U.S. TECH
A TRADITION IN TESTING SERVICES

FCC Part 25, Verification Application
of the
Axonn, L.L.C.
Model G-SENS STU

Issue Date: August 30, 2002
UST Project No: 02-0227

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GENERAL INFORMATION

GENERAL INFORMATION

1.1 Product Description

The Equipment Under Test is the Axonn, L.L.C. Model G-SENS STU. The EUT is a mobile "user to satellite" transmitter module that operates at the following 4 transmit frequencies: 1611.25 MHz, 1613.75 MHz, 1616.26 MHz, & 1618.75 MHz. The STU provides a modem functionality to transmit bursts of data containing user information to a satellite constellation. The satellites operate as linear transponders and the signal is redirected to a ground station where the user information is extracted and distributed.

For the purpose of this test the EUT was placed into a high power (+22 dBm) constant TX mode of operation.

1.2 Related Submittal(s)/Grant(s)

The EUT is subject to the following authorizations:

a) Verification as a transmitter as specified by Part 25.
b) Verification as a digital device as specified by Part 15.

The information contained in this report is presented for the Part 25 Verification authorization(s) for the EUT. A separate report has been prepared for the Part 15 Verification.

SECTION 2

TESTS AND MEASUREMENTS

TEST AND MEASUREMENTS

2.1 Configuration of Tested System

Prepared in accordance with the requirements of the FCC Rules and Regulations Part 2 & 25. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was off throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious emissions are shown in Figure 2.

The sample used for testing was received by U.S. Technologies on July 16, 2002 in good condition.

2.2 Test Facility

Radiated testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and submitted to the FCC, and accepted in their letter marked 31040/SIT. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number IC2982.

2.3 Test Equipment

Table 2 describes test equipment used to evaluate this product.

2.4 Modifications

No modifications were made by US Tech, to bring the EUT into compliance with FCC Part 25 limits for the transmitter portion of the EUT.

FIGURE 1

TEST CONFIGURATION

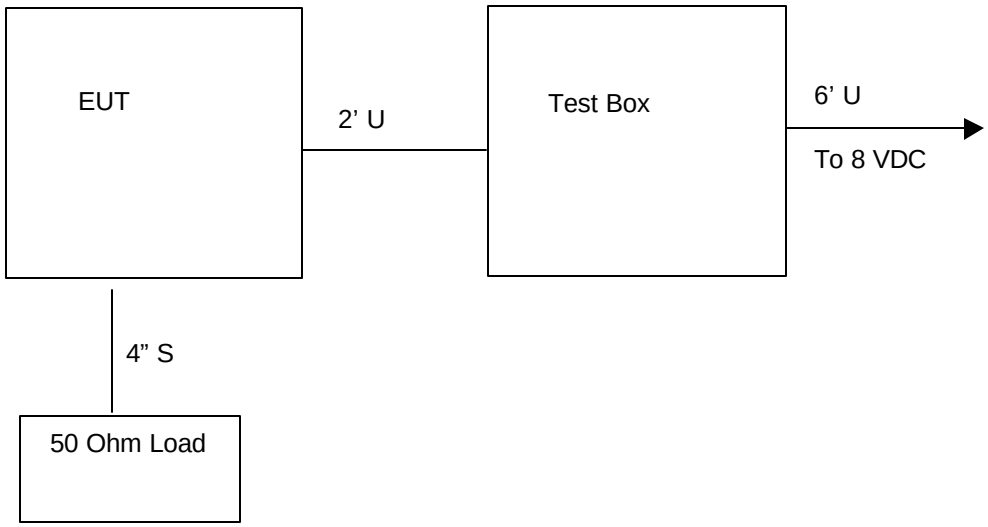


FIGURE 2a

Photograph(s) for Spurious Emissions

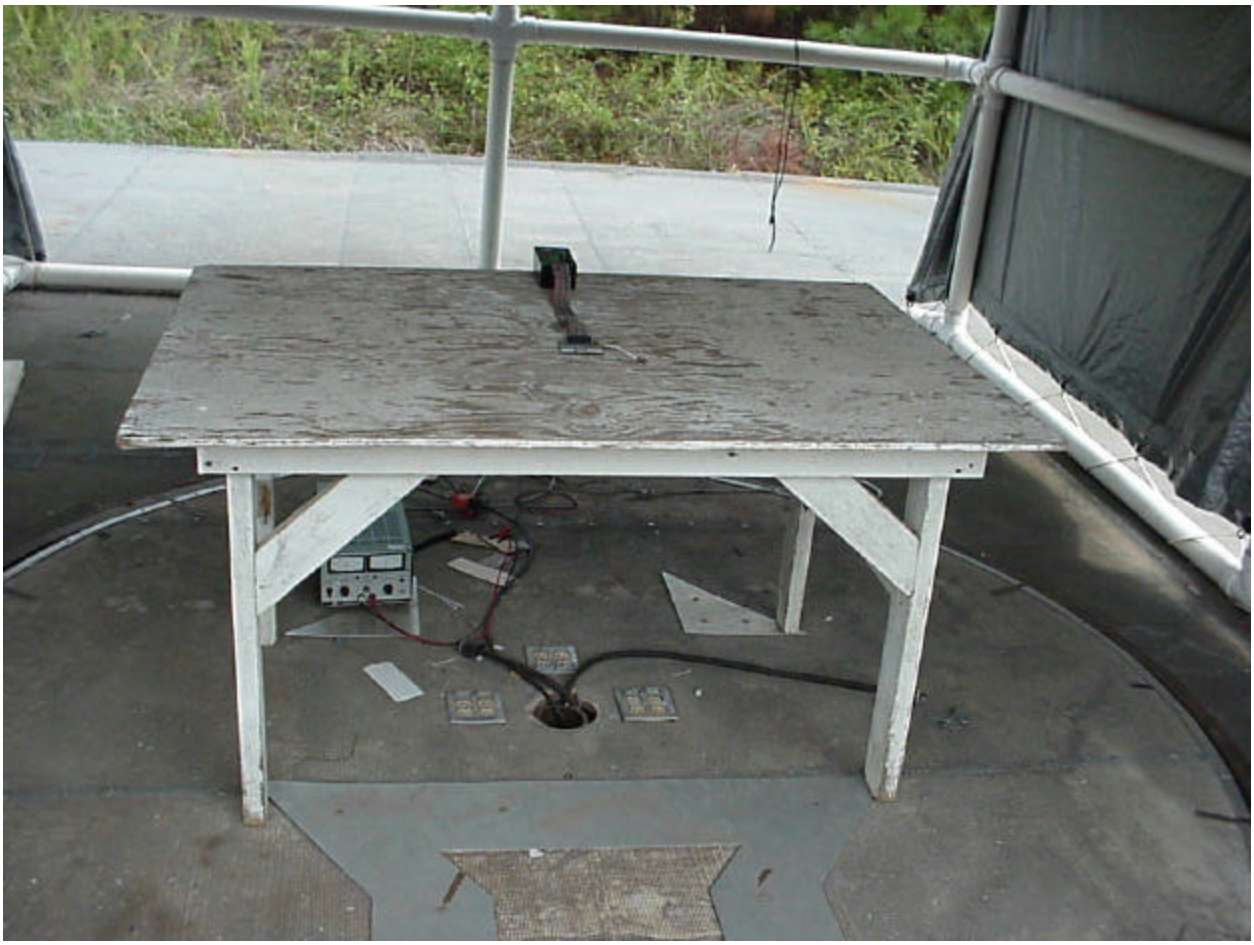


FIGURE 2b

Photograph(s) for Spurious Emissions (Cont.)

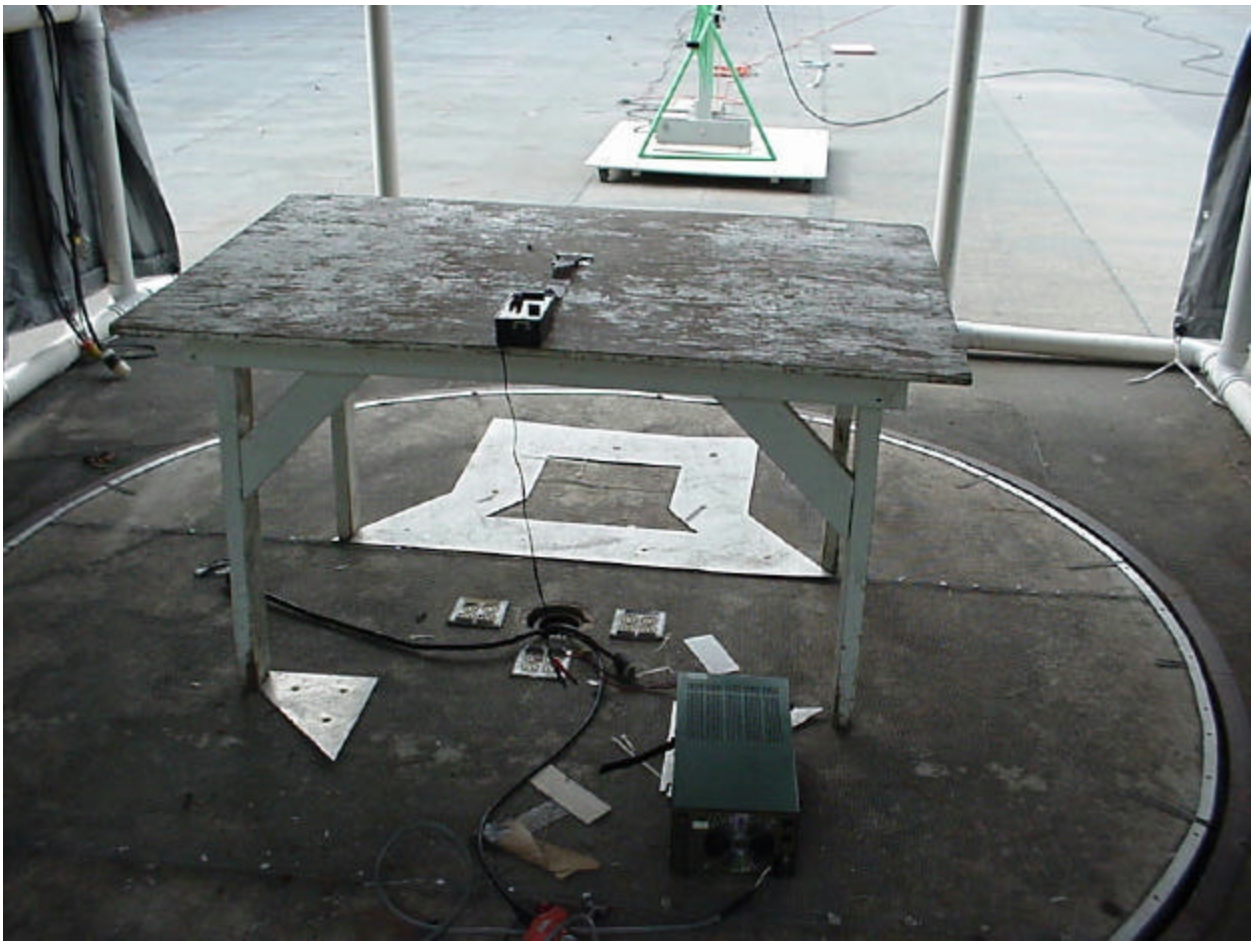


TABLE 1

EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Transmitter Axonn, L.L.C. (EUT)	G-SENS STU	None	None	4" S to 50 Ohm Load 2' U
Test Box Axonn, L.L.C.	N/A	N/A	N/A	6' U to 8 VDC

TABLE 2
TEST INSTRUMENTS

EQUIPMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	8558B	HEWLETT-PACKARD	2332A09900	3/27/02
SPECTRUM ANALYZER	8558B	HEWLETT-PACKARD	2332A10055	2/15/02
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	2/14/02
TEST RECEIVER	ESV	ROHDE & SCHWARZ	881485/040	10/10/01
SIGNAL GENERATOR	HP8648B	HEWLETT-PACKARD	3642U01679	8/22/01
COMB GENERATOR	8406A	HEWLETT-PACKARD	1632A01519	03/27/02
RF PREAMP	8447D	HEWLETT-PACKARD	2944A07436	5/6/02
RF PREAMP	8449B	HEWLETT-PACKARD	3008A00480	5/6/02
DIPOLE ANTENNA SET	A100	CDI	None	1/16/02
HORN ANTENNA	3105	EMCO	2060	9/23/01
HORN ANTENNA	3115	EMCO	9107-3723	7/12/02
BILOG ANTENNA	CBL6112B	CHASE	2584	2/31/02
LISN (x 2) 8028-50-TS24-BNC	8028	SOLAR ELE.	910494 & 910495	1/23/02
CALCULATION PROGRAM	N/A	N/A	Ver. 5.2	N/A

2.5 Antenna Description

According to Axonn L.L.C., the EUT will incorporate an antenna with +4 dBi or less gain. Additional information regarding the antenna was not provided.

2.6 RF Power Output (FCC Section 2.1046)

In bands shared coequally with terrestrial radio communications services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station operating in frequency bands between 1 and 15 GHz, shall not exceed the limits below.

For angles of elevation of the horizon greater than 5 degrees there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.

FCC Minimum Standard (FCC Section 25.204)

EIRP < +40 dBW (70 dBm) in any 4 kHz band for θ=0 degrees

The manufacturer has stated that the EUT has a maximum output power of +22 dBm (26 dBm EIRP).

