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FCC & Industry Canada Certification Test Report

For the

Quatech Inc.

Airborne WLAN Module

FCC ID: F4AWLNG551

IC: 3913A-WLNG551

WLL JOB# **11843-01**
February 28, 2011

Prepared for:

Quatech Inc.
5675 Hudson Industrial Parkway
Hudson, OH 44236

Prepared By:

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

ACCREDITED TESTING

Testing Certificate AT-1448

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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 Quatech Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Direct Sequence 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 the Quatech Inc. Airborne WLAN 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 Quatech Inc. Airborne WLAN Module complies with the limits for a Direct Sequence Spread Spectrum Transmitter under FCC Part 15.247 and Industry Canada RSS-210.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 28, 2011

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1 Introduction

1.1 Compliance Statement

The Quatech Inc. Airborne WLAN Module complies with the limits for a Direct Sequence Spread Spectrum Transmitter device under FCC Part 15.247 (10/2009) and Industry Canada RSS-210 issue 8.

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 FCC97-114, Guidance on Measurements for Direct Sequence Spread Spectrum Systems & KDB558074: "Measurement of Digital Transmission Systems operating under Section 15.247." The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Quatech Inc. 5675 Hudson Industrial Parkway Hudson, OH 44236
Quotation Number:	65979

1.4 Test Dates

Testing was performed on the following date(s):	2/2/2011- 2/14/2011

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, John Reidell
Client Representative	Scott Huling

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 Airborne WLAN Module is an industrialized 802.11b/g radio module for integration into an OEM's electronics.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Quatech Inc.
FCC ID:	F4AWLNG551
IC:	3913A-WLNG551
Model:	Airborne WLAN Module (Model Number: 930-8090-01C-G)
FCC Rule Parts:	§15.247
Industry Canada:	RSS210
Frequency Range:	2412 – 2462MHz
Maximum Output Power:	19.1 dBm (81.3mW) Peak
Modulation:	802.11b-DSSS, 802.11g- OFDM
Occupied Bandwidth:	802.11b-13.11MHz, 802.11g- 16.67MHz
Maximum Spurious TX:	370uV/m @3m – 12.006GHz
Maximum Spurious RX:	127.6uV/m @3m -1320.7MHz
Emission Designator:	13M1G1D, 16M7G1D
Keying:	Automatic
Type of Information:	Data
Number of Channels:	11
Antenna Connector	CN1 & CN2 antenna ports, U.FL connectors
Antenna Type	See Below- Highest Gain 5.5dBi
Power Output Level	Fixed
Interface Connector:	CN3 connector 36 pins, Hirose type DF12B
Power Source & Voltage:	3.3Vdc nominal, 3.0-3.6Vdc min-max.

2.2 Antenna Listings

The below antennas are proposed by the manufacturer for use with this device. Only the highest gain of each type has been tested for this report

Name/Description	Gain	Man/Model Number	Part Number
2.4 GHz 2.2dBi Reverse Polarity-SMA "Rubber Duck" Wireless LAN Antenna	2.2dBi	Quatech/ ACH2-AT-DP002	ACH2-AT-DP002
2.4 GHz 5.5dBi Reverse Polarity-SMA "Rubber Duck" Wireless LAN Antenna **	5.5dBi	Quatech/ ACH2-AT-DP003	ACH2-AT-DP003
2.4 GHz 5dBi IPEX MHF (U.FL) "Rubber Duck" Wireless LAN Antenna	5.0dBi	Quatech/ ACH2-AT-DP004	ACH2-AT-DP004
2.4 GHz 2dBi "Rubber Duck" with TNC Plug Reverse Polarity with IPEX MHF (U.FL) adapter cable.	2.0dBbi	Nearson/ S181xx-2450x	S181TR-2450S
Embedded Internal Antenna NanoBlue	2.0dBi	Laird (Centurion)/ NanoBlue-IP04	MAF94045
Embedded Internal Antenna NanoBlade **	3.8dBi	Laird (Centurion)/ NanoBlade-IP04	CAF94505
FXP.830 2.4/5 GHz Dual-band Dipole Antenna **	3.0dBi	taoglas/ FXP.830	FXP.830.07.0100C

** signifies antenna tested in this report

2.3 Test Configuration

The Airborne WLAN Module was configured as a standalone unit. 3.6VDC power was applied to the module from the support motherboard (via a 120VDC to 5VDC adaptor) that held the RF WLAN module. Onboard regulators on the module reduce the voltage to 3.3VDC

2.4 Testing Algorithm

The Airborne WLAN Module was programmed with command line entries via a support laptop Tera term communications program to transmit continuously at one of three channels, 2412MHz, 2437MHz, and 2462MHz. Worst case emission levels are provided in the test results data.

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 FCC97-114, Guidance on Measurements for Direct Sequence 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.

KDB558074: "Measurement of Digital Transmission Systems operating under Section 15.247."

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

Test Equipment Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name: **Bench Conducted RF Tests**		: **2/7/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
728	HP8564E	Spectrum Analyzer	4/30/12

Test Name: **Radiated Emissions**		Test Date: **02/14/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
71	HP - 85685A	PRESELECTOR RF	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
69	HP - 85650A	ADAPTER QP	7/1/2011
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	1/12/2012
474	HP - 8563E	ANALYZER SPECTRUM	2/28/2011
522	HP - 8449B	PRE-AMPLIFIER 1-26.5GHZ	7/27/2011
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	3/6/2011
667	MEGAPHASE - EM18-S1NK5-600	TEST CABLE FOR OATS TESTING DC TO 18 GHZ SMA MALE	5/7/2011
432	WLL - NONE	FILTER NOTCH 2.4GHZ-AMP INC.	3/24/2012
640	MEGAPHASE - TM40-K1K5-36	1G-40GHZ RIGHT ANGLE	1/3/2012

Test Name: **Conducted Emissions Voltage**		Test Date: **02/14/2011**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
72	HP - 8568B	ANALYZER SPECTRUM	6/22/2011
68	HP - 85650A	ADAPTER QP	6/22/2011
124	SOLAR - 8012-50-R-24-BNC	LISN	7/10/2011
78	HP - 11947A	LIMITER TRANSIENT	1/17/2012

3 Test Results

3.1 Test Summary

The Table Below shows the results of testing for compliance with a Direct Sequence Spread Spectrum System in accordance with FCC Part 15.247. Full results are shown in beginning in Section 4.2.

Table 4: Test Summary

TX Test Summary (Direct Sequence Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (2)	RSS-210 [A8. 2]	6dB Bandwidth	Pass
15.247 (2)(b)(3)	RSS-210 [A8.4]	Transmit Output Power	Pass
15.247 (e)	RSS-210 [A8.2 (b)]	Power Spectral Density	Pass
15.247 (d)	RSS-210 [A8. 5]	Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-210 Sect.2.2	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	Pass
RX/Digital Test Summary (Direct Sequence Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	Pass
15.209	RSS-210 sect 2.6	General Field Strength Limits	Pass

3.2 Occupied Bandwidth: (FCC Part §15.247 (2))

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. The lowest and highest data rates for each modulation type were evaluated.

For Direct Sequence Spread Spectrum Systems, FCC Part 15.247 requires the minimum 6 dB bandwidth using a 100 kHz Resolution bandwidth be greater than 500 kHz.

