FCC Certification Test Report
For the
Datamatic Ltd.
D420X MOSAIC Residential Gas Module

FCC ID: ODYD4200

WLL JOB# **11006**
June 23, 2009

Prepared for:

Datamatic Ltd.
3600 K Ave
Plano, TK 75074

Prepared By:

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

ACCREDITED
Testing Certificate 2675.01

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Prepared by:

James Ritter
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Reviewed by:

Steven D. Koster
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Abstract

This report has been prepared on behalf of Datamatic Ltd. 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 (7/2008) of the FCC. This Certification Test Report documents the test configuration and test results for the Datamatic Ltd. D420X Mosaic Residential Gas 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 the American Association for Laboratory Accreditation (A2LA) under Certificate 2675.01 as an independent FCC test laboratory.

The Datamatic Ltd. D420X Mosaic Residential Gas 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	June 23, 2009

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1 Introduction

1.1 Compliance Statement

The Datamatic Ltd. D420X Mosaic Residential Gas Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (7/2008).

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance 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:	Datamatic Ltd. 3600 K Ave Plano, TK 75074
Purchase Order Number:	DATA-2000006108
Quotation Number:	64920

1.4 Test Dates

Testing was performed on the following date(s):	6/22/2009 to 6/23/2009

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Steve Dovell
Client Representative	Ken Derry

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 D420X Mosaic Residential Gas Module Gas Module is a device that is capable of reading gas meters by detecting the rotation of the mechanical shaft that provides the movement to the meter's index (totalizer). The radio portion operates in the ISM Band.

Datamatic, Ltd manufactures a series of remote Residential Gas Meter Reading Devices. These are known as the D4200 American, D4201 Rockwell and D4202 Sprague. All three of the end-product embodiments utilize the same internal electronics with variations on the case design to accommodate the 3 different forms of Residential Gas Meters.

D4200 is an application specific, magnetically coupled, radio interface which is part of a MosaicR wireless mesh networking system. MosaicR is a proprietary frequency hopping spread spectrum (FHSS) network licensed from Axiometric, LLC and operates in the unlicensed 902 MHz to 928 MHz ISM band

MosaicR wireless networks are used in utility applications for automatic utility meter reading. MosaicR networks use proprietary communications protocols and only interoperate with other MosaicR devices designed by Datamatic, Ltd. They are not marketed to the general public for consumer applications.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Datamatic Ltd.
FCC ID:	ODYD4200
Model:	D420X Mosaic Residential Gas Module
FCC Rule Parts:	§15.247
Frequency Range:	902.5-927 MHz
Maximum Output Power:	165mW (22.17dBm)
Modulation:	FSK
Occupied Bandwidth:	156.7kHz (mesh mode) 362.0 (drive-by mode)
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Fixed
Antenna Connector	integral
Antenna Type	1dB omni (internal wire antenna)
Interface Cables:	The interface to the gas meter index shaft is through magnetically operated reed switches. No electrical connections exist between the D4200 and the application gas meter. A two wire programming port was used for testing purposes.
Power Source & Voltage:	two 3.6V Lithium Thionyl Chloride batteries

2.2 Test Configuration

The D420X Mosaic Residential Gas Module was configured with a lab power supply providing 3.6VDC power to the unit for conducted testing. Radiated testing used two 3.6V Lithium Thionyl Chloride batteries for input power. A A two wire programming port was used for setting channels.

2.3 Testing Algorithm

The D420X Mosaic Residential Gas Module was programmed for FHSS operation via HyperTerminal connection to a support laptop. Test commands allowed the unit to operate in single continuous channel or hopping mode in each of two configurations (mesh mode or Drive-by mode).

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

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by 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

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

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

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

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a,\ b,\ c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is <u>not</u> 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

Bench Tests

WLL Asset #	Manufacturer Model/Type	Function	Cal. Due
00528	Agilent, E4446A	Analyzer, Spectrum	6/10/2010
00067	HP, 8564E	Analyzer, Spectrum	10/10/2009

Radiated Tests

Test Name: **Radiated Emissions**		Test Date: **06/22/2009**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
69	HP, 85650A	Adapter, QP	07/09/2009
73	HP, 8568B	Analyzer, Spectrum	07/08/2009
71	HP, 85685A	Preselector, RF	07/09/2009
644	Sunol Science JB1	BiConalog Antenna	12/29/2009
425	ARA, DRG-118/A	Antenna, DRG, 1-18GHz	08/08/2009
474	HP, 8563E	Analyzer, Spectrum	02/03/2011
66	HP, 8449B	Pre-Amplifier, RF. 1-26.5GHz	07/15/2009
281	ITC, 21A-3A1	Waveguide 4.51-10.0GHz	02/19/2010
337	WLL, 1.2-5GHz	Filter, Band Pass	02/19/2010

4 Test Results

4.1 Duty Cycle Correction

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:

$$20 \times \text{LOG}(\text{dwell time}/100\text{ ms})$$

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. Since the dwell time of a single channel is greater than 100ms no additional duty cycle correction is allowed.

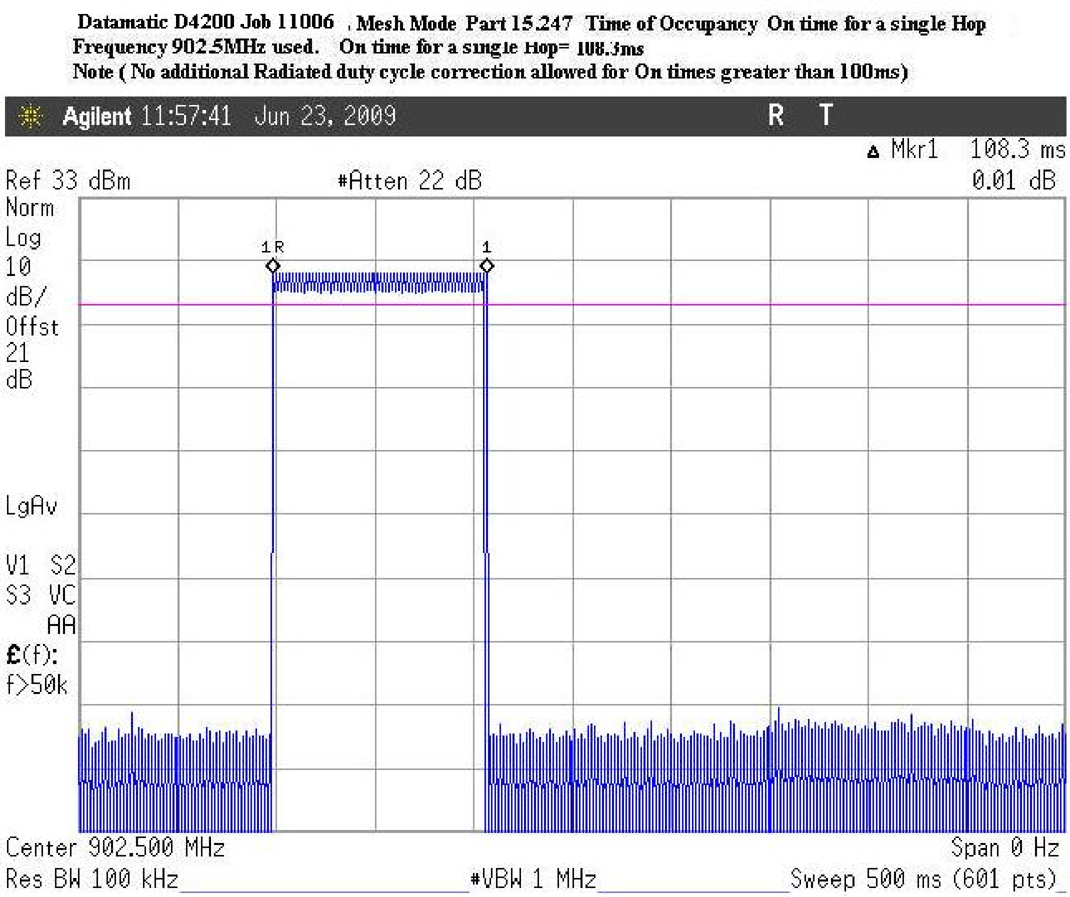

Figure 1: Duty Cycle Plot

4.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on a low, high and middle channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system. The EUT was tested in the 2 available modes, Mesh mode and Drive-by mode.

