Washington Laboratories, Ltd.

FCC & Industry Canada Certification Test Report
For the
Control Chief Corporation
Train Chief II Lightweight OCU

CBF-LTOCU-M
1339-R222991

WLL JOB# **8896-9023**
January 30, 2006

Prepared for:

Control Chief Corporation
200 Williams Street
Bradford, PA 16701

Prepared By:

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Documentation Specialist

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Chief EMC Engineer

Abstract

This report has been prepared on behalf of Control Chief Corporation to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Transmitter under Part 90 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-119 of Industry Canada. This Certification Test Report documents the test configuration and test results for a Control Chief Corporation Train Chief II Lightweight OCU.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Control Chief Corporation Train Chief II Lightweight OCU complies with the limits for a Licensed Transmitter device under FCC Part 90 and Industry Canada RSS-119.

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1 Introduction

1.1 Compliance Statement

The Control Chief Corporation Train Chief II Lightweight OCU complies with the limits for a Licensed Transmitter device under FCC Part 90 and Industry Canada RSS-119.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with ANSI TIA-603-B. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Control Chief Corporation 200 Williams Street Bradford, PA 16701
Purchase Order Number:	56113
Quotation Number:	62290-A

1.4 Test Dates

Testing was performed on the following date(s):	September 14, 2005 - December 22, 2005

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Greg Snyder
Client Representative	Rob Reese

2 Equipment Under Test

2.1 EUT Identification & Description

The Control Chief Corporation Train Chief II Lightweight OCU is part of the Train Chief® II LRCS permanently installed control system; directly interfaced to the appropriate locomotive electrical and pneumatic controls. The system consists of the following main components: (1) the receiver/controller unit and, (2) the wireless remote-control radio Operator Control Unit (OCU).

Table 1. Device Summary

ITEM	DESCRIPTION
Manufacturer:	Control Chief Corporation
FCC ID:	CBF-LTOCU-M
IC:	1339-R222991
Model:	Train Chief II Lightweight OCU
FCC Rule Parts:	§90.210
Industry Canada:	RSS-119
Frequency Range:	450 – 470MHz
Number of channels:	7
Maximum Output Power:	422mW (26.25dBm)
Modulation:	FSK
Occupied Bandwidth:	4.955kHz
Keying:	Manual
Type of Information:	Control
Power Output Level	Fixed
Antenna Type	Internal ¼ wave whip antenna
Frequency Tolerance:	2.5ppm
Emission Type(s):	F1D
Interface Cables:	None
Power Source & Voltage:	7.4vdc from battery

2.2 Test Configuration

The Train Chief II Lightweight OCU was tested in a stand-alone configuration. The internal antenna was replaced with a connector for conducted tests performed at the antenna terminal.

2.3 Testing Algorithm

The Train Chief II Lightweight OCU was setup to continuously transmit at the selected frequency with and without the unit modulated. The operation of the radio was controlled via an infrared controller attached to a PC running a diagnostic program provided by Control Chief.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and

Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603-93)

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. For the purposes of the measurements performed by Washington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2}/(n-1)$$

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

WLL Asset #	Manufacturer Model/Type	Function	Cal. Due
0072	HP 8568B	SPECTRUM ANALYZER	7/5/2006
0382	SUNOL JB1	BICONILOG ANTENNA	1/6/2006
0070	HP 85685A	RF PRESELECTOR	7/25/2006
0004	ARA DRG118/A	MICROWAVE HORN ANTENNA	2/17/2006
0034	EMCO BIA-30	BICON ANTENNA 30 – 200MHz	6/14/2006
0029	EMCO 3146A	LOG ANTENNA 200 -1000MHz	6/28/2006
0001	A.H. SYSTEMS SAS-200/518	LOG ANTENNA 1 -18GHz	3/11/2006
0066	HEWLETT-PACKARD 8449B	MICROWAVE PREAMP	6/14/2006
0068	HEWLETT-PACKARD 85650A	QUASI-PEAK ADAPTER	6/30/2006
0159	HEWLETT-PACKARD 8648A	SIGNAL GENERATOR	8/12/2006
0257	HEWLETT-PACKARD 8672A	SIGNAL GENERATOR	3/04/2006
NA	HEWLETT-PACKARD 8563A	SPECTRUM ANALYZER	4/27/2006
0117	RACAL DANA	FREQUENCY COUNTER	5/16/2006
0473	FLUKE, 111	MULTIMETER W/CURRENT CLAMP	5/14/2006
0361	GLOBAL SPECIALTIES, 1337	SUPPLY, POWER, DC	CNR
0254	TENNEY, TR64	ENVIRONMENTAL CHAMBER	10/6/2006

4 Test Results

4.1 RF Power Output: (FCC Part §2.1046 and Industry Canada RSS-119)

The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system. The EUT was setup to transmit an un-modulated signal.

Table 3. RF Power Output

Frequency	Level dBm	Level Watts
Mid Channel 460MHz	26.25	0.422

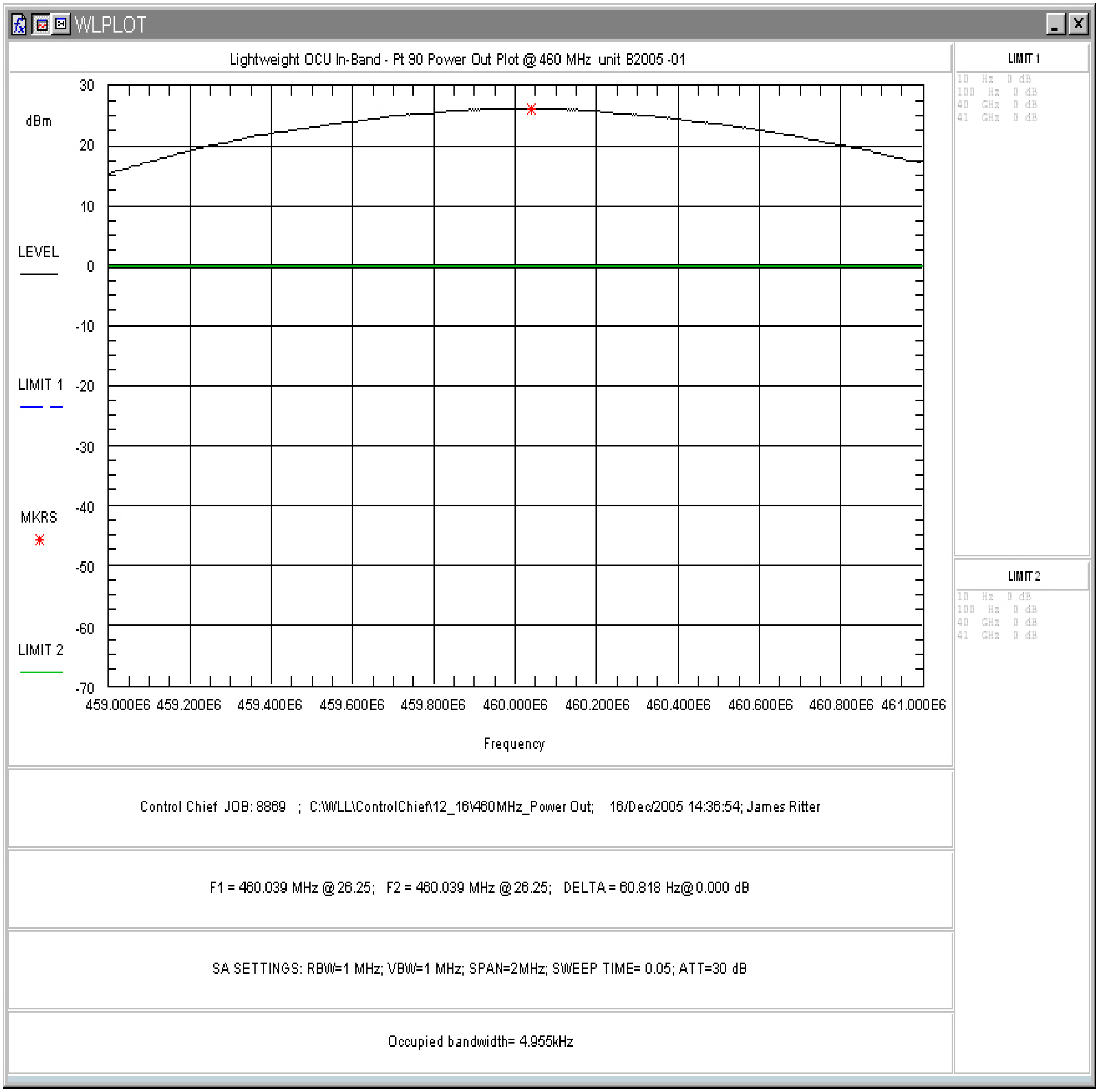

Figure 4-1. RF Peak Power, 460MHz

4.2 Occupied Bandwidth: (FCC Part §2.1049 and Industry Canada RSS-119, 6.7)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer via a direct connection through an attenuator.

