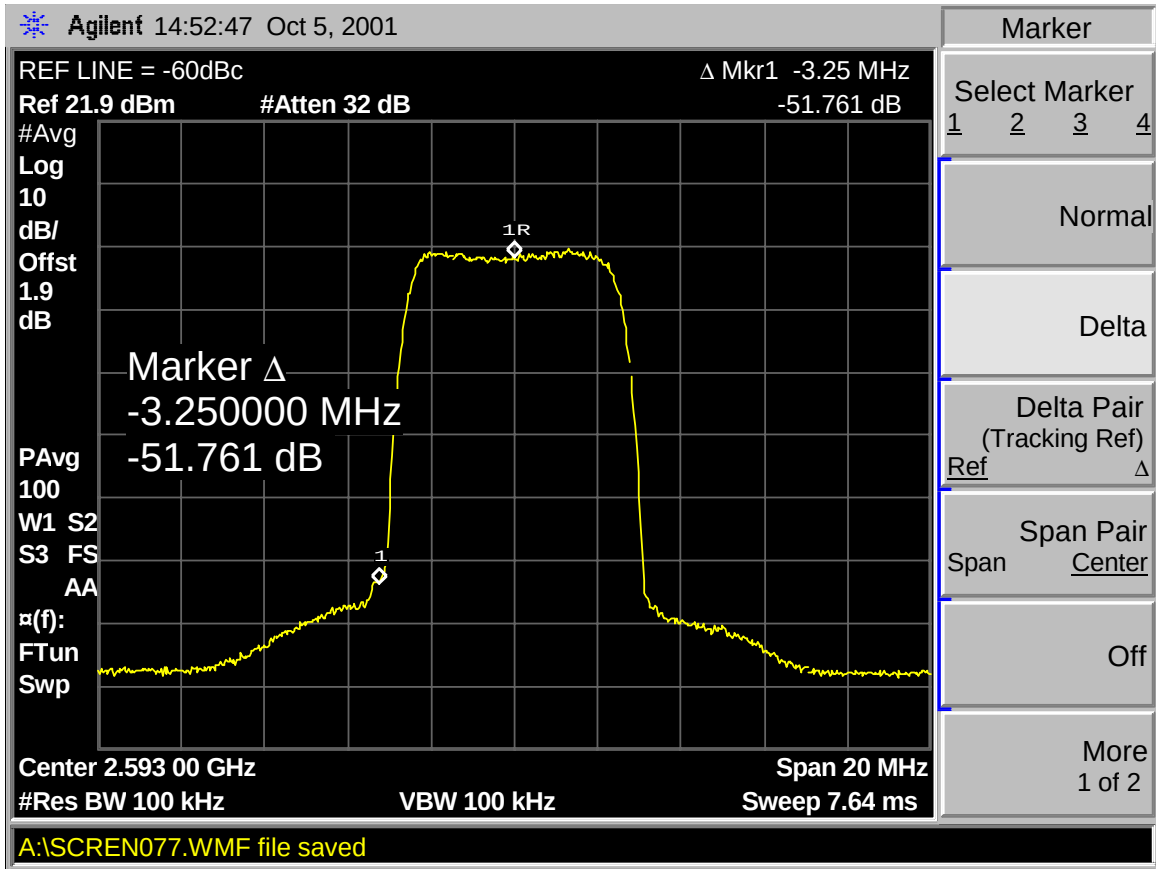
The ACPR at a 3.25 MHz offset to the upper side band at a channel frequency of 2503 MHz.



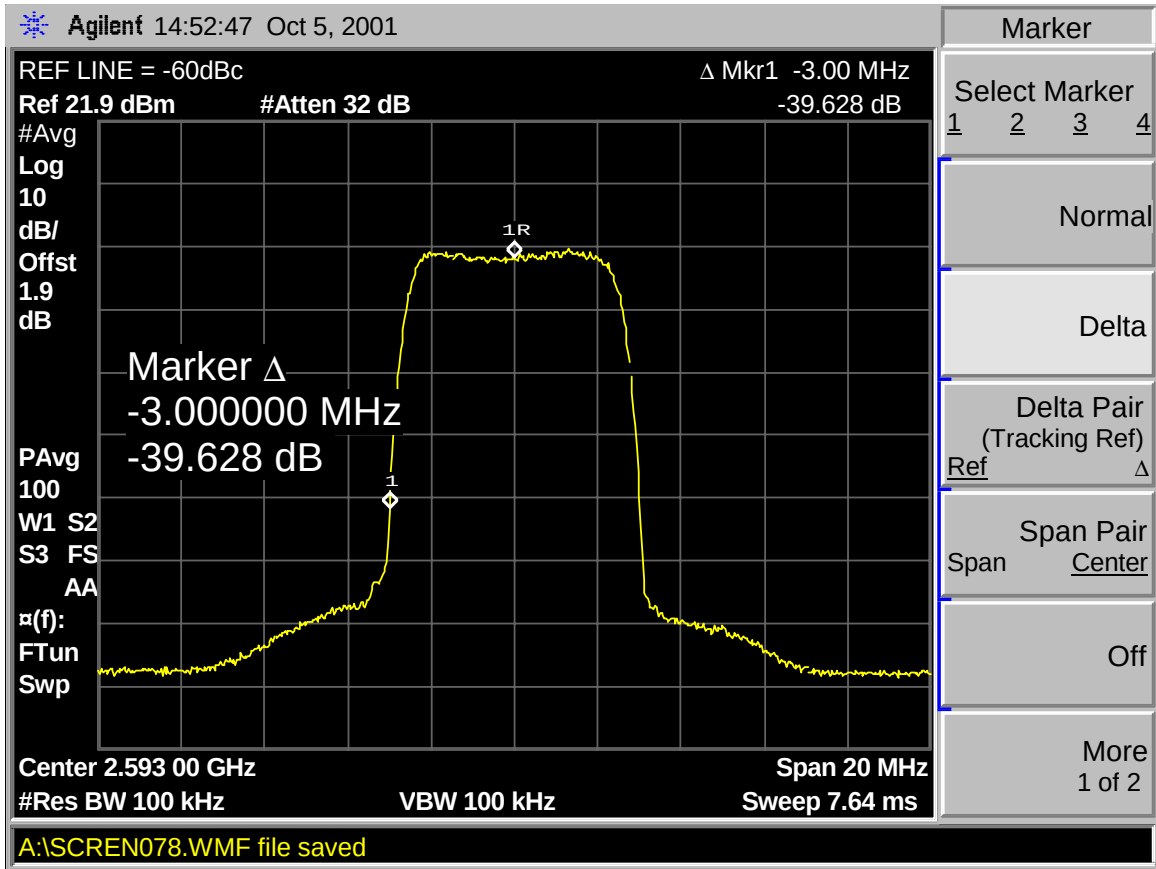
The ACPR at a 6 MHz offset to the upper side band at a channel frequency of 2503 MHz.



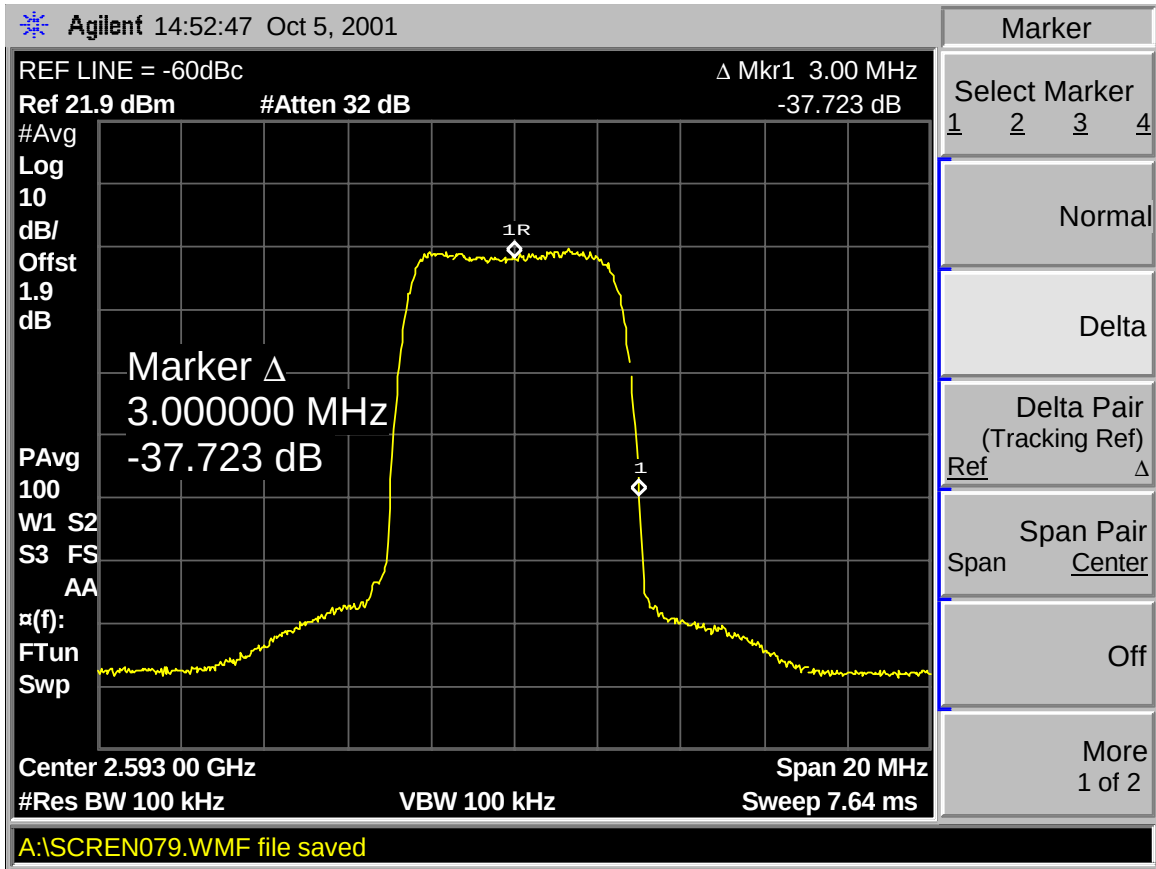
The ACPR at a 6 MHz offset to the lower side band at a channel frequency of 2593 MHz.



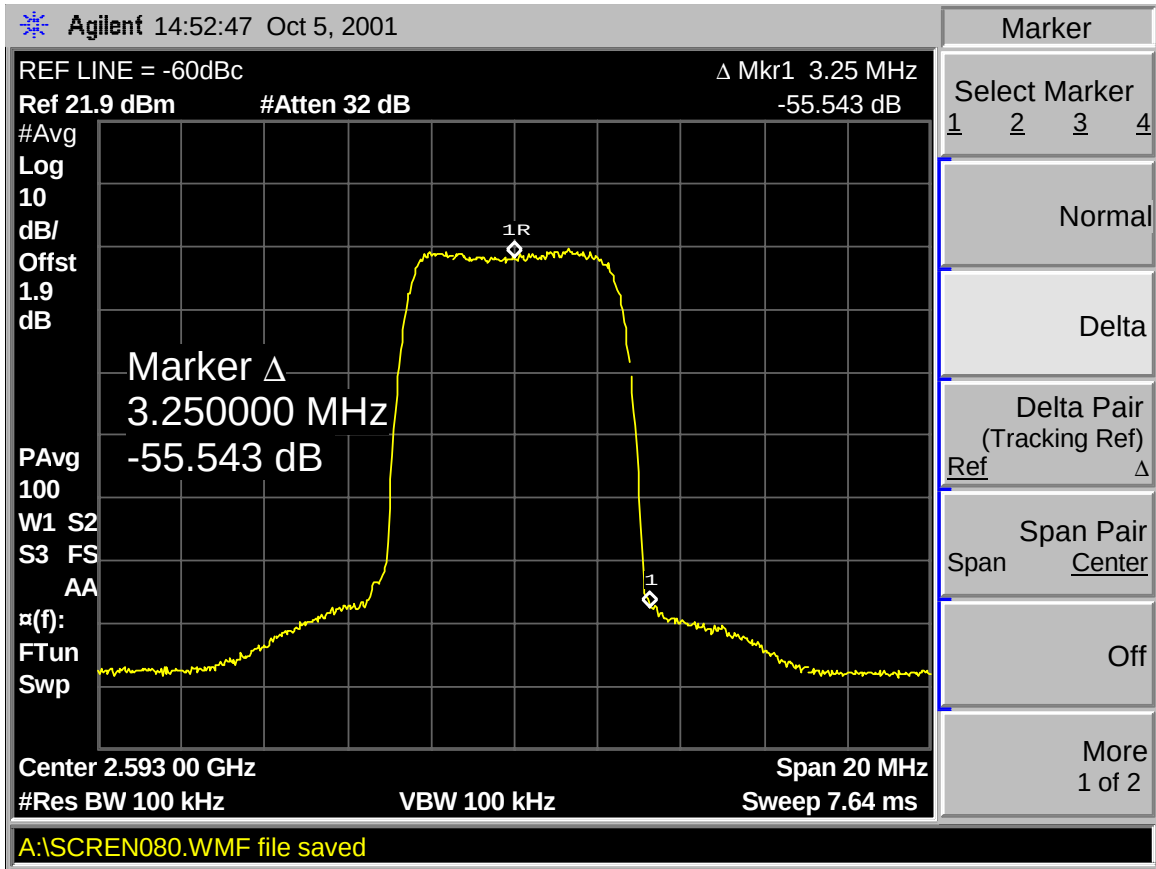
The ACPR at a 3.25 MHz offset to the lower side band at a channel frequency of 2593 MHz.



