Washington Laboratories, Ltd.

FCC & Industry Canada Certification Test Report

For the

Axiometric, LLC

Mesh Stamp

FCC ID: VE4-MM8

IC ID: TBD

WLL JOB# **10532**
December 2008

Prepared for:

Axiometric, LLC
10718 Vista Road
Columbia, MD 21044

Prepared By:

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

ACCREDITED

Testing Certificate 2675.01

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Prepared by: James Ritter
Compliance Engineer

Reviewed by: Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Axiometric, LLC to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (9/2007) 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 a Axiometric, LLC Mesh Stamp.

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 the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 as an independent FCC test laboratory.

The Axiometric, LLC Mesh Stamp complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

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1 Introduction

1.1 Compliance Statement

The Axiometric, LLC Mesh Stamp FHSS Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

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. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Axiometric, LLC 10718 Vista Road Columbia, MD 21044
Quotation Number:	64410

1.4 Test Dates

Testing was performed on the following date(s):	08/18/2008 to 08/21/2008

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter
Client Representative	Frank Moody

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 Axiometric, LLC Mesh Stamp Module is a small (30mm x 44mm) module with components on the top side and the AX_RFM_250 transceiver module on the bottom. The pads along the long edges may be populated with 0.100 pin-headers to allow the module to be plugged into devices with appropriate sockets. The module may be plugged directly into a third-party product and connected to an approved antenna (approved type modular approval grant) to enable the product to participate in an Axiometric wireless mesh network. The module specifically includes:

- AX_RFM_250 transceiver module

  (Axiometric has developed an RF transceiver module (AX_RFM_250) that is used in all Axiometric mesh products and contains all of the RF circuitry excluding the antenna system and power supply)
- ARM7 micro-controller
- 3.3vdc linear voltage regulator (regulates power to transceiver)
- Reverse SMA antenna connector

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Axiometric LLC
FCC ID Number	VE4-MM8
IC ID Number	TBD
EUT Name:	Mesh Stamp RF Module
Model:	Mesh Stamp
FCC Rule Parts:	15.247
Frequency Range:	902.5-927MHz
Maximum Output Power:	233mW (23.66dBm)
Modulation:	FHSS FSK
20dB Bandwidth:	180.86 kHz for mesh mode, 329.12 kHz for drive-by mode
Maximum Transmit Spurious Emission	5415.00 MHz @ 369.5 uV/m (3m) Margin= -2.6dB (limit=500uV/m)
Maximum Receiver Spurious Emission	408.53MHz @ 24.6 uV/m (3m) Margin= -18.2dB (limit=200uV/m)
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Fixed
Antenna Type	Tested with a 5.5dBi whip antenna
Interface :	24pins for data, 2 pins for DC power, 6 pin maintenance port, RF reverse SMA RF port
Power Source & Voltage:	3.6-6VDC
Manufacturer:	Axiometric LLC

2.2 Test Configuration

The Mesh Stamp module was tested as a stand-alone device with 5VDC power provided directly to the EUT from a 120VAC to 5 VDC PRS ac/DC adaptor. The EUT was connected to a support laptop for RF control via RS-232 maintenance port connection to a 6 pin header. The RF radiated tests were performed with a 5.5dBi whip antenna connected to the EUT.

2.3 Testing Algorithm

The Mesh Stamp was programmed via a 6 pin maintenance port on the EUT to a RS232 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.

2.4 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 the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 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

2.5.2 Measurement Uncertainty

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

The following measurement uncertainty calculation is provided:

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

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 4.55$ dB.

3 Test Equipment

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

Table 2: Test Equipment List

Equipment List- Conducted Antenna Port Tests

Test Name: **Radiated Emissions**			Test Date: **08/21/2008**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00528	AGILENT, E4446A	ANALYZER, SPECTRUM	02/15/2009
00474	HP, 8563E	ANALYZER, SPECTRUM	09/07/2008
00640	MEGAPHASE, TM40-K1K5-36	1G-40GHZ RIGHT ANGLE	09/11/2008

Equipment List- Radiated Emissions Tests

Test Name: **Radiated Emissions**			Test Date: **08/18/2008**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00069	HP, 85650A	ADAPTER, QP	07/09/2009
00071	HP, 85685A	PRESELECTOR, RF	07/09/2009
00073	HP, 8568B	ANALYZER, SPECTRUM	07/08/2009
00004	ARA, DRG-118/A	ANTENNA, DRG, 1-18GHZ	02/02/2009
00644	SUNOL SCIENCE JB1	BICONALOG ANTENNA	11/27/2009
00066	HP, 8449B	PRE-AMPLIFIER, RF. 1-26.5GHZ	07/15/2009
00474	HP, 8563E	ANALYZER, SPECTRUM	09/07/2008
00281	ITC, 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	02/19/2010
00337	WLL, 1.2-5GHZ	FILTER, BAND PASS	02/19/2010

Equipment List- Conducted AC powerline Emissions Tests

Test Name: **Conducted Emissions Voltage**			Test Date: **08/21/2008**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00125	SOLAR, 8028-50-TS-24-BNC	LISN	01/30/2009
00126	SOLAR, 8028-50-TS-24-BNC	LISN	01/30/2009
00068	HP, 85650A	ADAPTER, QP	07/07/2009
00072	HP, 8568B	ANALYZER, SPECTRUM	07/03/2009
00070	HP, 85685A	PRESELECTOR, RF W/OPT 8ZE	07/07/2009
00053	HP, 11947A	LIMITER, TRANSIENT	04/09/2009

4 Test Summary

The Table Below shows the results of testing for compliance with a Digital Transmission System in accordance with FCC Part 15.247:2007 and RSS210e issue 7. Full results are shown in section 5.

Table 3: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (a)(1)(iii)	RSS-210 [A8. 1]	20dB Bandwidth	Pass
15.247 (b)(1)	RSS-210 [A8.4 (2)]	Transmit Output Power	Pass
15.247 (a)(1)	RSS-210 [A8.1 (2)]	Channel Separation	Pass
15.247 (a)(1)(iii)	RSS-210 [A8. 1 (4)]	Number of Channels =50 Minimum	Pass
15.247 (a)(1)(iii)	RSS-210 [A8. 1 (4)]	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 [A8. 5]	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-Gen [7.2.3.2]	General Field Strength Limits (Restricted Bands & RE Limits)	Pass

5 Test Results

5.1 Duty Cycle Correction

In accordance with the FCC Public Notice the spurious radiated emissions measurements may be adjusted by 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 108.3ms for ‘Mesh Mode’ and 40ms for ‘Drive-by mode’. The unit makes a single hop transmission every 6 seconds. FCC part 15.247 also requires that for hopping signals with an occupied bandwidth of greater than 250kHz the total transmit dwell time must be no more than 0.4 seconds per 10 seconds . For signals less than 250 kHz the limit is 0.4 seconds per 20 seconds. As the ‘Mesh mode bandwidth is less than 250kHz and the ‘Drive-by’ mode is more than 250kHz both modes were tested and complied.

Even though the drive-by mode is 40ms no duty cycle correction was applied as the normal mode of operation ‘Mesh mode’ is over 100ms.

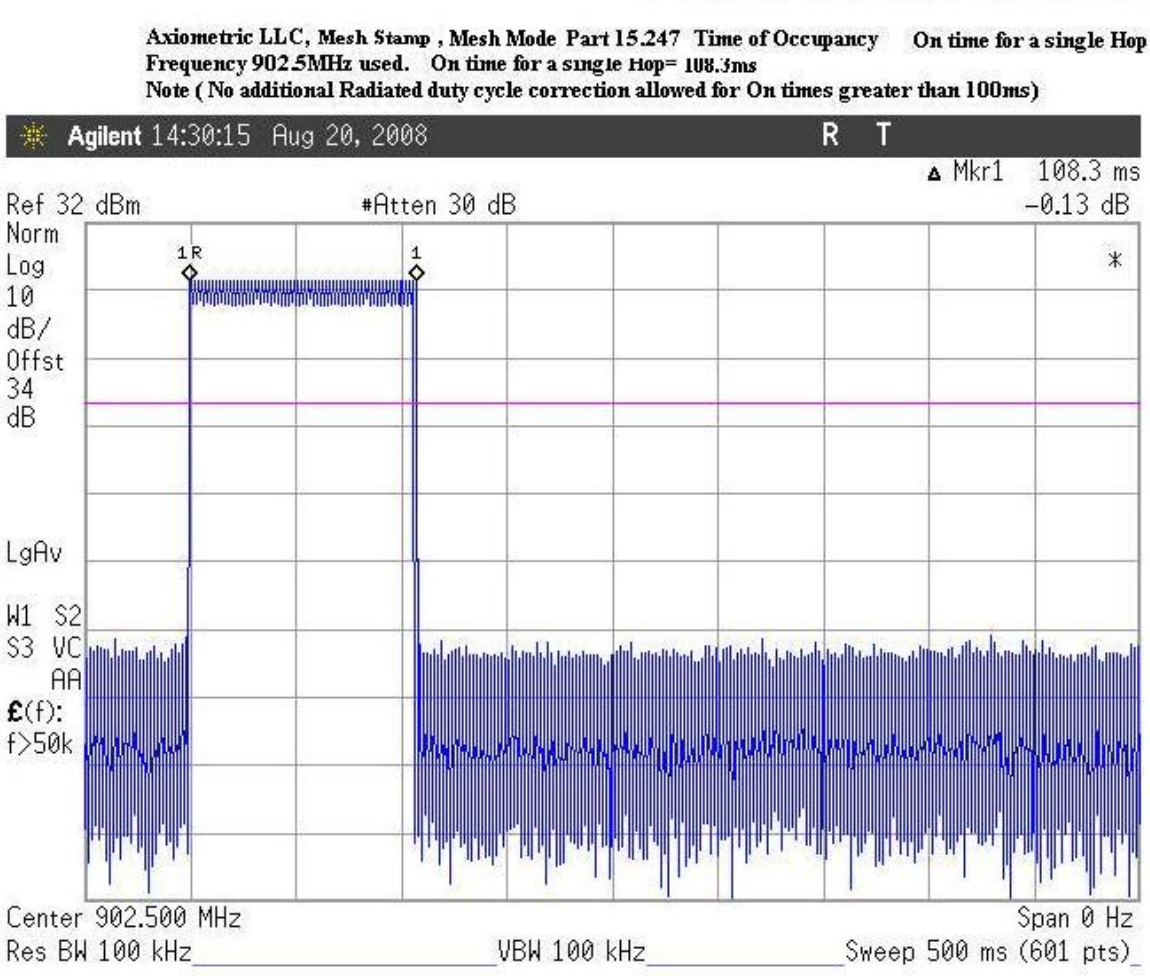

Figure 1. Dwell Time Per Hop, Mesh Mode

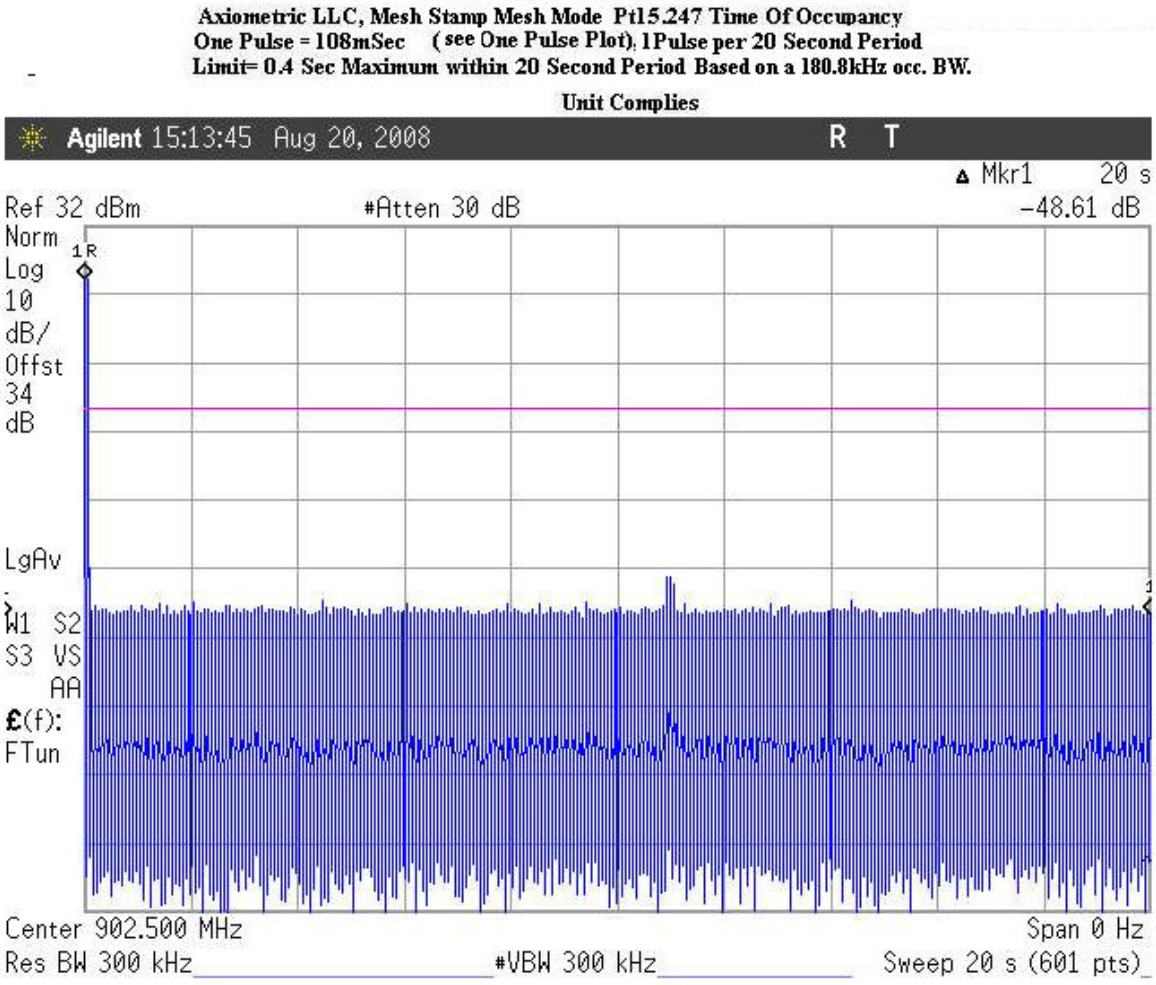

Figure 2. Time of Occupancy per 20 seconds, Mesh Mode

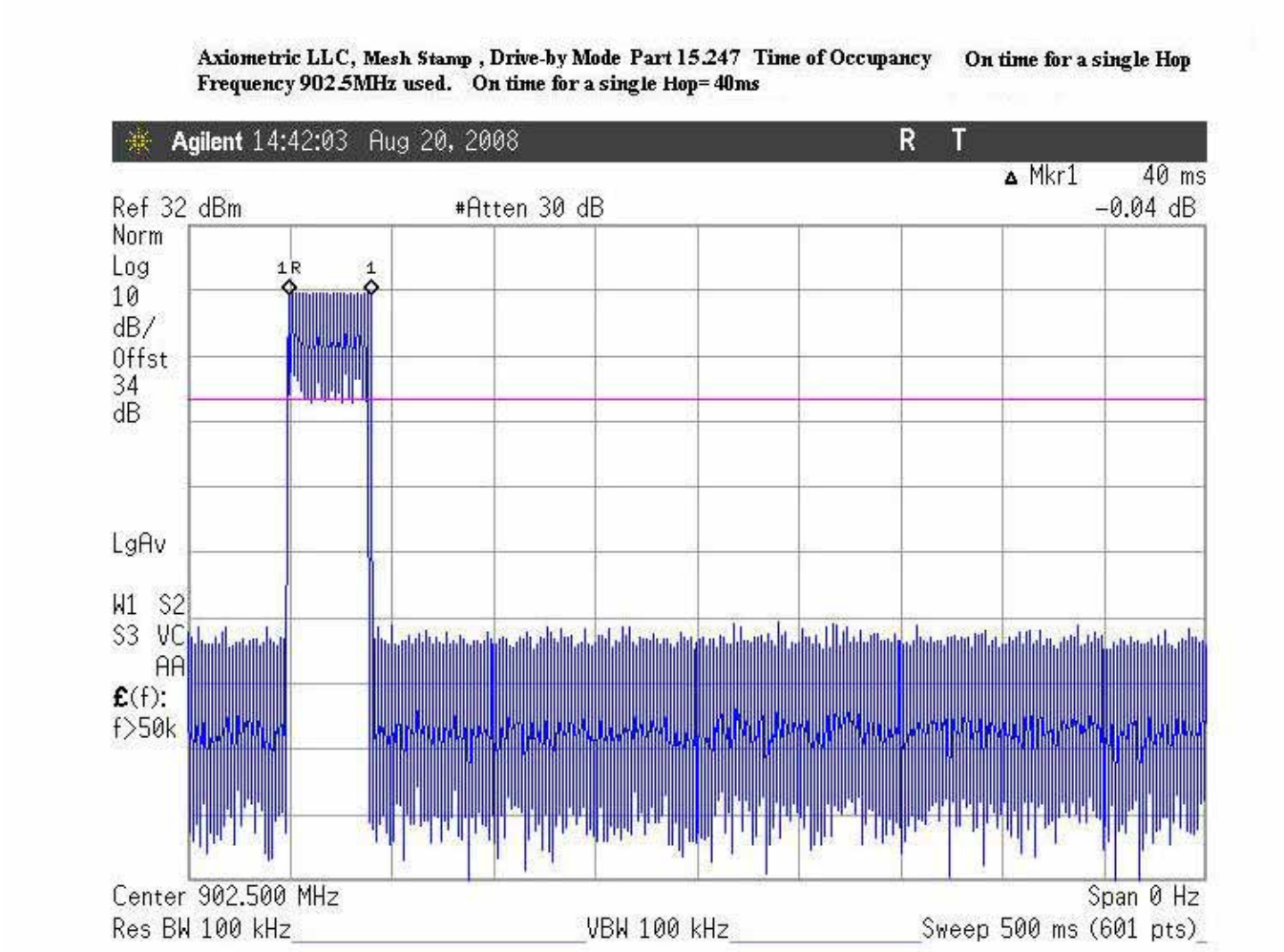

Figure 3. Dwell Time Per Hop, Drive-by Mode

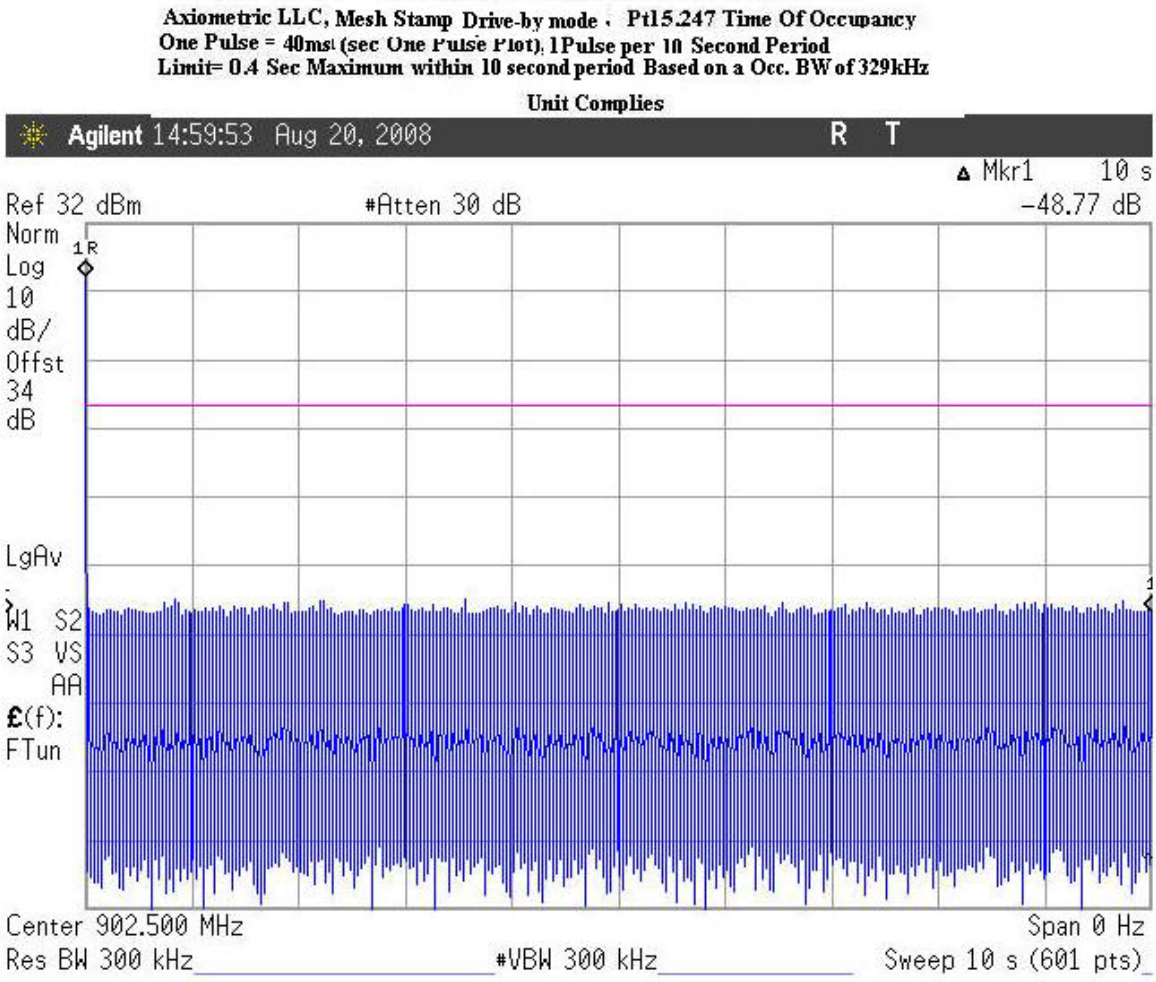

Figure 4. Time of Occupancy per 10 seconds, drive-by Mode

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.

2 modes of operation were available: a narrow bandwidth 'Mesh Mode' and a wider bandwidth 'Drive-by' mode.

Table 4: RF Power Output

Mode Tested	Frequency	Level	Limit	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	23.66 dBm	30 dBm	Pass
Mesh Mode	Center Channel: 915MHz	23.66 dBm	30 dBm	Pass
Mesh Mode	High Channel: 927MHz	23.33 dBm	30 dBm	Pass
Drive-by Mode	Low Channel: 902.5MHz	23.58 dBm	30 dBm	Pass
Drive-by Mode	Center Channel: 915MHz	23.50 dBm	30 dBm	Pass
Drive-by mode	High Channel: 927MHz	23.16 dBm	30 dBm	Pass

