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
RFN SelectComm-MRB3
Limited Module Approval

FCC ID: P9X-RFNSCOMMMR3
IC ID: 6766A-RFNSCOMMMR3

WLL JOB# **12437**
March 30, 2012

Re-Issued May 25, 2012

Prepared for:

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

Prepared By:

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

Testing Certificate AT-1448

FCC & Industry Canada Certification Test Report
for the
Cooper Power Systems
RFN SelectComm-MRB3
Limited Module Approval
FCC ID: P9X-RFNSCOMMMR3
IC ID: 6766A- RFNSCOMMMR3

March 30, 2012

Re-Issued May 25, 2012

WLL JOB# 12437

Prepared by:

Steven Dovell
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, for which they are seeking Limiter Modular Approval. The reason that LMA is requested is because the manufacturer wants to remove the 12V and 5V regulator circuits and power the unit from an external 3.3V source.

The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2010) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 of Industry Canada. This Certification Test Report documents the test configuration and test results for the Cooper Power Systems RFN SelectComm-MRB3 Limited 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 RFN SelectComm-MRB3 Limited 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	March 30, 2012
Rev 1	Corrected report	April 25, 2012
Rev 2	Changed FCC & IC ID	May 25, 2012

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The Cooper Power Systems RFN SelectComm-MRB3 Limited Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (10/2010) and Industry Canada RSS-210 issue 7.

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:	4504325795
Quotation Number:	66716

1.4 Test Dates

Testing was performed on the following date(s):	3/21/12 – 3/23/12

1.5 Test and Support Personnel

Washington Laboratories, LTD	Steven Dovell
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 RFN SelectComm-MRB3 is a radio communications device designed for use in Cooper Power System's EkaNet RF mesh networks. It has no sensor or meter directly associated with it, and can be used in a variety of applications to extend the range and reliability of the RF mesh network. It is designed to be used in Cooper's LCR. The RFN SelectComm-MRB3 provides a 915 MHz radio interface. The RFN SelectComm MRB3 is identical to the

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Cooper Power Systems
FCC ID:	P9X-RFNSCOMMMR3
IC:	6766A-RFNSCOMMMR3
Model:	RFN SelectComm-MRB3
FCC Rule Parts:	§15.247
Industry Canada:	RSS210
Frequency Range:	902.75 – 927.25MHz
Maximum Output Power:	29.73dBm (940mW)
Modulation:	FSK
Occupied Bandwidth:	480.361kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Variable from -30.33dBm to 29.84 dBm
Antenna Connector	MCX
Antenna Type	3 antennas: HGV-906U 900MHz Omnidirectional – 6dBi 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	480KFXD
Highest TX spurious Emission	107.6 uV/m @ 3m – 966.6MHz
Highest RX Spurious Emission	80.4uV/m @3m – 250.17MHz

2.2 Test Configuration

The Cooper Power Systems RFN SelectComm-MRB3, Equipment Under Test (EUT), was operated in the Cooper Power System Model LCR which was powered from 120VAC & 230VAC power. The LCR provides the regulated 3.3VDC that powers the RFN SelectComm MRB3. 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 RFN SelectComm-MRB3 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**		Test Date: **3/22/12**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00618	HP - 8563A	ANALYZER SPECTRUM	2/10/2013
528	AGILENT - E4446A	ANALYZER SPECTRUM	8/30/2012

Test Name: **Radiated Emissions**		Test Date: **03/23/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/27/2012
68	HP - 85650A	ADAPTER QP	6/22/2012
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	6/22/2012
72	HP - 8568B	ANALYZER SPECTRUM	6/22/2012
425	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	9/7/2013
66	HP - 8449B	PRE-AMPLIFIER RF. 1-26.5GHZ	12/12/2012
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	3/24/2012
337	WLL - 1.2-5GHZ	FILTER BAND PASS	3/24/2012

Test Name: **Conducted Emissions Voltage**		Test Date: **03/23/2012**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
124	SOLAR - 8012-50-R-24-BNC	LISN	7/8/2012
68	HP - 85650A	ADAPTER QP	6/22/2012
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	6/22/2012

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 7. 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	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	Pass
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	Pass
15.209	RSS-210 sect 2.6	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 39ms. This corresponds to a duty cycle correction of -8.1dB 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	19.5ms	NA	NA
Dwell time per 100ms	-14.199dB Correction	NA	NA
Time of Occupancy	0.156 sec per 10 sec	0.4 sec per 10 sec	Pass

