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FCC Certification Test Report

For the

RECONROBOTICS INC.

RECON SCOUT OPERATOR CONTROL UNIT (OCU)

FCC ID: UYXRSK2011-02

WLL REPORT# **12292-01 Rev 1**
December 22, 2011
Revised January 13, 2012

Prepared for:

ReconRobotics Inc.
7620 W. 78th Street
Edina, MN 55439

Prepared By:
Washington Laboratories, Ltd.
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Gaithersburg, Maryland 20879

ACCREDITED TESTING

Testing Certificate AT-1448

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Prepared by:

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Reviewed by:

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Abstract

This report has been prepared on behalf of ReconRobotics Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Transmitter under Part 95 Subpart C—Radio Control (R/C) Radio Service section of the FCC Rules and Regulations (10/2010)

Testing was performed at Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by the ANSI-ASQ National Accreditation Board/ACLASS. Refer to certificate and scope of accreditation AT-1448.

The ReconRobotics, Inc. Recon Scout Operator Control Unit (OCU) complies with the limits for a Licensed Transmitter device under FCC Part 95C.

Revision History	Reason	Date
Rev 0	Initial Release	December 22, 2011
Rev 1	Section 5.3.1,Unwanted Radiation Test method page 10 was re-written to show references to TIA-603-c and to clarify the supplied data tables.	January 13, 2012

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1 Introduction

1.1 Compliance Statement

The ReconRobotics Inc. Recon Scout Operator Control Unit (OCU) complied with the requirements of Part 95 Subpart C—Radio Control (R/C) Radio Service section of the FCC Rules and Regulations (10/2010).

1.2 Test Scope Summary

The following tests were performed to show compliance with Part 95 of the FCC rules:

Total Power	FCC Part 95.210 & Part 95.639(b)(3)
Emission Bandwidth	FCC Part 95.633(b)
Unwanted Radiation	FCC Part 95.635 (1)(10)(11)(12)
Frequency Tolerance	FCC Part 95.623(c)
Modulation Characteristics	FCC Part 2.1047 (part 95 not applicable to R/C device)

All measurements were performed in a radiated fashion. As the Frequency range of the EUT is less than 1 MHz only the center channel was tested.

The following rules were attested to by the manufacturer to show compliance with Part 95 of the FCC rules:

FRS unit and R/C transmitter antenna	FCC Part 95.647
(R/C Rule 15) Do I have to limit the length of my communications?	FCC Part 95.215

1.3 Contract Information

Customer:	ReconRobotics Inc.
	7620 W. 78th Street
	Edina, MN 55439
Purchase Order Number:	Check #6114
Quotation Number:	66537

1.4 Test Dates

Testing was performed on the following date(s):	10/24/2011 to 12/192011

1.5 Test and Support Personnel

Washington Laboratories, Ltd.	James Ritter
Client Representative	Andrew Drenner

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification

The results obtained relate only to the item(s) tested.

Table 1: Overview of Recon Scout Operator Control Unit (OCU), Equipment Under Test

ITEM	DESCRIPTION
Manufacturer:	ReconRobotics Inc.
EUT Name	Recon Scout Operator Control Unit
FCC ID:	UYXRSK2011-02
Model:	OCU03
FCC Rule Parts:	Part 95C
Frequency Range:	75.41-75.99MHz
Measured Output Power:	27.13dBm (516.42mW) conducted total power (without antenna) 28.13dBm (650.13mW)EIRP- with antenna 25.98dBm (396.28mW) ERP -with antenna
Modulation:	FM
Emission Bandwidth:	2.8kHz
Keying:	Automatic
Type of Information:	PWM
Number of Channels:	30 channels available- units fixed at factory for single channel
Antenna Connector	Internal mmcx (not user accessible)
Antenna Type	¼ wave whip permanently attached to chassis
Antenna Gain	1dBi, -1.15dBd
Frequency Tolerance:	0.002%
Emission Designator:	2K80F1D
Interface Cables:	None
Power Source & Voltage:	Rechargeable Battery, 11.3V nominal, 12.6Vmax

2.2 EUT Description

The Recon Scout robot is a surveillance robotic device meant to be deployed into settings where useful real time remote information can be transmitted from hazardous locations thereby improving the safety of personnel. The Recon Scout Operator Control Unit (OCU) receives black and white video information with no audio from the Recon Scout robot with a separate video receiver in the 430-448MHz range and displays that video on a TFT LCD screen. The OCU sends motion commands to the Recon Scout robot via a 75MHz R/C radio transmitter through a ¼ wave whip antenna.

2.3 Test Configuration

The ReconRobotics Inc. Recon Scout Operator Control Unit (OCU), Equipment Under Test (EUT), was operated from a Battery Operated power supply. The devices are pre-configured with the transmit frequency (not user changeable). As the frequency range of programmable channels is less than 1 MHz only the center channel at 75.71MHz was tested. The unit was a stand-alone handset device.

2.4 Equipment Configuration

The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Table 2: Equipment Configuration

Name / Description	Model Number	Part Number	Serial Number	Revision
Recon Scout Operator Control Unit	OCU3	--	0711C2098	--

2.5 Support Equipment

The following support equipment was used during testing:

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
None	----	----

2.6 Interface Cables

Table 4: Interface Cables

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded?	Termination Box ID & Port ID
1	DC IN (from Power Supply) Only for charging battery	Red/black cable with banana jacks on one end, various DC jacks on other	1	1	No	Port 1 (see block diagram)

2.7 EUT Modifications

The following modifications were made in order to comply with these tests:

1. An RF shield was added over the RF section in order to reduce spurious chassis harmonics.
2. The manufacturer removed the Video/Audio out connector due to spurious emissions.

2.8 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.9 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + ...}$$

where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution

divisor = 1.732 for rectangular distribution

divisor = 2 for normal distribution

divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

where U = expanded uncertainty

k = coverage factor

k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance.

The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 5 below.

Table 5: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	FCC Part 15	2.63 dB
Radiated Emissions	FCC Part 15	4.55 dB

3 Test Equipment

Test Name: **Temperature Stability**		Test Date:	**10/31/2011**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
117	Racal Dana	Frequency Counter	3/19/2012
646	Fluke 87	True RMS Multimeter	2/16/2012
641	HQ Power PS5005U	DC Power Supply	Na
669	Tenney	Temperature chamber	7/12/2012

Test Name: **Radiated Emissions**		Test Date:	**12/16/2011**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
69	HP - 85650A	ADAPTER QP	6/28/2012
71	HP - 85685A	PRESELECTOR RF	6/26/2012
73	HP - 8568B	ANALYZER SPECTRUM	6/26/2012
75	HP - 8648C	GENERATOR RF SIGNAL	3/16/2012
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	1/12/2012
7	ARA - LPB-2520	ANTENNA BICONILOG ANTENNA	10/11/2012
614	WLL - RG 223	CABLE COAXIAL BNC 18-M	12/27/2011

Test Name: **Conducted Emissions Voltage**		Test Date: **12/19/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
728	AGILENT - 8564EC	SPECTRUM ANALYZER 30HZ - 40GHZ	4/28/2012

4 Rule Declarations from Manufacturer

FCC part 95.647 FRS unit and R/C transmitter antenna requirements:

The antenna of each FRS unit, and the antenna of each R/C station transmitting in the 72–76 MHz band, must be an integral part of the transmitter. The antenna must have no gain (as compared to a half-wave dipole) and must be vertically polarized.

Response: The antenna used is a ¼ vertically polarized whip that is permanently attached to the chassis of the EUT and not user changeable. The listed gain is 1 dBi (isotropic), this is Equivalent to -1.15dBd (compared to a dipole) and thus complies to the above rule.

FCC Part 95.215 (R/C Rule 15) Do I have to limit the length of my communications?

This rule part states the conditions in which you may transmit continuously for more than 3 minutes

Response: The EUT is used to steer a wheeled robot in real time, often over uneven terrain, while the operator monitors progress by remote video. The EUT typically must transmit steering adjustments every few hundred milliseconds (on the order of human reaction time). The application thus meets the criterion "operation of the device requires at least one or more changes during each minute of the communications."

5 Test Results

5.1 Total Power [FCC Part 95.210 & Part 95.639(b)(3)]

5.1.1 Test Method

To measure the total power the EUT antenna was disconnected from its internal antenna port and replaced with a calibrated cable connected to a spectrum analyzer through appropriate attenuators. The EUT was the set to transmit at 75.71MHz with its modulation disabled. This level was recorded for the conducted power. As the antenna has a 1dBi gain (-1.15dBd gain) these numbers were added to the conducted gain to provide EIRP and ERP total power.

5.1.2 Test Limit

Part 95.210 and Part 95.639 (b) (3) state that a radio control (R/C) device in the 72-76MHz range is limited to 750mWatts carrier power.

5.1.3 Test Results

Test Name: Carrier Power		Test Date: 12/19/2011
Conducted Power @ Internal Antenna Port	**Total Power EIRP**	**Total Power ERP**
27.13dBm (516.42mW)	28.13dBm (650.13mW)EIRP	25.98dBm (396.28mW) ERP

5.1.4 Test Summary

The EIRP Total power (worst case) complies with the requirements part 95.210 and 95.639(b)(3).

5.2 Emission Bandwidth [FCC Part 95.633(b)]

5.2.1 Test Method

The emission bandwidth test was performed as an occupied bandwidth measurement. The EUT antenna was disconnected from its internal antenna port and replaced with a calibrated cable connected to a spectrum analyzer through appropriate attenuators. A spectrum analyzer was tuned to the center of the transmit frequency. The span of the analyzer was the reduced to approximately 2 to 3 times the span of the Tx signal. The resolution bandwidth of the device was lowered to approximately 1% of the estimated occupied bandwidth as per part 95.633. The span between points on each side of the Tx signal corresponding to 20dB below the peak were then recorded as the emission bandwidth.

5.2.2 Test Limit

Section 95.633 (b) states that the authorized bandwidth for an R/C device is 8 kHz. The emission bandwidth must not exceed this.