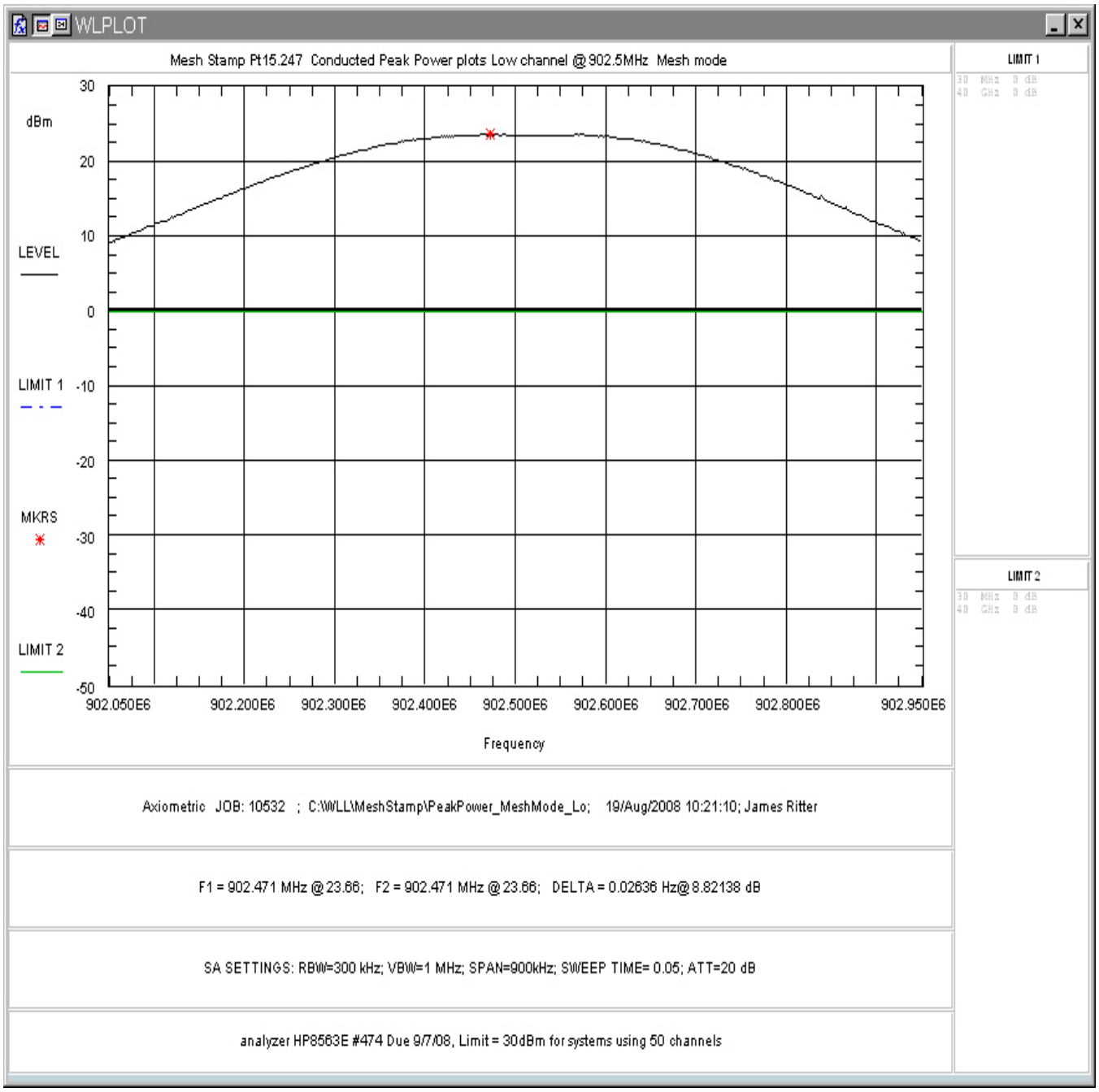

Figure 5. RF Peak Power, Mesh Mode, Low Channel

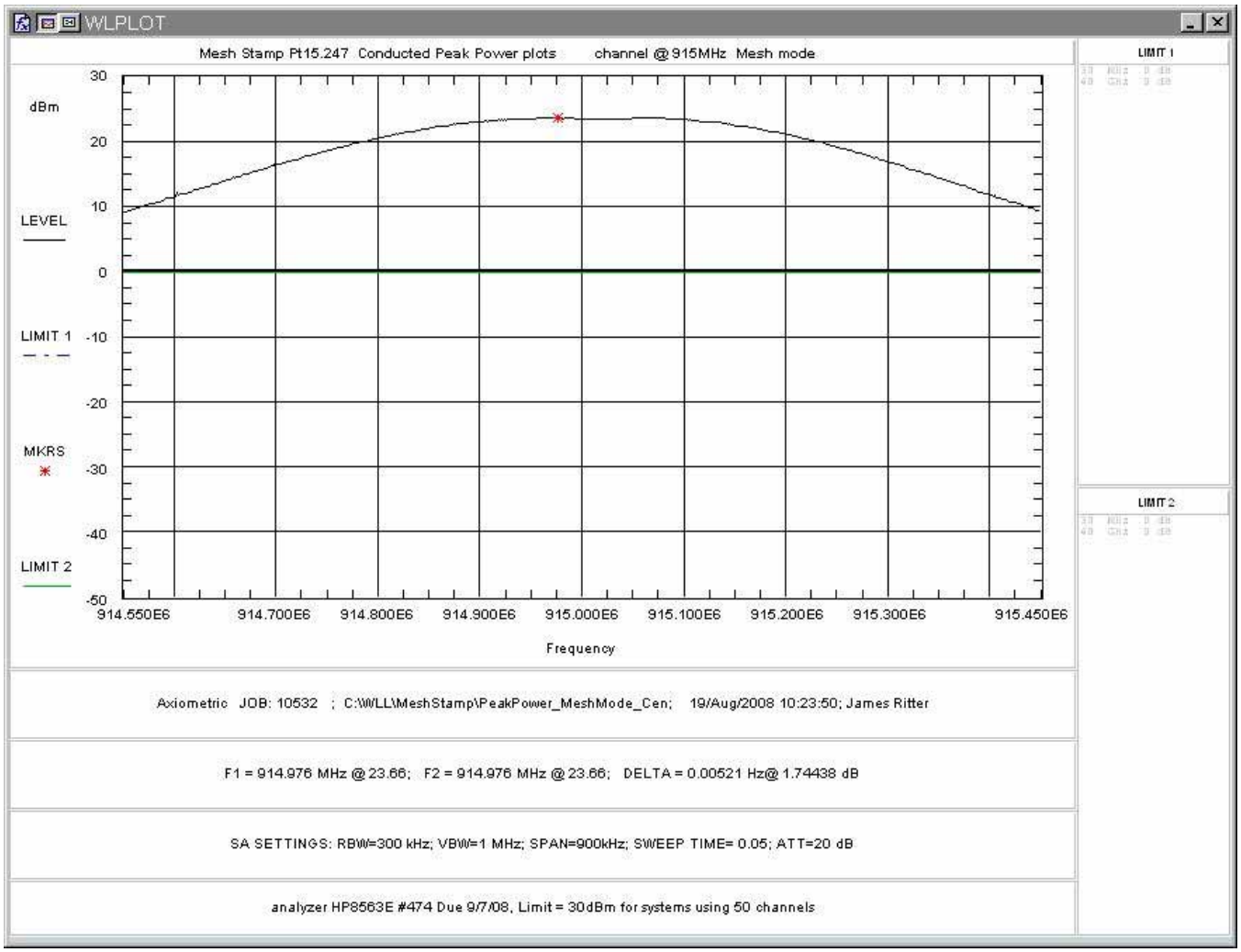

Figure 6. RF Peak Power, Mesh Mode, Center Channel

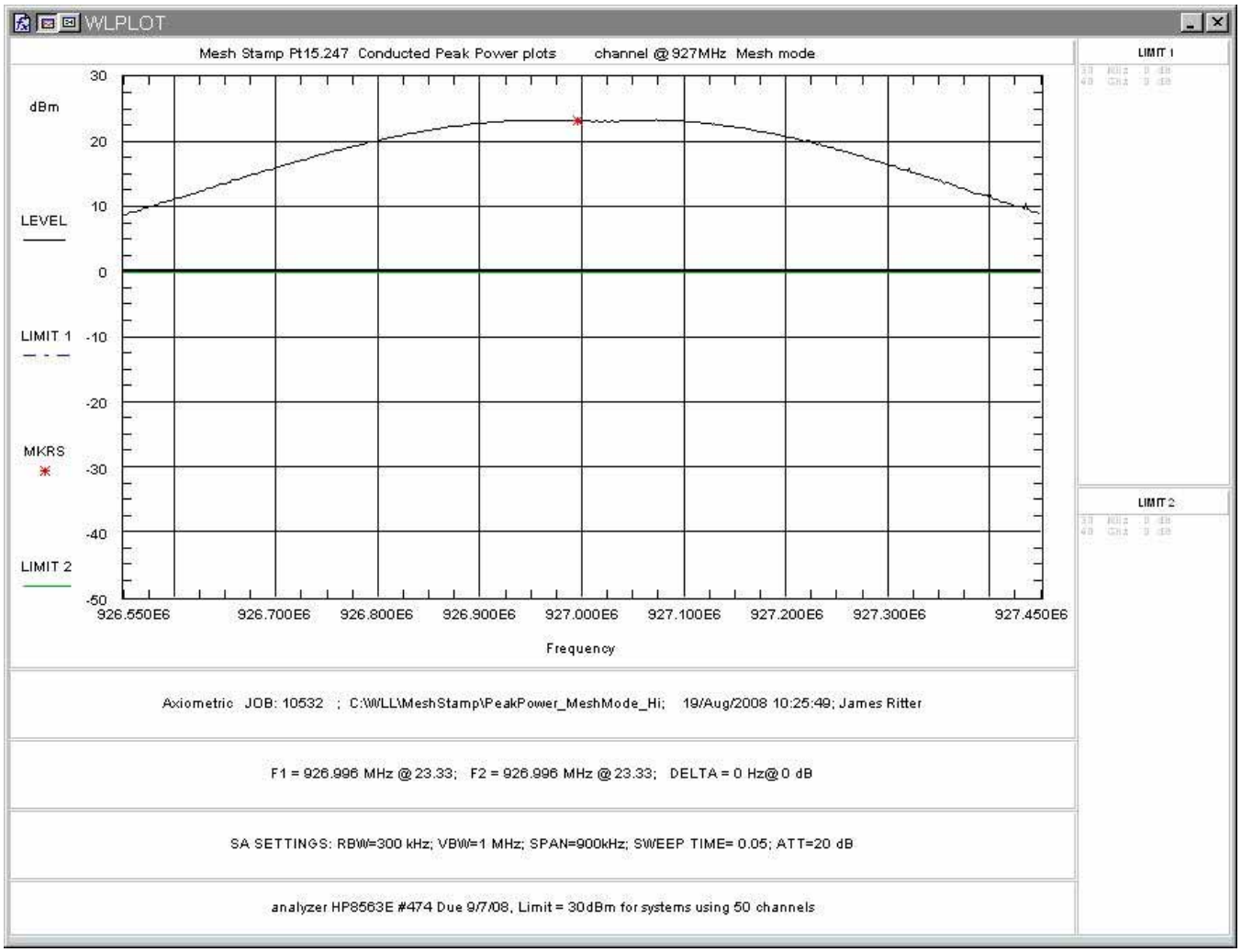

Figure 7. RF Peak Power, Mesh Mode, High Channel

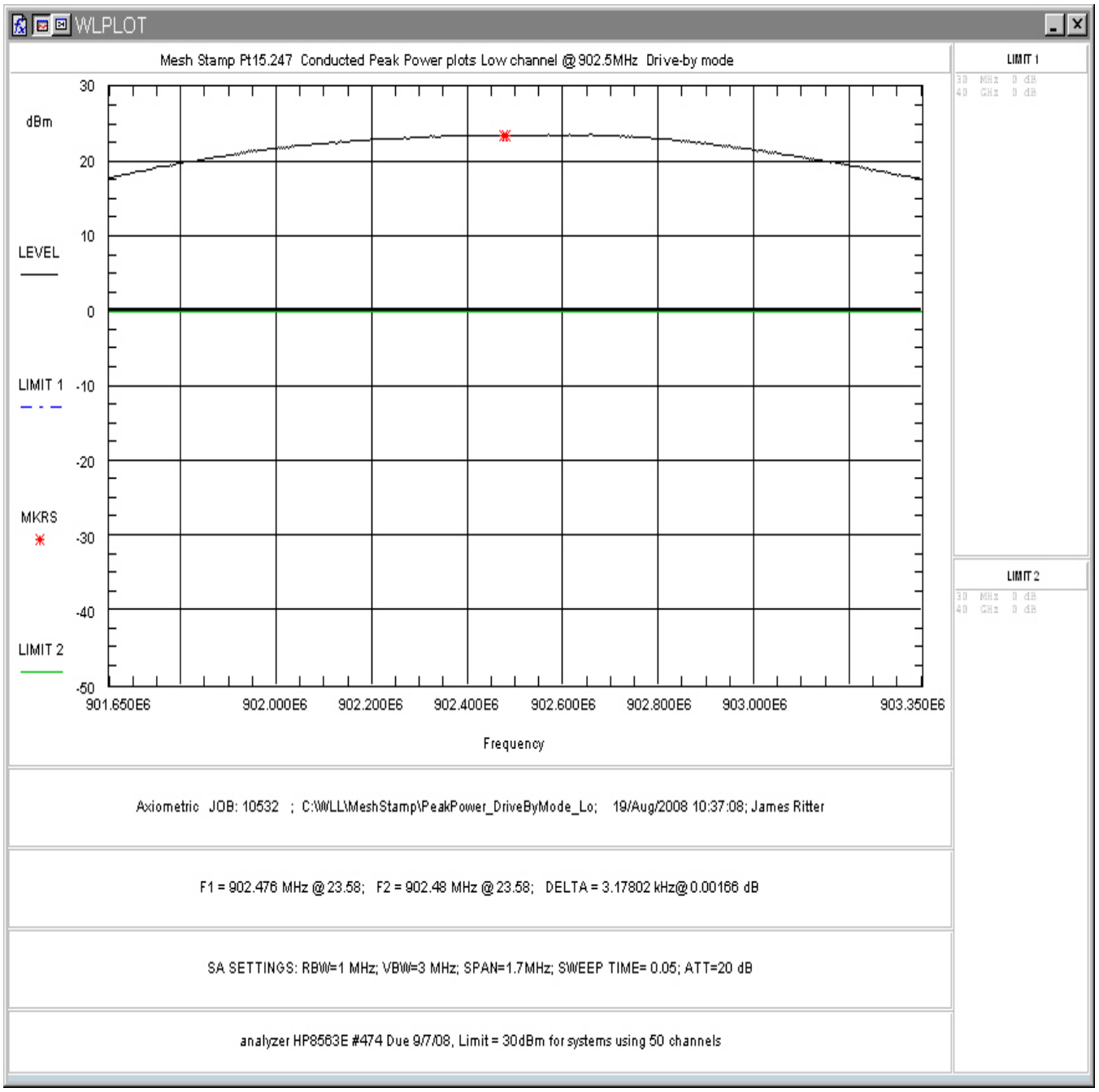

Figure 8. RF Peak Power, Drive-by Mode, Low Channel

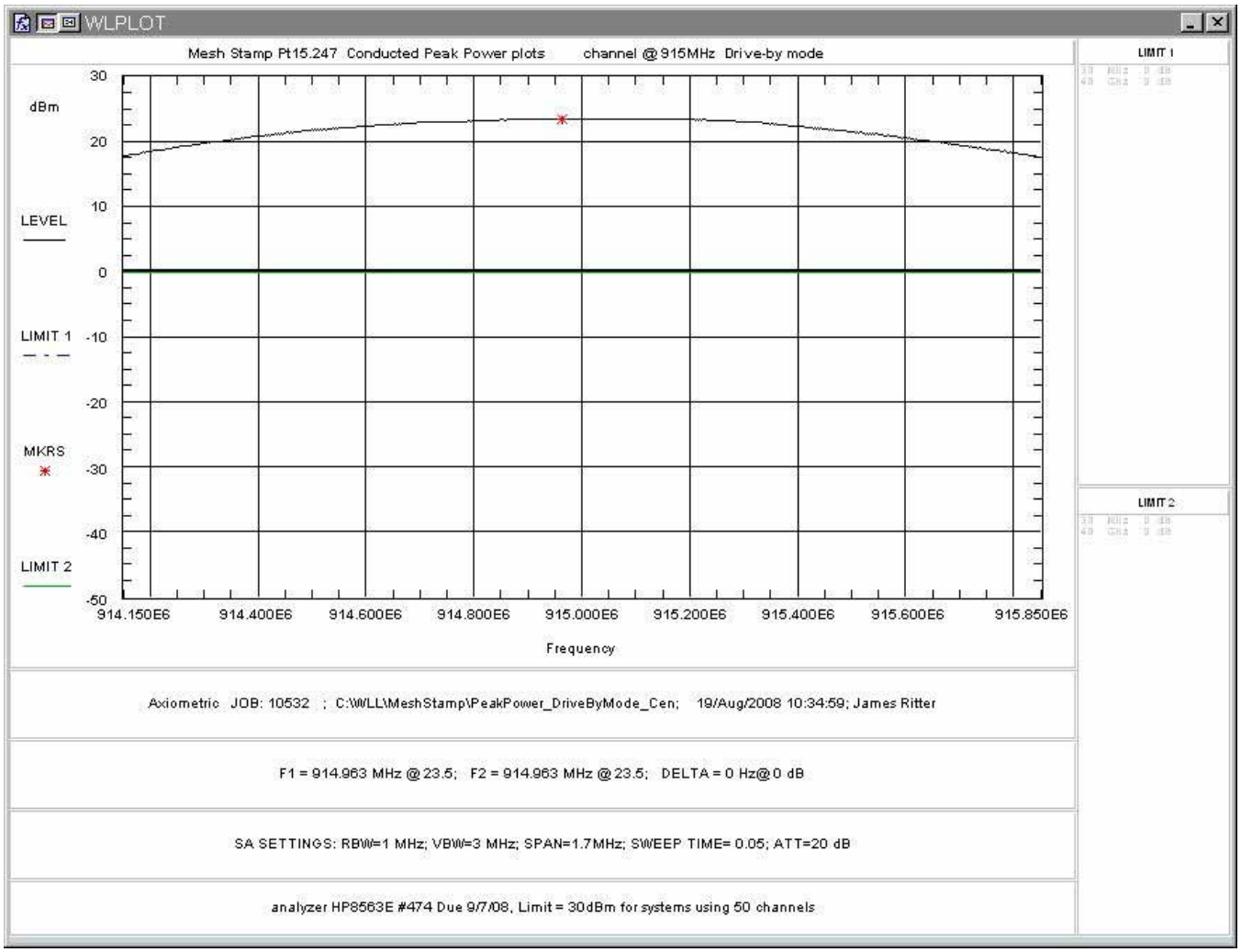

Figure 9. RF Peak Power, Drive-by Mode, Center Channel

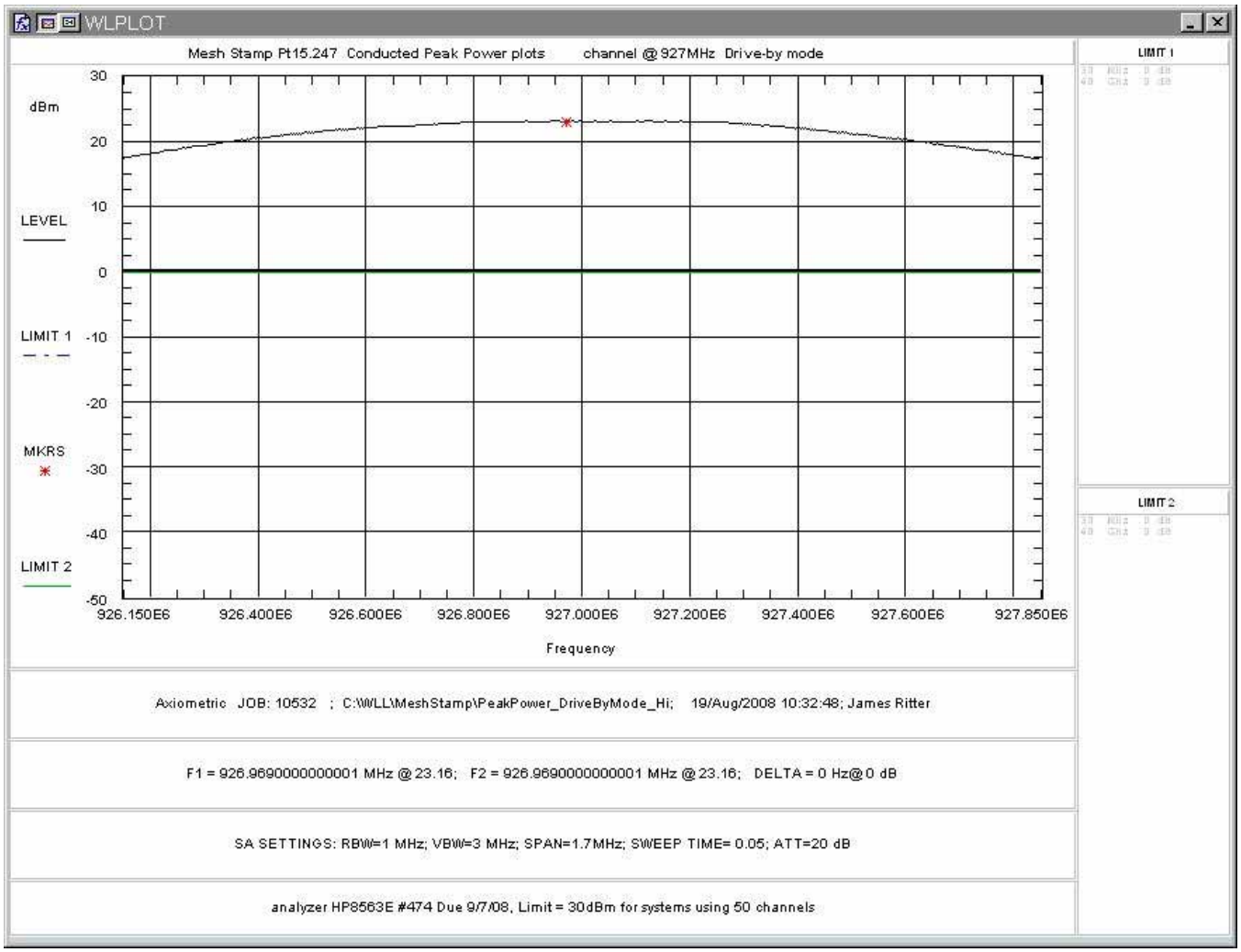

Figure 10. RF Peak Power, Drive-by Mode, High Channel

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 500 kHz.

Two modes of operation were available: a narrow bandwidth ‘Mesh Mode’ and a wider bandwidth ‘Drive-by’ mode, the occupied bandwidth was measured as shown:

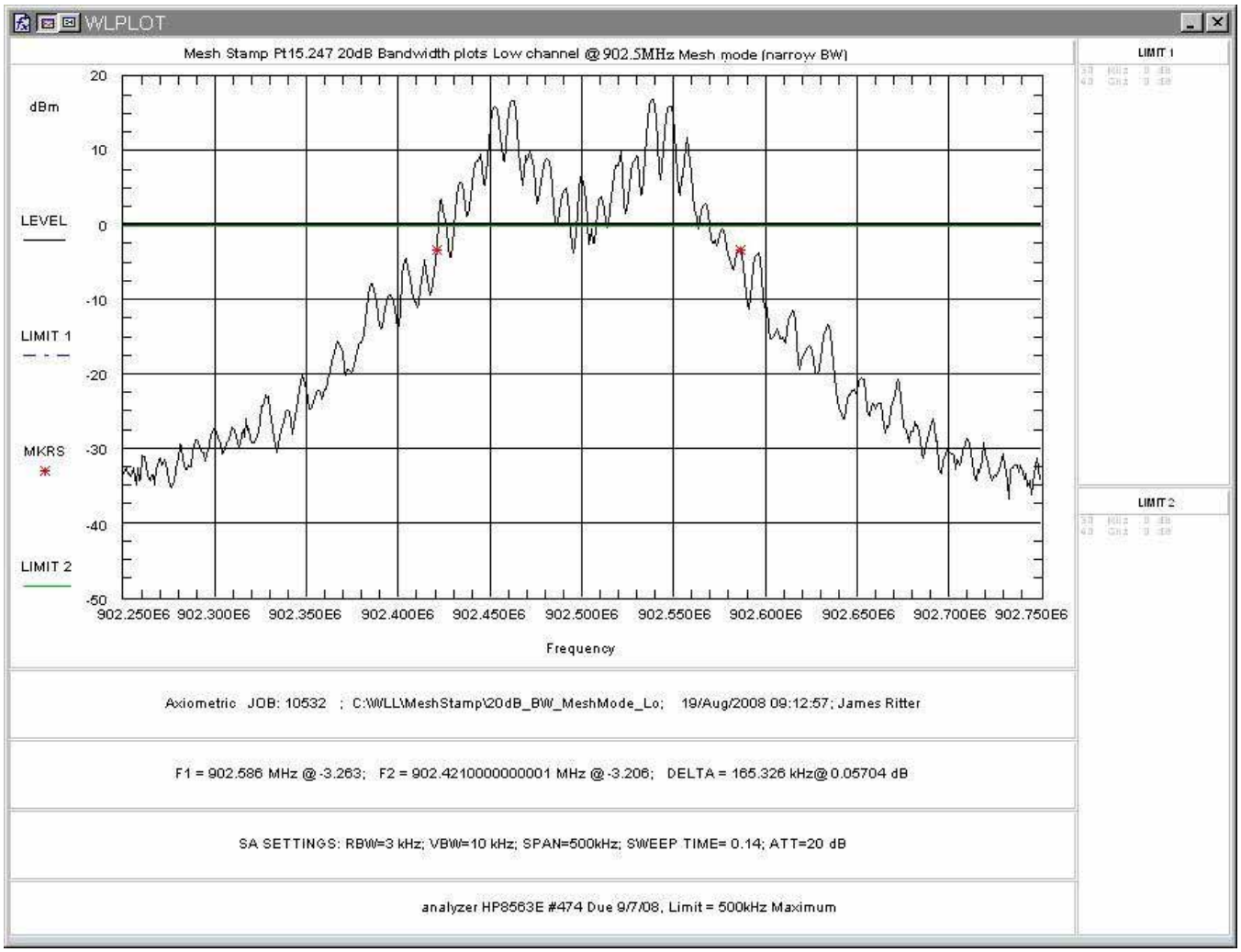

Figure 11. Occupied Bandwidth, Mesh Mode, Low Channel

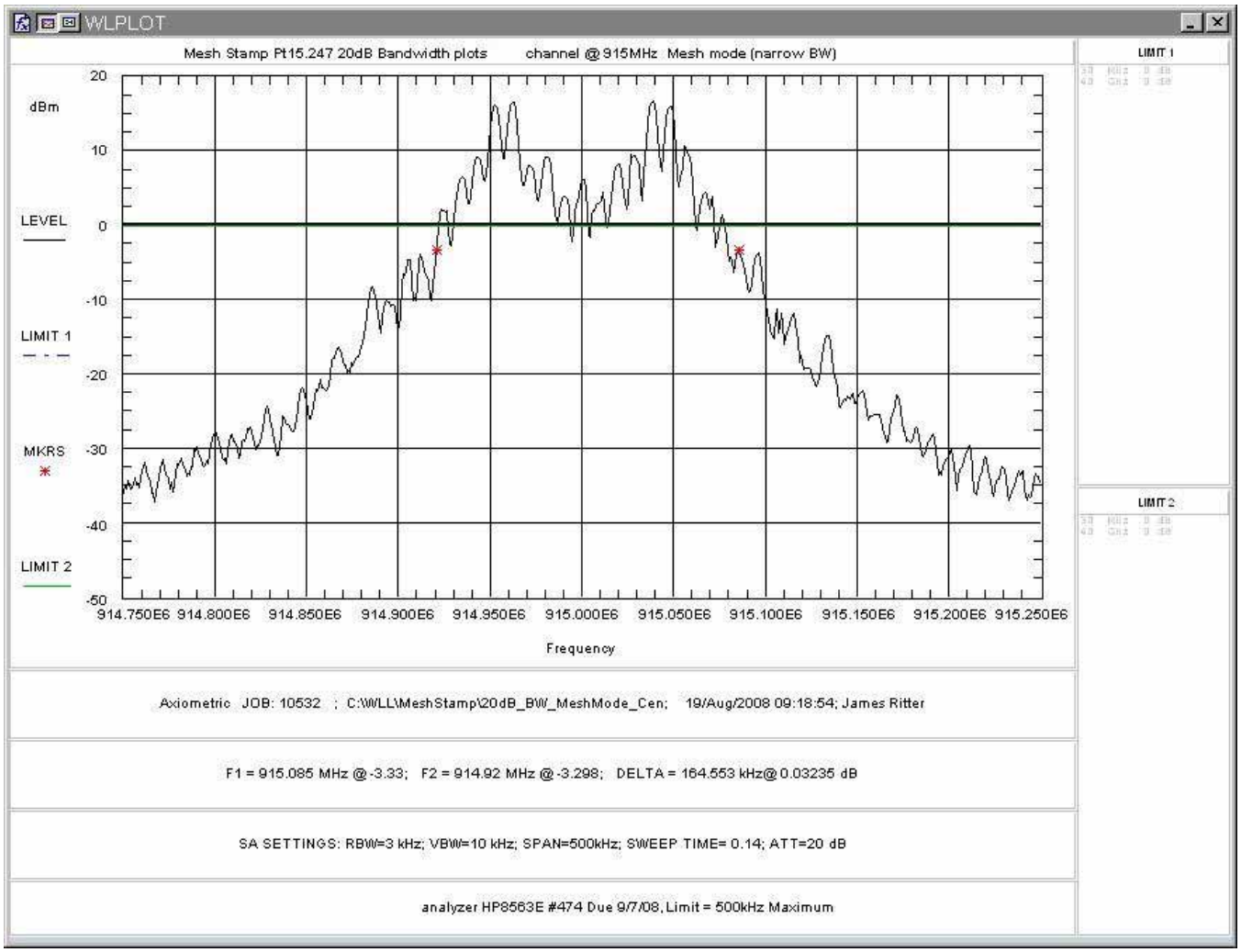

Figure 12. Occupied Bandwidth, Mesh Mode, Center Channel

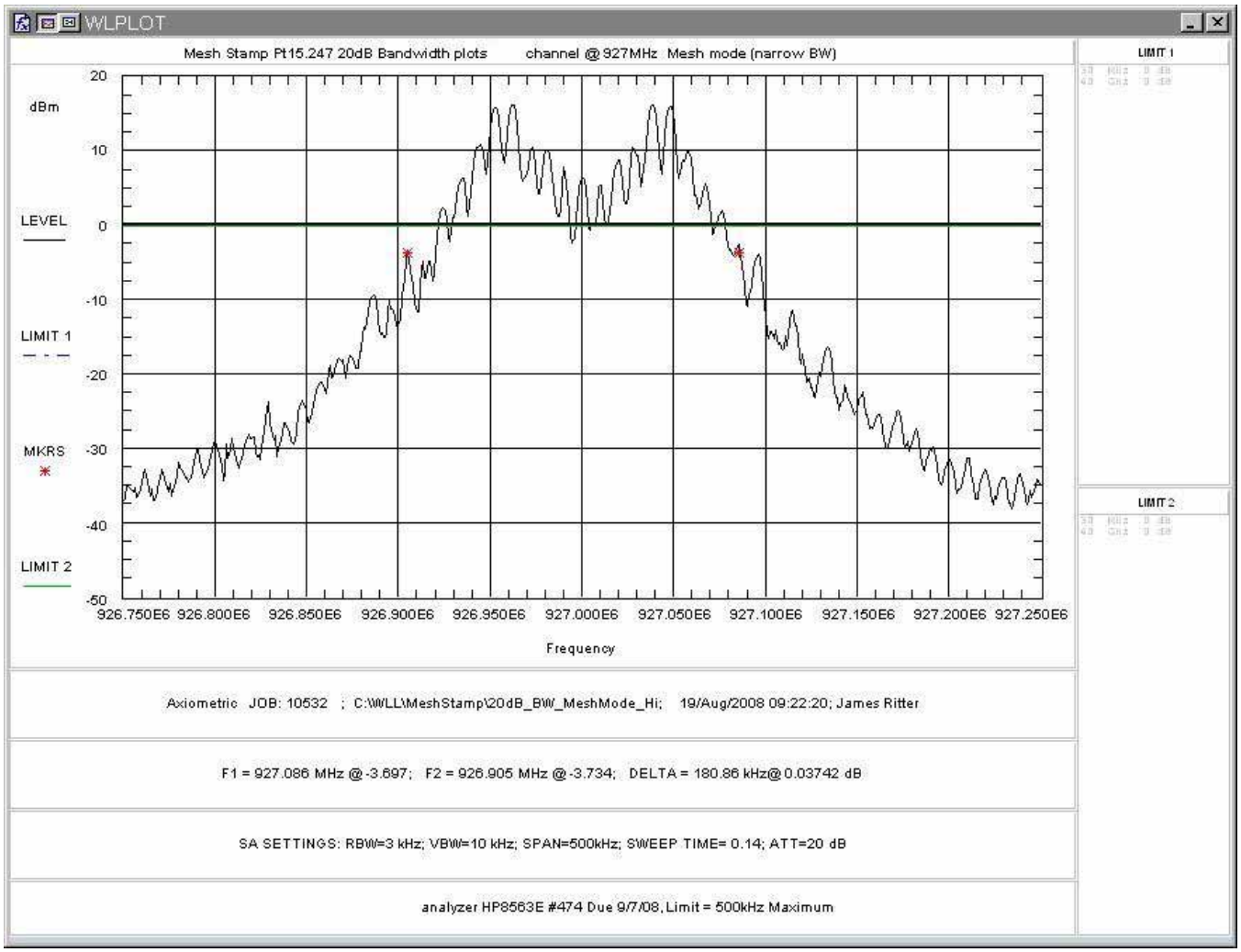

Figure 13. Occupied Bandwidth, Mesh Mode, High Channel

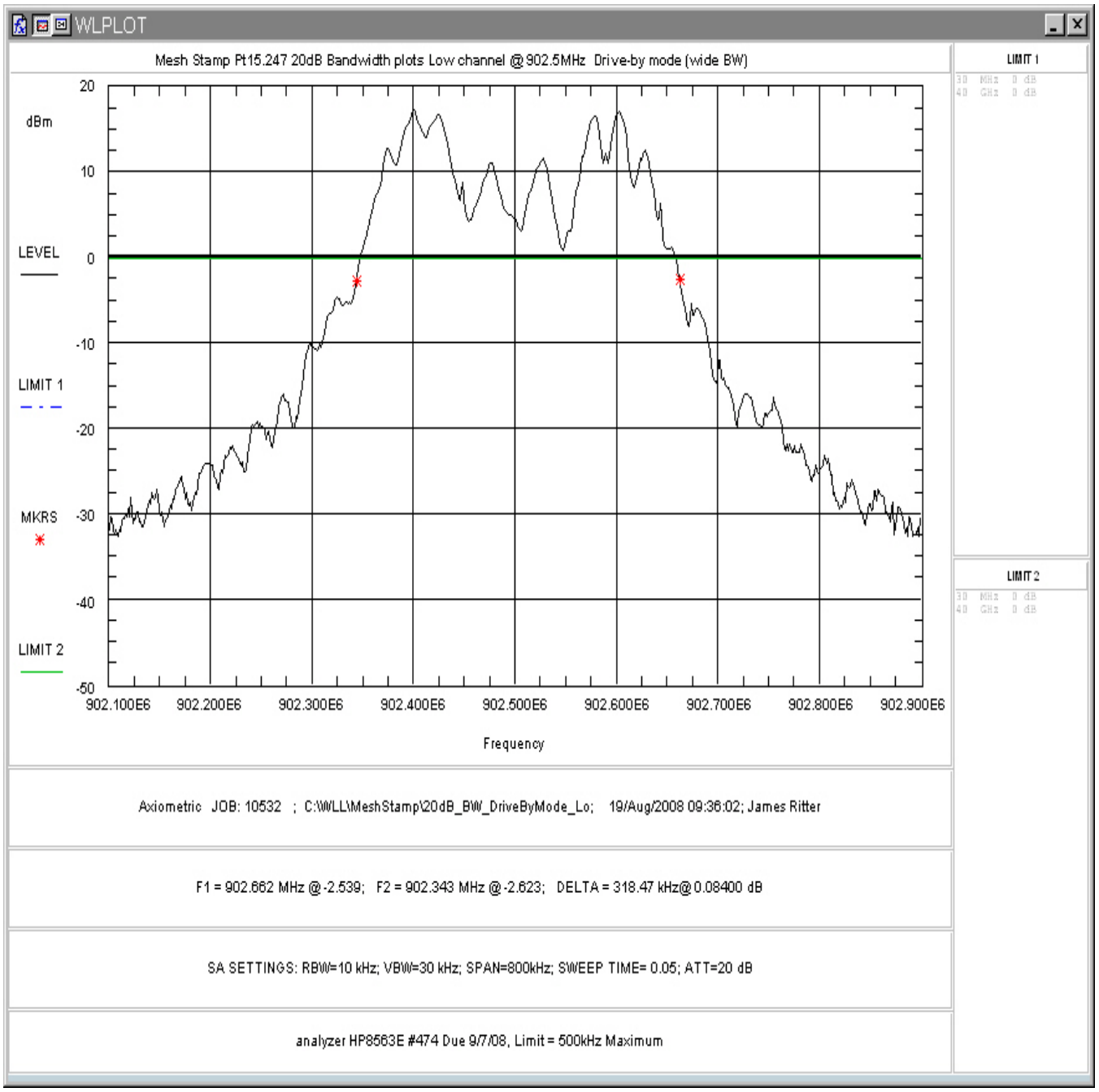

Figure 14. Occupied Bandwidth, Drive-by Mode, Low Channel

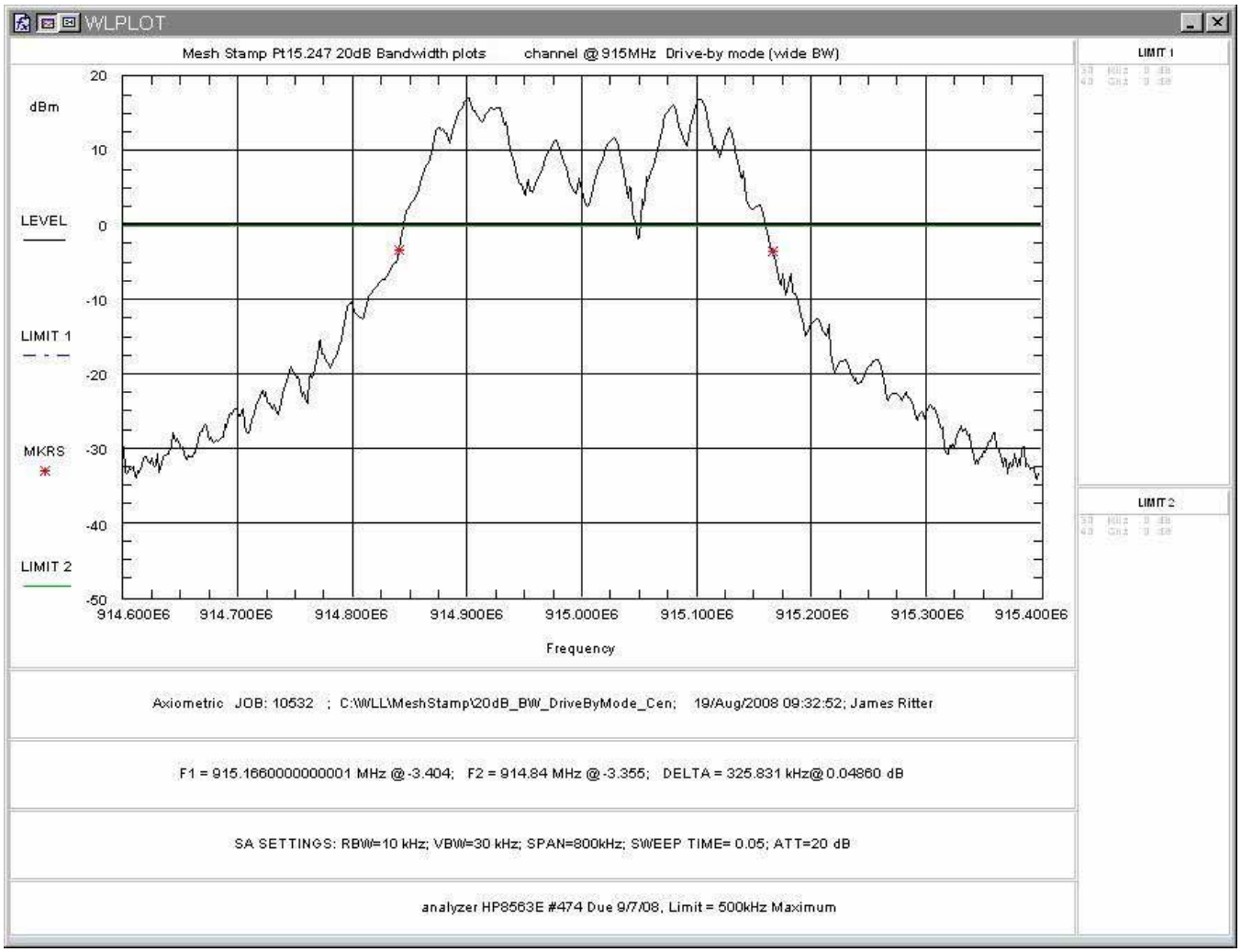

Figure 15. Occupied Bandwidth, Drive-by Mode, Center Channel

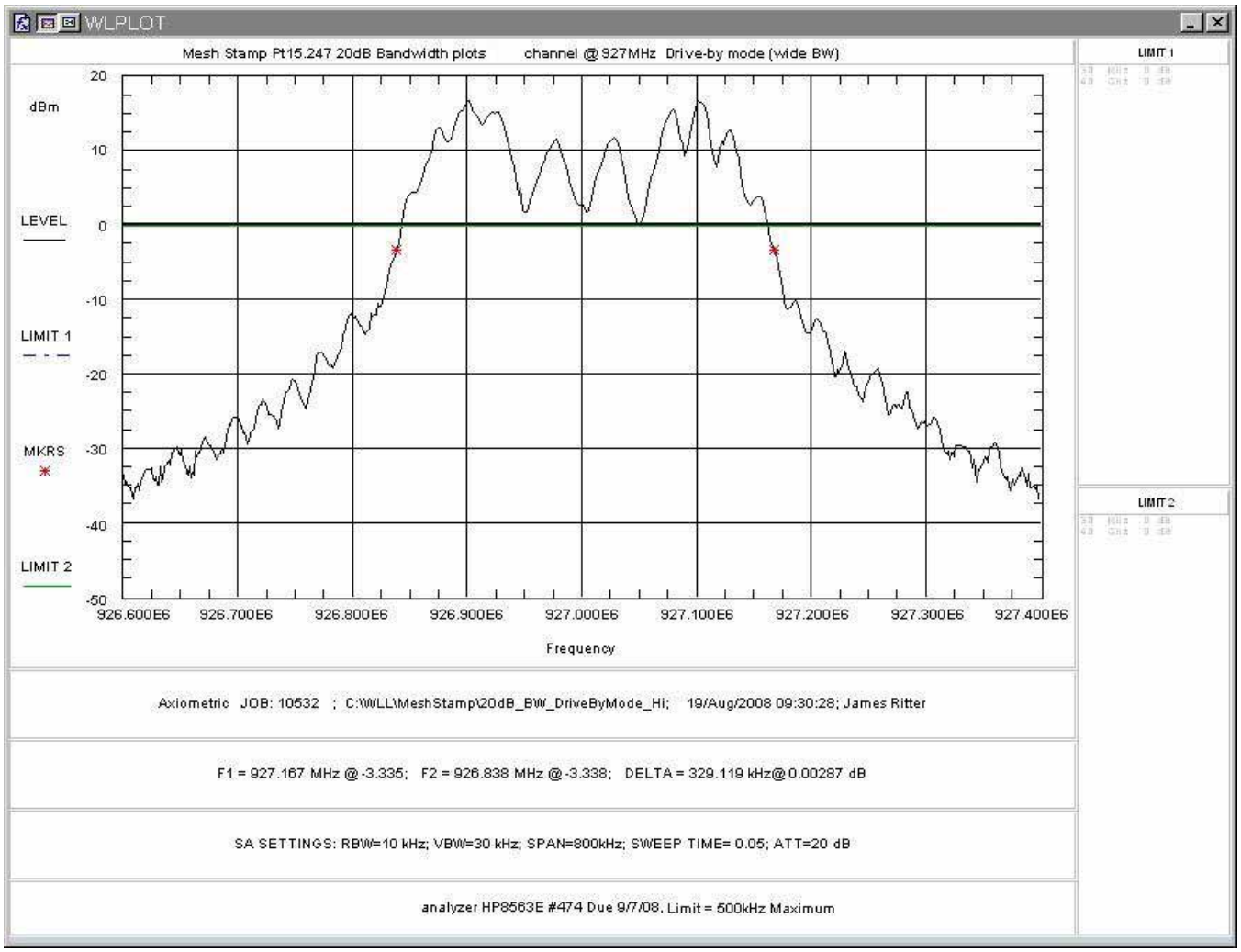

Figure 16. Occupied Bandwidth, Drive-by Mode, High Channel

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Mode Tested	Frequency	Bandwidth	Limit	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	165.33 kHz	500 kHz	Pass
Mesh Mode	Center Channel: 915MHz	164.55 kHz	500 kHz	Pass
Mesh Mode	High Channel: 927MHz	180.86 kHz	500 kHz	Pass
Drive-by Mode	Low Channel: 902.5MHz	318.47 kHz	500 kHz	Pass
Drive-by Mode	Center Channel: 915MHz	325.83 kHz	500 kHz	Pass
Drive-by mode	High Channel: 927MHz	329.12kHz	500 kHz	Pass

5.4 Carrier Frequency Separation 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 180.86 kHz so the channel spacing must be more than 180.86 kHz for mesh mode and 329.12 kHz for drive-by mode. In addition, the number of hopping channels be 50 or more for a system with an occupied bandwidth greater than 250kHz.

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 greater than 1% of the span and the video bandwidth was set greater than the RBW. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 2.3MHz. Also, the number of hopping channels was measured from 902 to 928MHz (to encompass the passband).

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 500kHz in both Mesh and Drive-by Modes and the number of channels used is 50 in both modes.

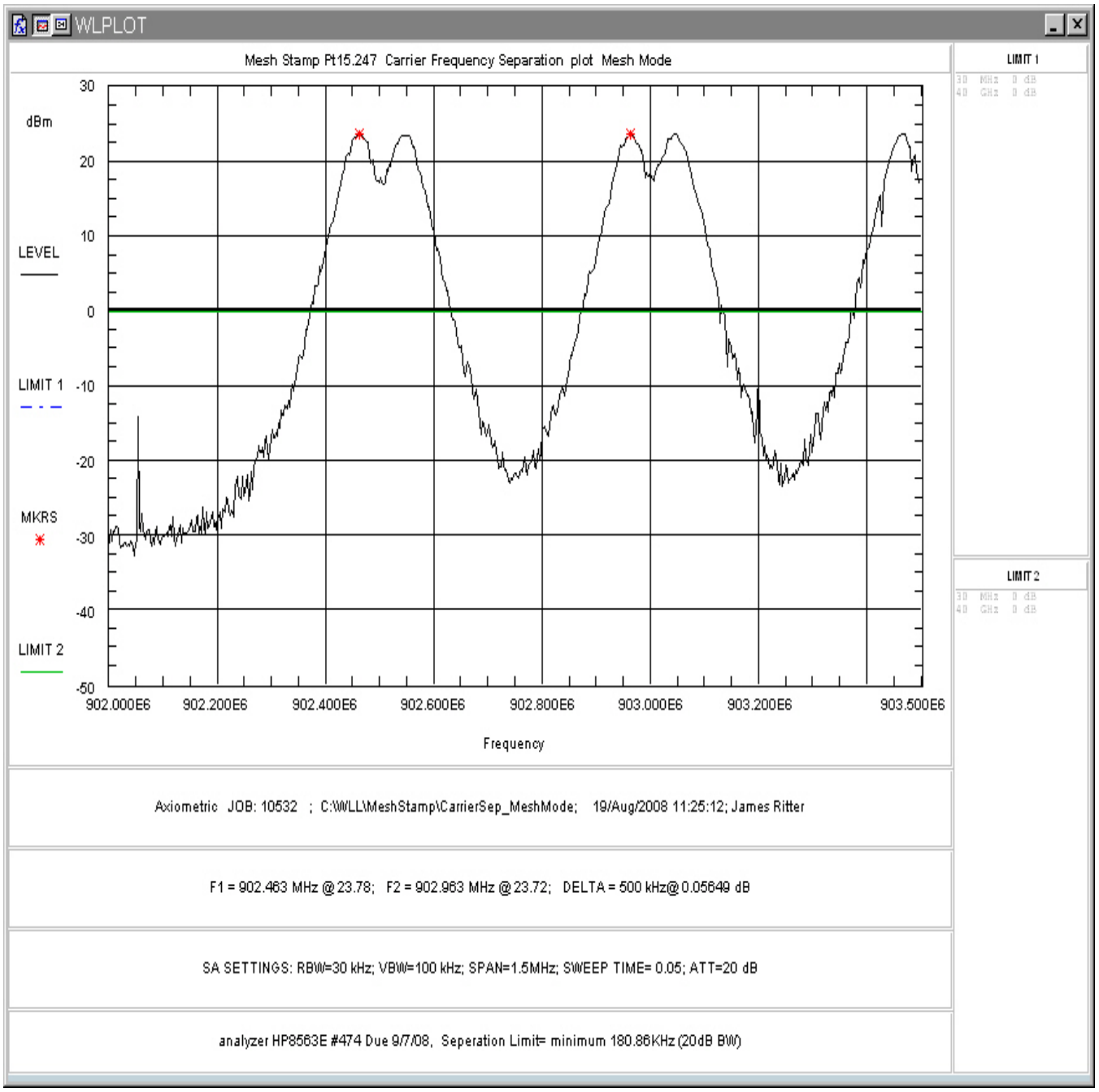

Figure 17, Channel Spacing, Mesh Mode

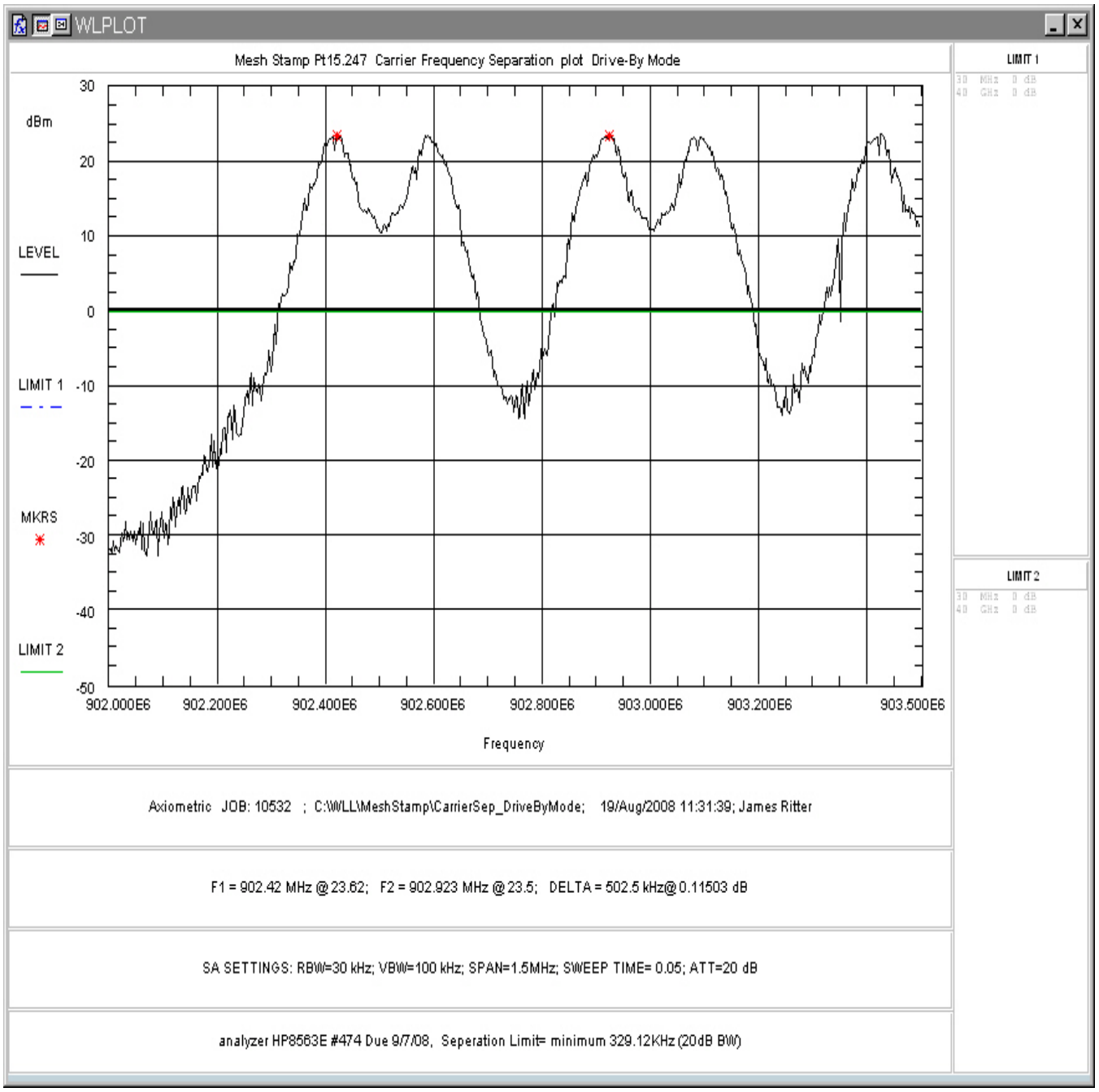

Figure 18, Channel Spacing, Drive-by Mode

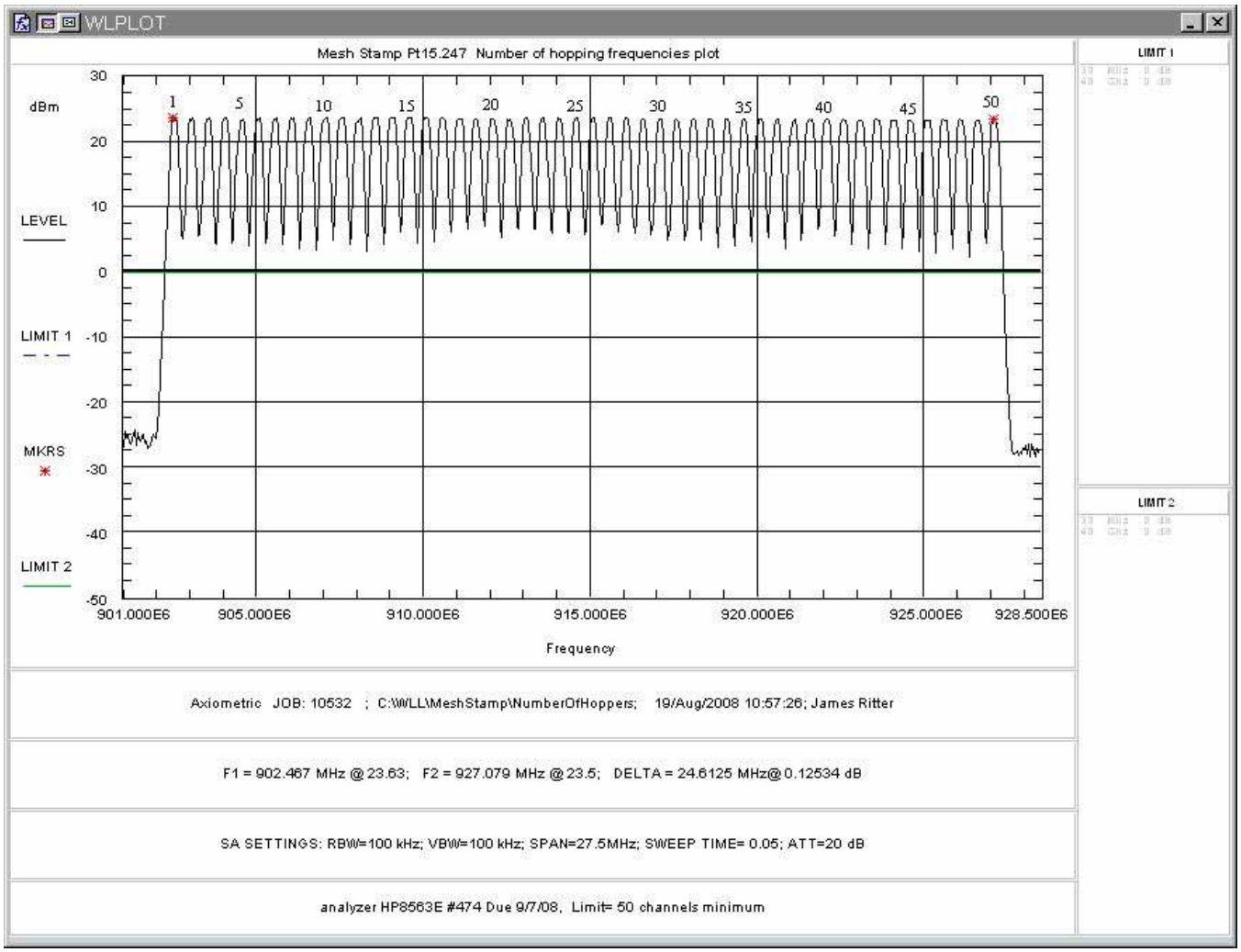

Figure 19, Number of Channels

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

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

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 30 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.