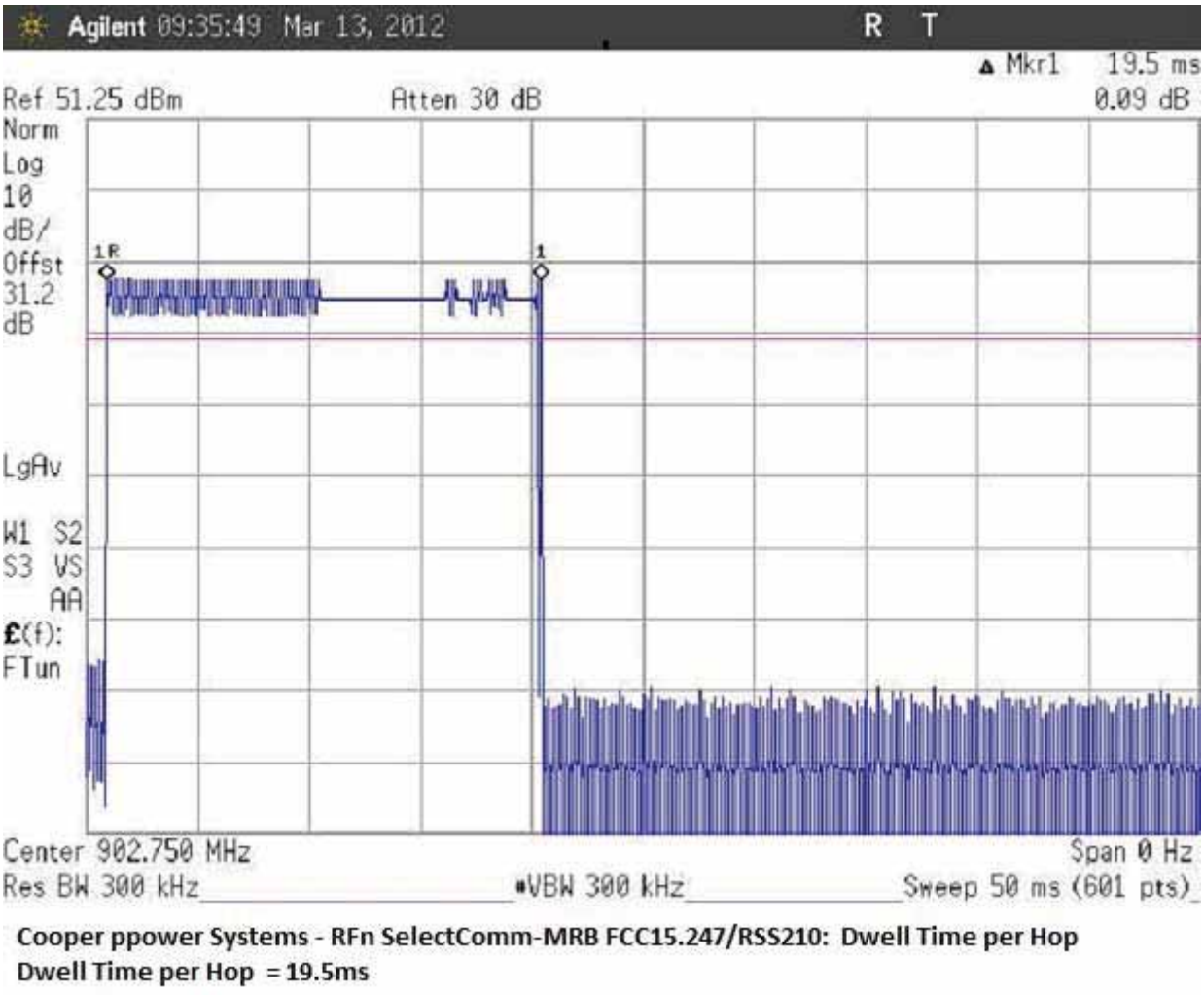


Figure 1: Single Hop Duty Cycle Plot

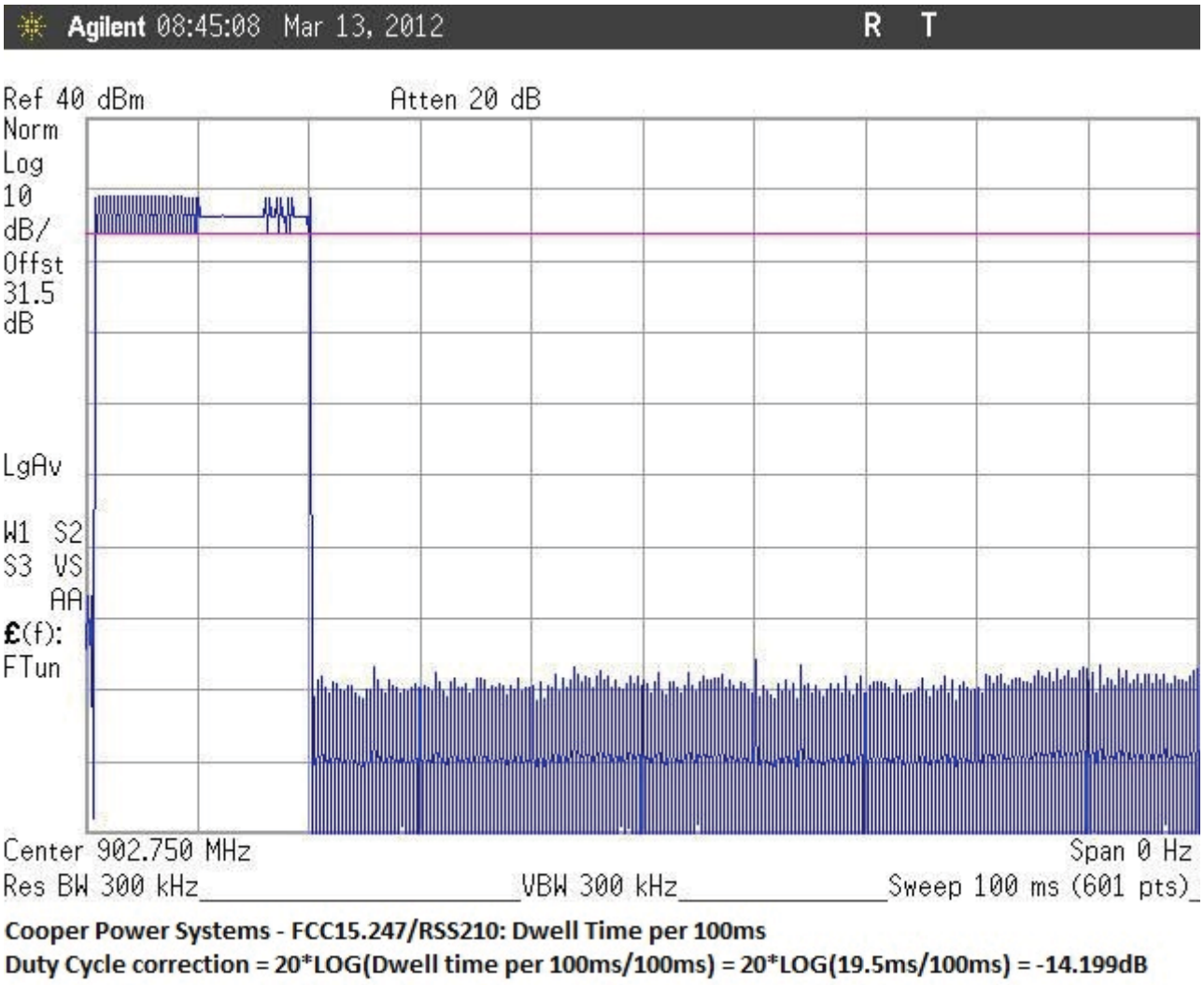
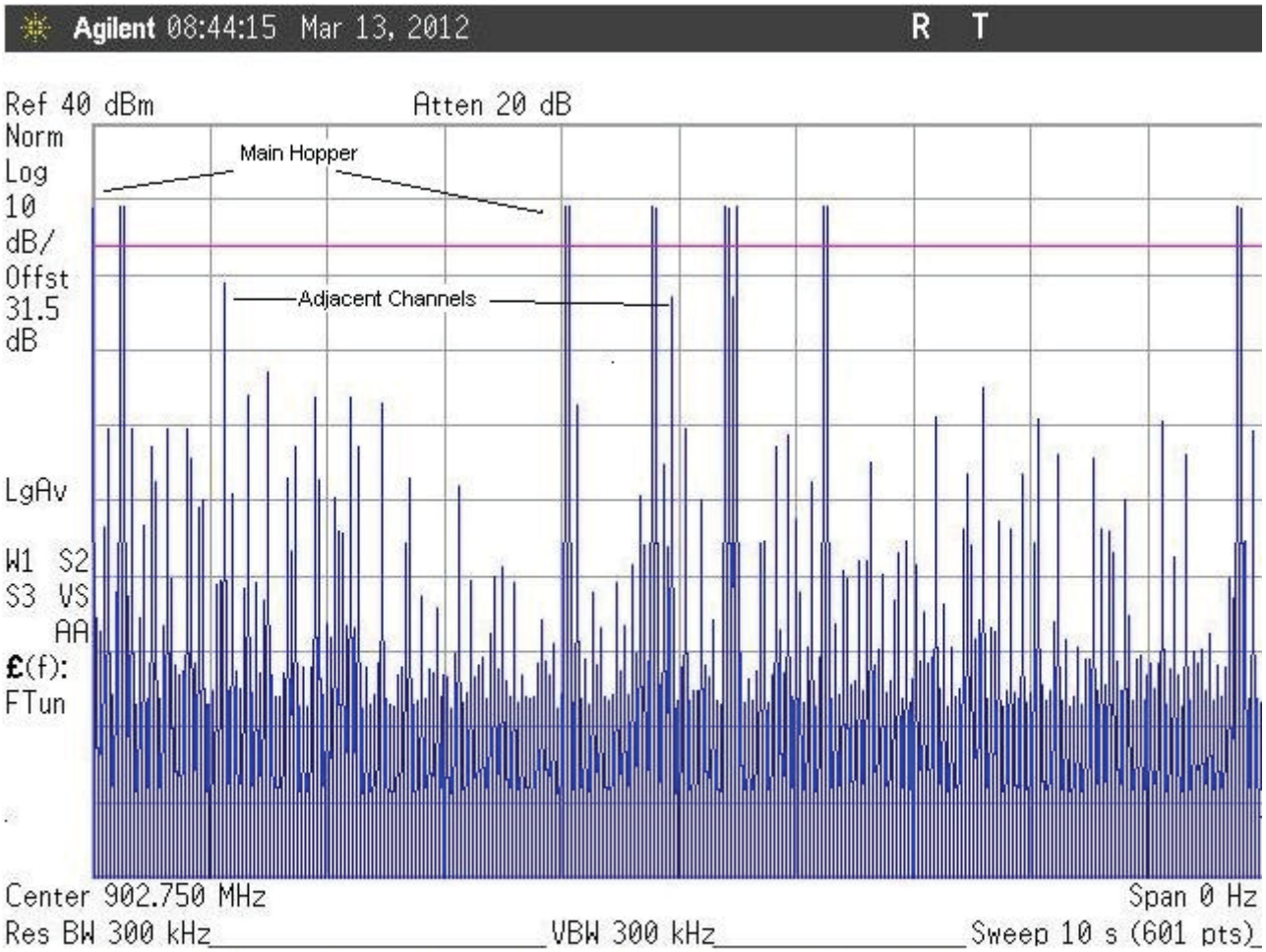


Figure 2: Dwell time per 100ms



Cooper Power Systems RFN SelectComm-MRB FCC15.247/RSS210: Time of Occupancy
Limit = 0.4sec / 10sec for 20dB bandwidths > 250kHz.
Plot shows 8 * 19.5ms = 0.156 sec/10sec

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 middle 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	Limit	Pass/Fail
Low Channel: 902.75MHz	High	28.97dBm	30 dBm	Pass
Center Channel: 914.75MHz	High	29.41dBm	30 dBm	Pass
High Channel: 927.25MHz	High	29.73dBm	30 dBm	Pass
Low Channel: 902.75MHz	Low	-30.07dBm	30 dBm	Pass
Center Channel: 914.75MHz	Low	-30.21dBm	30 dBm	Pass
High Channel: 927.25MHz	Low	-30.27dBm	30 dBm	Pass

