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FCC Certification Test Report
For the
Mueller Systems
MINODE-C&I Radio Module

FCC ID: SM6-MINODE-CIH

WLL JOB# **11985-01 Rev 1**
May 27, 2011
Revised June 27, 2011

Prepared for:

Mueller Systems
48 Leona Drive
Middleboro, MA, 02346 USA

Prepared By:

Washington Laboratories, Ltd.
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Testing Certificate AT-1448

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FCC ID: SM6-MINODE-CIH

May 26, 2011
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Prepared by:

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Abstract

This report has been prepared on behalf of Mueller Systems to support the attached Application for Equipment Authorization. The test report and application are submitted for a modular Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2009) of the FCC Rules. This Certification Test Report documents the test configuration and test results for a Mueller Systems MINODE-C&I Radio 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 Mueller Systems MINODE-C&I Radio Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

Revision History	Description of Change	Date
Rev 0	Initial Release	May 27, 2011
Rev 1	Corrected Frequency of added channels from 902.25 to 904.25MHz on page 27. Moved “added channel note” position on table 18 page 29 in order to clarify plot	June 27, 2011

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1 Introduction

1.1 Compliance Statement

The Mueller Systems MINODE-C&I Radio Module complies with the limits for a modular Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (10/2009).

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed in the host device. All measurements were performed in accordance with FCC Public Notice DA 00-705, "Filing and Measurement Guidelines 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:	Mueller Systems 48 Leona Drive Middleboro, MA, 02346 USA
Quotation Number:	66227

1.4 Test Dates

Testing was performed on the following date(s):	5/2/2011 to 5/25/2011

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Steve Dovell
Client Representative	David Splitz

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1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**eres
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

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2 Equipment Under Test

2.1 EUT Identification & Description

The Mueller Systems MINODE-C&I radio module is a battery powered transceiver using 902.5-927.35MHz FHSS technology. The system uses 2 modes of operation data mode which uses 50 channels from 902.5 to 927MHz. The system also has a hailing mode to awaken units that are sleeping (these units go into a sleep mode when inactive). The hailing frequencies consist of 50 hailing channels from 902.65 to 927.35MHz. Both of these modes use FHSS technology. The characteristics (power & bandwidth) of the hailing channels are identical to the data channels and are produced from the same RF circuitry. For more detailed information refer to the theory of operation.

Table 1 Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mueller Systems
FCC ID:	SM6-MINODE-CIH
Model:	MINODE-C&I Radio Module
FCC Rule Parts:	§15.247
Frequency Range:	902.5-927.35MHz
Maximum Output Power: (conducted at antenna port)	29.67dBm (926.8mW)
Modulation:	FM
Occupied Bandwidth:	42.13 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50 Data Channels & 50 Hailing Channels
Power Output Level	Fixed
Antenna Connector	MMCX
Antenna Type	2.7dBi dipole
Interface:	None
Power Source & Voltage:	120VAC

2.2 Modification

None.

2.3 Test Configuration

The MINODE-C&I Radio Module was operated from a 120VAC power source. Commands were sent to the MINODE-C&I Radio Module using a serial cable (maintenance port) to a support laptop using Windows HyperTerminal program. This connection was disconnected after the test mode was set (for radiated measurements).

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2.4 Testing Algorithm

The MINODE-C&I Radio Module was programmed via an internal 3 pin programming port on the EUT to a serial dB9 port on the support laptop. The support laptop used HyperTerminal to command the EUT to transmit on the lowest, center, and highest channels (of both data and hailing modes). Commands were also sent to allow the unit to transmit in a hopping fashion. The unit was preloaded with a typical data payload to transmit.

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

2.5 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.

2.6 Measurements

2.6.1 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

2.7 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

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

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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

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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: **Antenna Port Conducted Emissions**		Test Date: **04/14/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	ANALYZER SPECTRUM	9/27/2011
Ser #1053184	HP - 8563EC	ANALYZER SPECTRUM	02/13/2013

Test Name: **Radiated Emissions**		Test Date: **05/25/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	ANALYZER SPECTRUM	9/27/2011
626	ARA - DRG-118/A	ANTENNA HORN	6/3/2011
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	5/4/2012
742	PENN ENGINEERING - WR284	2.2-4.15GHZ BANDPASS FILTER	7/19/2012
280	ITC - 21C-3A1	WAVEGUIDE 3.45-11.0GHZ	3/24/2012
282	ITC - 21X-3A1	WAVEGUIDE 6.8-15GHZ	3/24/2012
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	1/12/2012

Test Name: **Conducted Emissions Voltage**		Test Date: **05/25/2011**	
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
68	HP - 85650A	ADAPTER QP	6/22/2011
72	HP - 8568B	ANALYZER SPECTRUM	6/22/2011

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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. Full results are shown in section 5.

Table 4 Test Summary Table

FCC Rule Part	Description	Result
15.247 (a)(1)(i)	20dB Bandwidth	Pass
15.247 (b)(2)	Transmit Output Power	Pass
15.247 (a)(1)	Channel Separation	Pass
15.247 (a)(1)(i)	Number of Channels =50 minimum	Pass
15.247 (a)(1)(i)	Time of Occupancy	Pass
15.247 (d)	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	AC Conducted Emissions	NA

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5 Test Results

5.1 Duty Cycle and Time of Occupancy

In accordance with the FCC Public Notice the spurious radiated emissions measurements may be adjusted if 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)

5.1.1 Data Mode Timing

As the Maximum Dwell time of this device is 200ms for data mode no duty cycle correction is allowed.

FCC part 15.247 requires that for hopping signals with an occupied bandwidth less than 250 kHz the limit is 0.4 seconds dwell time per 20 seconds

The following figures show the plot of the dwell time and time of occupancy for the transmitter. Based on this plot, the dwell time per hop is 200ms. As the unit is on a channel twice in a 20 second period the time of occupancy is 400ms per 20 seconds, thus complying with the 0.4 second requirement.

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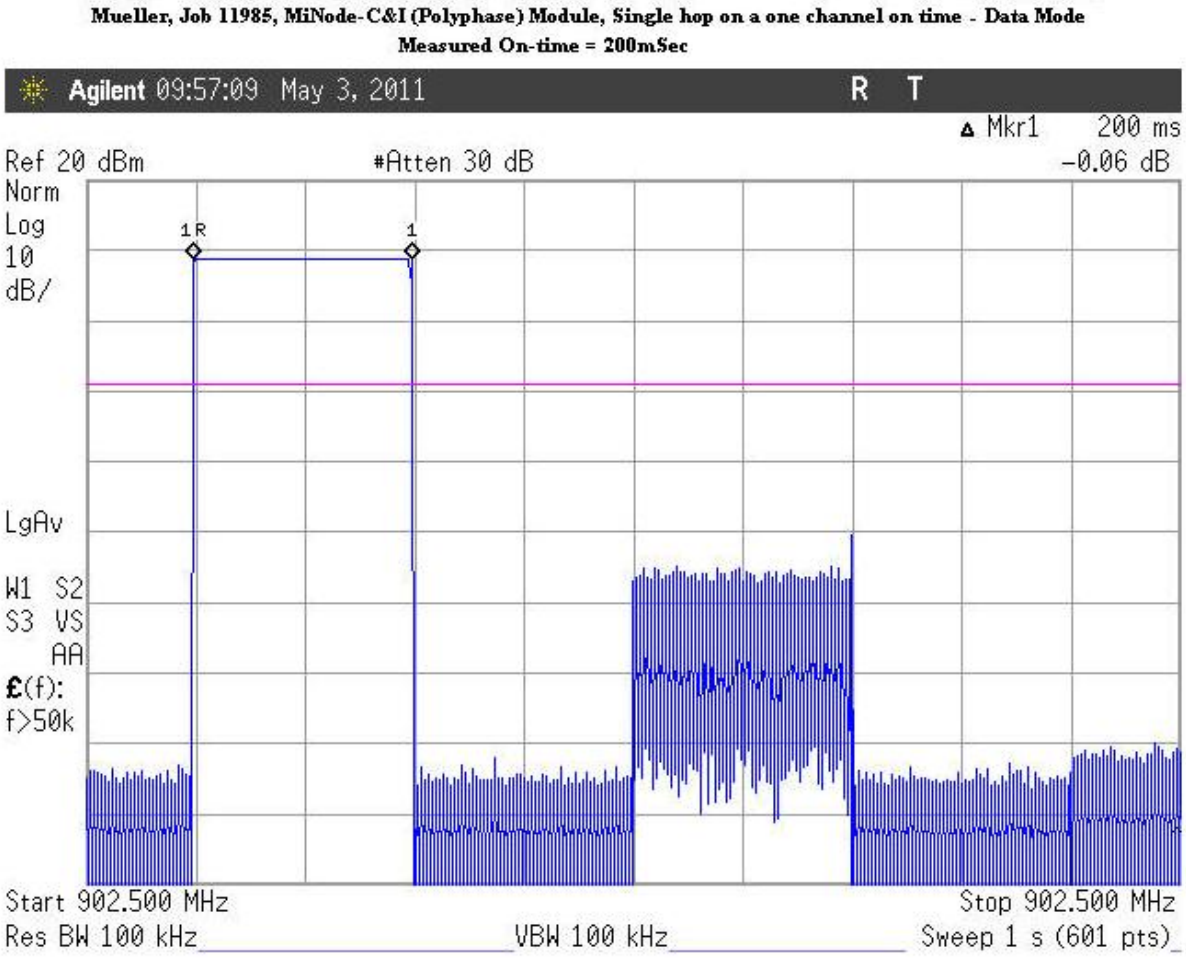

Figure 1 Data Channel Duty Cycle Plot

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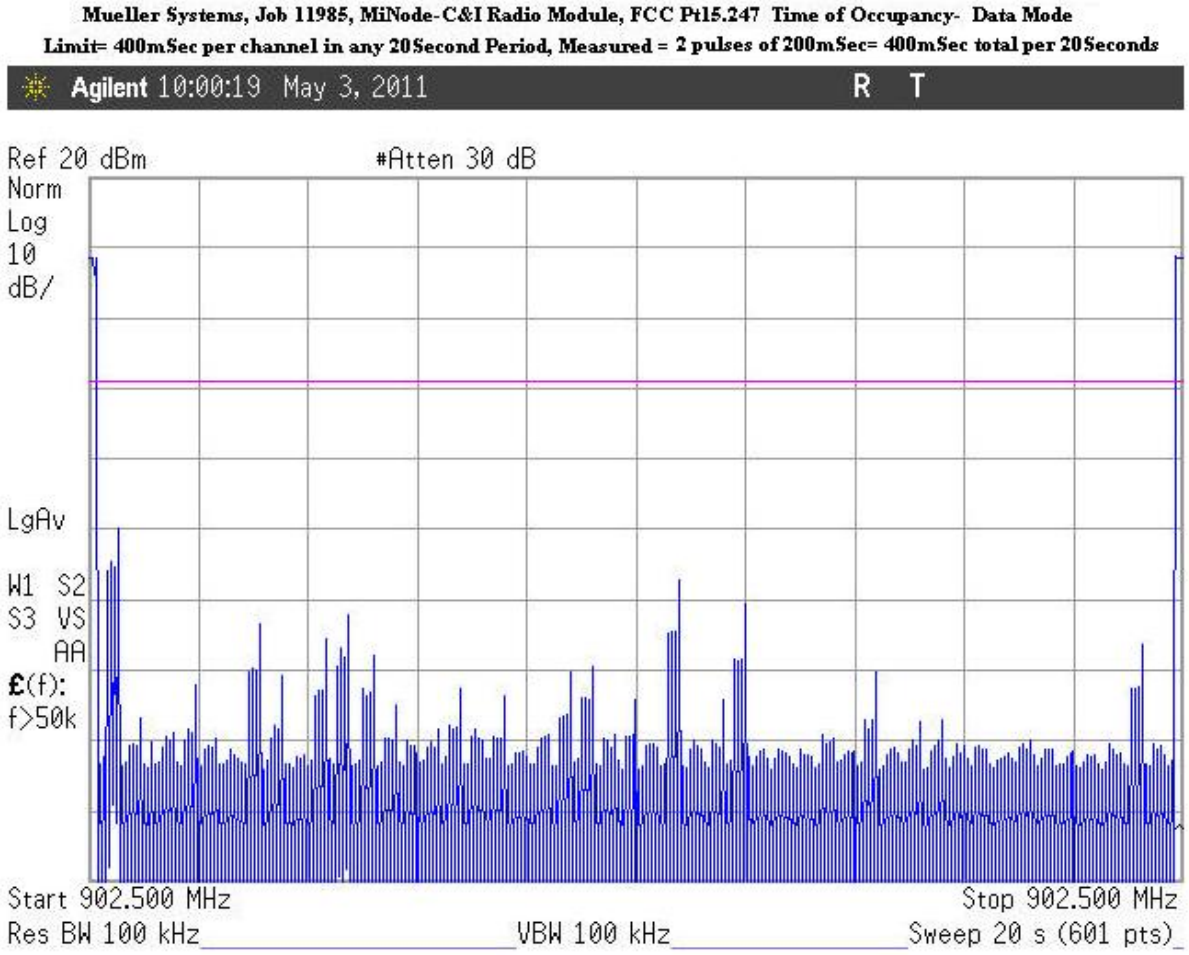

Figure 2 Data Channel Time of Occupancy Plot

5.1.2 Hailing Mode Timing

As the Maximum Dwell time of this device in hailing 400ms no duty cycle correction is allowed.

FCC part 15.247 requires that for hopping signals with an occupied bandwidth less than 250 kHz the limit is 0.4 seconds dwell time per 20 seconds

The following figures show the plot of the dwell time and time of occupancy for the transmitter. Based on this plot, the dwell time per hop is 395ms. As the unit is on a hailing channel once in a 20 second period the time of occupancy is 395ms per 20 seconds, thus complying with the 0.4 second requirement.

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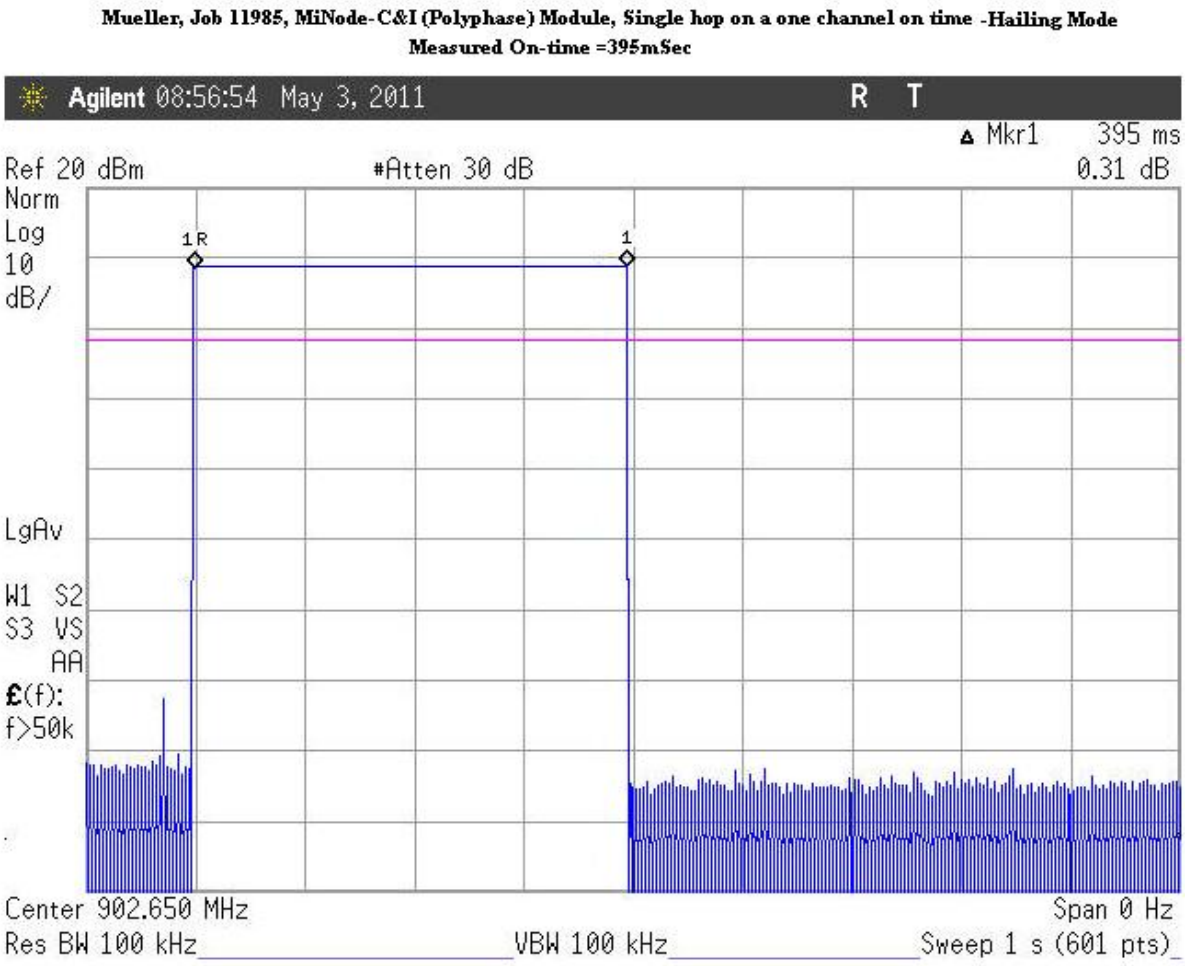

Figure 3 Hailing Channel Duty Cycle Plot

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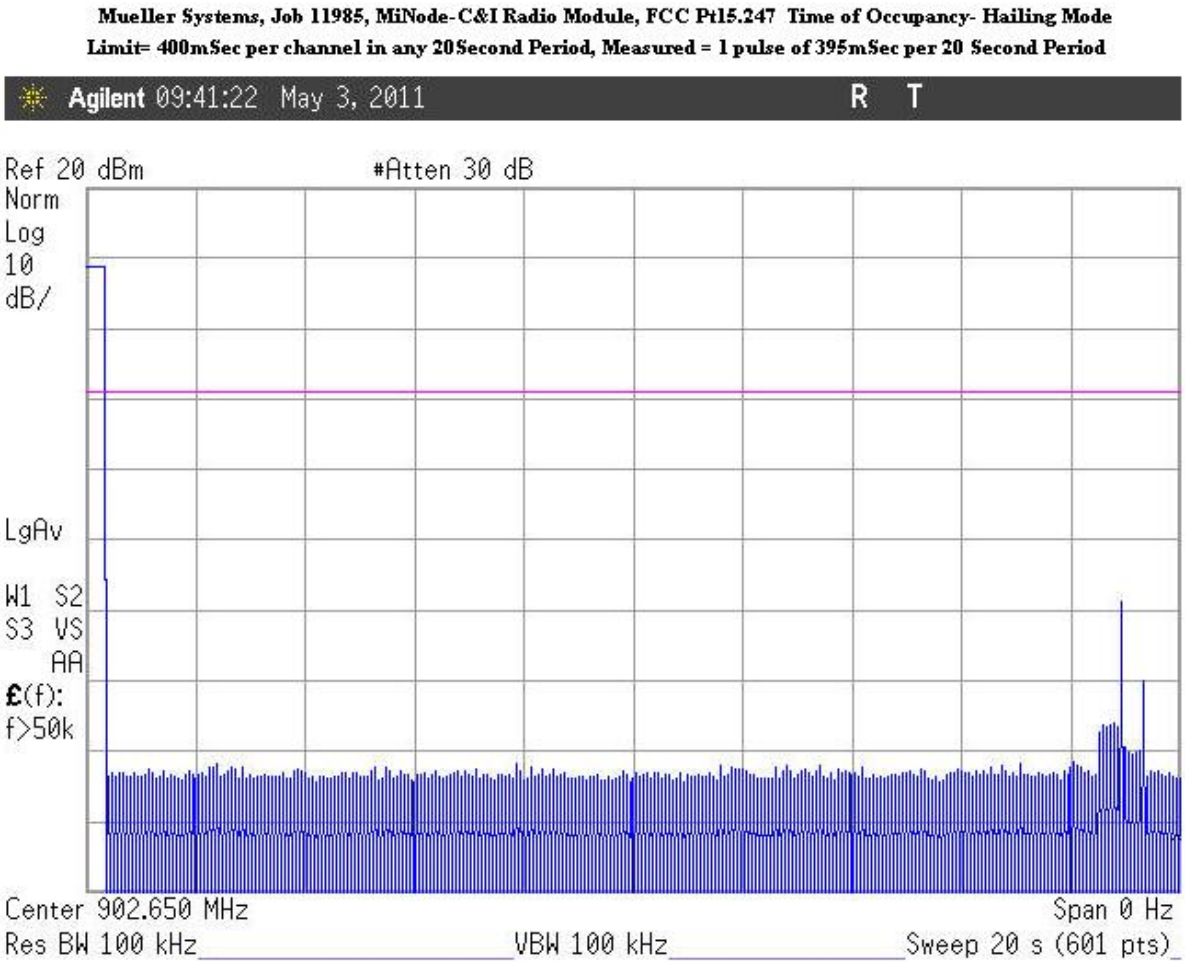

Figure 4 Hailing Channel Time of Occupancy Plot

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5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on the lowest, Center, and highest 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, cable, and other losses in the system.