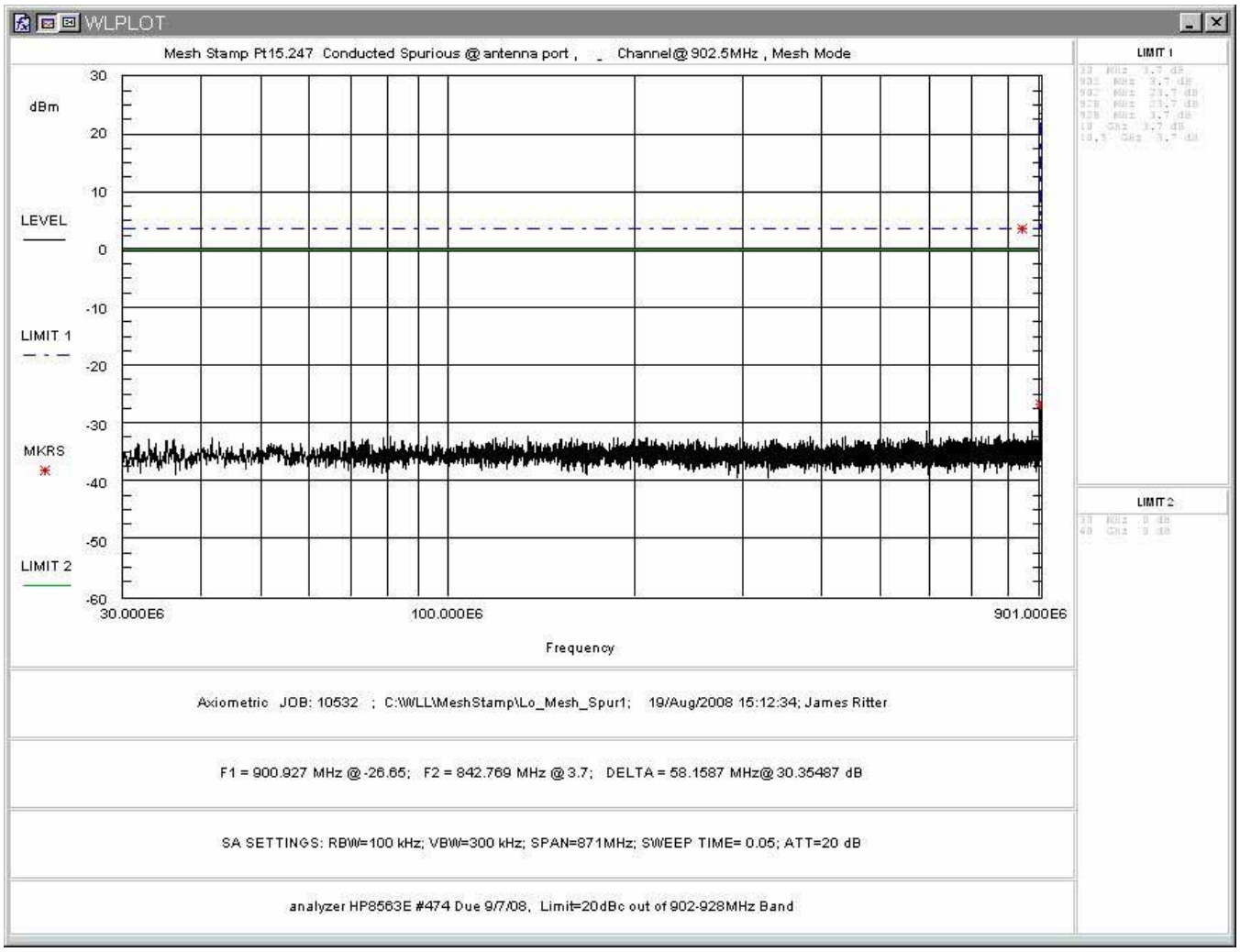

Figure 20. Conducted Spurious Emissions, Mesh Mode, Low Channel 30 - 901MHz

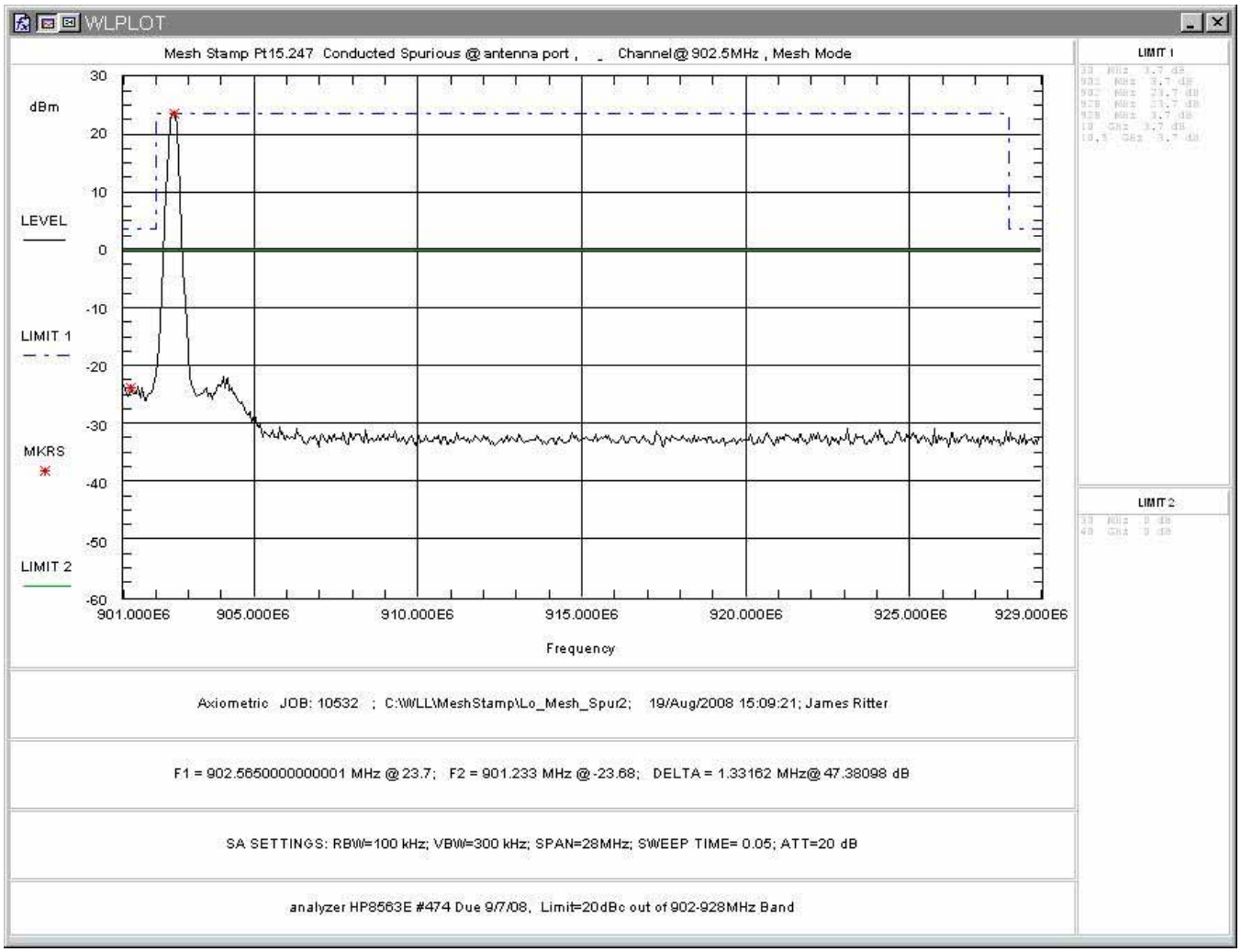

Figure 21. Conducted Spurious Emissions, Mesh Mode, Low Channel 901 – 929MHz

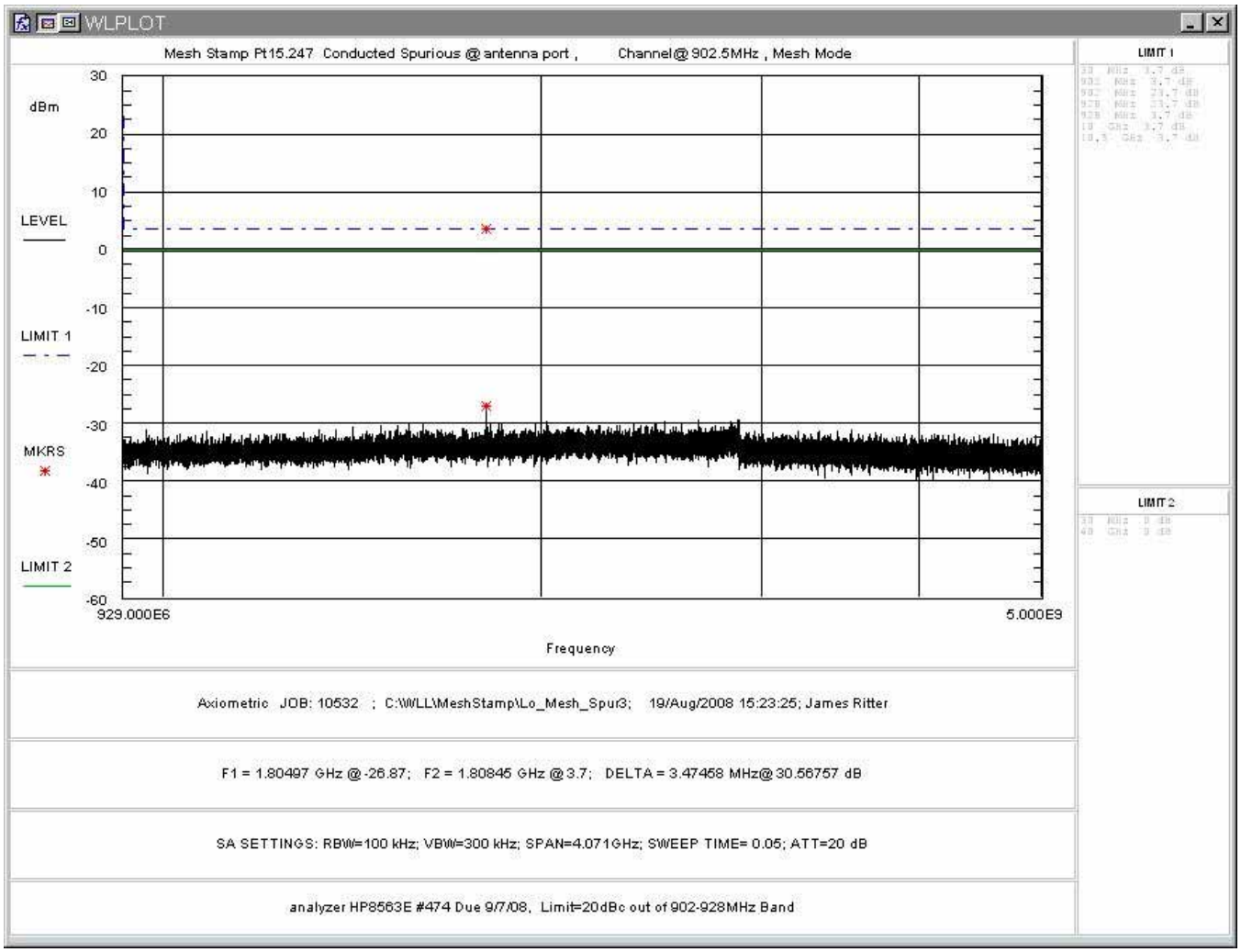

Figure 22. Conducted Spurious Emissions, Mesh Mode, Low Channel 929-5000MHz

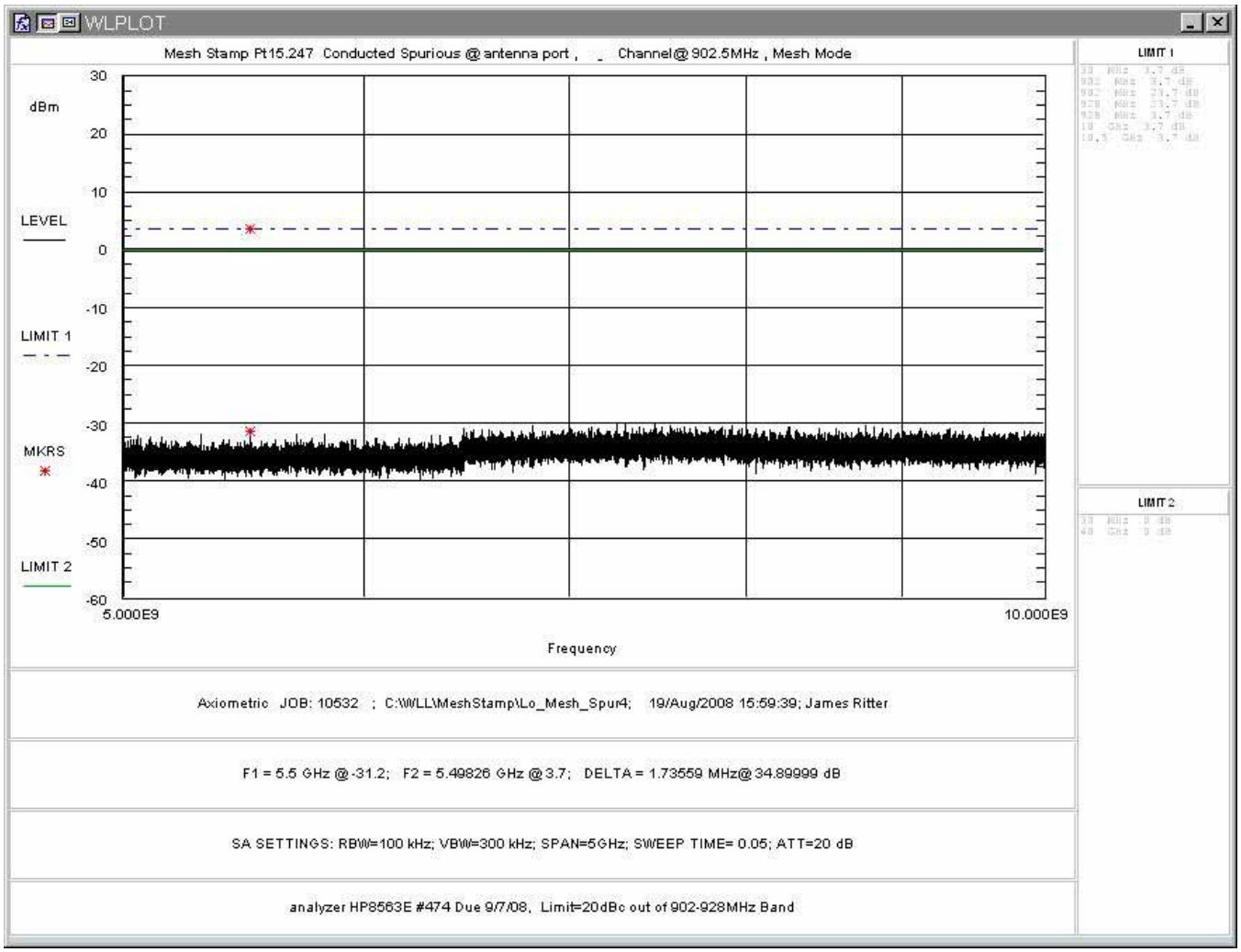

Figure 23. Conducted Spurious Emissions, Mesh Mode, Low Channel 5- 10GHz

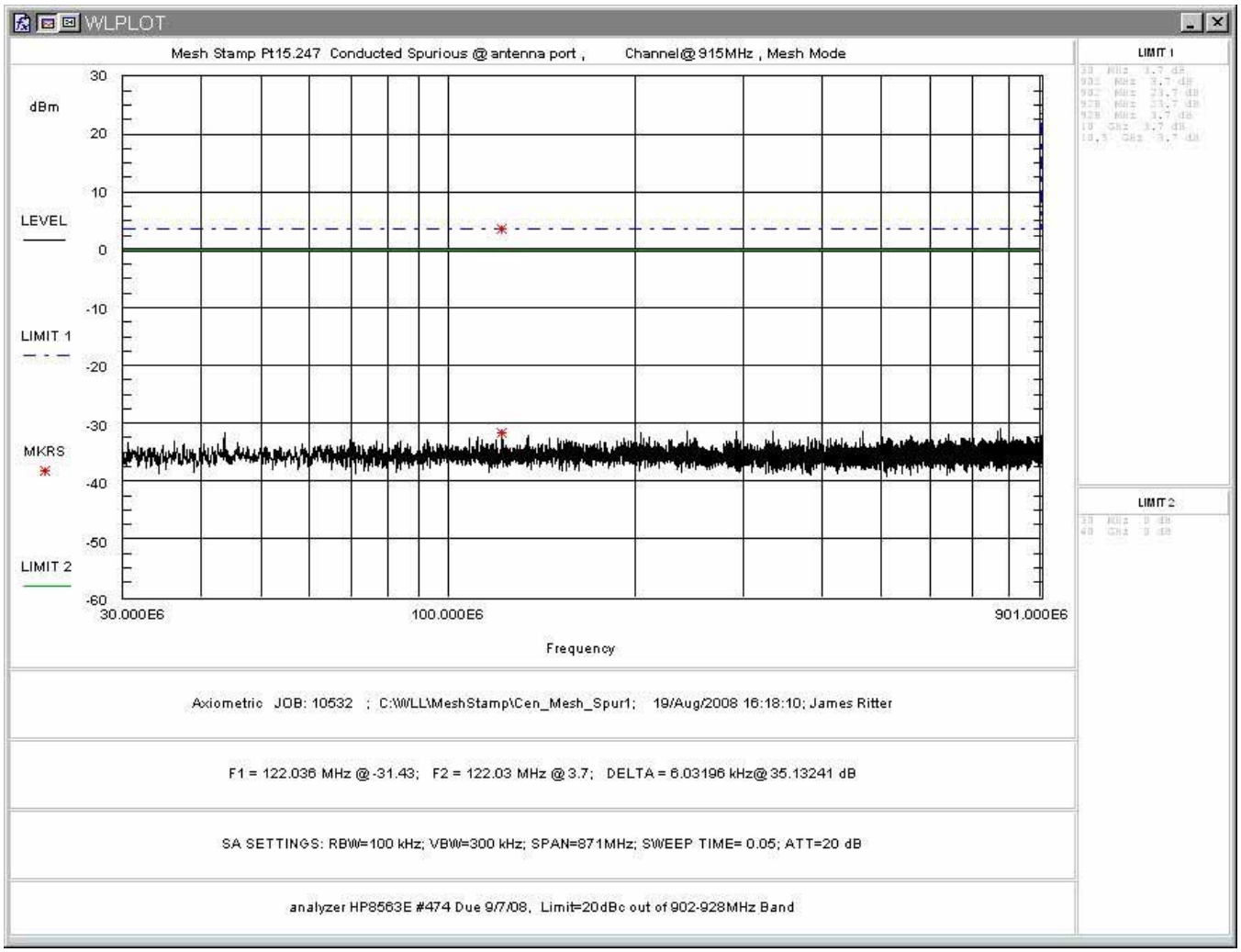

Figure 24. Conducted Spurious Emissions, Mesh Mode, Center Channel 30-901 MHz

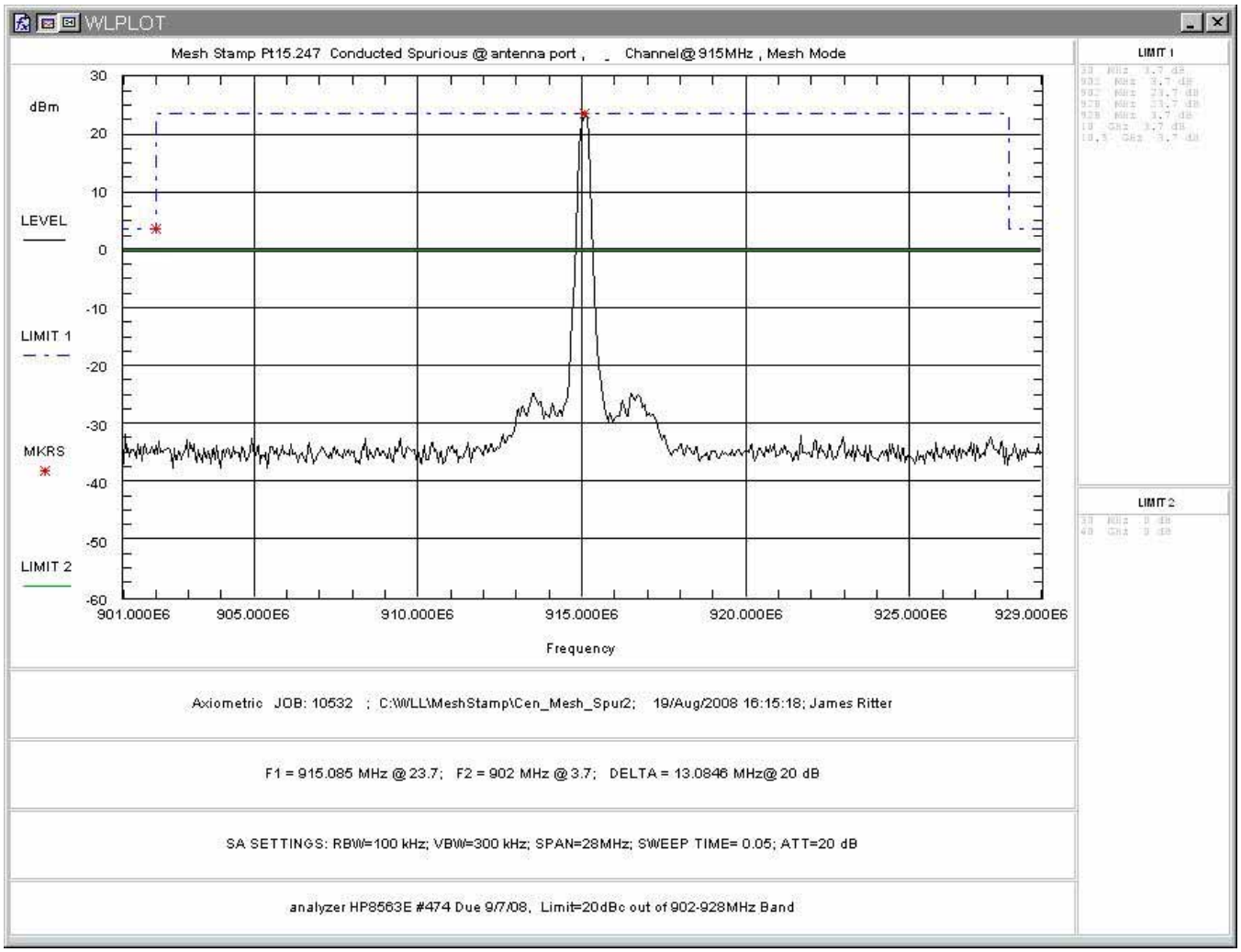

Figure 25. Conducted Spurious Emissions, Mesh Mode, Center Channel 901-929 MHz

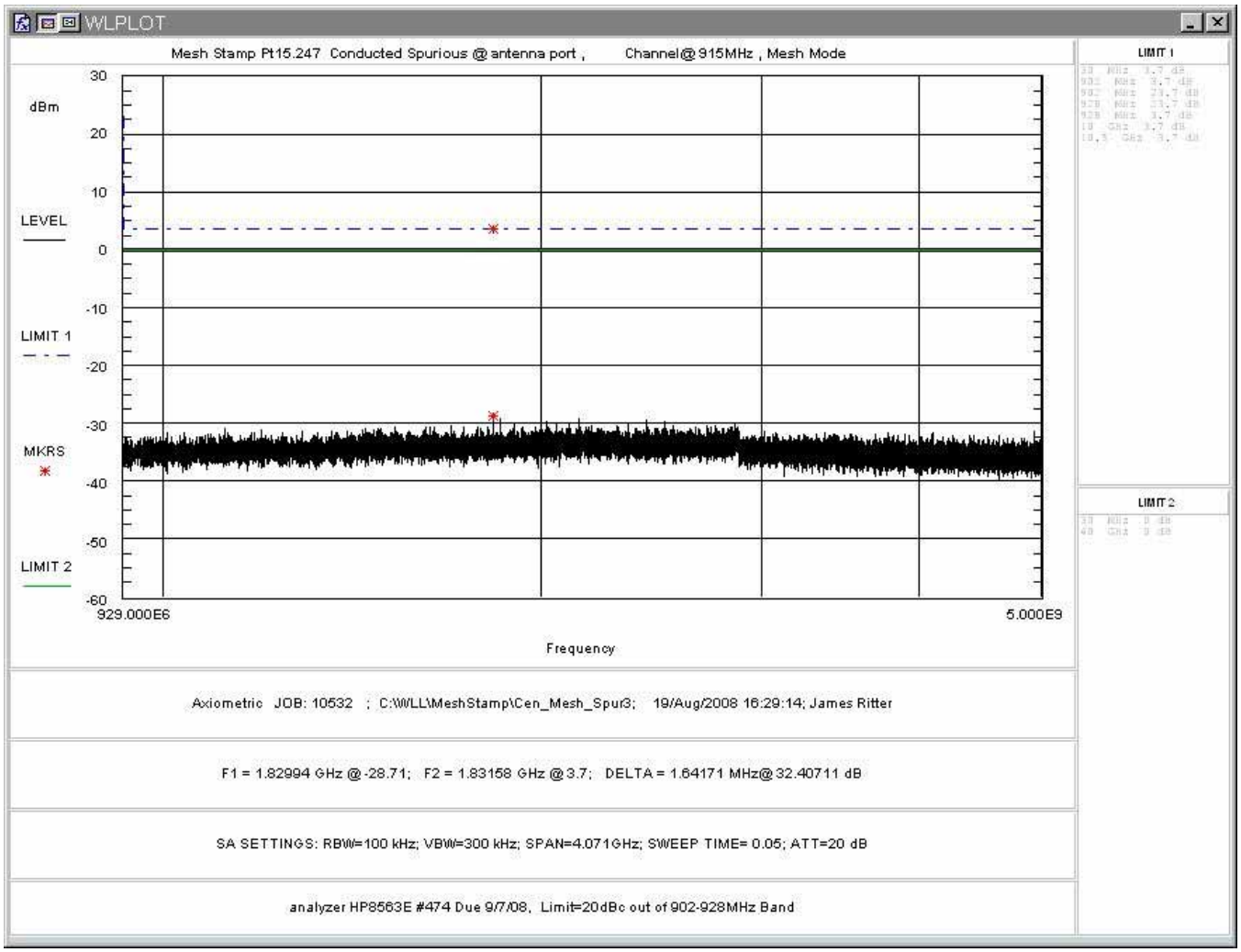

Figure 26. Conducted Spurious Emissions, Mesh Mode, Center Channel 929 -5000MHz

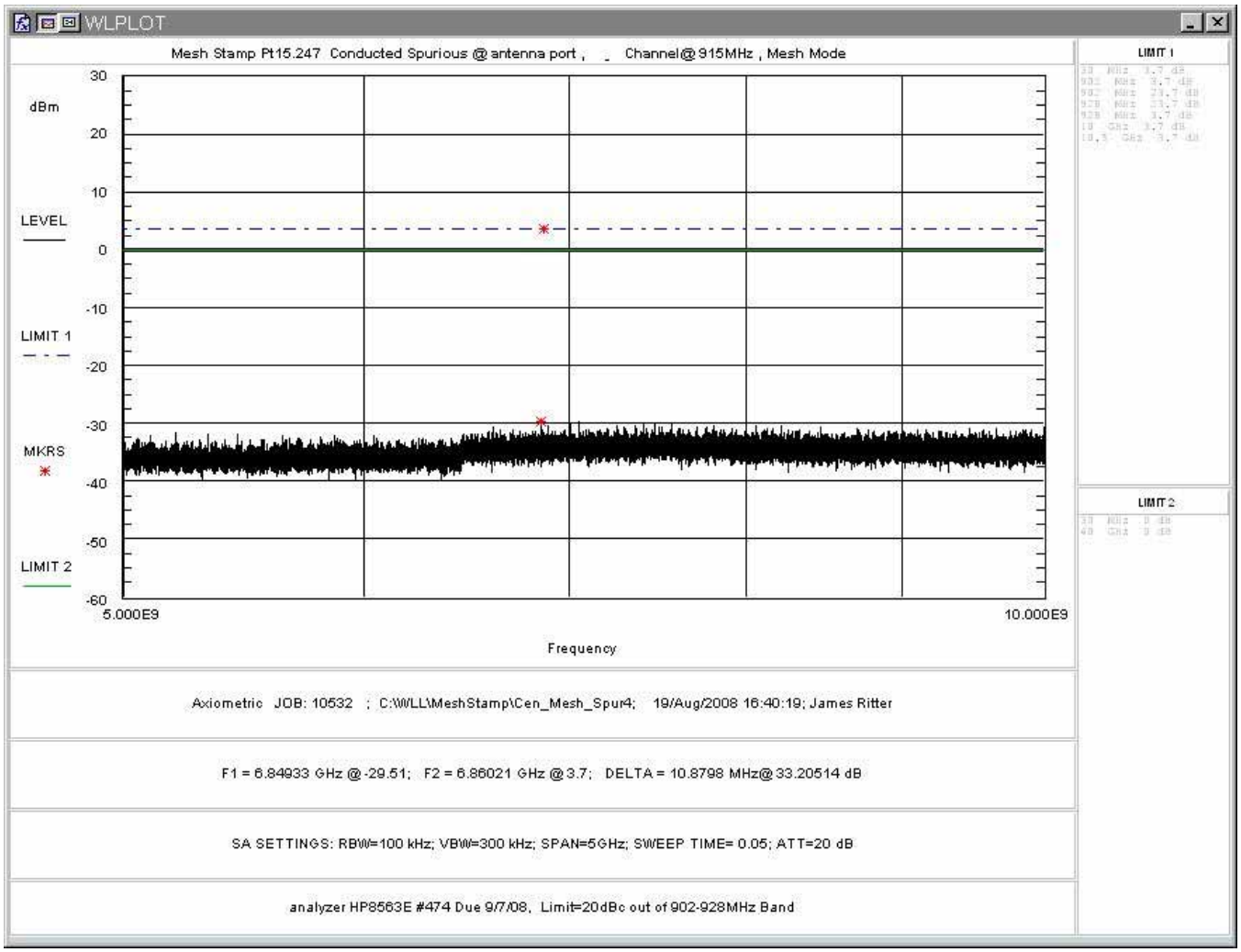

Figure 27. Conducted Spurious Emissions, Mesh Mode, Center Channel 5-10GHz

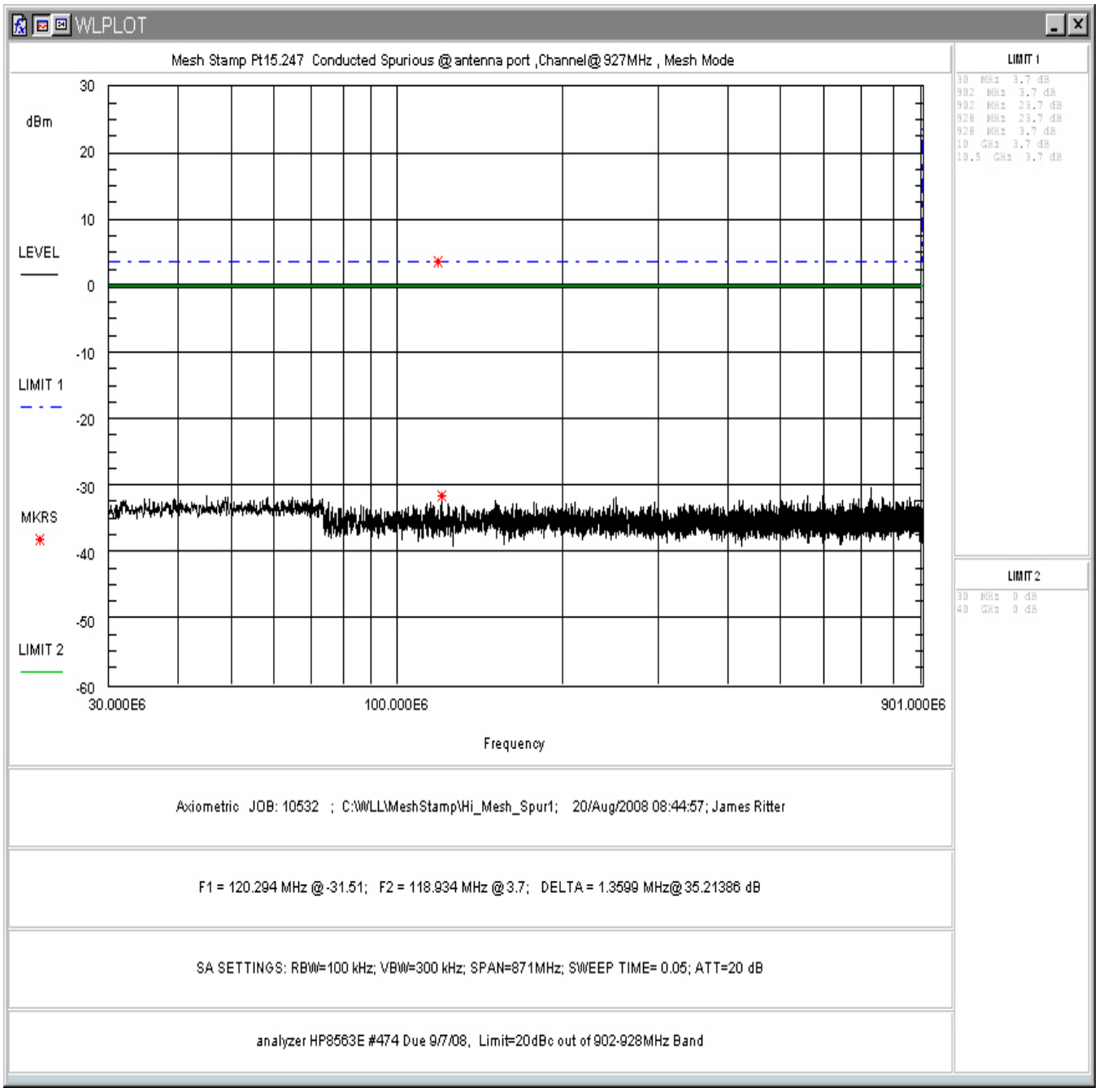

Figure 28. Conducted Spurious Emissions, Mesh Mode, High Channel 30-901MHz

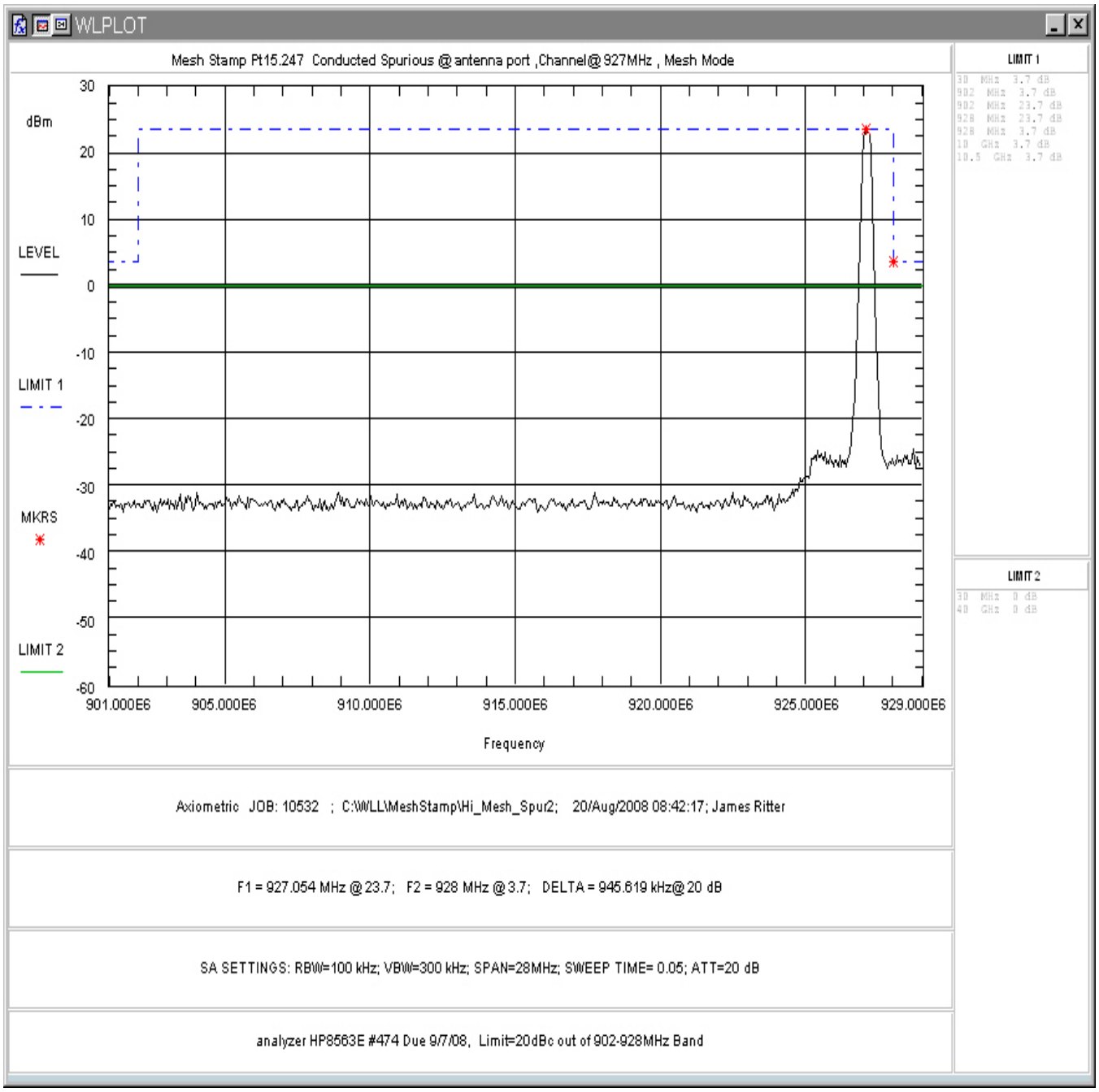

