Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive Gaithersburg, MD 20879
301.216.1500 . info@wll.com

FCC & Industry Canada Certification Test Report
For the
Cooper Power Systems
RFN420CL MODULE

FCC ID: P9X-RFN420CL
IC: 6766A-RFN420CL

WLL JOB# **11893**
June 7, 2011

Prepared for:

Cooper Power Systems
20201 Century Blvd. Suite 250
Germantown, MD 20874

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

ACCLASS ACCREDITED TESTING

Testing Certificate AT-1448

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Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Cooper Power Systems to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2009) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 issue 8 of Industry Canada. This Certification Test Report documents the test configuration and test results for the Cooper Power Systems RFN420CL Module.

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 ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Cooper Power Systems RFN420CL Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

Revision History	Description of Change	Date
Rev 0	Initial Release	June 7, 2011

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1 Introduction

1.1 Compliance Statement

The Cooper Power Systems RFN420CL Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (10/2009) and Industry Canada RSS-210 issue 8.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with FCC Public Notice DA-00-705 "Measurement Guidance for Frequency Hopping Spread Spectrum Systems. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Cooper Power Systems 20201 Century Blvd. Suite 250 Germantown, MD 20874
Purchase Order Number:	31471
Quotation Number:	66065

1.4 Test Dates

Testing was performed on the following date(s):	5/19/2011 to 6/2/2011

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter
Client Representative	Steve Seymour

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 & Description

The RFN420CL Module is a radio communications device designed for use in L+G Focus meters. It can also be used in Cooper Power Systems Gateways and Relay Nodes. The RFN420CL Module provides a 915 MHz radio interface to an RF mesh network, and a ZigBee interface for HAN applications.

This test report covers the 915MHz FHSS radio section. The Zigbee radio section will be covered in a separate report.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Cooper Power Systems
FCC ID:	P9X-RFN420CL
IC:	6766A-RFN420CL
Model:	RFN420CL
FCC Rule Parts:	§15.247
Industry Canada:	RSS210
Frequency Range:	902.75 – 927.25MHz
Maximum Output Power:	27.90dBm (616.6mW)
Modulation:	FSK
Occupied Bandwidth:	484.52 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Variable from -31.82dBm to 27.90dBm
Antenna Connector	MCX
Antenna Type	3 antennas: GH908U-PRO 900MHz Omnidirectional – 8dBi Gain TRA9023NP - Antenex Phantom 902-928MHz – 3dB Gain 915MHz Co-linear Antenna -2dB gain
Interface Cables:	None (plug in module)
Power Source & Voltage:	120/240VAC
Emission Designator	484KFXD
Highest TX spurious Emission	57.3uV/m@3m- 163.24MHz
Highest RX Spurious Emission	103uV/m @ 3m- 319.96MHz

2.2 Test Configuration

The Cooper Power Systems RFN420CL, Equipment Under Test (EUT), was operated from a 115Vac power supply. Programming commands were sent from a support laptop via a custom RS232 adaptor board to a header on the EUT module

2.3 Testing Algorithm

The RFN420CL was programmed for operation from a support laptop via a custom RS232 adaptor board to a header on the EUT module. UTF TeraTermPro console program was used on the support laptop to enter commands setting the EUT to the desired channel or hopping mode.

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 ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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

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

2.6 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

$k \leq 2$ 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 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name: **Bench Conducted RF Tests**		:	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
728	HP – 8564EC	ANALYZER SPECTRUM	4/28/2012
528	E4446A	ANALYZER SPECTRUM	8/27/2012

Test Name: **Radiated Emissions**			
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
71	HP - 85685A	PRESELECTOR RF	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
69	HP - 85650A	ADAPTER QP	7/1/2011
522	HP - 8449B	PRE-AMPLIFIER 1-26.5GHZ	7/27/2011
728	AGILENT - 8564EC	SPECTRUM ANALYZER 30HZ - 40GHZ	4/28/2012
337	WLL - 1.2-5GHZ	FILTER BAND PASS	3/24/2012
280	ITC - 21C-3A1	WAVEGUIDE 3.45-11.0GHZ	3/24/2012
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	1/12/2012
425	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	9/9/2011

Test Name: **Conducted Emissions Voltage**			
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
125	SOLAR - 8028-50-TS-24-BNC	LISN	7/10/2011
126	SOLAR - 8028-50-TS-24-BNC	LISN	7/10/2011
53	HP - 11947A	LIMITER TRANSIENT	3/11/2012
69	HP - 85650A	ADAPTER QP	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
71	HP - 85685A	PRESELECTOR RF	7/1/2011

4 Test Summary

The Table Below shows the results of testing for compliance with a Frequency Hopping System in accordance with FCC Part 15.247 10/2009 and RSS210 issue 8. Full results are shown in section 5.

Table 4: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	20dB Bandwidth	Pass
15.247 (b)(2)	RSS-210 [A8.4 (1)]	Transmit Output Power	Pass
15.247 (a)(1)	RSS-210 [A8.1 (b)]	Channel Separation	Pass
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	Number of Channels =50 minimum	Pass
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	Time of Occupancy	Pass
15.247 (d)	RSS-210 [A8. 5]	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-210 Sect.2.2 RSS-Gen 7.2.2	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	NA
RX/Digital Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	NA
15.209	RSS-210 sect 2.5	General Field Strength Limits	Pass

5 Test Results

5.1 Duty Cycle Correction and Time of Occupancy

In accordance with the FCC Public Notice the average spurious radiated emissions measurements may be further adjusted using a duty cycle correction factor if the dwell time per channel of the hopping signal is less than 100 ms.

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

The following figure shows the plot of the dwell time for the transmitter. Based on this plot, the dwell time per hop is 19.5ms. The maximum total dwell time per 100ms is 38ms. This corresponds to a duty cycle correction of -8.4dB for radiated spurious emissions.

The transmitter shall have a time of occupancy for systems having a 20dB bandwidth greater than 250 kHz of no more than 0.4seconds in any 10 second period.

These tests were conducted with the RF output connected through appropriate attenuators to the input of a spectrum analyzer set to zero span mode. The unit was set to hopping mode with the spectrum analyzer set to 902.75MHz. The results are shown in the plots below.

Table 5: Duty Cycle/time of Occupancy Results

Test	Result	Limit	Pass/Fail
Dwell time per Hop	19.0ms	NA	NA
Dwell time per 100ms	-8.4dB Correction	NA	NA
Time of Occupancy	0.285 sec per 10 sec	0.4 sec per 10 sec	Pass