Table 5 Data Channel RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.5MHz	29.67dBm	30dBm	Pass
Center Channel: 915.0MHz	29.26dBm	30dBm	Pass
High Channel: 927.0MHz	29.50dBm	30dBm	Pass

Table 6 Hailing Channel RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.65MHz	29.50dBm	30dBm	Pass
Center Channel: 915.35MHz	29.67dBm	30dBm	Pass
High Channel: 927.35MHz	29.59dBm	30dBm	Pass

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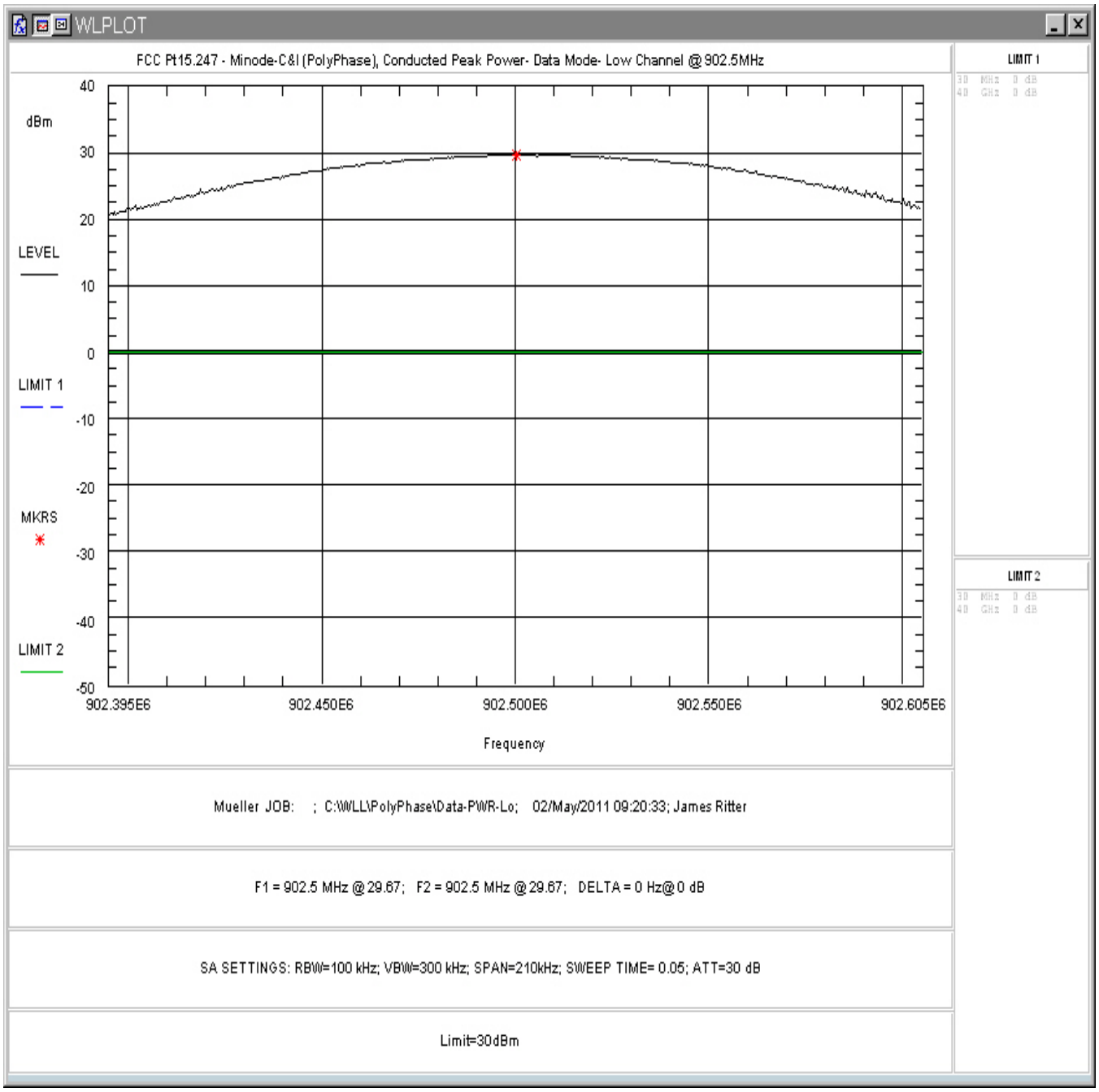

Figure 5 Data Channel RF Peak Power, Low Channel

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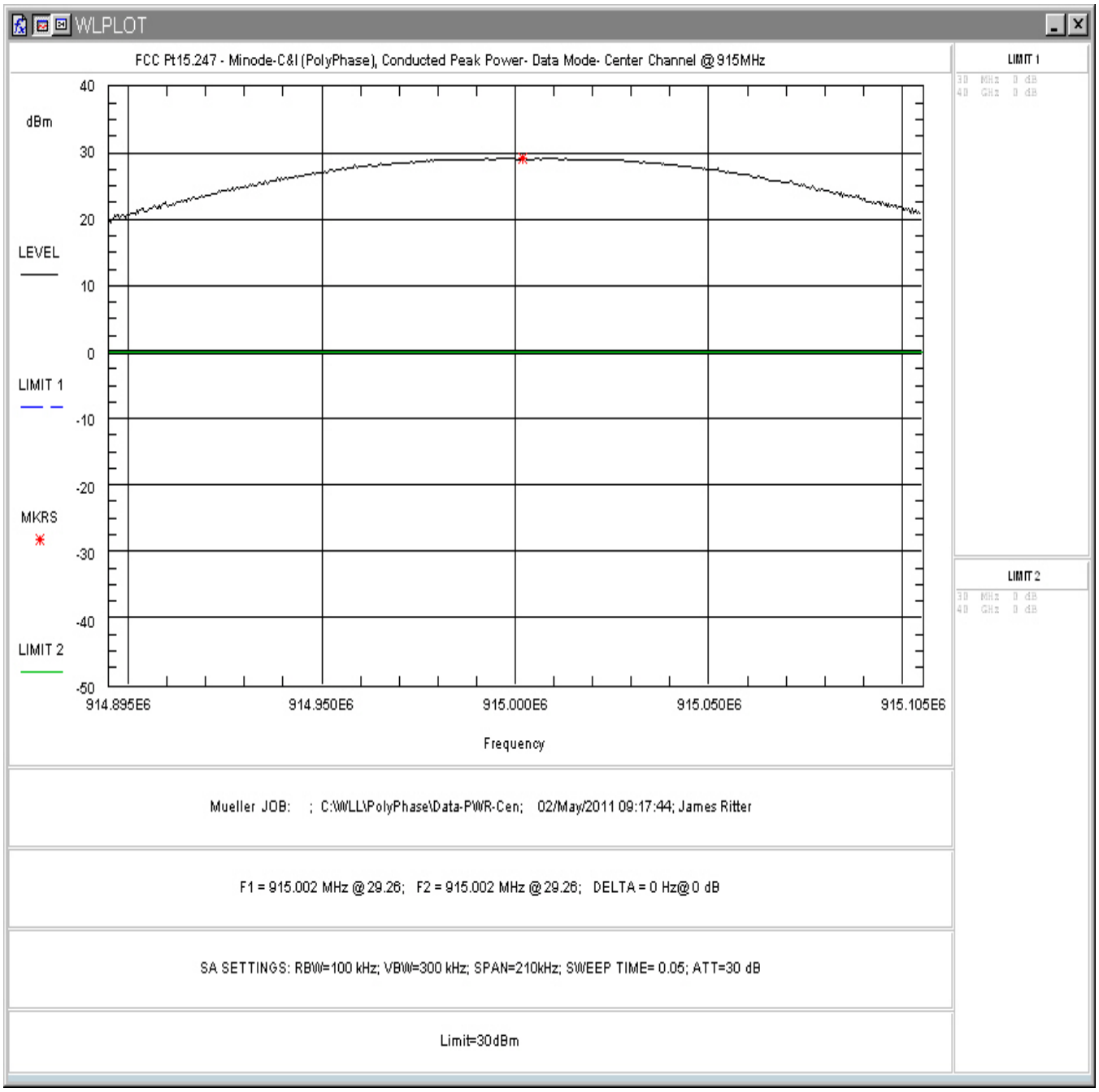

Figure 6 Data Channel RF Peak Power, Center Channel

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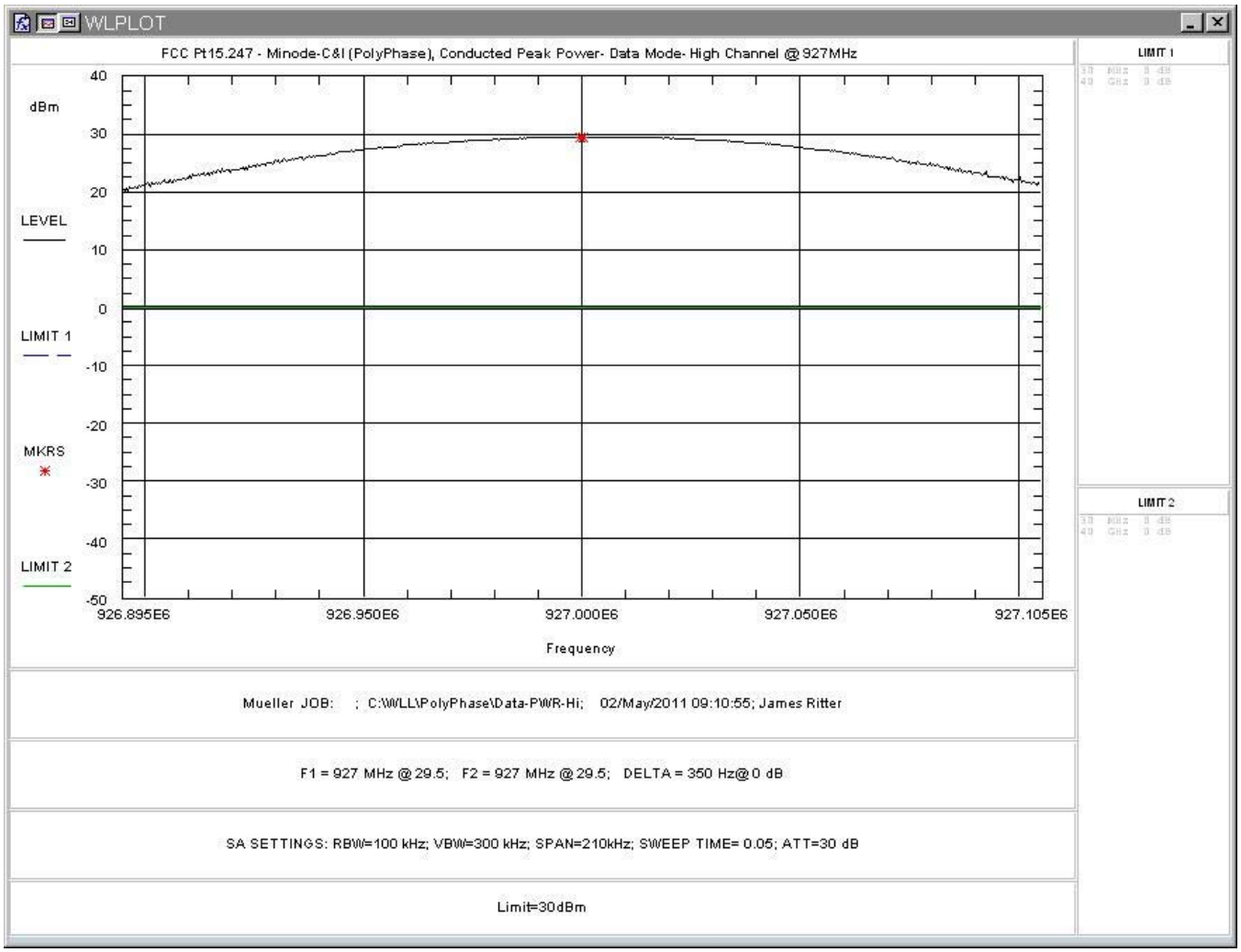

Figure 7 Data Channel RF Peak Power, High Channel

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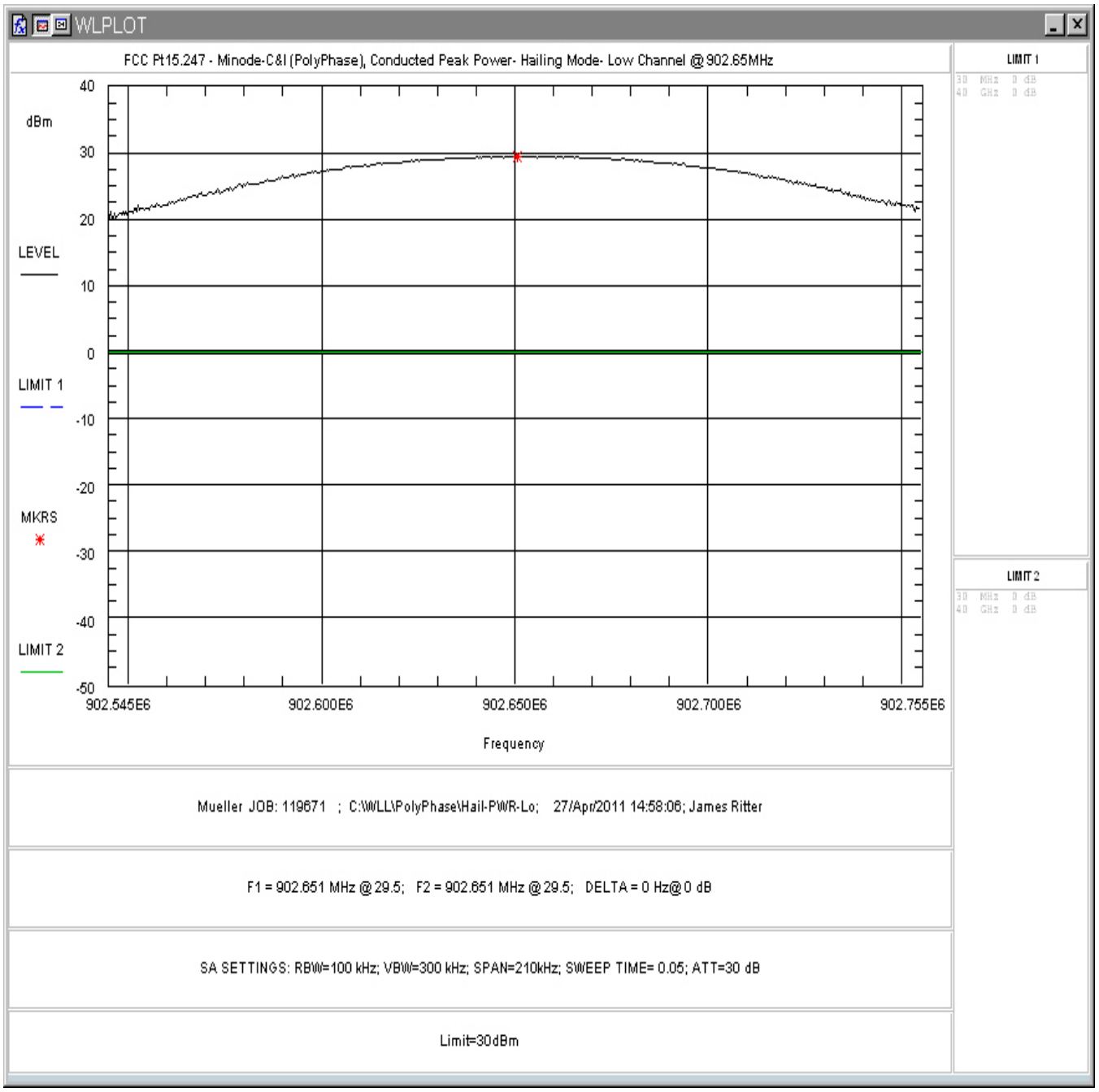

Figure 8 Hailing Channel RF Peak Power, Low Channel

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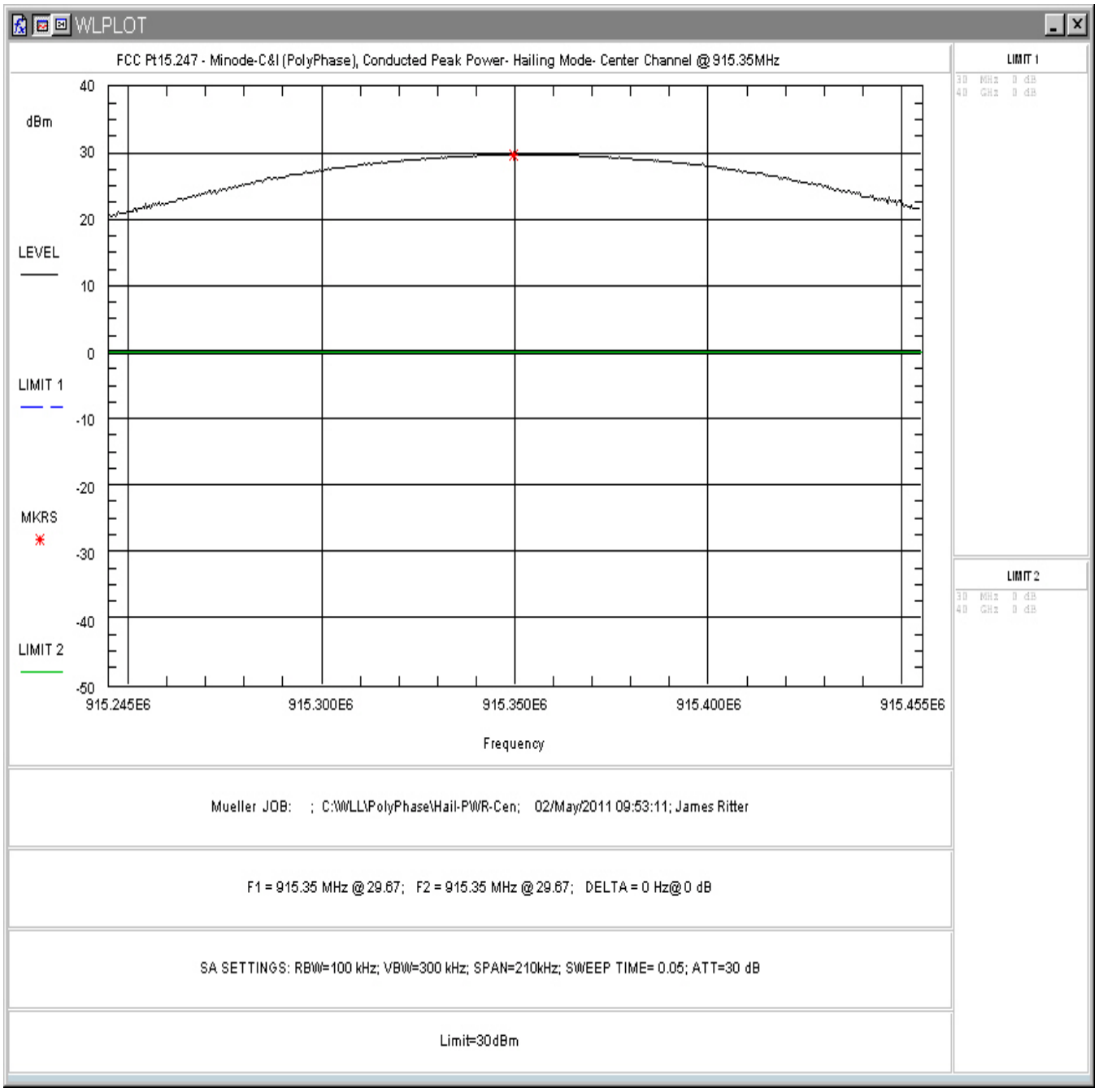

Figure 9 Hailing Channel RF Peak Power, Center Channel

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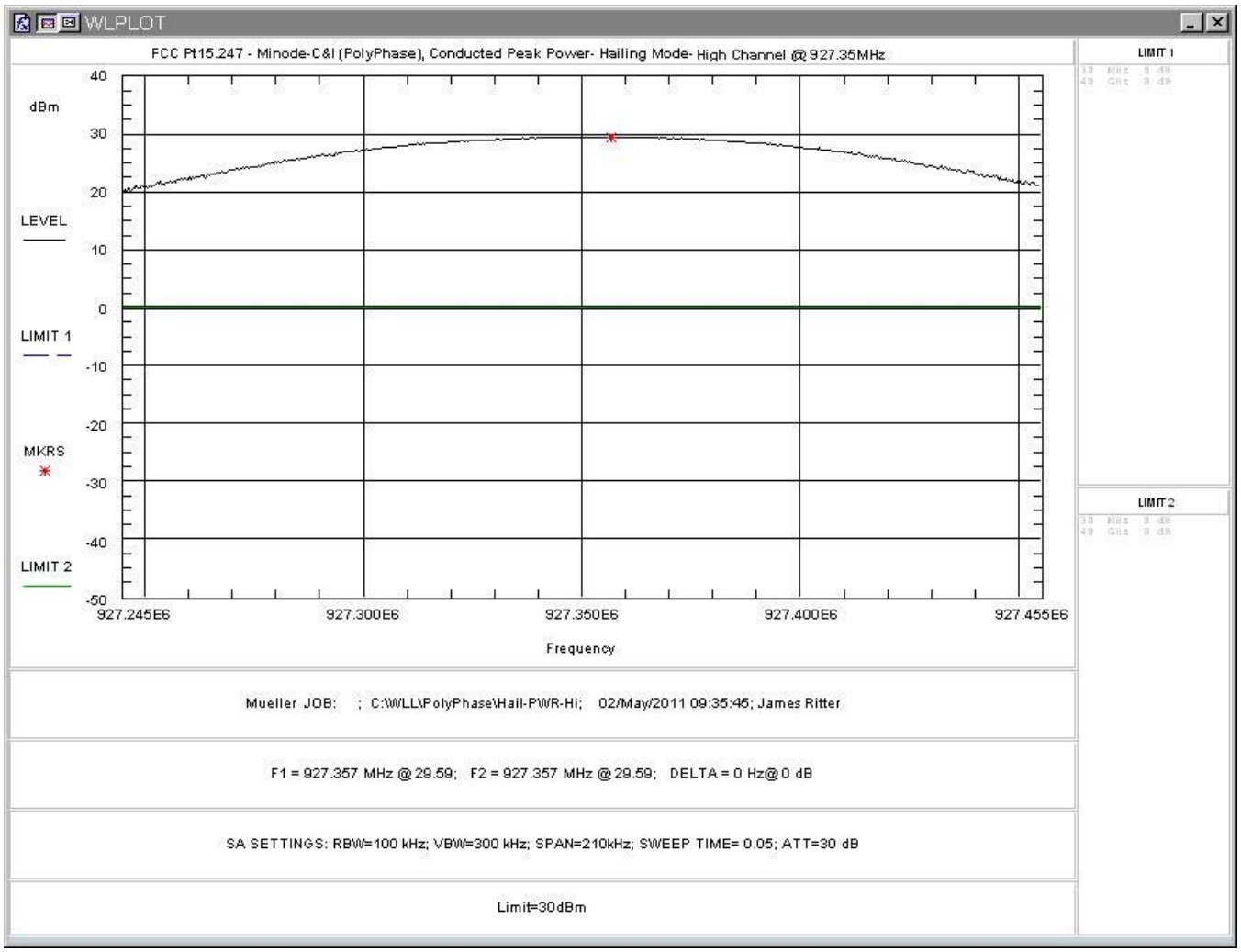

Figure 10 Hailing Channel RF Peak Power, High Channel

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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, operating in the 902-928MHz frequency range, FCC Part 15.247 requires that devices with occupied bandwidths less than 250kHz have a minimum of 50 hopping channels.

