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: 16 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: PS6BR1000-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

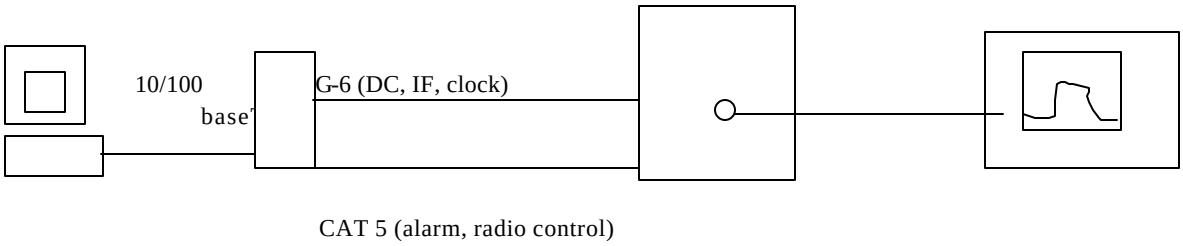
(2) RF Output Power Measurements

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

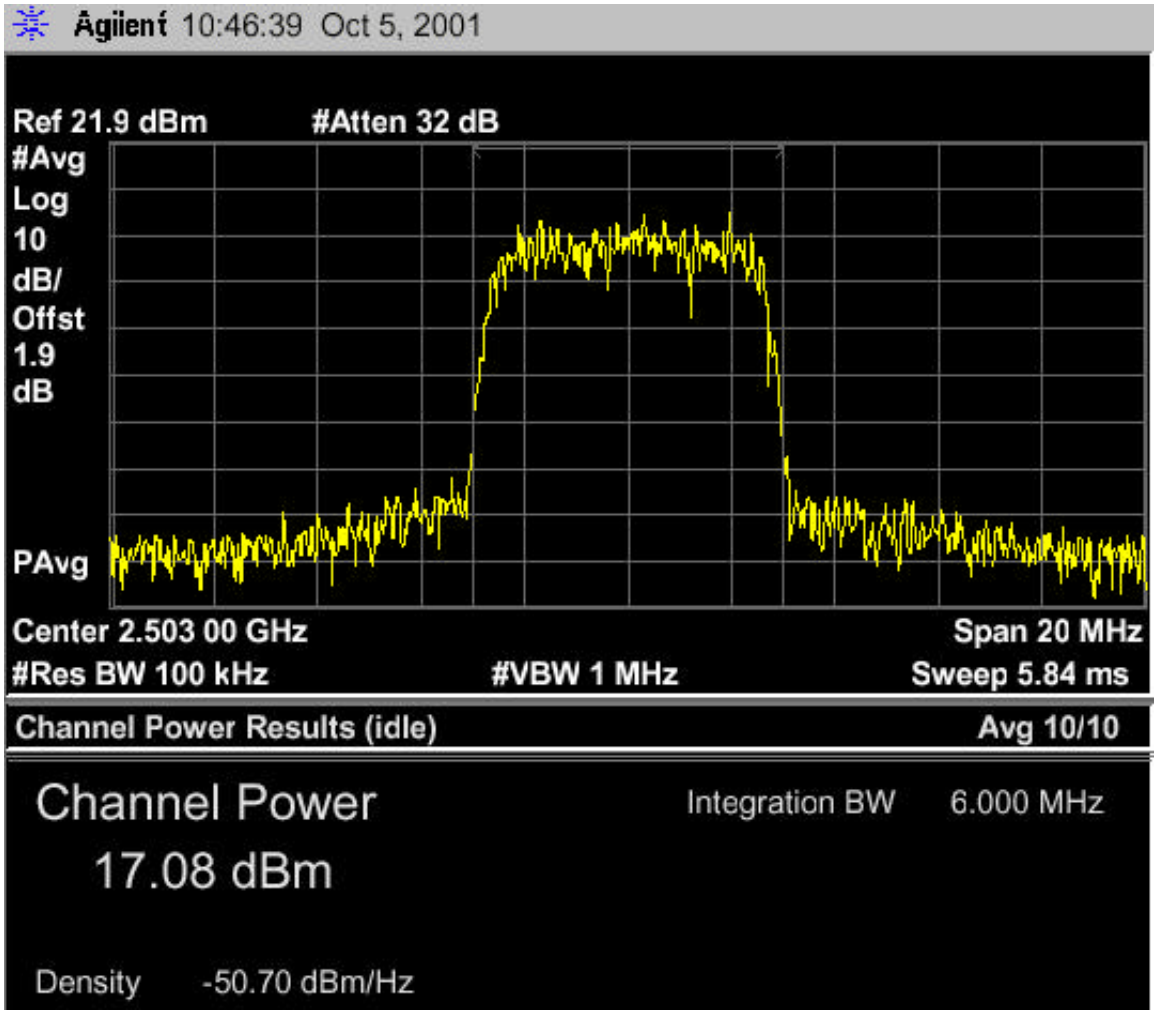
1. Set the IDU channel bandwidth parameters and output level to desired values. Output level is chosen to maximize RF output level from ODU.
2. Connect cable between E4440A and ODU antenna output port. Activate Channel Power subroutine via E4440A soft keys, plot and record results.

Test Results

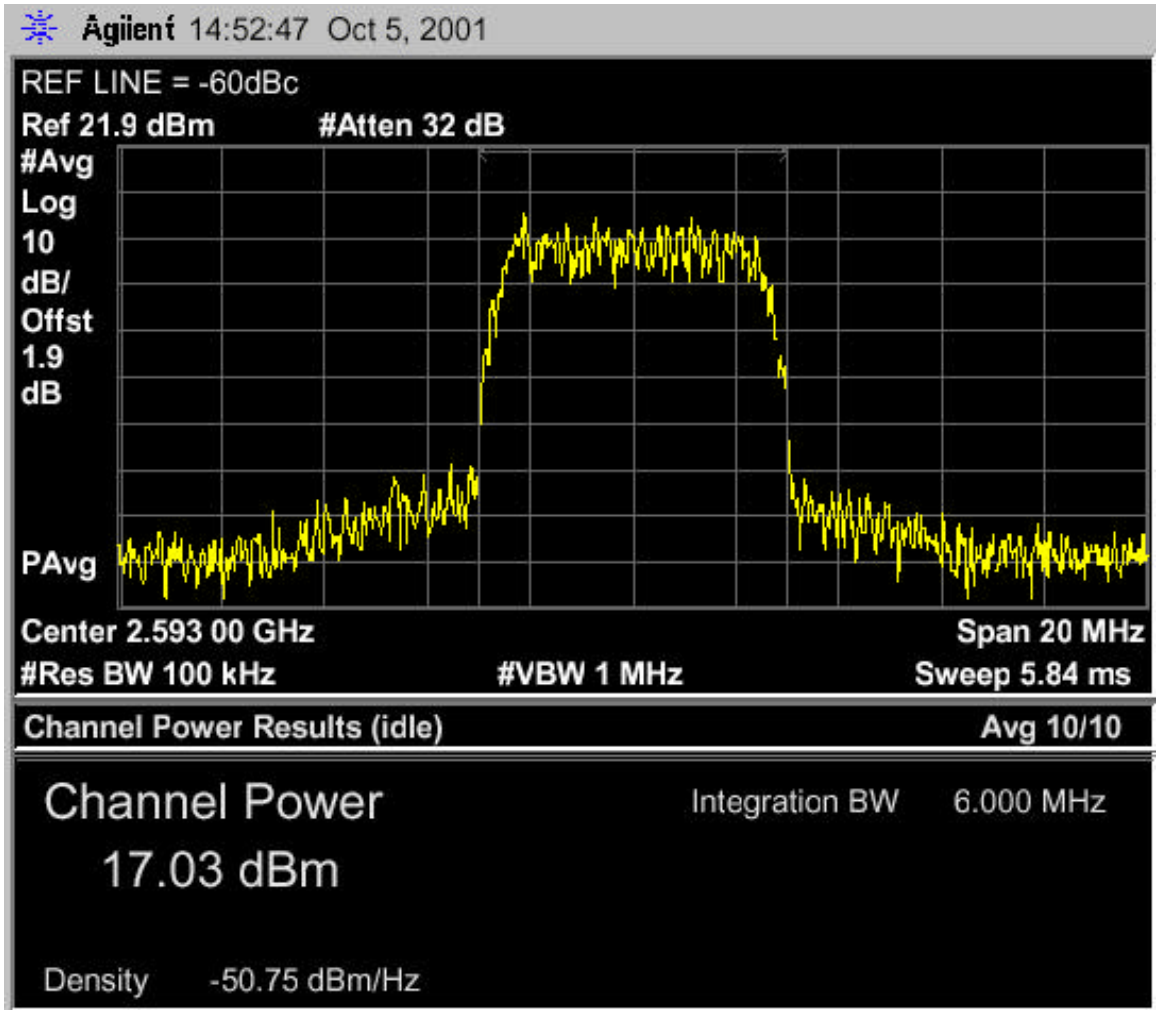
F(MHz)	P requested	P delivered
2503	17 dBm	17.08 dBm
2593	17 dBm	17.03 dBm
2683	17 dBm	17.05 dBm

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

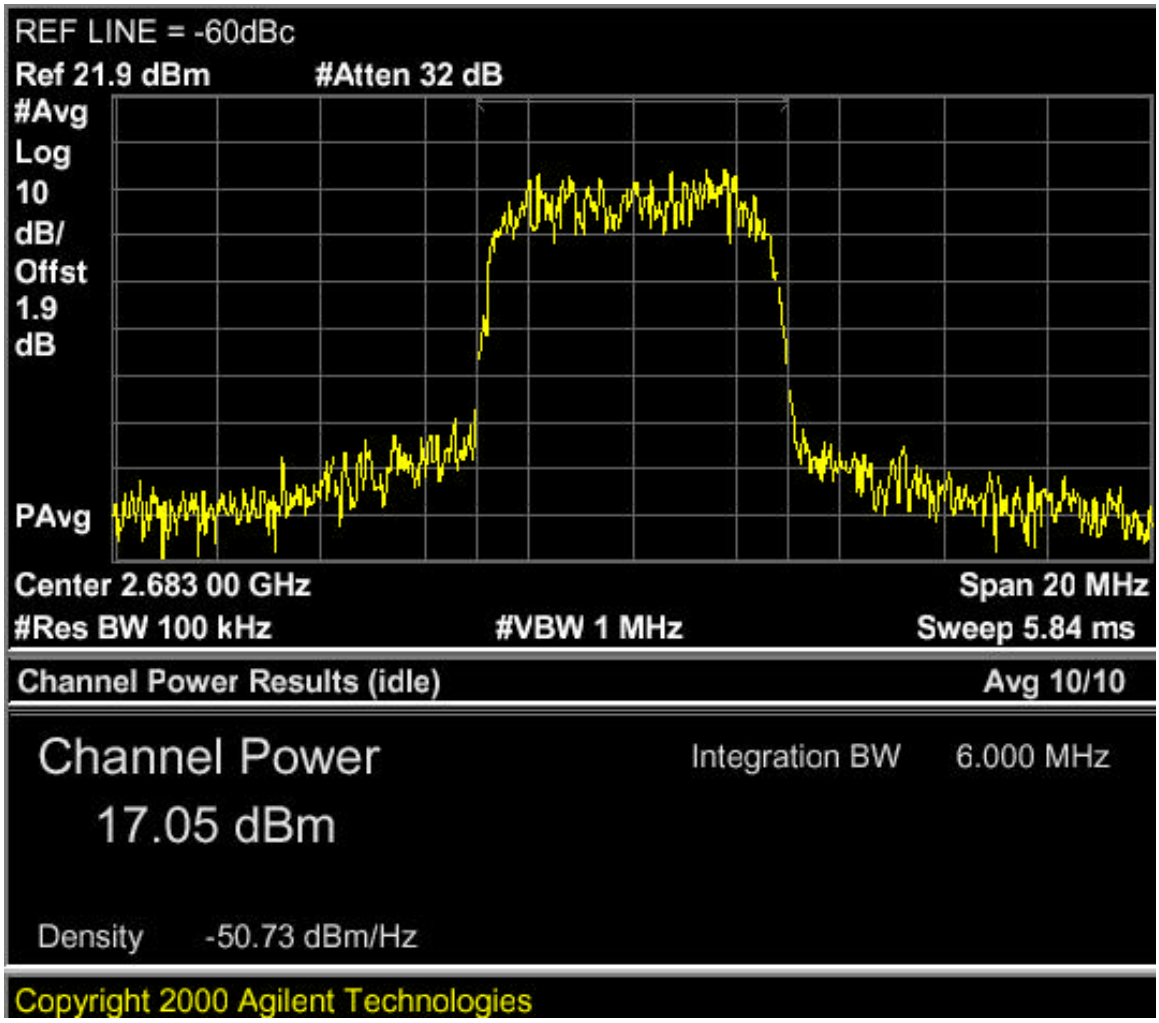
Power Output Spectrum Analyzer Graphs
fo = 2503 MHz (low channel)