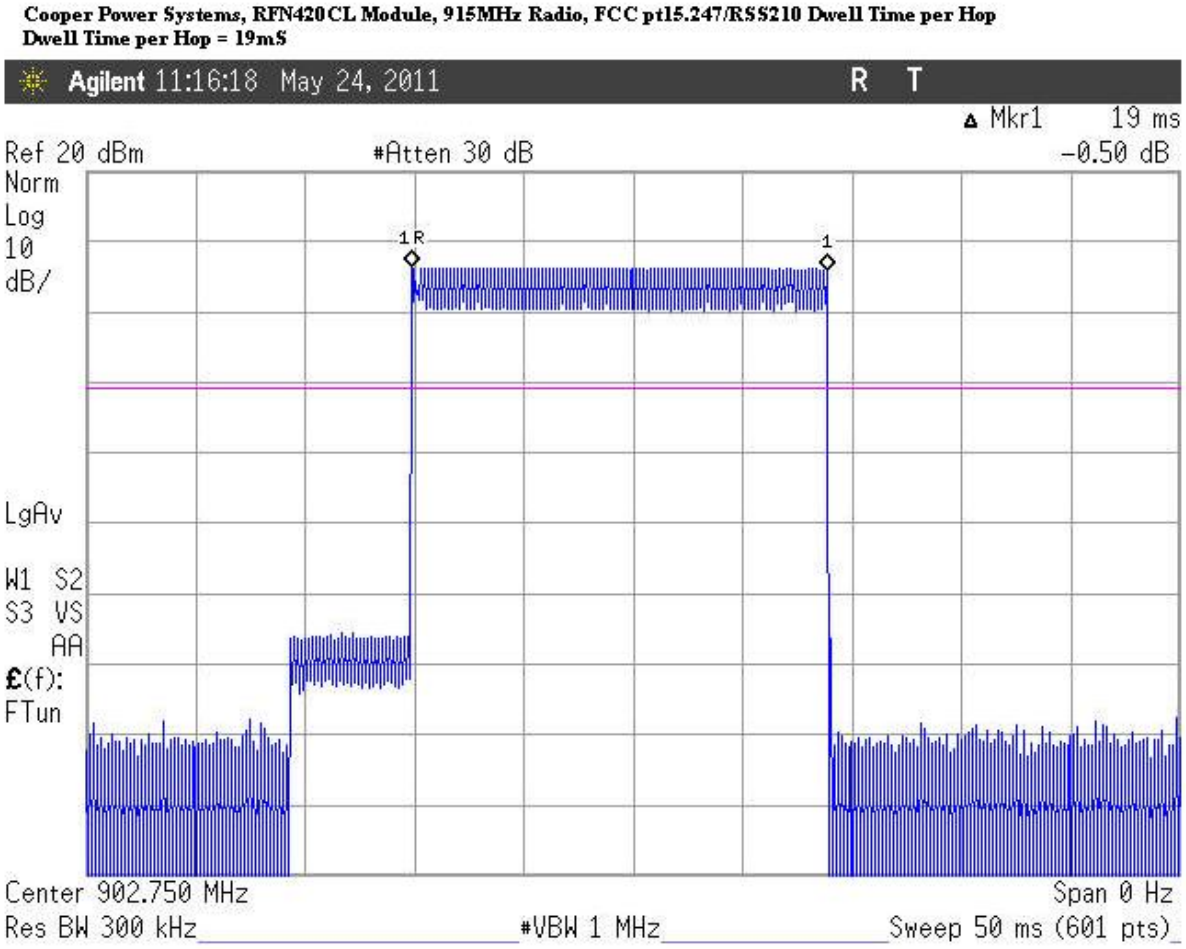

Figure 1: Single Hop Duty Cycle Plot

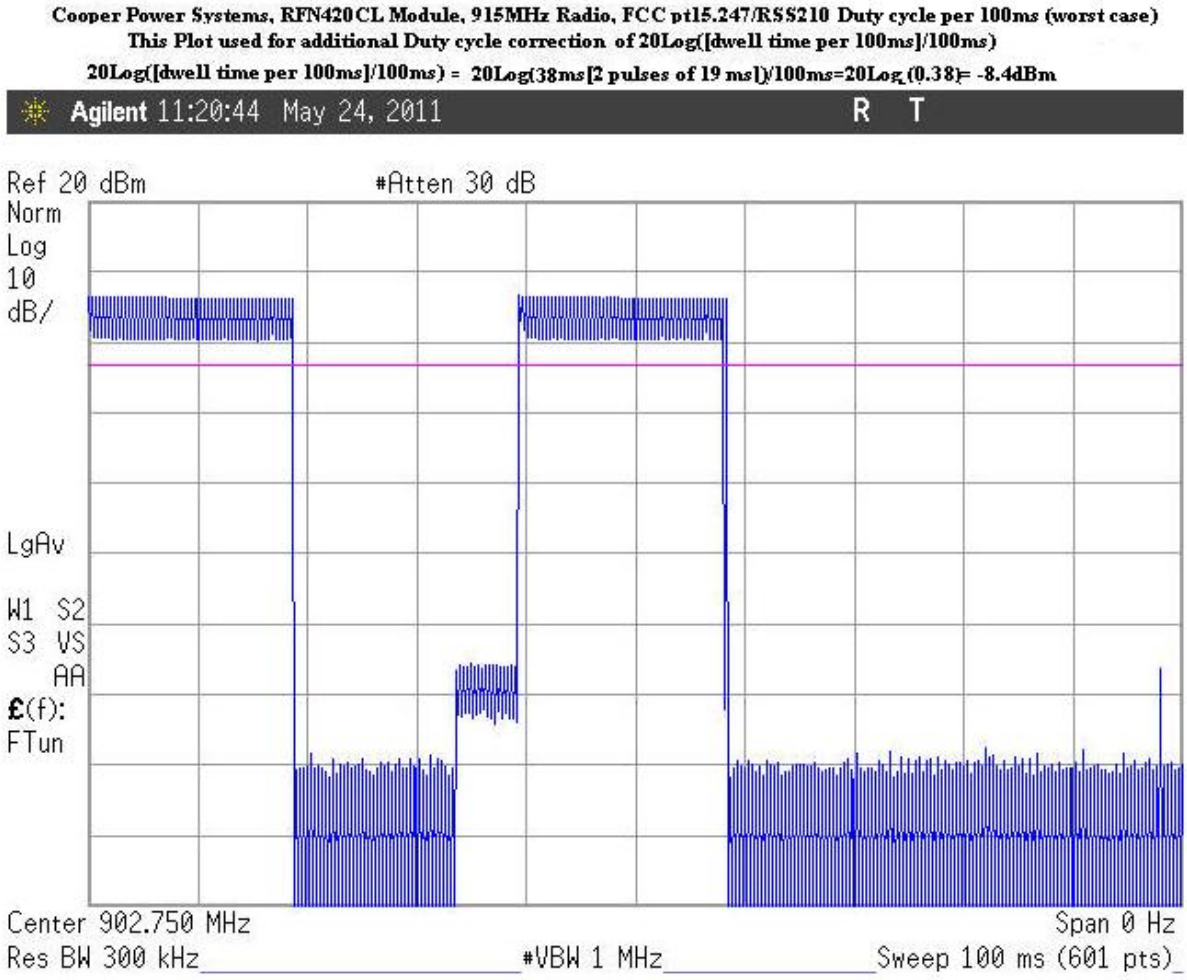

Figure 2: Dwell time per 100ms

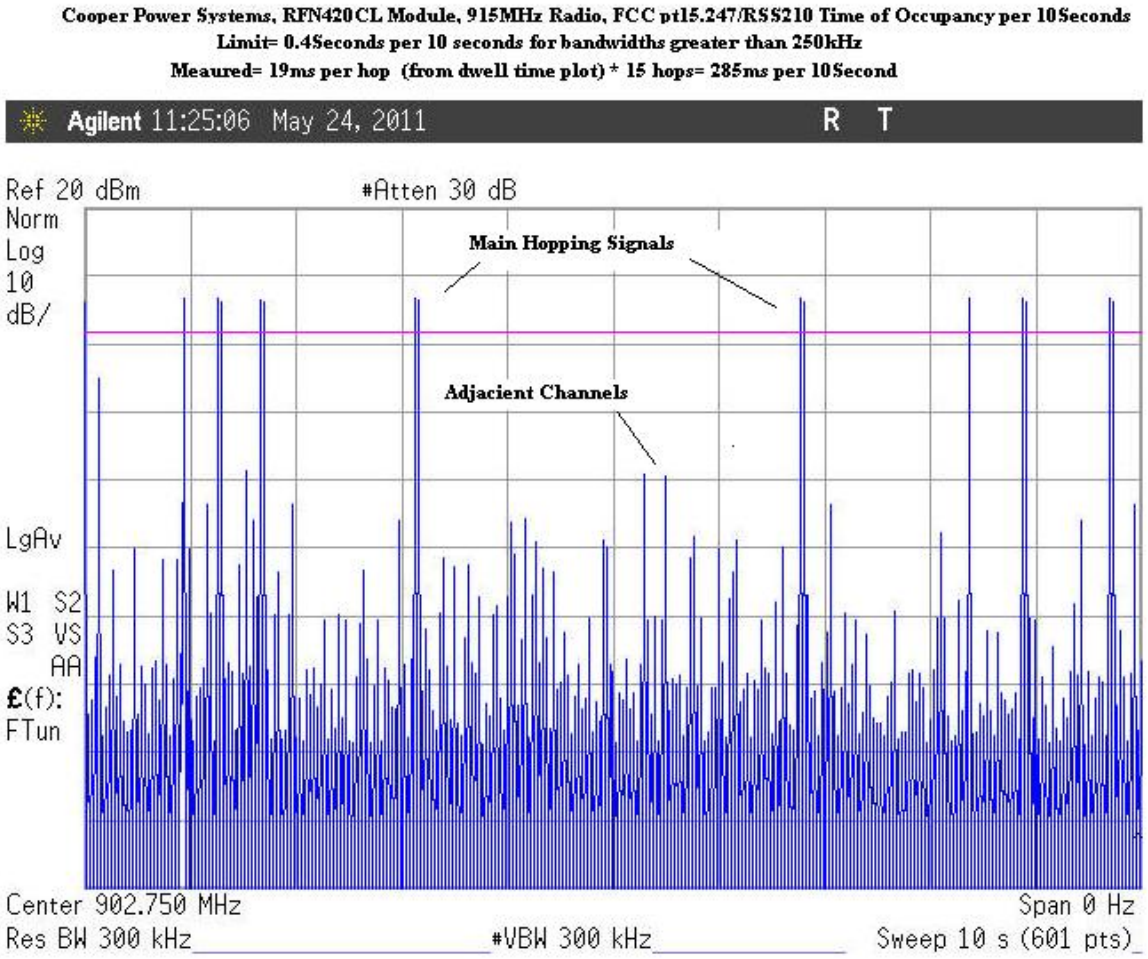

Figure 3: Time of Occupancy

5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on a low, high and Center channel. 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 has an adjustable output range. The highest and lowest power available is shown below.

Table 6: RF Power Output

Frequency	Power Setting	Level (dBm)	Limit (dBm)	Pass/Fail
Low Channel: 902.75MHz	High	27.10	30	Pass
Center Channel: 914.75MHz	High	27.16	30	Pass
High Channel: 927.25MHz	High	27.90	30	Pass
Low Channel: 902.75MHz	Low	-31.82	30	Pass
Center Channel: 914.75MHz	Low	-31.76	30	Pass
High Channel: 927.25MHz	Low	-31.76	30	Pass

