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

Mueller Systems

DCOM3 Radio Module

FCC ID: SM6-MINODE-WATER3
IC: 9235A–MINODEWATER

WLL JOB# **11550-01 Rev 2**

August 6, 2010

Re-issued February 1,2011

Prepared for:

Mueller Systems
48 Leona Drive
Middleboro, MA, 02346 USA

Prepared By:

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

ACCREDITED TESTING

Testing Certificate AT-1448

FCC & Industry Canada Certification Test Report
For the
Mueller Systems
DCOM3 Radio Module

FCC ID: SM6-MINODE-WATER3
IC: 9235A–MINODEWATER

August 6, 2010
Re-issued February 1, 2011

WLL JOB# 11550-01 Rev 2

Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

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 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 a Mueller Systems DCOM3 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 DCOM3 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	August 6, 2010
Rev 1	Incorporation of Industry Canada Cross reference table and addition of section 5.8 Receiver spurious emissions.	September 14, 2010
Rev 2	Testing and reporting of hailing mode of operation	February 1, 2011

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The Mueller Systems DCOM3 Radio Module complies with the limits for a modular Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (10/2009) and Industry Canada RSS210 issue 8.

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:	65647

1.4 Test Dates

Testing was performed on the following date(s):	7/28/2010 to 2/1/2011

1.5 Test and Support Personnel

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

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 Mueller Systems DCOM3 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-WATER3
IC:	9235A–MINODEWATER
Model:	DCOM3 Radio Module
FCC Rule Parts:	§15.247
Frequency Range:	902.5-927.35MHz
Maximum Output Power: (conducted at antenna port)	29.76dBm (946mW)
Modulation:	FM
Occupied Bandwidth:	43.2 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50 Data Channels & 50 Hailing Channels
Power Output Level	Fixed
Antenna Connector	integral
Antenna Type	0dBi fixed monopole antenna
Interface:	None
Power Source & Voltage:	3.5VDC Battery
Emission Designator	43K2FXD
Highest TX Spurious Emission	2707.5MHz 369.6uV/m @ 3m
Highest RX Spurious Emission	456.41MHz- 53.2uV/m @ 3m

2.2 Modification

None.

2.3 Test Configuration

The DCOM3 Radio Module was operated from 120VAC 60Hz power. Commands were sent to the DCOM3 Radio Module using a programming to a support laptop using Windows HyperTerminal program. This connection was disconnected after the test mode was set.

2.4 Testing Algorithm

The DCOM3 Radio Module was programmed via an internal 3 pin programming port on the EUT to a USB port on the support laptop. The support laptop used HyperTerminal to command the EUT to transmit on the lowest, center, and highest channels. 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

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

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: **Conducted Antenna Port**		Test Date:	**7/27/2010 & 1/31/2011**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
618	HP, 8563A	ANALYZER, SPECTRUM	06/04/2011
528	AGILENT, E4446A	ANALYZER, SPECTRUM	08/27/2011
728	AGILENT - 8564EC	SPECTRUM ANALYZER 30HZ - 40GHZ	4/30/2012

Test Name: **Radiated Emissions**		Test Date:	**8/3/2010 & 2/1/2011**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	5/7/2011
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/6/2011
618	HP - 8563A	ANALYZER SPECTRUM	6/4/2011
742	PENN ENGINEERING - WR284	2.2-4.15GHZ BANDPASS FILTER	7/19/2012
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	3/24/2012
69	HP - 85650A	ADAPTER QP	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
71	HP - 85685A	PRESELECTOR RF	7/1/2011
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	12/20/2011

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, RSS210 issue 8, and RSS-Gen issue 3. 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 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 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 once in a 20 second period the time of occupancy is 200ms per 20 seconds, thus complying with the 0.4 second requirement.

DCOM3 Radio Job 11550, Part15.247 Single pulse Duty Cycle Plot
On time per pulse=200ms (No duty cycle correction allowed as Duty exceeds 100ms)

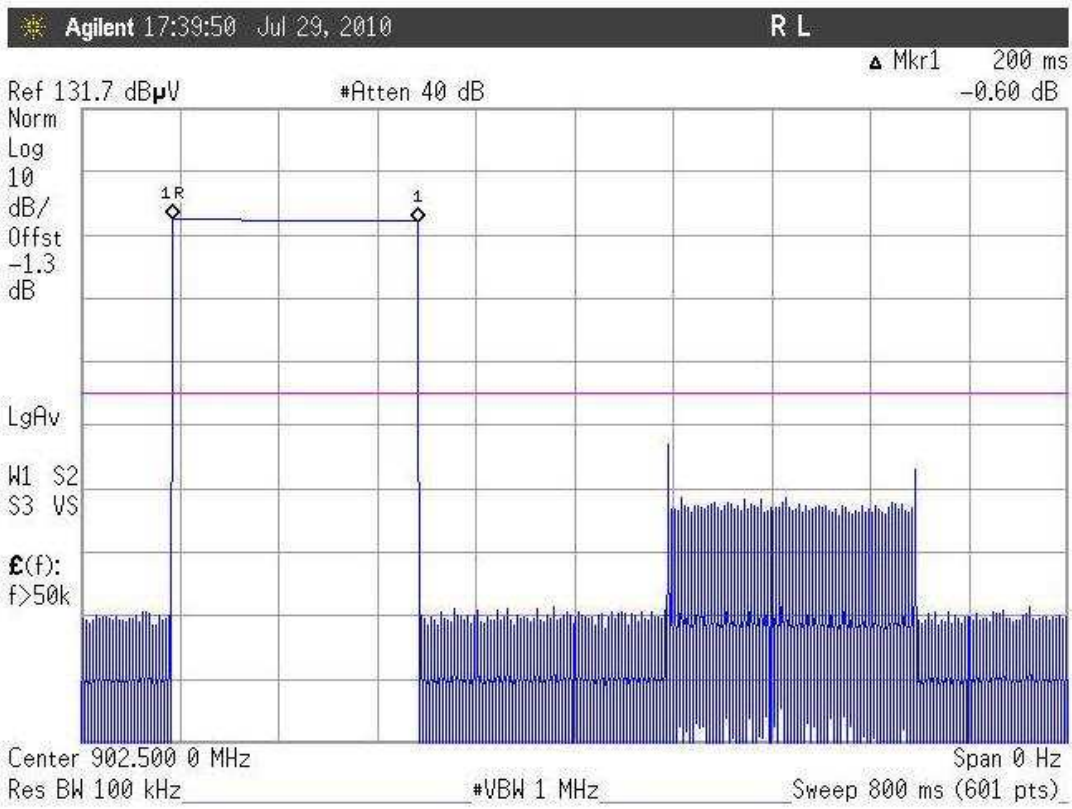

Figure 1 Data Channel Duty Cycle Plot

RFDC Radio Module, Job 11547, Time of Occupancy Plot
Limit = Maximum of 400mS per 20Seconds
Measured= 1 Pulse of 200mS (see Duty Cycle plot) per 20Sec.= 200mS - Complies with limit

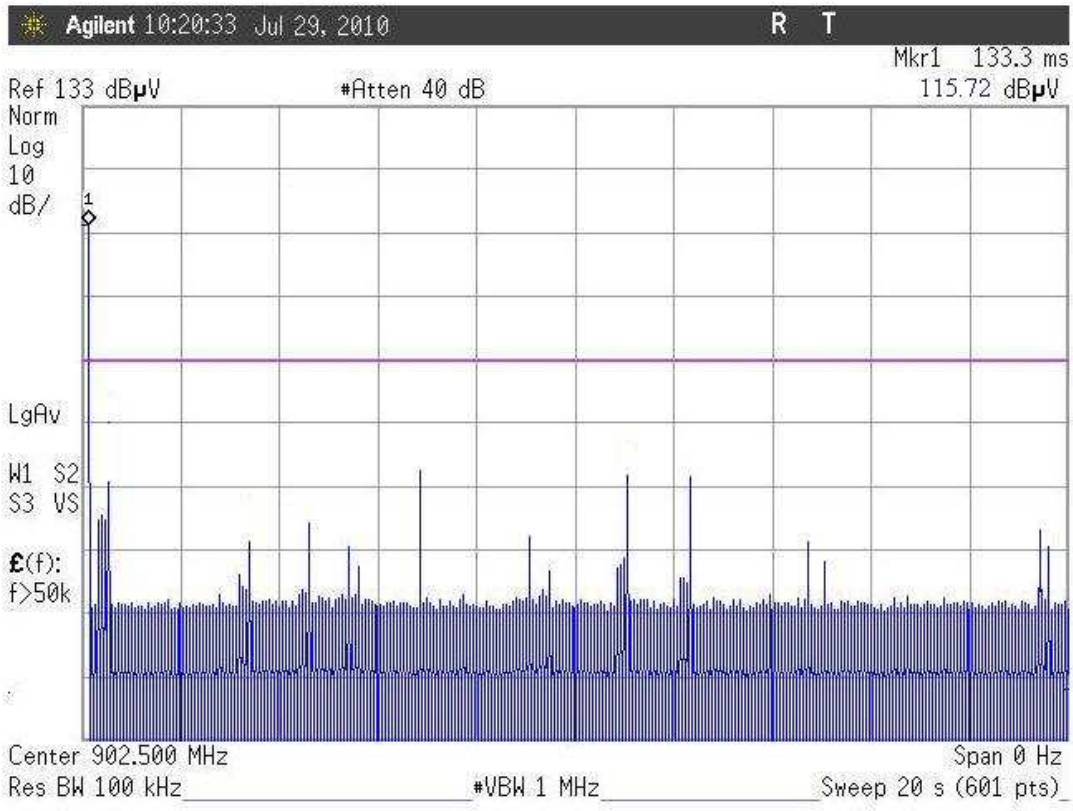

Figure 2 Data Channel Time of Occupancy Plot

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 400ms. As the unit is on a hailing channel once in a 20 second period the time of occupancy is 400ms per 20 seconds, thus complying with the 0.4 second requirement.

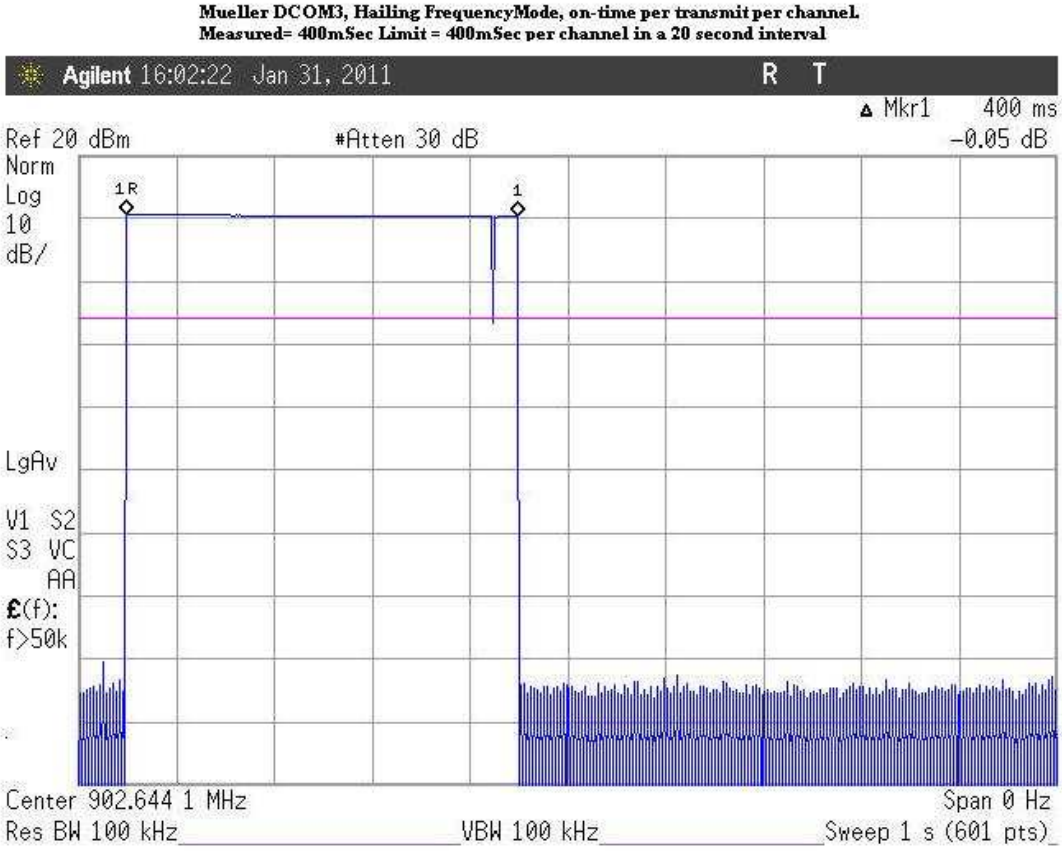

Figure 3 Hailing Channel Duty Cycle Plot

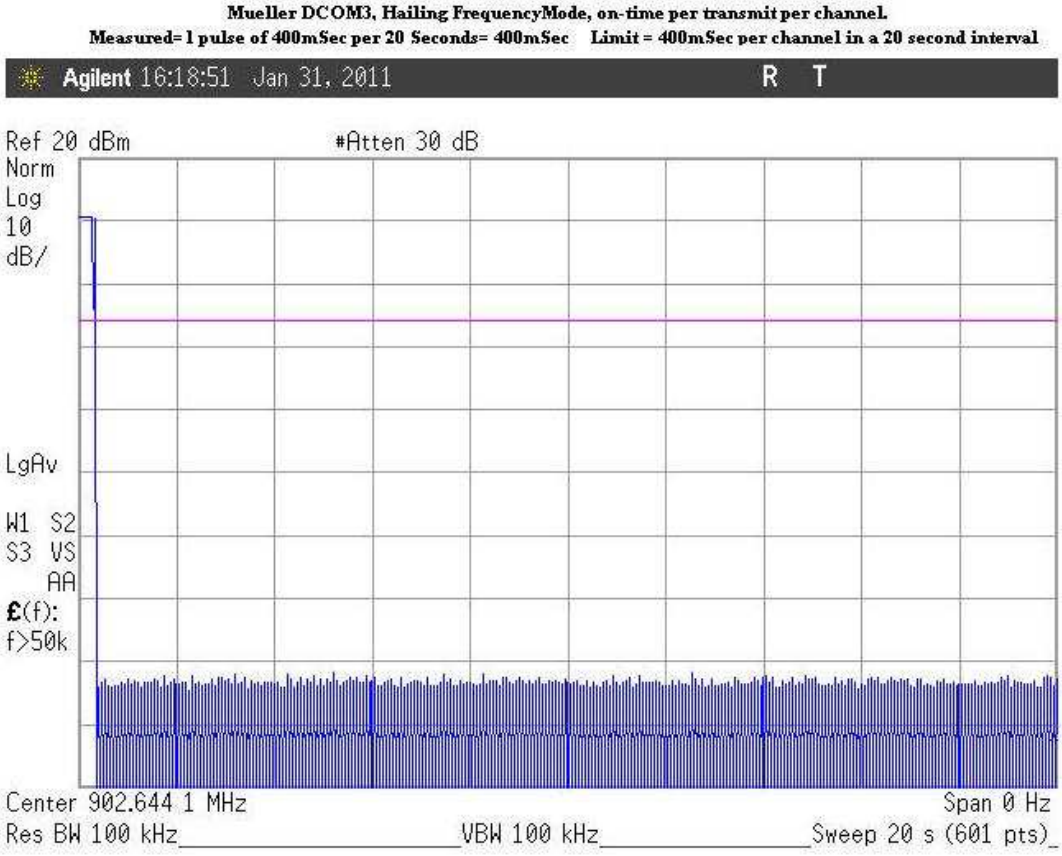

Figure 4 Hailing Channel Time of Occupancy Plot

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	29.51dBm	30dBm	Pass
Center Channel: 915.0MHz	29.76dBm	30dBm	Pass
High Channel: 927.0MHz	28.76dBm	30dBm	Pass

Table 6 Hailing Channel RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.65MHz	28.57dBm	30dBm	Pass
Center Channel: 915.35MHz	28.66dBm	30dBm	Pass
High Channel: 927.35MHz	28.83dBm	30dBm	Pass