TABLE 3
RF POWER OUTPUT

Frequency of Fundamental (MHz)	Measurement (dBm)	Measurement (Watt)	EIRP (dBm)	EIRP (Watt)
1611.25	21.65	0.146	25.65	0.367
1618.75	21.94	0.146	25.94	0.393

Note: Given the output power and antenna gain of +4 dBi, even the direct lobe of radiation meets the FCC's EIRP Requirement for $\theta = 0$ (+40 dBW)

Test Date: August 6, 2002

Tester Signature:  **Name: David Blethen**

Figure 3a.
RF Power Output

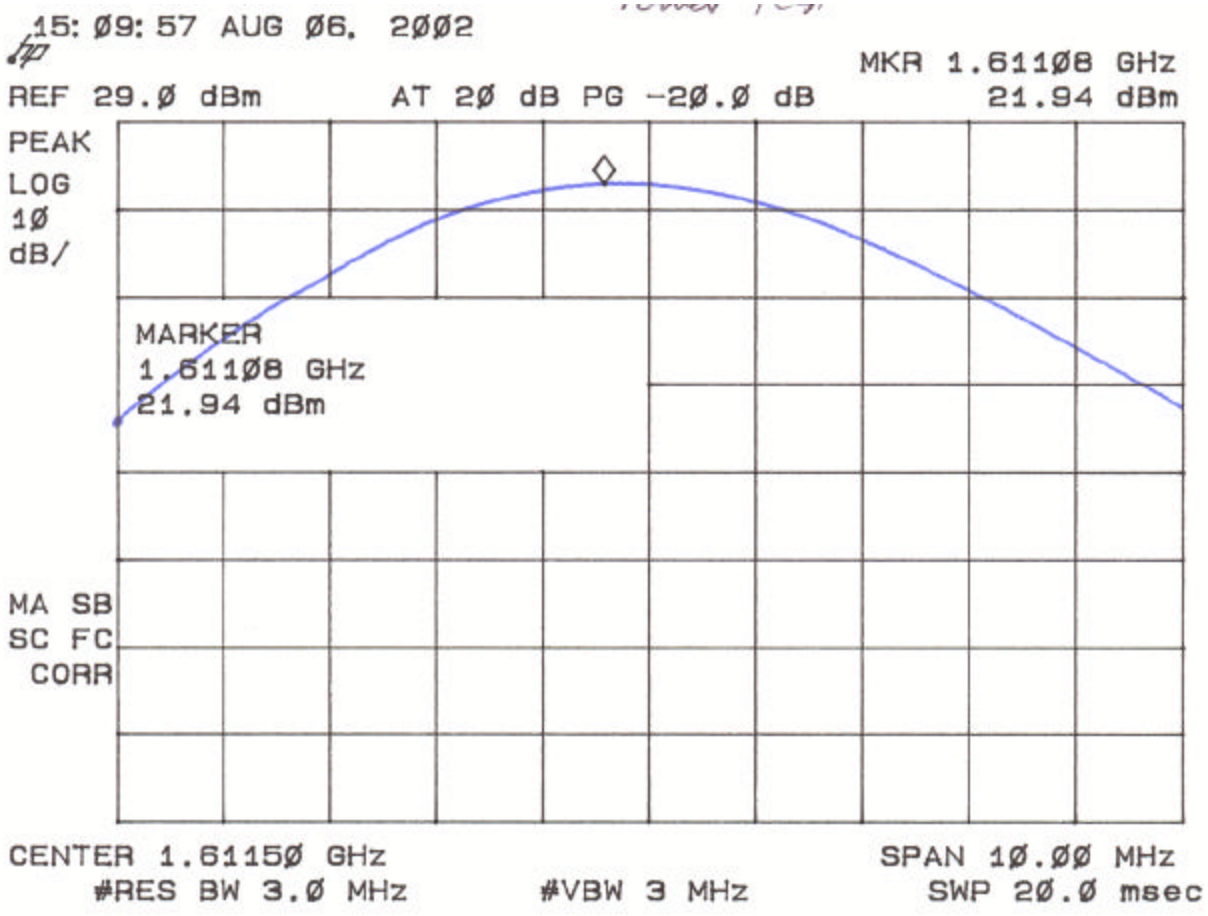
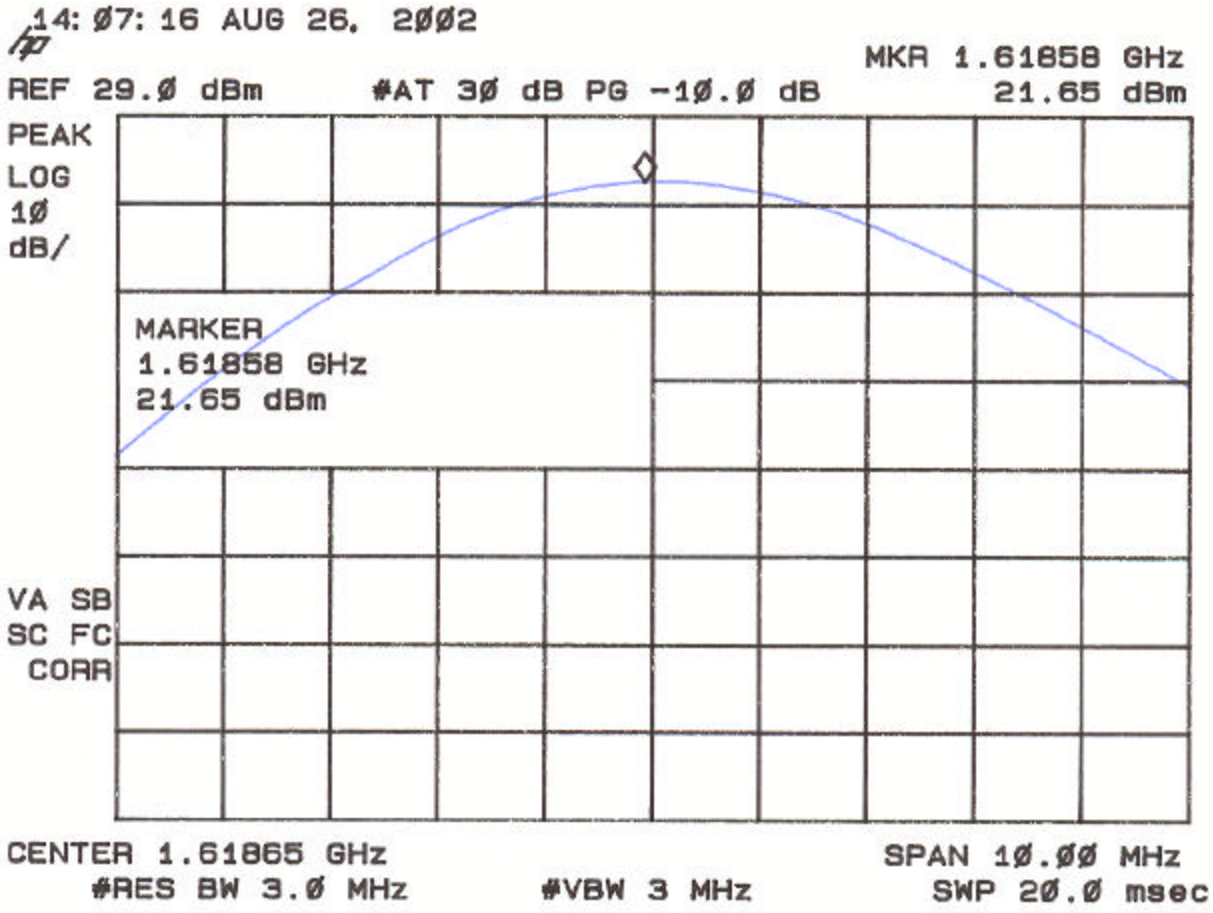


Figure 3b.
RF Power Output



2.7 Modulation Characteristics (FCC Section 2.1047)

Since the device incorporates digital modulation techniques, this information is not necessary.

Figure 4.
Modulation Characteristics

The EUT uses digital modulation techniques only which were employed during the tests for occupied bandwidth.

2.8 Occupied Bandwidth (FCC Section 2.1049)

EUT was modulated by its own internal sources. Low and High Channels were tested. The bandwidth of the fundamental was measured using a spectrum. The results are shown in Figure 5a through Figure 5d. Long sweep times were applied near to the fundamental to ensure a good signal was obtained.

FCC Minimum Standard (FCC Section 25.202(f))

For out-of-band emissions for frequencies removed from the midpoint of the assigned frequency by more than 50% up to and including 100% of the authorized bandwidth (2.5 MHz), at least 25 dB.

For out-of-band emissions for frequencies removed from the midpoint of the assigned frequency by more than 100% up to and including 250% of the authorized bandwidth (2.5 MHz), at least 35 dB.

For out-of-band emissions for frequencies removed from the midpoint of the assigned frequency segment by more than 250% of the authorized bandwidth (2.5 MHz), at least
43 + 10 log (P_{Watts}) attenuation below the mean power of the transmitter.

For Lowest Channel = 43 + 10 log (0.1462) = 34.6 dB
For Highest Channel = 43 + 10 log (0.1563) = 34.9 dB

The following plots show that all emissions were at least 50.4 dB below the fundamental.

Note:
A 3 kHz RBW was used instead. This was deemed to be comparable to 4 kHz RBW.

