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FCC Certification Test Report

For the

Axiometric, LLC

BER2 Repeater

FCC ID: VE4-BER2

WLL JOB# **13066-01**
October 8, 2013

Prepared for:

Axiometric, LLC
6200 Old Dobbin Lane
Ste 150
Columbia, MD 21045

Prepared By:

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

Testing Certificate AT-1448

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Prepared by: James Ritter
EMC laboratory Manager

Reviewed by: Steven D. Koster
Vice President

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 (10/2012) of the FCC Rules. This Certification Test Report documents the test configuration and test results for a Axiometric, LLC BER2 Repeater.

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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Axiometric, LLC BER2 Repeater complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

Revision History	Reason	Date
Rev 0	Initial Release	October 8, 2013

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1 Introduction

1.1 Compliance Statement

The Axiometric, LLC BER2 Repeater complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

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 6200 Old Dobbin Lane - Ste 150 Columbia, MD 21045
Quotation Number:	67558A

1.4 Test Dates

Testing was performed on the following date(s):	10/2/13 to 10/4/13

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 BER2 operates in two modes.

In a Mesh Plus water meter reading system, it operates as a battery powered repeater for water meter end nodes. Once every twenty minutes, the BER2 repeater wakes up for 18 seconds. It receives packets from surround water meter end nodes, and re-transmits the received packets.

In Drive-by mode, the BER2 operates as a USB powered mobile unit. As a mobile unit, the BER2 sends packets to water meter end nodes to request the end nodes transmit their water meter packets. The BER2 receives and stores the received water meter readings.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Axiometric LLC
FCC ID Number	VE4-BER2
EUT Name:	BER2 Repeater
Model:	BER2
FCC Rule Parts:	15.247
Frequency Range:	902.5-927MHz
Maximum Output Power:	355mW (25.5dBm)
Modulation:	FHSS FSK
20dB Bandwidth:	141.9 kHz for mesh mode, 365.4 kHz for drive-by mode
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50
Power Output Level	Fixed
Antenna Type	HG908U-PRO 8 dBi Whip
Power Source & Voltage:	Four 3.6Vdc Lithium battery or USB phantom power

2.2 Test Configuration

The BER2 Repeater was tested as a stand-alone device. The EUT and operate either with four 3.6V batteries or through power from a USB host. The device batteries cut off if USB power is applied. EUT prescans showed that the emissions profile is worst case in the USB mode. This is the mode that is reported here.

The EUT was connected to a support laptop for RF control via RS-232 maintenance port connection to a 6 pin header. The tests were performed with an 8dBi whip antenna separately mounted. The support laptop was removed while measurements were being performed.

The EUT was powered via a USB cable through an AC to USB adaptor (Barnes & Noble, model number BNRP5-850).

2.3 Testing Algorithm

The BER2 Repeater 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. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 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. The basis for uncertainty ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements the standard uncertainty are combined using the method described in to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage to determine the expanded uncertainty which is generally accepted for use in commercial, 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

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
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 3: Test Equipment List

Test Name:		Test Date: **10/2/2013**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	ANALYZER SPECTRUM	2/28/2014
74	HP - 8593A	ANALYZER SPECTRUM	10/4/2014

Test Name: **Radiated Emissions**		Test Date: **10/3/2013**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
728	AGILENT - 8564EC	SPECTRUM ANALYZER 30HZ - 40GHZ	5/22/2014
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	5/13/2014
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	5/29/2014
742	PENN ENGINEERING - WR284	2.2-4.15GHZ BANDPASS FILTER	5/29/2014
72	HP - 8568B	ANALYZER SPECTRUM	1/1/2014
68	HP - 85650A	ADAPTER QP	1/1/2014
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	1/1/2014
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	1/11/2014

Test Name: **Conducted Emissions Voltage**		Test Date: **10/04/2013**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
68	HP - 85650A	ADAPTER QP	1/1/2014
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	1/1/2014
72	HP - 8568B	ANALYZER SPECTRUM	1/1/2014
124	SOLAR - 8012-50-R-24-BNC	LISN	6/11/2014
78	HP - 11947A	LIMITER TRANSIENT	3/19/2014

4 Test Summary

The Table Below shows the results of testing for compliance for a Frequency Hopping System in accordance with FCC Part 15.247:2012 Full results are shown in section 5.

Table 4: Test Summary Table

FCC Rule Part	Description	Result
15.247 (a)(1)(i)	20dB Bandwidth	Pass
15.247 (b)(2)	Transmit Output Power	Pass
15.247 (a)(1)	Channel Separation	Pass
15.247 (a)(1)(i)	Number of Channels =50 minimum	Pass
15.247 (a)(1)(i)	Time of Occupancy	Pass
15.247 (d)	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	AC Conducted Emissions	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 176.7ms for 'Mesh Mode' and 66.67ms 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 to their respective limit.

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.

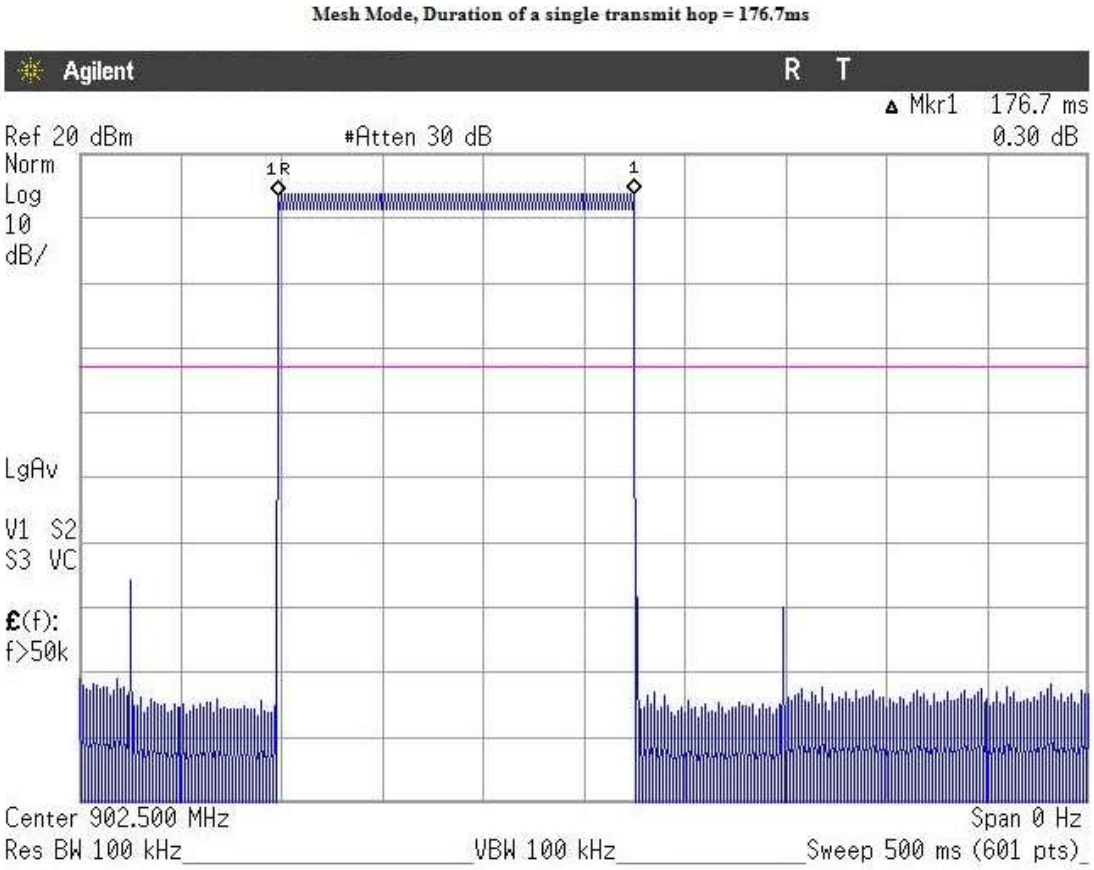

Figure 1. Dwell Time Per Hop, Mesh Mode

Time of Occupancy- Mesh Mode. Limit = 0.4 sec per 20 sec. EUT has 1 pulse of 176.7ms per 20 sec. EUT complies
Note: smaller peaks are spurs from other channels.

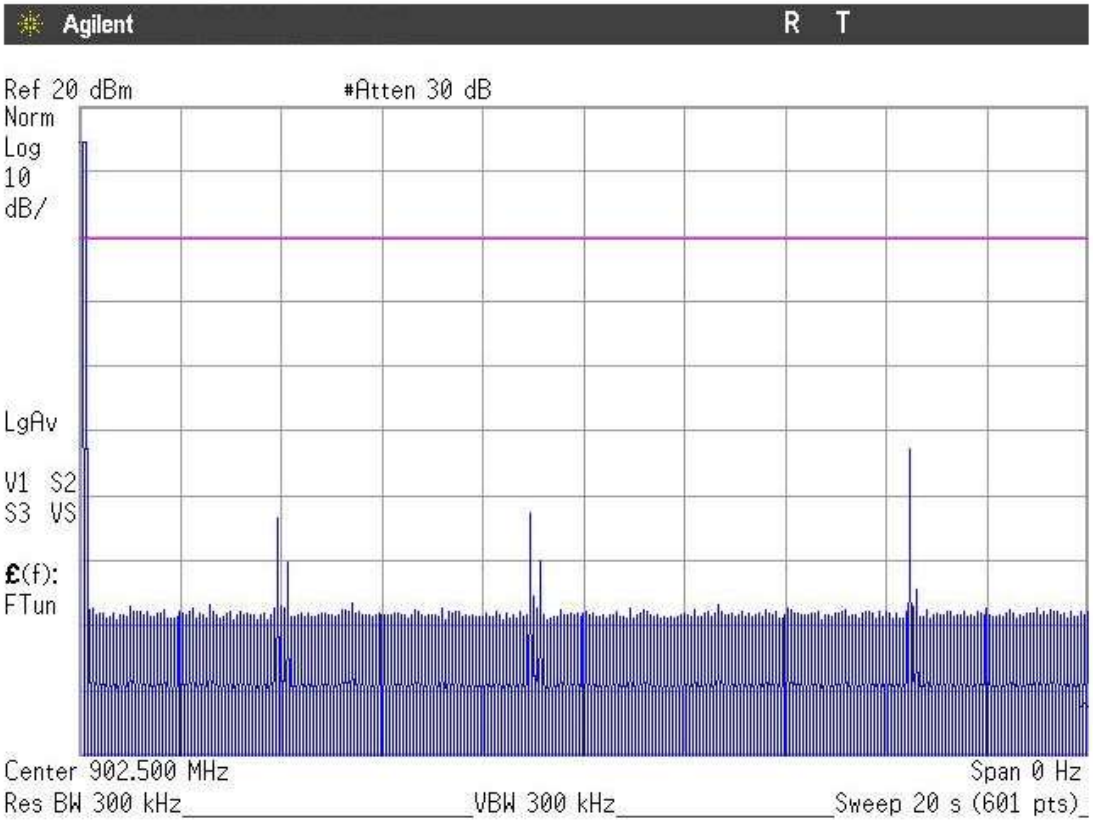

Figure 2. Time of Occupancy per 20 seconds, Mesh Mode

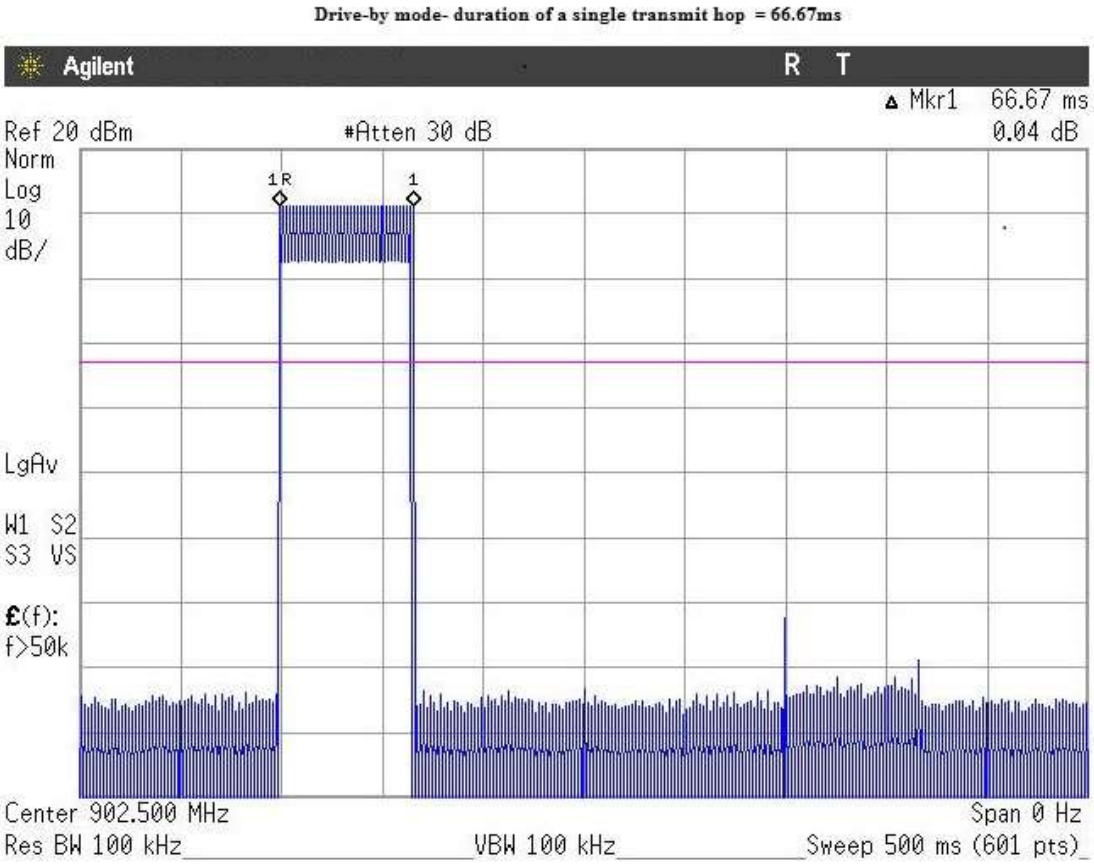

Figure 3. Dwell Time Per Hop, Drive-by Mode

BER2 Repeater

Time of Occupancy- Drive-by Mode Limit = 0.4 sec per 10 sec. EUT has one pulse of 66.67ms per 10 sec. EUT complies.
Note: smaller peaks are spurs from other channels.

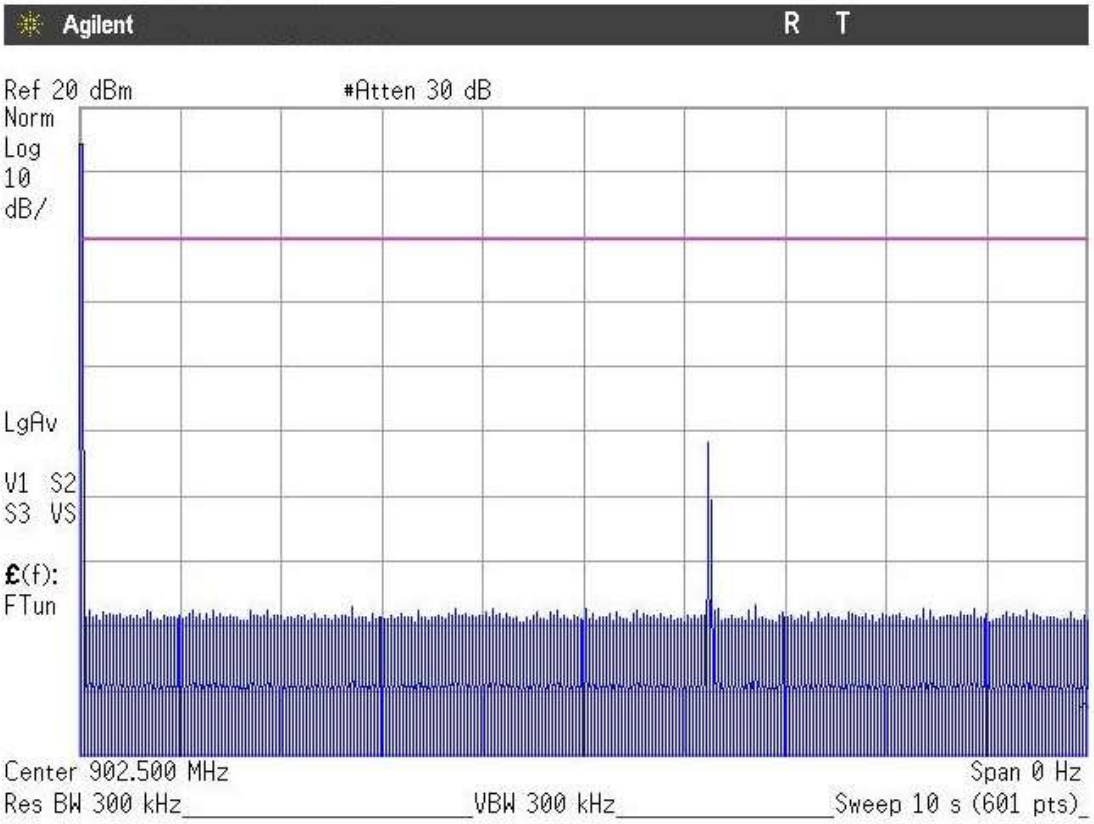

Figure 4. Time of Occupancy per 10 seconds, drive-by Mode

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 5: RF Power Output

Mode Tested	Frequency	Level (dBm)	Limit (dBm)	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	25.5	30	Pass
Mesh Mode	Center Channel: 915MHz	25.1	30	Pass
Mesh Mode	High Channel: 927MHz	24.8	30	Pass
Drive-by Mode	Low Channel: 902.5MHz	25.3	30	Pass
Drive-by Mode	Center Channel: 915MHz	25.1	30	Pass
Drive-by mode	High Channel: 927MHz	24.8	30	Pass