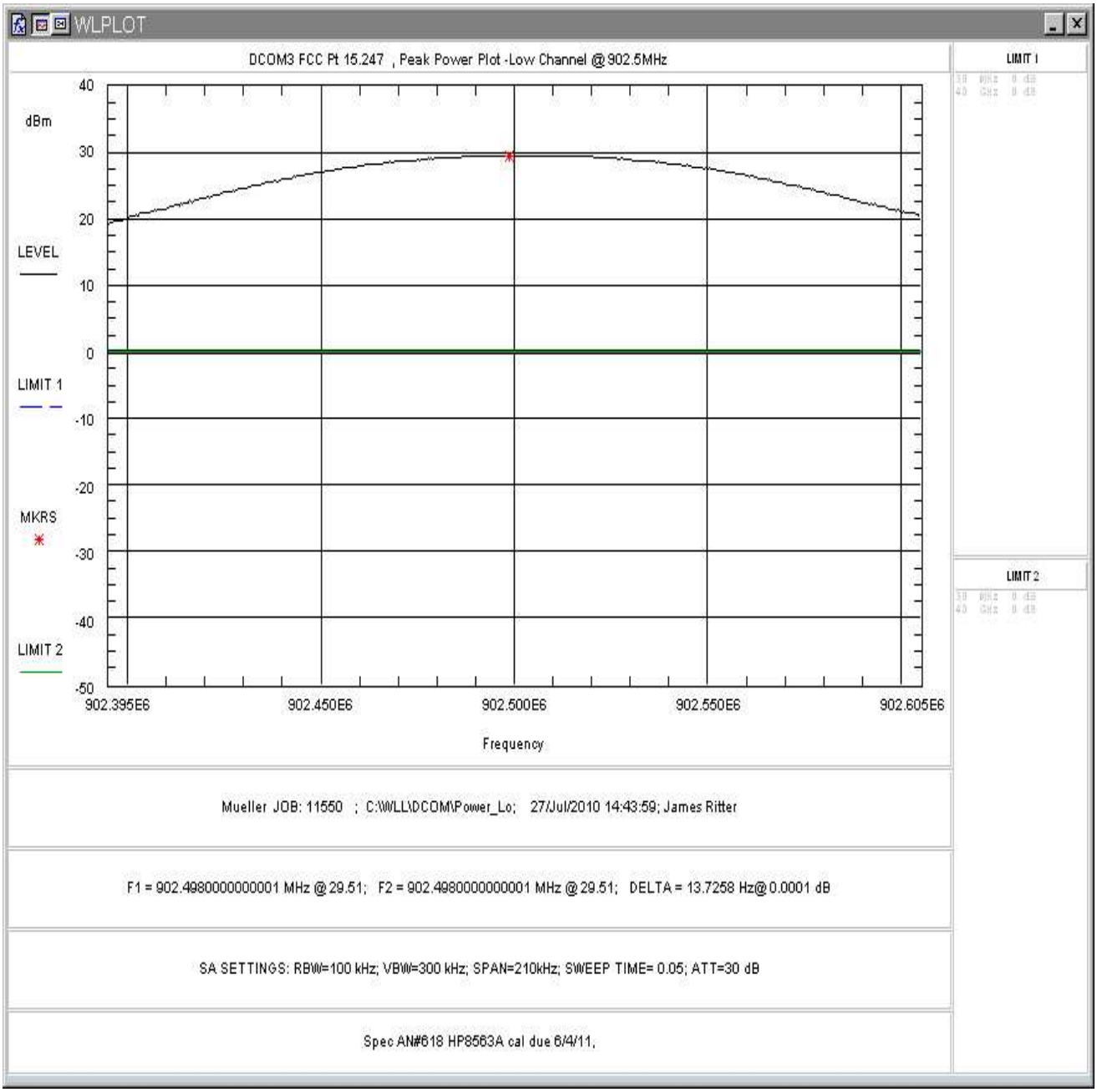

Figure 5 Data Channel RF Peak Power, Low Channel

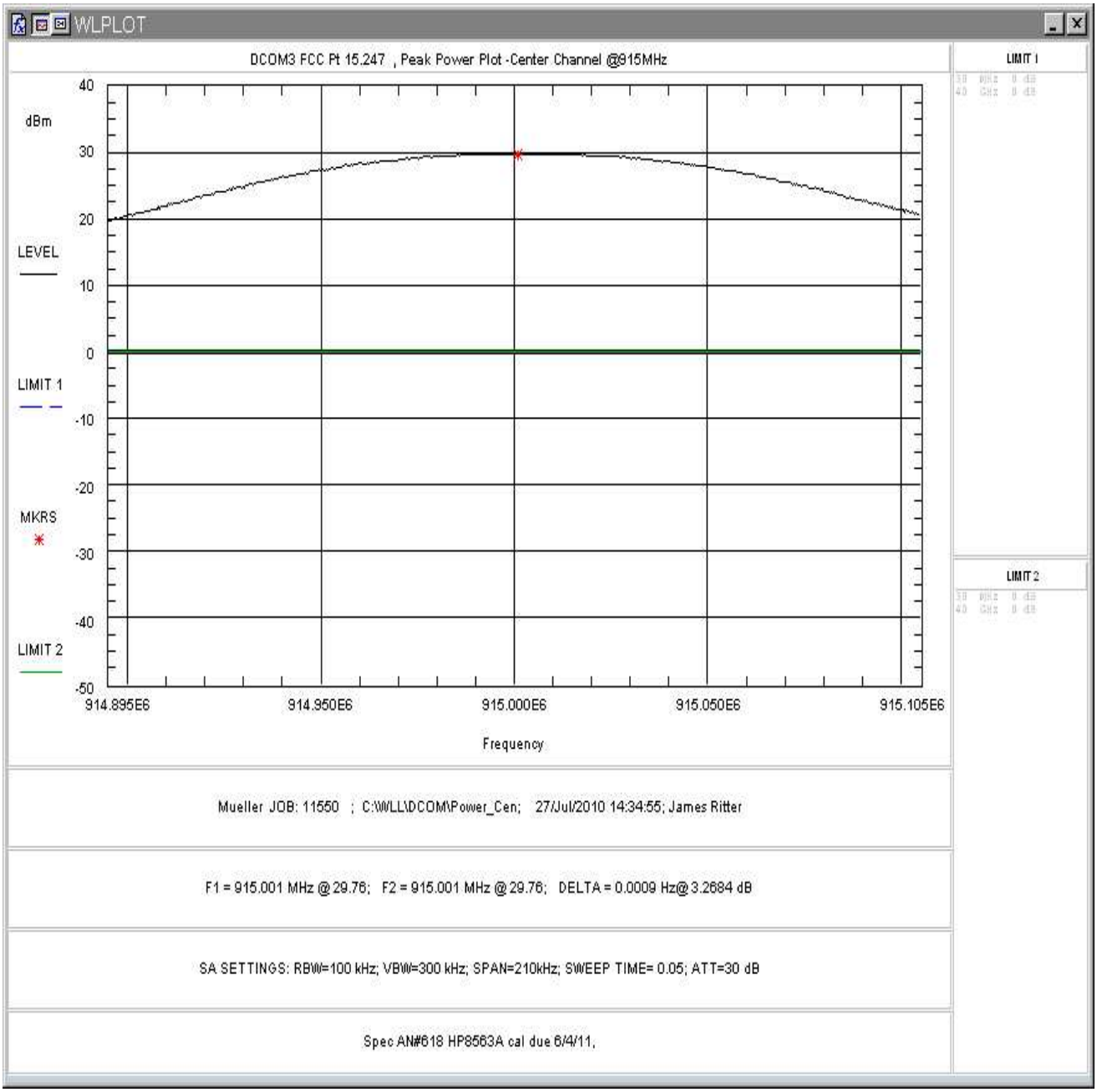

Figure 6 Data Channel RF Peak Power, Center Channel

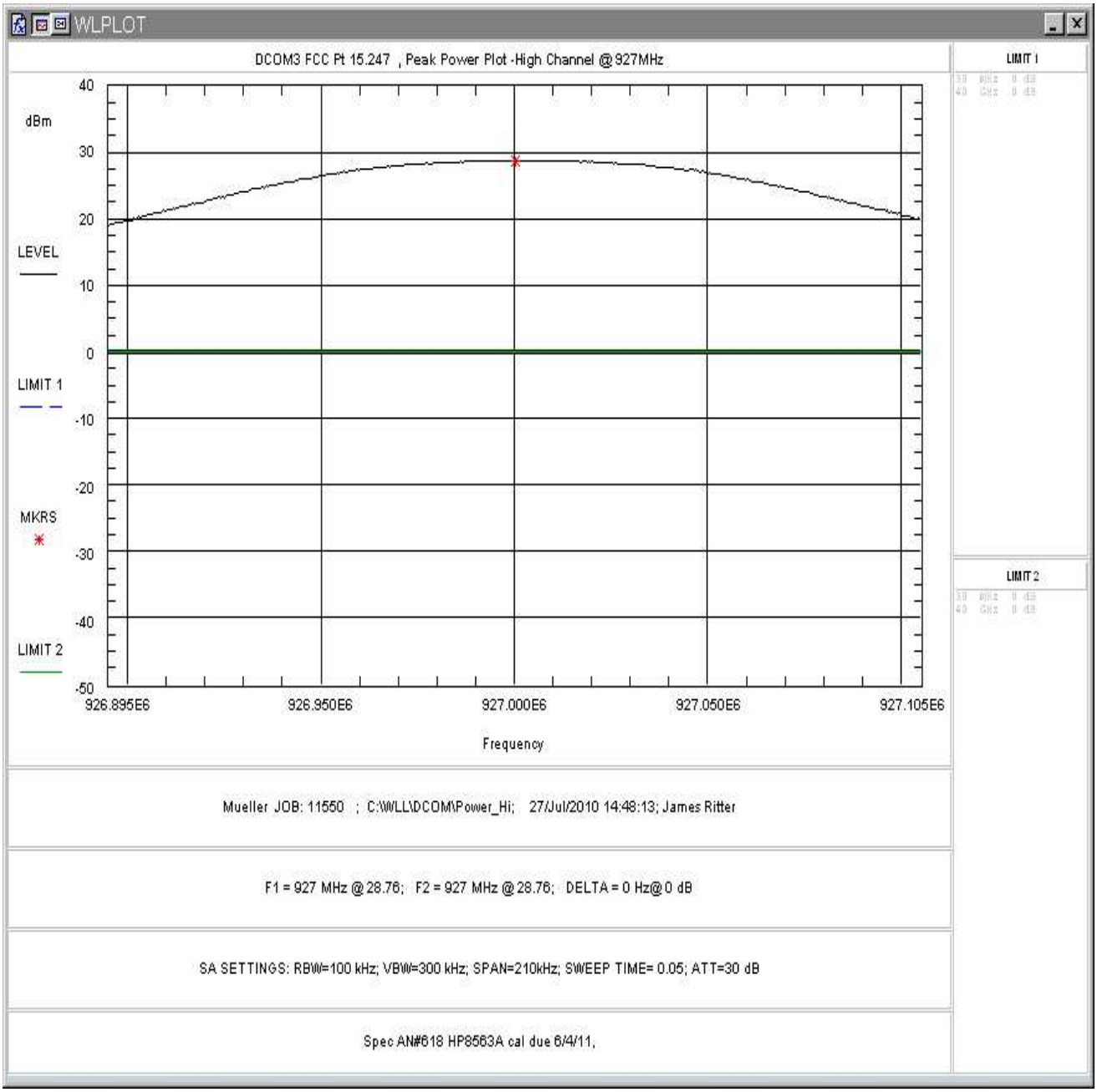

Figure 7 Data Channel RF Peak Power, High Channel

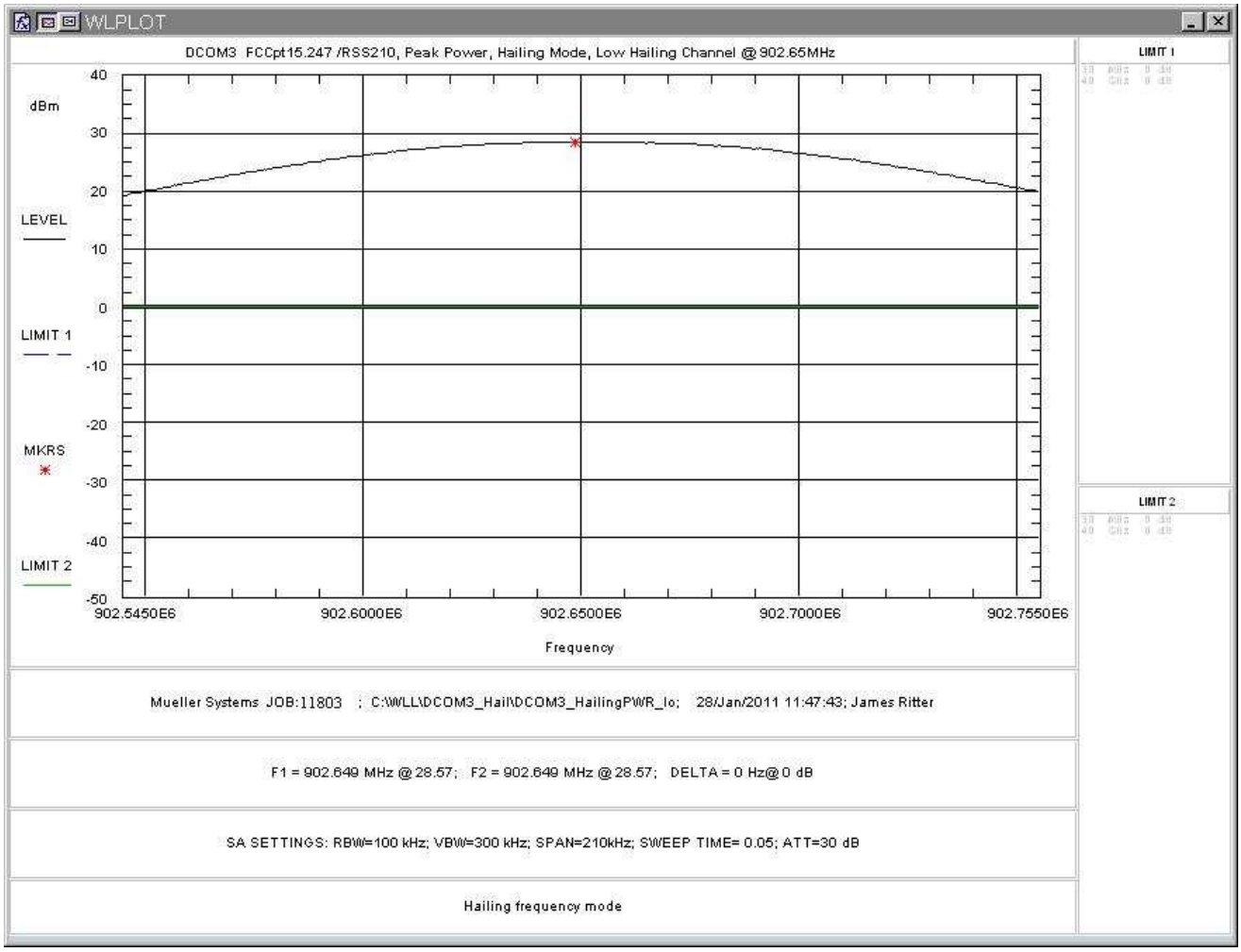

Figure 8 Hailing Channel RF Peak Power, Low Channel

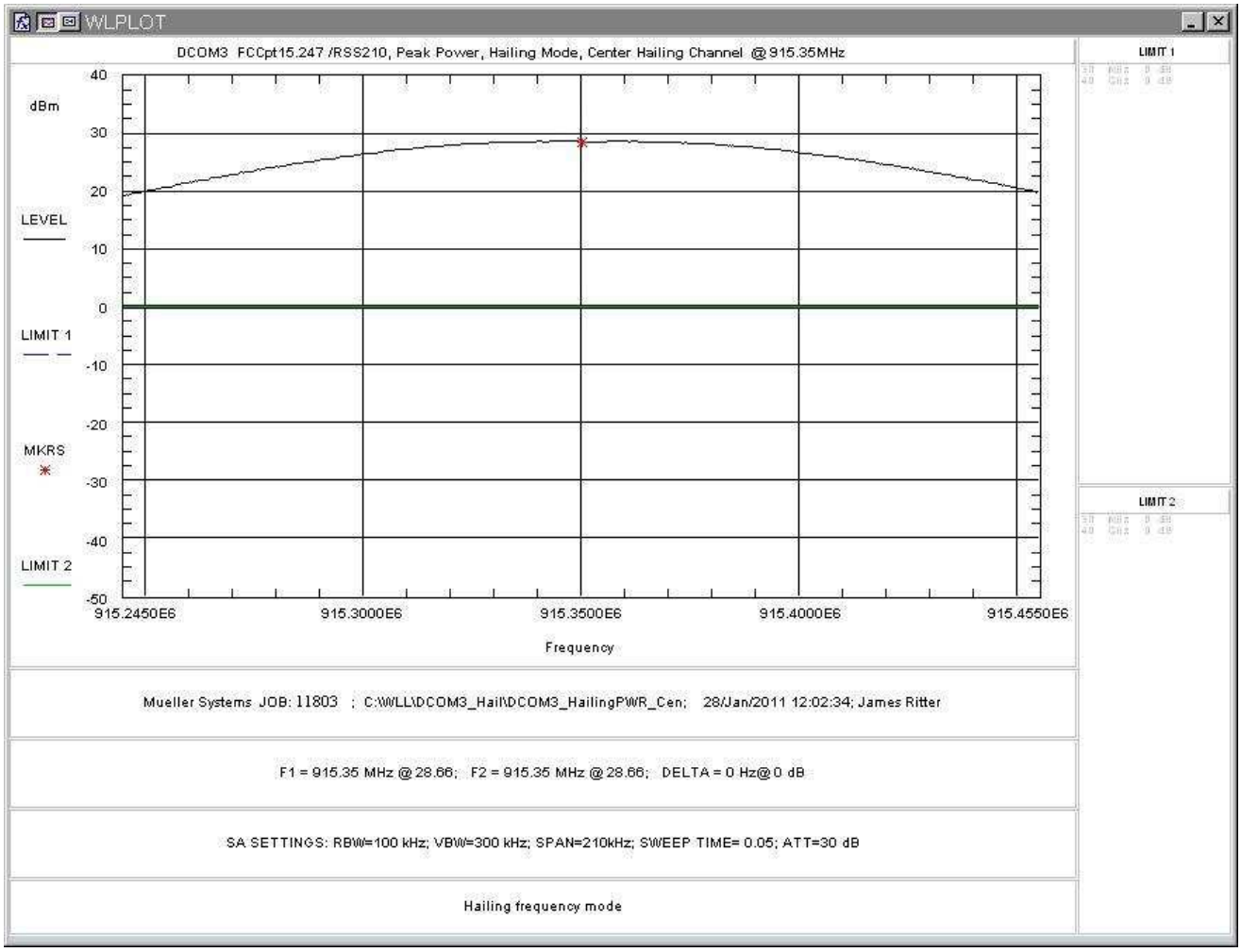

Figure 9 Hailing Channel RF Peak Power, Center Channel

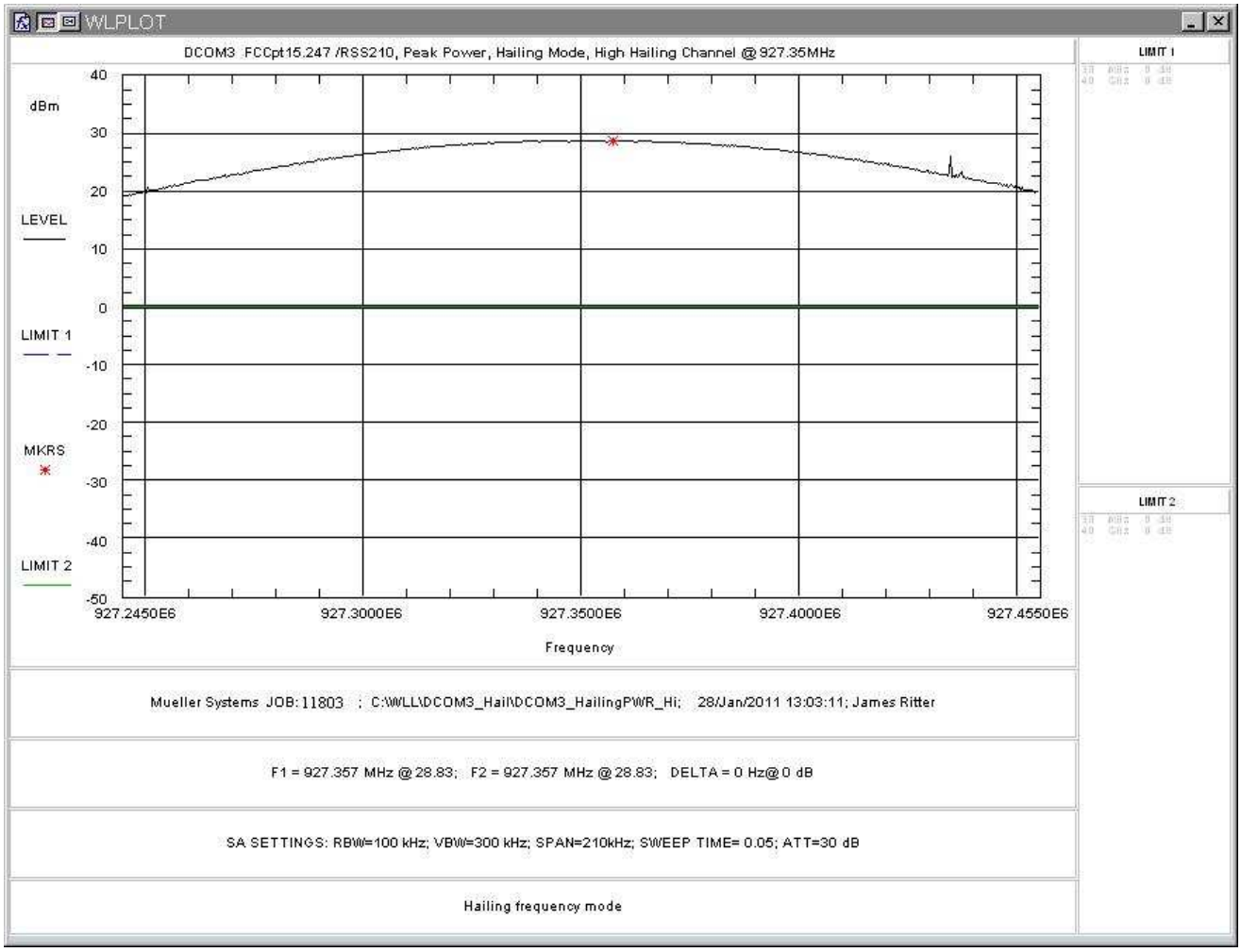

Figure 10 Hailing Channel RF Peak Power, High Channel

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, 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:

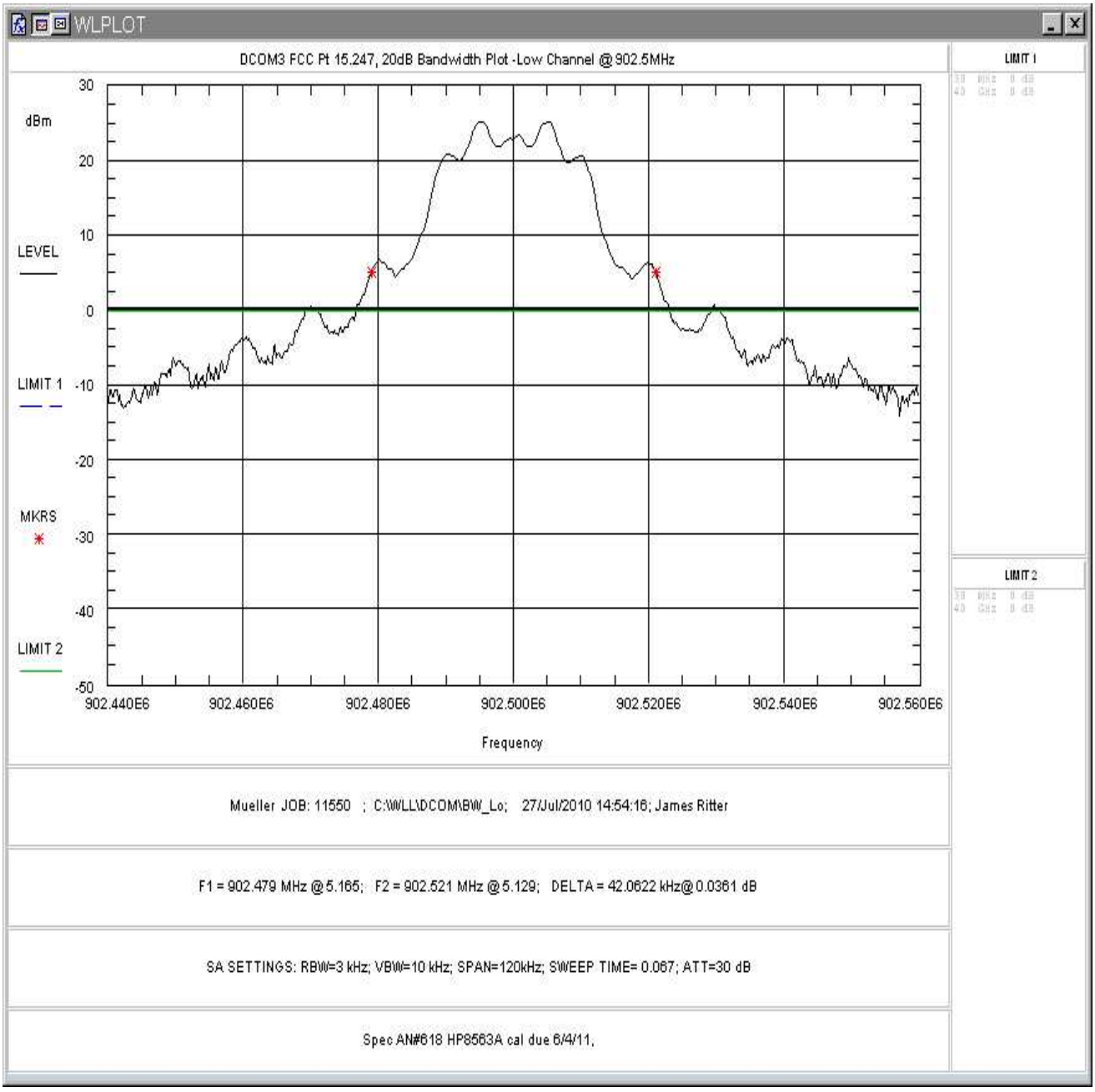

Figure 11 Data Channel Occupied Bandwidth, Low Channel

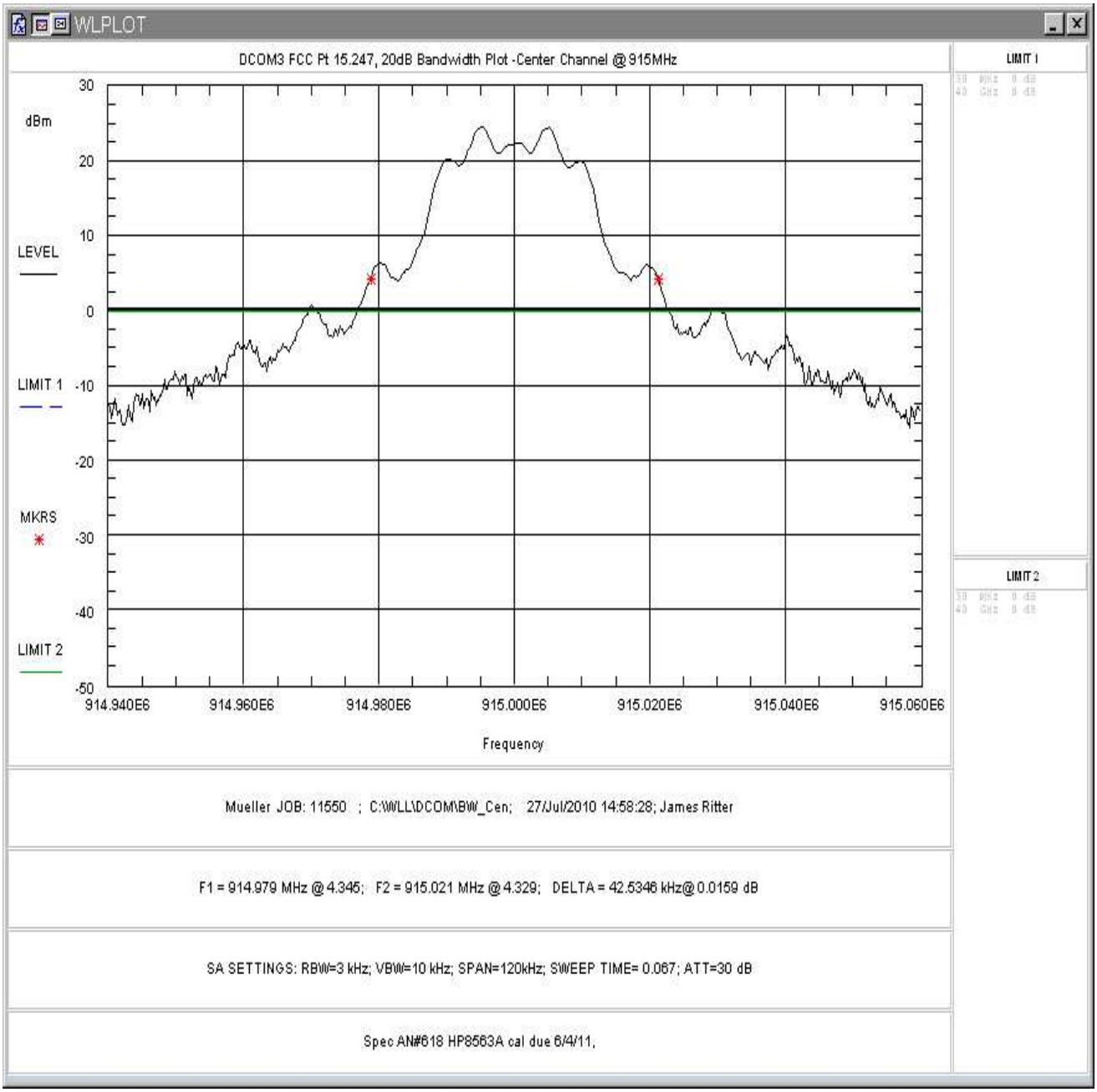

Figure 12 Data Channel Occupied Bandwidth, Center Channel

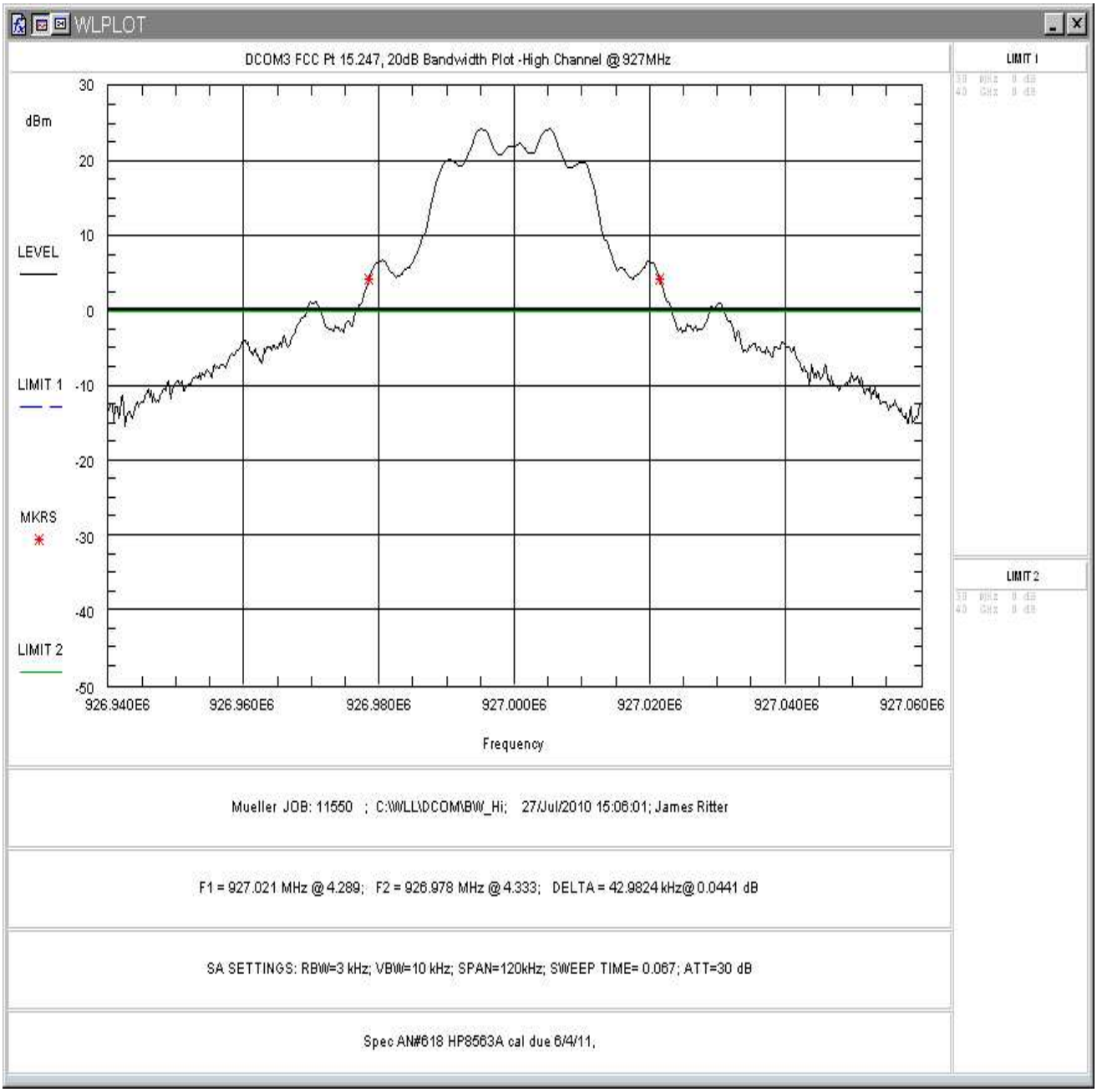

Figure 13 Data Channel Occupied Bandwidth, High Channel

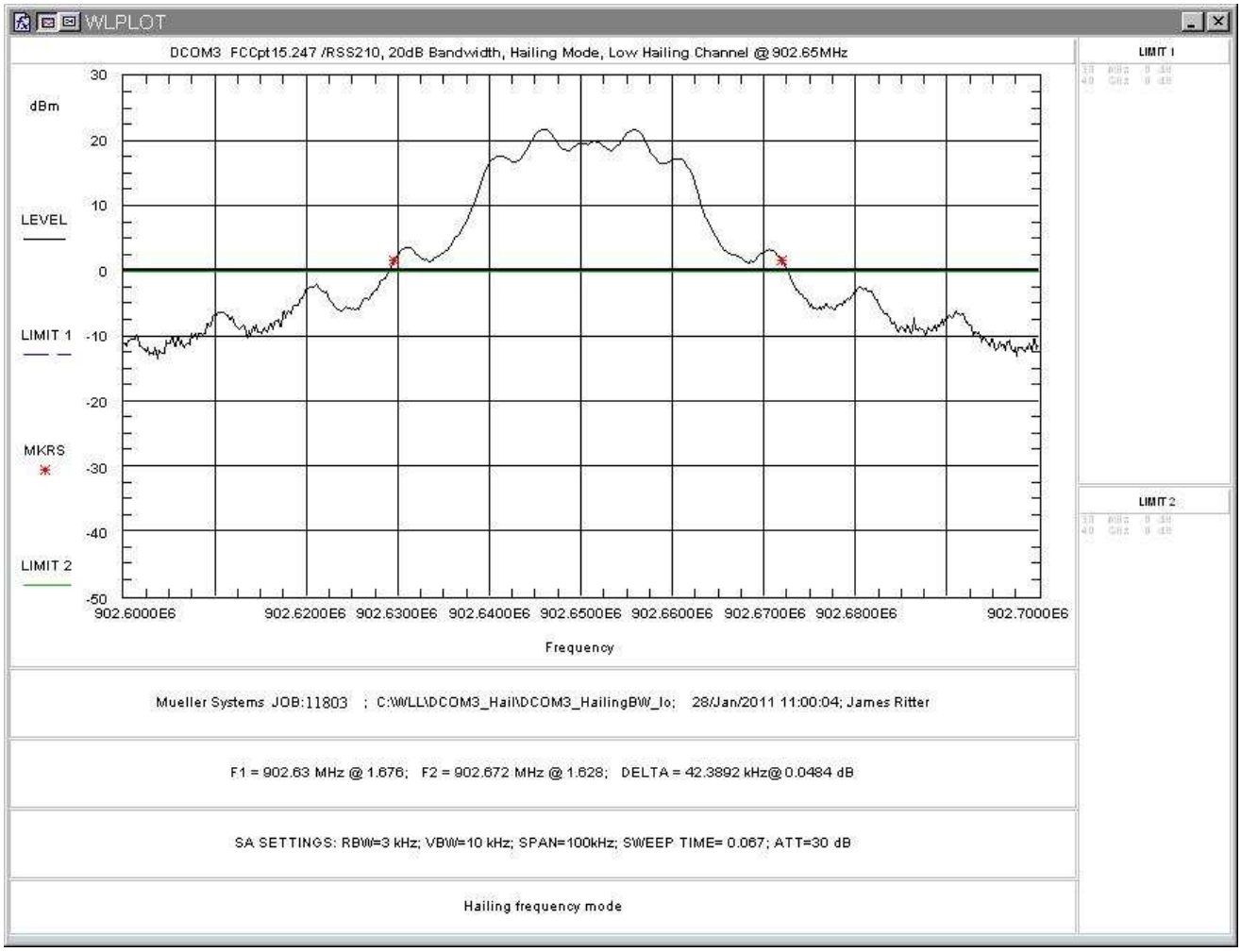

Figure 14 Hailing Channel Occupied Bandwidth, Low Channel

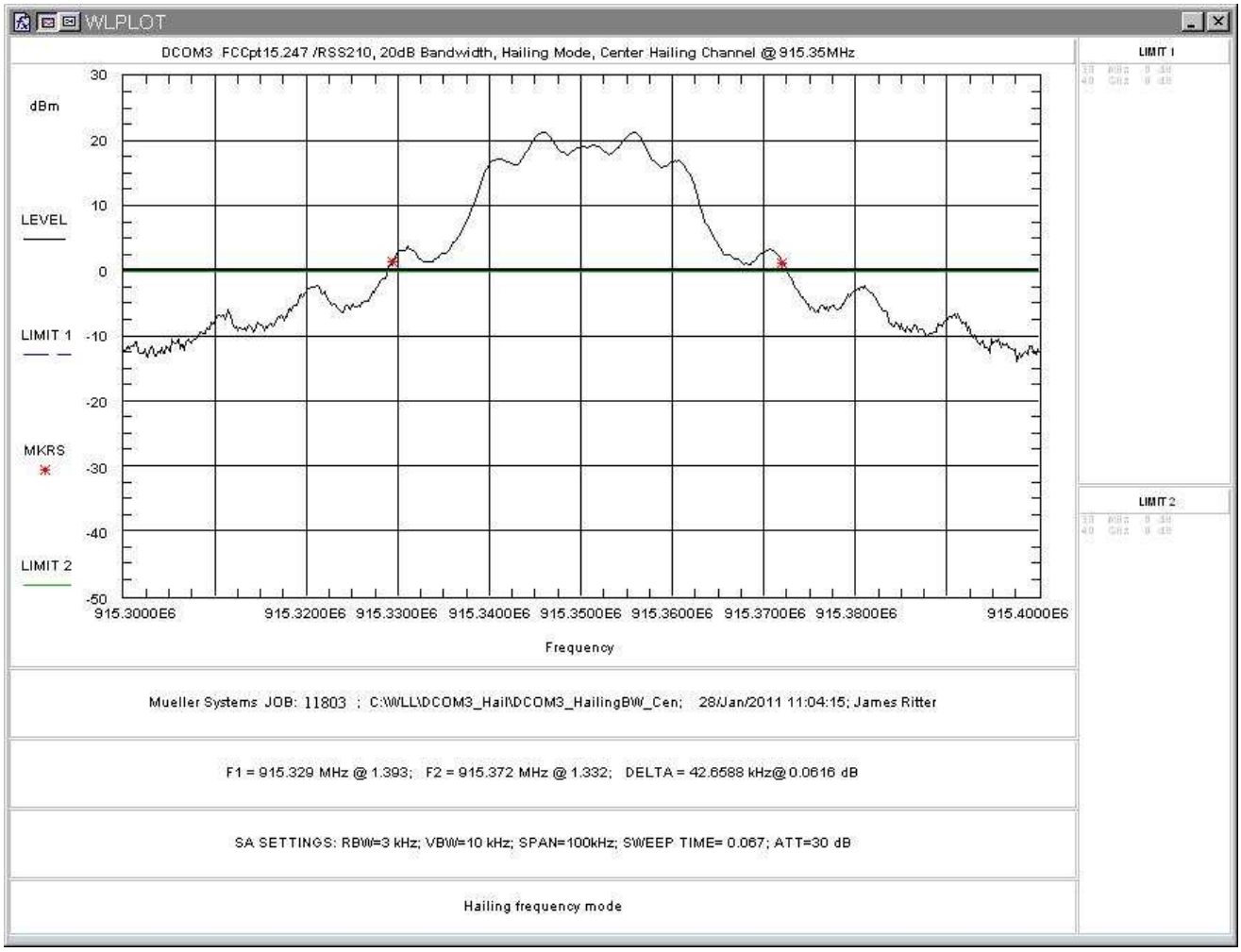

Figure 15 Hailing Channel Occupied Bandwidth, Center Channel

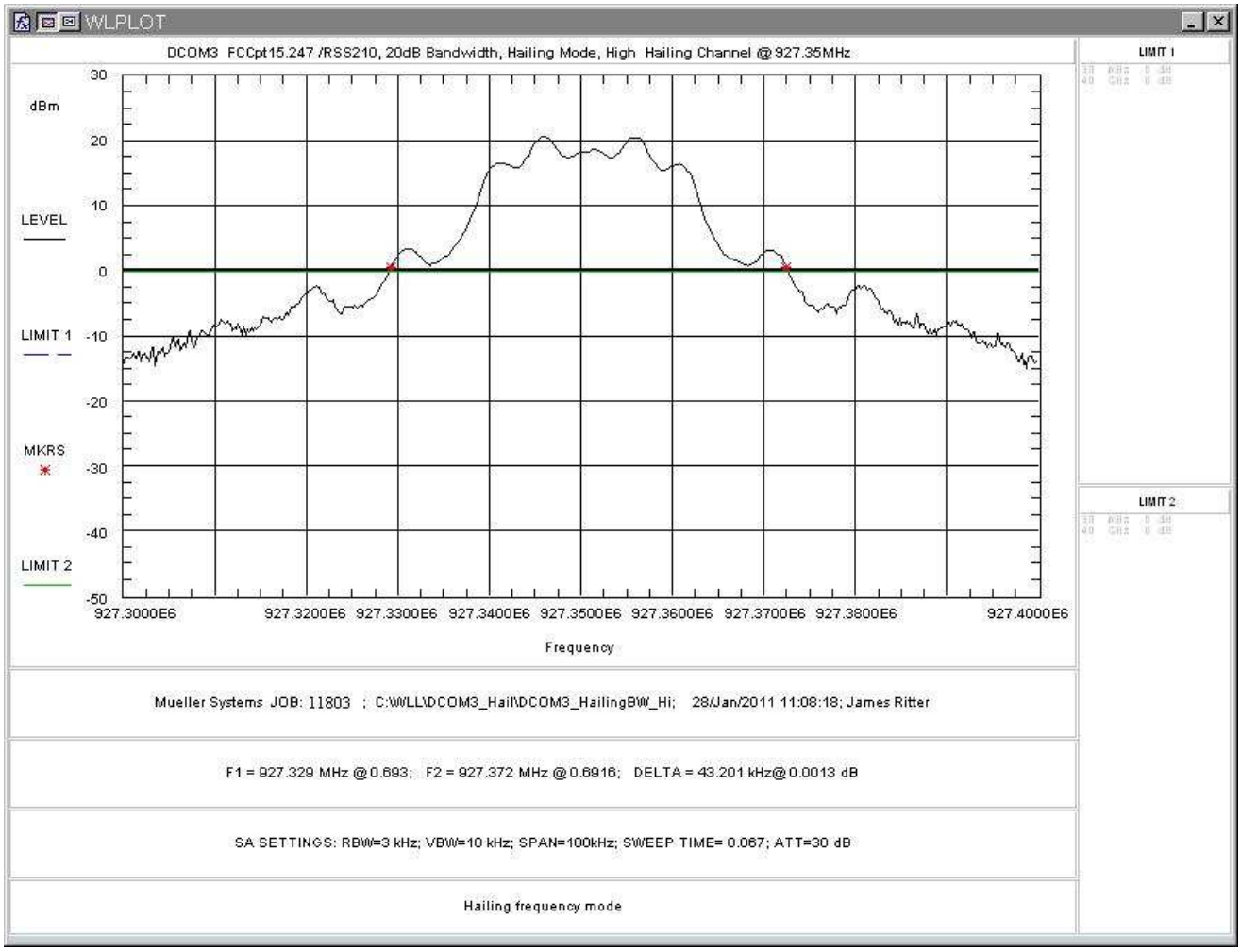

Figure 16 Hailing Channel Occupied Bandwidth, High Channel

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

Table 7 Data Channel Occupied Bandwidth Results

Frequency	Bandwidth
Low Channel: 902.5MHz	42.06 kHz
Center Channel: 915.0MHz	42.53 kHz
High Channel: 927.0MHz	42.98 kHz

Table 8 Hailing Channel Occupied Bandwidth Results

Frequency	Bandwidth
Low Channel: 902.65MHz	42.39 kHz
Center Channel: 915.35MHz	42.66 kHz
High Channel: 927.35MHz	43.201 kHz

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 25kHz or the 20 dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 43.11 kHz so the channel spacing must be more than 43.11 kHz. In addition, Part 15.247 requires that devices with occupied bandwidths less than 250kHz 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 250kHz 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 500kHz between channels, however, 2 channels have been removed at 909MHz and 921MHz. These channels have been replaced with 2 channels at 902.25MHz and 908.25MHz thus giving a 250kHz channel spacing between 904MHz -904.5MHz and 908MHz-908.5MHz. This still remains in compliance. Both the standard spacing and the spacing between the 2 bands above are shown.

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	42.98kHz Minimum	Pass
Number of Data Channels	50 channels	50 channels minimum	Pass
Hailing Channel Spacing	The closest channels are spaced 150kHz	43.11kHz Minimum	Pass
Number of Hailing Channels	50 channels	50 channels minimum	Pass