At the maximum data rate of 2400bps, provided internally via the Lightweight OCU, the occupied bandwidth was measured as shown in Figure 4-2. A Boonton Modulation analyzer was then connected to the output and the FM deviation was measured at 2.02kHz. Calculations of the necessary bandwidth follow the bandwidth plot. Table 4 provides a summary of the Occupied Bandwidth Results.

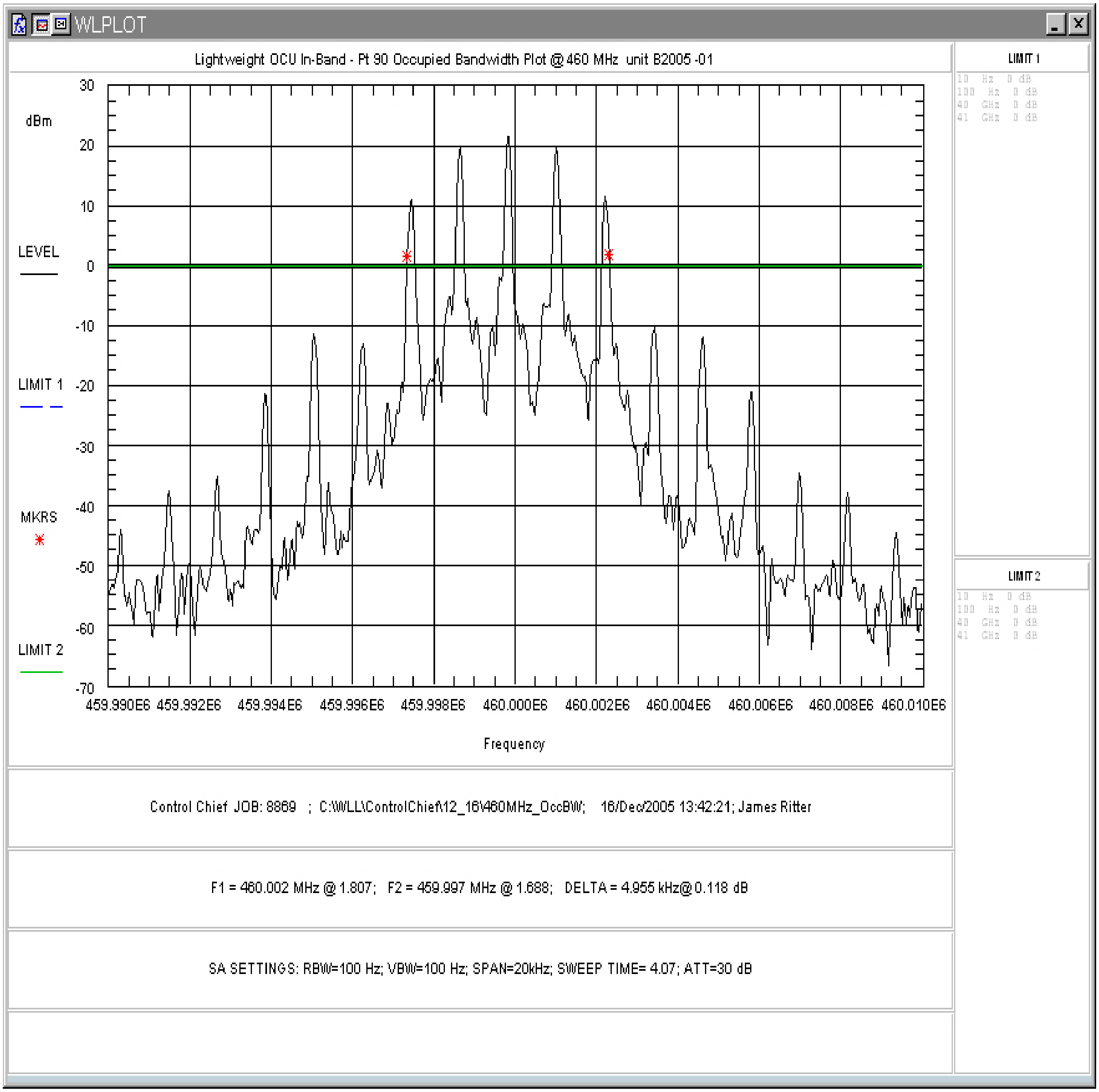

Figure 4-2. Occupied Bandwidth

Table 4. Occupied Bandwidth Results

Frequency	Bandwidth
Mid Channel: 460MHz	4.955kHz

The necessary bandwidth is then calculated as follows:

Bn = 2M + 2DK (K = 1.2)

2(2400) + 2(2020)(1.2) = 9.648kHz

The emission designator is then determined to be:

9K65F1D

4.3 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051 and Industry Canada RSS-119)

The EUT must comply with requirements for spurious emissions at antenna terminals per the limit specified in §90.210(d) and IC RSS-119 Section 6.4(d). The following specifies the limit for Emissions Mask D:

Emission Mask D: For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(f_d−2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spurious emissions and the emissions mask (in-band) emissions were then measured and recorded.

The following are plots of the conducted spurious emissions data.