Figure 5a.
Occupied Bandwidth 50 - 100% From Edge of Authorized Bandwidth - Low

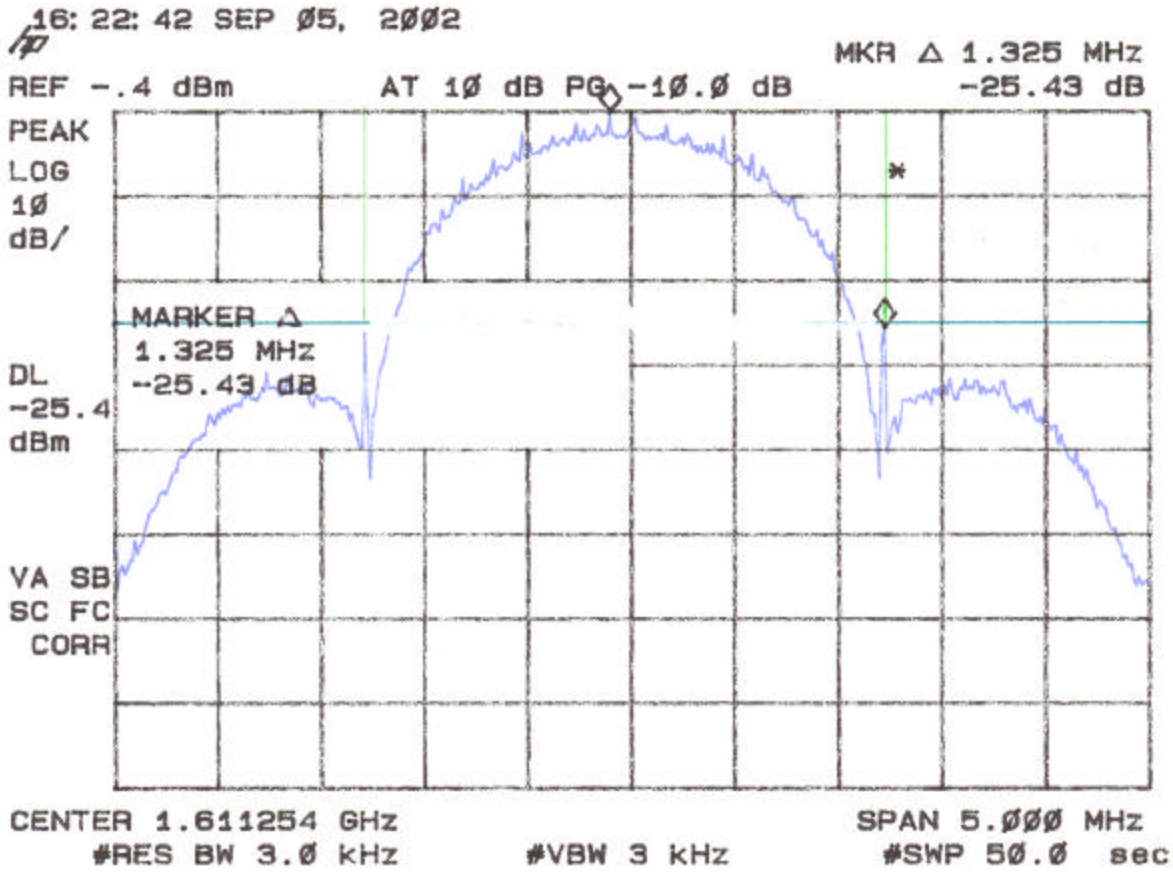


Figure 5b.
Occupied Bandwidth > 100% From Edge of Authorized Bandwidth - Low

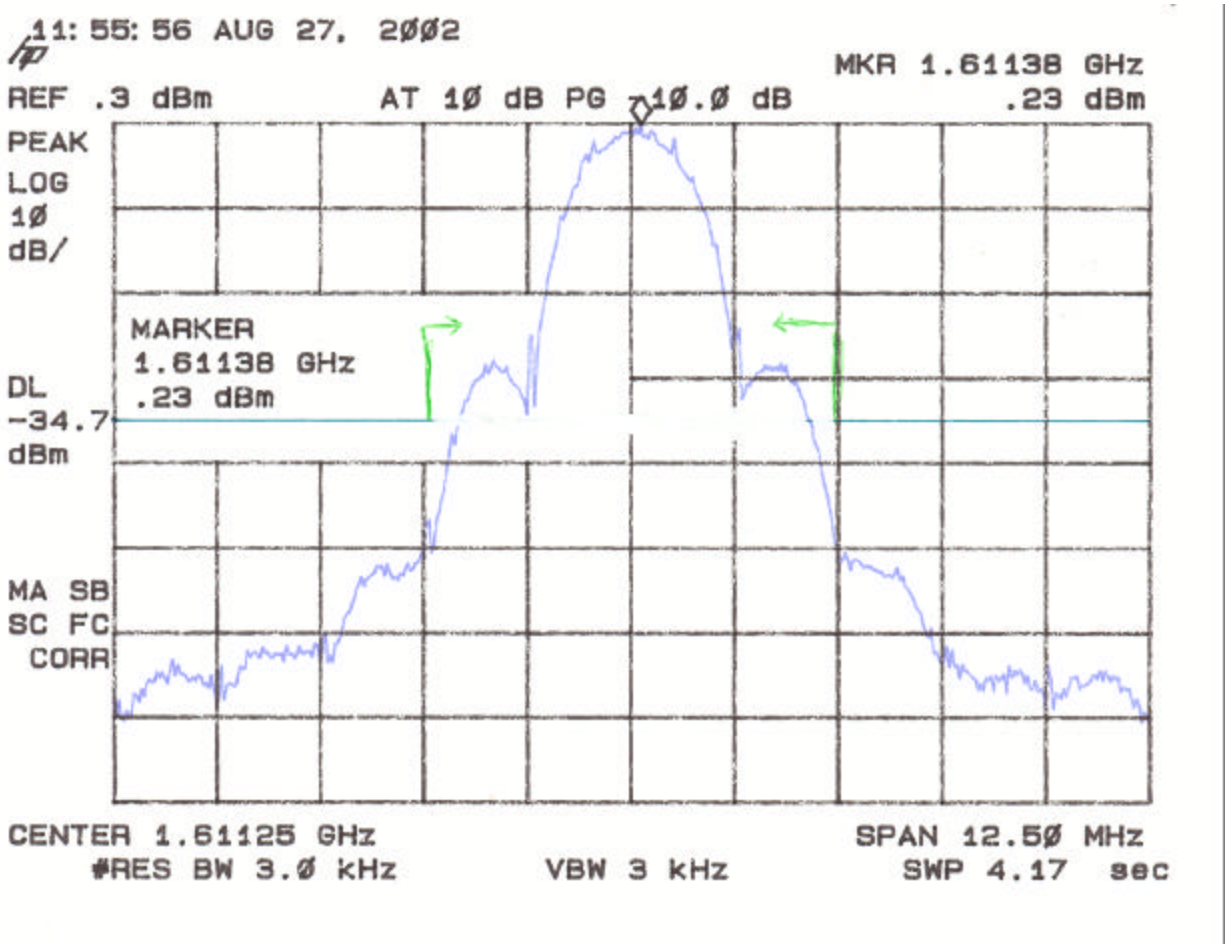


Figure 5c.
Occupied Bandwidth 50 - 100% From Edge of Authorized Bandwidth - High

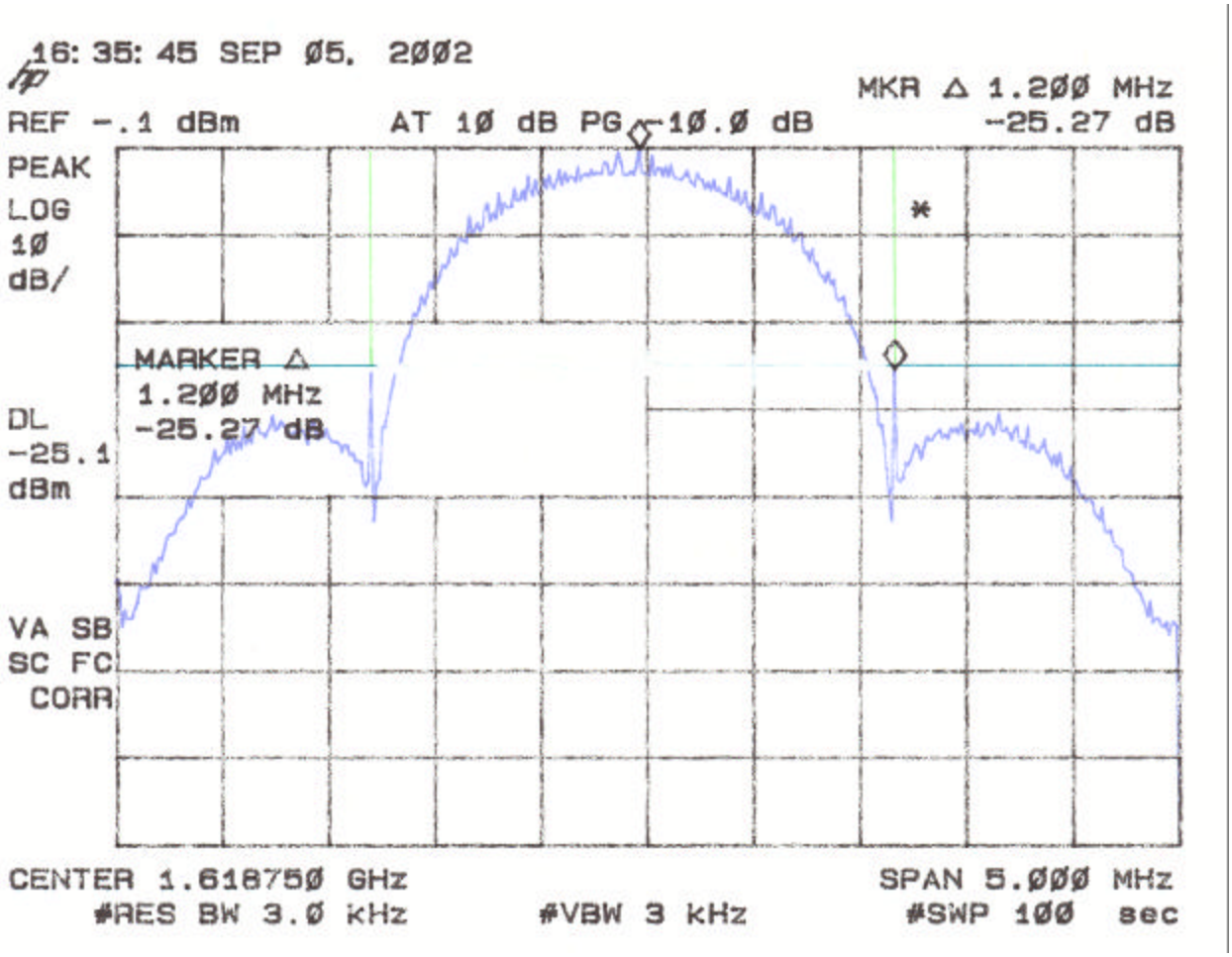
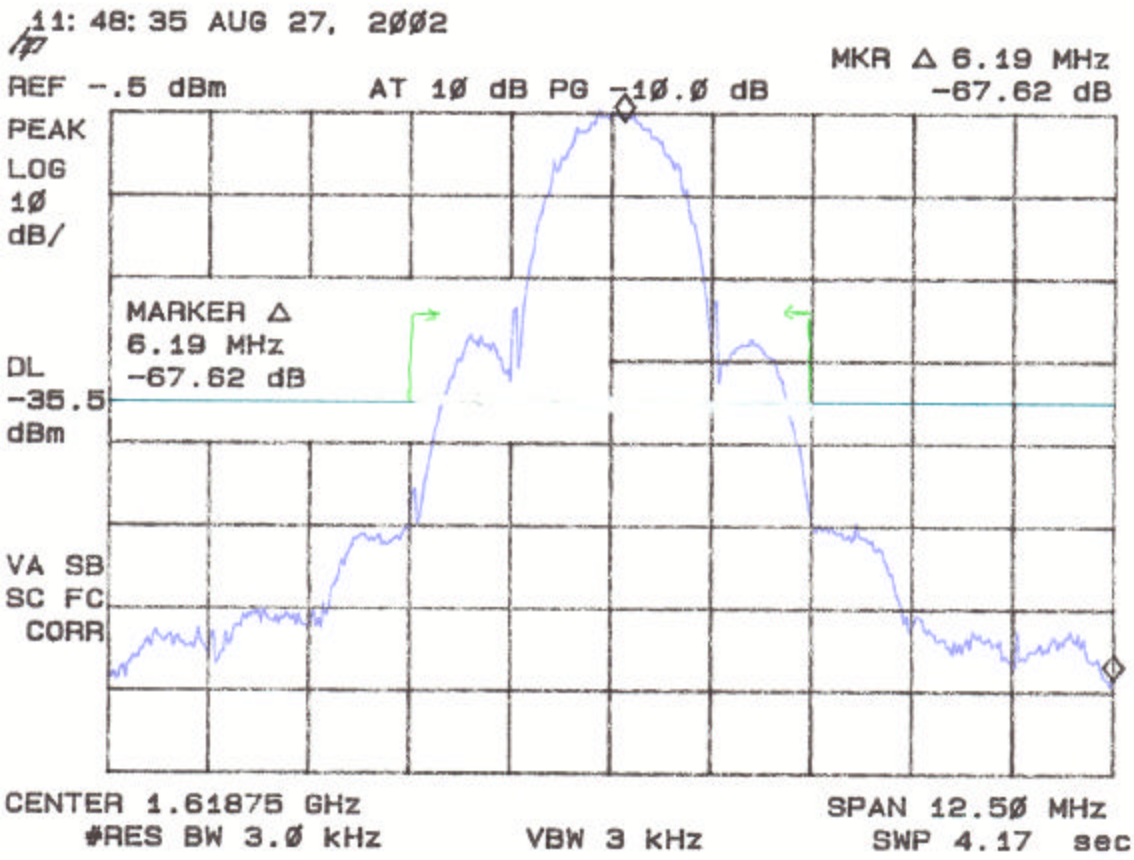


Figure 5d.
Occupied Bandwidth > 100% From Edge of Authorized Bandwidth - High



2.9 Spurious Emissions at Antenna Terminals (FCC Section 2.1051)

Spurious emissions appearing at the antenna terminals were measured with a spectrum analyzer by connecting the spectrum analyzer directly via a short cable to the antenna output terminals or across the antenna leads on the PCB as specified by the manufacturer. Results are shown in Figures 6a - 6p.

Protection of the radio-navigation-satellite service. Mobile earth stations operating in the 1610-1626.5 MHz band shall limit out-of- band emissions in the 1574.397-1576.443 MHz band so as not to exceed an e.i.r.p. density level of -70 dB (W/MHz) averaged over any 20 ms period. The e.i.r.p. of any discrete spurious emission (i.e., bandwidth less than 600 Hz) in the 1574.397-1576.443 MHz band shall not exceed -80 dBW.

FCC Minimum Standard (FCC Section 25.202(f))

For out-of-band emissions for frequencies removed from the midpoint of the assigned frequency segment by more than 250% of the authorized bandwidth (2.5 MHz), at least

$$43 + 10 \log (P_{Watts})$$ attenuation below the mean power of the transmitter.

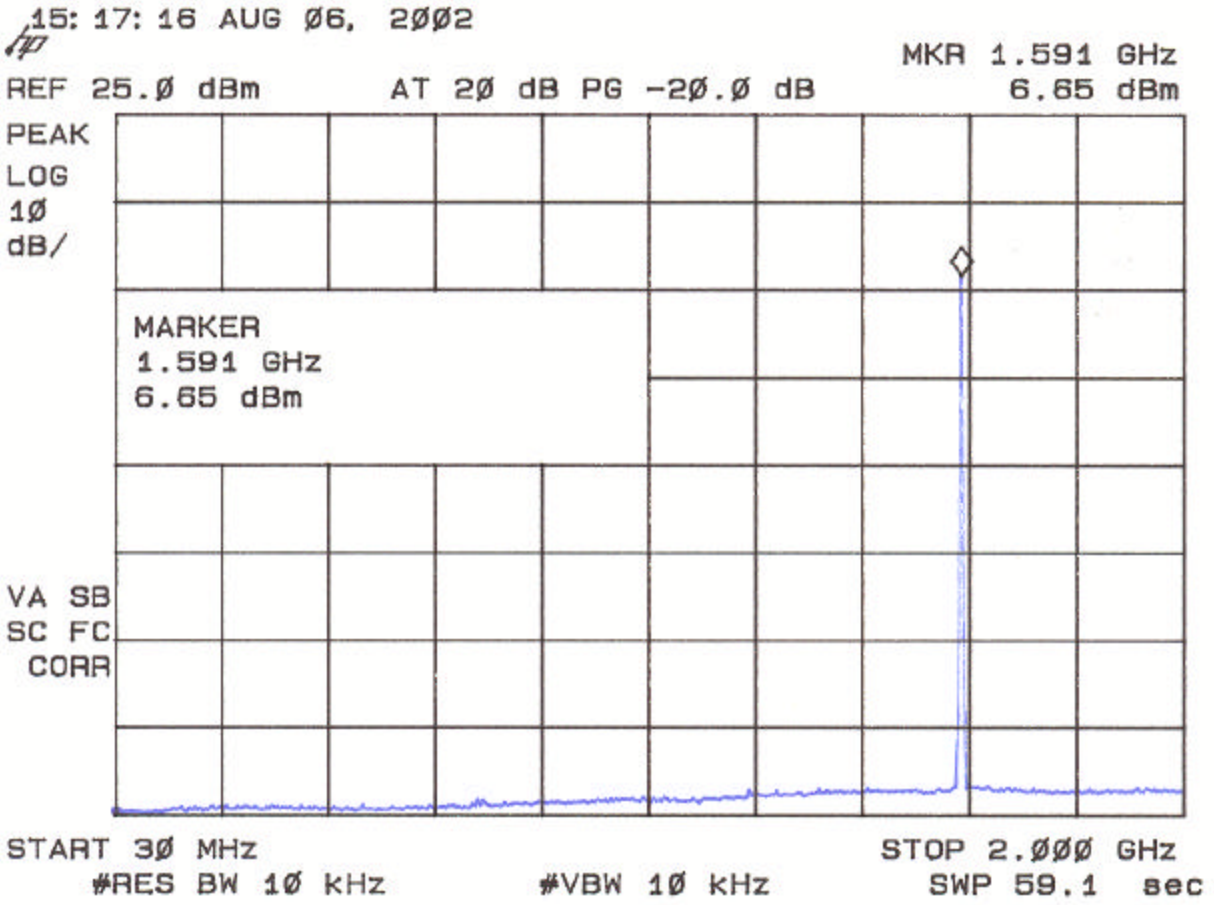
For Lowest Channel = 43 + 10 log (0.1462) = 34.6 dB
For Highest Channel = 43 + 10 log (0.1563) = 34.9 dB

The following plots show that all emissions were at least 50.4 dB below the fundamental.

Note:
A 10 kHz RBW was used instead. This was deemed to be comparable to 4 kHz RBW.

Additional requirement for 1574.397 - 1576.443 MHz (FCC Section 25.213(b))
- 80 dBW (- 50 dBm)

Figure 6a.
Spurious Emissions at Antenna Terminals



"The peak emission shown is actually 1611.25 MHz. The frequency appears off only due to the limited dynamic range of the measurement. The plot shows that there are no other spurious emissions on the 30-2000 MHz range other than the fundamental."