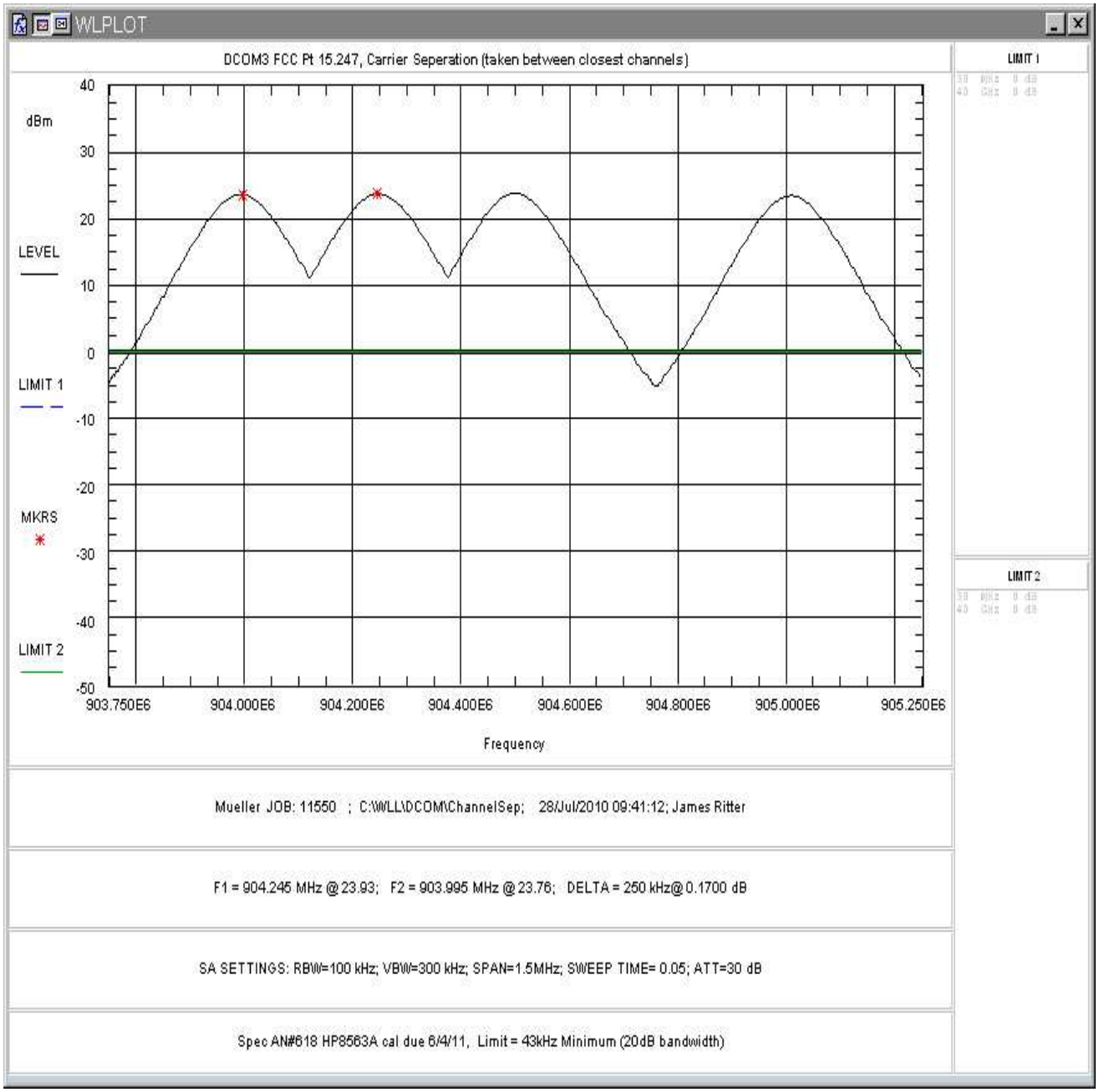

Figure 17 Data Channel spacing between, 250kHz

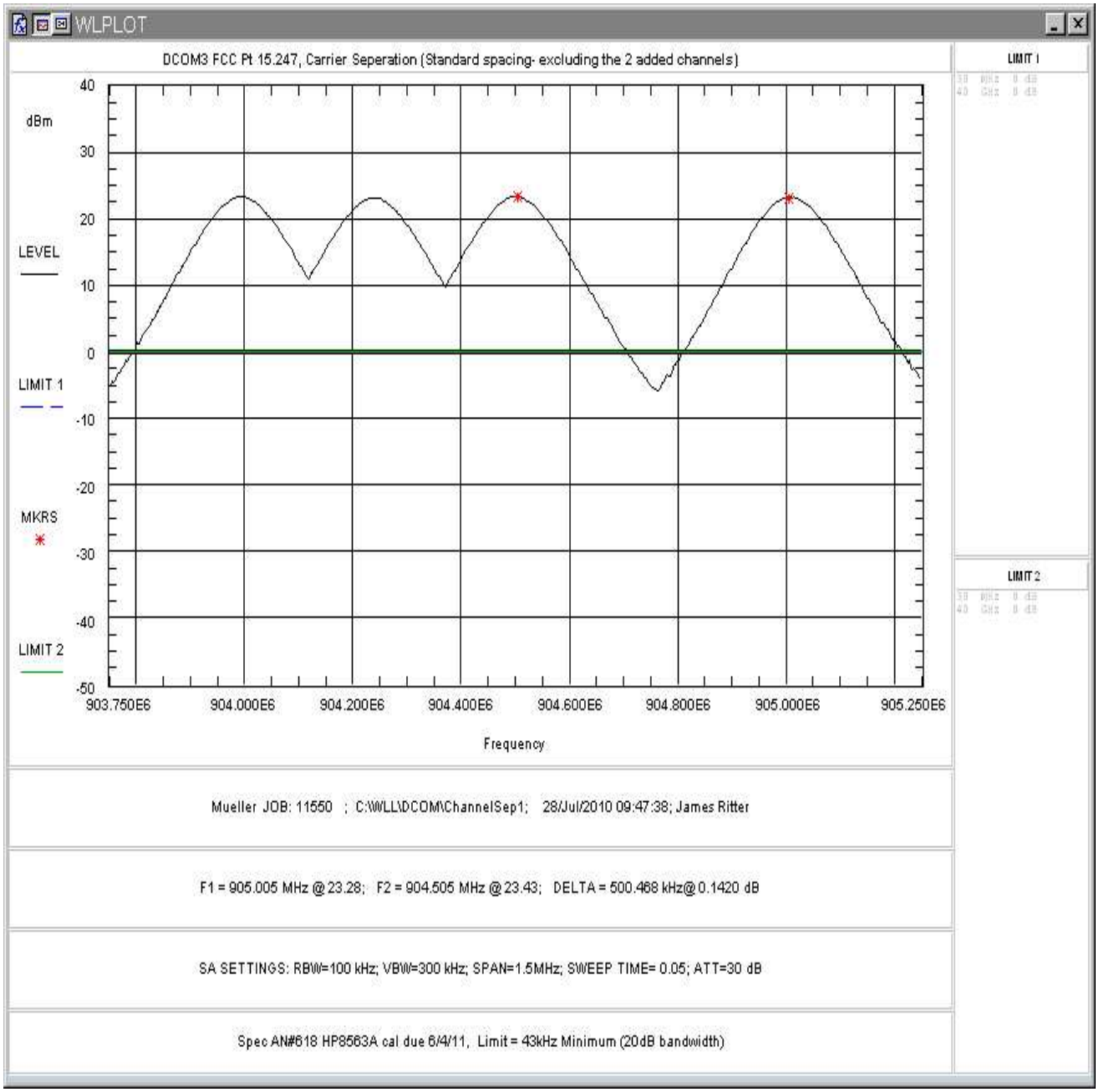

Figure 18 Data Channel Spacing, 500kHz

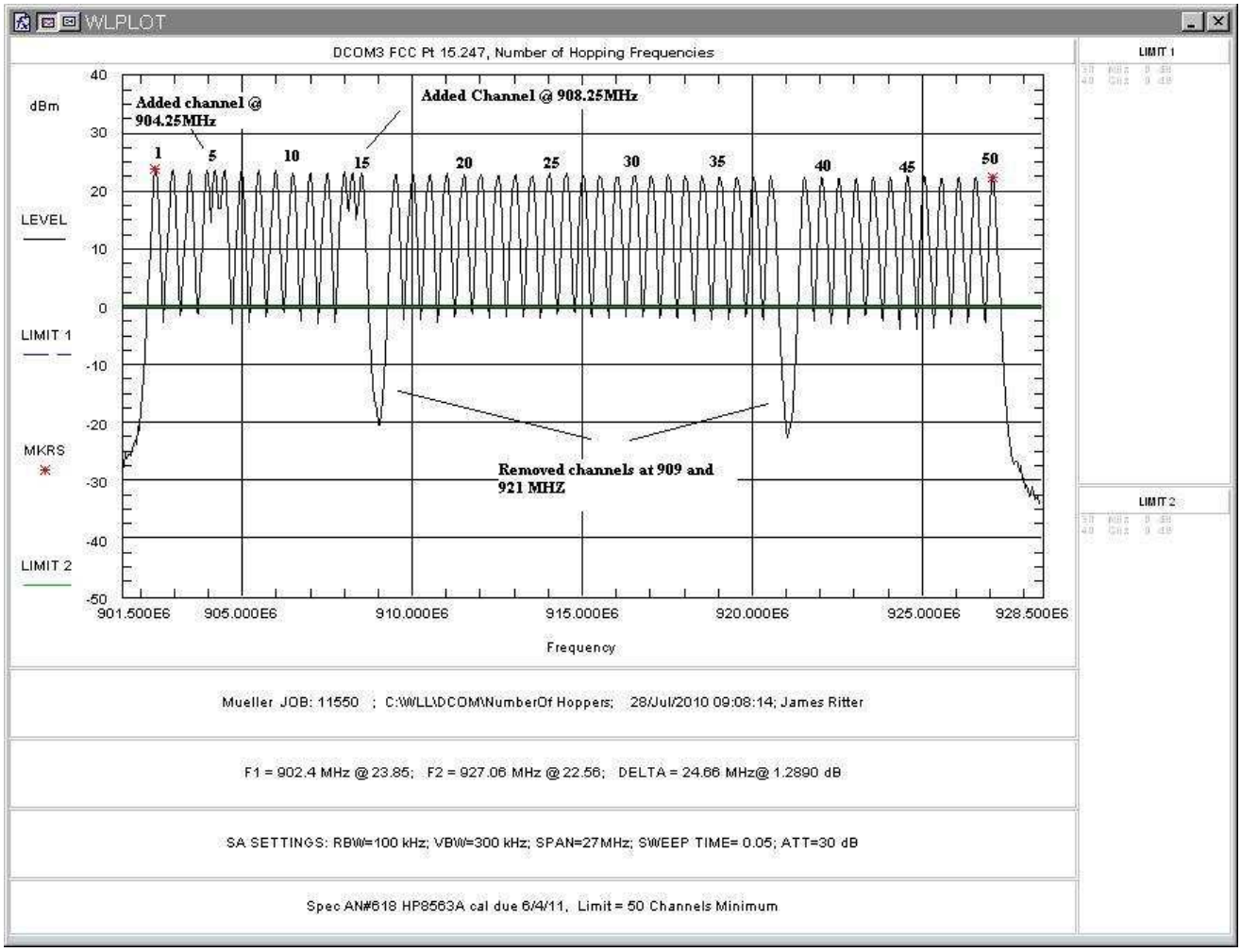

Figure 19 Number of Data Channels

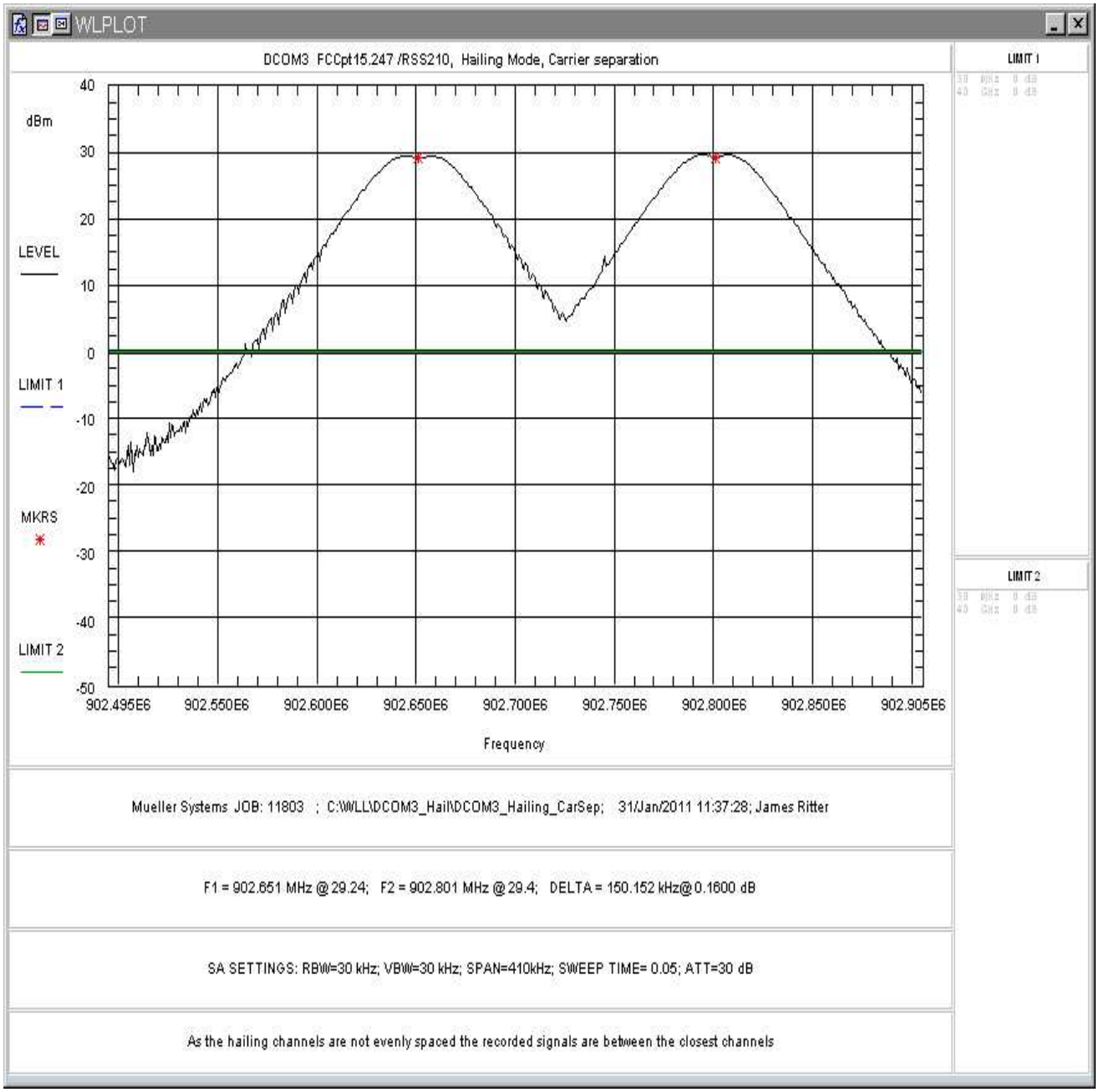

Figure 20 Hailing Channel Spacing

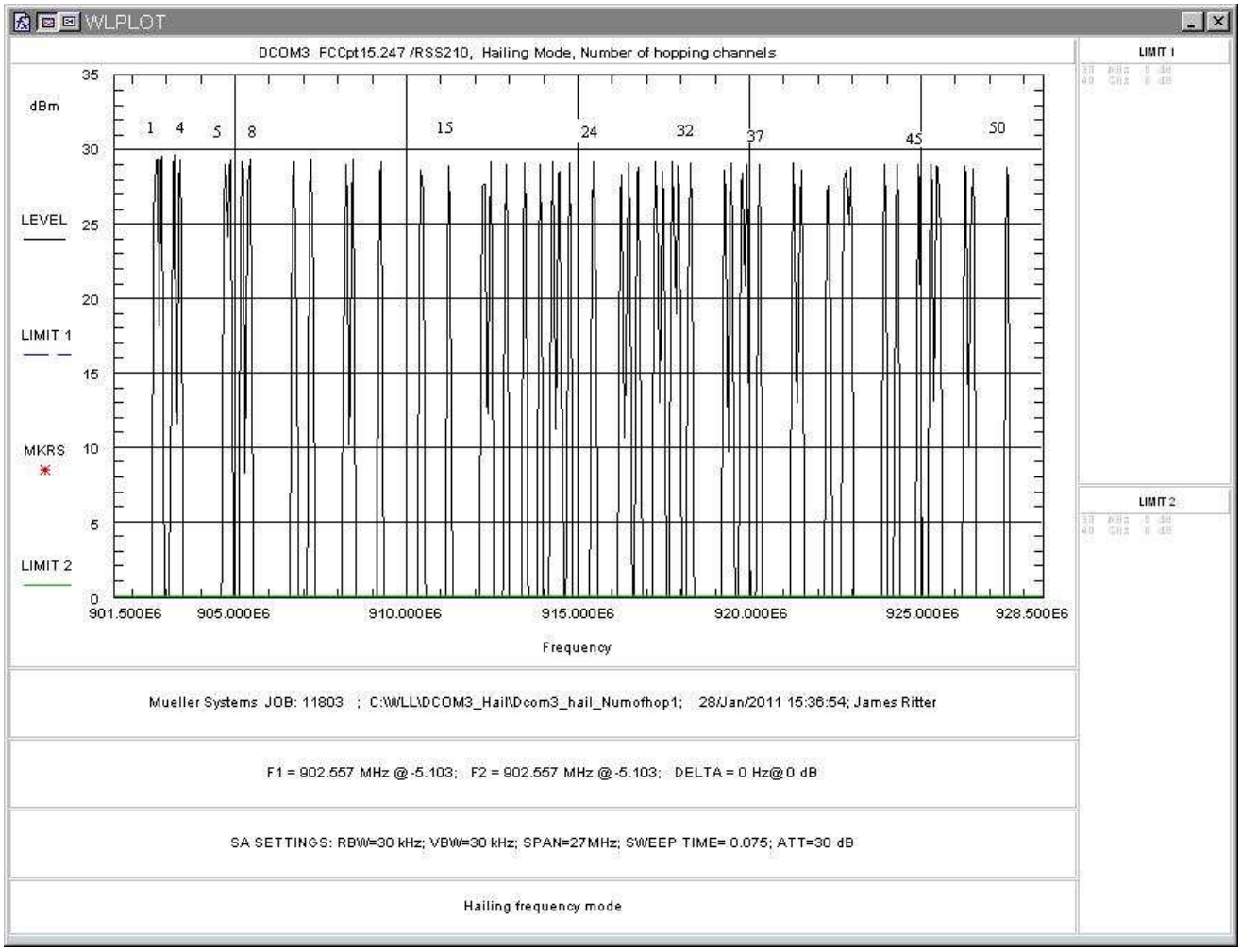

Figure 21 Number of Hailing Channels

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.