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

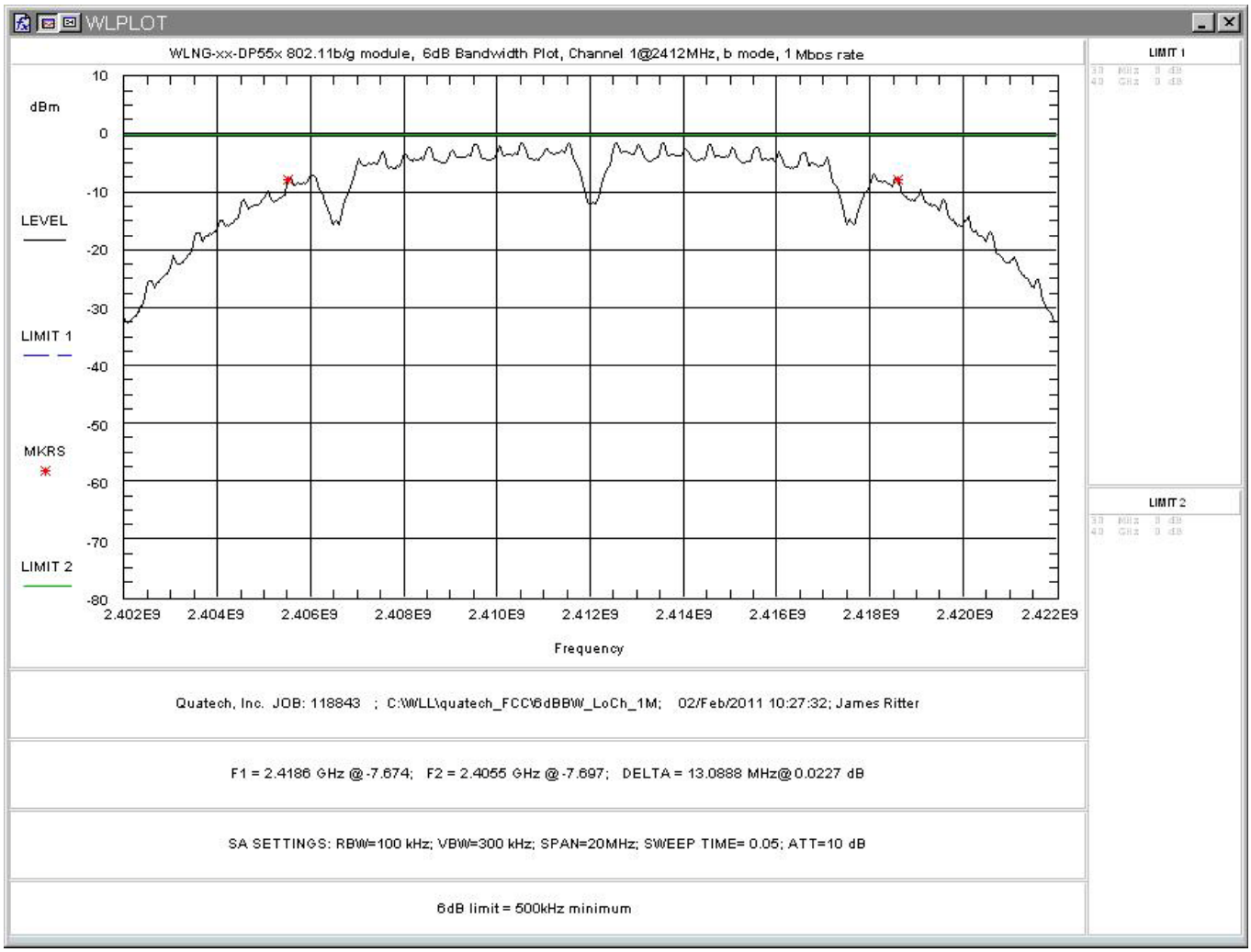

Figure 1: Occupied Bandwidth, 802.11b, 1Mbps, Channel 1

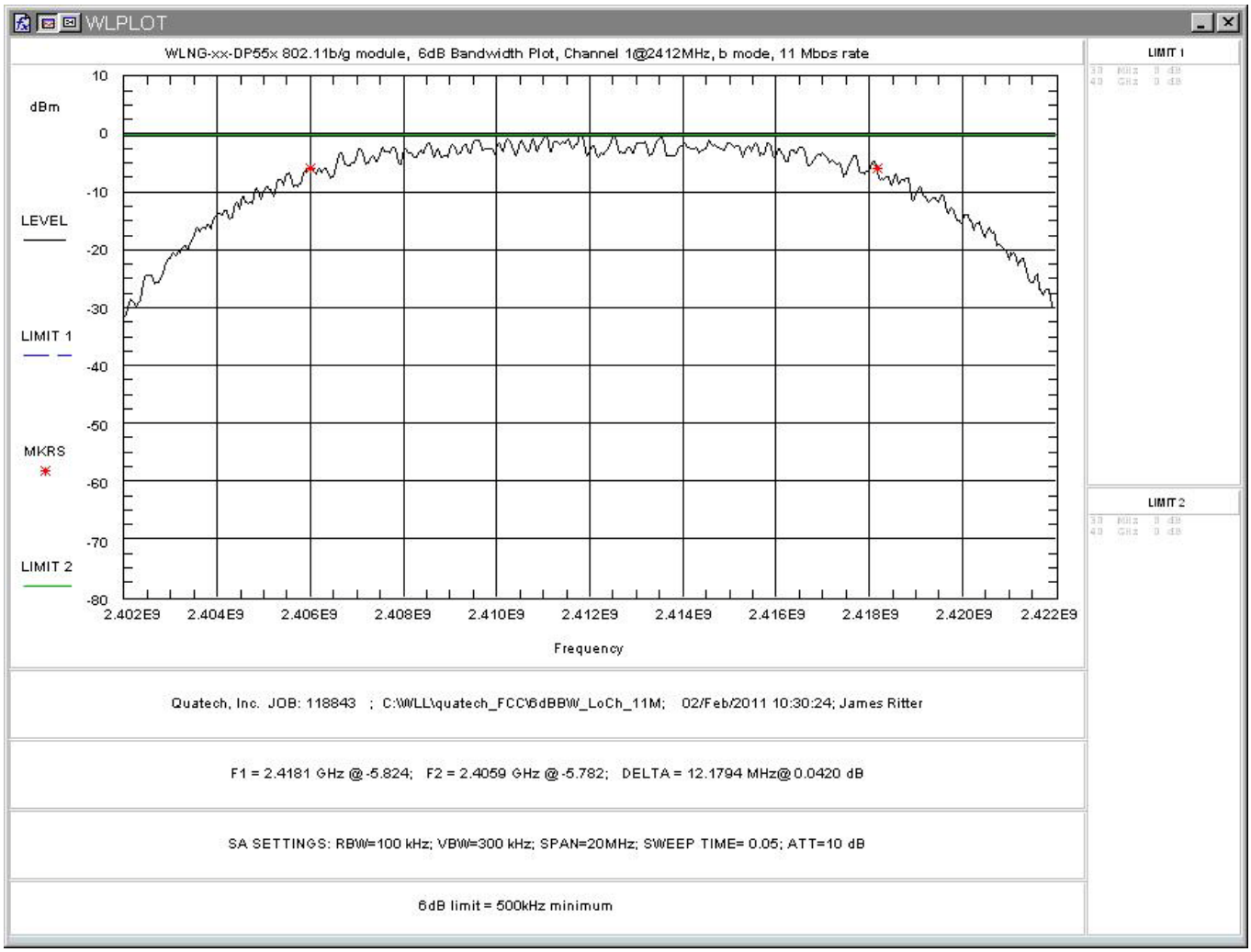

Figure 2: Occupied Bandwidth, 802.11b, 11Mbps, Channel 1

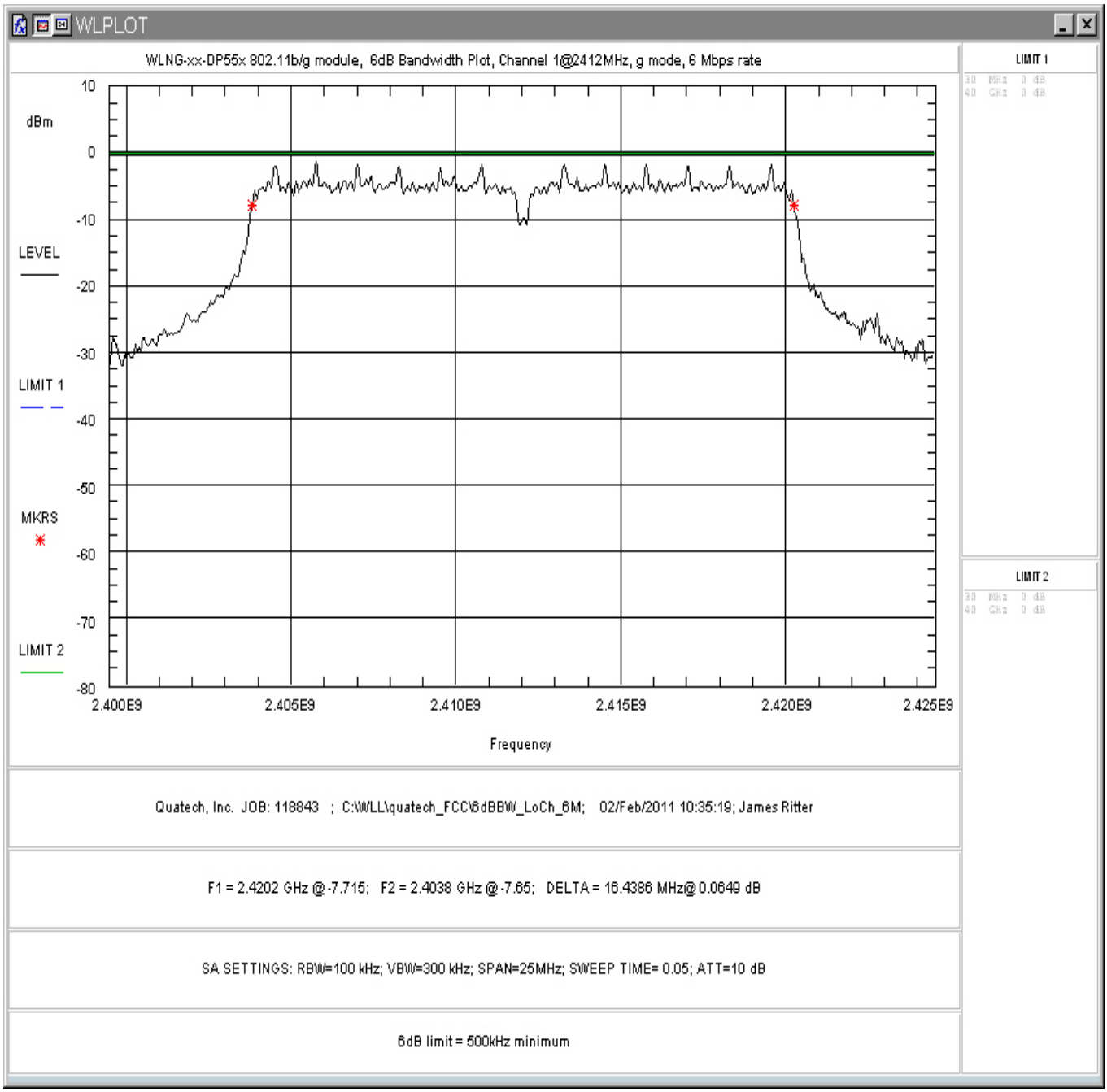

Figure 3: Occupied Bandwidth, 802.11g, 6Mbps, Channel 1

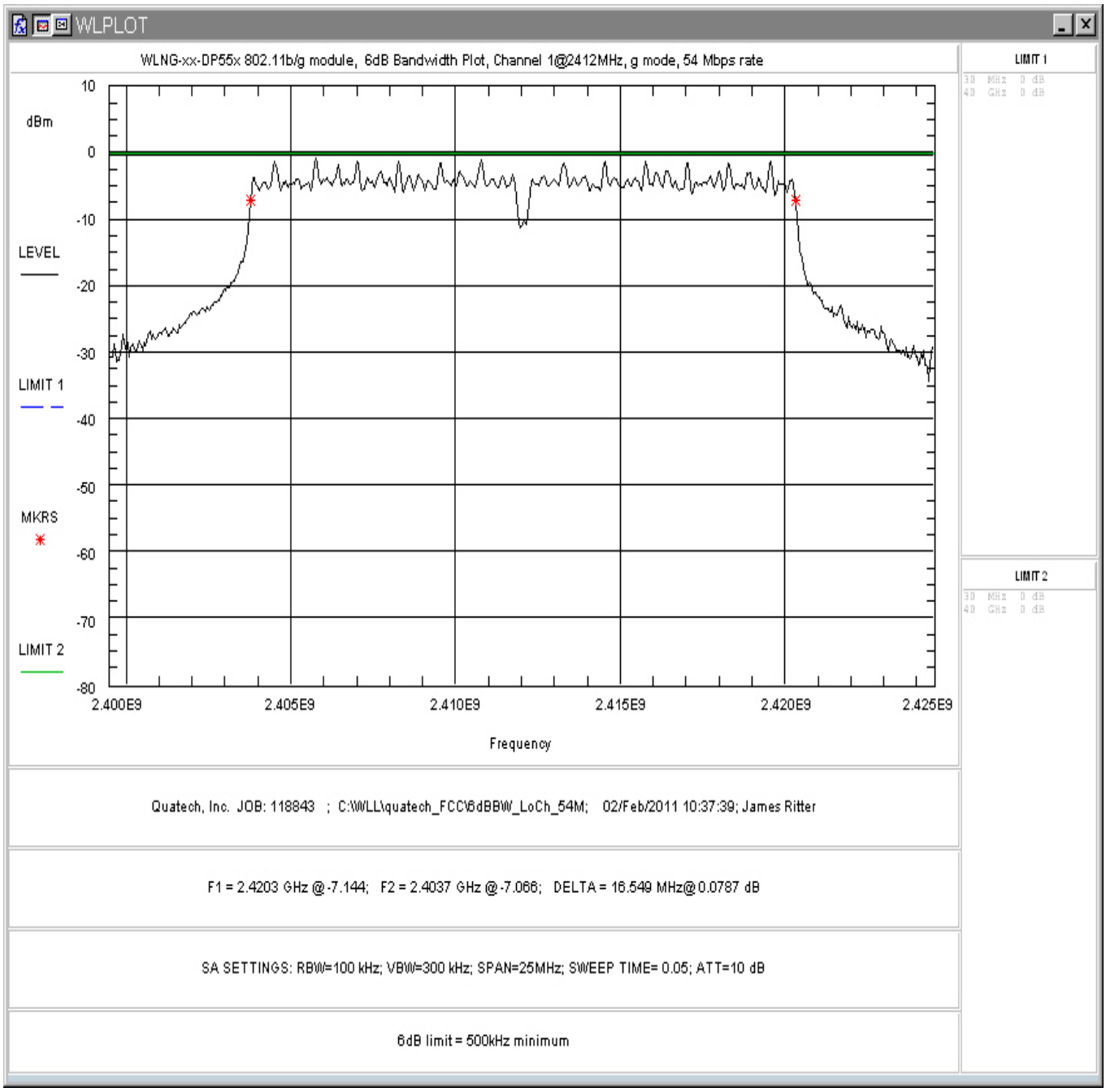

Figure 4: Occupied Bandwidth, 802.11g, 54Mbps, Channel 1

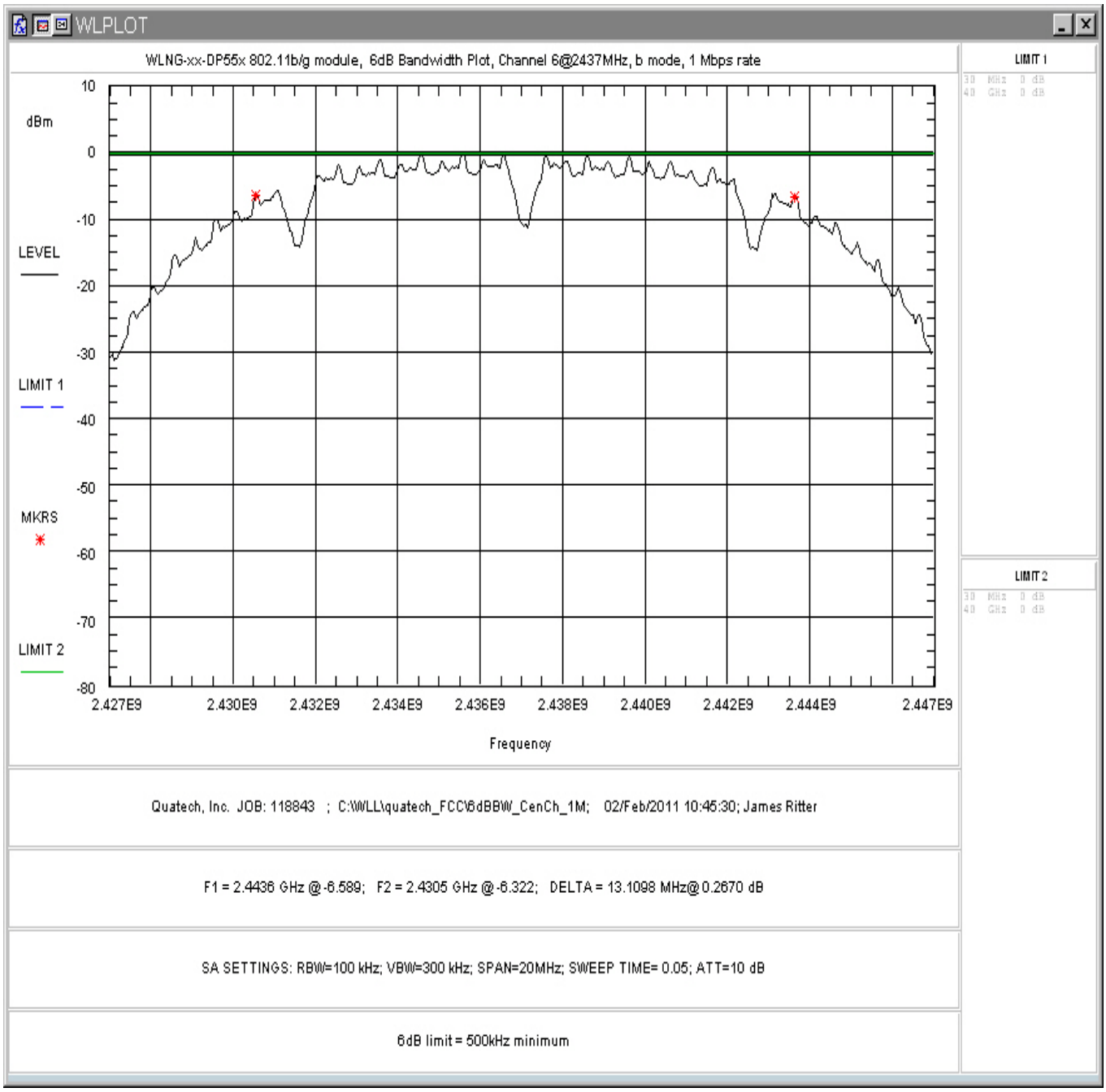

Figure 5: Occupied Bandwidth, 802.11b, 1Mbps, Channel 6

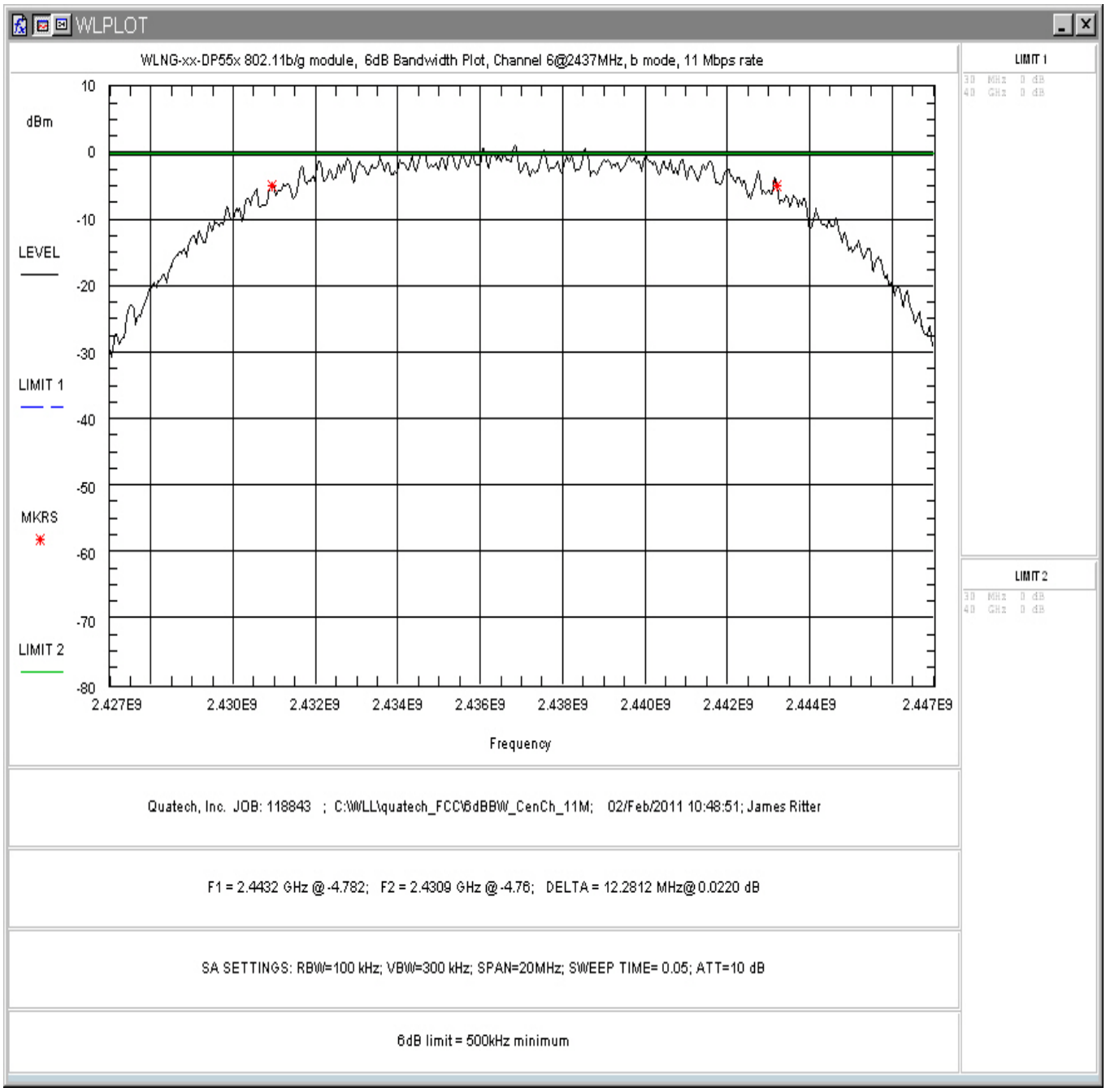

Figure 6: Occupied Bandwidth, 802.11b, 11Mbps, Channel 6

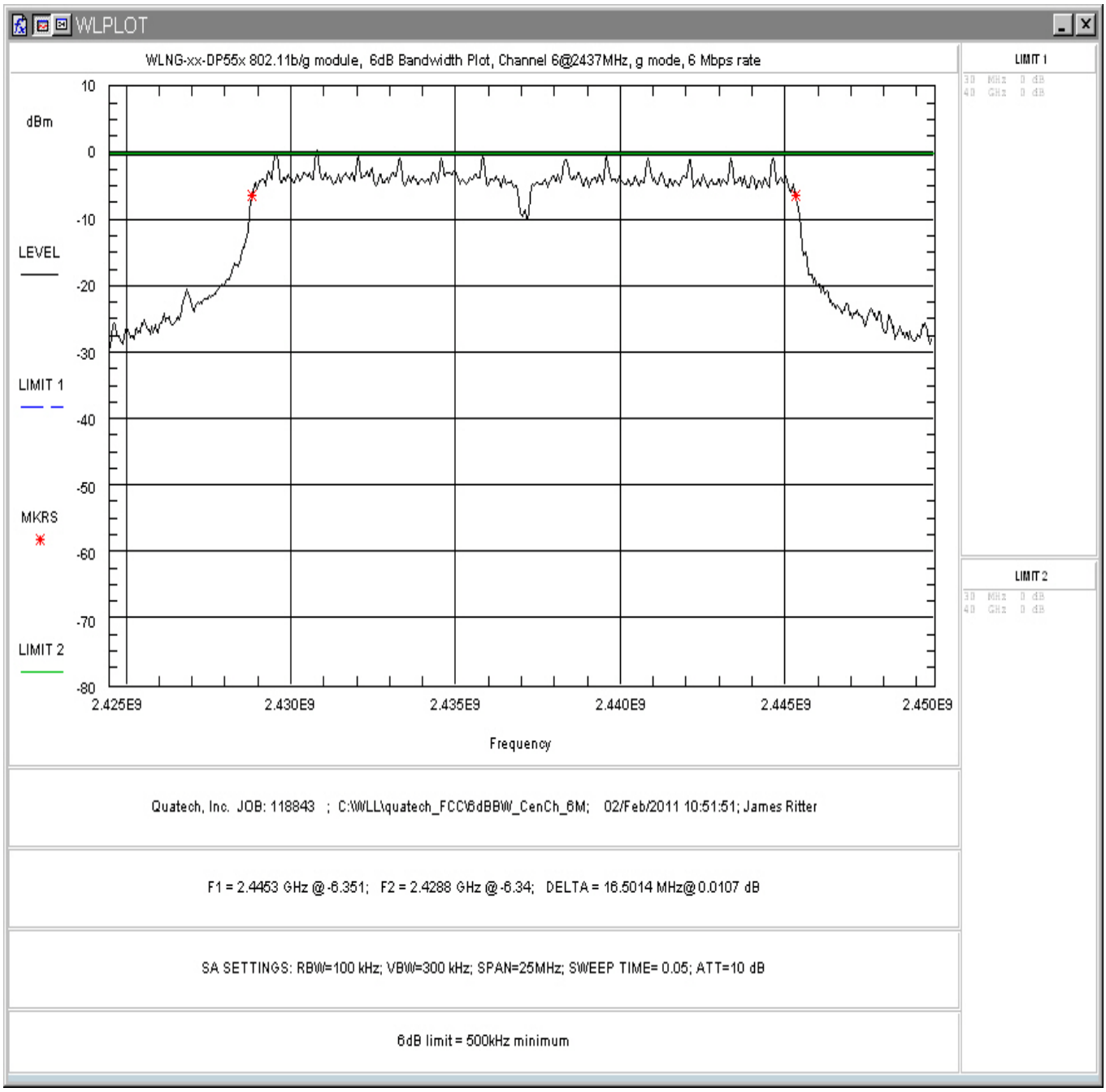

Figure 7: Occupied Bandwidth, 802.11g, 6Mbps, Channel 6

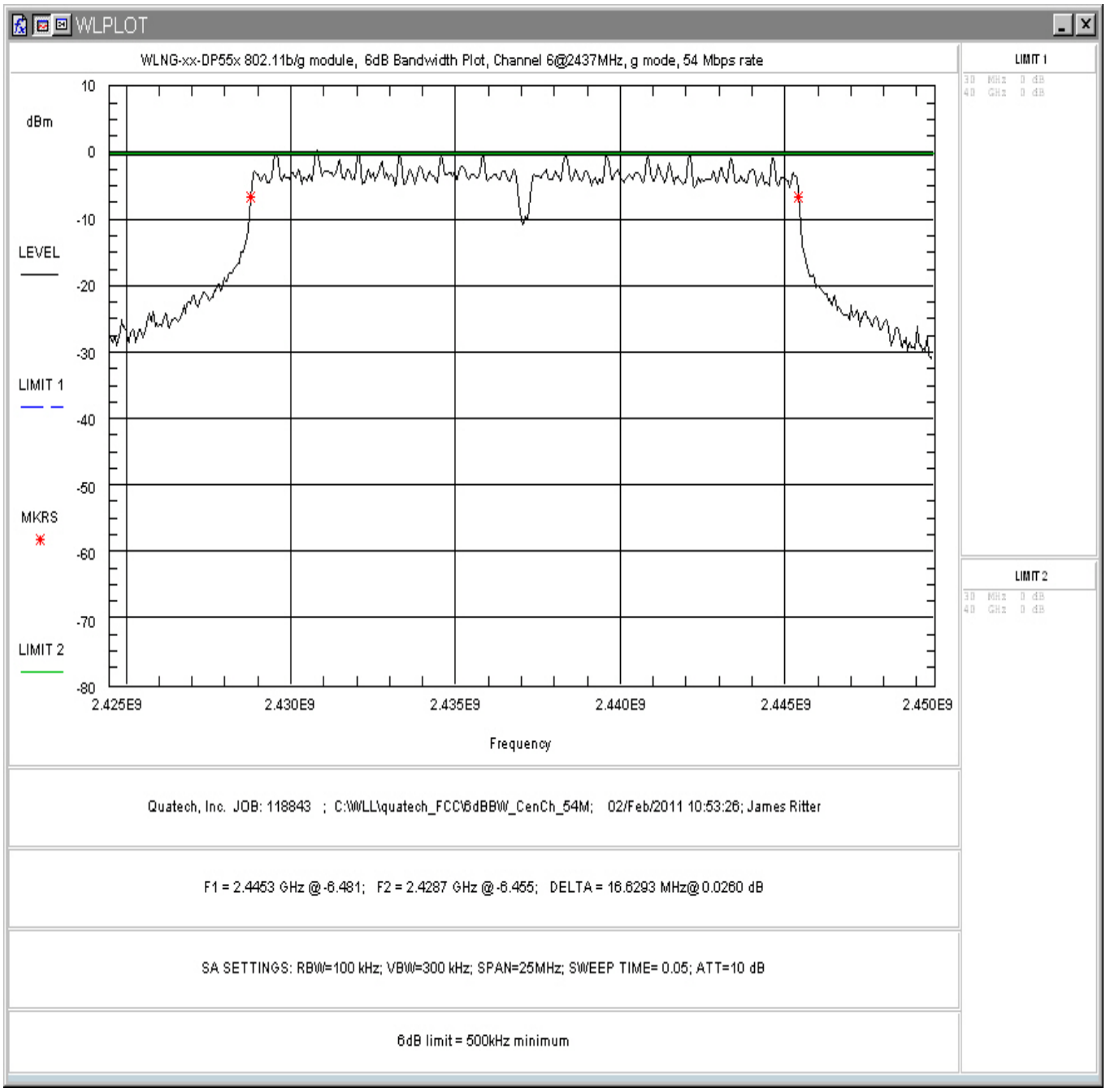

Figure 8: Occupied Bandwidth, 802.11g, 54Mbps, Channel 6

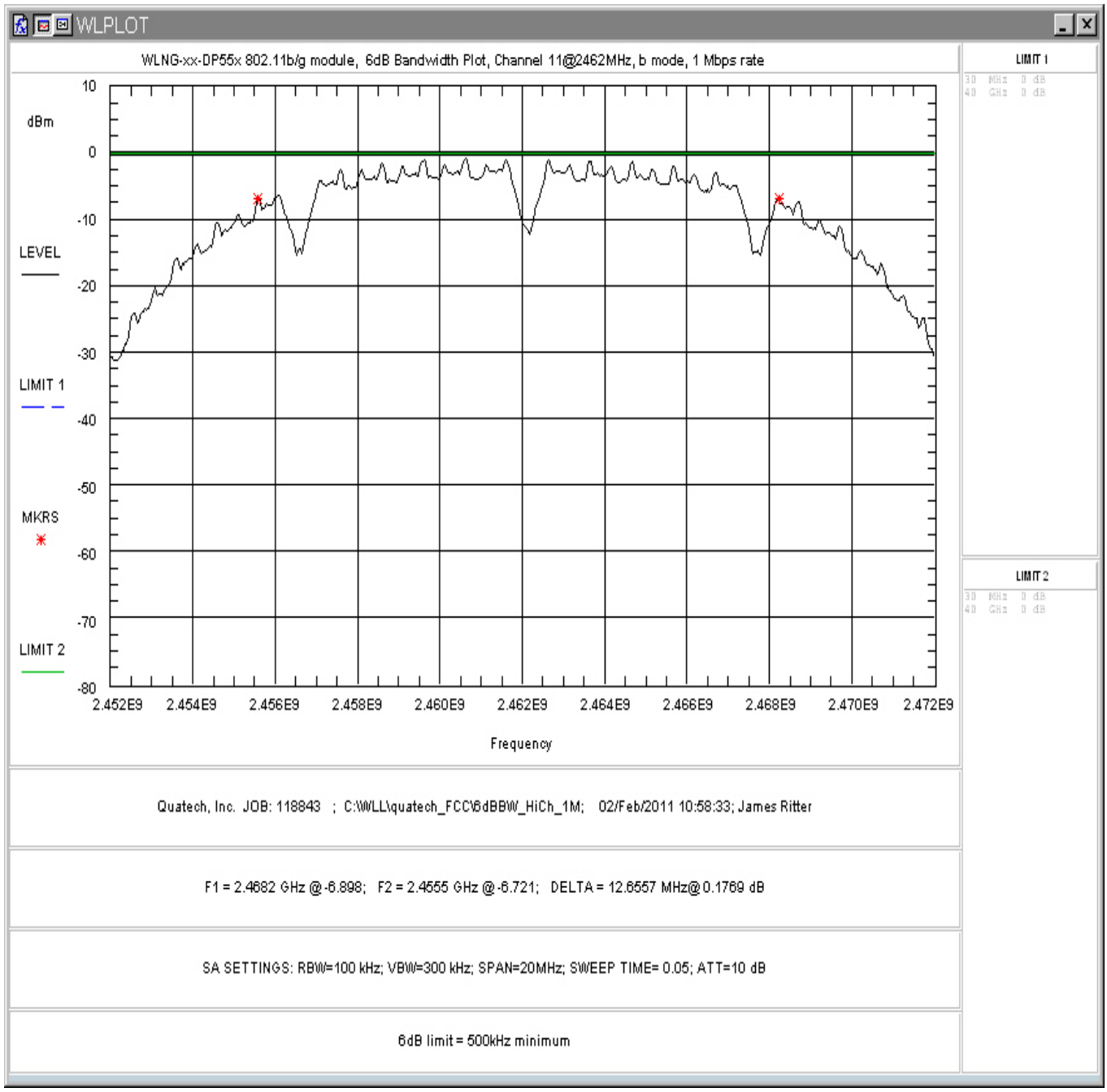

Figure 9: Occupied Bandwidth, 802.11b, 1Mbps, Channel 11

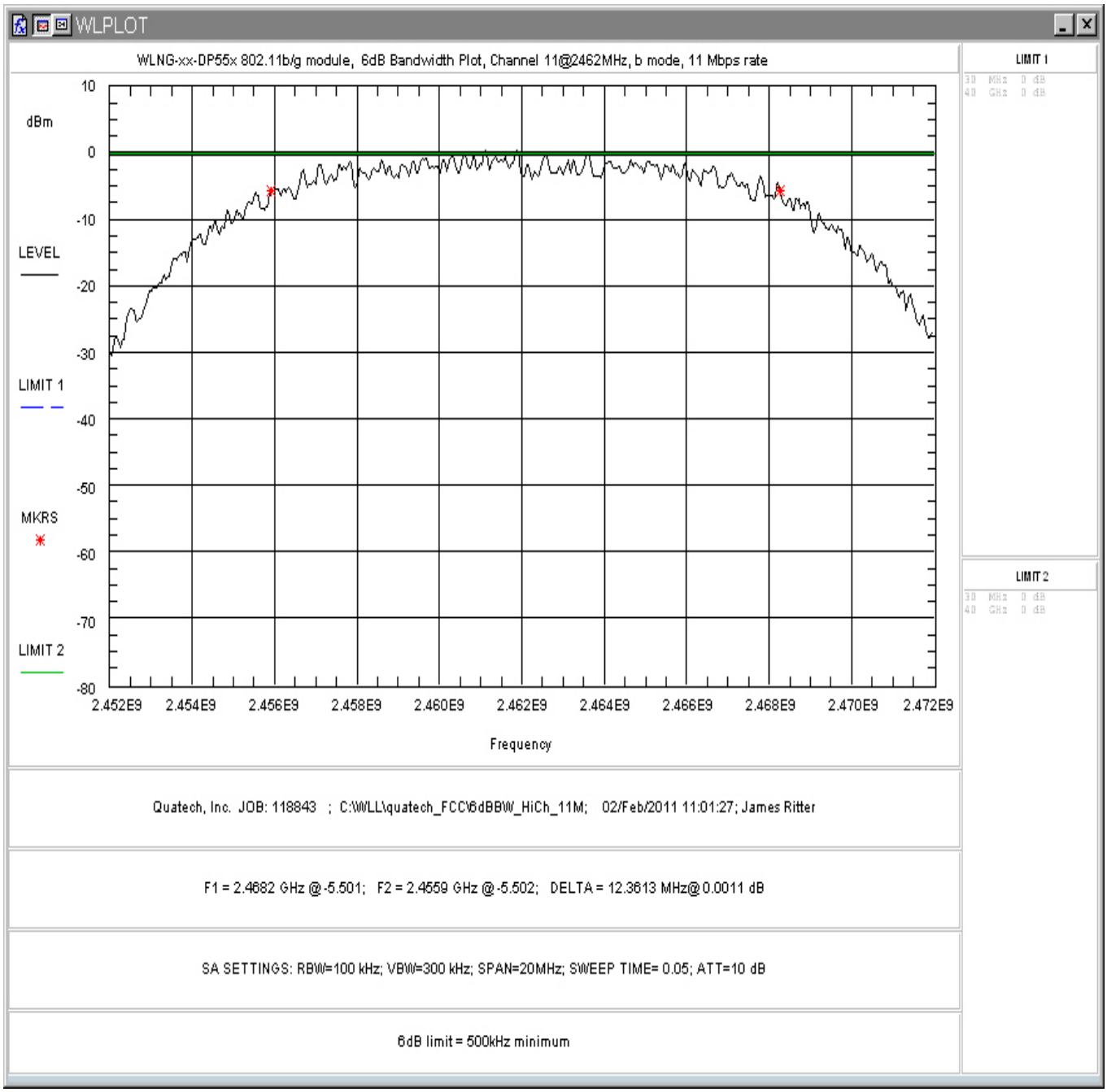

Figure 10: Occupied Bandwidth, 802.11b, 11Mbps, Channel 11

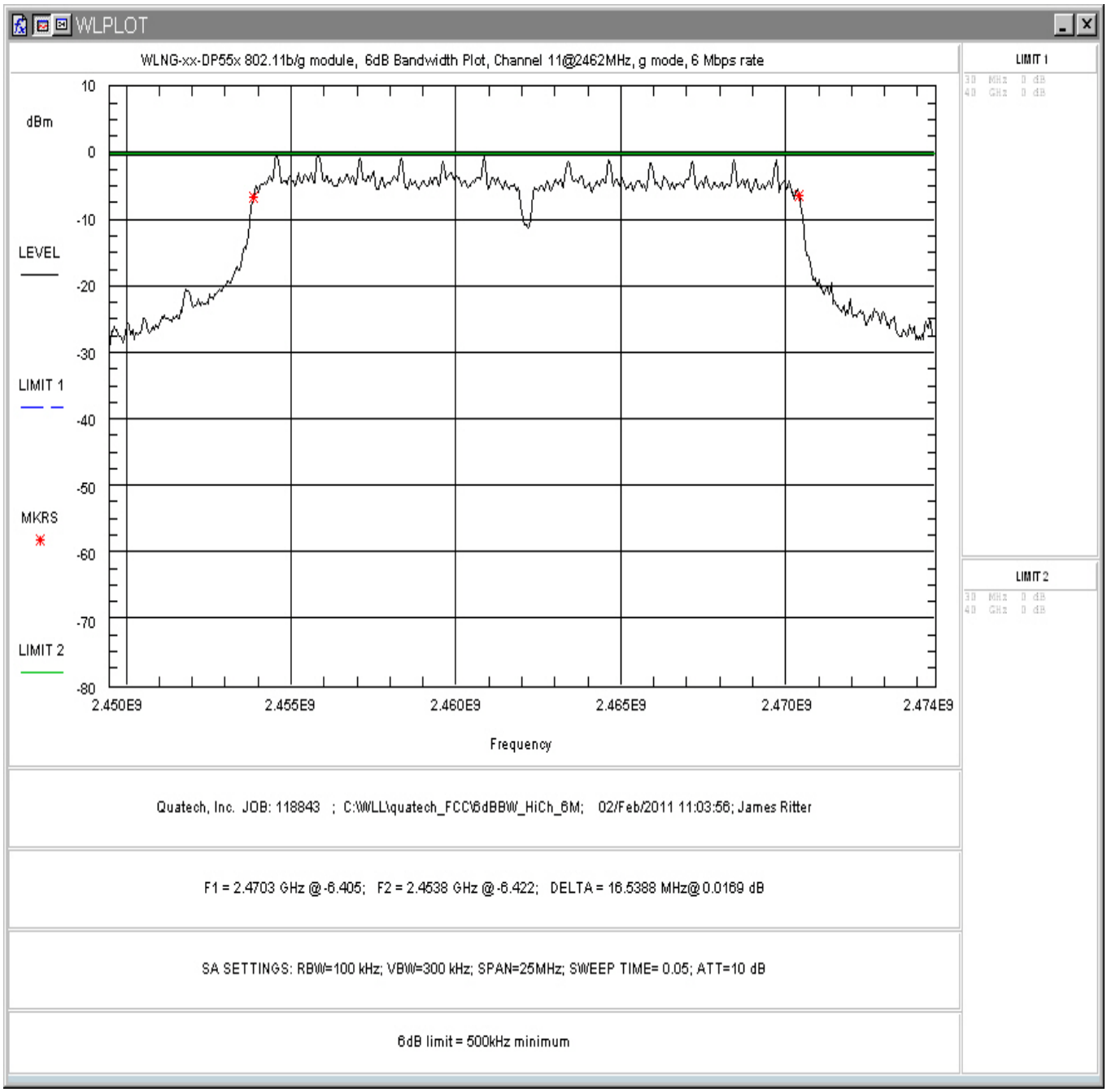

Figure 11: Occupied Bandwidth, 802.11g, 6Mbps, Channel 11

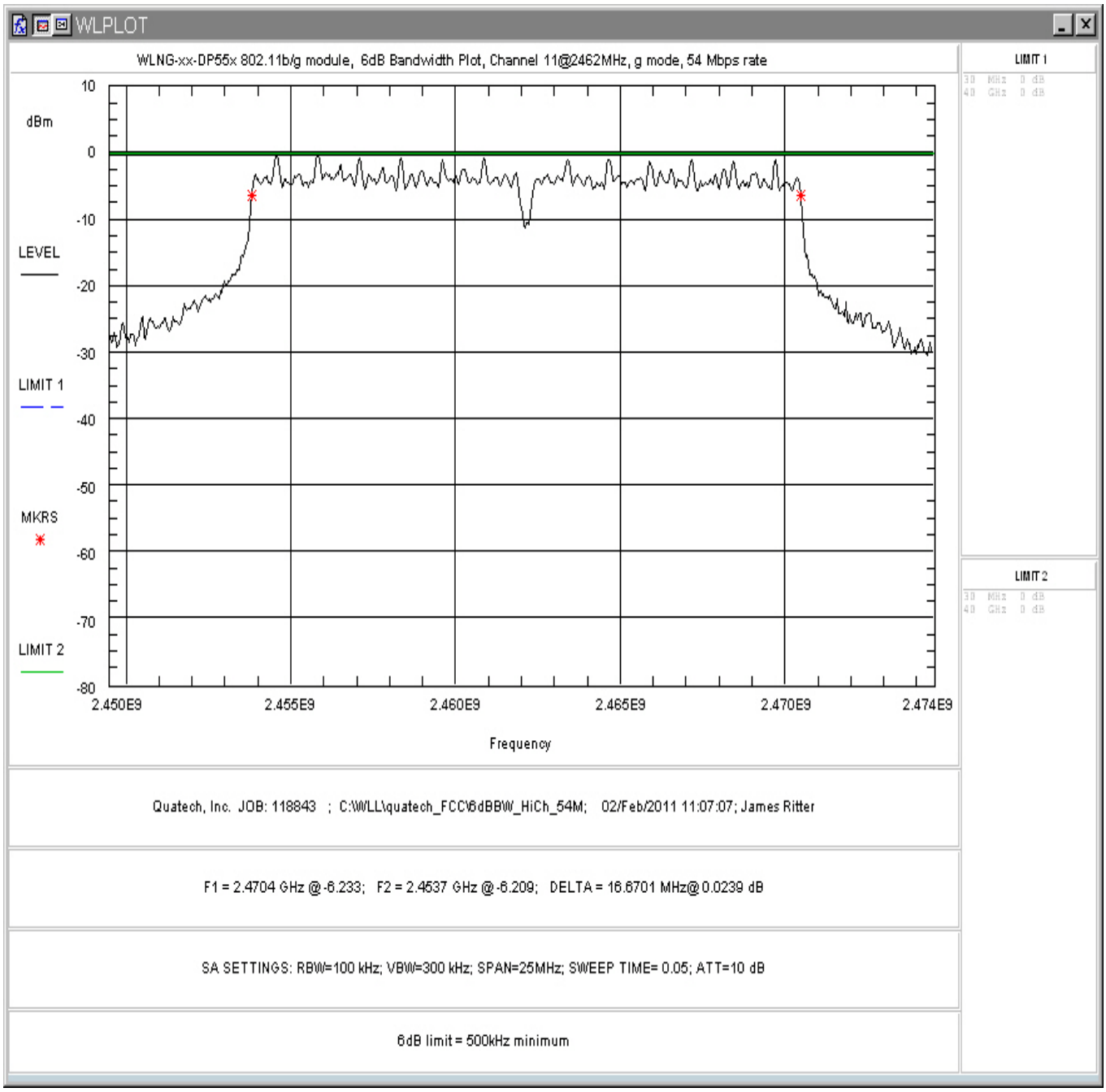

Figure 12: Occupied Bandwidth, 802.11g, 54Mbps, Channel 11

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Channel and/or Frequency	Mode	Data Rate (Mbps)	Bandwidth (MHz)	Limit (kHz)	Pass/Fail
Chan 1 @ 2412MHz	802.11b	1	13.01	>500kHz	Pass
Chan 1 @ 2412MHz	802.11b	11	12.18	>500kHz	Pass
Chan 1 @ 2412MHz	802.11g	6	16.44	>500kHz	Pass
Chan 1 @ 2412MHz	802.11g	54	16.55	>500kHz	Pass
Chan 6 @ 2437MHz	802.11b	1	13.11	>500kHz	Pass
Chan 6 @ 2437MHz	802.11b	11	12.28	>500kHz	Pass
Chan 6 @ 2437MHz	802.11g	6	16.50	>500kHz	Pass
Chan 6 @ 2437MHz	802.11g	54	16.63	>500kHz	Pass
Chan 11 @ 2462MHz	802.11b	1	12.66	>500kHz	Pass
Chan 11 @ 2462MHz	802.11b	11	12.36	>500kHz	Pass
Chan 11 @ 2462MHz	802.11g	6	16.54	>500kHz	Pass
Chan 11 @ 2462MHz	802.11g	54	16.67	>500kHz	Pass

3.3 RF Power Output: (FCC Part §15.247(b))

To measure the output power the modulation was started while the frequency dwelled on a low, center and high channels. The output from the transmitter was connected to an attenuator and then to the input of a wide-band power meter. The power meter offset was adjusted to compensate for the attenuator and other losses in the system. Peak Power was measured.