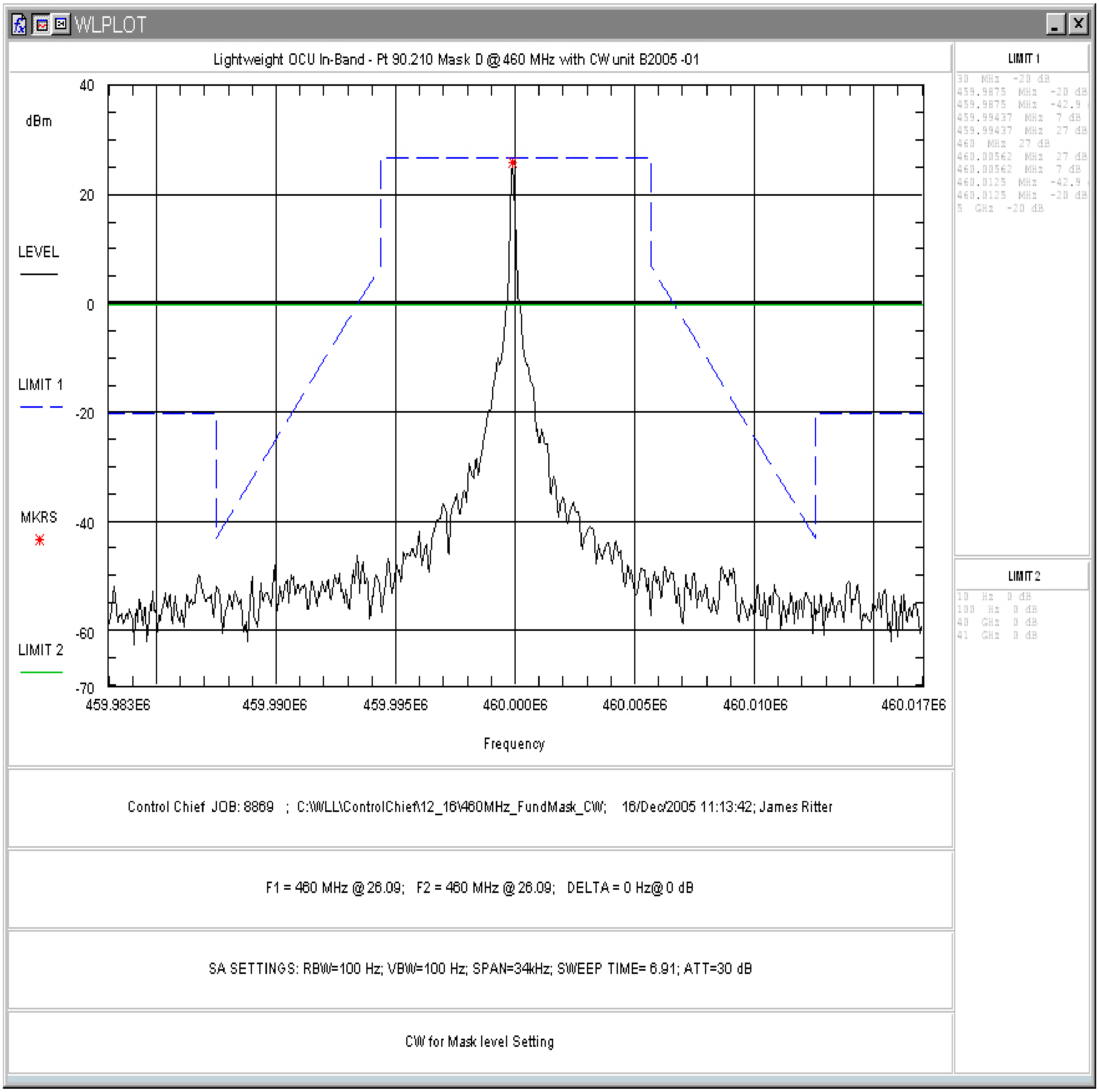

Figure 4-3. Emission Mask, CW Signal

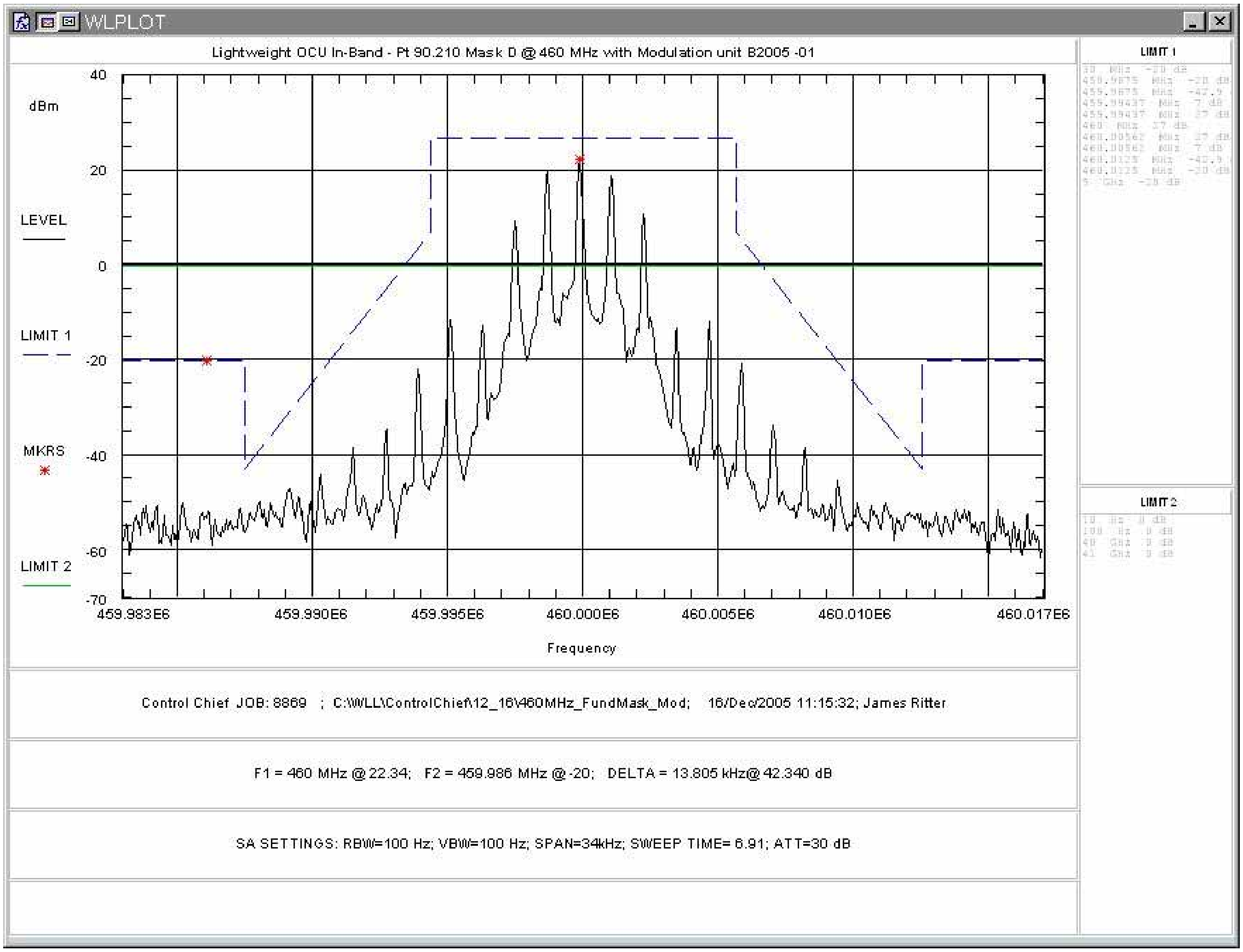

Figure 4-4. Emissions Mask, Mid Channel 460MHz, Modulated Signal

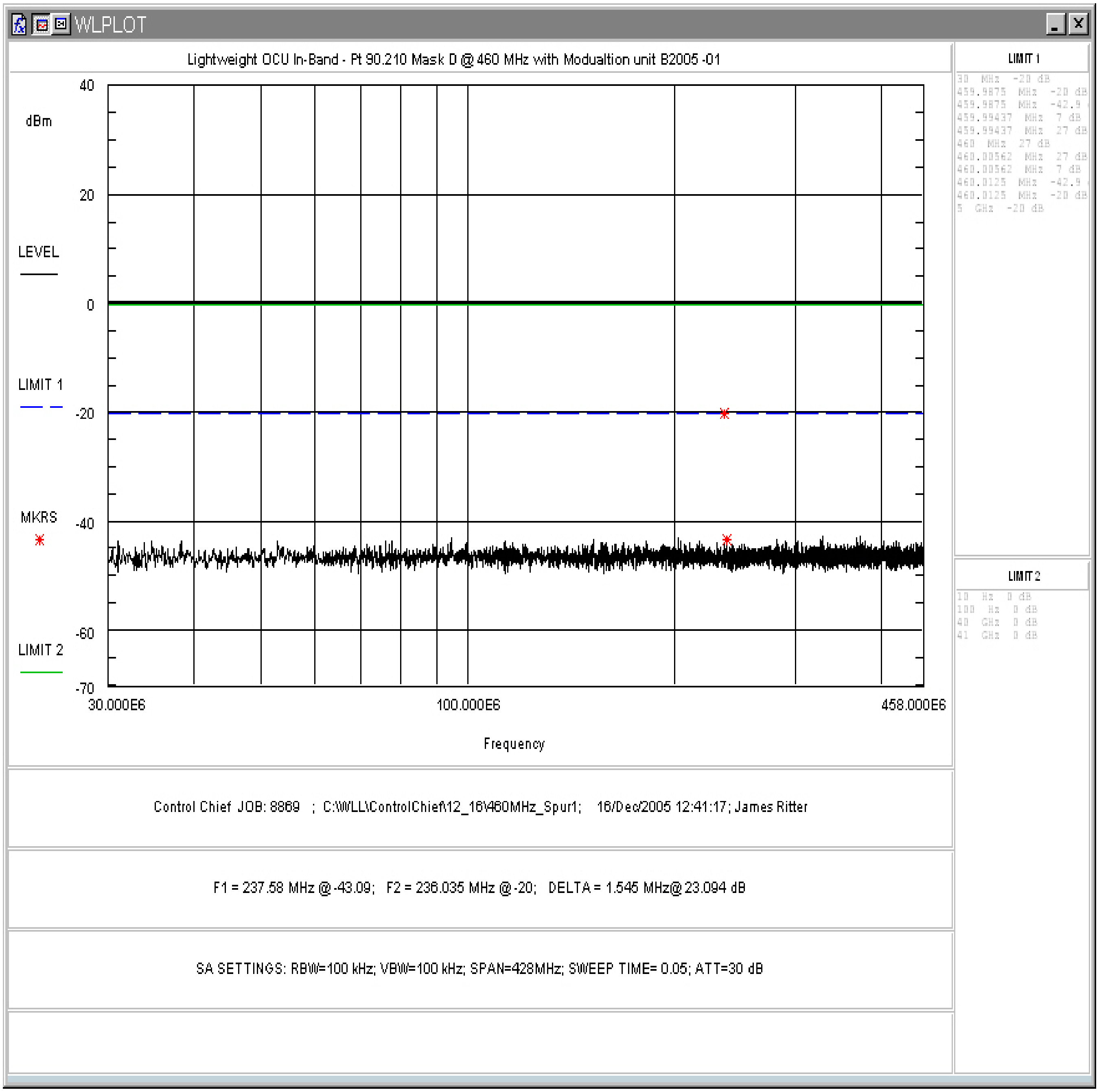

Figure 4-5. Conducted Spurious Emissions, Mid Channel 460MHz, 30M - 458MHz