5.5.1 Data Mode Conducted Spurious

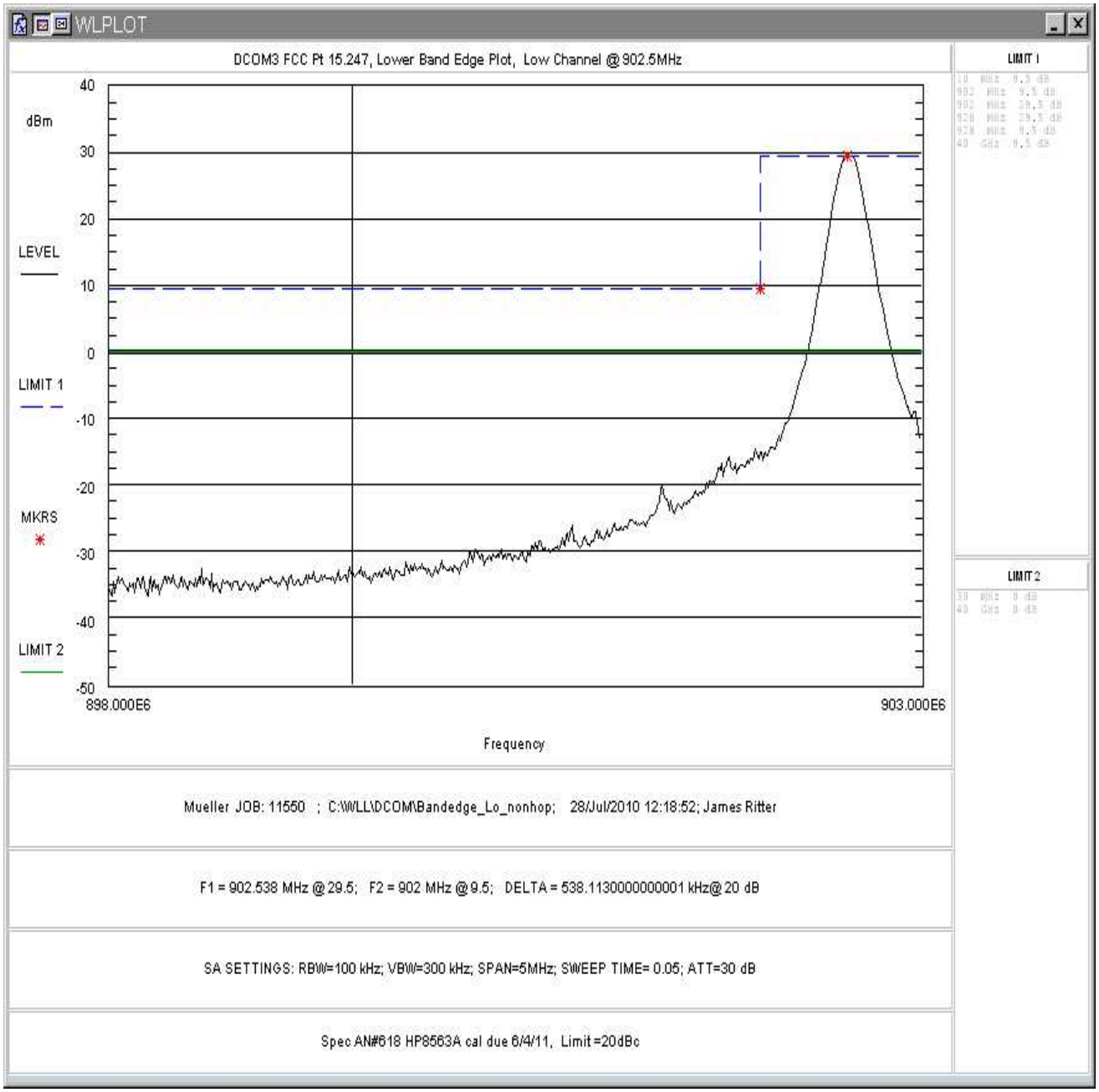

Figure 22 Lower Band Edge Plot, Low Data Channel

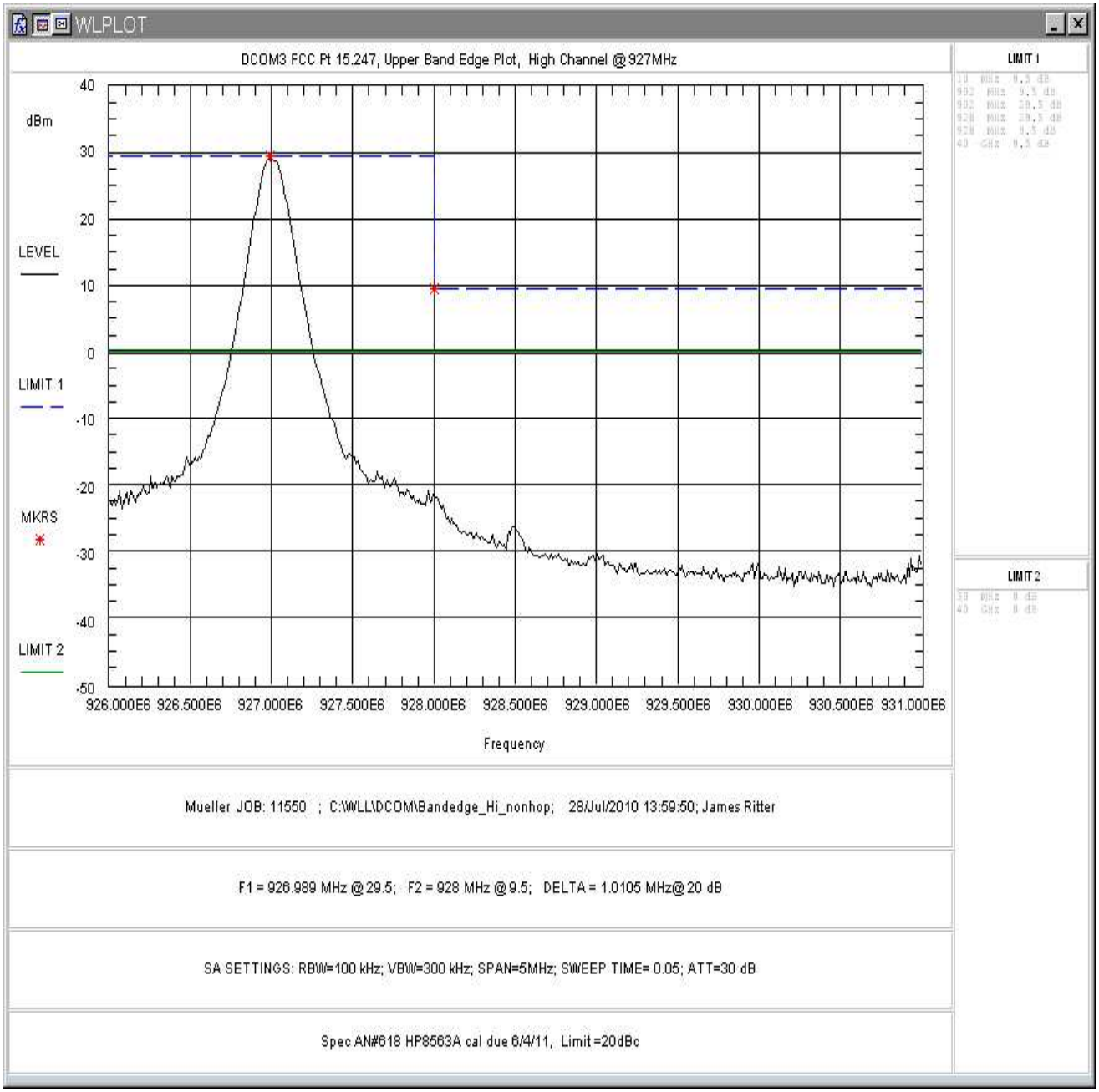

Figure 23 Upper Band Edge Plot, High Data Channel

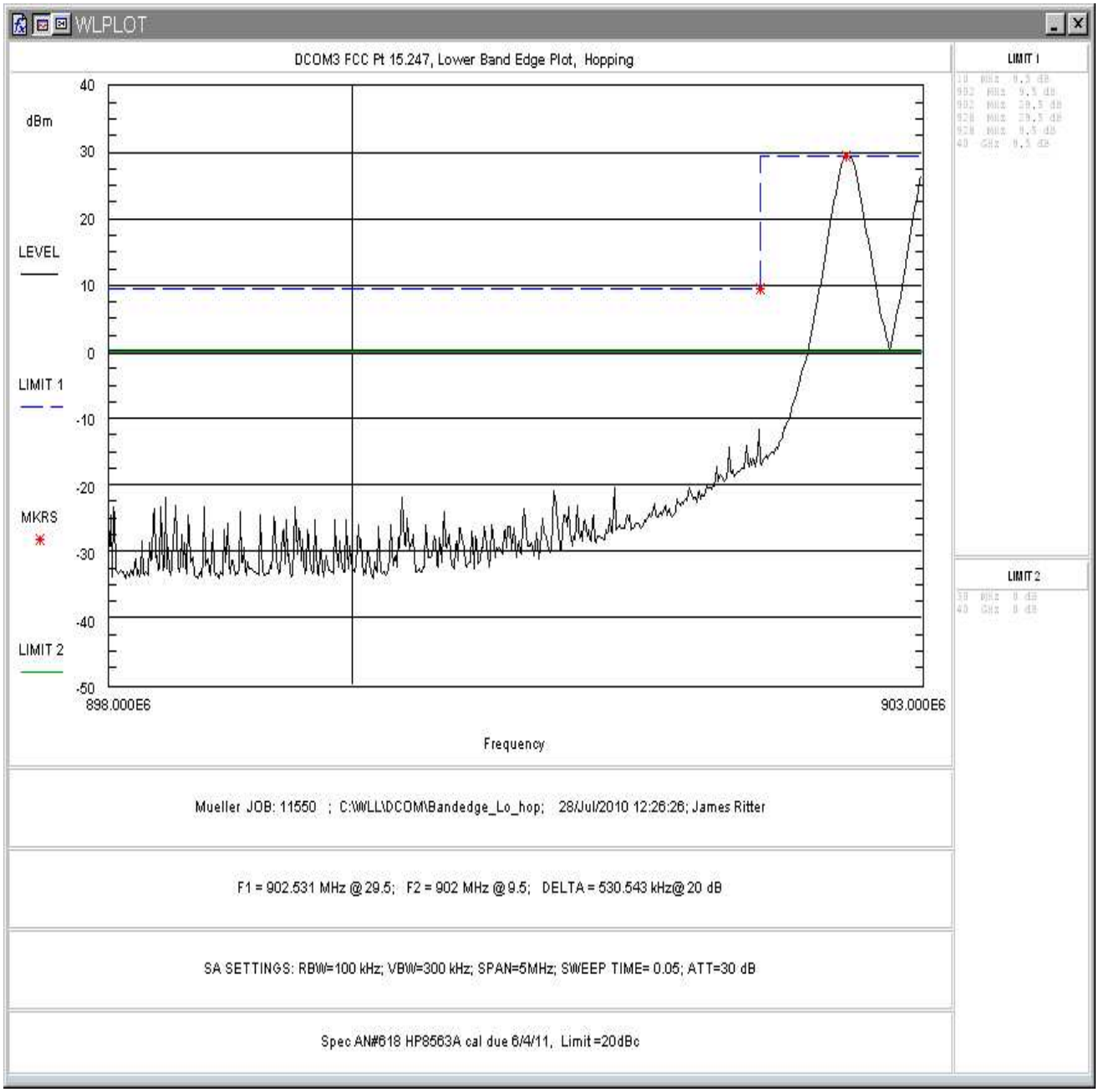

Figure 24 Lower Band Edge Plot, Data Hopping Mode

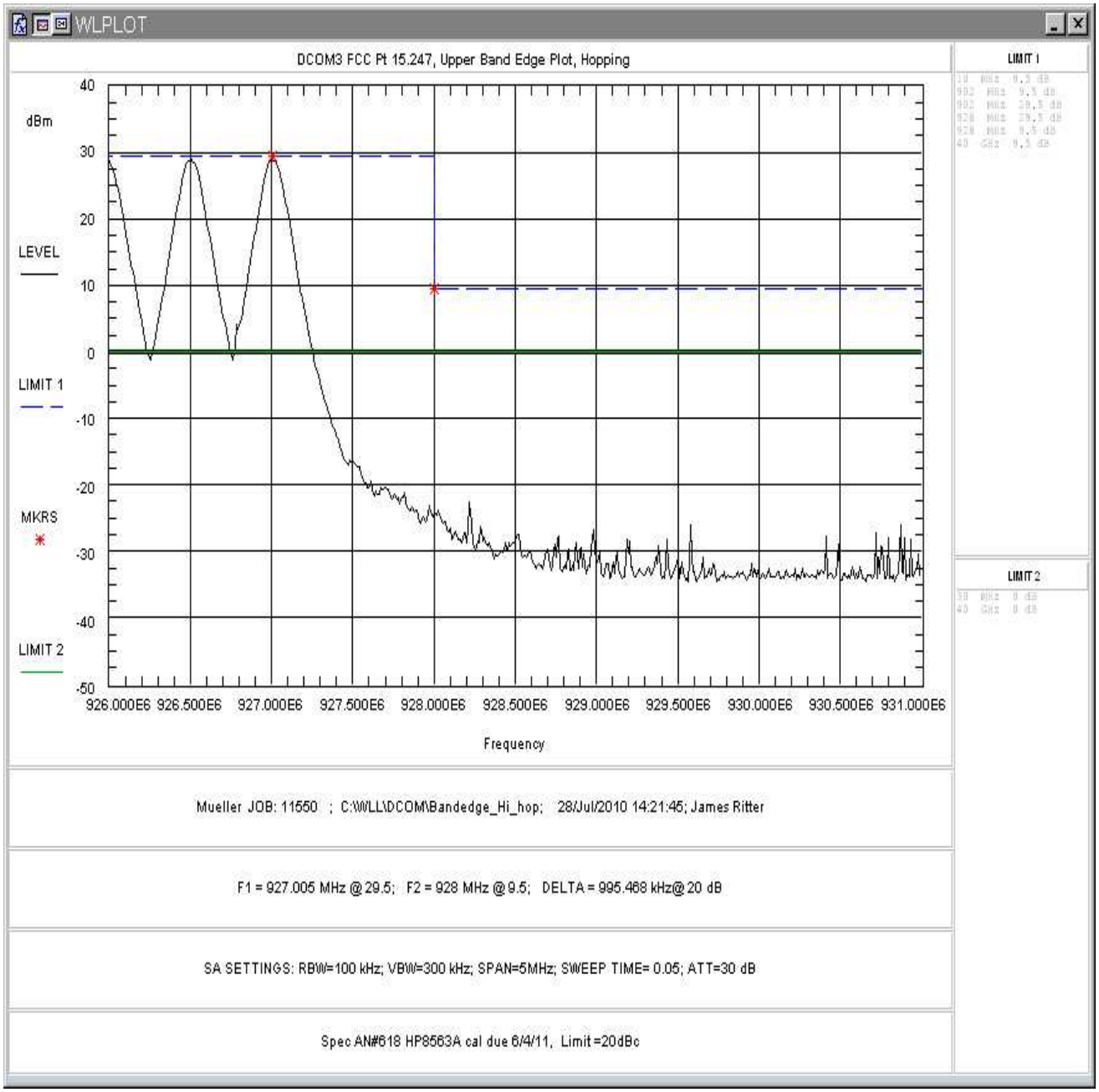

Figure 25 Upper Band Edge Plot, Data Hopping Mode

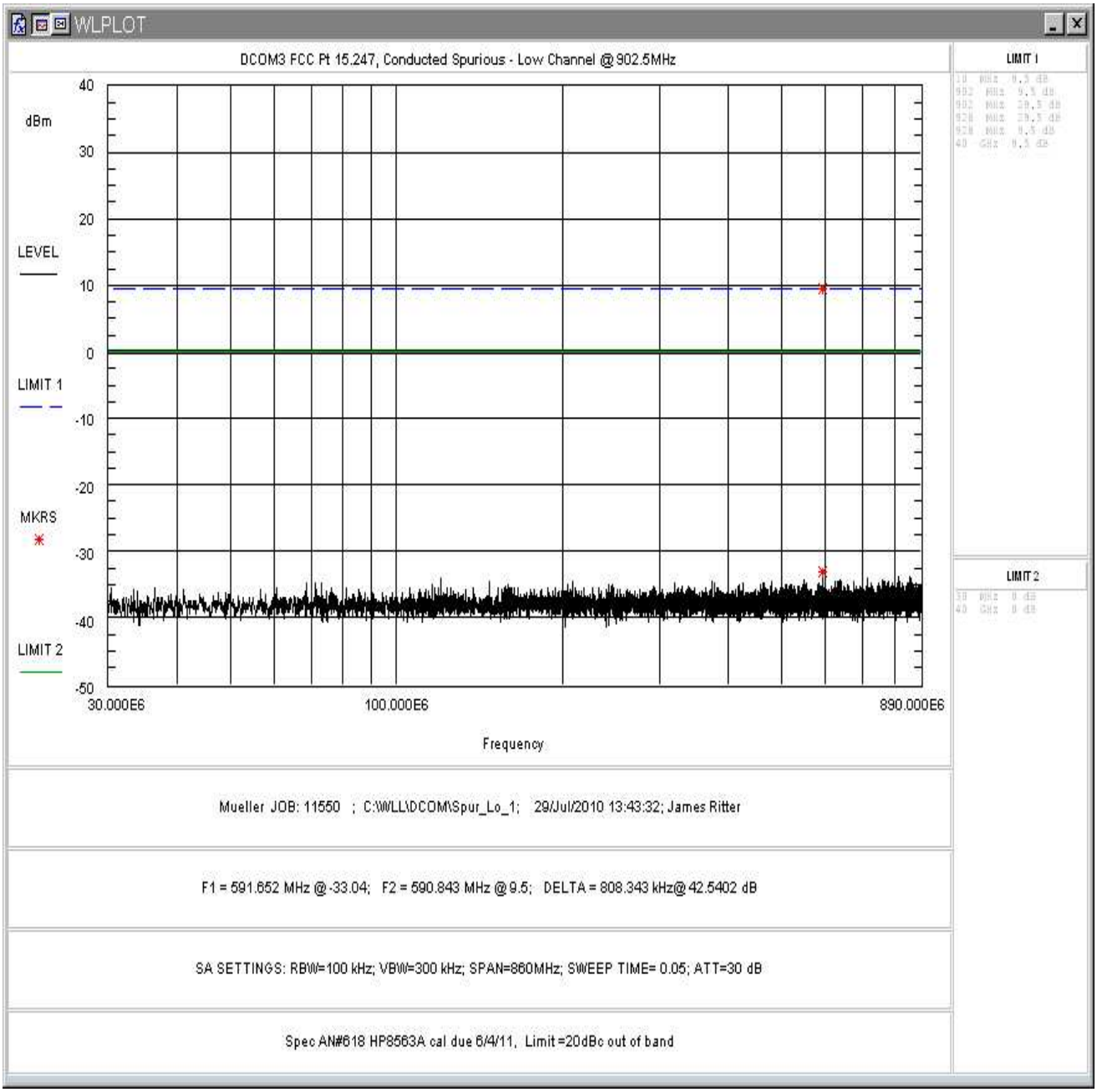

Figure 26 Conducted Spurious Emissions, Low Data Channel 30 - 890MHz

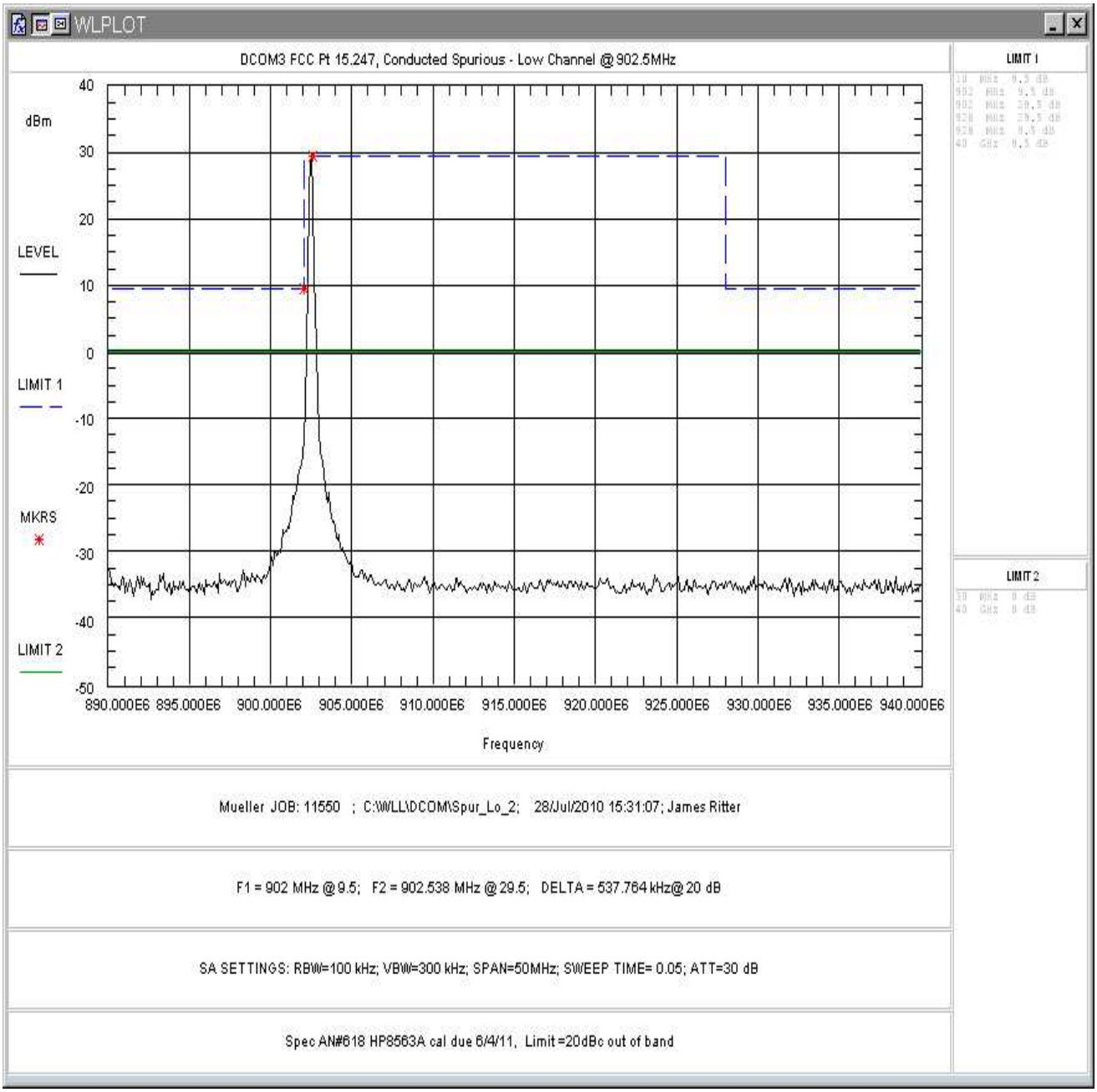

Figure 27 Conducted Spurious Emissions, Low Data Channel 890-940MHz

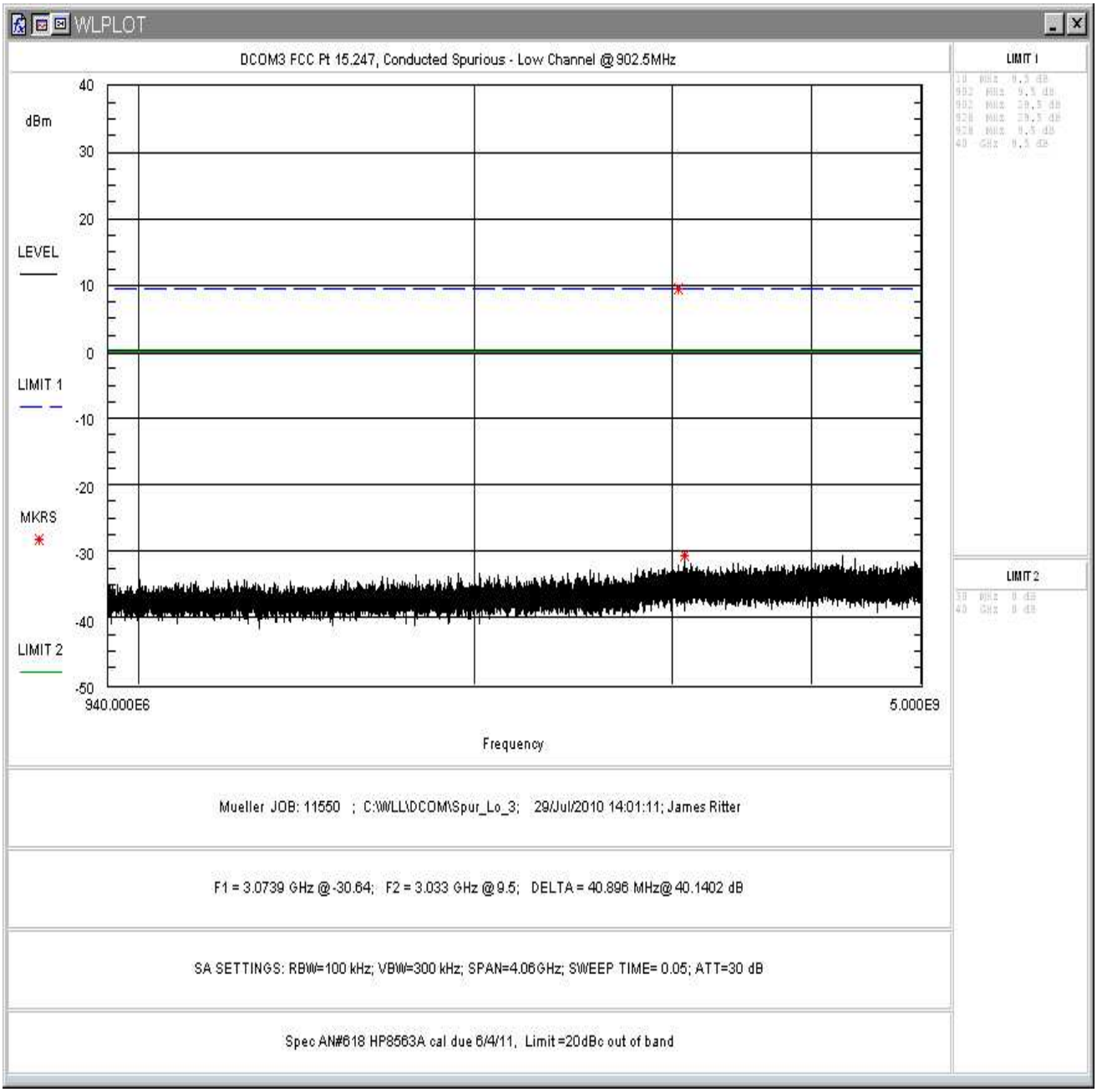

Figure 28 Conducted Spurious Emissions, Low Data Channel 940MHz -5GHz