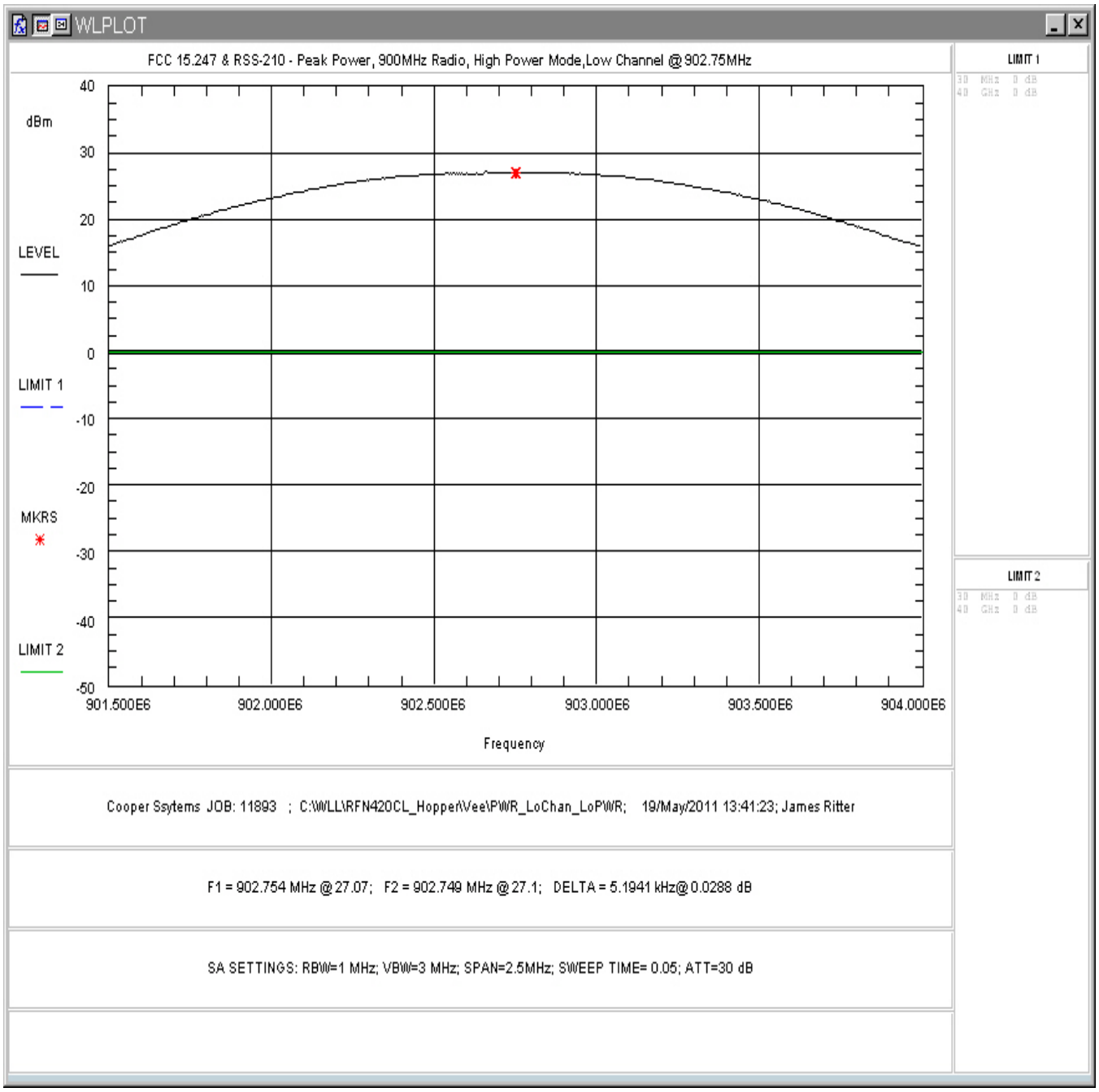

Figure 4: RF Peak Power, High Power, Low Channel

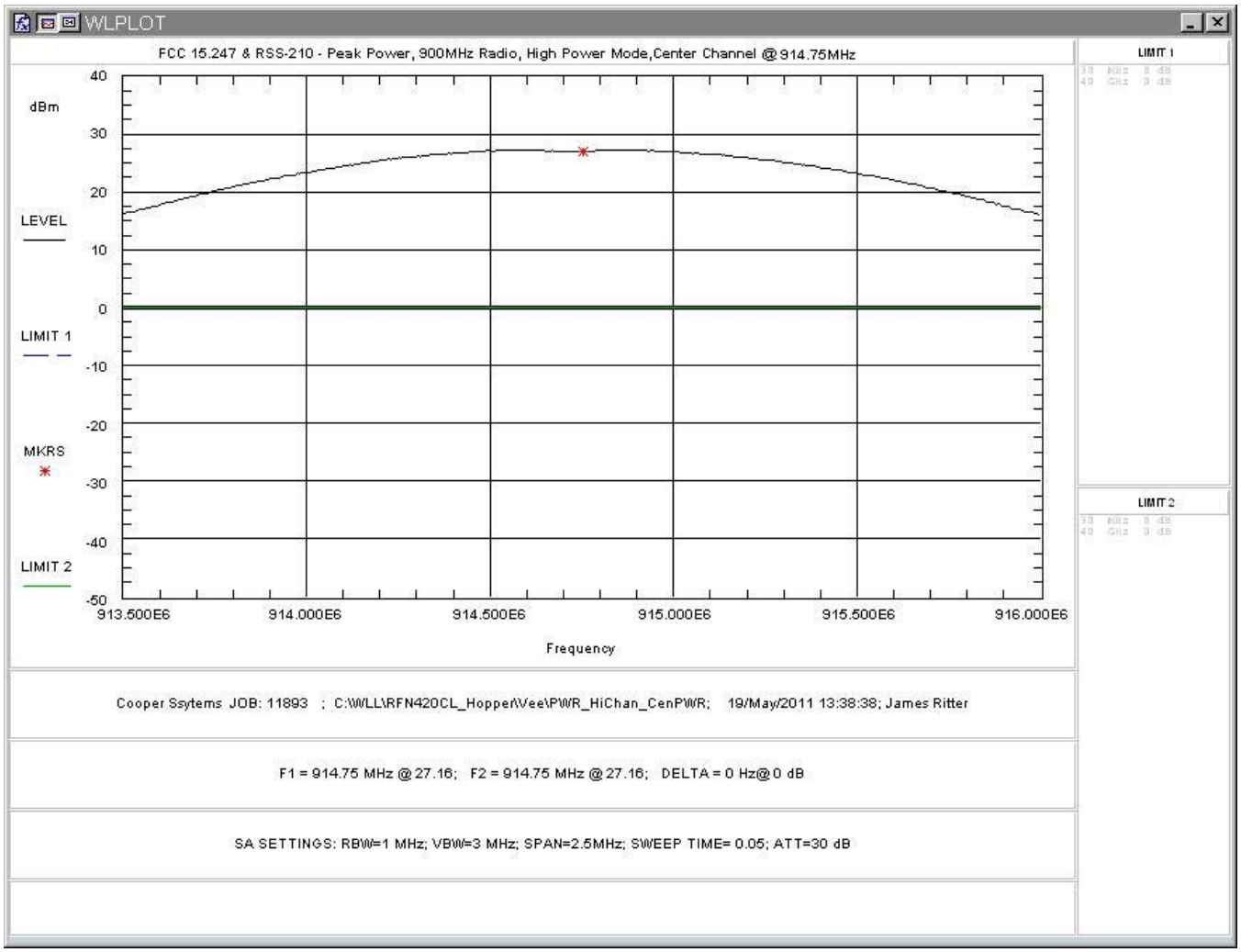

Figure 5: RF Peak Power, High Power, Center Channel

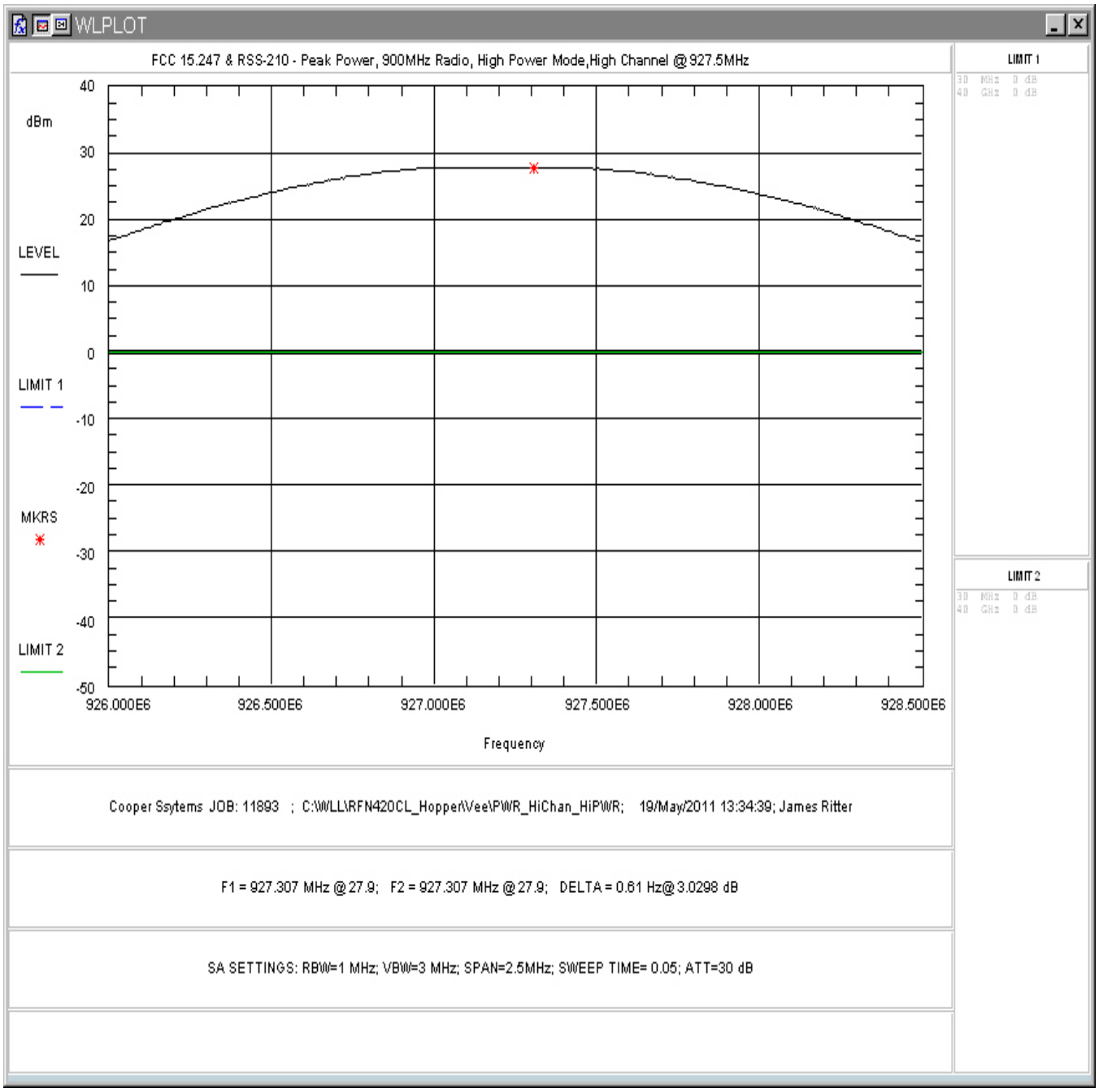

Figure 6: RF Peak Power, High Power, High Channel

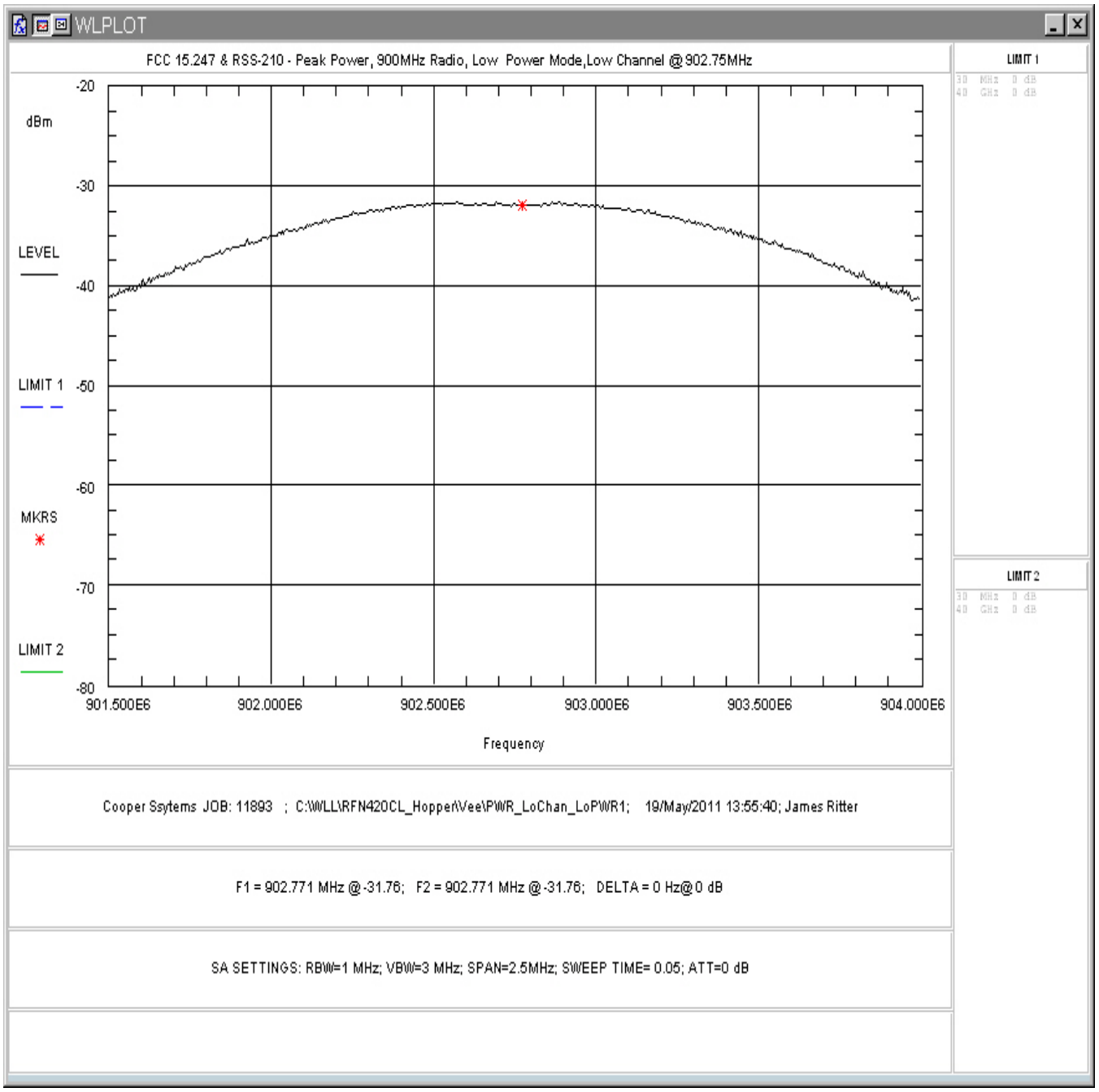

Figure 7: RF Peak Power, Low Power, Low Channel

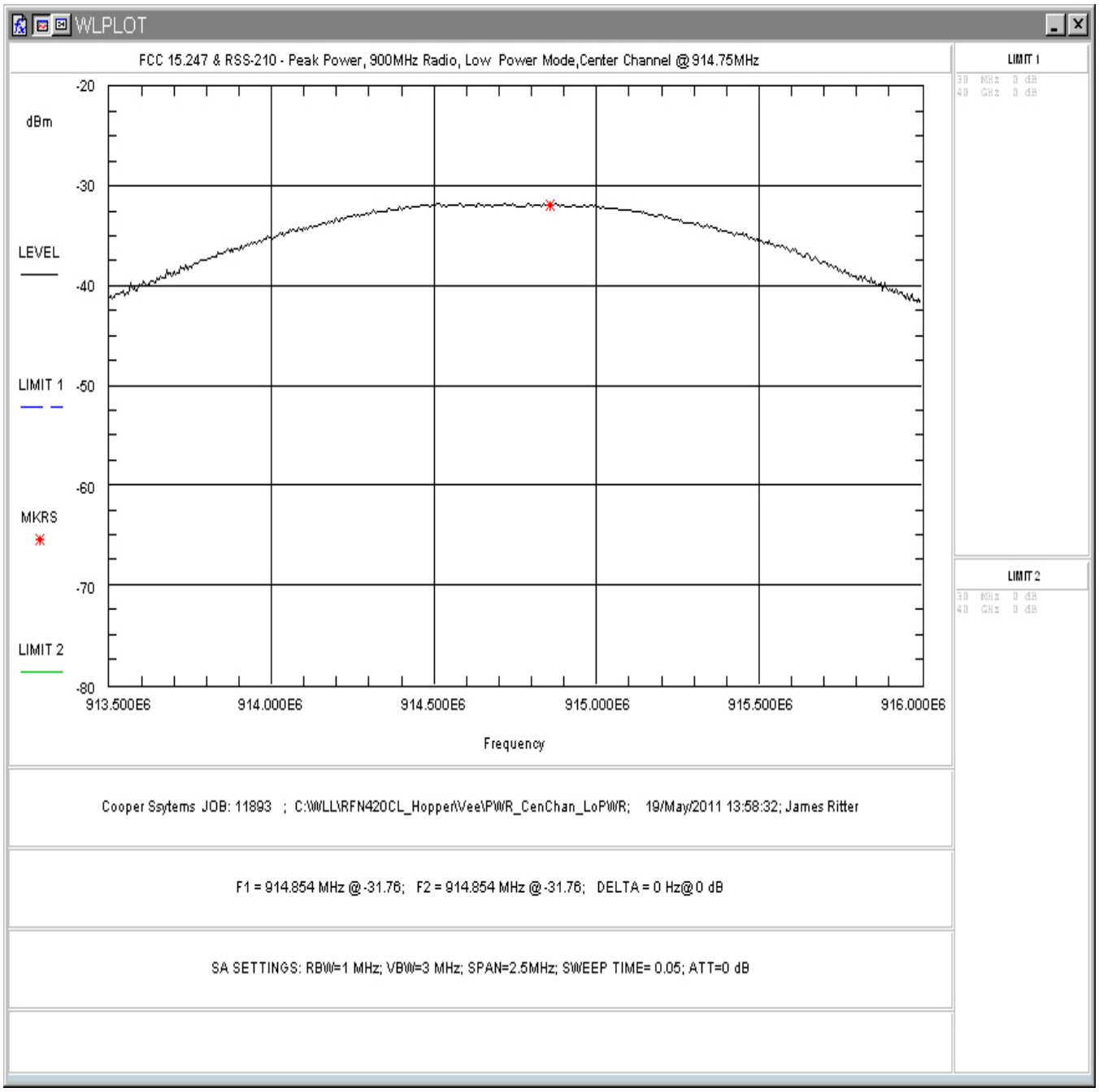

Figure 8: RF Peak Power, Low Power, Center Channel

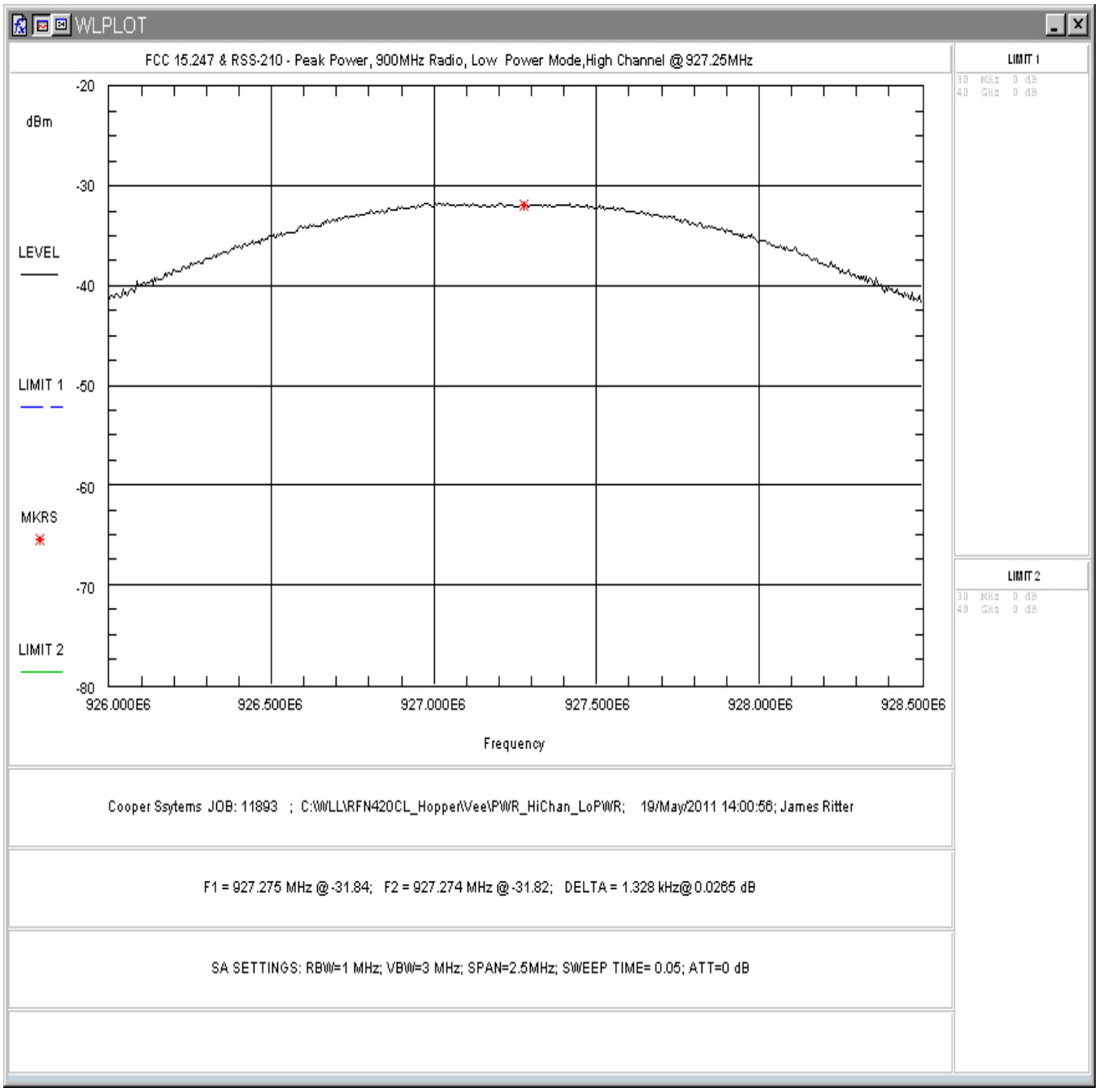

Figure 9: RF Peak Power, Low Power, High Channel

5.3 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For Frequency Hopping Spread Spectrum Systems, FCC Part 15.247 requires the maximum 20 dB bandwidth not exceed 500kHz.

At full modulation, the occupied bandwidth was measured as shown:

Table 7 provides a summary of the Occupied Bandwidth Results.

Table 7: Occupied Bandwidth Results

Frequency	Bandwidth (kHz)	Limit (kHz)	Pass/Fail
Low Channel: 902.75MHz	482.50	500	Pass
Center Channel: 914.75MHz	484.51	500	Pass
High Channel: 927.25MHz	477.14	500	Pass