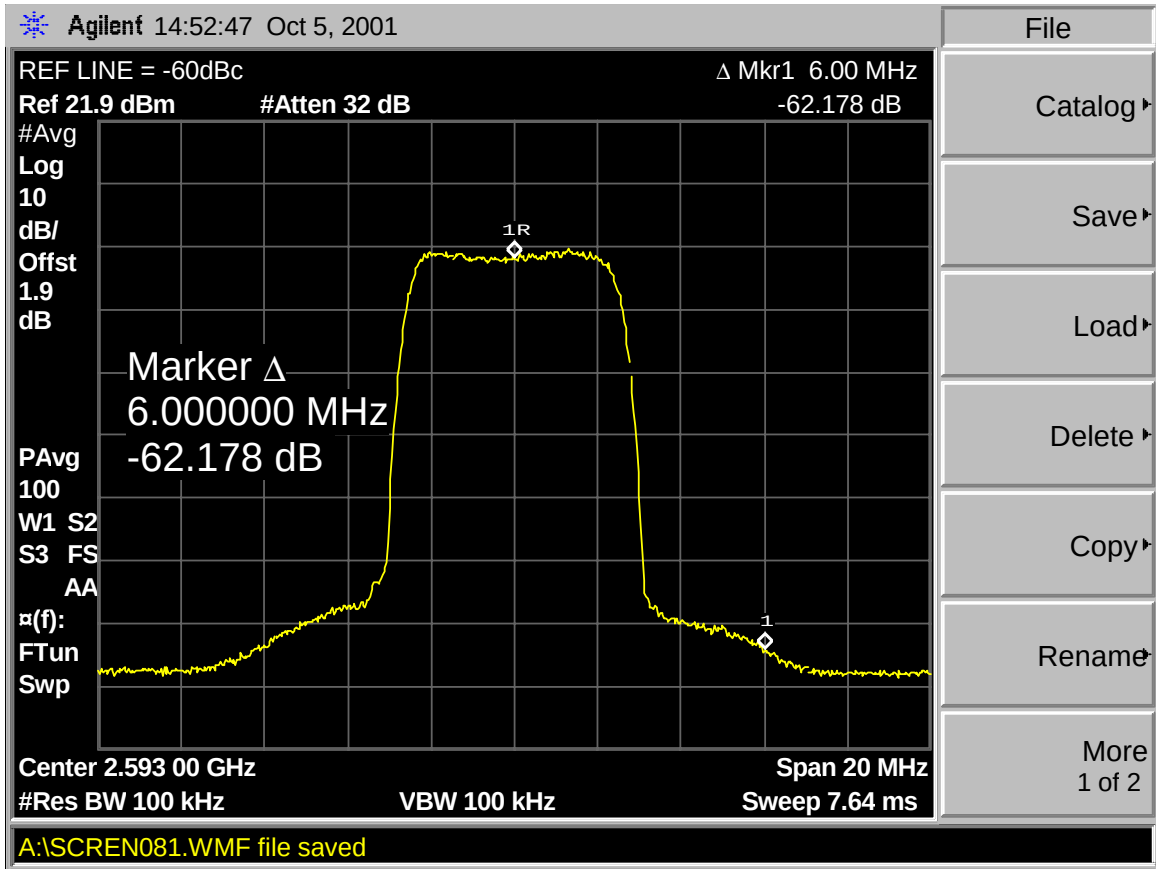
The ACPR at a 3 MHz offset to the lower side band at a channel frequency of 2593 MHz.



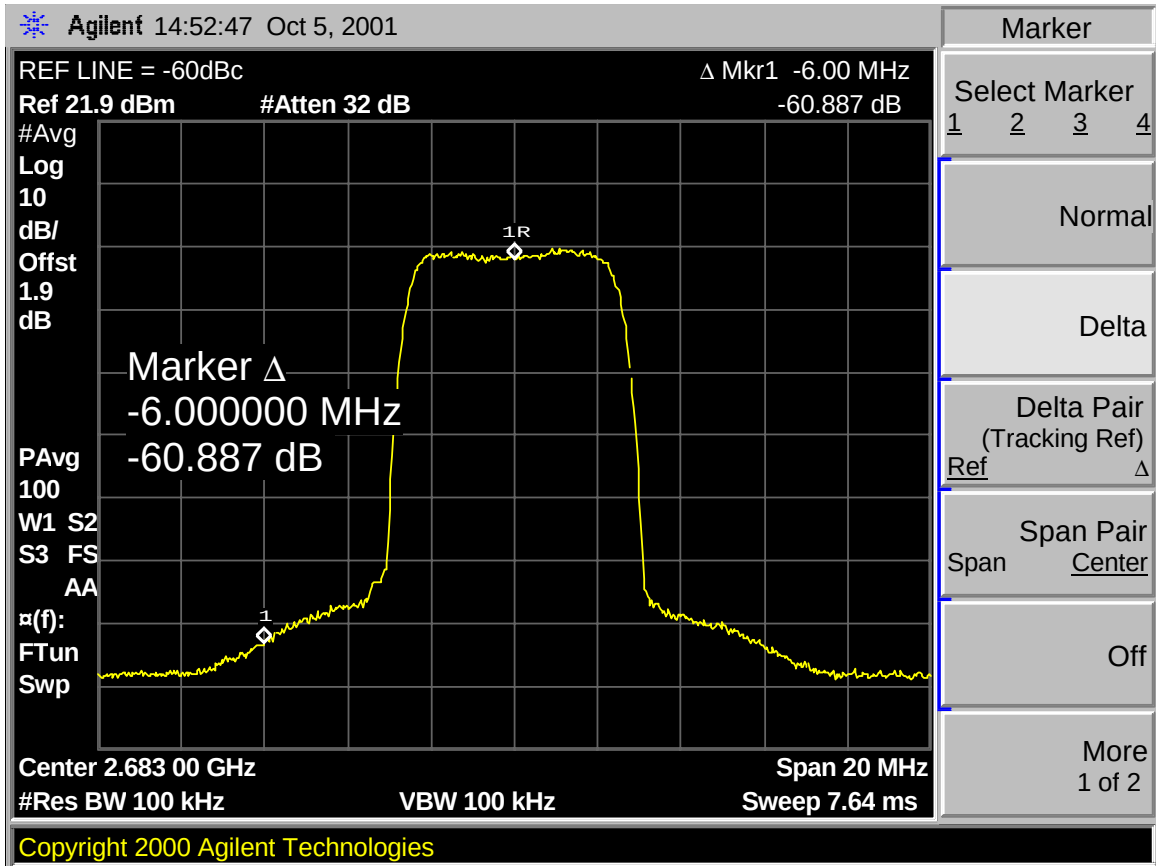
The ACPR at a 3 MHz offset to the upper side band at a channel frequency of 2593 MHz.



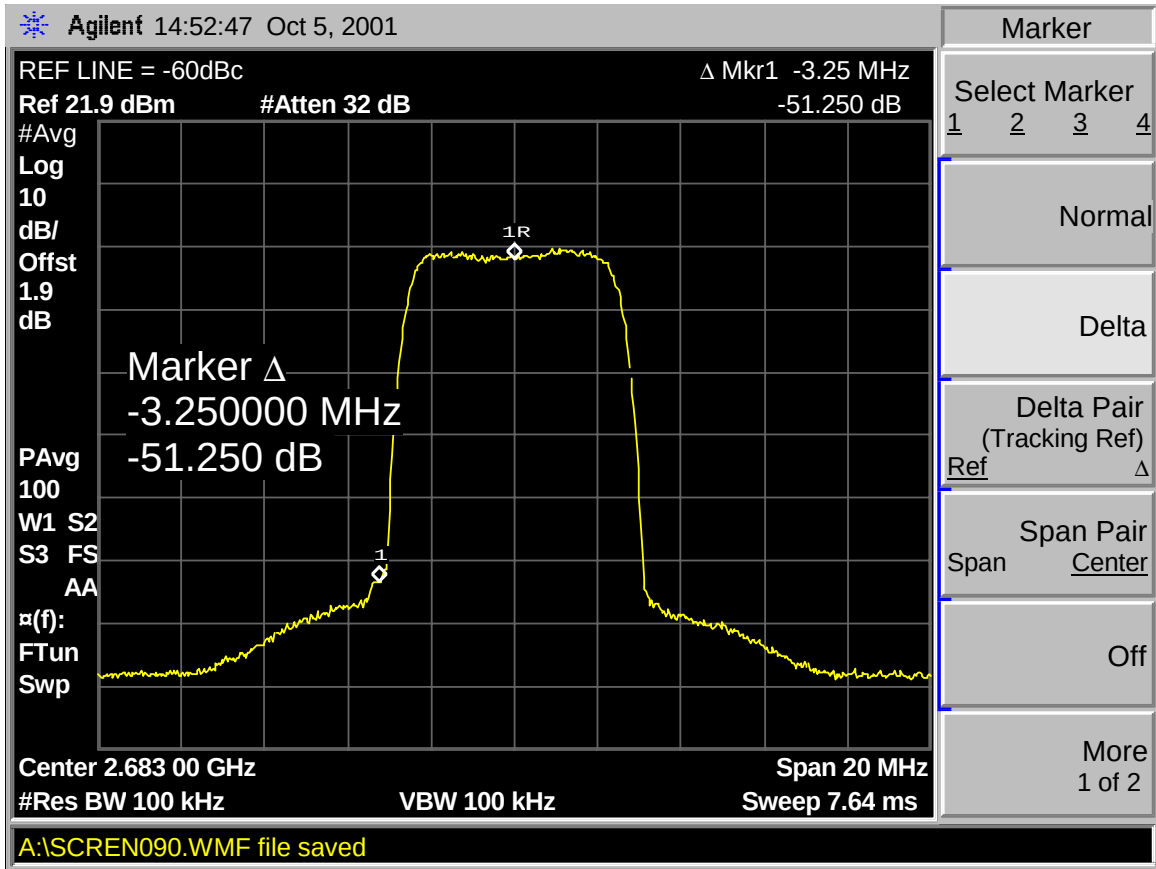
The ACPR at a 3.25 MHz offset to the upper side band at a channel frequency of 2593 MHz.



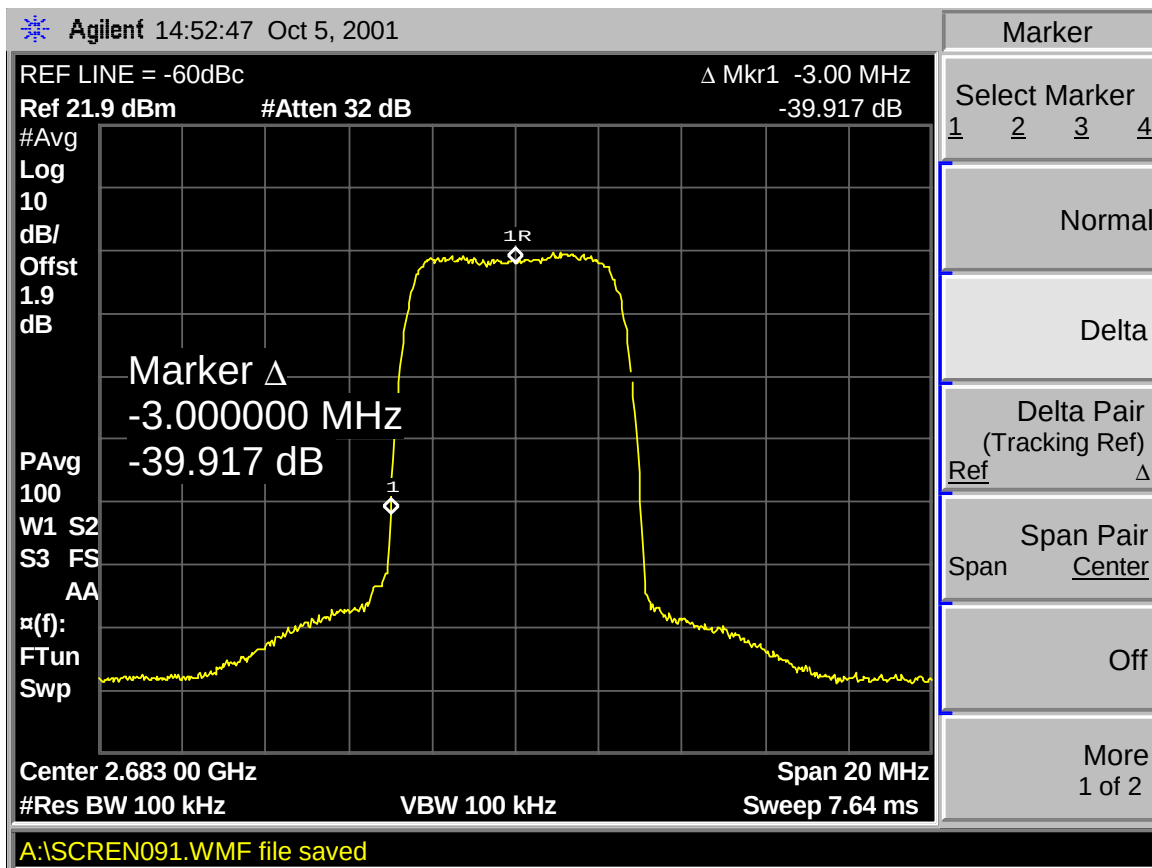
The ACPR at a 6 MHz offset to the upper side band at a channel frequency of 2593 MHz.