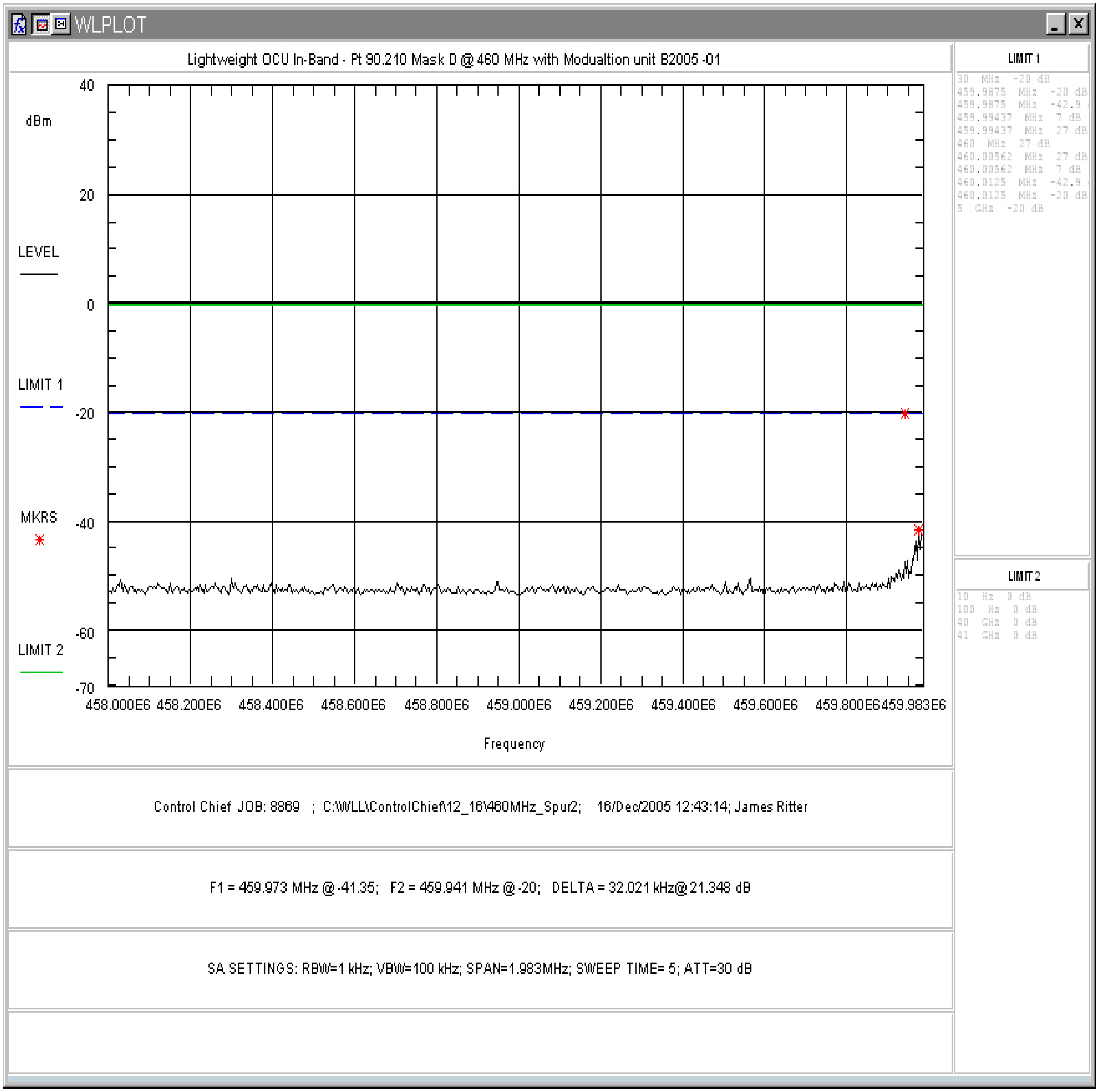

Figure 4-6. Conducted Spurious Emissions, Mid Channel, 458 – 459.98MHz

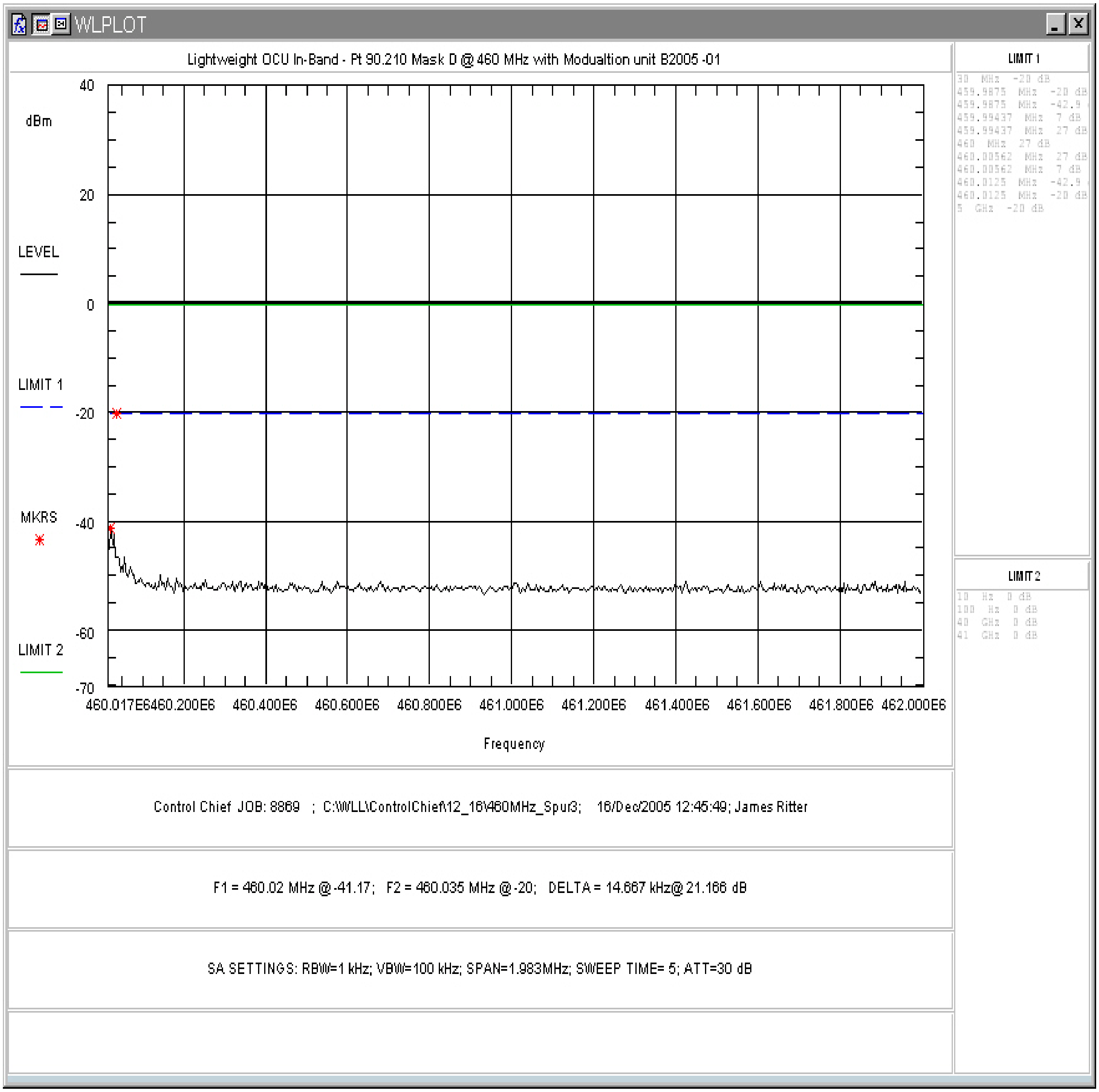

Figure 4-7. Conducted Spurious Emissions, Mid Channel, 460 – 462MHz

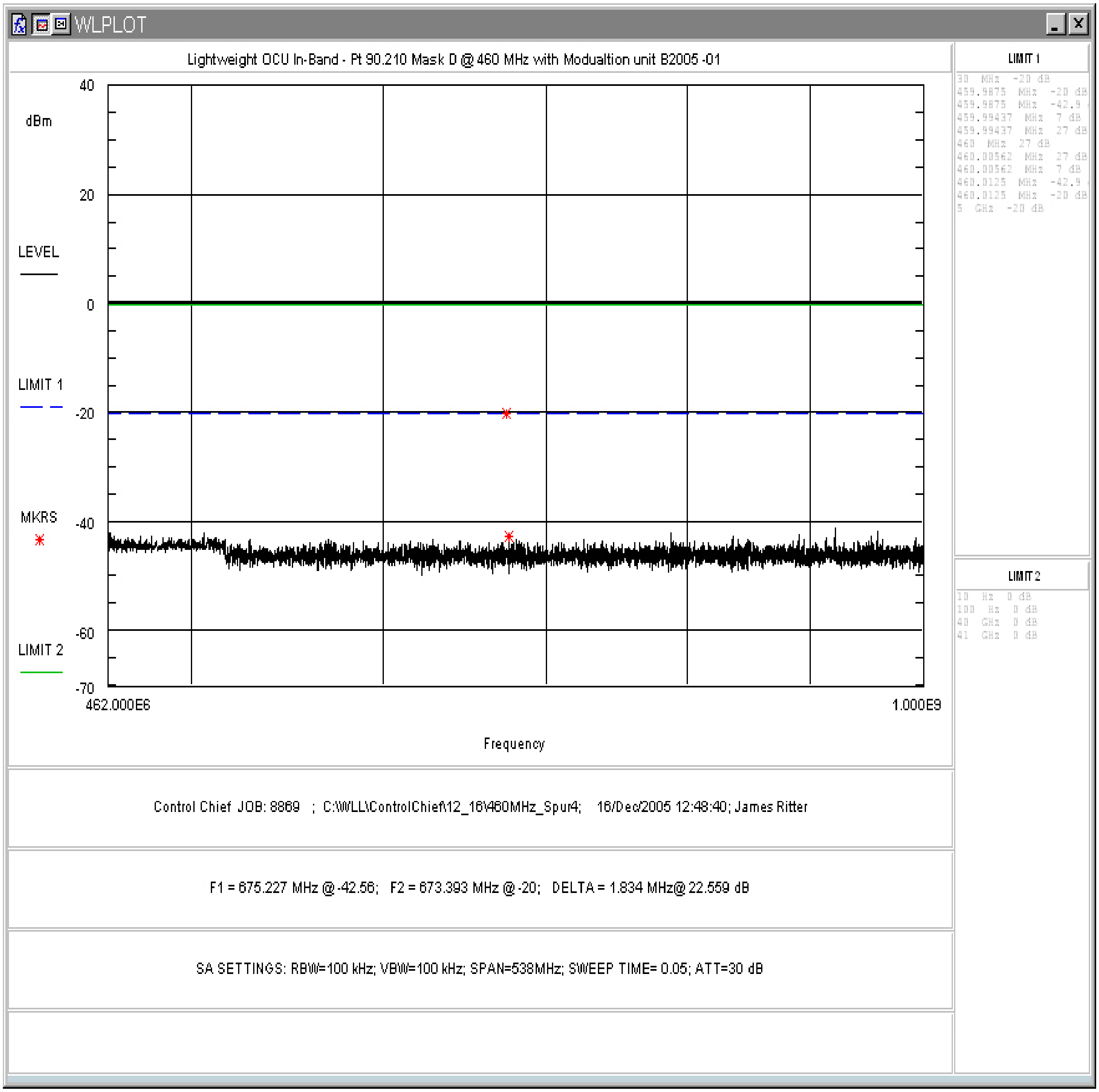

Figure 4-8. Conducted Spurious Emissions, Mid Channel, 462 – 1000MHz