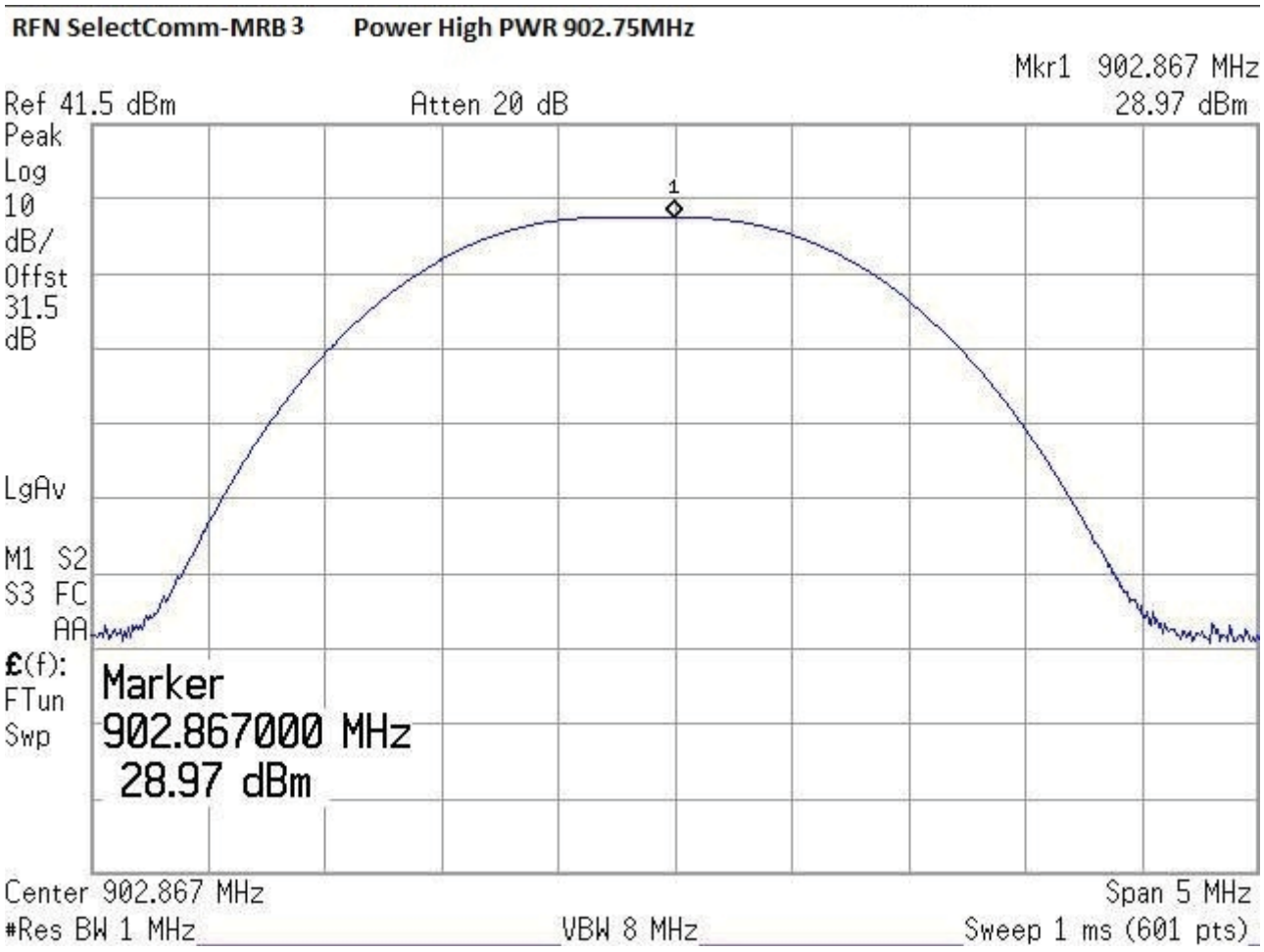


Figure 4: RF Peak Power, High Power, Low Channel

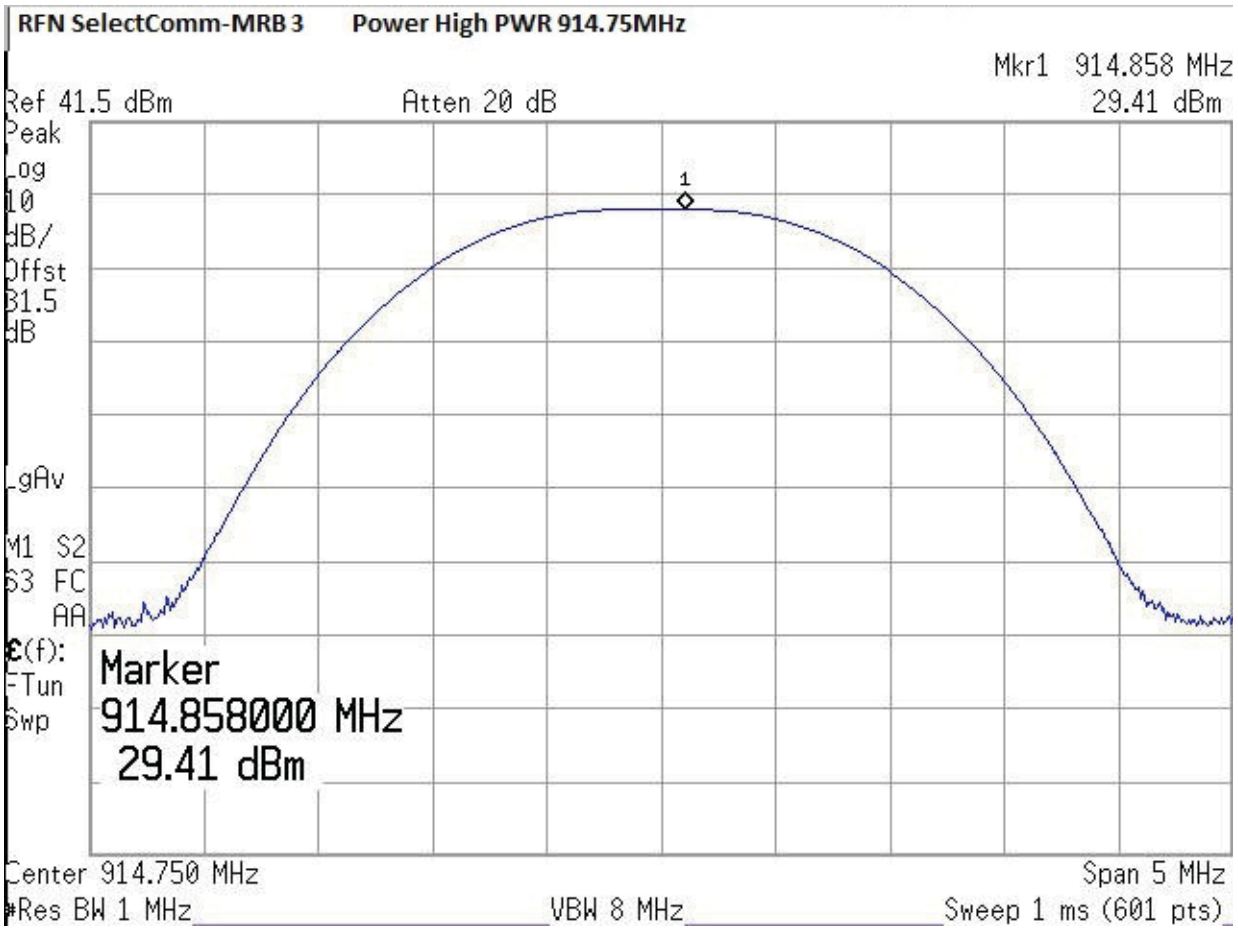


Figure 5: RF Peak Power, High Power, Center Channel

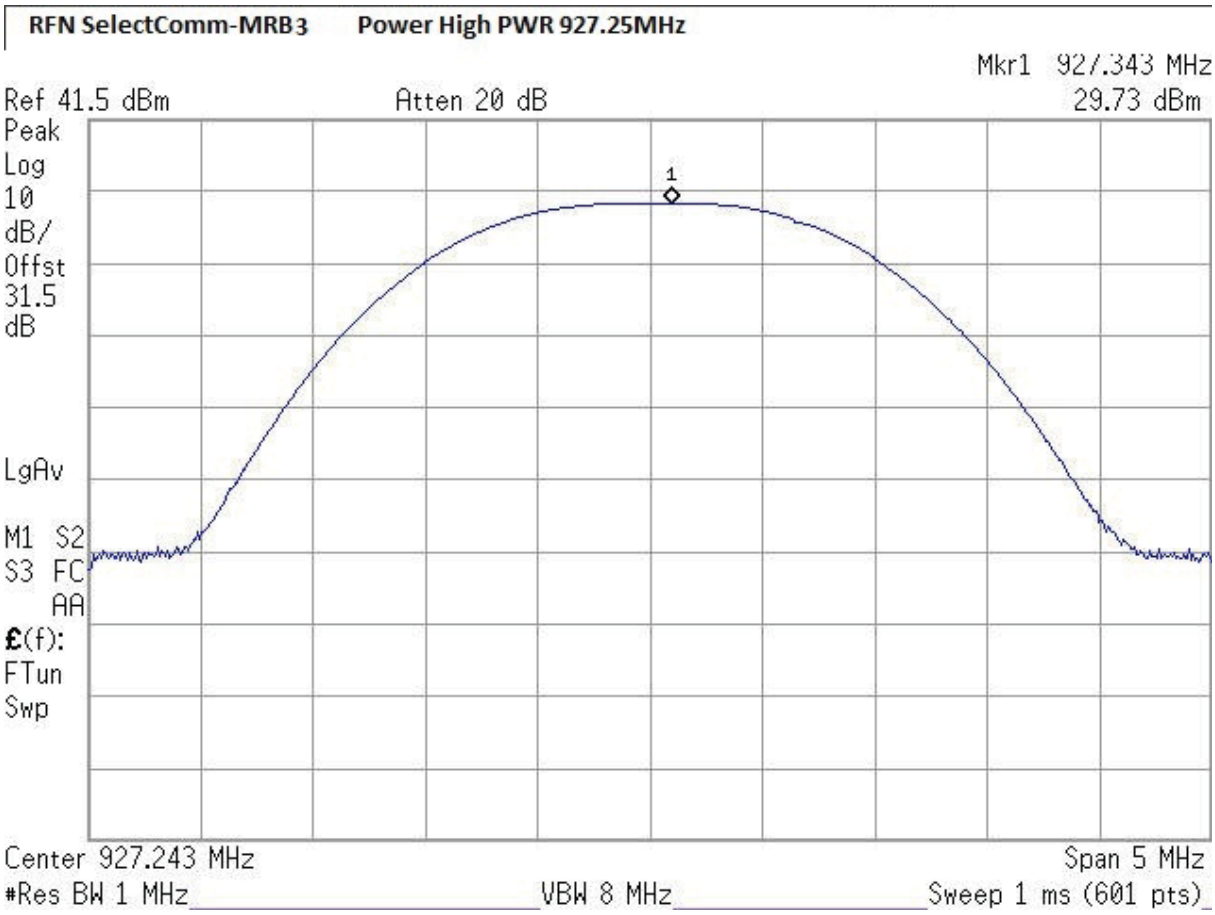


Figure 6: RF Peak Power, High Power, High Channel

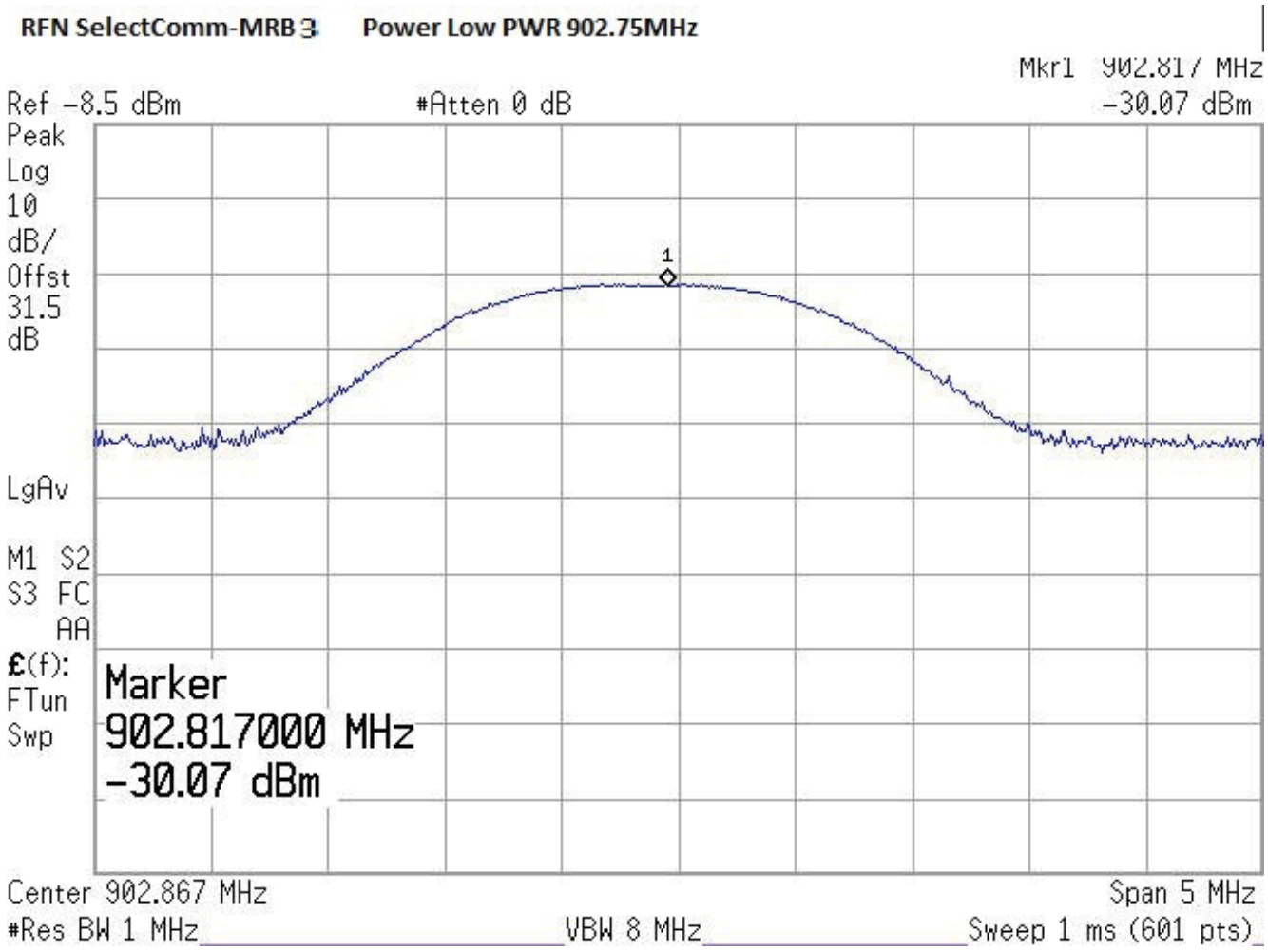


Figure 7: RF Peak Power, Low Power, Low Channel