Table 4: RF Power Output

Mesh Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.5MHz	22.17 dBm	30 dBm	Pass
Mid Channel: 915MHz	21.92 dBm	30 dBm	Pass
High Channel: 927MHz	21.67 dBm	30 dBm	Pass

Drive-by Mode

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.5MHz	22.17 dBm	30 dBm	Pass
Mid Channel: 915MHz	21.84 dBm	30 dBm	Pass
High Channel: 927MHz	21.36 dBm	30 dBm	Pass

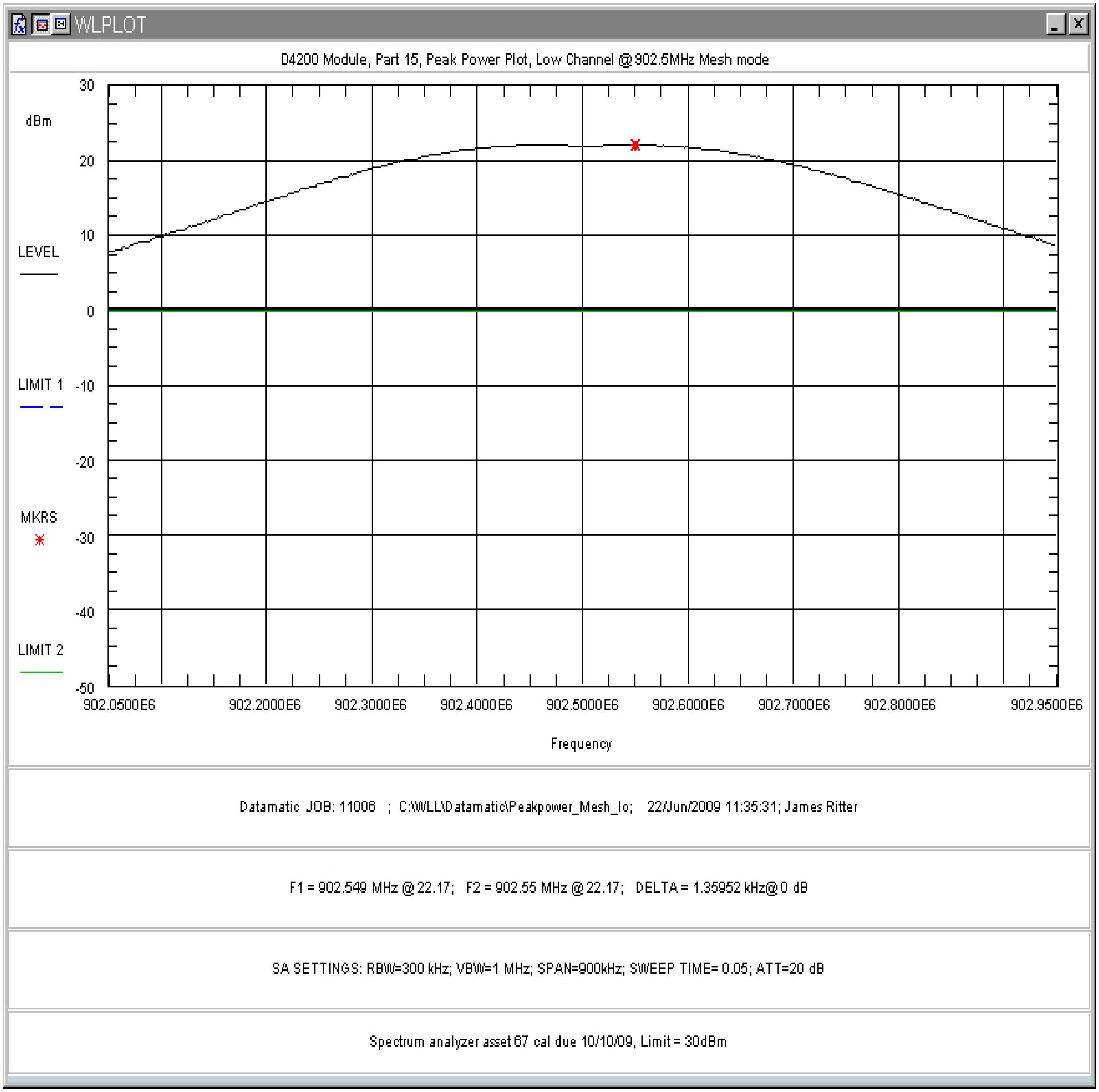

Figure 2: RF Peak Power, Low Channel, Mesh Mode

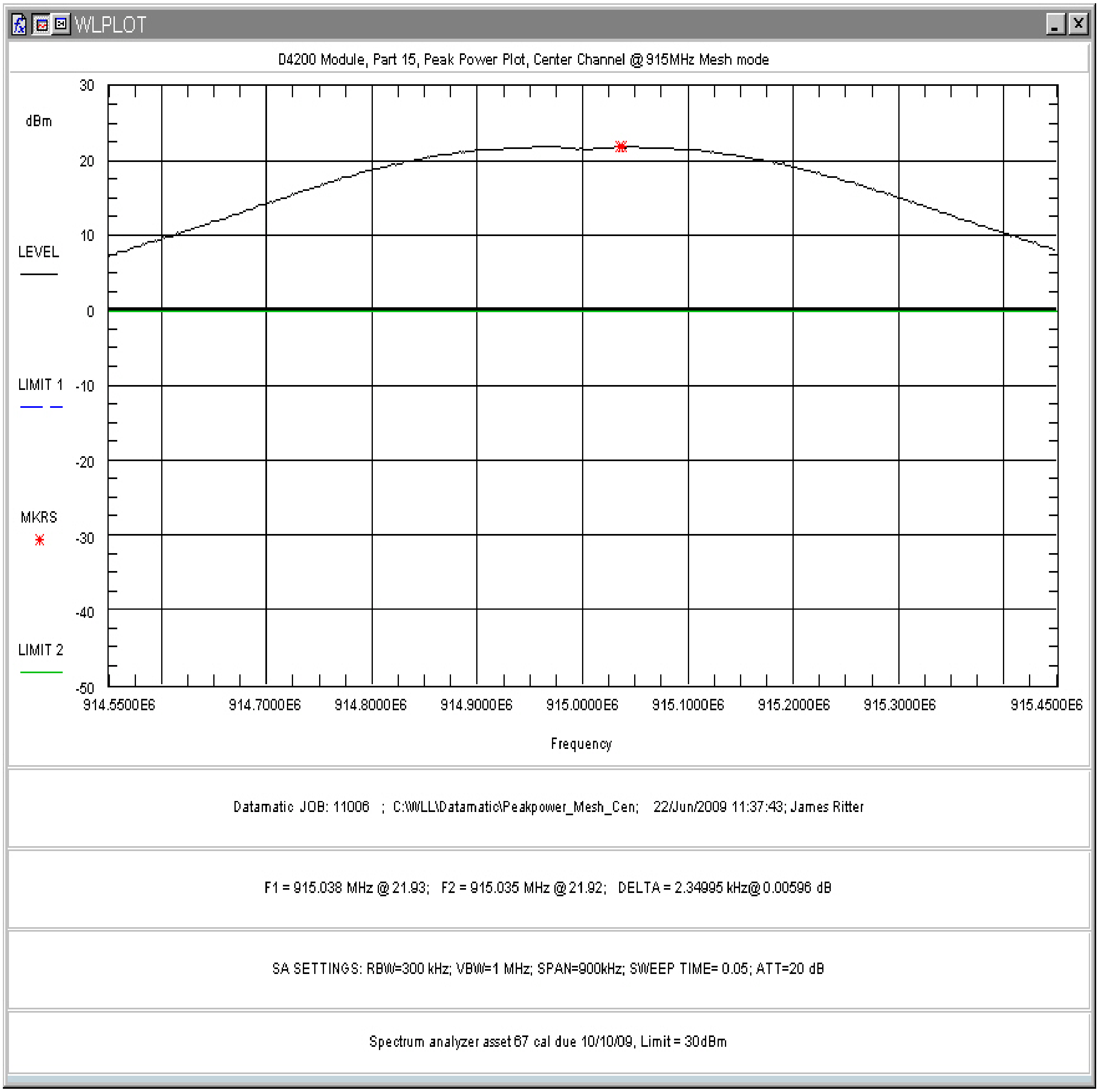

Figure 3: RF Peak Power, Center Channel, Mesh Mode