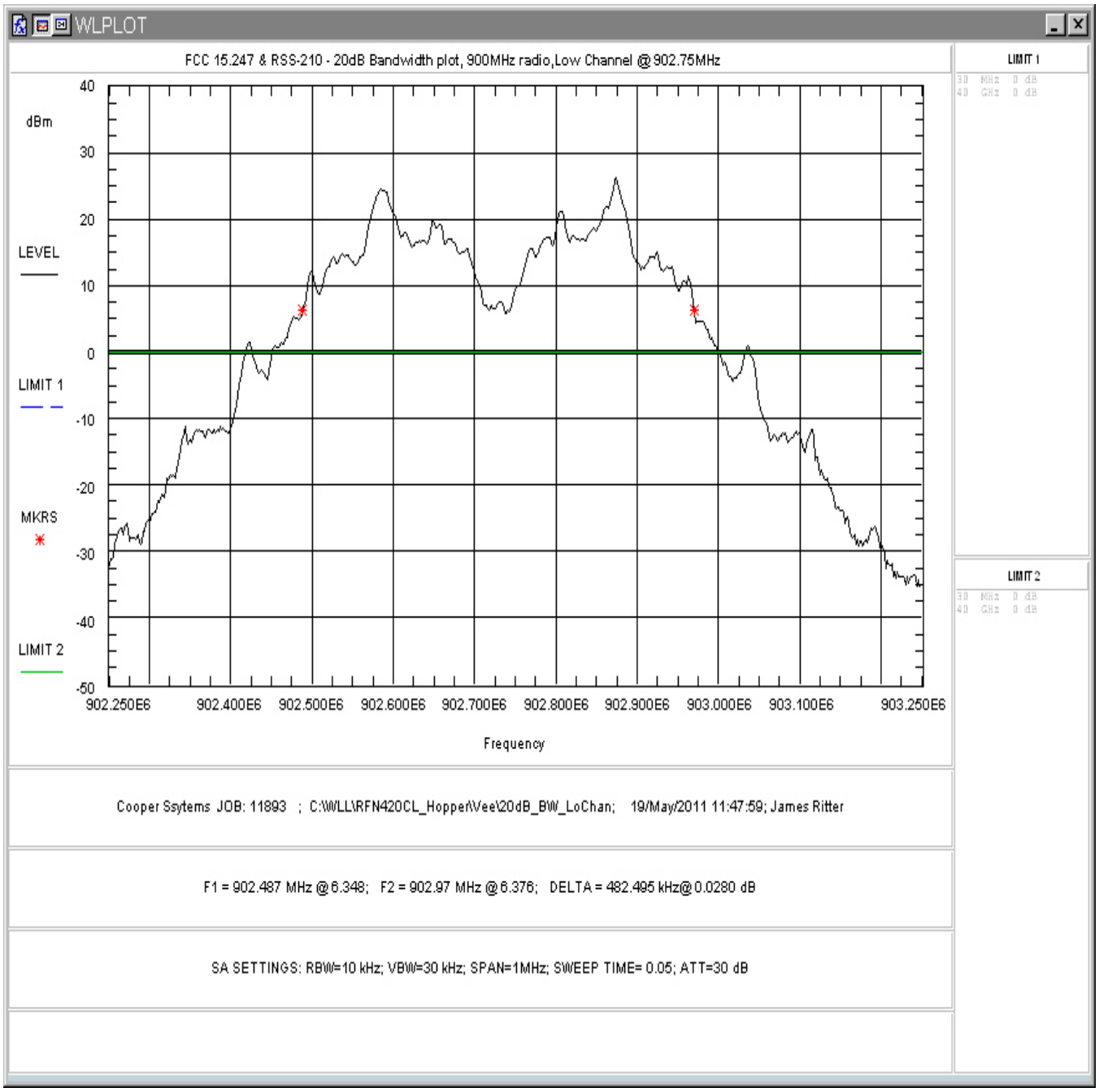

Figure 10: Occupied Bandwidth, Low Channel

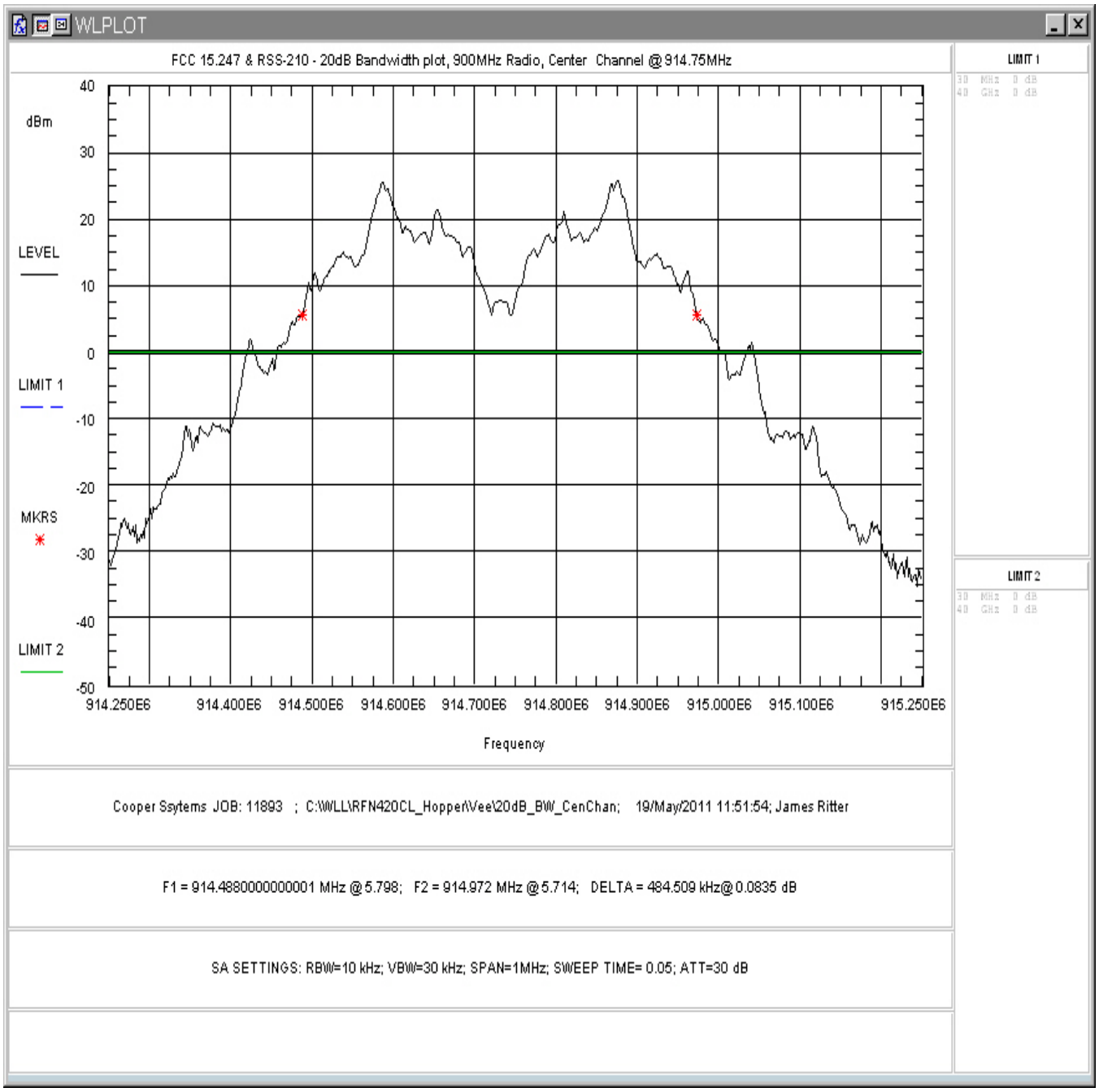

Figure 11: Occupied Bandwidth, Center Channel

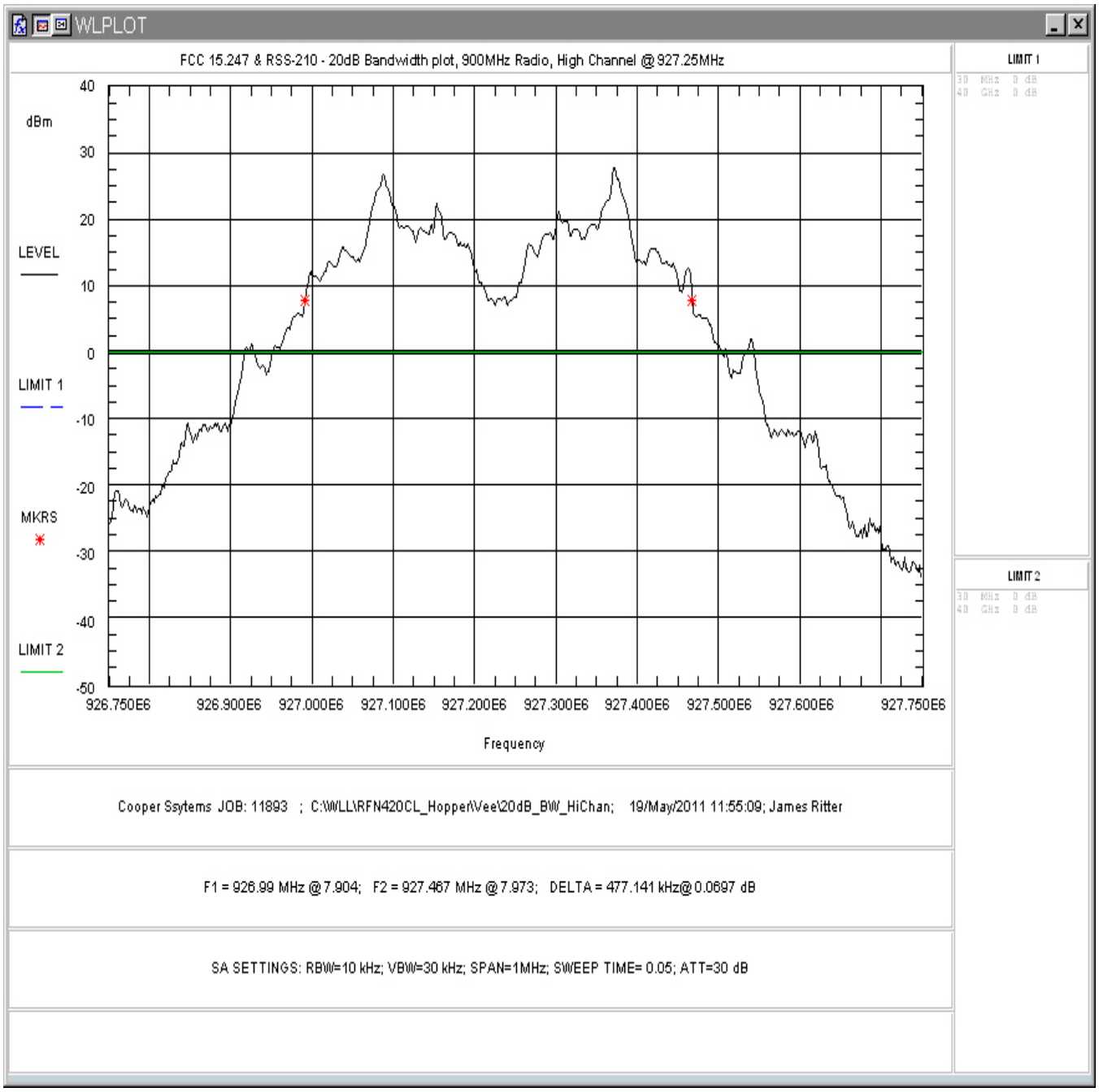

Figure 12: Occupied Bandwidth, High Channel

5.4 Channel Spacing and Number of Hop Channels (FCC Part §15247(a)(1)

Per the FCC requirements, frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 484.5kHz so the channel spacing must be more than 484.5kHz. In addition, for a 902-928MHz transmitter with an occupied bandwidth greater than 250kHz the minimum number of hopping channels shall be 25.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 20 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 30 kHz and the video bandwidth was set to 30 kHz. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 100kHz. Also, the number of hopping channels was measured from 902-928MHz using a RBW/VBW setting of 30kHz.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 500kHz and the number of channels used is 50.

Note: in the following plots each channel is composed of 2 distinct peaks.

Table 8: Channel Spacing and Number of Channels Results

Frequency	Result	Limit	Pass/Fail
Channel Spacing	500kHz	484.5kHz minimum	Pass
Number of channels	50 channels	25 channels minimum	Pass

