Washington Laboratories, Ltd.
www.wll.com
7560 Lindbergh Drive . Gaithersburg, MD 20879
301.216.1500 . info@wll.com

FCC Certification Test Report
For the
Mueller Technologies
UGM-LOW Transmitter Module

FCC ID: SM6-UGM-L-NS

WLL JOB# **10745-01**
February 11, 2009

Prepared for:

Mueller Technologies
230 Union Street
New Bedford, MA 02740

Prepared By:

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

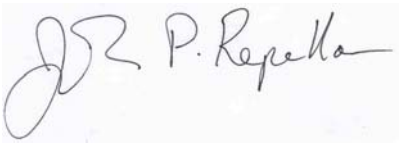
ACCREDITED
Testing Certificate 2675.01

FCC Certification Test Report
For the
Mueller Technologies
UGM-LOW Transmitter Module

FCC ID: SM6-UGM-L-NS

February 11, 2009

WLL JOB# 10745-01



Prepared by:

John P. Repella
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Mueller Technologies to support the attached Application for Equipment Authorization for which they are seeking Limiter Modular Approval. The reason that LMA is requested is because the manufacturer wants to remove the shield for cost reasons. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (7/2008) of the FCC Rules. This Certification Test Report documents the test configuration and test results for a Mueller Technologies UGM-L Transmitter 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 Mueller Technologies UGM-L Transmitter Module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The Mueller Technologies UGM-L Transmitter 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 with FCC Public Notice DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems". The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Mueller Technologies 230 Union Street New Bedford, MA 02740
Quotation Number:	

1.4 Test Dates

Testing was performed on the following date(s):	1/26/2008, 2/2/2009 to 2/5/2009

1.5 Test and Support Personnel

Washington Laboratories, LTD	John P. Repella
Client Representative	Tom Cullinan

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**eres
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**C**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**decibel**
DC	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification & Description

The Mueller Technologies SmartMeter UGM-LOW (Under Glass Module) is an ISM band 902 to 928 MHz frequency hopping transceiver module.

The module is intended to be installed in an off the shelf electric meter. The electric meters are designed to accept AMI option modules such as our UGM product. The electric meter interface provides power and a serial data connection to the UGM module.

The power supplied by the electric meter is an unregulated 9~15Vdc. The UGM low power module employs a switching regulator to regulate the supply voltage to 5Vdc and then a linear regulator for a local 3.3V supply.

The serial port is a logic level asynchronous port with a TX and RX lines. All data is buffered on the UGM module to/from the electric meter.

The UGM module design contains 2 basic blocks, a processor & memory block, an RF transceiver block. This low cost version removes RF shielding from all blocks.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mueller Technologies
FCC ID:	FCC ID: SM6-UGM-L-NS
Model:	UGM-L Transmitter Module
FCC Rule Parts:	§15.247
Frequency Range:	902.5-927MHz
Maximum Output Power: (conducted at antenna port)	25.7mW (14.1dBm)
Modulation:	FM
Occupied Bandwidth:	44.8 kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Fixed
Antenna Connector	MMCX
Antenna Type	2.7dBi dipole
Interface:	10 pin dual row socket (power & data), 10 pin dual row socket (programming port),
Power Source & Voltage:	9-15VDC

2.2 Test Configuration

The UGM-L Transmitter Module receives 9-15VDC unregulated power from an Electric meter provided by Mueller Technologies. The module was tested in the meter housing for radiated emissions and AC conducted emissions. Commands were sent to the UGM-L Transmitter Module using a programming port connected to a support laptop using Windows HyperTerminal program.

2.3 Testing Algorithm

The UGM-L Transmitter Module was programmed via a 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

2.6 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 not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

3 Test Equipment

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

Table 3: Test Equipment List

Test Name: **Conducted Antenna Port**		Test Date:	**2/02/2009**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
74	HP, 8563A	Analyzer, Spectrum	03/07/2009
528	Agilent, E4446A	Analyzer, Spectrum	02/15/2009

Test Name: **Radiated Emissions**		Test Date:	**2/03/2009**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
618	HP 8563A	Analyzer, Spectrum	03/07/2009
522	HP, 8449B	Pre-Amplifier, 1-26.5GHz	07/15/2009
425	ARA, DRG-118/A	Antenna, DRG, 1-18GHz	05/22/2009
337	WLL, 1.2-5GHz	Filter, Band Pass	02/19/2010
281	ITC, 21A-3A1	Waveguide 4.51-10.0GHz	02/19/2010
68	HP, 85650A	Adapter, QP	07/07/2009
72	HP, 8568B	Analyzer, Spectrum	07/03/2009
70	HP, 85685A	Preselector, RF w/opt 8ZE	07/07/2009
644	Sunol Science JB1	BiConalog Antenna	12/29/2009

Test Name: **Conducted Emissions Voltage**		Test Date:	**12/04/2008**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
125	Solar, 8028-50-TS-24-BNC	LISN	01/30/2009
126	Solar, 8028-50-TS-24-BNC	LISN	01/30/2009
68	HP, 85650A	Adapter, QP	07/07/2009
72	HP, 8568B	Analyzer, Spectrum	07/03/2009
70	HP, 85685A	Preselector, RF w/opt 8ZE	07/07/2009

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. Full results are shown in section 5.

Table 4: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)		
FCC Rule Part	**Description**	**Result**
15.247 (a)(1)(iii)	Time of Occupancy	Pass
15.247 (b)(1)	Transmit Output Power	Pass
15.247 (a)(1)(iii)	20dB Bandwidth	Pass
15.247 (a)(1)	Channel Separation	Pass
15.247 (a)(1)(iii)	Number of Channels	Pass
15.247 (d)	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.209	General Field Strength Limits (Restricted Bands)	Pass
15.207	AC Conducted Emissions	Pass
RX/Digital Test Summary (Frequency Hopping Spread Spectrum)		
FCC Rule Part	**Description**	**Result**
15.207	AC Conducted Emissions	Covered in a separate End Product Declaration of Conformity
15.209	General Field Strength Limits	Covered in a separate End Product Declaration of Conformity

5 Test Results

5.1 Duty Cycle and Time of Occupancy

In accordance with the FCC Public Notice the spurious radiated emissions measurements may be adjusted if using a duty cycle correction factor if the dwell time per channel of the hopping signal is less than 100 ms.

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

As the Maximum Dwell time of this device is 204.6ms no duty cycle correction is allowed.

The unit makes a single hop transmission in 20 seconds. FCC part 15.247 requires that for hopping signals with an occupied bandwidth less than 250 kHz the limit is 0.4 seconds dwell time per 20 seconds

The following figures show the plot of the dwell time and time of occupancy for the transmitter. Based on this plot, the dwell time per hop is 204.6ms. As the unit is on a channel only once in a 20 second period the time of occupancy is also 204.6ms, thus complying with the 0.4 second requirement.

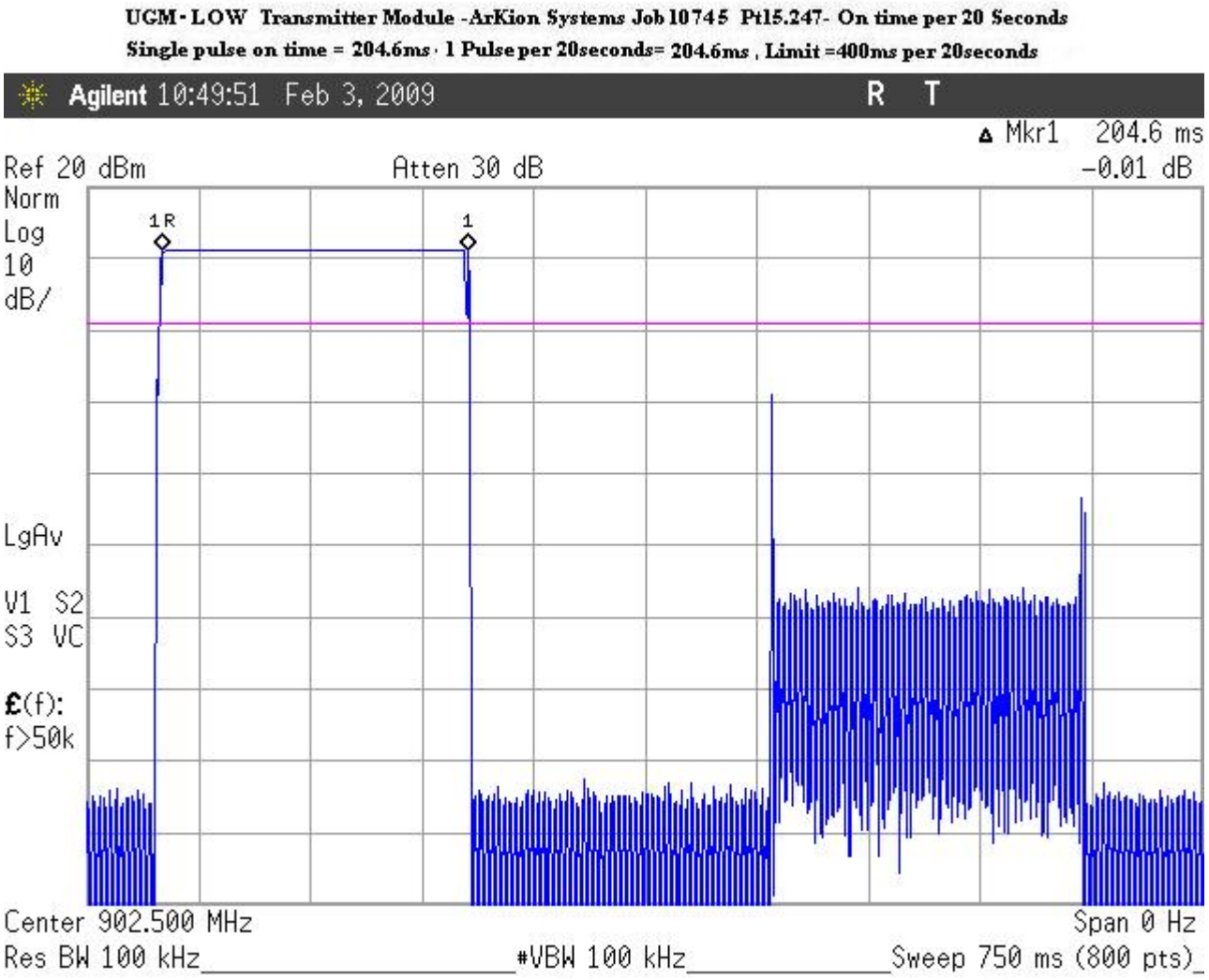


Figure 5-1: Duty Cycle Plot

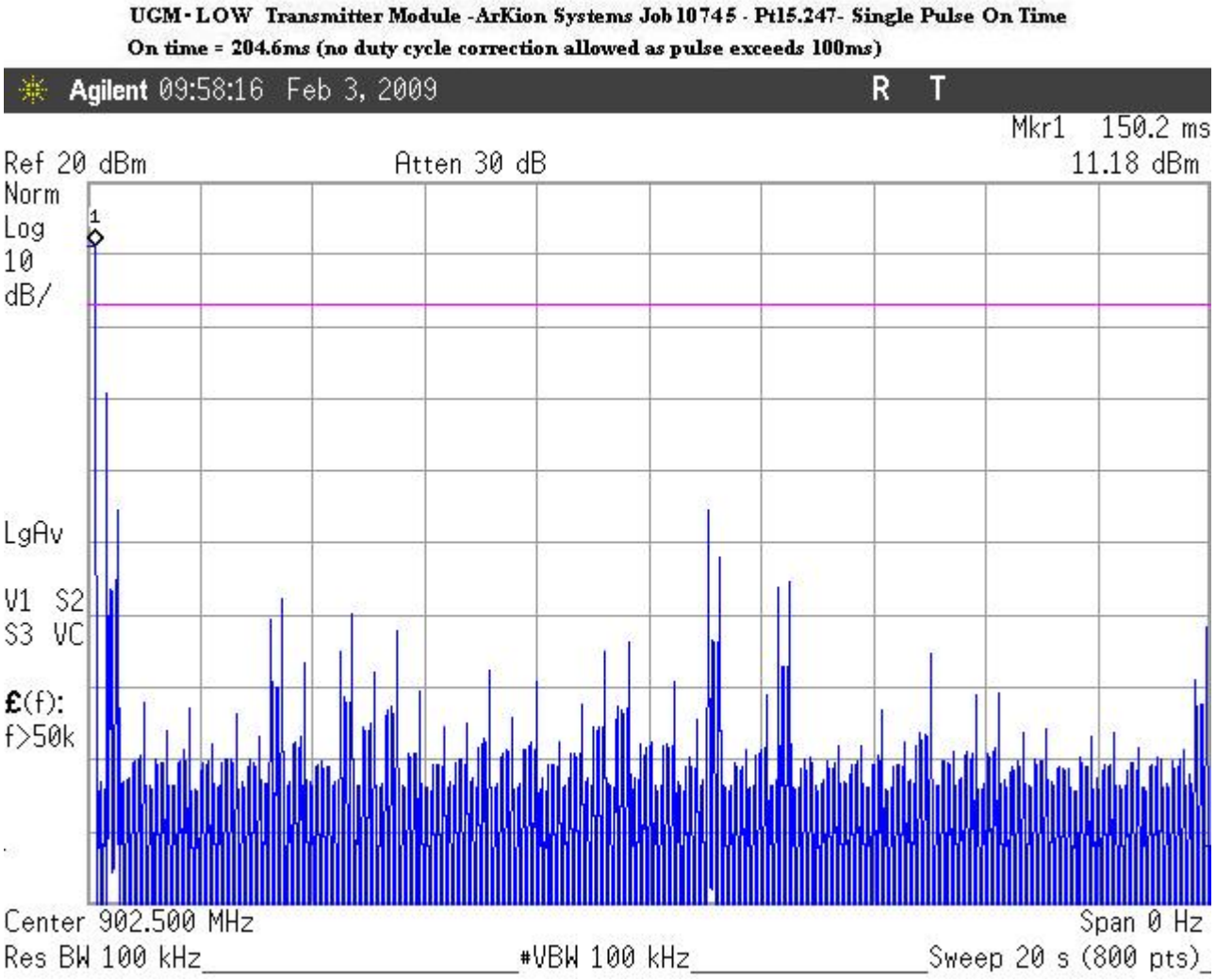


Figure 5-2: Time Of Occupancy Plot

5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on the lowest, middle and highest channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator, cable, and other losses in the system.