Figure 6b.
Spurious Emissions at Antenna Terminals

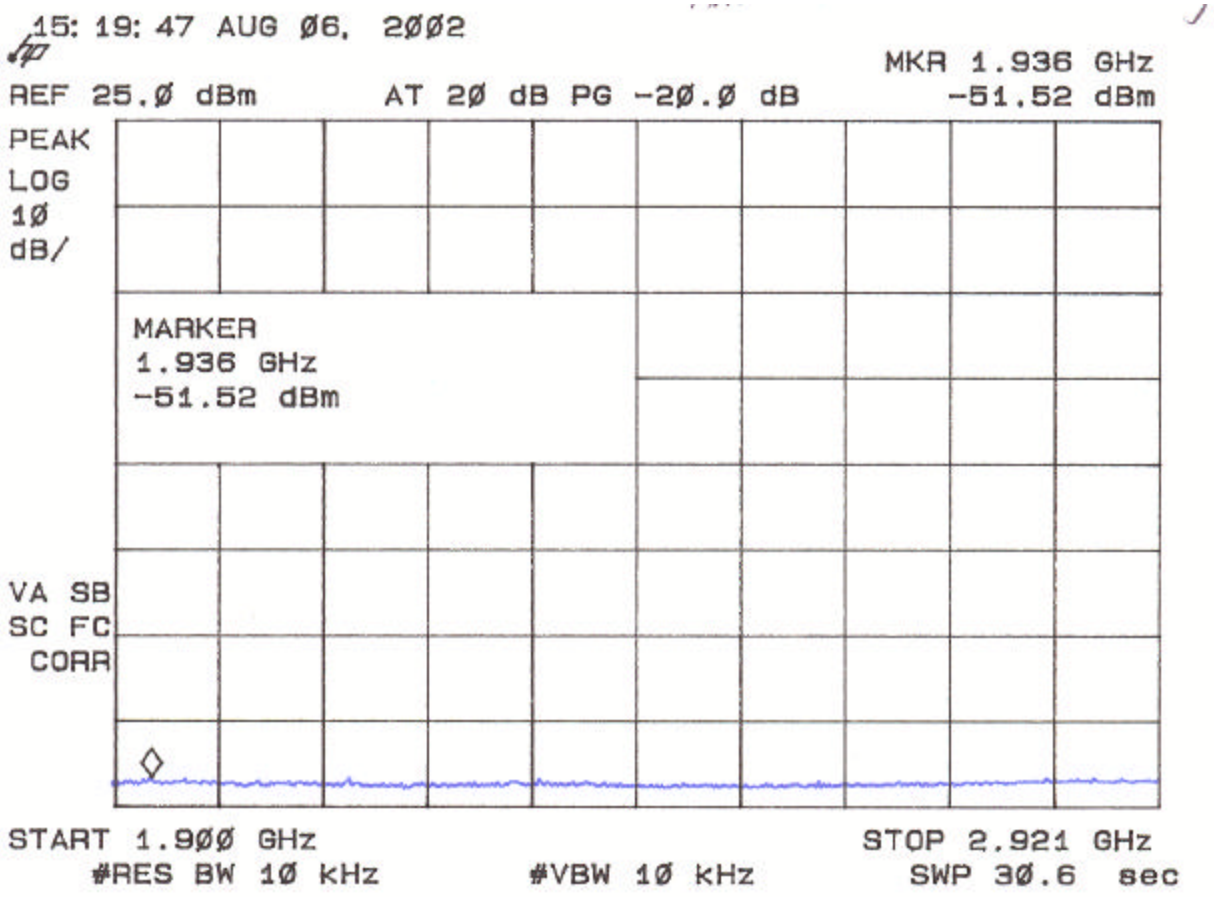


Figure 6c.
Spurious Emissions at Antenna Terminals

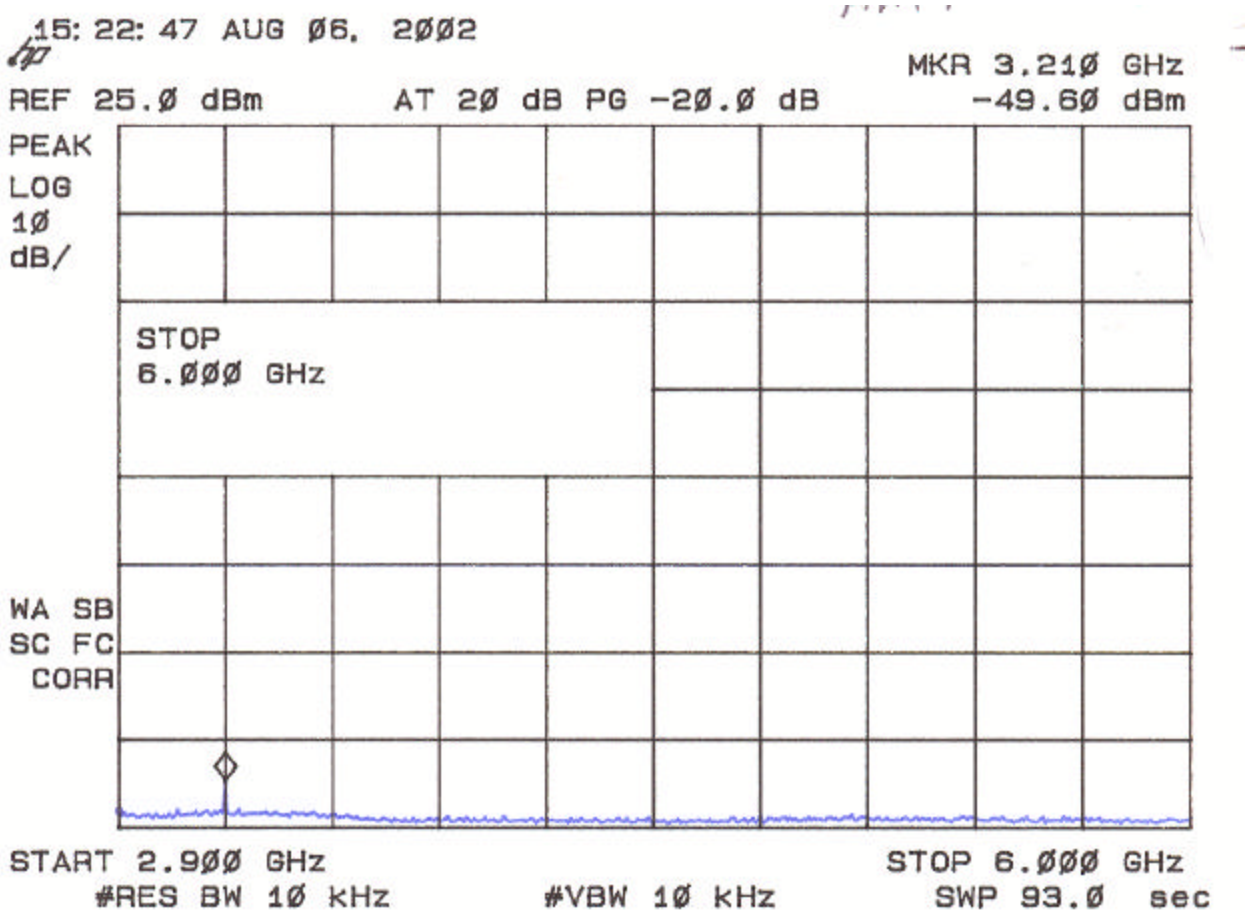


Figure 6d.
Spurious Emissions at Antenna Terminals

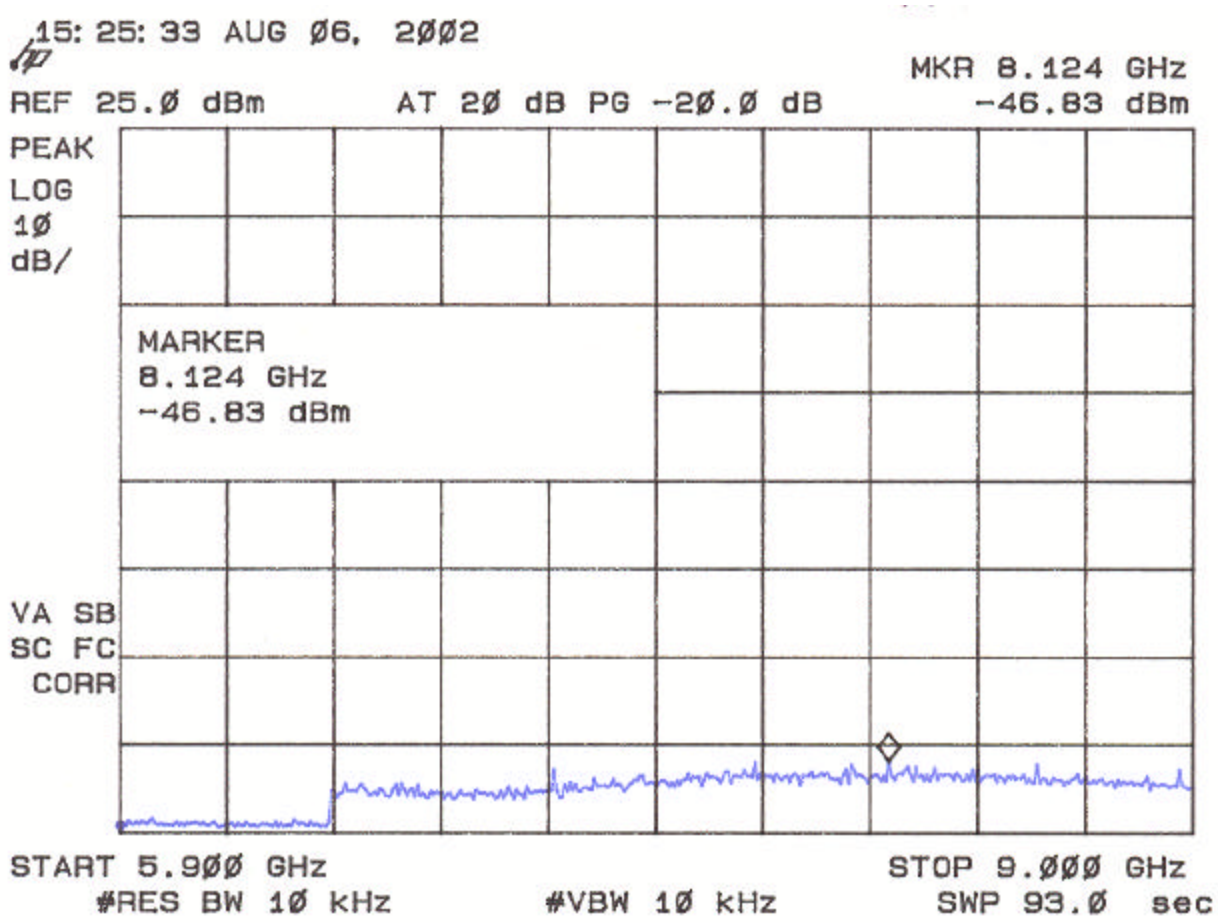


Figure 6e.
Spurious Emissions at Antenna Terminals

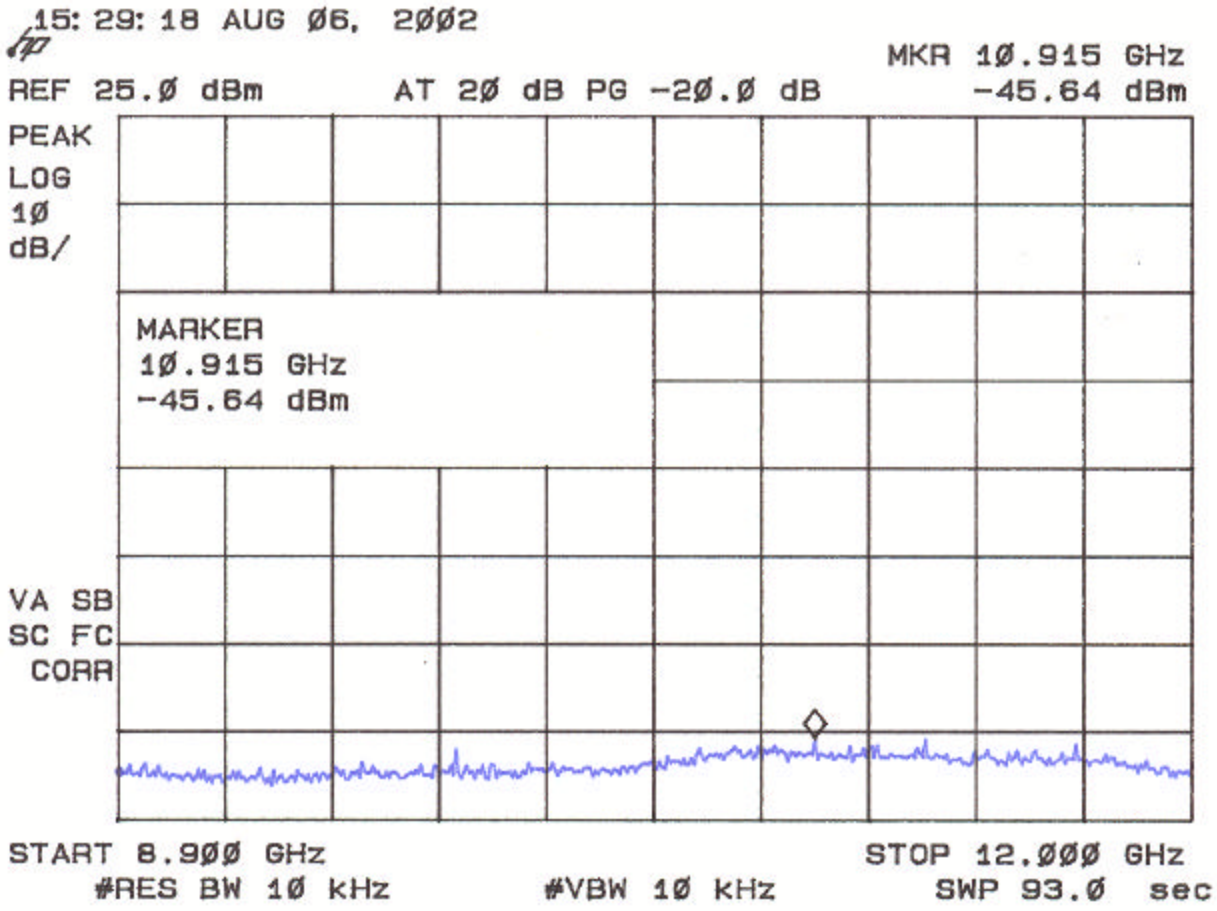


Figure 6f.
Spurious Emissions at Antenna Terminals

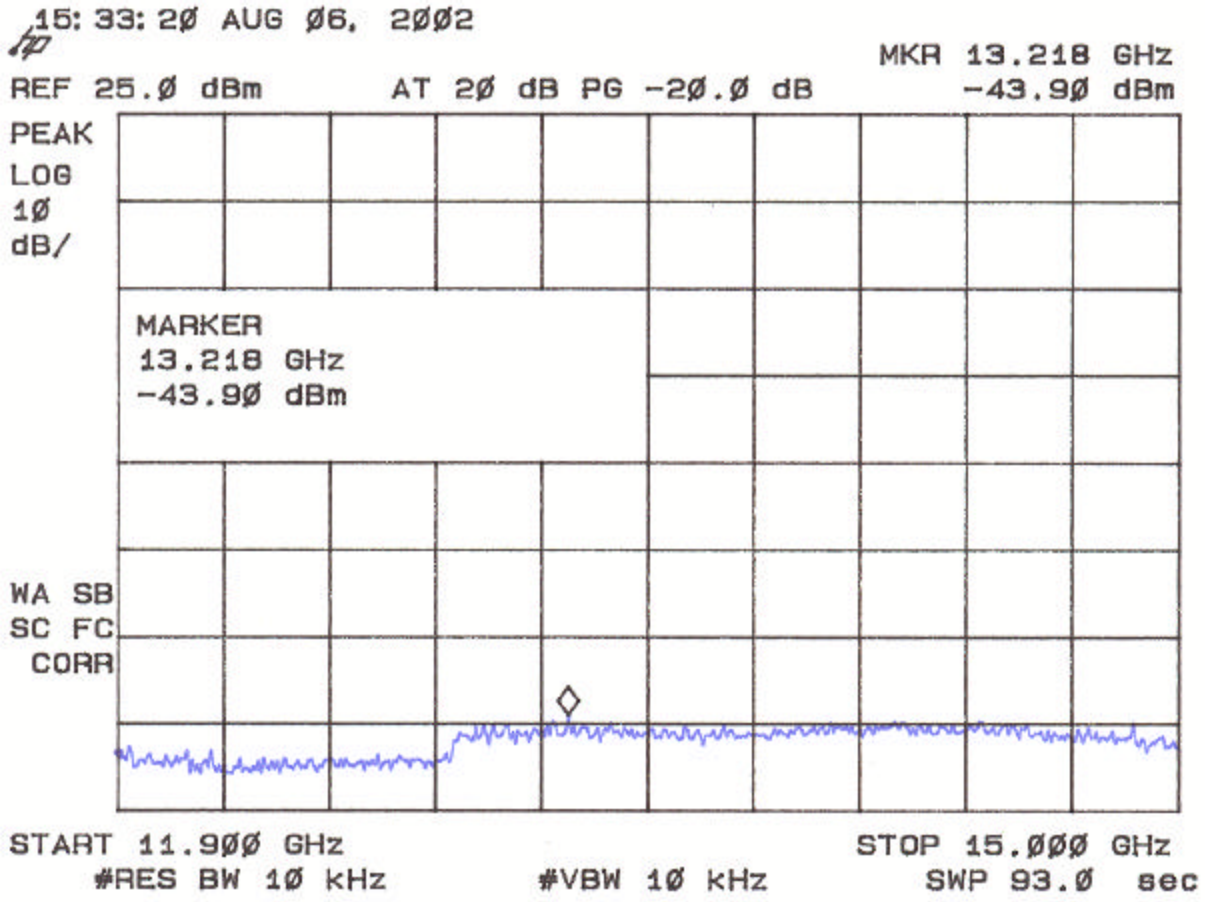


Figure 6g.
Spurious Emissions at Antenna Terminals