Table 6: RF Power Output

Channel and/or Frequency	Mode	Data Rate (Mbps)	Peak Measured Level (dBm)	Limit (dBm)	Pass/Fail
Chan 1 @ 2412MHz	802.11b	1	10.46	30	Pass
Chan 1 @ 2412MHz	802.11b	11	10.48	30	Pass
Chan 1 @ 2412MHz	802.11g	6	14.82	30	Pass
Chan 1 @ 2412MHz	802.11g	54	14.79	30	Pass
Chan 6 @ 2437MHz	802.11b	1	14.61	30	Pass
Chan 6 @ 2437MHz	802.11b	11	13.60	30	Pass
Chan 6 @ 2437MHz	802.11g	6	18.90	30	Pass
Chan 6 @ 2437MHz	802.11g	54	19.10	30	Pass
Chan 11 @ 2462MHz	802.11b	1	14.47	30	Pass
Chan 11 @ 2462MHz	802.11b	11	14.26	30	Pass
Chan 11 @ 2462MHz	802.11g	6	18.21	30	Pass
Chan 11 @ 2462MHz	802.11g	54	18.19	30	Pass

3.4 Power Spectral Density (Section §15.247(e))

Measurements for power spectral density were taken in accordance with 15.247(e). The measurements were performed using PSD Option 1 of "Measurement of Digital Transmission Systems operating under 15.247" (March 23, 2005).

The spectrum analyzer was set to peak detect mode with a RBW of 3kHz and a VBW of 10kHz. The highest level detected across any 3kHz band for continuous transmission was then recorded and compared to the limit 8dBm. The method used to discover the peak emission was to find the peak using a 100kHz RBW with a wide enough span to capture all peak emissions and then to zoom in on a 1.5MHz area around this point with a 3kHz RBW and a 500 second sweep. The following table and plots give the results for power spectral density testing.

Table 7: Power Spectral Density

Channel and/or Frequency	Mode	Data Rate (Mbps)	Spectral Density (dBm)	Limit (dBm)	Pass/Fail
Chan 1 @ 2412MHz	802.11b	1	-15.78	8	Pass
Chan 1 @ 2412MHz	802.11b	11	-13.91	8	Pass
Chan 1 @ 2412MHz	802.11g	6	-14.81	8	Pass
Chan 1 @ 2412MHz	802.11g	54	-14.47	8	Pass
Chan 6 @ 2437MHz	802.11b	1	-14.40	8	Pass
Chan 6 @ 2437MHz	802.11b	11	-12.43	8	Pass
Chan 6 @ 2437MHz	802.11g	6	-14.31	8	Pass
Chan 6 @ 2437MHz	802.11g	54	-14.47	8	Pass
Chan 11 @ 2462MHz	802.11b	1	-15.23	8	Pass
Chan 11 @ 2462MHz	802.11b	11	-13.18	8	Pass
Chan 11 @ 2462MHz	802.11g	6	-13.93	8	Pass
Chan 11 @ 2462MHz	802.11g	54	-14.37	8	Pass