5.2.3 Test Results

Figure 1 shows the plot of the Occupied bandwidth. The recorded level is 2.8 kHz

5.2.4 Test Summary

The EUT complied with the requirements of part 95.633(b)

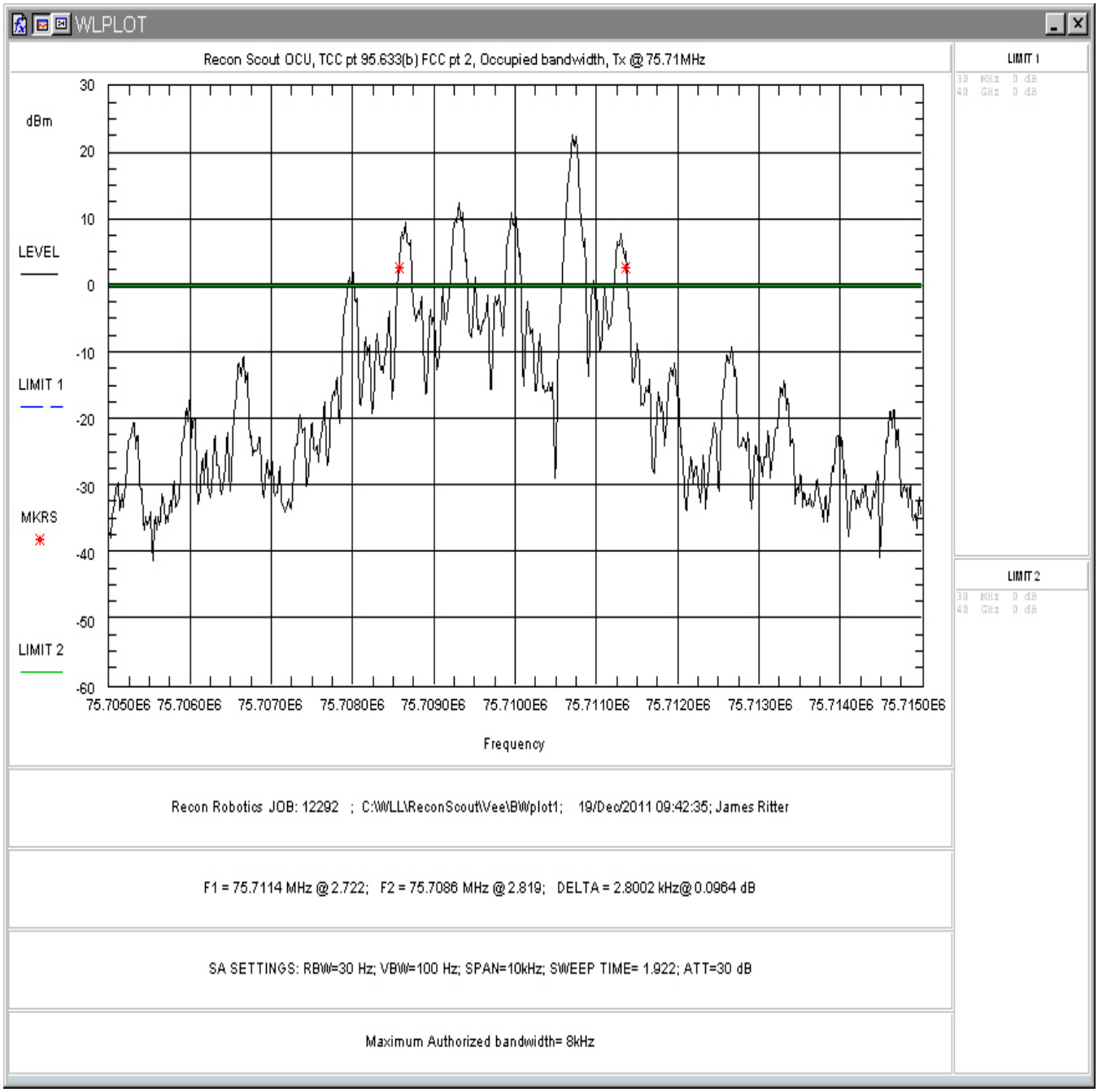

Figure 1: 20dB Occupied bandwidth

5.3 Unwanted Radiation [FCC Part 95.635 (1)(10)(11)(12)]

5.3.1 Test Method

The unwanted radiation tests were tested via 2 methods using the limits set for in FCC Part 95.635(1)(10)(11)(12) . The first method was a conducted method connecting the internal antenna connector to a spectrum analyzer. A resolution bandwidth of 30Hz was used inband (1% of occupied bandwidth). Larger resolution bandwidths were used out of band where possible to reduce the plots required to test the EUT (larger RBW's provide a worst case reading).

In addition the EUT was tested out of band (>250 % of authorized bandwidth) for radiated emissions on an open air test site (OATS) using the substitution method specified in TIA-603-C section 2.2.12 Unwanted Emissions with the following 2 exceptions:

1) Instead of replacing the EUT antenna with a non-reacting load the EUT antenna was left in place. This produces a worst case reading (combined case and antenna).

2) A resolution bandwidth of 100kHz was used for measurements vice a 10kHz RBW this will produce a higher worst case result.

A sample from the substitution tables is provided below to clarify them.

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	ERP Level (dBm)	ERP Limit (dBm)	Margin (dB)
151.42(a)	V(b)	0.0(b)	1.5(b)	25.69(c)	-54.2(d)	-58.0(e)	8.8(f)	5.0(g)	-52.9(h)	-55.1(i)	-26(j)	-29.1(k)

Columns:

a= Frequency of detected emission
b=Position of EUT and height/ polarization of receive antenna at maximum emission level
c= maximum field strength level of EUT emission on receiver without any corrections
d=Level of Signal Generator attached to a substitution antenna (replacing EUT) that produced a field strength identical to the EUT emission.
e=Signal Generator level at Substitution antenna (d minus any cable/connector losses)
f=Antenna Factor of substitution antenna used to get Antenna Gain
g=Substitution Antenna Gain
h=EIRP level of emission per TIA-603-C (column e plus column g) Note : numbers may have fractional differences due to rounding of numbers
i=ERP level , as The part 95 limit is stated in ERP vice EIRP a correction was used. (ERP= EIRP-2.15dB)
j= ERP limit as specified in FCC part 95.
k=Level of EUT ERP (column i) compared to ERP limit (Column j). Minus numbers indicate level below limit.

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The EUT was tested in 3 orthogonal positions for compliance. The EUT was then replaced with a substitution antenna of known gain and the levels of the initial emissions re-created with a signal generator feeding the substitution antenna. The signal generator reading was then converted to ERP as shown in the above table explanation. A resolution bandwidth of 100kHz was used for radiated measurements. The EUT antenna was in place for these readings.

Both tests were performed from 30MHz to the tenth harmonic of the fundamental frequency.

5.3.2 Test Limit

For an R/C device operating in the 72-76MHz region the limits are as follows:

(1) At least 25 dB (decibels) on any frequency removed from the center of the authorized bandwidth by more than 50% up to and including 100% of the authorized bandwidth.

(10) At least 45 dB on any frequency removed from the center of the authorized bandwidth by more than 100% up to and including 125% of the authorized bandwidth.

(11) At least 55 dB on any frequency removed from the center of the authorized bandwidth by more than 125% up to and including 250% of the authorized bandwidth.

(12) At least 56 + 10 log10 (T) dB on any frequency removed from the center of the authorized bandwidth by more than 250%.

5.3.3 Test Results

The conducted tests are shown in Figure 2 to Figure 13. Radiated results are shown in Table 1 to Table 8.

5.3.4 Test Summary

The EUT complied with the requirements of FCC Part 95.635(1)(10)(11)(12).