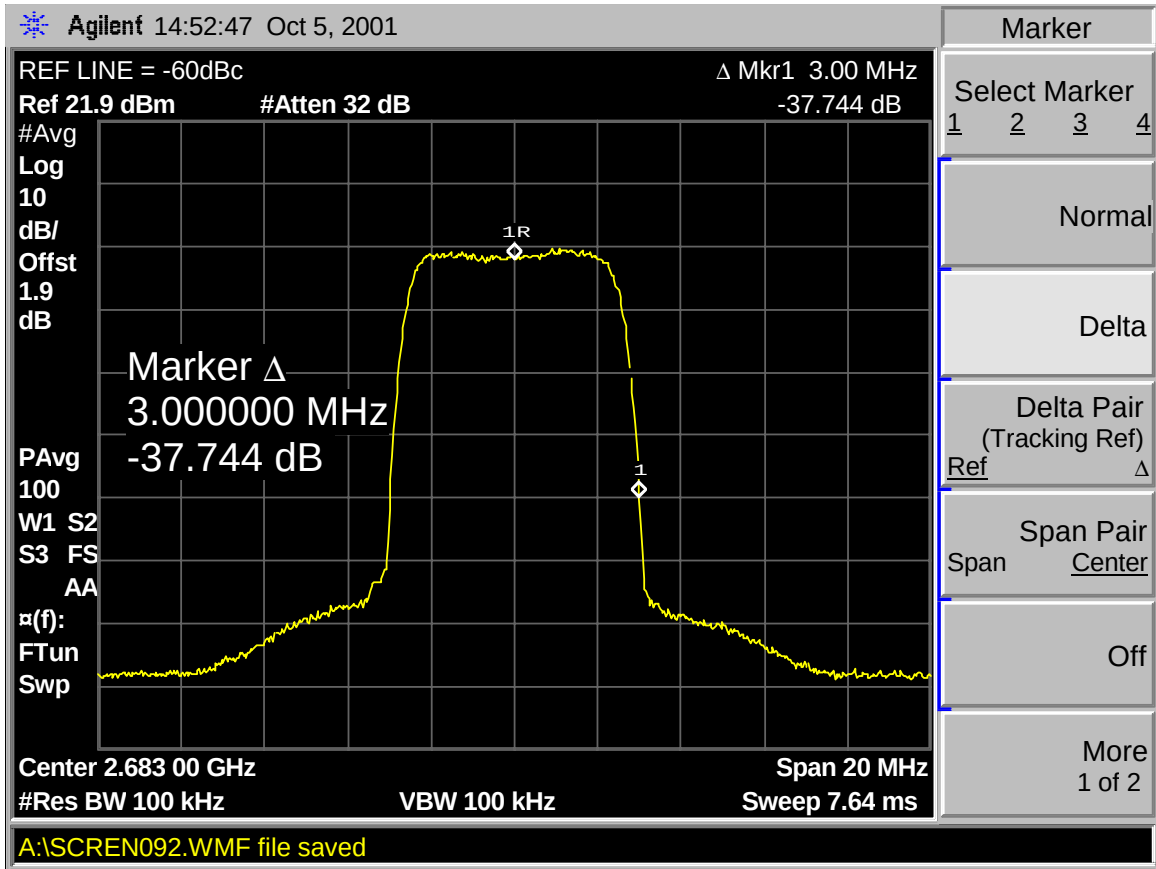
The ACPR at a 6 MHz offset to the lower side band at a channel frequency of 2683 MHz.



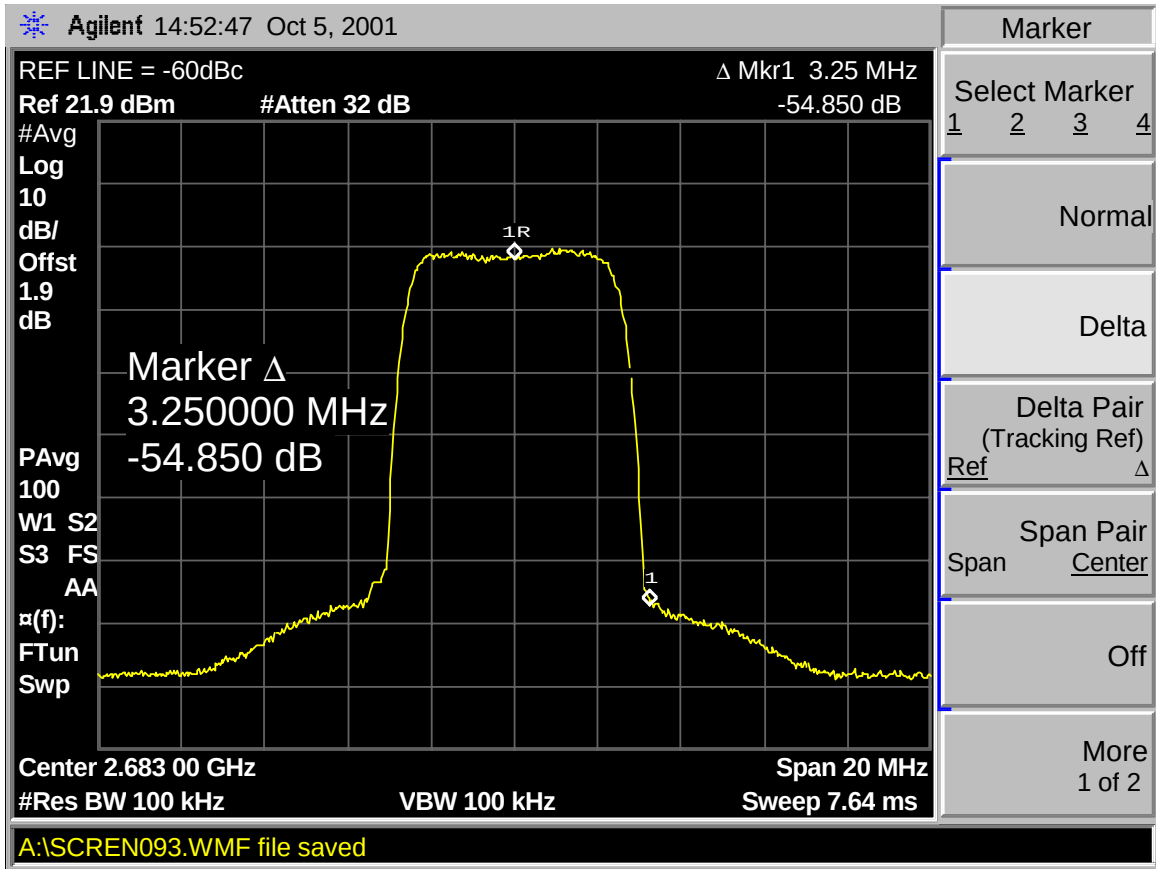
The ACPR at a 3.25 MHz offset to the lower side band at a channel frequency of 2683 MHz.



The ACPR at a 3 MHz offset to the lower side band at a channel frequency of 2683 MHz.



The ACPR at a 3 MHz offset to the upper side band at a channel frequency of 2683 MHz.

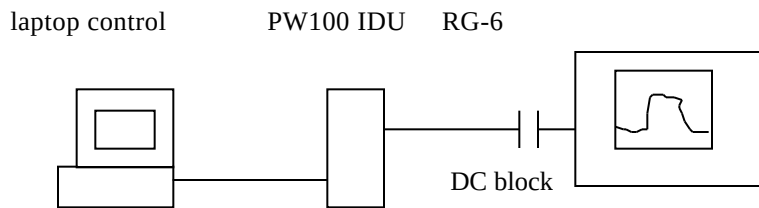


The ACPR at a 3.25 MHz offset to the upper side band at a channel frequency of 2683 MHz.



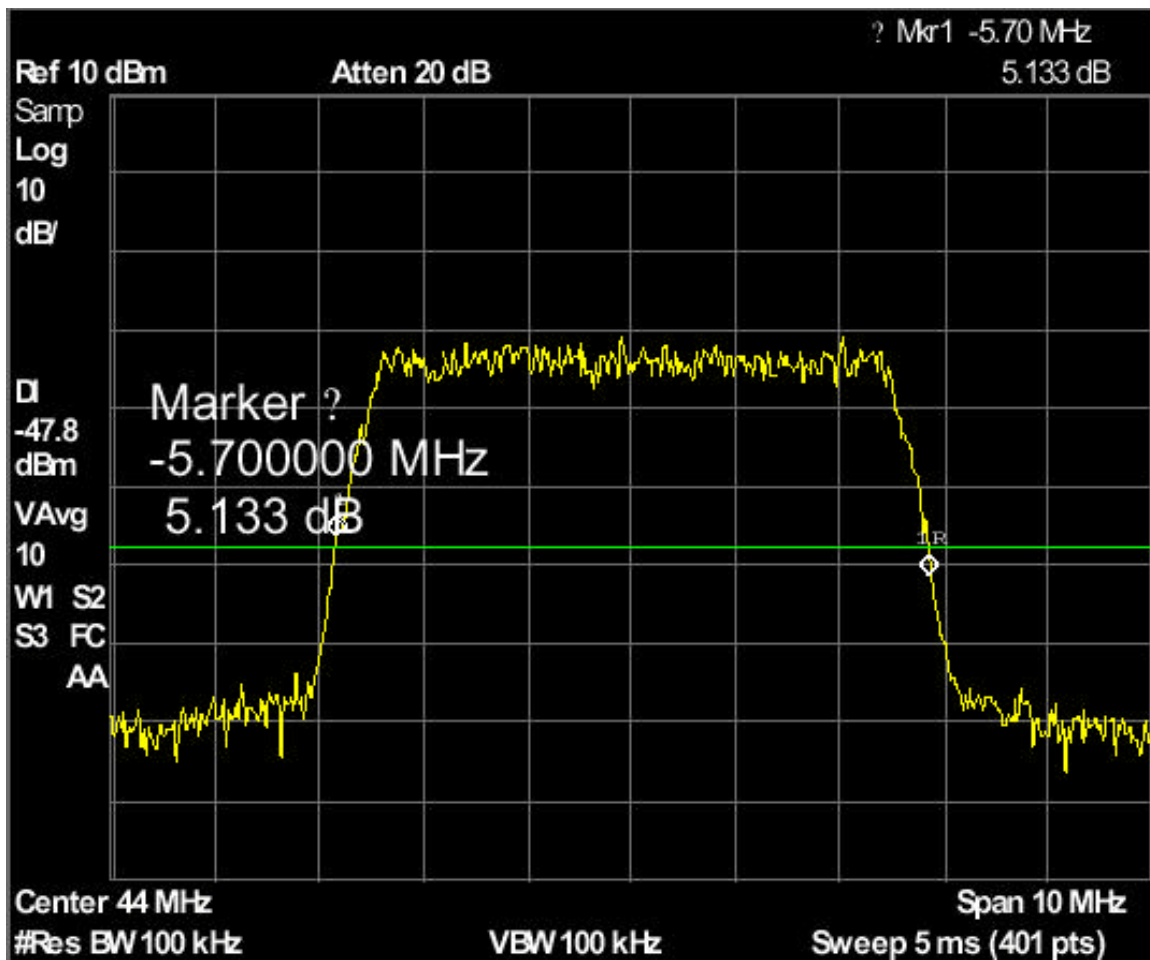
**Section 2.1049 Occupied Bandwidth****Measurement equipment used:**

Agilent E4440A Spectrum Analyzer  
Coaxial cable (worst case 1.9 dB attenuation at 26 GHz )

**Test set-up:****Fig. 2****Test Procedures and Results:**

Occupied bandwidth at ODU is identical to IF bandwidth at IDU. Using the built-in analyzer software routine, occupied BW is measured as 5.7 MHz. Refer spectrum analyzer plots below showing IDU occupied bandwidth.

## Occupied Bandwidth (at IF frequency)



**Section 2.1051 Spurious and Harmonic Emissions at Antenna Terminals****Measurement equipment used:**

Agilent E4440A Spectrum Analyzer  
Coaxial cable (worst case 1.9 dB attenuation at 26 GHz )

**Test set-up:**

Refer to Figure 1 above

**Test Procedures**

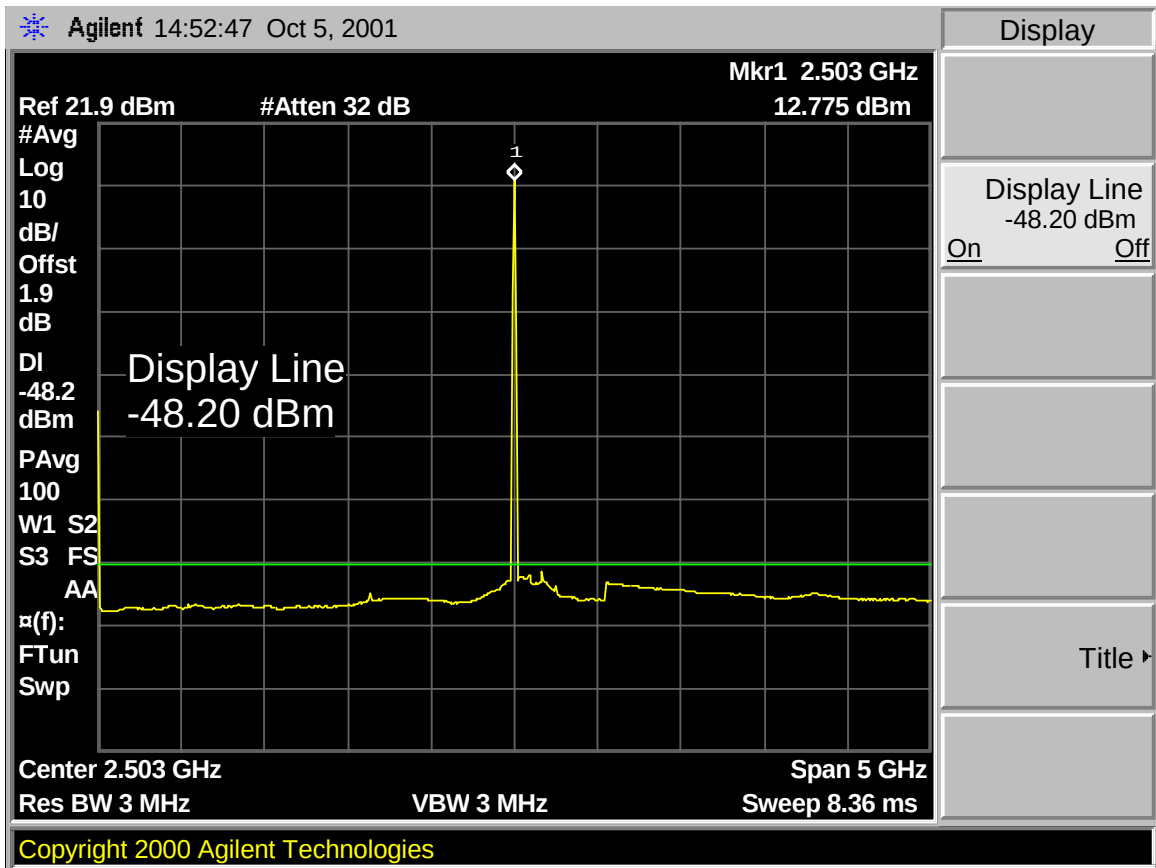
Section 21.908(e) requires that for a 100 kHz measurement bandwidth, all emissions removed from the channel edge by more than 3 MHz must be attenuated at least 60 dB below the channel emission flat top.