Table 5: RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel: 902.5MHz	14.07 dBm	30 dBm	Pass
Mid Channel: 915.0MHz	14.07 dBm	30 dBm	Pass
High Channel: 927.0MHz	14.07 dBm	30 dBm	Pass

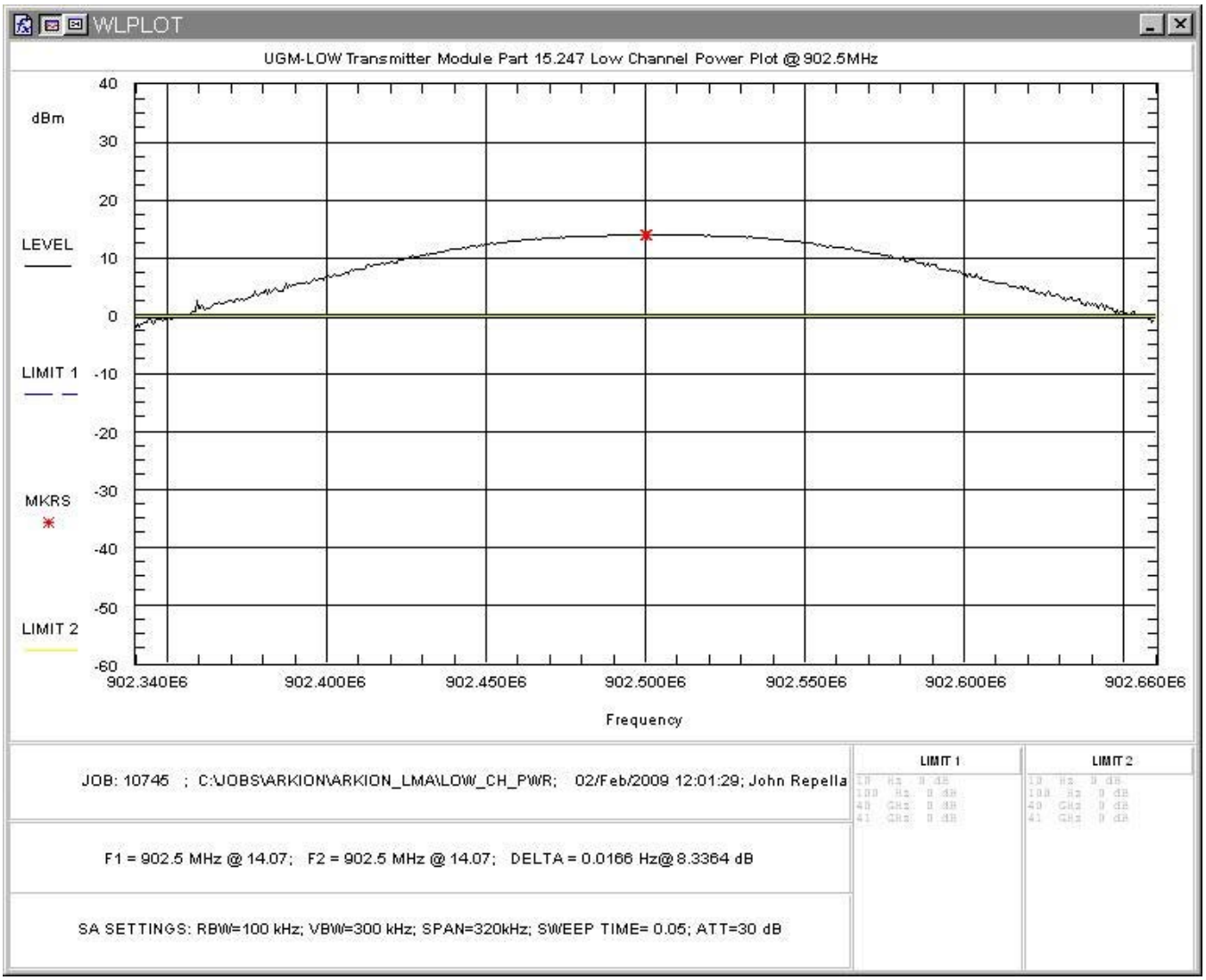


Figure 5-3: RF Peak Power, Low Channel

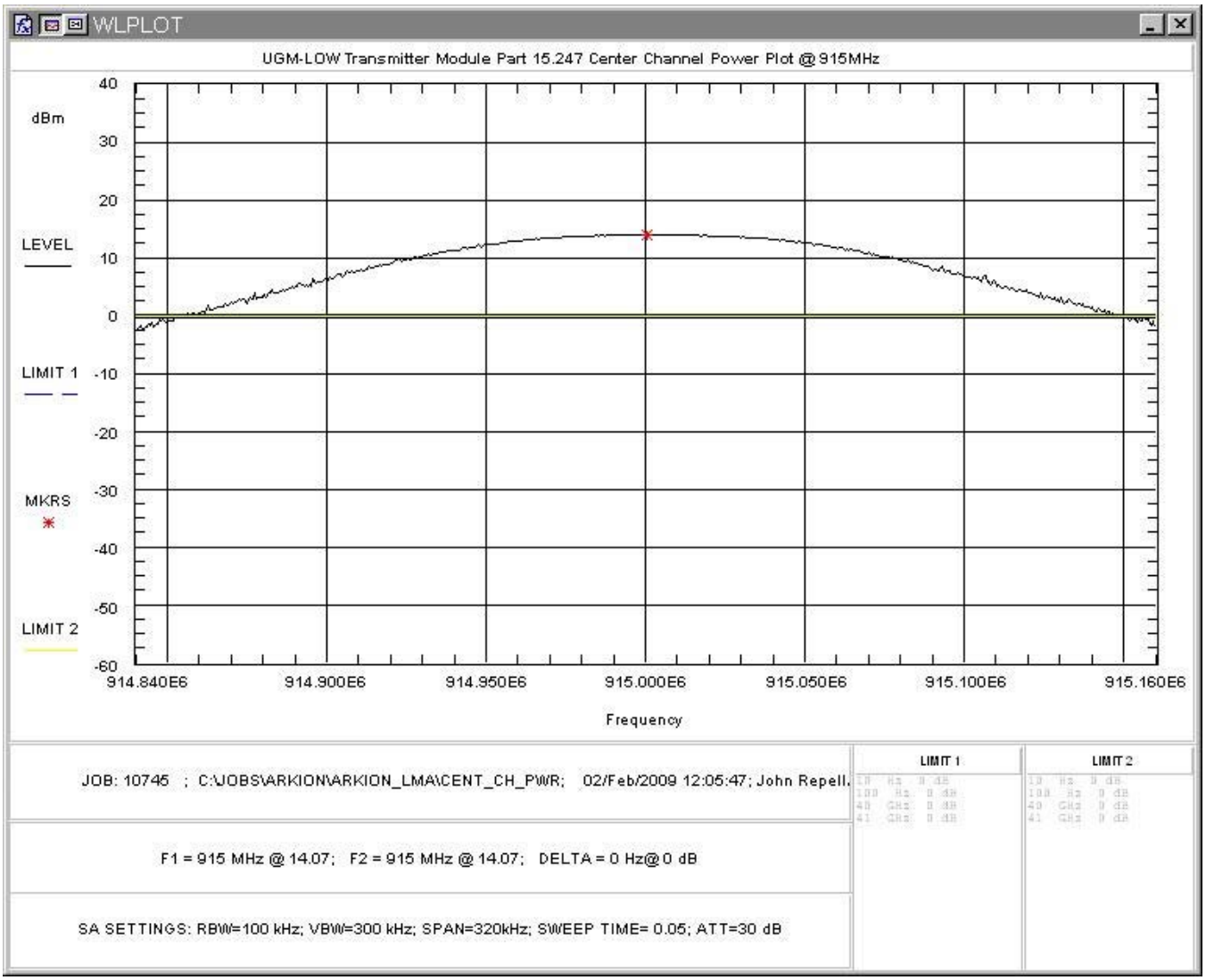


Figure 5-4: RF Peak Power, Mid Channel

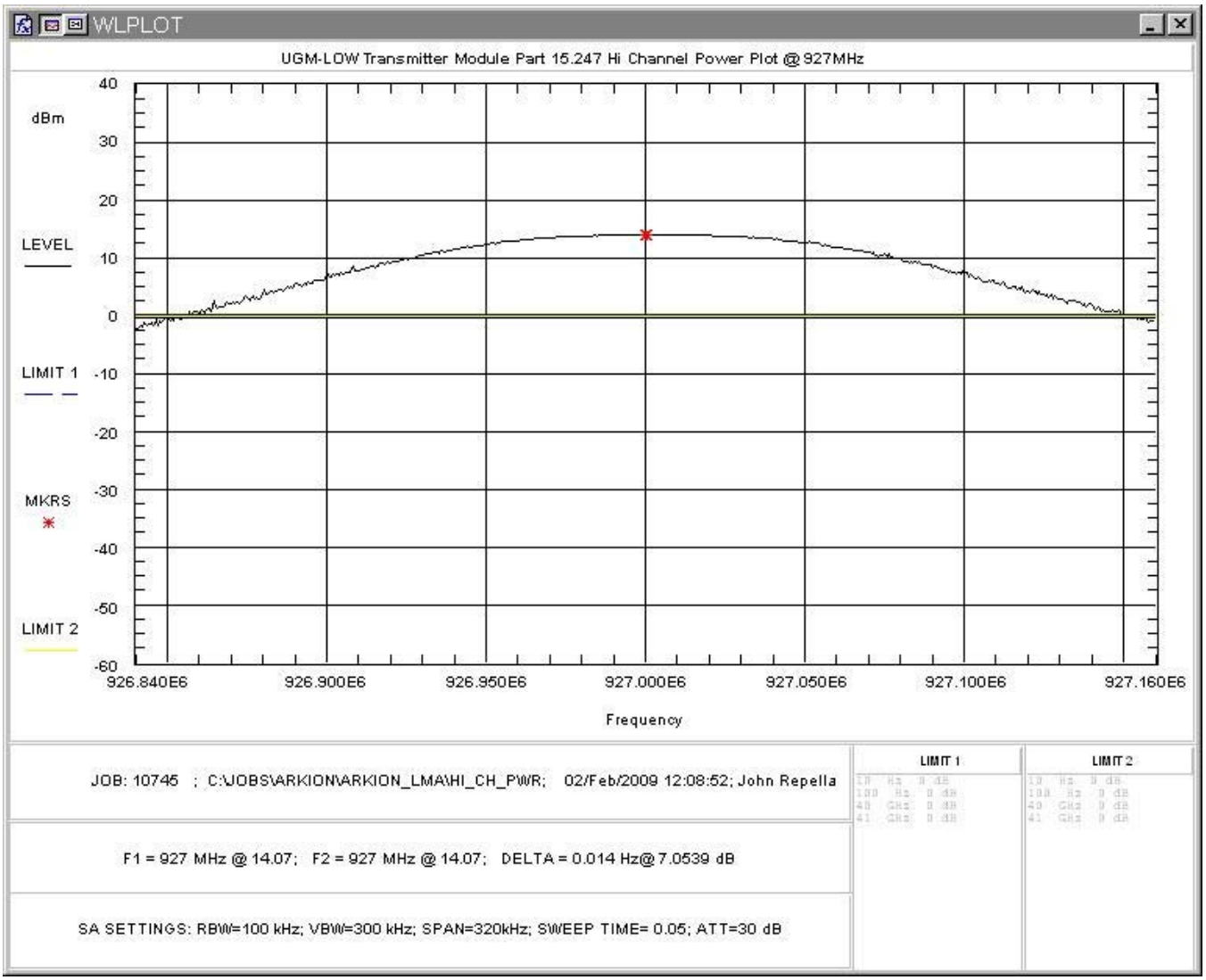


Figure 5-5: RF Peak Power, High Channel

5.3 Occupied Bandwidth: (FCC Part §2.1049)

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

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

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

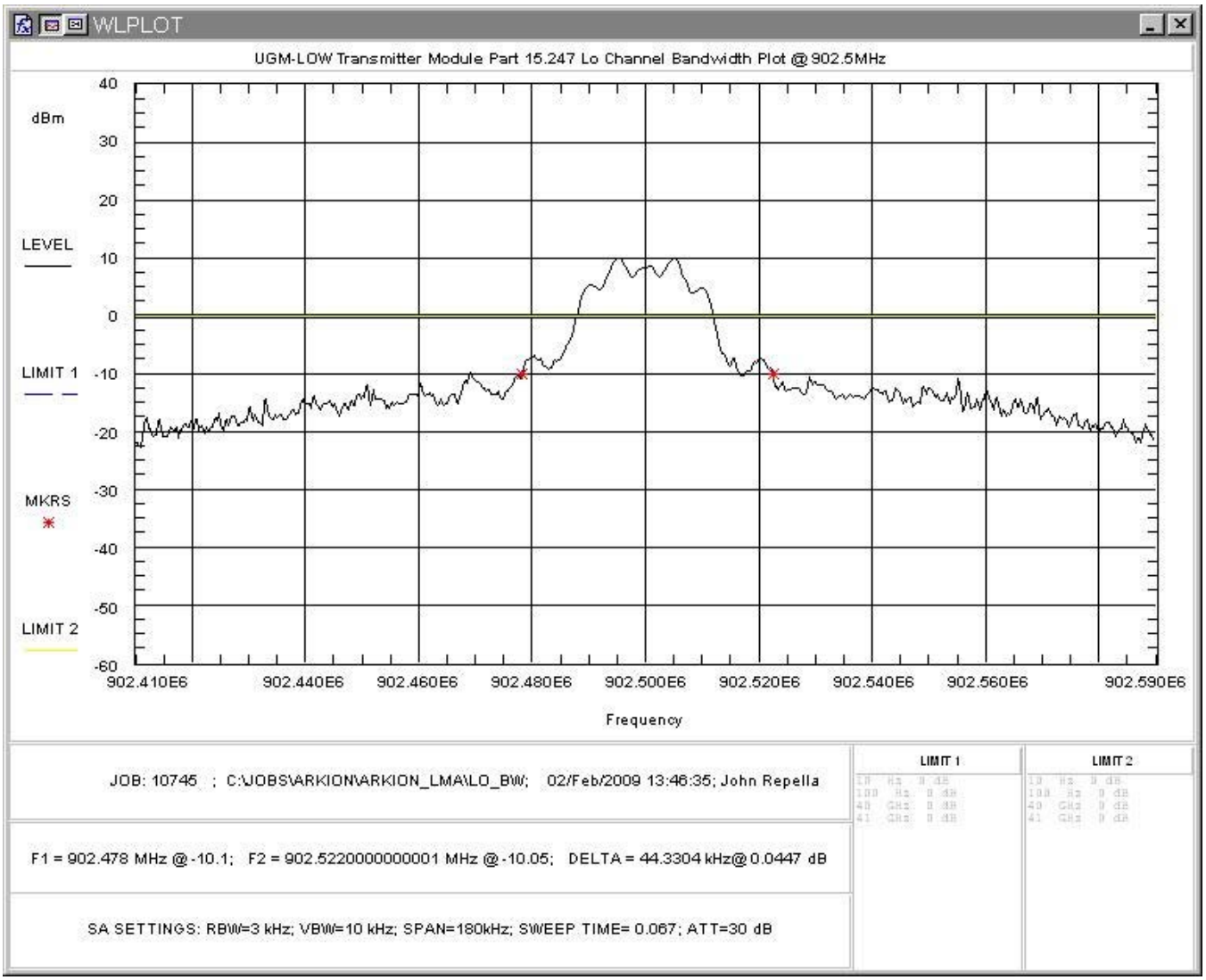


Figure 5-6: Occupied Bandwidth, Low Channel

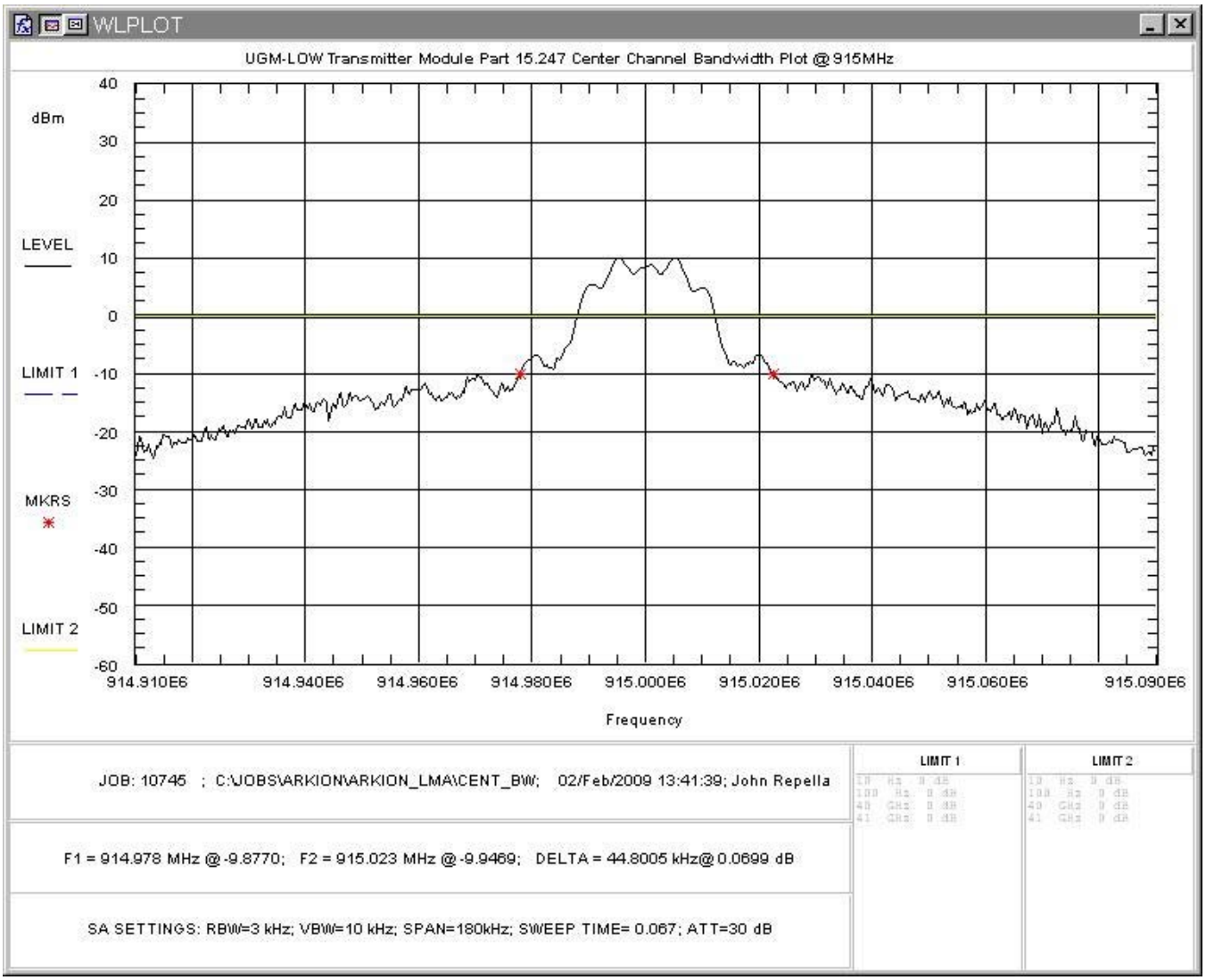


Figure 5-7: Occupied Bandwidth, Mid Channel

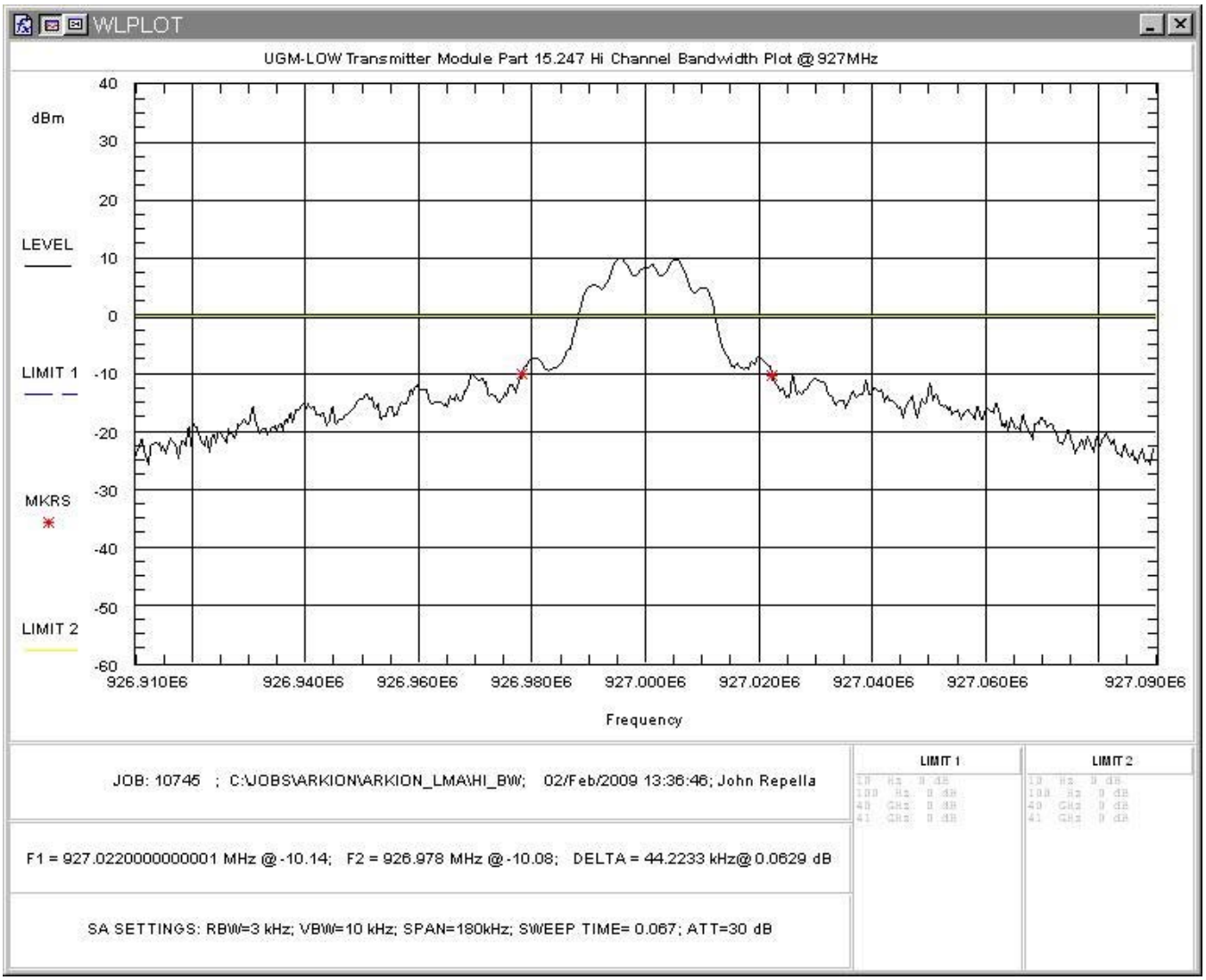


Figure 5-8: Occupied Bandwidth, High Channel

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

Frequency	Bandwidth
Low Channel: 902.5MHz	44.3kHz
Mid Channel: 915.0MHz	44.8kHz
High Channel: 927.0MHz	44.2kHz

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