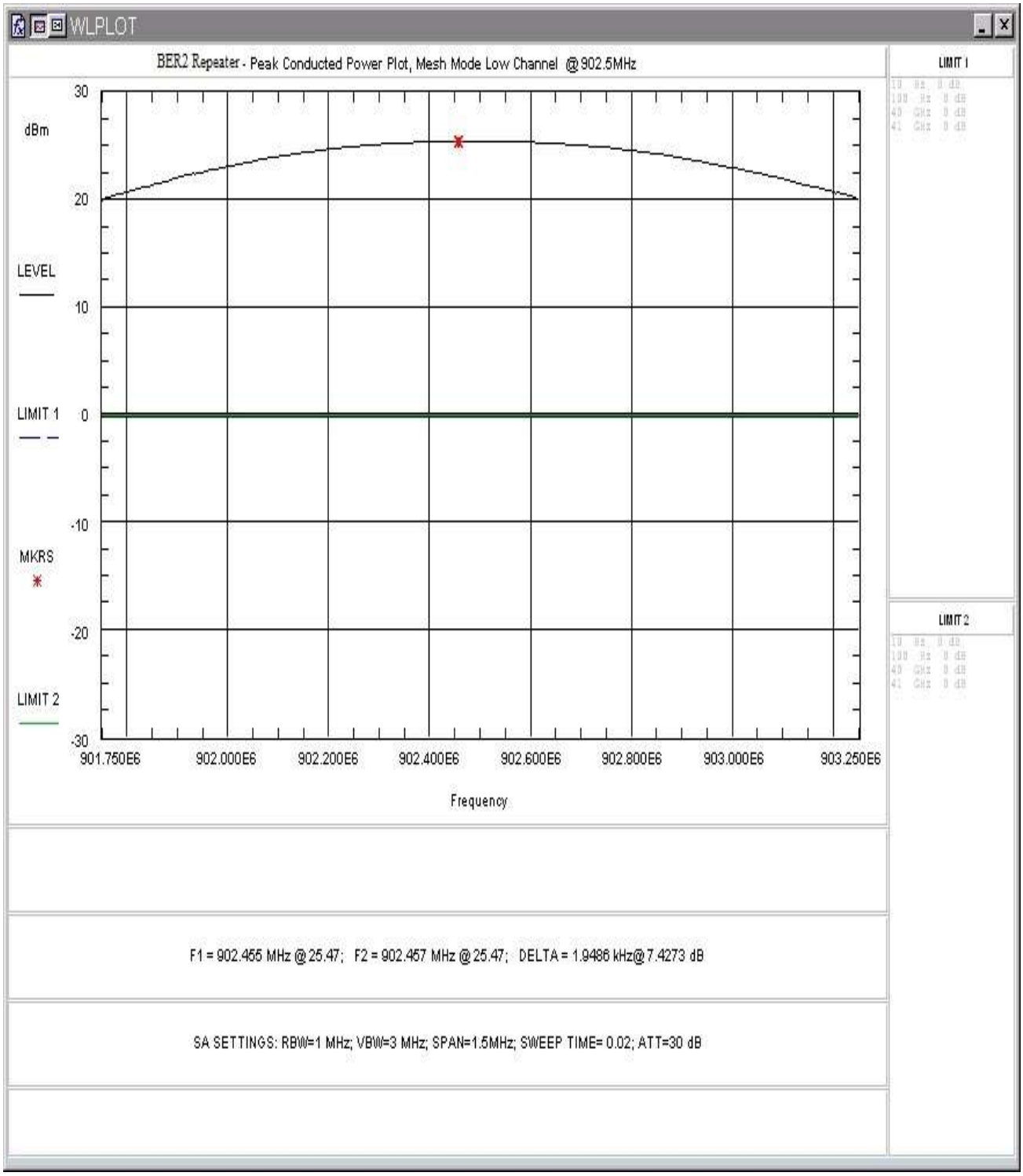

Figure 5. RF Peak Power, Mesh Mode, Low Channel

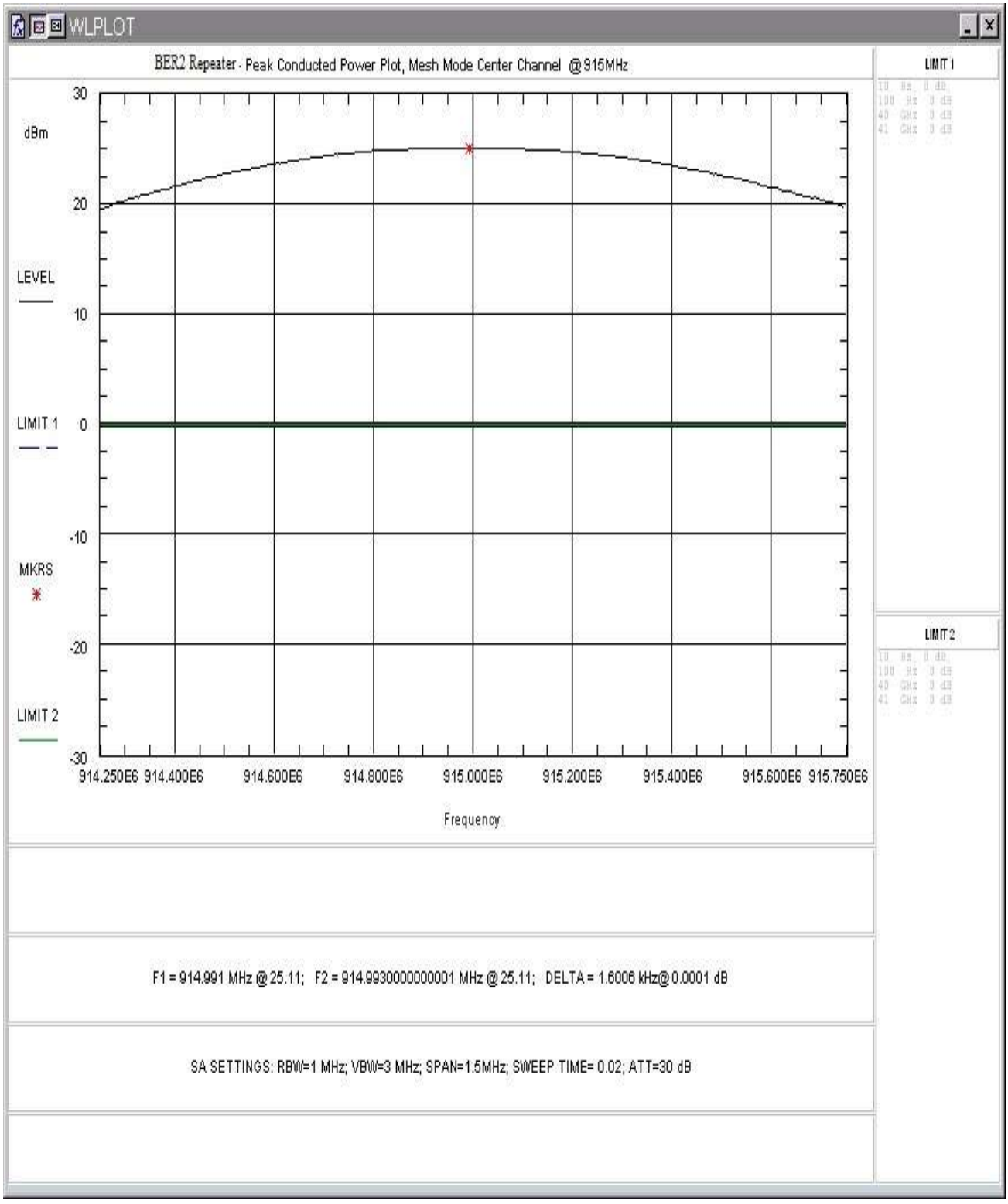

Figure 6. RF Peak Power, Mesh Mode, Center Channel

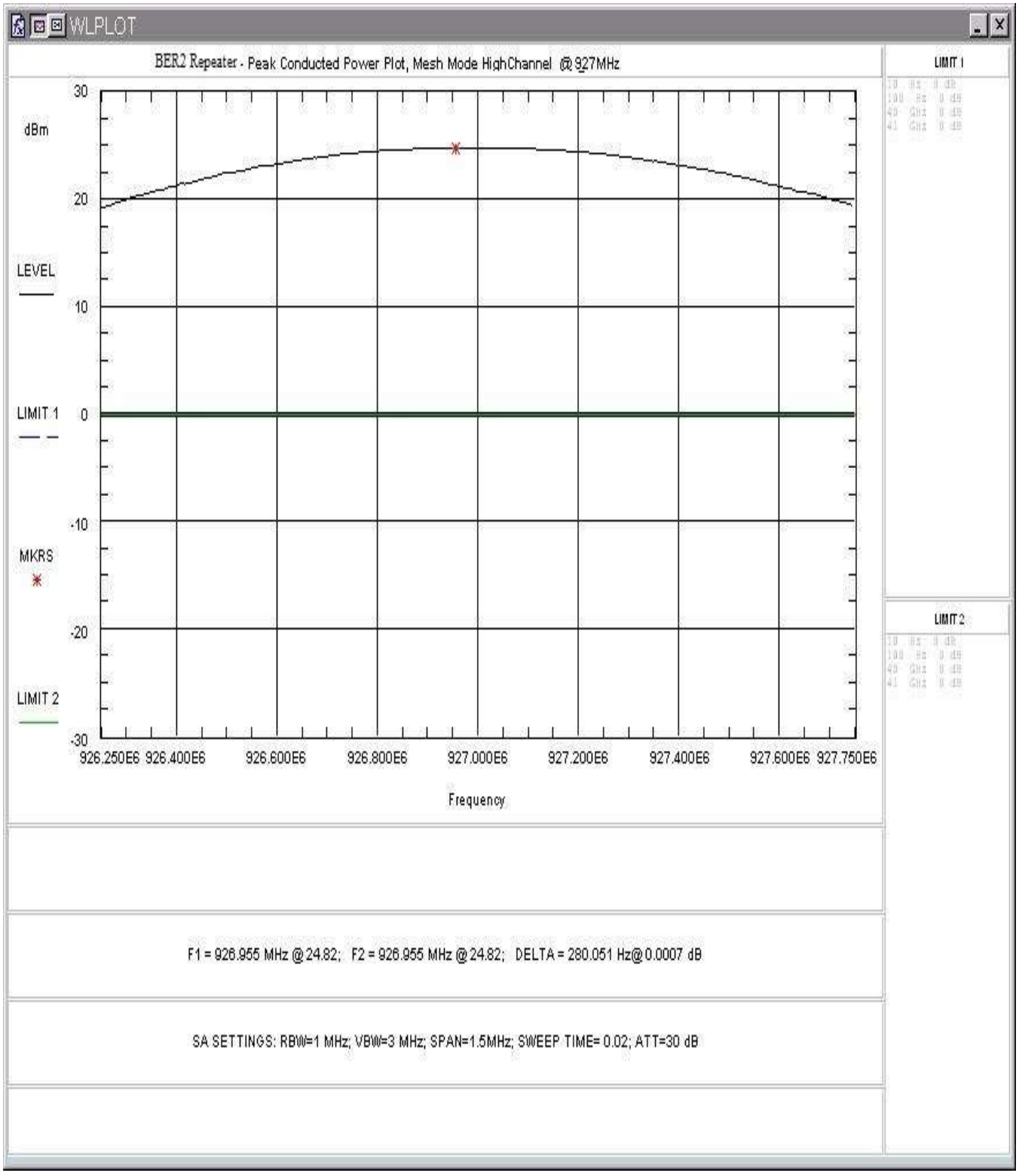

Figure 7. RF Peak Power, Mesh Mode, High Channel

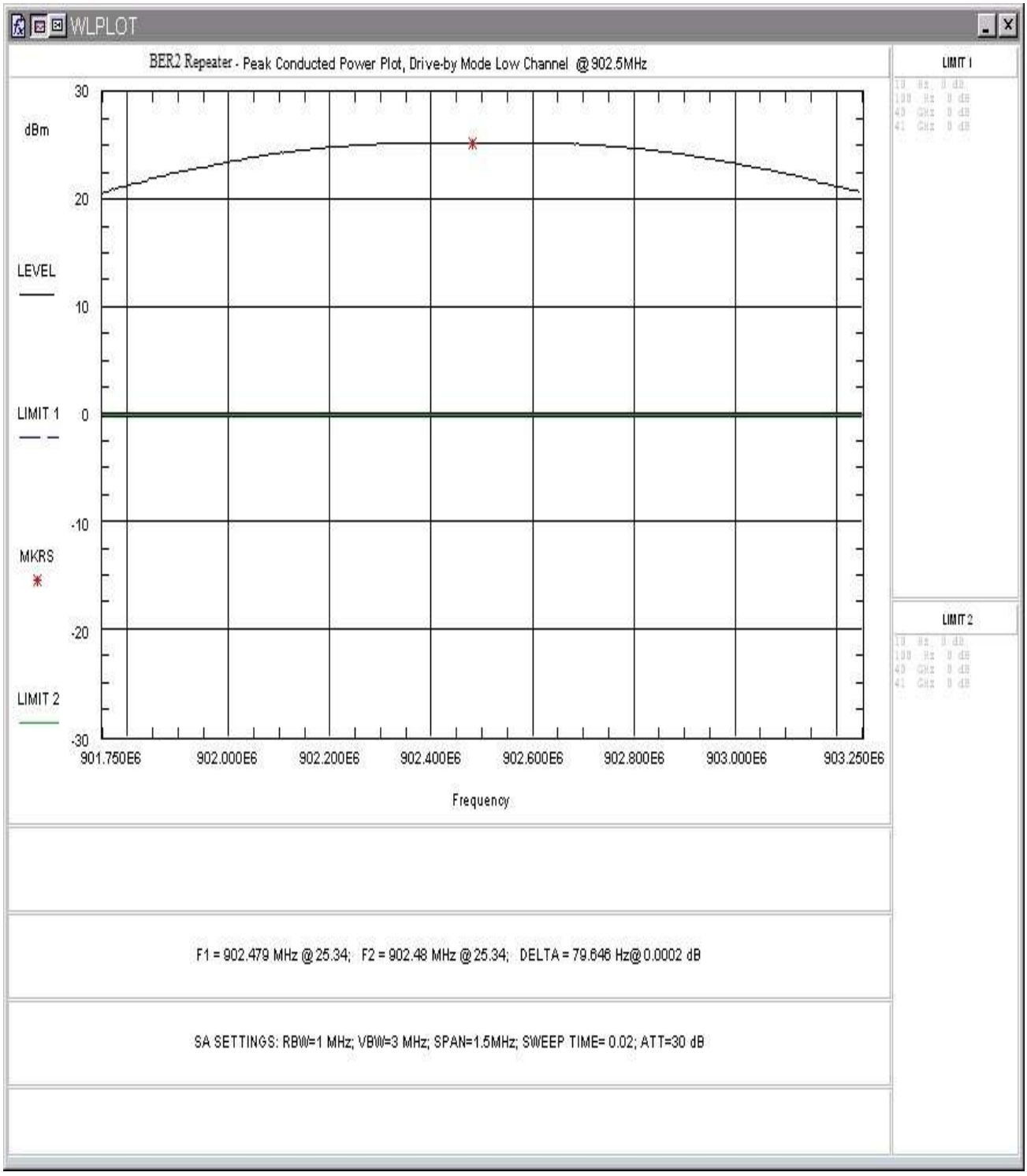

Figure 8. RF Peak Power, Drive-by Mode, Low Channel

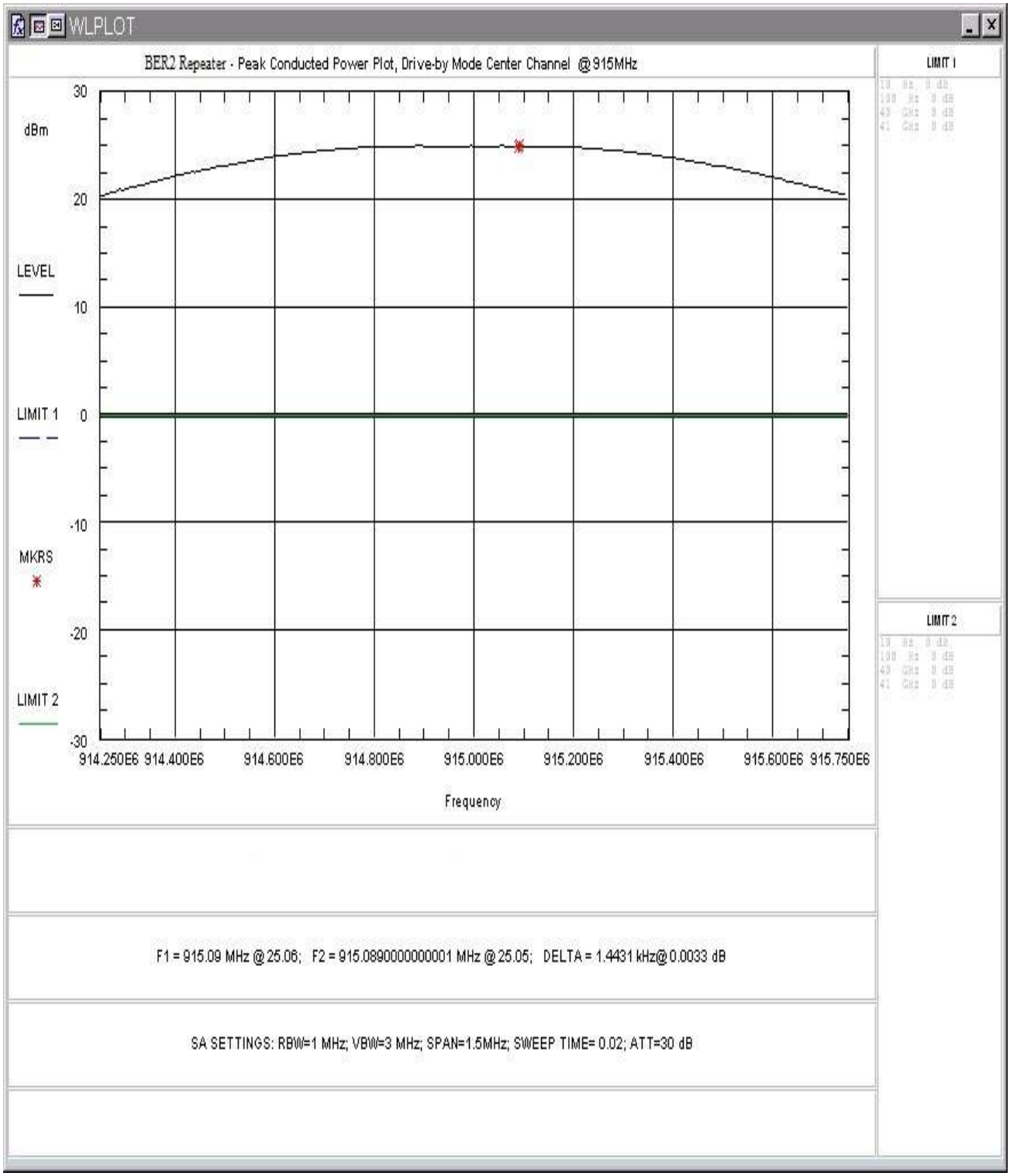

Figure 9. RF Peak Power, Drive-by Mode, Center Channel

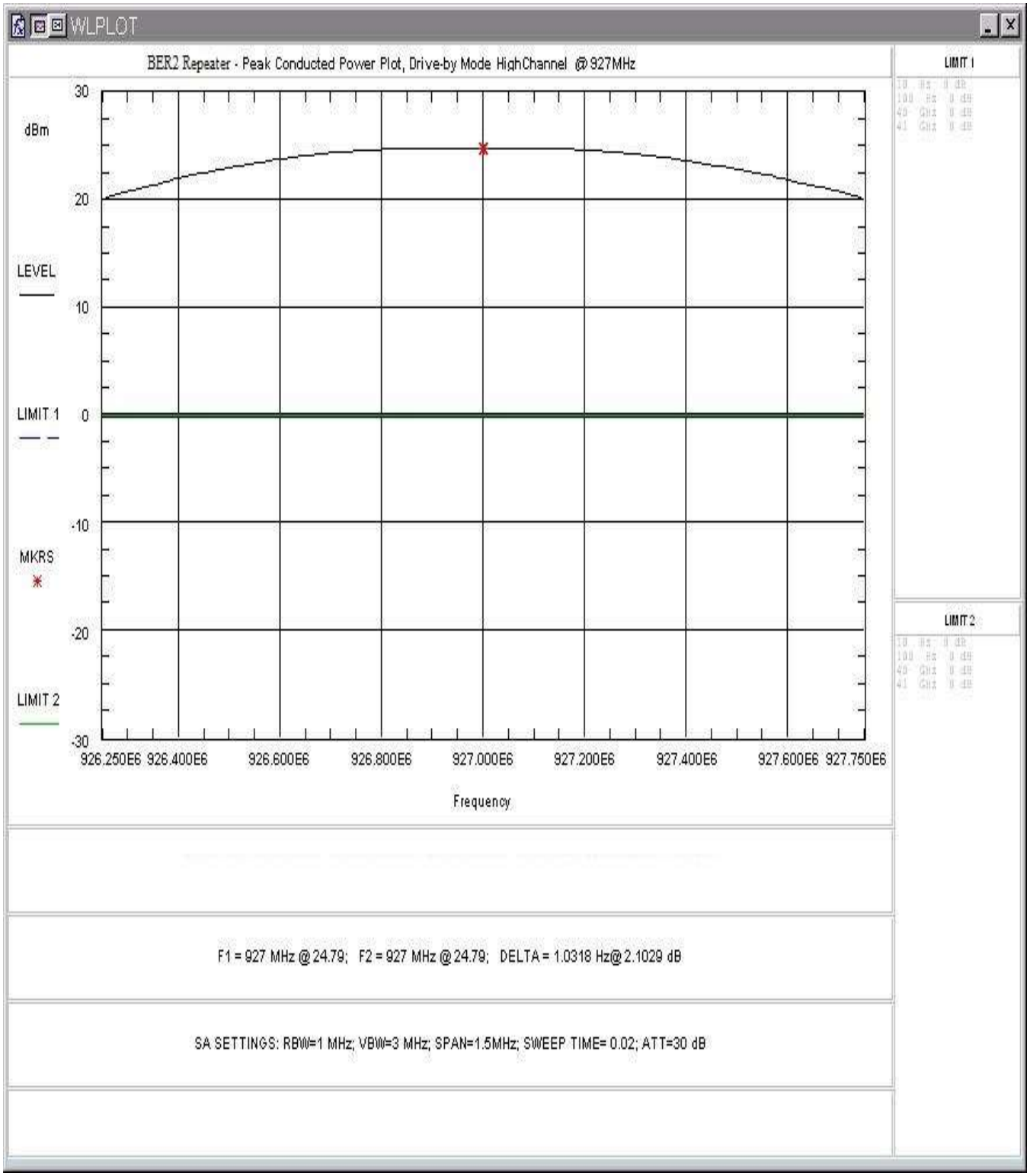

Figure 10. RF Peak Power, Drive-by Mode, High Channel

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:

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

Mode Tested	Frequency	Bandwidth (kHz)	Limit (kHz)	Pass/Fail
Mesh Mode	Low Channel: 902.5MHz	141.94	500	Pass
Mesh Mode	Center Channel: 915MHz	141.48	500	Pass
Mesh Mode	High Channel: 927MHz	141.94	500	Pass
Drive-by Mode	Low Channel: 902.5MHz	344.65	500	Pass
Drive-by Mode	Center Channel: 915MHz	365.40	500	Pass
Drive-by mode	High Channel: 927MHz	365.26	500	Pass

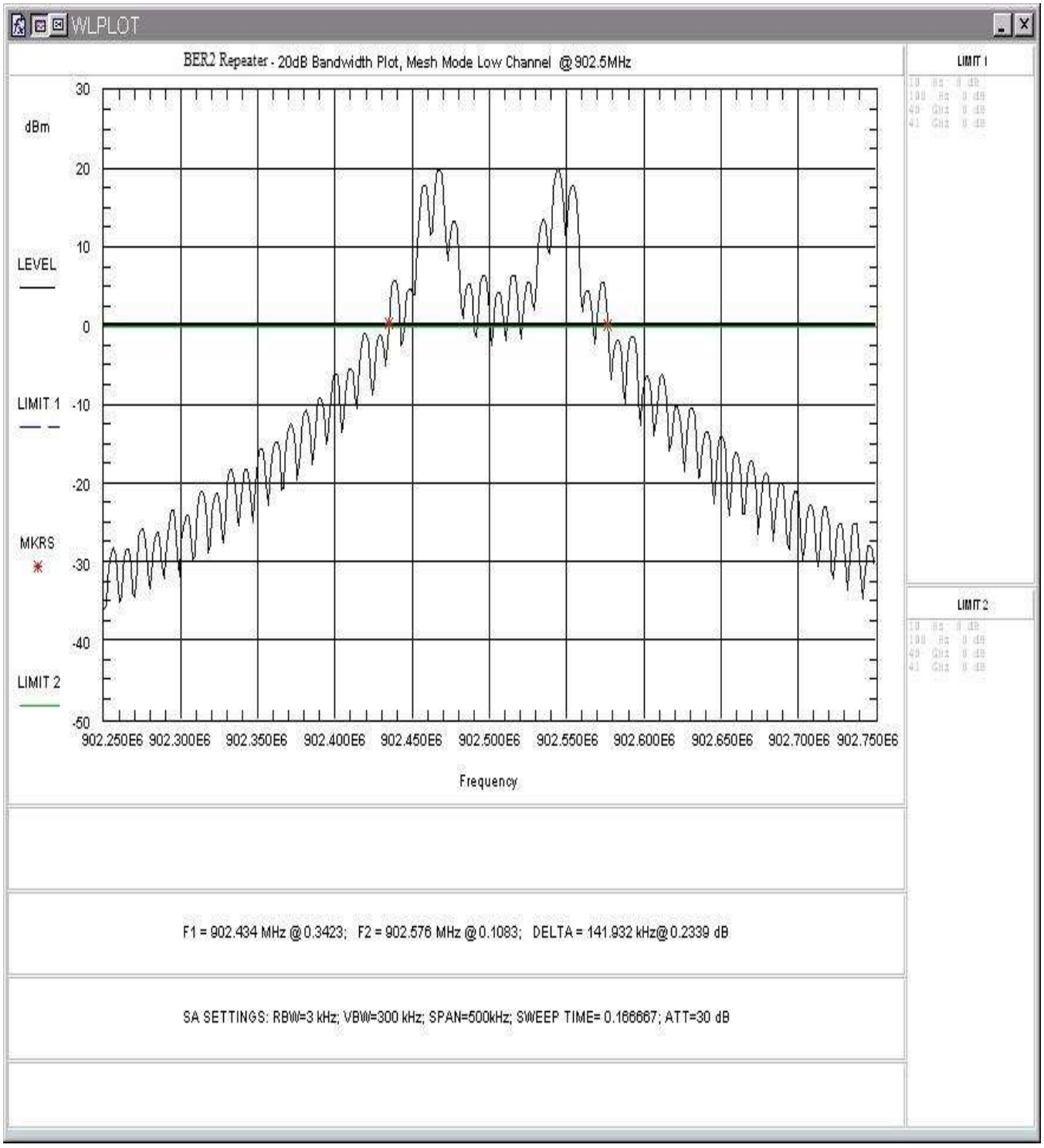

Figure 11. Occupied Bandwidth, Mesh Mode, Low Channel

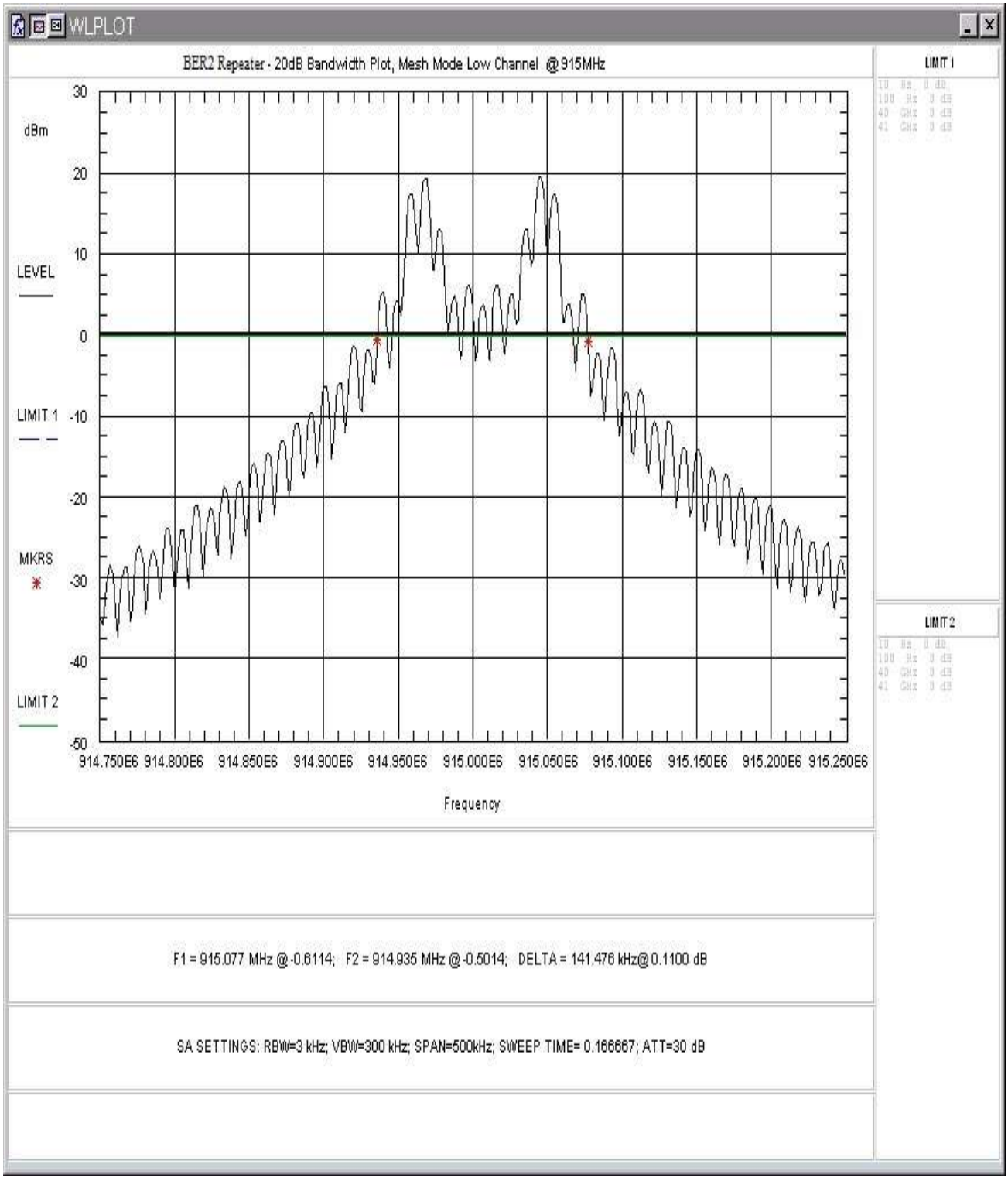

Figure 12. Occupied Bandwidth, Mesh Mode, Center Channel

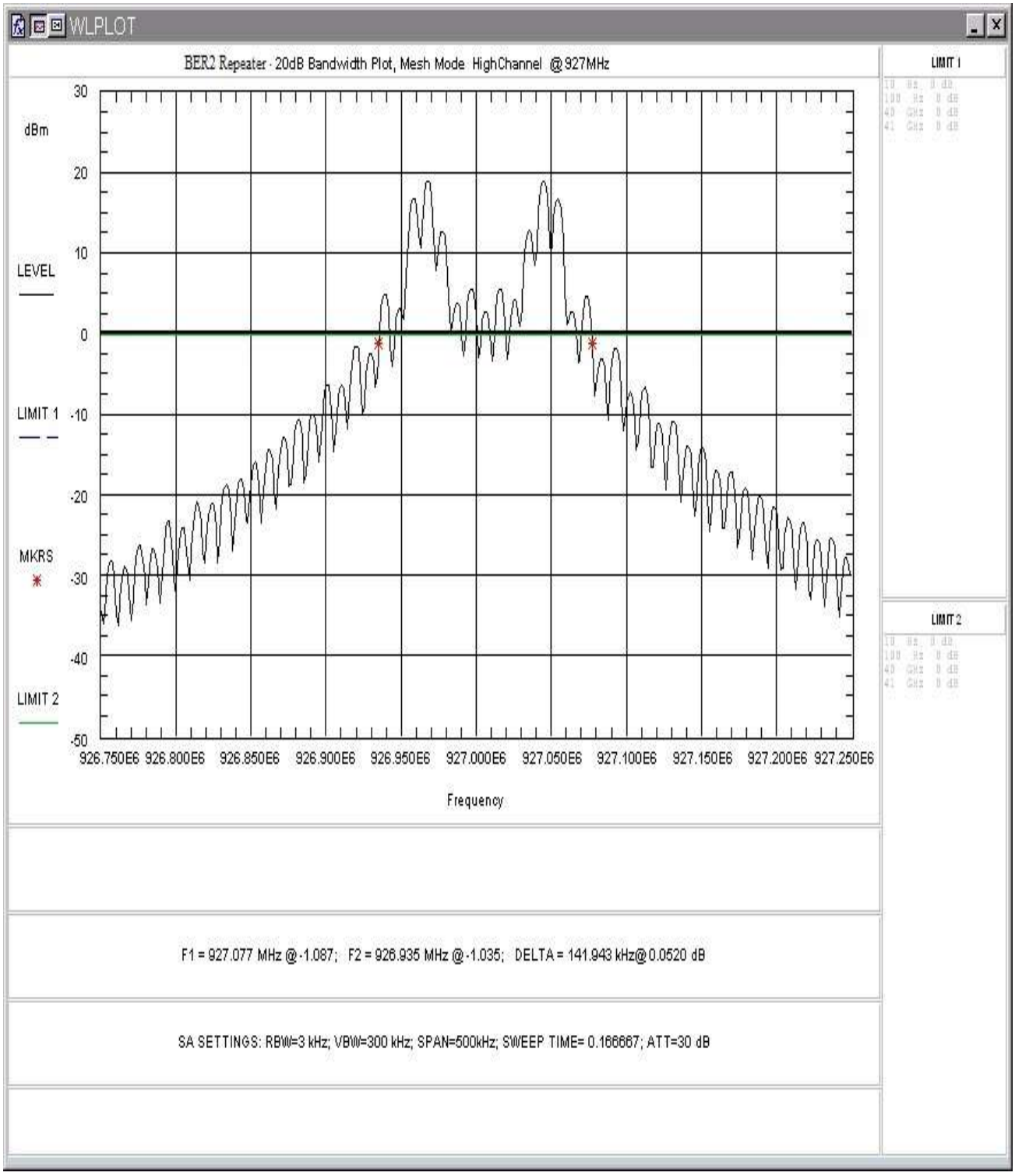

Figure 13. Occupied Bandwidth, Mesh Mode, High Channel

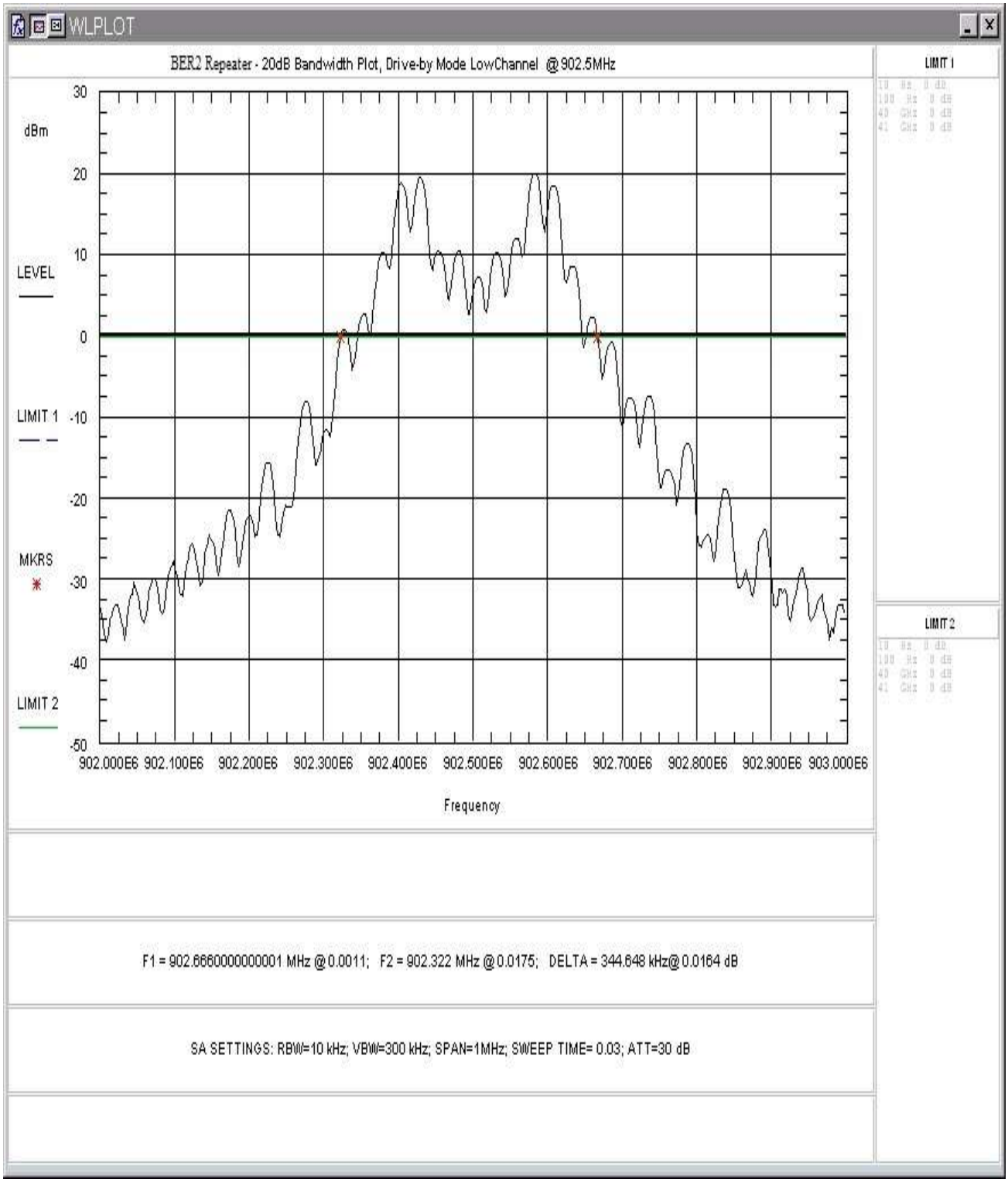

Figure 14. Occupied Bandwidth, Drive-by Mode, Low Channel

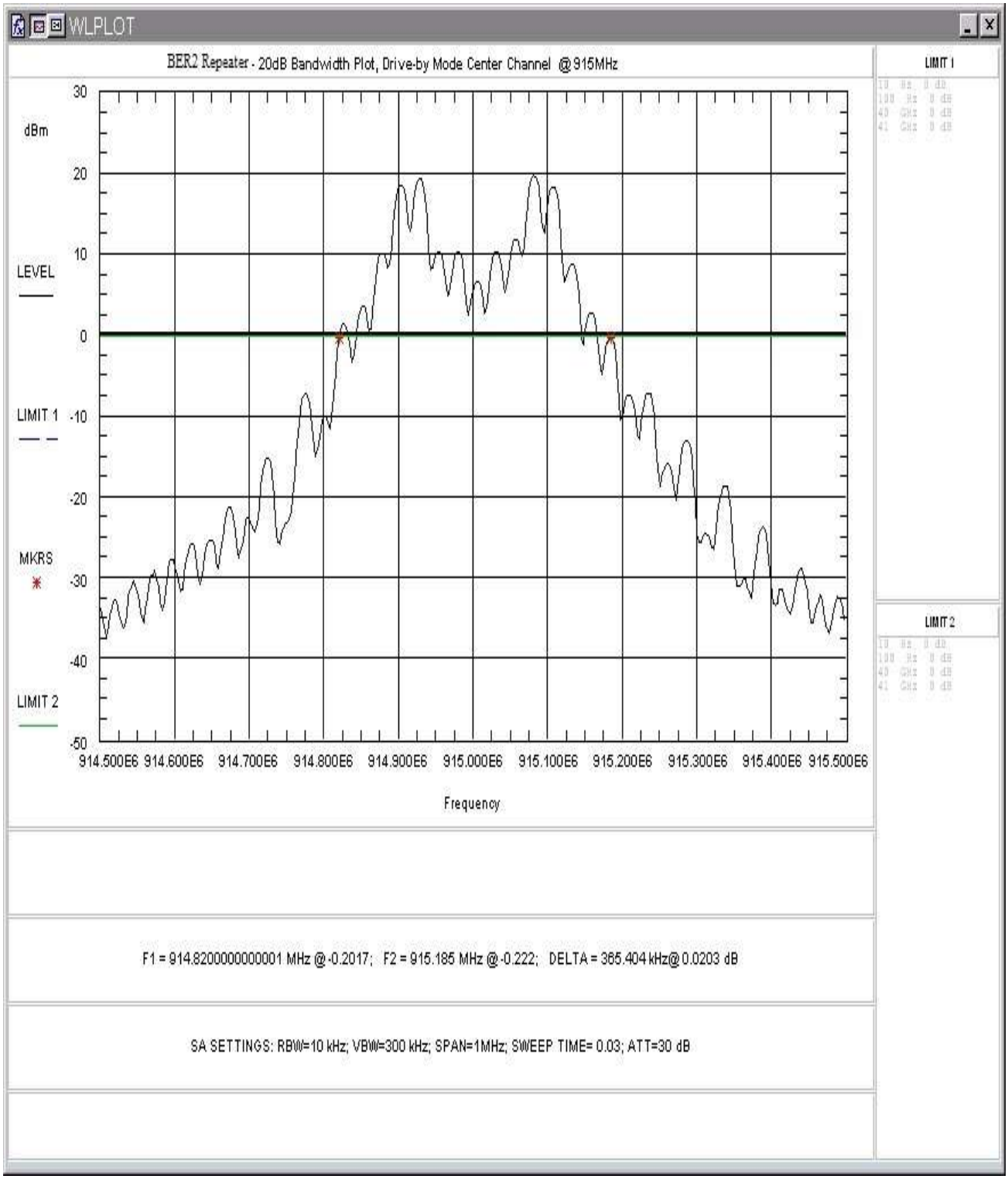

Figure 15. Occupied Bandwidth, Drive-by Mode, Center Channel