1. Set spectrum analyzer to TX output center frequency, RES BW = 100 kHz, VID BW = 100 kHz Hz.
2. Set spectrum analyzer to record Average reading.
3. Set DISPLAY LINE to a level 60 dB below flat top peak
4. Record transmitter output spectrum from 1 MHz to 10<sup>th</sup> harmonic of TX output frequency
5. Plot spectrum analyzer output traces.

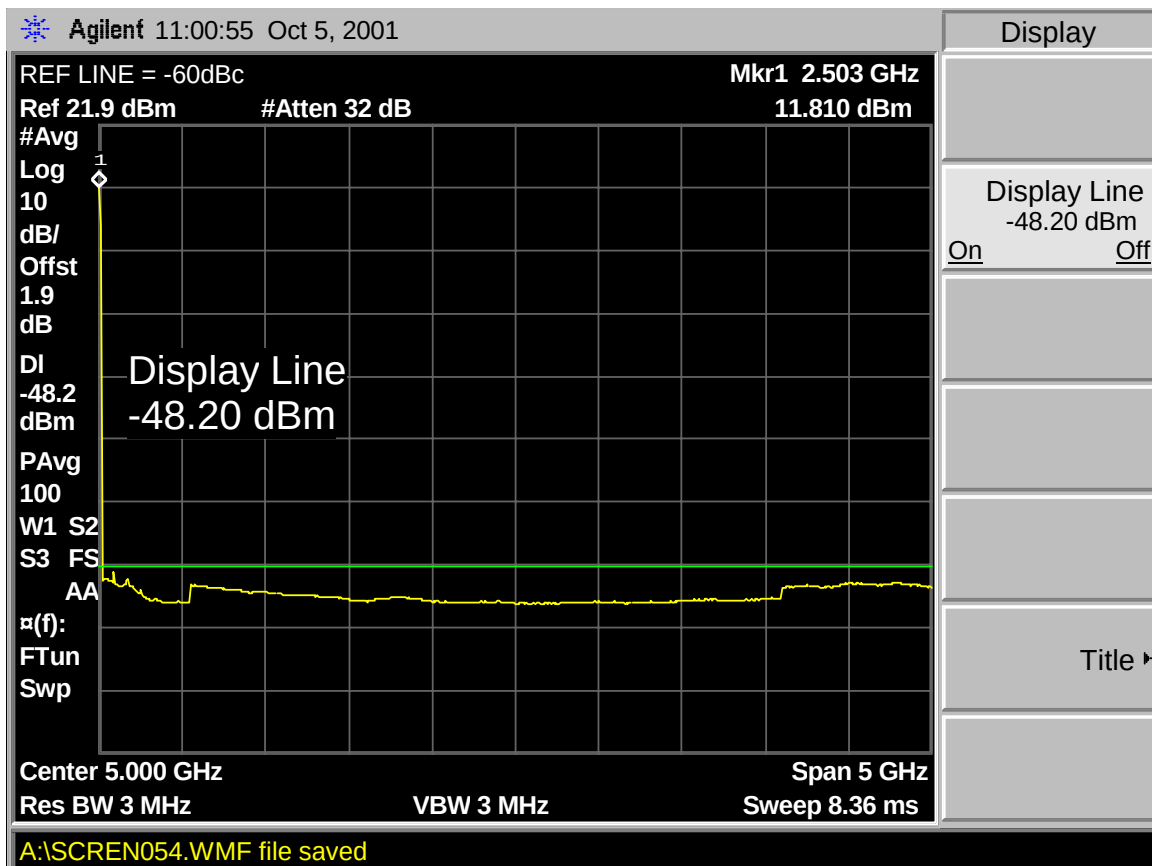
**Test Results**

**PASS.** Refer to data plots below.

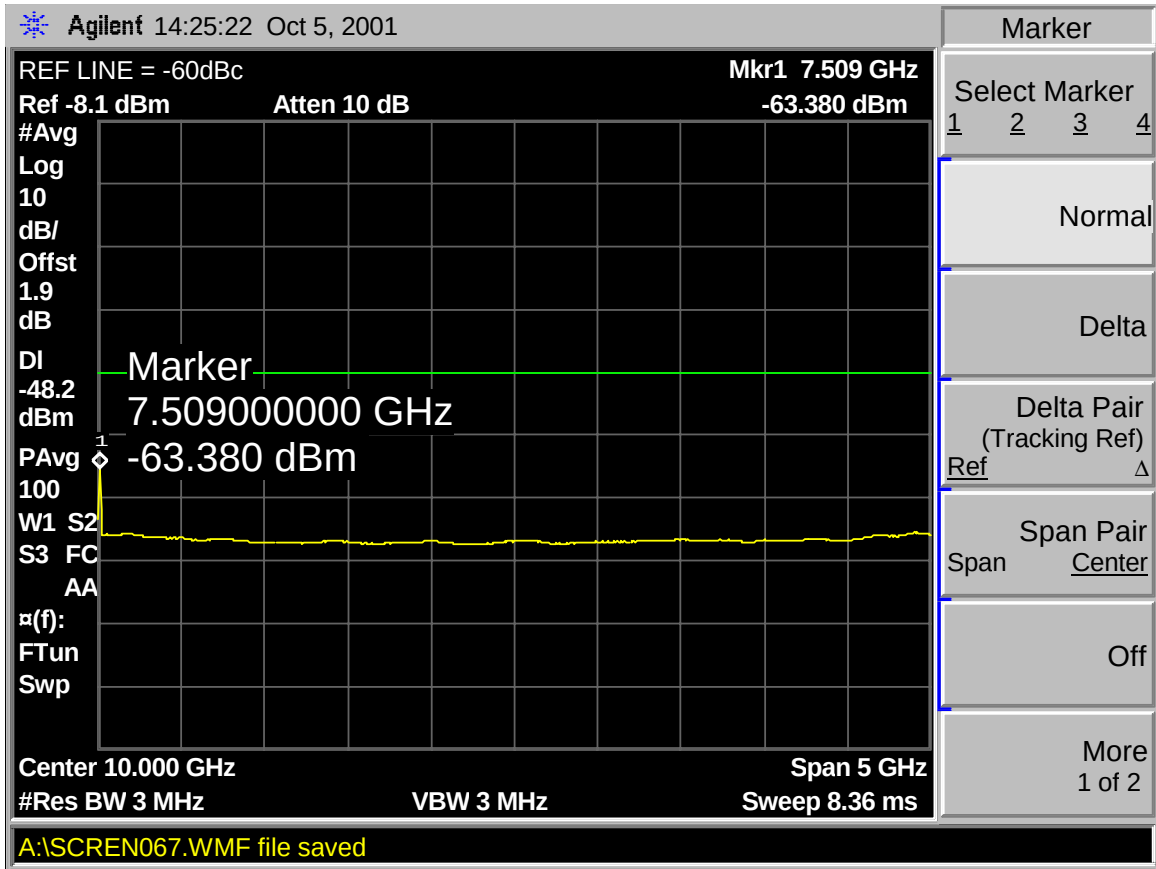
**Spurious Emissions, Antenna Conducted Output Spectrum Analyzer Graphs**



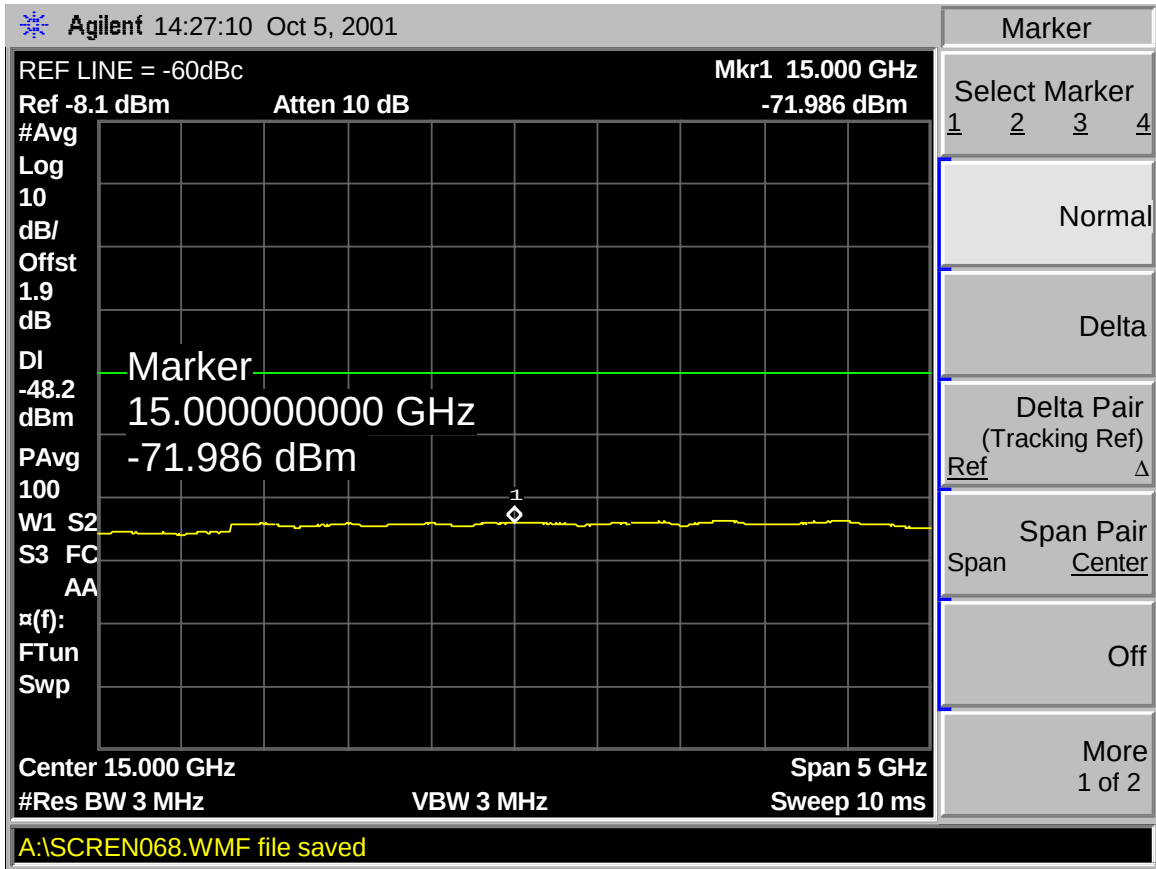
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level.



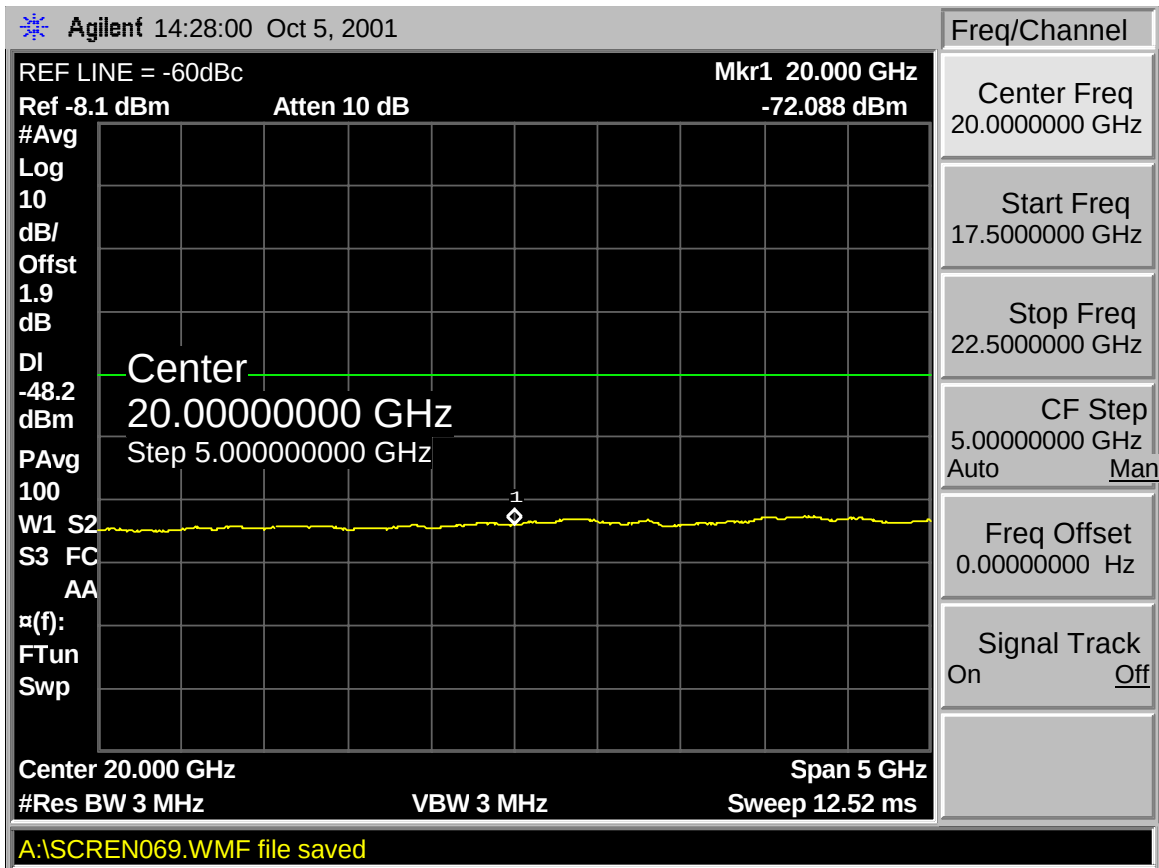
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level.