Per the FCC requirements, frequency hopping systems operating in the 902-928MHz shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 44.8 kHz so the channel spacing must be more than 44.8 kHz. In addition, Part 15.247 requires that devices with occupied bandwidths less than 250 kHz have a minimum of 50 hopping channels.

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

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 507 kHz and the number of hopping channels is 50.

Table 7: Channel spacing and number of hopping channels summary

Test	Result	Limit	Pass/Fail
Channel spacing	507kHz	44.8kHz Minimum	Pass
Number of Channels	50 channels	50 channels minimum	Pass

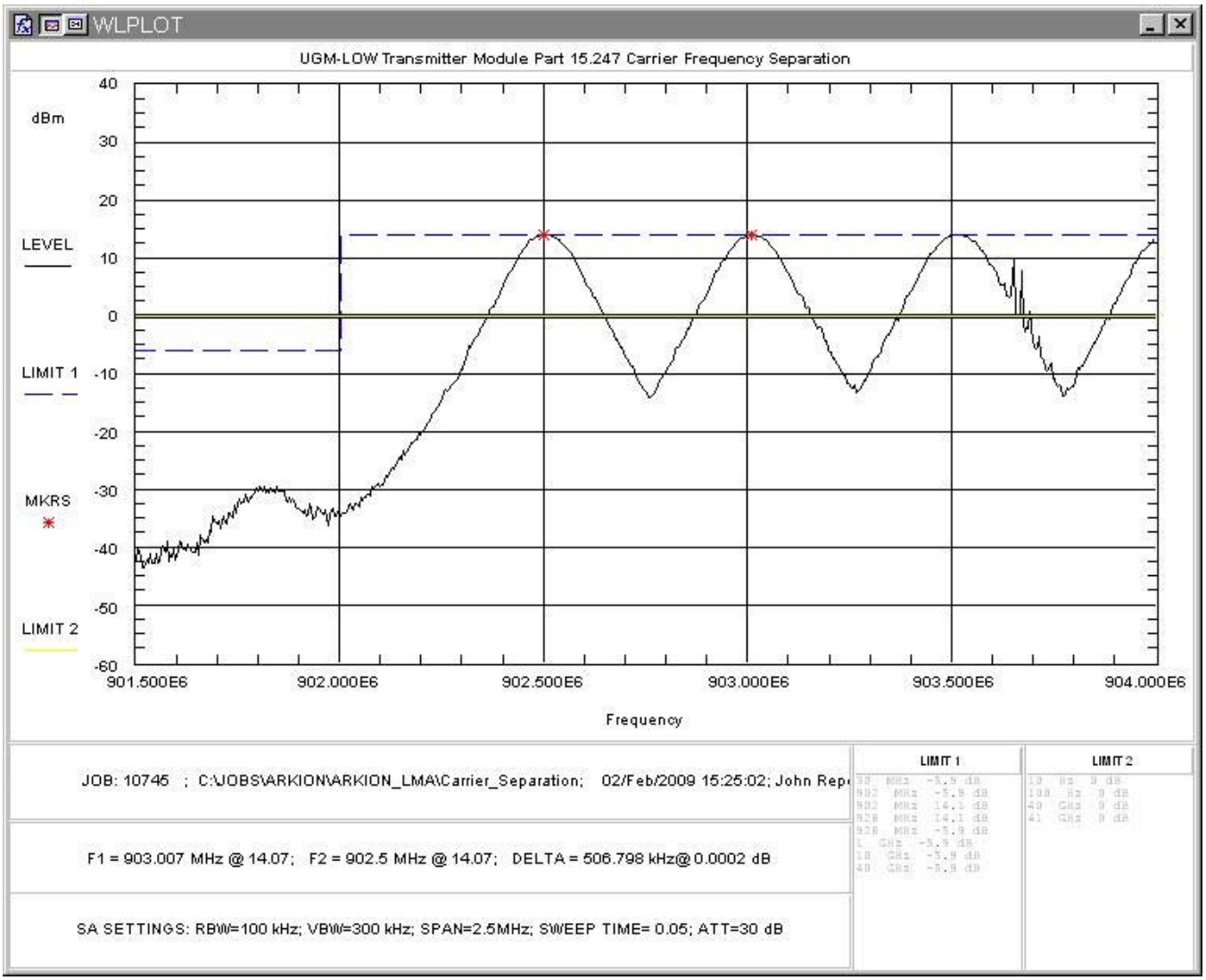


Figure 5-9: Carrier Frequency Separation, 500kHz

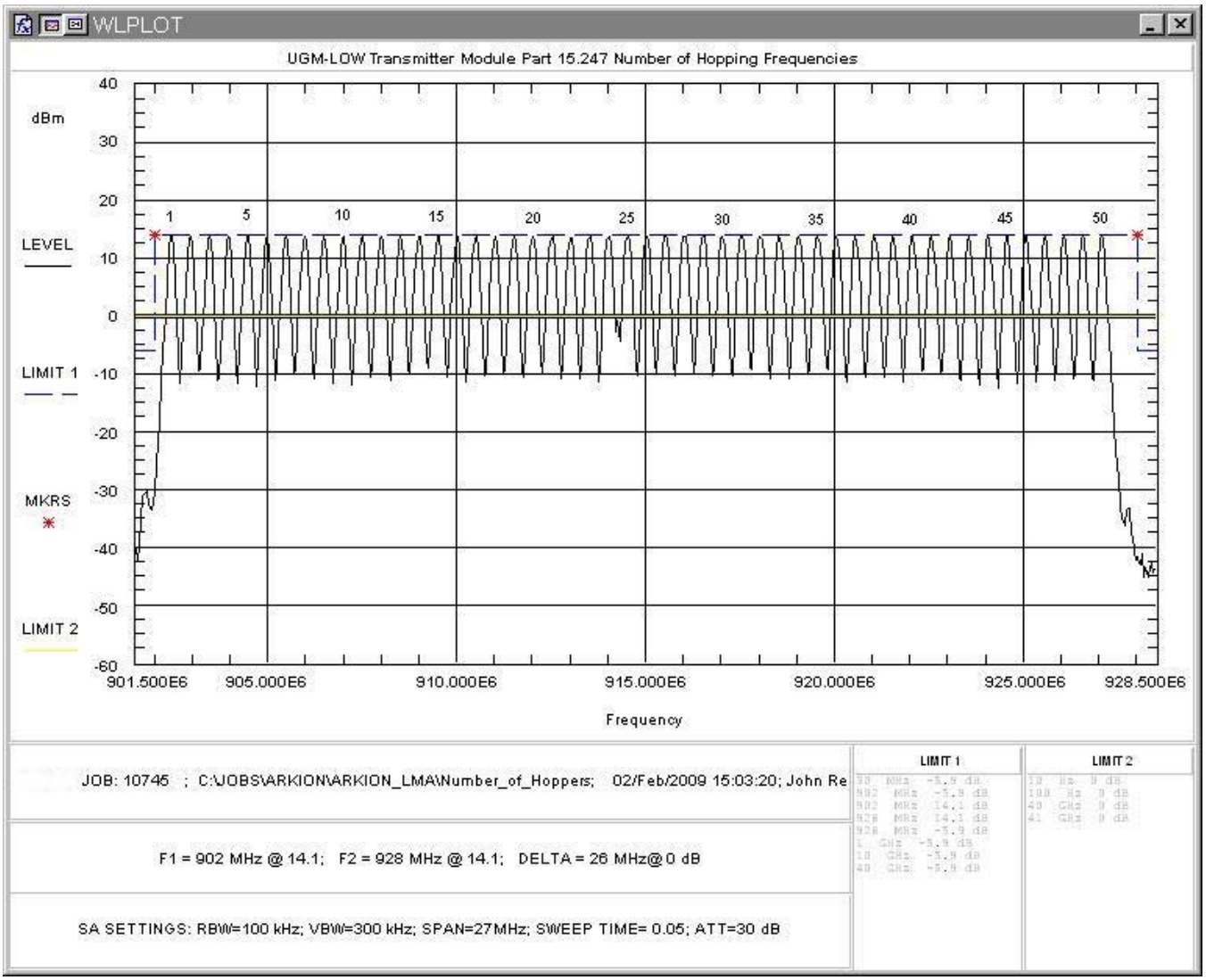


Figure 5-10: Number of Channels

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

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

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a suitable attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the maximum modulated transmit frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

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

The following are plots of the conducted spurious emissions data.