Figure 29. Conducted Spurious Emissions, Mesh Mode, High Channel 901-929MHz

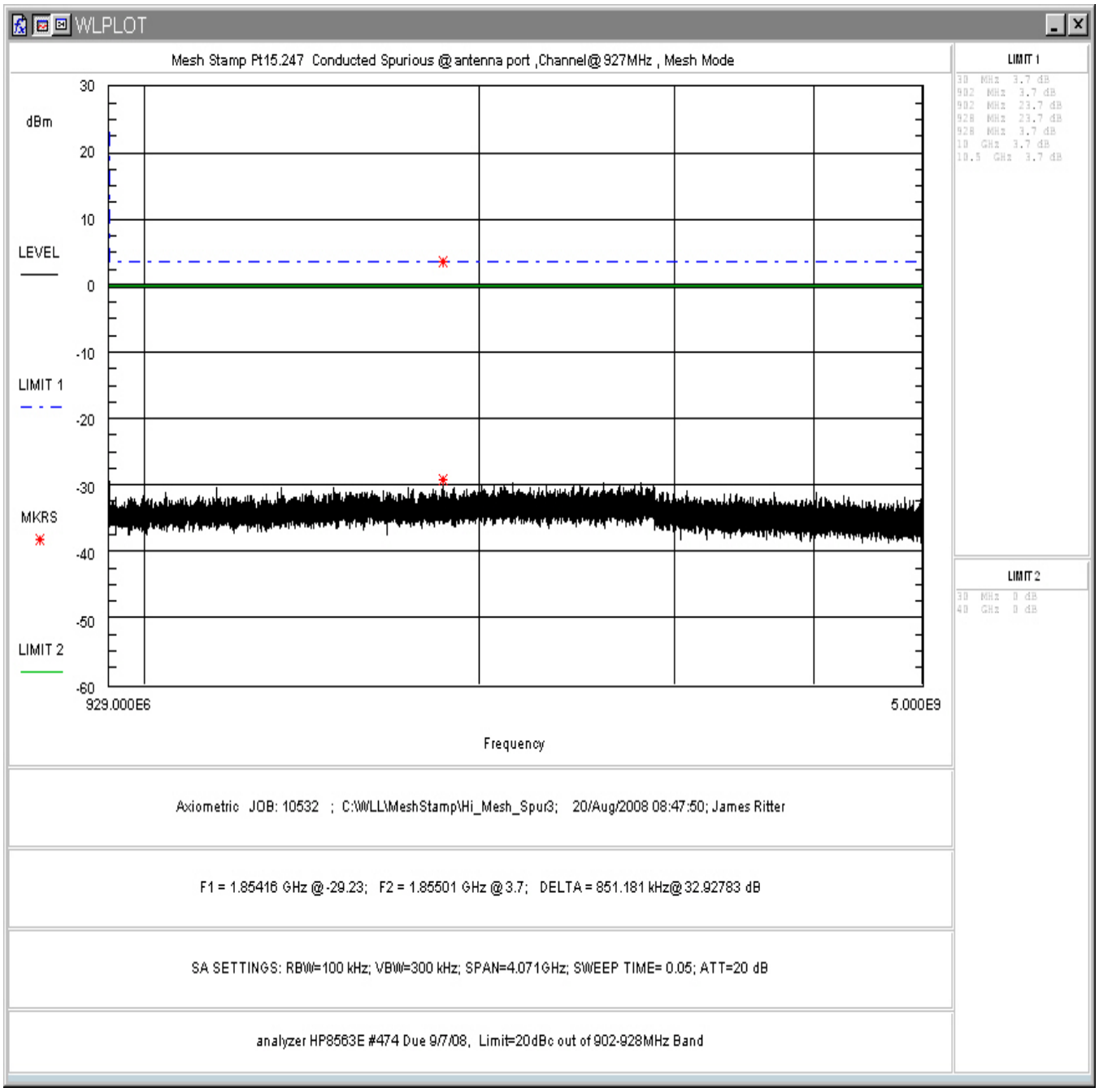

Figure 30. Conducted Spurious Emissions, Mesh Mode, High Channel 929-5000MHz

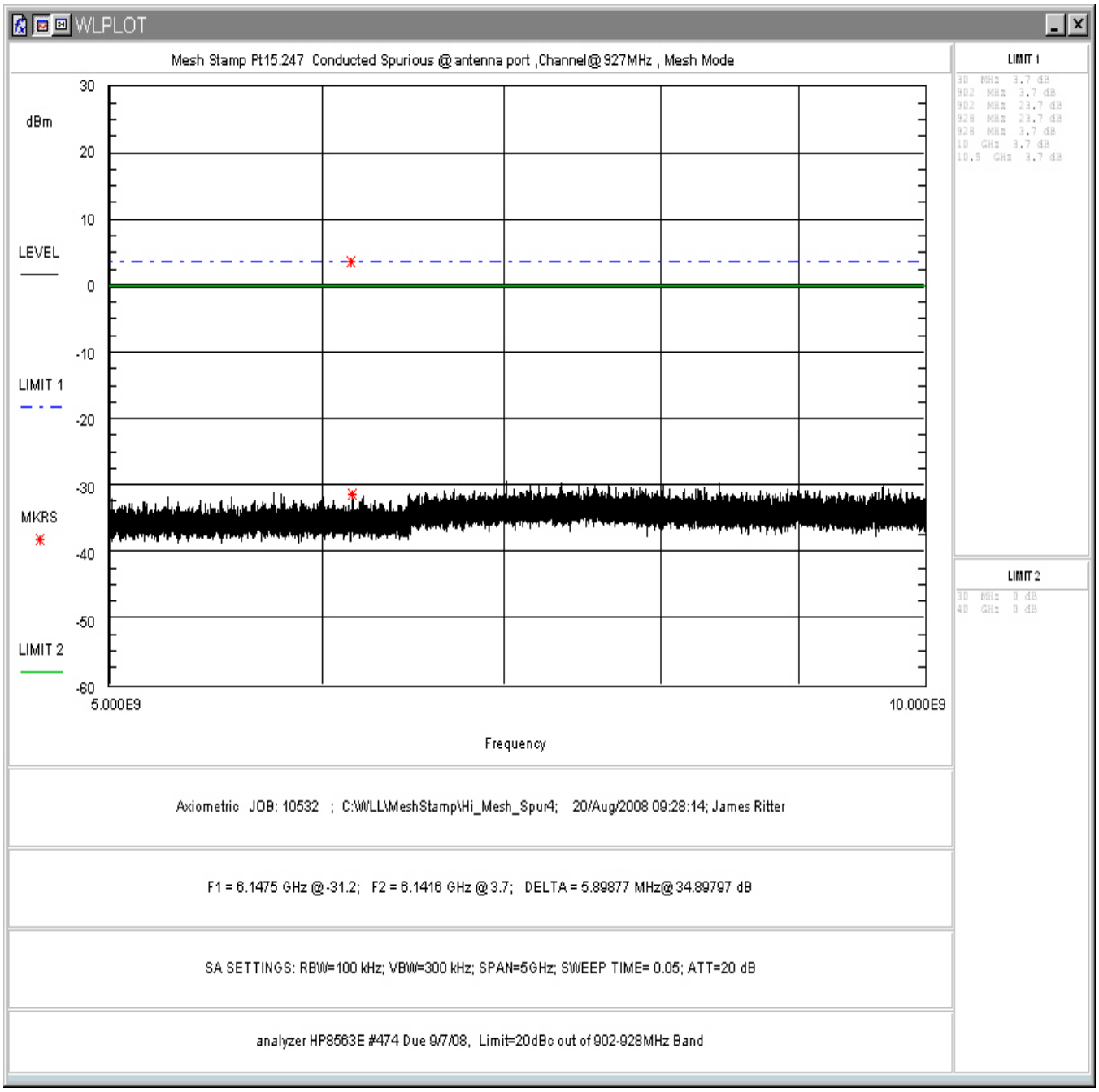

Figure 31. Conducted Spurious Emissions, Mesh Mode, High Channel 5-10GHz

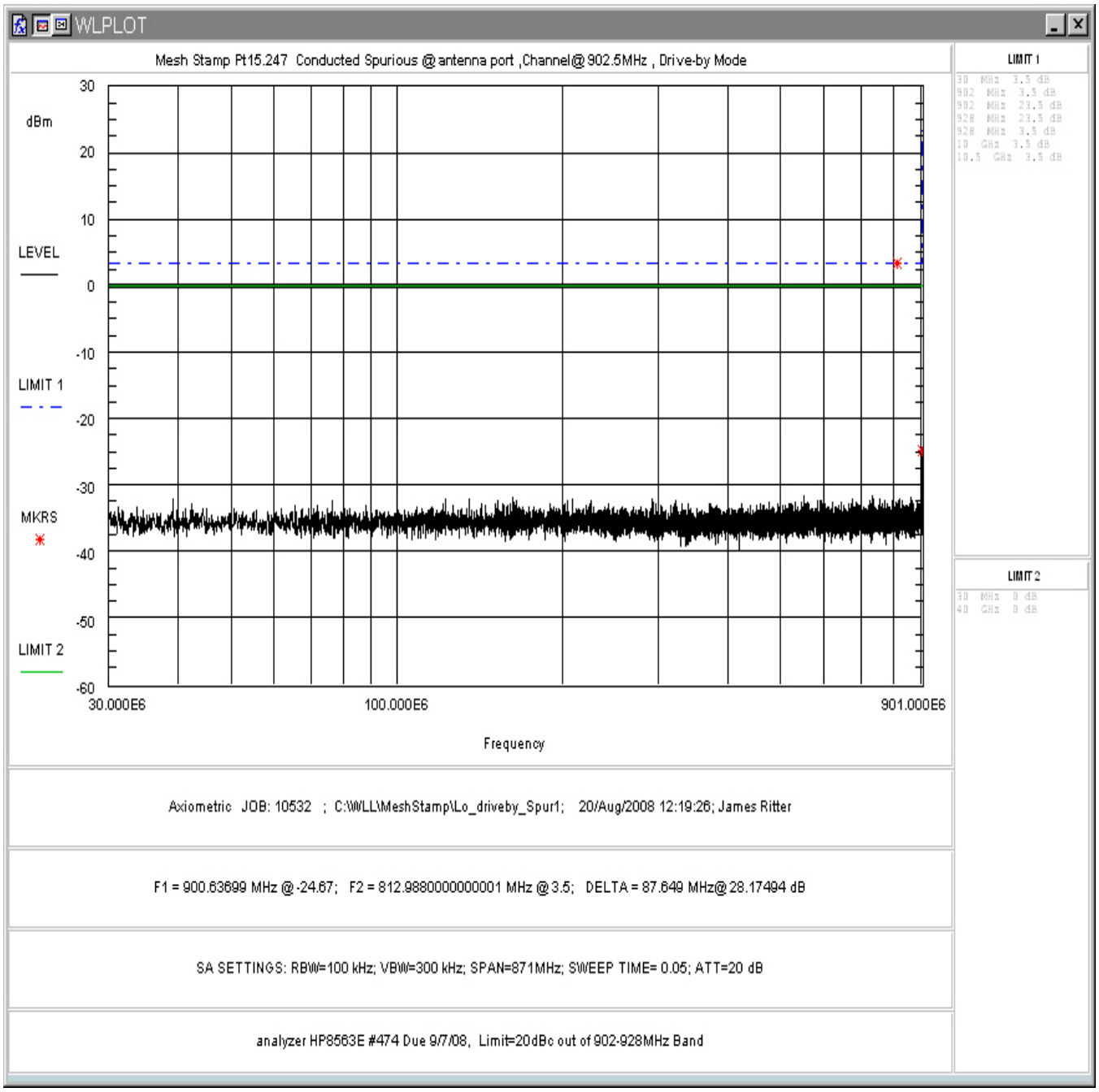

Figure 32. Conducted Spurious Emissions, Drive-by Mode, Low Channel 30-901MHz

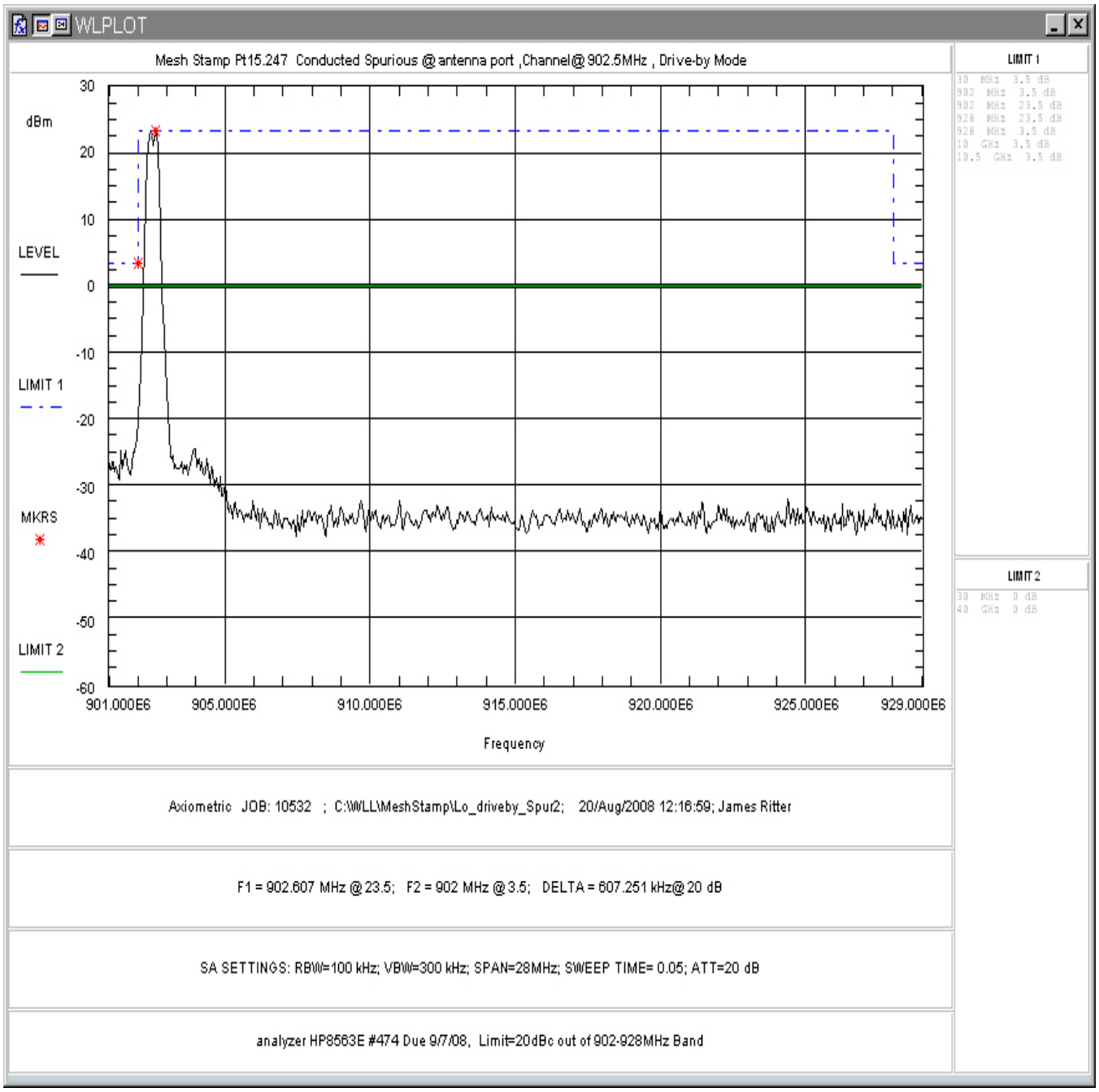

Figure 33. Conducted Spurious Emissions, Drive-by Mode, Low Channel 901-929MHz

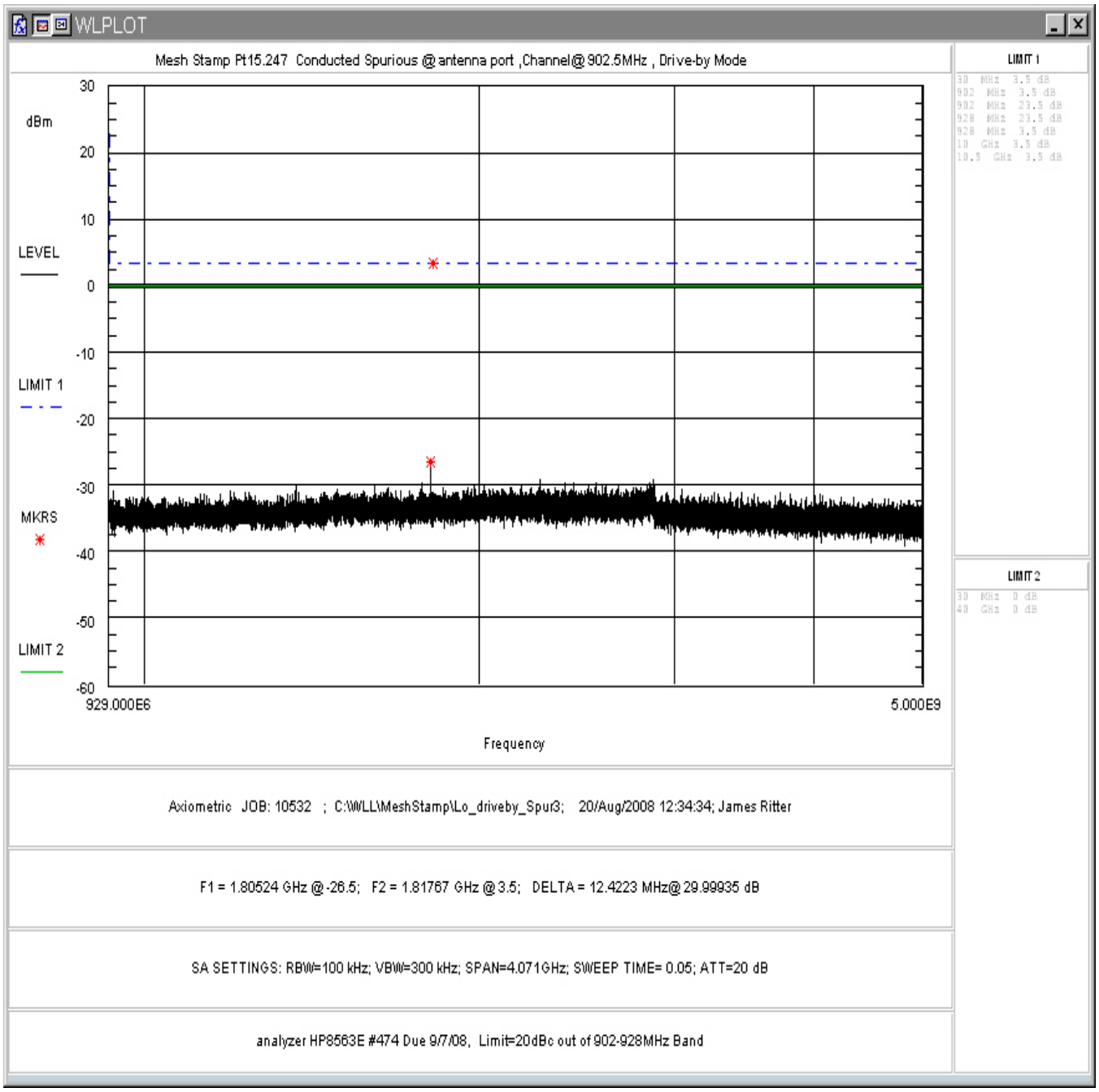

Figure 34. Conducted Spurious Emissions, Drive-by Mode, Low Channel 929-5000MHz

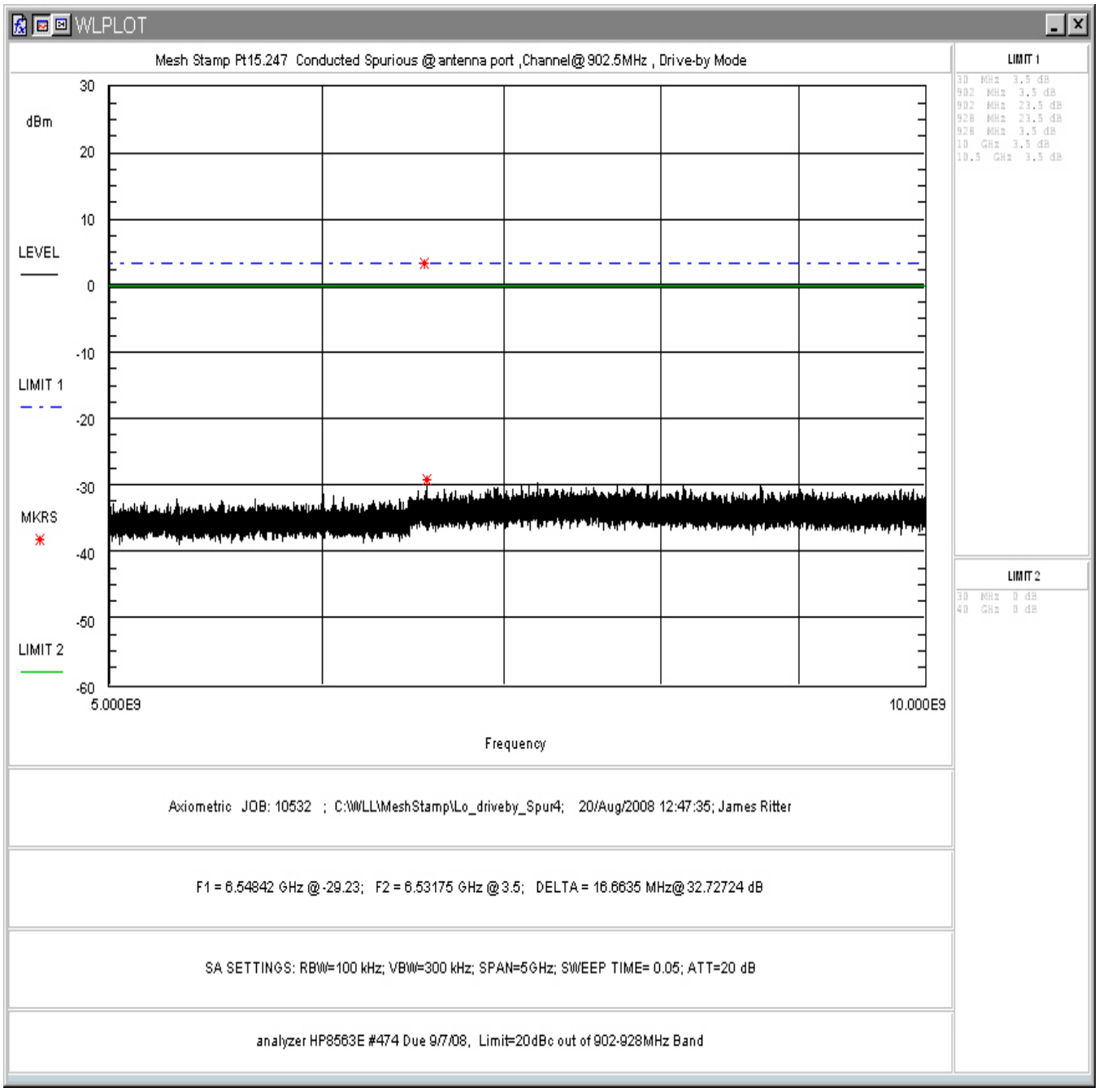

Figure 35. Conducted Spurious Emissions, Drive-by Mode, Low Channel 5-10GHz

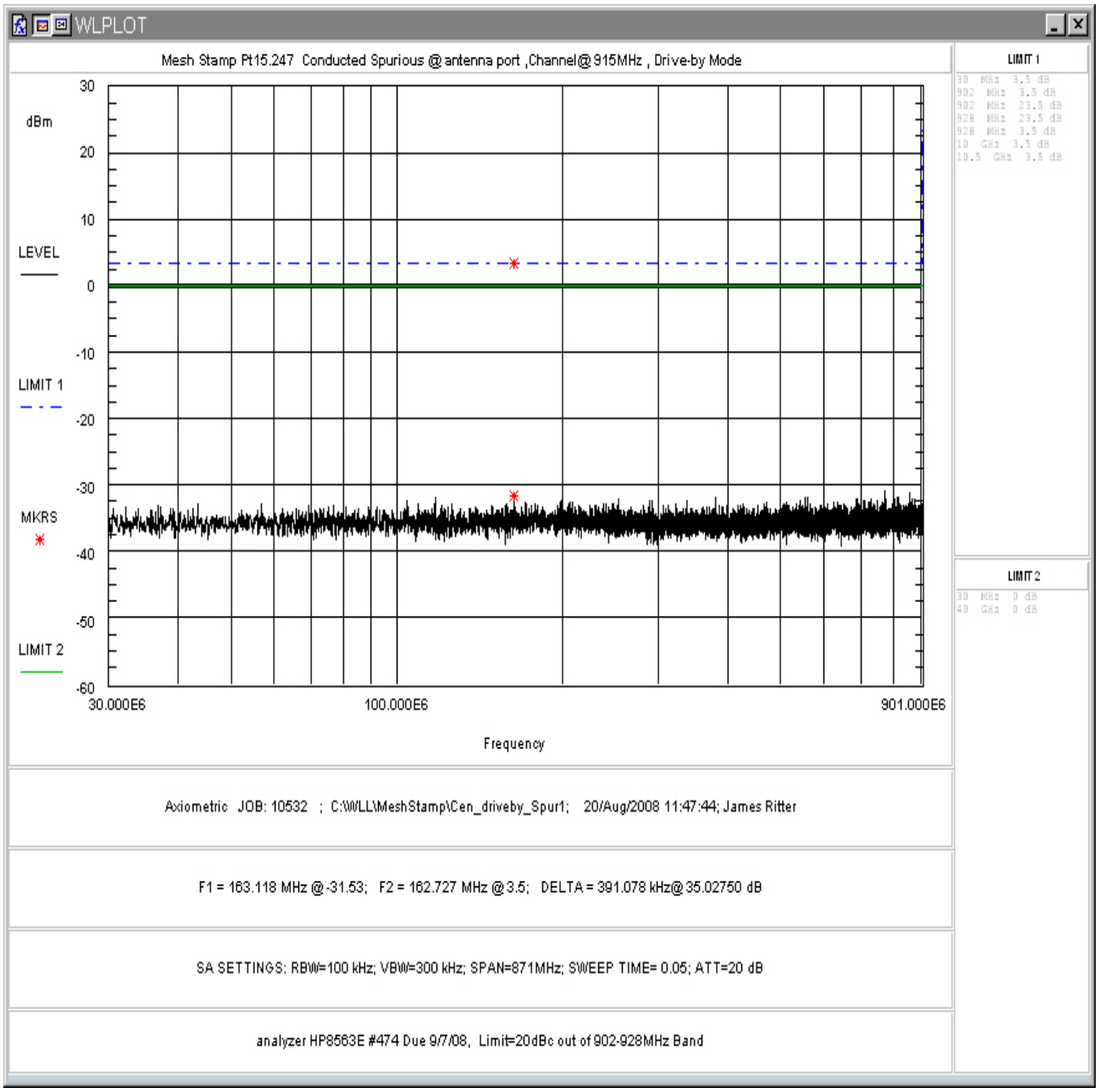

Figure 36. Conducted Spurious Emissions, Drive-by Mode, Center Channel 30 - 901MHz

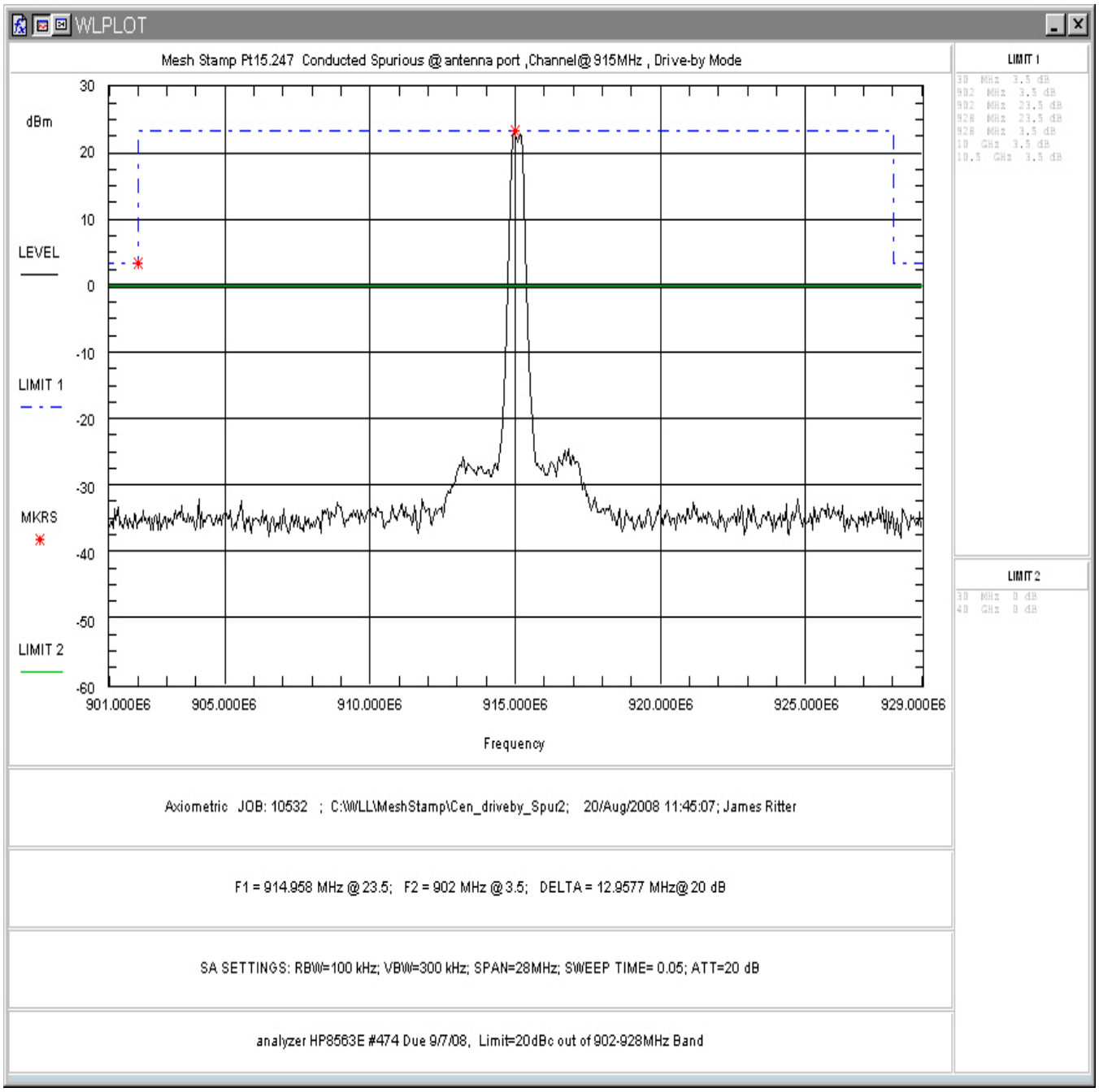

Figure 37. Conducted Spurious Emissions, Drive-by Mode, Center Channel 901-929MHz

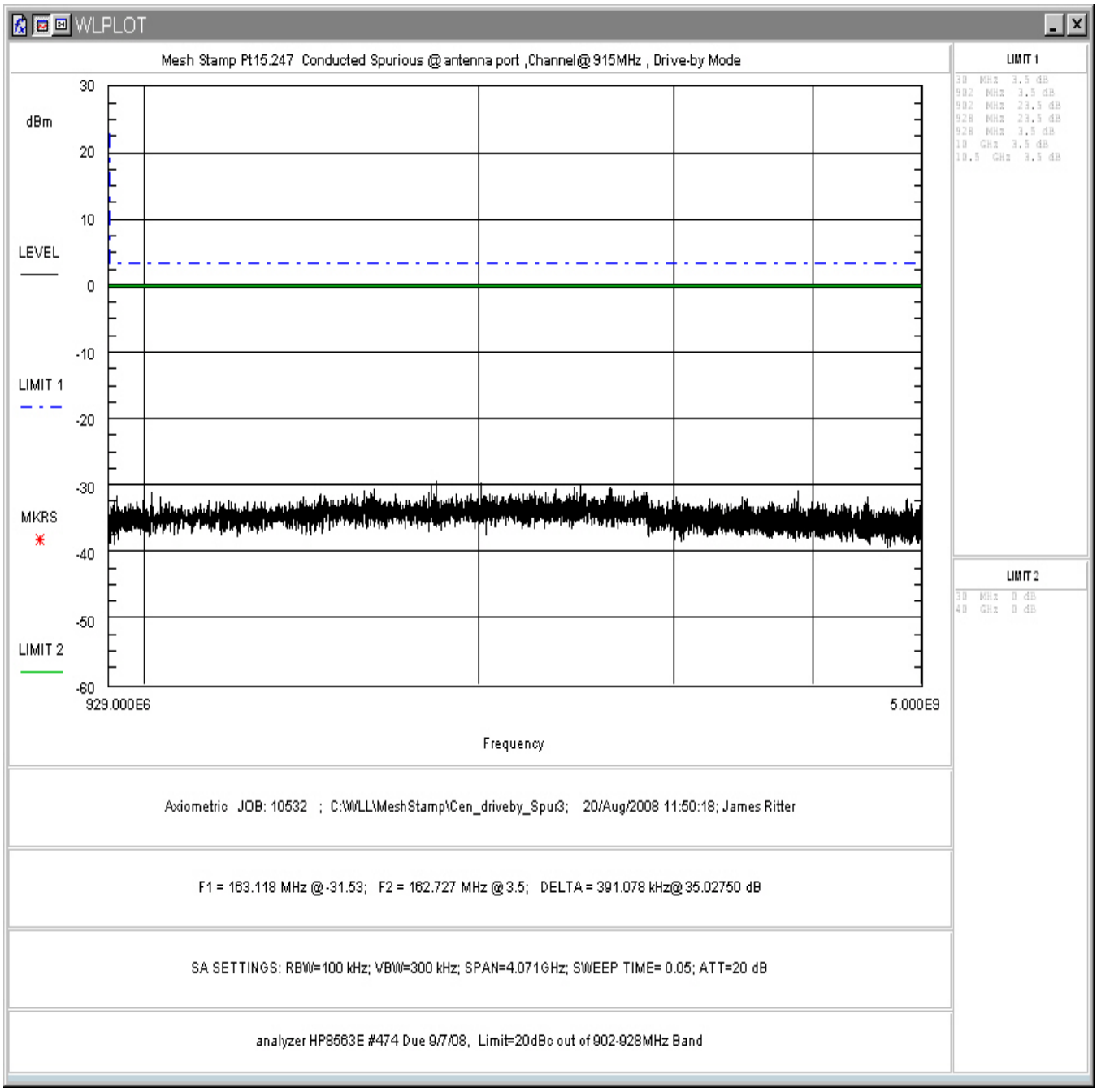

Figure 38. Conducted Spurious Emissions, Drive-by Mode, Center Channel 929-5000MHz