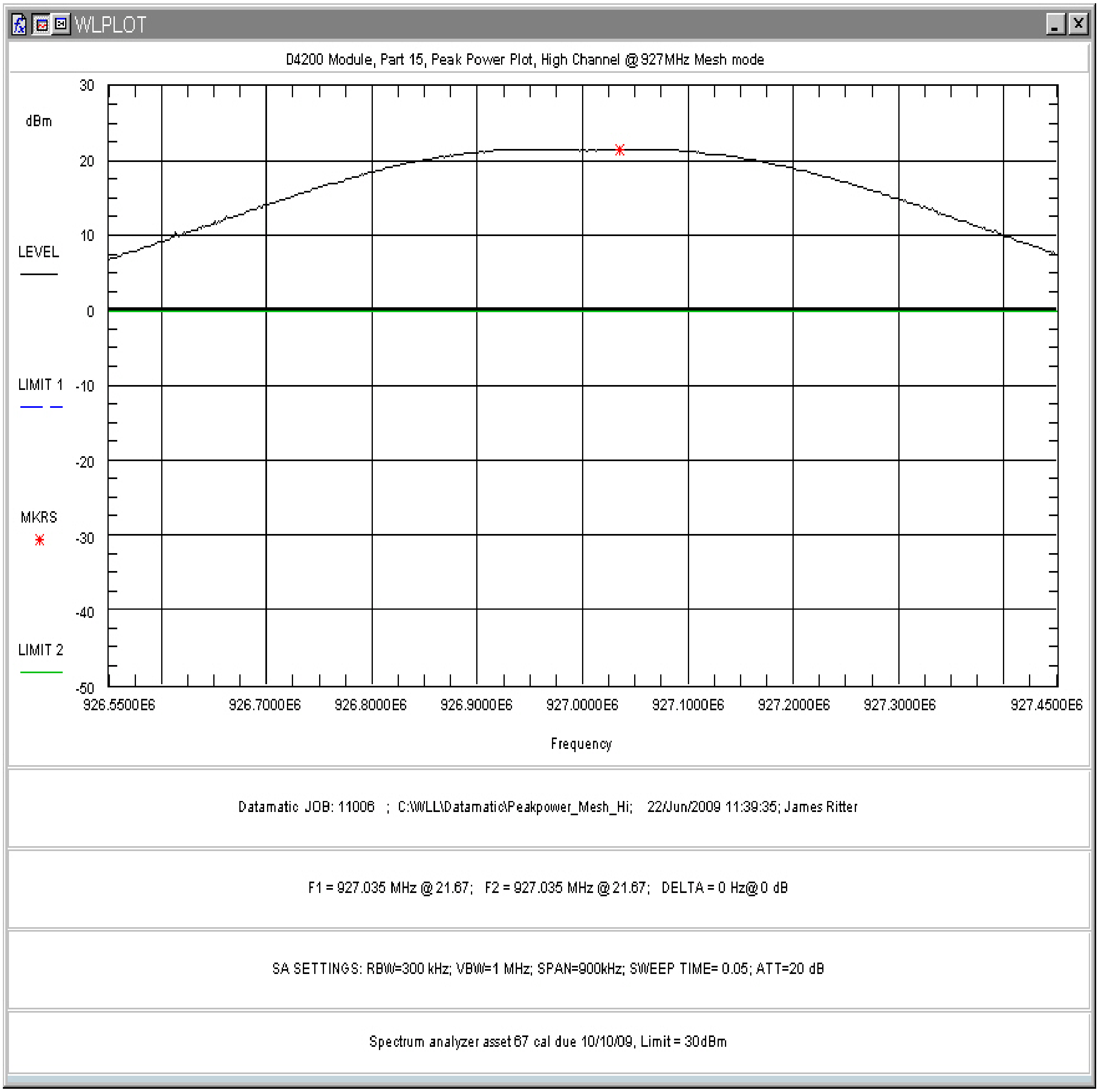

Figure 4: RF Peak Power, High Channel, Mesh Mode

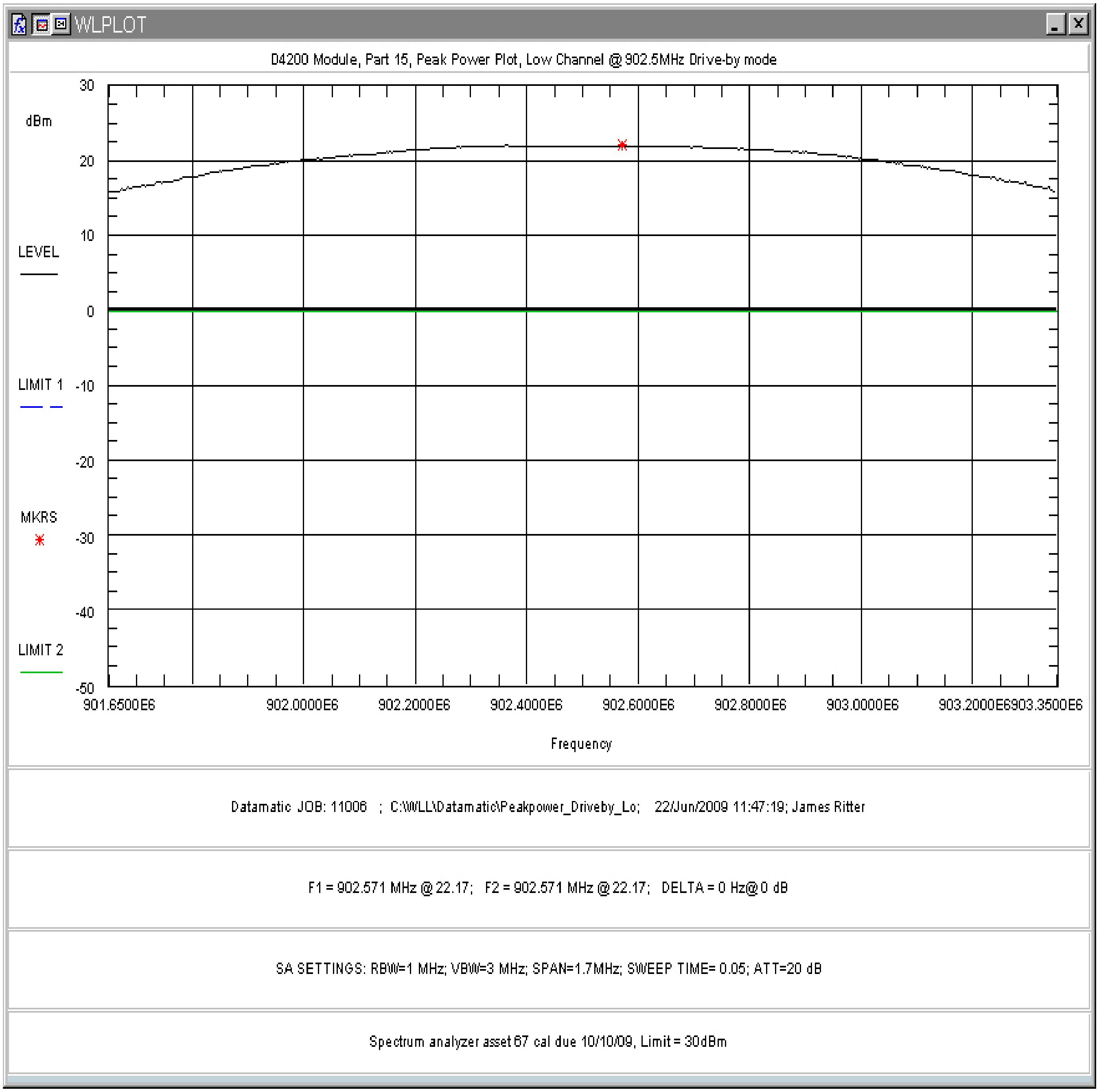

Figure 5: RF Peak Power, Low Channel, Drive-by Mode

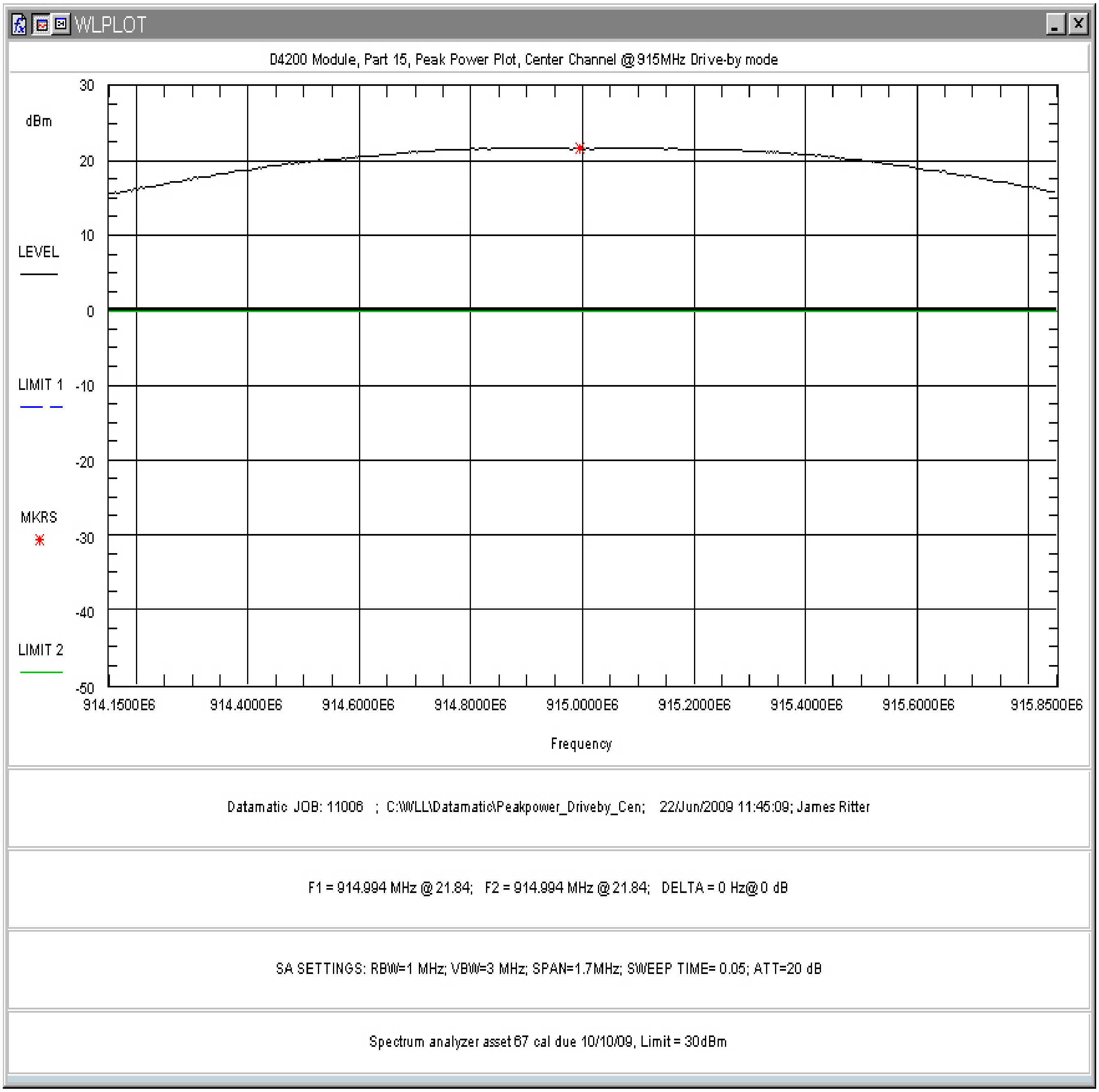

Figure 6: RF Peak Power, Center Channel, Drive-by Mode

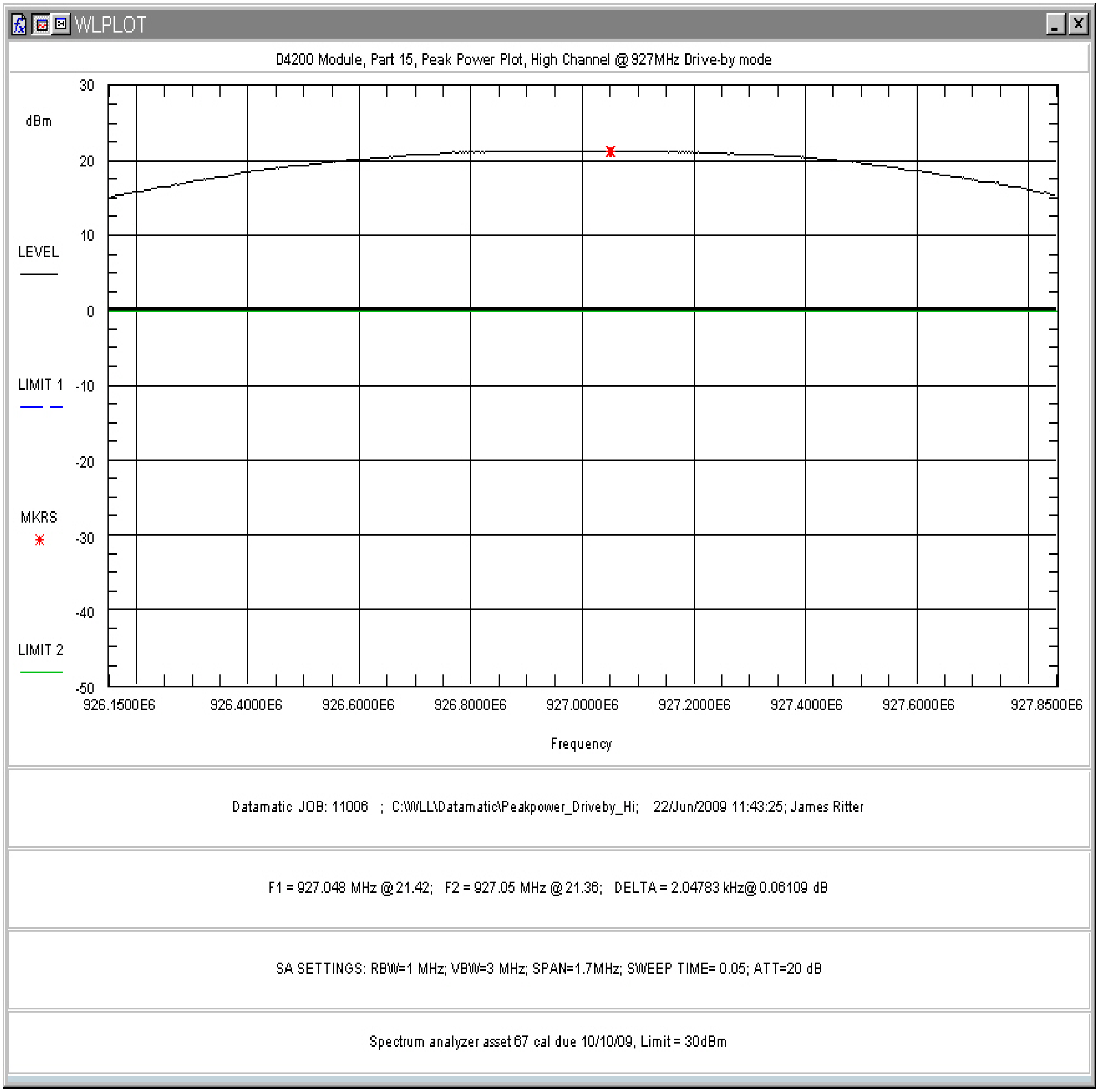

Figure 7: RF Peak Power, High Channel, Drive-by Mode

4.3 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. The EUT was testing in the 2 available modes, Mesh mode and Drive-by mode.