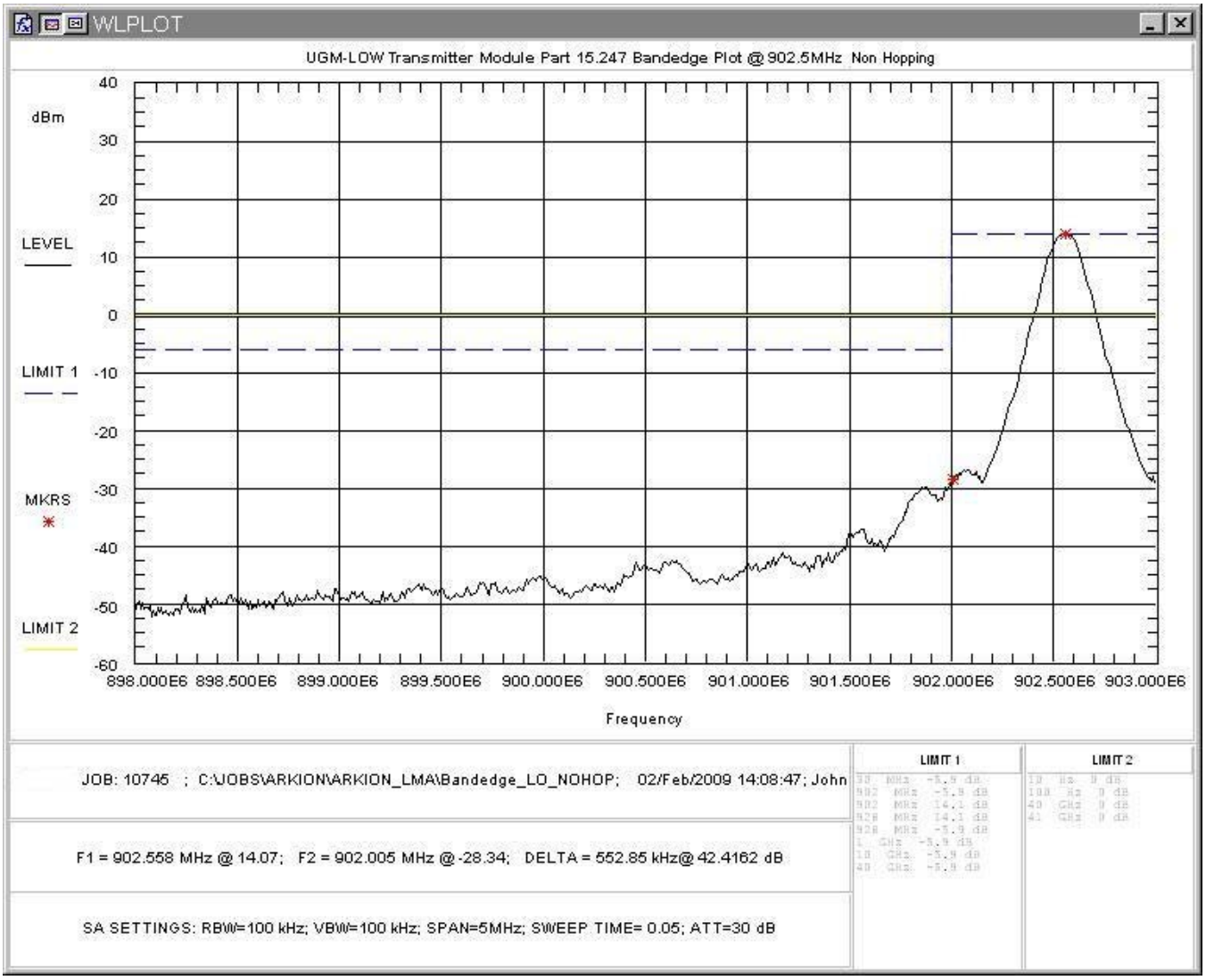


Figure 5-11: Lower Band Edge Plot, Low Channel

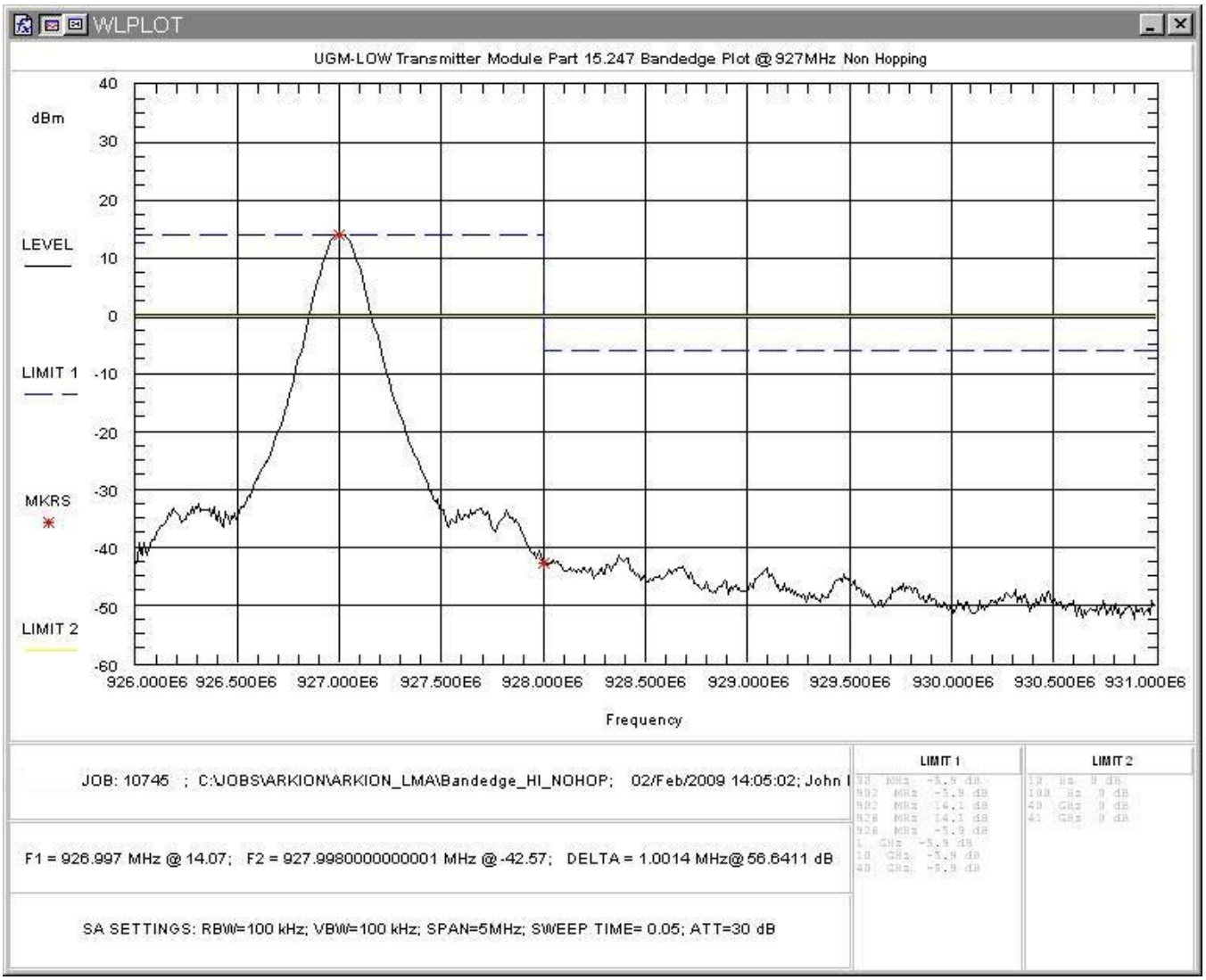


Figure 5-12: Upper Band Edge Plot, High Channel

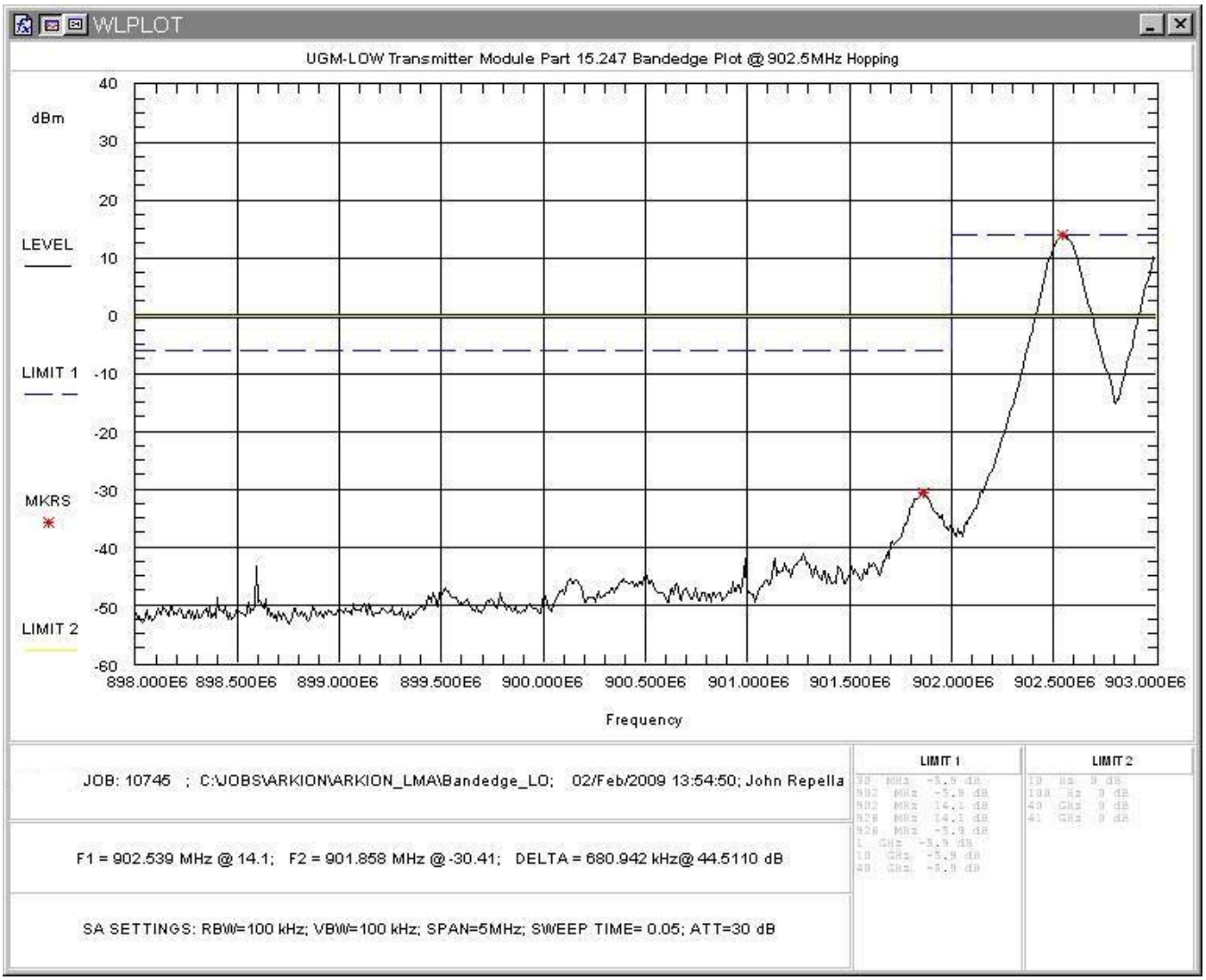


Figure 5-13: Lower Band Edge Plot, Hopping Mode

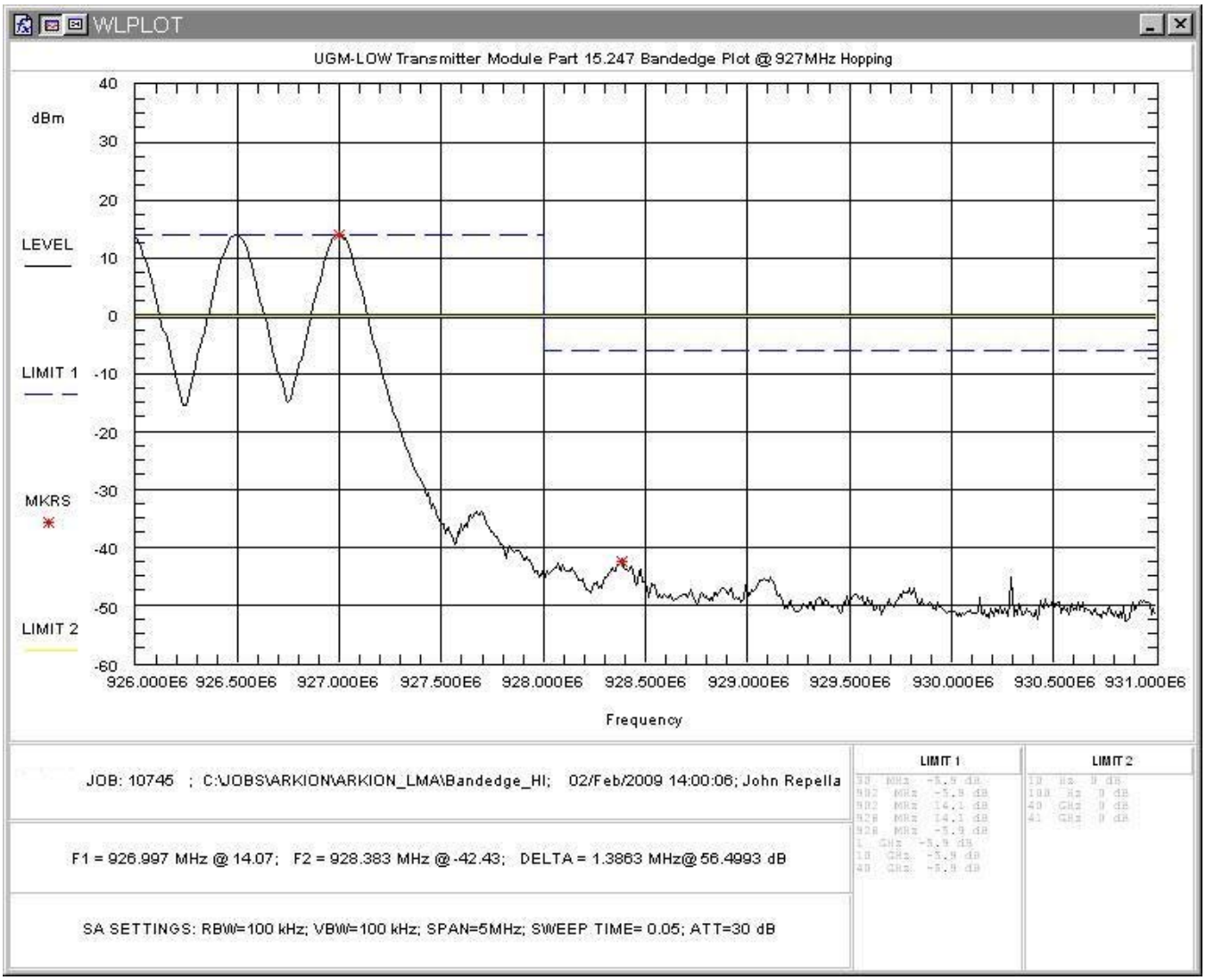


Figure 5-14: Upper Band Edge Plot, Hopping Mode

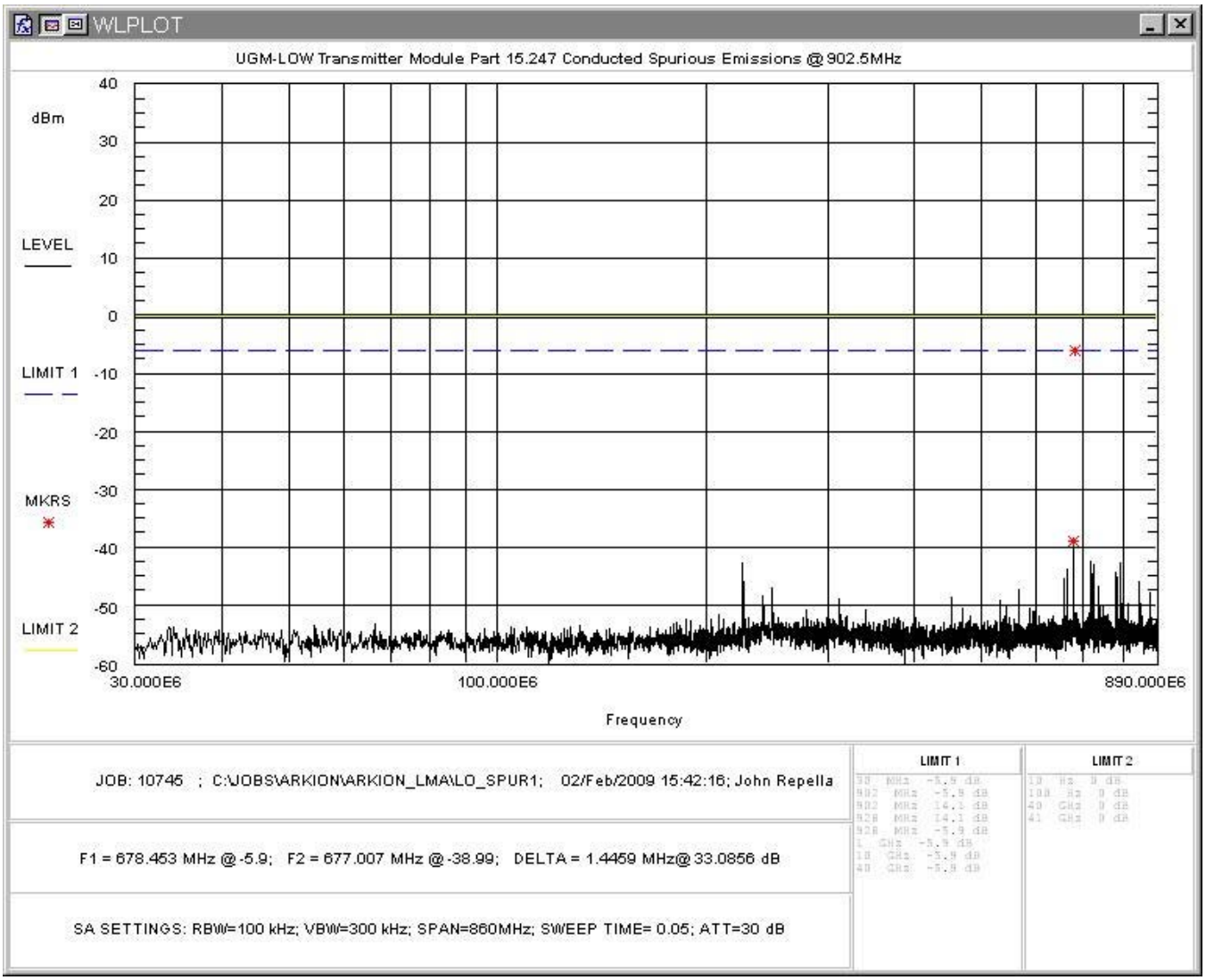


Figure 5-15: Conducted Spurious Emissions, Low Channel 30 - 890MHz

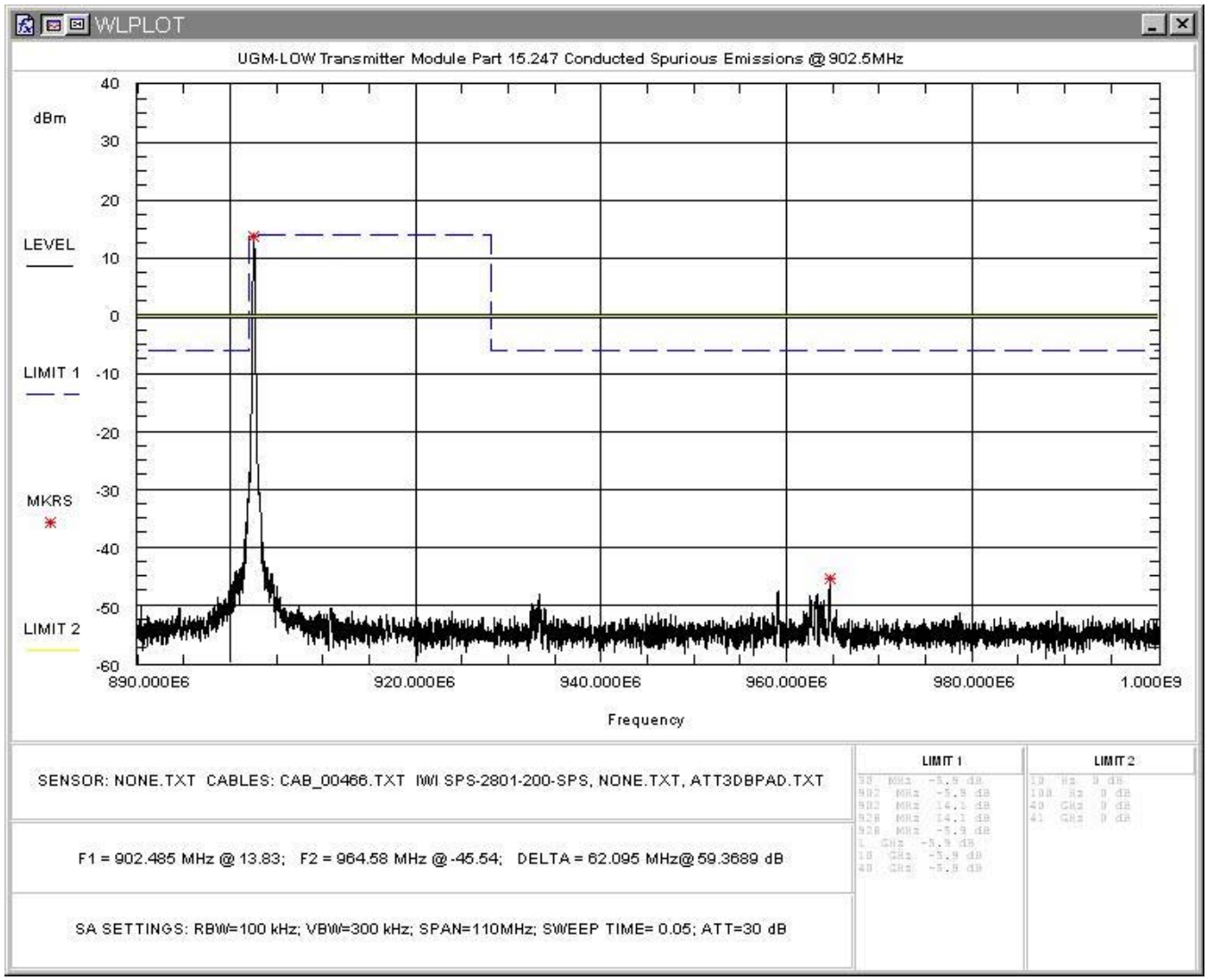