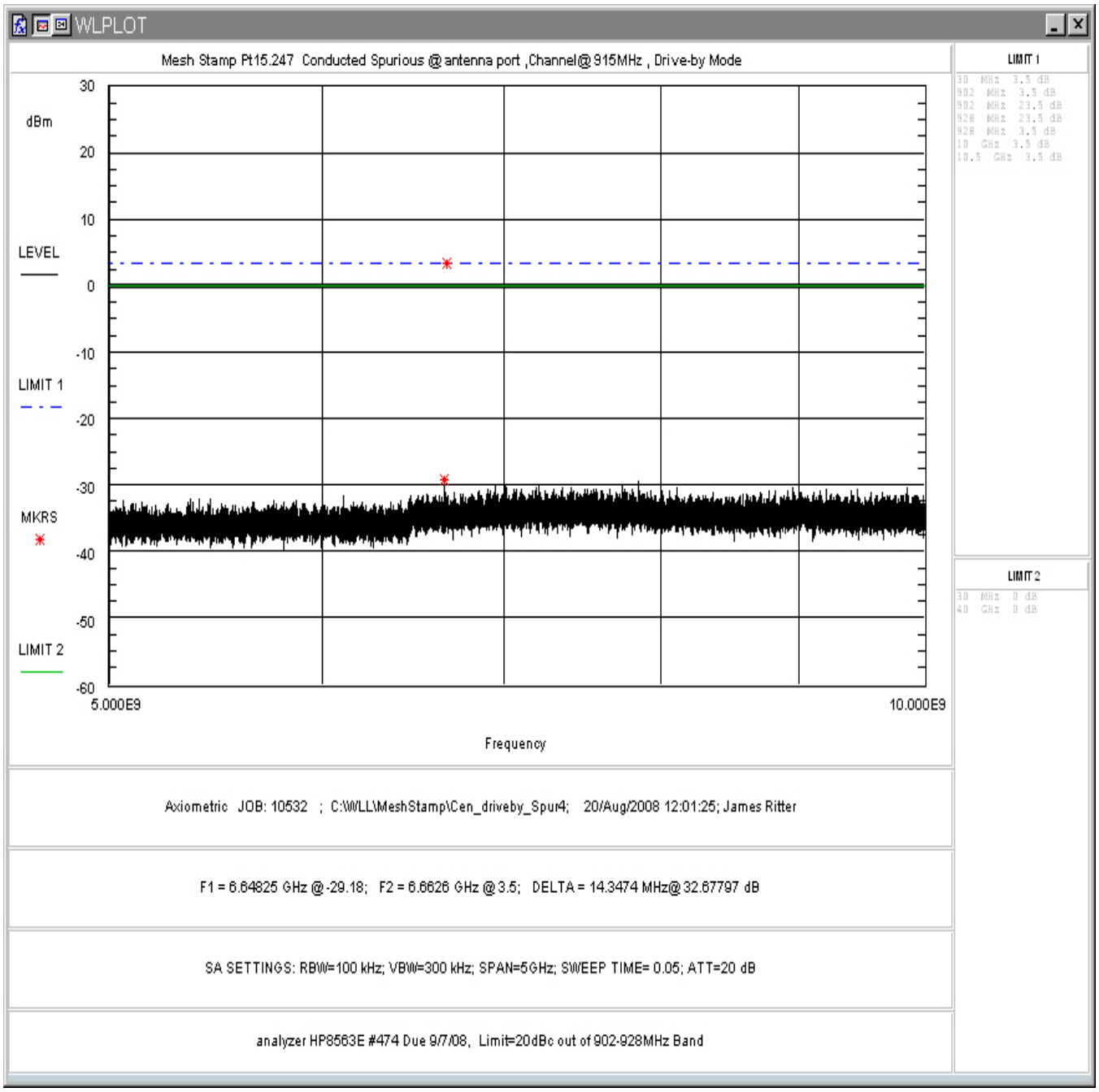

Figure 39. Conducted Spurious Emissions, Drive-by Mode, Center Channel 5-10GHz

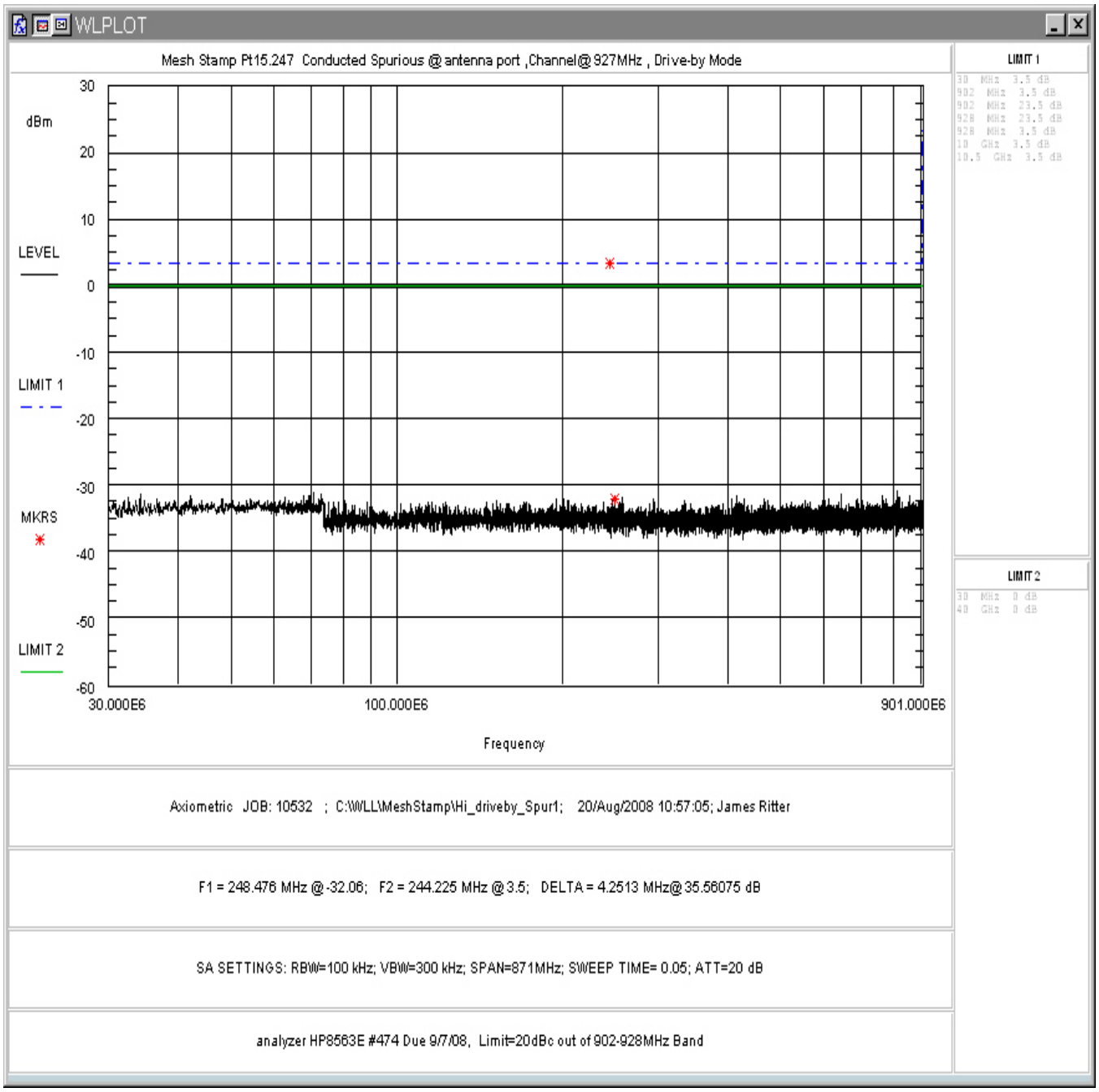

Figure 40. Conducted Spurious Emissions, Drive-by Mode, High Channel 30-901MHz

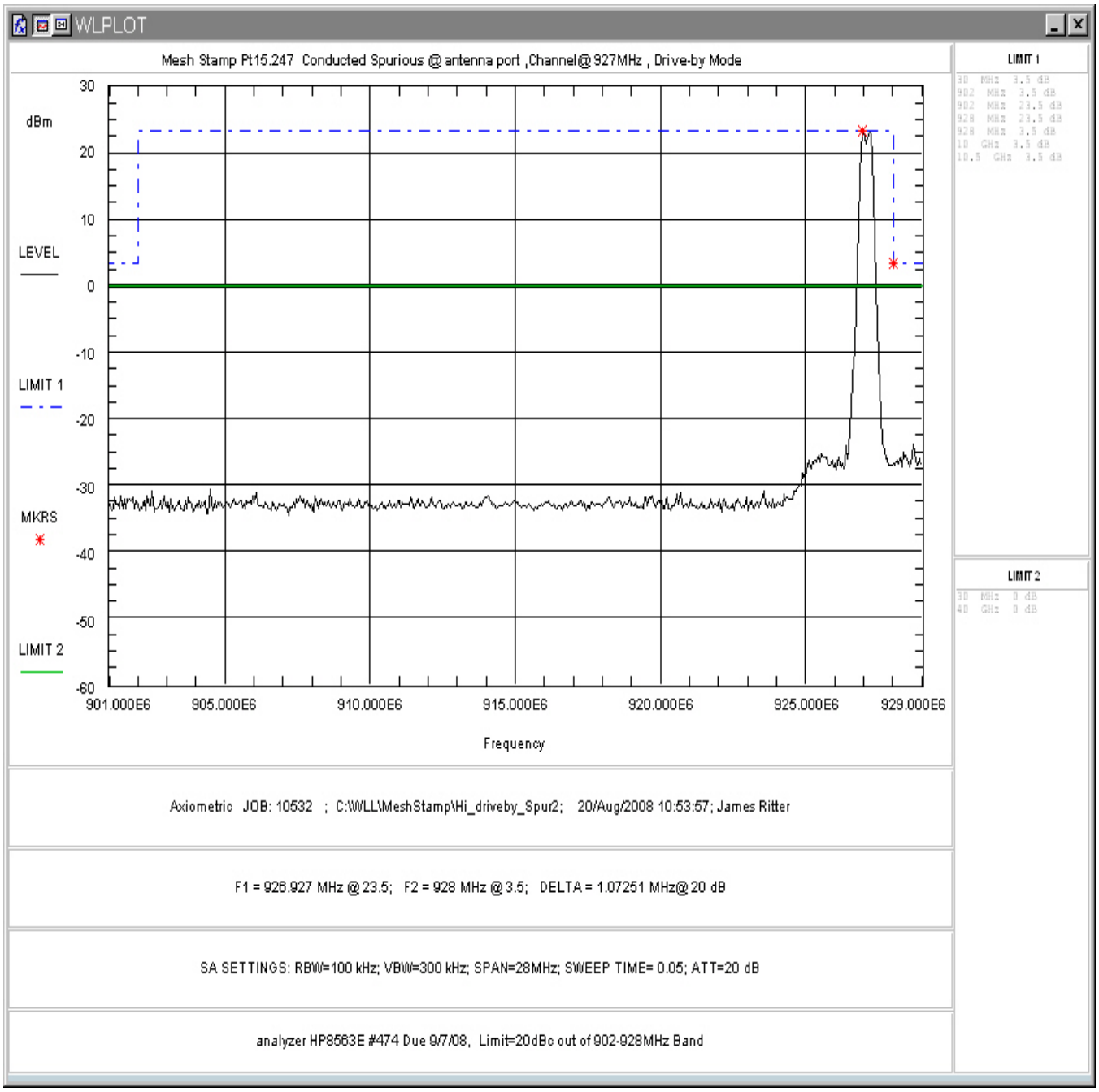

Figure 41. Conducted Spurious Emissions, Drive-by Mode, High Channel 901-929MHz

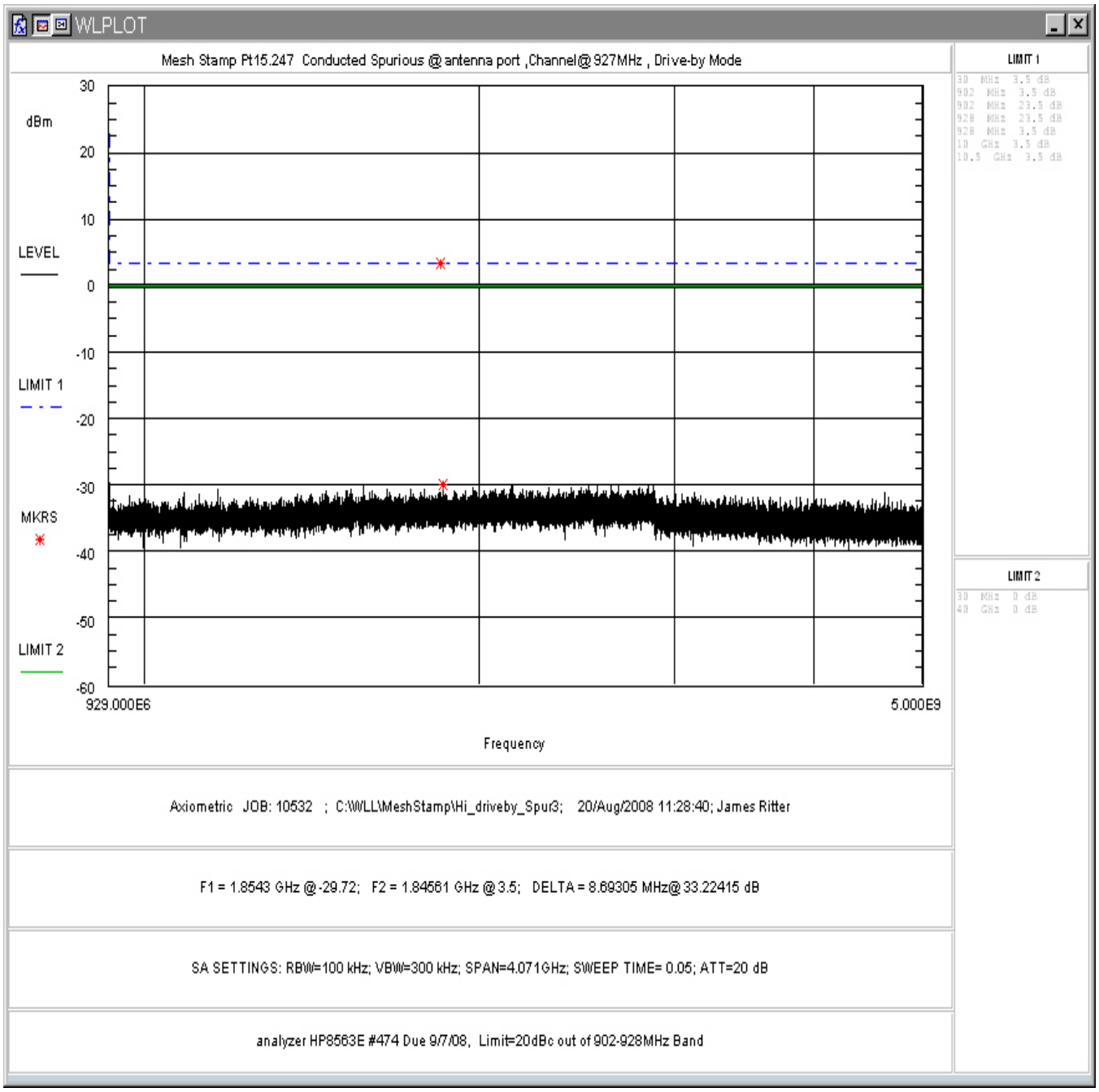

Figure 42. Conducted Spurious Emissions, Drive-by Mode, High Channel 929-5000MHz

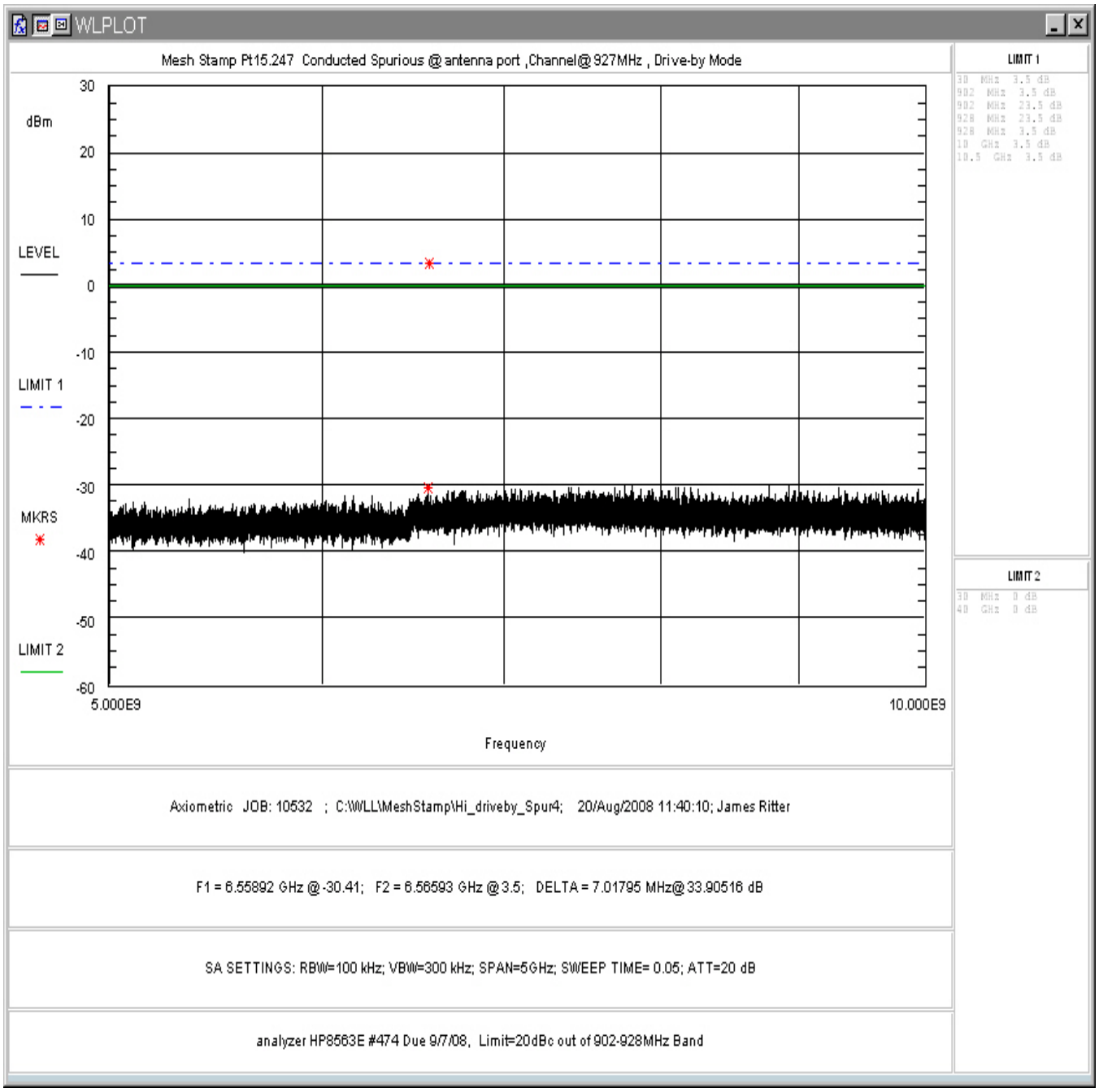

Figure 43. Conducted Spurious Emissions, Drive-by Mode, High Channel 5-10GHz

5.5.1 Band Edge Requirements

Close up plots of the upper and lower 902-928MHz Band-edges in both Mesh and Drive-by modes are provided below with the EUT fixed at the lower and upper frequencies. Plots are also provided with the EUT hopping functions enabled. Emissions must be attenuated 20dB from the peak emission outside of the 902-928 Band.