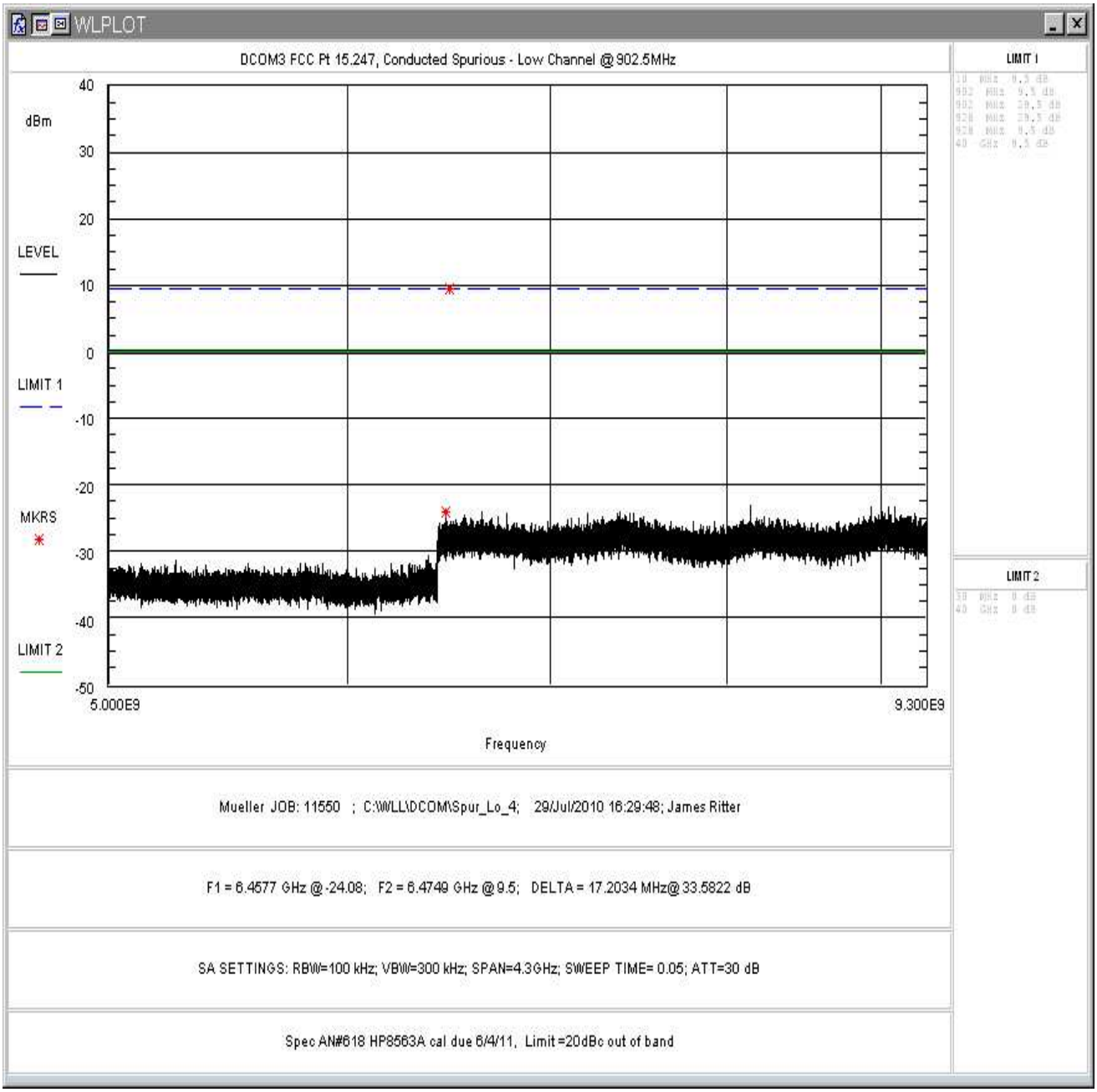

Figure 29 Conducted Spurious Emissions, Low Data Channel 5 -9.3GHz

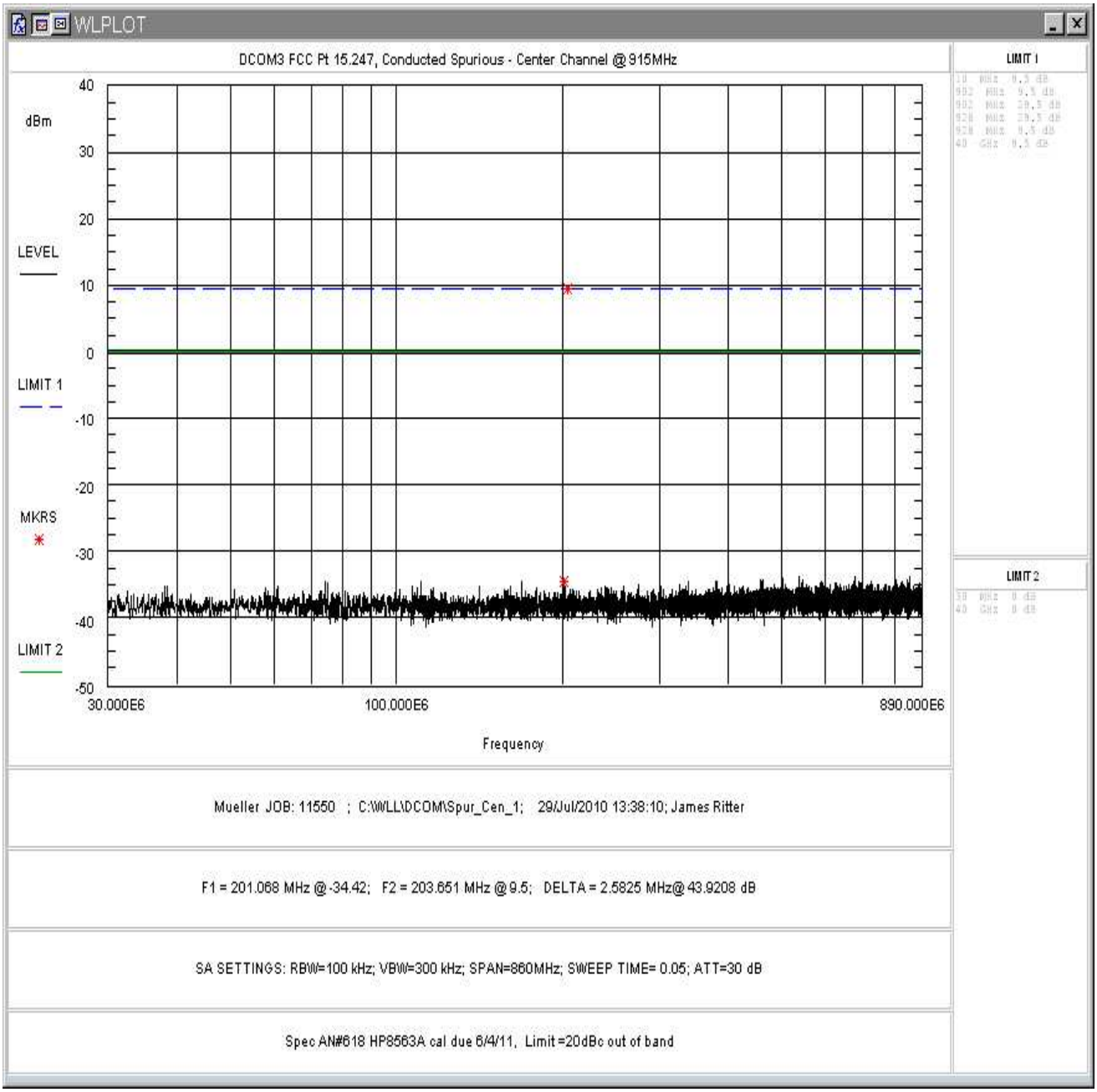

Figure 30 Conducted Spurious Emissions, Center Data Channel 30 - 890MHz

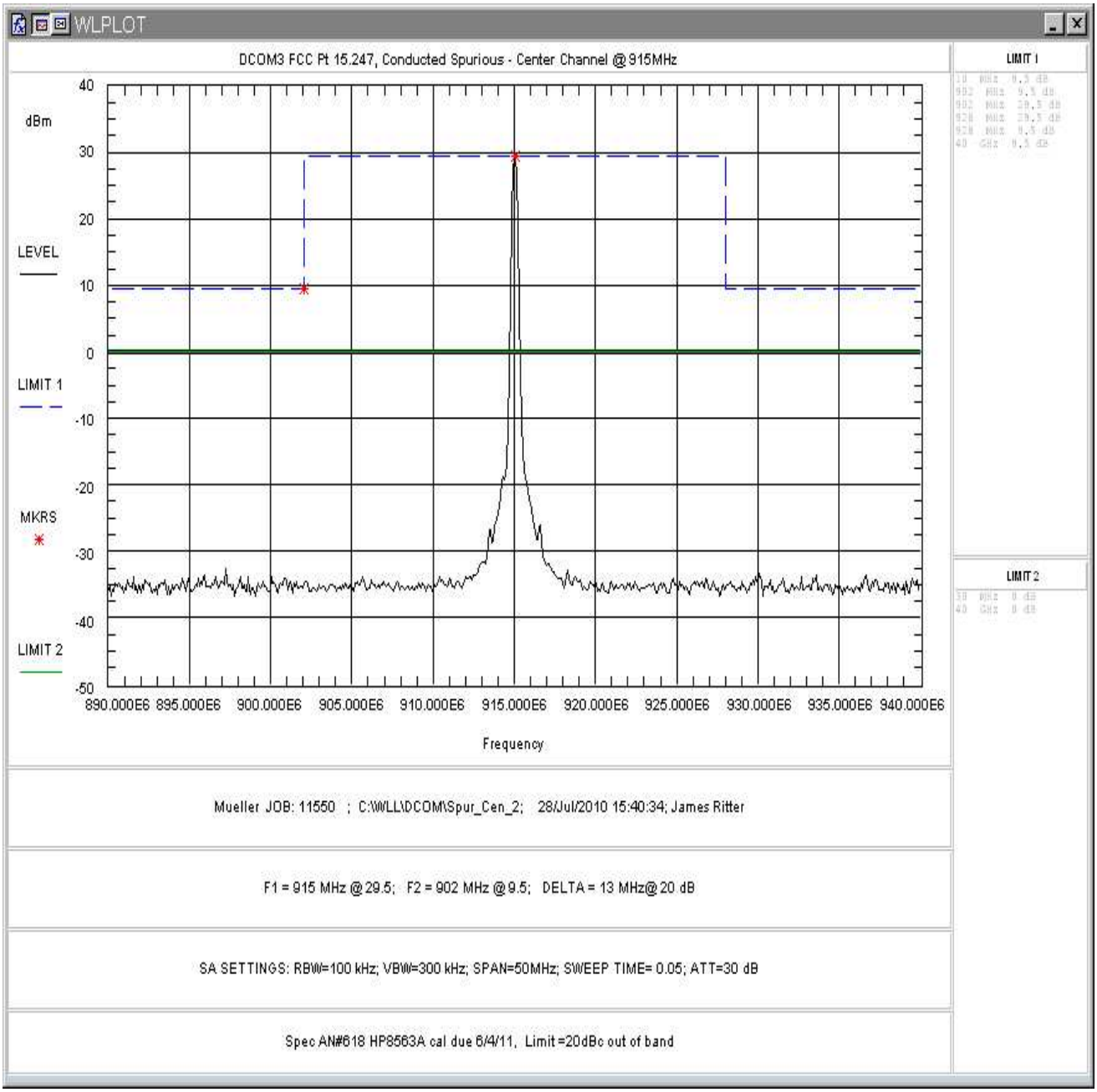

Figure 31 Conducted Spurious Emissions, Center Data Channel 890-940MHz

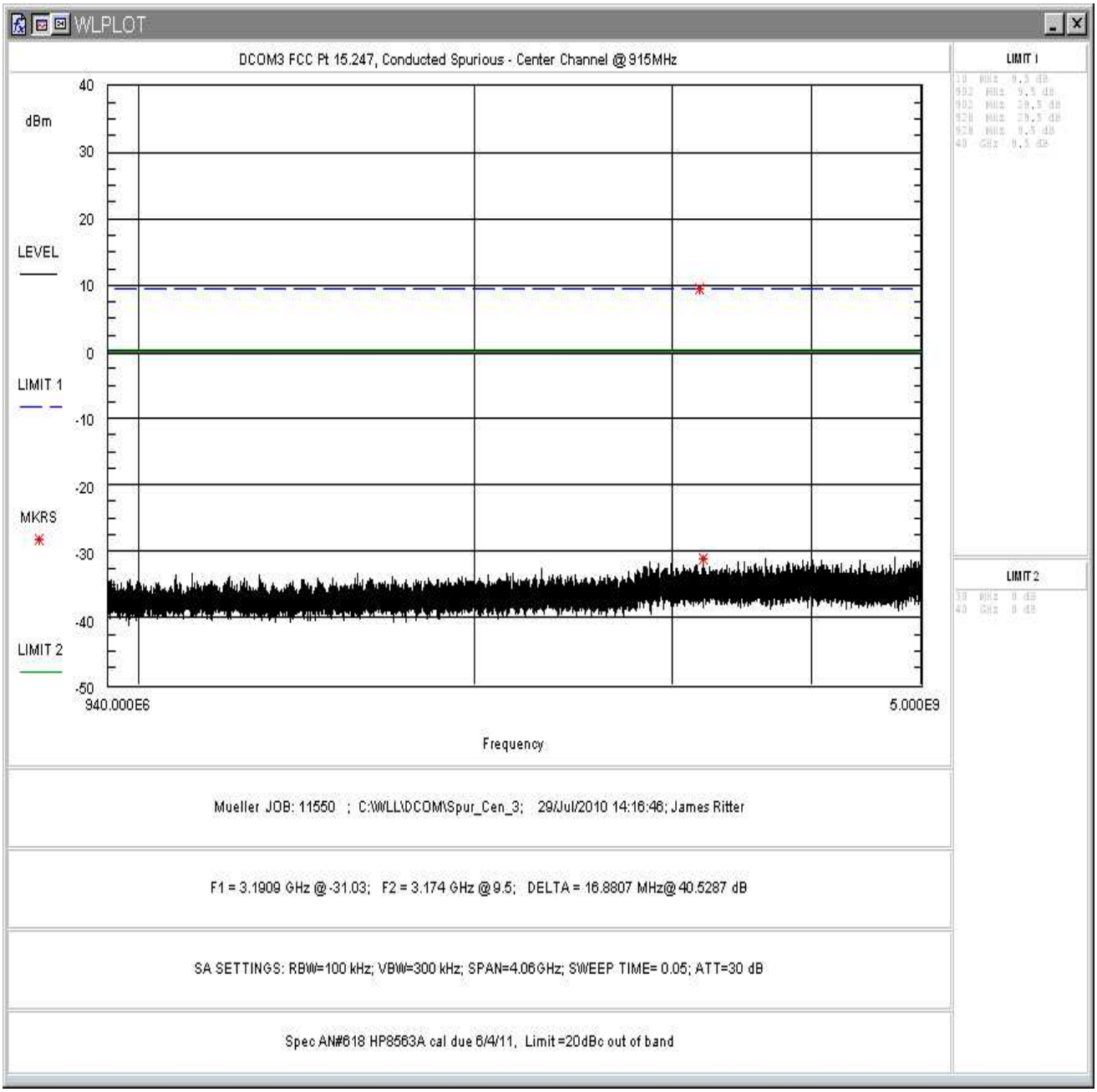

Figure 32 Conducted Spurious Emissions, Center Data Channel 940MHz -5GHz

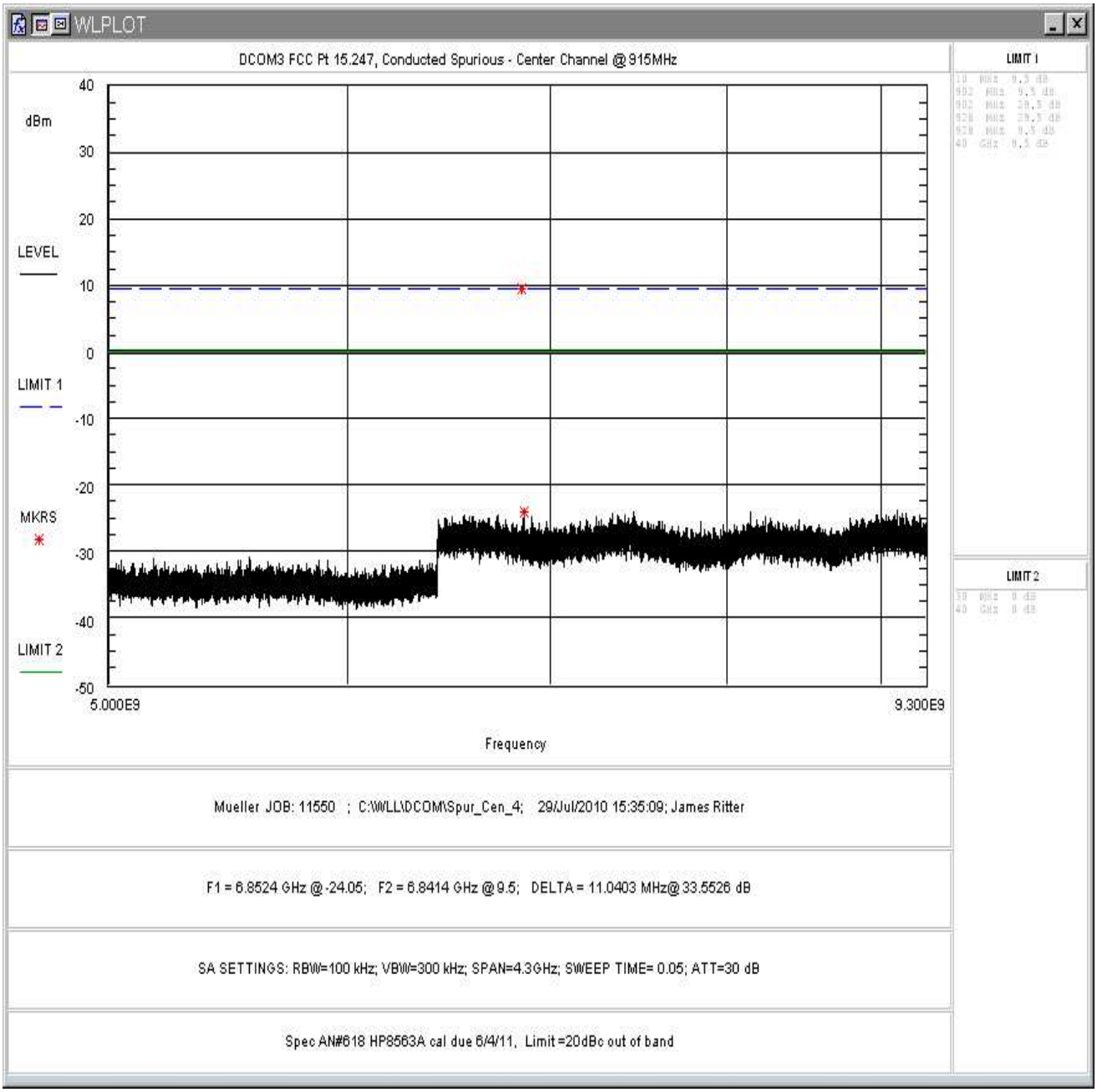

Figure 33 Conducted Spurious Emissions, Center Data Channel 5 – 9.3GHz

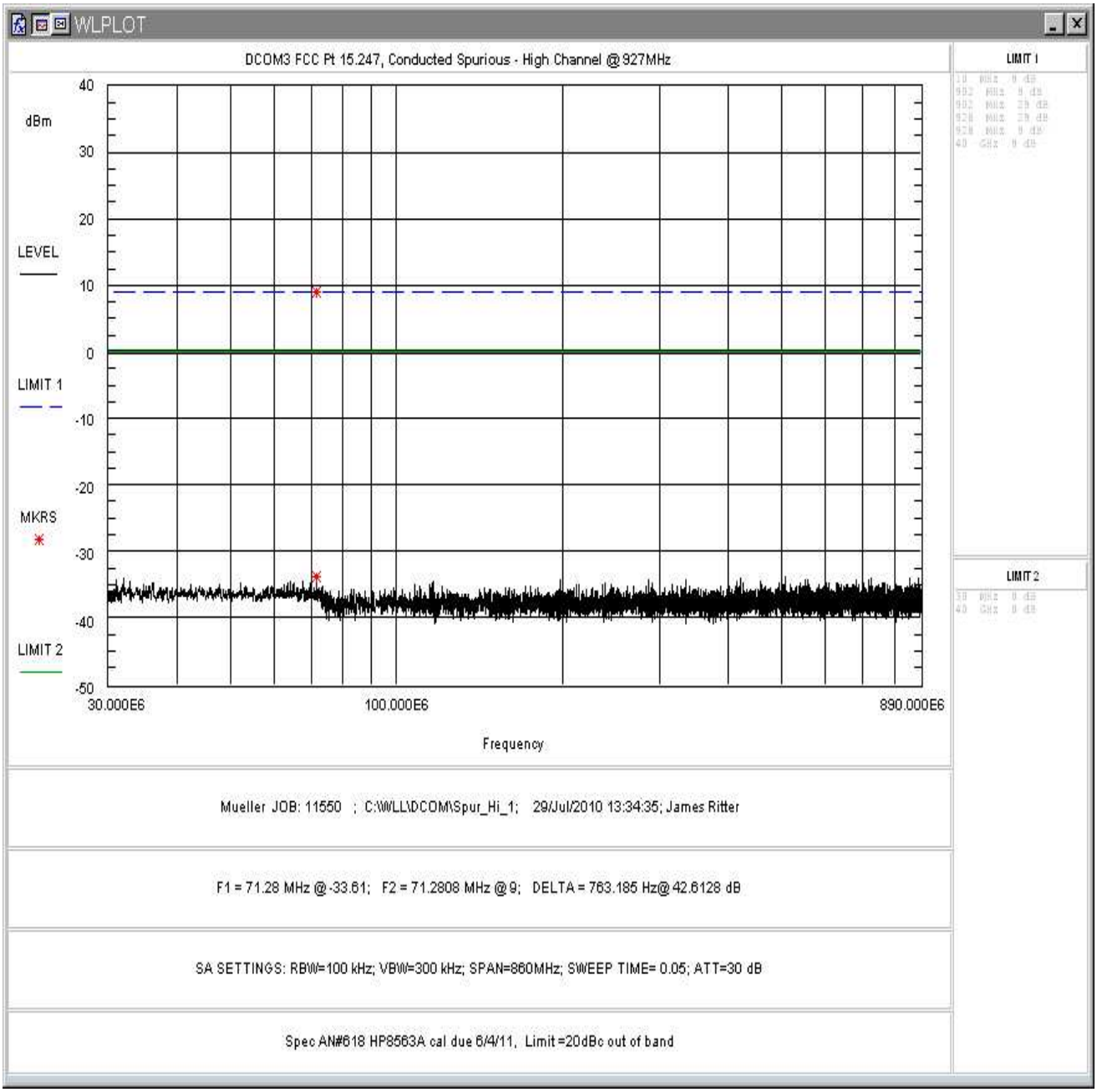

Figure 34 Conducted Spurious Emissions, High Data Channel 30 - 890MHz

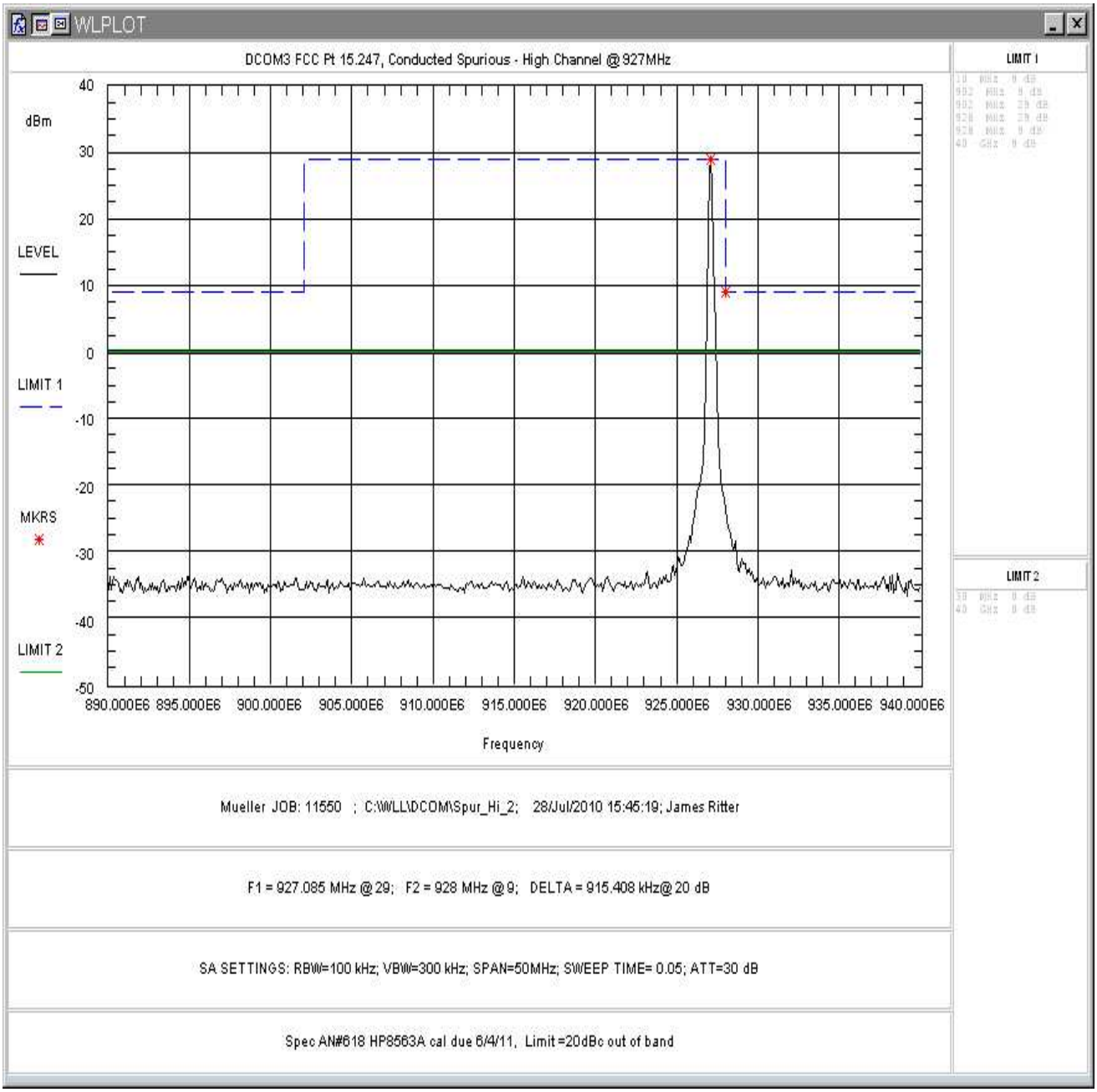