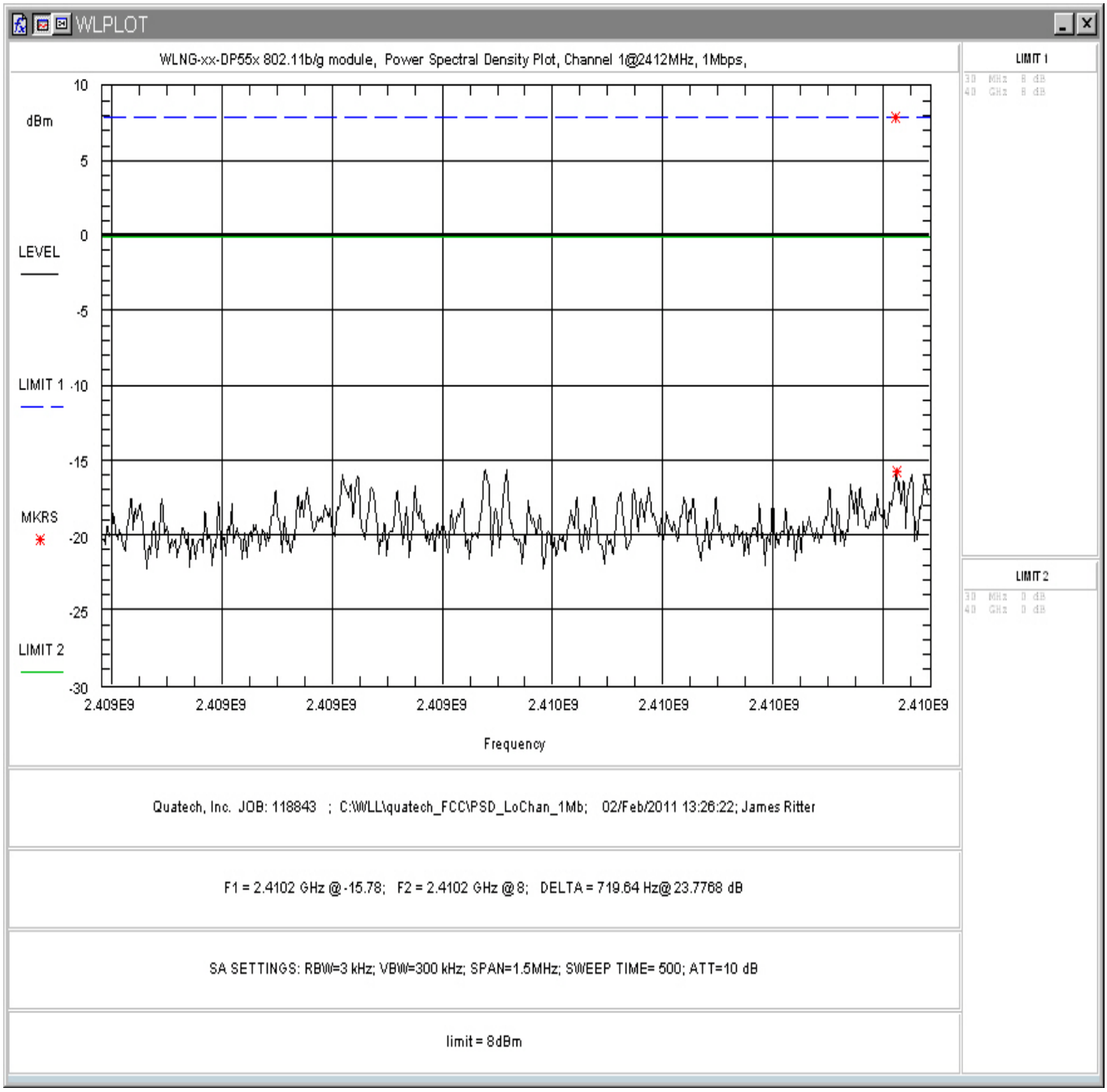

Figure 13: Power Spectral Density, 802.11b, 1Mbps, Channel 1

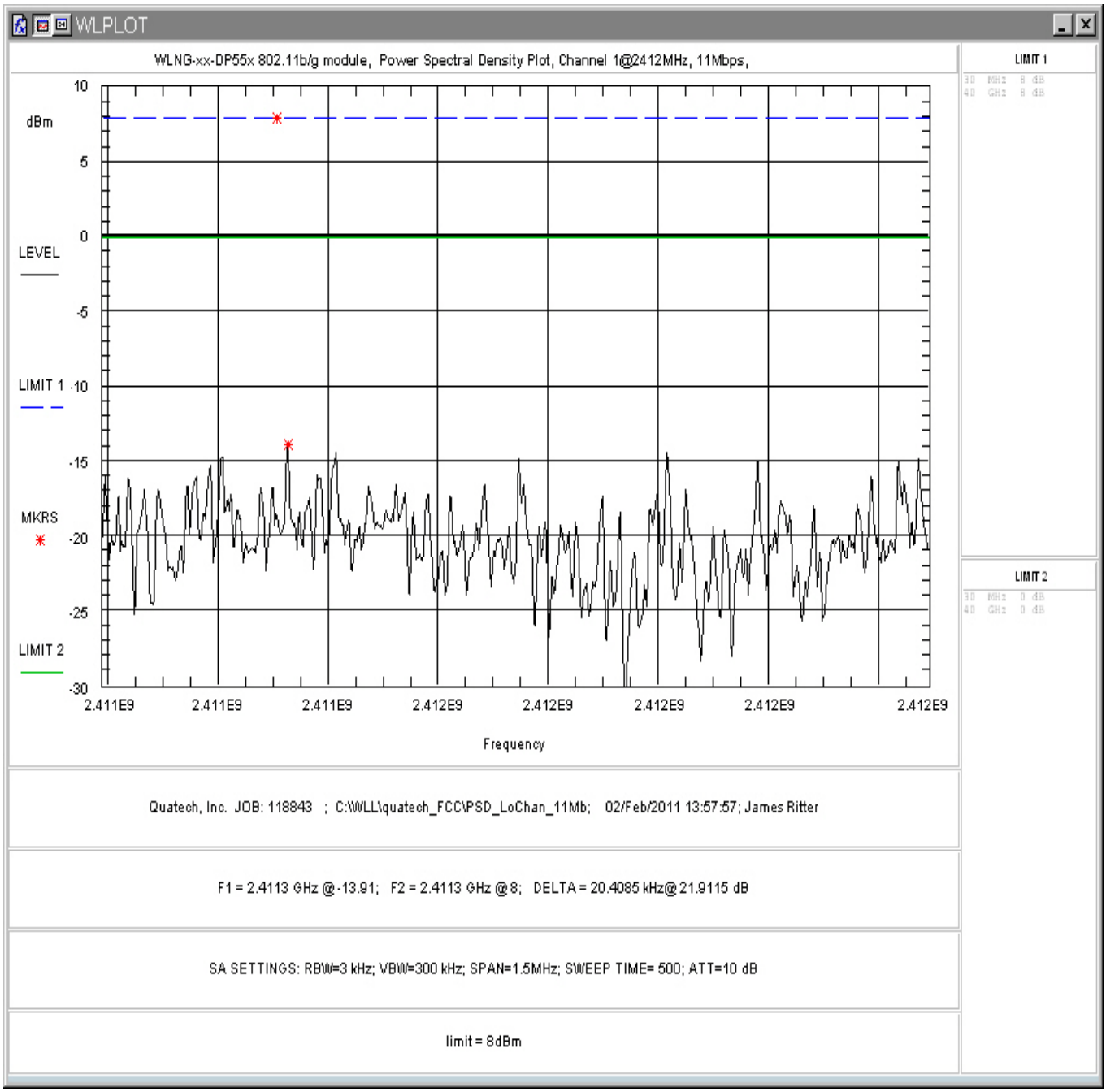

Figure 14: Power Spectral Density, 802.11b, 11Mbps, Channel 1

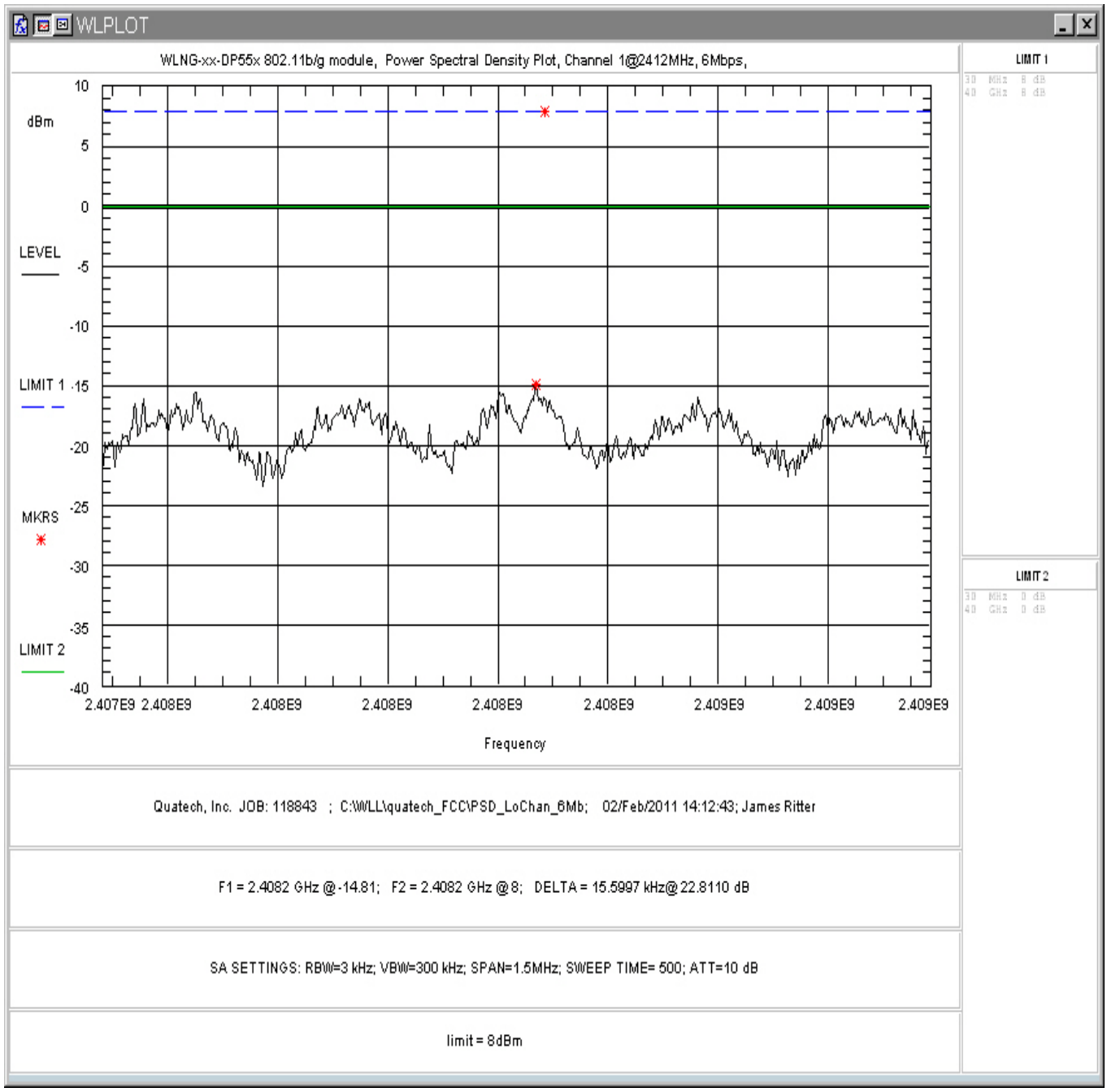

Figure 15: Power Spectral Density, 802.11g, 6Mbps, Channel 1

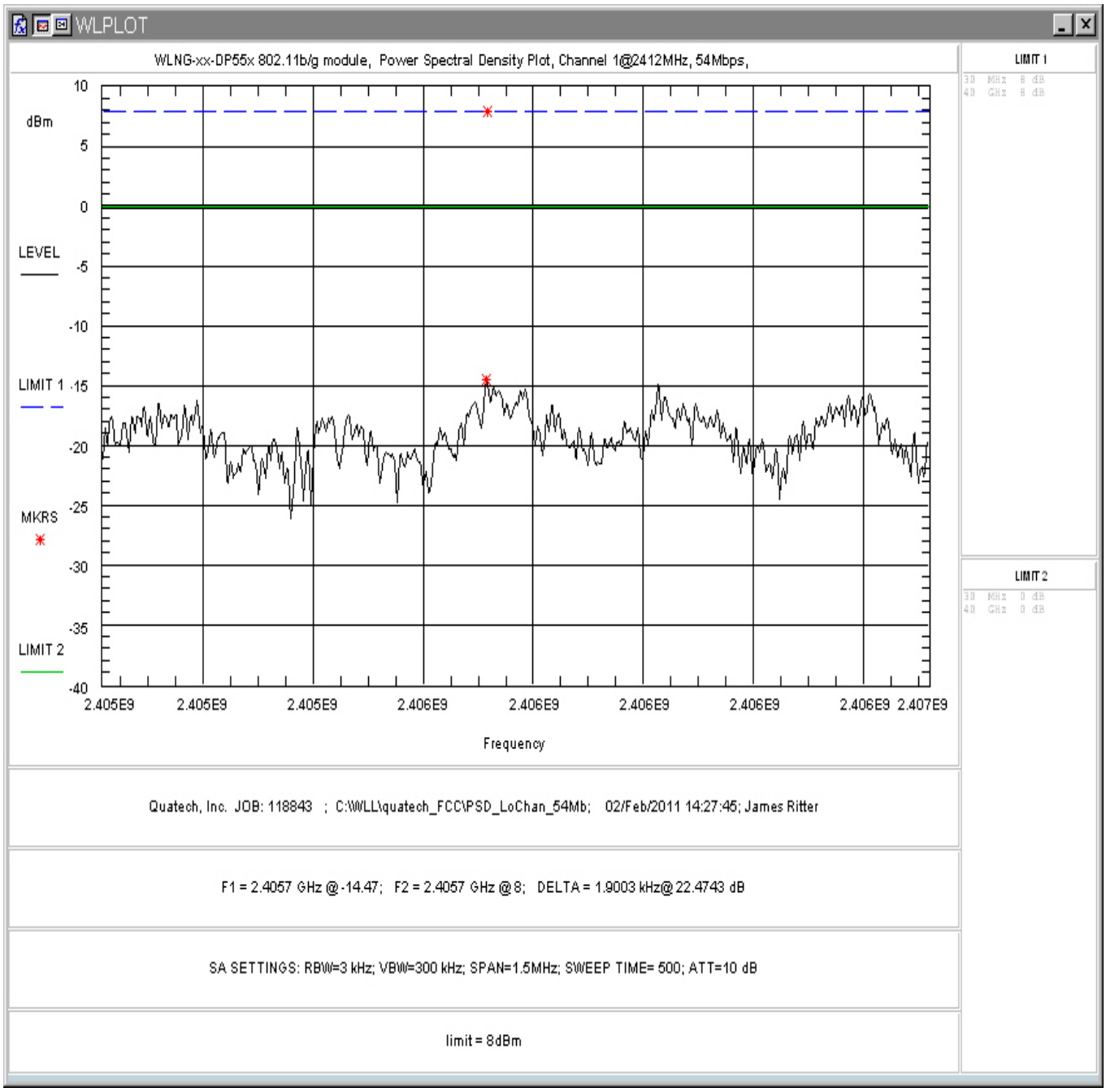

Figure 16: Power Spectral Density, 802.11g, 54Mbps, Channel 1

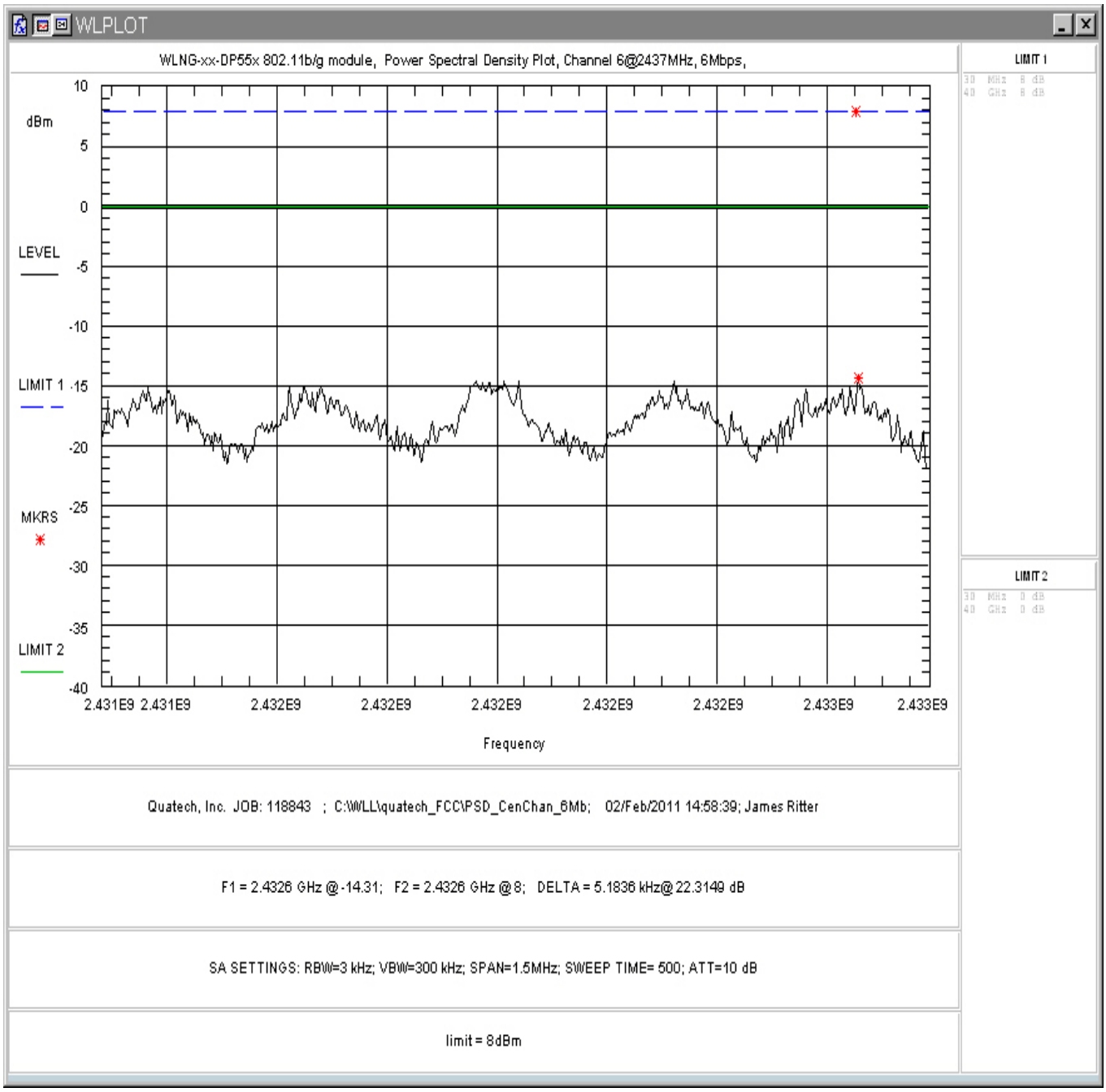

Figure 17: Power Spectral Density, 802.11b, 1Mbps, Channel 6

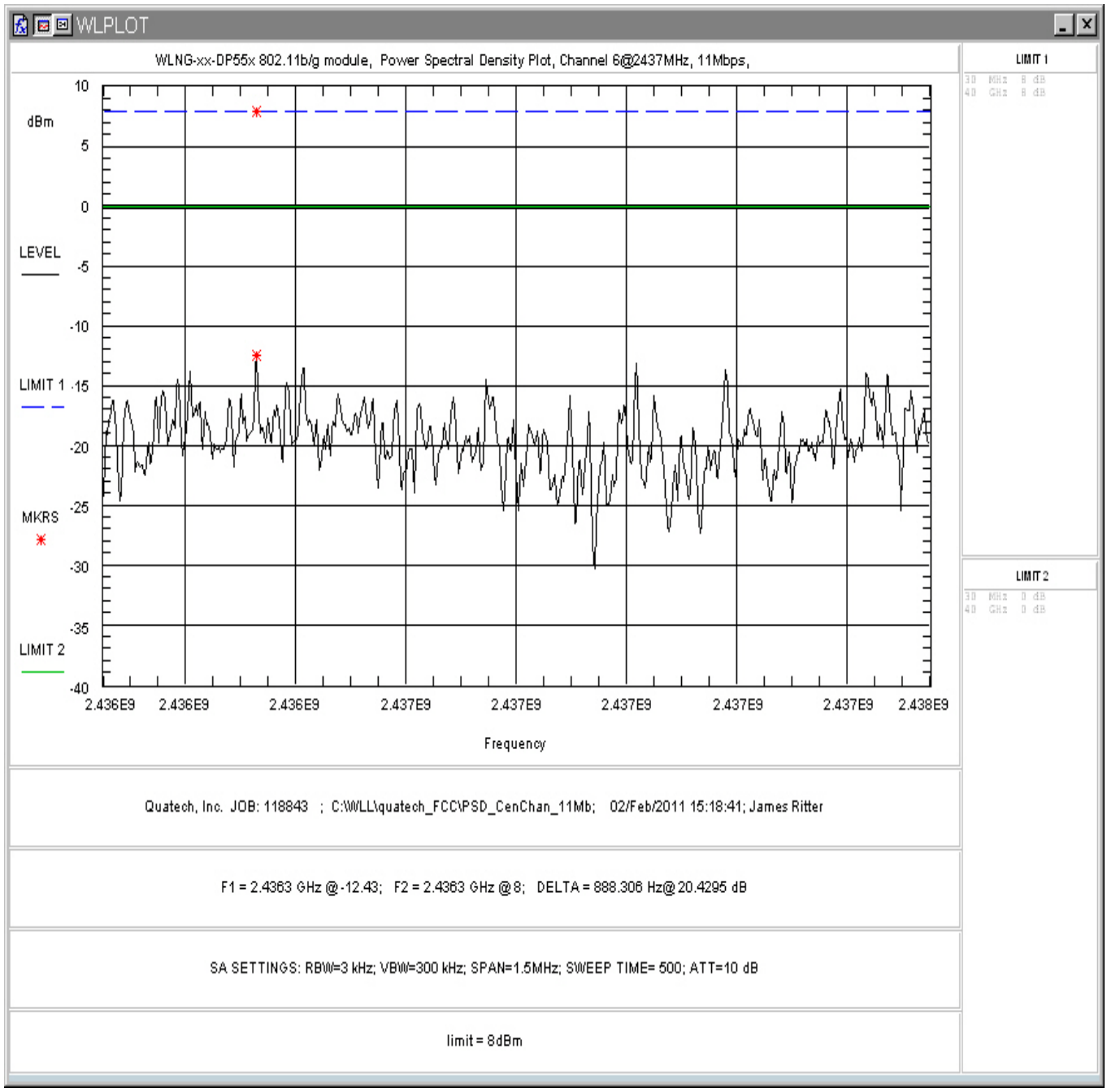

Figure 18: Power Spectral Density, 802.11b, 11Mbps, Channel 6

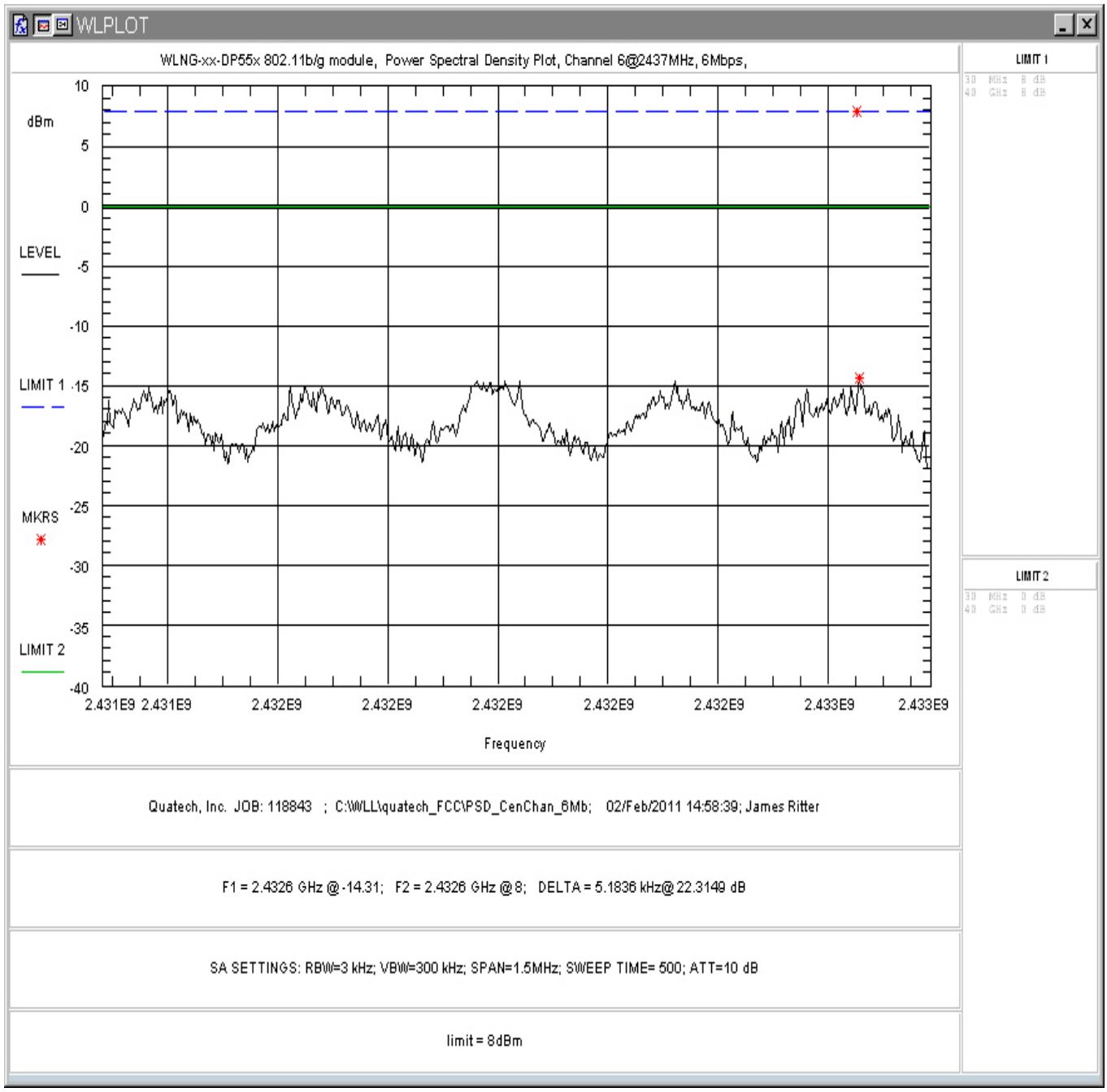

Figure 19: Power Spectral Density, 802.11g, 6Mbps, Channel 6

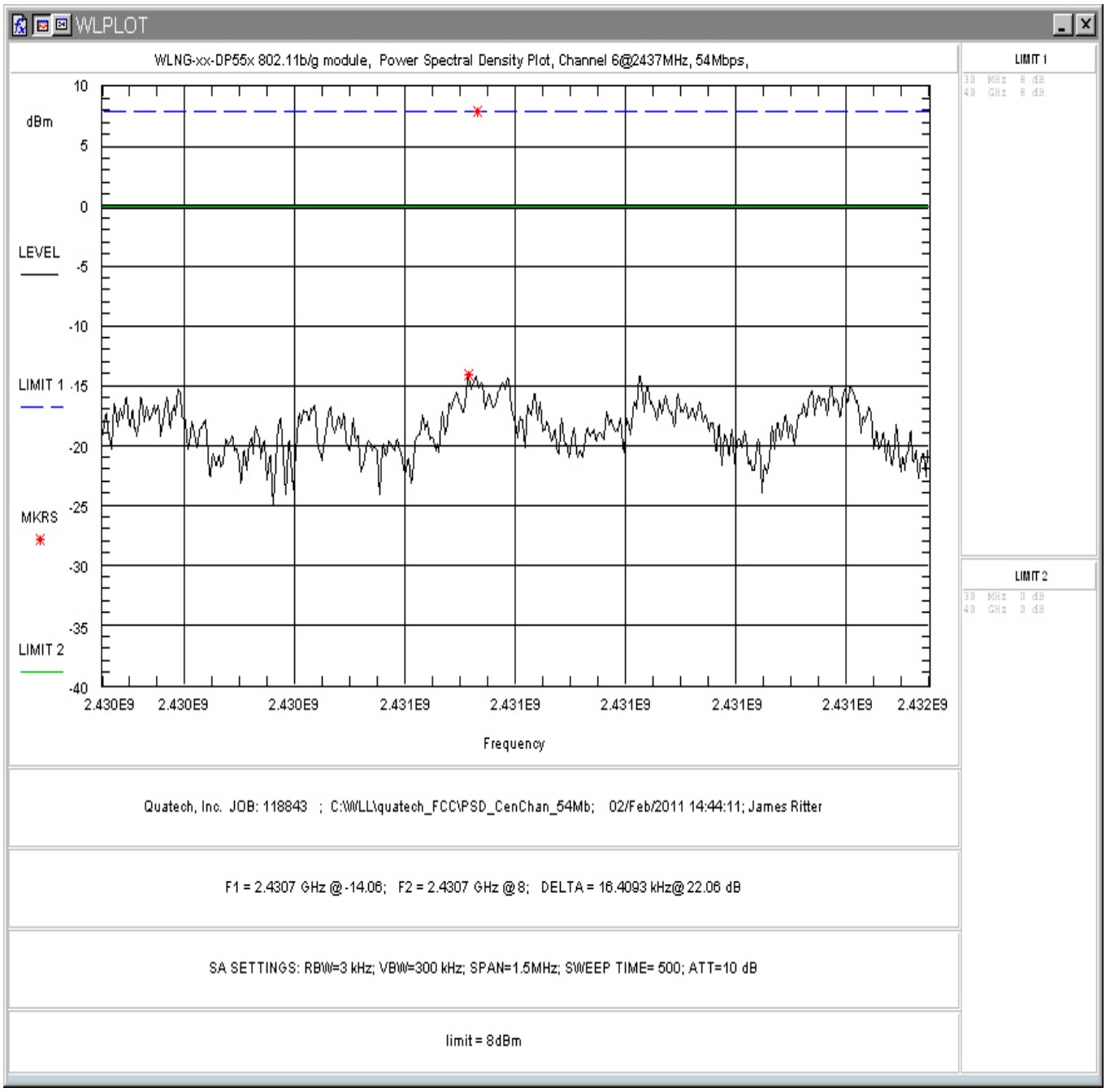

Figure 20: Power Spectral Density, 802.11g, 54Mbps, Channel 6