Figure 5-16: Conducted Spurious Emissions, Low Channel 890-1000MHz

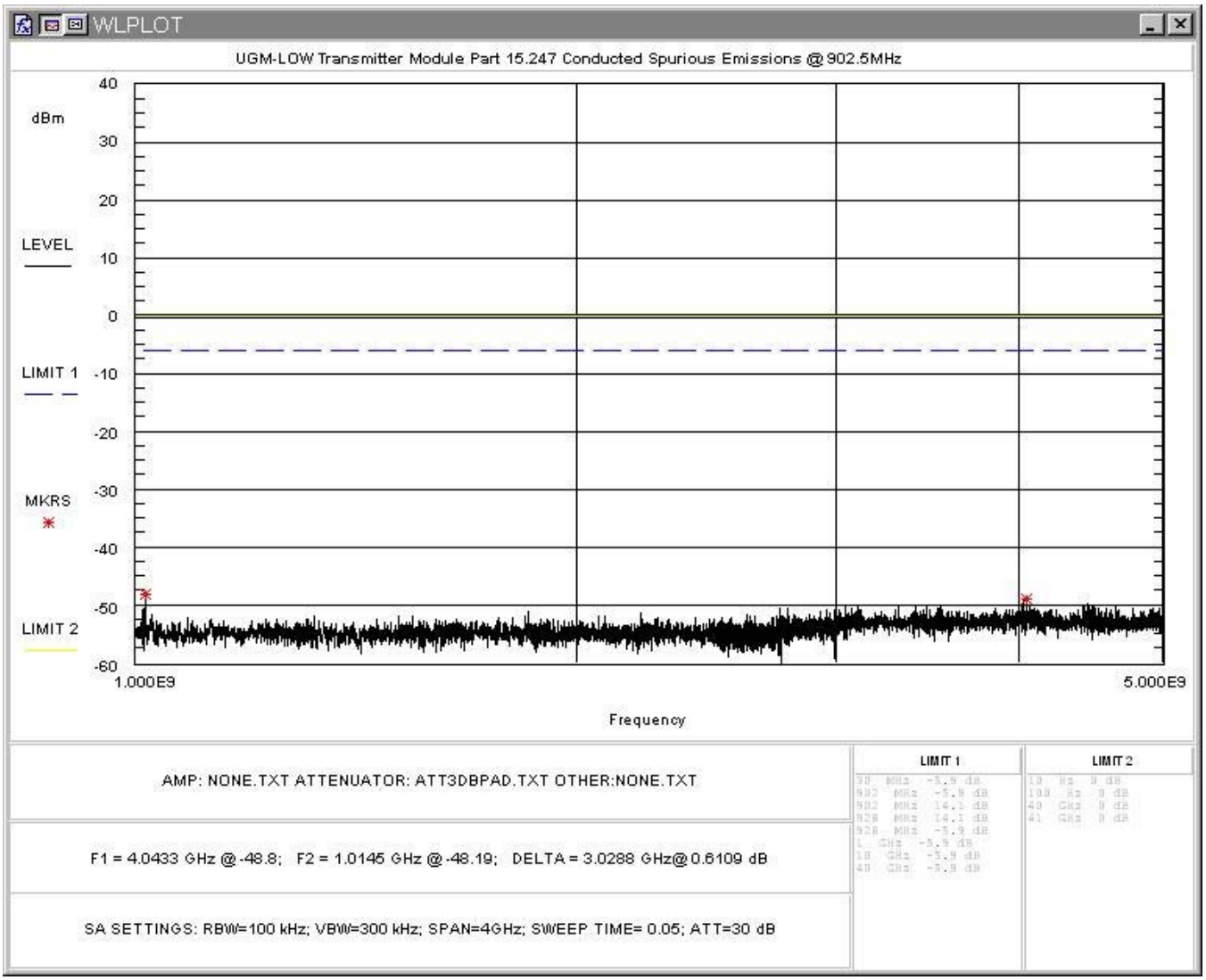


Figure 5-17: Conducted Spurious Emissions, Low Channel 1-5GHz

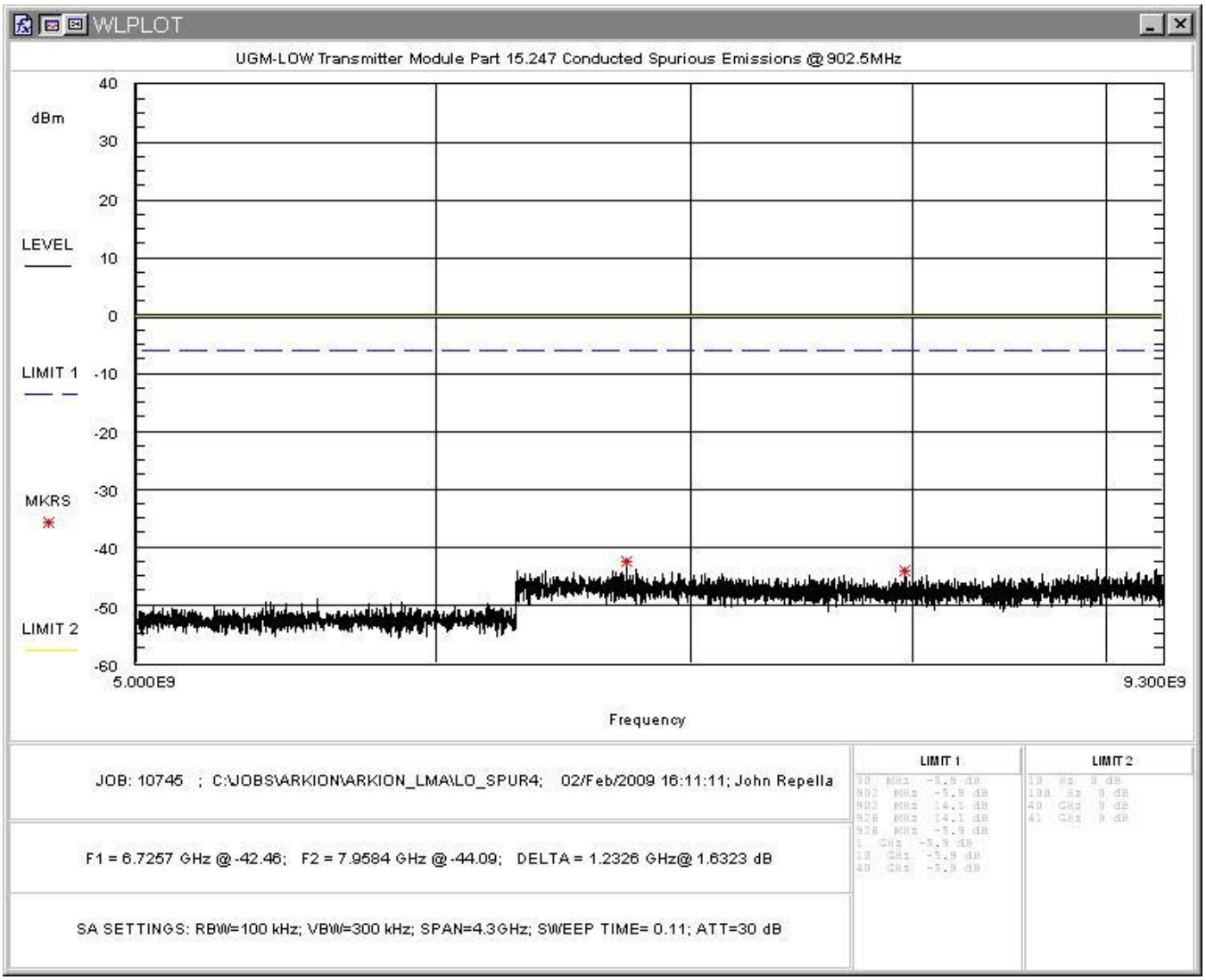


Figure 5-18: Conducted Spurious Emissions, Low Channel 5 -9.3GHz

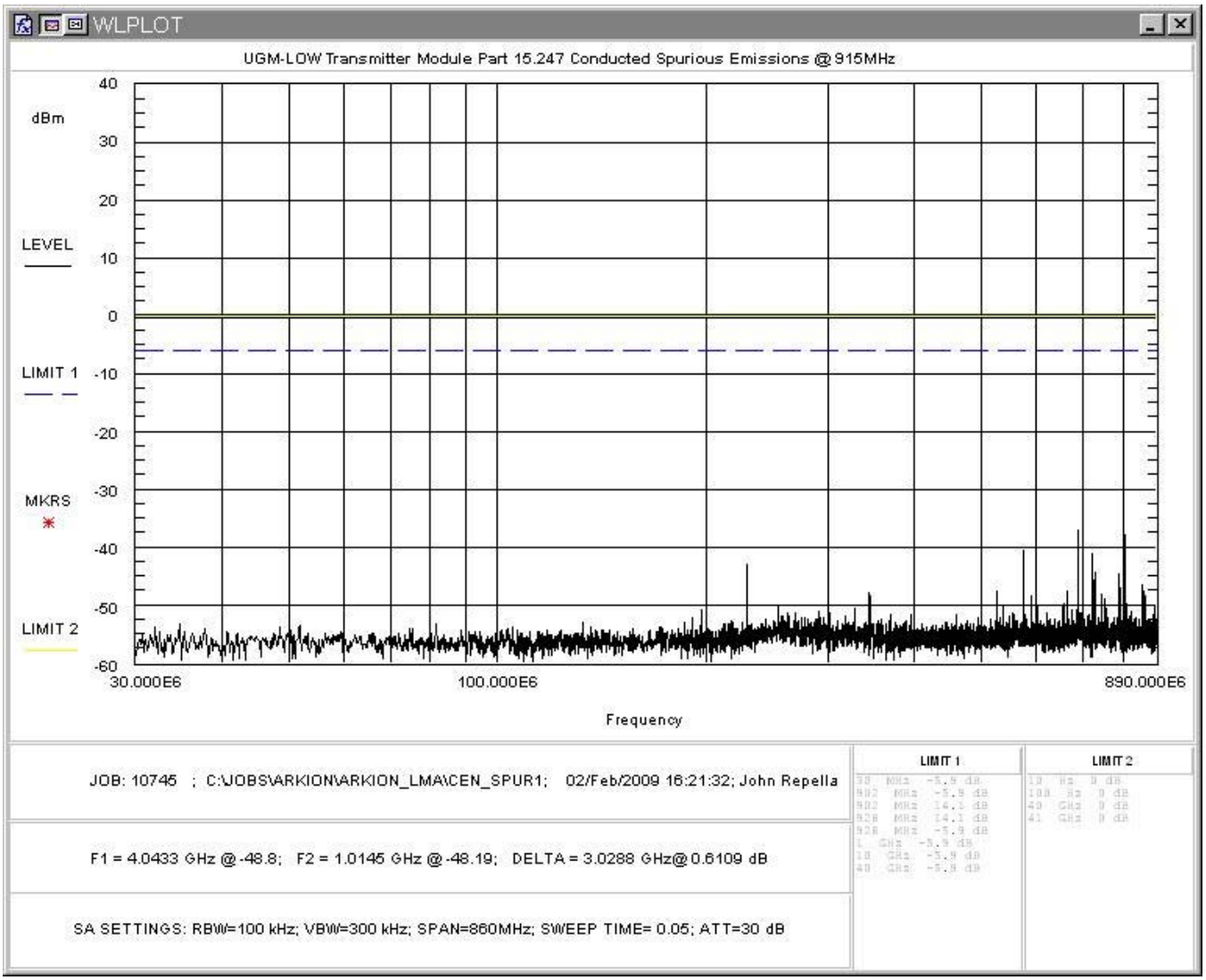


Figure 5-19: Conducted Spurious Emissions, Center Channel 30 - 890MHz

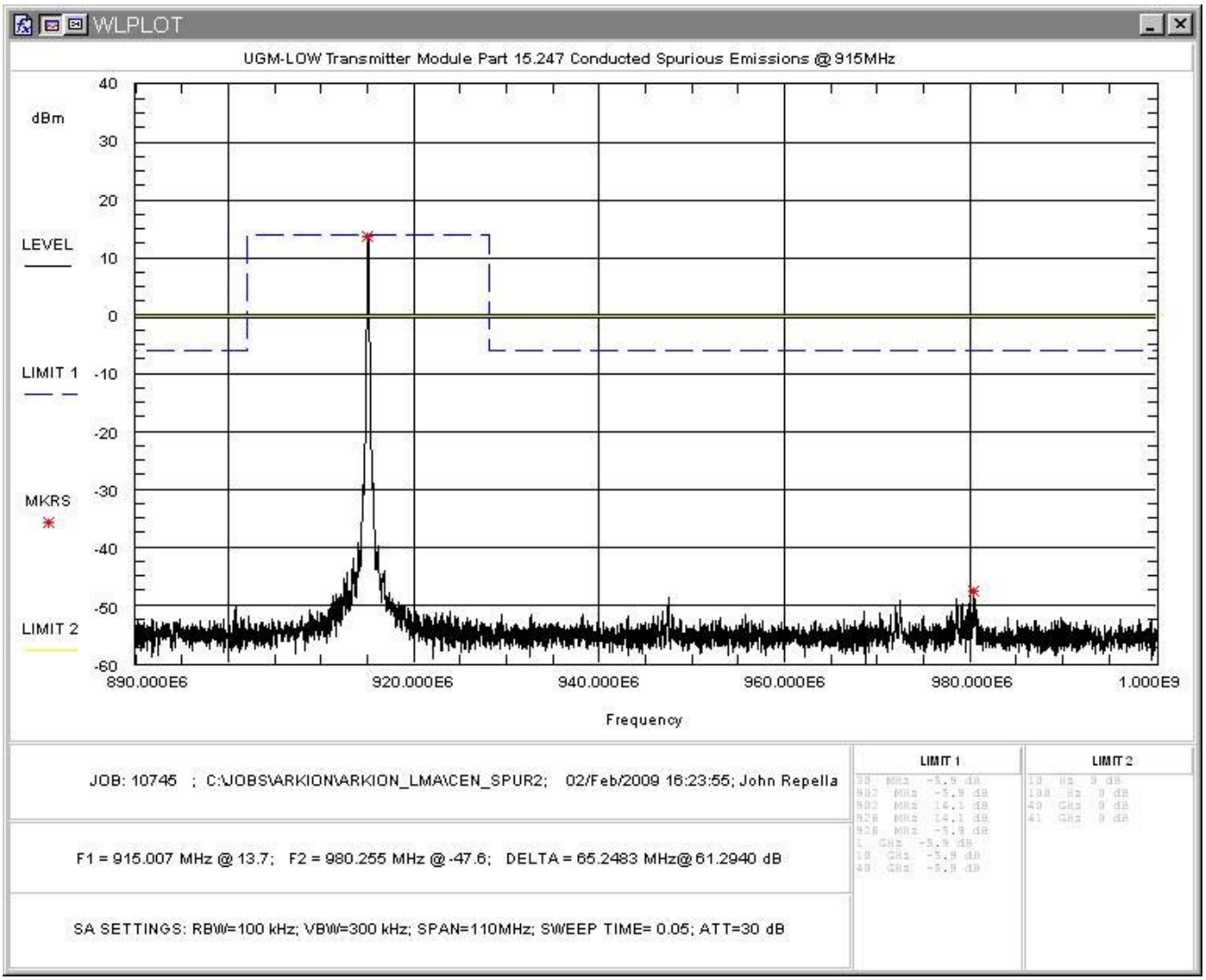


Figure 5-20: Conducted Spurious Emissions, Center Channel 890-1000MHz