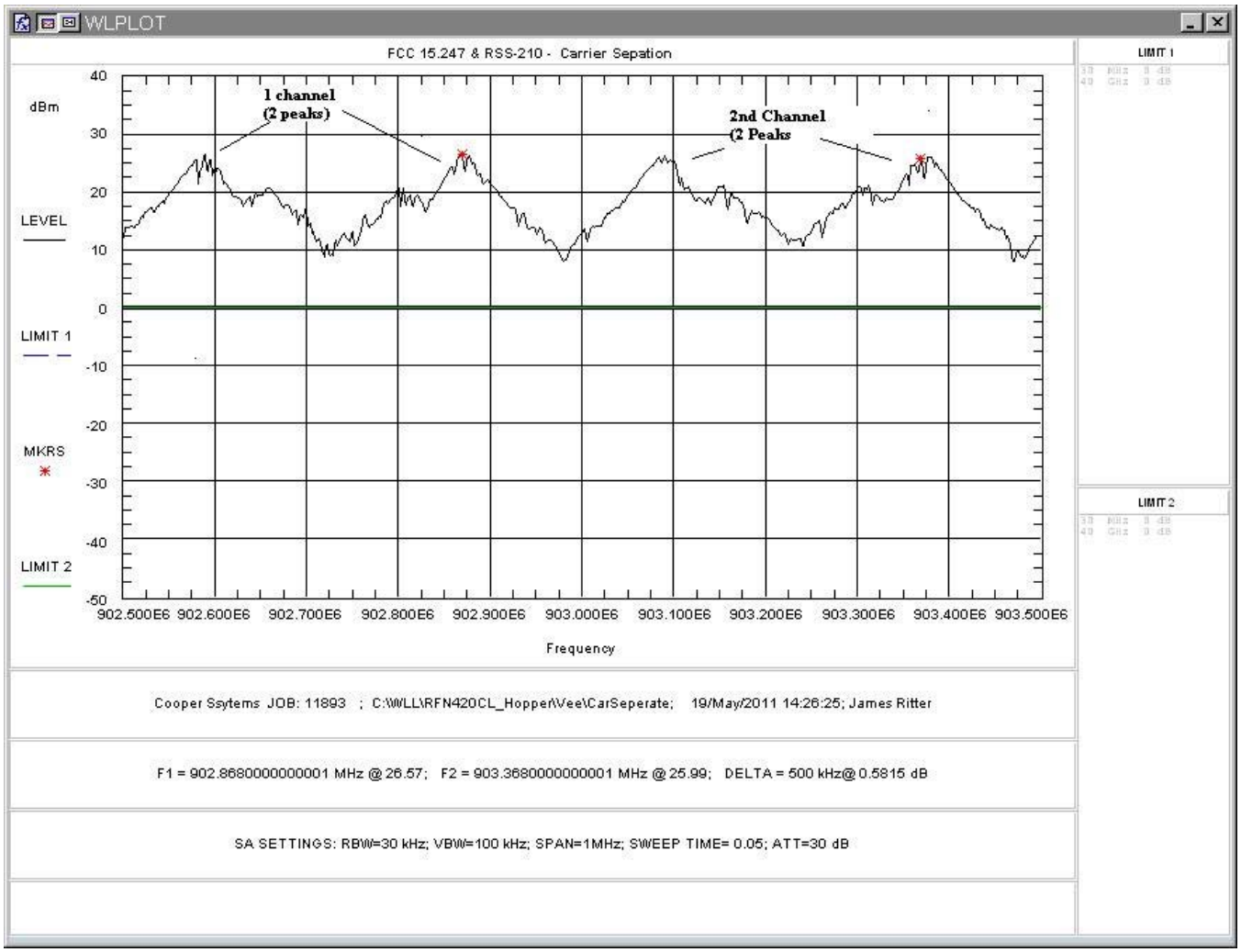

Figure 13: Channel Spacing

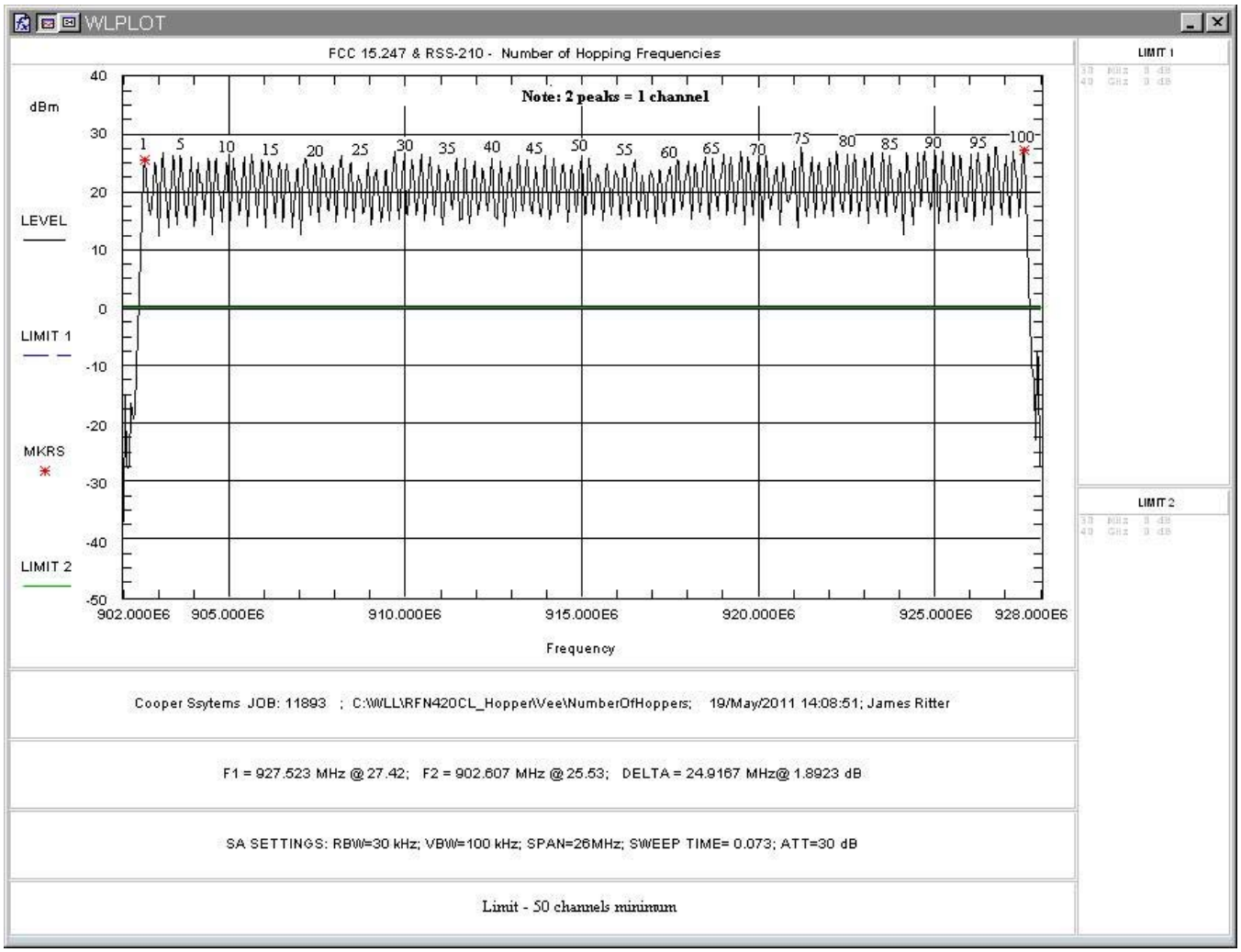

Figure 14: Number of Hopping Channels

5.5 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(c) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

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 spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

The following are plots of the conducted spurious emissions data.