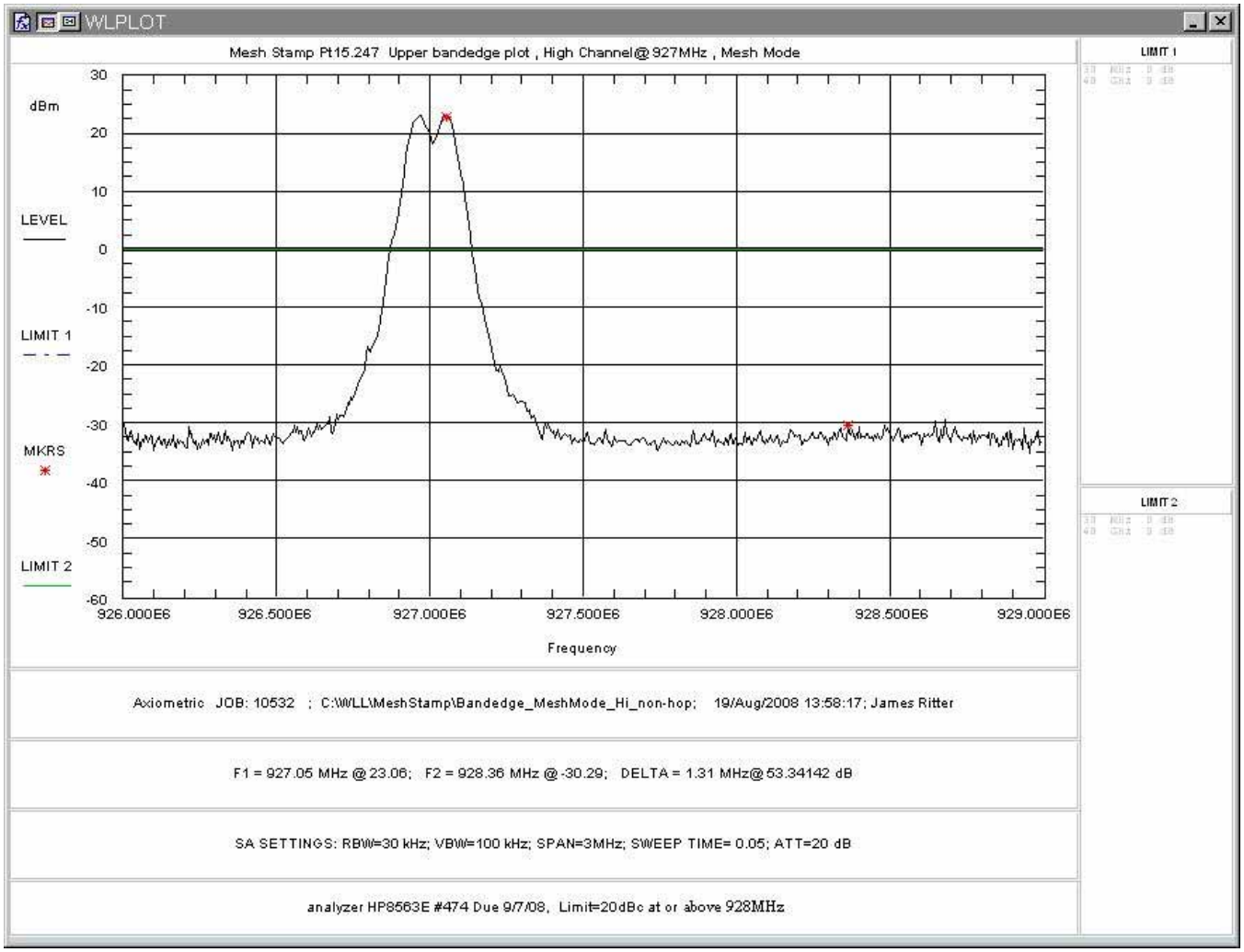

Figure 44. Conducted Lower Band-edge, Mesh Mode, Low Channel

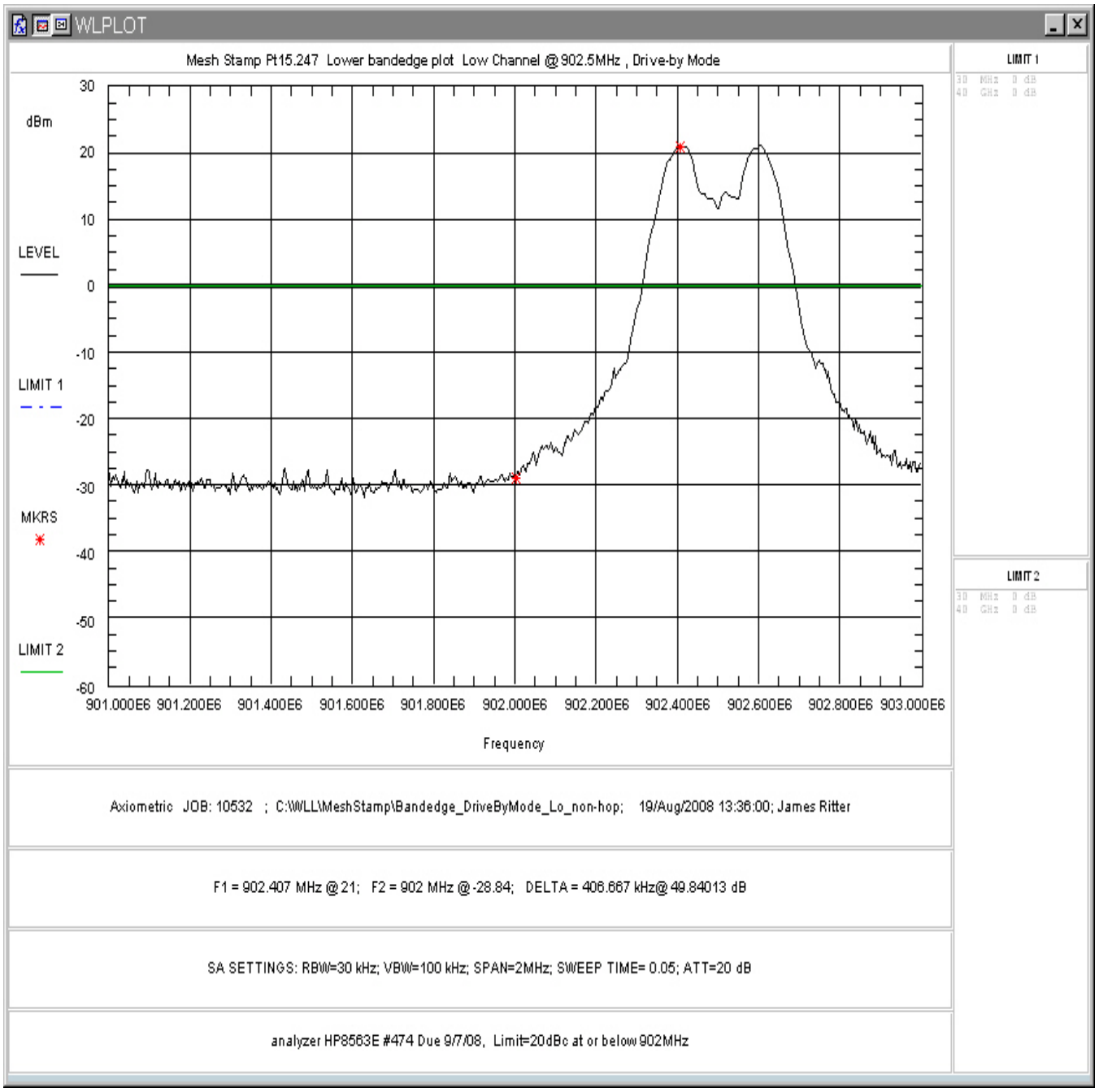

Figure 45. Conducted Lower Band-edge, Drive-by Mode, Low Channel

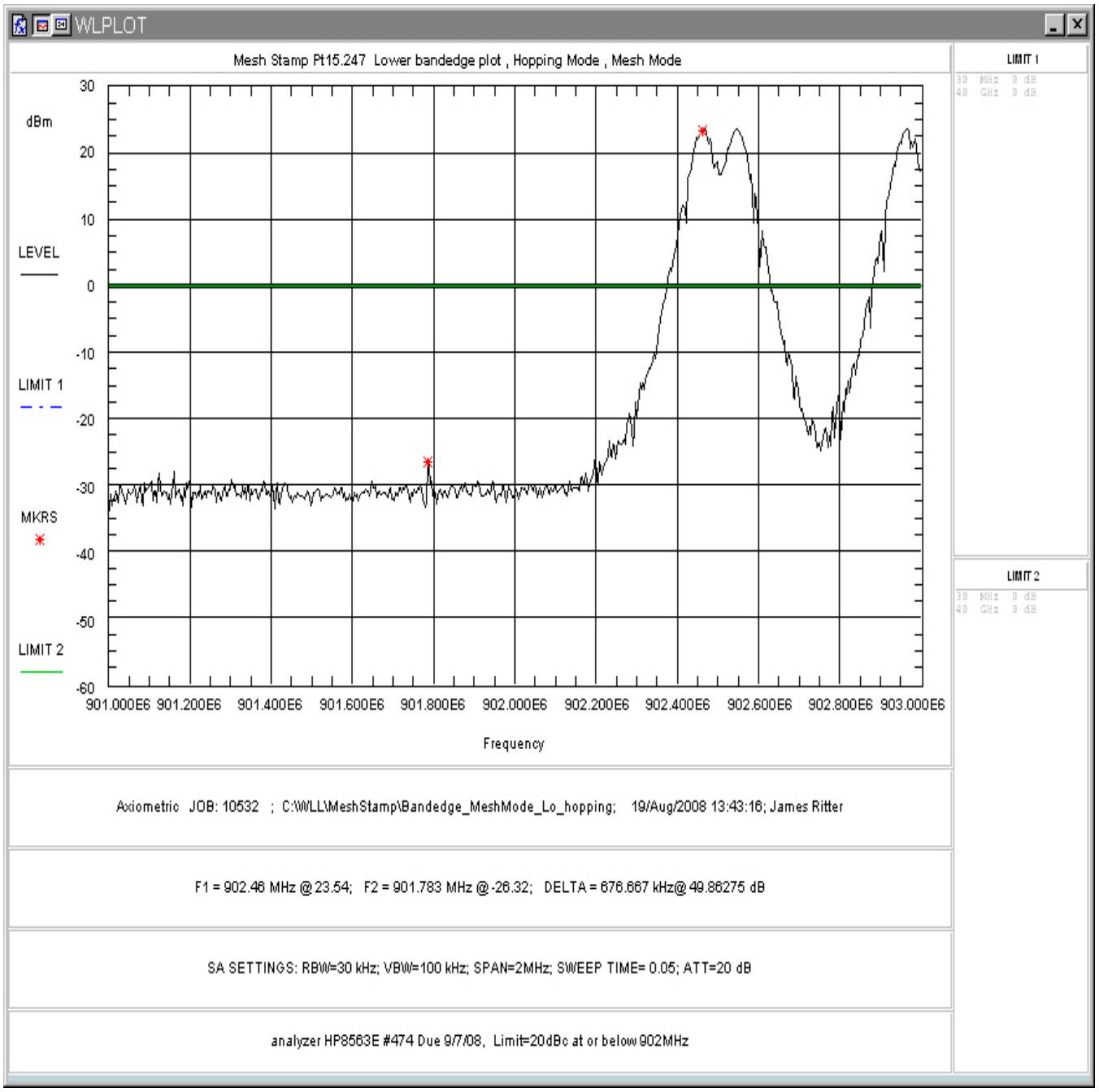

Figure 46. Conducted Lower Band-edge, Mesh Mode, Hopping

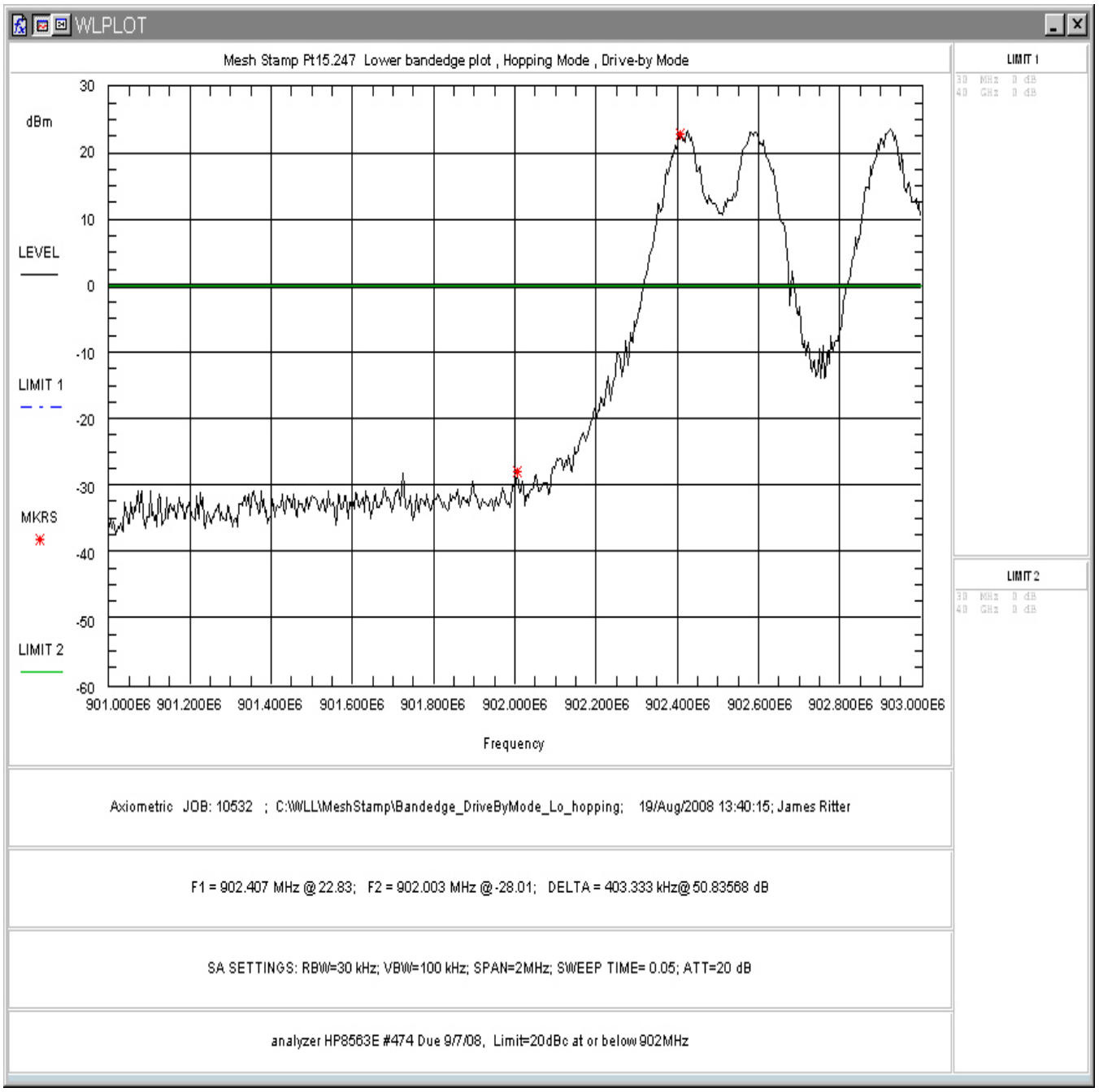

Figure 47. Conducted Lower Band-edge, Drive-by Mode, Hopping

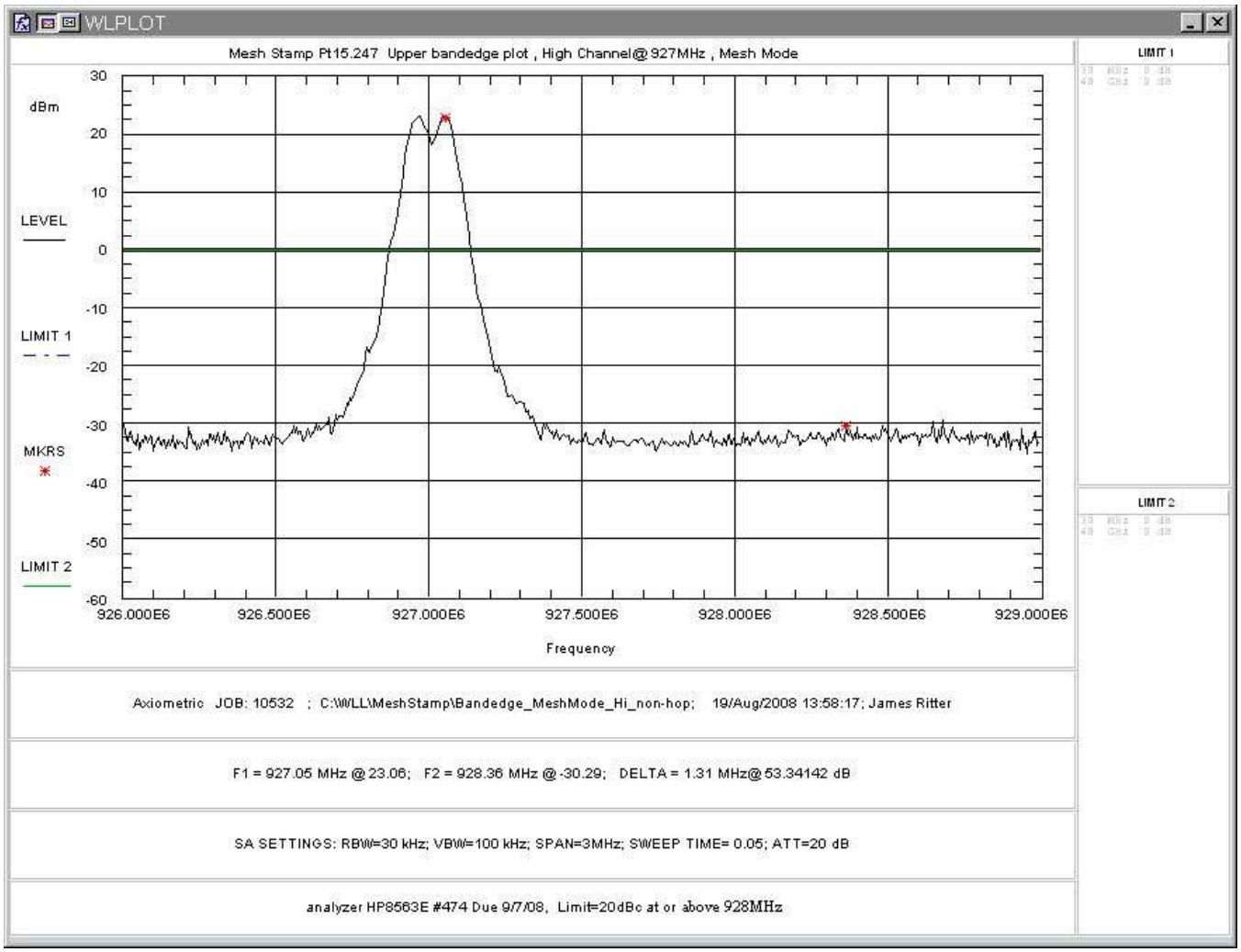

Figure 48. Conducted Upper Band-edge, Mesh Mode, High Channel

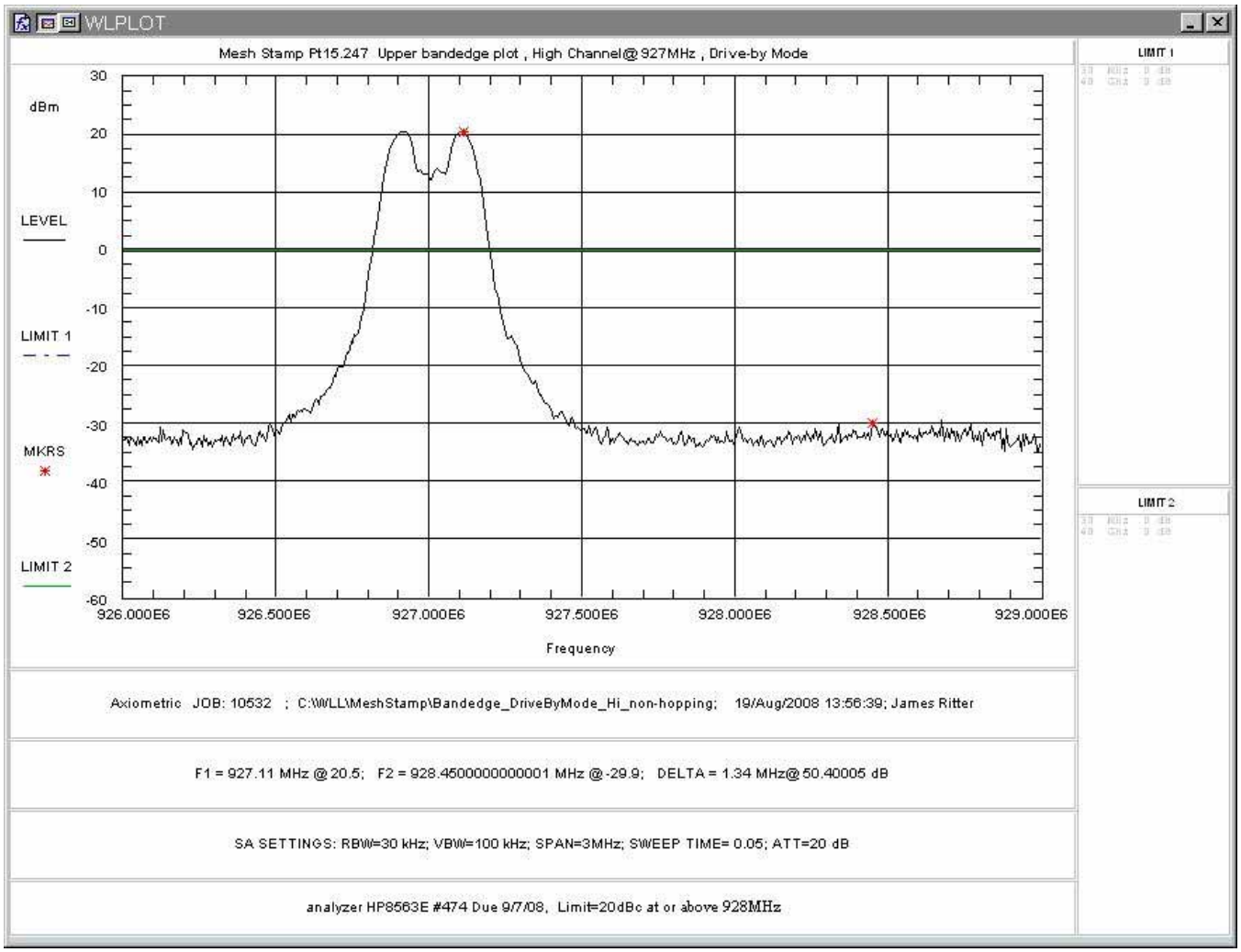

Figure 49. Conducted Upper Band-edge, Drive-by Mode, High Channel

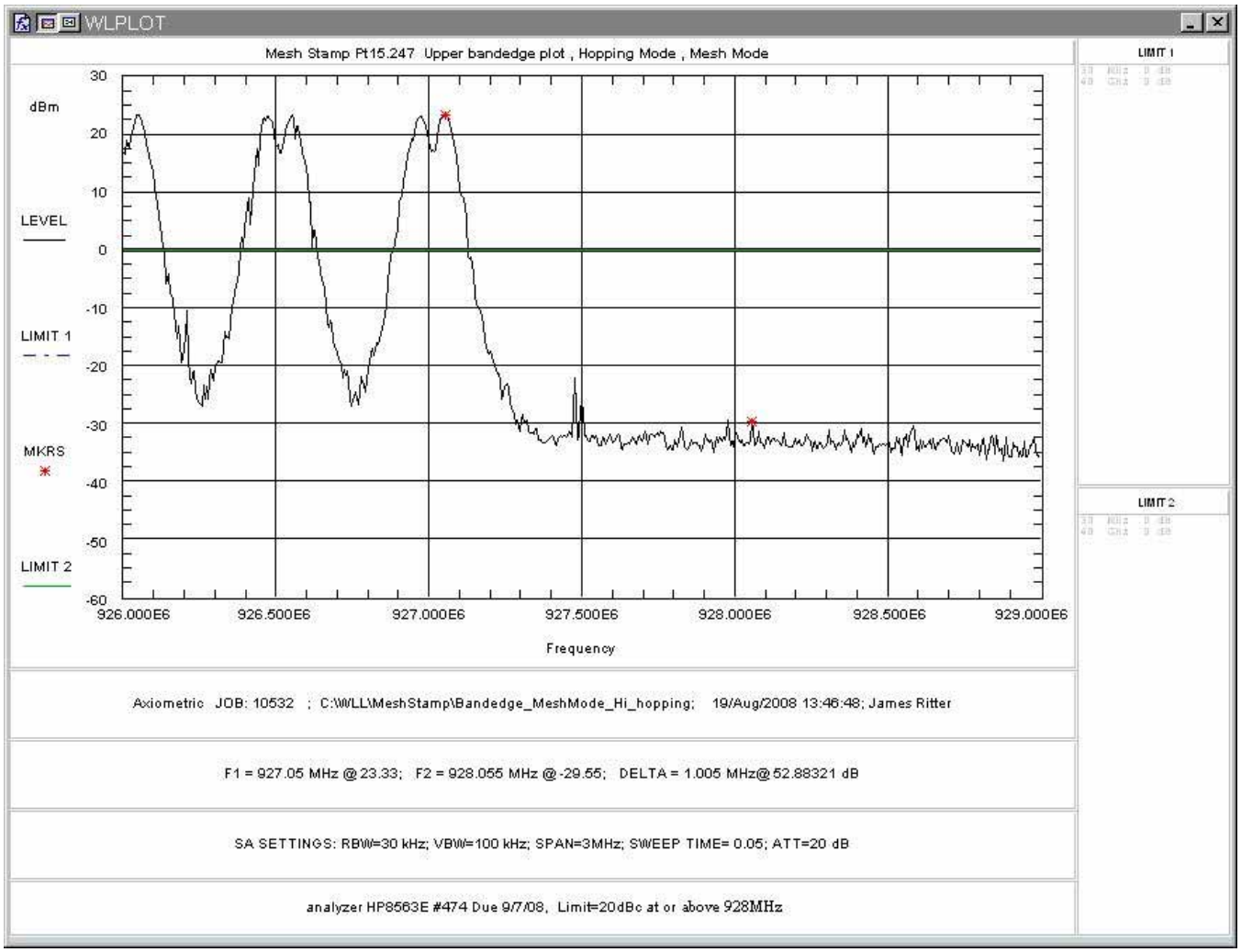

Figure 50. Conducted Upper Band-edge, Mesh Mode, Hopping

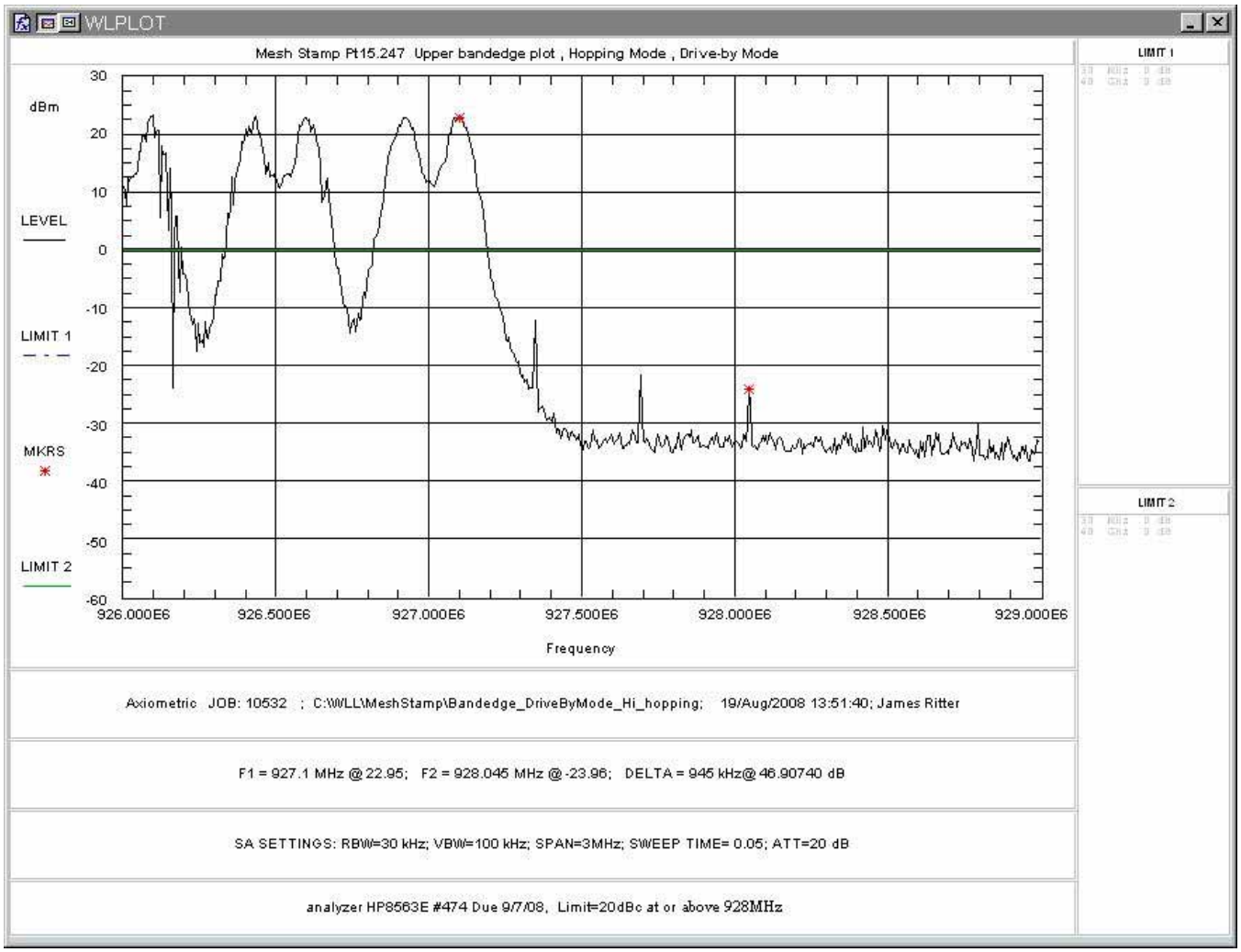

Figure 51. Conducted Upper Band-edge, Drive-by Mode, Hopping

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 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 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 module was tested in 3 orthogonals with the worst case readings reported (unit flat was worst case). The radiated tests were measured with the EUT connected to a 5.5dBi whip antenna.

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)

Table 6: Radiated Emission Test Data (Restricted Bands), Center Channel

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
Peak											
2707.500	V	0.0	2.7	52.7	29.5	2.2	35.4	48.9	279.9	5000.0	-25.0
3610.000	V	270.0	2.5	51.2	30.7	3.9	35.3	50.5	333.9	5000.0	-23.5
4512.500	V	225.0	2.5	50.5	32.0	4.9	35.5	51.9	393.5	5000.0	-22.1
5415.000	V	45.0	2.6	52.3	33.5	5.4	35.6	55.7	608.3	5000.0	-18.3
8122.500	V	45.0	2.5	43.0	37.4	7.2	35.8	51.7	385.8	5000.0	-22.3
9025.000	V	0.0	2.5	44.0	38.0	8.0	35.9	54.1	508.2	5000.0	-19.9
Avg											
2707.500	V	0.0	2.7	44.5	29.5	2.2	35.4	40.8	109.3	500.0	-13.2
3610.000	V	270.0	2.5	41.5	30.7	3.9	35.3	40.8	109.7	500.0	-13.2
4512.500	V	225.0	2.5	42.7	32.0	4.9	35.5	44.1	159.8	500.0	-9.9
5415.000	V	45.0	2.6	44.3	33.5	5.4	35.6	47.7	242.2	500.0	-6.3
8122.500	V	45.0	2.5	33.0	37.4	7.2	35.8	41.7	122.0	500.0	-12.3
9025.000	V	0.0	2.5	32.5	38.0	8.0	35.9	42.6	135.2	500.0	-11.4
Peak											
2707.500	H	22.0	2.3	54.8	29.5	2.2	35.4	51.1	358.9	5000.0	-22.9
3610.000	H	0.0	2.6	53.0	30.7	3.9	35.3	52.3	412.2	5000.0	-21.7
4512.500	H	245.0	2.6	50.2	32.0	4.9	35.5	51.6	378.9	5000.0	-22.4
5415.000	H	45.0	2.4	52.3	33.5	5.4	35.6	55.7	608.3	5000.0	-18.3
8122.500	H	180.0	2.3	42.2	37.4	7.2	35.8	50.9	350.7	5000.0	-23.1
9025.000	H	0.0	2.3	43.8	38.0	8.0	35.9	54.0	498.4	5000.0	-20.0
Avg											
2707.500	H	22.0	2.3	46.3	29.5	2.2	35.4	42.6	134.9	500.0	-11.4
3610.000	H	0.0	2.6	43.8	30.7	3.9	35.3	43.1	143.4	500.0	-10.8
4512.500	H	245.0	2.6	41.1	32.0	4.9	35.5	42.5	133.3	500.0	-11.5
5415.000	H	45.0	2.4	48.0	33.5	5.4	35.6	51.4	369.5	500.0	-2.6
8122.500	H	180.0	2.3	32.7	37.4	7.2	35.8	41.4	117.5	500.0	-12.6
9025.000	H	0.0	2.3	31.7	38.0	8.0	35.9	41.8	122.9	500.0	-12.2
Non harmonics											
116.994	V	90.0	1.2	10.0	13.1	1.7	0.0	24.8	17.3	150.0	-18.8
129.485	V	270.0	1.1	8.6	13.8	1.7	0.0	24.1	16.1	150.0	-19.4
258.767	V	270.0	1.6	7.9	12.2	2.6	0.0	22.6	13.5	200.0	-23.4
408.530	V	90.0	1.7	10.1	15.9	3.1	0.0	29.1	28.6	200.0	-16.9
960.930	V	90.0	1.2	13.5	23.0	5.5	0.0	42.1	127.1	500.0	-11.9
999.955	V	90.0	90.0	13.9	23.3	5.7	0.0	42.9	139.6	500.0	-11.1
116.994	H	0.0	3.7	12.2	13.1	1.7	0.0	27.0	22.3	150.0	-16.6
129.485	H	180.0	3.5	9.4	13.8	1.7	0.0	24.9	17.7	150.0	-18.6
408.530	H	190.0	2.8	8.0	15.9	3.1	0.0	27.0	22.4	200.0	-19.0
960.930	H	0.0	2.0	10.8	23.0	5.5	0.0	39.4	93.1	500.0	-14.6
999.955	H	190.0	1.5	10.2	23.3	5.7	0.0	39.2	91.2	500.0	-14.8

Table 7: Radiated Emission Test Data (Restricted Bands), Center Channel

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
Peak											
2745.000	V	90.0	2.8	51.7	29.6	2.4	35.5	48.2	257.4	5000.0	-25.8
3660.000	V	45.0	2.7	49.3	30.8	4.0	35.3	48.8	276.5	5000.0	-25.1
4575.000	V	220.0	2.6	46.4	32.1	4.9	35.6	47.9	248.1	5000.0	-26.1
7320.000	V	45.0	2.4	44.0	37.1	6.4	35.6	51.9	395.4	5000.0	-22.0
8235.000	V	180.0	2.4	43.7	37.5	7.3	35.8	52.6	426.8	5000.0	-21.4
9150.000	V	180.0	2.5	43.3	38.1	8.0	35.9	53.6	476.2	5000.0	-20.4
Avg											
2745.000	V	90.0	2.8	44.5	29.6	2.4	35.5	41.0	112.7	500.0	-12.9
3660.000	V	45.0	2.7	40.8	30.8	4.0	35.3	40.3	103.9	500.0	-13.6
4575.000	V	220.0	2.6	34.9	32.1	4.9	35.6	36.4	66.0	500.0	-17.6
7320.000	V	45.0	2.4	32.0	37.1	6.4	35.6	39.9	99.3	500.0	-14.0
8235.000	V	180.0	2.4	32.0	37.5	7.3	35.8	40.9	111.4	500.0	-13.0
9150.000	V	180.0	2.5	31.7	38.1	8.0	35.9	41.9	124.4	500.0	-12.1
Peak											
2745.000	H	0.0	2.4	51.5	29.6	2.4	35.5	48.0	252.4	5000.0	-25.9
3660.000	H	45.0	2.6	48.0	30.8	4.0	35.3	47.5	237.2	5000.0	-26.5
4575.000	H	0.0	2.5	46.8	32.1	4.9	35.6	48.3	259.8	5000.0	-25.7
7320.000	H	90.0	2.6	45.0	37.1	6.4	35.6	52.9	443.7	5000.0	-21.0
8235.000	H	190.0	2.4	42.5	37.5	7.3	35.8	51.4	373.0	5000.0	-22.5
9150.000	H	190.0	2.4	44.8	38.1	8.0	35.9	55.1	565.9	5000.0	-18.9
Avg											
2745.000	H	0.0	2.4	46.9	29.6	2.4	35.5	43.4	147.9	500.0	-10.6
3660.000	H	45.0	2.6	41.5	30.8	4.0	35.3	41.0	112.2	500.0	-13.0
4575.000	H	0.0	2.5	34.7	32.1	4.9	35.6	36.2	64.3	500.0	-17.8
7320.000	H	90.0	2.6	31.5	37.1	6.4	35.6	39.4	93.8	500.0	-14.5
8235.000	H	190.0	2.4	32.3	37.5	7.3	35.8	41.2	115.3	500.0	-12.7
9150.000	H	190.0	1.5	32.1	38.1	8.0	35.9	42.3	130.7	500.0	-11.7
Non harmonics											
116.994	V	90.0	1.2	11.0	13.1	1.7	0.0	25.8	19.4	150.0	-17.8
129.485	V	270.0	1.1	9.0	13.8	1.7	0.0	24.5	16.9	150.0	-19.0
258.767	V	190.0	1.5	10.7	12.2	2.6	0.0	25.4	18.7	200.0	-20.6
408.530	V	180.0	1.9	9.6	15.9	3.1	0.0	28.6	27.0	200.0	-17.4
992.960	V	270.0	1.7	11.3	23.3	5.7	0.0	40.2	102.9	500.0	-13.7
116.994	H	0.0	3.7	12.2	13.1	1.7	0.0	27.0	22.3	150.0	-16.6
129.485	H	180.0	3.5	9.4	13.8	1.7	0.0	24.9	17.7	150.0	-18.6
408.530	H	190.0	2.8	8.0	15.9	3.1	0.0	27.0	22.4	200.0	-19.0
992.960	H	180.0	2.6	8.1	23.3	5.7	0.0	37.0	71.2	500.0	-16.9

Table 8: Radiated Emission Test Data (Restricted Bands), Center Channel

Frequency (MHz)	Polarity H/V	Az Deg	Ant. Hght (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Amp Gain (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
Peak											
2781.000	V	90.0	2.7	50.0	29.6	2.6	35.5	46.8	218.8	5000.0	-27.2
3708.000	V	270.0	2.6	50.8	30.8	4.2	35.3	50.5	335.9	5000.0	-23.5