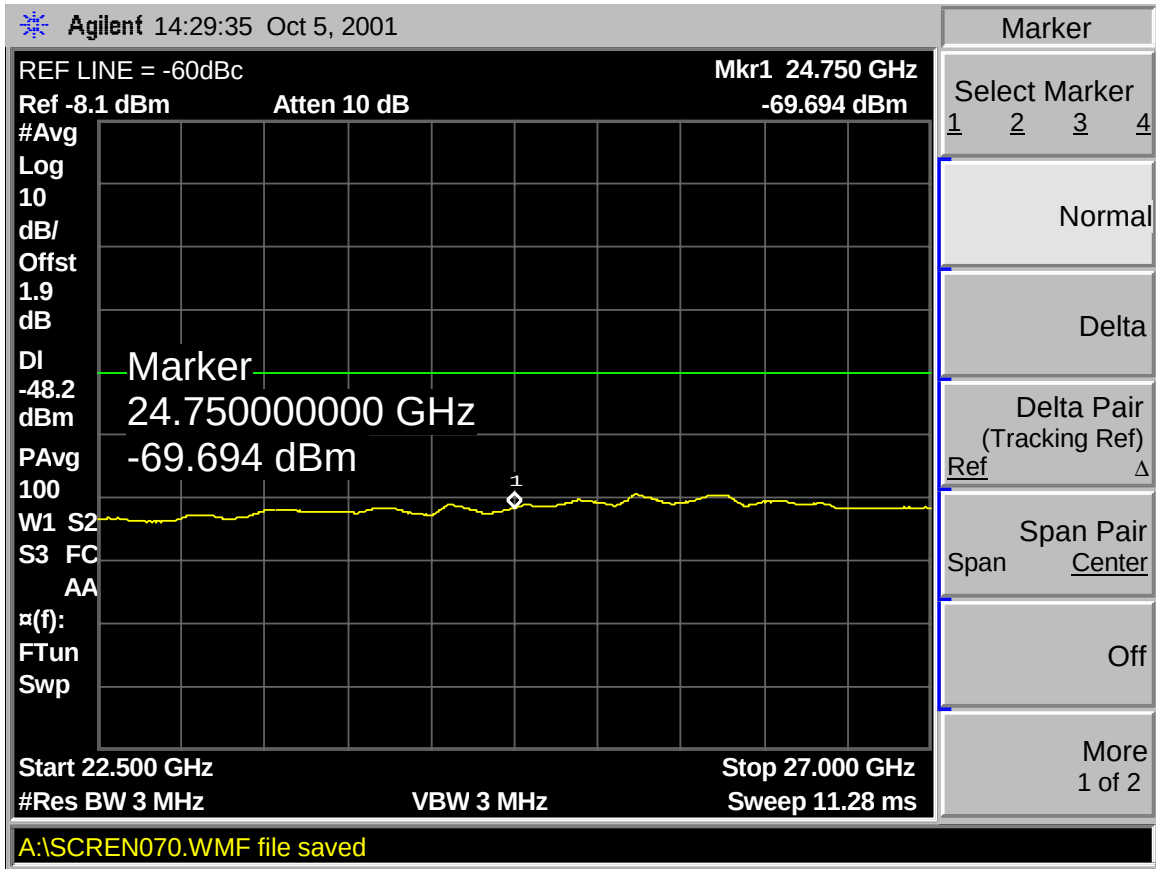
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level. The spurious output measured is the third harmonic of 2503 MHz.



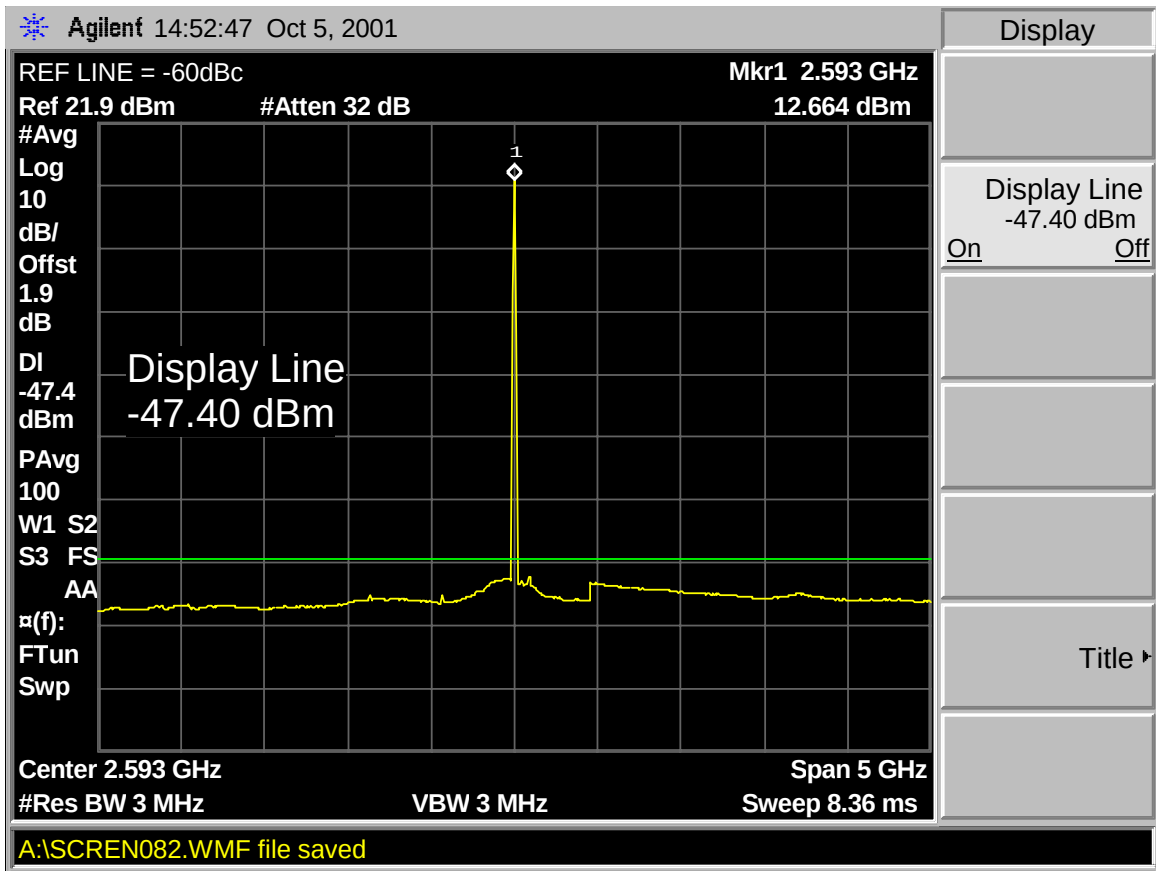
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level.



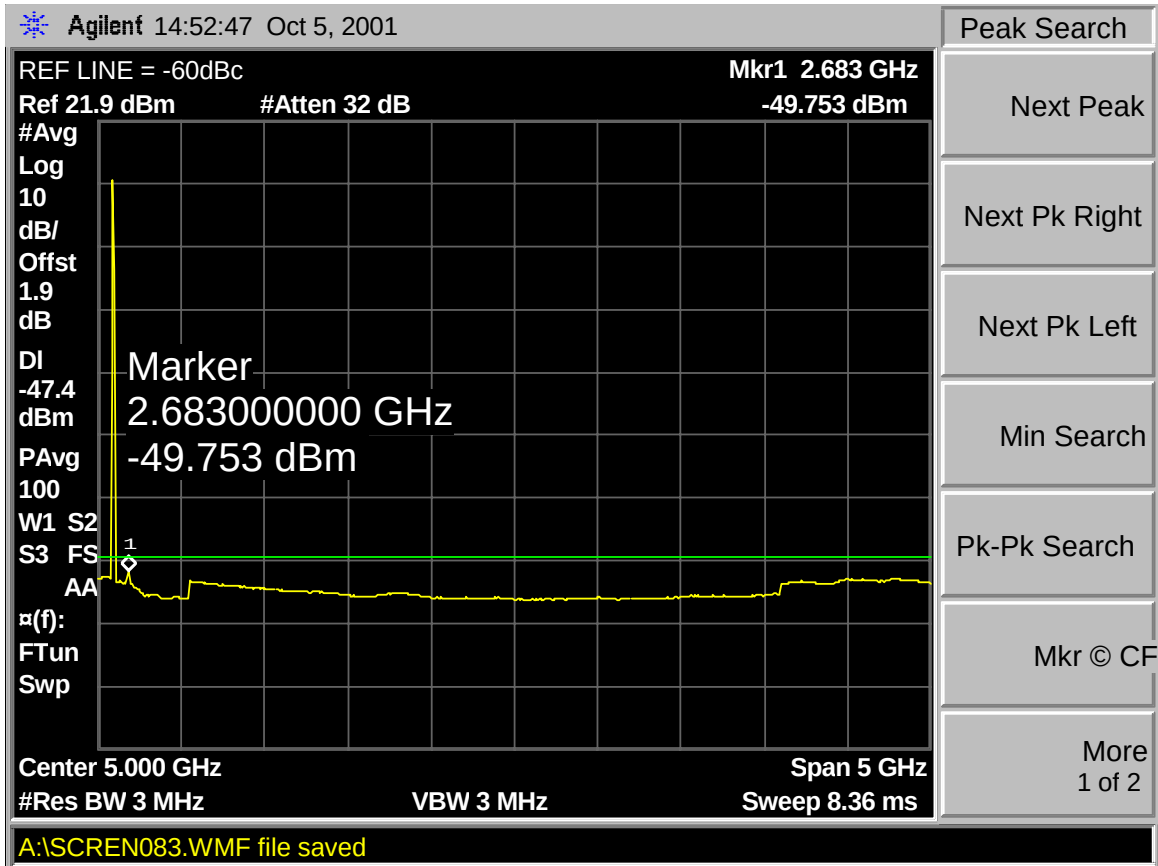
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level.



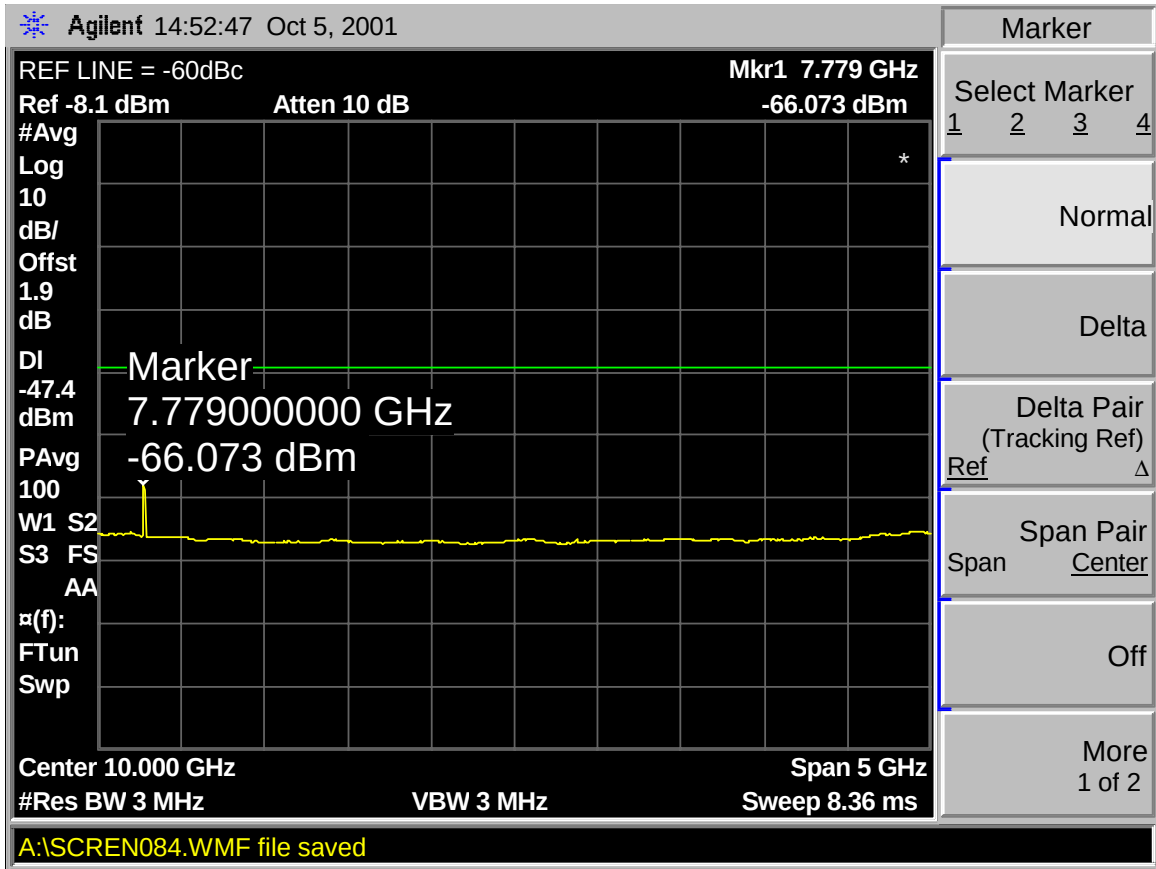
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a -60 dBc level.