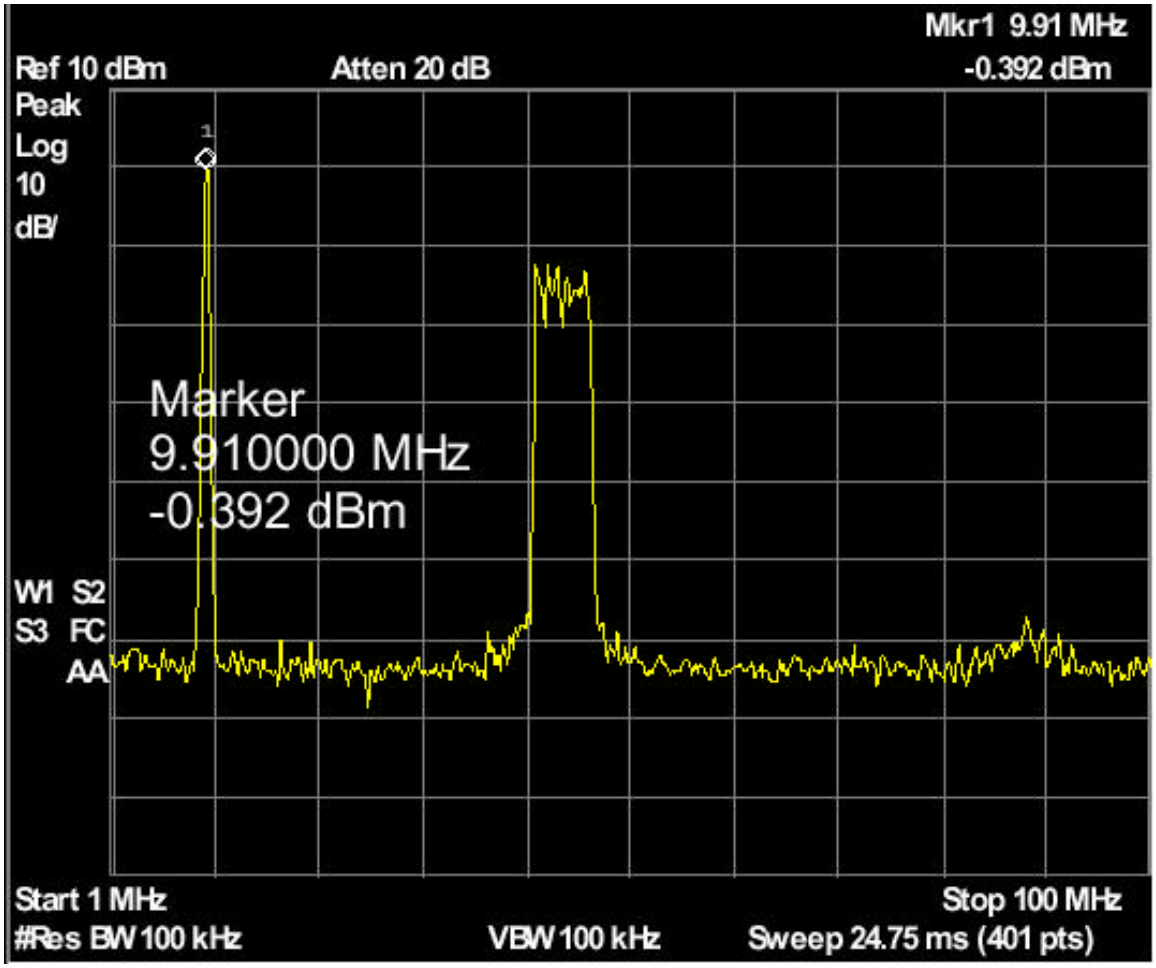
Power Output Spectrum Analyzer Graphs
fo = 2593 MHz (middle channel)



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.

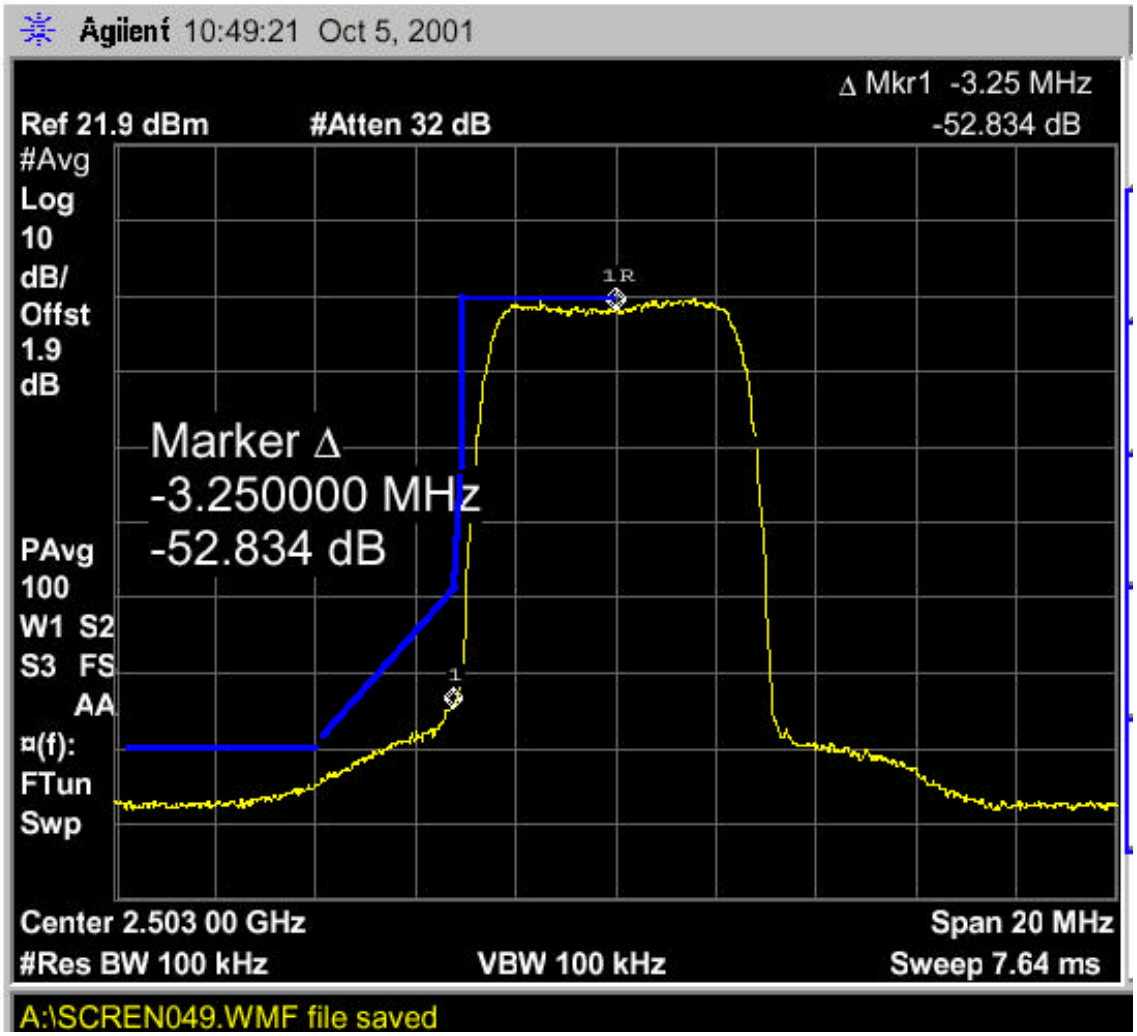
Test Results

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

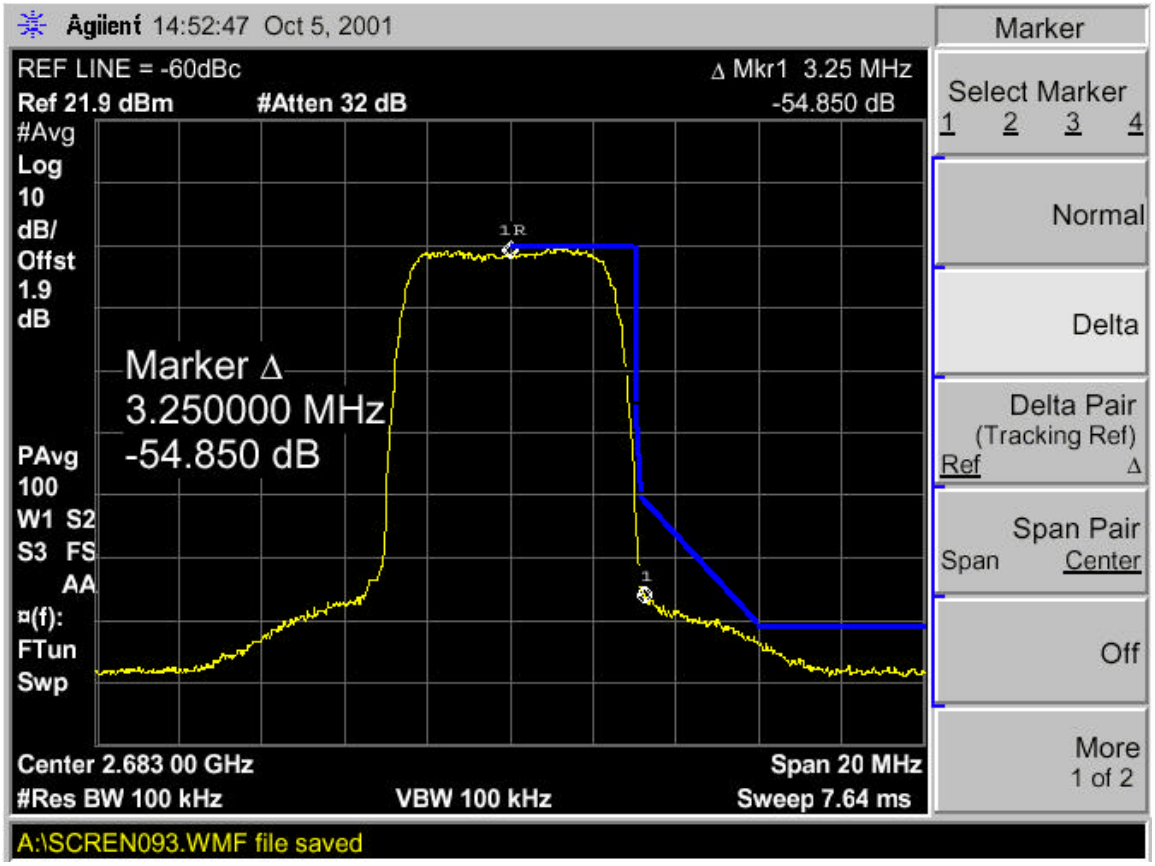
Lowest: 2503 MHz
Middle: 2593 MHz
Highest: 2683 MHz

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

Channel Mask for fo = 2503 MHz (lowest channel)



Channel mask for fo = 2683 MHz (highest channel)



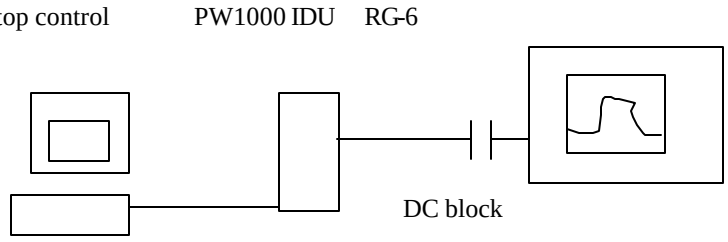
Section 2.1049 Occupied Bandwidth

Measurement equipment used:

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

Test set-up:

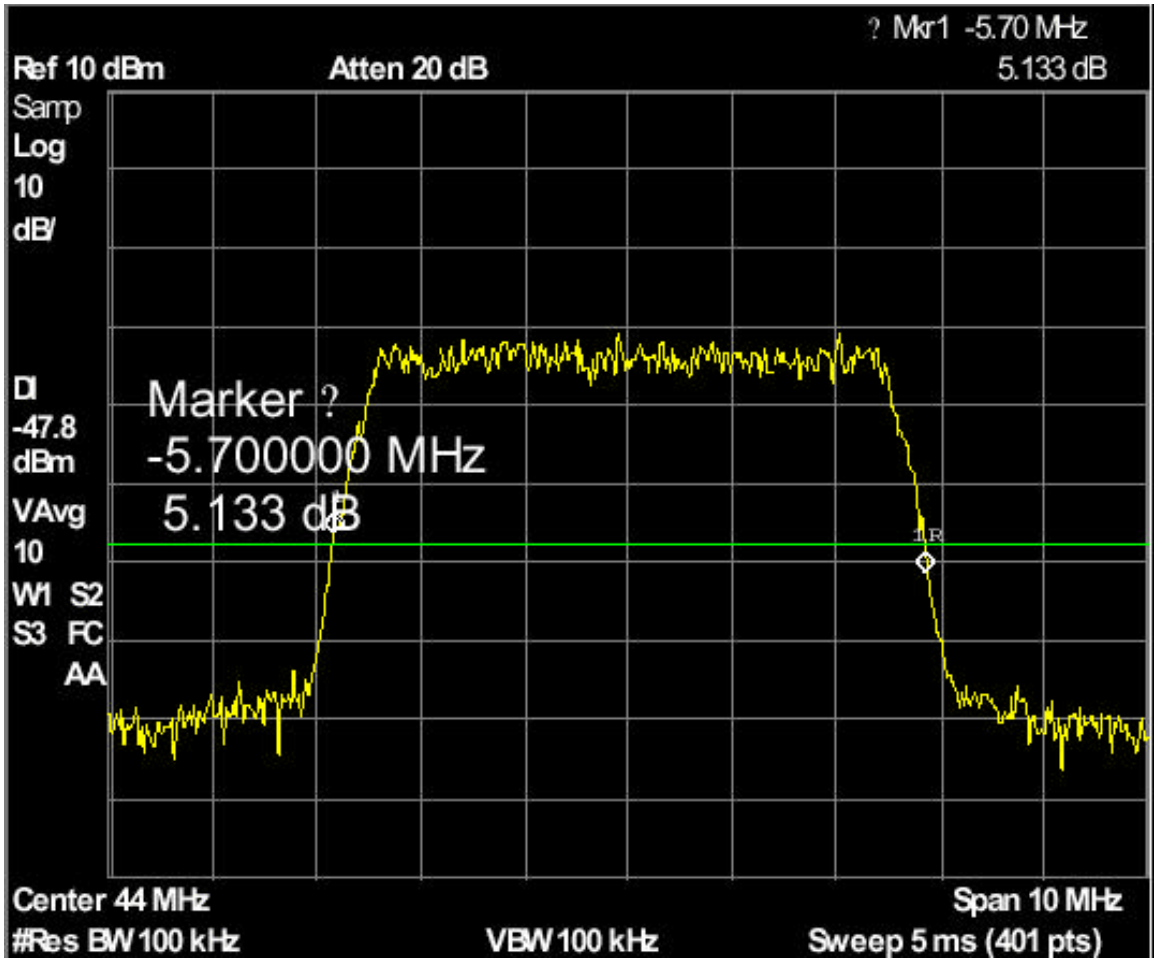
Fig. 2



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

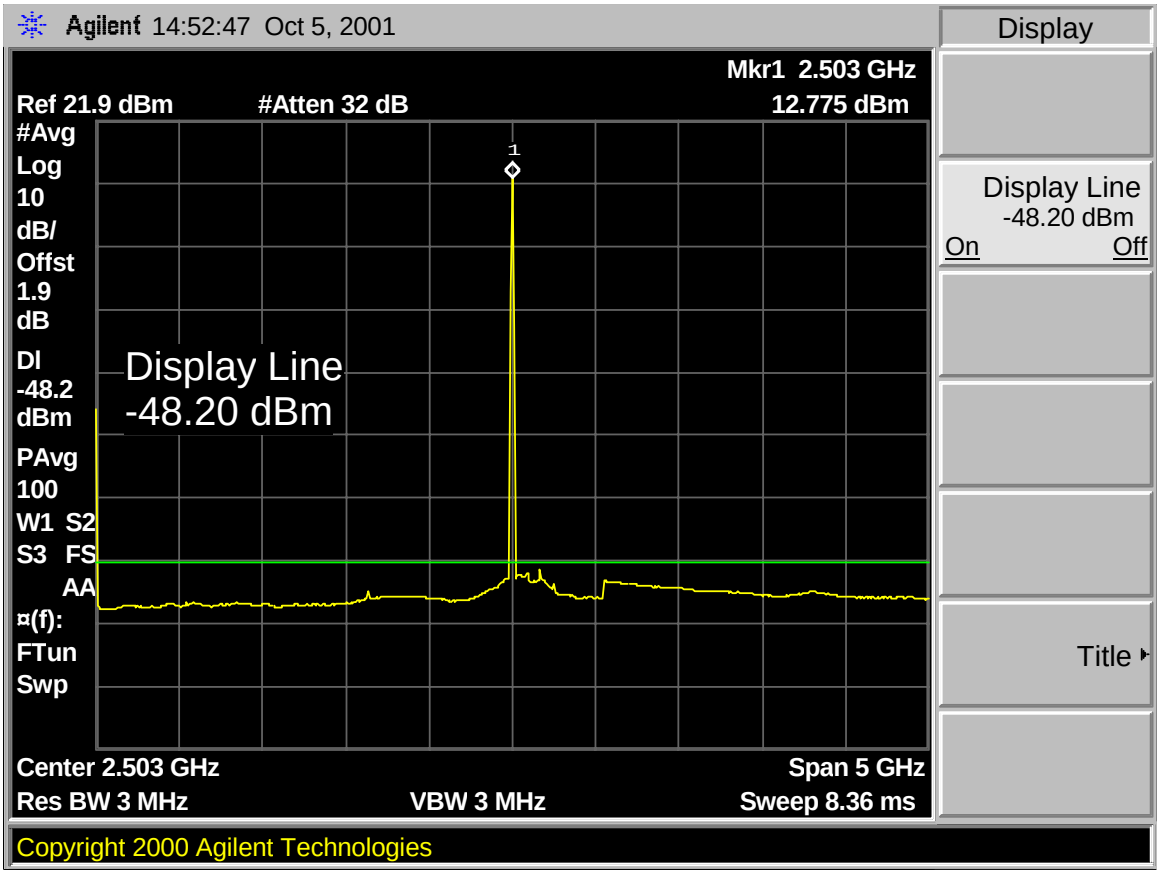
Section 21.908(e) requires that for a 100 kHz measurement bandwidth, all emissions removed from the channel edge by more than 3 MHz must be attenuated at least 60 dB below the channel emission flat top.

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^{th} harmonic of TX output frequency
5. Plot spectrum analyzer output traces.

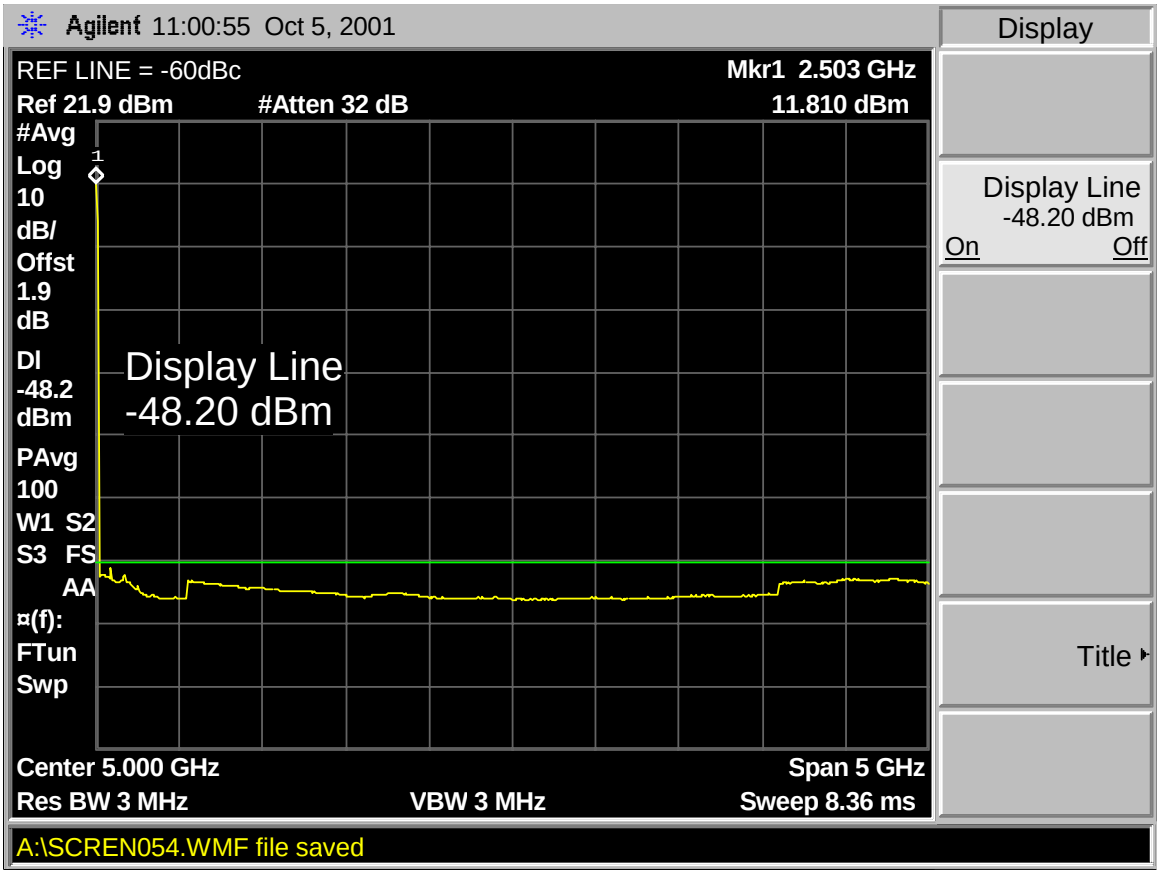
Test Results

PASS. Refer to data plots below.

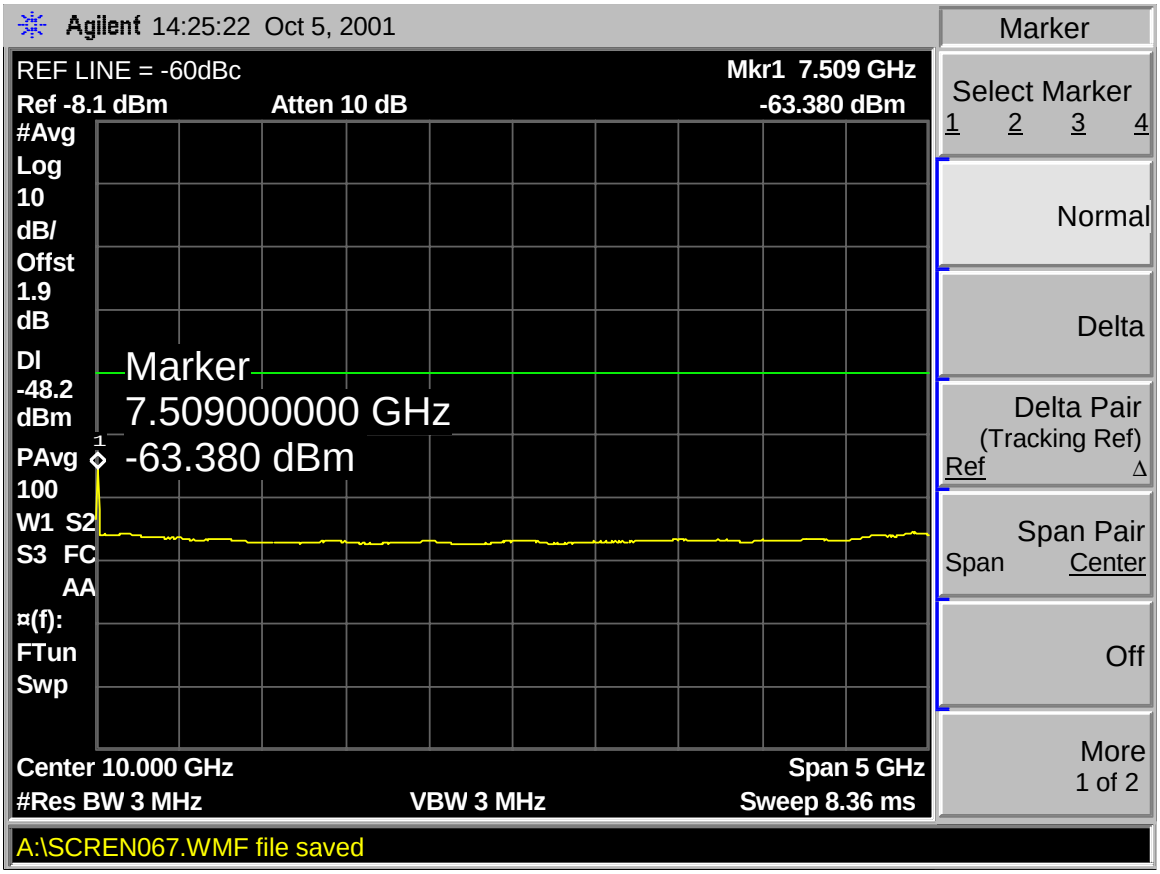
Spurious Emissions, Antenna Conducted Output Spectrum Analyzer Graphs



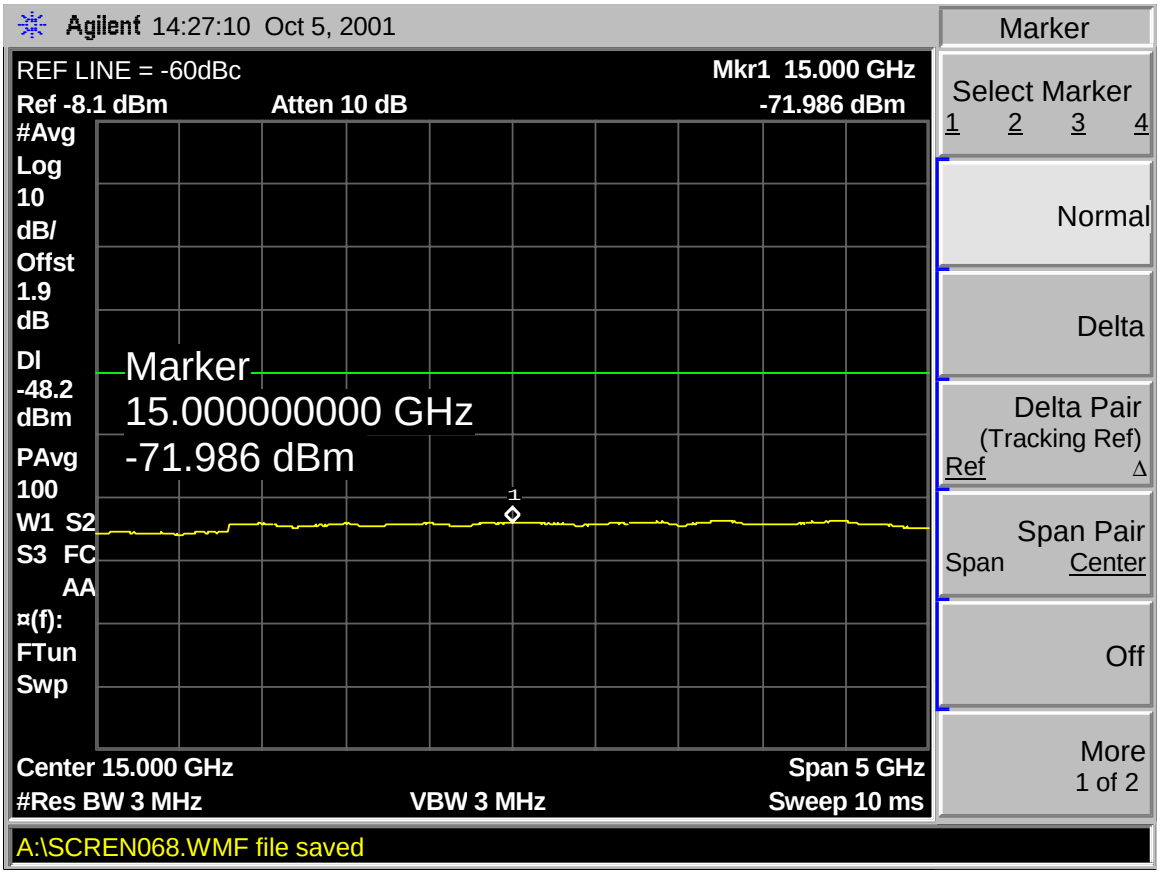
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level.