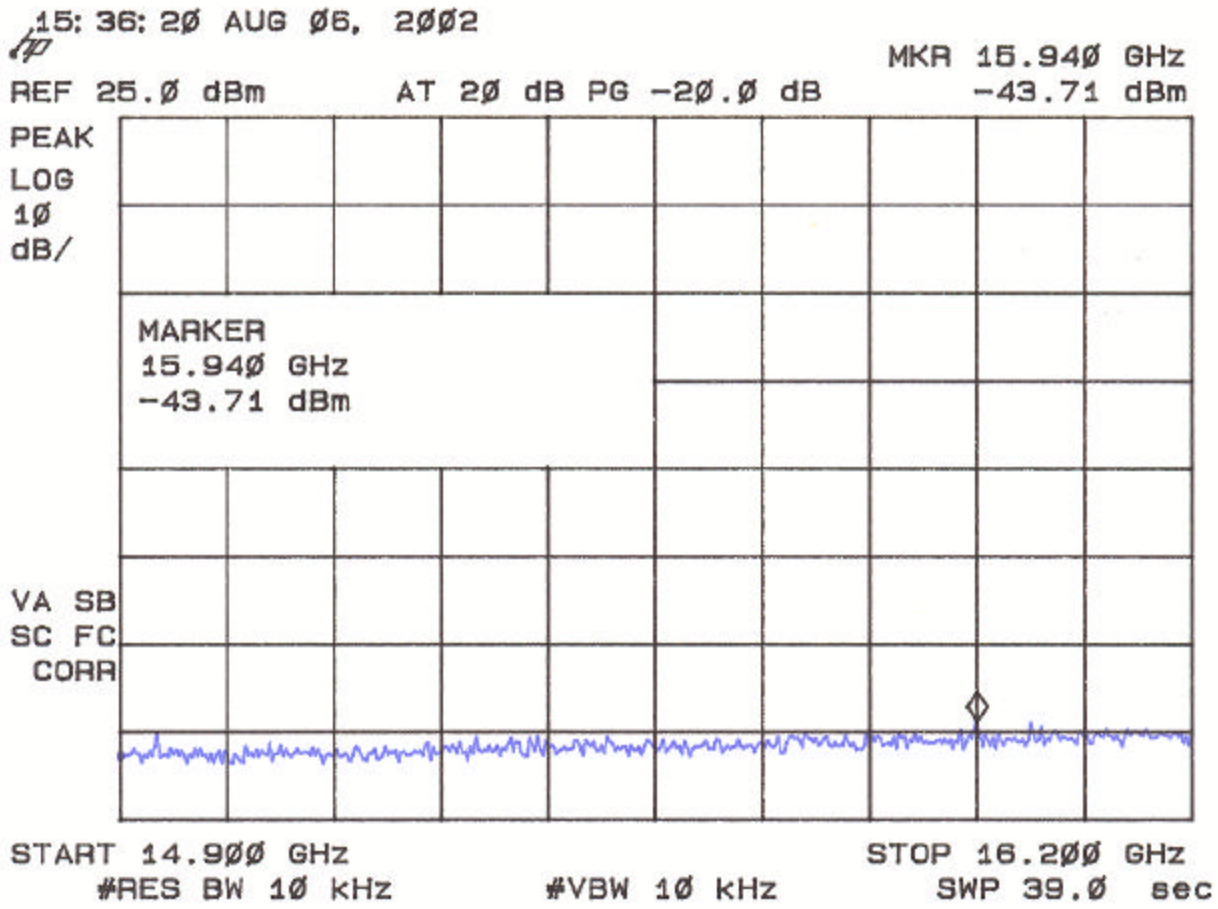


Figure 6h.
Spurious Emissions at Antenna Terminals

Limit = -80 dBW = -50 dBm

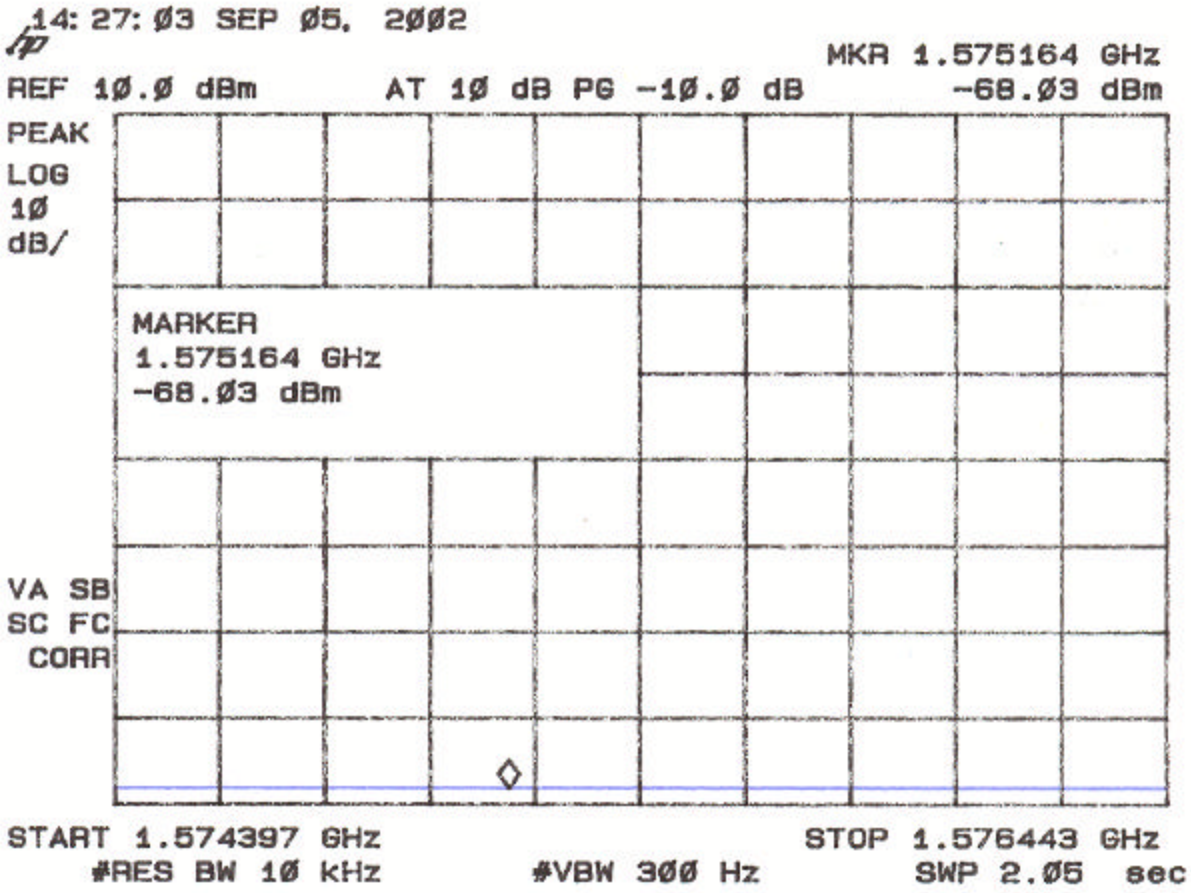
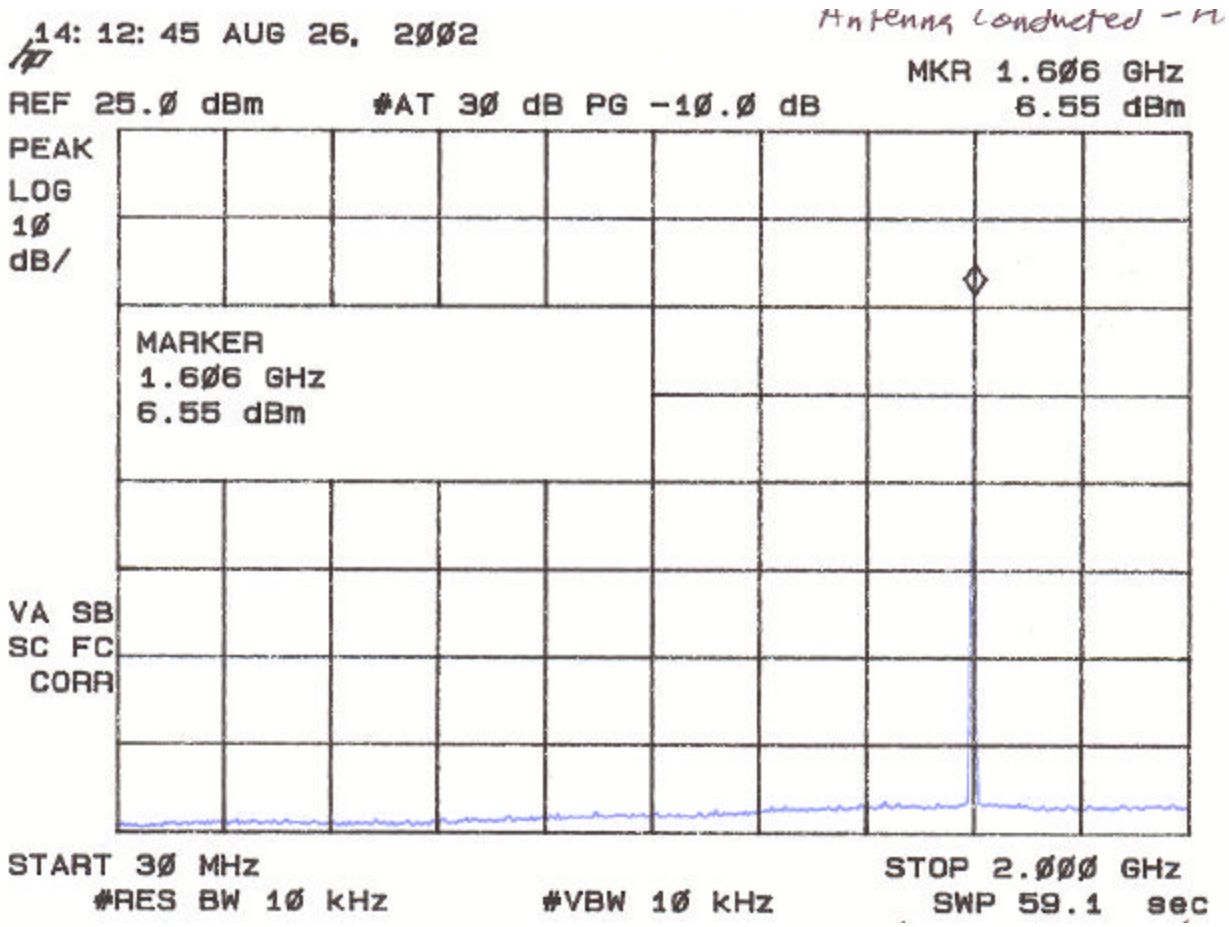


Figure 6i.
Spurious Emissions at Antenna Terminals



"The peak emission shown is actually 1618.75 MHz. The frequency appears off only due to the limited dynamic range of the measurement. The plot shows that there are no other spurious emissions on the 30-2000 MHz range other than the fundamental."