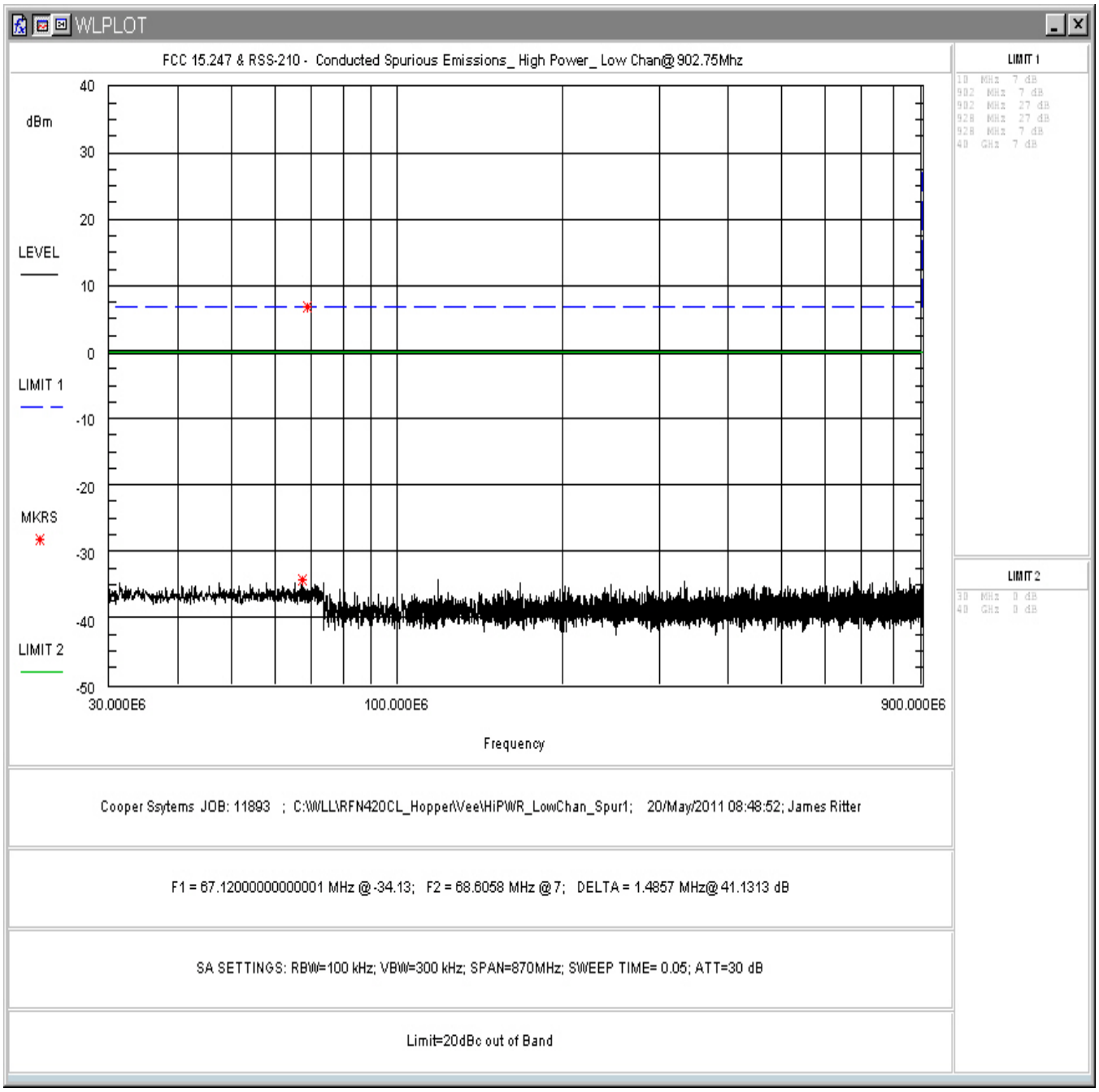

Figure 15: Conducted Spurious Emissions, High Power, Low Channel 30 - 900MHz

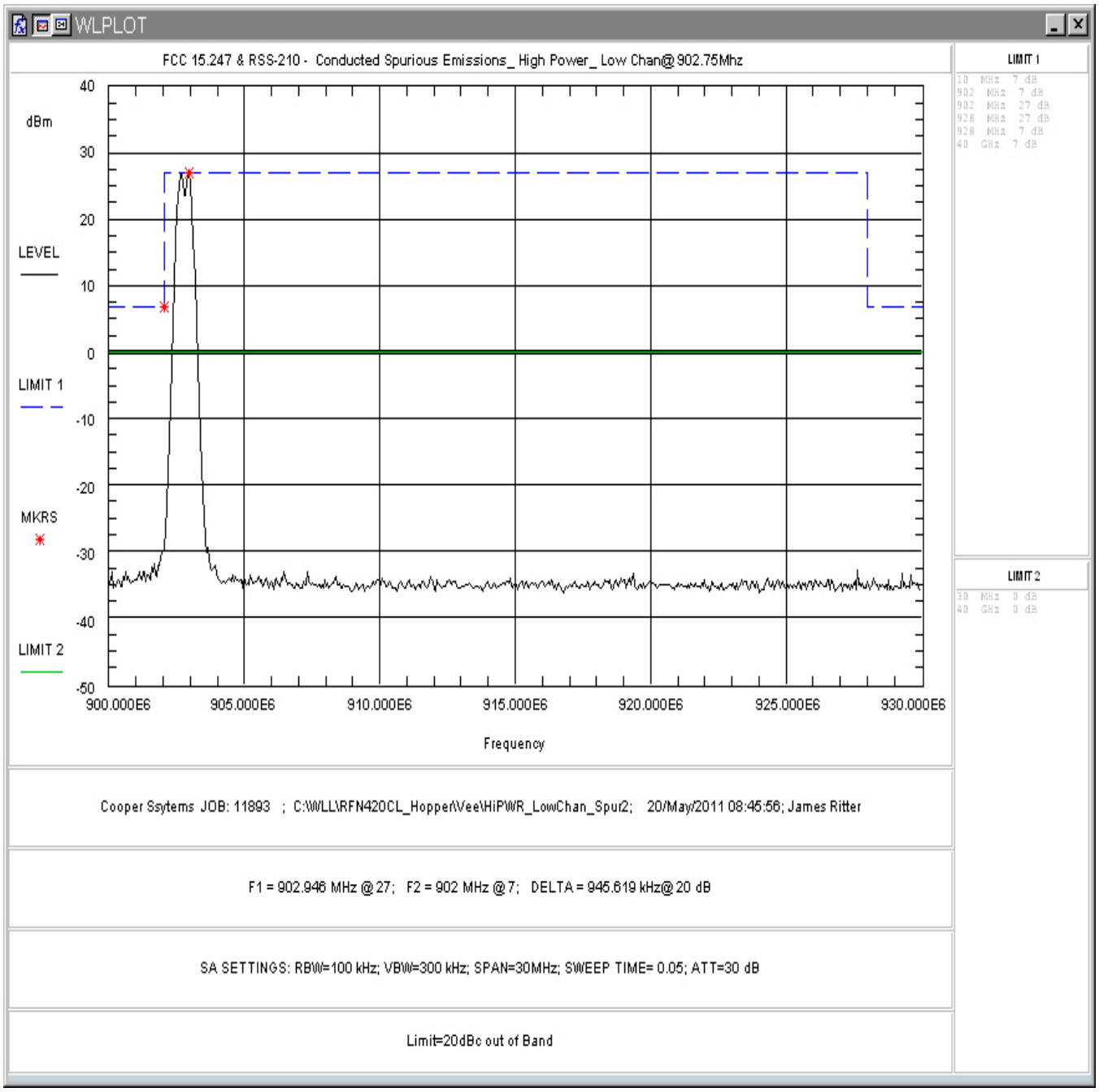

Figure 16: Conducted Spurious Emissions, High Power, Low Channel 900 – 930MHz

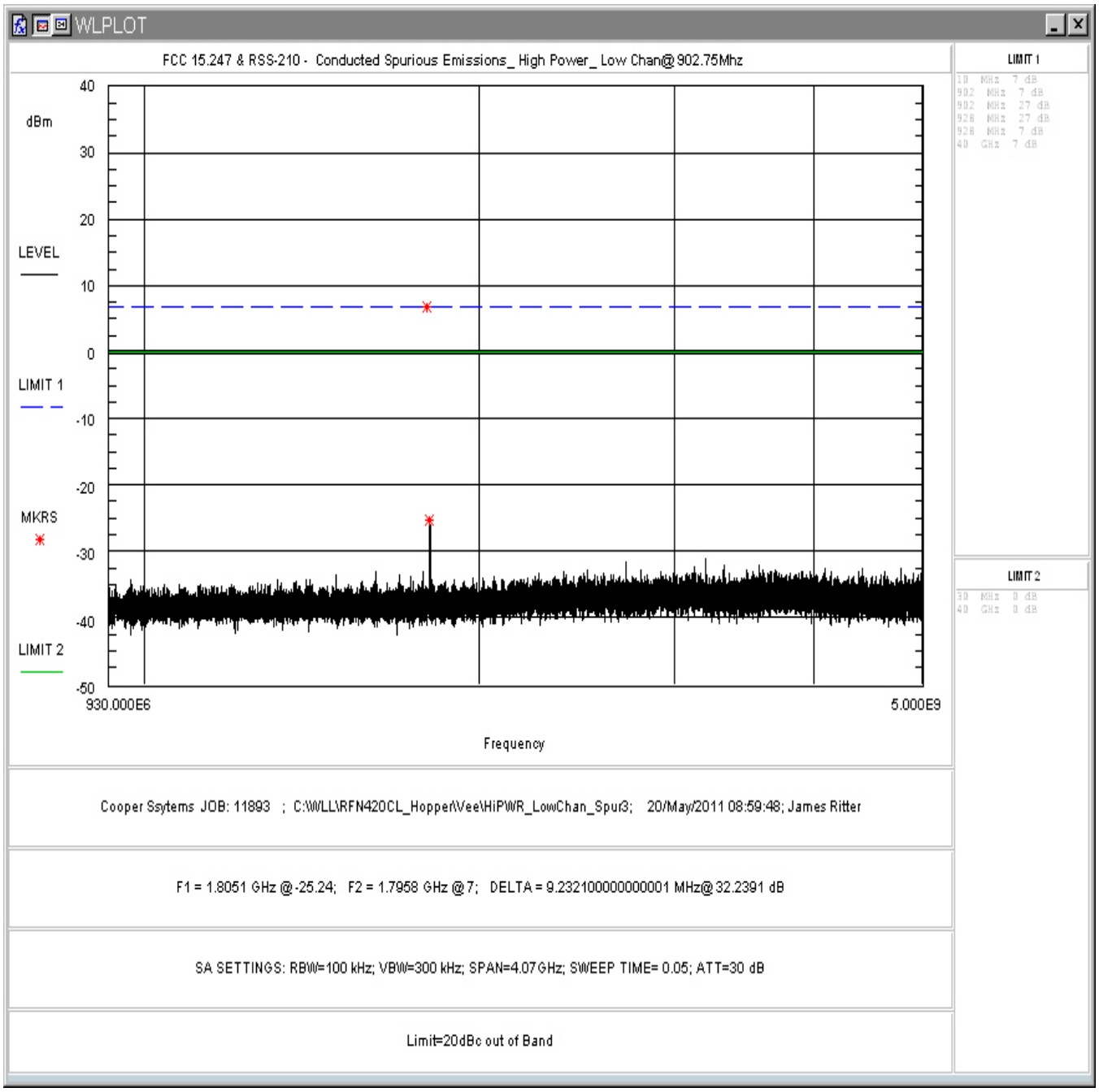

Figure 17: Conducted Spurious Emissions, High Power, Low Channel 930-5000MHz

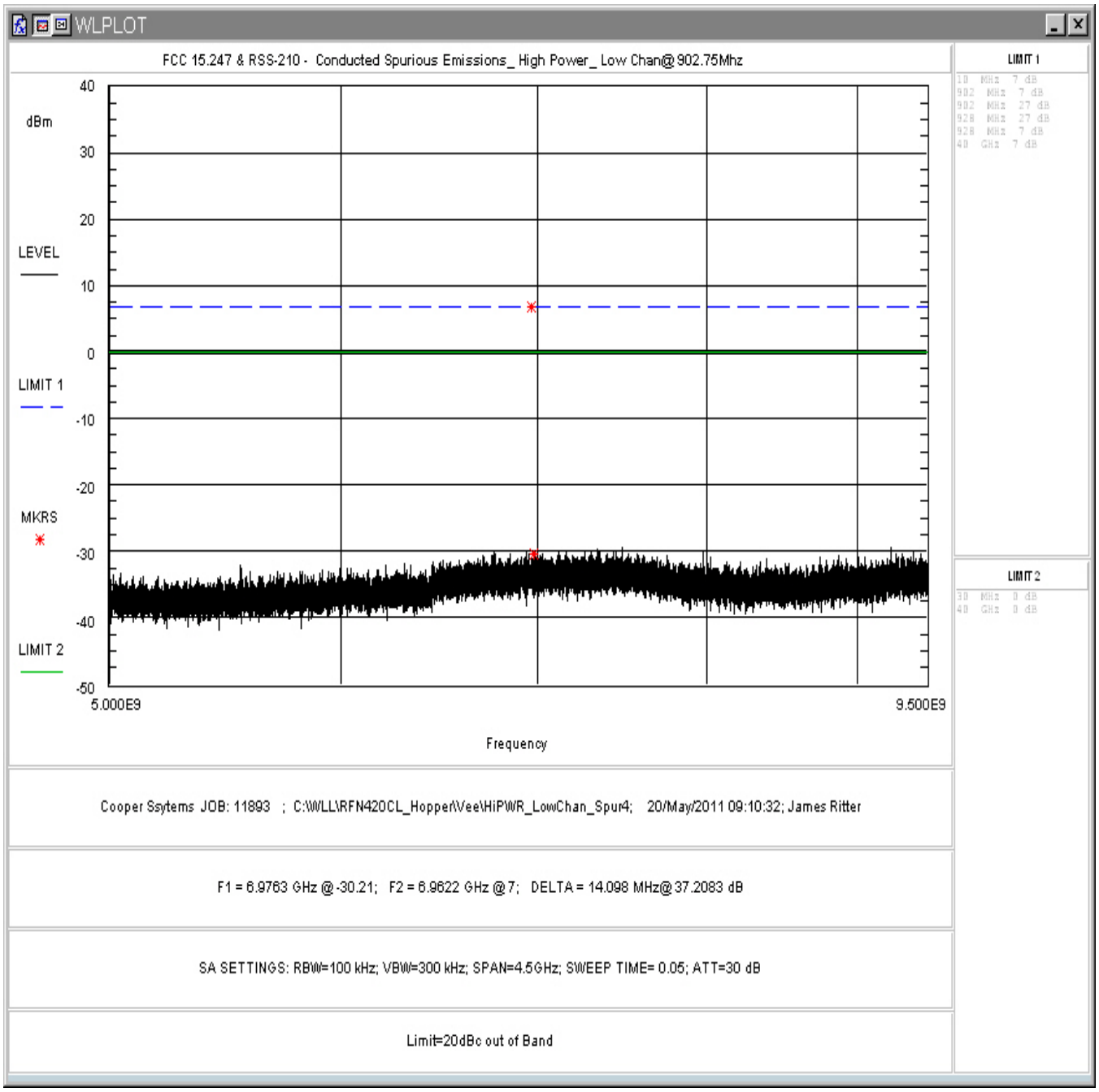