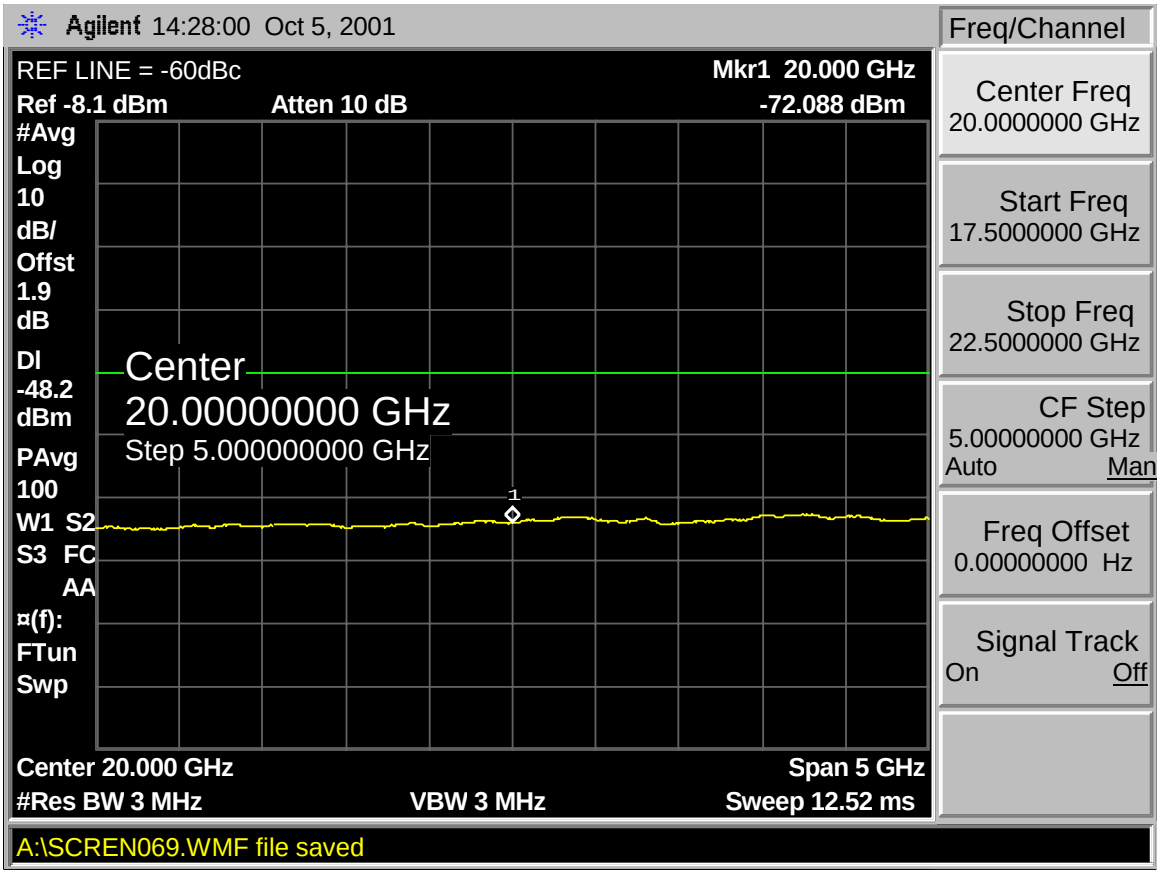
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level.



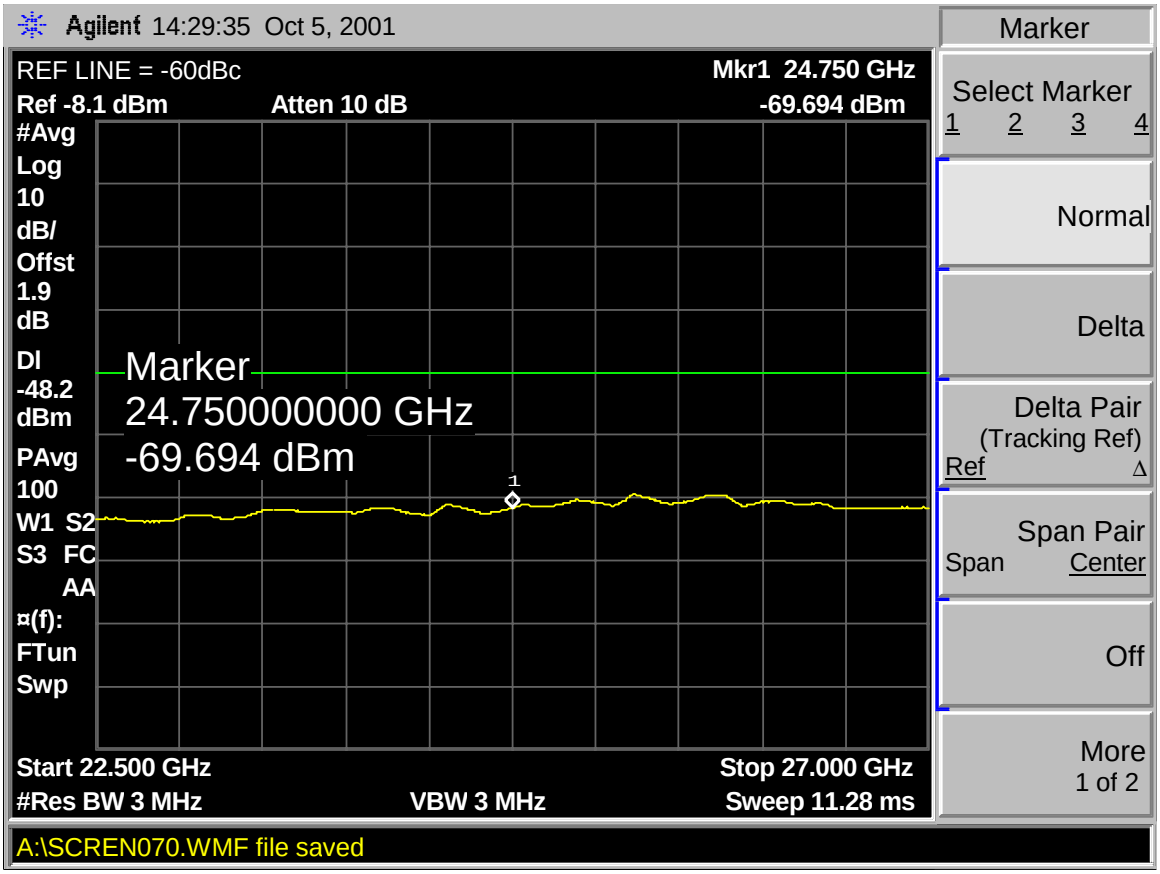
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level. The spurious output measured is the third harmonic of 2503 MHz.



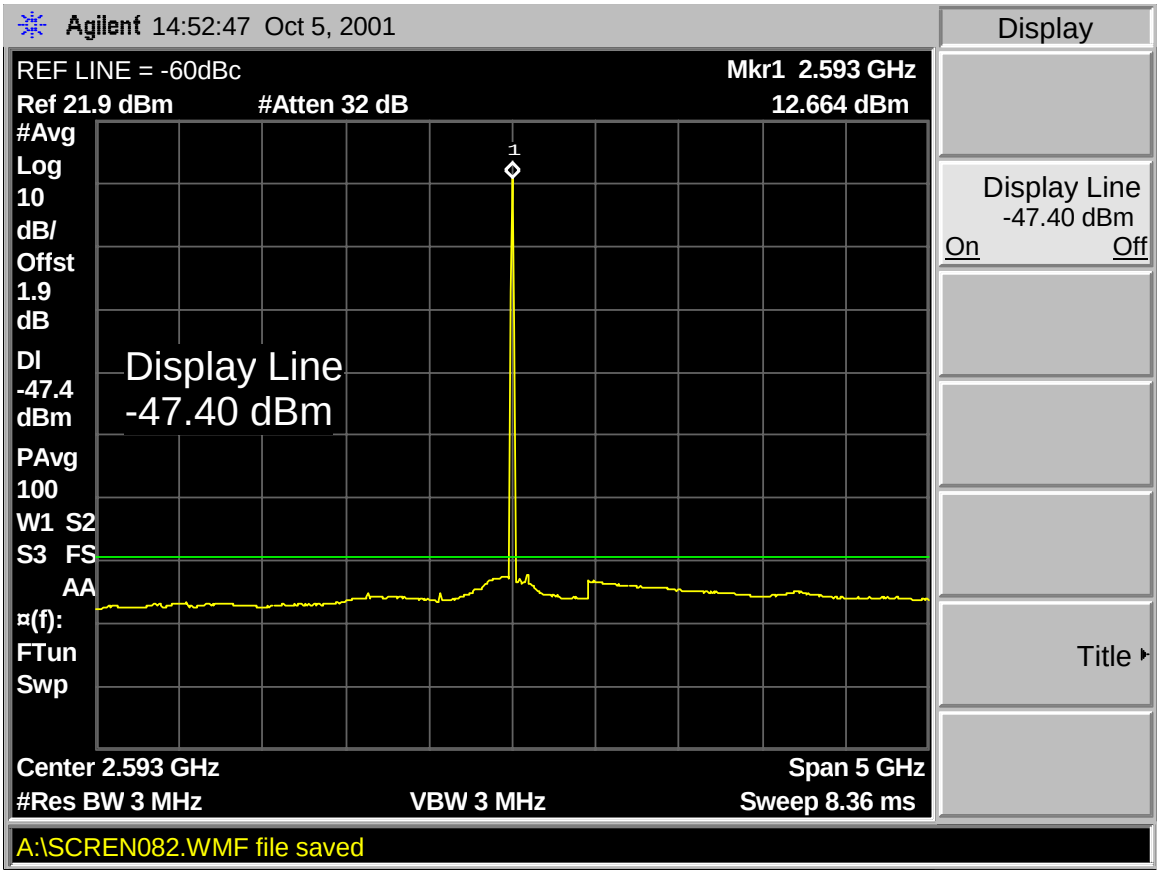
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level.



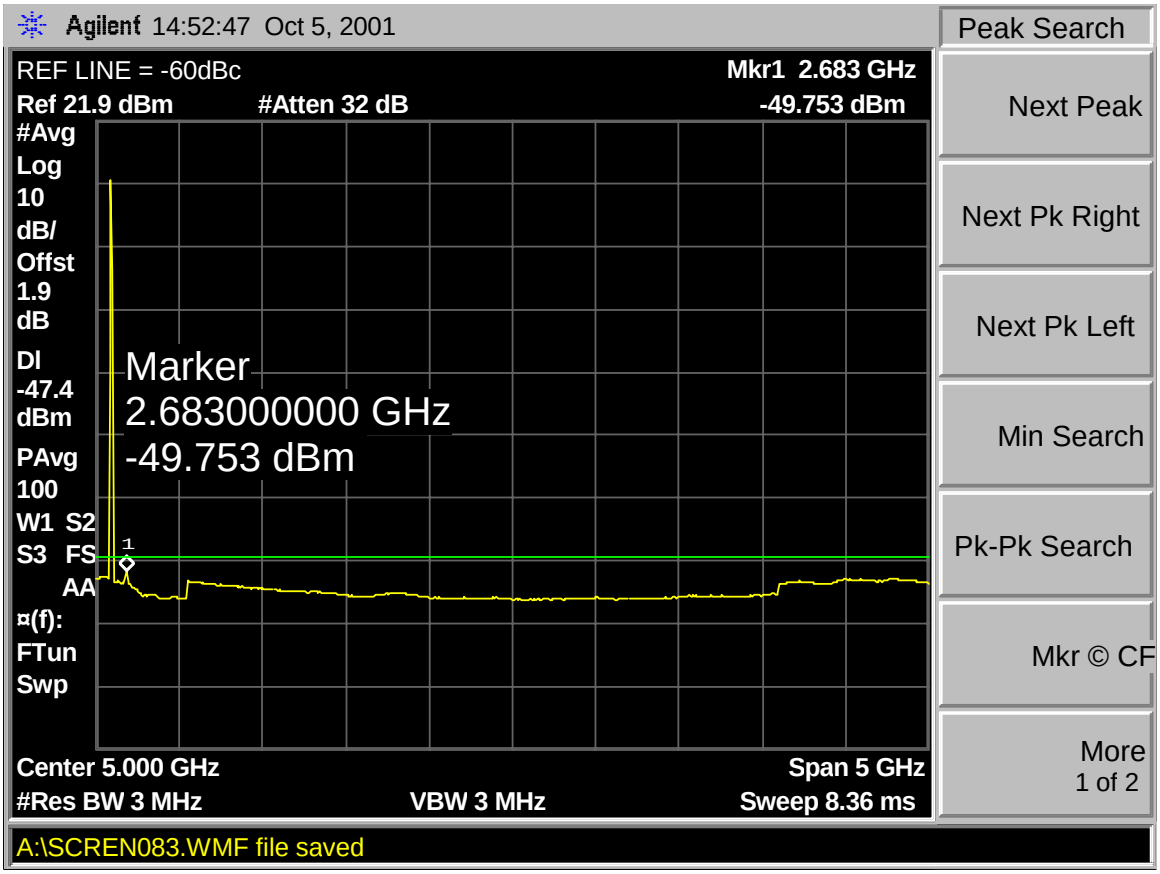
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level.



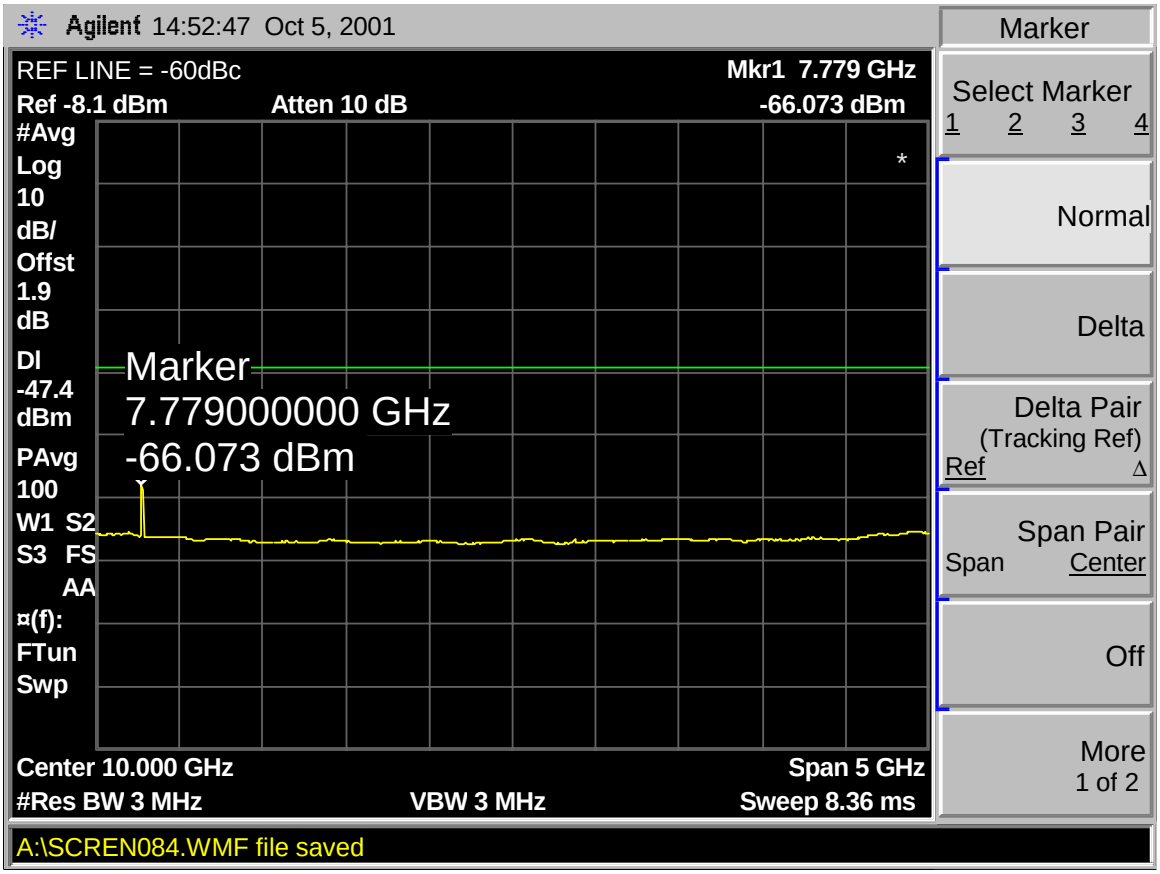
Broadband spurious search with channel output set to 2503 MHz. The green reference line represents a –60 dBc level.