Figure 6j.
Spurious Emissions at Antenna Terminals

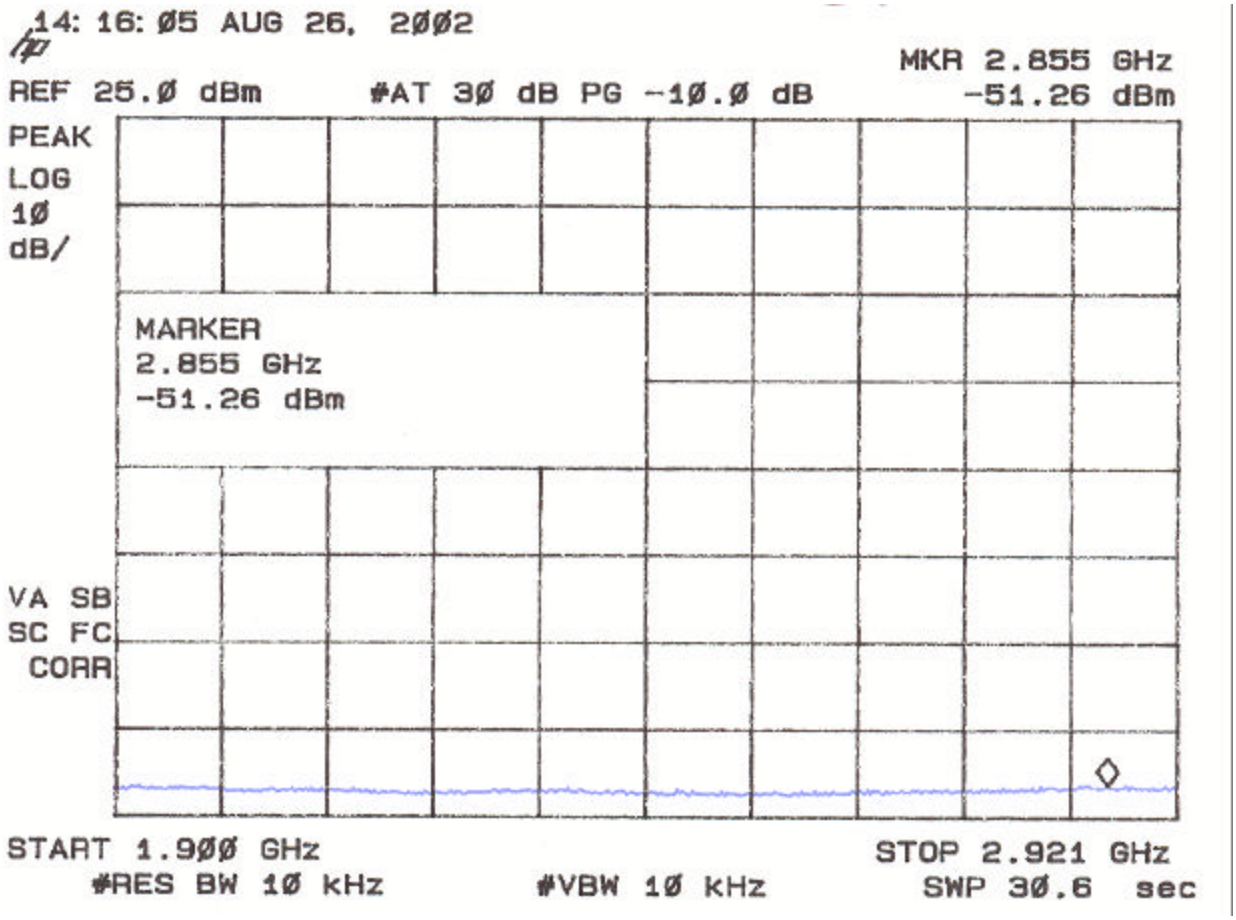


Figure 6k.
Spurious Emissions at Antenna Terminals

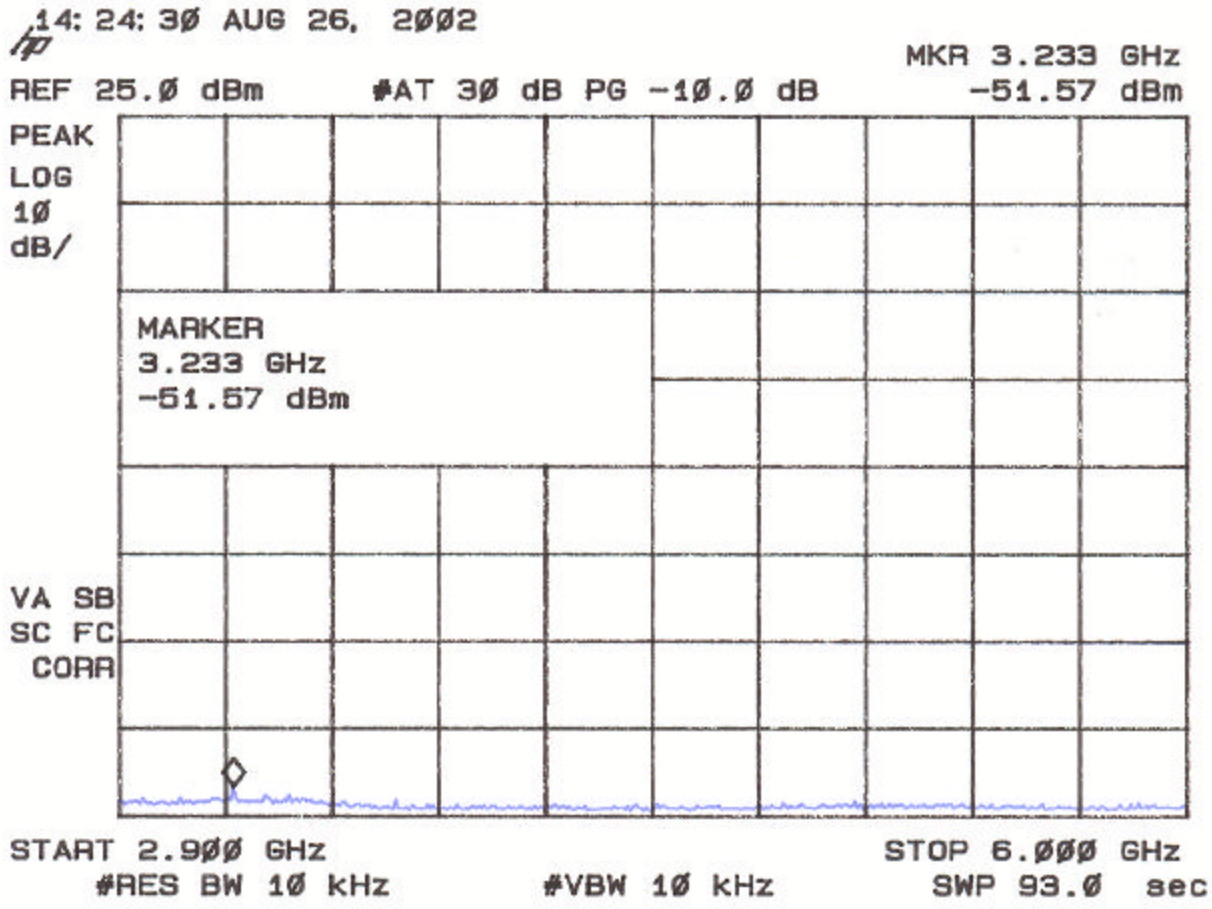


Figure 6l.
Spurious Emissions at Antenna Terminals

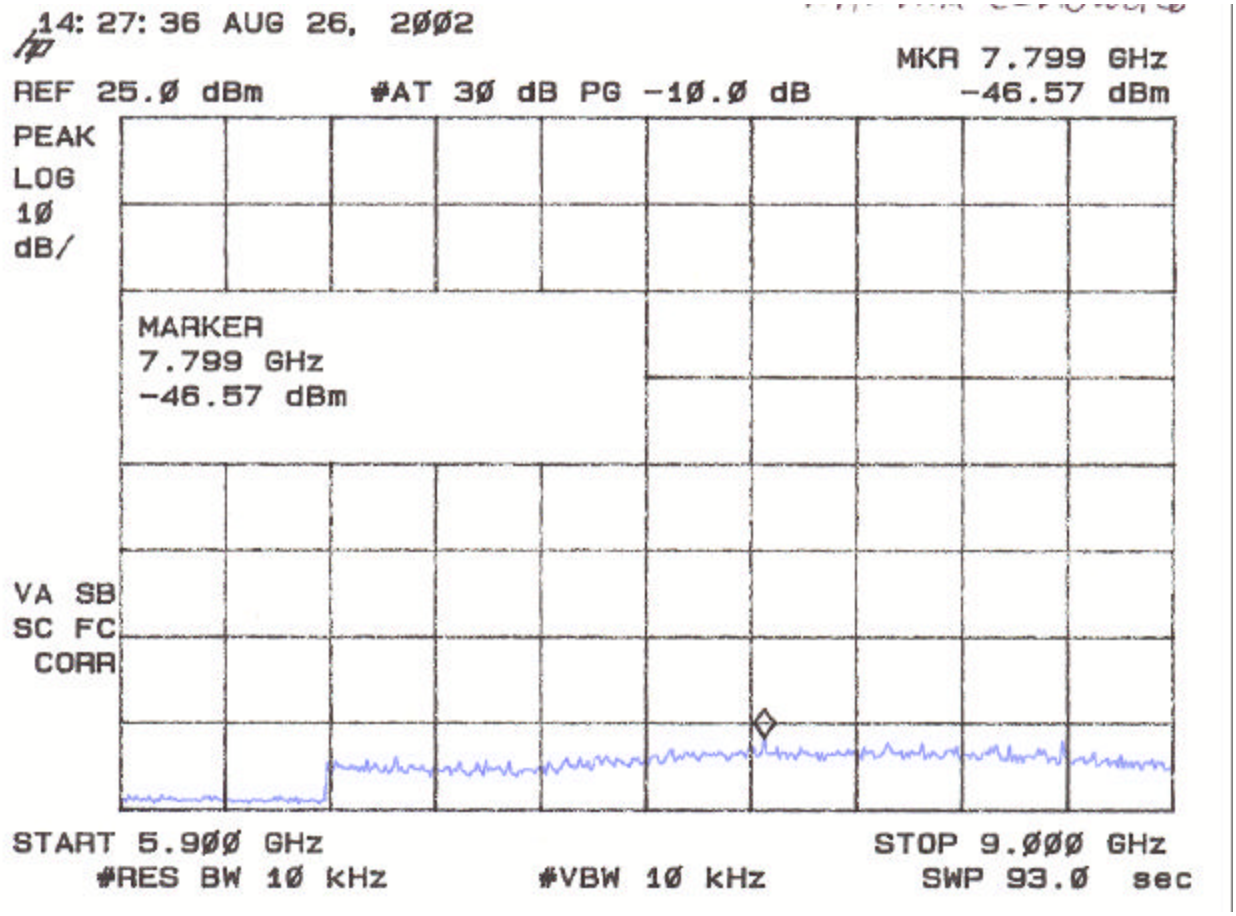


Figure 6m.
Spurious Emissions at Antenna Terminals

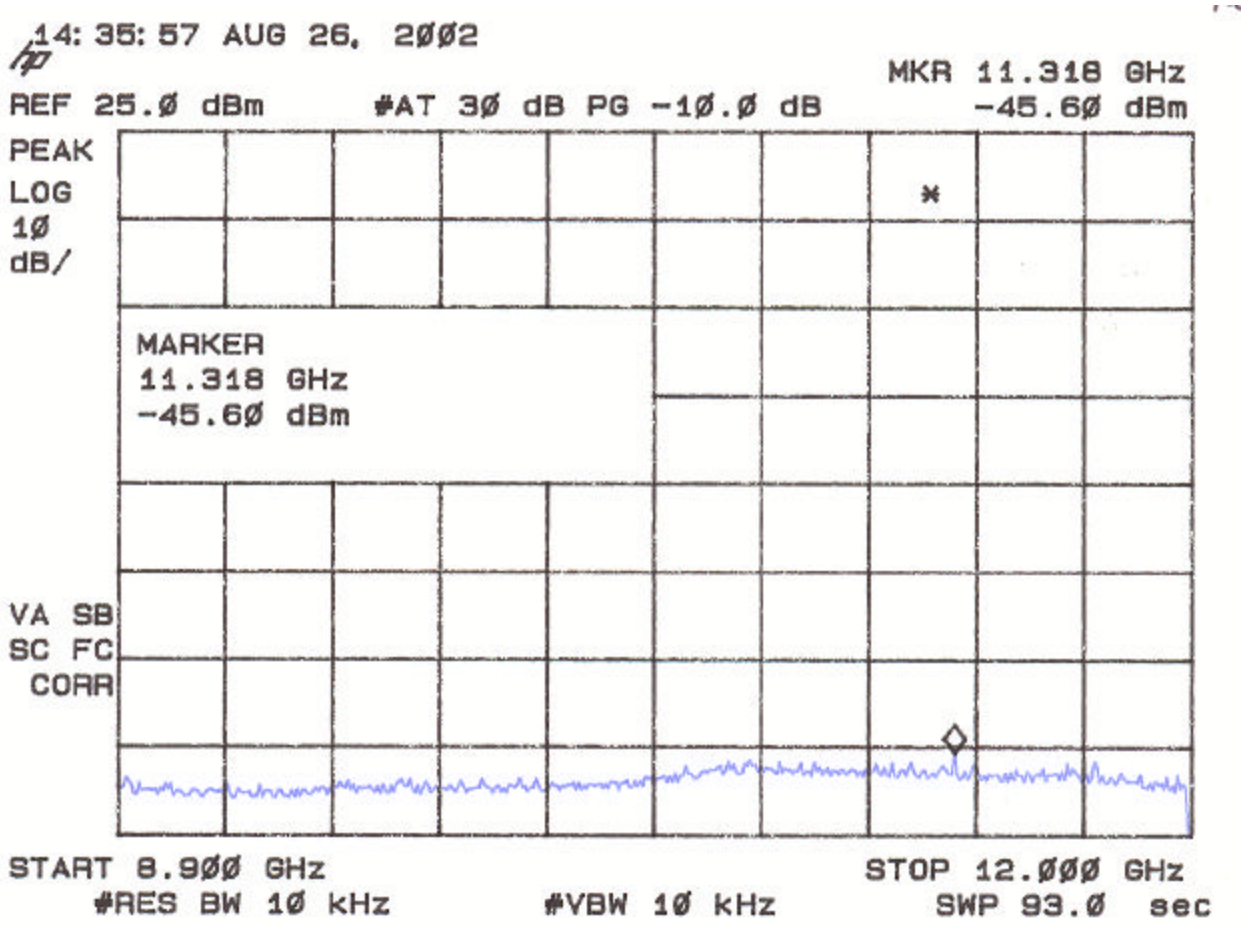


Figure 6n.
Spurious Emissions at Antenna Terminals

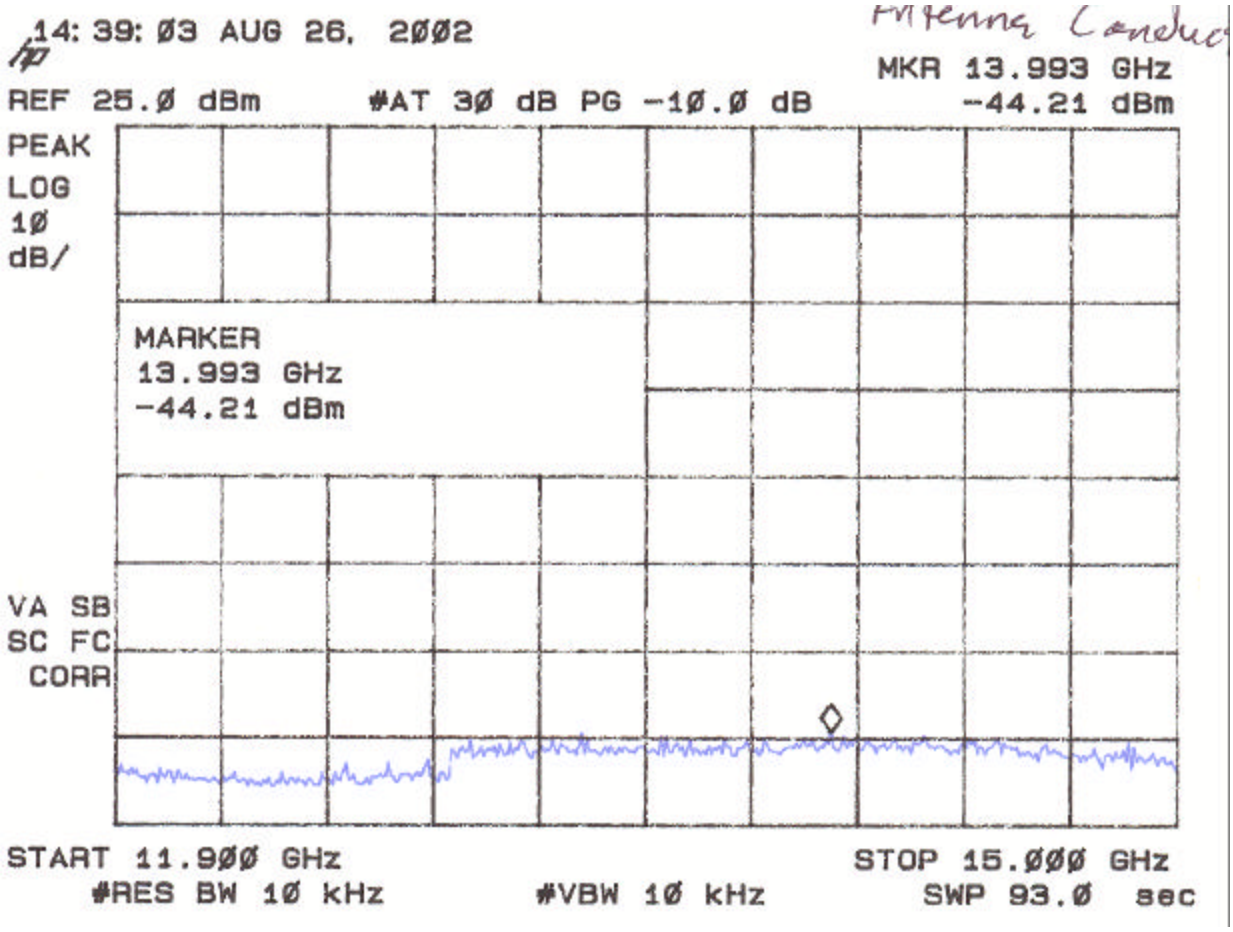


Figure 6o.
Spurious Emissions at Antenna Terminals

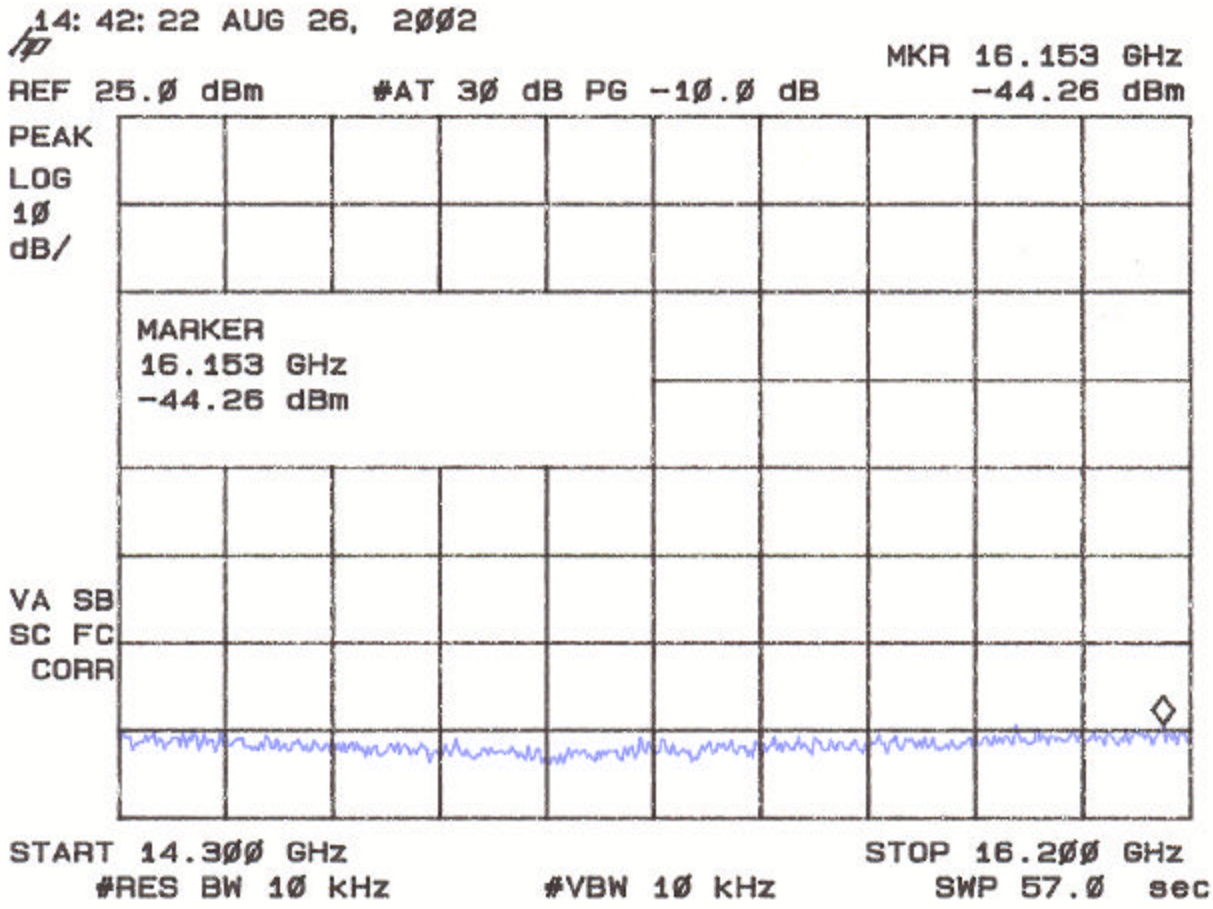
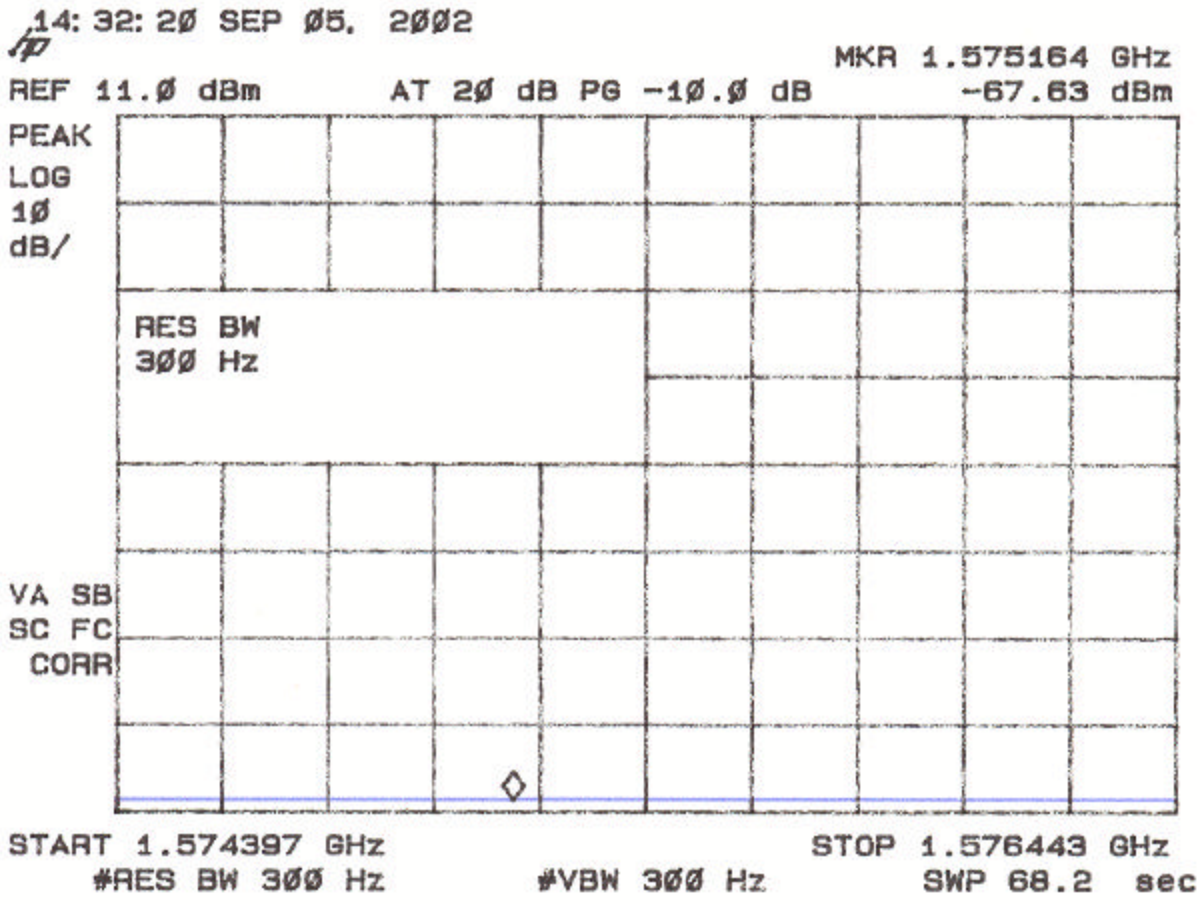


Figure 6p.
Spurious Emissions at Antenna Terminals

Limit= -80 dBW = -50 dBm



2.10 Field Strength of Spurious Radiation (FCC Section 2.1053)

Spurious emissions were evaluated from 30 MHz to 16.2 GHz at an EUT to antenna distance of 1 or 3 meters. The EUT was tested with an external power source and modulated by its own internal sources. Both a low and high channel were tested. The EUT was placed on an open area test site and the spurious emissions tested as stipulated by EIT/TIA-603: 1992 section 2.2.12. Measurements for 30 to 1000 MHz were made with the analyzer's bandwidth set to 120 kHz. Measurements above 1 GHz were made with the analyzer's bandwidth set to 1 MHz. The worse case results are shown in Table 4.

FCC Minimum Standard (FCC Section 25.202(f))

For out-of-band emissions for frequencies removed from the midpoint of the assigned frequency segment by more than 250% of the authorized bandwidth (2.5 MHz), at least

$$43 + 10 \log (P_{Watts})$$ attenuation below the mean power of the transmitter.

For Lowest Channel = 43 + 10 log (0.1462) = 34.6 dB
For Highest Channel = 43 +10 log (0.1563) = 34.9 dB

FIELD STRENGTH OF SPURIOUS RADIATION

Limit: 43 + 10 log (P_{Watts}) = 43 + 10 log (0.1462) = 34.6 dB

TABLE 4a

Worse Case Mode = Low Channel

Frequency (MHz)	Polarity (H or V)	Corrected Substitution Level Relative to Dipole (dBm)	Attenuated Level Below Carrier Power (dB)