Figure 18: Conducted Spurious Emissions, High Power, Low Channel 5-9.5GHz

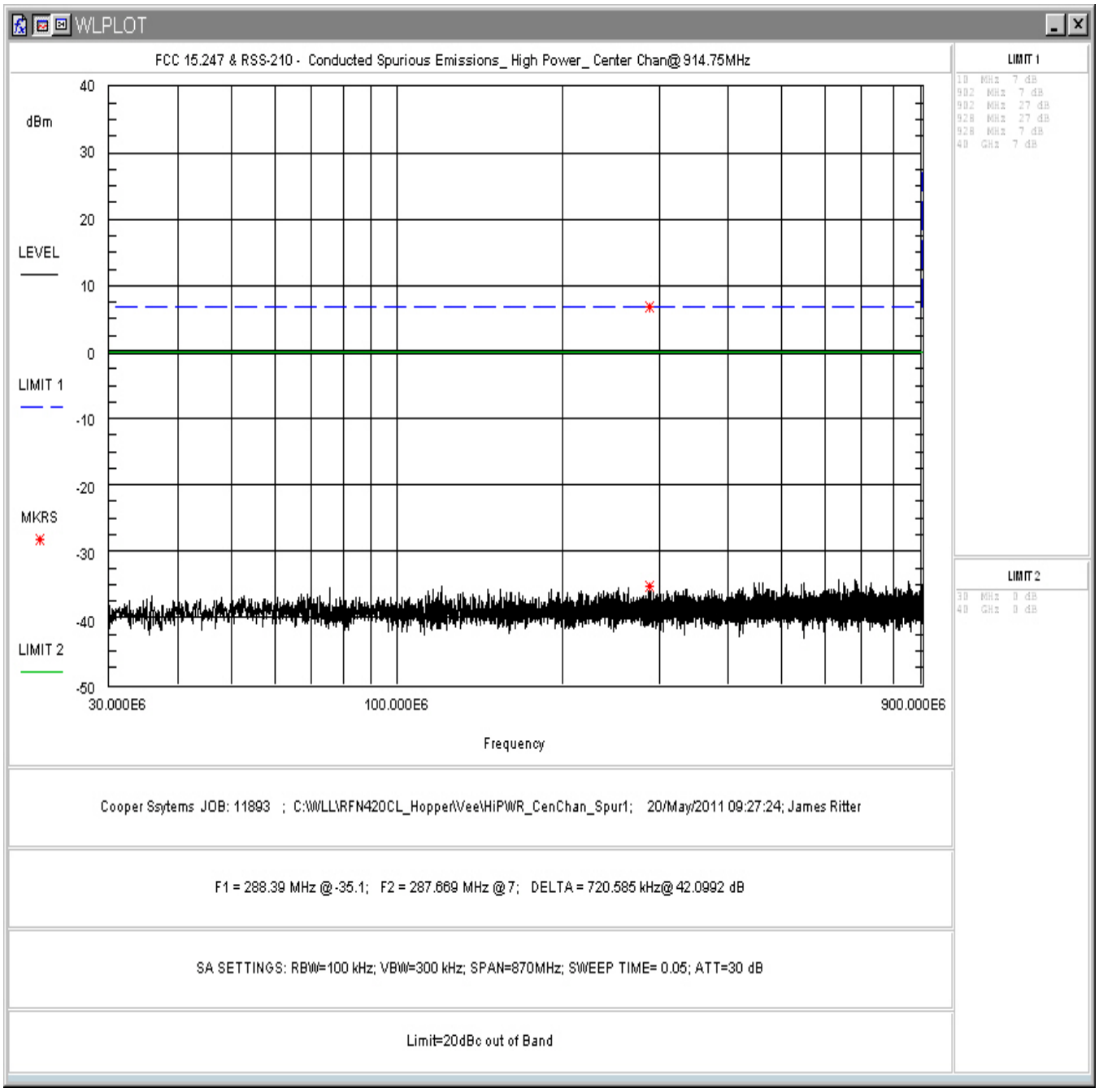

Figure 19: Conducted Spurious Emissions, High Power, Center Channel 30 - 900MHz

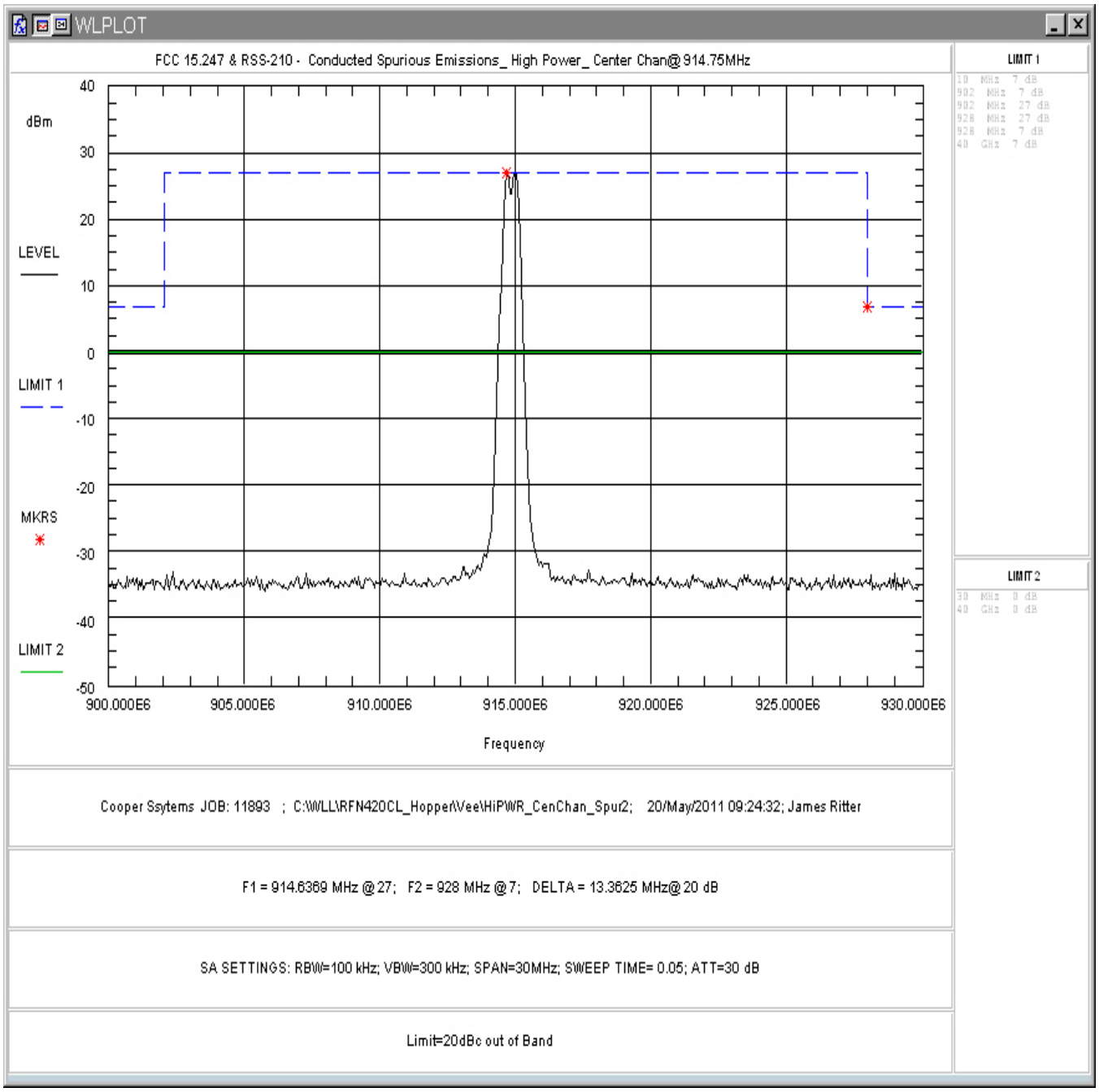

Figure 20: Conducted Spurious Emissions, High Power, Center Channel 900 – 930MHz

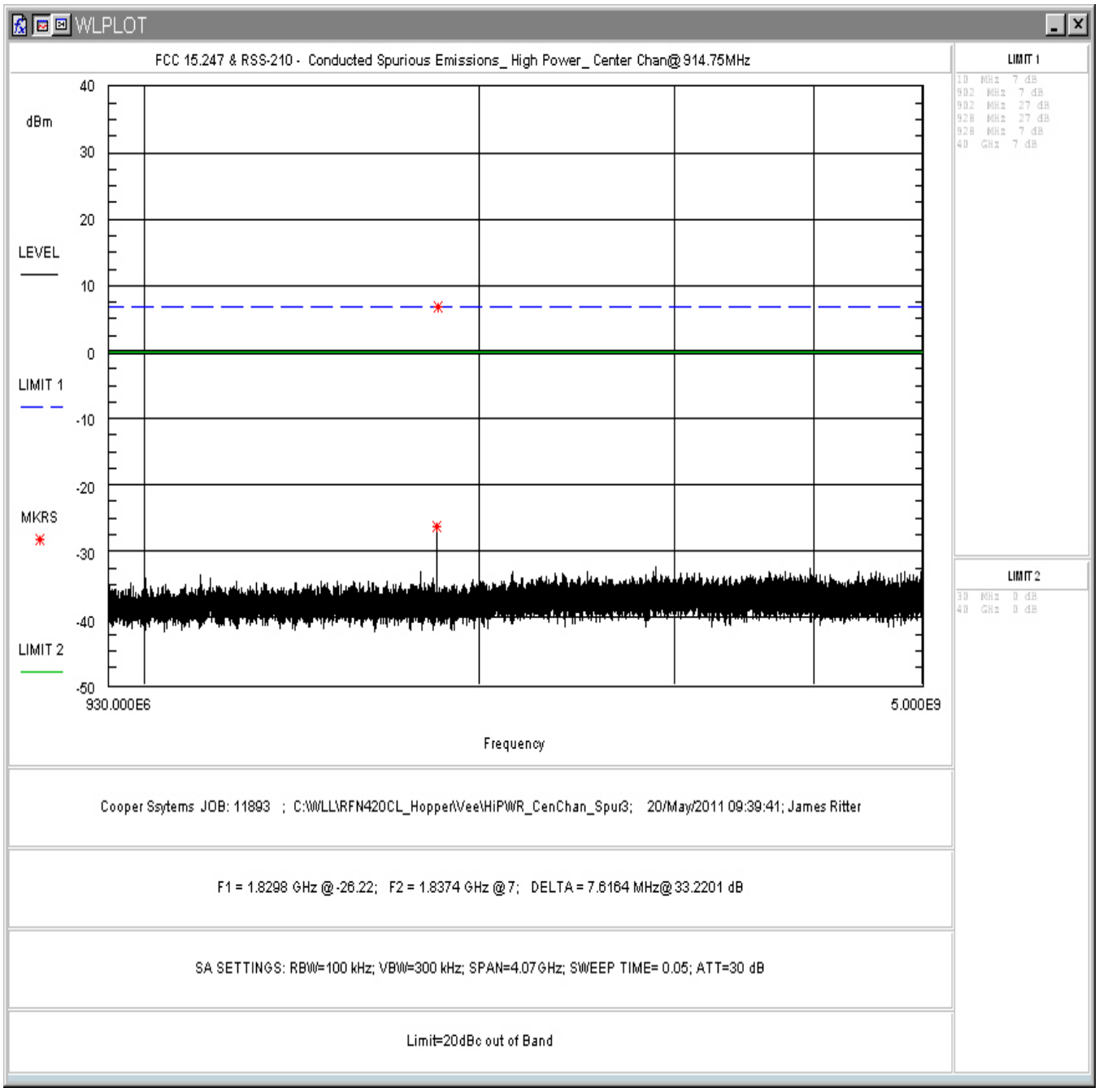

Figure 21: Conducted Spurious Emissions, High Power, Center Channel 930-5000MHz