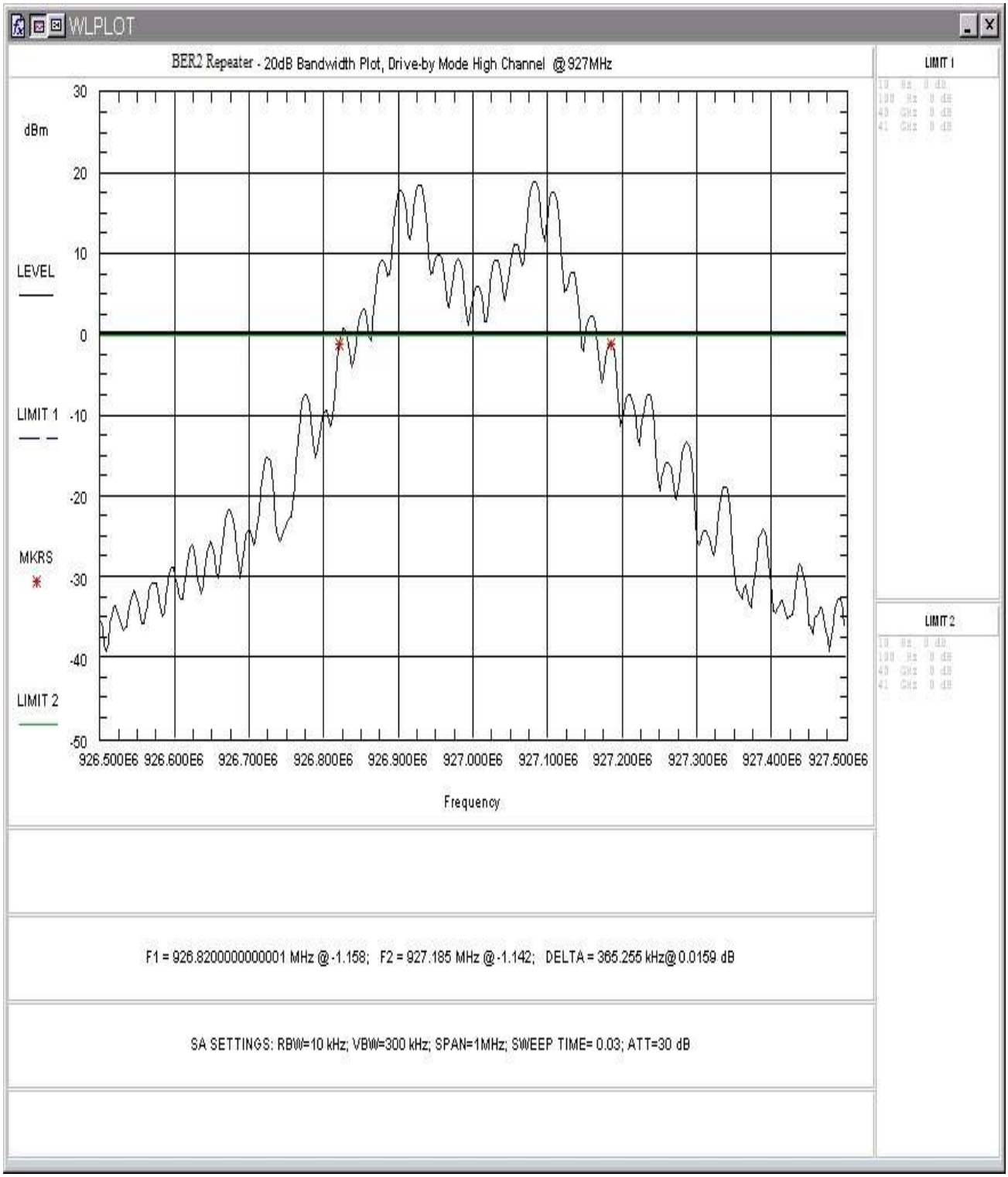

Figure 16. Occupied Bandwidth, Drive-by Mode, High Channel

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 141.94 kHz so the channel spacing must be more than 141.94 kHz for mesh mode and 365.26 kHz for drive-by mode. In addition, the number of hopping channels shall 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.

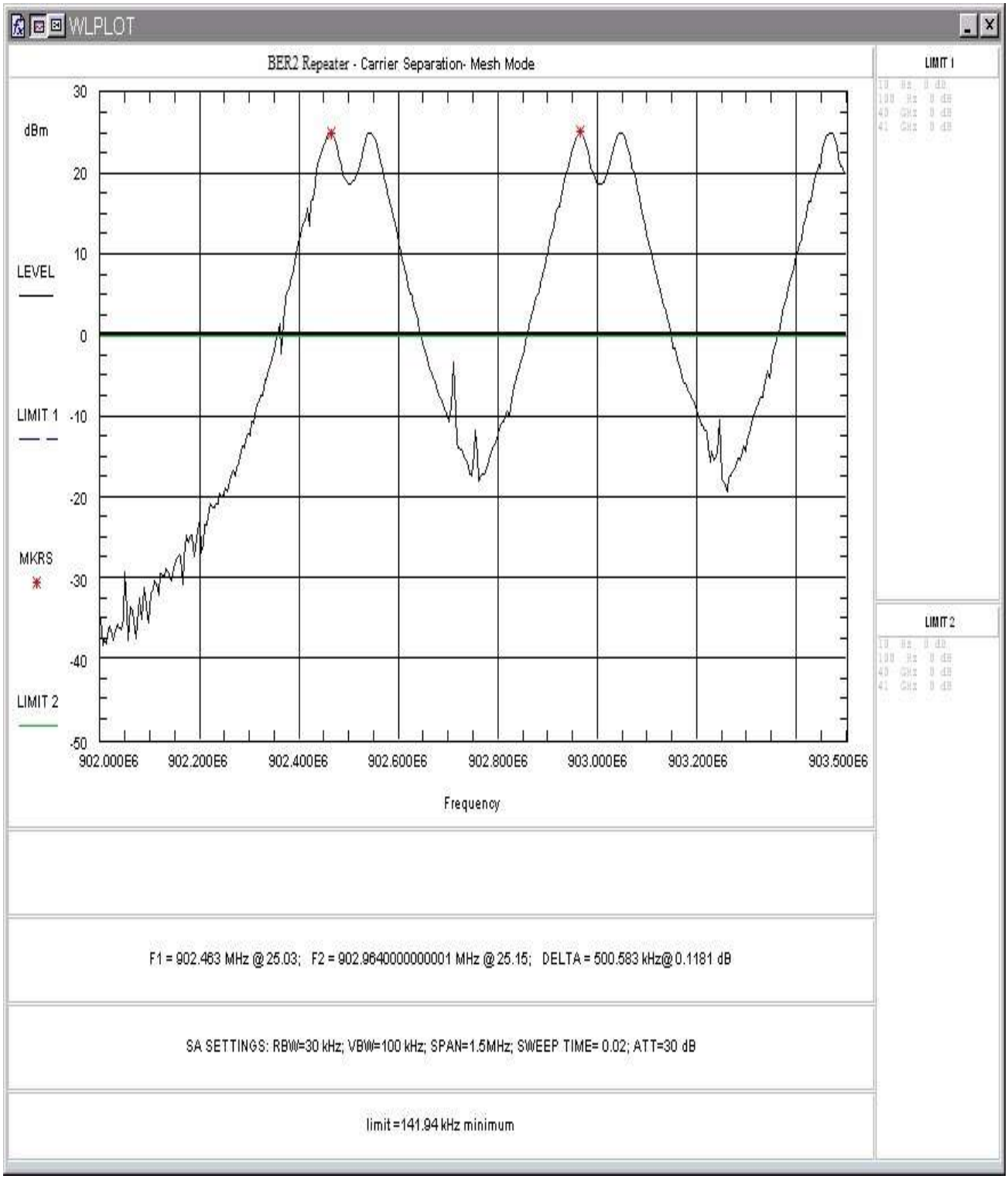

Figure 17, Channel Spacing, Mesh Mode

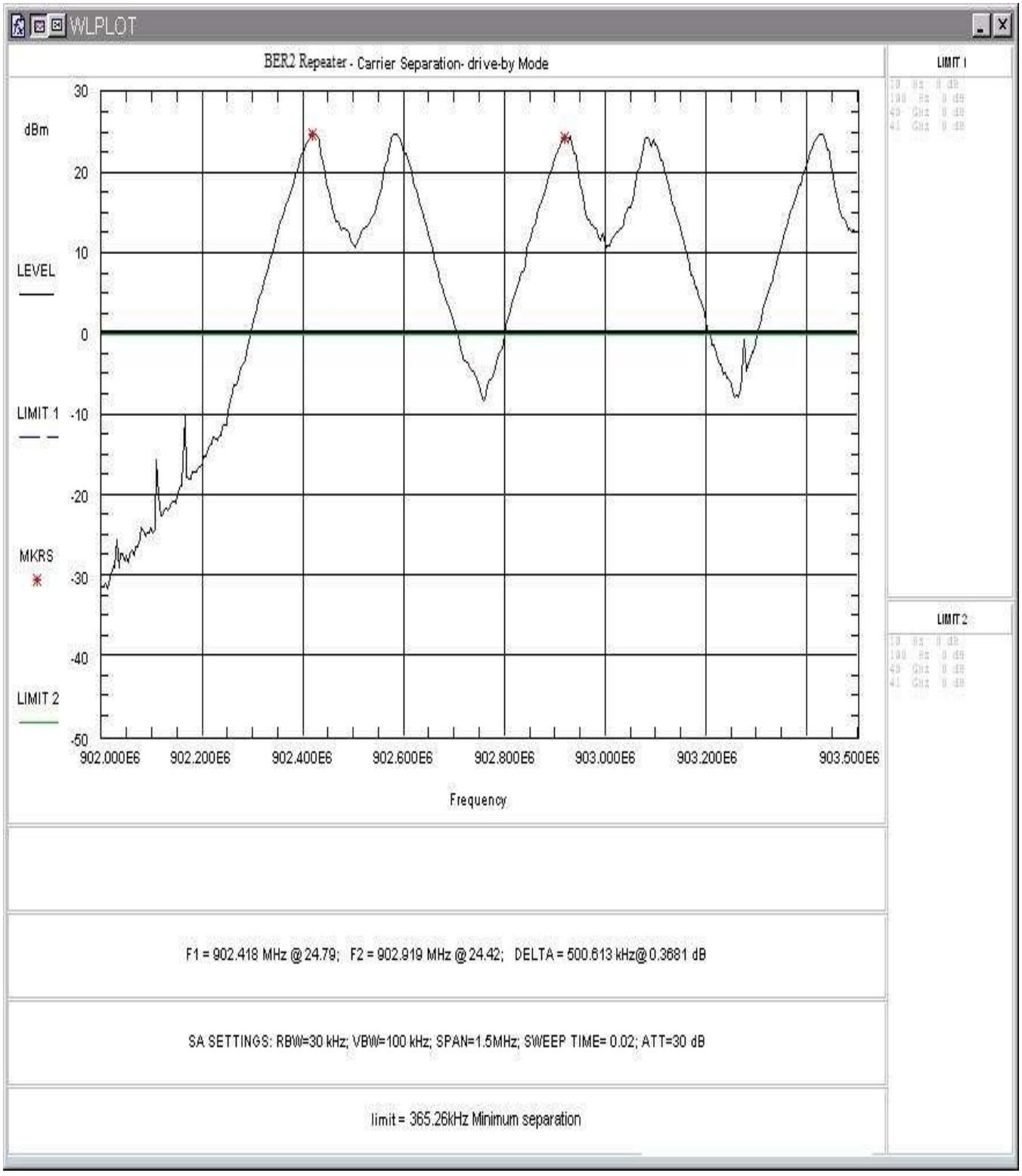

Figure 18, Channel Spacing, Drive-by Mode

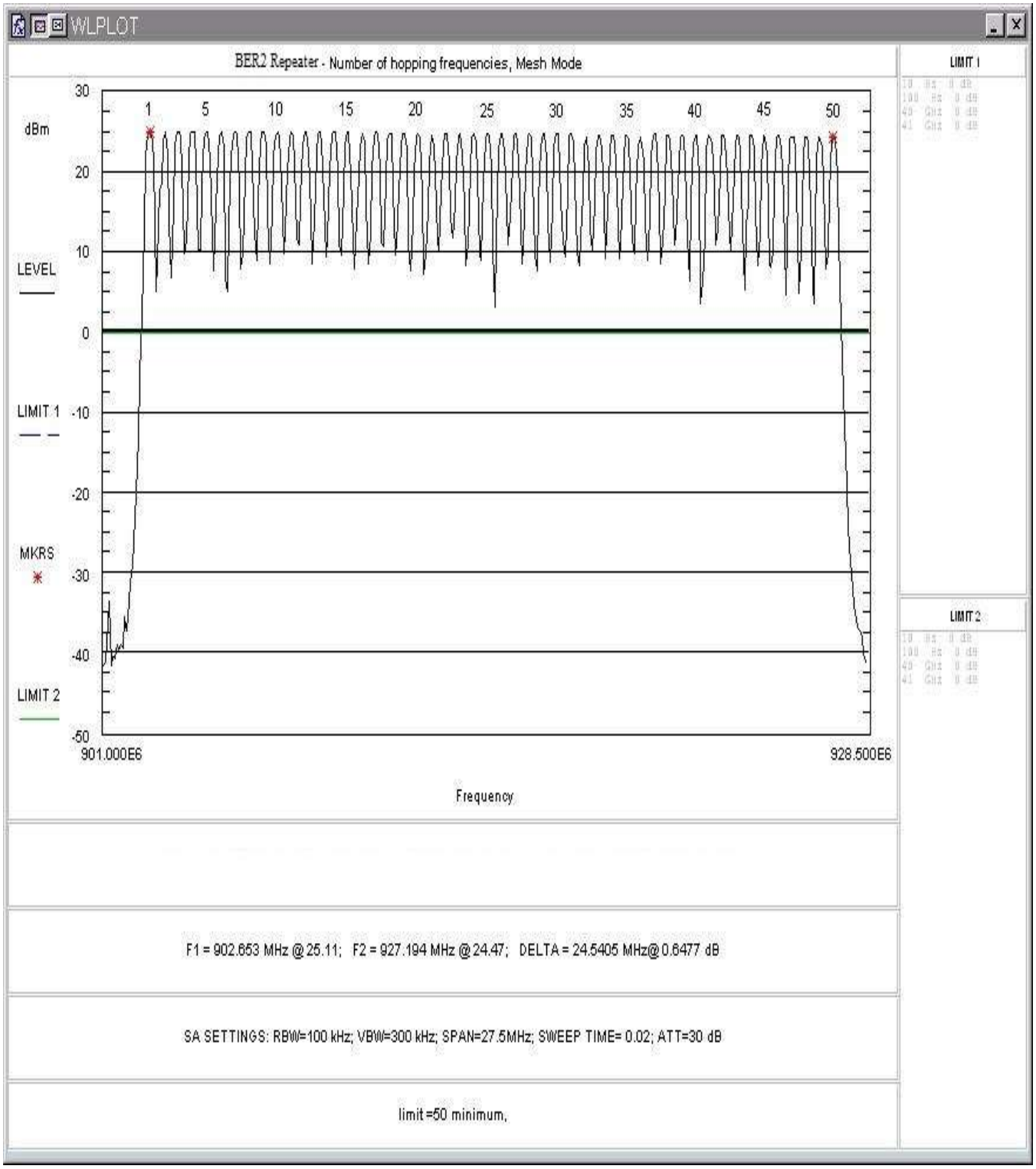

Figure 19, Number of Channels Mesh Mode

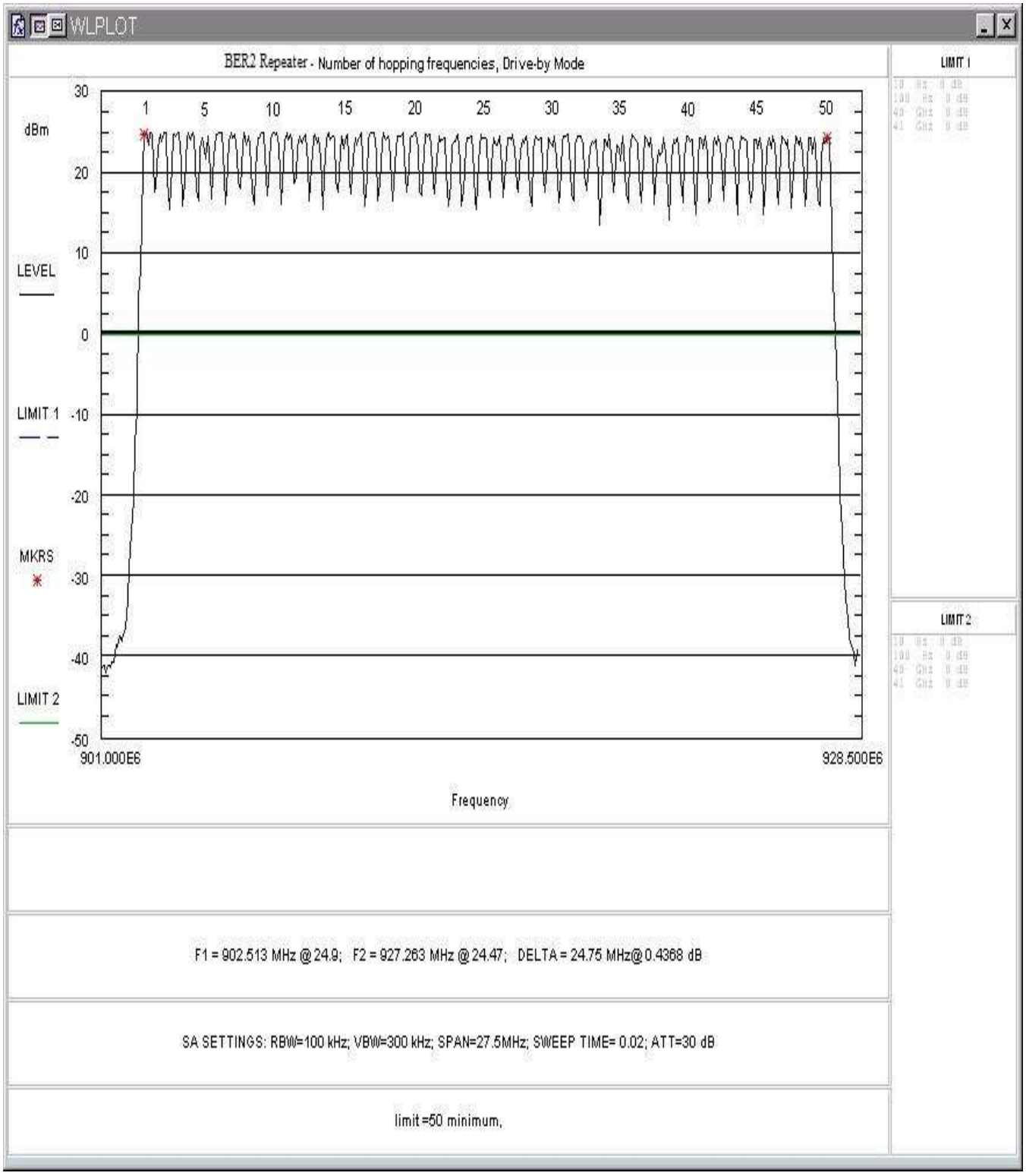

Figure 20, Number of Channels Drive-by Mode

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 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 300 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.