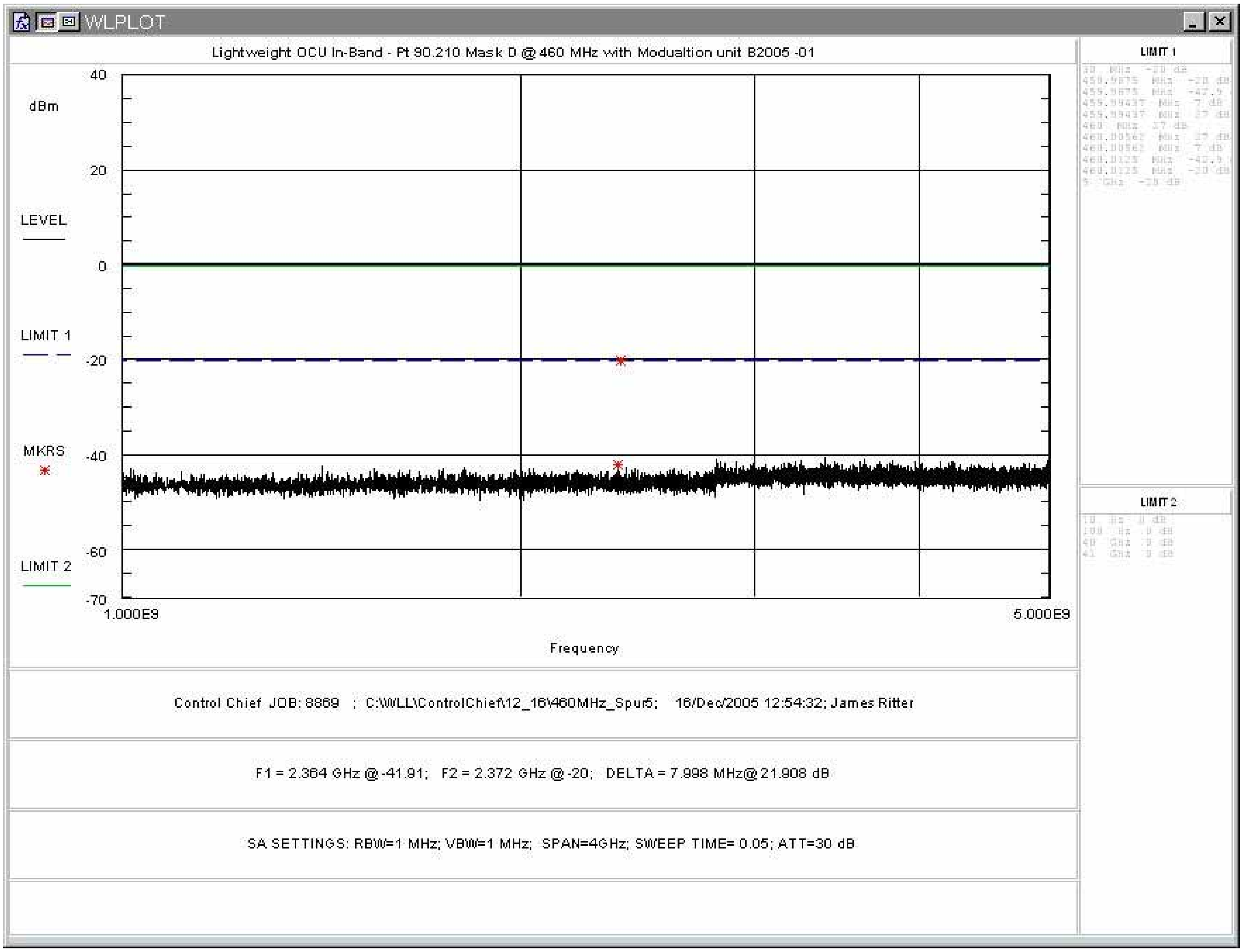

Figure 4-9. Conducted Spurious Emissions, Mid Channel, 1 - 5GHz

4.4 Radiated Spurious Emissions: (FCC Part §2.1053 and Industry Canada RSS-119)

The EUT must comply with requirements for radiated spurious emissions emanating from the case.