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

The below tables provide a summary of the Occupied Bandwidth Results.

Table 7 Data Channel Occupied Bandwidth Results

Frequency	Bandwidth
Low Channel: 902.5MHz	41.90kHz
Center Channel: 915.0MHz	42.03kHz
High Channel: 927.0MHz	42.13kHz

Table 8 Hailing Channel Occupied Bandwidth Results

Frequency	Bandwidth
Low Channel: 902.65MHz	41.51kHz
Center Channel: 915.35MHz	41.11kHz
High Channel: 927.35MHz	41.85kHz

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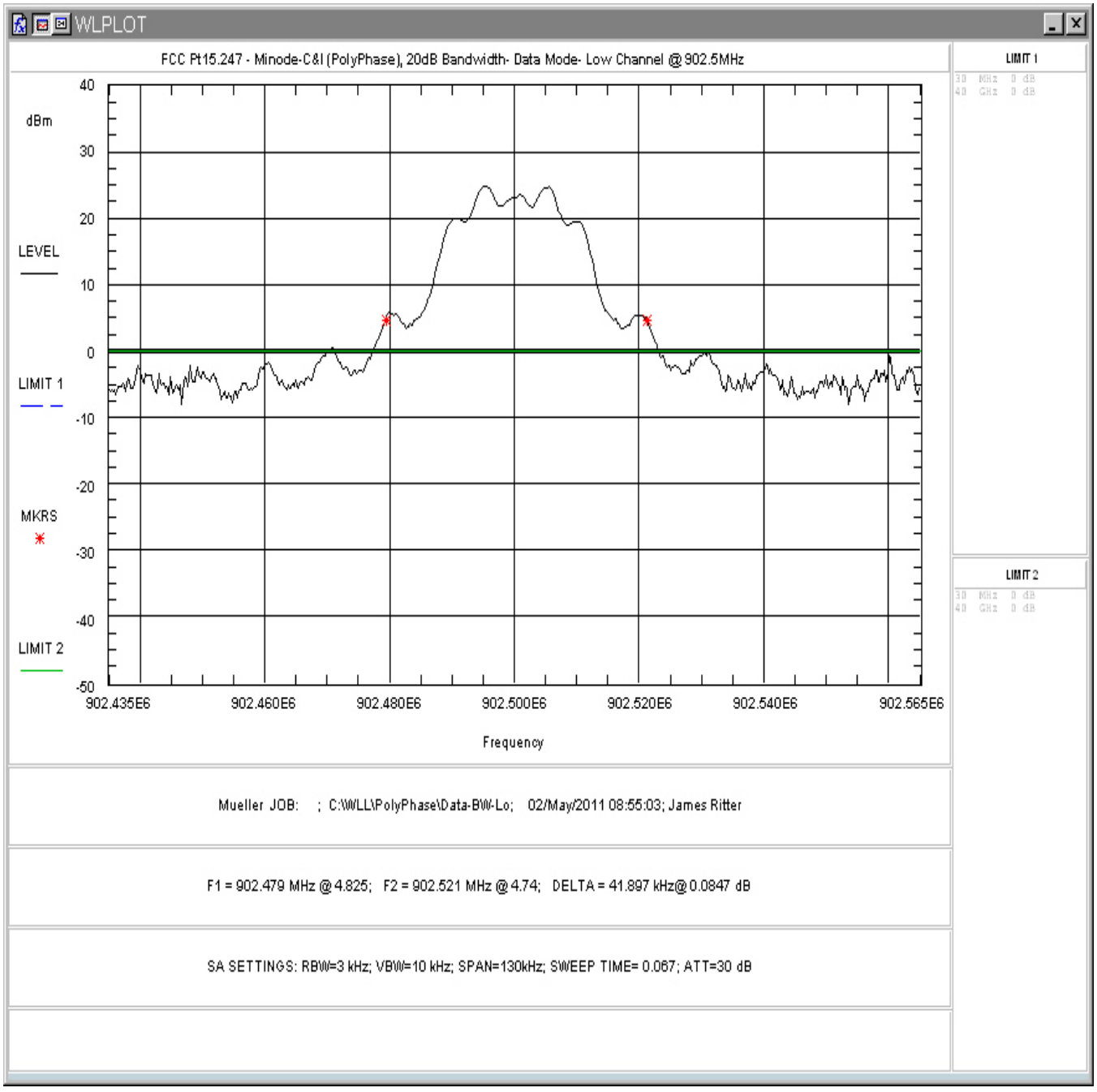

Figure 11 Data Channel Occupied Bandwidth, Low Channel

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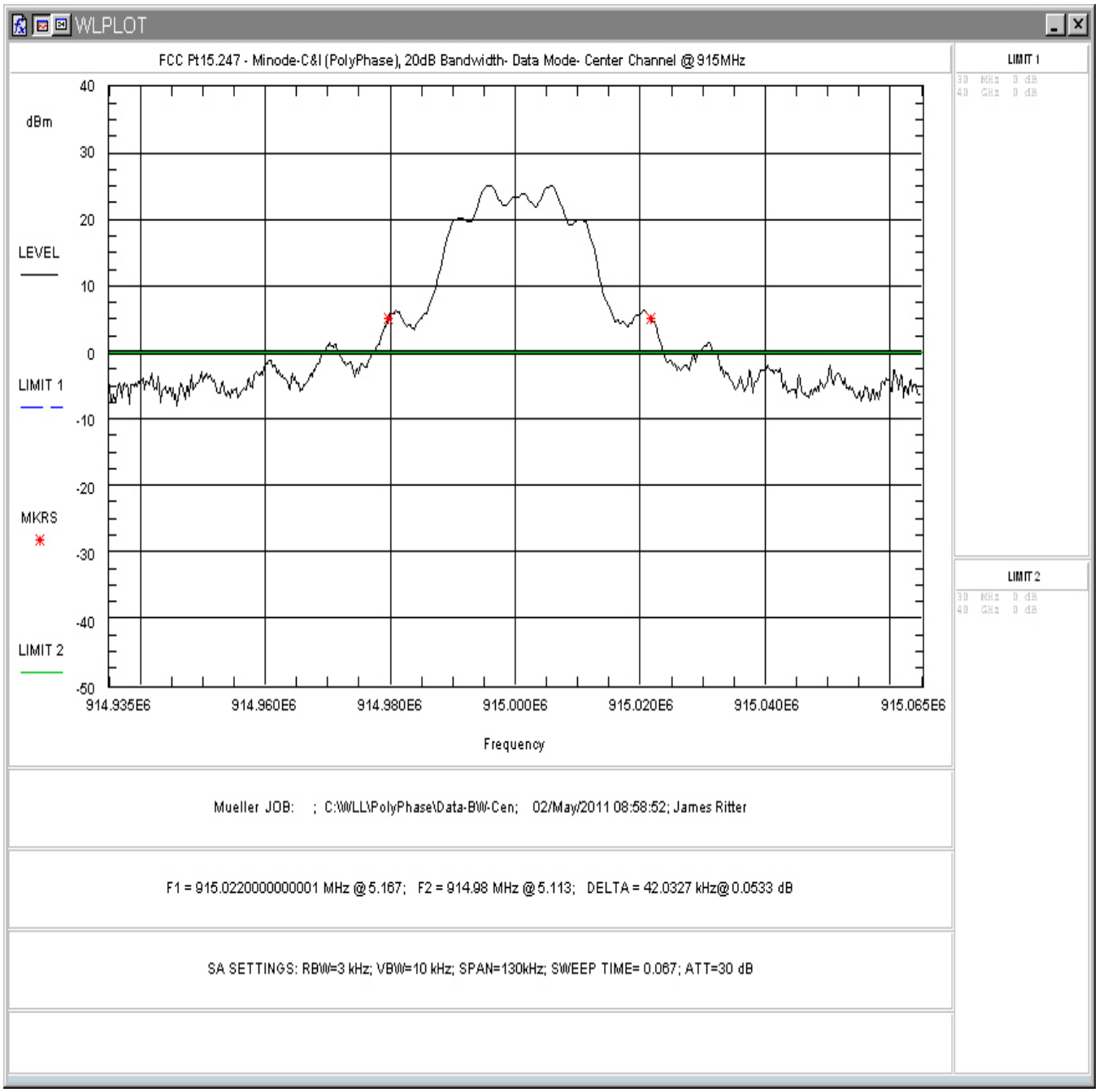

Figure 12 Data Channel Occupied Bandwidth, Center Channel

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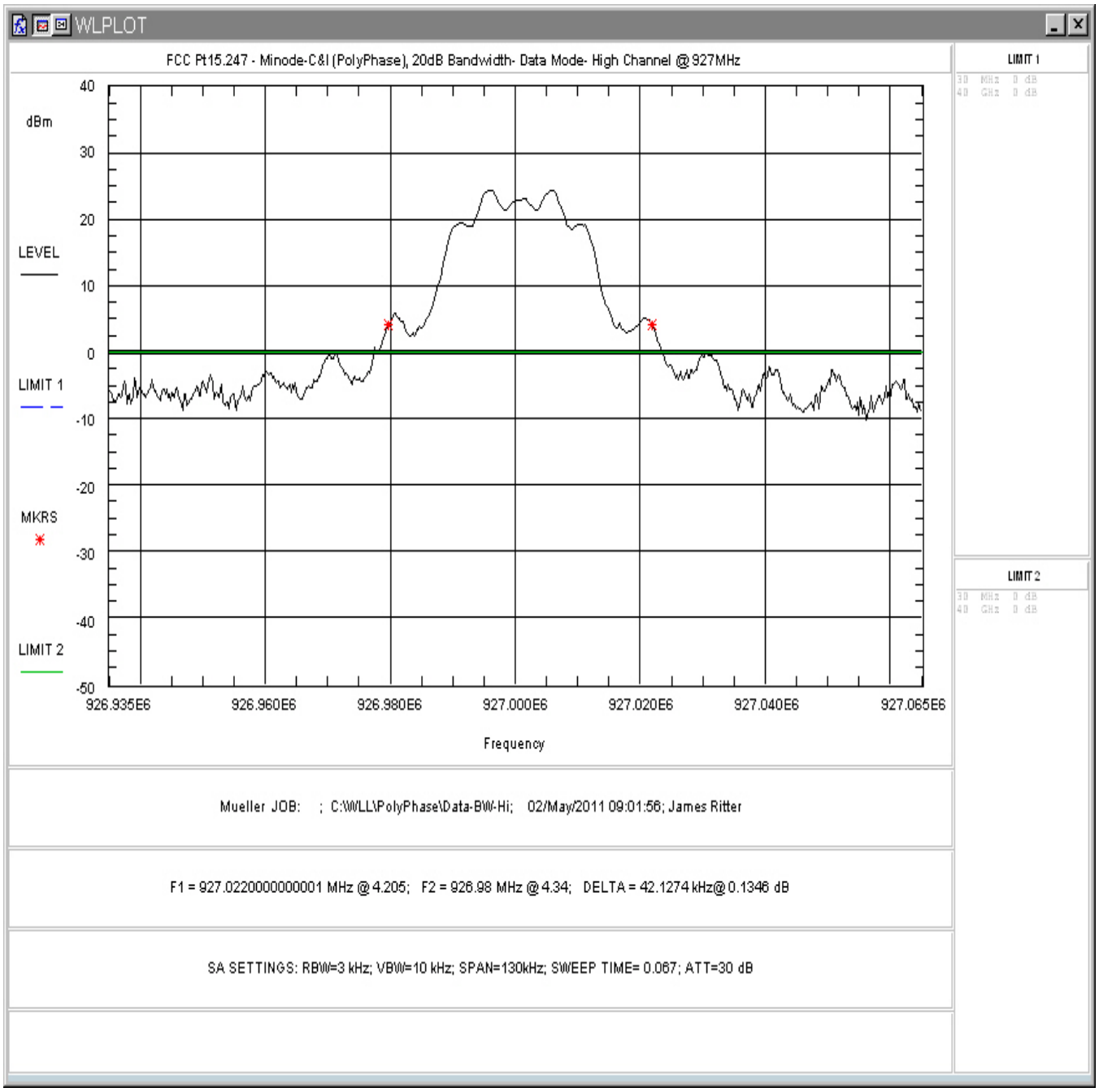

Figure 13 Data Channel Occupied Bandwidth, High Channel

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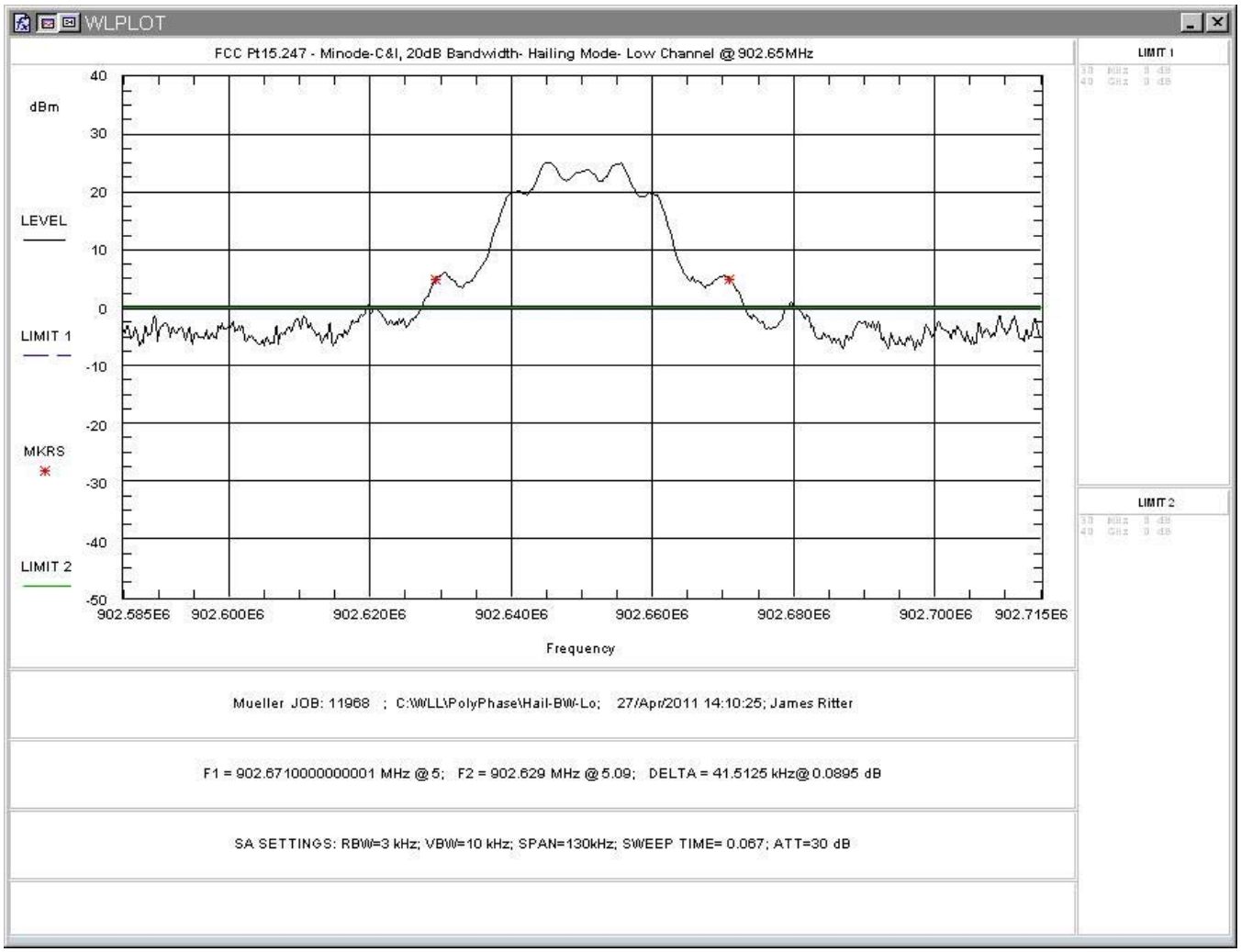

Figure 14 Hailing Channel Occupied Bandwidth, Low Channel

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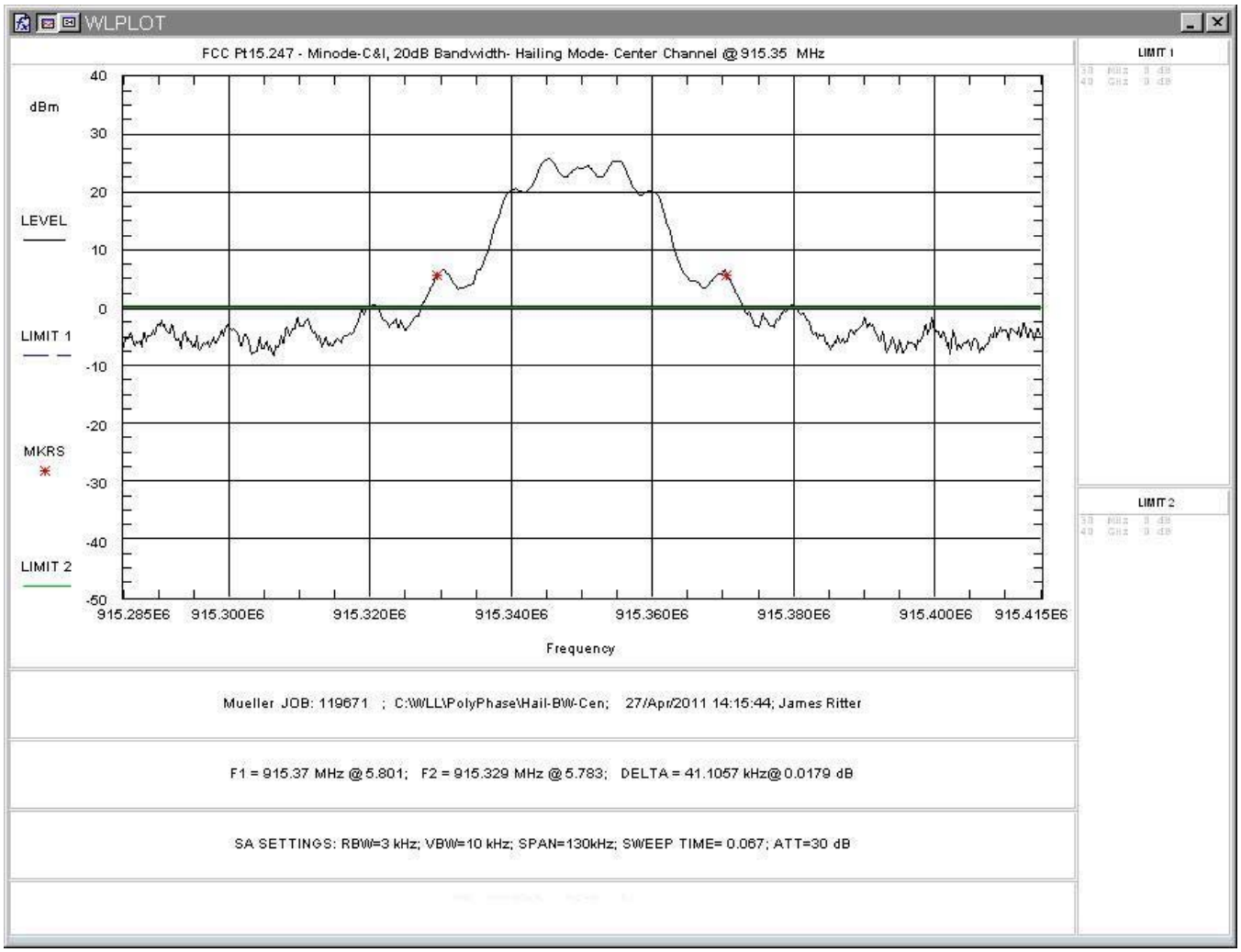

Figure 15 Hailing Channel Occupied Bandwidth, Center Channel

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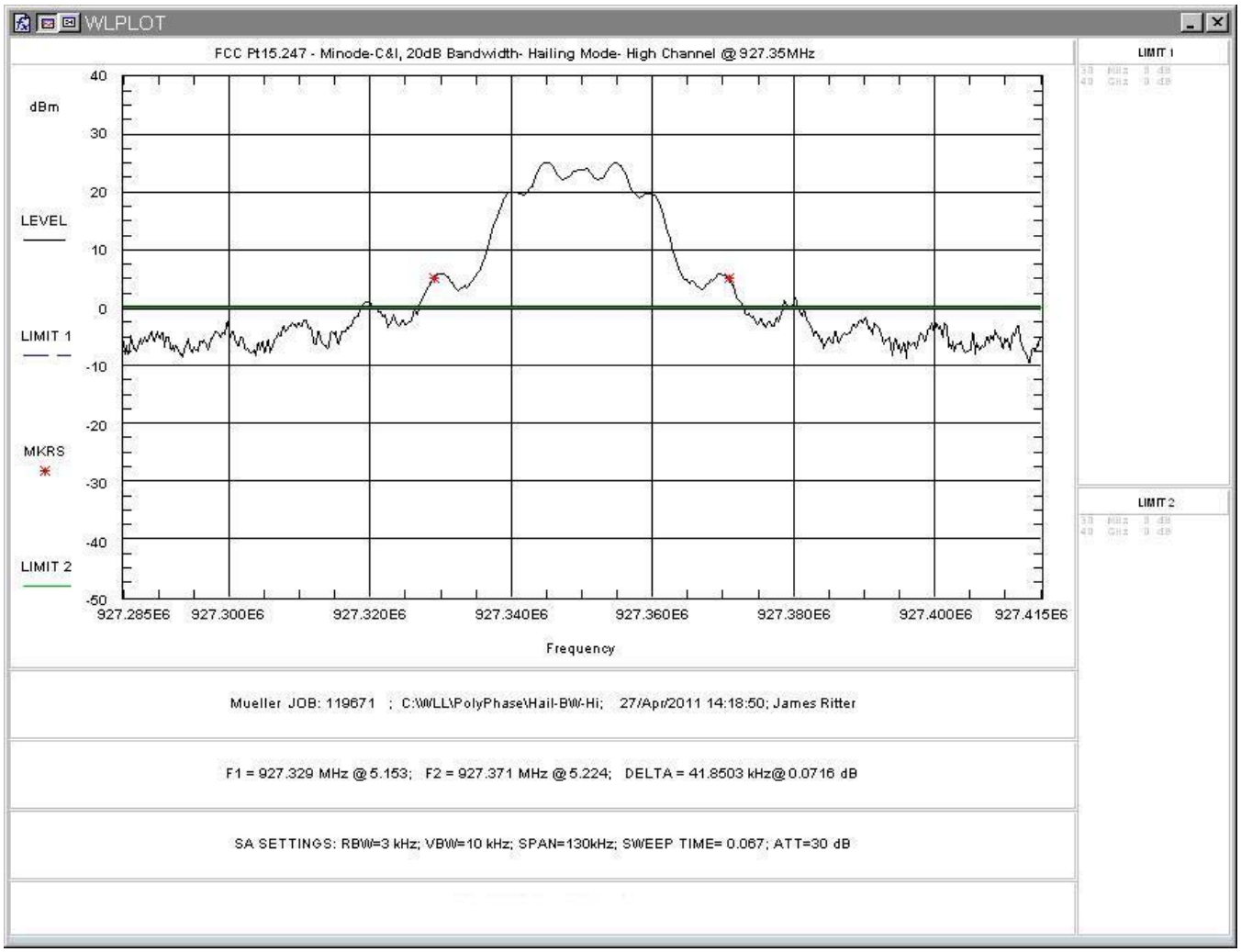

Figure 16 Hailing Channel Occupied Bandwidth, High Channel

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

Per the FCC requirements, frequency hopping systems operating in the 902-928MHz shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 42.13 kHz so the channel spacing must be more than 68 kHz. In addition, Part 15.247 requires that devices with occupied bandwidths less than 250 kHz have a minimum of 50 hopping channels.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a calibrated cable and attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator/cable. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 2MHz. Also, the number of hopping channels was measured within the 902-928MHz frequency range.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 250 kHz for data channels and the number of hopping channels is 50 for both data and hailing channels.