Figure 35 Conducted Spurious Emissions, High Data Channel 890-940MHz

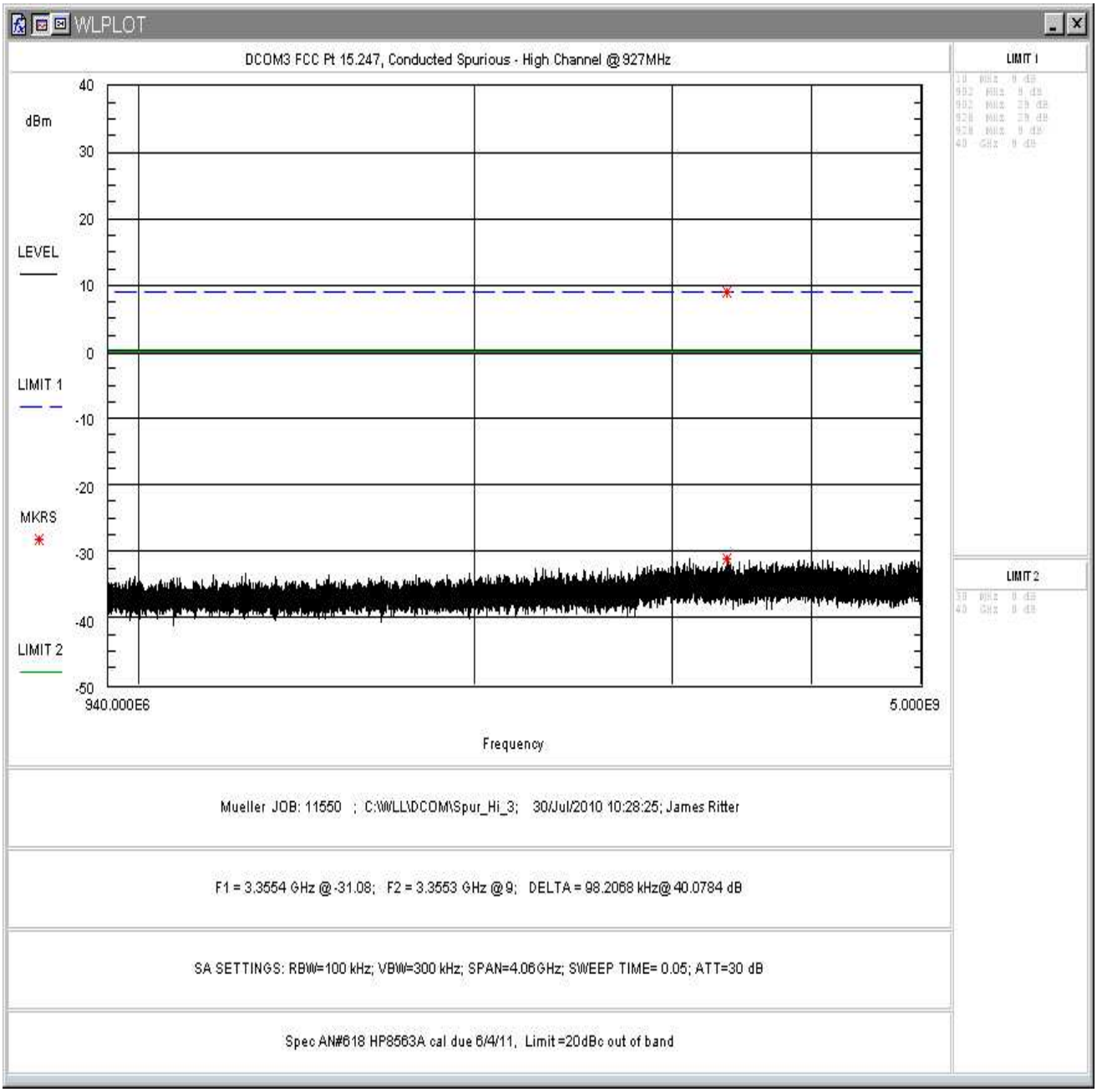

Figure 36 Conducted Spurious Emissions, High Data Channel 940MHz -5GHz

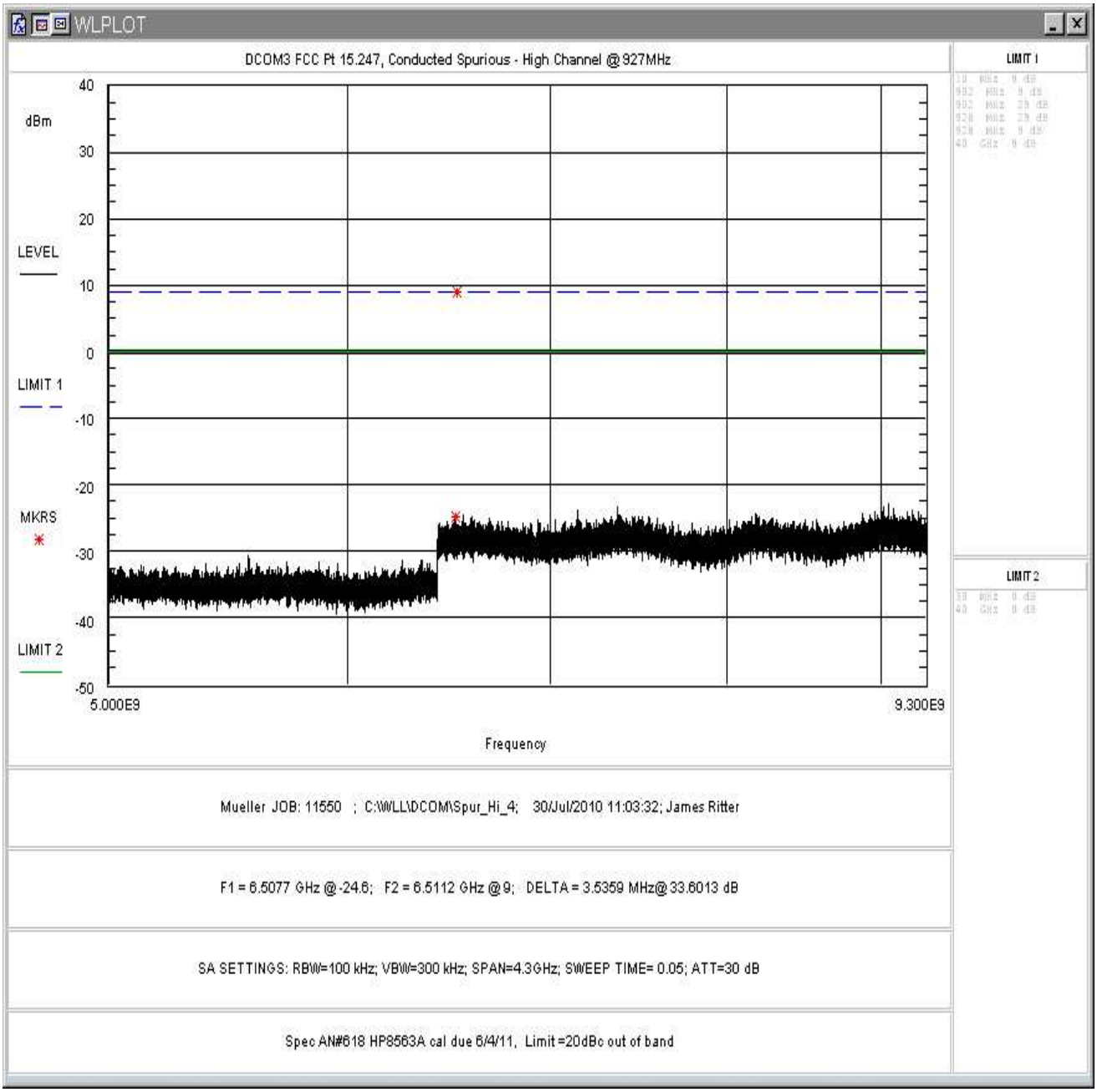

Figure 37 Conducted Spurious Emissions, High Data Channel 5-9.3GHz

5.5.2 Hailing Mode Conducted Spurious

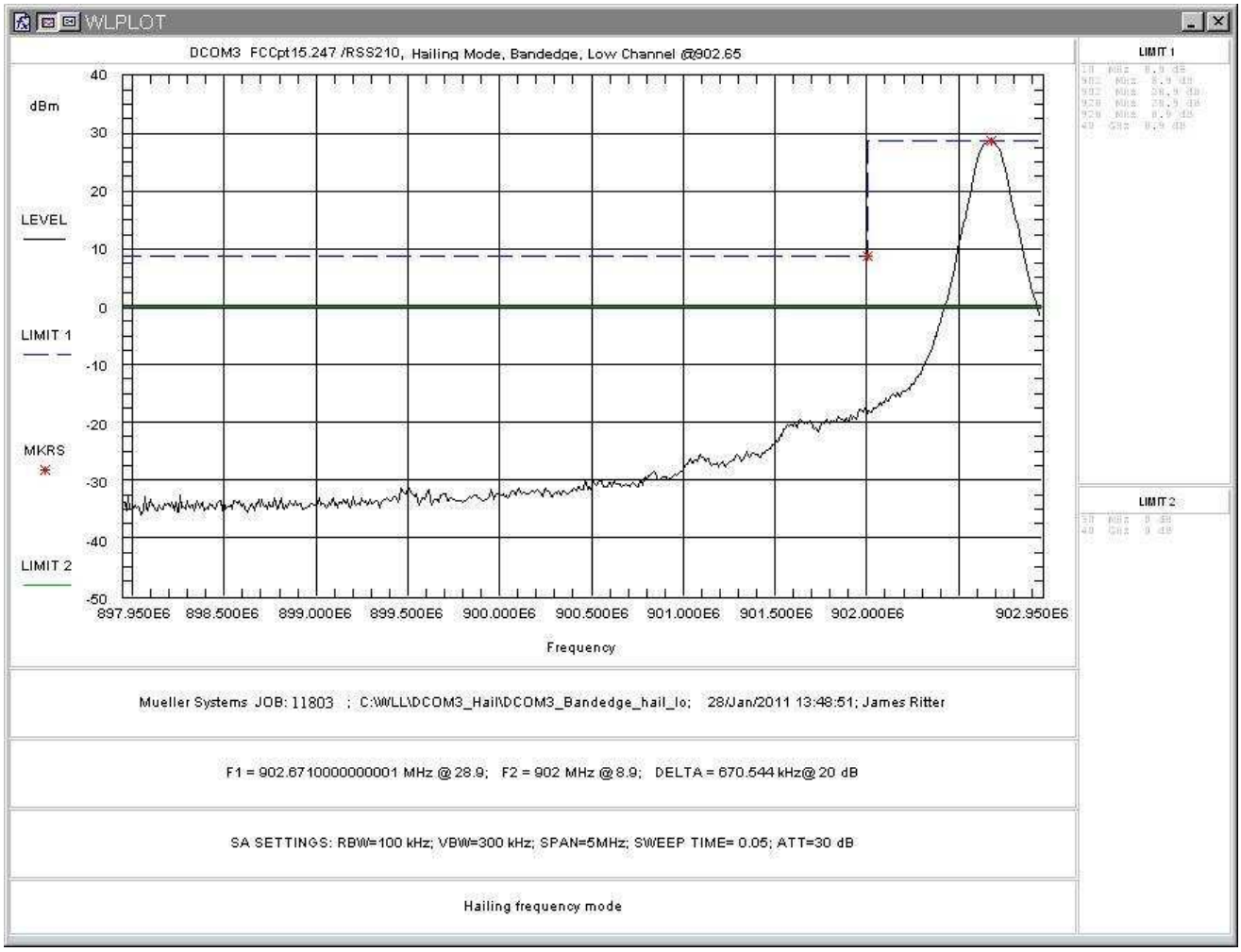

Figure 38 Low Band Edge Plot, Low Hailing Channel

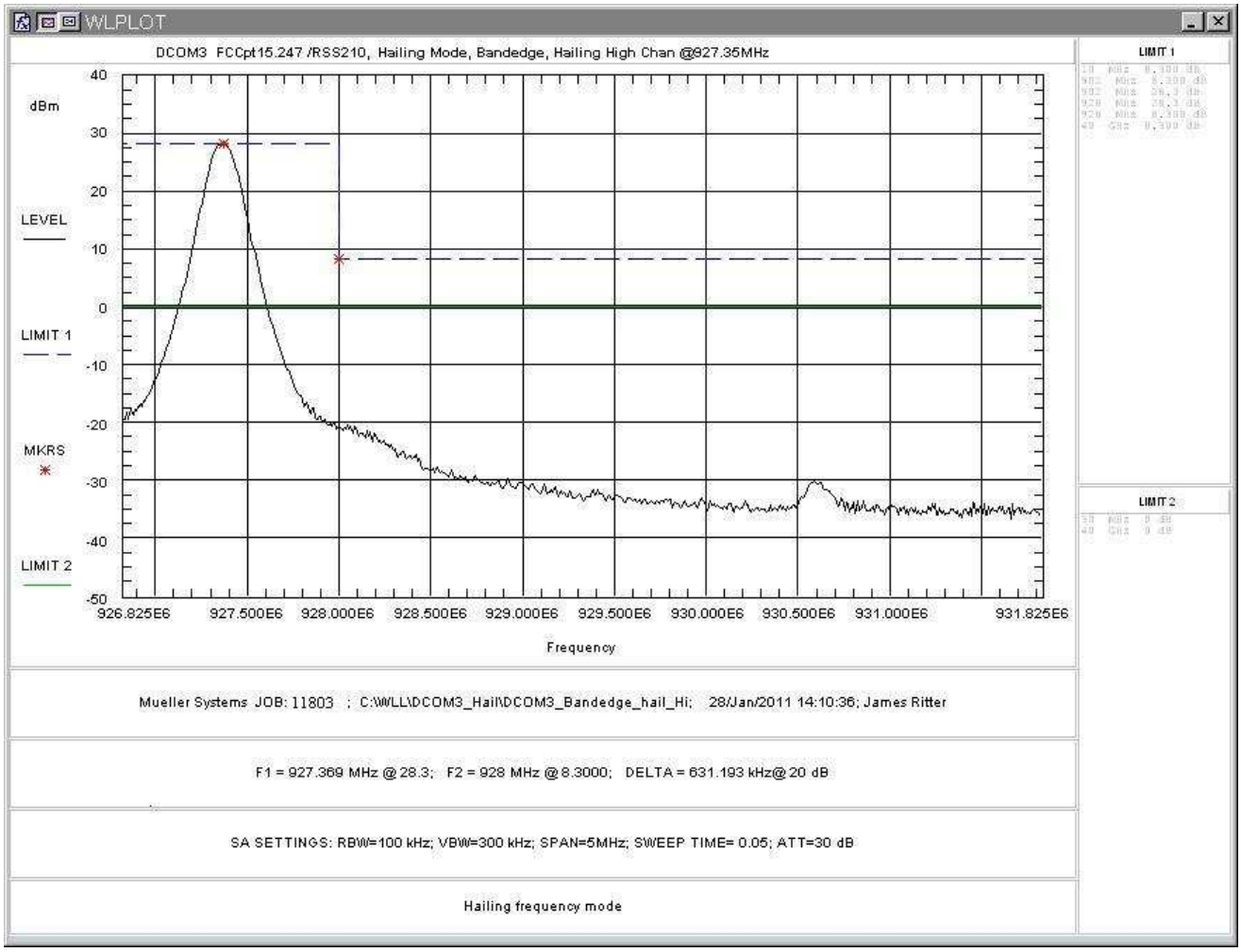

Figure 39 Upper Band Edge Plot, High Hailing Channel

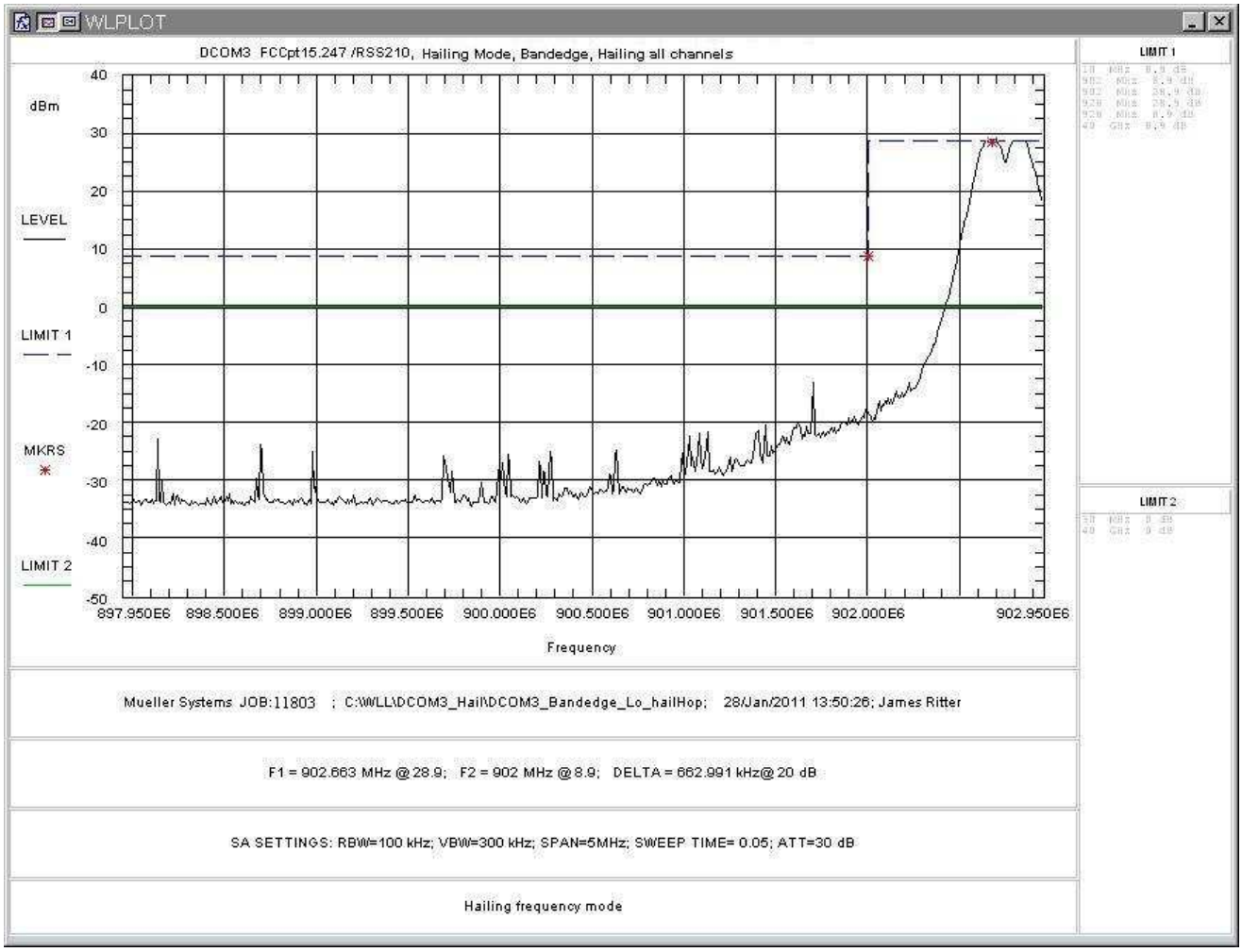

Figure 40 Low Band Edge Plot, Hopping Hailing Channel

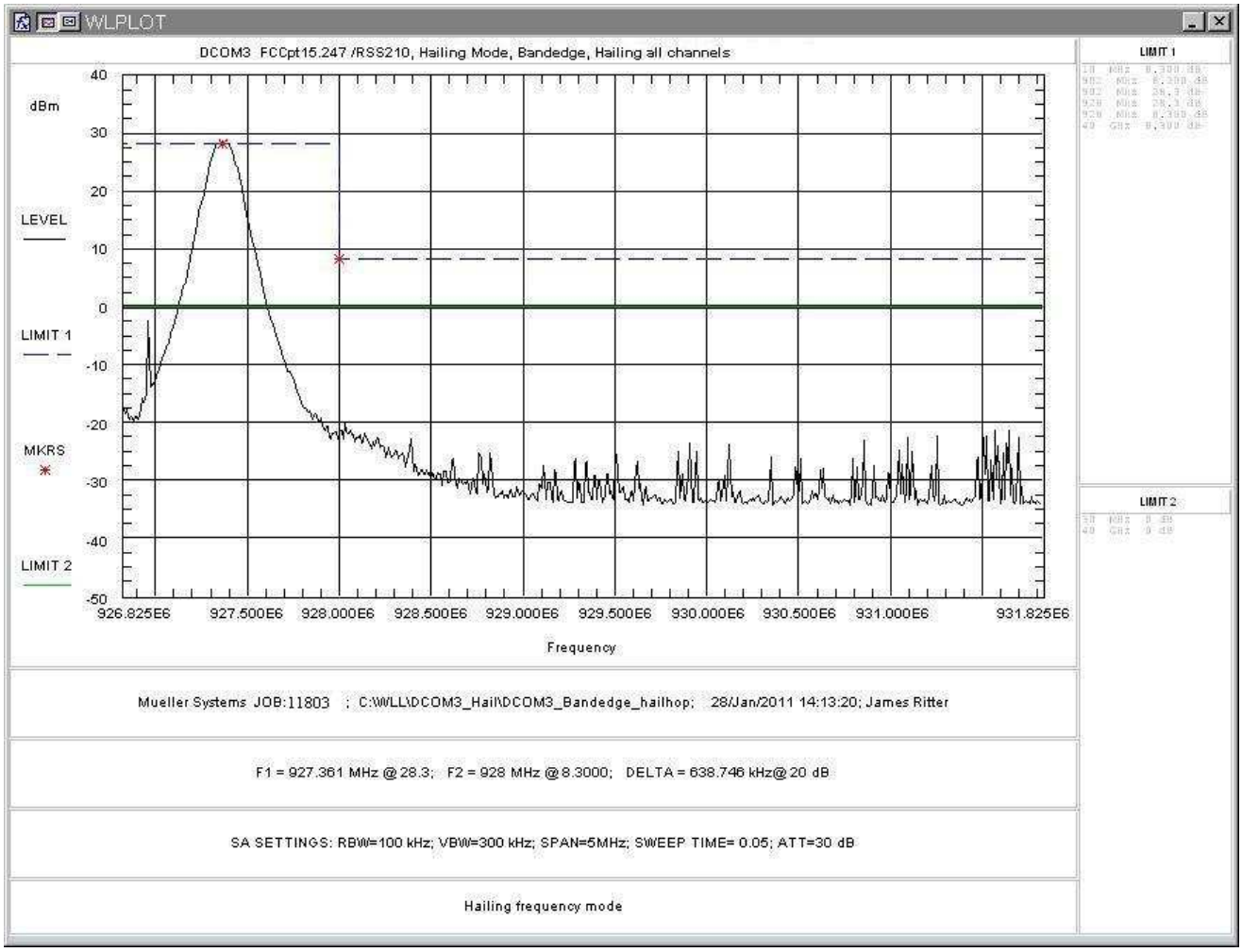

Figure 41 Upper Band Edge Plot, Hopping Hailing Channel

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.