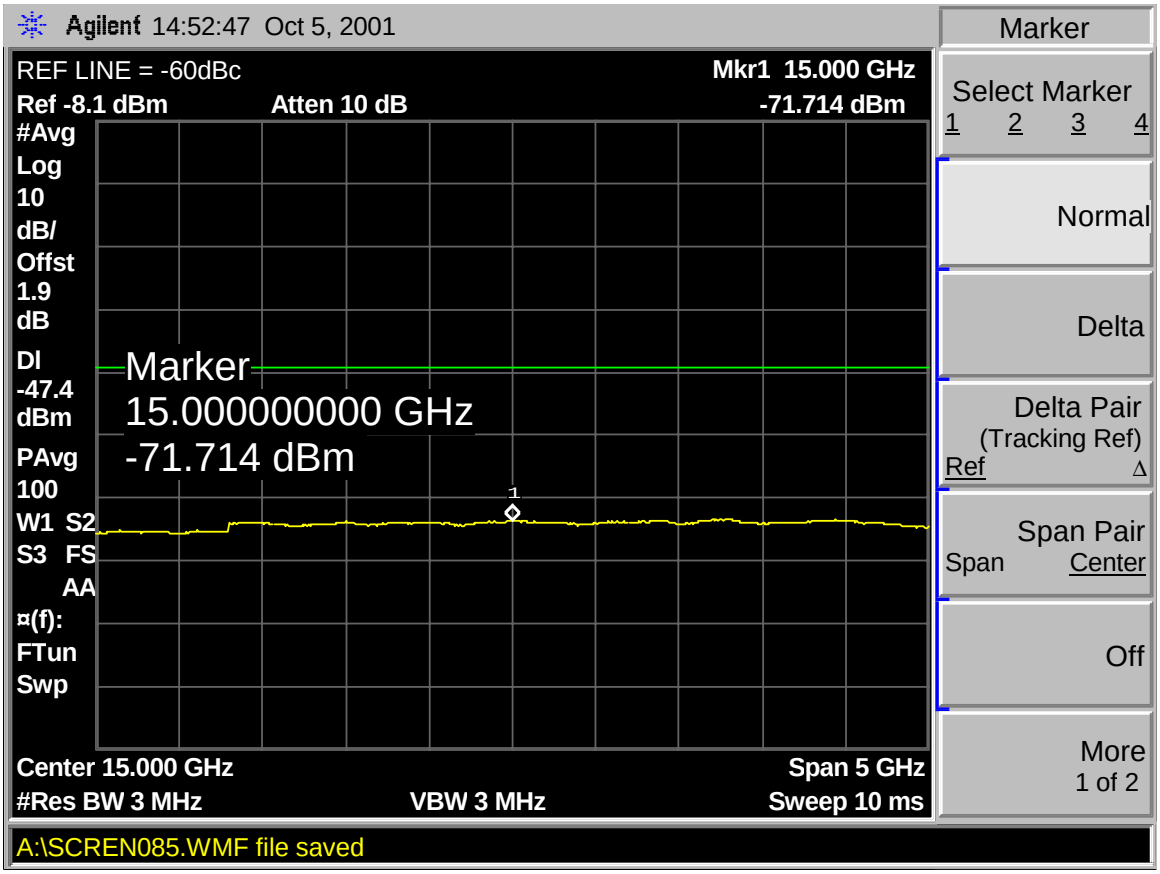
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level.



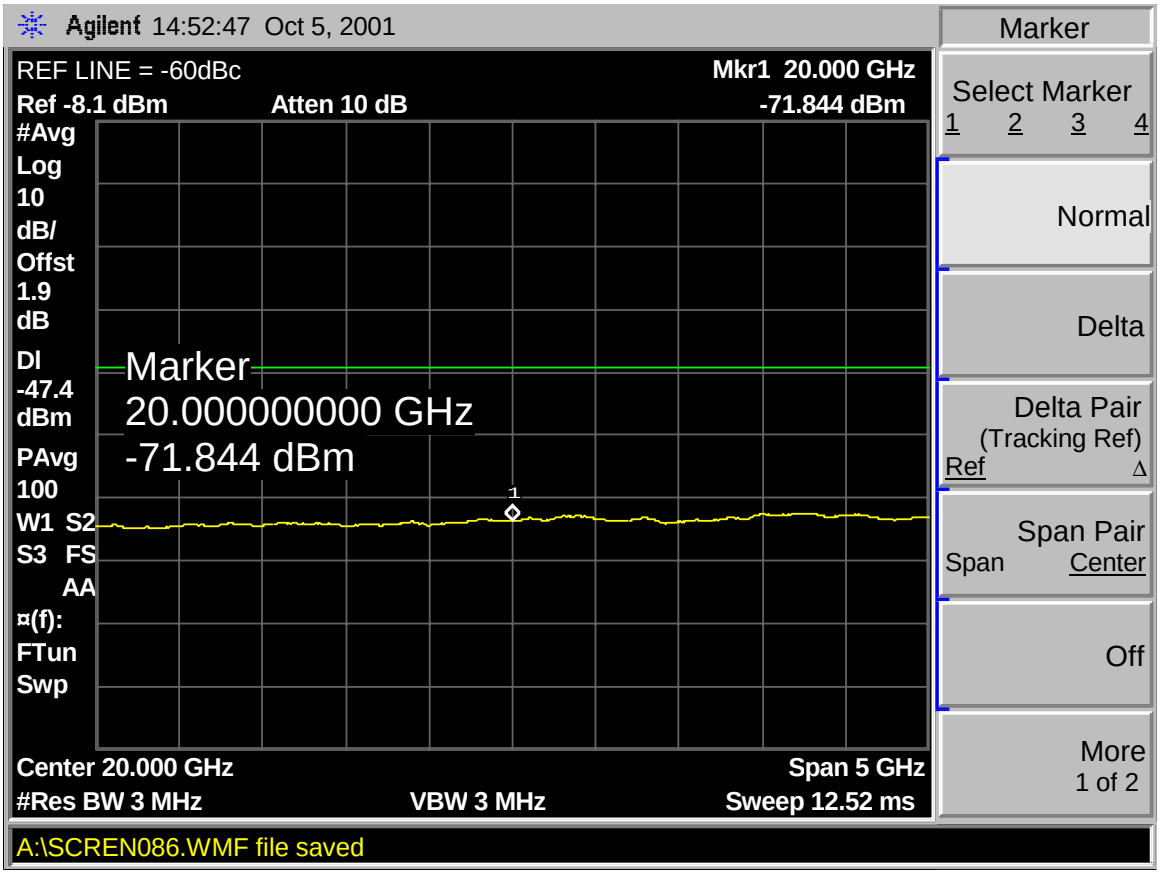
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level.



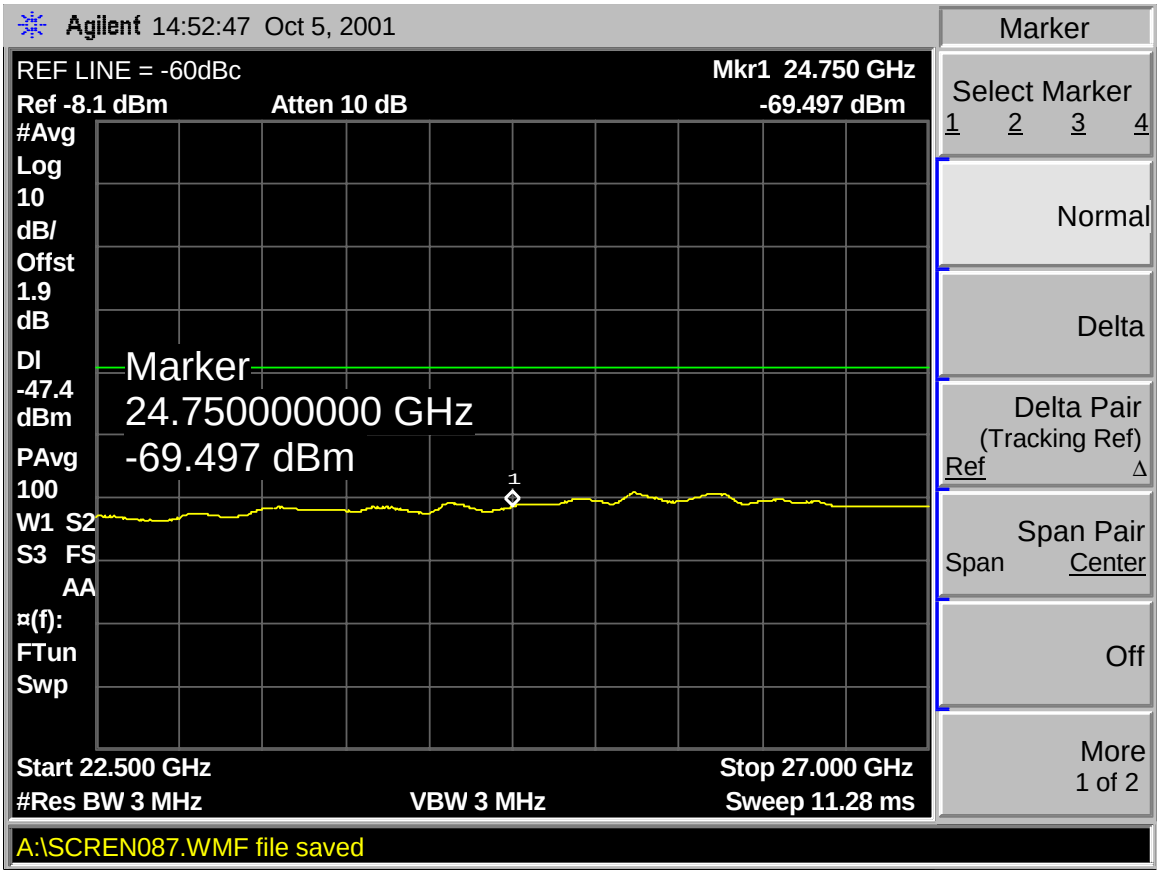
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level. The spurious output measured is the third harmonic of 2593 MHz.



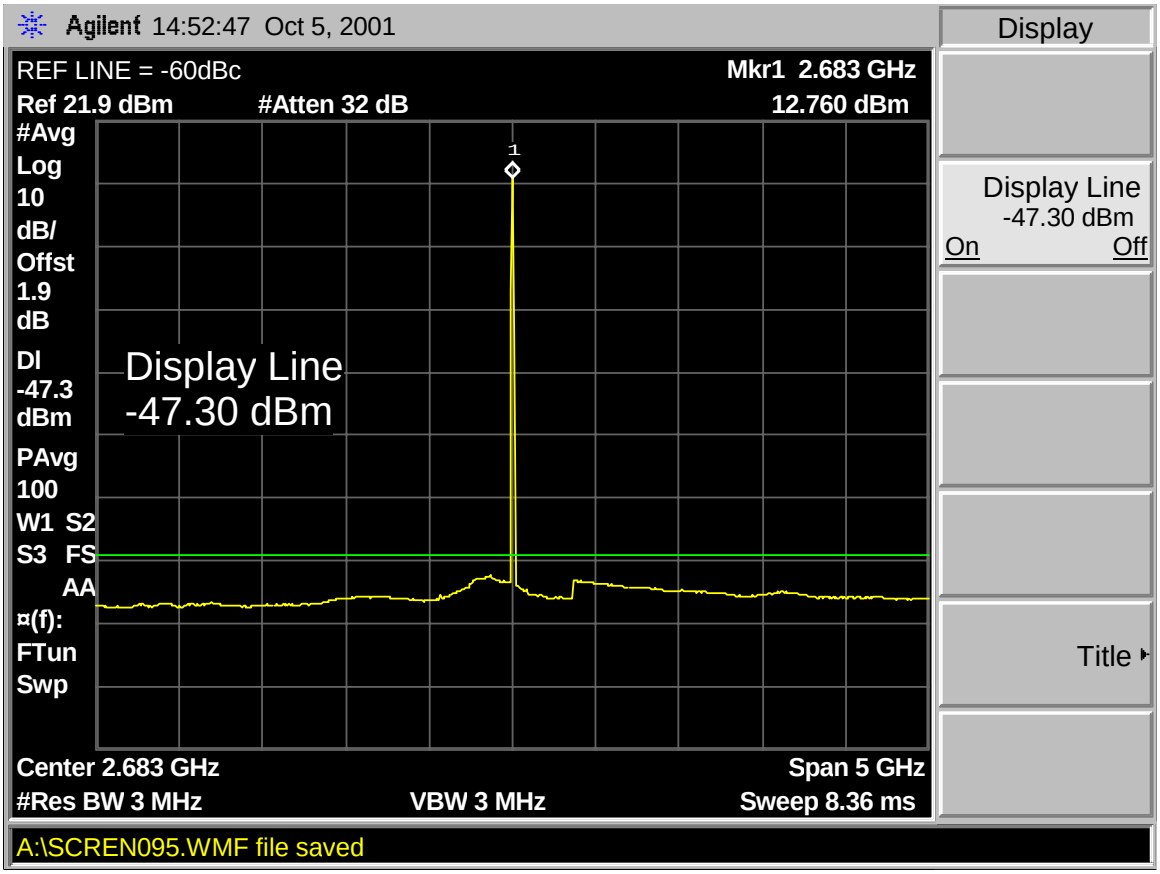
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level.