Note: The Data channel plan for this unit has a typical channel spacing of 500 kHz between channels, however, 2 channels have been removed at 909MHz and 921MHz. These channels have been replaced with 2 channels at 904.25MHz and 908.25MHz thus giving a 250 kHz channel spacing between 904MHz -904.5MHz and 908MHz-908.5MHz. This still remains in compliance. The closest channel spacing are provided.

In addition the hailing channels are not evenly dispersed within the band with the closest hailing channels spaced 150 kHz apart.

Table 9 Channel spacing and number of hopping channels summary

Test	Result	Limit	Pass/Fail
Data Channel Spacing	250kHz channel spacing between 904MHz -904.5MHz and 908MHz-908.5MHz. 500kHz between other channels	42.13 kHz Minimum	Pass
Number of Data Channels	50 channels	50 channels minimum	Pass
Hailing Channel Spacing	The closest channels are spaced 150kHz	41.85 kHz Minimum	Pass
Number of Hailing Channels	50 channels	50 channels minimum	Pass

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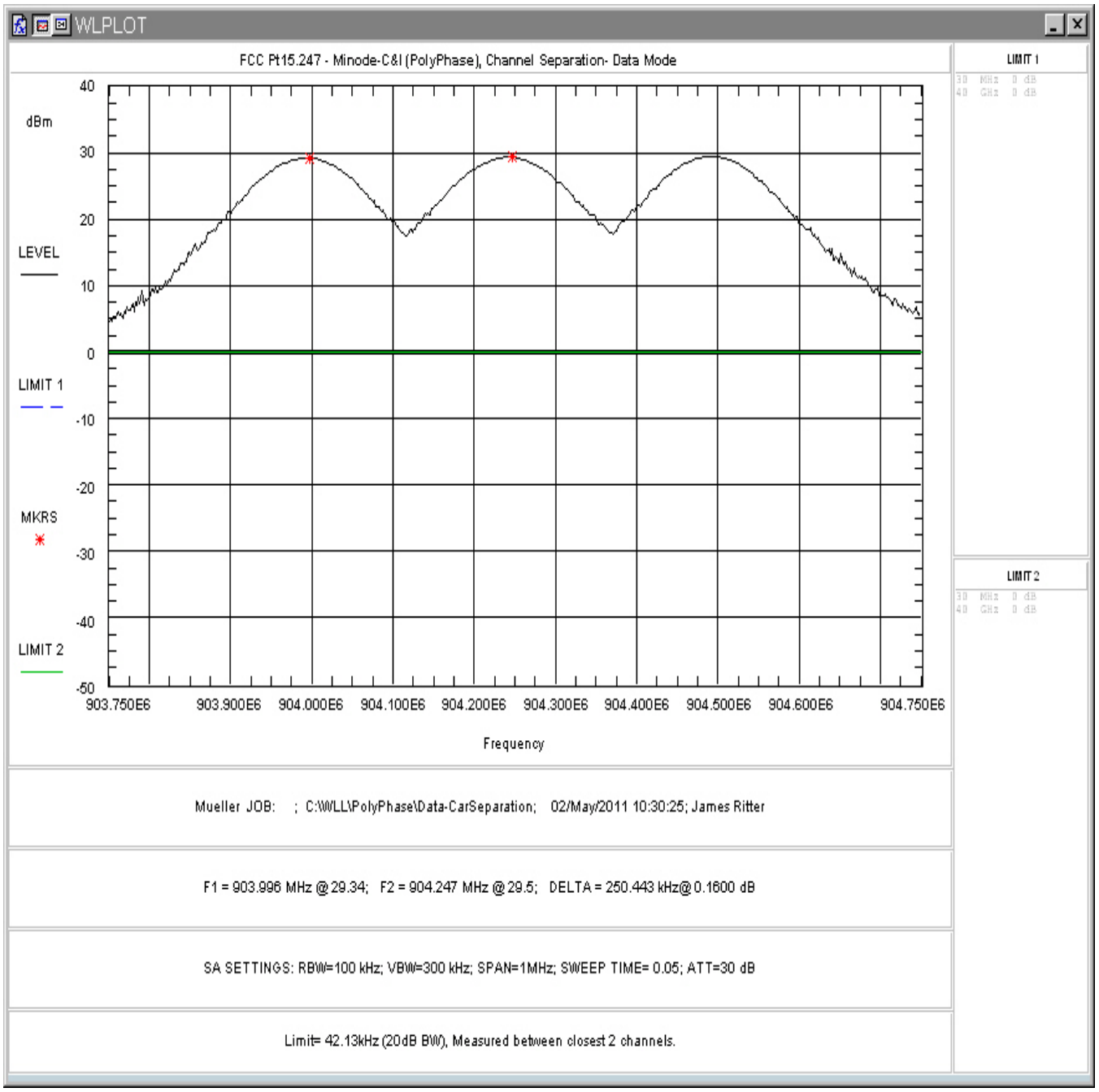

Figure 17 Data Channel spacing, 250kHz

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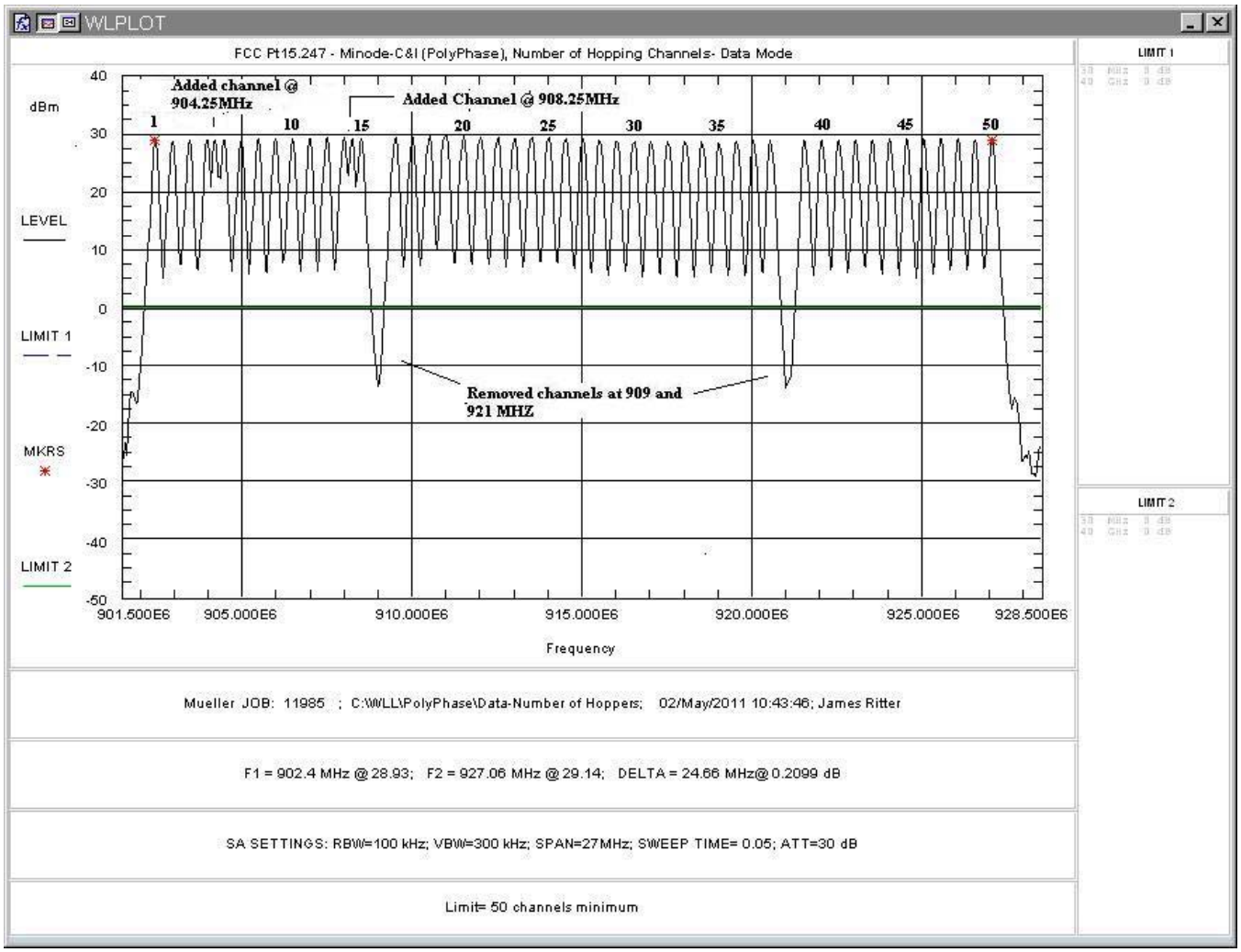

Figure 18 Number of Data Channels

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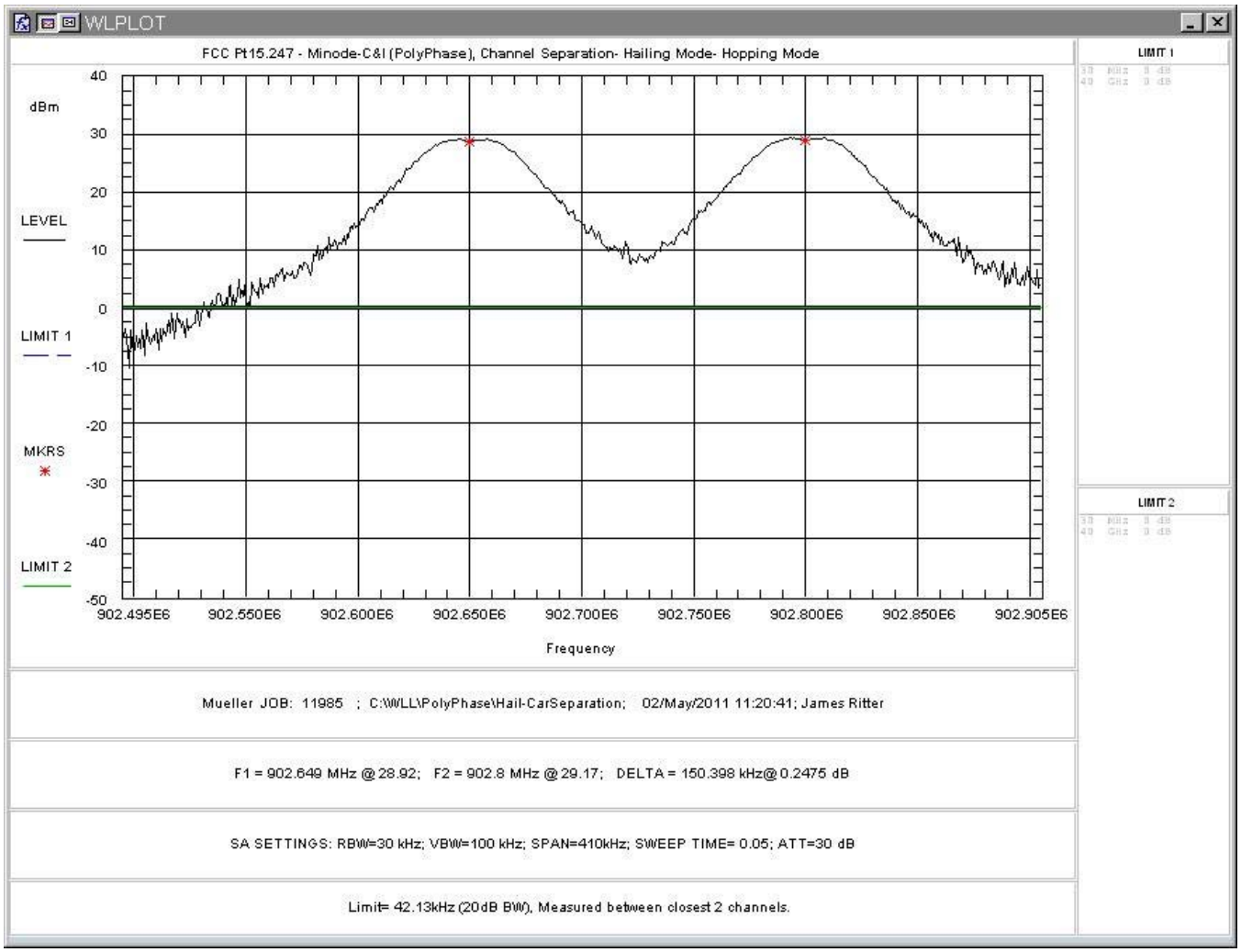

Figure 19 Hailing Channel Spacing

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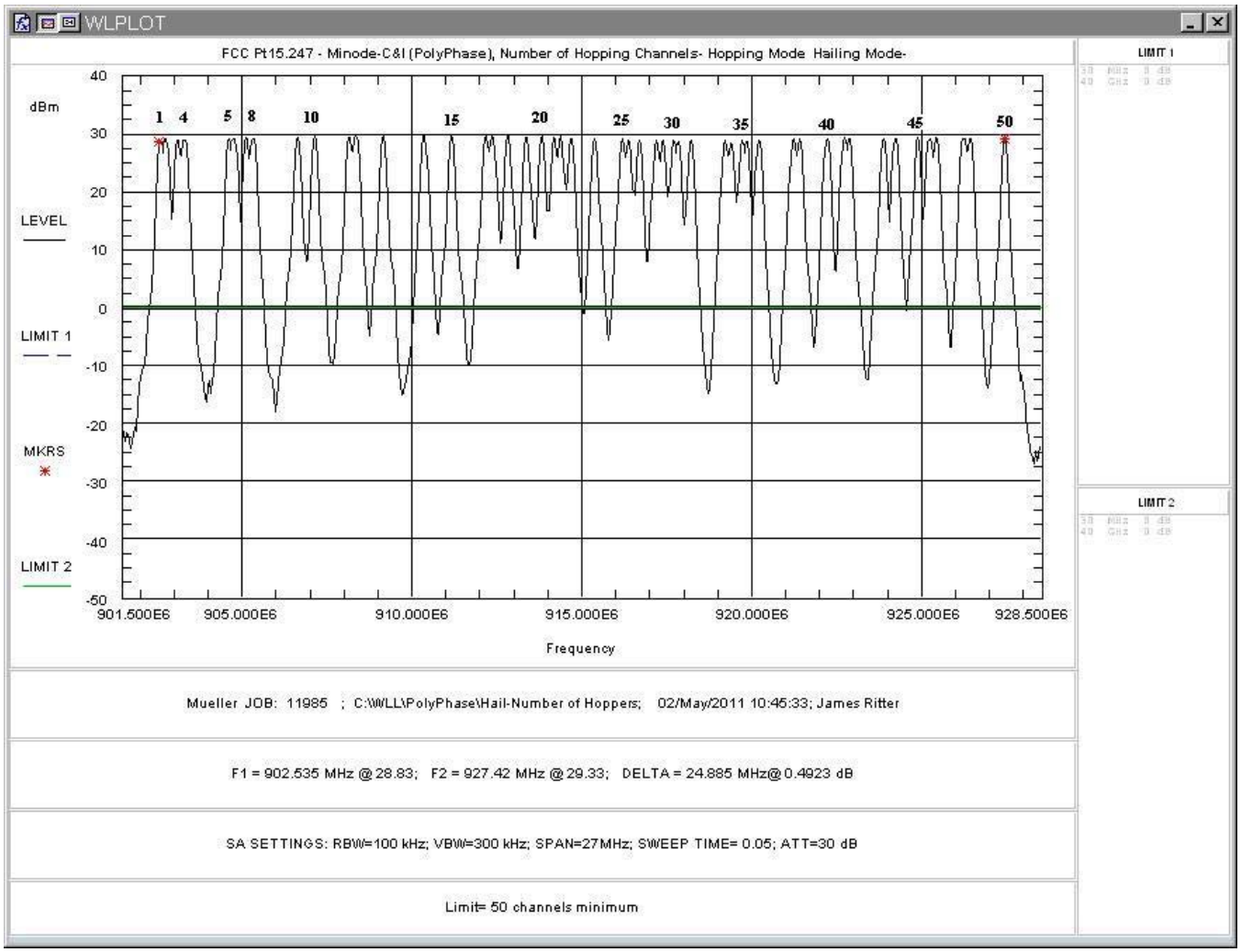

Figure 20 Number of Hailing Channels

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

The EUT must comply with requirements for spurious emissions at the antenna terminal. Per §15.247(c) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the device is operating shall be attenuated 20 dB below the highest power level in any 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 suitable 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 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the maximum modulated transmit frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

Close-up plots of the 902-928MHz band edges are provided in both the hopping and non-hopping modes to show compliance at both of these points.

The following are plots of the conducted spurious emissions data.

As the Hailing and Data channels have the same characteristics (power, bandwidth) and use the same RF path the low, center, and high channels have been selected from all available channels.

Band-edge plots are provided for both the lowest and highest frequency used in data and hailing mode.