4635.000	V	45.0	2.5	45.8	32.2	5.0	35.6	47.4	233.9	5000.0	-26.6
7416.000	V	0.0	2.3	43.0	37.1	6.4	35.6	50.9	349.4	5000.0	-23.1
8343.000	V	180.0	2.3	45.0	37.5	7.4	35.8	54.1	508.7	5000.0	-19.9
9270.000	V	180.0	2.4	43.5	38.3	8.0	35.9	53.8	491.2	5000.0	-20.2
Avg											
2781.000	V	90.0	2.7	43.7	29.6	2.6	35.5	40.5	105.6	500.0	-13.5
3708.000	V	270.0	2.6	45.5	30.8	4.2	35.3	45.2	181.8	500.0	-8.8
4635.000	V	45.0	2.5	34.5	32.2	5.0	35.6	36.1	63.7	500.0	-17.9
7416.000	V	0.0	2.3	33.4	37.1	6.4	35.6	41.3	115.7	500.0	-12.7
8343.000	V	180.0	2.3	32.0	37.5	7.4	35.8	41.1	113.9	500.0	-12.9
9270.000	V	180.0	2.4	31.8	38.3	8.0	35.9	42.1	127.7	500.0	-11.9
Peak											
2781.000	H	0.0	2.4	51.5	29.6	2.6	35.5	48.3	260.0	5000.0	-25.7
3708.000	H	0.0	2.2	50.2	30.8	4.2	35.3	49.9	311.3	5000.0	-24.1
4635.000	H	90.0	2.4	45.3	32.2	5.0	35.6	46.9	220.9	5000.0	-27.1
7416.000	H	170.0	2.3	42.5	37.1	6.4	35.6	50.4	329.8	5000.0	-23.6
8343.000	H	0.0	2.4	44.5	37.5	7.4	35.8	53.6	480.2	5000.0	-20.4
9270.000	H	180.0	2.5	43.7	38.3	8.0	35.9	54.0	500.9	5000.0	-20.0
Avg											
2781.000	H	0.0	2.4	45.5	29.6	2.6	35.5	42.3	130.3	500.0	-11.7
3708.000	H	0.0	2.2	43.7	30.8	4.2	35.3	43.4	147.3	500.0	-10.6
4635.000	H	90.0	2.4	35.3	32.2	5.0	35.6	36.9	69.8	500.0	-17.1
7416.000	H	170.0	2.3	31.2	37.1	6.4	35.6	39.1	89.8	500.0	-14.9
8343.000	H	0.0	2.4	31.5	37.5	7.4	35.8	40.6	107.5	500.0	-13.4
9270.000	H	180.0	2.5	32.0	38.3	8.0	35.9	42.3	130.7	500.0	-11.7
116.994	V	120.0	1.2	12.2	13.1	1.7	0.0	27.0	22.3	150.0	-16.6
129.485	V	240.0	1.1	9.5	13.8	1.7	0.0	25.0	17.9	150.0	-18.5
408.530	V	190.0	2.0	9.4	15.9	3.1	0.0	28.4	26.4	200.0	-17.6
966.040	V	270.0	1.5	20.3	23.1	5.6	0.0	49.0	280.6	500.0	-5.0
116.994	H	10.0	3.3	11.1	13.1	1.7	0.0	25.9	19.6	150.0	-17.7
129.485	H	190.0	3.6	9.6	13.8	1.7	0.0	25.1	18.1	150.0	-18.4
408.530	H	180.0	3.0	9.0	15.9	3.1	0.0	28.0	25.2	200.0	-18.0
966.040	H	0.0	2.1	13.7	23.1	5.6	0.0	42.4	131.3	500.0	-11.6

5.7 Receiver Radiated Spurious Emissions: (FCC Part §15.209, RSS-Gen [7.2.3.2])

The EUT must comply with the requirements for radiated spurious emissions from the receiver. These emissions must meet the limits specified in §15.209 and RSS-Gen.

5.7.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The emissions were measured using the following resolution bandwidths:

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

5.7.2 Test Summary

The EUT complied with the requirements for receiver radiated emissions FCC 15.209 IC RSS-Gen. Receiver Radiated Spurious Test Data. The receiver was scanned from 30-2781MHz (3 times the highest receiver frequency of 927MHz).

Table 9: Receiver Radiated Test Data

Frequency (MHz)	Polarity H/V	Azimuth Degree	Ant. Height (m)	SA Level (QP) (dBµV)	Ant. Corr. (dB/m)	Cable Corr. (dB)	Corr. Level (dBµV/m)	Corr. Level (µV/m)	Limit (µV/m)	Margin (dB)
39.720	V	190.0	1.0	6.9	13.0	0.9	20.8	10.9	100.0	-19.2
45.320	V	0.0	1.0	9.8	9.9	1.0	20.7	10.9	100.0	-19.3
85.170	V	270.0	1.2	12.9	7.7	1.4	22.0	12.6	100.0	-18.0
116.994	V	270.0	1.2	8.5	13.1	1.7	23.3	14.5	150.0	-20.3
195.000	V	270.0	1.2	10.6	11.6	2.2	24.4	16.6	150.0	-19.1
258.767	V	100.0	1.3	5.6	12.2	2.6	20.3	10.4	200.0	-25.7
408.530	V	90.0	1.8	12.4	15.9	3.1	31.4	37.2	200.0	-14.6
566.309	V	0.0	1.9	11.2	18.5	3.9	33.7	48.2	200.0	-12.4
39.720	H	180.0	4.0	4.3	13.0	0.9	18.2	8.1	100.0	-21.8
45.320	H	0.0	3.8	10.2	9.9	1.0	21.1	11.4	100.0	-18.9
85.170	H	0.0	3.8	10.7	7.7	1.4	19.8	9.8	100.0	-20.2
116.994	H	190.0	3.5	5.6	13.1	1.7	20.4	10.4	150.0	-23.2
258.767	H	225.0	3.1	7.8	12.2	2.6	22.5	13.4	200.0	-23.5
408.530	H	340.0	2.5	8.8	15.9	3.1	27.8	24.6	200.0	-18.2
566.309	H	180.0	2.3	9.7	18.5	3.9	32.2	40.5	200.0	-13.9

5.8 AC Conducted Emissions (FCC Pt.15.207, RSS-Gen [7.2.2])

5.8.1 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

5.8.2 Test Procedure

The EUT was 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.

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

5.8.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. This system runs off of 230VAC. Table 10-11 provides the test results for phase and neutral line power line conducted emissions.

Emissions were tested in both “transmit on” and “transmit off “state with the EUT tuned to 915MHz.

As the module is typically powered from DC, the unit was powered via a PRS AC/DC adaptor Model HP-5V2 (supplied by Axiometric).

Table 10: Conducted Emissions Data, Transmit On

LINE 1 - 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)
0.196	44.1	23.9	10.1	0.4	54.7	34.5	63.8	53.8	-9.1	-19.3
0.294	39.9	21.6	10.3	0.4	50.6	32.3	60.4	50.4	-9.8	-18.1
0.395	43.3	27.2	10.4	0.2	53.9	37.8	58.0	48.0	-4.0	-10.1
0.588	38.6	21.3	10.5	0.1	49.2	31.9	56.0	46.0	-6.8	-14.1
1.673	36.3	17.5	10.7	0.2	47.2	28.4	56.0	46.0	-8.8	-17.6
3.842	32.6	12.4	10.9	0.4	43.9	23.7	56.0	46.0	-12.1	-22.3
14.869	28.9	10.1	12.0	1.3	42.2	23.4	60.0	50.0	-17.8	-26.6

LINE 2 - 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)
0.196	43.0	29.2	10.1	0.2	53.3	39.5	63.8	53.8	-10.5	-14.3
0.294	40.4	27.3	10.3	0.3	50.9	37.8	60.4	50.4	-9.5	-12.6
0.395	44.3	33.5	10.4	0.2	54.9	44.1	58.0	48.0	-3.1	-3.9
0.588	40.3	28.1	10.5	0.1	51.0	38.7	56.0	46.0	-5.0	-7.3
1.673	39.9	23.9	10.7	0.2	50.8	34.8	56.0	46.0	-5.2	-11.2
3.842	34.3	19.0	10.9	0.4	45.6	30.3	56.0	46.0	-10.4	-15.7
14.869	26.6	13.2	12.0	1.1	39.7	26.3	60.0	50.0	-20.3	-23.7

Table 11: Conducted Emissions Data, Transmit Off

LINE 1 - 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)
0.196	43.0	20.5	10.1	0.4	53.6	31.1	63.8	53.8	-10.2	-22.7
0.294	40.5	22.7	10.3	0.4	51.2	33.4	60.4	50.4	-9.2	-17.0
0.395	43.8	23.9	10.4	0.2	54.4	34.5	58.0	48.0	-3.5	-13.4
0.588	37.9	22.3	10.5	0.1	48.5	32.9	56.0	46.0	-7.5	-13.1
1.673	37.9	19.1	10.7	0.2	48.8	30.0	56.0	46.0	-7.2	-16.0
3.842	33.2	14.7	10.9	0.4	44.5	26.0	56.0	46.0	-11.5	-20.0
14.869	28.2	9.4	12.0	1.3	41.5	22.7	60.0	50.0	-18.5	-27.3

LINE 2 - 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)
0.196	42.4	23.4	10.1	0.2	52.7	33.7	63.8	53.8	-11.1	-20.1
0.294	43.5	29.2	10.3	0.3	54.0	39.7	60.4	50.4	-6.4	-10.7
0.395	43.1	30.2	10.4	0.2	53.6	40.8	58.0	48.0	-4.3	-7.2
0.588	42.3	25.5	10.5	0.1	52.9	36.1	56.0	46.0	-3.1	-9.9
1.673	38.5	25.0	10.7	0.2	49.4	35.9	56.0	46.0	-6.6	-10.1
3.842	34.8	20.1	10.9	0.4	46.1	31.4	56.0	46.0	-9.9	-14.6
14.869	30.7	11.1	12.0	1.1	43.8	24.2	60.0	50.0	-16.2	-25.8