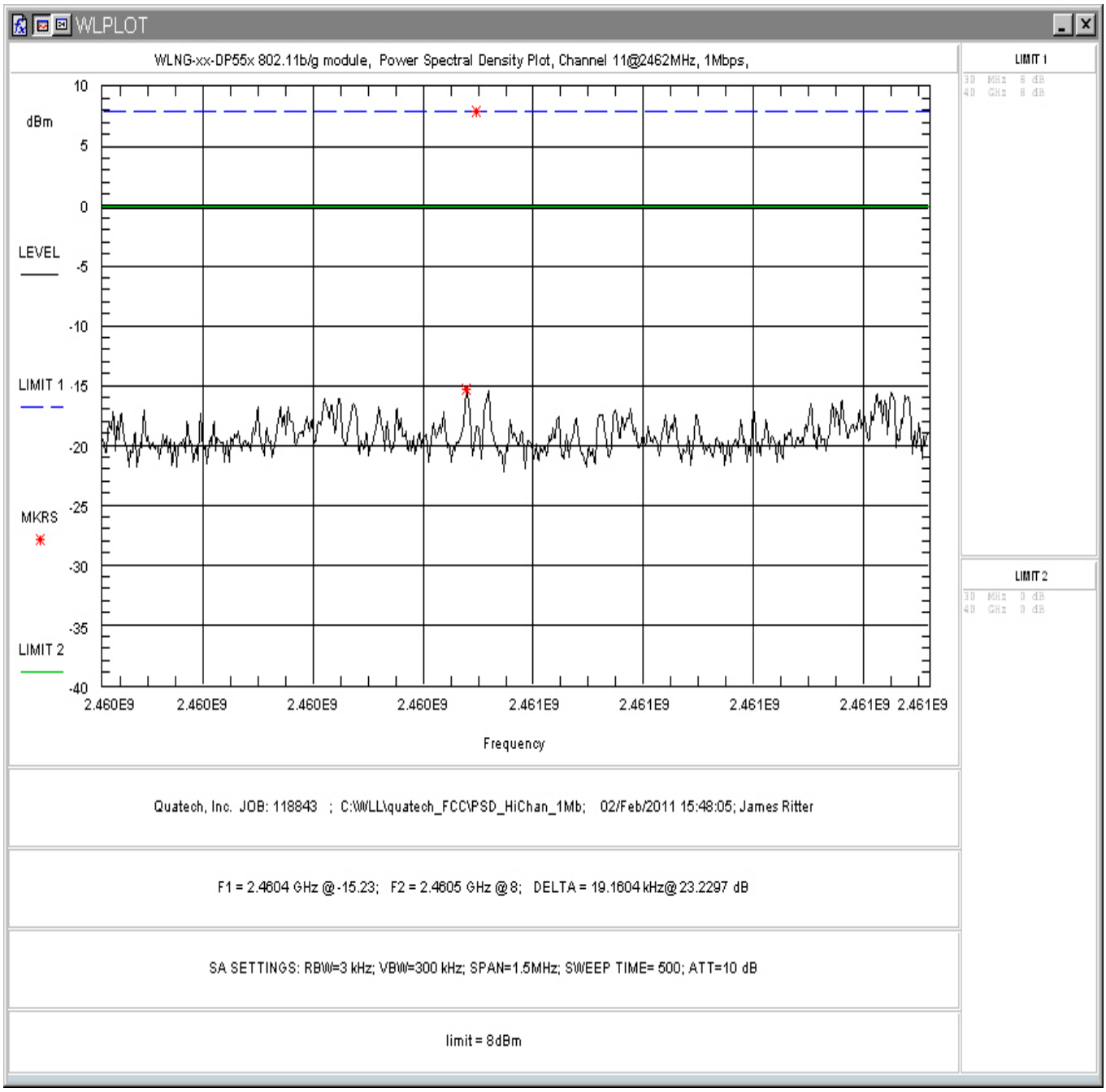

Figure 21: Power Spectral Density, 802.11b, 1Mbps, Channel 11

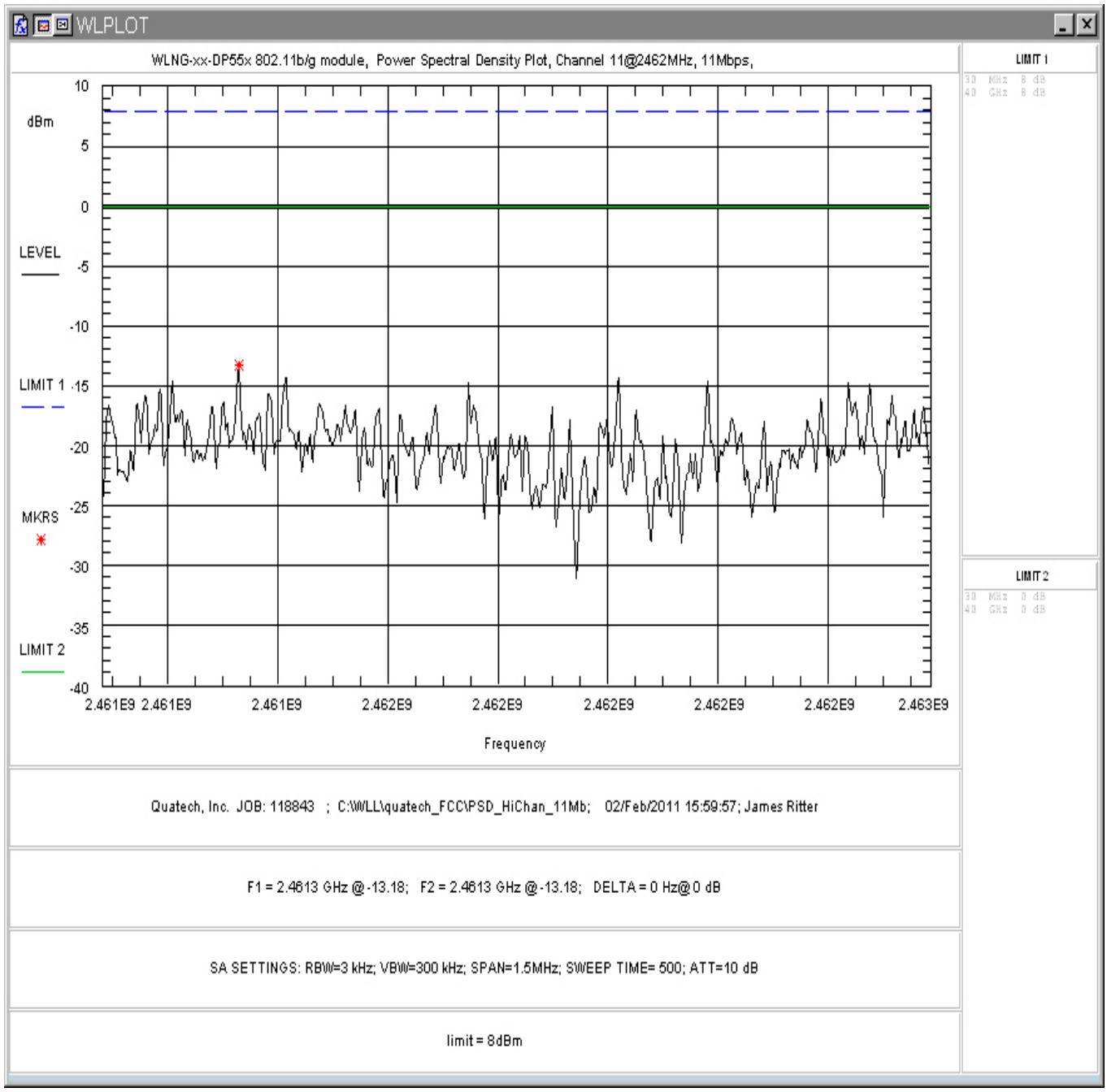

Figure 22: Power Spectral Density, 802.11b, 11Mbps, Channel 11

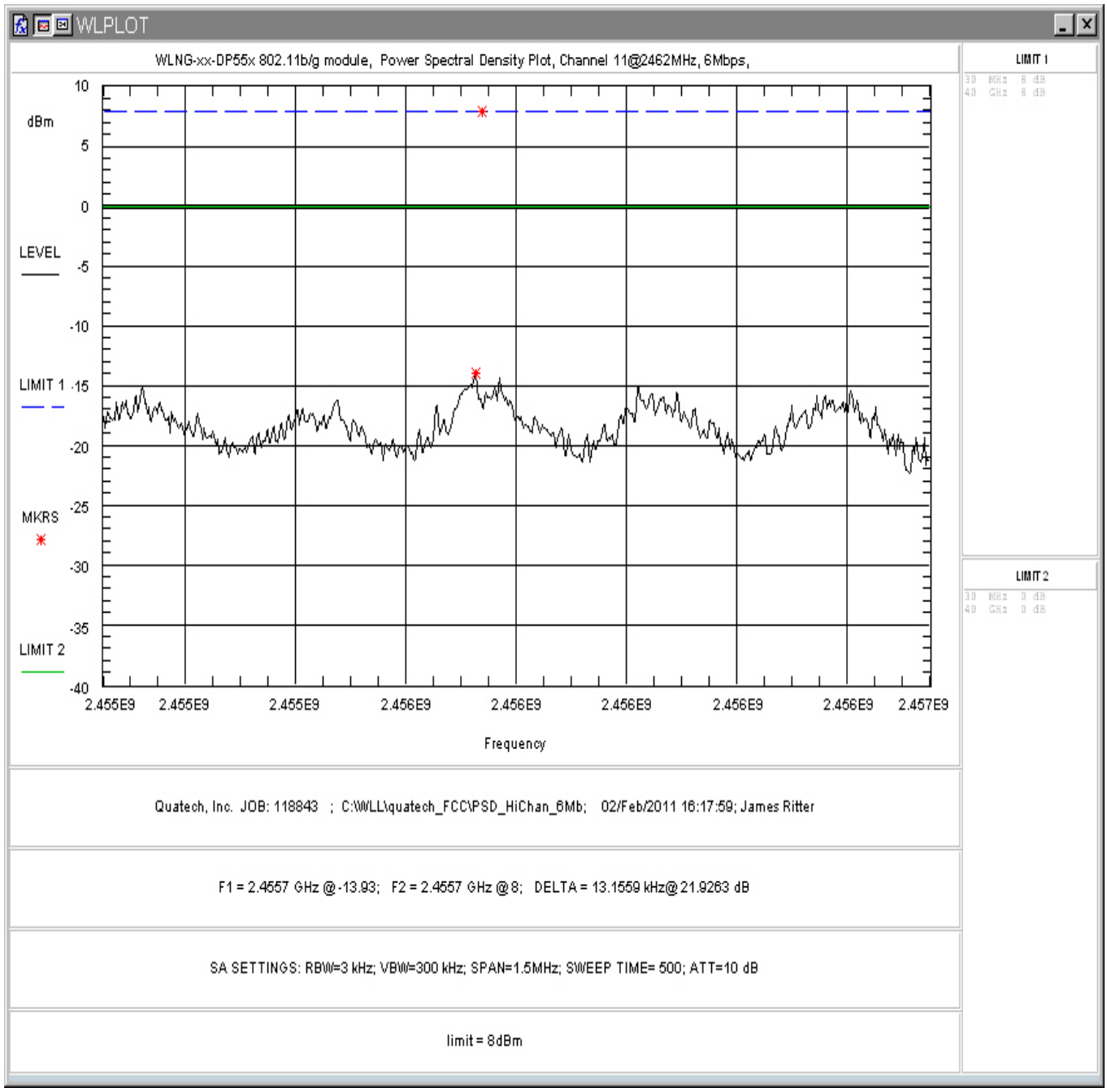

Figure 23: Power Spectral Density, 802.11g, 6Mbps, Channel 11

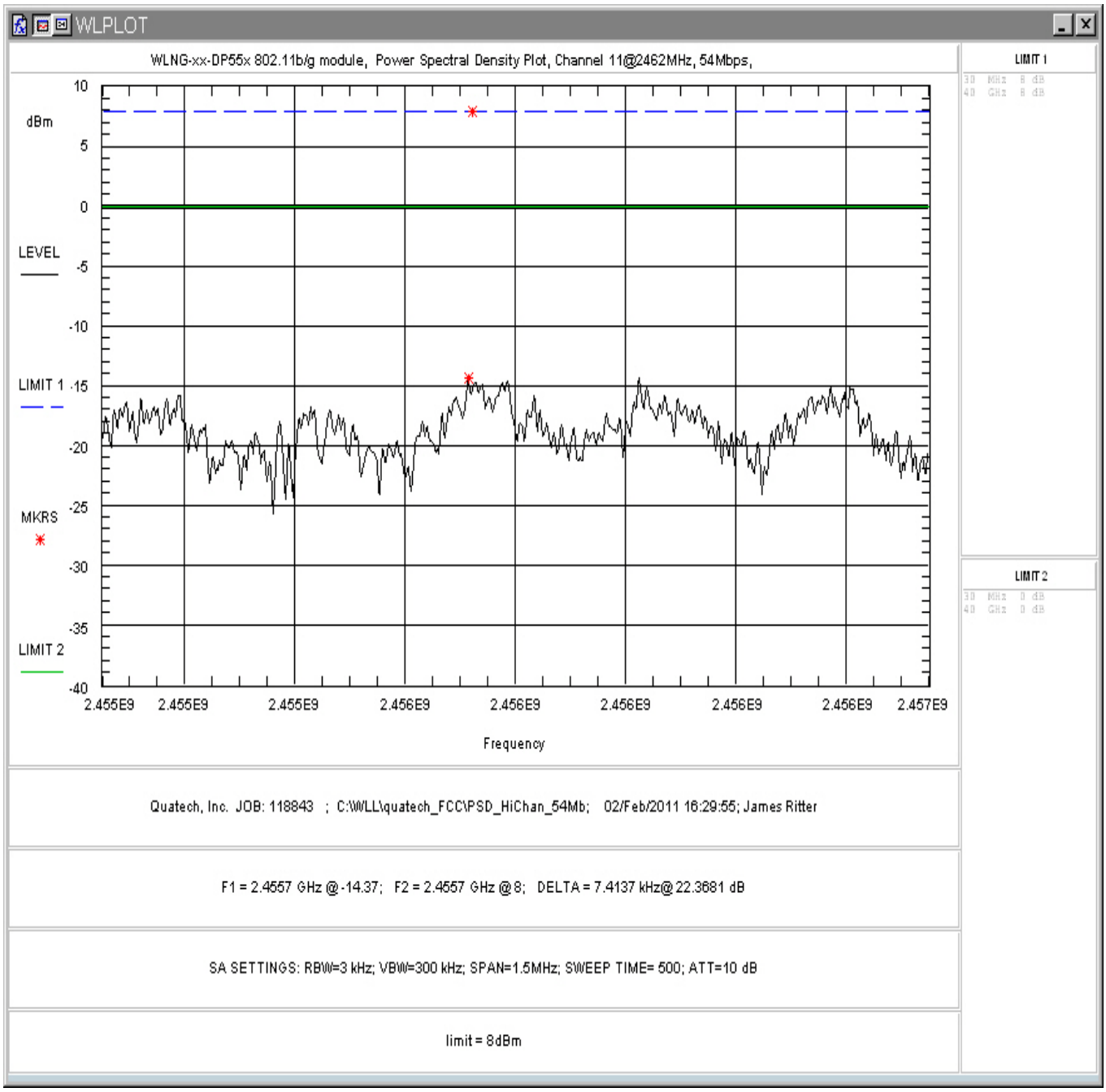

Figure 24: Power Spectral Density, 802.11g, 54Mbps, Channel 11

3.5 Conducted Spurious Emissions at Antenna Terminals (FCC Part §15.247(c))

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 20 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 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.

These tests were conducted with the highest data rates in each mode (802.11b=11Mbps & 802.11g= 54Mbps).

The following are plots of the conducted spurious emissions data.