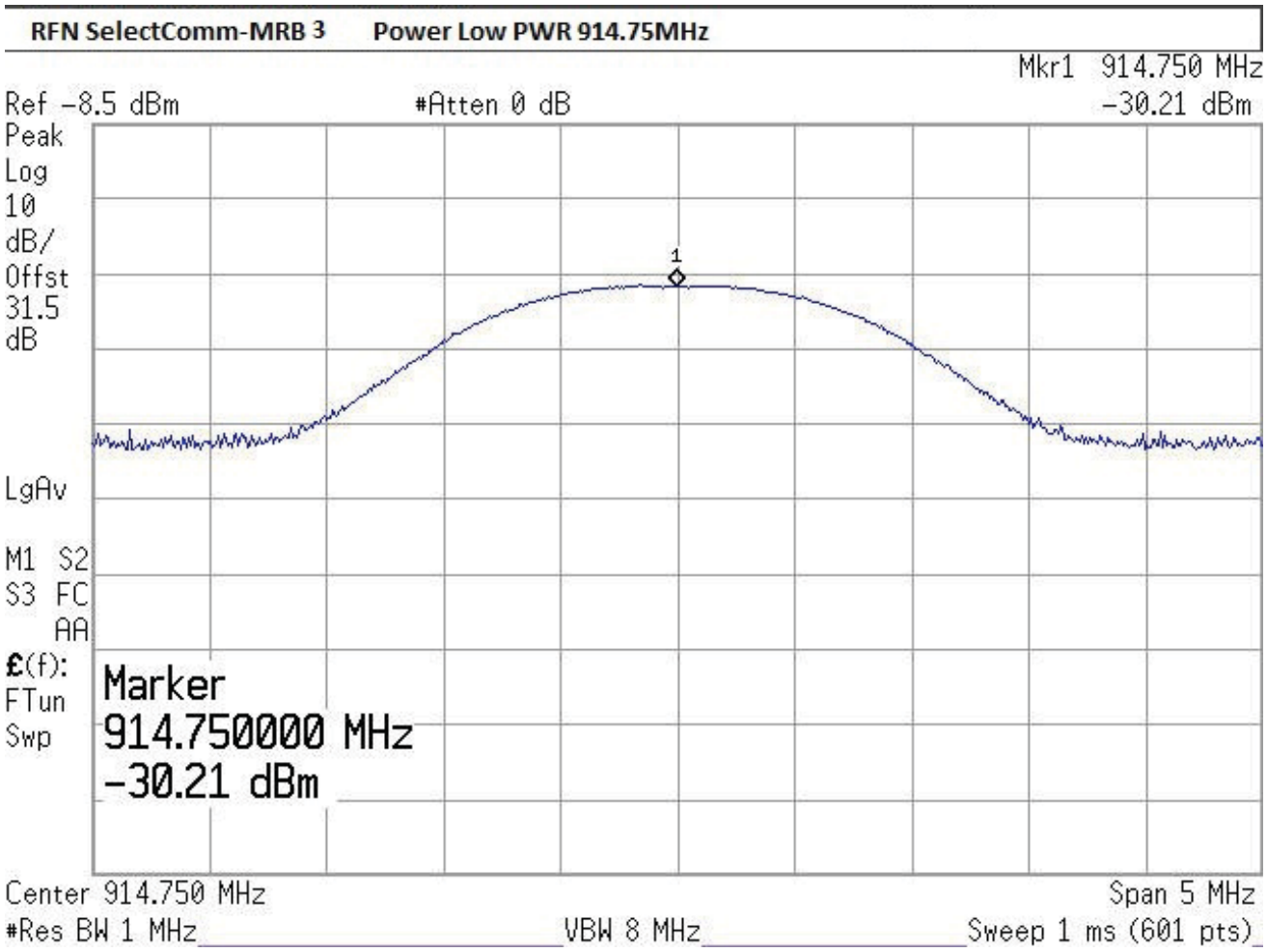


Figure 8: RF Peak Power, Low Power, Center Channel

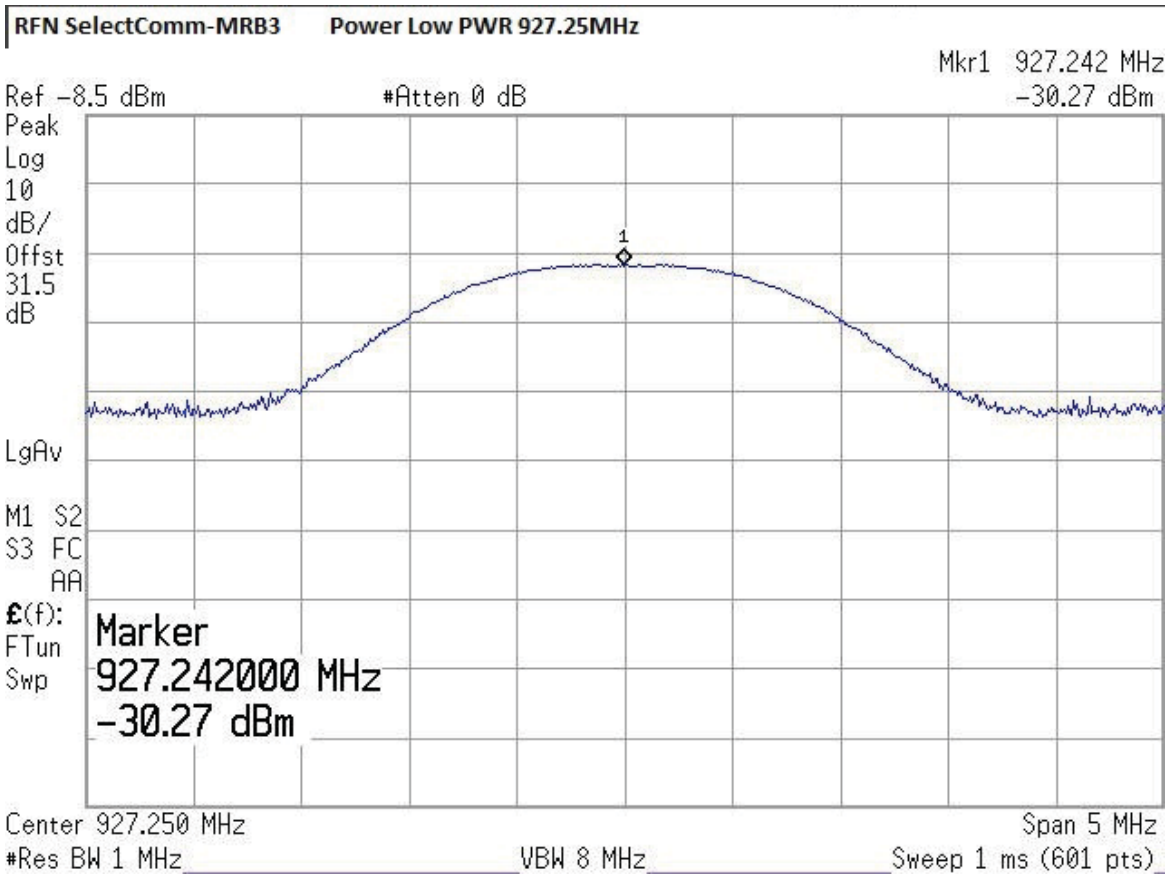


Figure 9: RF Peak Power, Low Power, High Channel

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	Limit	Pass/Fail
Low Channel: 902.75MHz	480.099kHz	500 kHz	Pass
Center Channel: 914.75MHz	470.368kHz	500 kHz	Pass
High Channel: 927.25MHz	480.361kHz	500 kHz	Pass