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

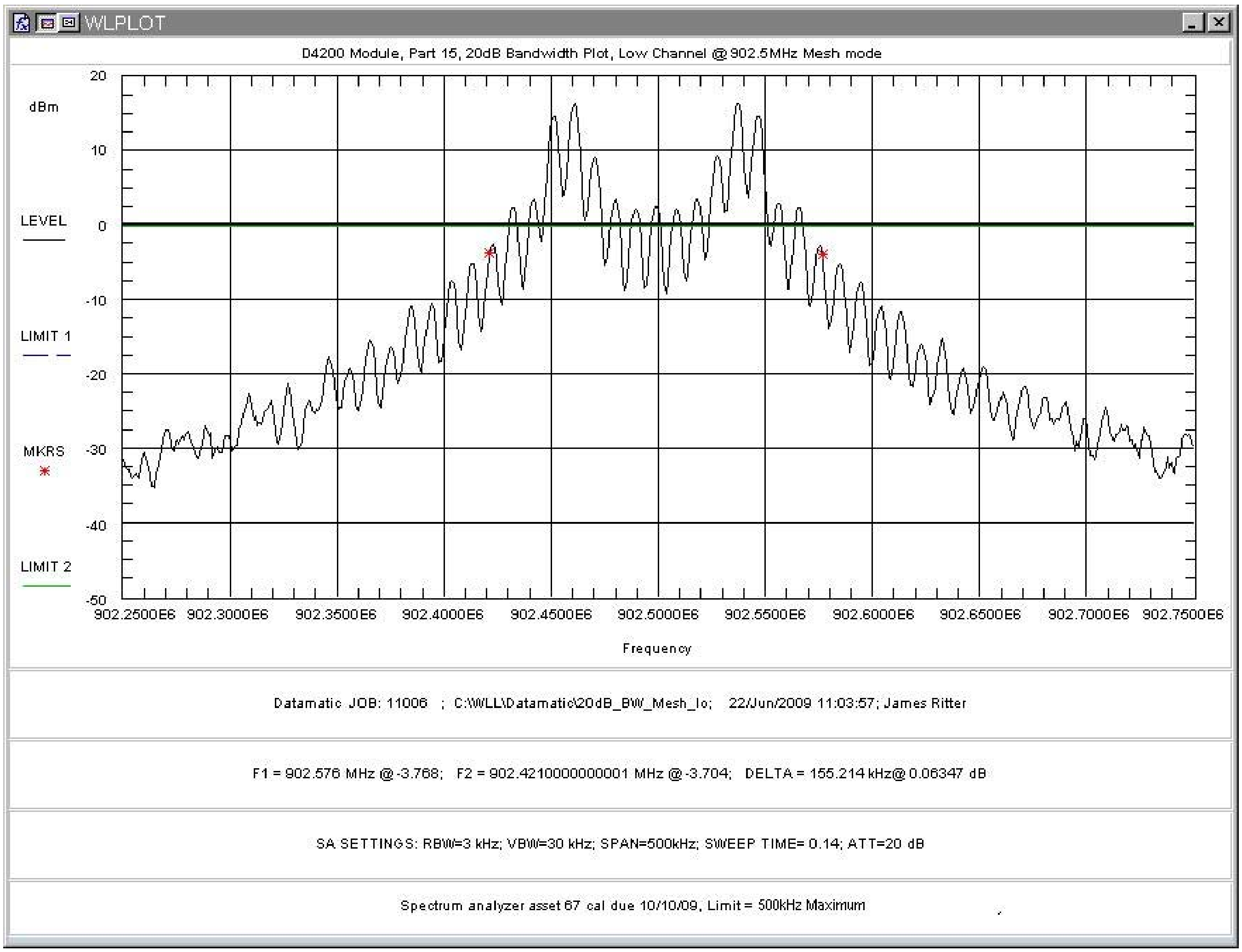

Figure 8: Occupied Bandwidth, Low Channel, Mesh Mode

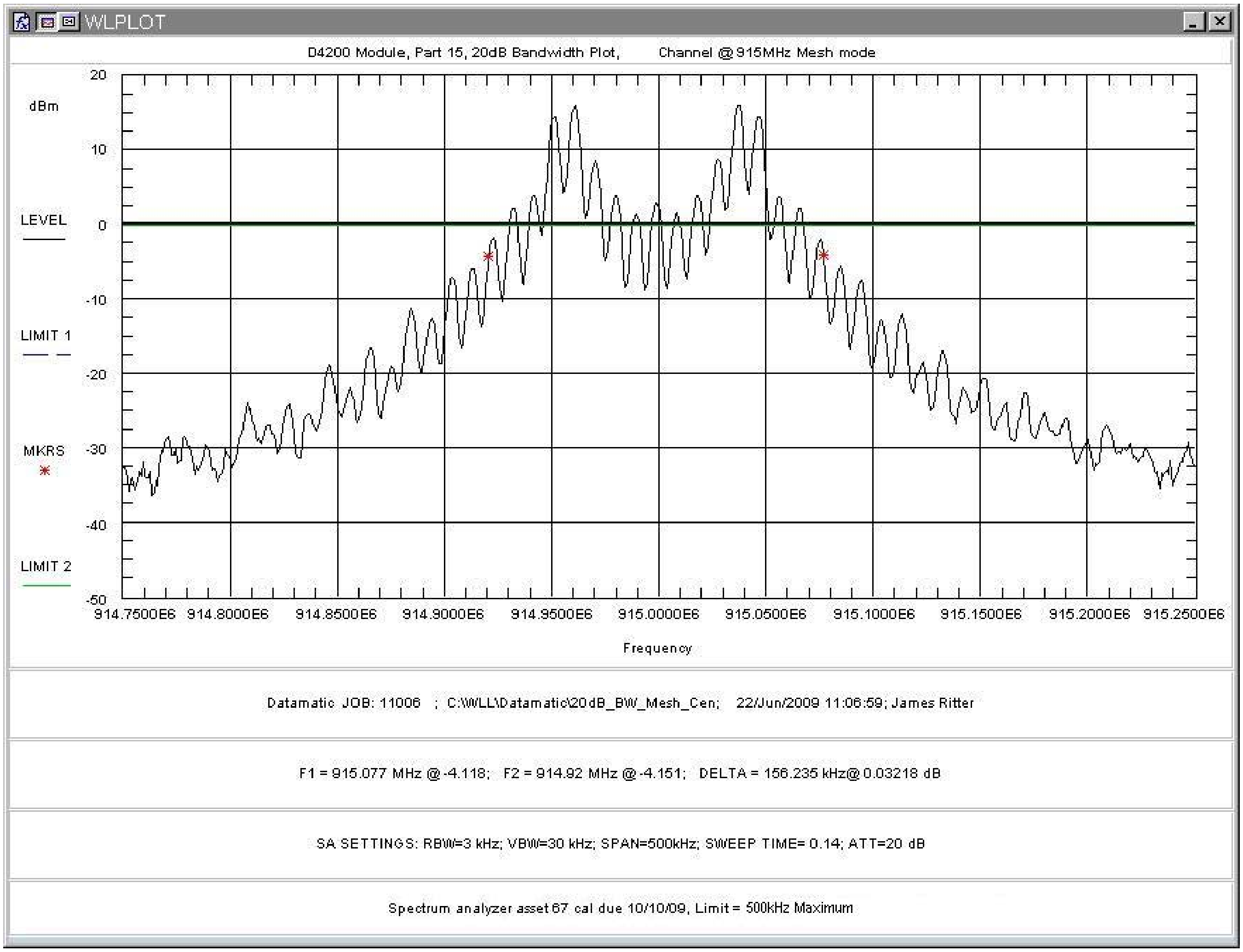

Figure 9: Occupied Bandwidth, Center Channel, Mesh Mode

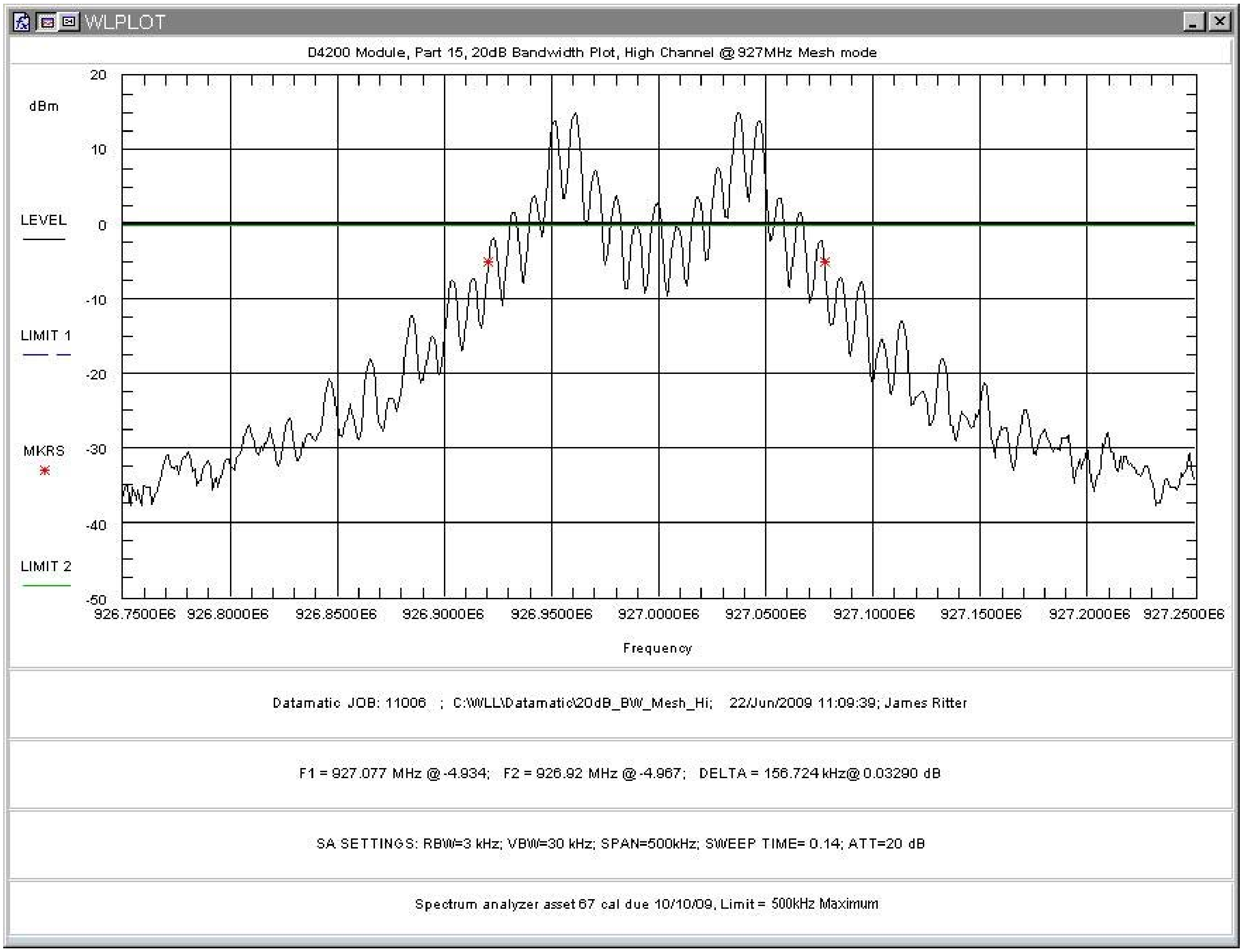

Figure 10: Occupied Bandwidth, High Channel, Mesh Mode

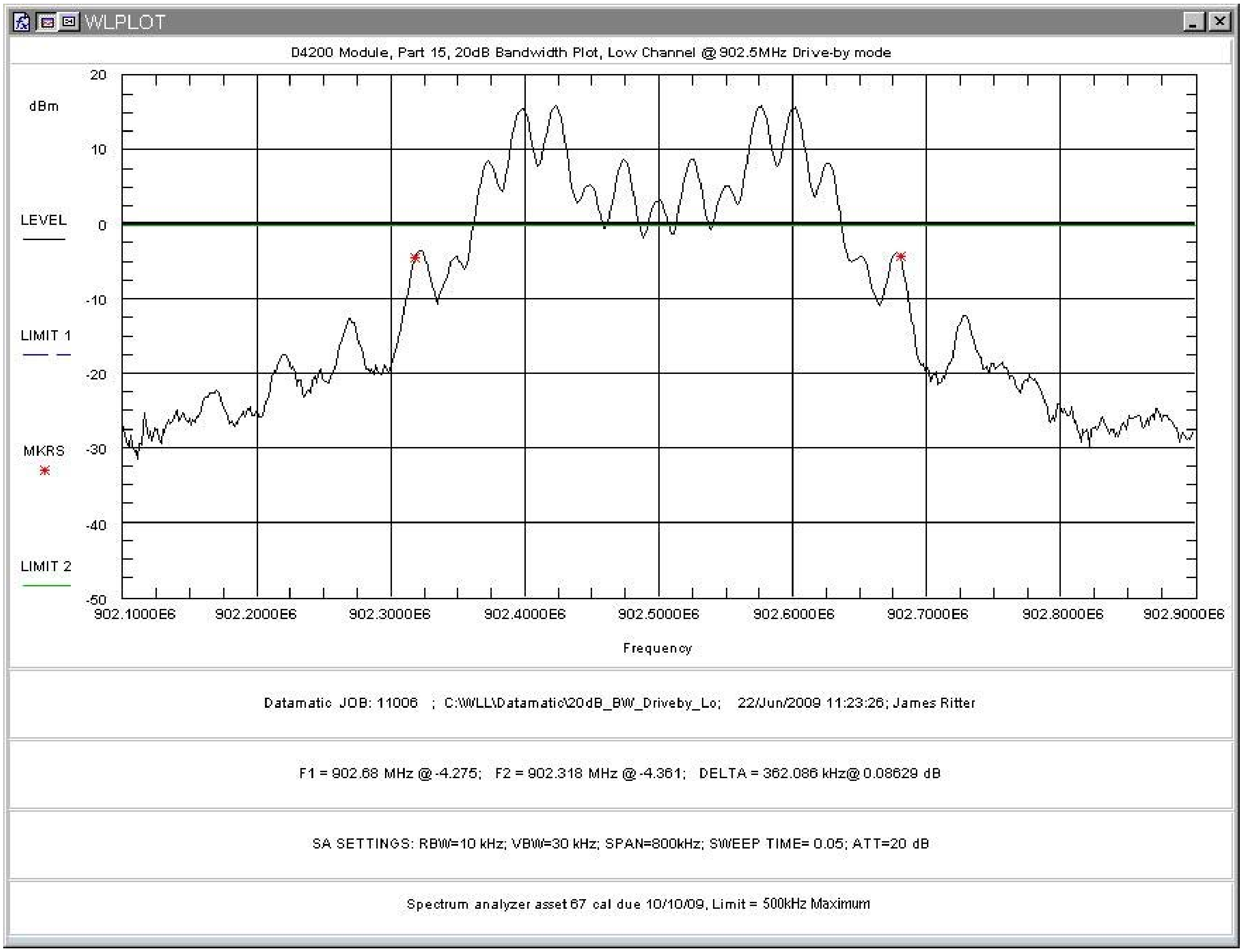

Figure 11: Occupied Bandwidth, Low Channel, Drive-by Mode

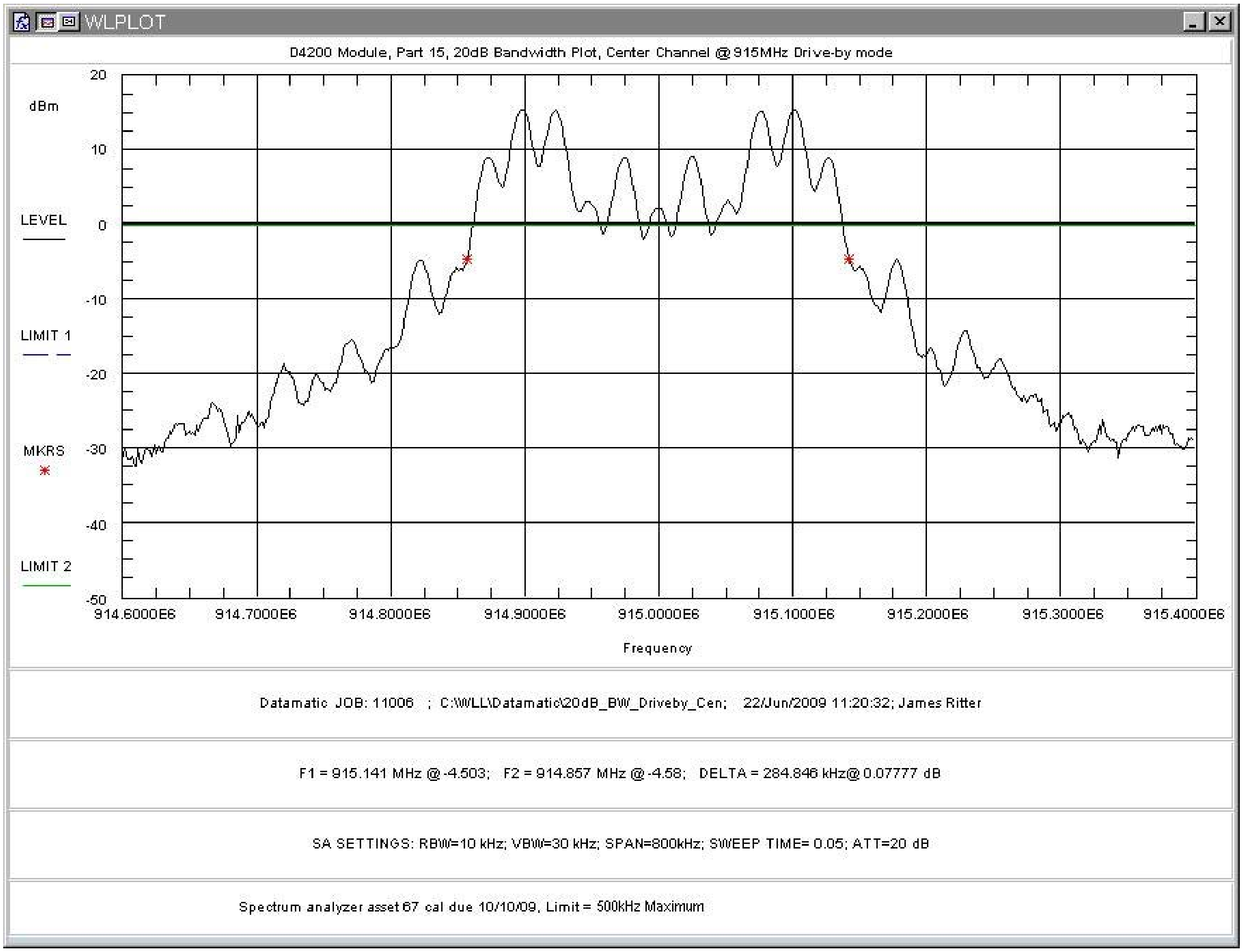

Figure 12: Occupied Bandwidth, Center Channel, Drive-by Mode