4.4.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The output of the transmitter was terminated into a 50ohm load. 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 height of the antenna was varied between 1 and 4 meters. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The spurious emission levels were measured and compared with the limit of FCC Part 90. As the unit was tested with the output terminated the absolute limit for the spurious emissions was calculated using 50+10Log(TP).

Emissions were scanned up to the 10^{th} harmonic of the fundamental. The unit was tested in three orthogonal planes with the highest emissions for each emission detected reported. The signal substitution method per TIA/EIA-603 was used to obtain EIRP levels.

The limit is calculated as follows:

Output Power = 422mW = 26.25dBm

Limit = 26.25dBm – (50+10Log(0.422W)) = -20dBm (ERP)

Table 5: Radiated Emission Test Data

CLIENT:	Control Chief	DATE:	12/19/05
TESTER:	James Ritter	JOB #:	8896
EUT Information:		**Test Requirements:**	
EUT:	Lightweight OCU	TEST STANDARD:	FCC Part 90
Configuration:	Transmitting into dummy load	DISTANCE:	3m
Tx Frequency:	460 MHz	LIMIT:	Part 90 Mask D
Power (Watts)	0.5		

Note: Transceiver only operates in one orthogonal (otherwise tilt error occurs)

Frequency (MHz)	Pol H/V	Az Deg	Ant. Hght (m)	Spur Level dBμV	Sub. Sig. Gen. Level dBm	Sub. Power Level dBm	Sub. Ant. Factor dB/m	Sub. Ant. Gain dBi	EIRP Level dBm	Limit dBm	Margin dB
33.42	V	40.0	1.0	13.4	-56.9	-57.7	11.5	-10.8	-68.5	-20.0	-48.5
141.36	V	66.0	1.6	5.9	-70.4	-72.8	12.8	0.5	-72.3	-20.0	-52.3
163.70	V	84.0	1.3	8.4	-70.1	-72.8	14.7	-0.2	-73.0	-20.0	-53.0
166.70	V	96.0	1.0	9.5	-63.6	-66.3	15.0	-0.4	-66.7	-20.0	-46.7
172.71	V	113.0	1.2	9.6	-67.2	-70.3	15.8	-0.9	-71.2	-20.0	-51.2
182.47	V	98.0	1.1	11.9	-63.2	-66.3	16.9	-1.5	-67.8	-20.0	-47.8
183.97	V	100.0	1.0	13.5	-62.3	-65.3	17.1	-1.6	-66.9	-20.0	-46.9
207.25	V	99.0	1.4	8.5	-70.4	-73.2	17.1	-0.5	-73.7	-20.0	-53.7
343.30	V	220.0	1.2	5.8	-76.6	-81.3	14.3	6.6	-74.7	-20.0	-54.7
400.52	V	10.0	1.6	5.0	-68.6	-73.6	15.9	6.3	-67.3	-20.0	-47.3
407.43	V	27.0	1.6	9.4	-63.4	-68.3	16.3	6.1	-62.2	-20.0	-42.2
457.73	V	354.0	2.7	18.0	-54.2	-59.8	16.8	6.6	-53.2	-20.0	-33.2
1380.00	V	356.0	1.0	59.3	-46.5	-49.5	27.0	6.0	-43.5	-20.0	-23.5
1840.00	V	289.0	1.0	52.0	-53.5	-57.3	29.7	5.8	-51.5	-20.0	-31.5
2300.00	V	291.0	1.0	46.5	-56.0	-59.8	32.1	5.4	-54.4	-20.0	-34.4
2760.00	V	317.0	1.0	48.1	-52.0	-57.0	34.6	4.4	-52.6	-20.0	-32.6
3220.00	V	22.0	1.0	37.3	-60.0	-65.3	35.3	5.1	-60.3	-20.0	-40.3
3680.00	V	9.0	1.0	37.5	-61.0	-65.6	35.2	6.3	-59.3	-20.0	-39.3
4140.00	V	0.0	1.0	31.2	NA	NA	NA	NA	NA	NA	NA
4600.00	V	0.0	1.0	29.8	NA	NA	NA	NA	NA	NA	NA
141.59	H	346.0	3.1	8.0	-71.1	-73.5	12.8	0.5	-73.0	-20.0	-53.0
141.91	H	14.0	2.0	6.6	-76.7	-79.3	12.8	0.5	-78.8	-20.0	-58.8
163.70	H	38.0	2.3	14.6	-65.6	-68.4	14.7	-0.2	-68.6	-20.0	-48.6
166.70	H	198.0	2.0	12.2	-67.9	-70.7	15.0	-0.4	-71.1	-20.0	-51.1
168.13	H	180.0	1.8	15.3	-66.0	-68.9	15.2	-0.5	-69.4	-20.0	-49.4
169.67	H	18.0	1.8	13.5	-66.9	-69.9	15.5	-0.7	-70.6	-20.0	-50.6
172.71	H	7.0	2.2	13.8	-64.2	-67.4	15.8	-0.9	-68.3	-20.0	-48.3
182.47	H	197.0	1.8	14.7	-65.0	-68.3	16.9	-1.5	-69.8	-20.0	-49.8
183.97	H	39.0	2.0	15.4	-63.4	-66.5	17.1	-1.6	-68.1	-20.0	-48.1
195.18	H	53.0	1.7	12.5	-66.3	-69.1	17.2	-1.2	-70.3	-20.0	-50.3
207.25	H	23.0	2.5	17.8	-51.1	-53.6	17.1	-0.5	-54.1	-20.0	-34.1
222.97	H	20.0	1.6	10.9	-67.7	-71.2	15.6	1.6	-69.6	-20.0	-49.6
343.30	H	165.0	3.6	5.7	-70.2	-75.1	14.3	6.6	-68.5	-20.0	-48.5

Frequency (MHz)	Pol H/V	Az Deg	Ant. Hght (m)	Spur Level dBµV	Sub. Sig. Gen. Level dBm	Sub. Power Level dBm	Sub. Ant. Factor dB/m	Sub. Ant. Gain dBi	EIRP Level dBm	Limit dBm	Margin dB
400.52	H	317.0	2.0	2.5	-72.7	-78.0	15.9	6.3	-71.7	-20.0	-51.7
407.43	H	59.0	2.3	7.2	-64.8	-70.0	16.3	6.1	-63.9	-20.0	-43.9
457.73	H	215.0	3.1	12.8	-58.3	-64.1	16.8	6.6	-57.5	-20.0	-37.5
1380.00	H	316.0	1.0	54.0	-52.0	-55.0	27.0	6.0	-49.0	-20.0	-29.0
1840.00	H	298.0	1.0	51.3	-51.5	-55.2	29.7	5.8	-49.4	-20.0	-29.4
2300.00	H	339.0	1.0	46.7	-53.0	-56.7	32.1	5.4	-51.3	-20.0	-31.3
2760.00	H	348.0	1.0	41.5	-55.5	-60.4	34.6	4.4	-56.0	-20.0	-36.0
3220.00	H	292.0	1.0	37.3	-60.5	-65.5	35.3	5.1	-60.4	-20.0	-40.4
3680.00	H	179.0	1.0	39.3	-57.0	-62.1	35.2	6.3	-55.8	-20.0	-35.8
4140.00	H	0.0	1.0	29.5	NA	NA	NA	NA	NA	NA	NA
4600.00	H	0.0	1.0	28.9	NA	NA	NA	NA	NA	NA	NA

4.5 Receiver Spurious Emissions

The EUT must comply with requirements for receiver spurious emissions. The limits for spurious emissions are defined in section 8 of RSS-119.

4.5.1 Test Procedure

To measure the spurious emissions of the EUT was placed into receive mode and tuned to 460MHz. The antenna was connected to the EUT during testing. The frequency was scanned from 30M – 1GHz and the emissions were recorded and compared to the limit of specified in Section 8 of RSS-119.

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 height of the antenna was varied between 1 and 4 meters.