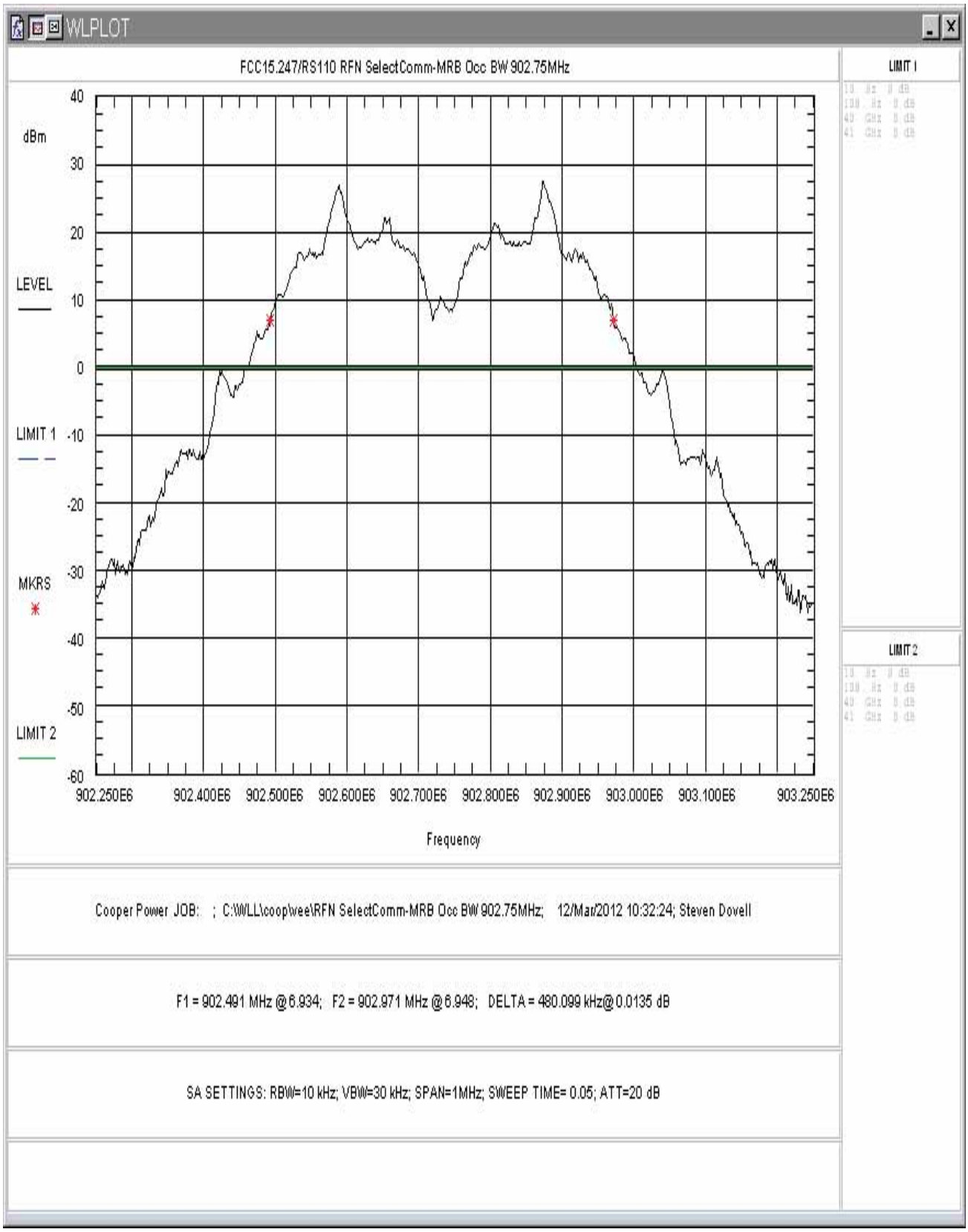


Figure 10: Occupied Bandwidth, Low Channel

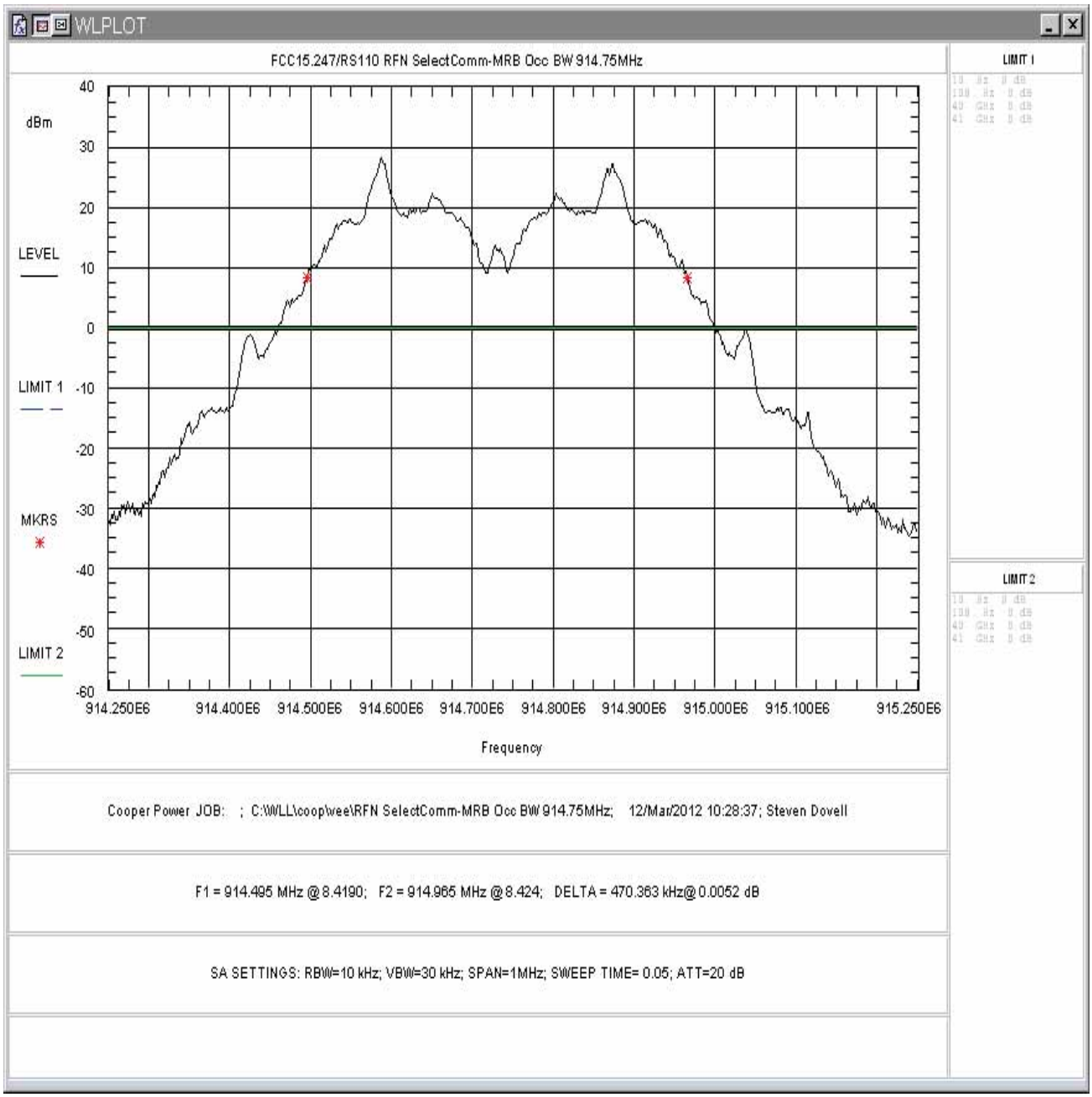


Figure 11: Occupied Bandwidth, Center Channel

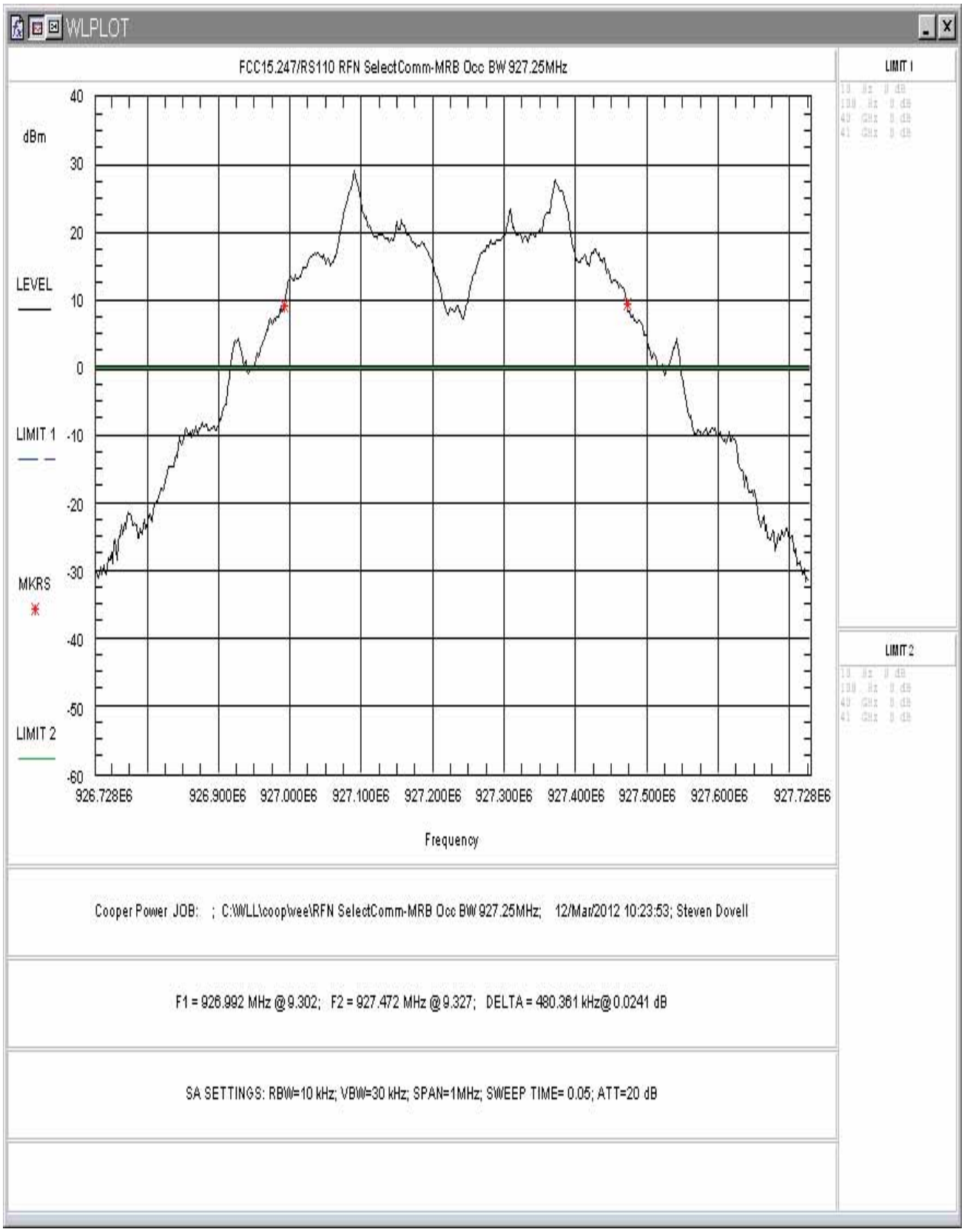


Figure 12: Occupied Bandwidth, High Channel

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 480.361kHz so the channel spacing must be more than 480.361kHz. 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 1MHz. Also, the number of hopping channels was measured from 902-928MHz using a RBW/VBW setting of 100kHz.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 498.333kHz and the number of channels used is 50.