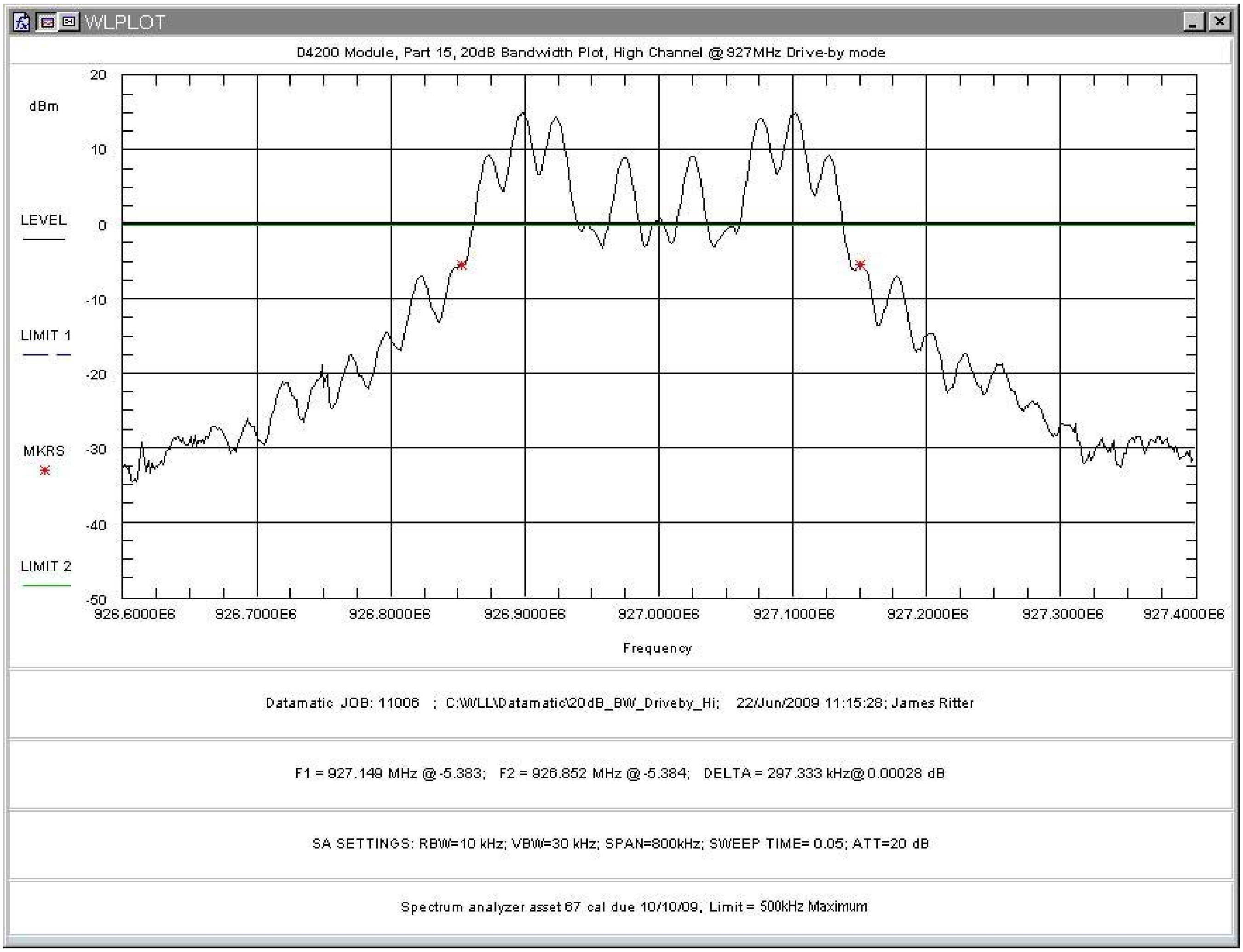

Figure 13 Occupied Bandwidth, High Channel, Drive-by Mode

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Mesh Mode

Frequency	Bandwidth	Limit	Pass/Fail
Low Channel: 902.5MHz	155.2kHz	500kHz	Pass
Mid Channel: 915MHz	156.2kHz	500kHz	Pass
High Channel: 927MHz	156.7kHz	500kHz	Pass

Drive-by Mode

Frequency	Bandwidth	Limit	Pass/Fail
Low Channel: 902.5MHz	362.1kHz	500kHz	Pass
Mid Channel: 915MHz	284.9kHz	500kHz	Pass
High Channel: 927MHz	297.3kHz	500kHz	Pass

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

Per the FCC requirements, frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 362.1 kHz so the channel spacing must be more than 362.1 kHz. In addition, for a 902-928 MHz transmitter the number of hopping channels shall be stated.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 1.5MHz. Also, the number of hopping channels was measured from 902MHz to 928MHz.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 500 kHz and the number of channels used is 50. The EUT was testing in the 2 available modes, Mesh mode and Drive-by mode.