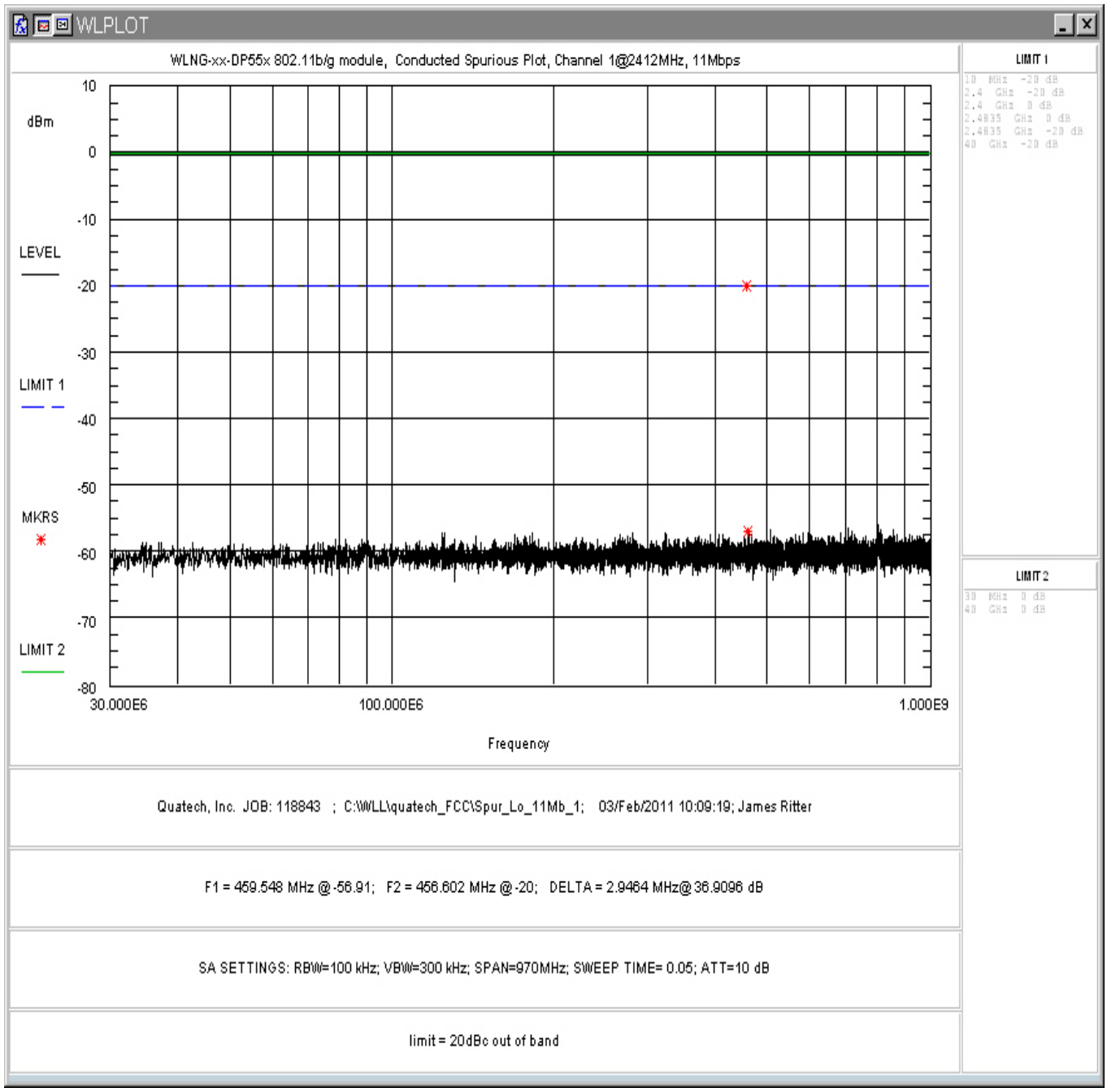

Figure 25: Conducted Spurious Emissions, Channel 1, 11Mbps, 30 - 1000MHz

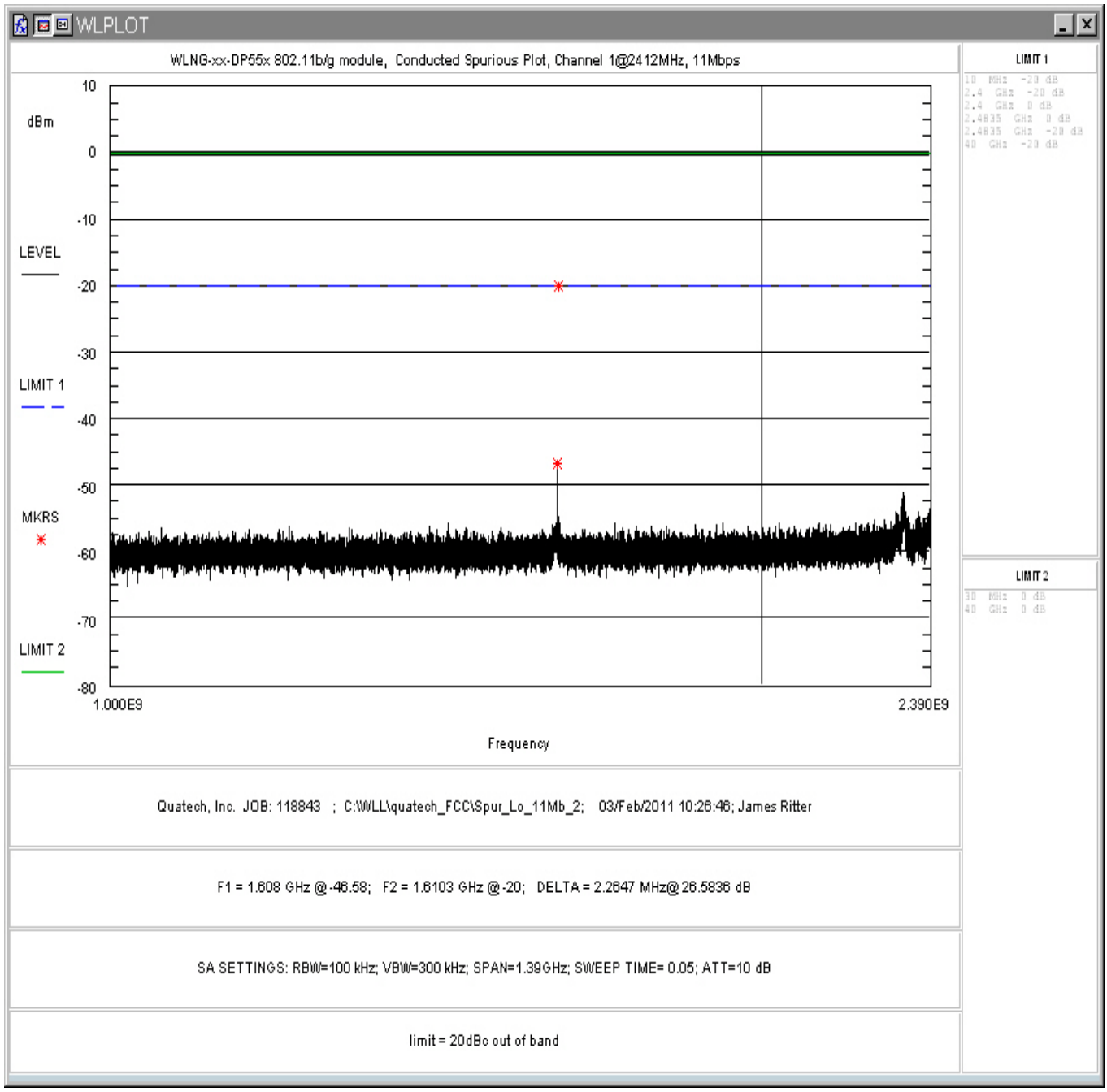

Figure 26: Conducted Spurious Emissions, Channel 1, 11Mbps, 1 – 2.39GHz

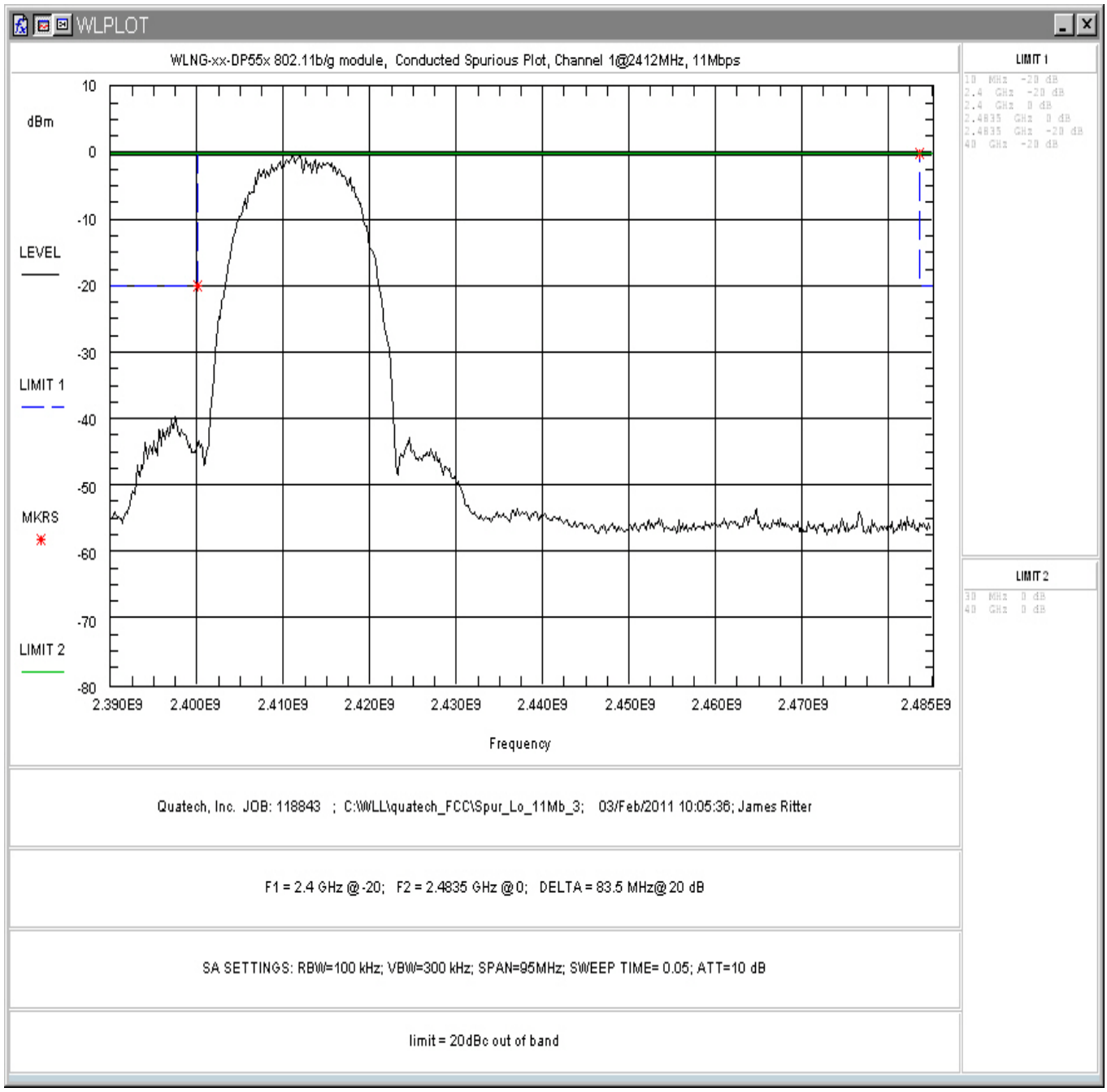

Figure 27: Conducted Spurious Emissions, Channel 1, 11Mbps, 2.39 – 2.485GHz

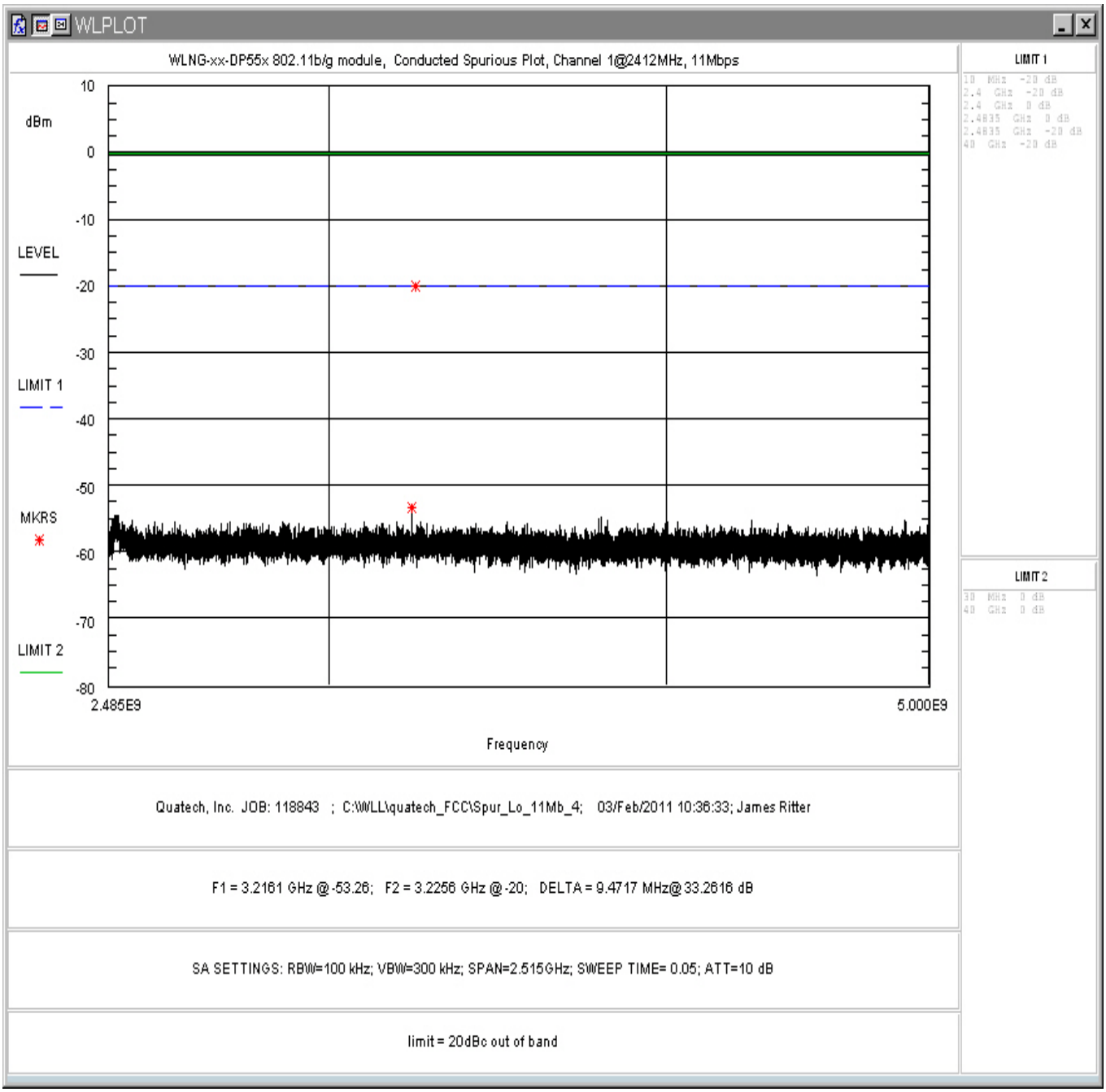

Figure 28: Conducted Spurious Emissions, Channel 1, 11Mbps, 2.485 - 5GHz

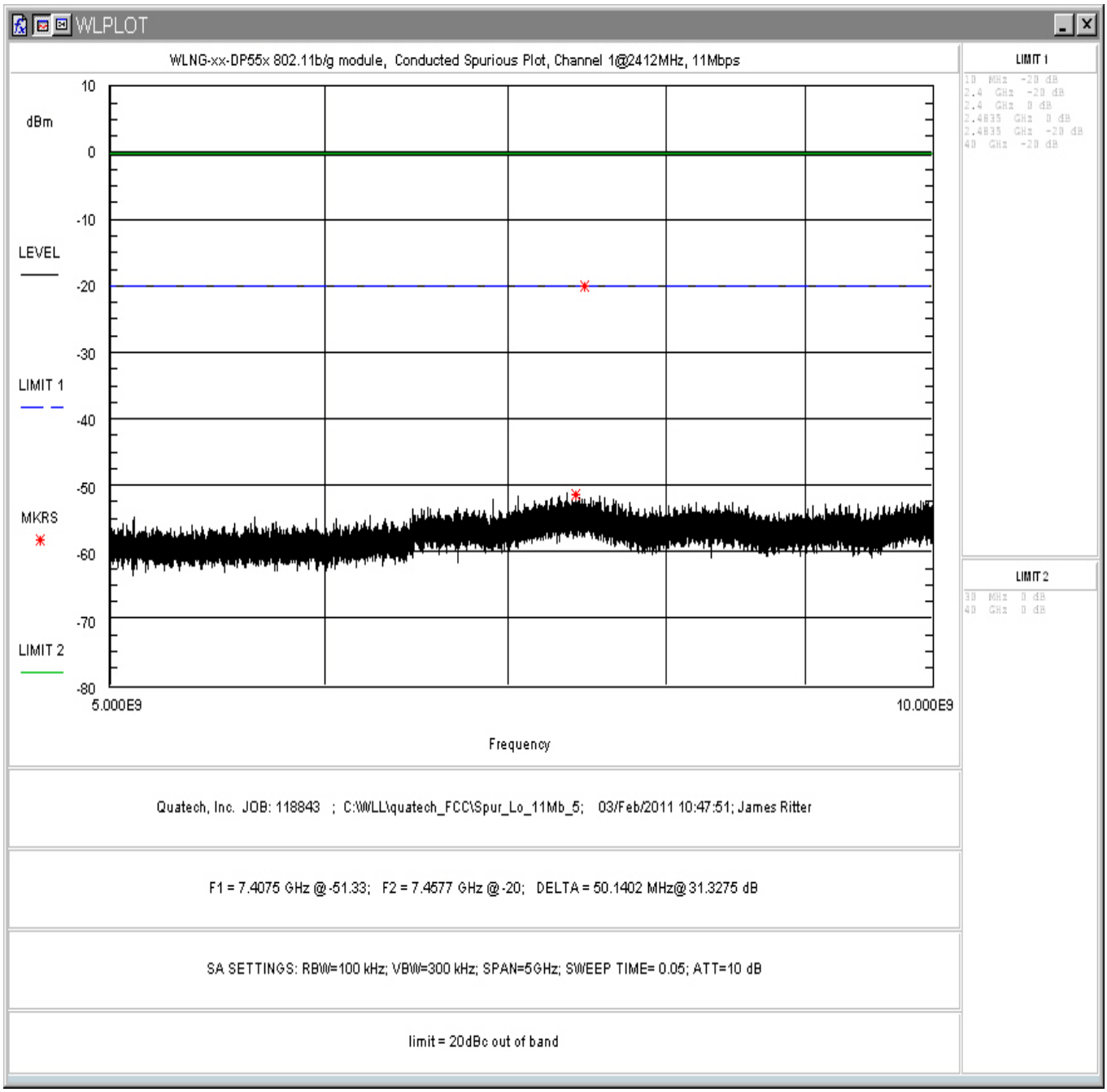

Figure 29: Conducted Spurious Emissions, Channel 1, 11Mbps, 5 - 10GHz

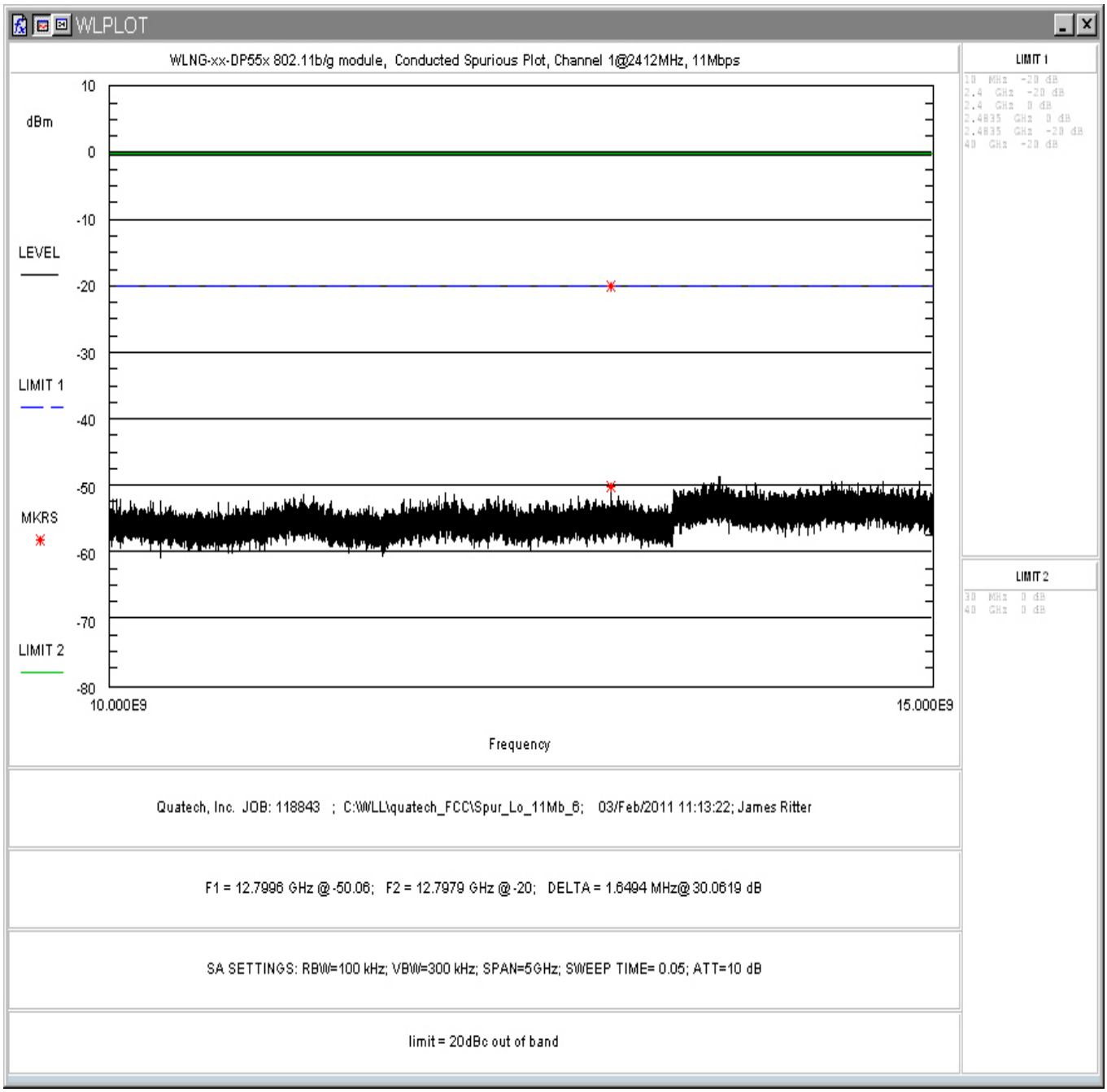