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

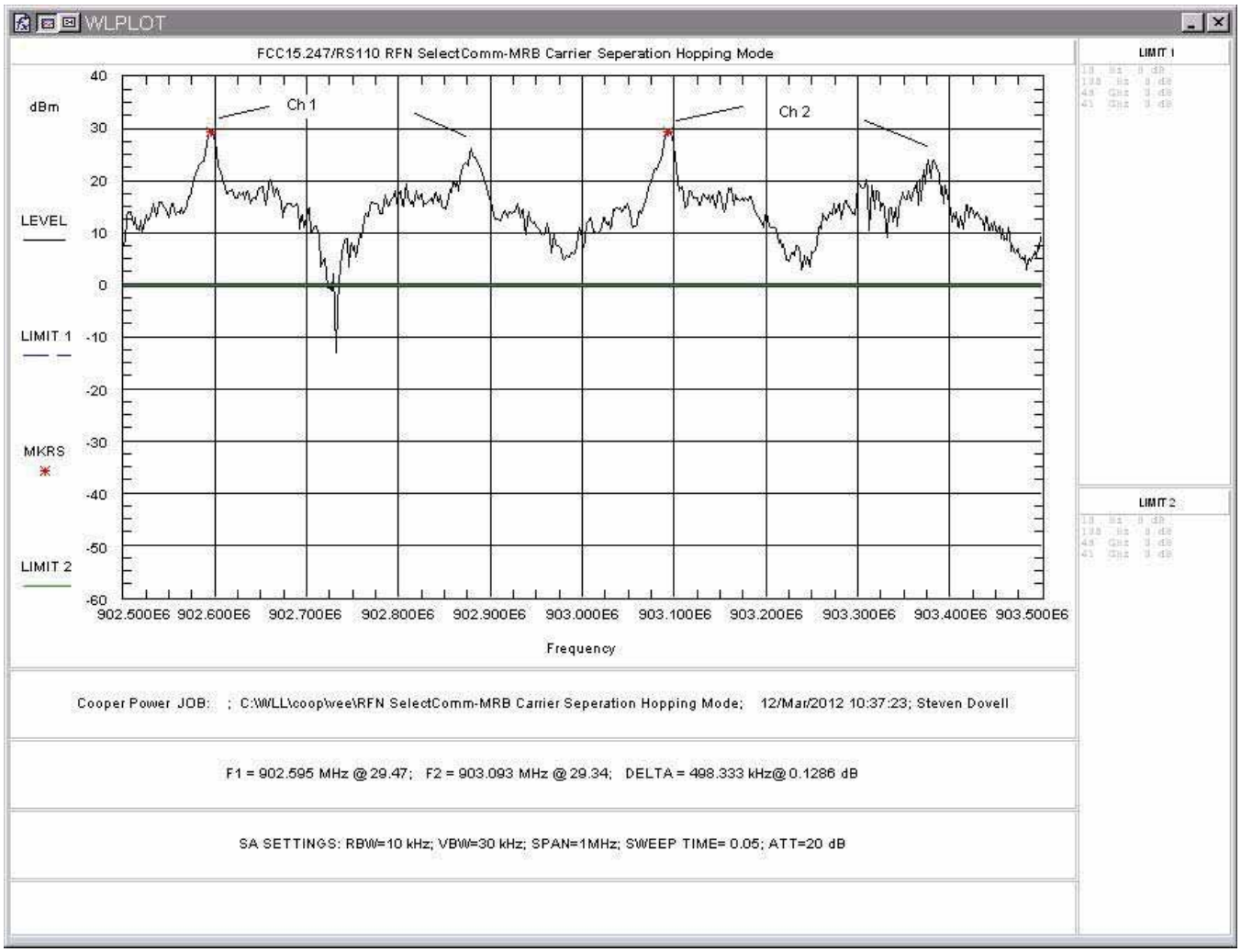


Figure 13: Channel Spacing

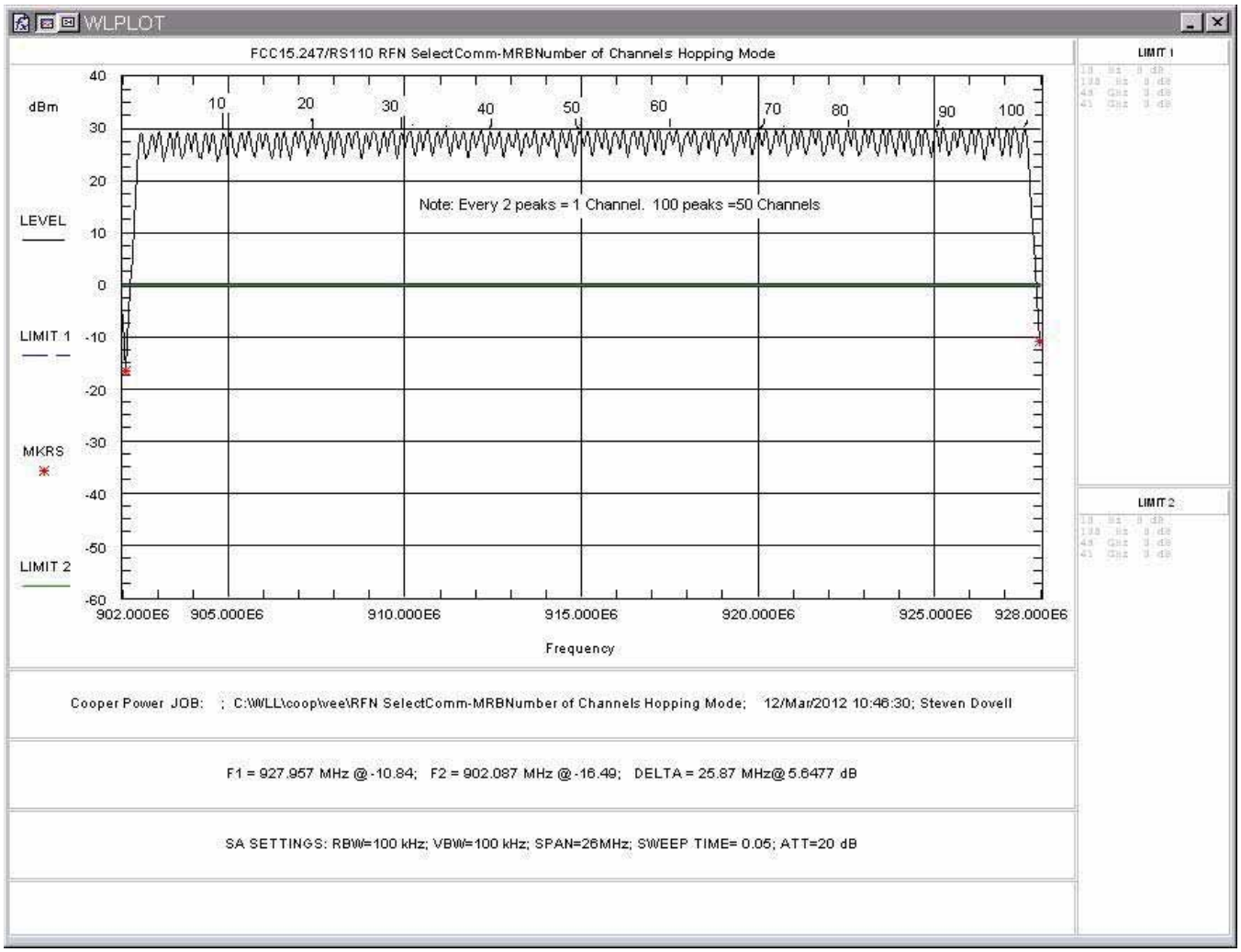


Figure 14: Number of Hopping Channels

Table 8: Channel Spacing and Number of Channels Results

Frequency	Result	Limit	Pass/Fail
Channel Spacing	498.333kHz	480.36kHz minimum	Pass
Number of channels	50 channels	25 channels minimum	Pass

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.