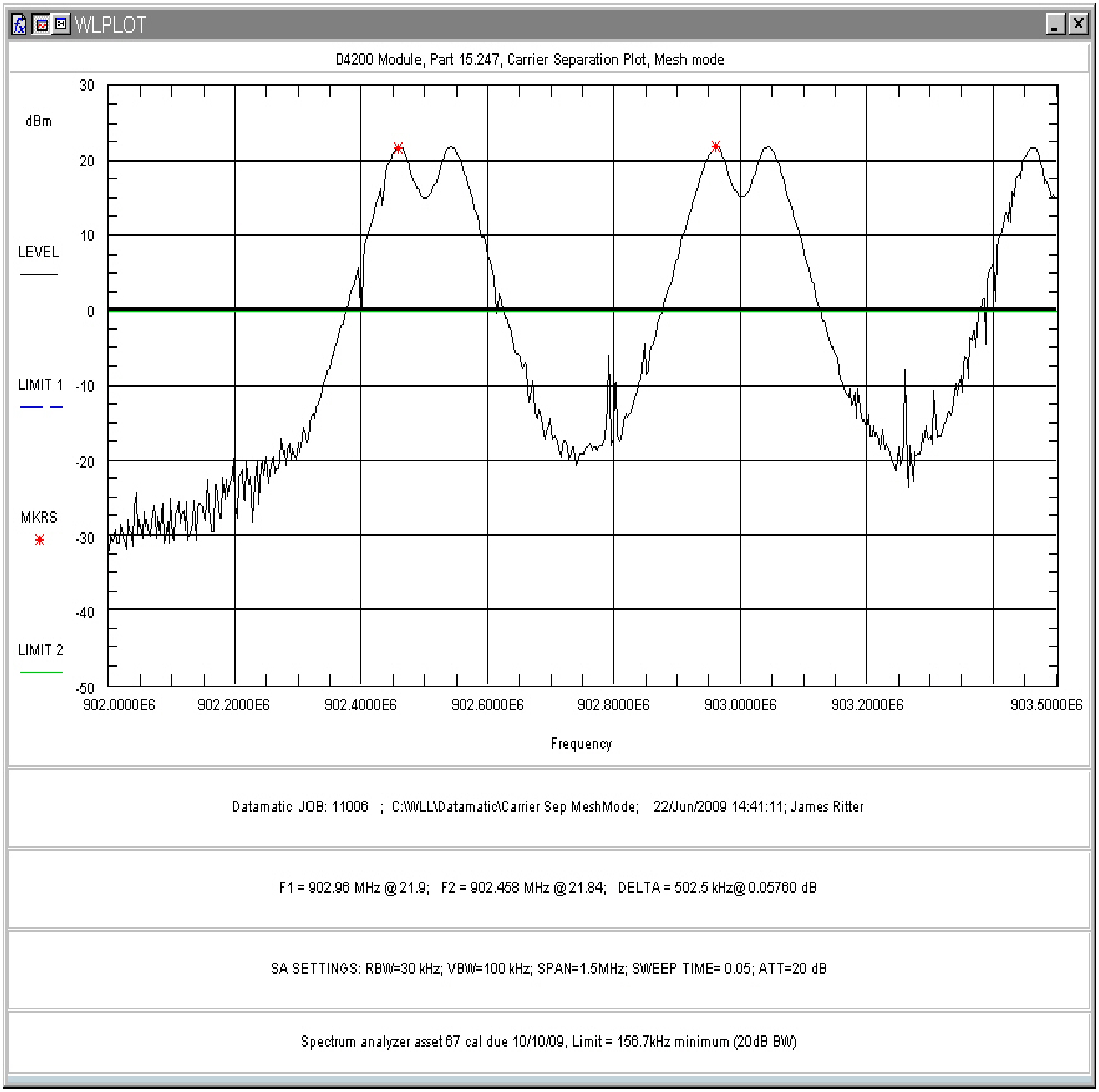

Figure 14: Channel Spacing, Mesh Mode

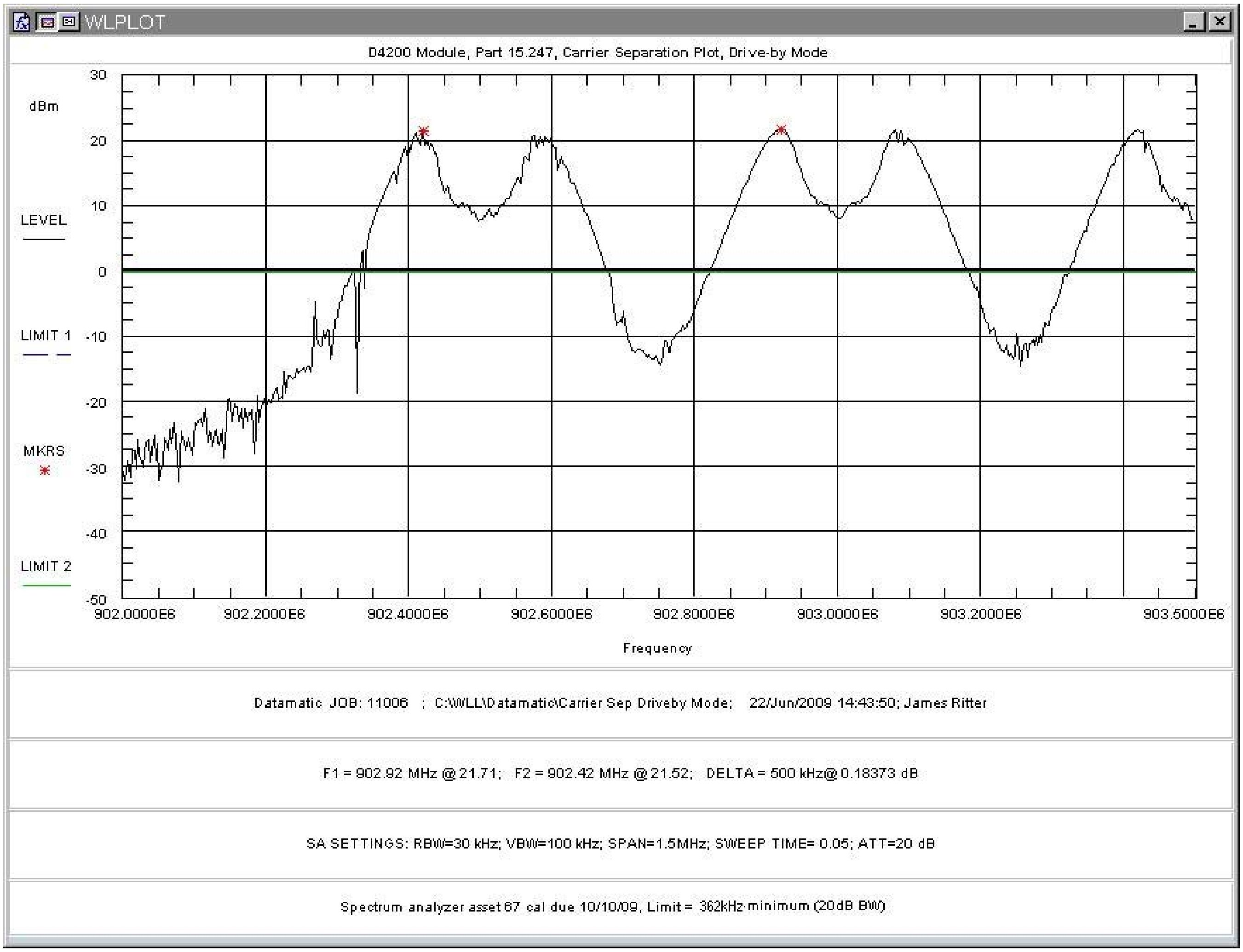

Figure 15: Channel spacing, Drive-by Mode

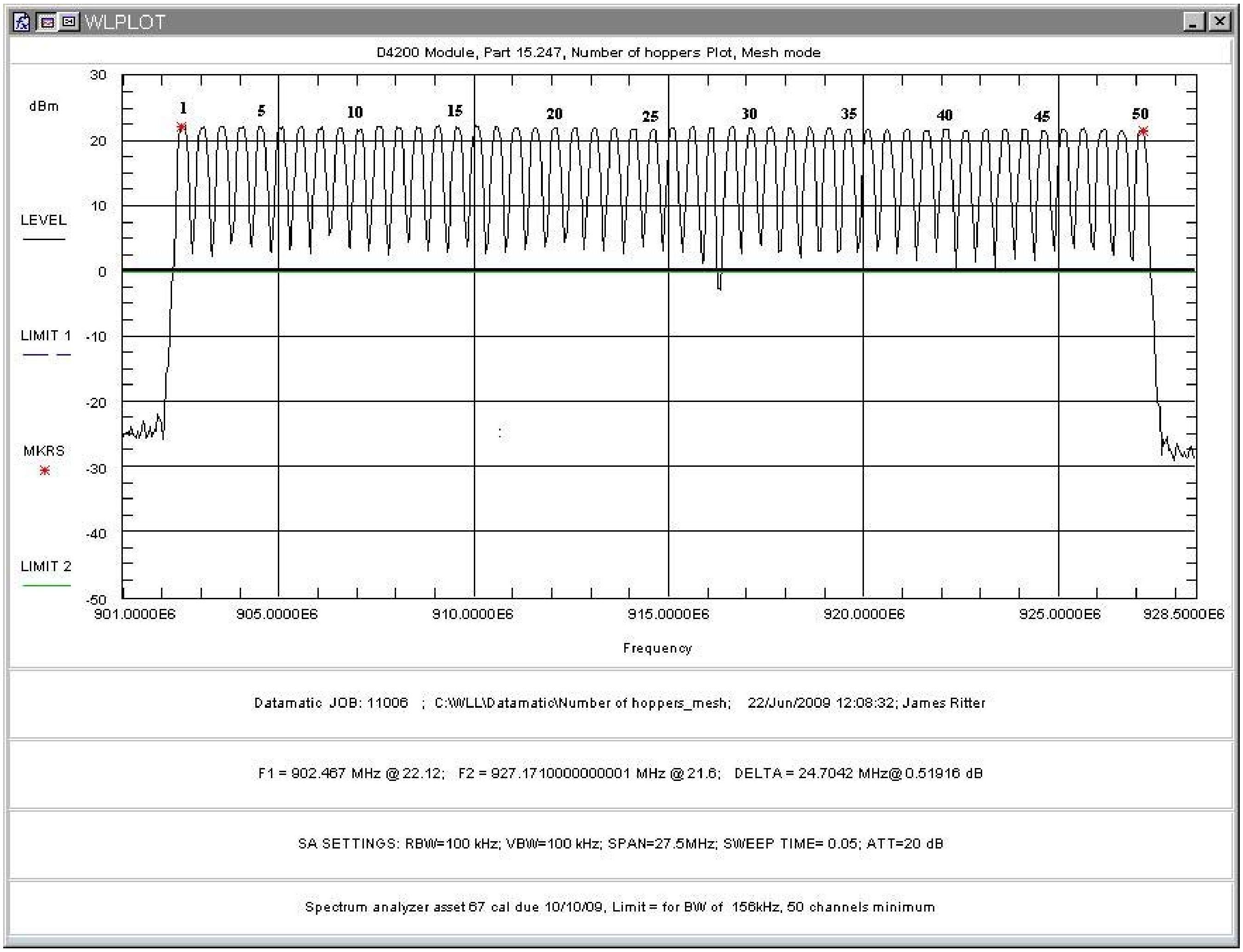

Figure 16: Number of Channels, Mesh Mode

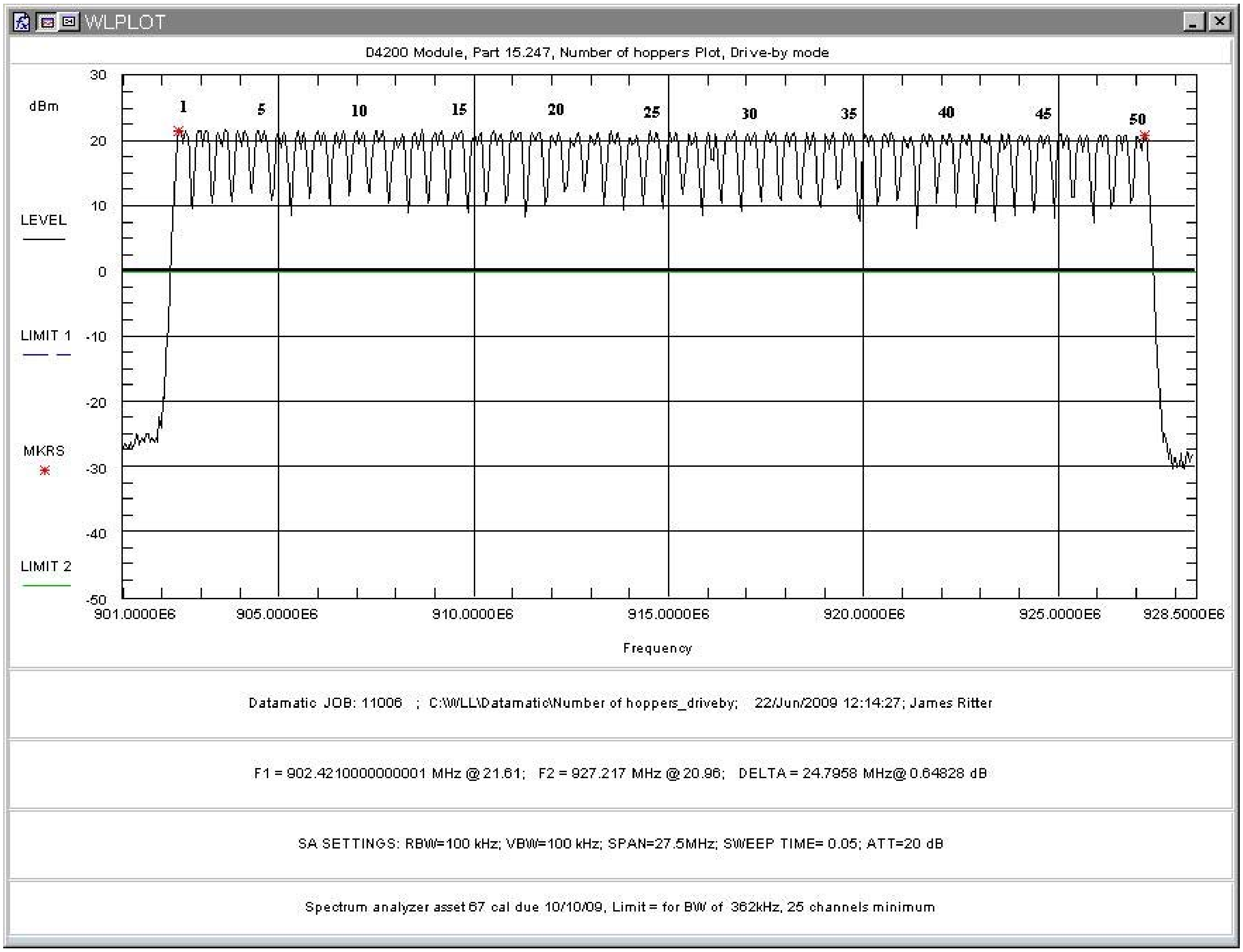

Figure 17: Number of Channels, Drive-by Mode

4.5 Channel Time of Occupancy

As per Per §15.247(a) (1)(i) frequency hopping systems operating in the 902-928 MHz band must have an average time of occupancy on any frequency not greater 0.4 seconds within a 20 second period for channel bandwidths less than 250kHz. For systems with bandwidths greater than 250kHz the time of occupancy shall not be greater than 0.4 seconds per 10 second period.