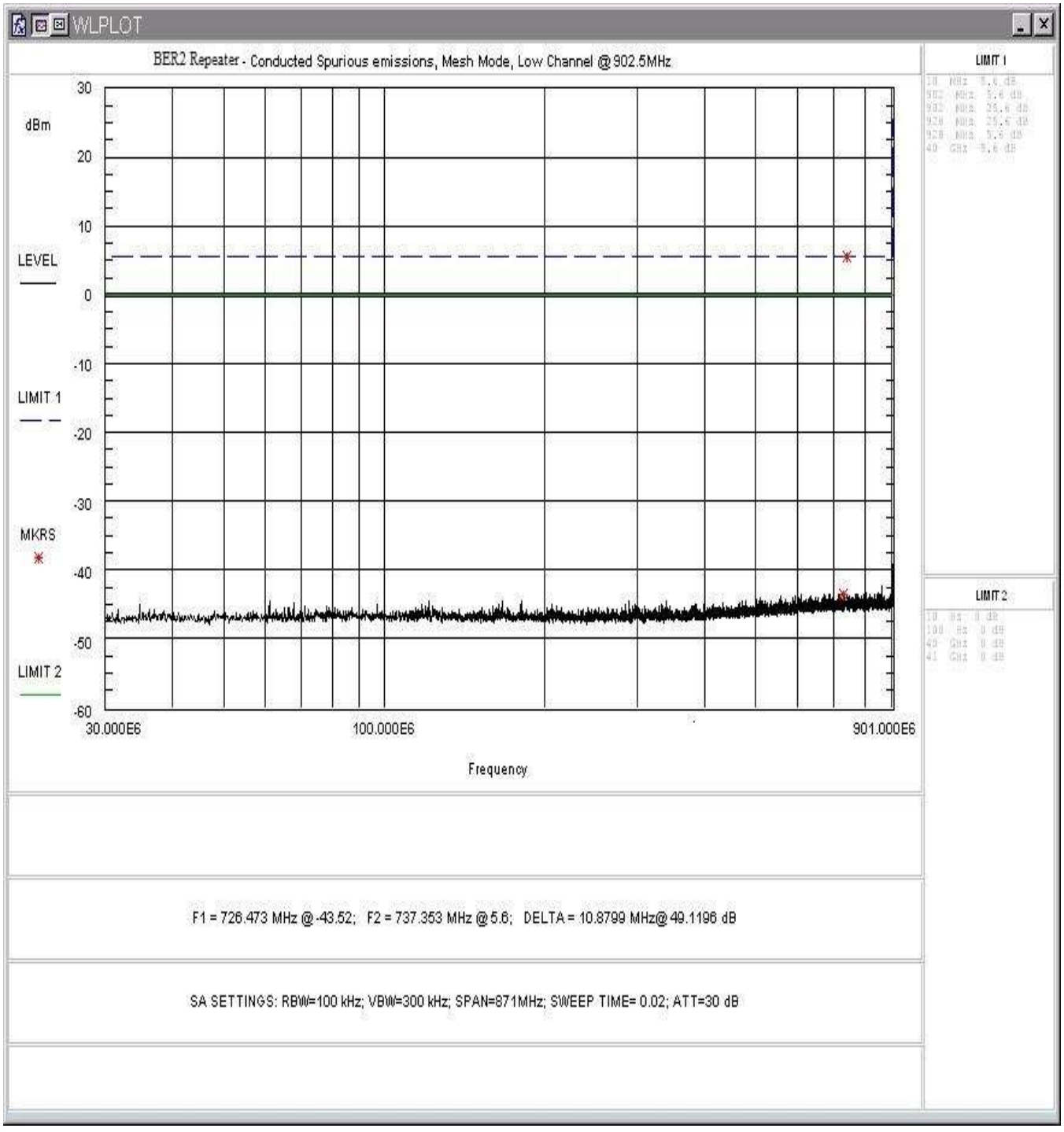

Figure 21. Conducted Spurious Emissions, Mesh Mode, Low Channel 30 - 901MHz

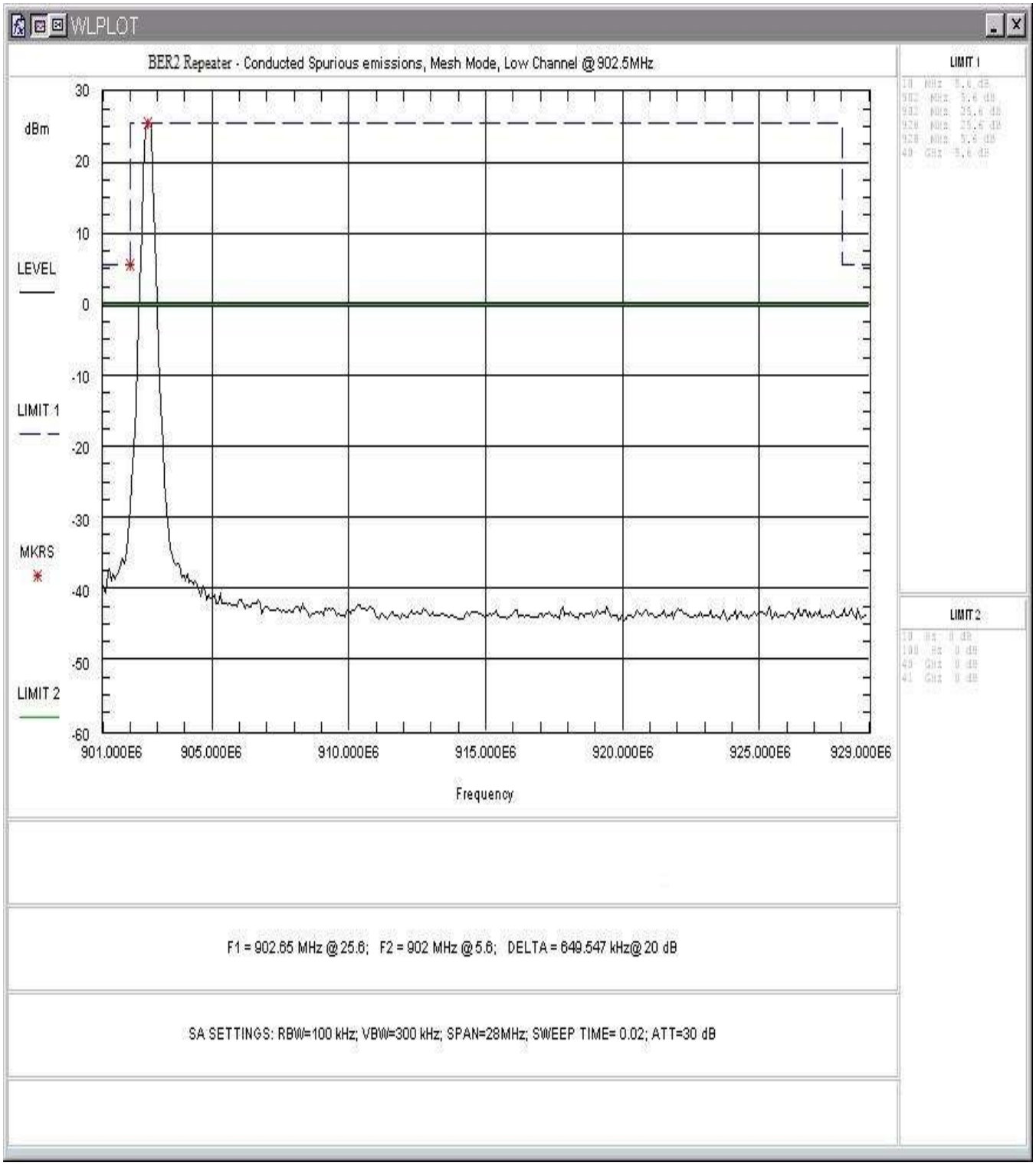

Figure 22. Conducted Spurious Emissions, Mesh Mode, Low Channel 901 – 929MHz

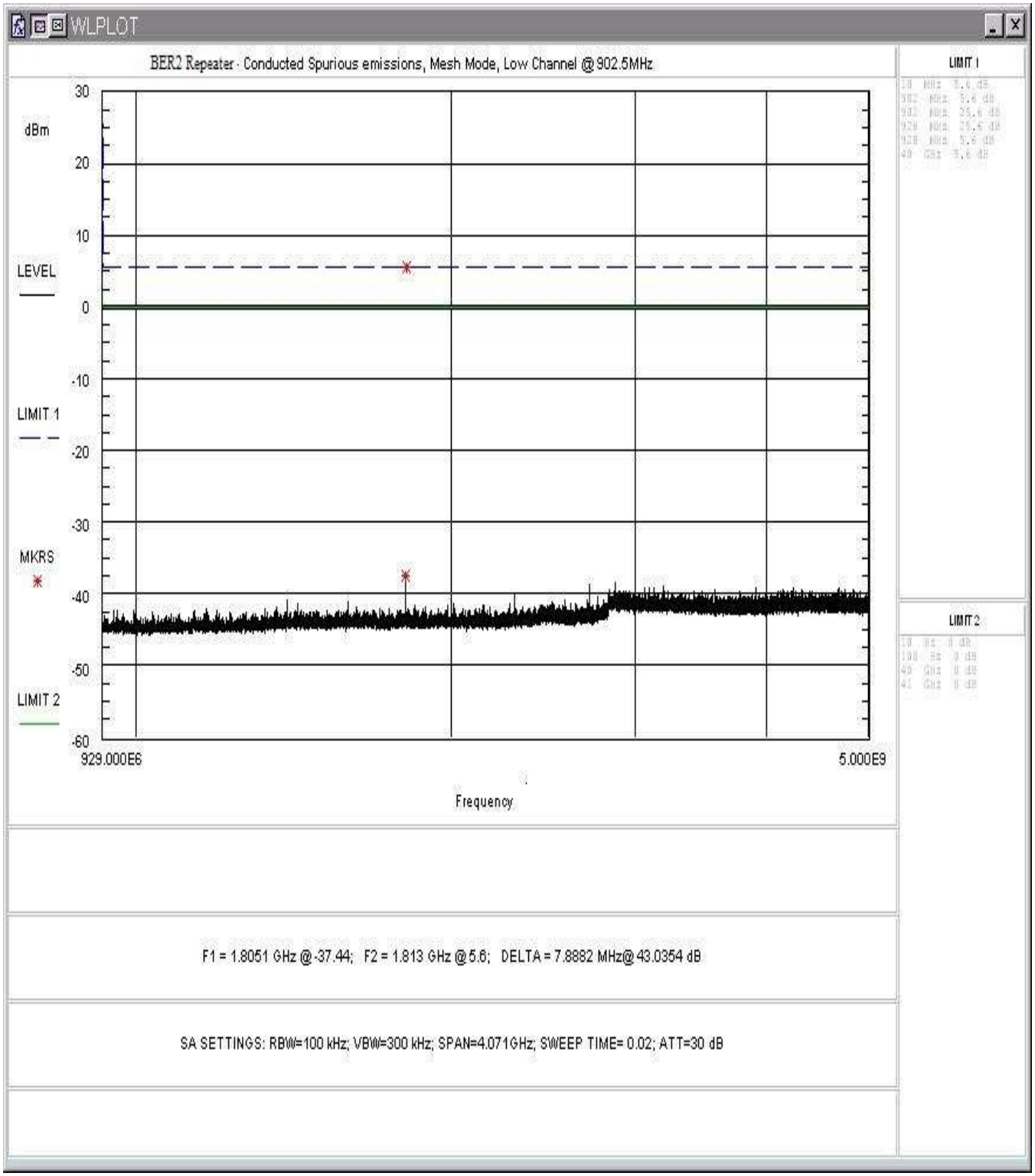

Figure 23. Conducted Spurious Emissions, Mesh Mode, Low Channel 929-5000MHz

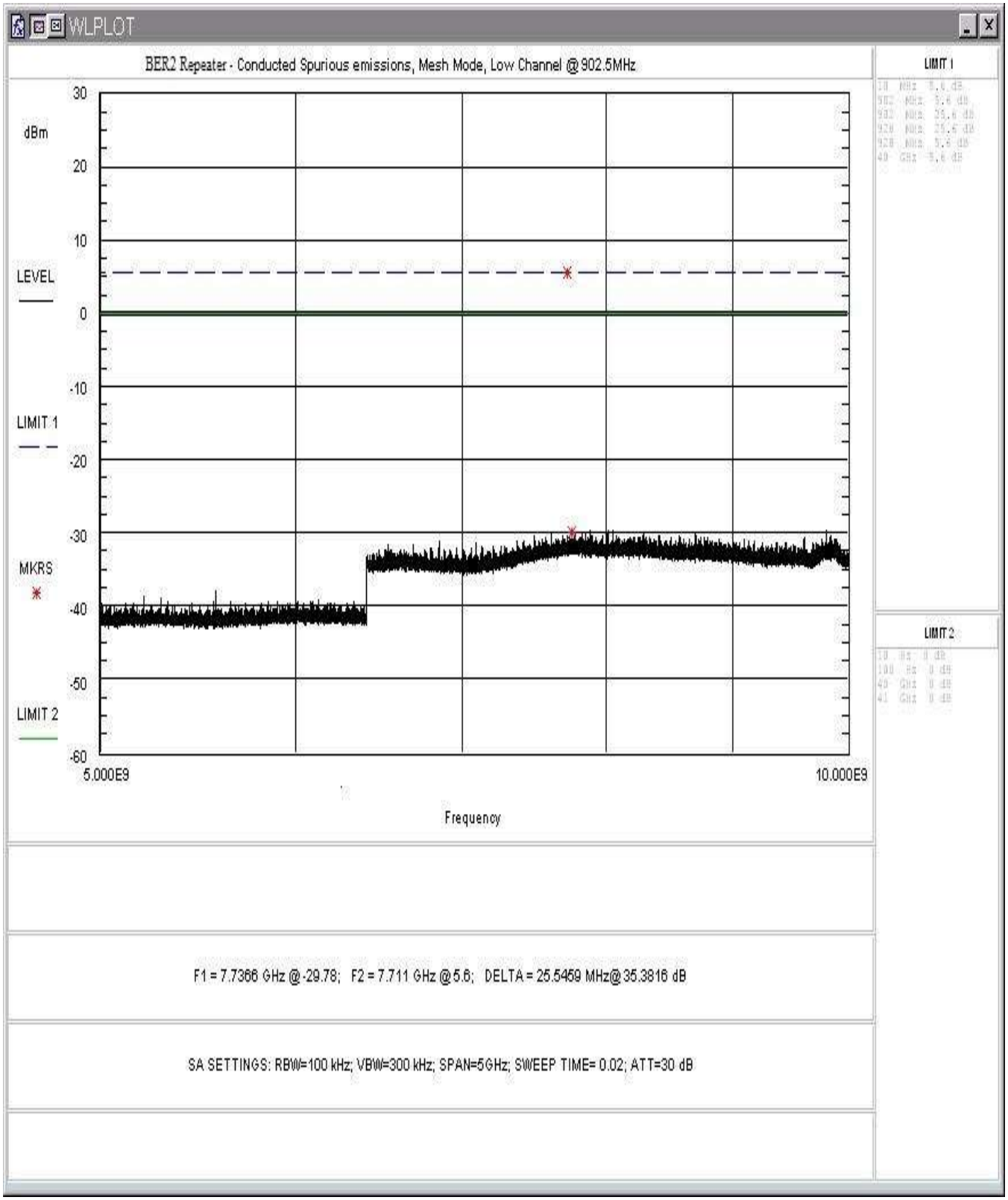

Figure 24. Conducted Spurious Emissions, Mesh Mode, Low Channel 5- 10GHz

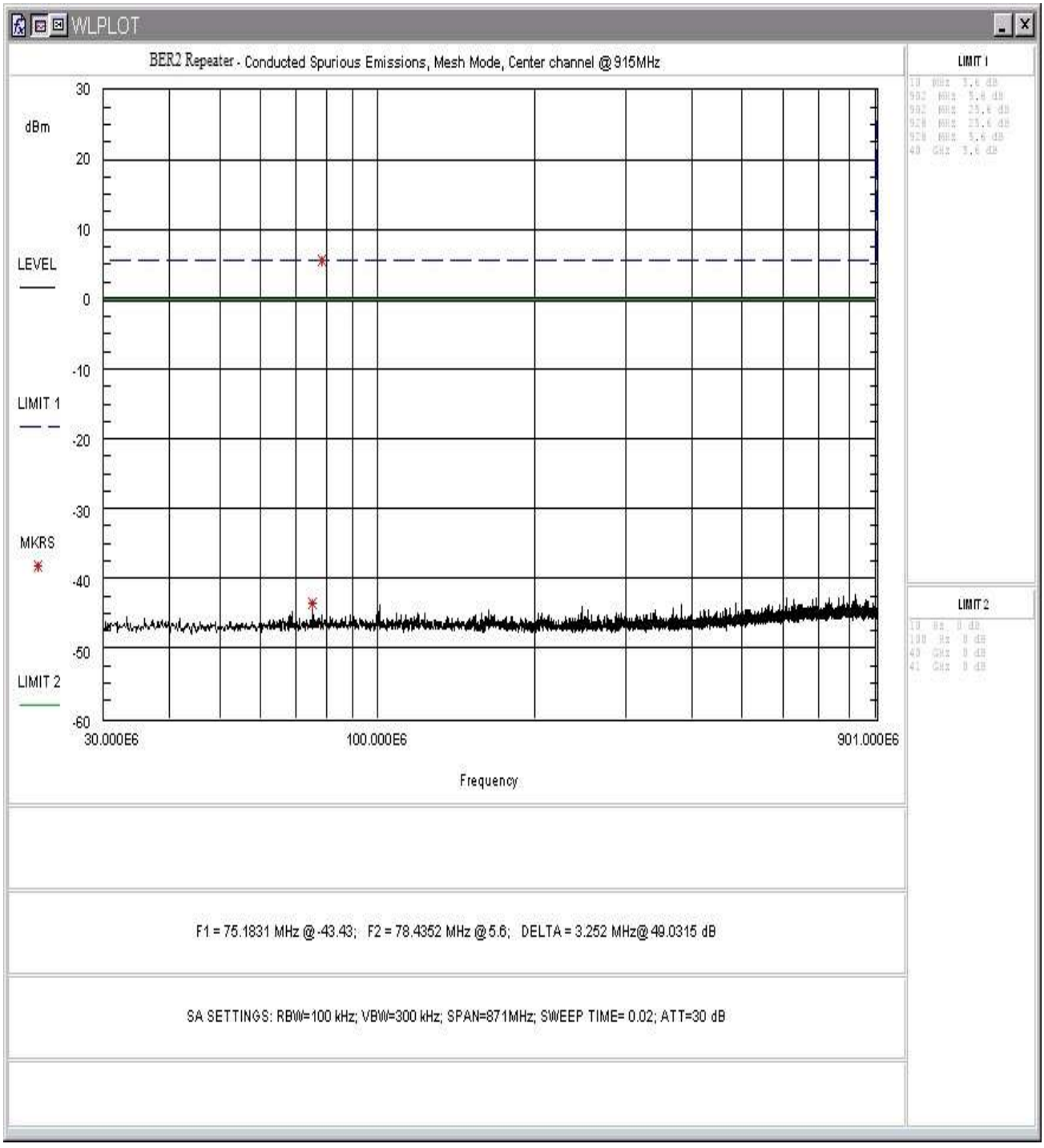

Figure 25. Conducted Spurious Emissions, Mesh Mode, Center Channel 30-901 MHz