Figure 30: Conducted Spurious Emissions, Channel 1, 11Mbps, 10-15GHz

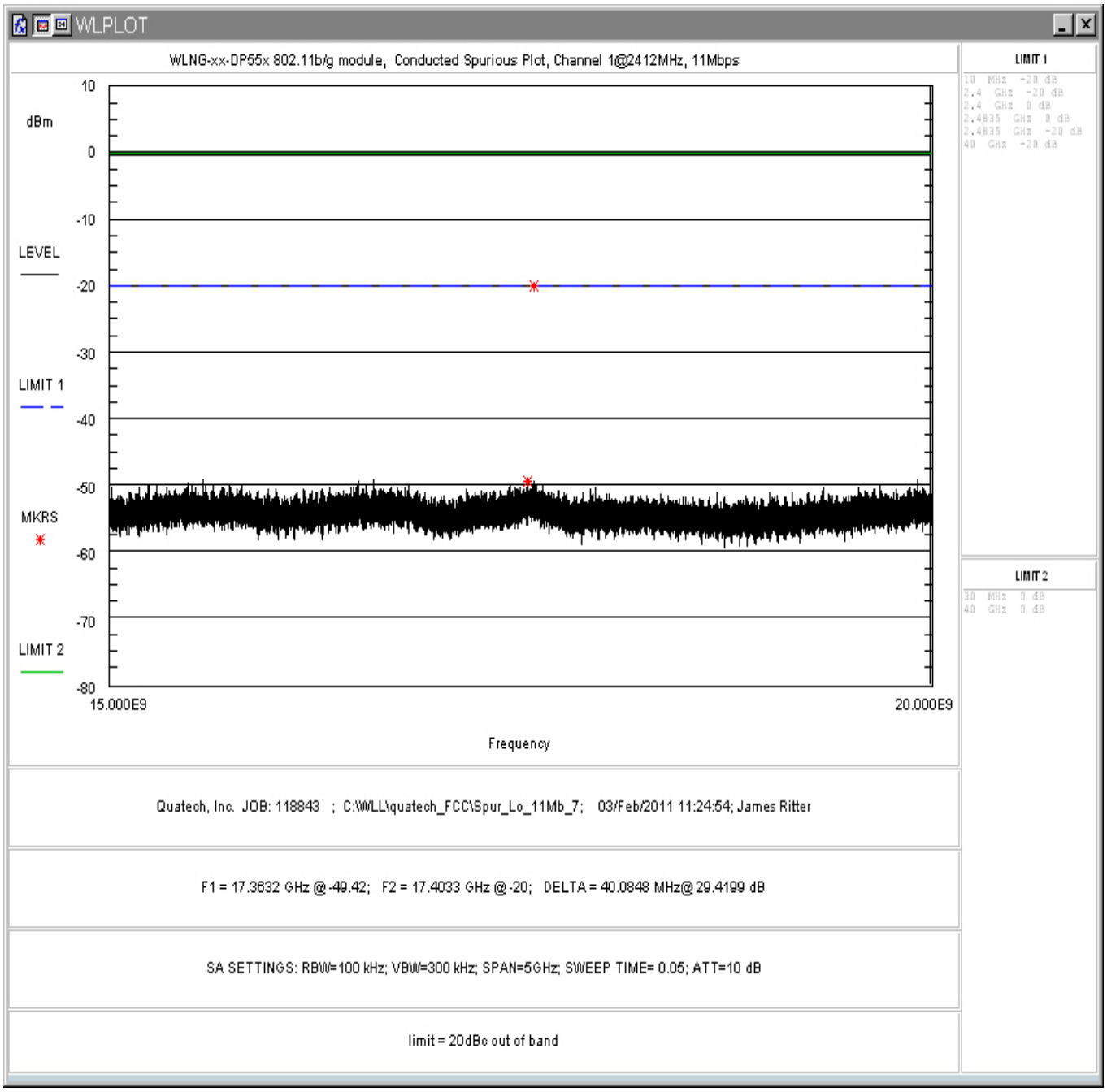

Figure 31: Conducted Spurious Emissions, Channel 1, 11Mbps, 15-20GHz

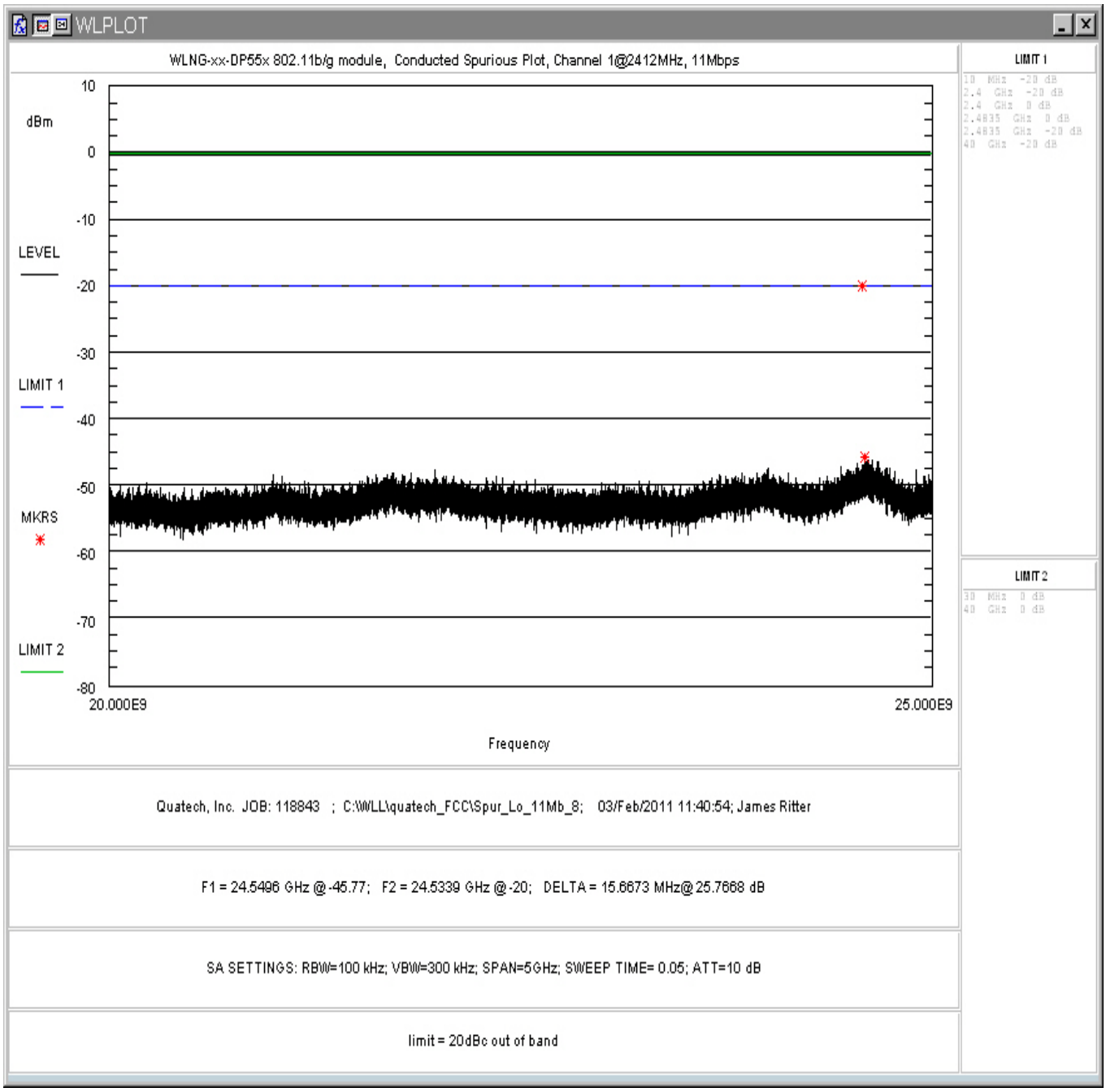

Figure 32: Conducted Spurious Emissions, Channel 1, 11Mbps, 20-25 GHz

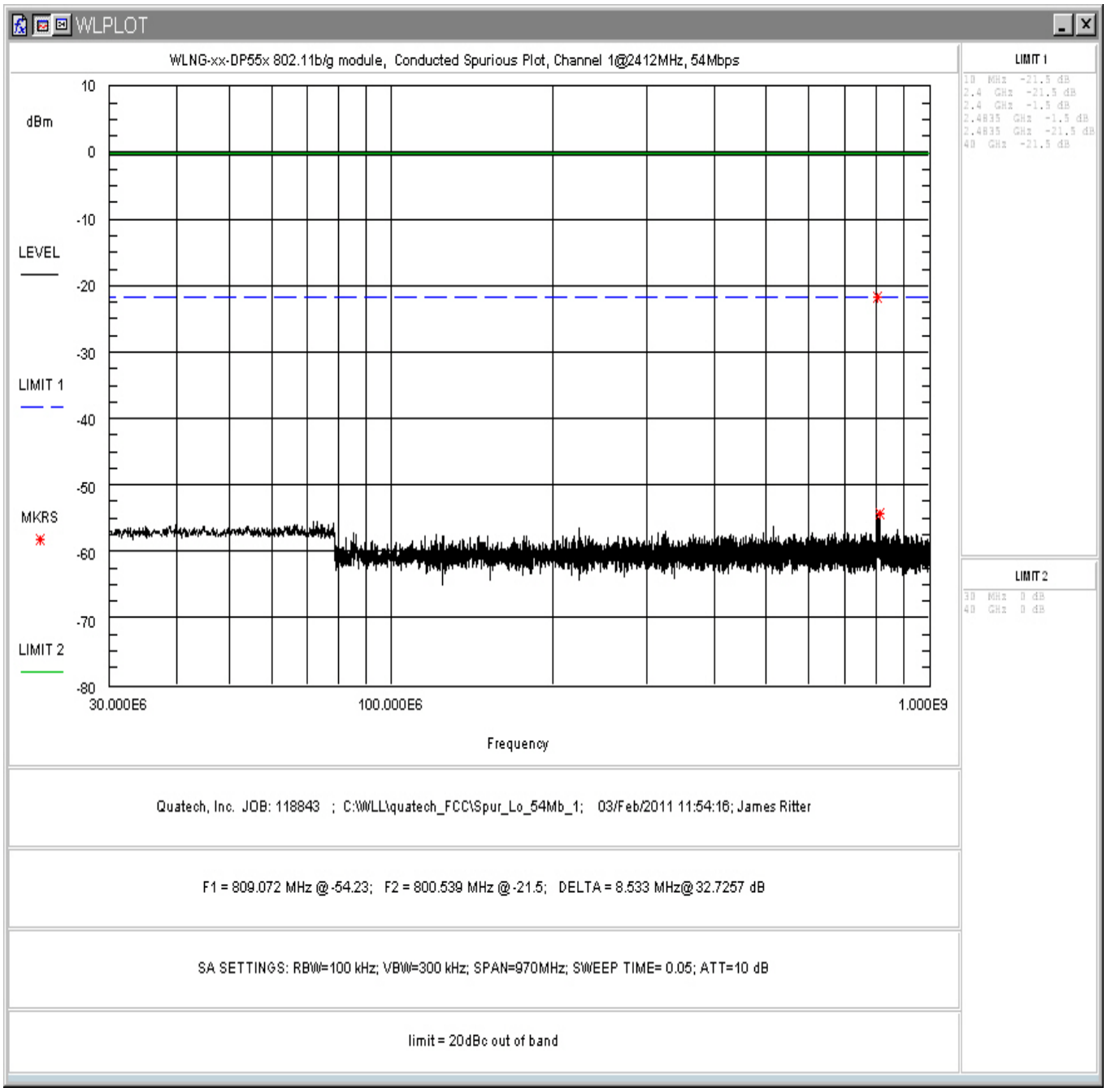

Figure 33: Conducted Spurious Emissions, Channel 1, 54Mbps, 30 - 1000MHz

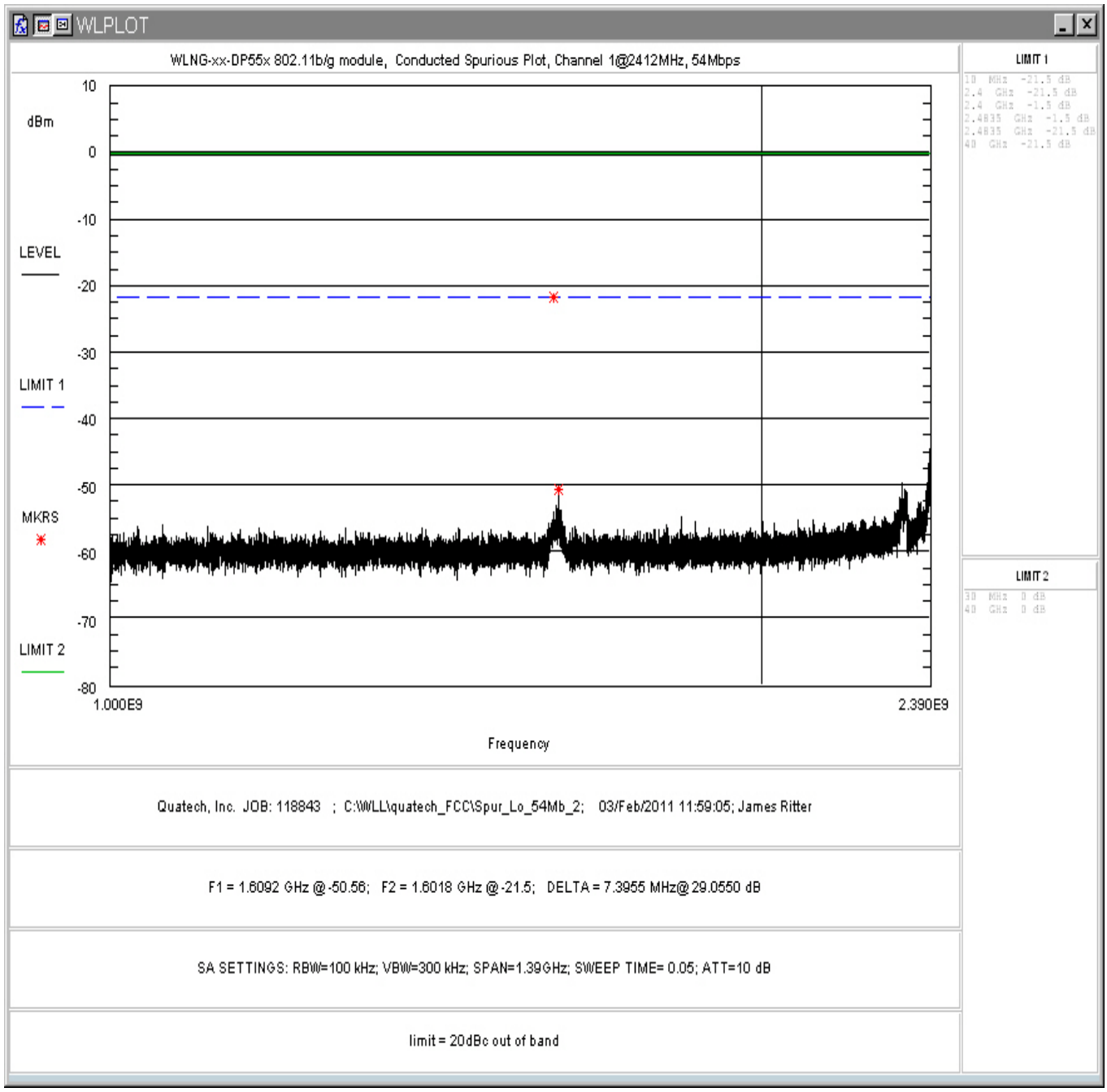

Figure 34: Conducted Spurious Emissions, Channel 1, 54Mbps, 1 – 2.39GHz

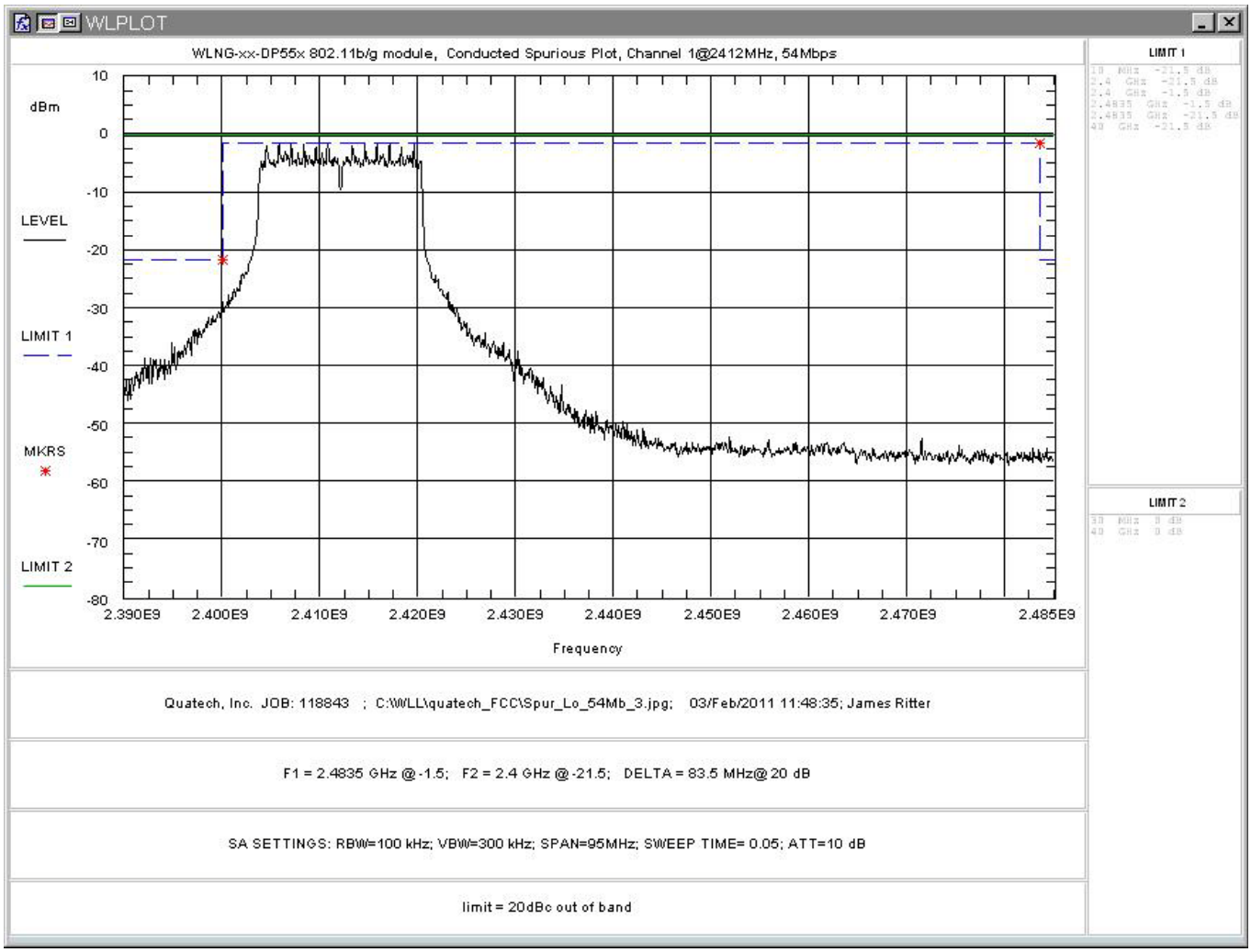

Figure 35: Conducted Spurious Emissions, Channel 1, 54Mbps, 2.39 – 2.485GHz

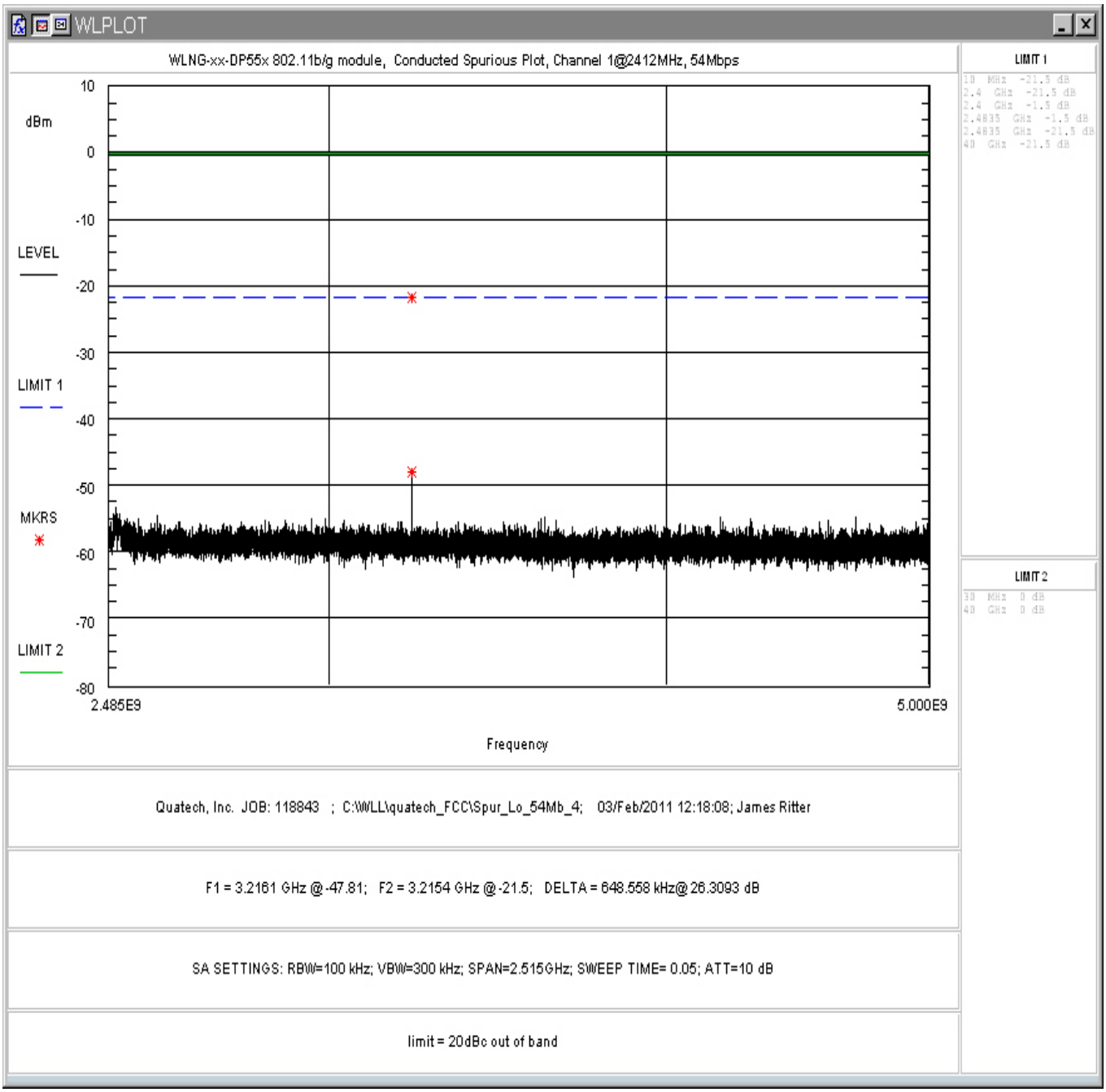