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5.5.1 Band-edge Conducted Spurious Emissions

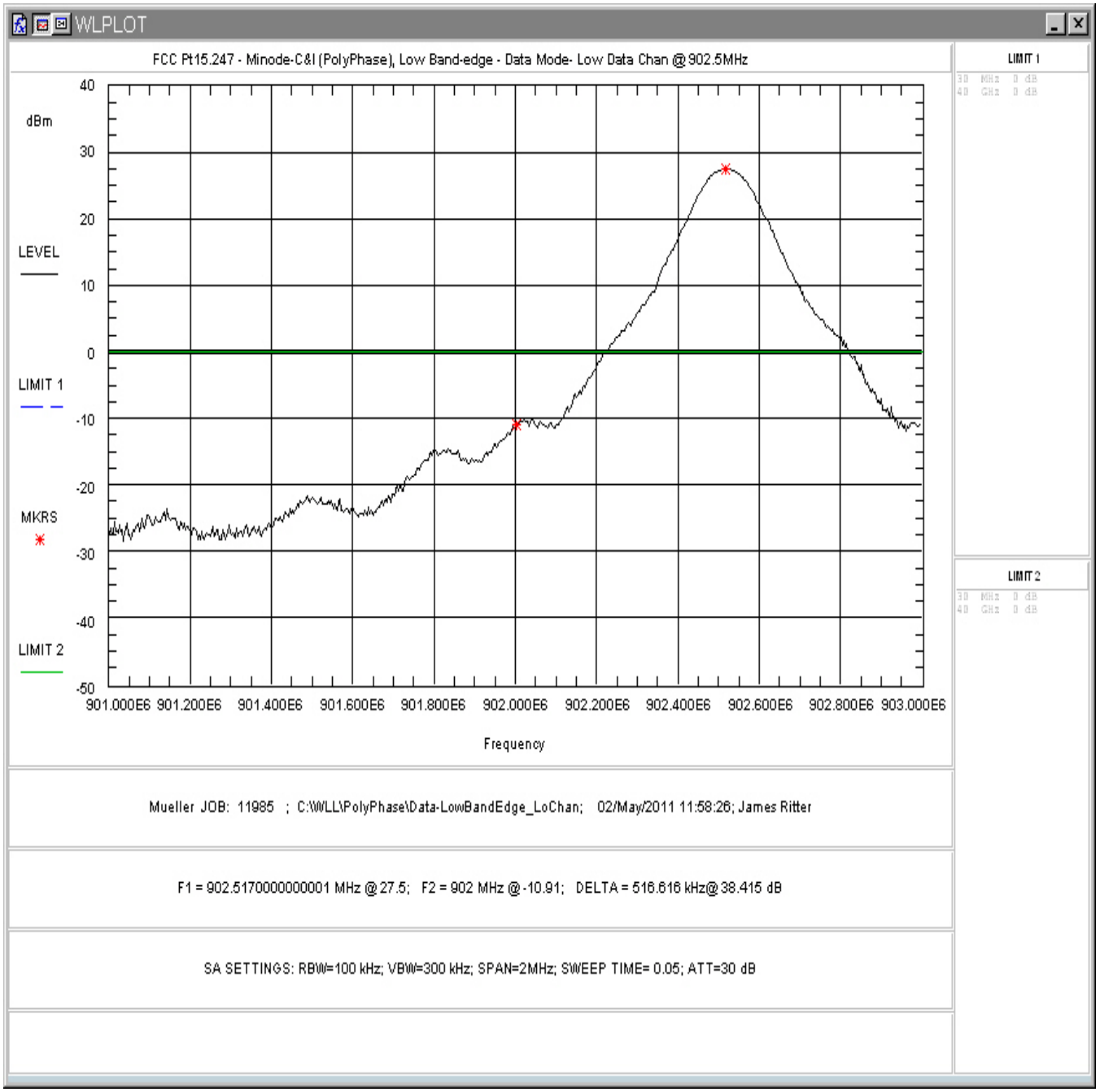

Figure 21 Lower Band Edge Plot, Low Data Channel

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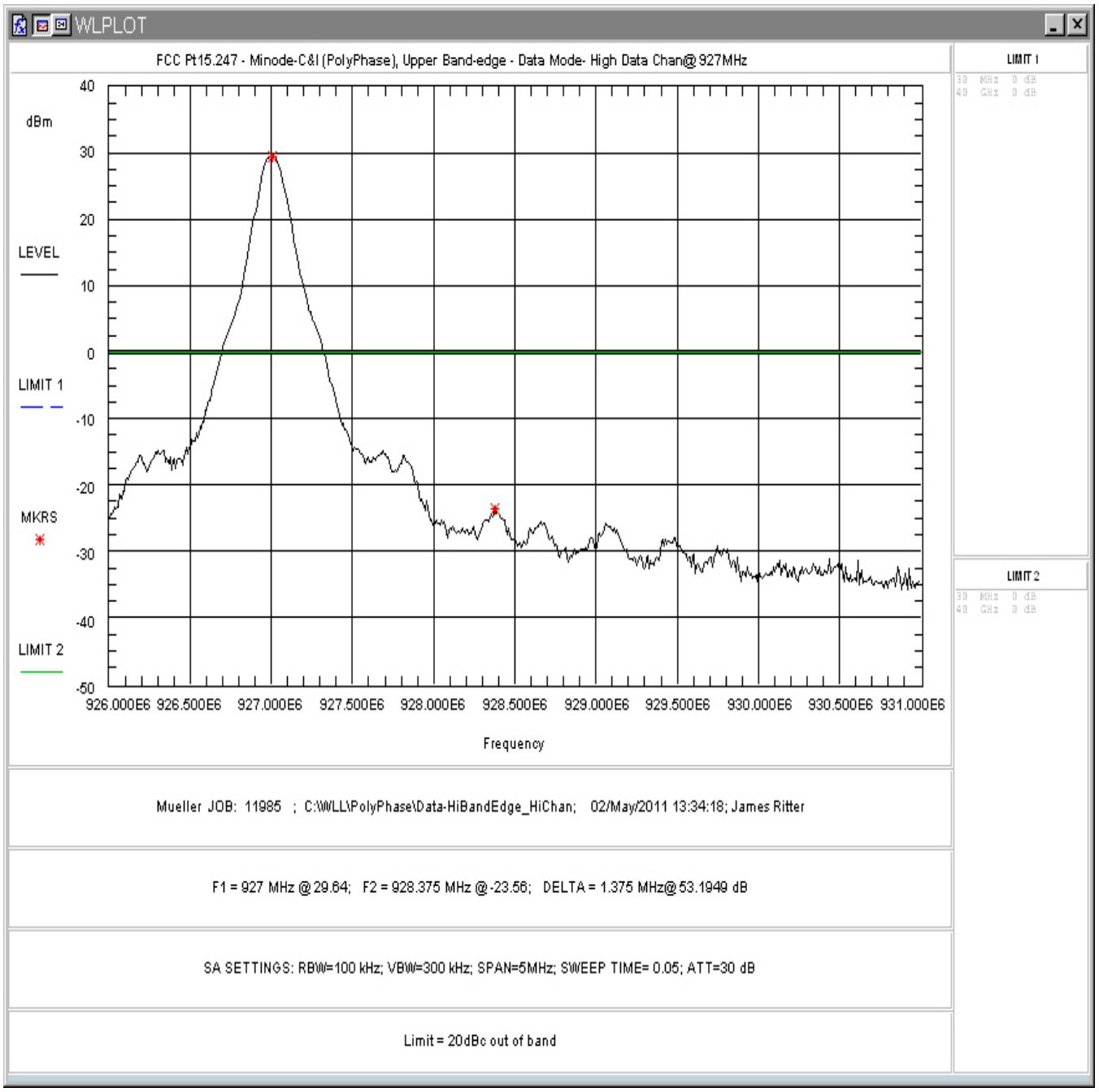

Figure 22 Upper Band Edge Plot, High Data Channel

 © 2011 Washington Laboratories, Ltd.

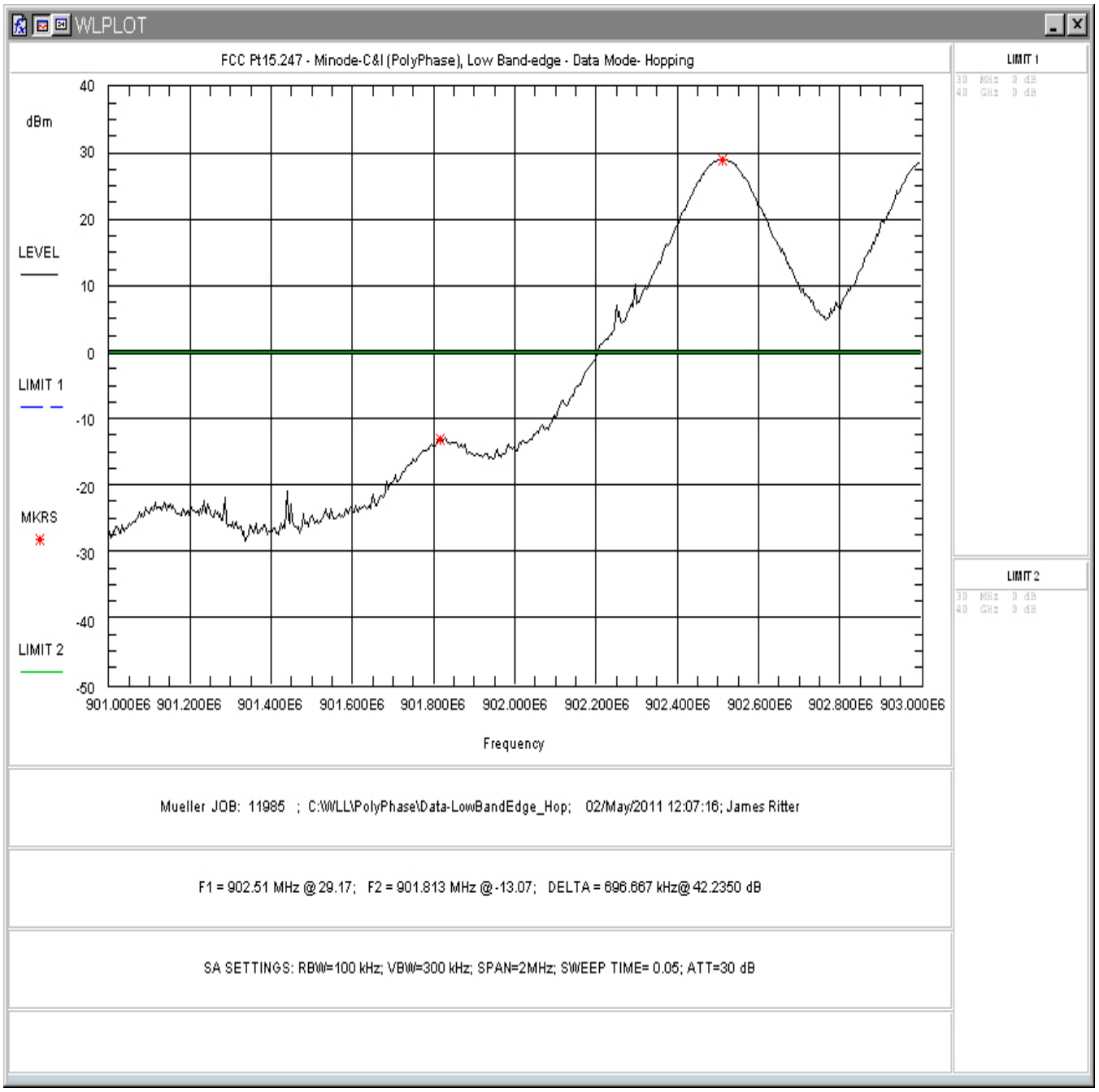

Figure 23 Lower Band Edge Plot, Data Hopping Mode

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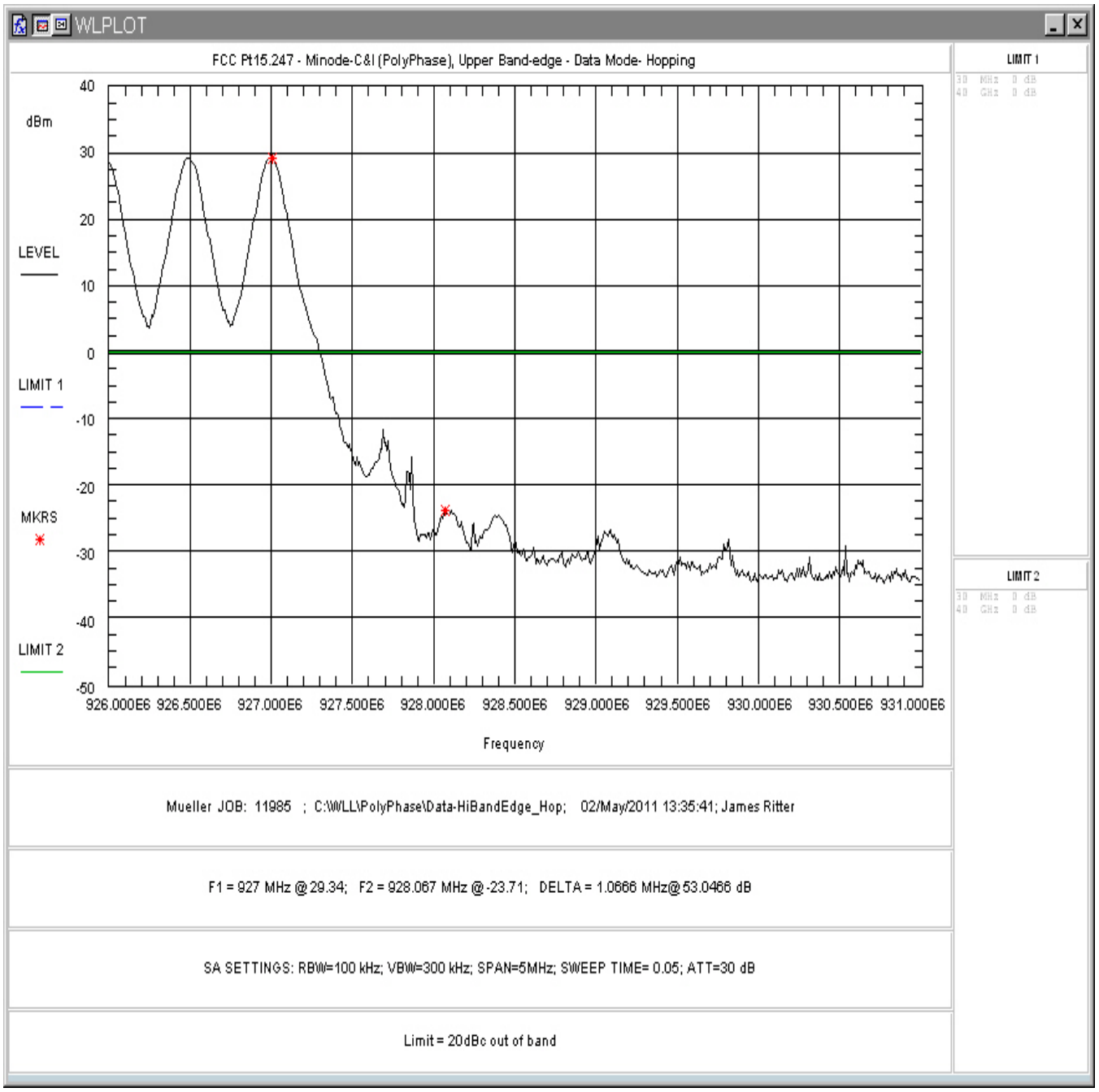

Figure 24 Upper Band Edge Plot, Data Hopping Mode

 © 2011 Washington Laboratories, Ltd.

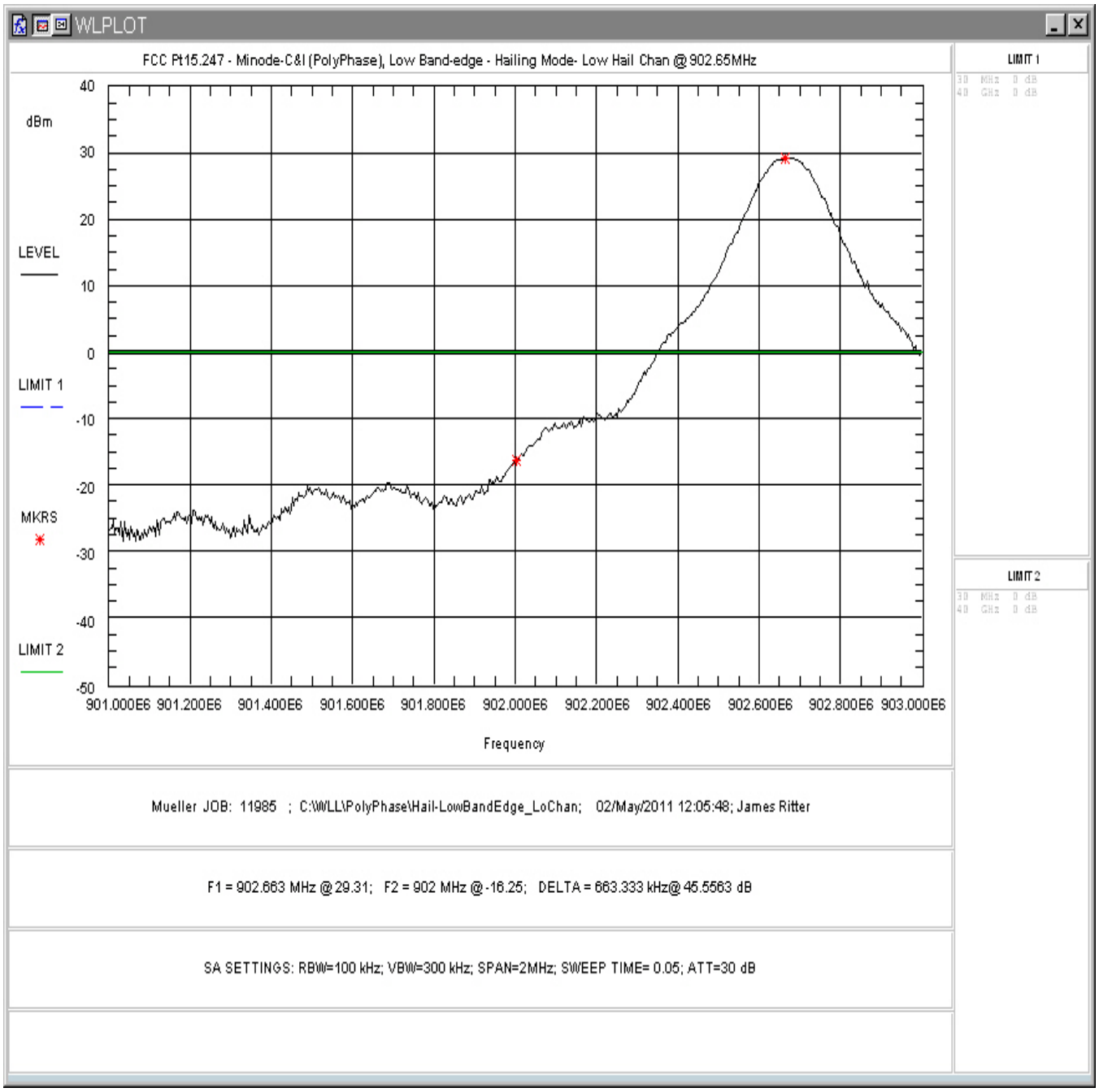

Figure 25 Lower Band Edge Plot, Low Hailing Channel

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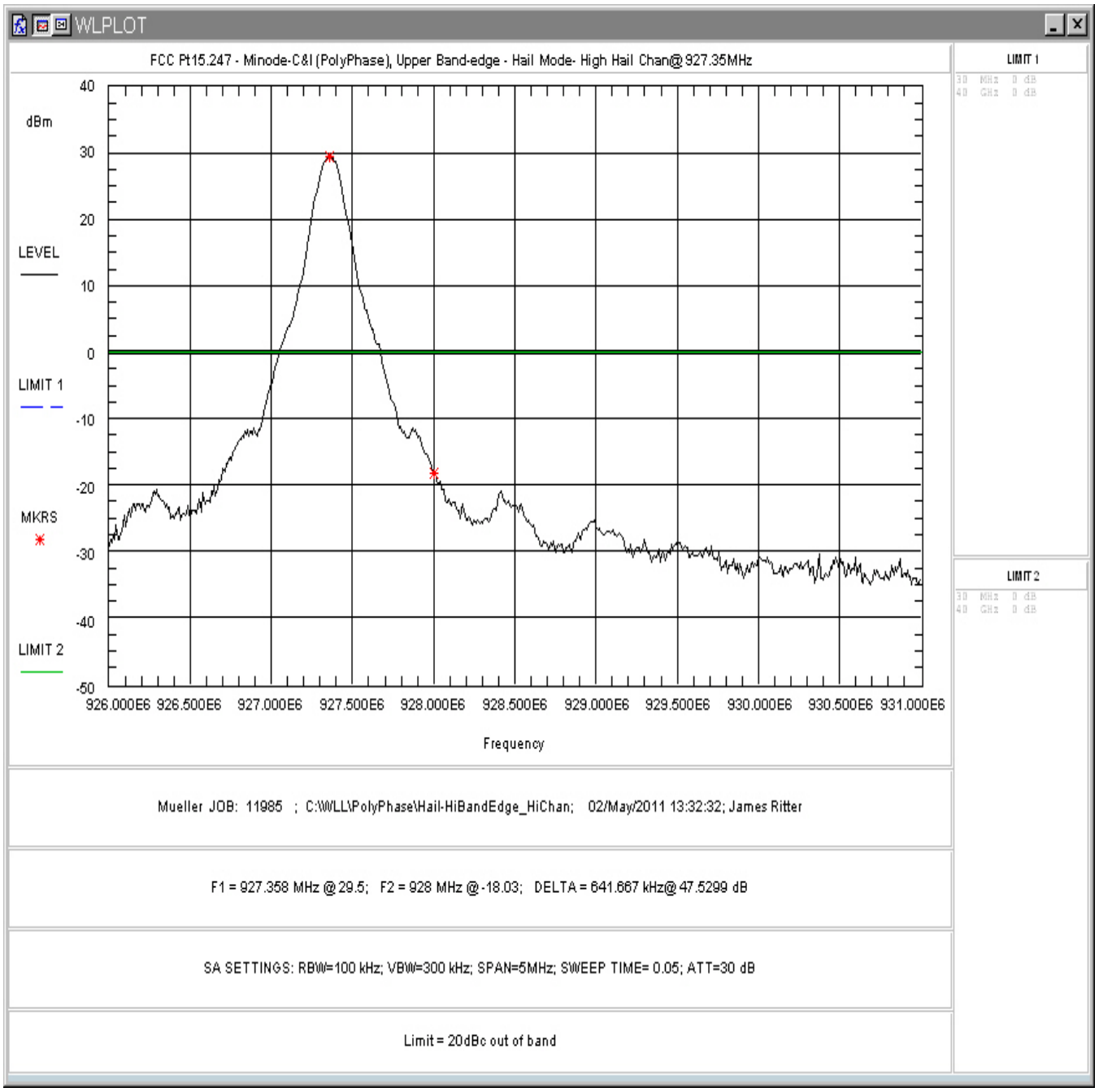