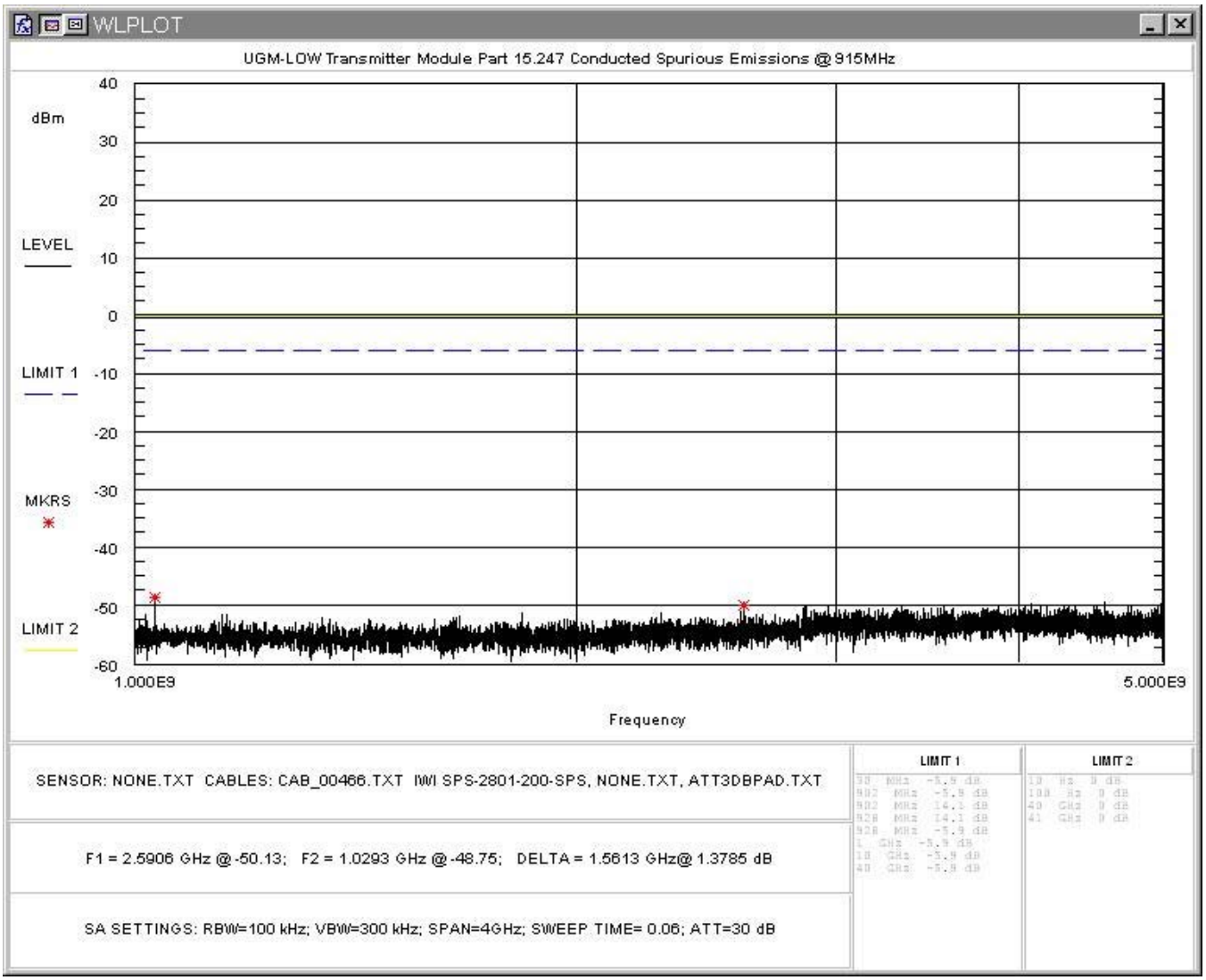


Figure 5-21: Conducted Spurious Emissions, Center Channel 1-5GHz

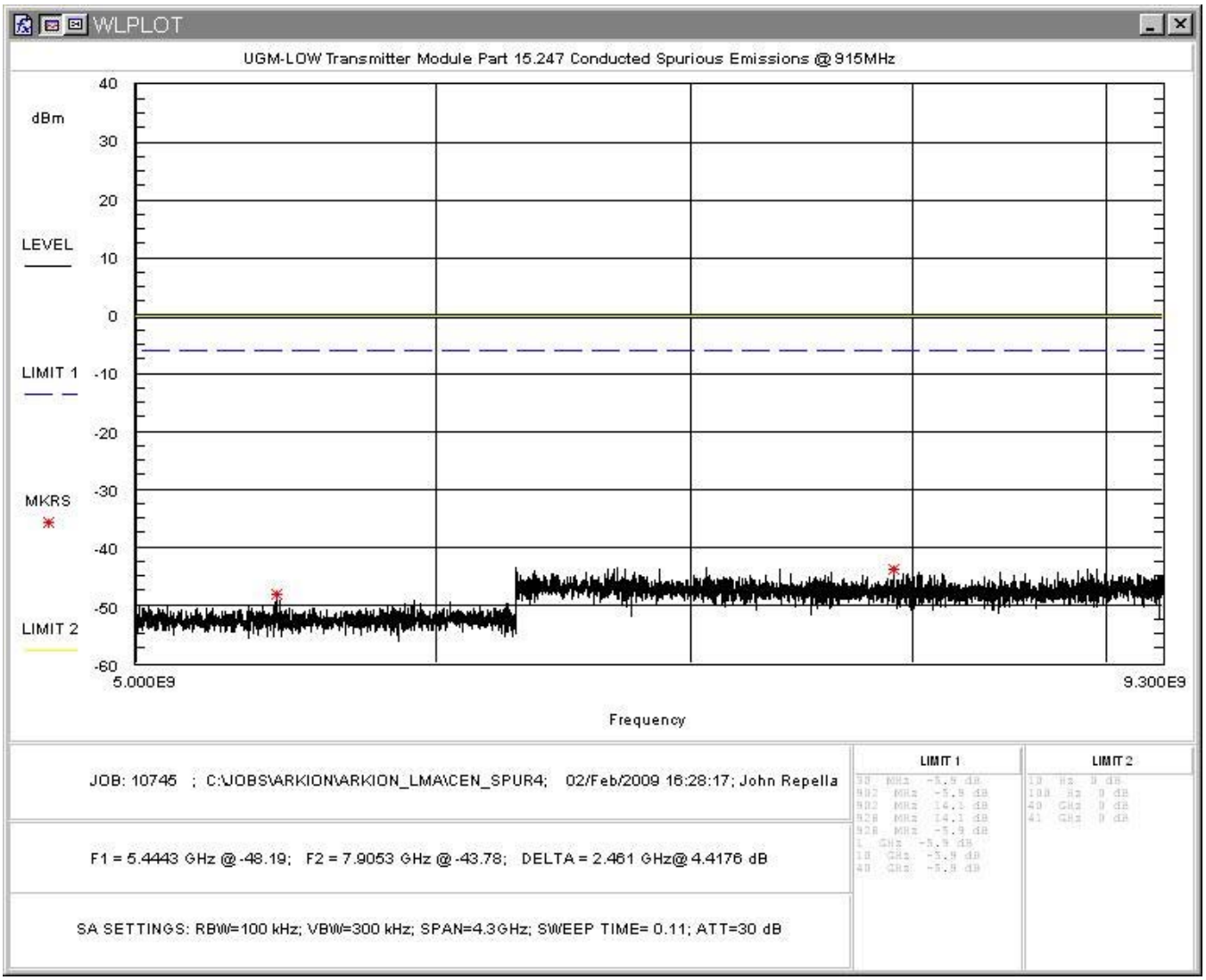


Figure 5-22: Conducted Spurious Emissions, Center Channel 5 – 9.3GHz

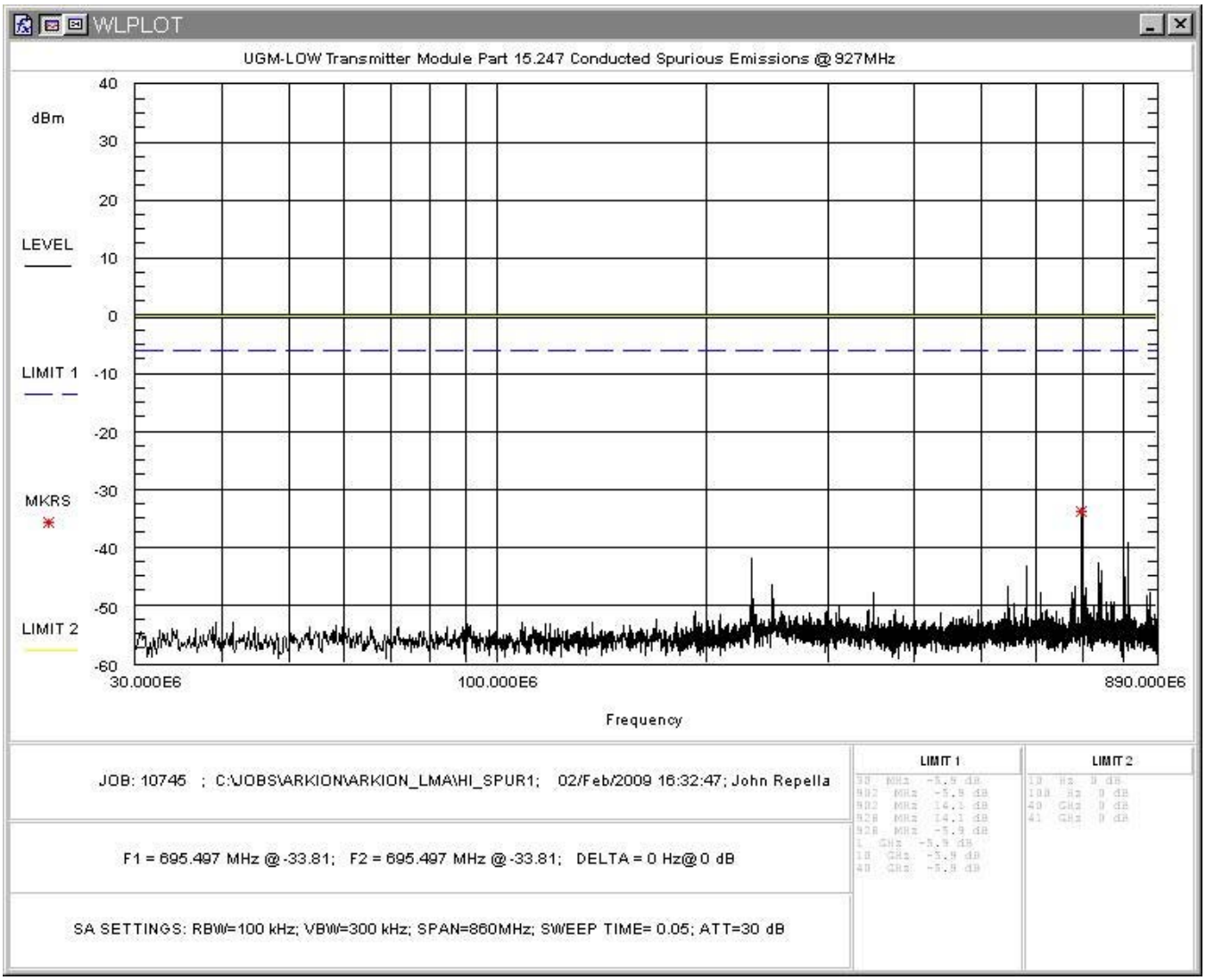


Figure 5-23: Conducted Spurious Emissions, High Channel 30 - 890MHz

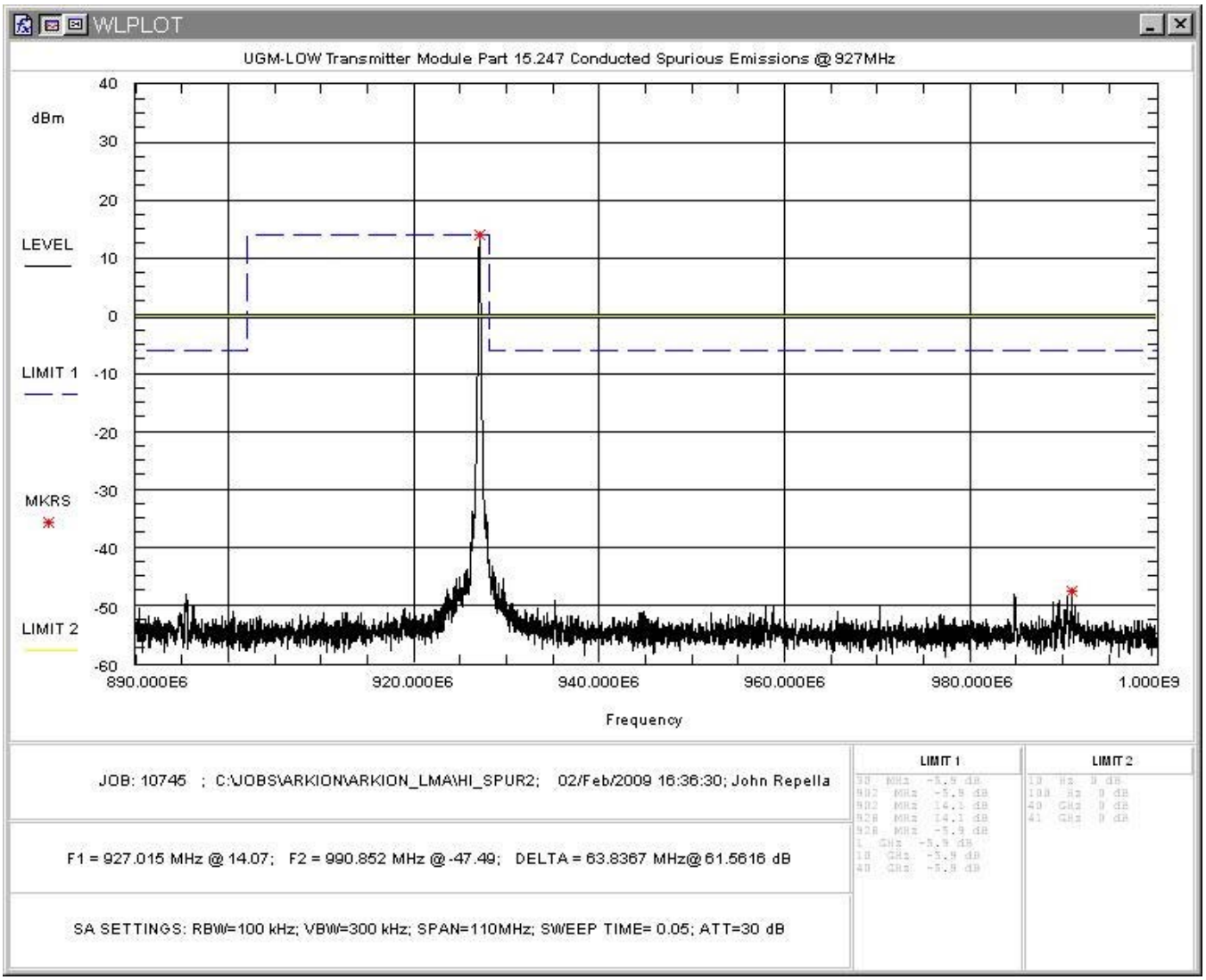


Figure 5-24: Conducted Spurious Emissions, High Channel 890-1000MHz

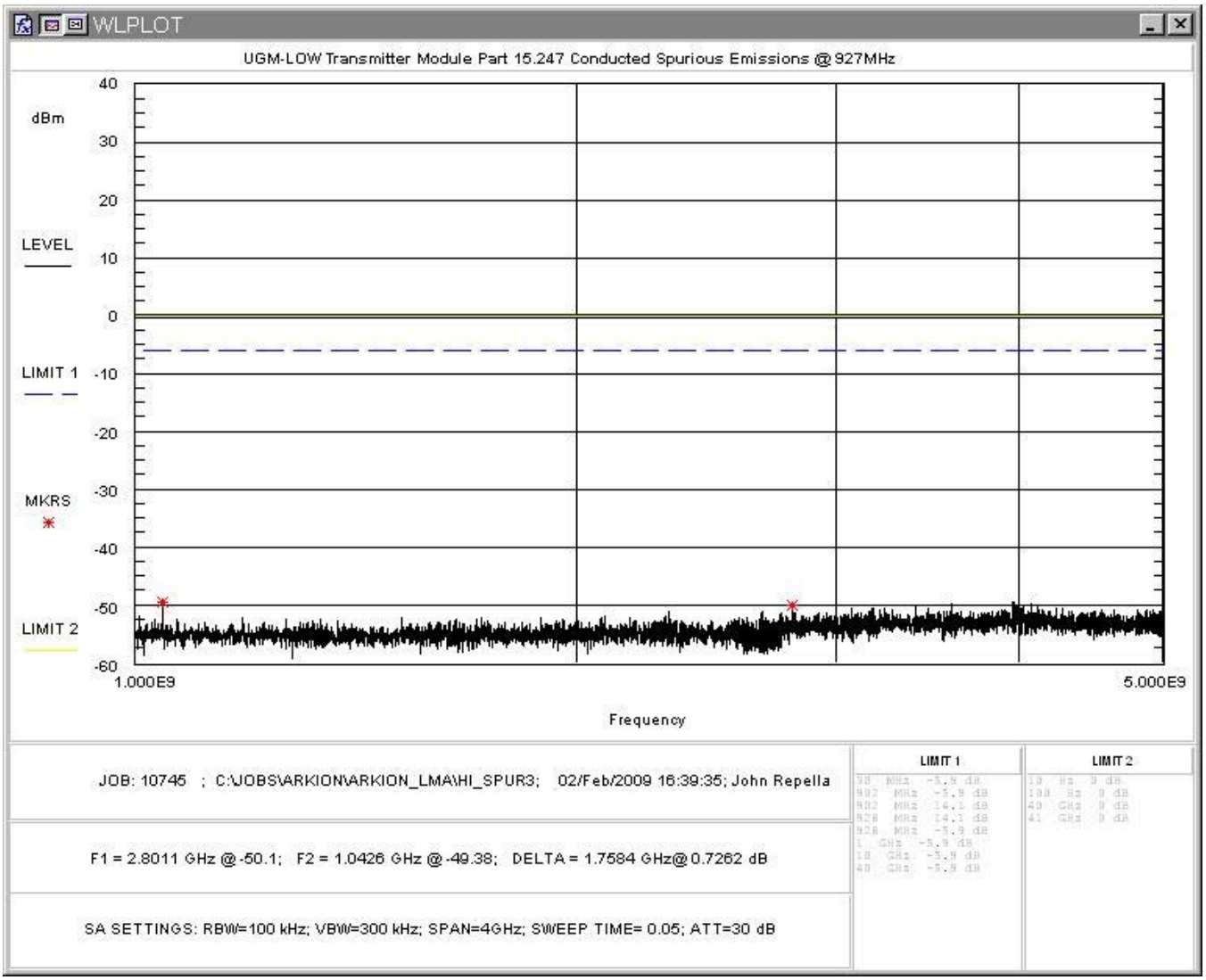