Figure 36: Conducted Spurious Emissions, Channel 1, 54Mbps, 2.485 - 5GHz

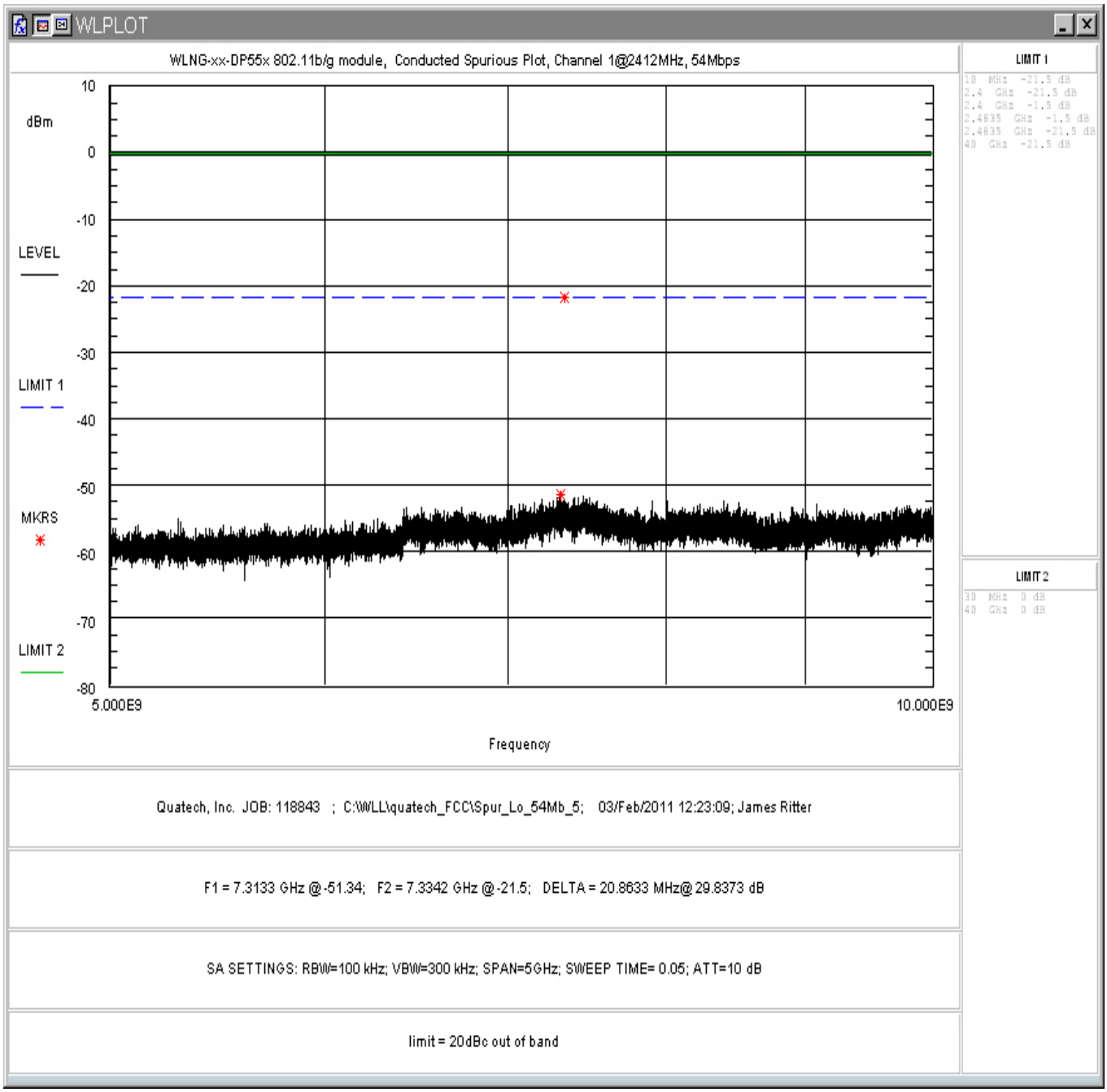

Figure 37: Conducted Spurious Emissions, Channel 1, 54Mbps, 5 - 10GHz

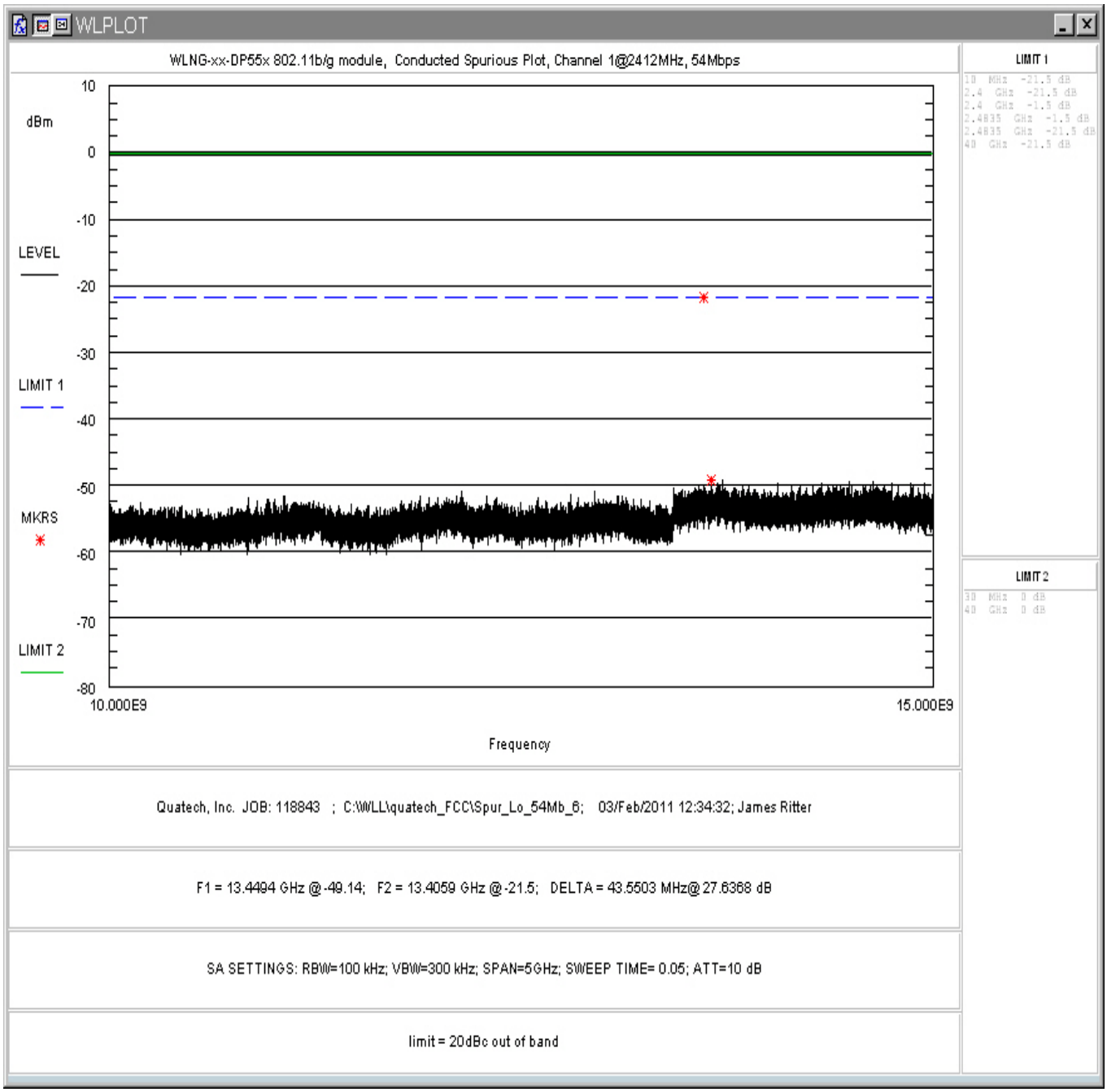

Figure 38: Conducted Spurious Emissions, Channel 1, 54Mbps, 10-15GHz

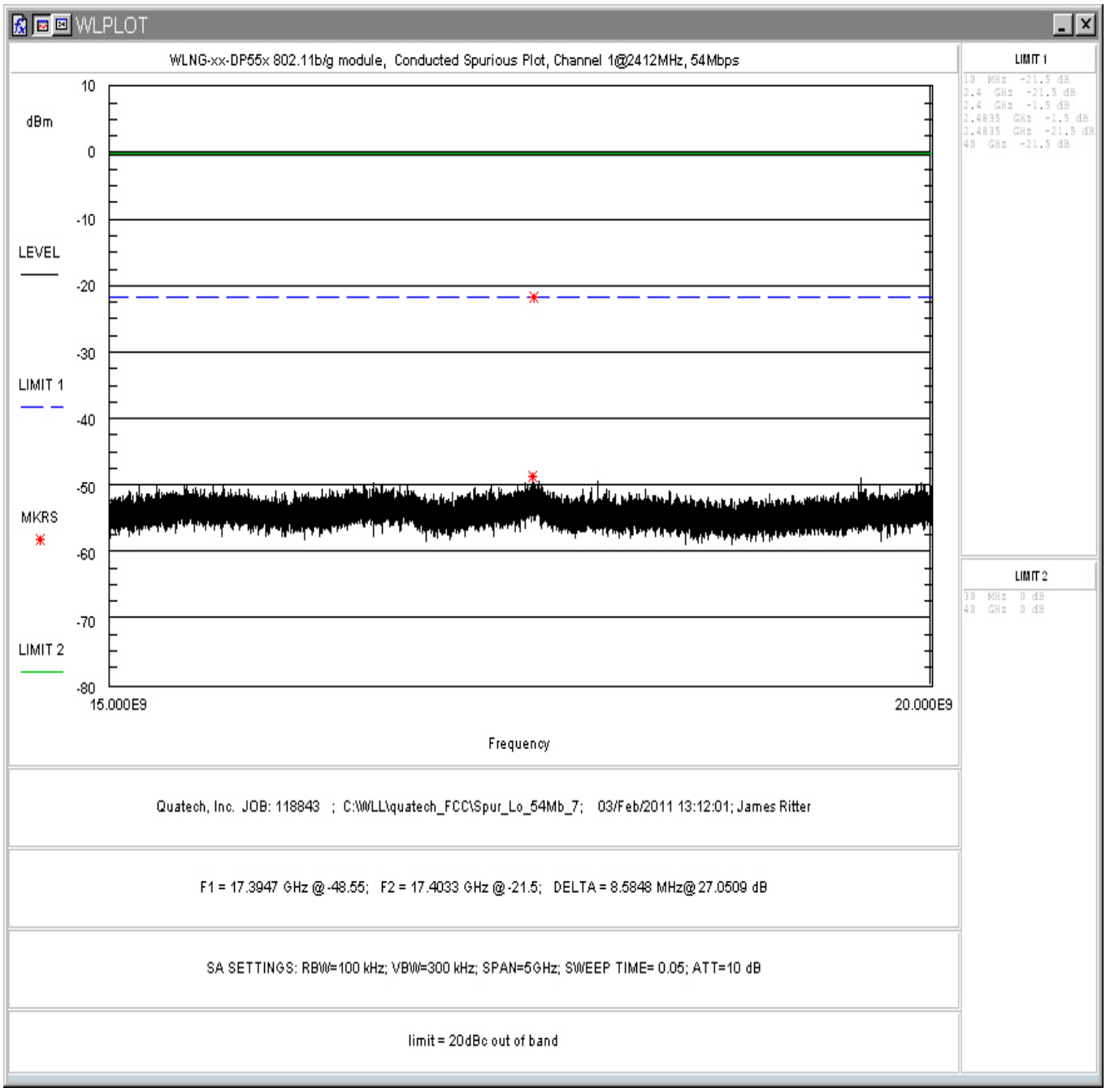

Figure 39: Conducted Spurious Emissions, Channel 1, 54Mbps, 15-20GHz

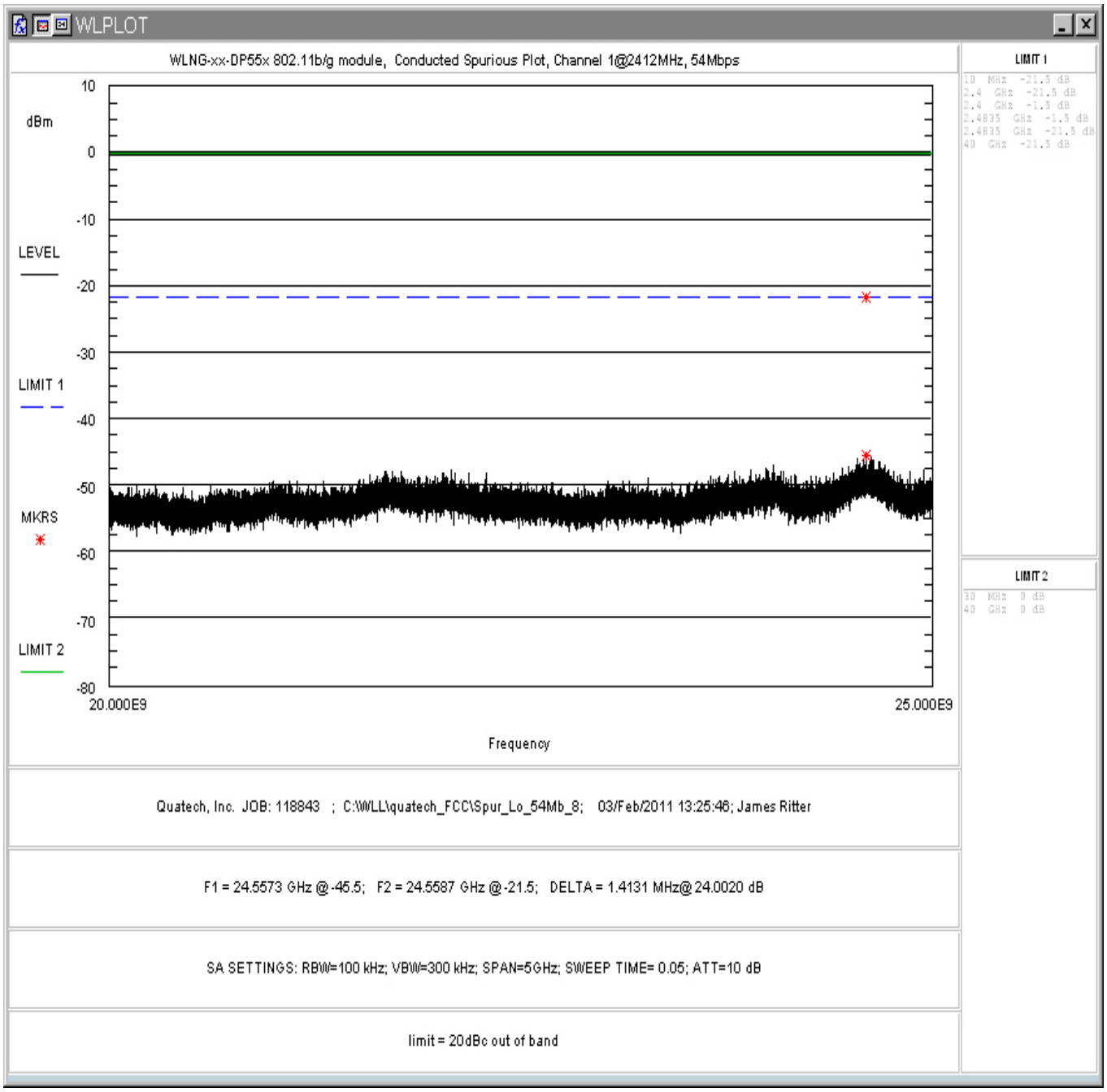

Figure 40: Conducted Spurious Emissions, Channel 1, 54Mbps, 20-25 GHz

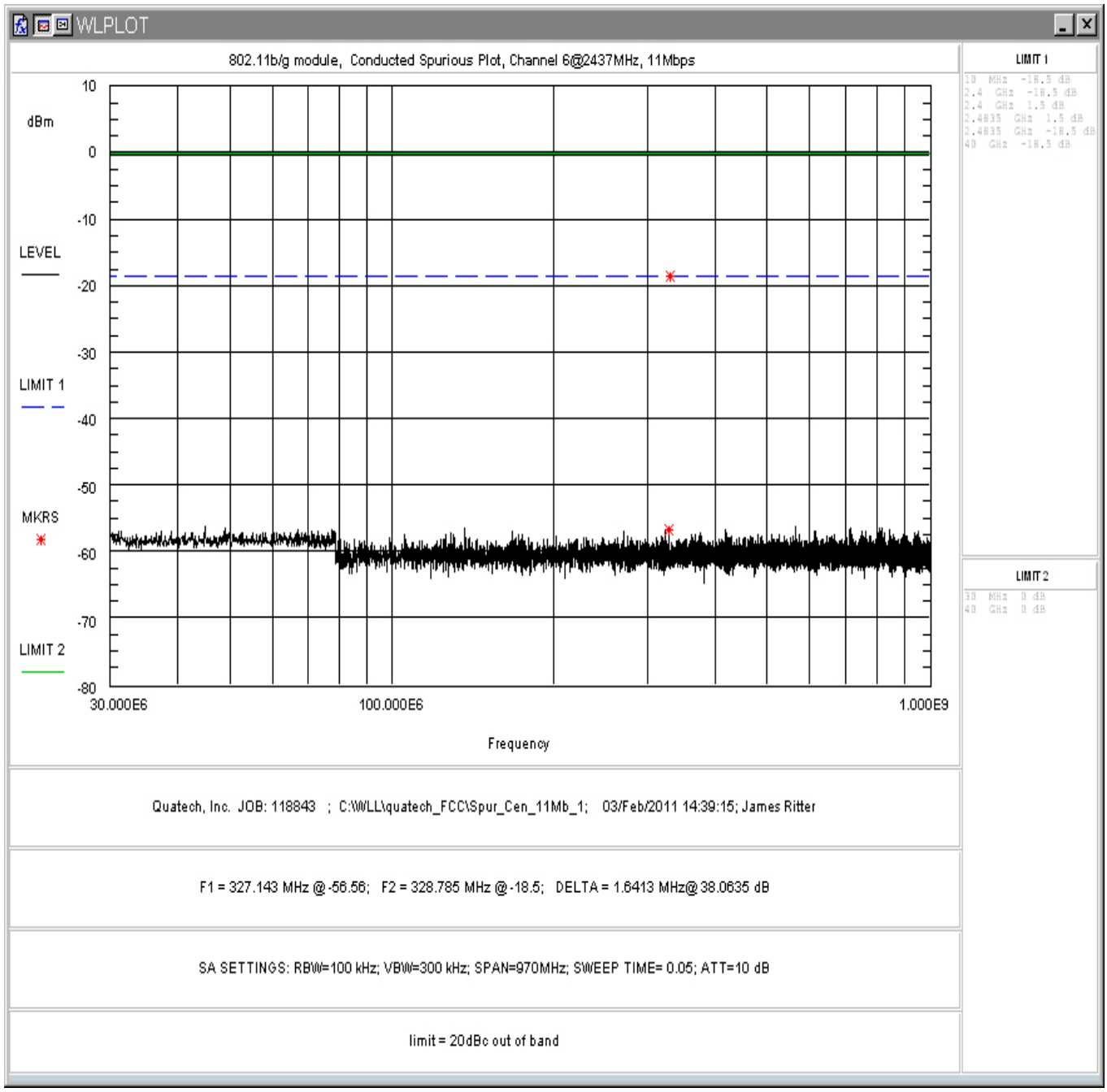

Figure 41: Conducted Spurious Emissions, Channel 6, 11Mbps, 30 - 1000MHz