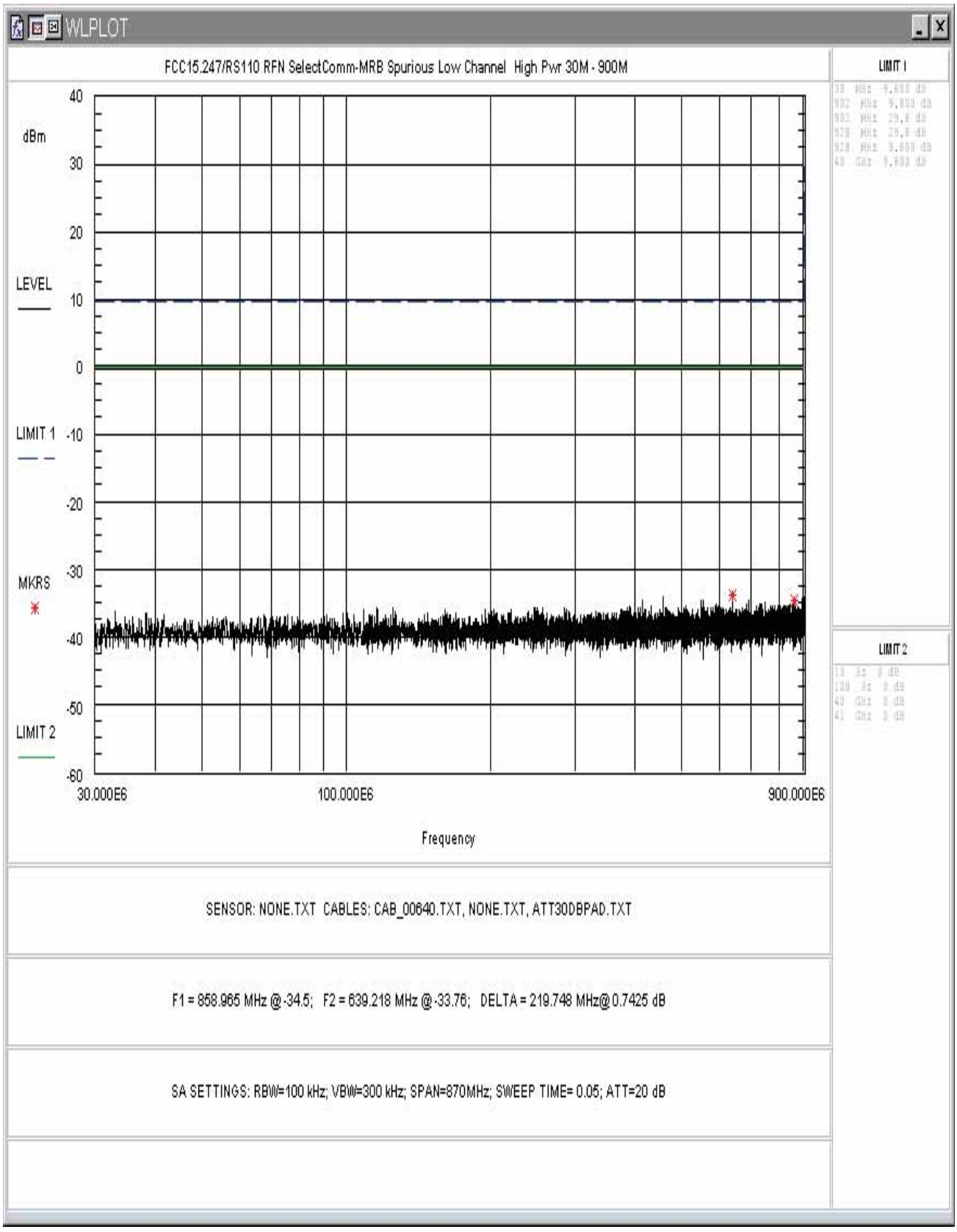


Figure 15: Conducted Spurious Emissions, High Power, Low Channel 30 - 900MHz

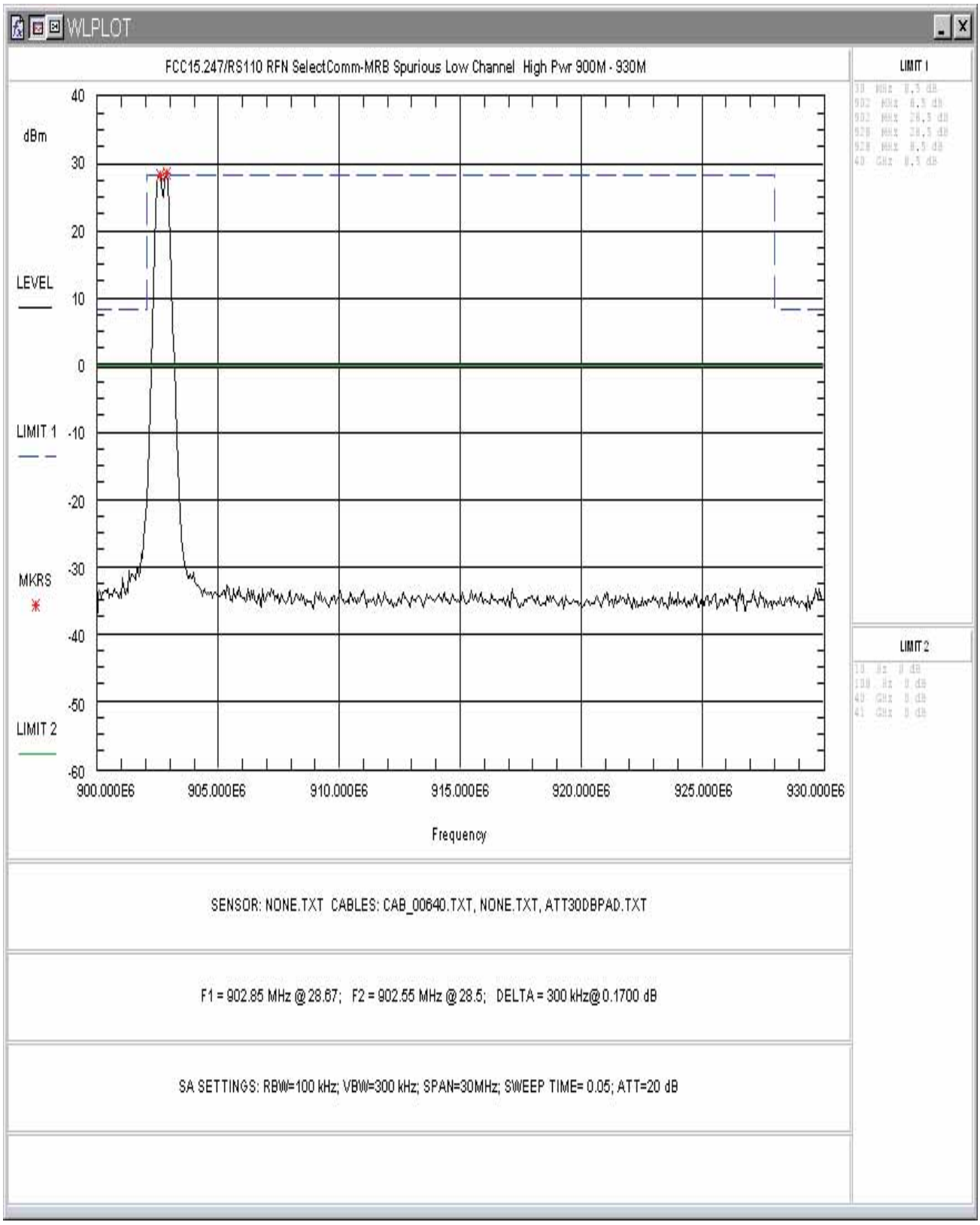


Figure 16: Conducted Spurious Emissions, High Power, Low Channel 900 – 930MHz

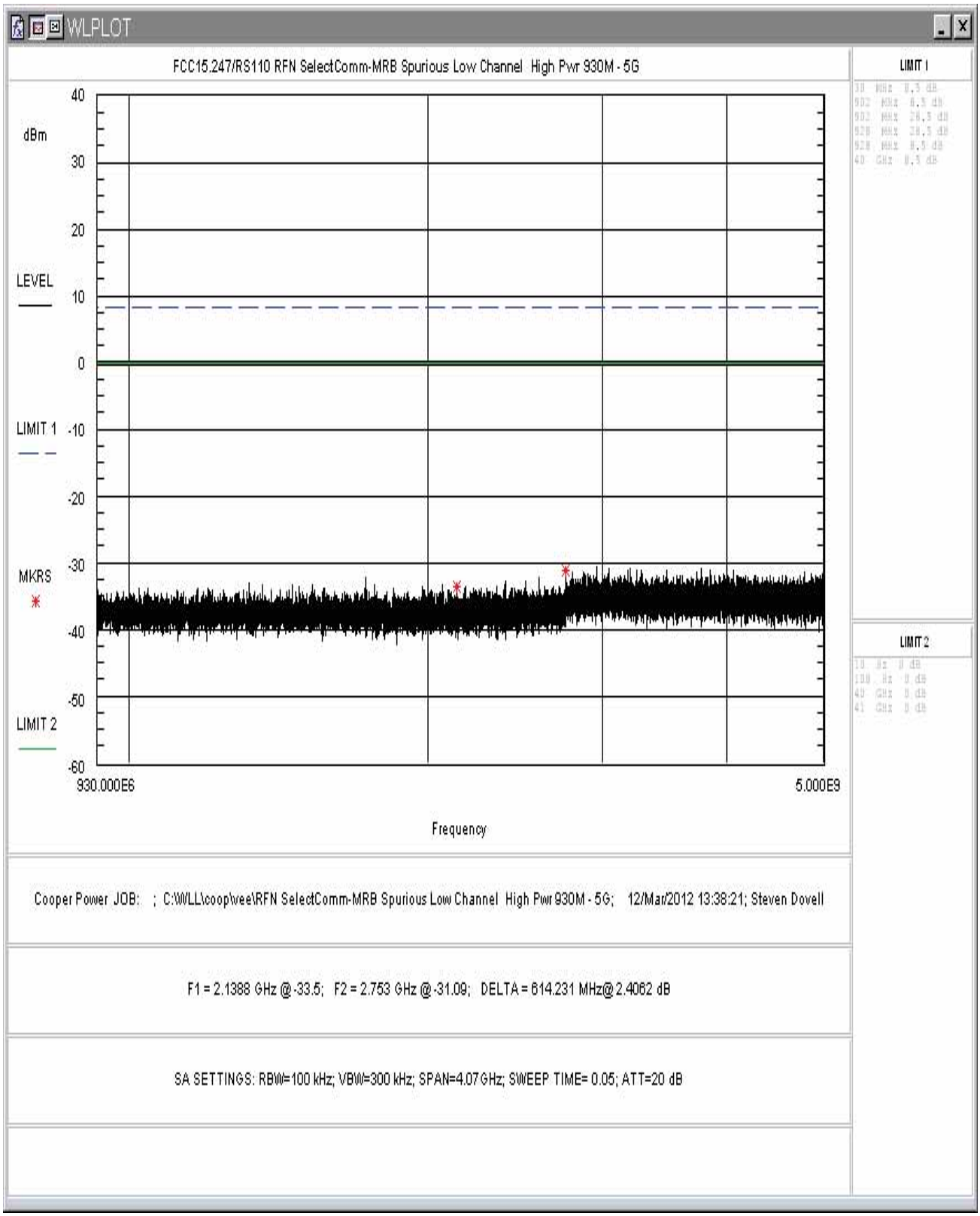


Figure 17: Conducted Spurious Emissions, High Power, Low Channel 930-5000MHz

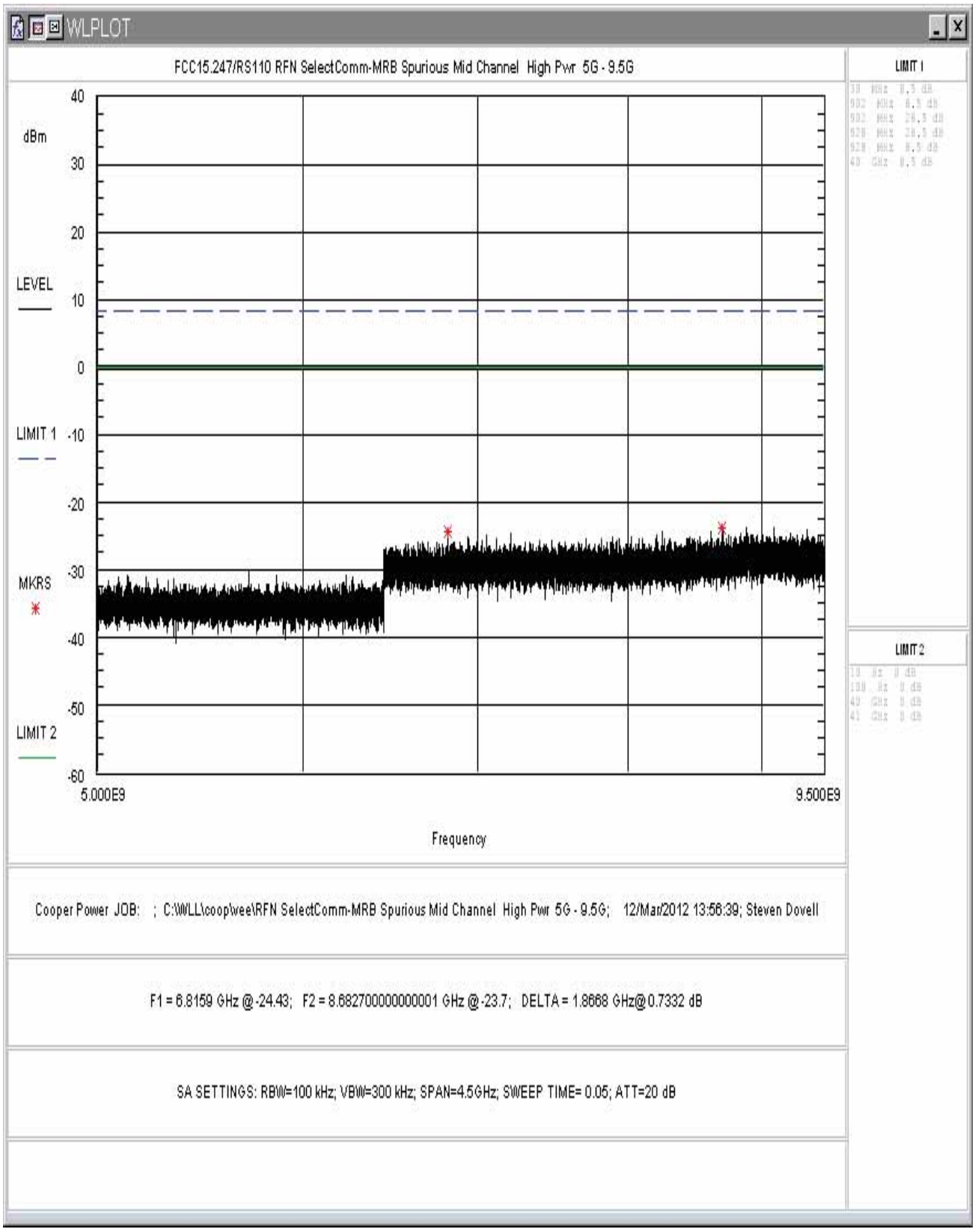


Figure 18: Conducted Spurious Emissions, High Power, Low Channel 5-9.5GHz