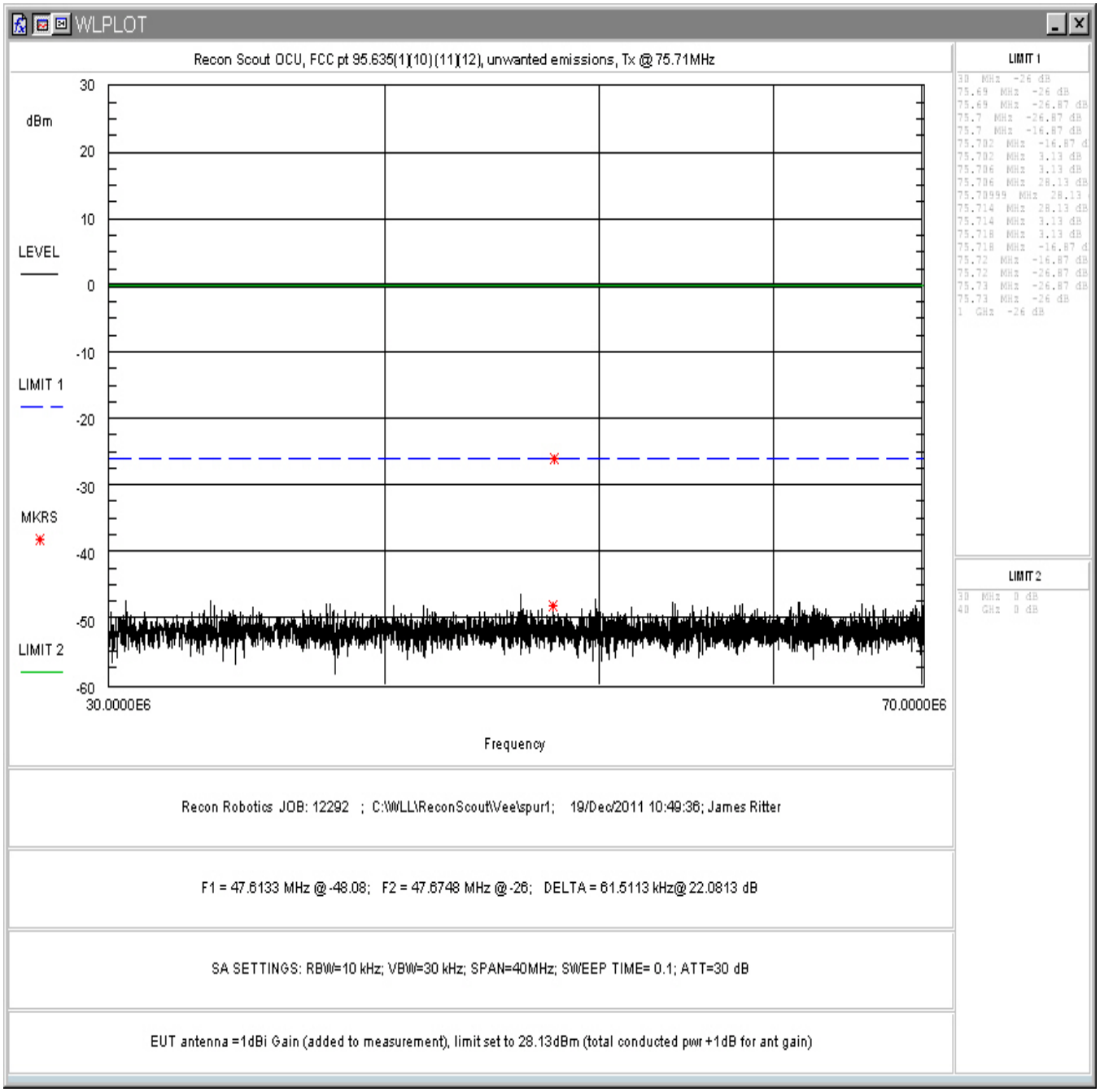

Figure 2: Unwanted Emissions, 30-70MHz

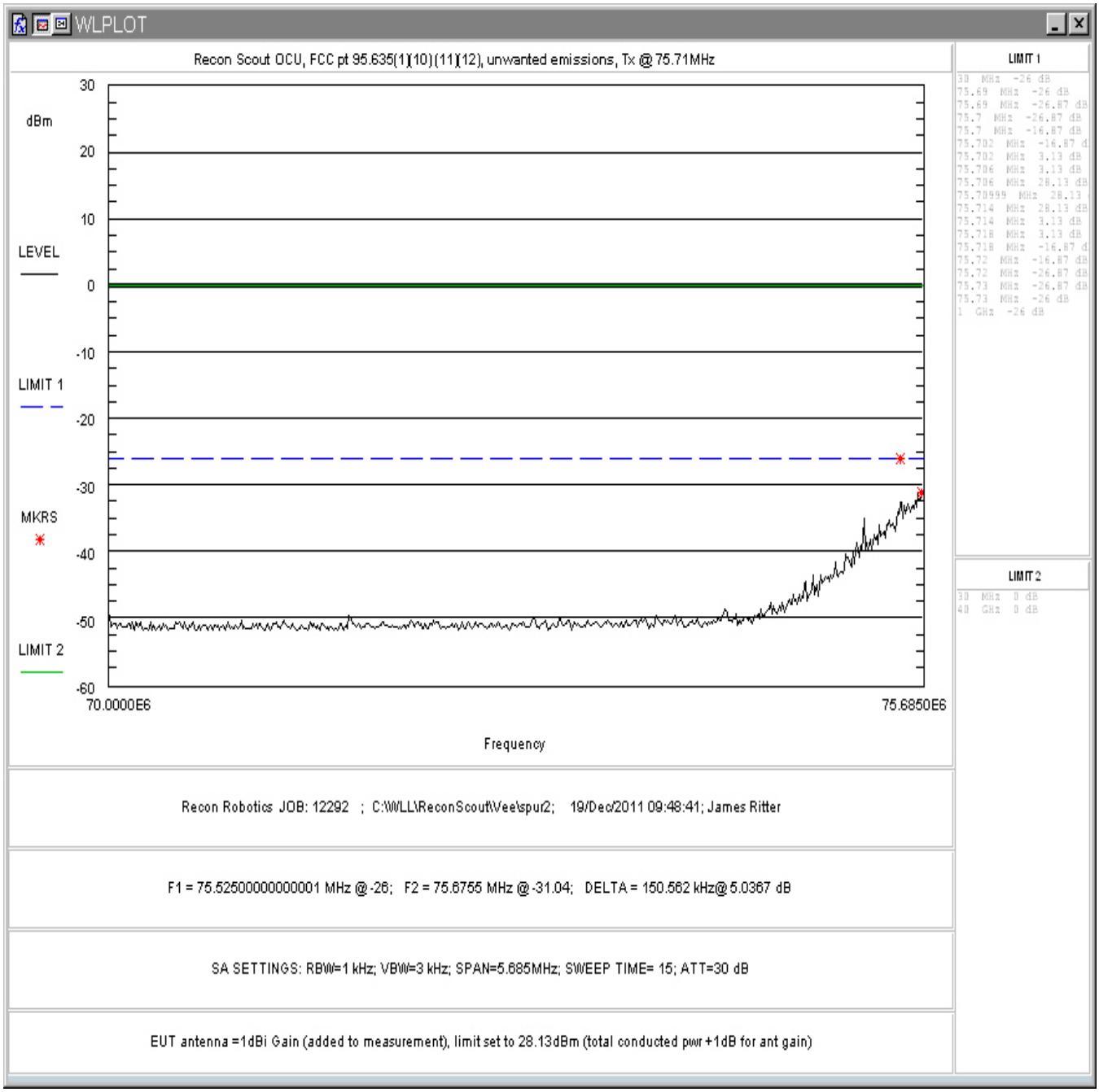

Figure 3: Unwanted Emissions, 70-75.585MHz

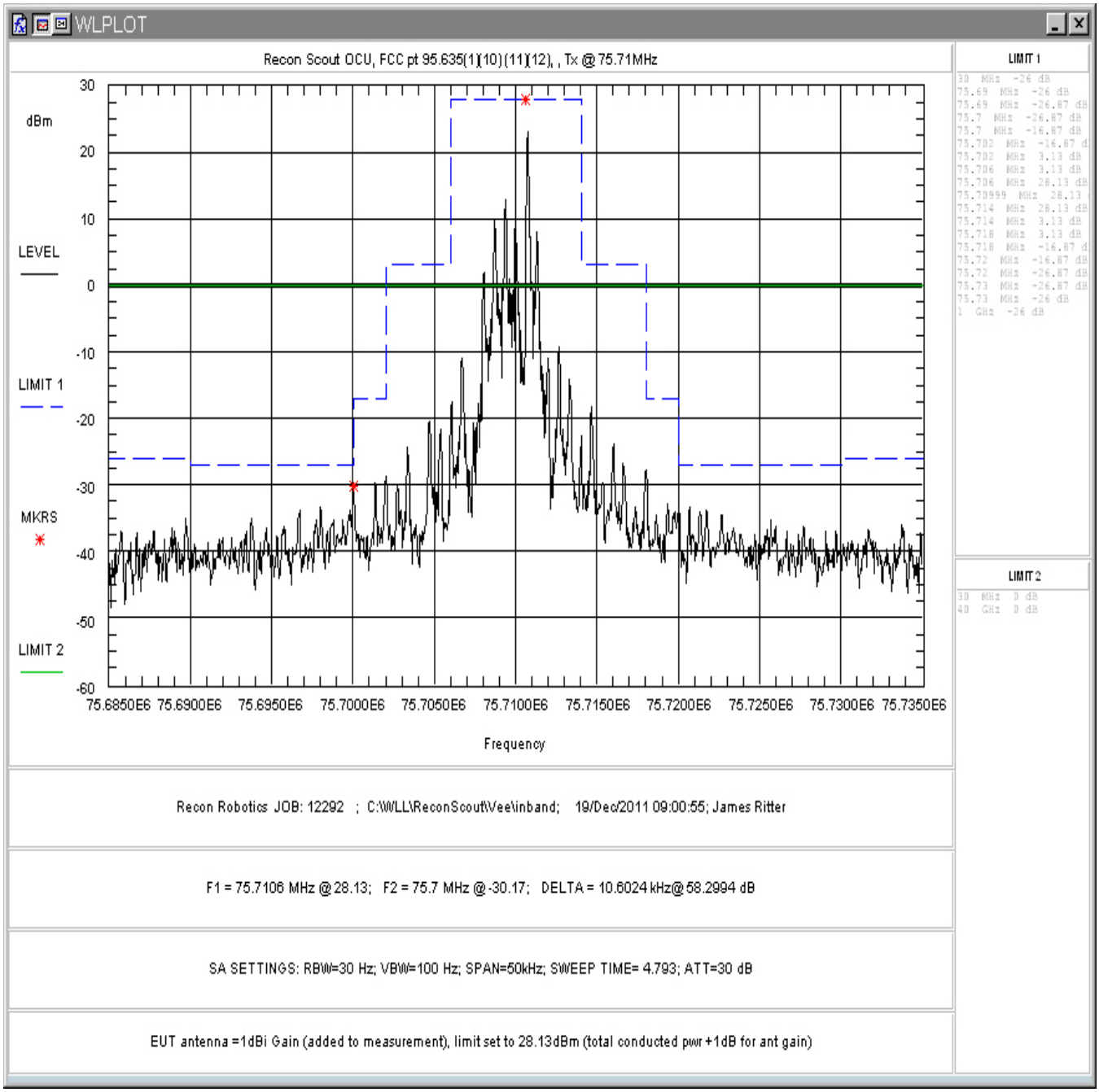

Figure 4: Unwanted Emissions, 75.685 – 75.735MHz

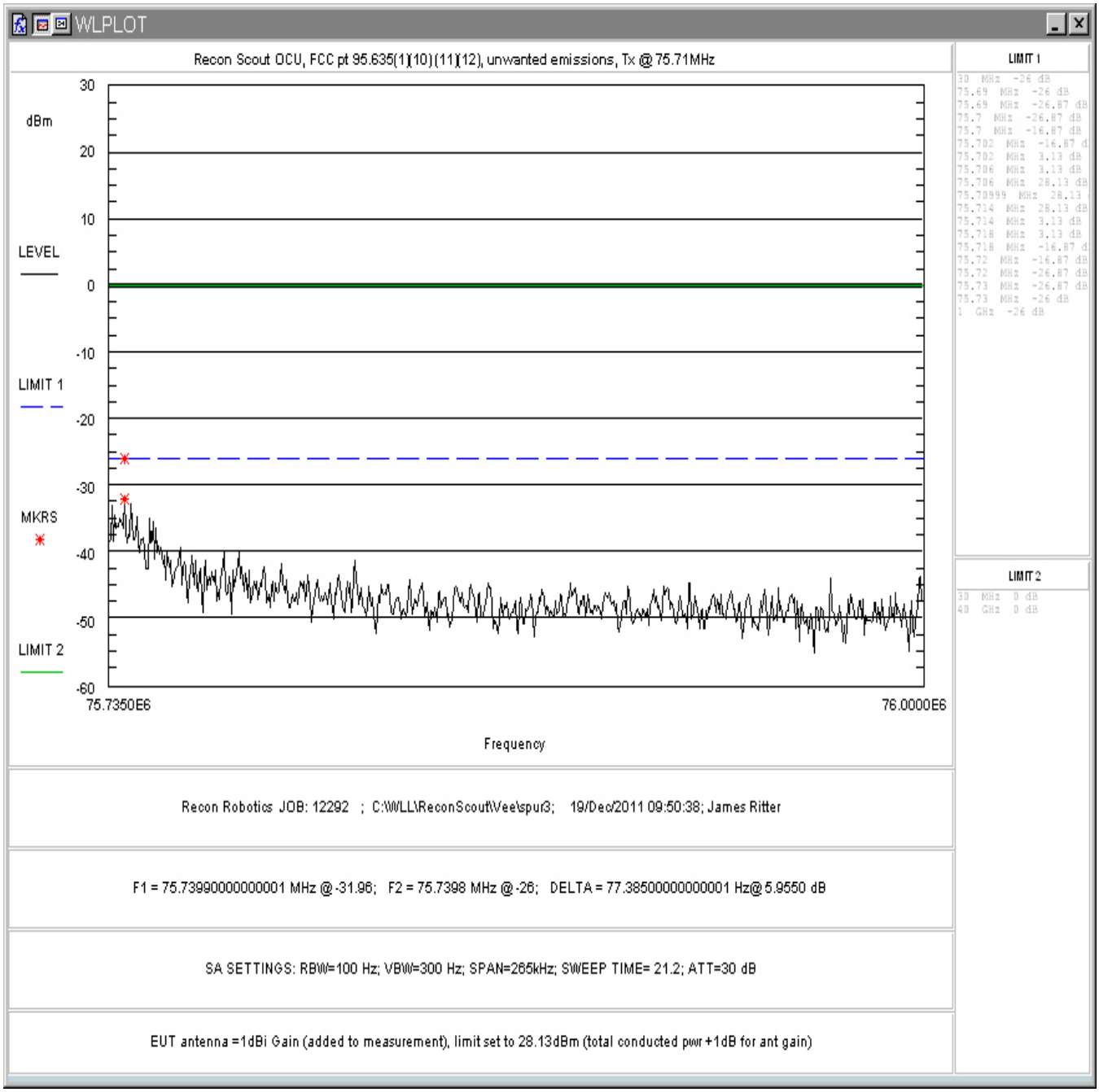

Figure 5: Unwanted Emissions, 75.735 – 76MHz

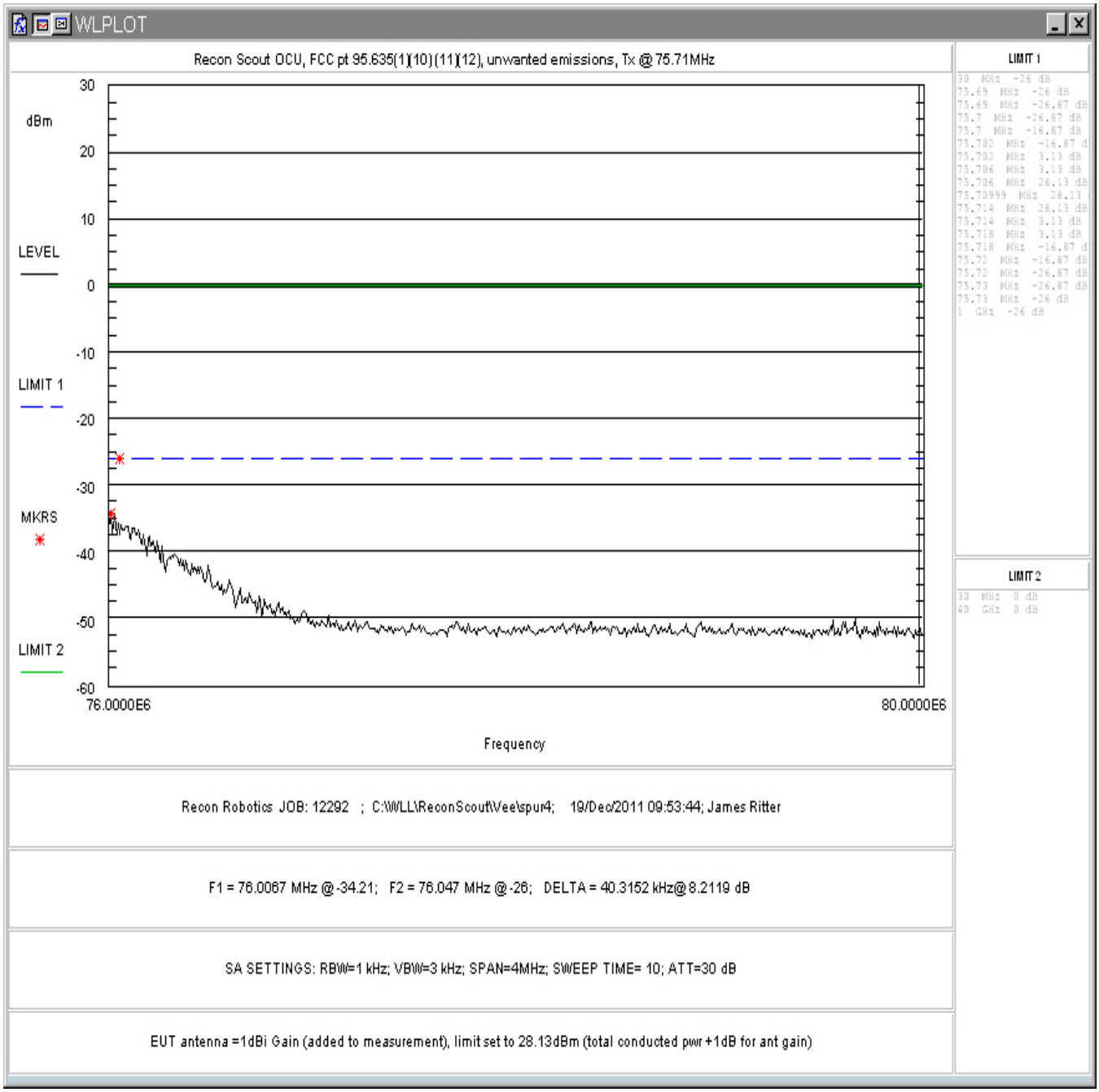

Figure 6: Unwanted Emissions, 76 - 80MHz

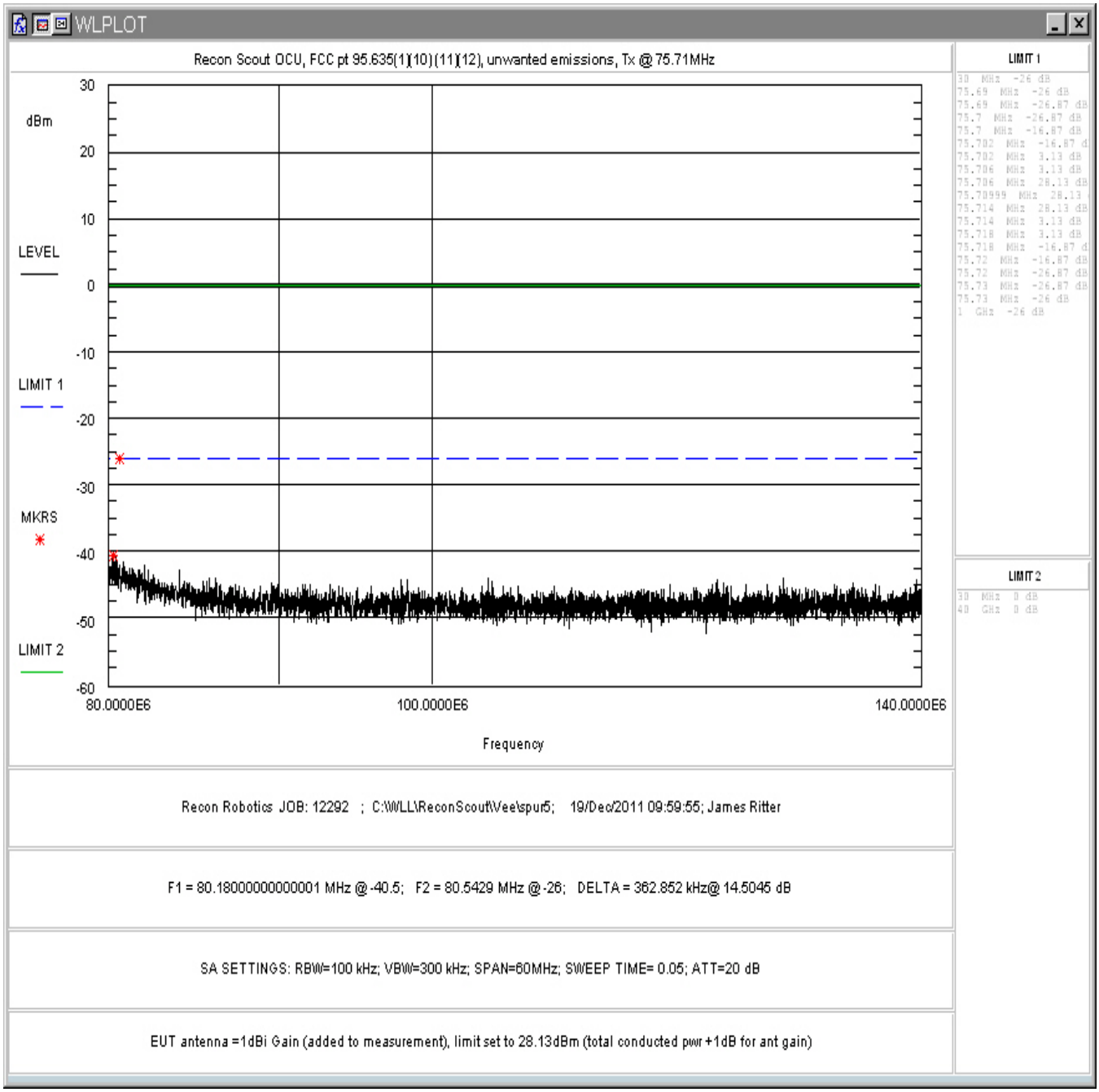

Figure 7: Unwanted Emissions, 80 – 140MHz

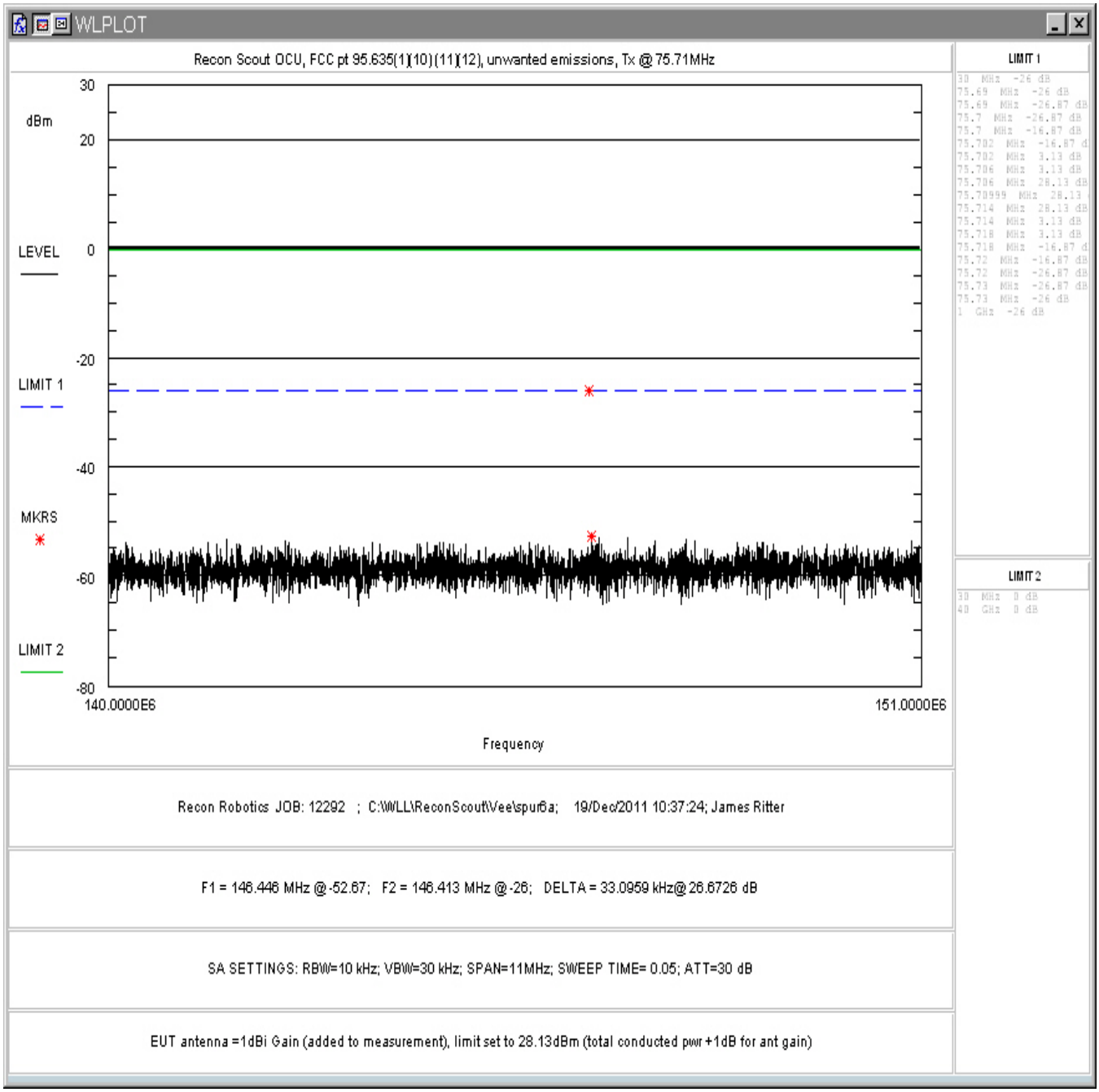

Figure 8: Unwanted Emissions, 140 – 151MHz

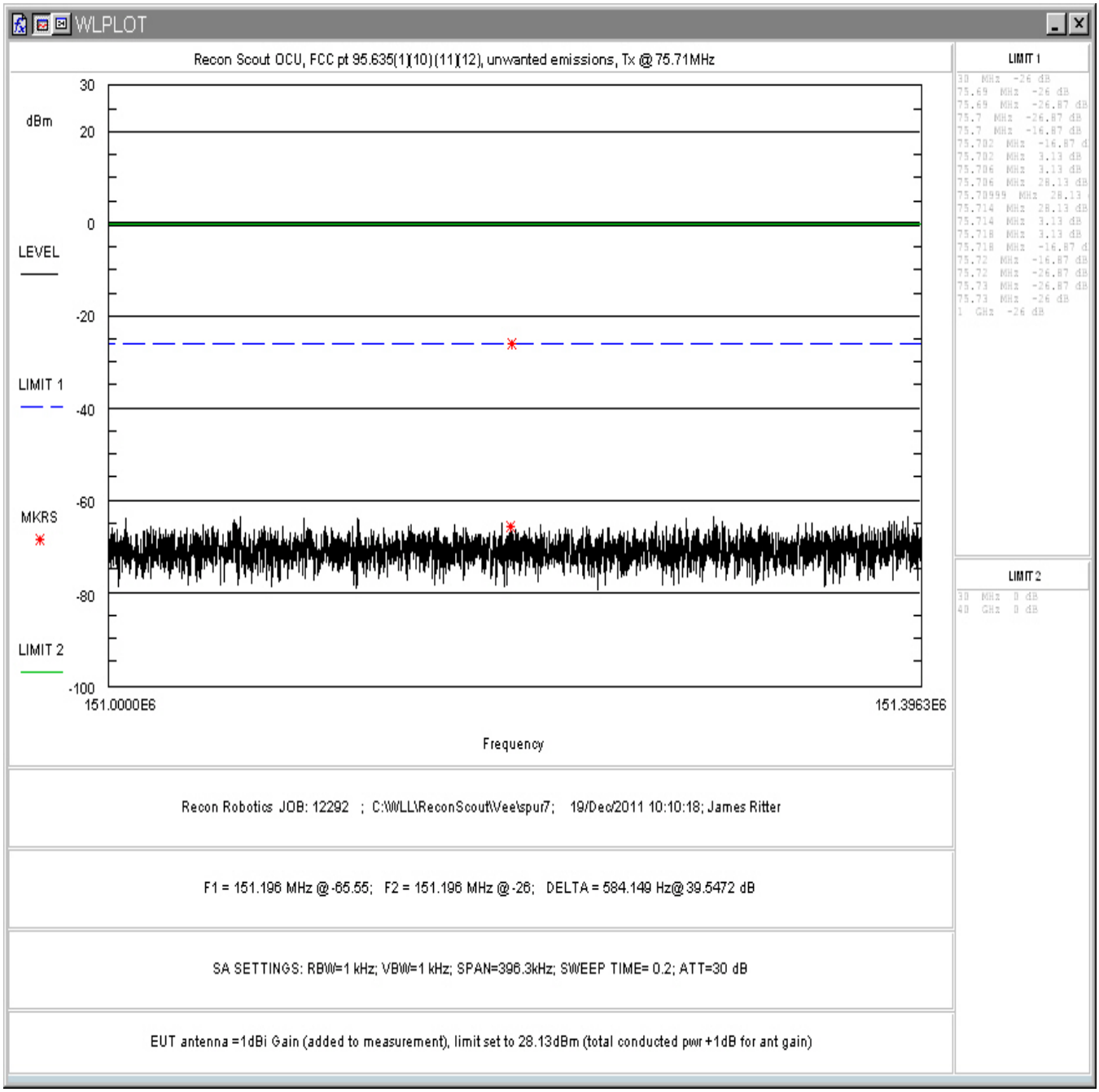

Figure 9: Unwanted Emissions, 151 – 151.3963MHz