225	H	-54.0	75.7
3223	V	-36.6	58.2

SAMPLE CALCULATION:

Attenuated Level Below Carrier Power =
10 log (TX Power in mW) – Corrected Substitution Level (dBm)
10 log (146.2) - -36.6 = 58.2

Test Date: August 8 & 22, 2002

Tester Signature:  **Name: David Blethen**

2.11 Frequency Stability (FCC Section 2.1055 and 25.202(d))

The frequency tolerance of the carrier signal was measured by while ambient temperature was varied from -30 to 50 degrees centigrade. The frequency tolerance was verified at 10 degree increments. Additionally, the supply voltage was varied from 85% to 115% of the nominal value (except for hand carried, battery powered equipment which was additionally measured at battery endpoint). The data is shown in the following tables and figures.

FCC Minimum Standard

0.001% (10 ppm)

Report Number: 02-0227 Issue Date: August 30, 2002
Customer: Axonn, L.L.C.
Model: G-SENS STU

FCC Verification
Axonn Model G-SENS STU
Frequency Stability vs. Temperature (At Startup)

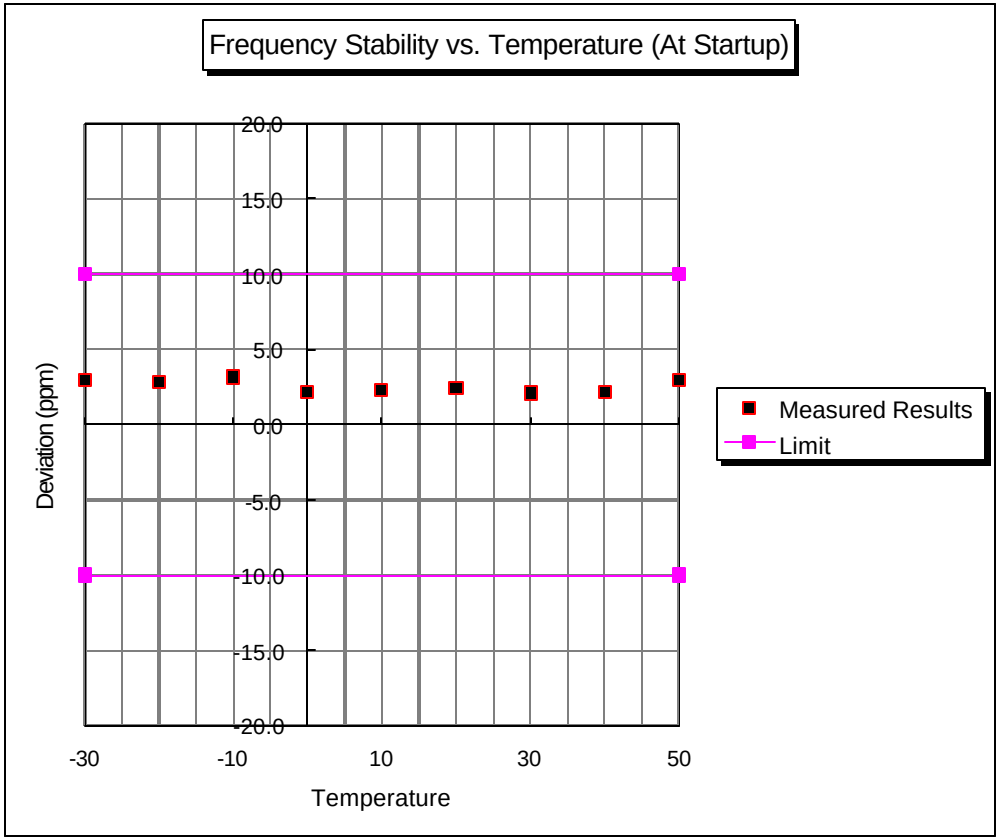
Test Results Reviewed By:

Timothy R. Johnson
NARTE Certified Engineer

Temperature (degrees C)	Measured Frequency (MHz)	Deviation (ppm)
-30	1611.254800	3.0
-20	1611.254605	2.9
-10	1611.255092	3.2
0	1611.253494	2.2
10	1611.253762	2.3
20	1611.253917	2.4
30	1611.253370	2.1
40	1611.253438	2.1
50	1611.254805	3.0

Actual TX Frequency was: 1611.250 MHz

Maximum Deviation = 0.001% or 10 ppm



Report Number: 02-0227 Issue Date: August 30, 2002
Customer: Axonn, L.L.C.
Model: G-SENS STU

FCC Verification
Axonn Model G-SENS STU
Frequency Stability vs. Temperature (2 minutes after startup)

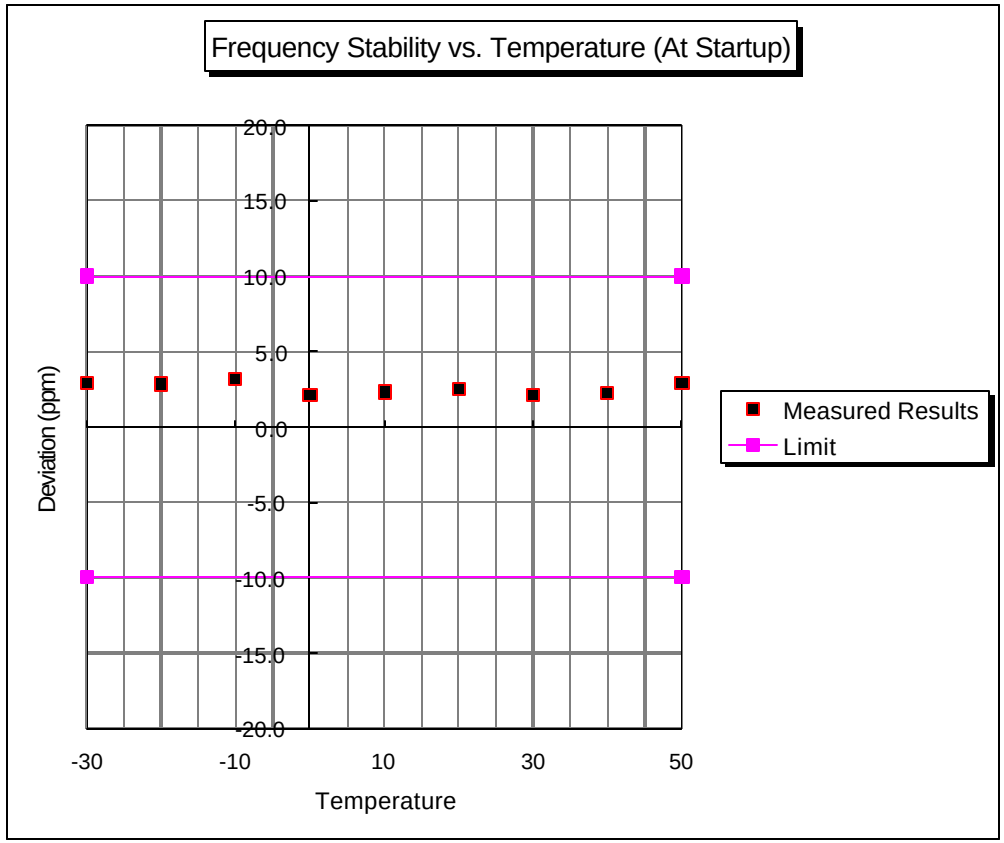
Test Results Reviewed By:

Timothy R. Johnson
NARTE Certified Engineer

Temperature (degrees C)	Measured Frequency (MHz)	Deviation (ppm)
-30	1611.254700	2.9
-20	1611.254561	2.8
-10	1611.255036	3.1
0	1611.253346	2.1
10	1611.253730	2.3
20	1611.253989	2.5
30	1611.253366	2.1
40	1611.253609	2.2
50	1611.254733	2.9