Figure 26 Upper Band Edge Plot, High Hailing Channel

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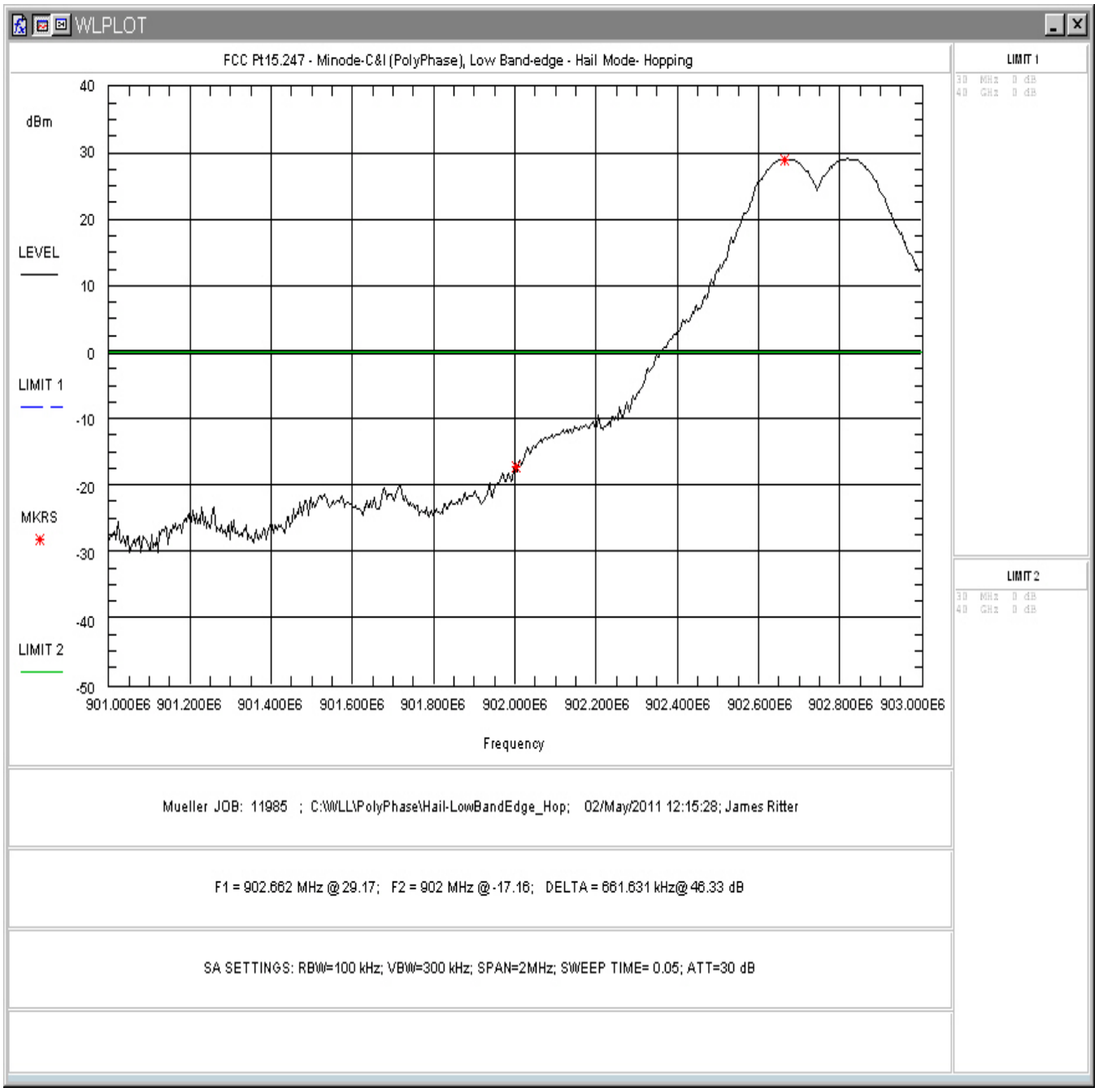

Figure 27 Lower Band Edge Plot, Hailing Hopping Mode

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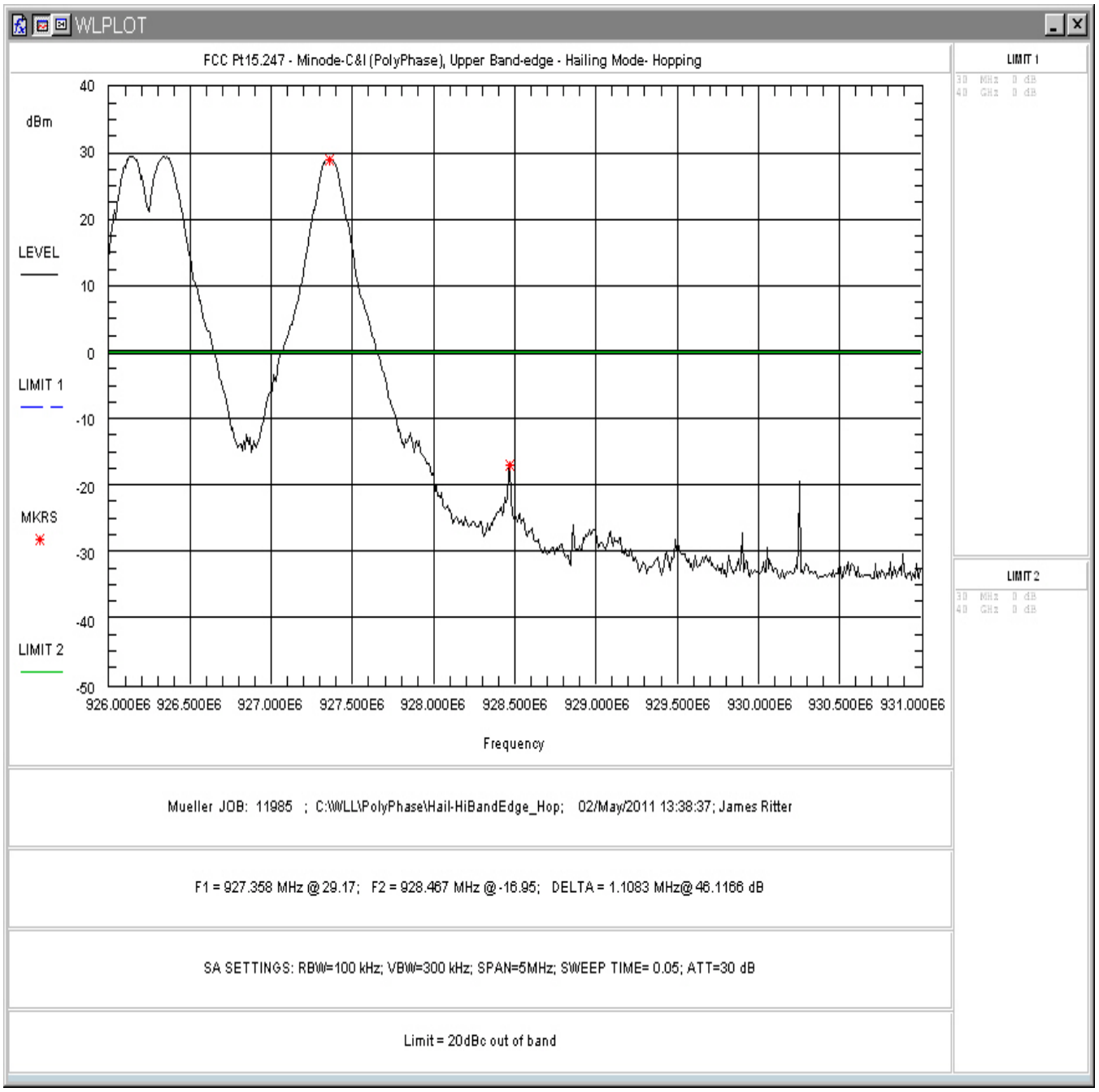

Figure 28 Upper Band Edge Plot, Hailing Hopping Mode

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5.5.2 Conducted Spurious Emissions

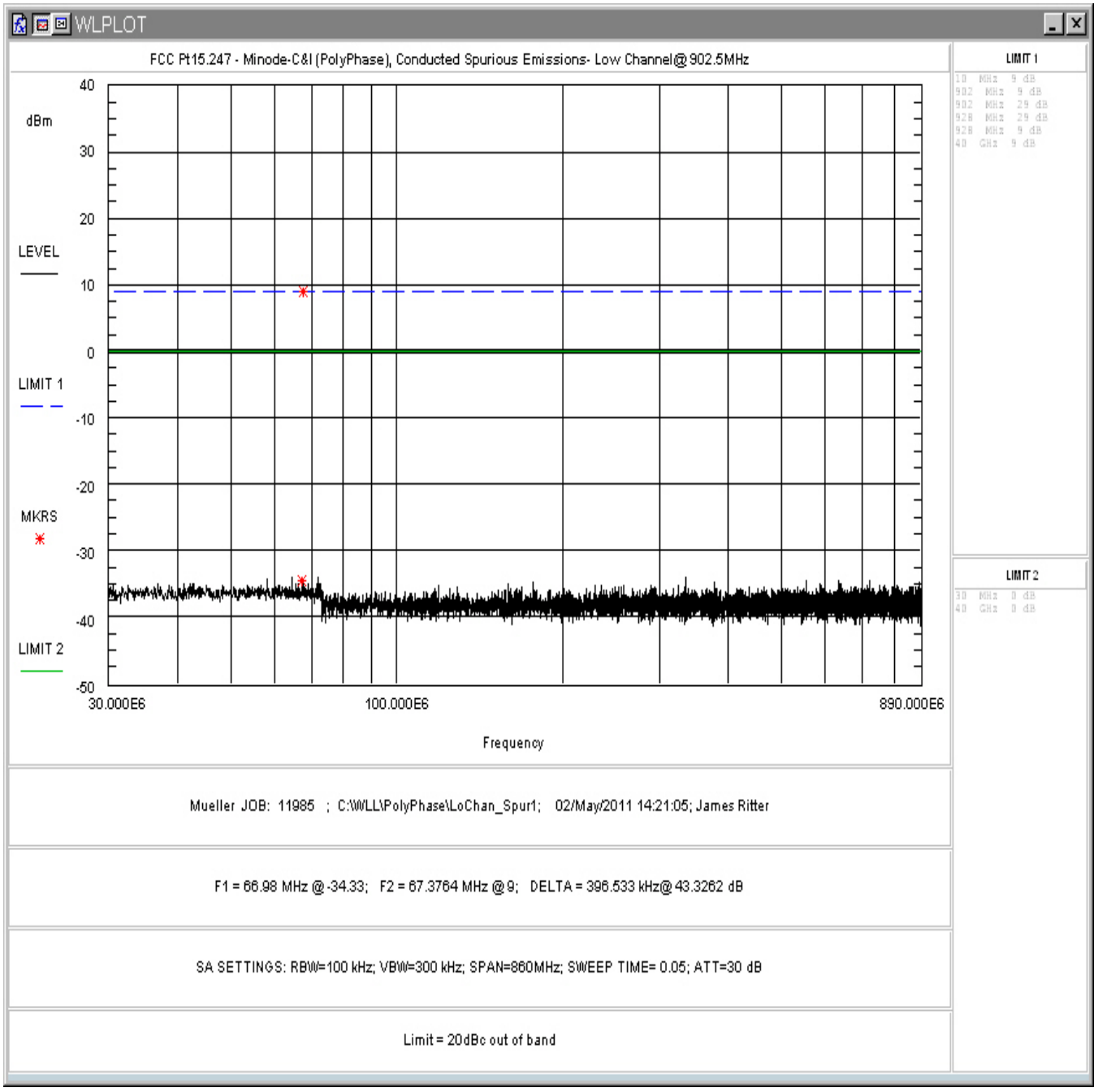

Figure 29 Conducted Spurious Emissions, Low Channel, 30-890MHz

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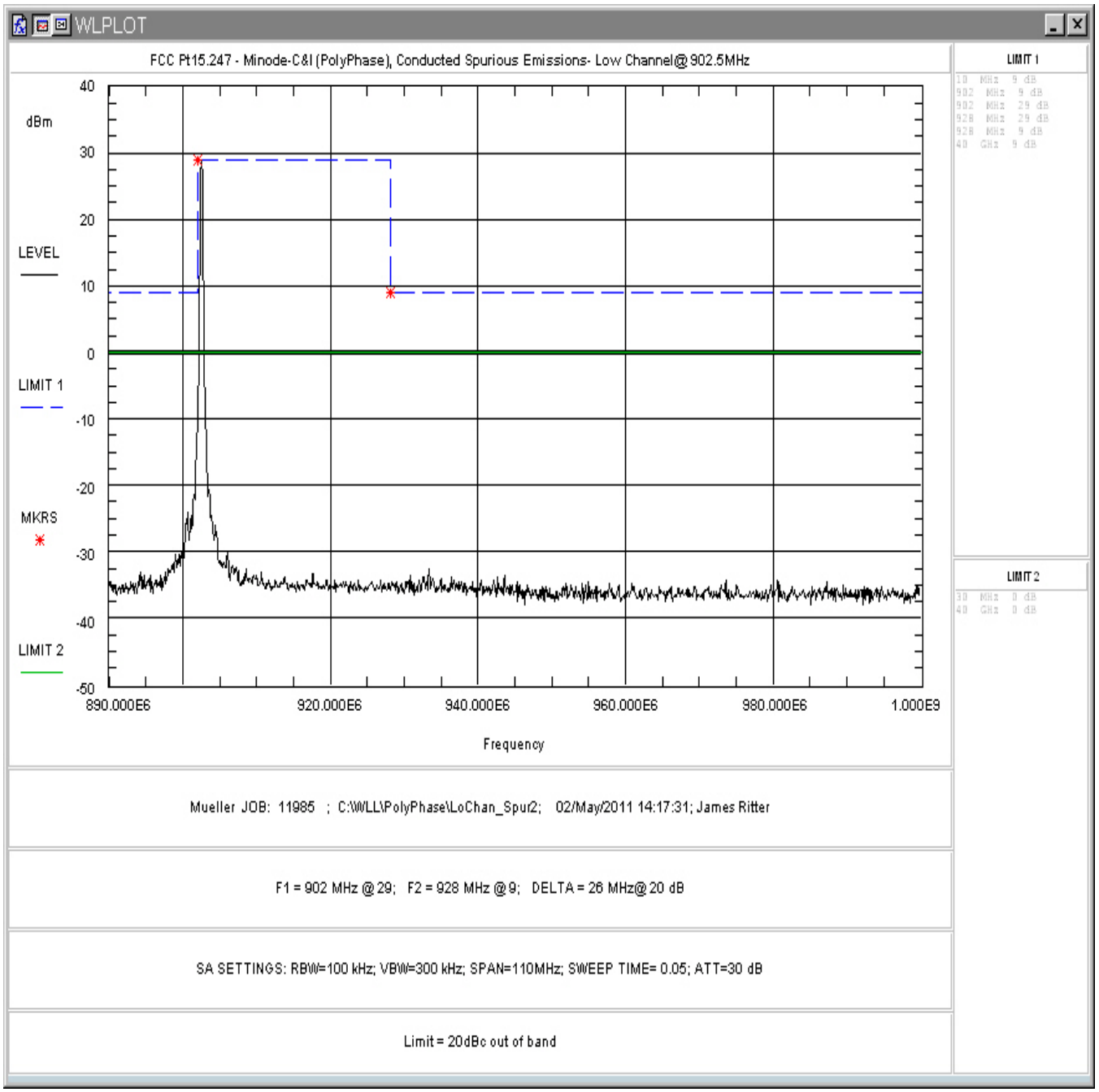

Figure 30 Conducted Spurious Emissions, Low Channel, 890-1000MHz

 © 2011 Washington Laboratories, Ltd.

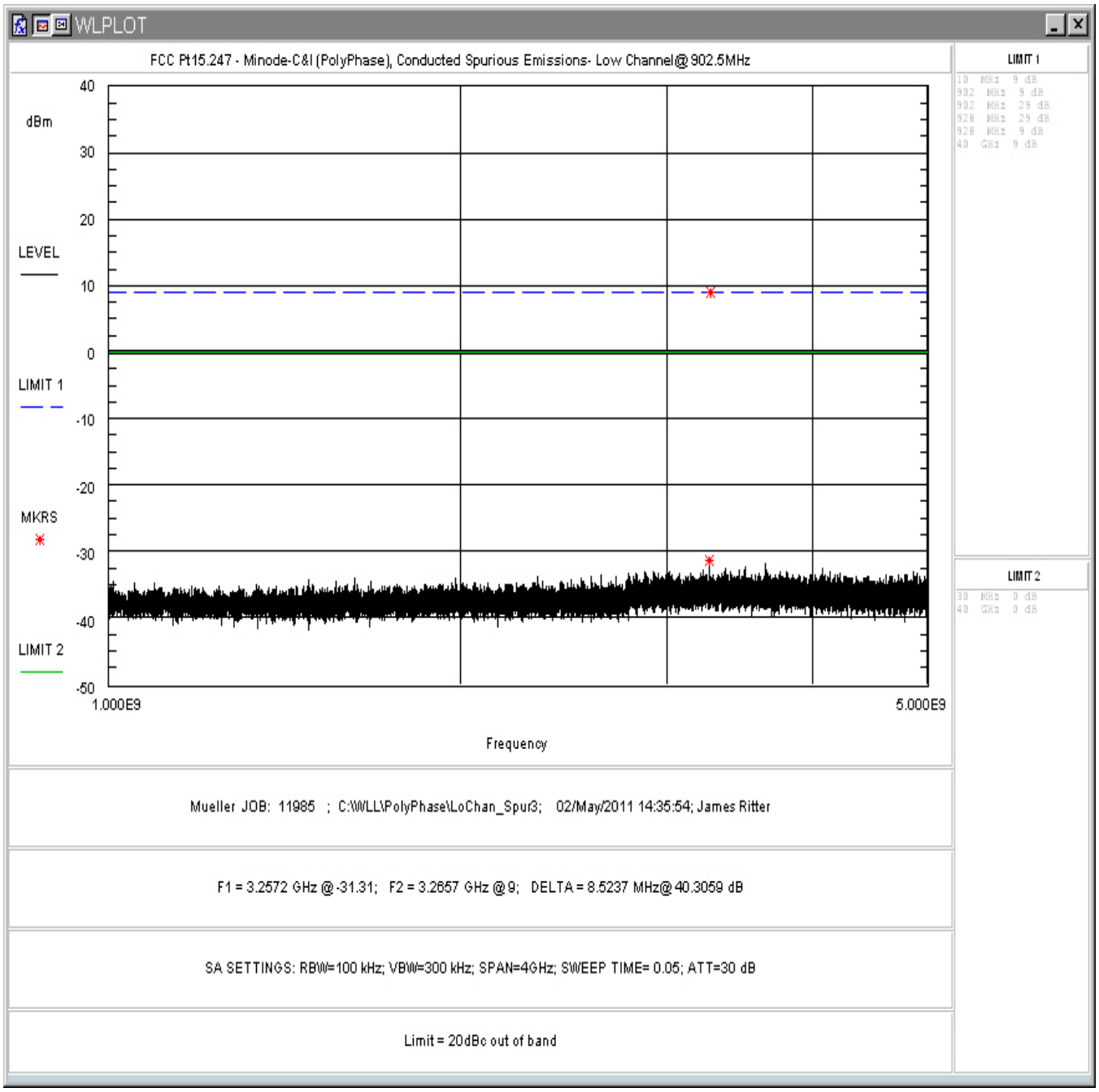

Figure 31 Conducted Spurious Emissions, Low Channel, 1-5GHz

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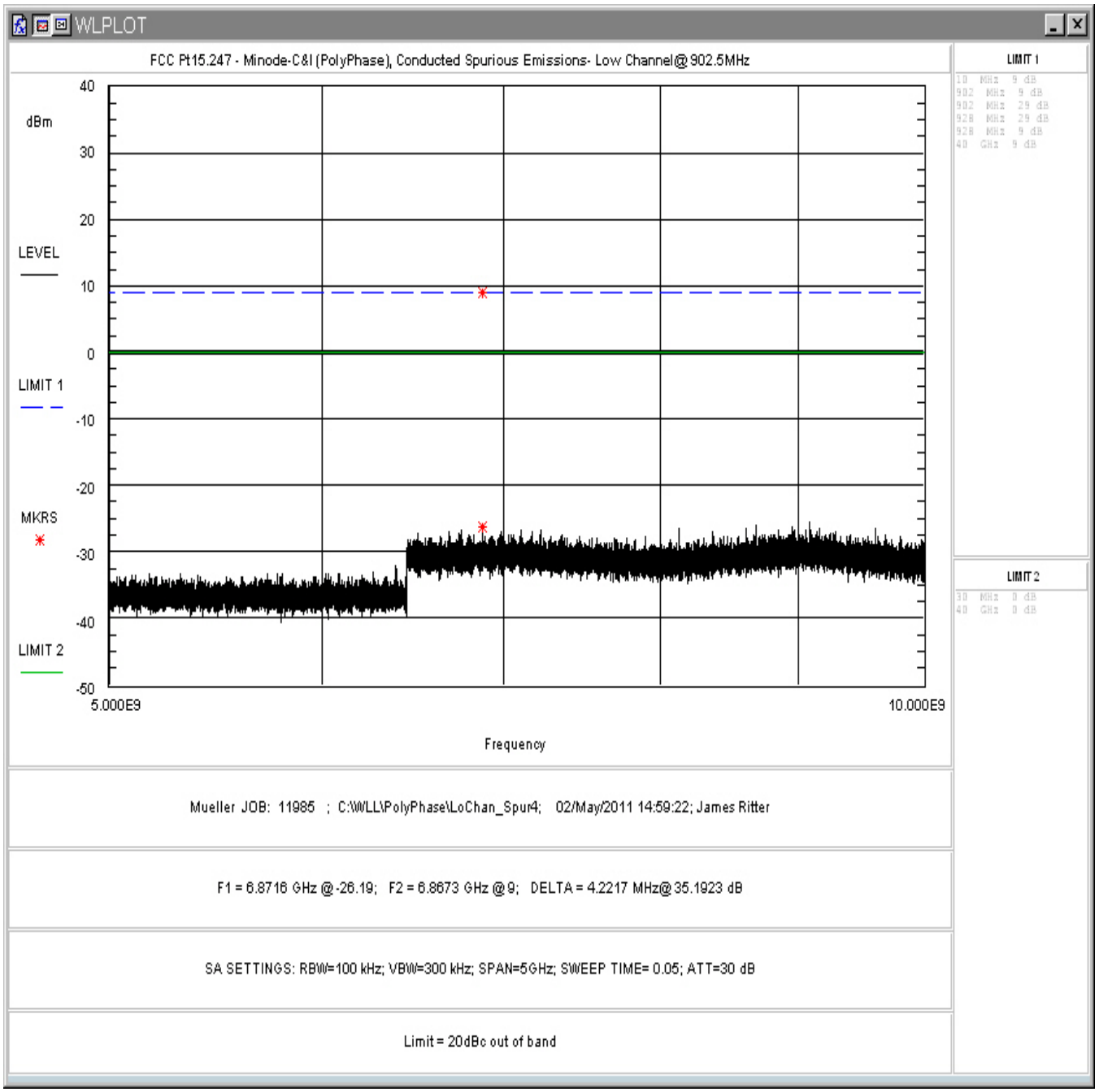