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level):	V dBµV
Antenna Factor (Ant Corr):	AFdB/m
Cable Loss Correction (Cable Corr):	CCdB
Amplifier Gain:	GdB
Electric Field (Corr Level):	EdBµV/m = VdBµV + AFdB/m + CCdB - GdB
To convert to linear units:	EµV/m = antilog (EdBµV/m/20)

Data are supplied in the following tables. Testing was performed to 5GHz. No emissions were detected above 1GHz. All detected emissions are reported in the following table.

Table 6: Radiated Emissions - Receiver

CLIENT:	Control Chief	DATE:	12/19/05
TESTER:	James Ritter	JOB #:	8897
EUT Information:		**Test Requirements:**	
EUT:	Lightweight OCU	TEST STANDARD:	RSS-119
Configuration:	Rx tuned to 460 MHz- Tx disabled	DISTANCE:	3m
CLOCKS:	45 MHz , 455 kHz	CLASS:	B
Test Equipment/Limit:			
ANTENNA:	A_00382	LIMIT:	LFCC_3m_Class_B
CABLE:	CSITE1_3m	AMPLIFIER (dB)	None

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin dB
114.426	V	120.0	1.0	4.5	13.5	2.0	20.0	10.0	150.0	-23.5
154.200	V	0.0	1.0	7.0	12.3	2.3	21.6	12.0	150.0	-21.9
163.700	V	166.0	1.0	4.8	12.1	2.4	19.2	9.2	150.0	-24.3
166.700	V	263.0	1.4	8.4	12.0	2.4	22.8	13.8	150.0	-20.7
172.710	V	8.1	1.2	8.1	11.8	2.4	22.3	13.0	150.0	-21.2
182.495	V	181.0	1.0	8.4	11.5	2.5	22.4	13.2	150.0	-21.1
184.002	V	200.0	1.2	8.9	11.5	2.5	22.9	14.0	150.0	-20.6
196.027	V	350.0	1.0	5.5	11.9	2.6	20.0	10.0	150.0	-23.5
247.940	V	189.0	1.3	8.4	11.8	3.0	23.2	14.5	200.0	-22.8
324.216	V	323.0	2.0	12.5	14.1	3.5	30.1	32.0	200.0	-15.9
343.300	V	252.0	1.3	4.8	14.2	3.6	22.7	13.6	200.0	-23.4
413.700	V	190.0	2.2	8.0	16.2	4.0	28.1	25.5	200.0	-17.9
457.730	V	137.0	1.7	13.9	16.7	4.3	34.9	55.5	200.0	-11.1
114.426	H	260.0	3.2	5.1	13.5	2.0	20.6	10.7	150.0	-22.9
166.700	H	250.0	3.4	3.8	12.0	2.4	18.2	8.1	150.0	-25.3
172.710	H	327.0	2.3	7.3	11.8	2.4	21.5	11.9	150.0	-22.0
182.495	H	238.0	3.3	6.8	11.5	2.5	20.8	11.0	150.0	-22.7
184.002	H	0.0	3.6	6.3	11.5	2.5	20.3	10.4	150.0	-23.2
196.027	H	140.0	2.6	3.7	11.9	2.6	18.2	8.1	150.0	-25.3
247.940	H	258.0	2.8	12.0	11.8	3.0	26.8	21.9	200.0	-19.2
324.216	H	119.0	2.7	9.7	14.1	3.5	27.3	23.2	200.0	-18.7
343.300	H	227.0	2.6	7.4	14.2	3.6	25.3	18.3	200.0	-20.8
413.700	H	235.0	1.9	5.7	16.2	4.0	25.8	19.6	200.0	-20.2
450.000	H	109.0	2.7	10.0	16.7	4.2	30.9	35.0	200.0	-15.1
457.730	H	176.0	2.5	10.9	16.7	4.3	31.9	39.3	200.0	-14.1

4.6 Frequency Stability: (FCC Part §2.1055 and Industry Canada RSS-119, Section 7)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter. The following table is the data for the frequency deviation testing.

Table 7. Frequency Deviation as a Function of Temperature

Temperature (Centigrade)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Limit (in Hz)
Ambient (26C)	459.999857	0.0	0	
-30	459.999899	42.0	0.000009	1150
-20	459.999896	39.0	0.000008	1150
-10	459.999922	65.0	0.000014	1150
0	459.999932	75.0	0.000016	1150
10	459.999810	-47.0	0.000010	1150
20	459.999835	-22.0	0.000005	1150
30	459.999866	9.0	0.000002	1150
40	459.999836	-21.0	0.000005	1150
50	459.999875	18.0	0.000004	1150

Table 8. Frequency Deviation as a Function of Voltage

Voltage (Volts)	Frequency (MHz)	Difference (Hz)	Deviation (%)	Limit (in Hz)
At rated 7.4 VDC	459.999925		0.0	
at 5 VDC (unit stops below 5 VDC)	460.000250	325.0	0.000071	1150

4.7 Transient Frequency Behavior (FCC §90.214 and RSS-119 Section 6.5)

For transmitters operation in the 450M to 470MHz frequency range the transient frequency behavior must be measured and comply with the requirements of FCC §90.214 and Industry Canada Section 6.5.

4.7.1 Procedure

To perform the transient frequency behavior testing the antenna was removed and the output was connected to test setup. The procedure described in TIA-603-B was used for performing the testing.

The EUT was tuned to 460MHz and the output was fed into a variable attenuator. This output was then connected through a directional coupler into a combiner input port. The 2nd port of the combiner was connected to the output of a signal generator which was programmed to the center frequency of the transmitter with a 1kHz FM modulated signal at 12.5kHz deviation. The output of the combiner was fed into the spectrum analyzer. The video output of the spectrum analyzer was then connected to the channel 1 of the oscilloscope while the coupled output of the EUT transmit signal was fed into a RF detector and then to channel 2 of the oscilloscope for triggering the scope upon the EUT being keyed. Reference Figure 4-10 for the general test setup.

The spectrum analyzer and oscilloscope were then setup per TIA-603-B so that the oscilloscope would display the +/-12.5kHz deviation across the entire display. The EUT was modulated during this test. Upon keying the transmitter the oscilloscope triggered capturing the results of the Tx turn-on (t1 and t2). The scope was then adjusted so the triggering would occur on the Tx turn-off (t3). The limits applied between the t2 and t3 are per the frequency stability requirements as reported in Section 4.6.

The following oscilloscope plots show the results of the transient frequency behavior test.