Actual TX Frequency was: 1611.250 MHz

Maximum Deviation = 0.001% or 10 ppm



Report Number: 02-0227 Issue Date: August 30, 2002
Customer: Axonn, L.L.C.
Model: G-SENS STU

FCC Verification
Axonn Model G-SENS STU
Frequency Stability vs. Temperature (5 minutes after startup)

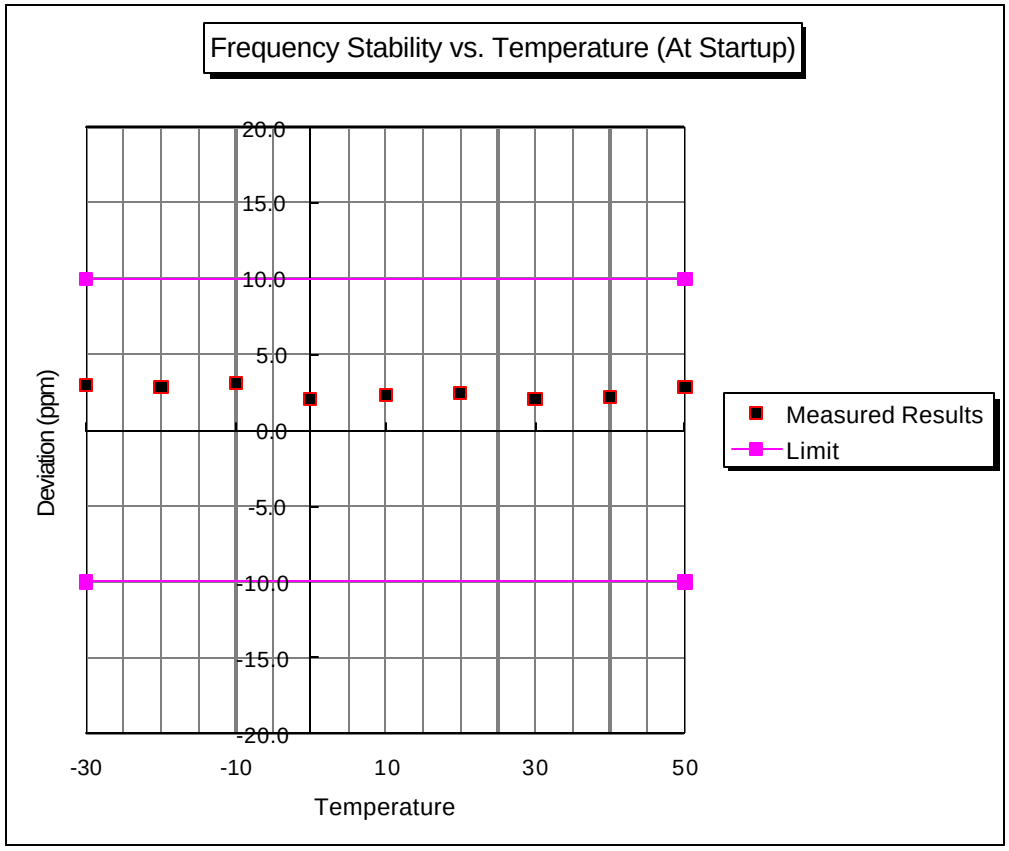
Test Results Reviewed By:

Timothy R. Johnson
NARTE Certified Engineer

Temperature (degrees C)	Measured Frequency (MHz)	Deviation (ppm)
-30	1611.254900	3.0
-20	1611.254613	2.9
-10	1611.255040	3.1
0	1611.253374	2.1
10	1611.253757	2.3
20	1611.253953	2.5
30	1611.253318	2.1
40	1611.253554	2.2
50	1611.254673	2.9

Actual TX Frequency was: 1611.250 MHz

Maximum Deviation = 0.001% or 10 ppm



Report Number: 02-0227 Issue Date: August 30, 2002
Customer: Axonn, L.L.C.
Model: G-SENS STU

FCC Verification
Axonn Model G-SENS STU
Frequency Stability vs. Temperature (10 minutes after startup)

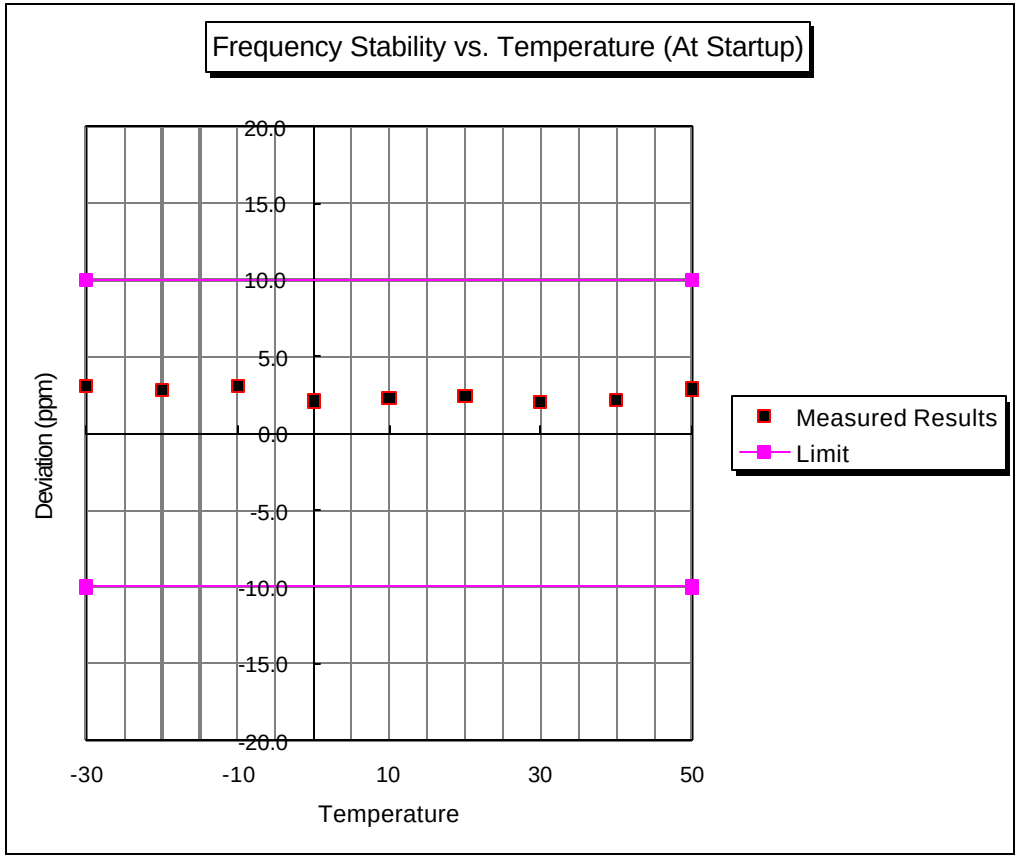
Test Results Reviewed By:

Timothy R. Johnson
NARTE Certified Engineer

Temperature (degrees C)	Measured Frequency (MHz)	Deviation (ppm)
-30	1611.255050	3.1
-20	1611.254581	2.8
-10	1611.255036	3.1
0	1611.253398	2.1
10	1611.253773	2.3
20	1611.253973	2.5
30	1611.253346	2.1
40	1611.253562	2.2
50	1611.254661	2.9

Actual TX Frequency was: 1611.250 MHz

Maximum Deviation = 0.001% or 10 ppm



Report Number: 02-0227 Issue Date: August 30, 2002
Customer: Axonn, L.L.C.
Model: G-SENS STU

FCC Verification
Axonn Model G-SENS STU
Frequency Stability vs. Voltage

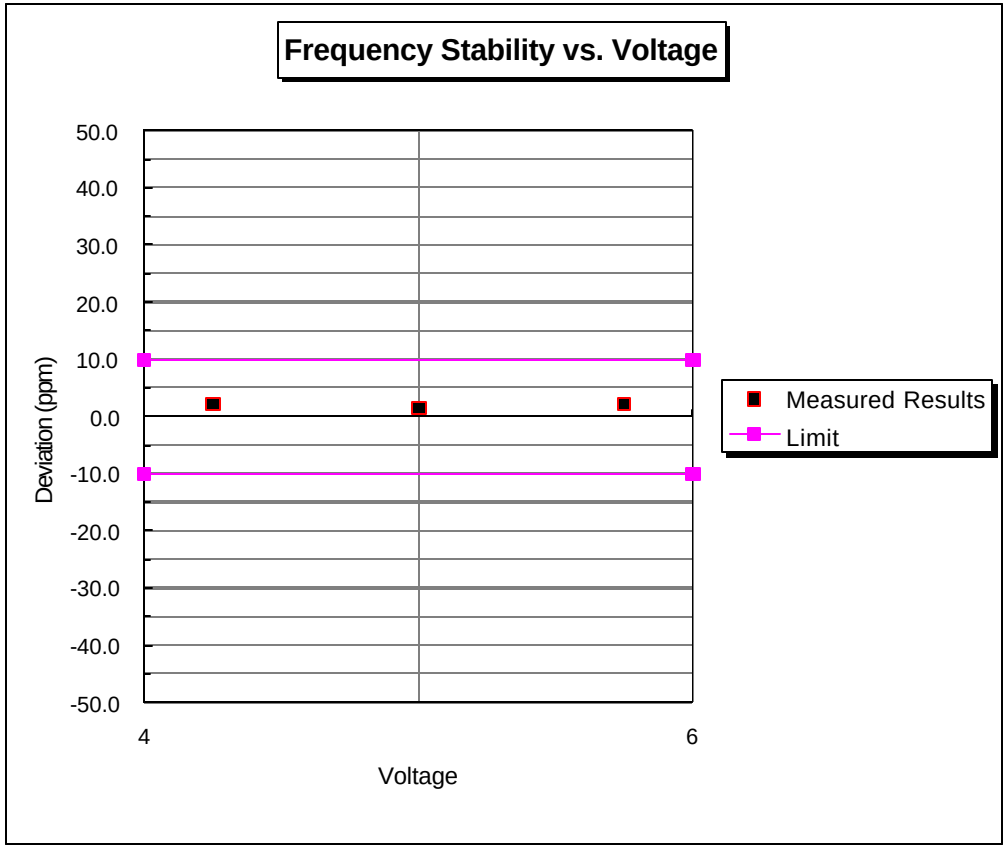
Test Results Reviewed By:

Timothy R. Johnson
NARTE Certified Engineer

Voltage (V DC)	Measured Frequency (MHz)	Deviation (ppm)
4.25	1611.253554	2.2
5	1611.252602	1.6
5.75	1611.253689	2.3

Actual TX Frequency was: 1611.250 MHz

Maximum Deviation = N/A



SECTION 3

PHOTOGRAPHS

PHOTOS OF THE TESTED EUT

The following photos are attached:

Photo 1. EUT, Top View
Photo 2. EUT, Bottom View

Photo 1. EUT, Top View

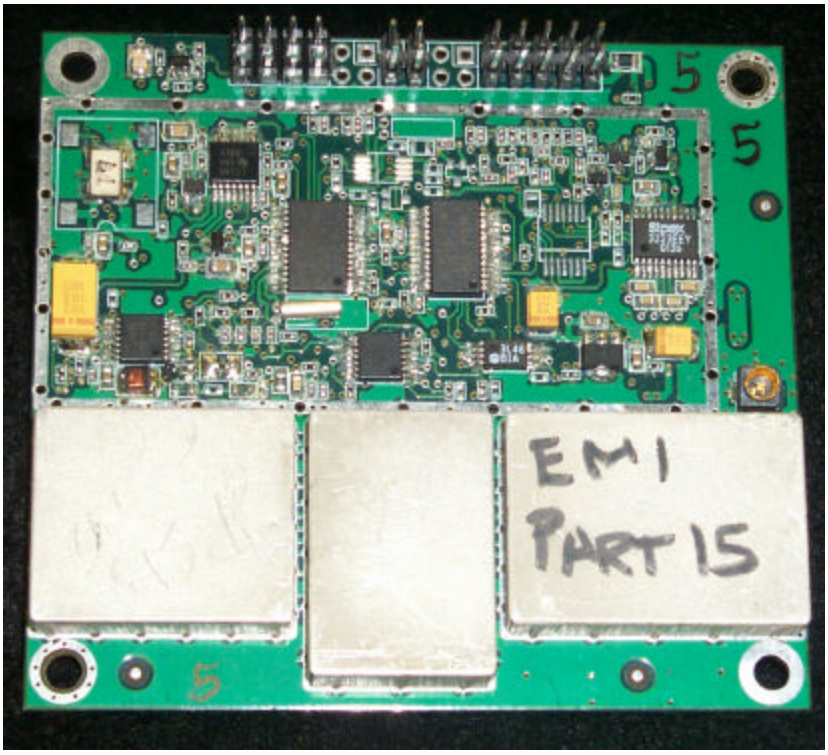
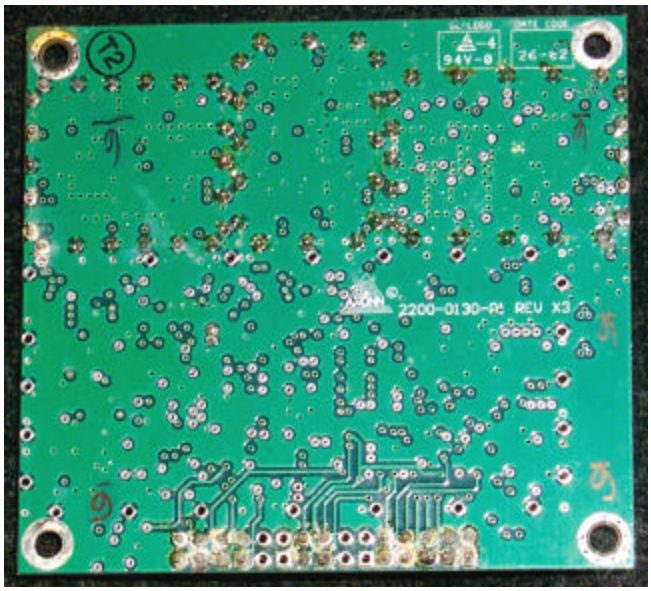


Photo 2. EUT, Bottom View



SECTION 4

RF EXPOSURE INFORMATION

4.1 RF Safety Requirements to 2.1091 for Mobile Transmitters

Power Output

The EUT's maximum expected output power as shown in section 2.6 is

Frequency of Fundamental (MHz)	Measurement (dBm)	Measurement (Watt)	EIRP (dBm)	EIRP (Watt)
1618.75	21.94	0.156	25.94	0.393

Source Based Time Averaging

This information has not been included and the MPE calculations specified below do not take into consideration any duty cycle correction.

MPE Calculations

The limits for this unit (uncontrolled exposure) is 1.0 mW/cm^2. Taking the RF Density Field Equation:

$S = (EIRP \text{ in } mW)/(4\pi R^2)$ and solving for Distance R

$R = SQRT (EIRP \text{ in } mW)/(S4\pi)$

Solving the above equation yields

$R (cm) = SQRT (393(mw))/(1.0(mW/cm^2)*4*\pi) = 5.6$ cm

The device should be installed to maintain 20 cm from humans during use. Information regarding installation and use should be contained in the users manual.