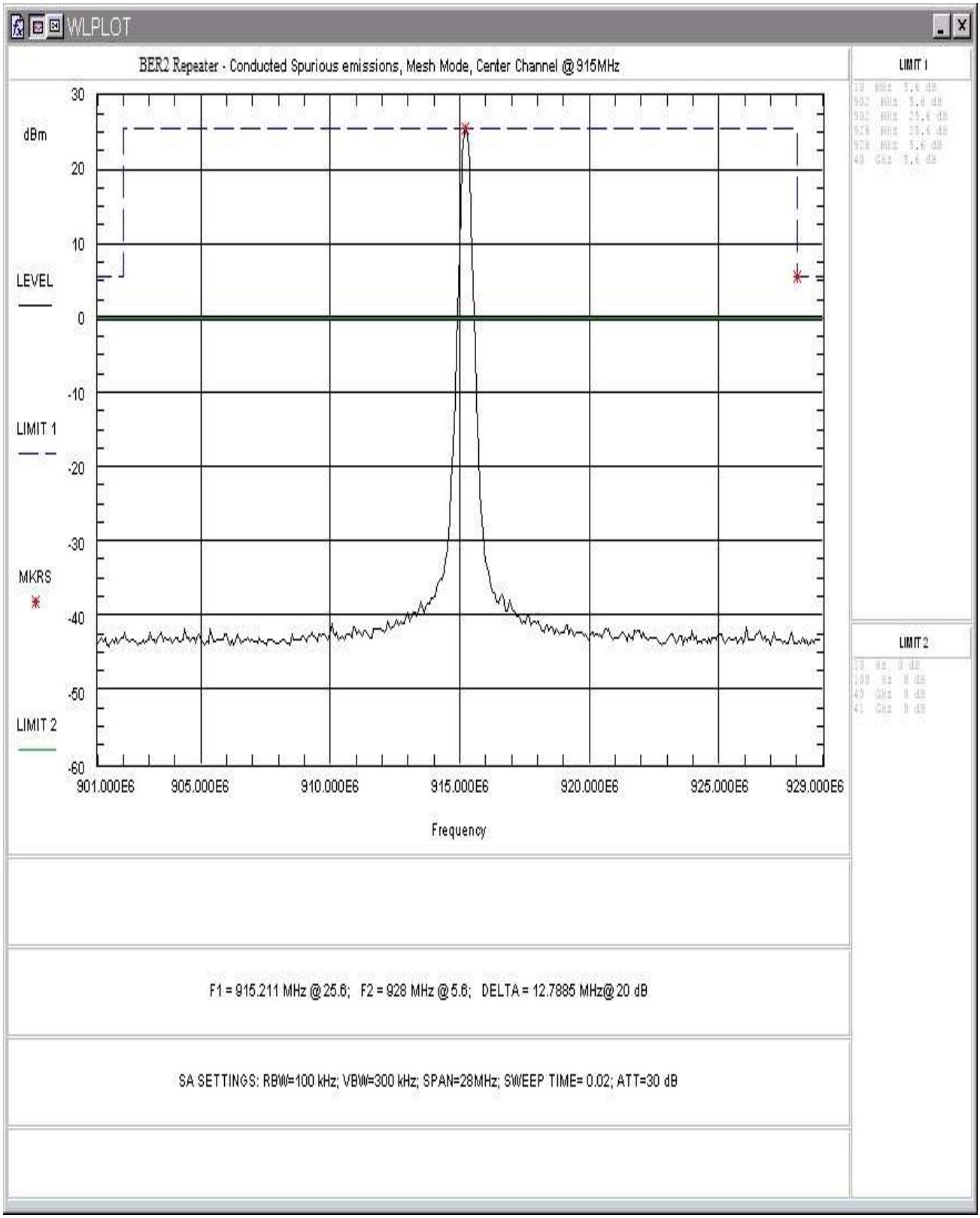

Figure 26. Conducted Spurious Emissions, Mesh Mode, Center Channel 901-929 MHz

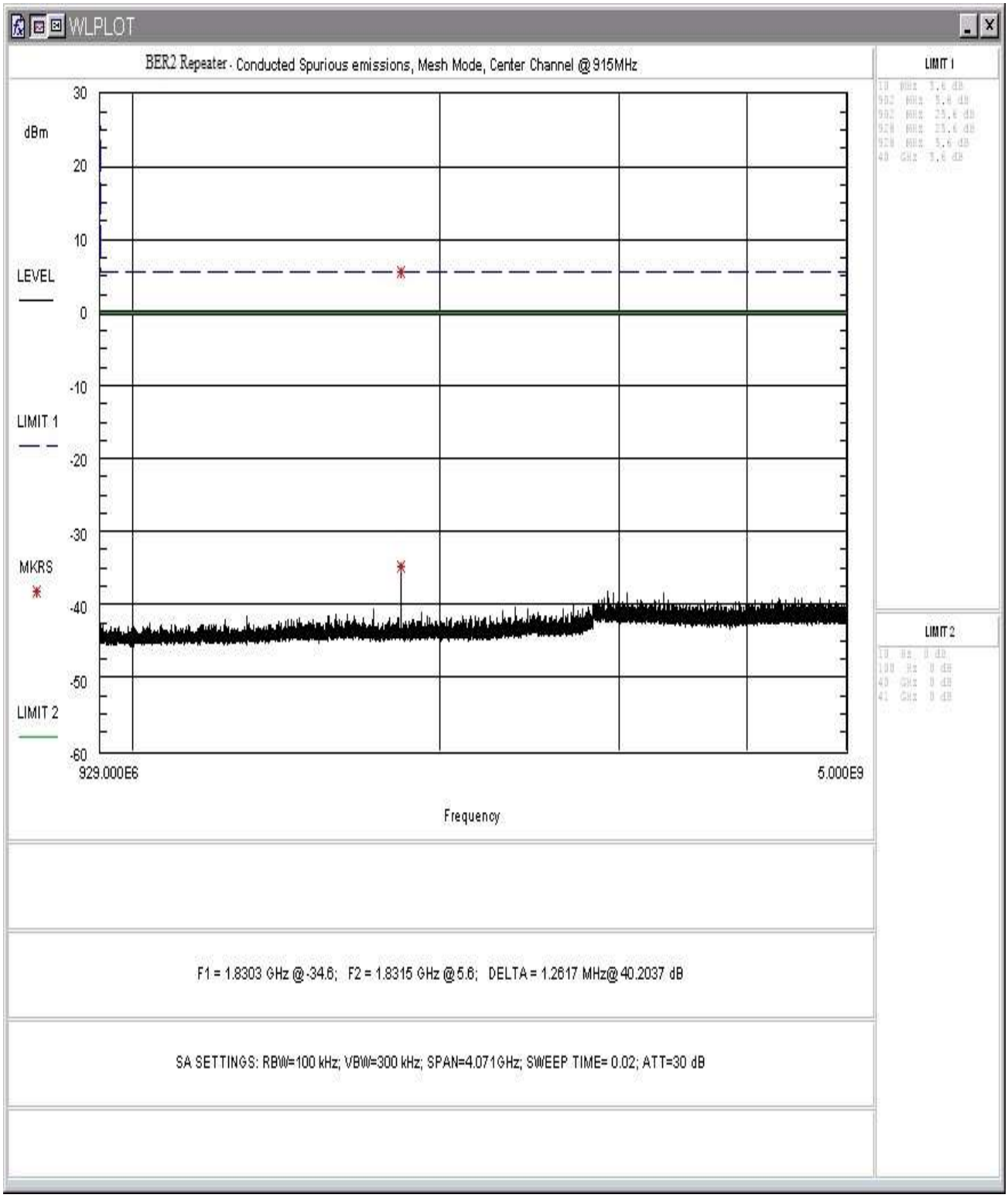

Figure 27. Conducted Spurious Emissions, Mesh Mode, Center Channel 929 -5000MHz

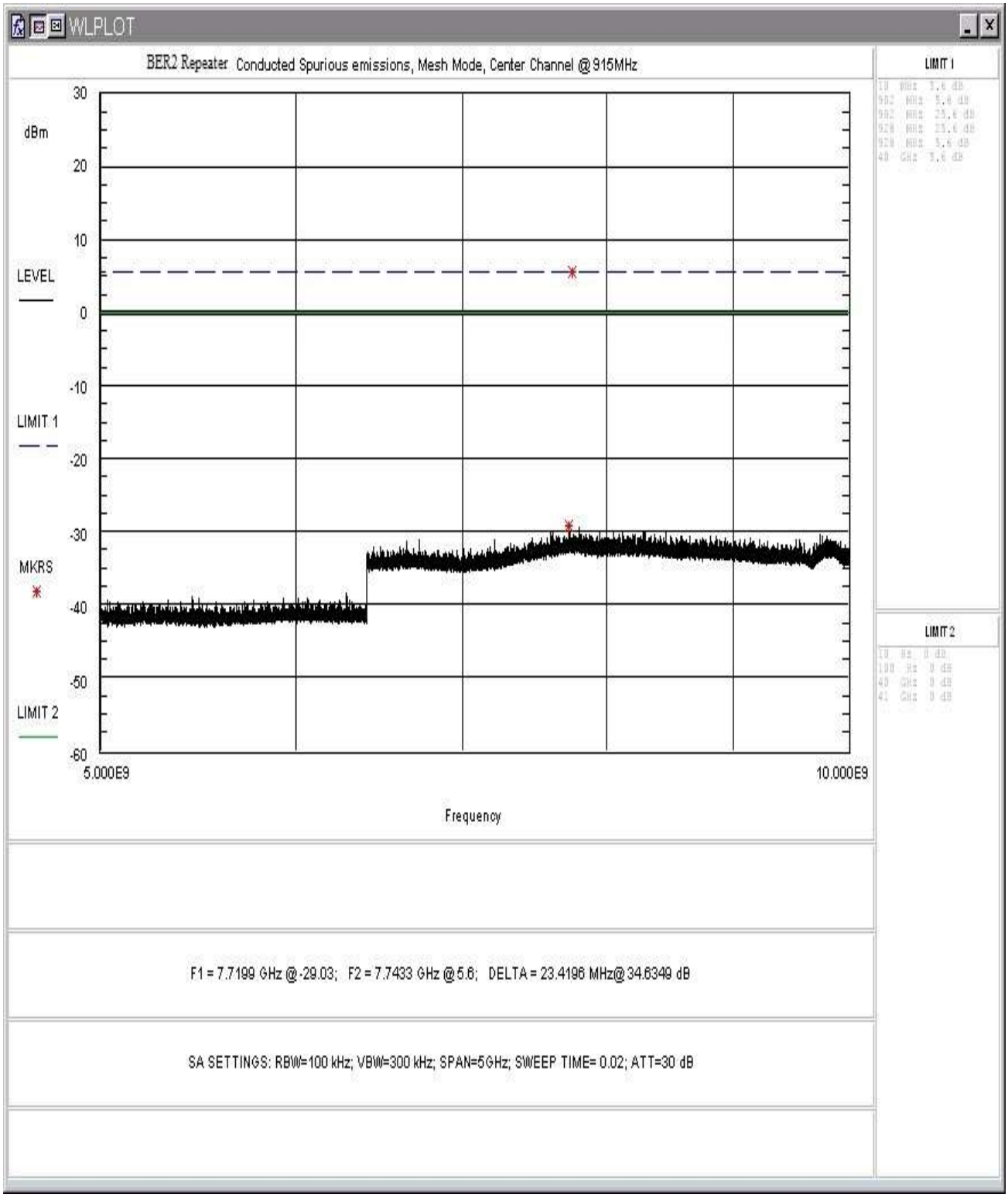

Figure 28. Conducted Spurious Emissions, Mesh Mode, Center Channel 5-10GHz

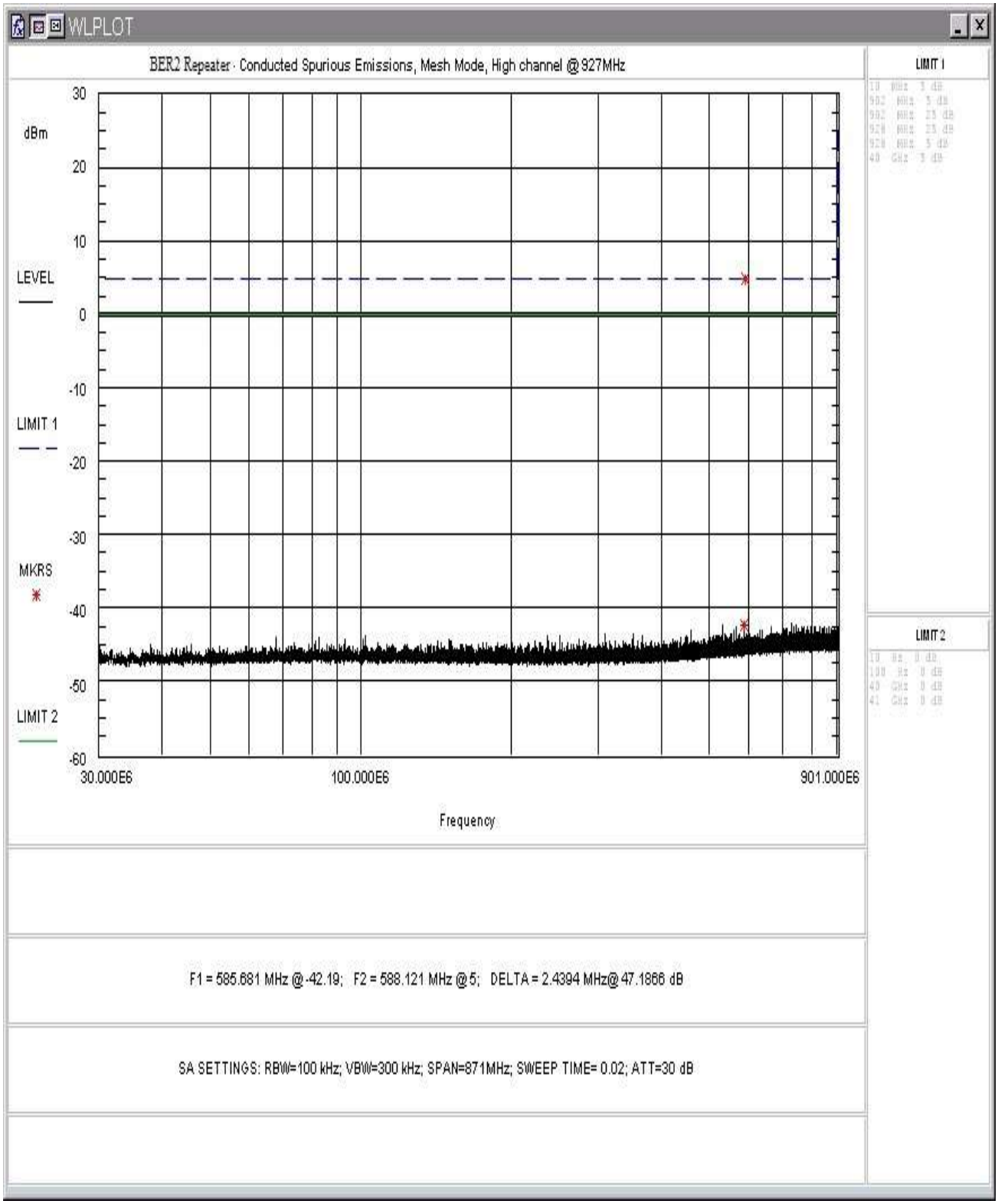

Figure 29. Conducted Spurious Emissions, Mesh Mode, High Channel 30-901MHz

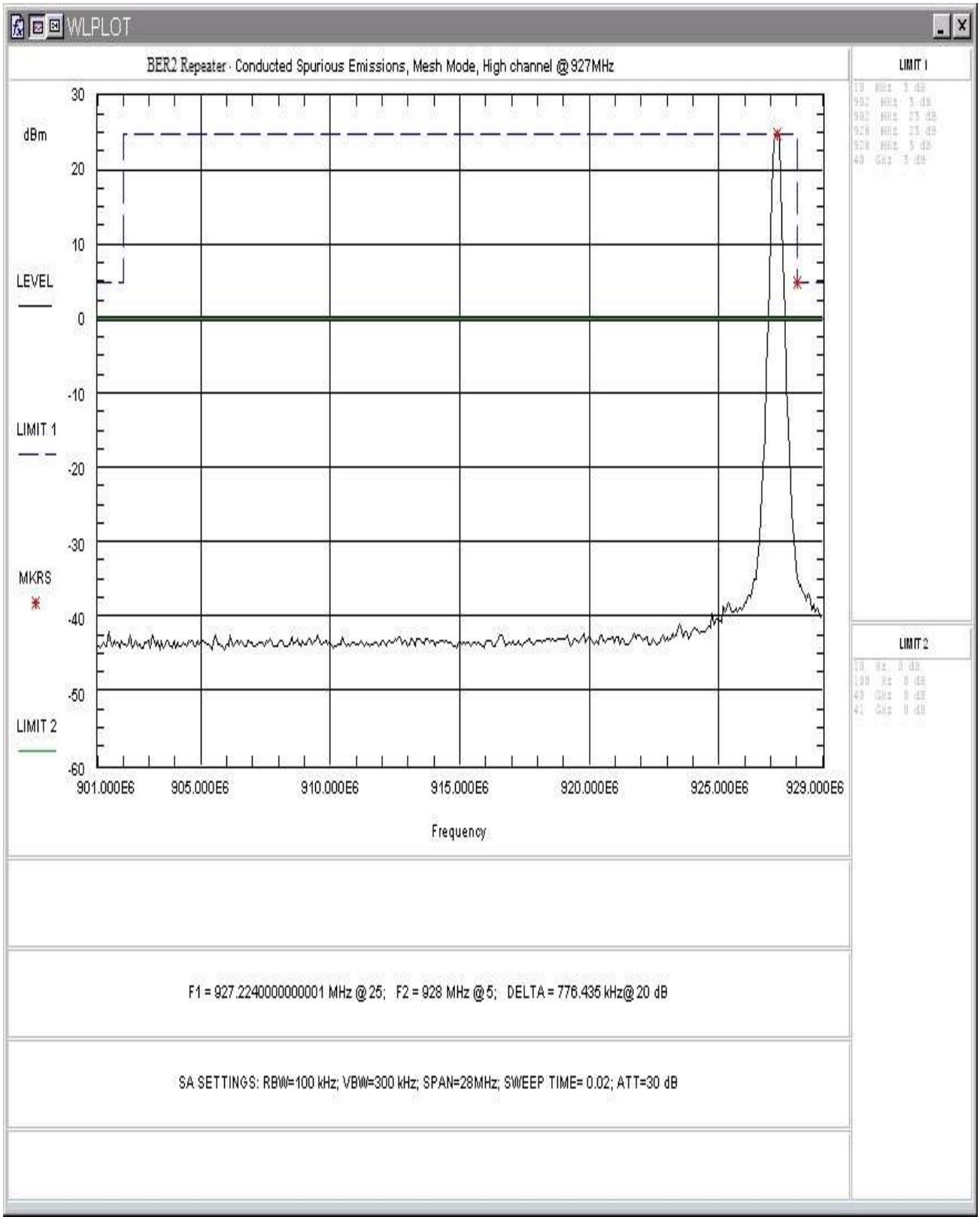

Figure 30. Conducted Spurious Emissions, Mesh Mode, High Channel 901-929MHz