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to >100 kHz. The spectrum analyzer was set to zero span and the dwell time of an individual channel hop was measured. The analyzer was then set to the appropriate time interval (10 or 20 seconds) and the number of times the channel occurred was recorded and multiplied by the bandwidth of that pulse. The total time must be less than 0.4 seconds.

The following table and plots show the results for Mesh mode and Drive-by mode.

Table 6: Time of Occupancy Results

Mesh Mode

Frequency	Time per Hop (ms)	Number of Hops per 20Sec	Total Dwell Time (ms)	Limit (ms)	Results
902.5MHz	108.3	1	108.3	400	Pass

Drive-by Mode

Frequency	Time per Hop (ms)	Number of Hops per 10Sec	Total Dwell Time (ms)	Limit (ms)	Results
902.5MHz	40	1	40	400	Pass

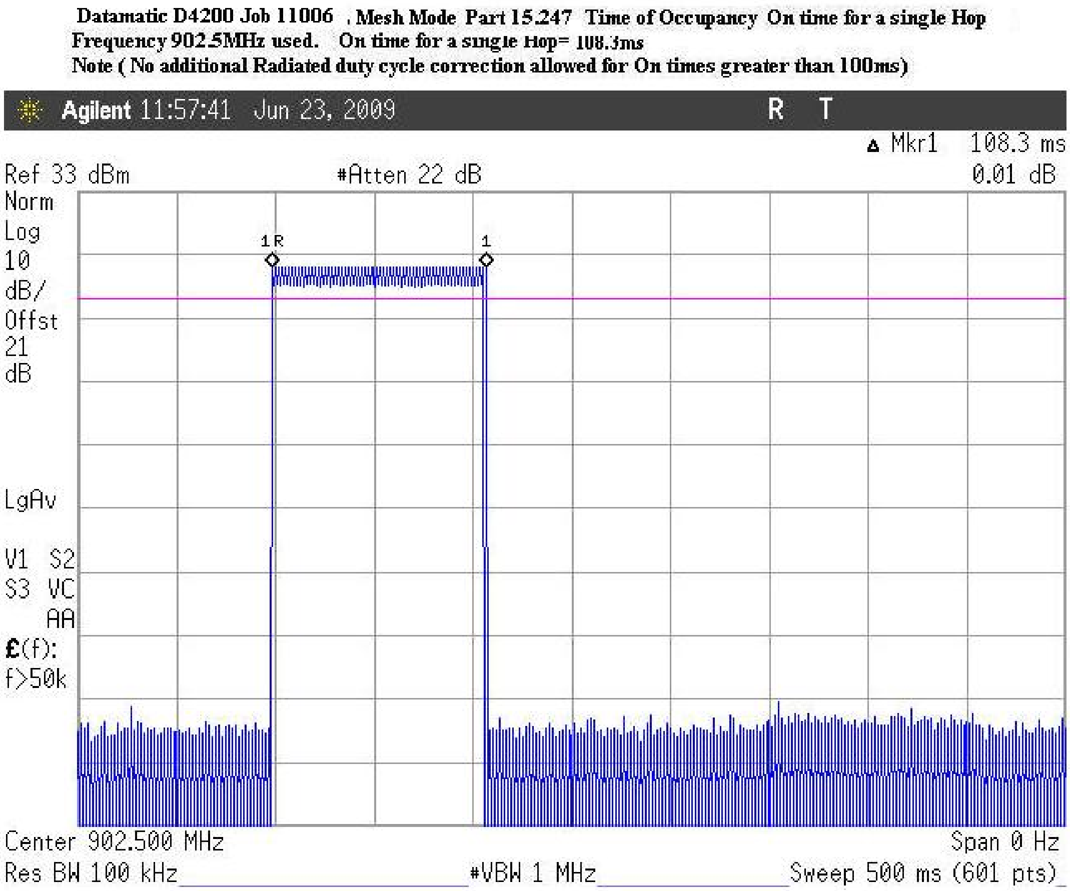

Figure 18: Time of Occupancy, Dwell time per hop, Mesh Mode