Figure 5-25: Conducted Spurious Emissions, High Channel 1-5GHz

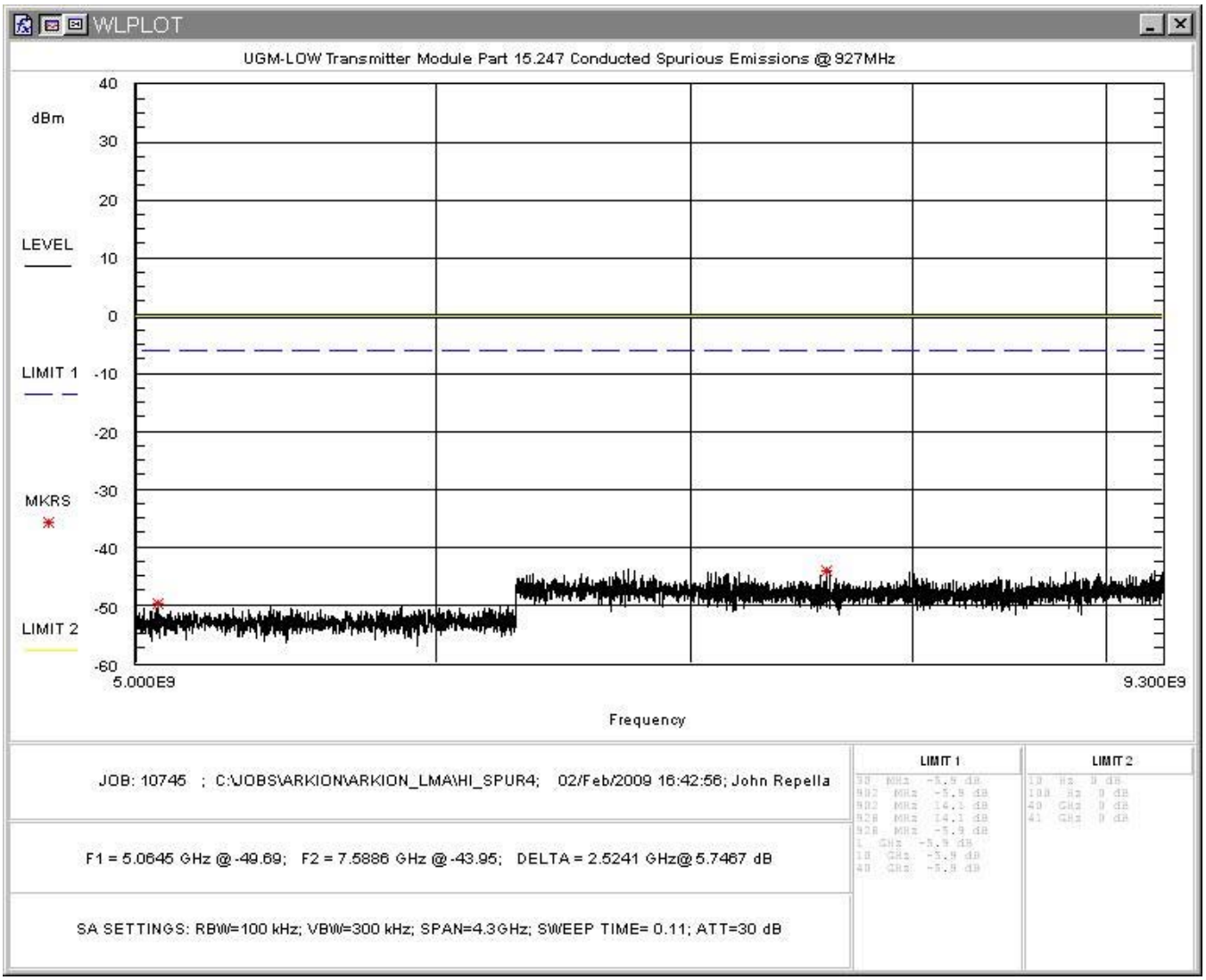


Figure 5-26: Conducted Spurious Emissions, High Channel 5-9.3GHz

5.6 Radiated Spurious Emissions: (FCC Part §2.1053)

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

5.6.1 Test Procedure

The EUT was placed on a motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The EUT was tested in 3 orthogonals with the worst case readings provided. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