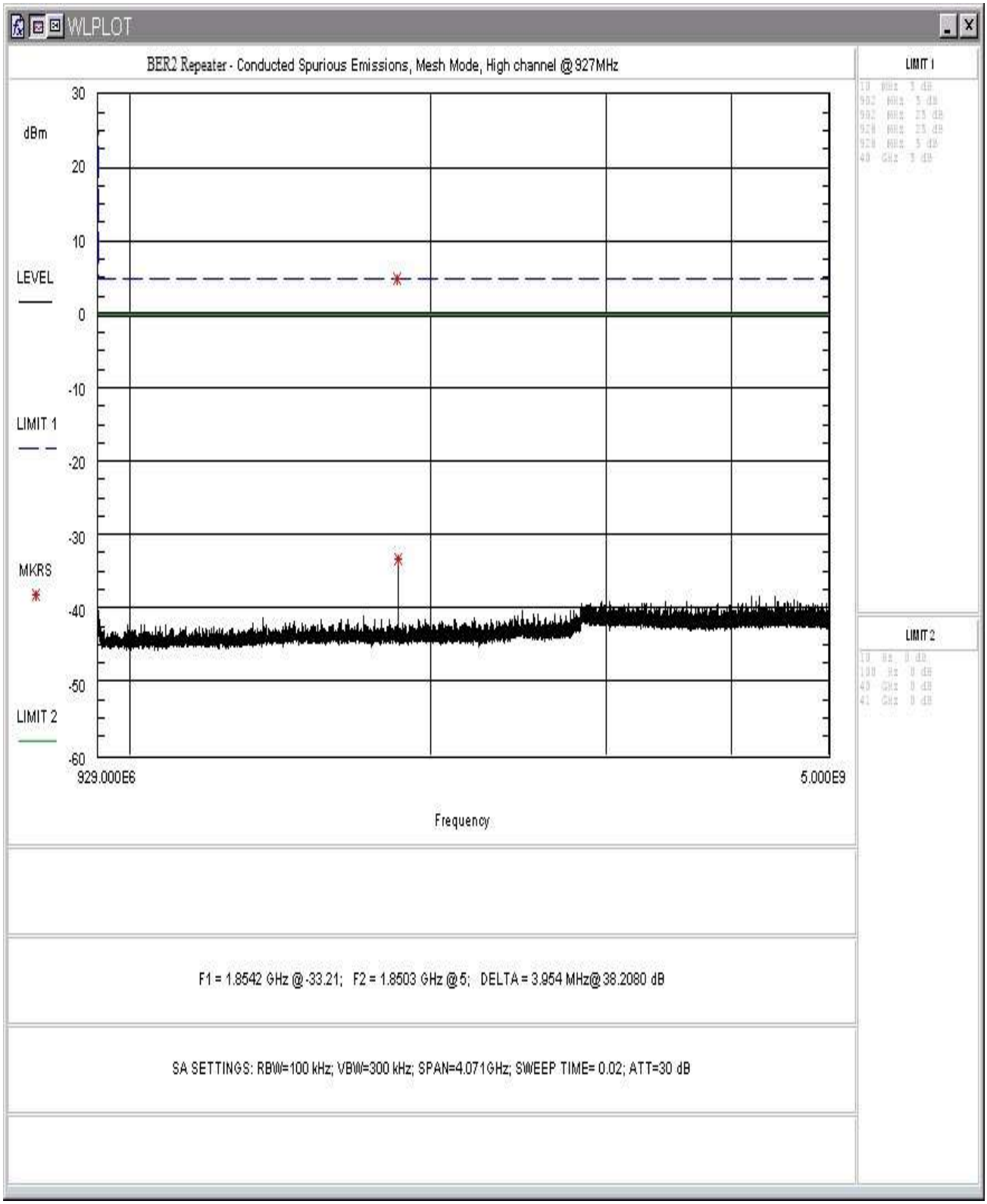

Figure 31. Conducted Spurious Emissions, Mesh Mode, High Channel 929-5000MHz

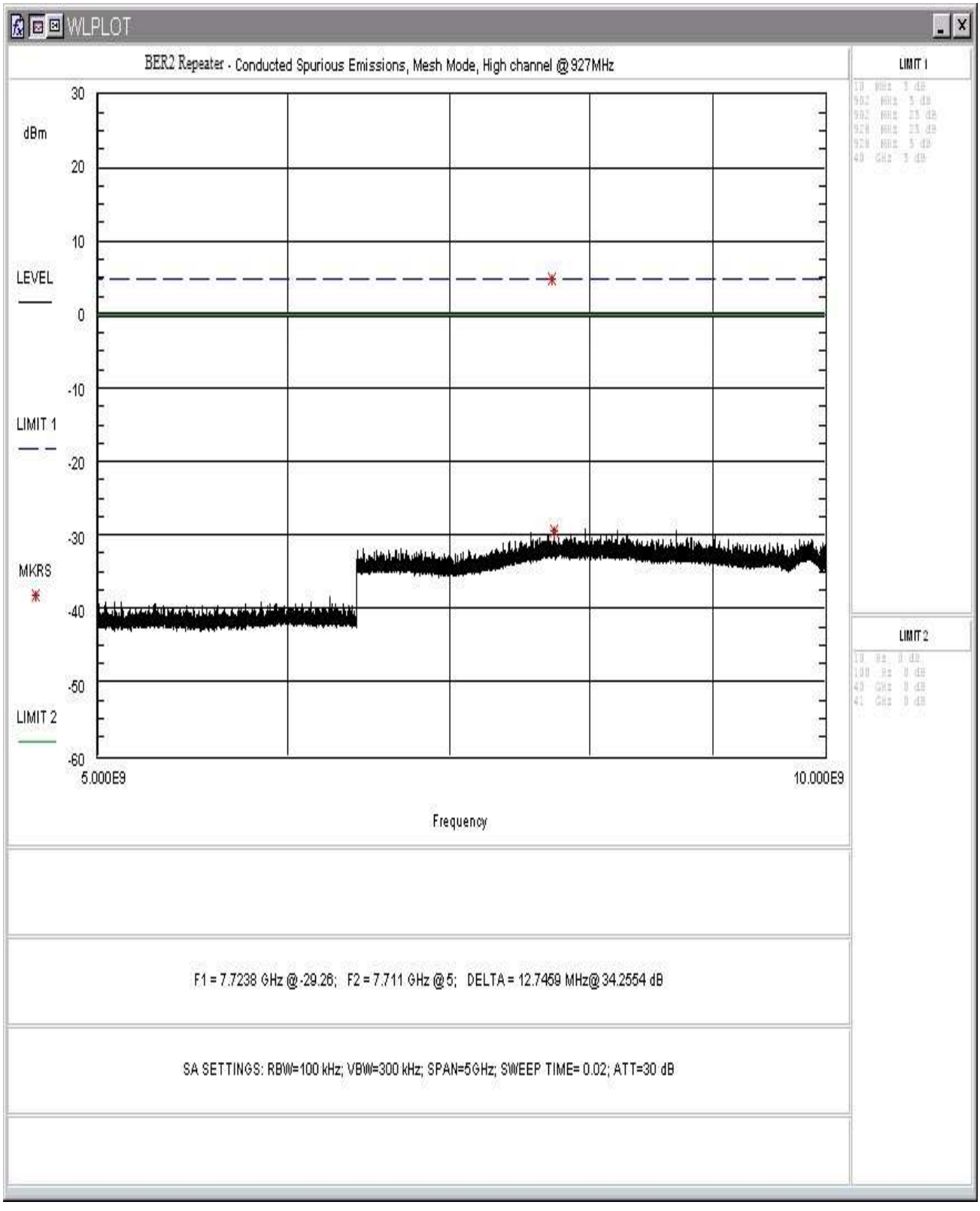

Figure 32. Conducted Spurious Emissions, Mesh Mode, High Channel 5-10GHz

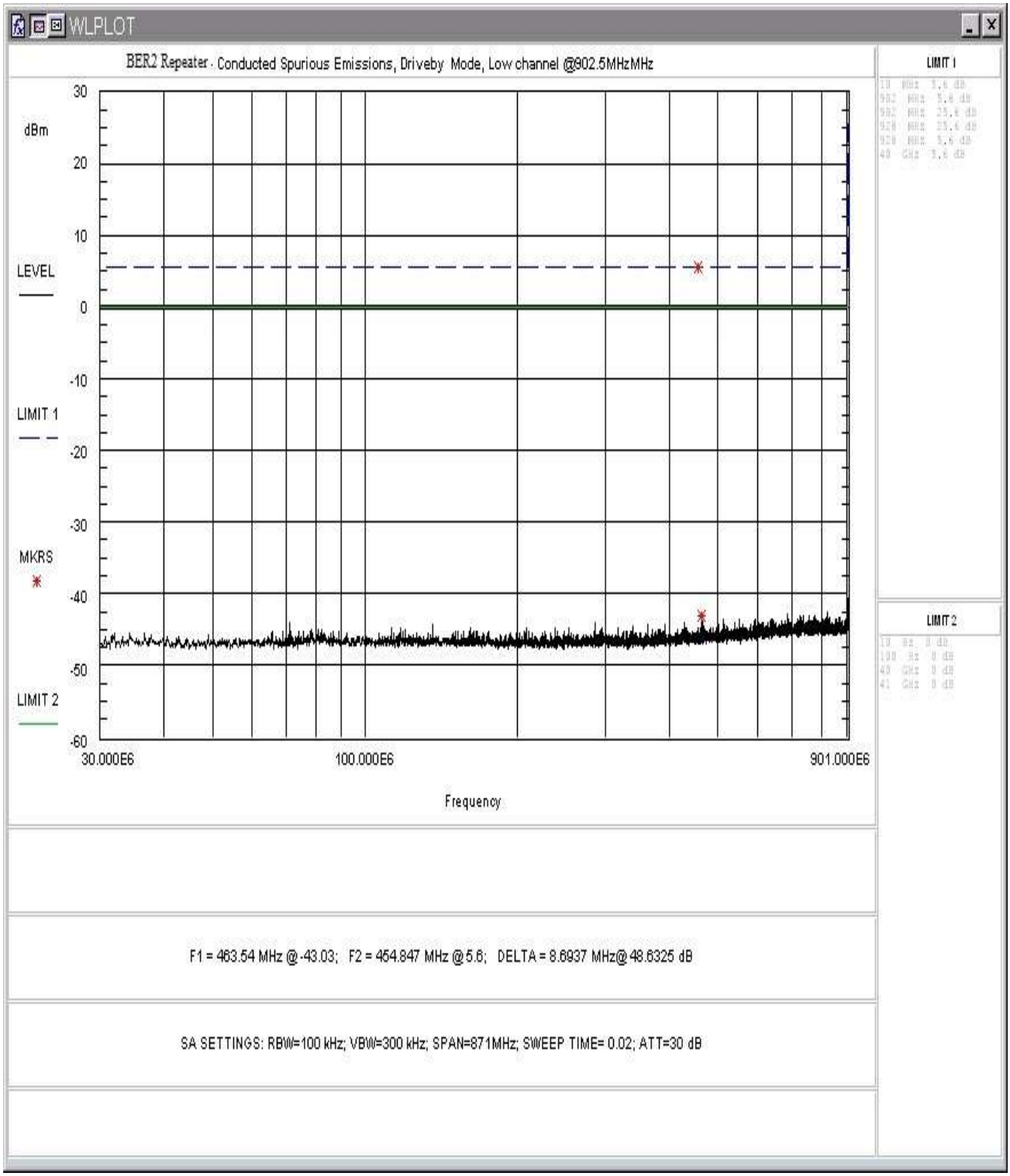

Figure 33. Conducted Spurious Emissions, Drive-by Mode, Low Channel 30-901MHz

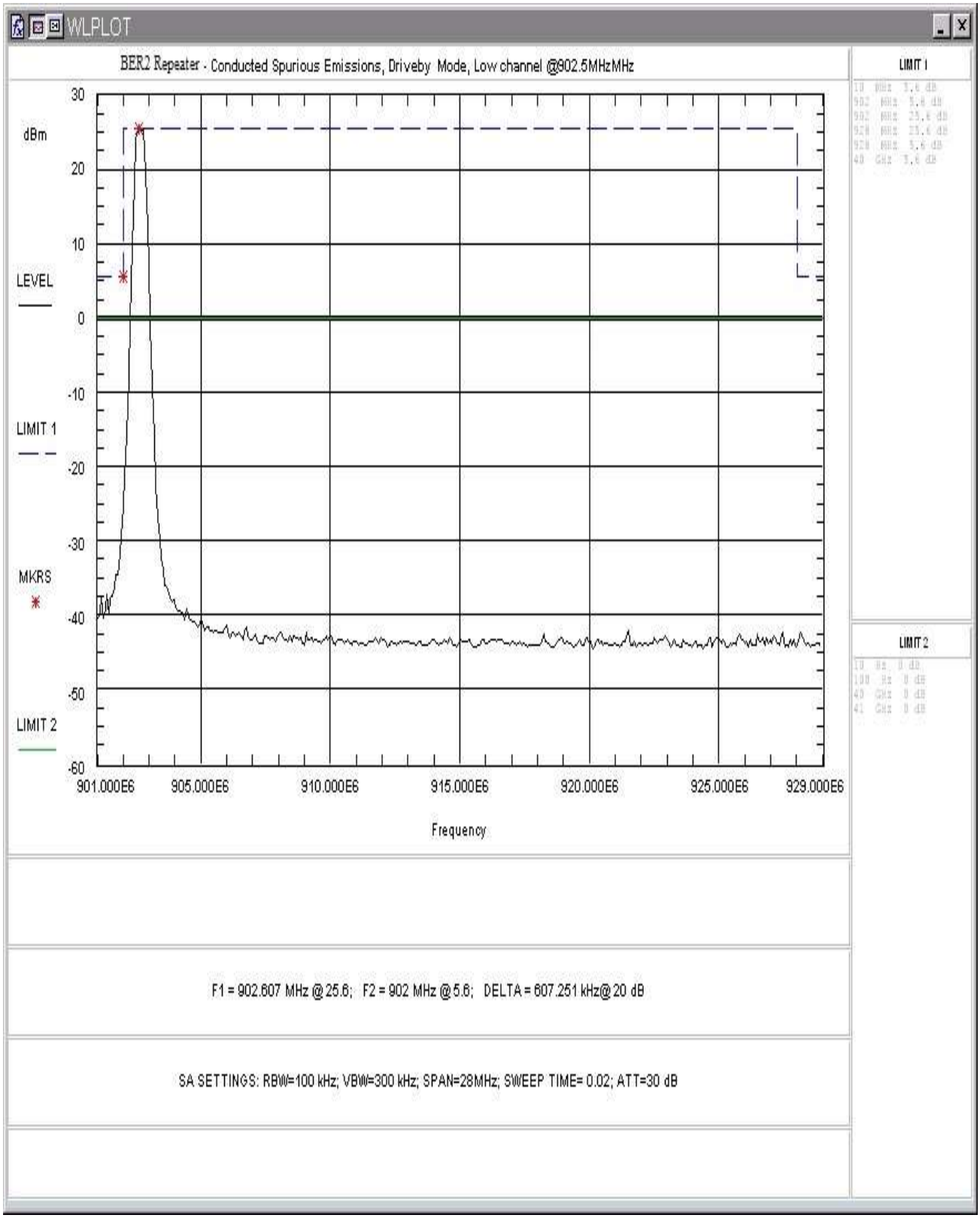

Figure 34. Conducted Spurious Emissions, Drive-by Mode, Low Channel 901-929MHz

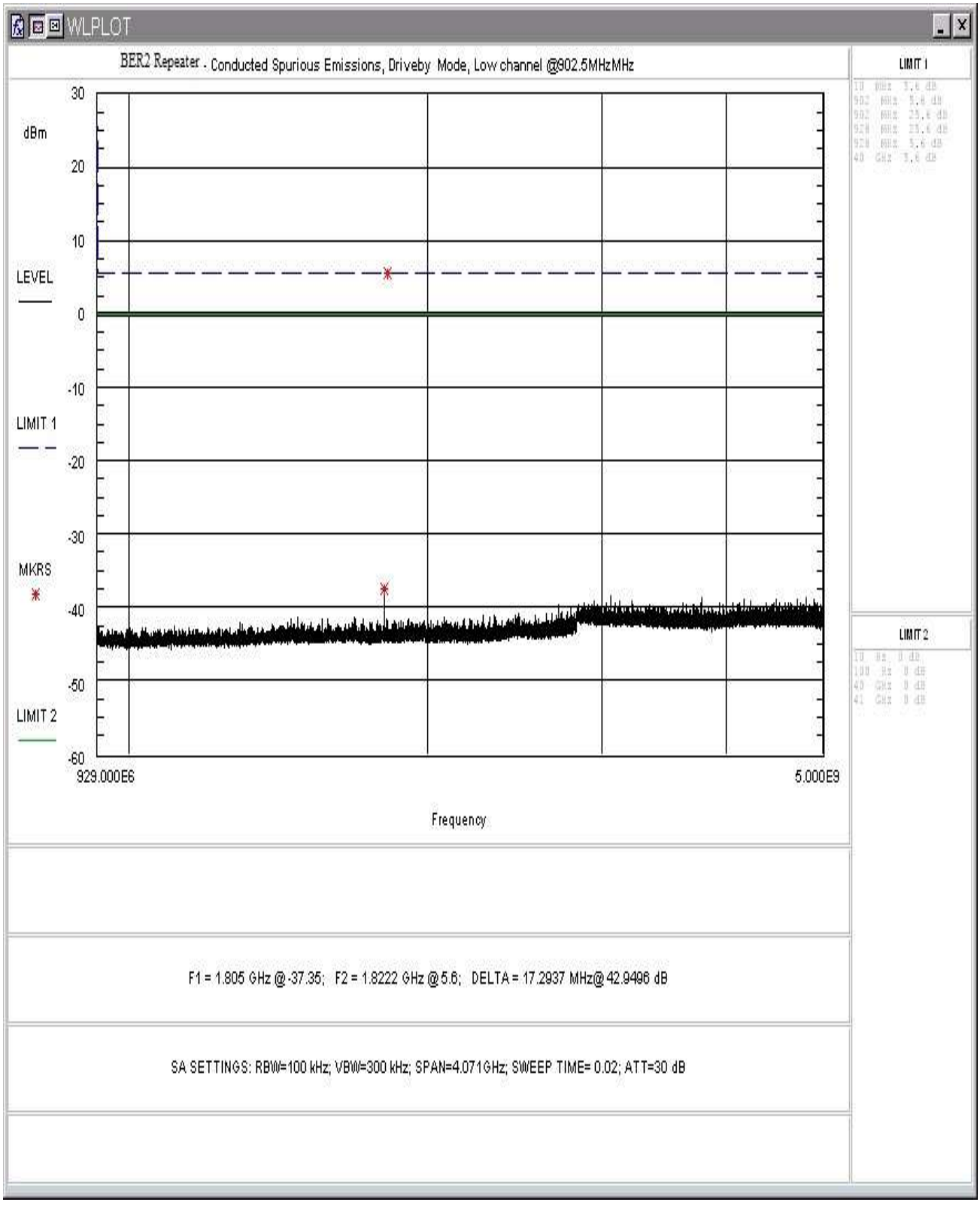

Figure 35. Conducted Spurious Emissions, Drive-by Mode, Low Channel 929-5000MHz