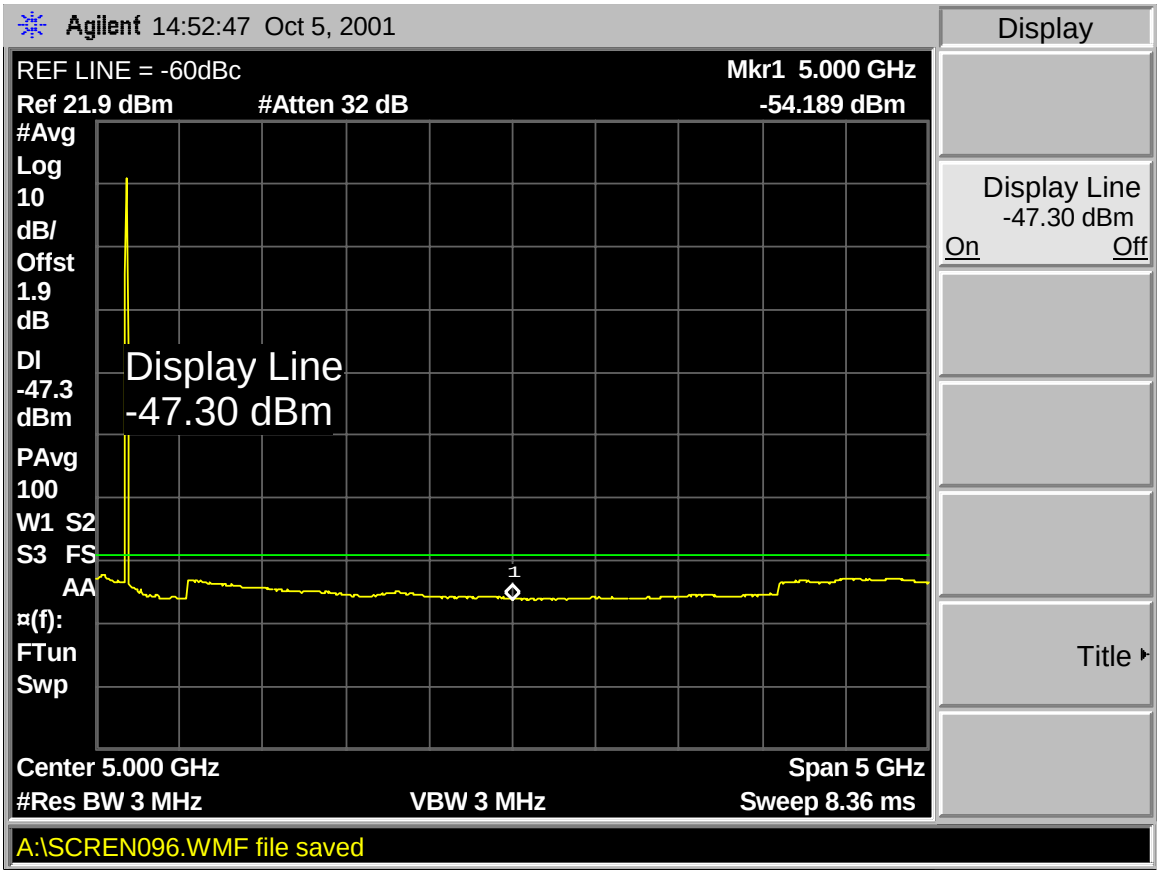
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level.



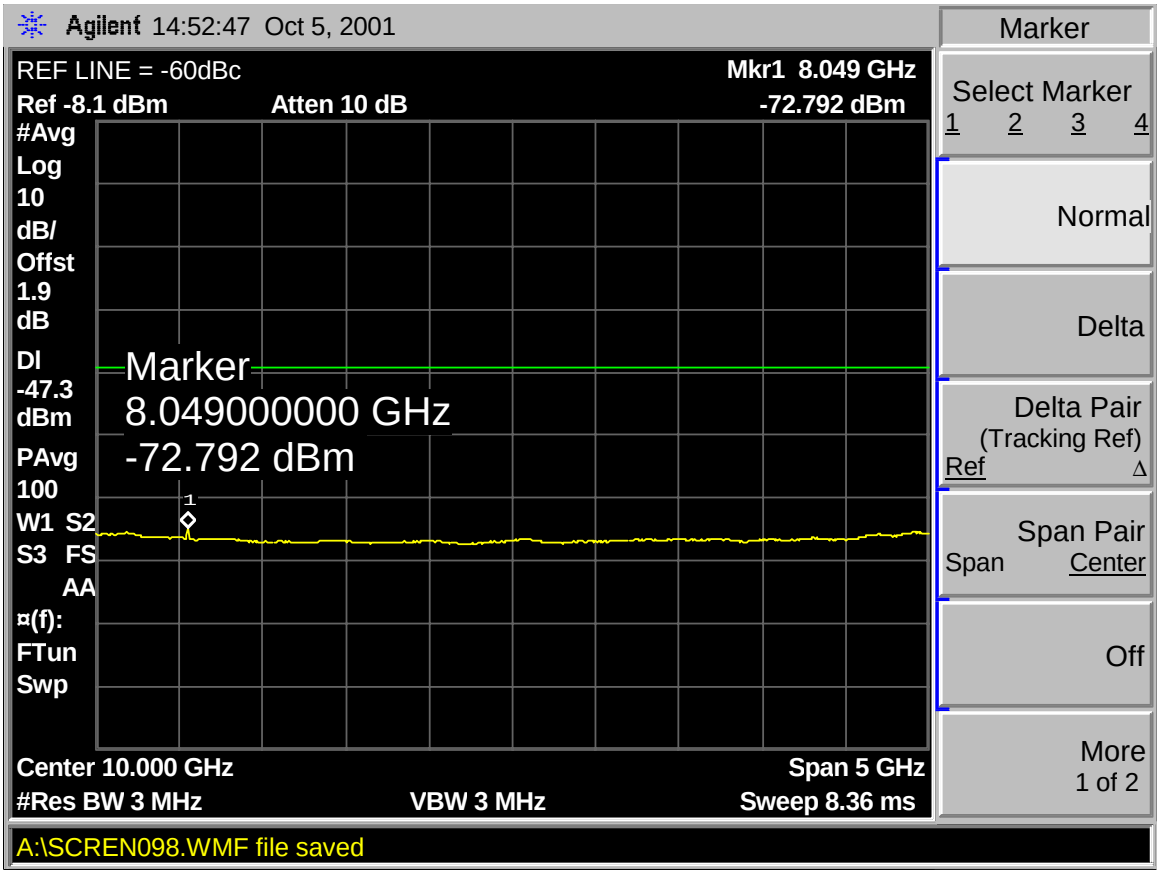
Broadband spurious search with channel output set to 2593 MHz. The green reference line represents a –60 dBc level.



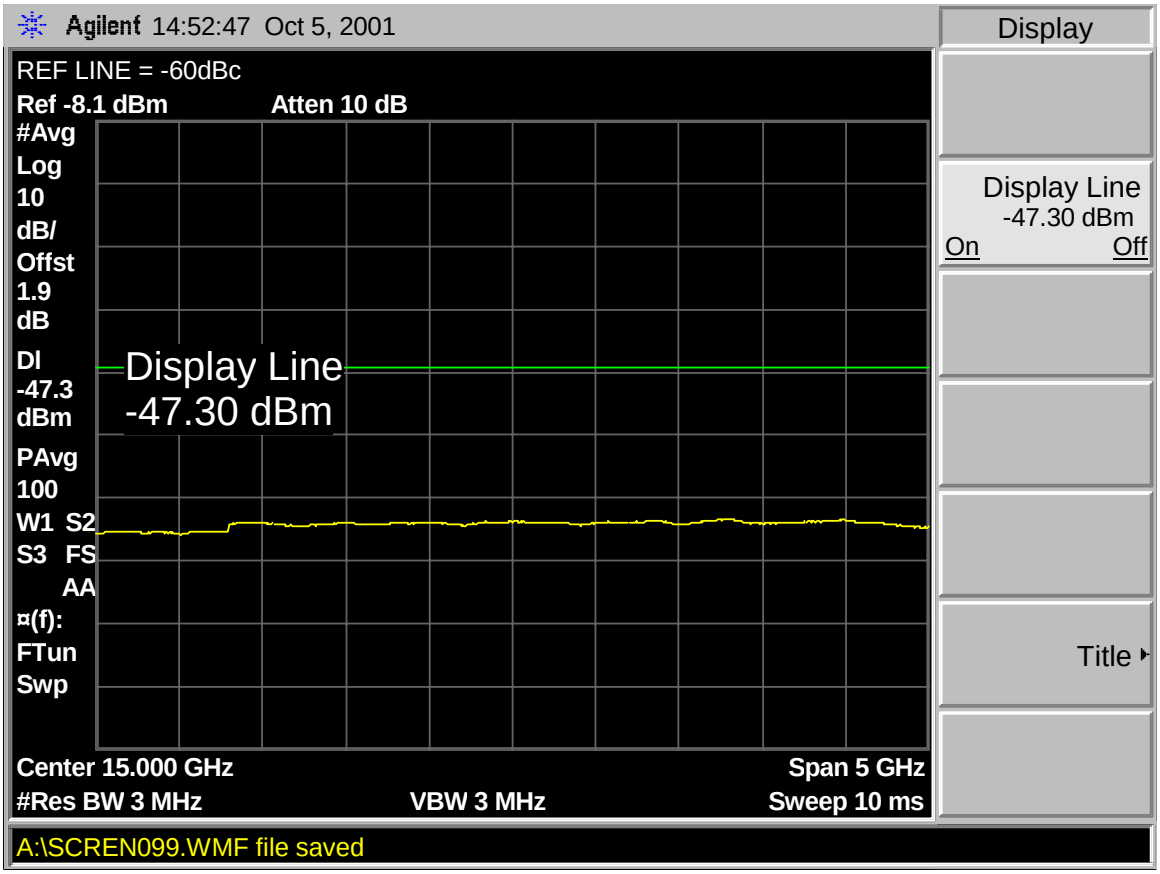
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a –60 dBc level.



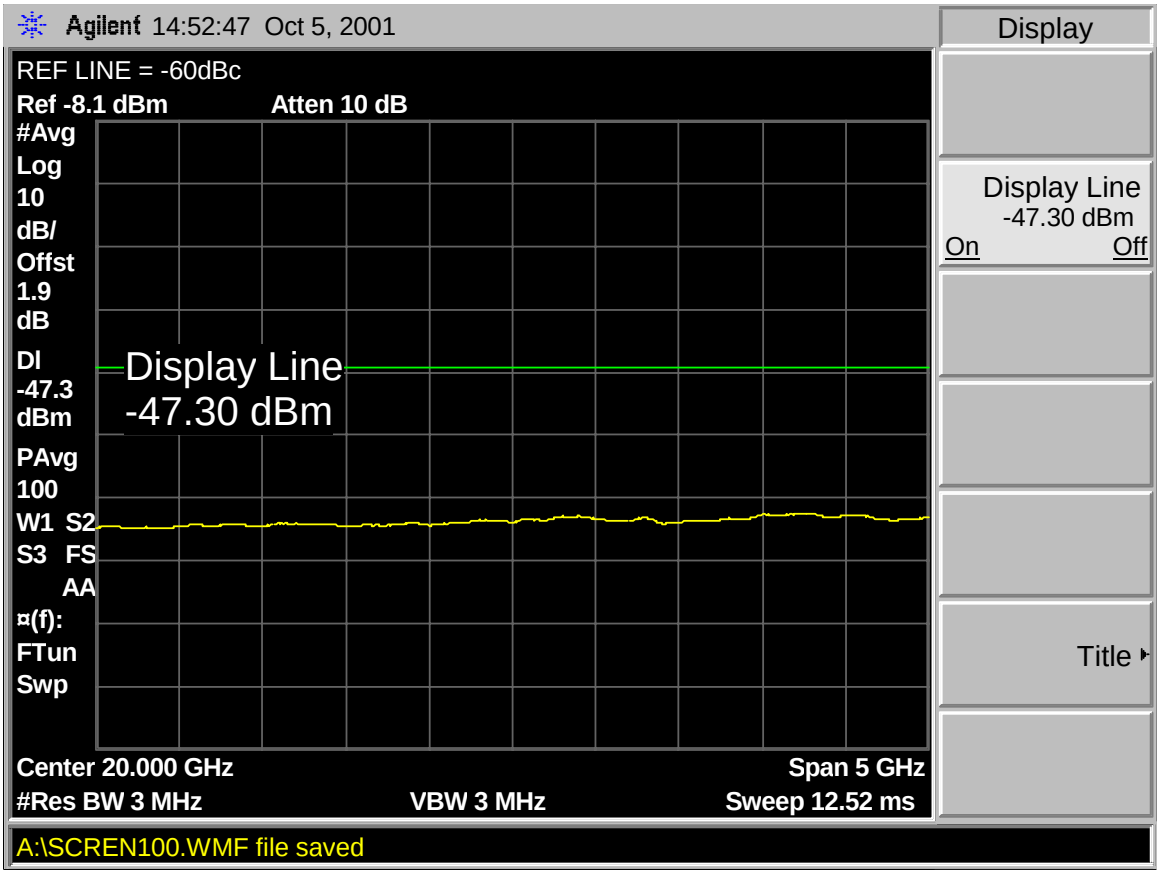
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a –60 dBc level.