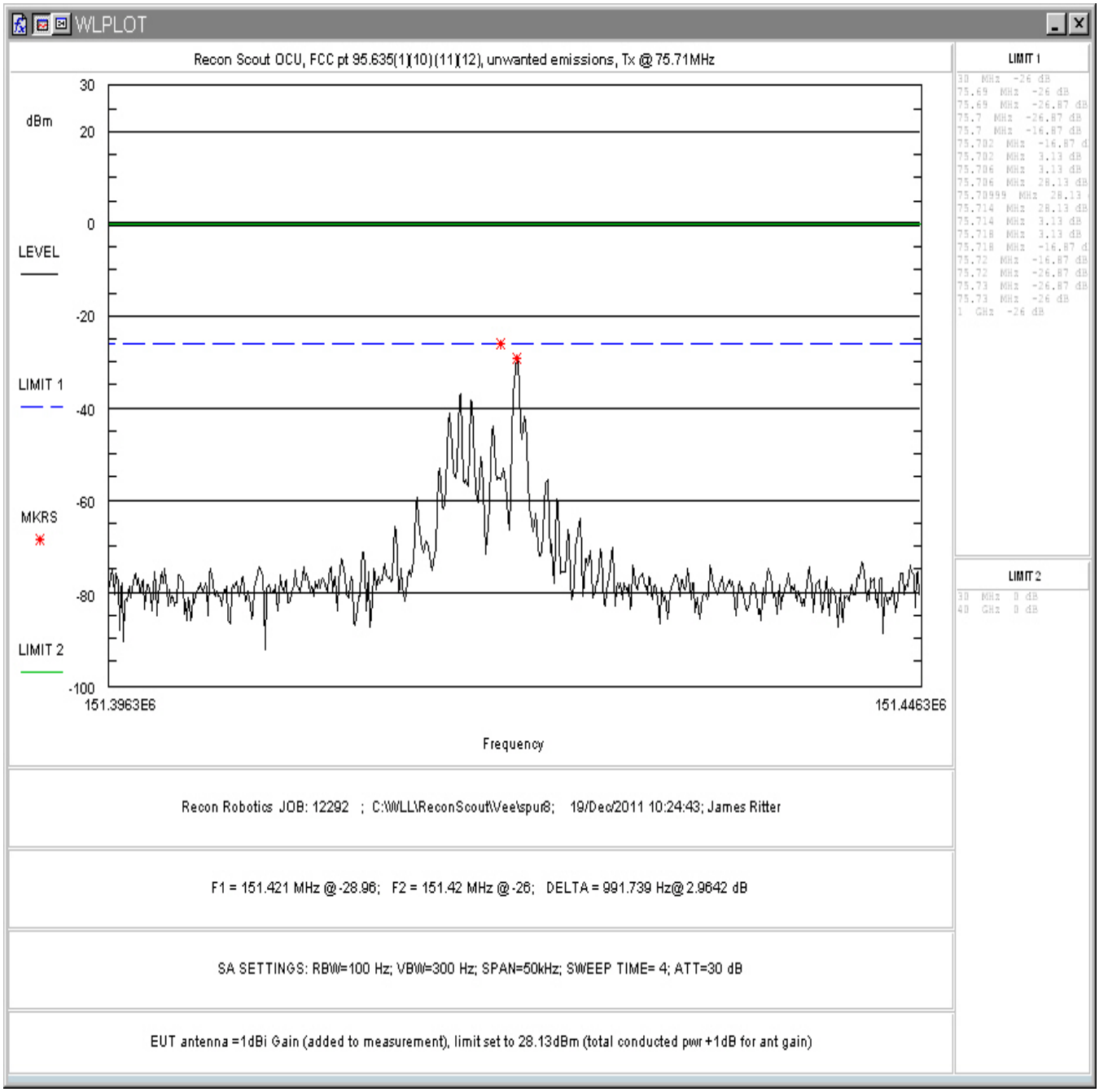

Figure 10: Unwanted Emissions, 151.3963 – 151.4463MHz

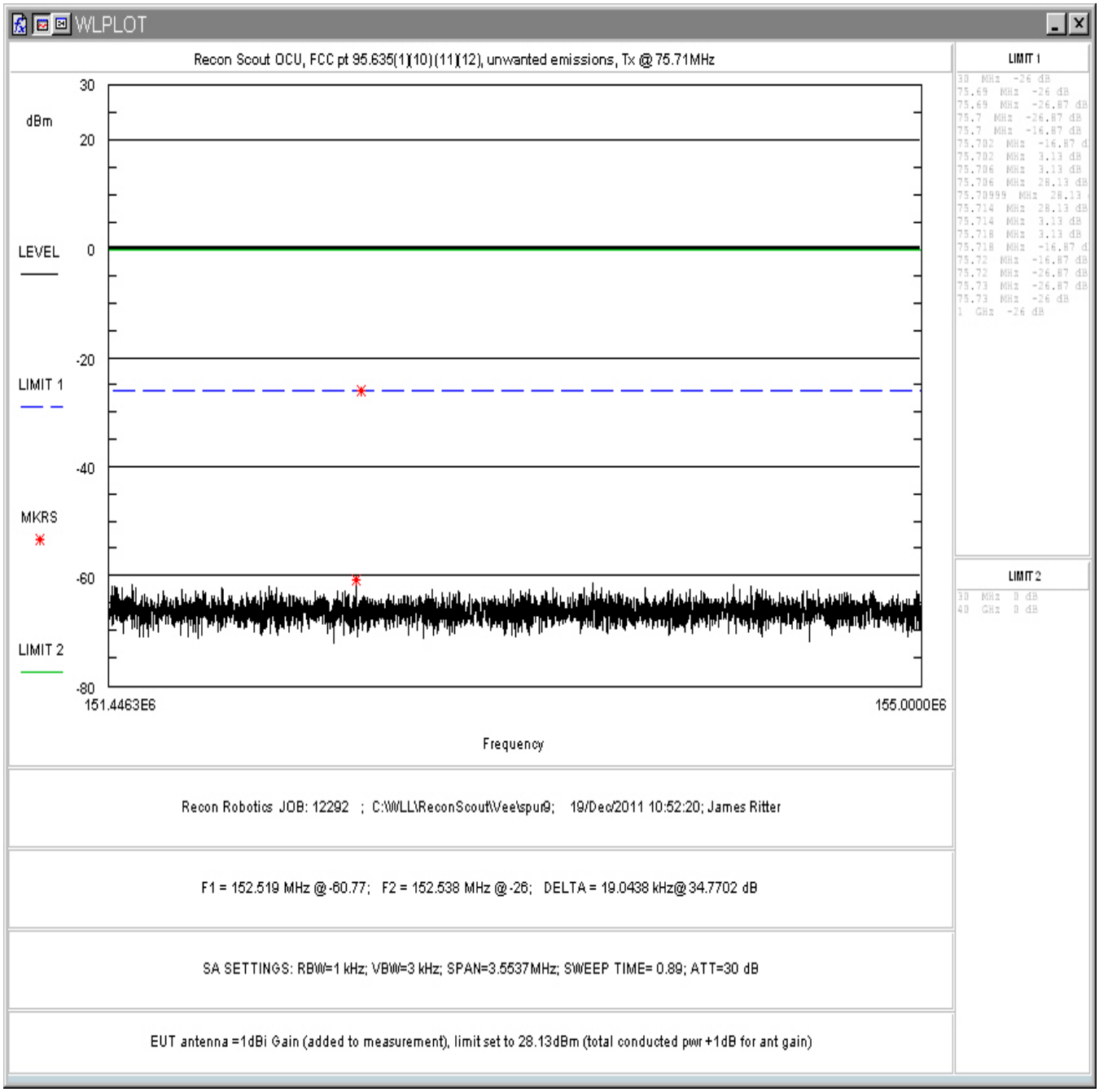

Figure 11: Unwanted Emissions, 151.4463 – 155MHz

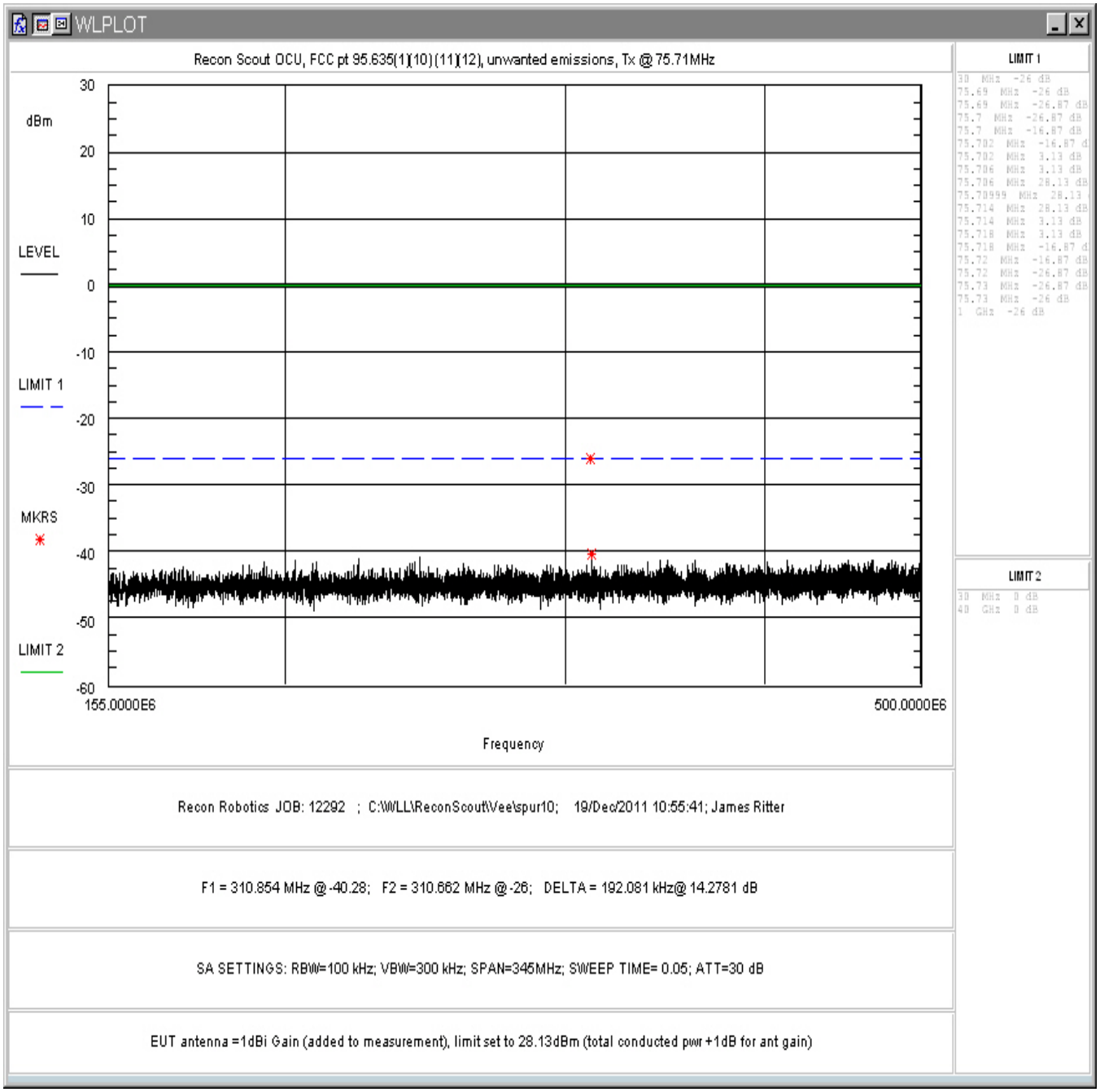

Figure 12: Unwanted Emissions, 155 – 500MHz

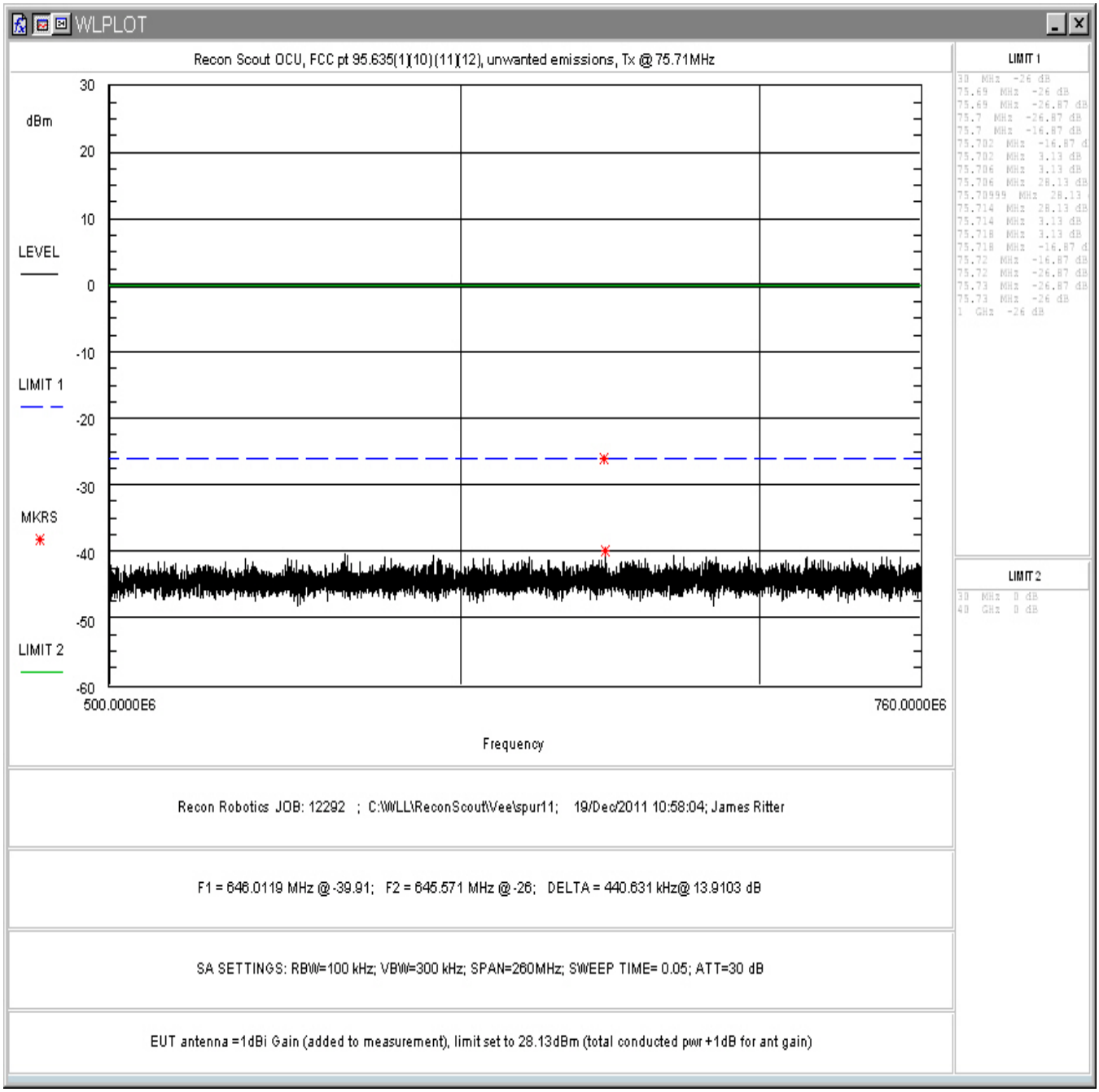

Figure 13: Unwanted Emissions, 500-760MHz

Table 6: Unwanted Emissions, Radiated emissions, Unit Upright

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	ERP Level (dBm)	ERP Limit (dBm)	Margin (dB)
Harmonics												
151.42	V	90.0	1.0	34.4	-45.5	-49.3	8.8	5.0	-44.2	-46.4	-26	-20.4
227.13	V	270.0	1.0	33.7	-48.5	-53.0	12.5	4.9	-48.2	-50.3	-26	-24.3