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

(Emissions were common to all tested channels except as noted in comments column, emissions evaluated with Form 1S (120VAC) & 2S(220VAC) meters)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
109.630	V	135.00	1.00	4.90	14.1	8.9	150.0	-24.5	
244.126	V	0.00	1.30	6.90	13.9	11.0	200.0	-25.2	
247.890	V	0.00	1.30	5.70	14.0	9.6	200.0	-26.3	
249.428	V	0.00	1.30	6.10	14.0	10.1	200.0	-25.9	
253.990	V	0.00	1.30	9.00	13.9	14.0	200.0	-23.1	
257.436	V	0.00	1.30	9.60	14.2	15.4	200.0	-22.3	
322.396	V	225.00	1.60	4.90	16.6	11.9	200.0	-24.5	
326.405	V	300.00	1.50	7.60	16.7	16.4	200.0	-21.7	
400.10	V	0.00	1.50	10.40	18.7	28.5	200.0	-16.9	
962.46	V	60.00	1.00	21.31	27.5	277.0	500.0	-5.1	902.5MHz QP
963.14	V	60.00	1.00	23.70	27.6	365.4	500.0	-2.7	902.5MHz QP
964.510	V	60.00	1.00	23.70	27.6	366.7	500.0	-2.7	902.5MHz QP
972.350	V	90.00	1.40	19.00	28.0	223.0	500.0	-7.0	915MHz
978.484	V	90.00	1.40	16.20	28.1	164.2	500.0	-9.7	915MHz
980.29	V	90.00	1.40	19.00	28.1	227.6	500.0	-6.8	915MHz
984.699	V	60.00	1.00	17.10	28.2	183.1	500.0	-8.7	927MHz
989.510	V	60.00	1.00	16.90	28.3	181.1	500.0	-8.8	927MHz
990.884	V	60.00	1.00	16.50	28.3	173.6	500.0	-9.2	927MHz
109.857	H	135.00	3.60	8.00	14.2	12.8	150.0	-21.4	
244.426	H	135.00	1.80	8.70	13.9	13.6	200.0	-23.4	
248.076	H	180.00	1.50	8.50	14.0	13.3	200.0	-23.5	
251.750	H	180.00	1.30	9.30	14.0	14.6	200.0	-22.8	
253.546	H	180.00	1.30	10.80	13.9	17.3	200.0	-21.3	
257.436	H	180.00	1.30	11.90	14.2	20.1	200.0	-20.0	
322.396	H	225.00	1.00	14.00	16.6	33.9	200.0	-15.4	
326.761	H	225.00	1.00	13.90	16.7	33.8	200.0	-15.4	
400.10	H	330.00	1.00	16.60	18.7	58.3	200.0	-10.7	
962.46	H	315.00	1.30	11.00	27.5	84.5	500.0	-15.4	902.5MHz
963.14	H	315.00	1.30	12.80	27.6	104.2	500.0	-13.6	902.5MHz
964.510	H	315.00	1.30	11.80	27.6	93.2	500.0	-14.6	902.5MHz
971.925	H	45.00	1.30	13.00	28.0	111.7	500.0	-13.0	915MHz
972.485	H	45.00	1.30	11.90	28.0	98.5	500.0	-14.1	915MHz
980.299	H	45.00	1.30	14.80	28.1	140.3	500.0	-11.0	915MHz
984.699	H	90.00	1.00	9.50	28.2	76.3	500.0	-16.3	927MHz
989.510	H	90.00	1.00	10.80	28.3	89.7	500.0	-14.9	927MHz
990.884	H	90.00	1.00	9.30	28.3	75.8	500.0	-16.4	927MHz

Table 9: Radiated Emission Test Data, High Frequency Data (>1GHz)

(Restricted Bands)

Low Channel-902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
Peak Readings									
2707.5	V	300	1.46	52.67	-2.7	315.9	5000.0	-24.0	
3610	V	295	1.34	48.46	-0.2	257.4	5000.0	-25.8	
4512.5	V	340	1.95	45.71	1.9	239.3	5000.0	-26.4	
5415.01	V	0	1.8	44.00	3.9	247.7	5000.0	-26.1	AMB
8122.5	V	0	1.5	44.00	9.7	485.0	5000.0	-20.3	AMB
9025	V	0	1.5	44.16	11.0	573.8	5000.0	-18.8	AMB
Average Readings									
2707.5	V	300	1.46	49.05	-2.7	208.2	500.0	-7.6	
3610	V	295	1.34	39.44	-0.2	91.1	500.0	-14.8	
4512.5	V	340	1.95	37.11	1.9	88.9	500.0	-15.0	
5415.01	V	0	1.8	33.60	3.9	74.8	500.0	-16.5	AMB
8122.5	V	0	1.5	32.70	9.7	132.1	500.0	-11.6	AMB
9025	V	0	1.5	32.80	11.0	155.2	500.0	-10.2	AMB
Peak Readings									
2707.5	H	330	1.56	52.46	-2.7	308.4	5000.0	-24.2	
3610	H	18	1.56	46.12	-0.2	196.6	5000.0	-28.1	
4512.5	H	41	1.60	44.86	1.9	217.0	5000.0	-27.2	
5415.01	H	0	1.50	43.50	3.9	233.8	5000.0	-26.6	AMB
8122.5	H	0	1.5	44.00	9.7	485.0	5000.0	-20.3	AMB
9025	H	0	1.5	44.16	11.0	573.8	5000.0	-18.8	AMB
Average Readings									
2707.5	H	330	1.56	49.23	-2.7	212.6	500.0	-7.4	
3610	H	18	1.56	35.72	-0.2	59.4	500.0	-18.5	
4512.5	H	41	1.60	35.22	1.9	71.5	500.0	-16.9	
5415.01	H	0	1.50	32.60	3.9	66.7	500.0	-17.5	AMB
8122.5	H	0	1.5	32.50	9.7	129.0	500.0	-11.8	AMB
9025	H	0	1.5	32.70	11.0	153.4	500.0	-10.3	AMB

Center Channel – 915MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
Peak Readings									
2745	V	300	1.5	49.43	-2.4	223.9	5000.0	-27.0	
3660	V	295	1.5	45.62	-0.1	189.2	5000.0	-28.4	
4575	V	340	1.6	43.54	2.0	189.1	5000.0	-28.4	
7320	V	0	1.8	44.00	8.3	410.9	5000.0	-21.7	AMB
8235	V	0	1.5	44.00	9.9	496.0	5000.0	-20.1	AMB
9150	V	0	1.5	44.16	11.1	579.0	5000.0	-18.7	AMB
Average Readings									
2745	V	30	1.5	47.71	-2.4	183.7	500.0	-8.7	
3660	V	295	1.5	37.96	-0.1	78.3	500.0	-16.1	
4575	V	340	1.6	36.85	2.0	87.5	500.0	-15.1	
7320	V	0	1.8	33.70	8.3	125.5	500.0	-12.0	AMB
8235	V	0	1.5	32.70	9.9	135.0	500.0	-11.4	AMB
9150	V	0	1.5	32.80	11.1	156.6	500.0	-10.1	AMB
Peak Readings									
2745	H	20	1.6	52.62	-2.4	323.3	5000.0	-23.8	
3660	H	18	1.60	43.31	-0.1	145.0	5000.0	-30.8	
4575	H	41	1.60	44.86	2.0	220.2	5000.0	-27.1	
7320	H	0	1.50	43.55	8.3	390.2	5000.0	-22.2	AMB
8235	H	0	1.5	44.00	9.9	496.0	5000.0	-20.1	AMB
9150	H	0	1.5	44.16	11.1	579.0	5000.0	-18.7	AMB
Average Readings									
2745	H	20	1.6	49.20	-2.4	218.1	500.0	-7.2	
3660	H	18	1.56	37.13	-0.1	71.2	500.0	-16.9	
4575	H	41	1.60	35.87	2.0	78.2	500.0	-16.1	
7320	H	0	1.50	32.60	8.3	110.6	500.0	-13.1	AMB
8235	H	0	1.5	32.50	9.9	132.0	500.0	-11.6	AMB
9150	H	0	1.5	32.70	11.1	154.8	500.0	-10.2	AMB

High Channel-927MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
Peak Readings									
2781	V	340	1.6	47.76	-2.2	189.9	5000.0	-28.4	
3708	V	31	1.5	45.70	0.1	194.5	5000.0	-28.2	
4635	V	340	1.6	43.93	2.1	200.5	5000.0	-27.9	AMB
7416	V	0	1.6	43.66	8.3	396.2	5000.0	-22.0	AMB
8343	V	0	1.5	43.50	10.1	478.3	5000.0	-20.4	AMB
Average Readings									
2781	V	300	1.6	42.20	-2.2	100.1	500.0	-14.0	
3708	V	31	1.6	37.40	0.1	74.8	500.0	-16.5	
4635	V	340	1.6	36.40	2.1	84.3	500.0	-15.5	AMB
7416	V	0	1.6	33.04	8.3	116.6	500.0	-12.6	AMB
8343	V	0	1.6	33.10	10.1	144.4	500.0	-10.8	AMB
Peak Readings									
2781	H	13	1.6	50.66	-2.2	265.2	5000.0	-25.5	
3708	H	70	1.6	46.78	0.1	220.2	5000.0	-27.1	
4635	H	41	1.6	43.63	2.1	193.7	5000.0	-28.2	AMB
7416	H	0	1.6	44.00	8.3	412.0	5000.0	-21.7	AMB
8343	H	0	1.6	44.16	10.1	516.0	5000.0	-19.7	AMB
Average Readings									
2781	H	13	1.6	47.78	-2.2	190.4	500.0	-8.4	
3708	H	70	1.6	38.58	0.1	85.7	500.0	-15.3	
4635	H	41	1.6	34.30	2.1	66.2	500.0	-17.6	AMB
7416	H	0	1.6	32.50	8.3	109.6	500.0	-13.2	AMB
8343	H	0	1.6	32.70	10.1	137.9	500.0	-11.2	AMB

5.7 AC Conducted Emissions (FCC Pt.15.207)

5.7.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

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

5.7.2 Test 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

5.7.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. This system runs off of 120VAC. Table 10-11 provides the test results for phase and neutral line power line conducted emissions.

Emissions were tested in the "transmit on" state with the EUT tuned to 915MHz.

As the module is typically powered from DC, the unit was powered via 120VAC & 220VAC supplied to a Smartmeter-L electric meter assembly. The Smartmeter provided unregulated 9-15 VDC to UGM-L module

Table 10: Conducted Emissions Data, Transmit On @120VAC

Neutral

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.156	33.580	10.4	10.1	0.3	44.0	20.8	65.7	55.7	-21.7	-34.9
0.199	27.430	8.1	10.2	0.5	38.1	18.7	63.6	53.6	-25.6	-34.9
10.244	23.100	22.1	11.1	1.0	35.2	34.2	60.0	50.0	-24.8	-15.8
16.114	15.220	6.0	11.4	1.3	27.9	18.7	60.0	50.0	-32.1	-31.3
21.836	27.400	22.8	11.6	1.5	40.5	35.9	60.0	50.0	-19.5	-14.1
23.511	29.623	21.7	11.7	1.5	42.8	34.8	60.0	50.0	-17.2	-15.2

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)
0.156	32.120	9.3	10.1	0.1	42.4	19.5	65.7	55.7	-23.3	-36.1
0.199	26.290	7.1	10.2	0.3	36.7	17.5	63.6	53.6	-26.9	-36.1
10.244	23.490	22.6	11.1	0.8	35.4	34.5	60.0	50.0	-24.6	-15.5
16.114	19.790	11.3	11.4	1.2	32.3	23.8	60.0	50.0	-27.7	-26.2
21.604	23.760	18.0	11.6	1.2	36.6	30.8	60.0	50.0	-23.4	-19.2
23.511	27.820	19.7	11.7	1.2	40.7	32.5	60.0	50.0	-19.3	-17.5

Table 11: Conducted Emissions Data, Transmit On @220VAC

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)
0.326	16.580	5.3	10.2	0.3	27.1	15.8	59.6	49.6	-32.4	-33.7
0.388	15.600	5.1	10.2	0.3	26.1	15.6	58.1	48.1	-32.1	-32.6
10.244	21.520	19.2	11.1	1.0	33.6	31.3	60.0	50.0	-26.4	-18.7
26.119	16.200	6.8	11.8	1.5	29.5	20.1	60.0	50.0	-30.5	-29.9
27.403	18.600	9.3	11.8	1.6	32.0	22.7	60.0	50.0	-28.0	-27.3
28.030	15.900	6.6	11.8	1.6	29.4	20.1	60.0	50.0	-30.6	-29.9

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)
0.326	16.650	6.2	10.2	0.2	27.1	16.6	59.6	49.6	-32.5	-32.9
0.388	15.520	5.9	10.2	0.2	25.9	16.3	58.1	48.1	-32.2	-31.8
10.244	21.860	19.6	11.1	0.8	33.8	31.5	60.0	50.0	-26.2	-18.5
26.119	16.020	8.1	11.8	1.2	29.0	21.1	60.0	50.0	-31.0	-28.9
27.403	18.150	11.3	11.8	1.3	31.3	24.4	60.0	50.0	-28.7	-25.6
28.030	15.820	6.8	11.8	1.4	29.0	19.9	60.0	50.0	-31.0	-30.1