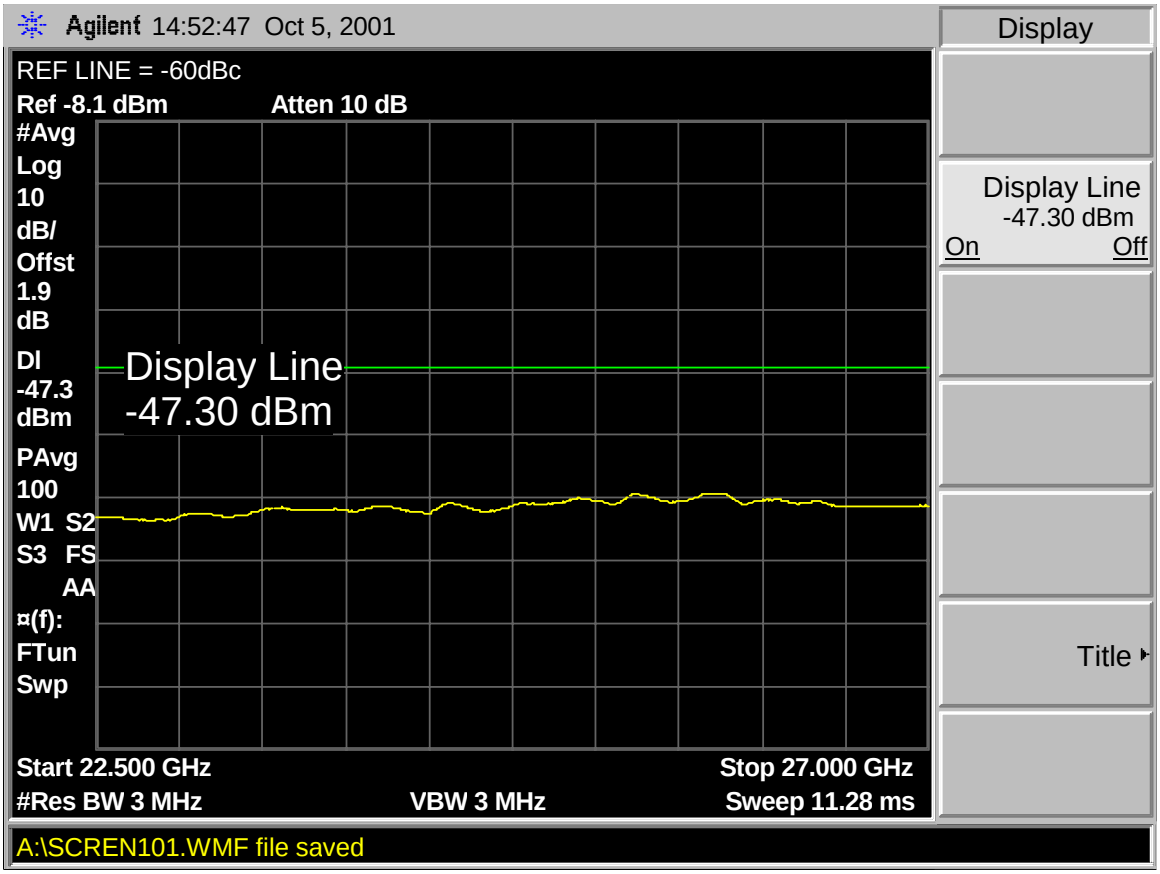
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a –60 dBc level. The spurious output measured is the third harmonic of 2683 MHz.



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.



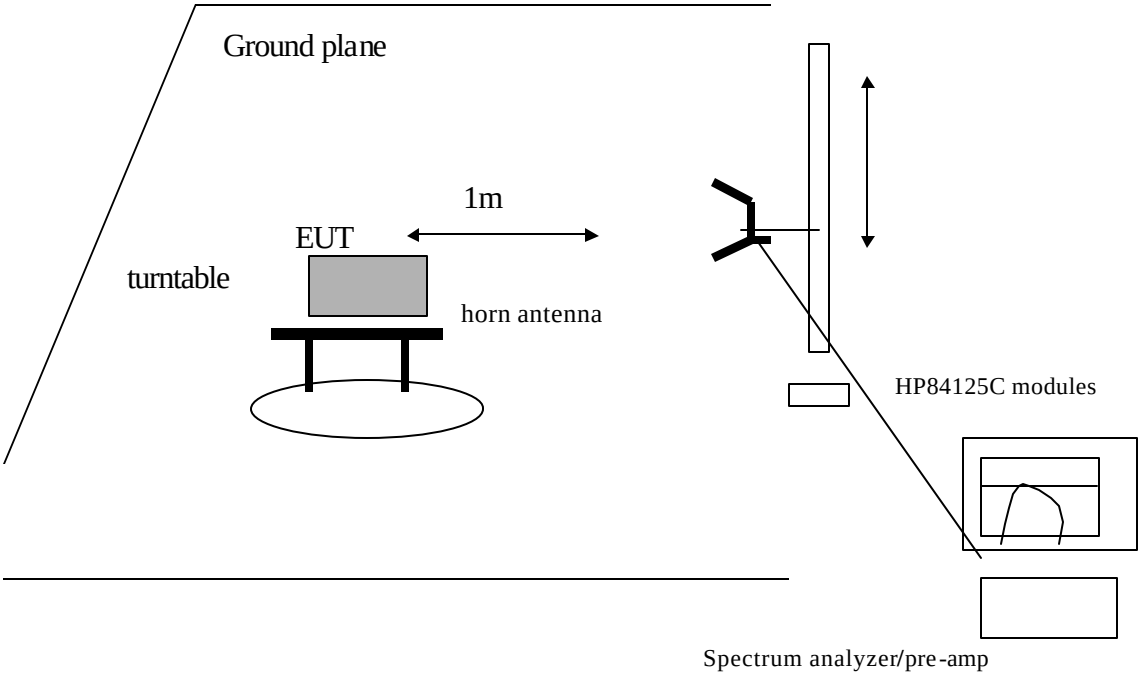
Broadband spurious search with channel output set to 2683 MHz. The green reference line represents a –60 dBc level.

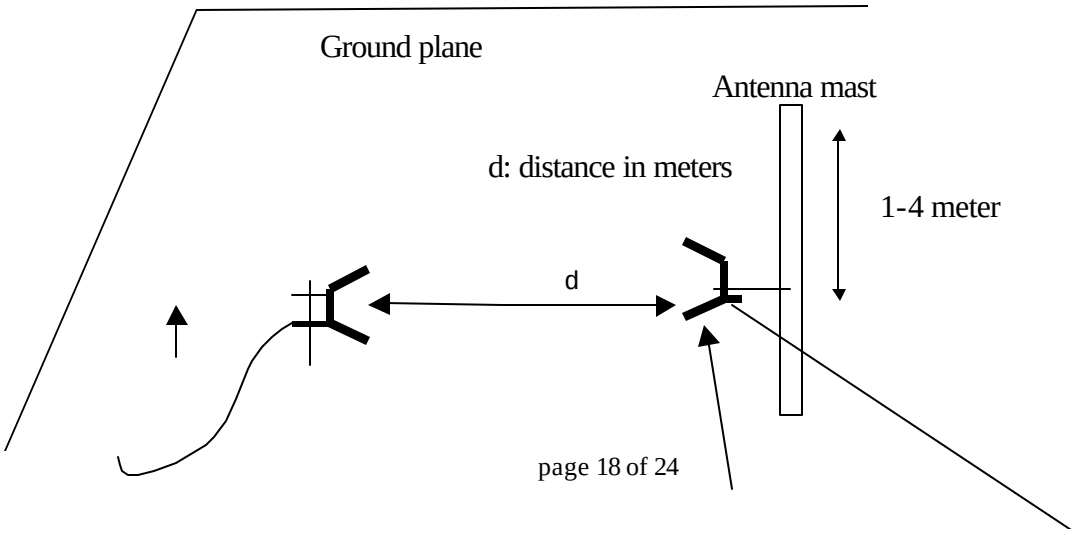
Section 2.1053 Field Strength of Spurious and Harmonic Radiation

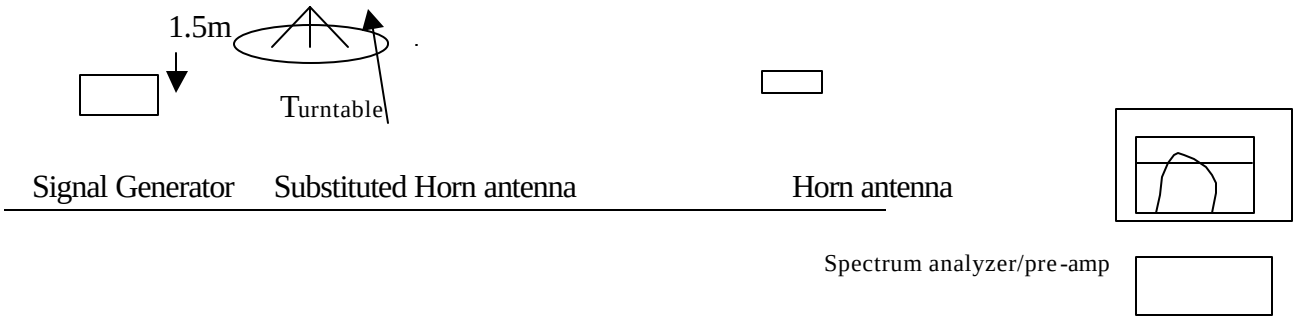
Measurement Equipment Used:

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)

Applicant: Aperto Networks
FCC ID: PS6BR1000-A1

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

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

17 dBm + 10 log(.120/5.7) = 17 - 16.8 = 0.2 dBm

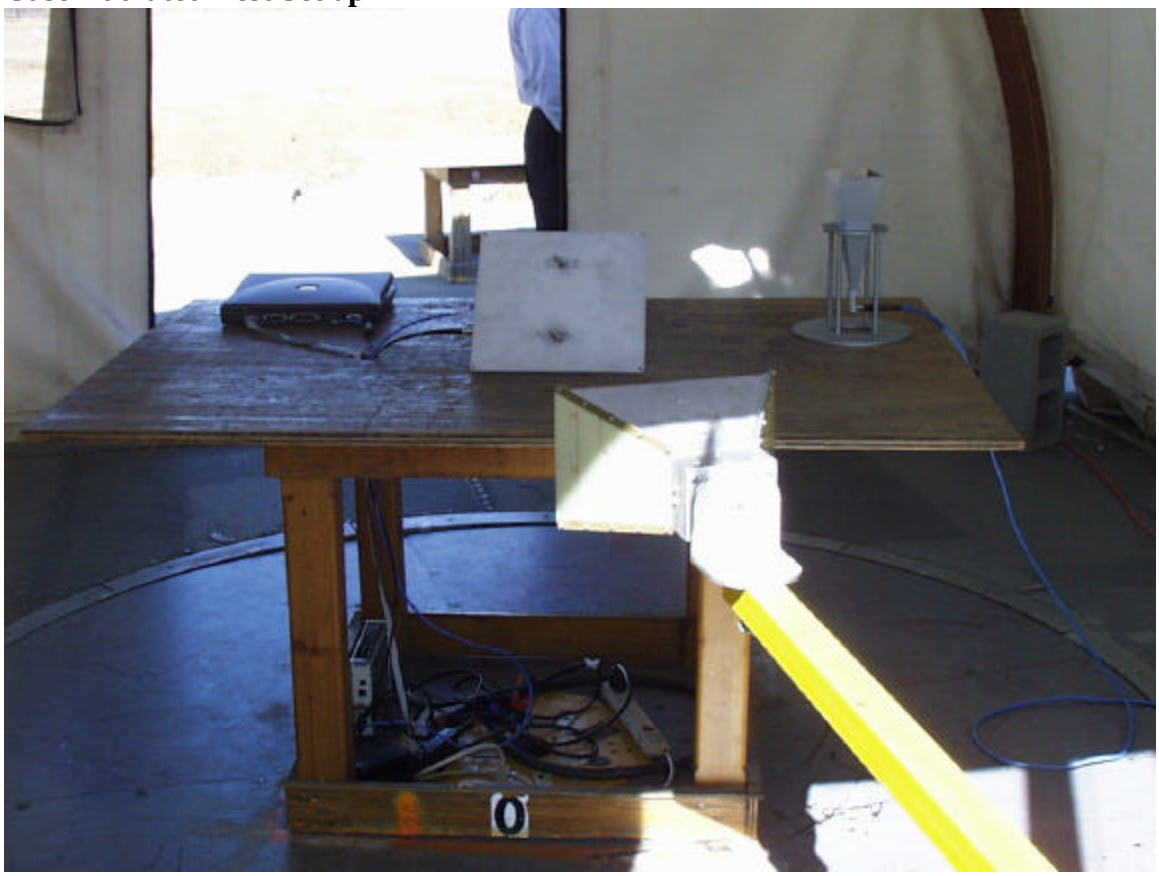
Emission limit beyond mask: 0.2dBm - 60 dB = -59.8 dBm in 120 kHz