302.84	V	270.0	1.1	12.1	-69.8	-75.0	13.8	6.0	-69.0	-71.1	-26	-45.1
378.55	V	45.0	1.0	5.3	-71.1	-77.1	15.1	6.7	-70.4	-72.5	-26	-46.5
454.26	V	90.0	1.0	0.9	-73.2	-79.7	15.9	7.5	-72.2	-74.3	-26	-48.3
529.97	V	45.0	1.0	-0.2	-75.0	-82.0	17.7	7.0	-75.0	-77.2	-26	-51.2
605.68	V	45.0	1.0	0.4	-74.8	-82.4	18.4	7.4	-75.0	-77.1	-26	-51.1
681.39	V	0.0	2.1	-1.4	-74.7	-82.9	19.0	7.9	-75.0	-77.2	-26	-51.2
757.10	V	0.0	2.3	-1.0	-70.8	-79.3	20.2	7.6	-71.7	-73.8	-26	-47.8
Non Harmonics												
37.82	V	0.0	1.0	21.4	-38.0	-40.0	16.4	-14.6	-54.6	-56.7	-26	-30.7
57.19	V	190.0	1.2	19.3	-59.5	-61.9	11.1	-5.8	-67.7	-69.8	-26	-43.8
146.70	V	45.0	1.2	21.1	-58.3	-62.0	8.4	5.1	-56.9	-59.1	-26	-33.1
417.46	V	10.0	1.3	4.5	-73.4	-79.6	16.5	6.1	-73.5	-75.6	-26	-49.6
Harmonics												
151.42	H	180.0	2.3	35.5	-49.4	-53.2	8.8	5.0	-48.1	-50.3	-26	-24.3
227.13	H	90.0	2.5	15.4	-60.1	-64.6	12.5	4.9	-59.8	-61.9	-26	-35.9
302.84	H	180.0	2.1	2.2	-72.0	-77.2	13.8	6.0	-71.2	-73.3	-26	-47.3
378.55	H	90.0	1.8	1.0	-75.9	-81.9	15.1	6.7	-75.2	-77.3	-26	-51.3
454.26	H	180.0	1.6	-1.2	-79.3	-85.8	15.9	7.5	-78.3	-80.4	-26	-54.4
Non Harmonics												
57.19	H	90.0	2.9	14.2	-62.5	-64.9	11.1	-5.8	-70.7	-72.8	-26	-46.8
146.70	H	270.0	2.6	10.9	-74.3	-78.0	8.4	5.1	-72.9	-75.1	-26	-49.1
417.46	H	90.0	2.2	2.3	-76.6	-82.8	16.5	6.1	-76.7	-78.8	-26	-52.8