The manufacturer has provided 2 RF shield vendors for usage, a primary vendor: Leader Technologies Part Number: SMS-203 and an alternate vendor: Laird Technologies, PN BMIS-203. Both shield configurations were tested for radiated emissions.

As the Hailing channels share all the same circuitry and parameters of the data channels only the highest hailing channel was tested for radiated emissions as this is the highest frequency in the band for this device (the lowest hailing frequency is higher than the lowest data frequency).

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

Table 10: Radiated Emission Test Data, Low Frequency Data (<1GHz)

(emissions were common to all tested channels,
the frequencies listed are the highest emitted restricted & non-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)
35.00	V	270.00	1.00	7.60	17.1	17.2	100.0	-15.3
46.30	V	270.00	1.00	15.10	9.4	16.8	100.0	-15.5
79.67	V	125.00	1.00	16.00	10.1	20.1	100.0	-13.9
157.87	V	125.00	1.94	16.00	14.1	31.9	150.0	-13.4
217.51	V	90.00	2.00	9.50	13.2	13.7	200.0	-23.3
248.23	V	180.00	1.40	8.20	13.8	12.5	200.0	-24.1
450.59	V	45.00	1.00	10.90	21.1	39.9	200.0	-14.0
456.39	V	45.00	1.00	11.60	21.1	43.3	200.0	-13.3
960.00	V	0.00	1.00	1.90	28.3	32.3	500.0	-23.8
46.64	H	170.00	4.00	7.90	9.3	7.2	100.0	-22.8
79.72	H	270.00	4.00	19.30	10.1	29.4	100.0	-10.6
113.37	H	180.00	4.00	17.20	15.7	44.3	150.0	-10.6
157.87	H	180.00	4.00	7.30	14.1	11.7	150.0	-22.1
217.51	H	200.00	3.17	9.50	13.2	13.7	200.0	-23.3
250.00	H	125.00	217.35	13.00	13.7	21.7	200.0	-19.3
450.42	H	350.00	1.00	12.70	21.1	49.1	200.0	-12.2
456.41	H	350.00	1.00	13.40	21.1	53.2	200.0	-11.5
960.00	H	0.00	1.00	1.70	28.3	31.6	500.0	-24.0

Table 11: Radiated Emission Test Data, SMS-203 Shield, High Frequency Data (>1GHz)

(Restricted Bands)

(Worst case readings are with EUT Flat)

Low Data Channel-902.5MHz

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)
Peak Readings								
2707.50	V	95.00	2.78	54.20	-1.4	434.3	5000.0	-21.2
3610.00	V	90.00	2.75	45.80	0.5	207.1	5000.0	-27.7
4512.50	V	10.00	2.47	43.00	2.5	188.4	5000.0	-28.5
5415.00	V	180.00	2.47	42.50	5.8	259.6	5000.0	-25.7
8122.50	V	0.00	2.50	41.50	10.1	379.8	5000.0	-22.4
Average Readings								
2707.50	V	95.00	2.78	52.80	-1.4	369.6	500.0	-2.6
3610.00	V	90.00	2.75	36.50	0.5	71.0	500.0	-17.0
4512.50	V	10.00	2.47	33.20	2.5	61.0	500.0	-18.3
5415.00	V	180.00	2.47	32.80	5.8	85.0	500.0	-15.4
8122.50	V	0.00	2.50	31.50	10.1	120.1	500.0	-12.4
Non Harmonics								
None								
Peak Readings								
2707.50	H	355.00	2.81	49.20	-1.4	244.2	5000.0	-26.2
3610.00	H	0.00	2.86	46.00	0.5	212.0	5000.0	-27.5
4512.50	H	90.00	2.50	42.70	2.5	182.0	5000.0	-28.8
5415.00	H	90.00	2.50	40.80	5.8	213.5	5000.0	-27.4
8122.50	H	0.00	2.50	41.50	10.1	379.8	5000.0	-22.4
Average Readings								
2707.50	H	355.00	2.81	46.20	-1.4	172.9	500.0	-9.2
3610.00	H	0.00	2.86	37.20	0.5	77.0	500.0	-16.3
4512.50	H	90.00	2.50	35.00	2.5	75.0	500.0	-16.5
5415.00	H	90.00	2.50	30.20	5.8	63.0	500.0	-18.0
8122.50	H	0.00	2.50	31.50	10.1	120.1	500.0	-12.4
Non Harmonics								
None								

Center Data Channel – 915MHz

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)
Peak Readings								
2745.00	V	125.00	2.58	53.20	-1.5	384.8	5000.0	-22.3
3660.00	V	180.00	2.60	46.30	0.6	220.3	5000.0	-27.1
4575.00	V	10.00	2.52	42.00	2.4	166.6	5000.0	-29.5
7320.00	V	0.00	2.50	42.00	9.0	356.5	5000.0	-22.9
8235.00	V	0.00	2.50	42.00	10.3	411.3	5000.0	-21.7
Average Readings								
2745.00	V	125.00	2.58	50.20	-1.5	272.4	500.0	-5.3
3660.00	V	180.00	2.60	38.80	0.6	92.9	500.0	-14.6
4575.00	V	10.00	2.52	33.30	2.4	61.2	500.0	-18.2
7320.00	V	0.00	2.50	32.00	9.0	112.7	500.0	-12.9
8235.00	V	0.00	2.50	32.00	10.3	130.1	500.0	-11.7
Non Harmonics None								
Peak Readings								
2745.00	H	90.00	2.45	50.30	-1.5	275.5	5000.0	-25.2
3660.00	H	15.00	2.47	45.00	0.6	189.7	5000.0	-28.4
4575.00	H	180.00	2.50	41.50	2.4	157.3	5000.0	-30.0
7320.00	H	90.00	2.50	41.80	9.0	348.4	5000.0	-23.1
8235.00	H	90.00	2.50	43.50	10.3	488.8	5000.0	-20.2
Average Readings								
2745.00	H	90.00	2.45	44.80	-1.5	146.3	500.0	-10.7
3660.00	H	15.00	2.47	36.20	0.6	68.9	500.0	-17.2
4575.00	H	180.00	2.50	30.30	2.4	43.3	500.0	-21.2
7320.00	H	90.00	2.50	32.00	9.0	112.7	500.0	-12.9
8235.00	H	90.00	2.50	32.00	10.3	130.1	500.0	-11.7
Non Harmonics None								

High Data Channel-927MHz

Frequency Hz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
Peak Readings								
2781.00	V	200.00	2.47	51.80	0.0	389.0	5000.0	-22.2
3708.00	V	175.00	2.50	45.00	0.0	177.8	5000.0	-29.0
4635.00	V	0.00	2.51	41.80	0.0	123.0	5000.0	-32.2
7416.00	V	0.00	2.51	43.30	0.0	146.2	5000.0	-30.7
8343.00	V	0.00	2.50	42.00	0.0	125.9	5000.0	-32.0
Average Readings								
2781.00	V	200.00	2.47	48.70	0.0	272.3	500.0	-5.3
3708.00	V	175.00	2.50	36.30	0.0	65.3	500.0	-17.7
4635.00	V	0.00	2.51	30.30	0.0	32.7	500.0	-23.7
7416.00	V	0.00	2.51	32.00	0.0	39.8	500.0	-22.0
8343.00	V	0.00	2.50	32.00	0.0	39.8	500.0	-22.0
Non Harmonics								
None								
Peak Readings								
2781.00	H	90.00	2.00	50.60	0.0	338.8	5000.0	-23.4
3708.00	H	185.00	2.00	45.67	0.0	192.1	5000.0	-28.3
4635.00	H	0.00	2.00	41.00	0.0	112.2	5000.0	-33.0
7416.00	H	0.00	2.00	41.50	0.0	118.9	5000.0	-32.5
8343.00	H	0.00	2.00	43.30	0.0	146.2	5000.0	-30.7
Average Readings								
2781.00	H	90.00	2.00	48.30	0.0	260.0	500.0	-5.7
3708.00	H	185.00	2.00	38.20	0.0	81.3	500.0	-15.8
4635.00	H	0.00	2.00	30.10	0.0	32.0	500.0	-23.9
7416.00	H	0.00	2.00	31.60	0.0	38.0	500.0	-22.4
8343.00	H	0.00	2.00	31.80	0.0	38.9	500.0	-22.2
Non Harmonics								
None								

High Hailing Channel-927.35MHz

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)
Peak Readings								
2782.05	V	0.00	2.00	56.67	-1.5	575.5	5000.0	-18.8
3709.40	V	180.00	2.04	42.00	0.8	138.8	5000.0	-31.1
4636.80	V	10.00	2.29	44.50	3.3	246.4	5000.0	-26.1
7418.85	V	90.00	2.38	45.00	9.6	539.7	5000.0	-19.3
8346.20	V	190.00	1.95	36.83	9.9	216.5	5000.0	-27.3
Average Readings								
2782.05	V	0.00	2.00	52.50	-1.5	356.1	500.0	-2.9
3709.40	V	180.00	2.04	30.33	0.8	36.2	500.0	-22.8
4636.80	V	10.00	2.29	32.87	3.3	64.6	500.0	-17.8
7418.85	V	90.00	2.38	32.33	9.6	125.5	500.0	-12.0
8346.20	V	190.00	1.95	29.80	9.9	96.4	500.0	-14.3
Non Harmonics								
None								
Peak Readings								
2782.05	H	10.00	2.60	56.17	-1.5	543.3	5000.0	-19.3
3709.40	H	0.00	2.10	39.33	0.8	102.1	5000.0	-33.8
4636.80	H	340.00	2.07	38.83	3.3	128.3	5000.0	-31.8
7418.85	H	90.00	2.22	39.00	9.6	270.5	5000.0	-25.3
8346.20	H	90.00	2.40	37.67	9.9	238.5	5000.0	-26.4
Average Readings								
2782.05	H	0.00	0.00	52.33	-1.5	349.2	500.0	-3.1
3709.40	H	0.00	2.10	30.00	0.8	34.9	500.0	-23.1
4636.80	H	340.00	2.07	30.10	3.3	47.0	500.0	-20.5
7418.85	H	90.00	2.22	29.73	9.6	93.0	500.0	-14.6
8346.20	H	90.00	2.40	29.50	9.9	93.1	500.0	-14.6
Non Harmonics								
None								

Figure 42. Radiated Emission Test Data, BMIS-203 Shield, High Frequency Data (>1GHz) (Restricted Bands)

(Worst case readings are with EUT Flat)

Low Data Channel-902.5MHz

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)
Peak Readings								
2707.50	V	90.00	2.34	53.60	-1.4	405.3	5000.0	-21.8
3610.00	V	120.00	2.34	47.50	0.5	251.9	5000.0	-26.0
4512.50	V	125.00	2.37	42.67	2.5	181.4	5000.0	-28.8
5415.00	V	90.00	2.11	42.00	5.8	245.1	5000.0	-26.2
8122.50	V	0.00	2.10	40.00	10.1	319.6	5000.0	-23.9
Average Readings								
2707.50	V	90.00	2.34	50.80	-1.4	293.6	500.0	-4.6
3610.00	V	120.00	2.34	40.20	0.5	108.7	500.0	-13.3
4512.50	V	125.00	2.37	34.00	2.5	66.9	500.0	-17.5
5415.00	V	90.00	2.11	31.20	5.8	70.7	500.0	-17.0
8122.50	V	0.00	2.10	31.80	10.1	124.3	500.0	-12.1
Non Harmonics								
None								
Peak Readings								
2707.50	H	0.00	2.52	53.00	-1.4	378.2	5000.0	-22.4
3610.00	H	250.00	2.50	45.20	0.5	193.3	5000.0	-28.3
4512.50	H	180.00	2.53	51.20	2.5	484.3	5000.0	-20.3
5415.00	H	225.00	2.50	47.20	5.8	446.0	5000.0	-21.0
8122.50	H	0.00	2.50	40.80	10.1	350.4	5000.0	-23.1
Average Readings								
2707.50	H	0.00	2.52	51.00	-1.4	300.5	500.0	-4.4
3610.00	H	250.00	2.50	39.00	0.5	94.7	500.0	-14.5
4512.50	H	180.00	2.53	47.67	2.5	322.6	500.0	-3.8
5415.00	H	225.00	2.50	41.50	5.8	231.4	500.0	-6.7
8122.50	H	0.00	2.50	31.60	10.1	121.5	500.0	-12.3
Non Harmonics								
None								

Center Data Channel – 915MHz

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)
Peak Readings								
2745.00	V	185.00	2.97	53.80	-1.5	412.3	5000.0	-21.7
3660.00	V	345.00	2.94	46.70	0.6	230.7	5000.0	-26.7
4575.00	V	180.00	2.34	42.50	2.4	176.5	5000.0	-29.0
7320.00	V	90.00	2.30	40.00	9.0	283.2	5000.0	-24.9
8235.00	V	180.00	2.30	42.00	10.3	411.3	5000.0	-21.7
Average Readings								
2745.00	V	185.00	2.97	51.80	-1.5	327.5	500.0	-3.7
3660.00	V	345.00	2.94	37.36	0.6	78.7	500.0	-16.1
4575.00	V	180.00	2.34	42.50	2.4	176.5	500.0	-9.0
7320.00	V	90.00	2.30	40.00	9.0	283.2	500.0	-4.9
8235.00	V	180.00	2.30	32.00	10.3	130.1	500.0	-11.7
Non Harmonics None								
Peak Readings								
2745.00	H	350.00	2.78	54.70	-1.5	457.3	5000.0	-20.8
3660.00	H	185.00	2.88	47.00	0.6	238.8	5000.0	-26.4
4575.00	H	180.00	2.75	42.00	2.4	166.6	5000.0	-29.5
7320.00	H	180.00	2.50	41.00	9.0	317.7	5000.0	-23.9
8235.00	H	180.00	2.50	41.00	10.3	366.5	5000.0	-22.7
Average Readings								
2745.00	H	350.00	2.78	52.50	-1.5	355.0	500.0	-3.0
3660.00	H	185.00	2.88	42.30	0.6	139.0	500.0	-11.1
4575.00	H	180.00	2.75	38.20	2.4	107.6	500.0	-13.3
7320.00	H	180.00	2.50	31.80	9.0	110.2	500.0	-13.1
8235.00	H	180.00	2.50	32.00	10.3	130.1	500.0	-11.7
Non Harmonics None								

High Data Channel-927MHz

Frequency Hz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
Peak Readings								
2781.00	V	170.00	2.76	52.50	-1.3	363.0	5000.0	-22.8
3708.00	V	172.00	2.73	49.30	0.7	314.9	5000.0	-24.0
4635.00	V	125.00	2.60	43.33	3.1	208.7	5000.0	-27.6
7416.00	V	0.00	2.60	44.00	9.6	476.0	5000.0	-20.4
8343.00	V	0.00	2.60	43.50	9.9	465.9	5000.0	-20.6
Average Readings								
2781.00	V	170.00	2.76	49.50	-1.3	257.0	500.0	-5.8
3708.00	V	172.00	2.73	42.70	0.7	147.3	500.0	-10.6
4635.00	V	125.00	2.60	36.70	3.1	97.3	500.0	-14.2
7416.00	V	0.00	2.60	34.00	9.6	150.5	500.0	-10.4
8343.00	V	0.00	2.60	32.30	9.9	128.3	500.0	-11.8
Non Harmonics								
None								
Peak Readings								
2781.00	H	90.00	2.48	53.00	-1.3	384.5	5000.0	-22.3
3708.00	H	250.00	2.48	47.67	0.7	261.0	5000.0	-25.6
4635.00	H	350.00	2.36	44.50	3.1	238.8	5000.0	-26.4
7416.00	H	125.00	2.30	44.70	9.6	515.9	5000.0	-19.7
8343.00	H	270.00	2.30	43.00	9.9	439.8	5000.0	-21.1
Average Readings								
2781.00	H	90.00	2.48	50.30	-1.3	281.8	500.0	-5.0
3708.00	H	250.00	2.48	39.00	0.7	96.2	500.0	-14.3
4635.00	H	350.00	2.36	38.70	3.1	122.5	500.0	-12.2
7416.00	H	125.00	2.30	35.00	9.6	168.9	500.0	-9.4
8343.00	H	270.00	2.30	33.00	9.9	139.1	500.0	-11.1
Non Harmonics								
None								

5.7 AC Conducted Emissions (FCC Pt.15.207)

5.7.1 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

5.7.2 Test Data

As the EUT is battery powered this test is not applicable.

5.8 Receiver Radiated Emissions

5.8.1 Requirements

Test Arrangement: Table Top

Compliance Standard: RSS210 section 2.6

RSS210 Compliance Limits for Receivers	
Frequency	**Limits**
30-88 MHz	100 μV/m
88-216 MHz	150 μV/m
216-960 MHz	200 μV/m
＞960MHz	500 μV/m

5.8.2 Test Procedure

The requirements of RSS210 section 2.6 call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive 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. Biconical and log periodic broadband 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 output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 3 GHz were measured. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak, peak, or average as appropriate. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

All measurements above 1GHz were made at a distance of 3m with a Resolution Bandwidth of 1MHz and a Video bandwidth of 10Hz.

5.8.3 Test Data

The EUT complied with the Receiver Radiated Emissions requirements. Table 9 provides the test results for radiated emissions.

5.8.4 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the Industry Canada limit.

Example:

Spectrum Analyzer Voltage: VdBµV

Antenna Correction Factor: AFdB/m

Cable Correction Factor: CFdB

Electric Field: EdBV/m = V dBµV + AFdB/m + CFdB

To convert to linear units of measure: EdBV/m/20 Inv log

Table 12: Receiver Radiated Emission Test Data

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)
35.00	V	270.00	1.00	7.60	17.1	17.2	100.0	-15.3
46.30	V	270.00	1.00	15.10	9.4	16.8	100.0	-15.5
79.67	V	125.00	1.00	16.00	10.1	20.1	100.0	-13.9
157.87	V	125.00	1.94	16.00	14.1	31.9	150.0	-13.4
217.51	V	90.00	2.00	9.50	13.2	13.7	200.0	-23.3
248.23	V	180.00	1.40	8.20	13.8	12.5	200.0	-24.1
450.59	V	45.00	1.00	10.90	21.1	39.9	200.0	-14.0
456.39	V	45.00	1.00	11.60	21.1	43.3	200.0	-13.3
960.00	V	0.00	1.00	1.90	28.3	32.3	500.0	-23.8
46.64	H	170.00	4.00	7.90	9.3	7.2	100.0	-22.8
79.72	H	270.00	4.00	19.30	10.1	29.4	100.0	-10.6
113.37	H	180.00	4.00	17.20	15.7	44.3	150.0	-10.6
157.87	H	180.00	4.00	7.30	14.1	11.7	150.0	-22.1
217.51	H	200.00	3.17	9.50	13.2	13.7	200.0	-23.3
250.00	H	125.00	217.35	13.00	13.7	21.7	200.0	-19.3
450.42	H	350.00	1.00	12.70	21.1	49.1	200.0	-12.2
456.41	H	350.00	1.00	13.40	21.1	53.2	200.0	-11.5
960.00	H	0.00	1.00	1.70	28.3	31.6	500.0	-24.0

No signals noted above 1GHz