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

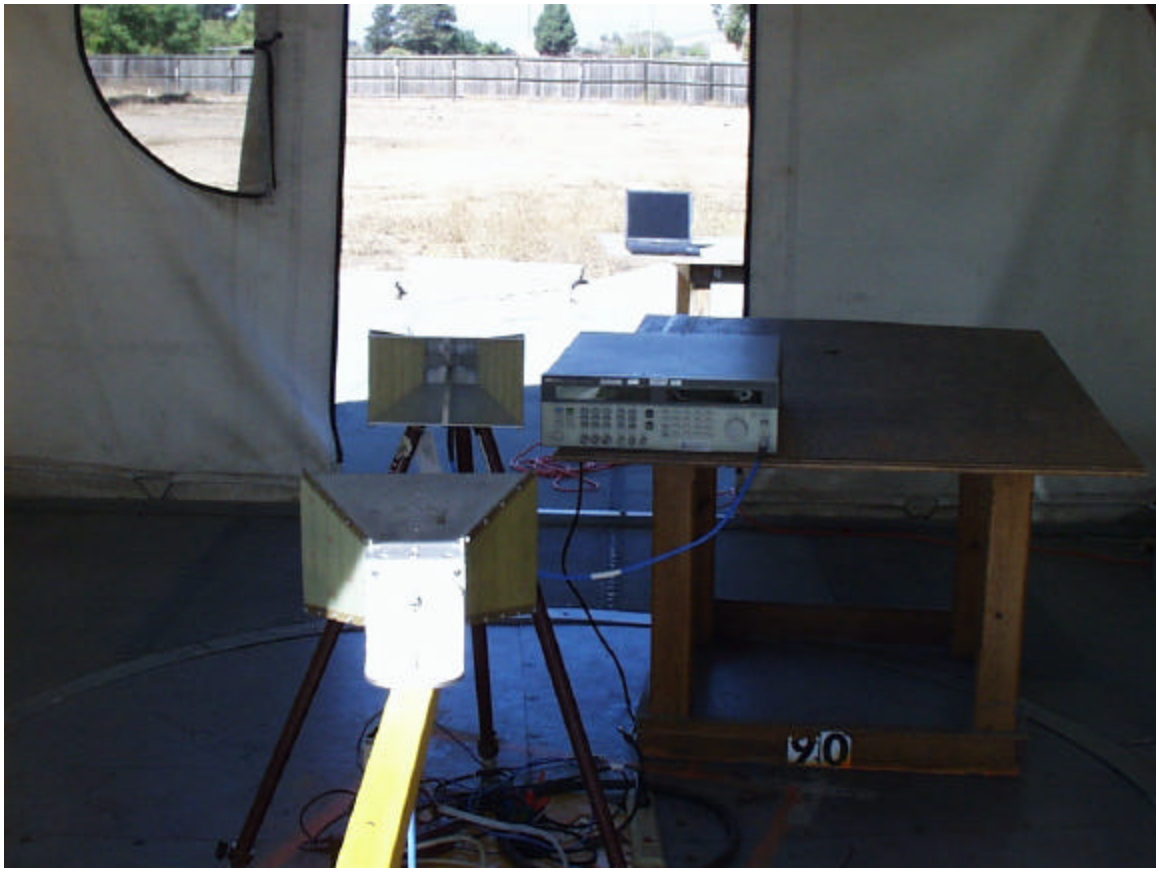
Frequency GHz	SA reading dBuV	Sig Gen dBm	CL dB	Gain dBi	Gain dBd	ERP dBm	Limit dBm	Margin dB
5.186	20.94	-113	5.1	10.3	8.1	-110	-59.8	-50.2
7.779	19.9	-113	5.85	11.1	8.9	-109.95	-59.8	-50.15
10.372	18.7	-113	6.75	12	9.8	-109.95	-59.8	-50.15
12.965	22.5	-113	8.25	11.6	9.4	-111.85	-59.8	-52.05
15.558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

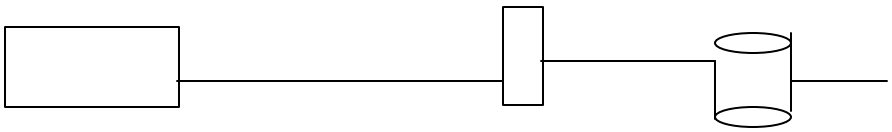
The OCXO in the IDU establishes a phase lock that maintains transmitter frequency over temperature within approximately 0.5 ppm. A more detailed description of how this is accomplished is found in the operational description for this product (separate document). Temperature-frequency data for the OCXO 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 x 2683 = 1610 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

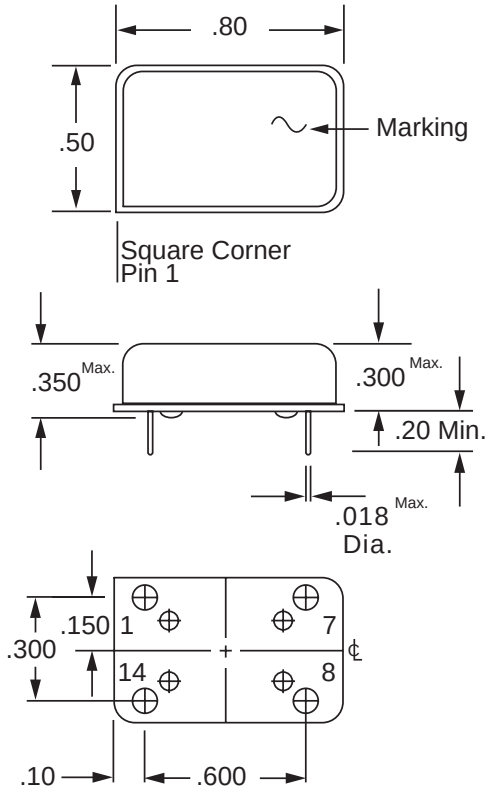
All testing was performed at Aperto Networks (antenna conducted measurement) and at Compliance Certification Services (radiated emissions) under my supervision. Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted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

THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals

VECTRON INTERNATIONAL
A DOVER TECHNOLOGIES COMPANY

CO-770 Series 4 Pin DIP

Oven Controlled Crystal Oscillator



Pin	Function
1	Frequency control
7	0V, Case
8	Output
14	Vcc

Features

- Extremely Small Dimensions
- Very Fast Warm-up
- Low Power Consumption
- Shock Resistance: 2000g/0.3 ms (1/2 sine)
- Vibration Resistance: 10g/10 to 2000 Hz
- Acceleration Sensitivity: 3.5 x 10^{-9}/G
- Standard 10 MHz Version Available from Stock

Applications

- Telecom Transmission and Switching Equipment
- Wireless Communication Equipment
- Networking Equipment

Description

The model CO-770, low profile 4 Pin DIP Oven Controlled Crystal Oscillator (OCXO) is available in frequencies from 10 kHz to 24 MHz with higher frequencies available to 80 MHz on special order.

This unit provides exceptionally low aging rates and temperature stabilities in an extremely small package. It measures only 0.50" x 0.80" x 0.35" (12.7mm x 20.3mm x 8.9mm); provides aging rates of <3 x 10^{-9}/day average, <7 x 10^{-7}/first year and <4 x 10^{-6} over 10 years with temperature stabilities from ± 5 x 10^{-8} over 0°C to 50°C. Wider temperature ranges are available to -40°C to +85°C.

The CO-770 series offers a +5V or +12V supply and HCMOS or clipped sinewave output options.

CO-770 4 Pin DIP Oven Controlled Crystal Oscillator

Performance Characteristics

Parameter	Characteristic
Frequency	10 MHz Standard. Advertised specifications available from 10 kHz to 24 MHz. Available to 80 MHz on special order.
Temperature Stability	0°C to +50°C: B58: ± 5 x 10^{-8} -20°C to +70°C: D17: ± 1 x 10^{-7} -40°C to +85°C: H27: ± 2 x 10^{-7}
Aging	<3 x 10^{-9}/day average, <7 x 10^{-7} first year, <4 x 10^{-6} for 10 years
Frequency vs. Supply (± 4%)	± 1 x 10^{-7}
Short Term (Allan Variance)	<5 x 10^{-10}, 0.1 seconds to 10 seconds
Supply/Output	Type / Supply Voltage / Output CO-770: +12 Vdc ± 0.5V: HCMOS* CO-771: + 5 Vdc ± 0.2V: Clipped Sine (1-2VPK-PK into 1K W) CO-772: + 5 Vdc ± 0.2V: HCMOS* CO-773: +12 Vdc ± 0.5V: Clipped Sine (1-2VPK-PK into 1K W)
*Symmetry (@50% Vdd)	60/40 to 40/60
*Rise/Fall Time: (10-90%) (15pF load)	<7ns
*Level 0 and 1	<0.4V, >4.5V
Input Current	+12 Vdc: <25 mA @ +30°C, <40 mA @ -20°C +5 Vdc: <60 mA @ +30°C, <80 mA @ -20°C
Turn-on Current	+12 Vdc: <120 mA first 10 seconds +5 Vdc: <200 mA first 10 seconds
Warm-Up @ 25° C (24 hours off relative to the frequency 2 hours after turn-on)	<1 x 10^{-6} 15 seconds <1 x 10^{-7} 60 seconds <5 x 10^{-8} 10 minutes
Phase Noise (Typical @ 10 MHz) Sine and HCMOS	Offset / +12 Vdc Phase Noise / +5 Vdc Phase Noise 1 Hz: - 70 dBc/Hz: - 60 dBc/Hz 10 Hz: -100 dBc/Hz: - 90 dBc/Hz 100 Hz: -125 dBc/Hz: -120 dBc/Hz 1 kHz: -135 dBc/Hz: -130 dBc/Hz
Acceleration Sensitivity: (Worst case axis)	3.5 x 10^{-9}/G
Frequency Voltage Control	>± 4 ppm range with 0 to +5V input (external resistor adjustment available on special order)
Size	0.50" x 0.80" x 0.35" (12.7 x 20.3 x 8.9 mm)
Base	4 pin DIP package with standoffs
How To Order	CO-77 ☐ ☐ at ☐ Supply/Output Temperature Stability Option Frequency

For Additional Information Please Contact:

VECTRON INTERNATIONAL
A DOVER TECHNOLOGIES COMPANY

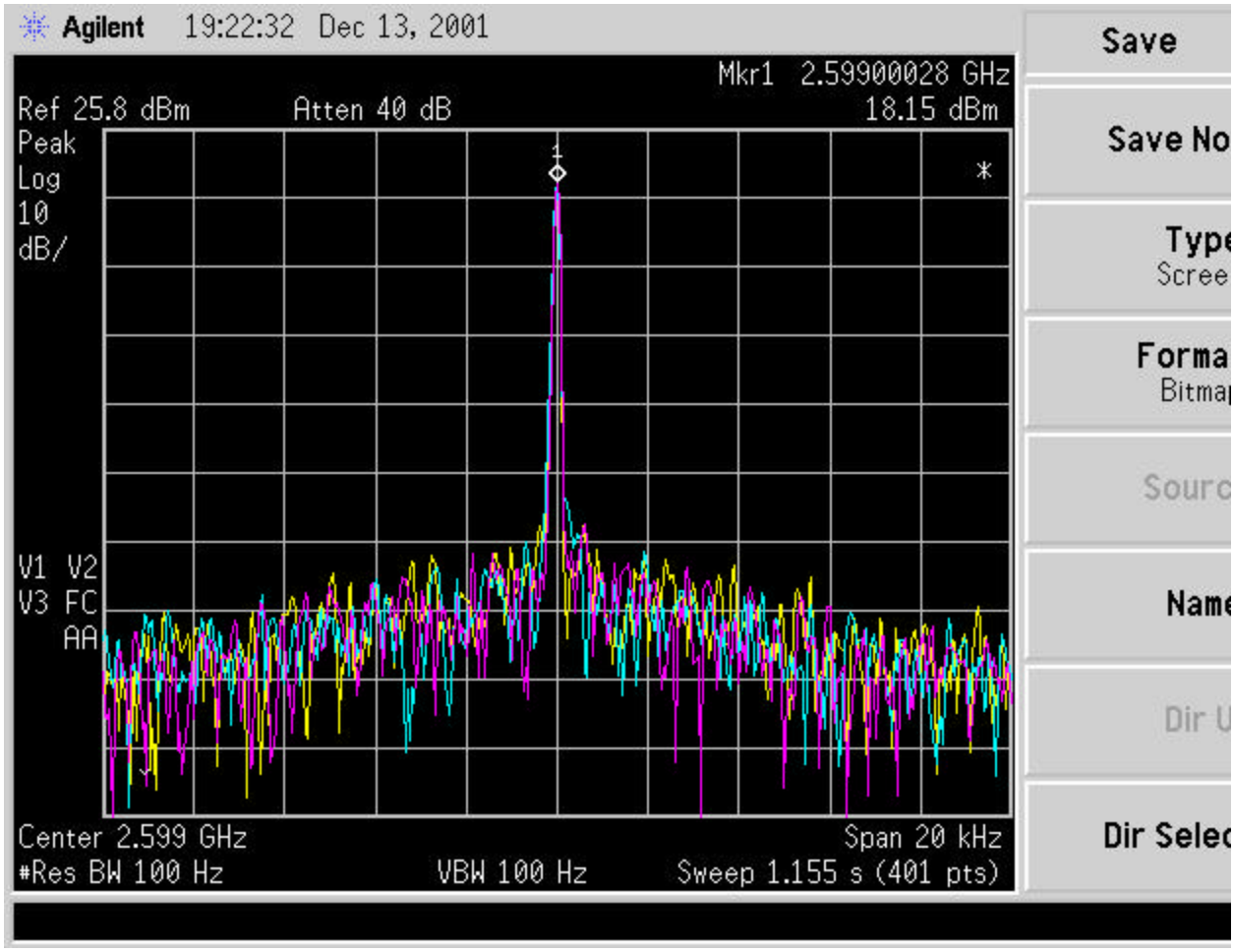
USA: Vectron International • 166 Glover Avenue, Norwalk, CT 06856 • Tel: 1-88-VECTRON-1 • Fax: 1-888-FAX-VECTRON
EUROPE: In Denmark, Finland, Ireland, Italy, Isreal, Norway, Spain, UK: Tel: 44(0) 1703 766 288 • Fax: 44 (0) 1703 766 822
In Austria, Belgium, France, Germany, Luxembourg, Netherlands, Sweden, Switzerland: Tel: 49 (0) 72 63 648 0 • Fax: 49(0) 72 63 619 6
ASIA: In China, Taiwan, Japan: Tel: 1-603-598-0070 • Fax: 1-603-598-0075
In Korea, Singapore, Australia, India: Tel: 1-203-853-4433 • Fax: 1-203-849-1423

Frequency Stability Of MMDS Radio.
Aperto Networks
FCC ID: PS6BR1000-A1

Attached is data sheet showing the EUT meets a drift of less than 200 Hz. Each division is 20 kHz/10 = 2 kHz and the signal varies less than 1/5 division over the entire frequency range. Marker function shows actual frequency drift of 28 Hz.

Temperature was swept over the -30C to +50C range, results were recorded for -30C, -10C and +50C.

The radio is the same for base station and subscriber unit. The companion indoor units are different, but their output frequencies are determined by the same OCXQ. The EUT easily meets the .001% (+/- 26 kHz max drift) requirement for the base station, and remaining in the frequency band for the subscriber unit, as per the requirements of 21.101 and footnotes.



Frequency Stability is better than10 ppm (26kHz @2599 Mhz) across

temperature.
Synthesizer is locked to the reference from IDU, which derives accuracy from an OCXO.
Cyan trace is at +10 deg c.
Green trace is at -30 deg c.
Magenta trace is at +50 deg c.