Table 7: Unwanted Emissions, Radiated emissions, Unit Flat

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	ERP Level (dBm)	ERP Limit (dBm)	Margin (dB)
Harmonics												
151.42	V	0.0	1.5	25.6	-54.2	-58.0	8.8	5.0	-52.9	-55.1	-26	-29.1
227.13	V	0.0	1.4	11.8	-71.0	-75.5	12.5	4.9	-70.7	-72.8	-26	-46.8
302.84	V	90.0	1.2	7.2	-74.9	-80.1	13.8	6.0	-74.1	-76.2	-26	-50.2
378.55	V	0.0	1.5	0.7	-75.9	-81.9	15.1	6.7	-75.2	-77.3	-26	-51.3
454.26	V	180.0	2.0	1.3	-72.3	-78.8	15.9	7.5	-71.3	-73.4	-26	-47.4
Non Harmonics												
37.82	V	90.0	1.2	4.6	-54.5	-56.5	16.4	-14.6	-71.1	-73.2	-26	-47.2
57.19	V	90.0	1.4	14.9	-64.0	-66.4	11.1	-5.8	-72.2	-74.3	-26	-48.3
146.70	V	90.0	1.2	8.1	-70.5	-74.2	8.4	5.1	-69.1	-71.3	-26	-45.3
417.46	V	350.0	1.2	6.1	-72.1	-78.3	16.5	6.1	-72.2	-74.3	-26	-48.3
Harmonics												
151.42	H	180.0	2.6	35.4	-49.3	-53.1	8.8	5.0	-48.0	-50.2	-26	-24.2
227.13	H	10.0	2.6	25.0	-58.6	-63.1	12.5	4.9	-58.3	-60.4	-26	-34.4
302.84	H	90.0	1.6	14.3	-60.8	-66.0	13.8	6.0	-60.0	-62.1	-26	-36.1
378.55	H	0.0	1.7	2.1	-74.5	-80.5	15.1	6.7	-73.8	-75.9	-26	-49.9
454.26	H	0.0	1.6	1.4	-76.9	-83.4	15.9	7.5	-75.9	-78.0	-26	-52.0
Non Harmonics												
57.19	H	90.0	2.4	14.2	-62.4	-64.8	11.1	-5.8	-70.6	-72.7	-26	-46.7
146.70	H	0.0	1.9	8.9	-76.5	-80.2	8.4	5.1	-75.1	-77.3	-26	-51.3
417.46	H	20.0	1.7	3.5	-76.0	-82.2	16.5	6.1	-76.1	-78.2	-26	-52.2

Table 8: Unwanted Emissions, Radiated emissions, Unit Onside

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	ERP Level (dBm)	ERP Limit (dBm)	Margin (dB)
Harmonics												
151.42	V	90.0	1.2	38.2	-41.9	-45.7	8.8	5.0	-40.6	-42.8	-26	-16.8
227.13	V	270.0	1.3	12.3	-70.1	-74.6	12.5	4.9	-69.8	-71.9	-26	-45.9
302.84	V	0.0	1.6	1.9	-78.8	-84.0	13.8	6.0	-78.0	-80.1	-26	-54.1
378.55	V	0.0	1.6	1.6	-75.1	-81.1	15.1	6.7	-74.4	-76.5	-26	-50.5
454.26	V	90.0	1.4	1.3	-72.4	-78.9	15.9	7.5	-71.4	-73.5	-26	-47.5
Non Harmonics												
37.82	V	270.0	1.0	9.2	-49.9	-51.9	16.4	-14.6	-66.5	-68.6	-26	-42.6
57.19	V	90.0	1.2	14.9	-63.8	-66.2	11.1	-5.8	-72.0	-74.1	-26	-48.1
146.70	V	0.0	1.2	6.4	-72.4	-76.1	8.4	5.1	-71.0	-73.2	-26	-47.2
417.46	V	45.0	1.0	4.7	-73.3	-79.5	16.5	6.1	-73.4	-75.5	-26	-49.5
Harmonics												
151.42	H	0.0	1.9	45.1	-39.8	-43.6	8.8	5.0	-38.5	-40.7	-26	-14.7
227.13	H	10.0	2.7	27.6	-55.9	-60.4	12.5	4.9	-55.6	-57.7	-26	-31.7
302.84	H	0.0	2.4	1.9	-72.9	-78.1	13.8	6.0	-72.1	-74.2	-26	-48.2
378.55	H	0.0	1.9	0.9	-75.5	-81.5	15.1	6.7	-74.8	-76.9	-26	-50.9
454.26	H	0.0	1.5	0.6	-77.5	-84.0	15.9	7.5	-76.5	-78.6	-26	-52.6
Non Harmonics												
57.19	H	90.0	2.0	12.5	-63.8	-66.2	11.1	-5.8	-72.0	-74.1	-26	-48.1
146.70	H	10.0	2.1	4.5	-80.7	-84.4	8.4	5.1	-79.3	-81.5	-26	-55.5
417.46	H	10.0	1.2	1.2	-78.3	-84.5	16.5	6.1	-78.4	-80.5	-26	-54.5

5.4 Frequency Tolerance [FCC Part 95.623(c)]

5.4.1 Test Method

The EUT was placed in a calibrated temperature chamber. A receive antenna was placed in the temperature chamber with the device connected to a frequency counter outside the chamber. The EUT was set to transmit at 75.71MHz with an unmodulated carrier. A frequency reading was taken with the temperature at ambient (26C). The EUT was turned off and the temperature chamber set to -30 Celsius after 1 hour at this temperature the unit was turned on and a frequency reading was taken. The unit was turned back off and the temperature changed to -20 C. This process was repeated in 10 degree increments up to 50 Degrees Celsius allowing the unit to stabilize for 1 hour at each level before turning on the unit and recording the frequency. At each level the frequency recorded was compared to the ambient reading with the amount of deviation in Hz compared to the part 95 limit.

5.4.2 Test Limit

Part 95.623(c) states that R/C devices marketed after 1993 must have a frequency tolerance of at least 0.002%.

5.4.3 Test Results

The test results are show in Table 9 and Table 10.

5.4.4 Test Summary

The EUT complied with the requirements of Part 95.623(c).

Table 9: Frequency Tolerance vs. Temperature

Temperature (Centigrade)	Frequency (MHz)	Deviation (Hz)	Limit@ .002% (+/- Hz)	Pass/Fail
26 (ambient)	75.710186	0	1514	NA
-30	75.710226	40	1514	Pass
-20	75.710233	47	1514	Pass
-10	75.710227	41	1514	Pass
0	75.710216	30	1514	Pass
10	75.710208	22	1514	Pass
20	75.710202	16	1514	Pass
30	75.710182	-4	1514	Pass
40	75.710163	-23	1514	Pass
50	75.710155	-31	1514	Pass

Table 10: Frequency Tolerance vs. Battery Voltage

Battery Voltage (Volts)	Frequency (MHz)	Deviation (Hz)	Limit@ .002% (+/- Hz)	Pass/Fail
12.6 (Full Battery)	75.710208	0	1514	NA
10.3 (Low End Point)	75.710205	3	1514	Pass

5.5 Modulation Characteristics [FCC Part 2.1047, 95.637]

5.5.1 Test Method

As part 95.637 'Modulation Standards' has no requirements for an R/C device plots are provided below of the modulating signal for reference only.