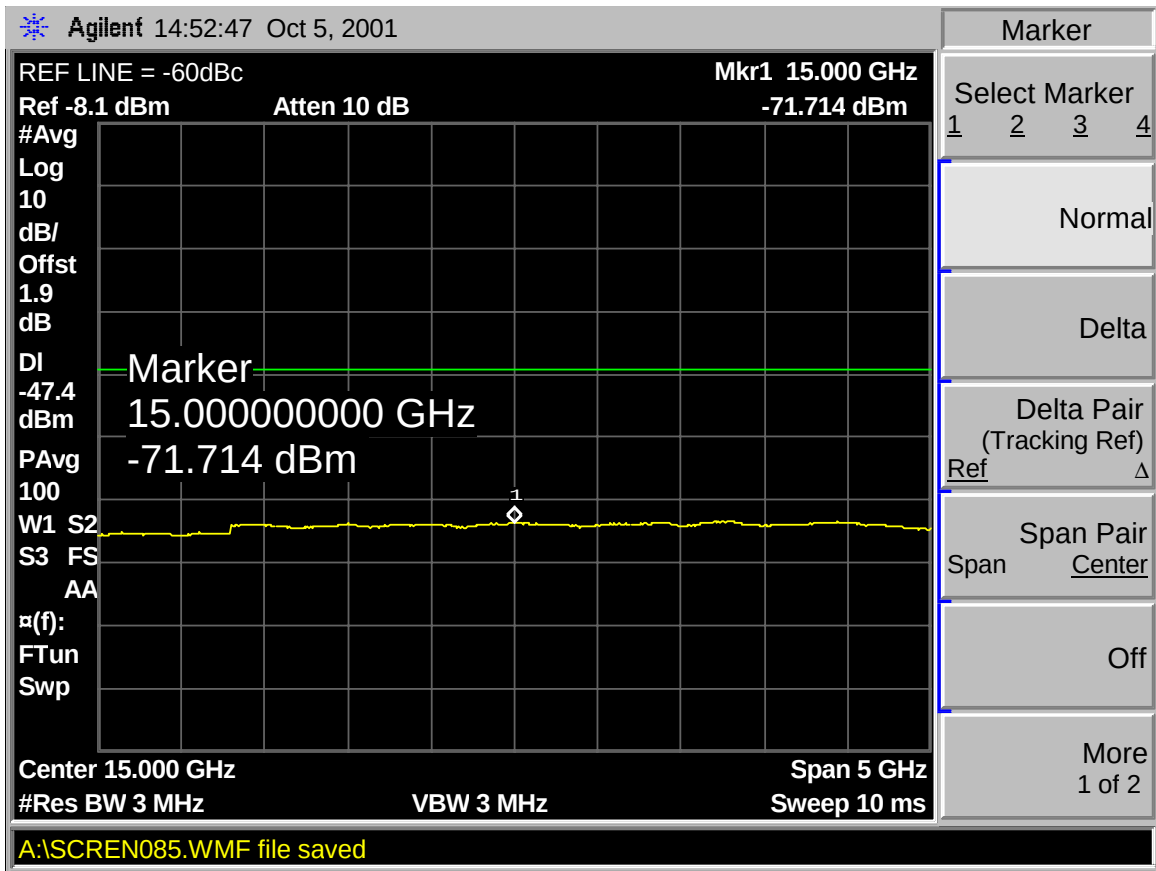
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level.



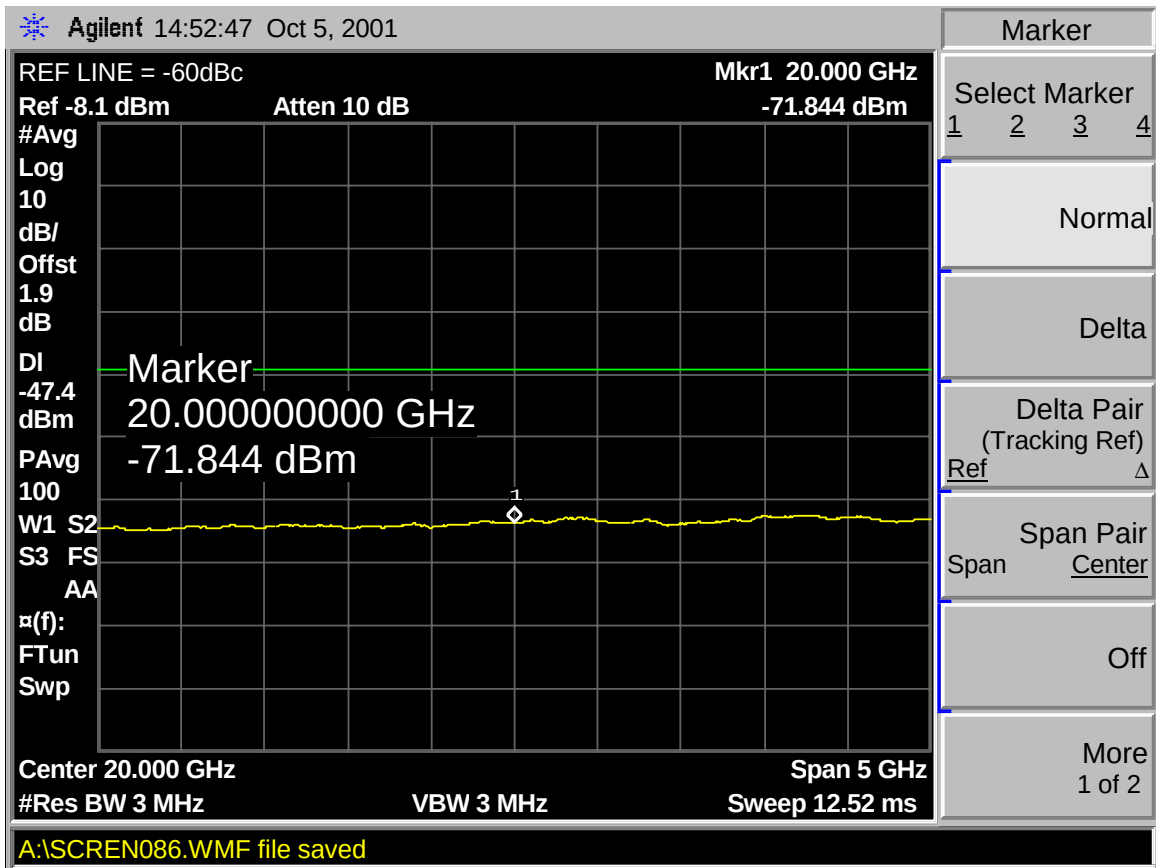
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level.



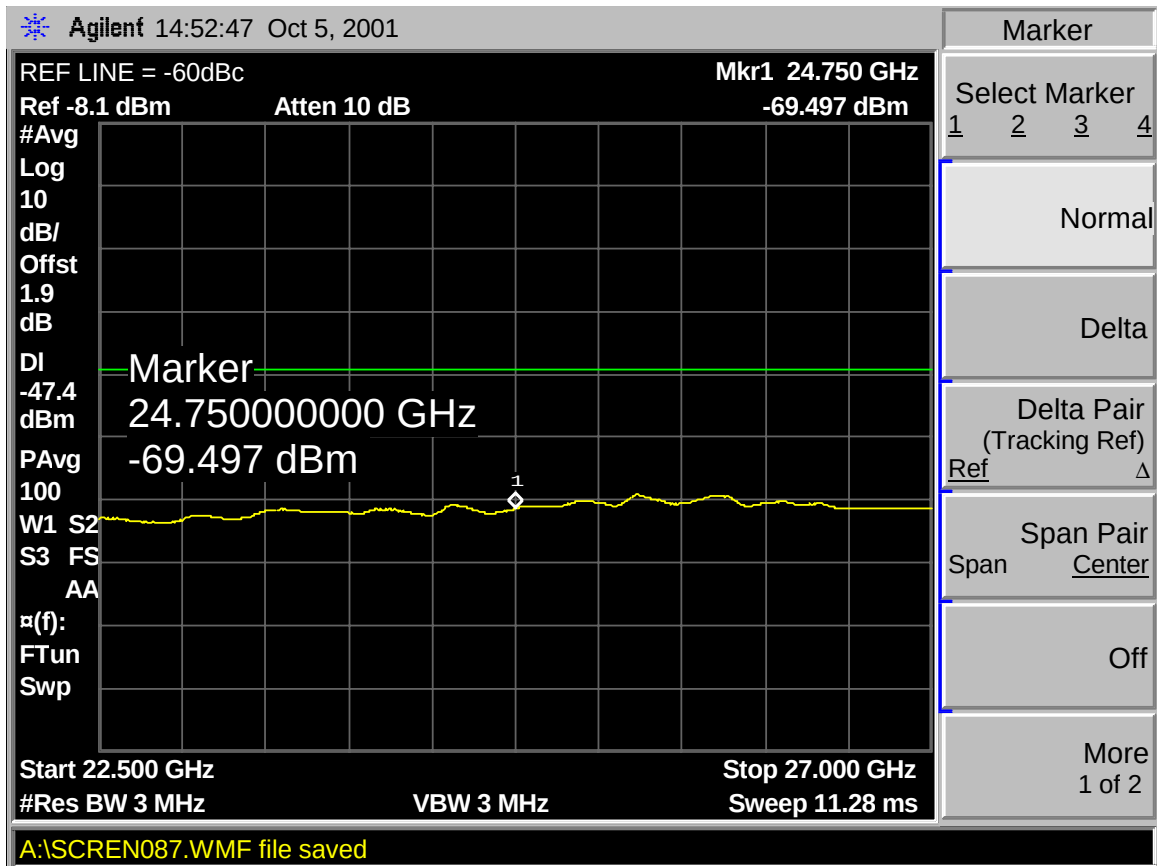
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level. The spurious output measured is the third harmonic of 2593 MHz.



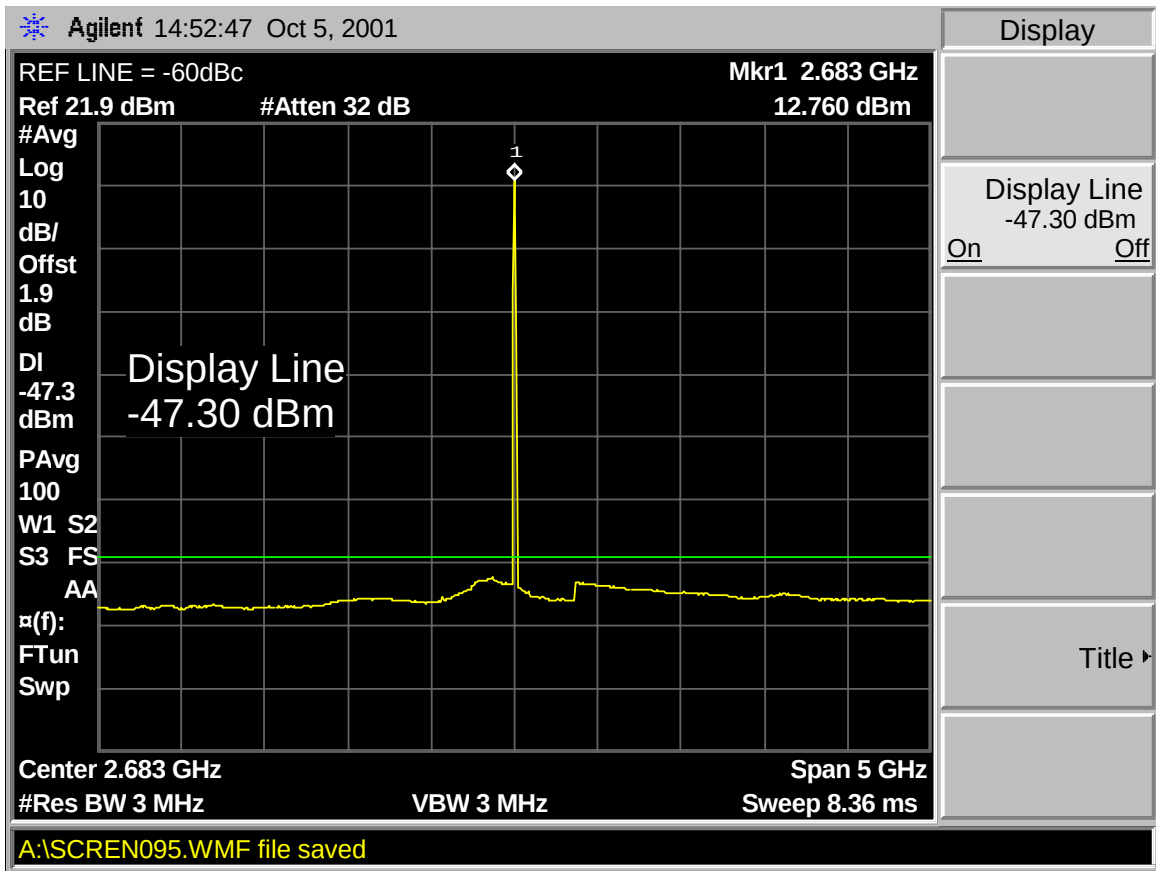
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level.