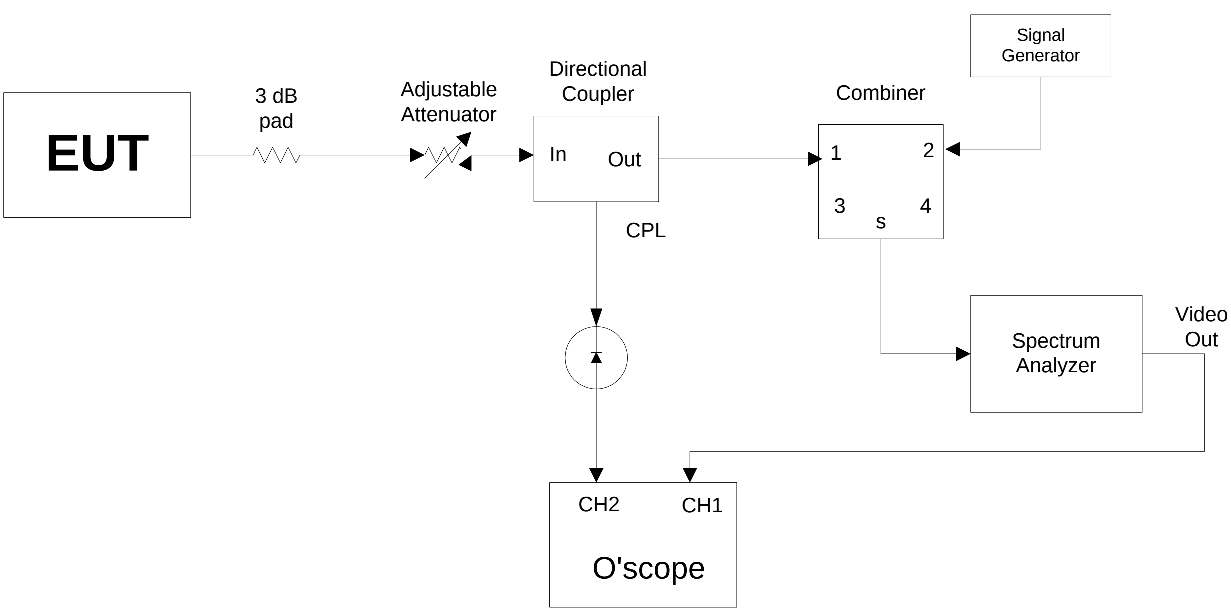

Figure 4-10. General Transient Frequency Behavior Test Setup

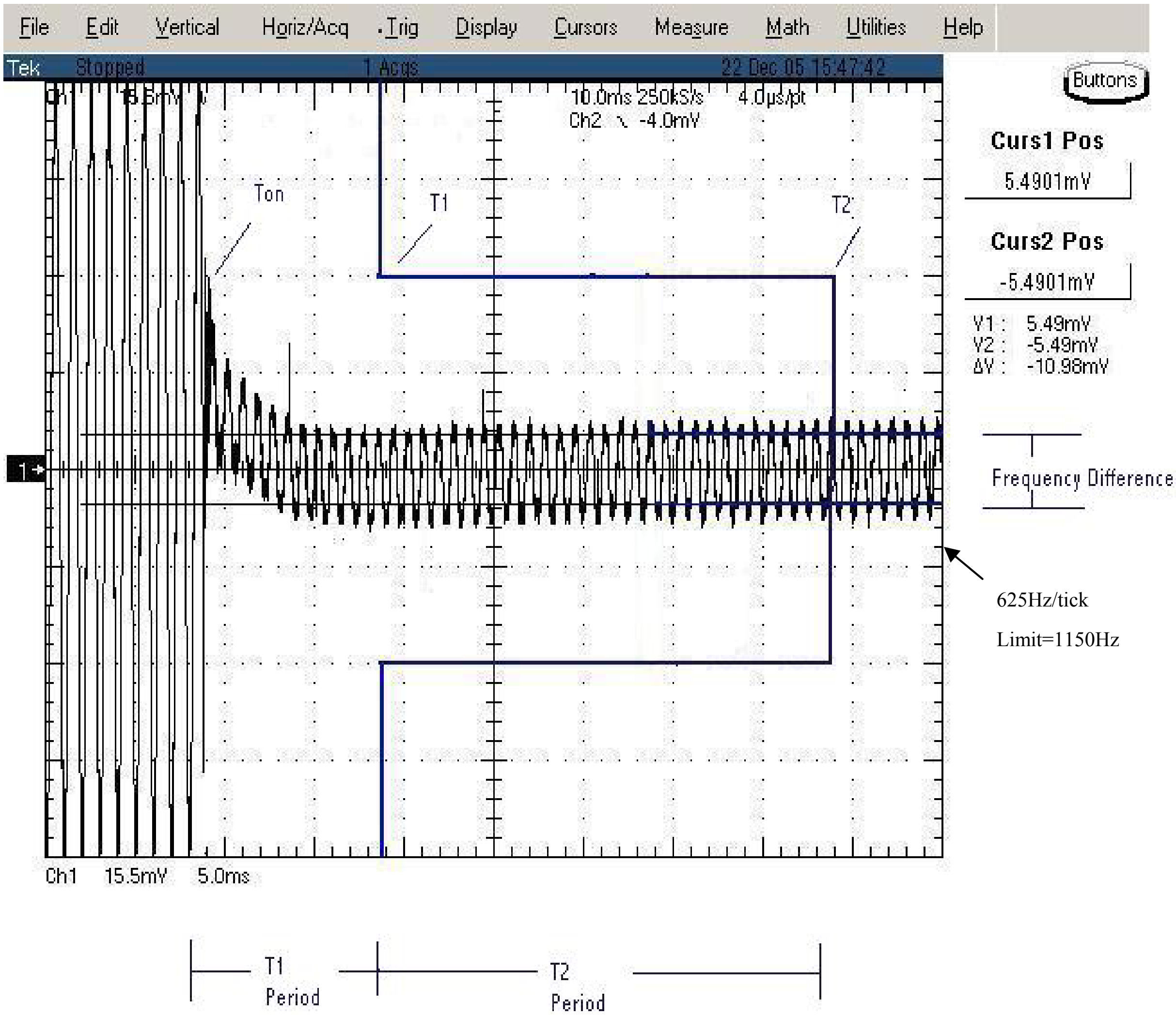

Figure 4-11. Transient Frequency Behavior, Turn-on

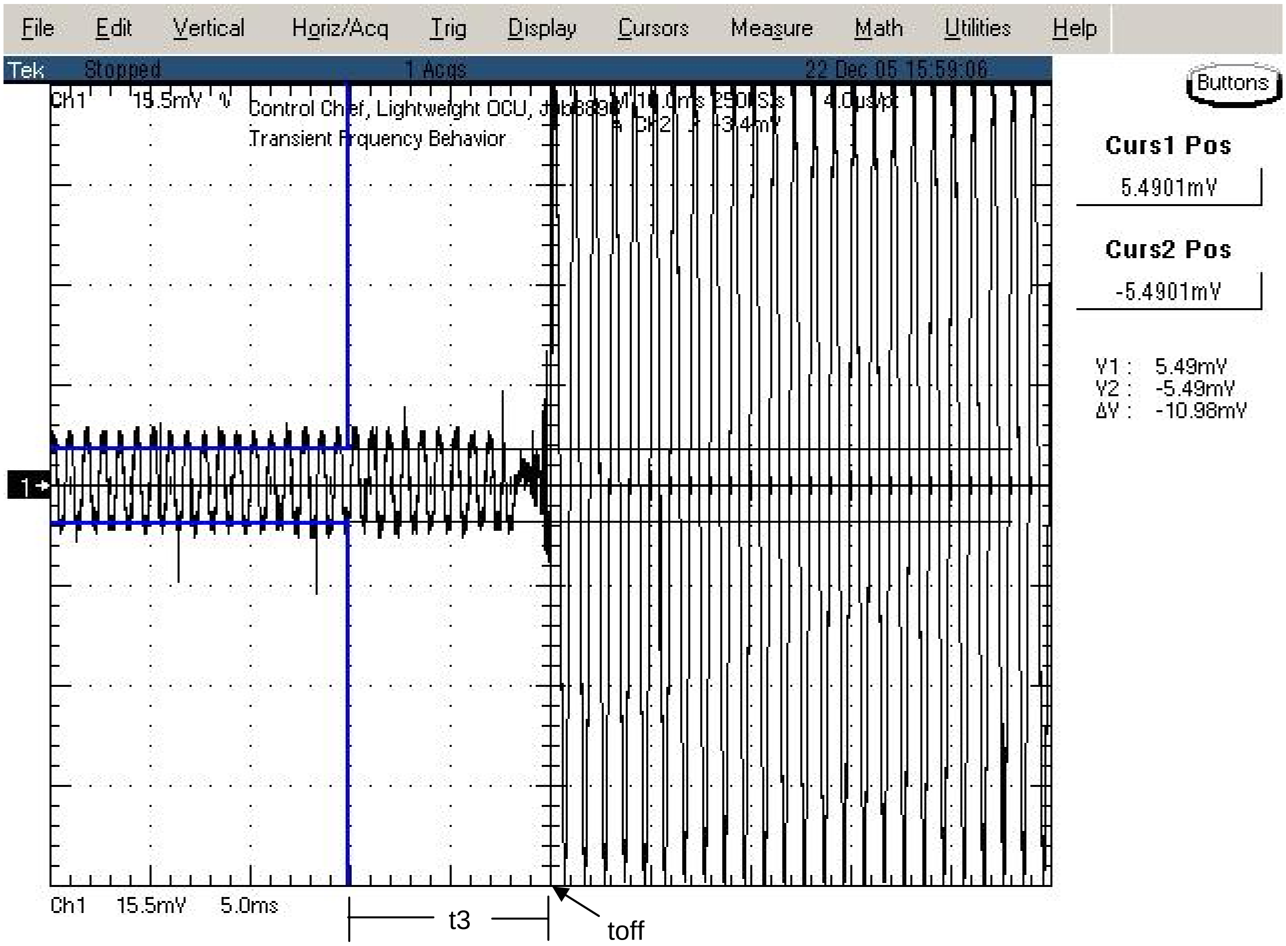

Figure 4-12. Transient Frequency Behavior, Turn-off