Figure 32 Conducted Spurious Emissions, Low Channel, 5-10GHz

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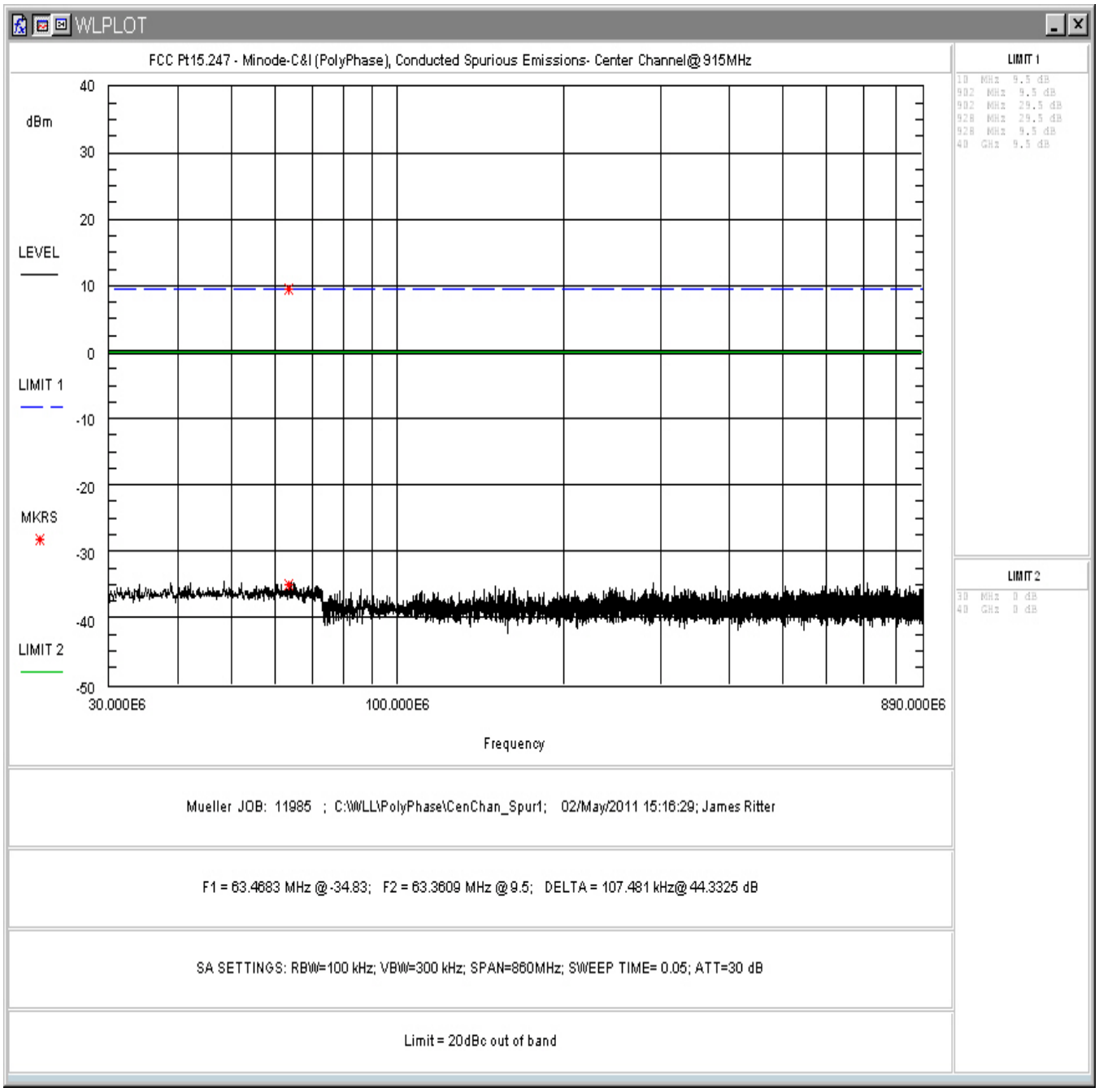

Figure 33 Conducted Spurious Emissions, Center Channel, 30-890MHz

 © 2011 Washington Laboratories, Ltd.

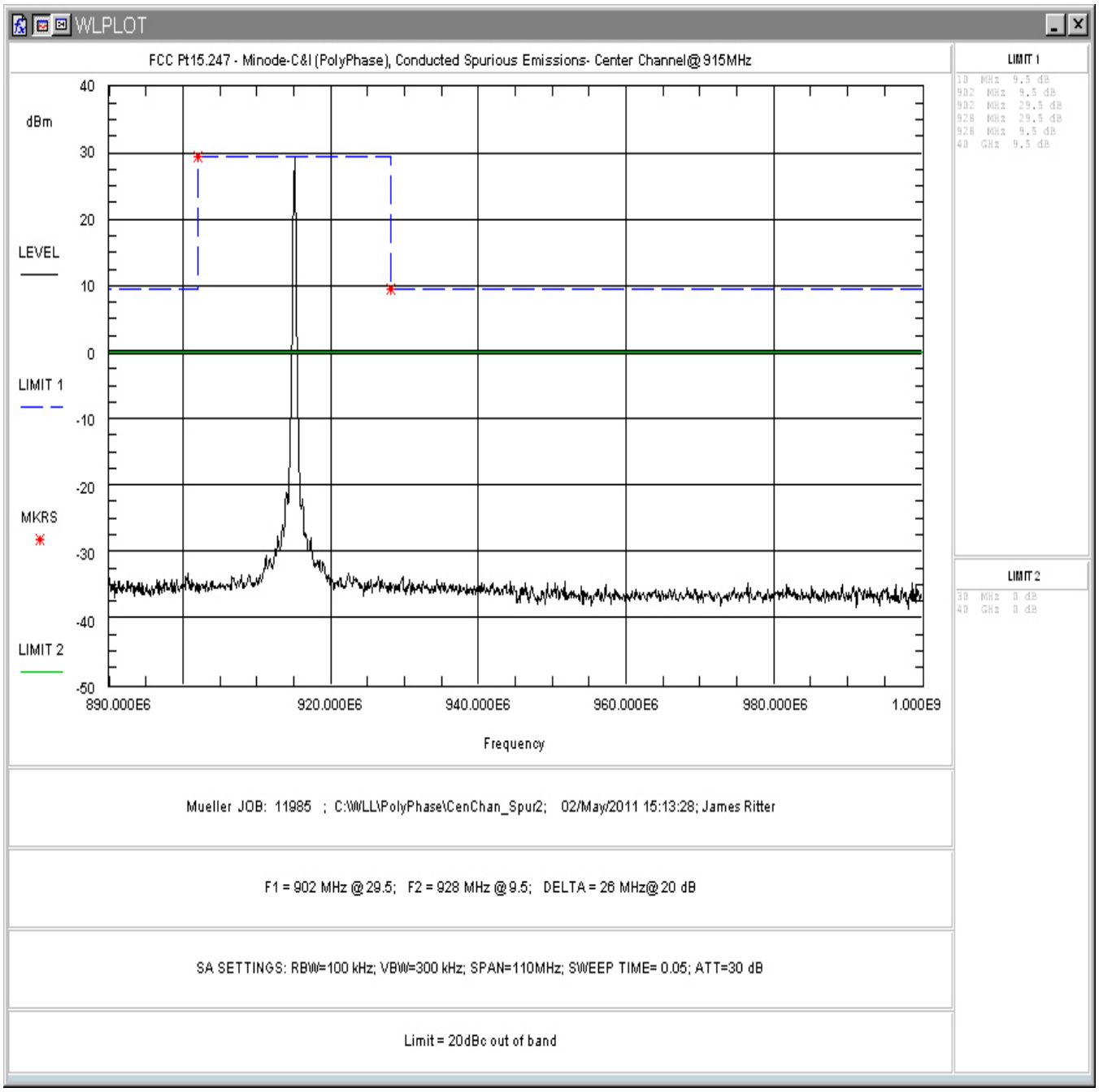

Figure 34 Conducted Spurious Emissions, Center Channel, 890-1000MHz

 © 2011 Washington Laboratories, Ltd.

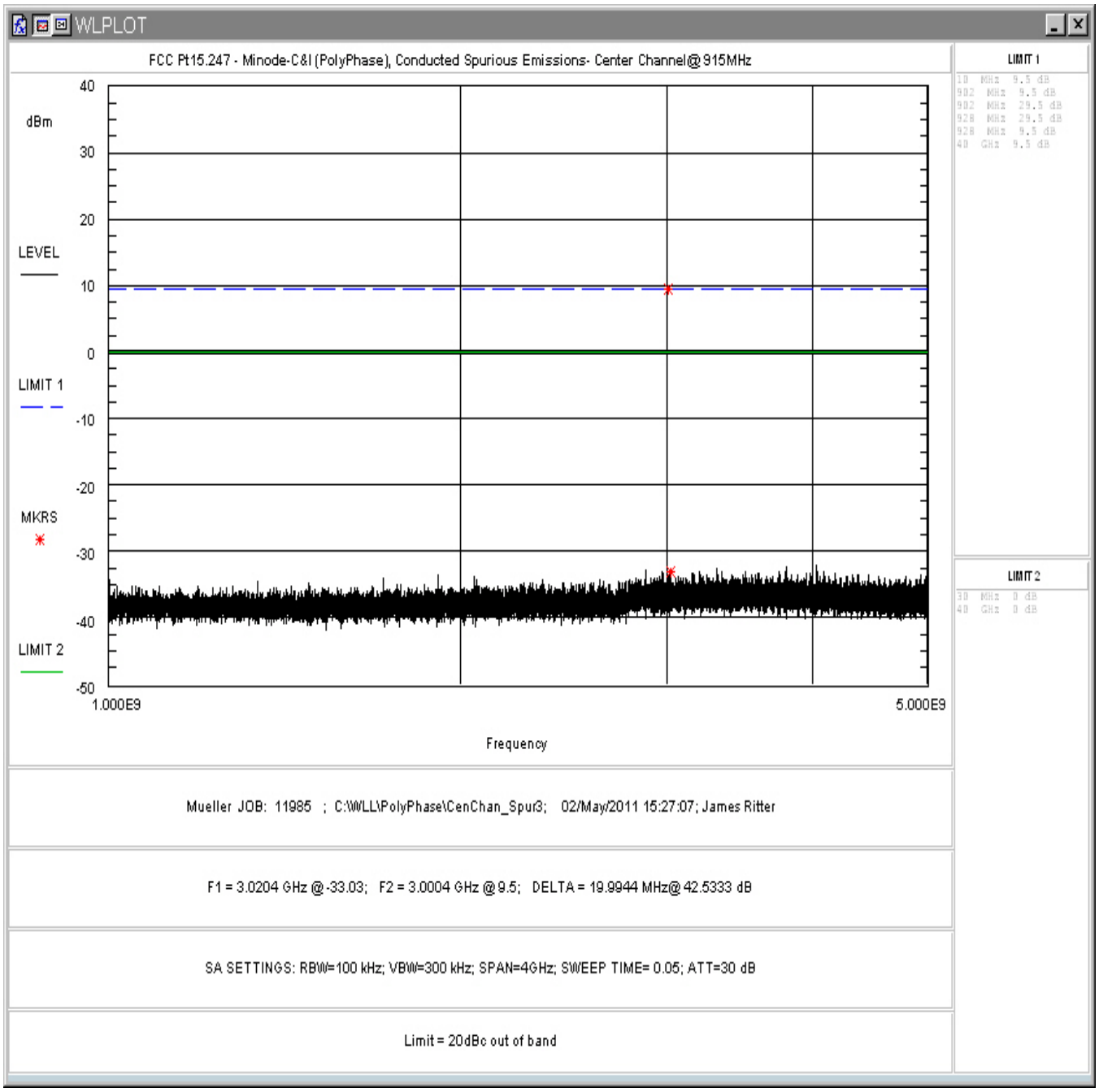

Figure 35 Conducted Spurious Emissions, Center Channel, 1-5GHz

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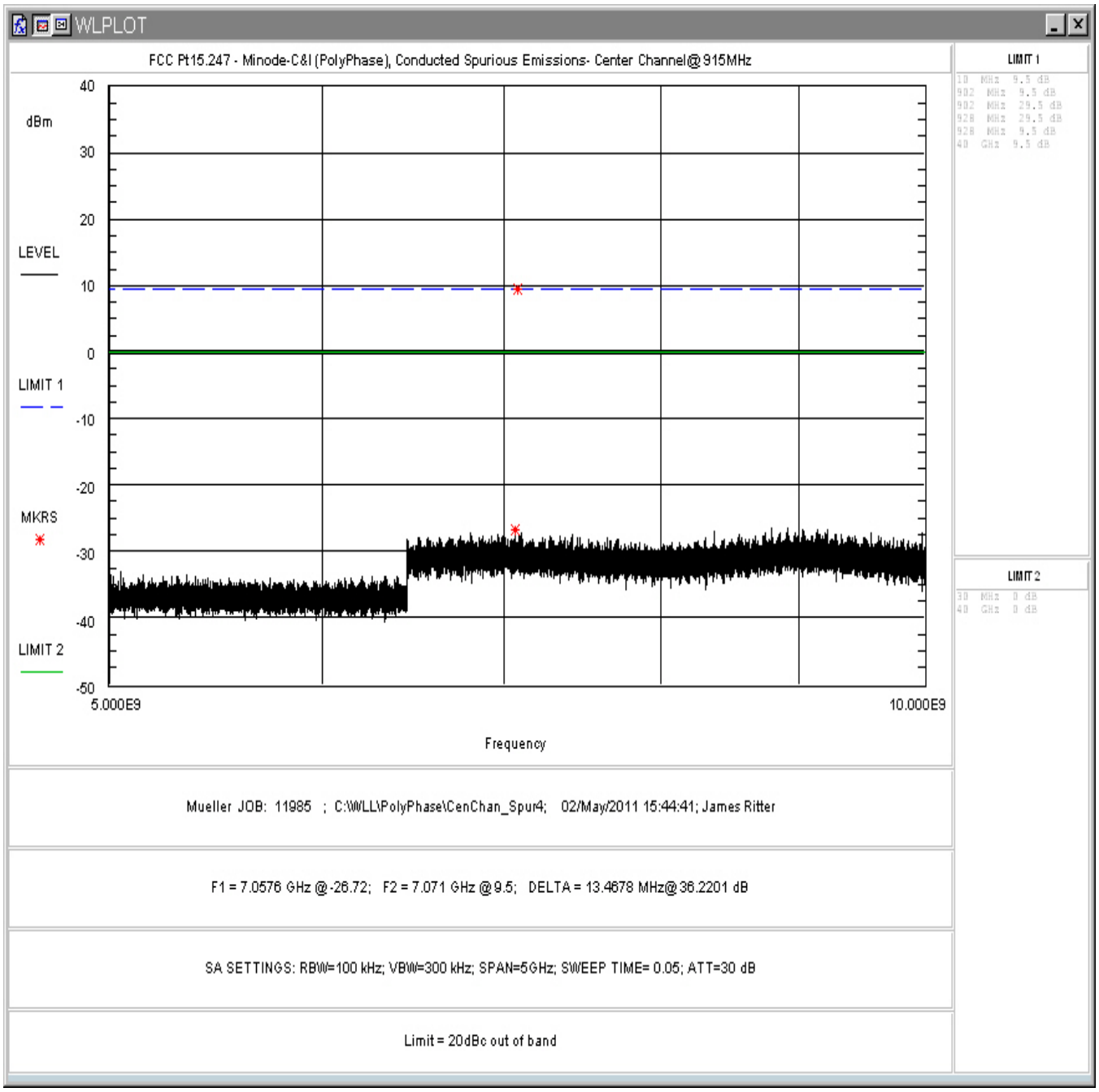

Figure 36 Conducted Spurious Emissions, Center Channel, 5-10GHz

 © 2011 Washington Laboratories, Ltd.

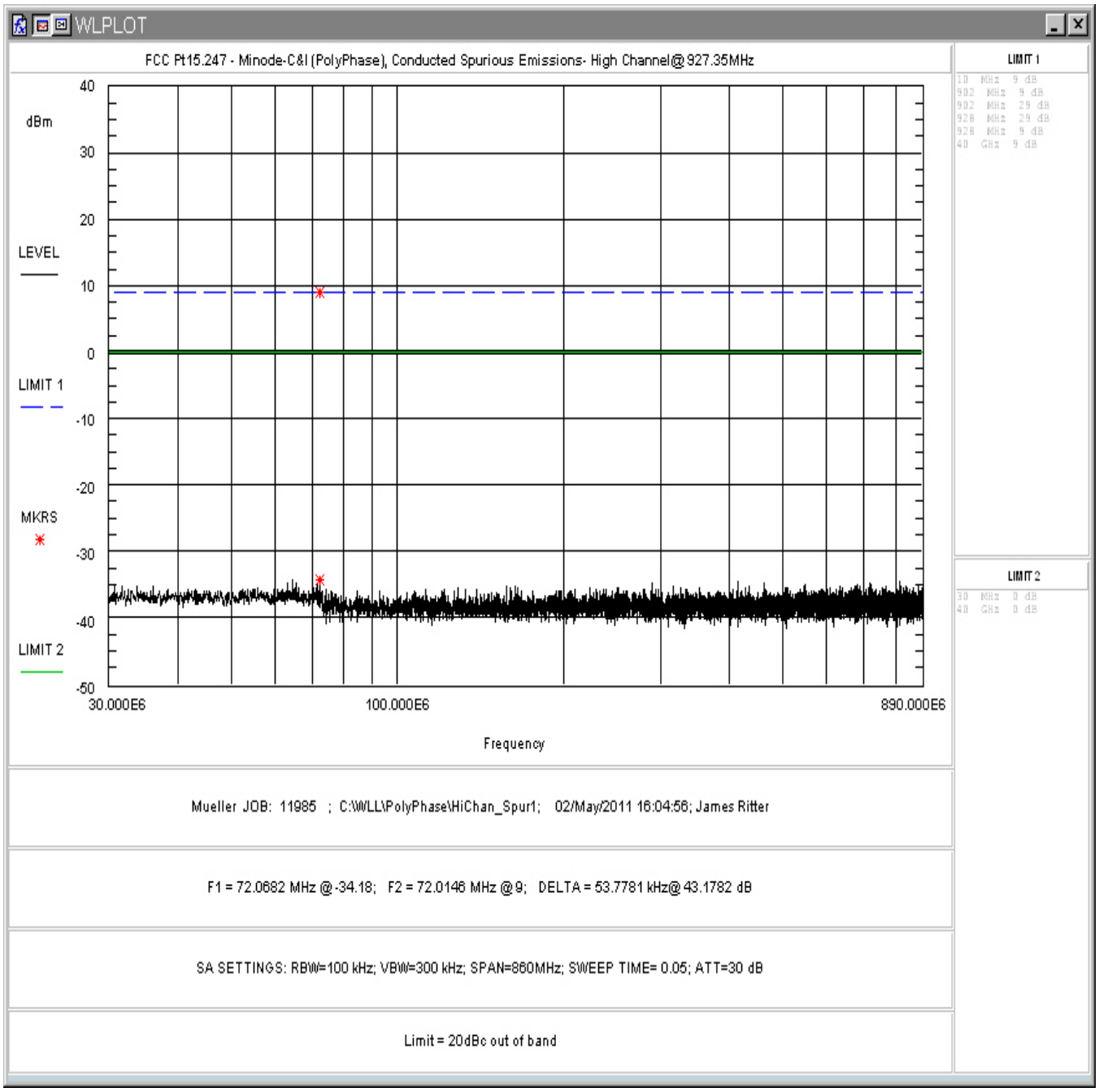

Figure 37 Conducted Spurious Emissions, High Channel, 30-890MHz

 © 2011 Washington Laboratories, Ltd.

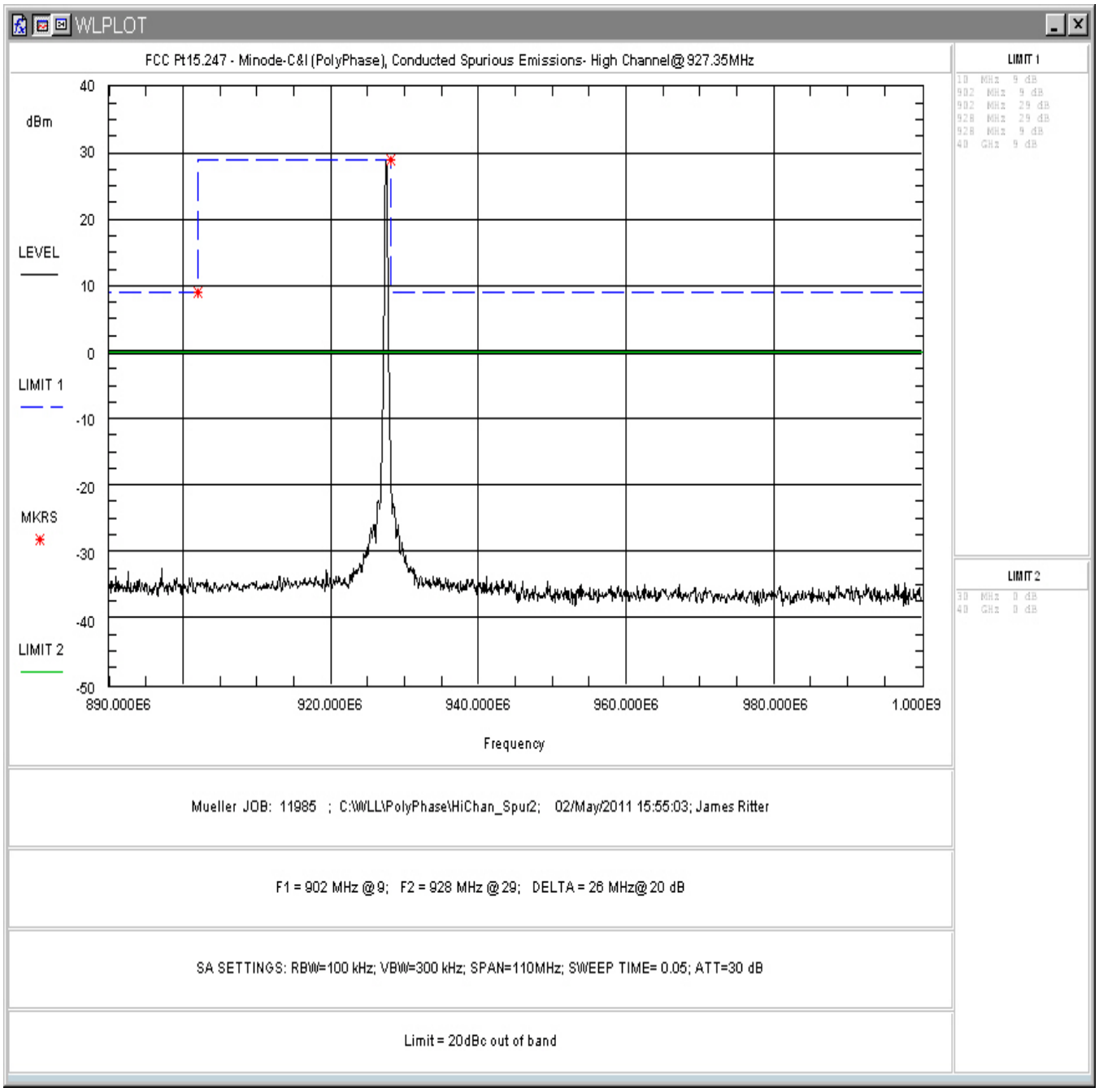

Figure 38 Conducted Spurious Emissions, High Channel, 890-1000MHz

 © 2011 Washington Laboratories, Ltd.