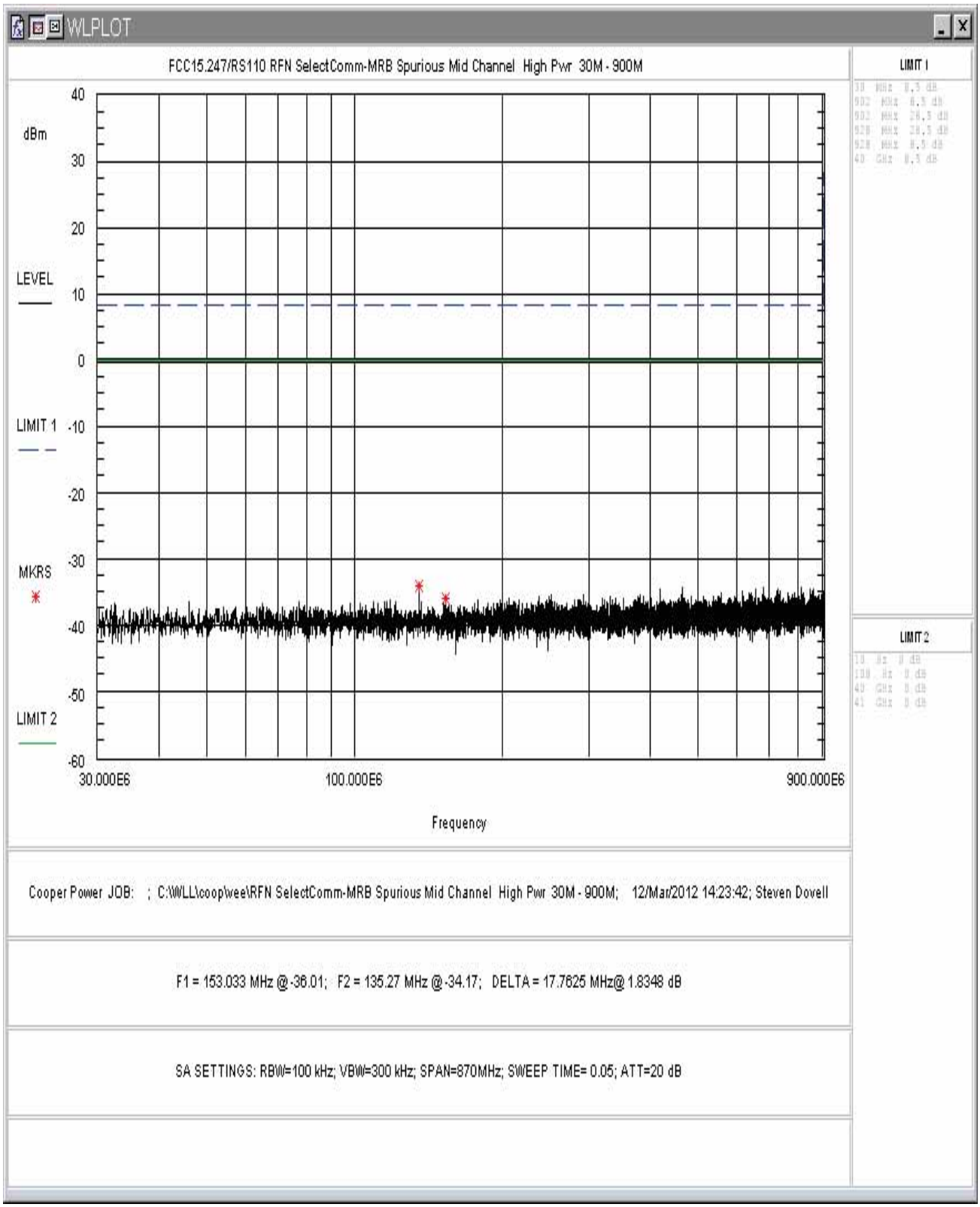


Figure 19: Conducted Spurious Emissions, High Power, Center Channel 30 - 900MHz

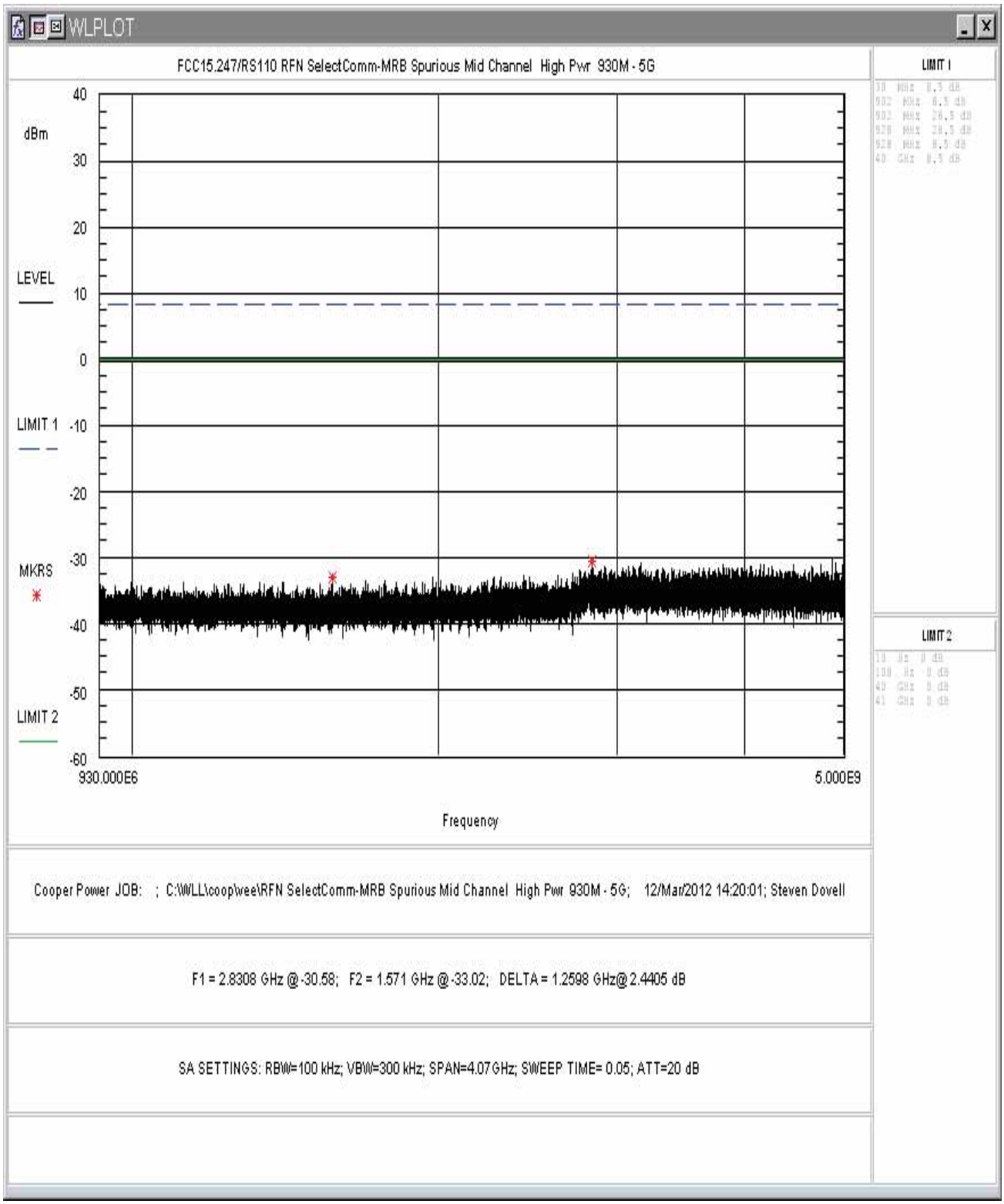


Figure 20: Conducted Spurious Emissions, High Power, Center Channel 900 – 930MHz

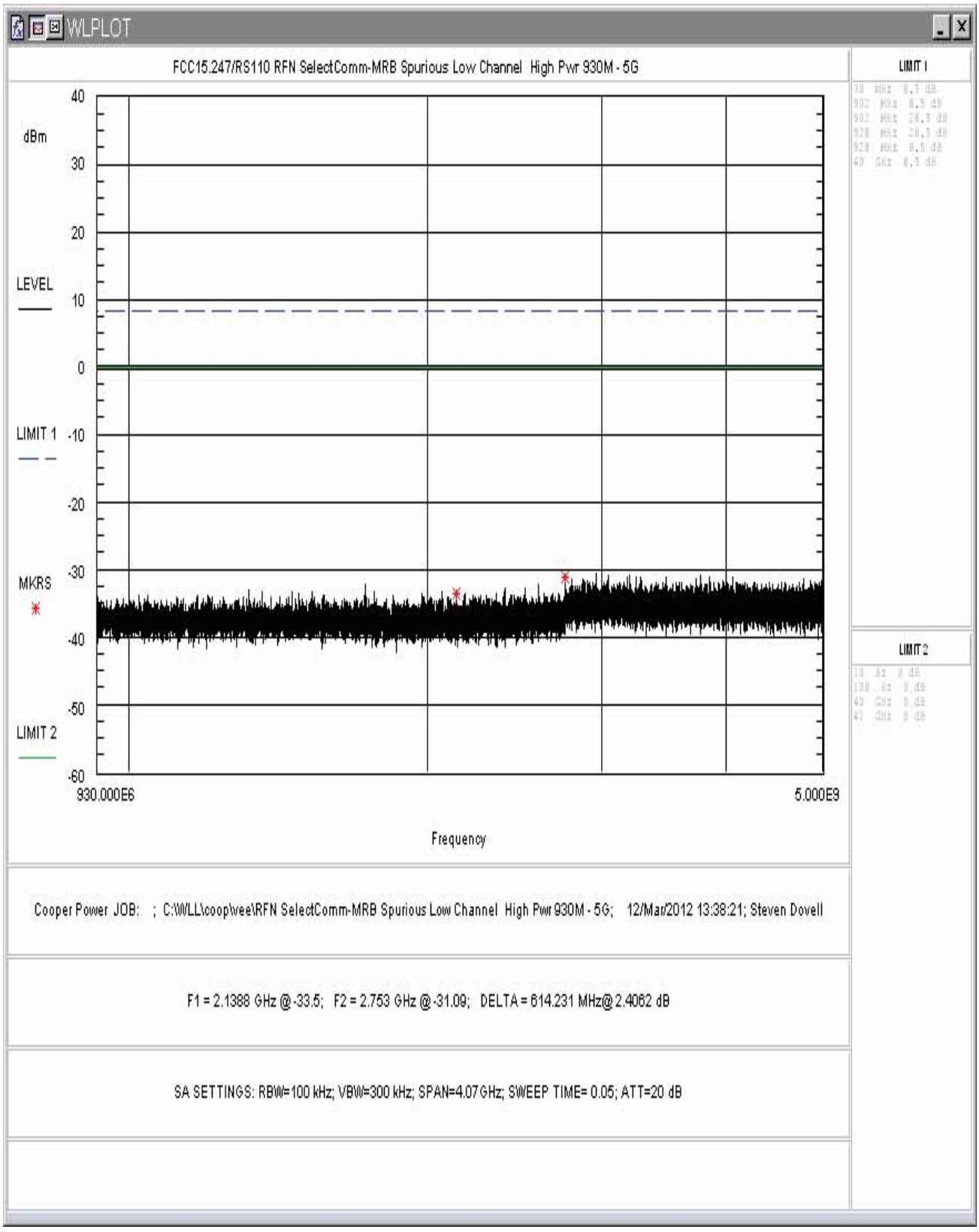


Figure 21: Conducted Spurious Emissions, High Power, Center Channel 930-5000MHz

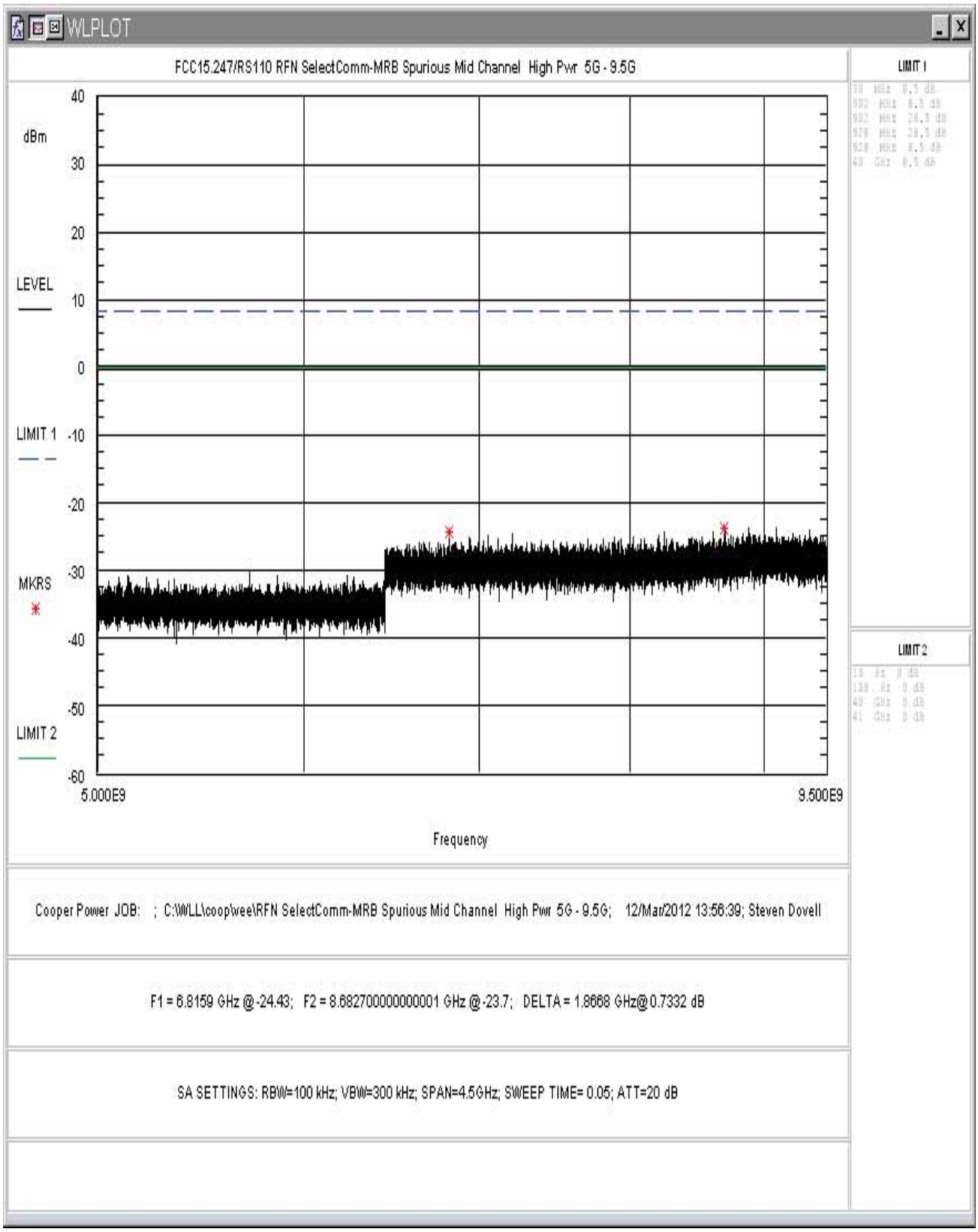


Figure 22: Conducted Spurious Emissions, High Power, Center Channel 5-9.5GHz