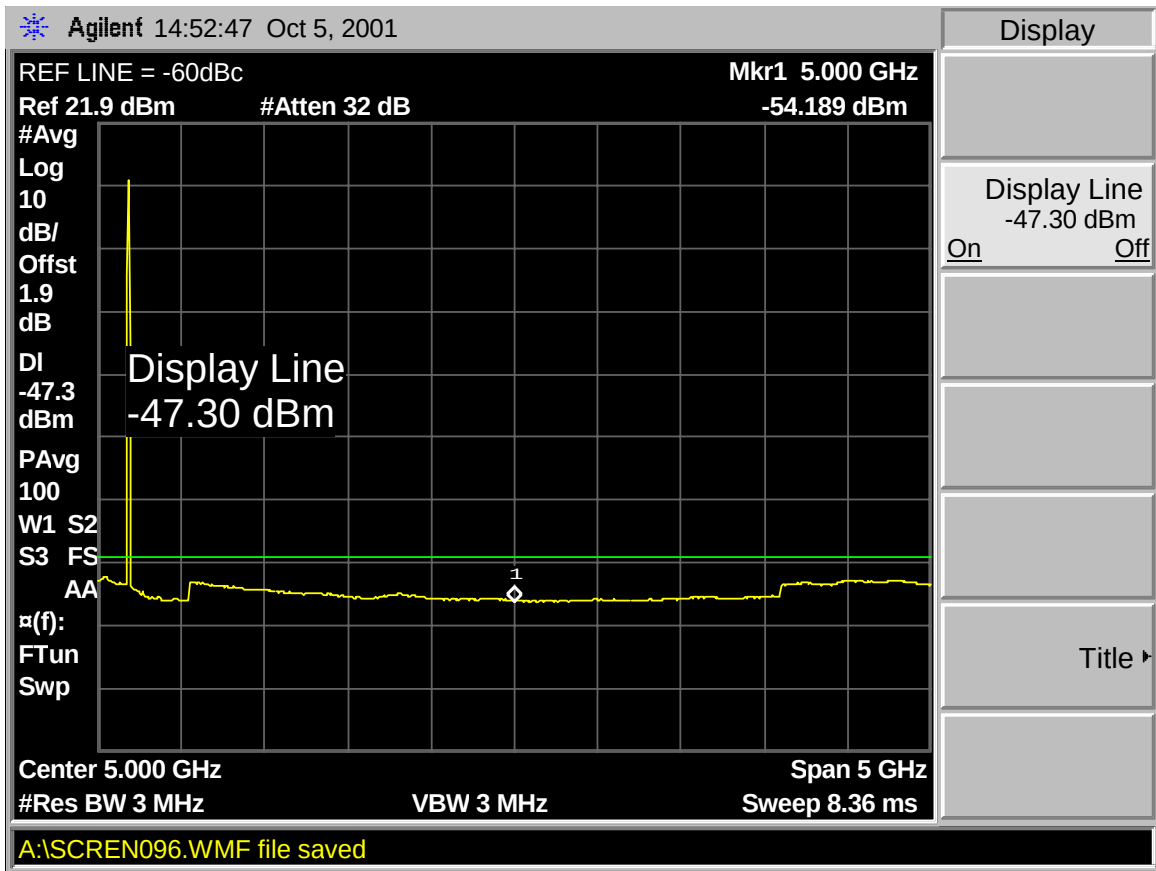
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level.



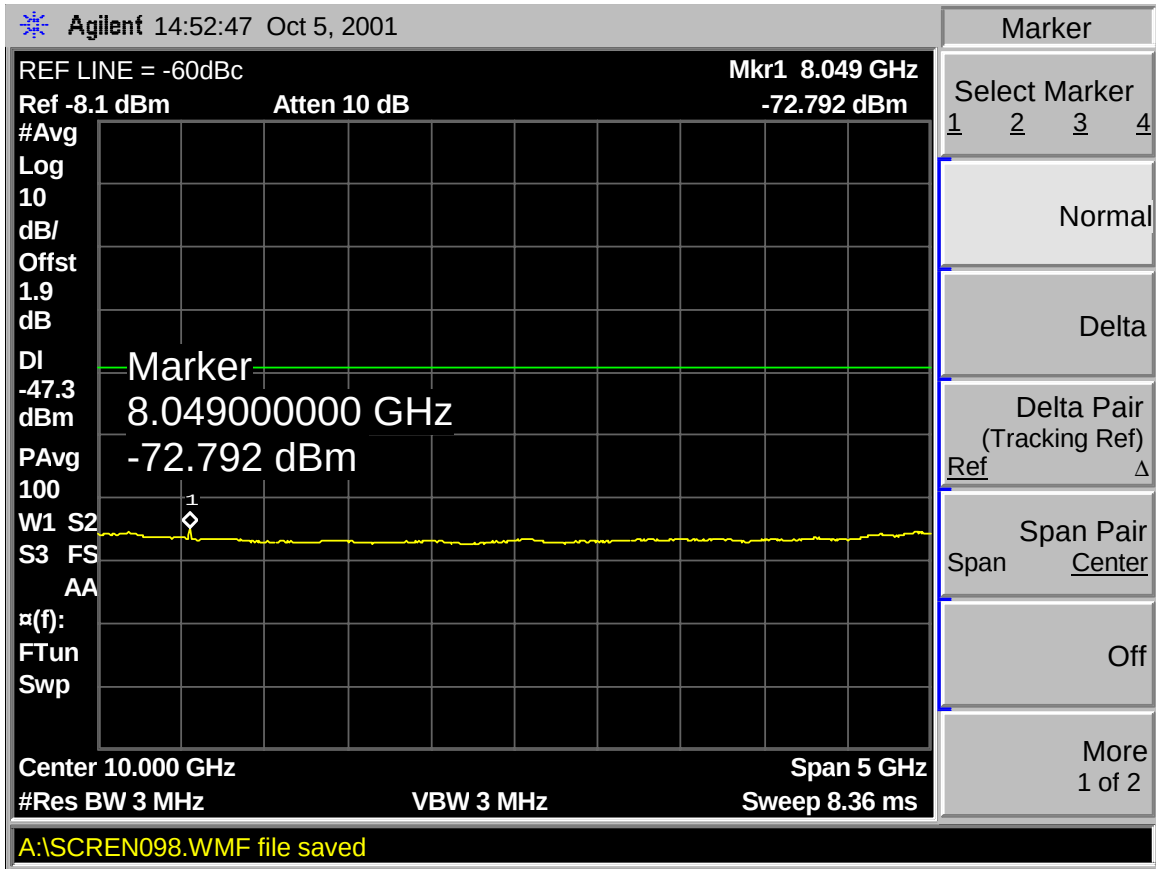
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a -60 dBc level.



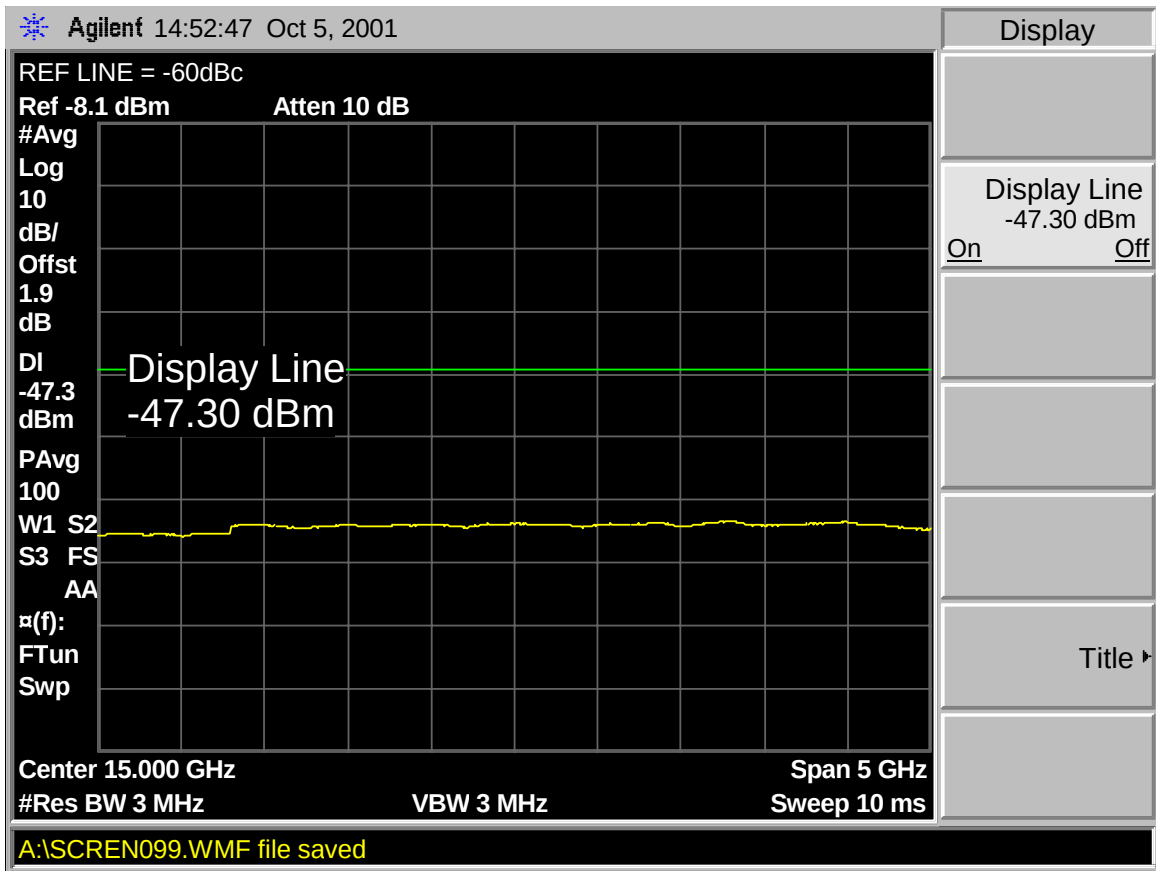
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level.



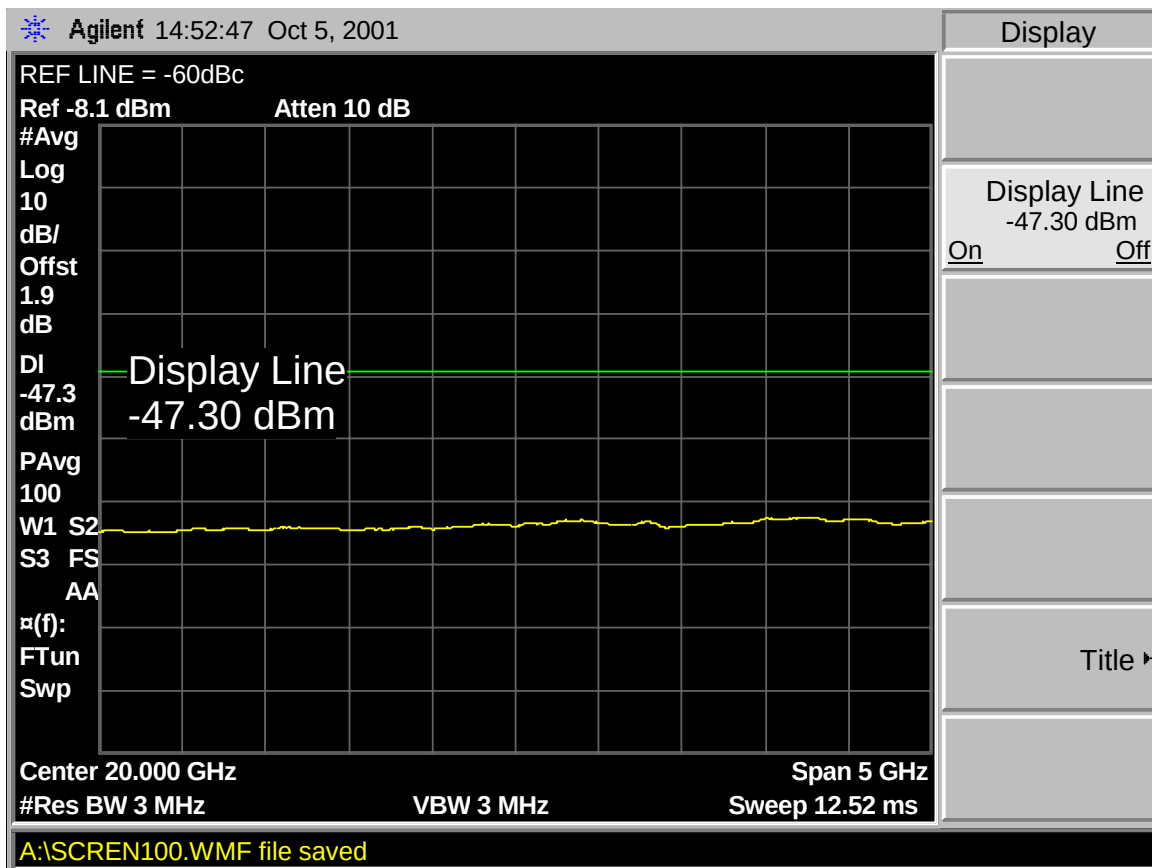
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level.



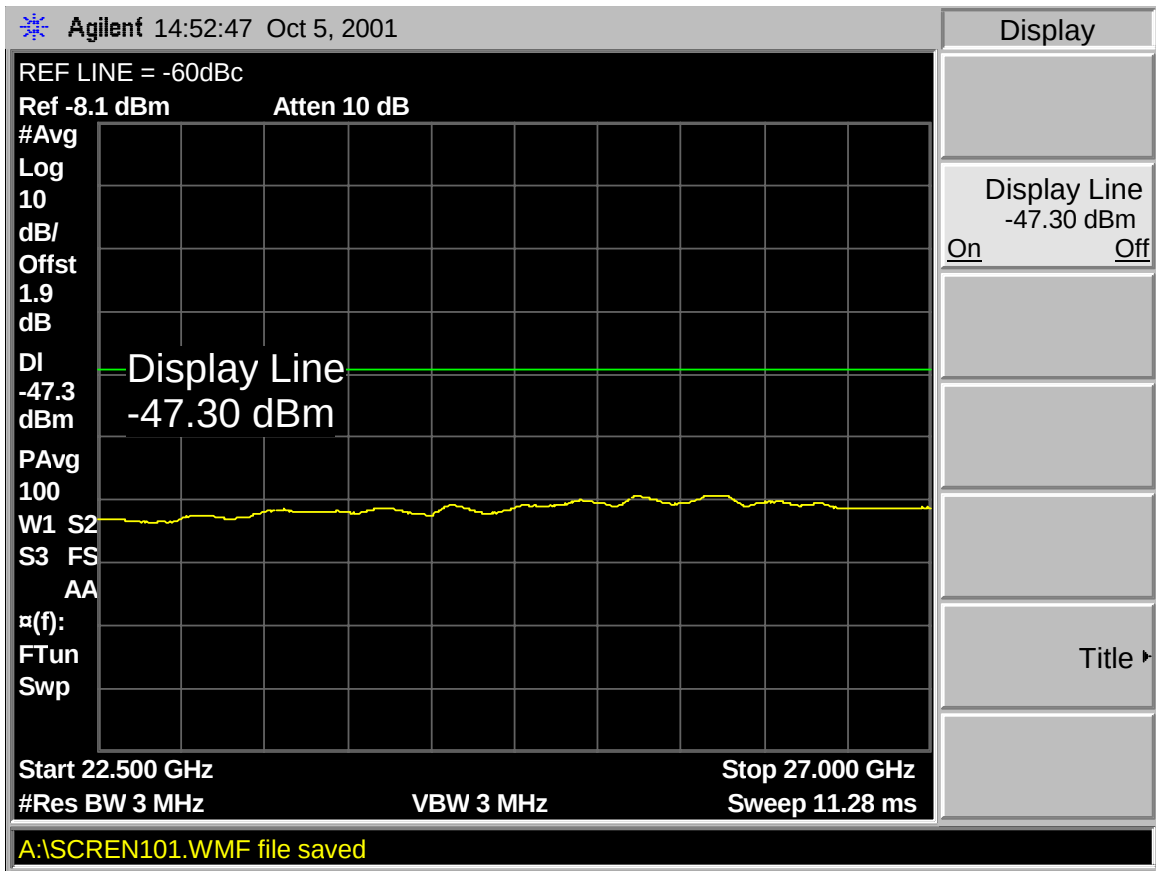
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level. The spurious output measured is the third harmonic of 2683 MHz.



Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level.



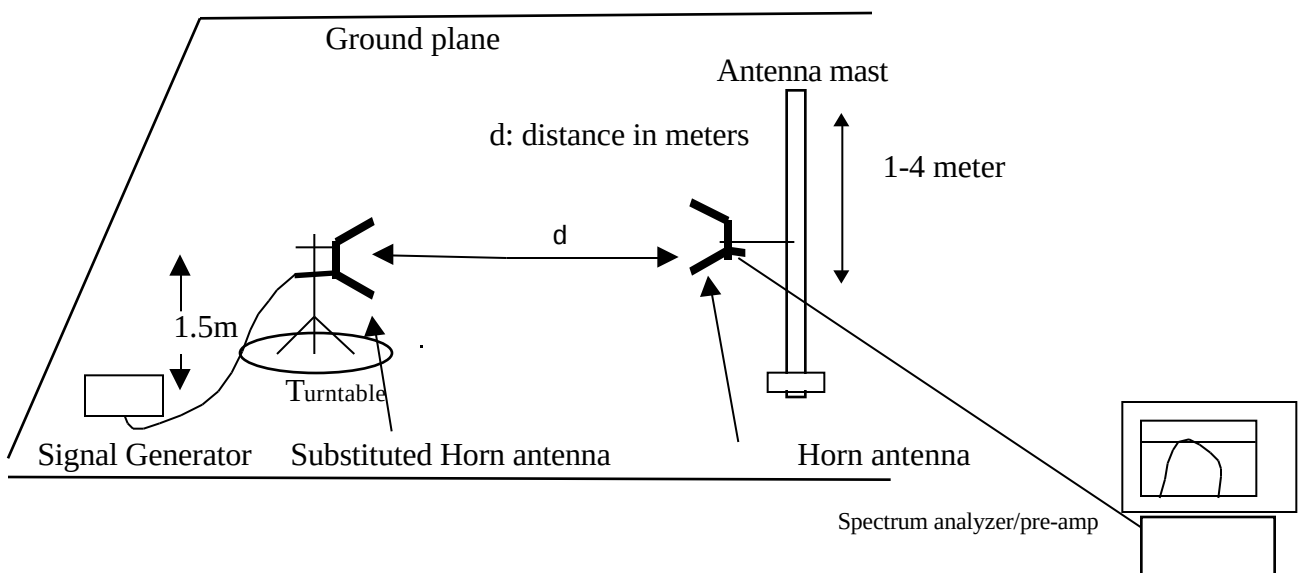
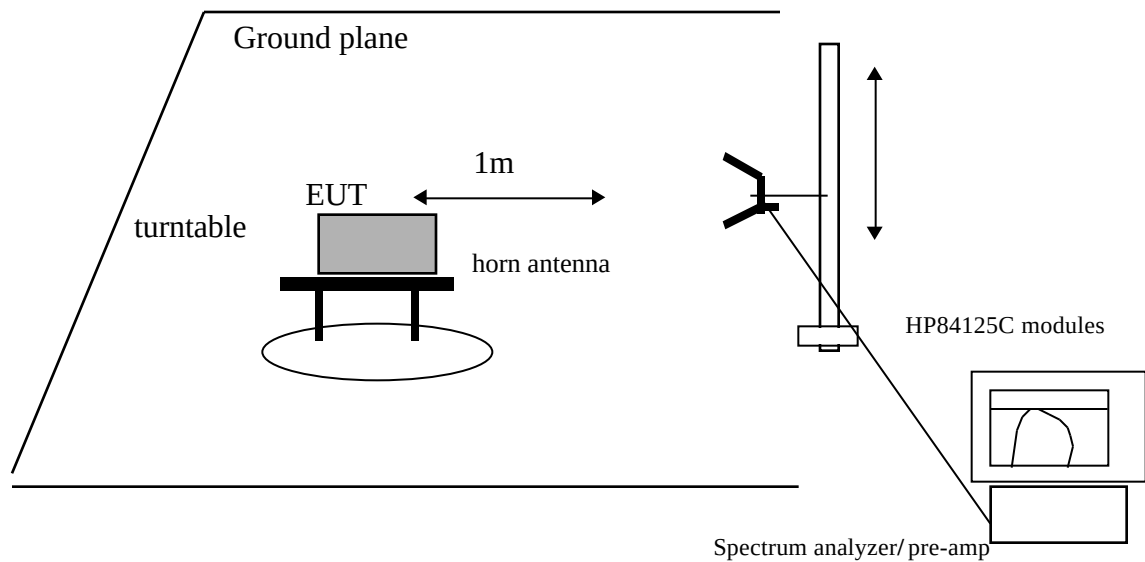
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level.



Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a -60 dBc level.

**Section 2.1053 Field Strength of Spurious and Harmonic Radiation****Measurement Equipment Used:**

HP 8595EM Spectrum Analyzer  
EMCO 3115 Horn antenna, 1- 18 GHz  
Antenna Research Associates MWH 1826/B, 18 - 26.5 GHz  
HP 8449D pre-amplifier

**Test Set-Up**

**Minimum Requirement**

The magnitude of each spurious and harmonic emission detected as being radiated from the EUT must be at a level more than 60 dB below the emission flat top.

**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.

**Test Results**

**Pass.** All emissions detected were ambient or noise floor, and at least 24 dB below limits. Refer to test data below.

Case Radiated Emissions Test  
(Substitution Method)

Test date: 17-Oct-01  
Location: CCS Site A  
Tested by: Hue Vang (CCS)  
T. Cokenias  
C. Fuentes (Aperto)

Applicant: Aperto Networks  
FCC ID: PS6SR1000-A1

Measurement bandwidth: 120 kHz  
Emission bandwidth: 5.7 MHz  
Pout, 6 MHz ch: 17 dBm  
Relative mask peak for 120 kHz measurement bandwidth:

$$17 \text{ dBm} + 10 \log(.120/5.7) = 17 - 16.8 = 0.2 \text{ dBm}$$

Emission limit beyond mask:  $0.2 \text{ dBm} - 60 \text{ dB} = -59.8 \text{ dBm}$  in 120 kHz

fo = 2593 MHz 1 m separation distance All readings vertical polatiry (worst case)

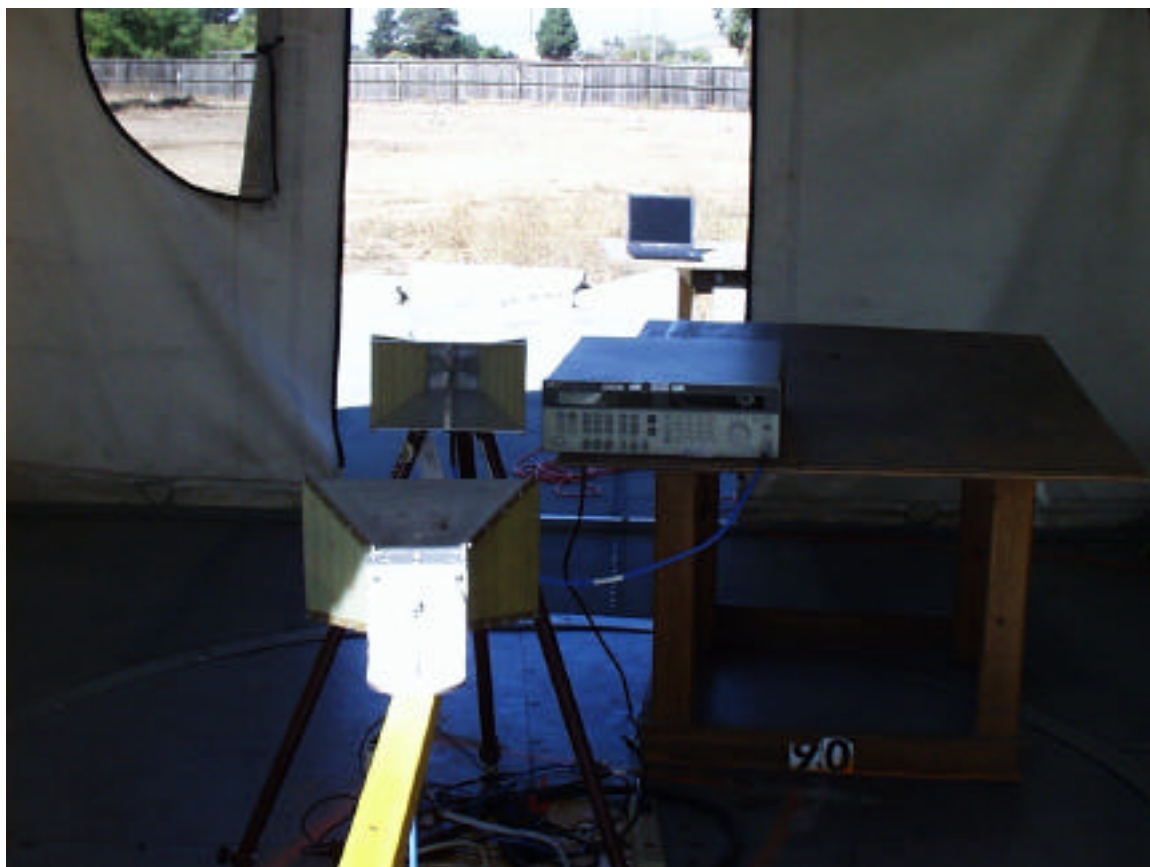
| Frequency<br>GHz | SA reading<br>dBuV | Sig Gen<br>dBm | CL<br>dB | Gain<br>dBi | Gain<br>dBd | ERP<br>dBm | Limit<br>dBm | Margin<br>dB |
|------------------|--------------------|----------------|----------|-------------|-------------|------------|--------------|--------------|
| 5.186            | 20.94              | -113           | 5.1      | 10.3        | 8.1         | -110       | -59.8        | -50.2        |
| 7.779            | 19.9               | -113           | 5.85     | 11.1        | 8.9         | -109.95    | -59.8        | -50.15       |
| 10.372           | 18.7               | -113           | 6.75     | 12          | 9.8         | -109.95    | -59.8        | -50.15       |
| 12.965           | 22.5               | -113           | 8.25     | 11.6        | 9.4         | -111.85    | -59.8        | -52.05       |
| 15.558           | 23.8               | -87.9          | 9        | 14.6        | 12.4        | -84.5      | -59.8        | -24.7        |

to 10 fo no emission detected at 0.5 ft (15cm), noise only

### Case Radiated Test Set-up



## Substitution Set-up



## 2.1055 Frequency Stability

A 10 MHz oven controlled crystal oscillator (OCXO) is the frequency determining portion of the Aperto MMDS transmitter.

### Temperature v Frequency, -30C to +50C

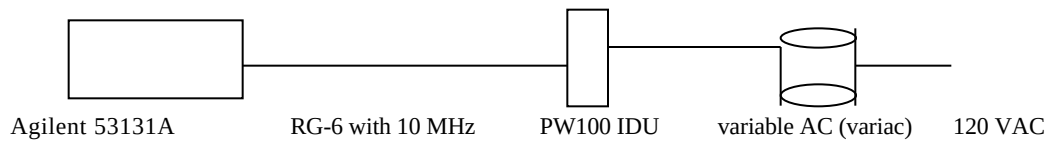
The OCXO in the IDU establishes a phase lock that maintains transmitter frequency over temperature within approximately 0.5 ppm. A more detailed description of how this is accomplished is found in the operational description for this product (separate document). Temperature-frequency data for the OCXO is presented in a separate document.

### Operating Voltage v Frequency

#### Measurement Equipment Used

Agilent 53131A Frequency counter s/n MY40002076 cal 12 Oct 2000

#### Test Set-up



#### Test Procedures

Operating voltage was varied from 100 - 140 VAC while monitoring 10 MHz output.

#### Test Results

Frequency counter varied 0.57 - 0.59 Hz above 10 MHz reference, seemingly independent of AC input voltage to IDU.

**Conclusion:** Reference oscillator variation over temperature and over voltage is less than 0.6 ppm. At 2683 MHz this represents a maximum frequency shift of approximately

$$0.6 \times 2683 = 1610 \text{ Hz}$$

Based on transmitter emissions mask data, transmitter emission will be within the required frequency mask at all times over operating ranges of temperature and supply voltage.

## Part 15 Digital Device Emissions

Tests were performed on the PW100 IDU to measure radiated and conducted emissions per Part 15 of the Rules. The IDU meets class B limits; a separate verification report is being held on file at Aperto Networks.

### **Test Site**

All testing was performed at Aperto Networks (antenna conducted measurement) and at Compliance Certification Services (radiated emissions) under my supervision. Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.

THOMAS N. COKENIAS  
Consultant, EMC&Radio Type Approvals