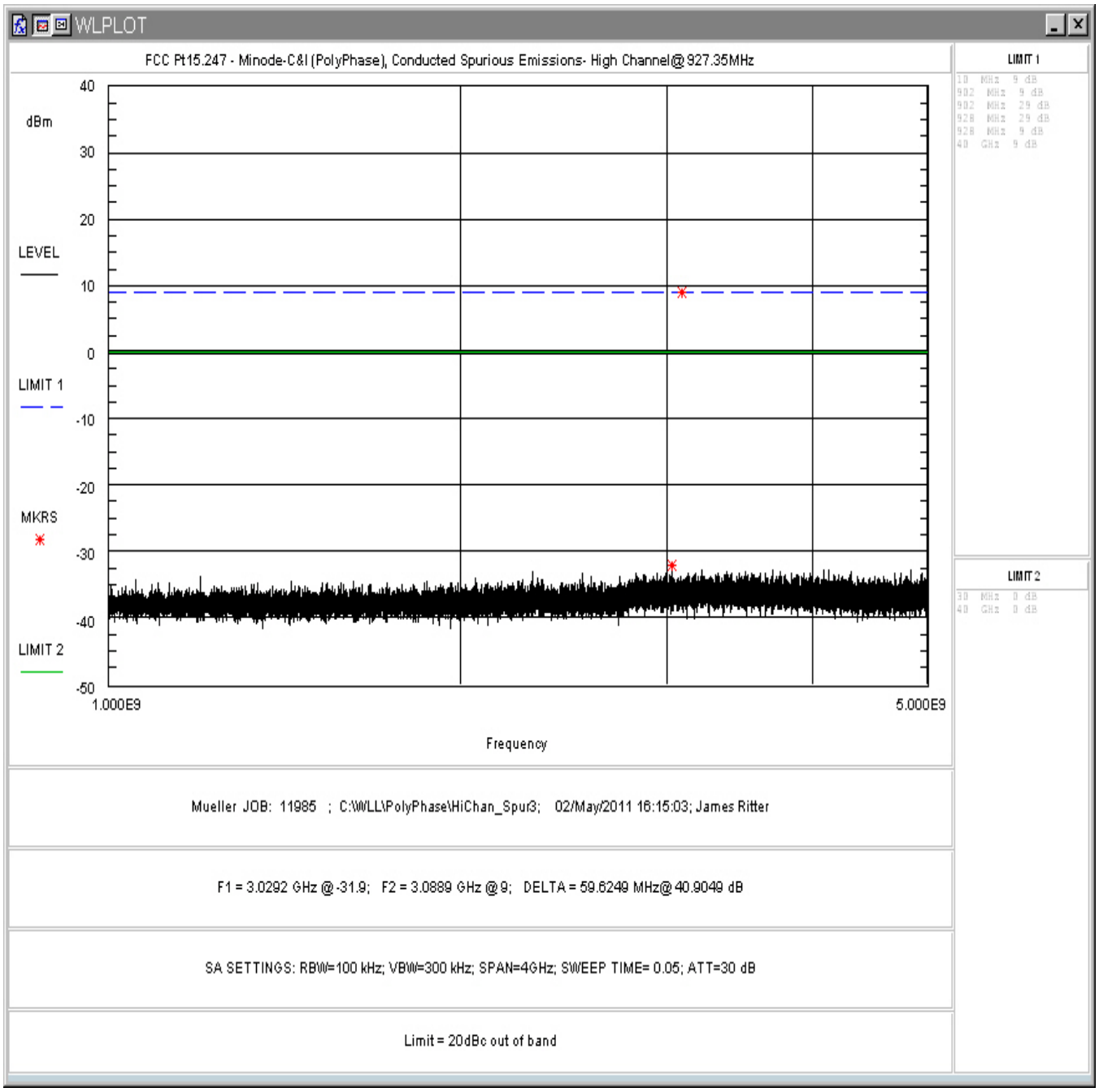

Figure 39 Conducted Spurious Emissions, High Channel, 1-5GHz

 © 2011 Washington Laboratories, Ltd.

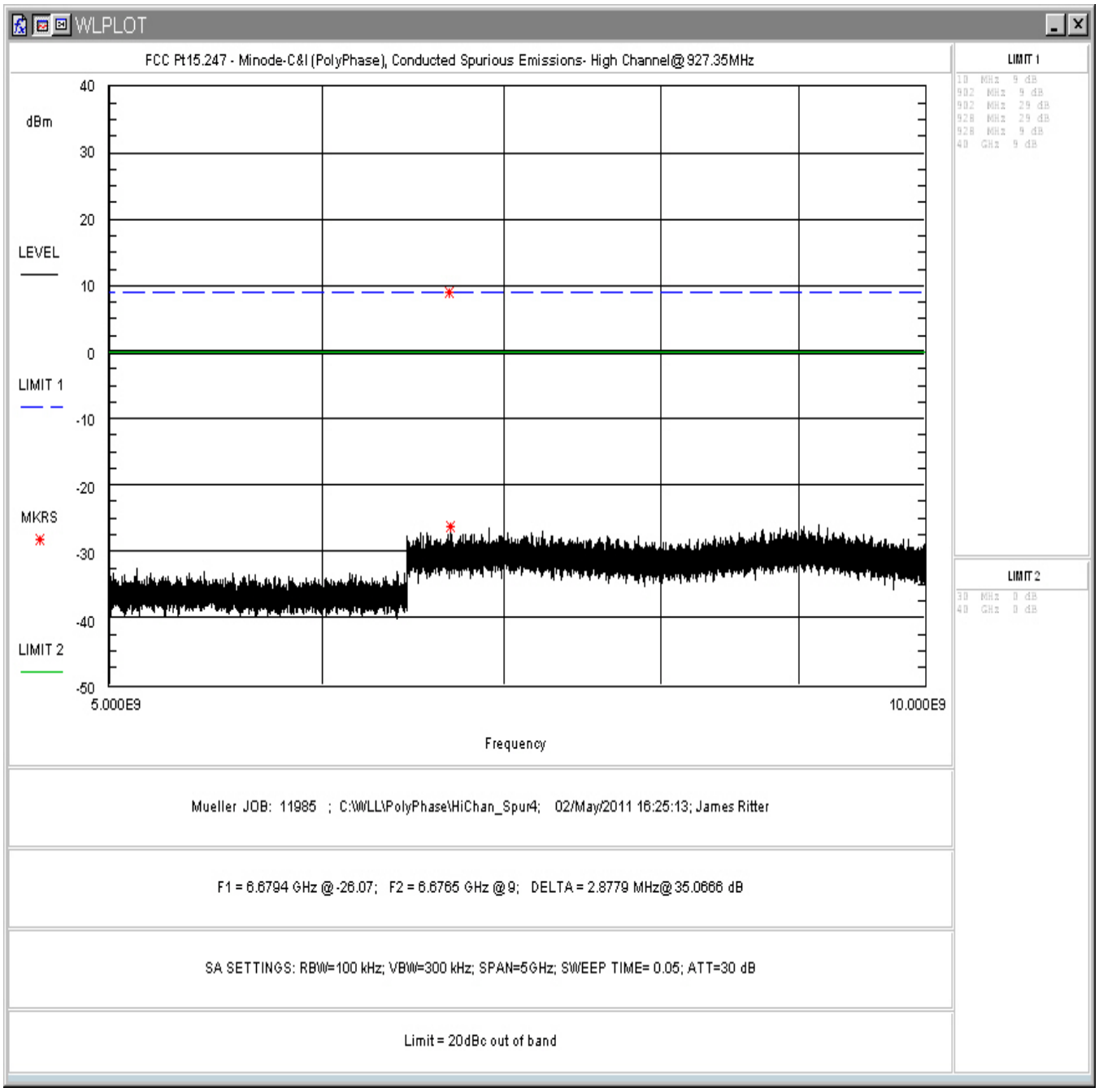

Figure 40 Conducted Spurious Emissions, Center Channel, 5-10GHz

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5.6 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

5.6.1 Test Procedure

The EUT was placed on a 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 EUT was tested in 3 orthogonals with the worst case readings provided. Both the horizontal and vertical field components were measured. Measurements below 1 GHz include both restricted and non-restricted bands.

As the Hailing and Data channels have the same characteristics (power, bandwidth) and use the same RF path the low, center, and high channels have been selected from all available channels.

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	10 Hz (Avg.) 1MHz (Peak)

5.6.2 Areas of concern

None

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Table 10: Radiated Emission Test Data, Low Frequency Data (<1GHz) (emissions were common to all tested channels)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
84.35	V	90.00	1.00	14.80	9.1	15.6	100.0	-16.1
111.18	V	270.00	1.00	4.30	13.4	7.7	150.0	-25.8
168.85	V	45.00	1.00	5.70	13.7	9.4	150.0	-24.1
133.48	V	42.00	1.00	7.60	14.6	12.8	150.0	-21.4
228.87	V	0.00	1.00	5.20	13.3	8.5	200.0	-27.5
267.00	V	185.00	1.00	4.80	15.3	10.1	200.0	-25.9
463.26	V	117.00	1.00	3.80	20.2	15.9	200.0	-22.0
56.86	H	139.00	3.23	11.40	8.1	9.4	100.0	-20.5
84.35	H	90.00	4.00	14.80	9.1	15.6	100.0	-16.1
117.92	H	90.00	4.00	15.70	14.5	32.4	150.0	-13.3
133.53	H	180.00	3.00	4.40	14.6	8.9	150.0	-24.6
168.85	H	180.00	3.80	4.90	13.7	8.6	150.0	-24.9
228.87	H	112.00	2.50	5.60	13.3	8.9	200.0	-27.1
267.00	H	116.00	2.60	4.50	15.3	9.8	200.0	-26.2
463.51	H	280.00	1.40	2.90	20.2	14.4	200.0	-22.9

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Table 11: Radiated Emission Test Data, High Frequency Data (>1GHz), Low Channel (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
TX 902.5									
2707.50	V	45.00	2.58	53.28	1.2	530.3	5000.0	-19.5	Peak
3610.00	V	270.00	2.50	50.10	6.4	668.3	5000.0	-17.5	Peak
4512.50	V	340.00	2.50	48.30	7.9	642.5	5000.0	-17.8	Peak
5415.00	V	0.00	2.30	40.70	11.3	397.8	5000.0	-22.0	Peak
8122.50	V	0.00	2.00	41.80	18.5	1037.2	5000.0	-13.7	Peak
9025.00	V	0.00	2.00	42.10	21.4	1491.7	5000.0	-10.5	Peak
2707.50	V	45.00	2.58	50.00	1.2	363.5	500.0	-2.8	Average
3610.00	V	270.00	2.50	45.50	6.4	393.5	500.0	-2.1	Average
4512.50	V	340.00	2.50	44.20	7.9	400.8	500.0	-1.9	Average
5415.00	V	0.00	2.30	31.30	11.3	134.8	500.0	-11.4	Average
8122.50	V	0.00	2.00	31.50	18.5	316.9	500.0	-4.0	Average
9025.00	V	0.00	2.00	31.60	21.4	445.3	500.0	-1.0	Average
2707.50	H	45.00	3.42	51.10	1.2	412.6	5000.0	-21.7	Peak
3610.00	H	25.00	3.34	46.20	6.4	426.6	5000.0	-21.4	Peak
4512.50	H	90.00	3.00	42.20	7.9	318.3	5000.0	-23.9	Peak
5415.00	H	90.00	3.00	41.50	11.3	436.2	5000.0	-21.2	Peak
8122.50	H	0.00	3.00	40.40	18.5	882.8	5000.0	-15.1	Peak
9025.00	H	0.00	3.00	43.80	21.4	1814.2	5000.0	-8.8	Peak
2707.50	H	45.00	3.42	46.40	1.2	240.2	500.0	-6.4	Average
3610.00	H	25.00	3.34	39.45	6.4	196.1	500.0	-8.1	Average
4512.50	H	90.00	3.00	33.40	7.9	115.6	500.0	-12.7	Average
5415.00	H	90.00	3.00	31.00	11.3	130.2	500.0	-11.7	Average
8122.50	H	0.00	3.00	31.50	18.5	316.9	500.0	-4.0	Average
9025.00	H	0.00	3.00	31.10	21.4	420.4	500.0	-1.5	Average

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Table 12: Radiated Emission Test Data, High Frequency Data (>1GHz), Center Channel (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
TX 915									
2745.00	V	90.00	2.58	47.42	1.4	277.4	5000.0	-25.1	Peak
3660.00	V	185.00	2.50	43.20	6.7	311.2	5000.0	-24.1	Peak
4575.00	V	270.00	2.50	40.80	7.8	268.6	5000.0	-25.4	Peak
7320.00	V	260.00	2.30	41.39	19.3	1088.1	5000.0	-13.2	Peak
8235.00	V	350.00	2.00	41.40	18.9	1035.3	5000.0	-13.7	Peak
9150.00	V	300.00	2.00	39.90	22.0	1245.6	5000.0	-12.1	Peak
2745.00	V	90.00	2.58	40.96	1.4	131.9	500.0	-11.6	Average
3660.00	V	185.00	2.50	31.70	6.7	82.8	500.0	-15.6	Average
4575.00	V	270.00	2.50	30.60	7.8	83.0	500.0	-15.6	Average
7320.00	V	260.00	2.30	29.60	19.3	280.0	500.0	-5.0	Average
8235.00	V	350.00	2.00	30.59	18.9	298.2	500.0	-4.5	Average
9150.00	V	300.00	2.00	30.56	22.0	425.0	500.0	-1.4	Average
2745.00	H	90.00	3.11	45.00	1.4	210.0	5000.0	-27.5	Peak
3660.00	H	45.00	3.23	41.67	6.7	261.0	5000.0	-25.6	Peak
4575.00	H	265.00	3.56	40.72	7.8	266.2	5000.0	-25.5	Peak
7320.00	H	125.00	3.50	40.25	19.3	954.3	5000.0	-14.4	Peak
8235.00	H	45.00	3.00	42.05	18.9	1115.7	5000.0	-13.0	Peak
9150.00	H	90.00	3.00	41.46	22.0	1490.7	5000.0	-10.5	Peak
2745.00	H	90.00	3.11	38.00	1.4	93.8	500.0	-14.5	Average
3660.00	H	45.00	3.23	31.92	6.7	84.9	500.0	-15.4	Average
4575.00	H	265.00	3.56	30.00	7.8	77.5	500.0	-16.2	Average
7320.00	H	125.00	3.50	29.54	19.3	278.1	500.0	-5.1	Average
8235.00	H	45.00	3.00	30.65	18.9	300.3	500.0	-4.4	Average
9150.00	H	90.00	3.00	30.55	22.0	424.5	500.0	-1.4	Average

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Table 13: Radiated Emission Test Data, High Frequency Data (>1GHz), High Channel (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
TX 927.35									
2782.05	V	90.00	2.58	47.00	1.7	271.3	5000.0	-25.3	Peak
3709.40	V	0.00	2.22	45.66	6.9	425.5	5000.0	-21.4	Peak
4636.75	V	350.00	2.54	42.42	8.2	338.0	5000.0	-23.4	Peak
7418.80	V	180.00	2.30	40.89	19.7	1068.1	5000.0	-13.4	Peak
8346.15	V	0.00	2.00	40.10	19.5	951.9	5000.0	-14.4	Peak
2782.05	V	90.00	2.58	37.80	1.7	94.1	500.0	-14.5	Average
3709.40	V	0.00	2.22	37.60	6.9	168.2	500.0	-9.5	Average
4636.75	V	350.00	2.54	31.73	8.2	98.7	500.0	-14.1	Average
7418.80	V	180.00	2.30	30.90	19.7	338.2	500.0	-3.4	Average
8346.15	V	0.00	2.00	30.56	19.5	317.4	500.0	-3.9	Average
2782.05	H	85.00	3.31	44.70	1.7	208.2	5000.0	-27.6	Peak
3709.40	H	350.00	3.23	42.30	6.9	289.0	5000.0	-24.8	Peak
4636.75	H	265.00	3.20	41.70	8.2	311.1	5000.0	-24.1	Peak
7418.80	H	65.00	3.15	42.00	19.7	1213.7	5000.0	-12.3	Peak
8346.15	H	90.00	3.00	40.23	19.5	966.2	5000.0	-14.3	Peak
2782.05	H	85.00	3.31	36.26	1.7	78.8	500.0	-16.1	Average
3709.40	H	350.00	3.23	32.64	6.9	95.0	500.0	-14.4	Average
4636.75	H	265.00	3.20	32.20	8.2	104.2	500.0	-13.6	Average
7418.80	H	65.00	3.15	30.83	19.7	335.4	500.0	-3.5	Average
8346.15	H	90.00	3.00	30.60	19.5	318.8	500.0	-3.9	Average

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5.7 AC Conducted Emissions (FCC Pt.15.207)

Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

FCC Compliance Limits		
Frequency	**Quasi-peak**	**Average**
0.15 - 0.5MHz	66 to 56dBµV	56 to 46dBµV
0.5 - 5MHz	56dBµV	46dBµV
5 - 30MHz	60dBµV	50dBµV

5.7.1 Test Procedure

The requirements of FCC Part 15 (10/2009) call for the EUT to be placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements the post-detector filter was set to 10 Hz.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

Conducted Data Reduction and Reporting

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

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5.7.2 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 14 and Table 15 provides the test results for phase and neutral line power line conducted emissions

Table 14: AC Conducted Emissions: 120VAC

NEUTRAL

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.155	33.8	12.5	10.3	0.5	44.6	23.3	65.7	55.7	-21.1	-32.4
0.305	32.1	14.9	10.2	0.5	42.8	25.6	60.1	50.1	-17.3	-24.5
1.886	23.5	12.7	10.5	0.4	34.4	23.6	56.0	46.0	-21.6	-22.4
17.700	25.2	20.6	11.4	1.5	38.1	33.5	60.0	50.0	-21.9	-16.5
21.820	28.9	14.4	11.6	2.0	42.5	28.0	60.0	50.0	-17.5	-22.0
25.370	27.6	14.1	11.7	2.5	41.9	28.4	60.0	50.0	-18.1	-21.6

PHASE

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.150	36.0	11.6	10.3	0.7	47.0	22.6	66.0	56.0	-19.0	-33.4
1.135	32.1	12.2	10.4	0.4	42.9	23.0	56.0	46.0	-13.1	-23.0
2.221	17.6	8.3	10.6	0.4	28.6	19.3	56.0	46.0	-27.4	-26.7
22.810	29.9	24.4	11.6	3.1	44.6	39.1	60.0	50.0	-15.4	-10.9
25.640	33.0	20.5	11.7	3.7	48.4	35.9	60.0	50.0	-11.6	-14.1
28.450	28.1	16.1	11.9	4.3	44.3	32.3	60.0	50.0	-15.7	-17.7

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Table 15: AC Conducted Emissions: 230VAC

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.150	43.2	12.9	10.3	0.5	54.0	23.7	66.0	56.0	-12.0	-32.3
0.184	40.2	14.0	10.3	0.5	51.0	24.8	64.3	54.3	-13.3	-29.5
0.892	31.0	12.6	10.4	0.4	41.7	23.3	56.0	46.0	-14.3	-22.7
1.256	30.2	12.1	10.4	0.4	41.0	22.9	56.0	46.0	-15.0	-23.1
22.750	28.6	15.0	11.6	2.1	42.3	28.7	60.0	50.0	-17.7	-21.3
25.820	27.8	24.0	11.8	2.6	42.2	38.4	60.0	50.0	-17.8	-11.6

PHASE

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.160	42.7	9.4	10.3	0.7	53.7	20.4	65.5	55.5	-11.8	-35.1
0.848	27.4	7.5	10.4	0.4	38.1	18.2	56.0	46.0	-17.9	-27.8
1.198	26.5	6.9	10.4	0.4	37.3	17.7	56.0	46.0	-18.7	-28.3
2.061	21.7	6.9	10.6	0.4	32.6	17.8	56.0	46.0	-23.4	-28.2
25.370	32.7	22.2	11.7	3.6	48.1	37.6	60.0	50.0	-11.9	-12.4
29.730	26.4	15.9	12.0	4.5	42.9	32.4	60.0	50.0	-17.1	-17.6

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