5.5.2 Test Limit

None

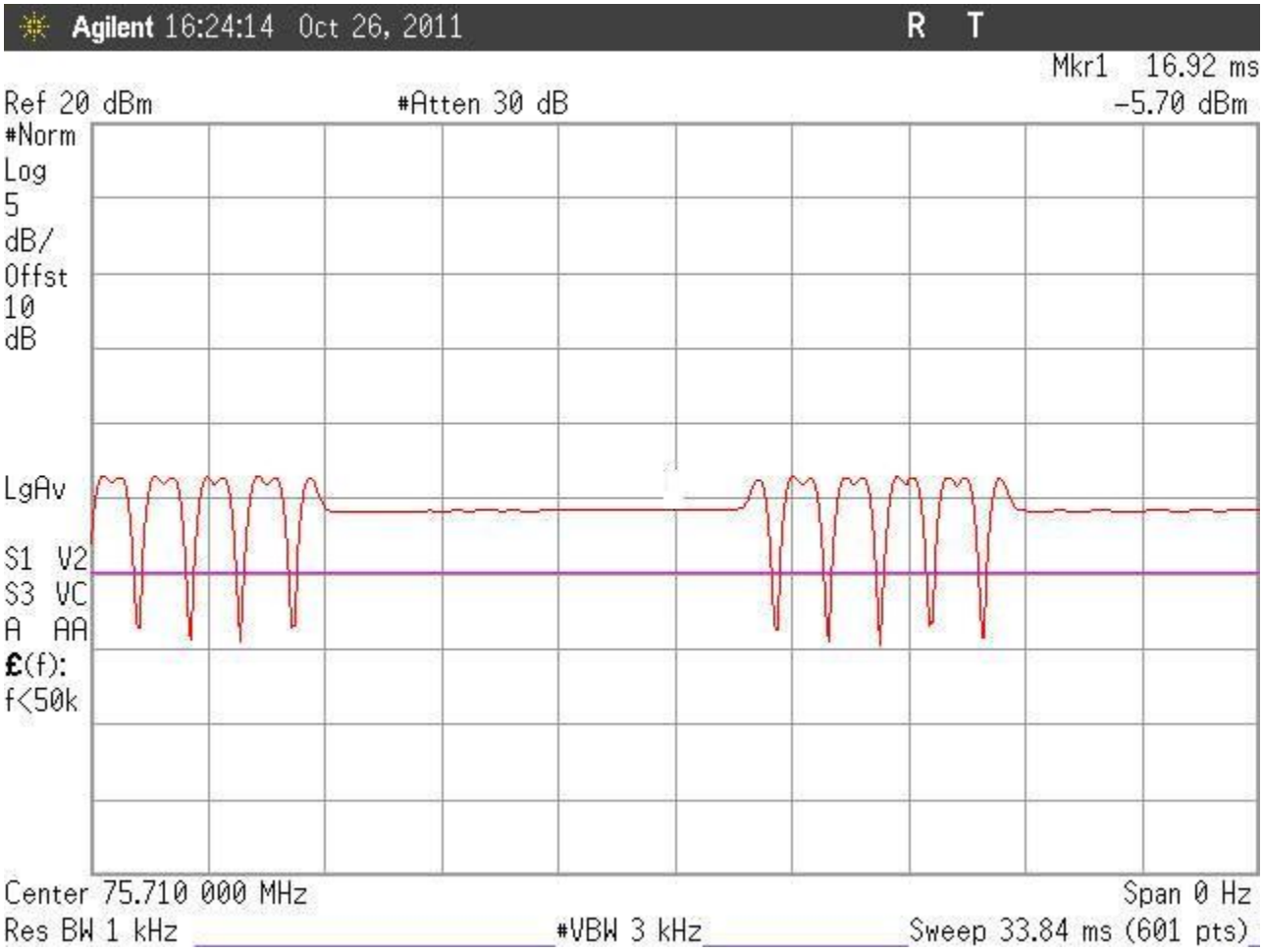

Figure 14: Modulating Signal Center Joystick Position

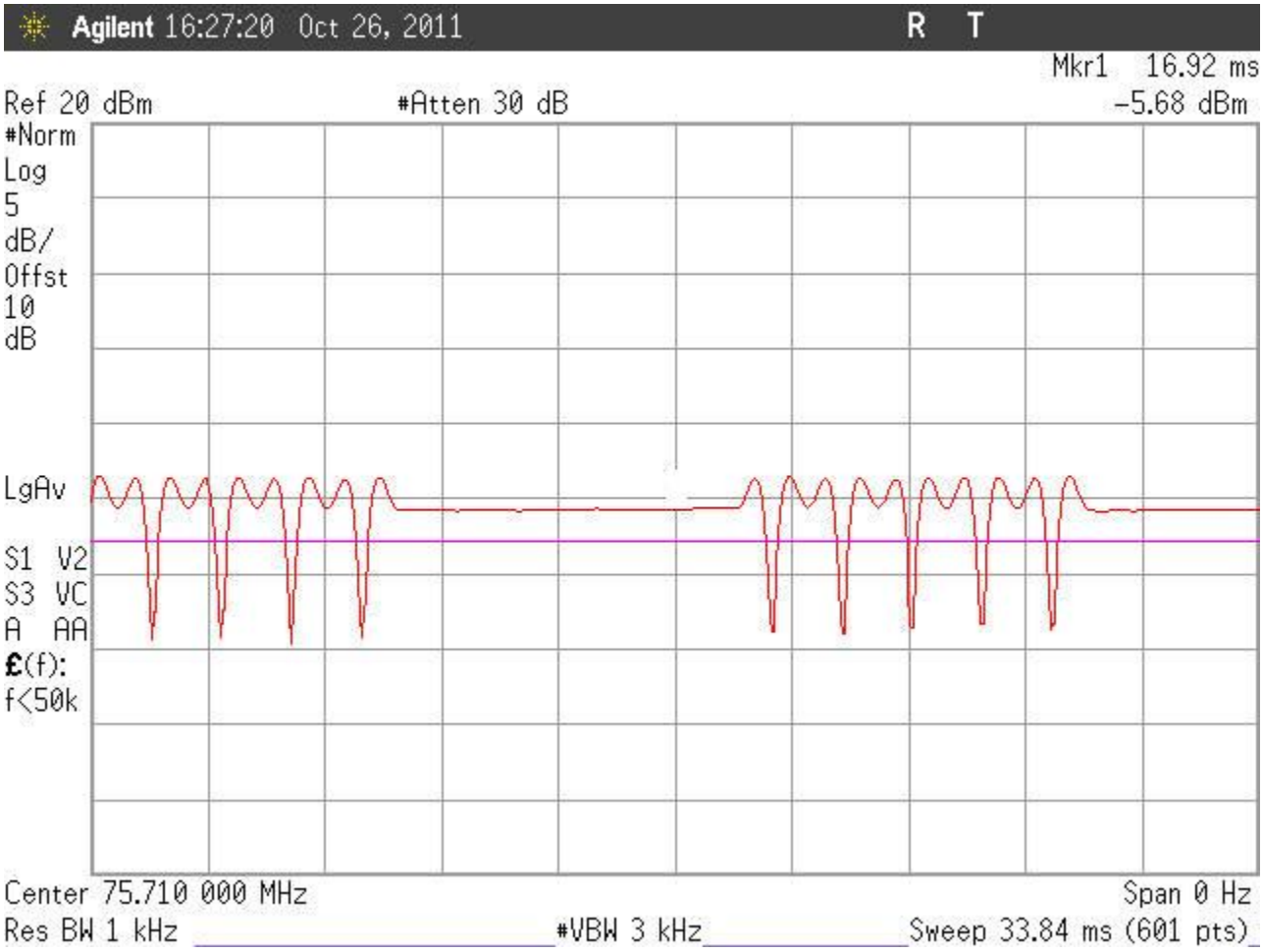

Figure 15: Modulating Signal Joystick Down

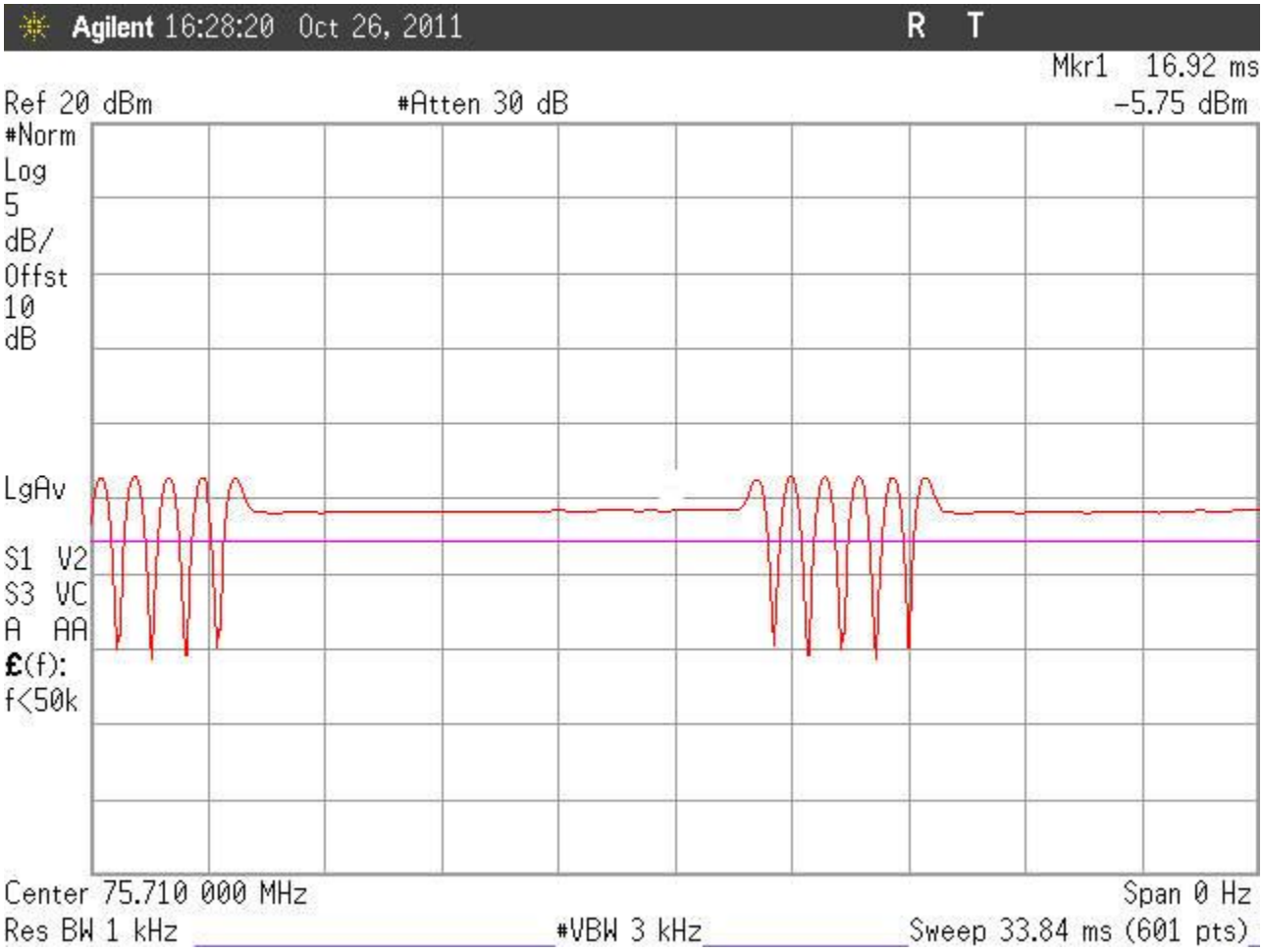

Figure 16: Modulating Signal Joystick Up

Figure 17: Modulating Signal Joystick Left

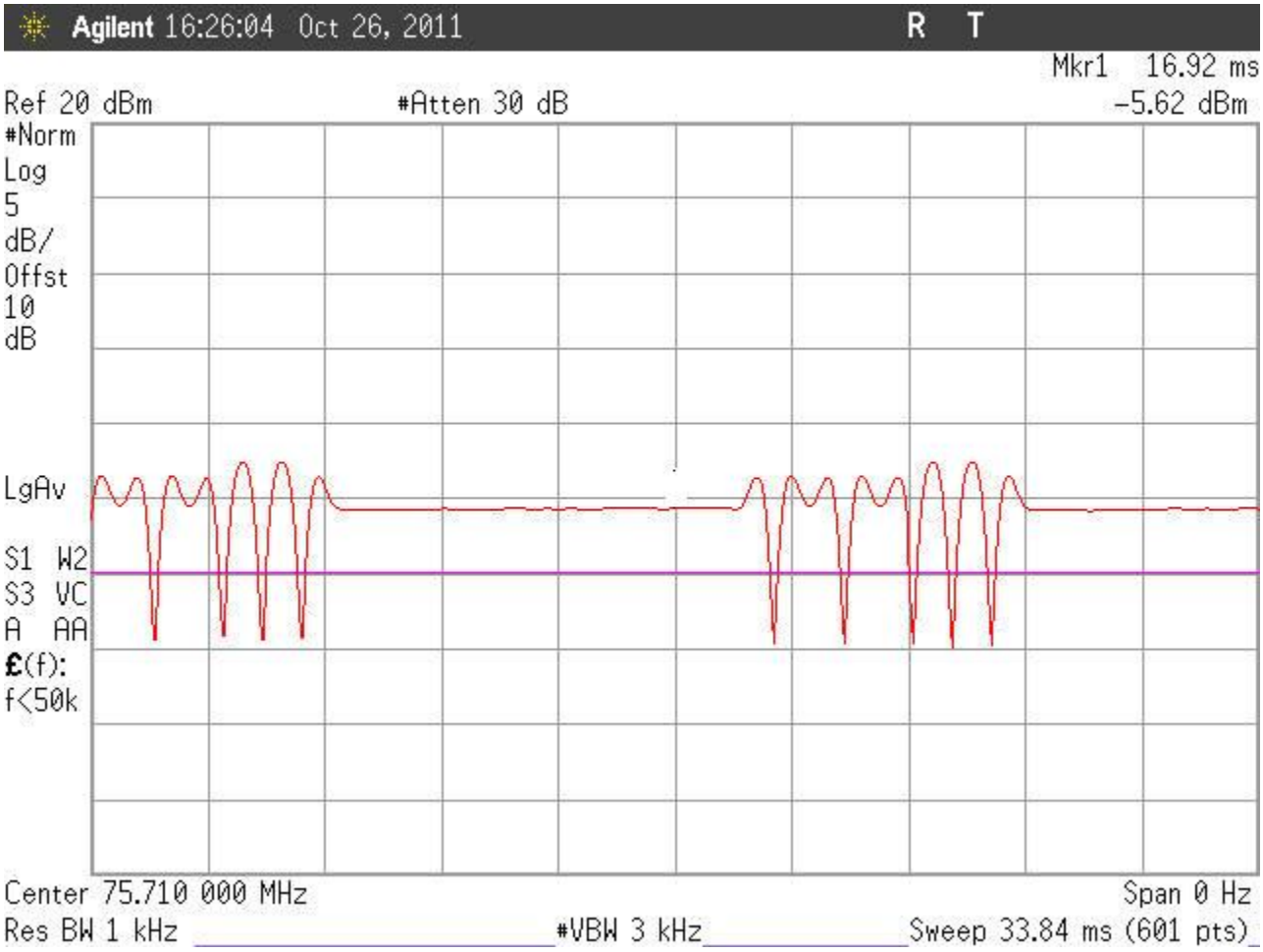

Figure 18: Modulating Signal Joystick Right

5.6 Voltage and Current of Final Power Amplifier (FCC Part 2)

The voltage and current present at the transmitter final RF power amplifier is as follows:

E= 3.0 Vdc
I= 720 ma.