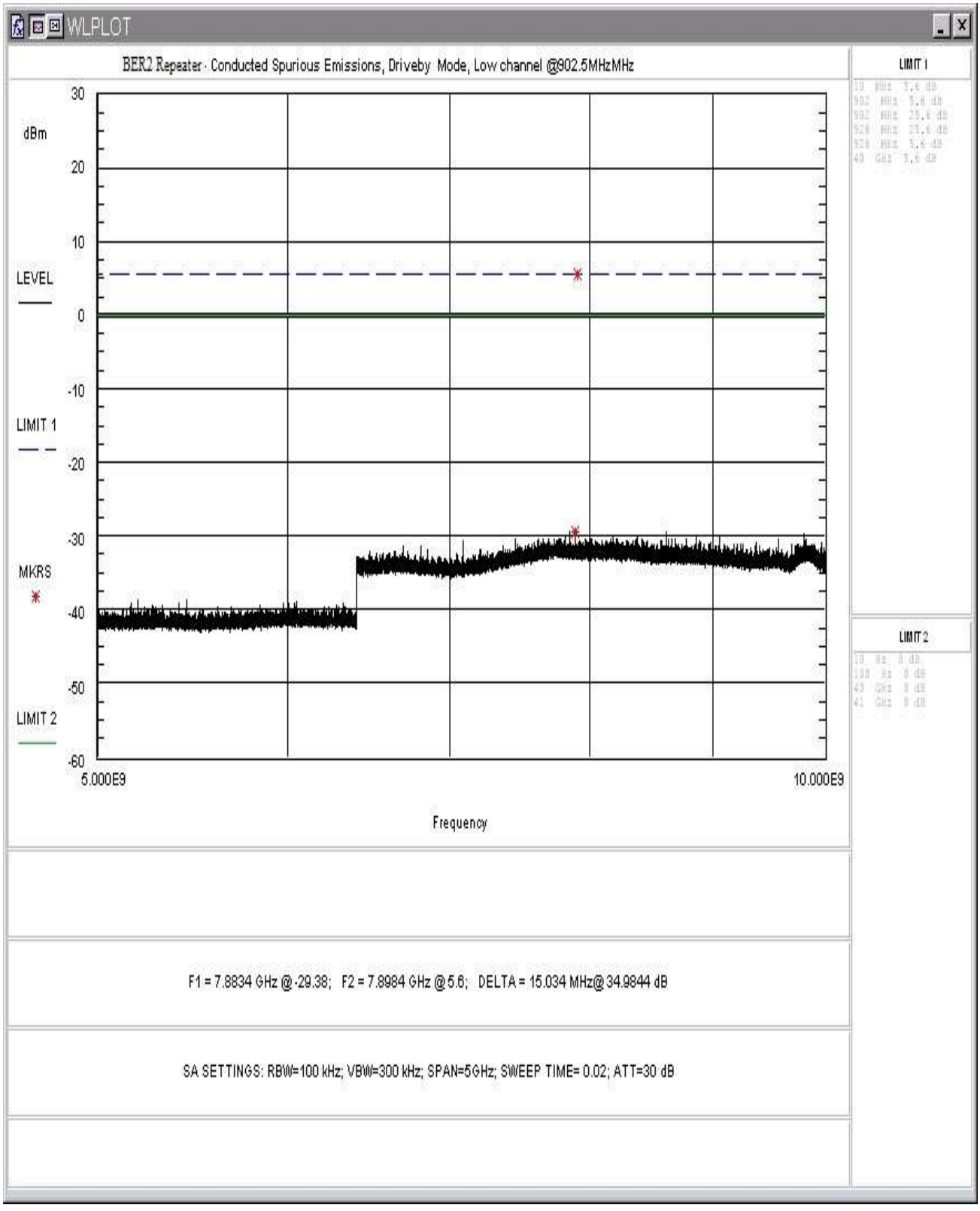

Figure 36. Conducted Spurious Emissions, Drive-by Mode, Low Channel 5-10GHz

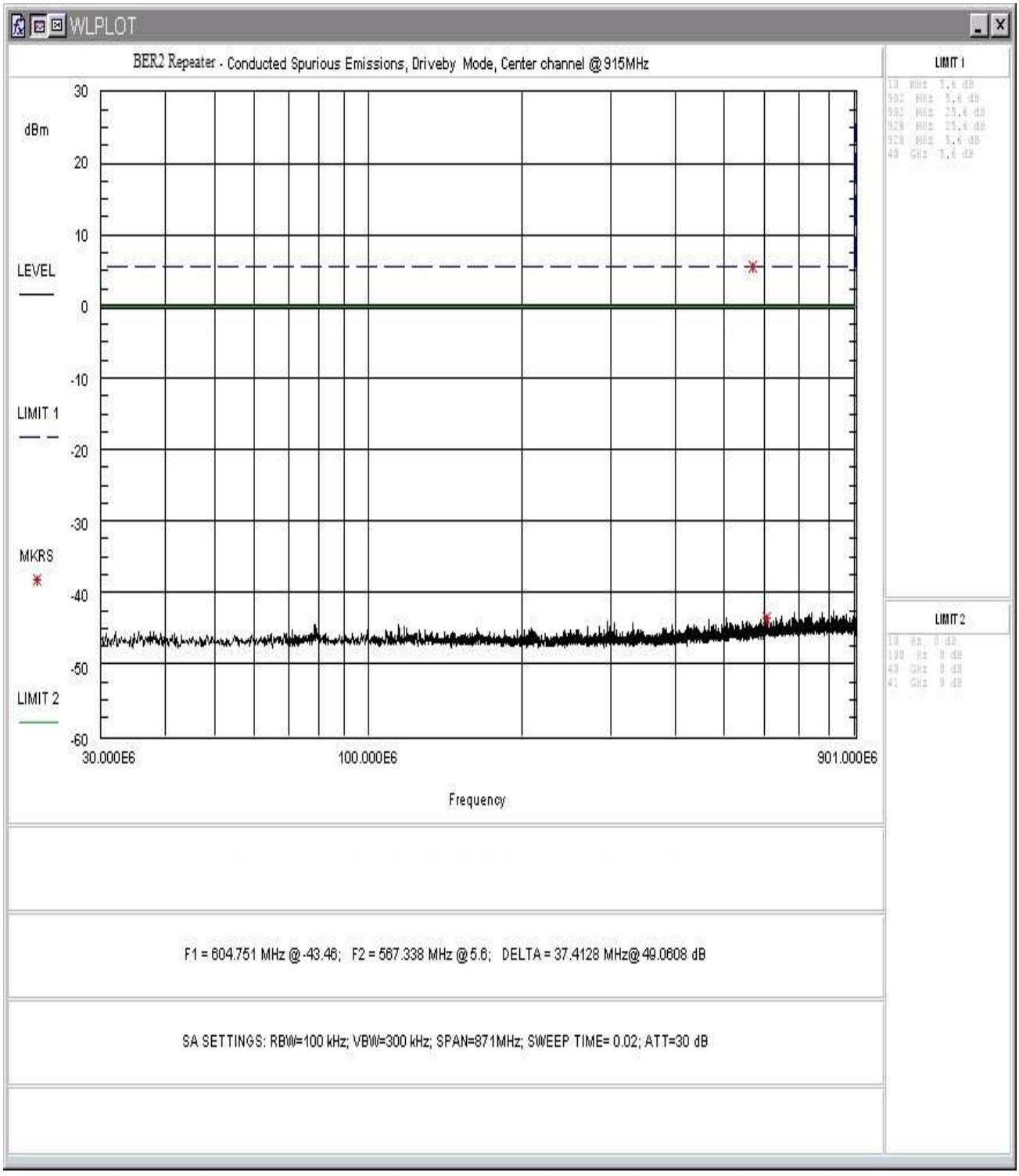

Figure 37. Conducted Spurious Emissions, Drive-by Mode, Center Channel 30 - 901MHz

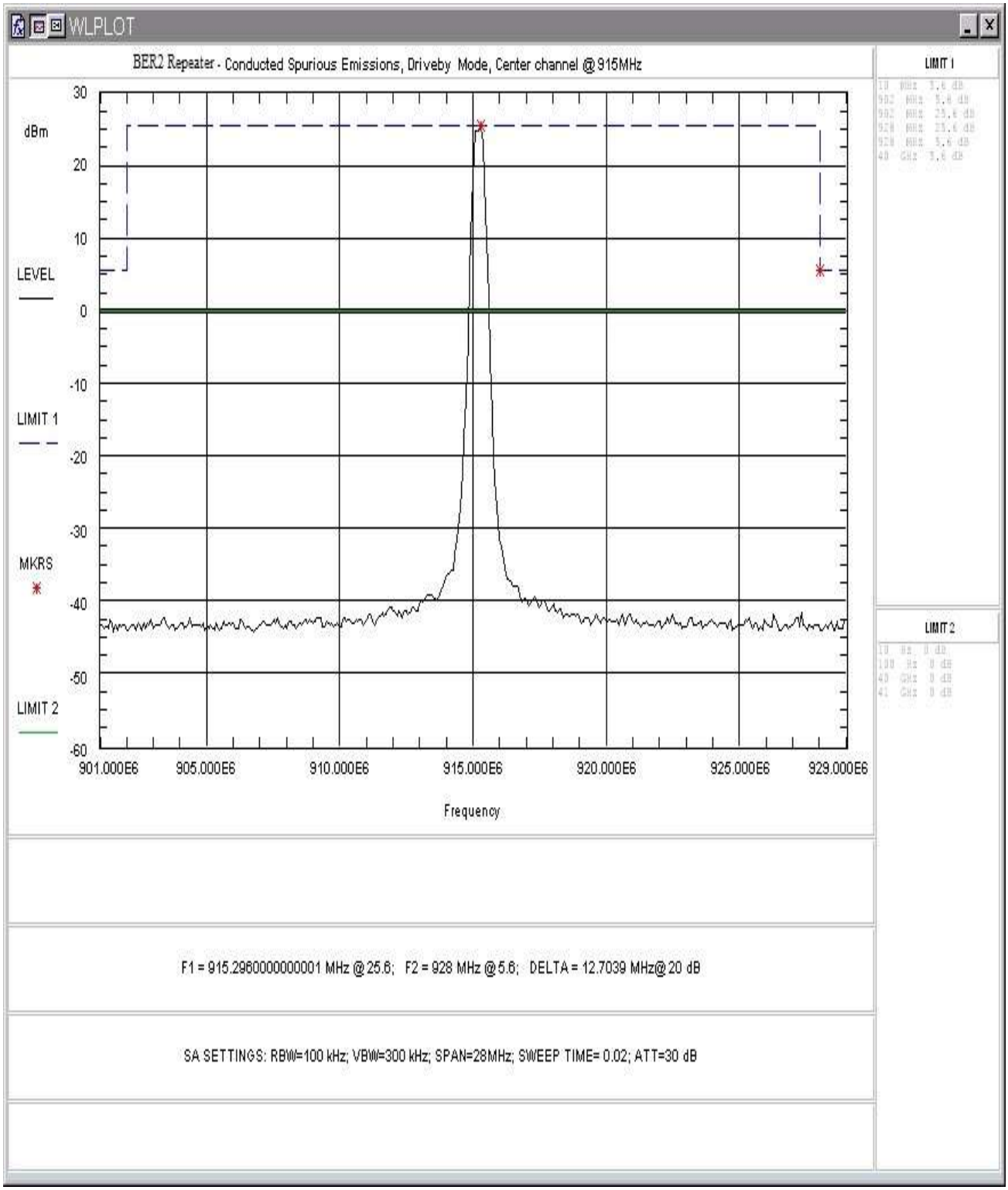

Figure 38. Conducted Spurious Emissions, Drive-by Mode, Center Channel 901-929MHz

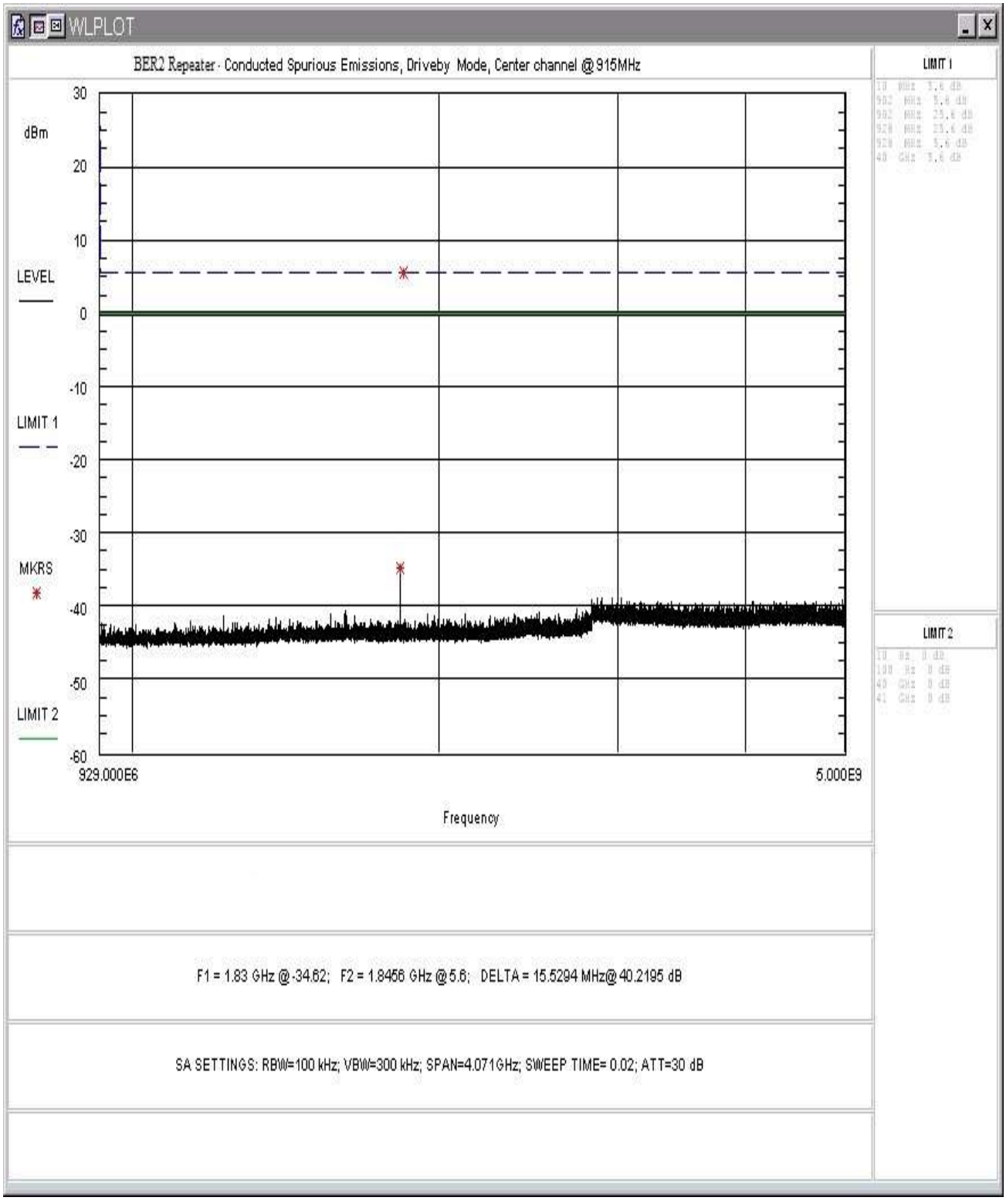

Figure 39. Conducted Spurious Emissions, Drive-by Mode, Center Channel 929-5000MHz

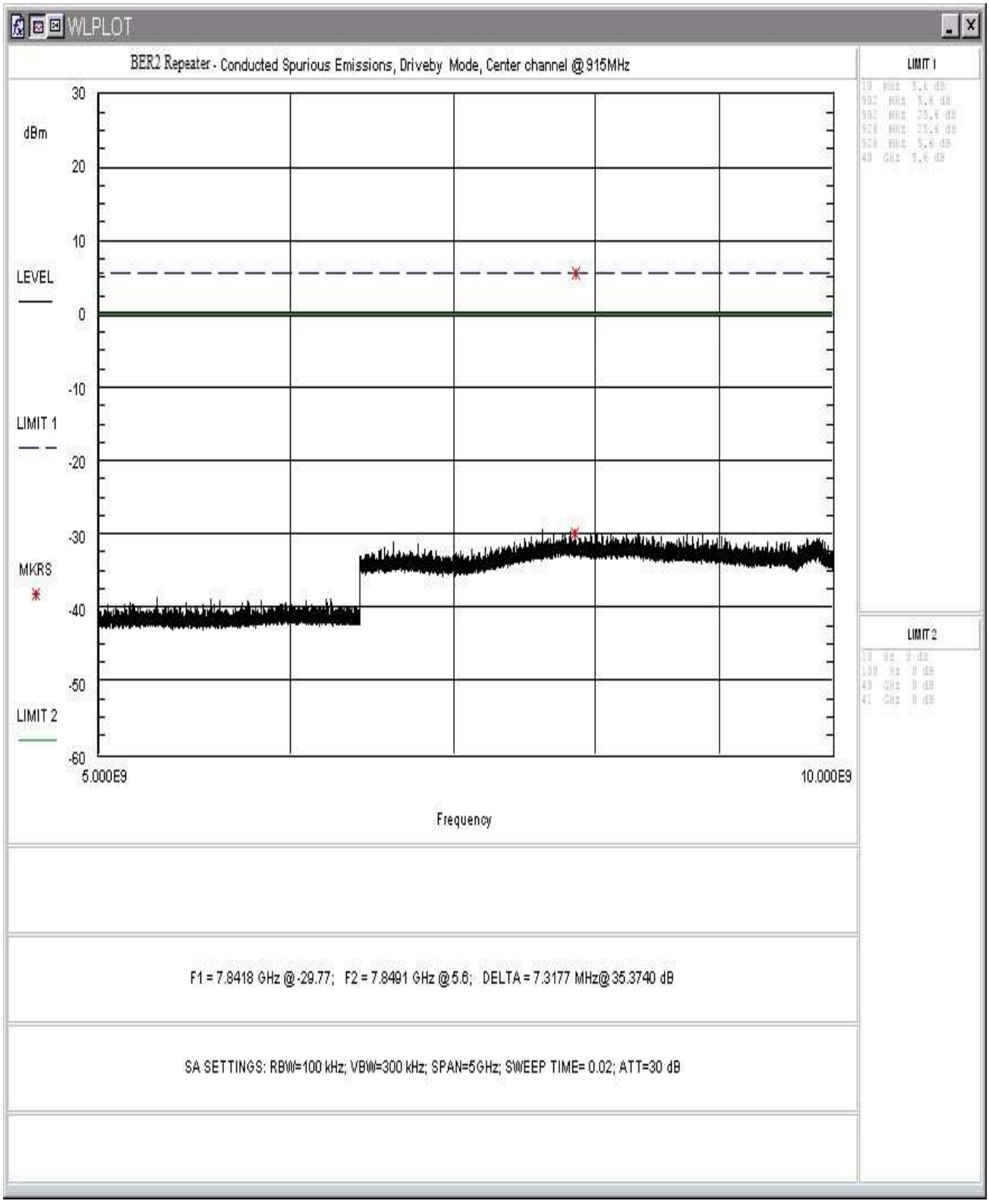

Figure 40. Conducted Spurious Emissions, Drive-by Mode, Center Channel 5-10GHz

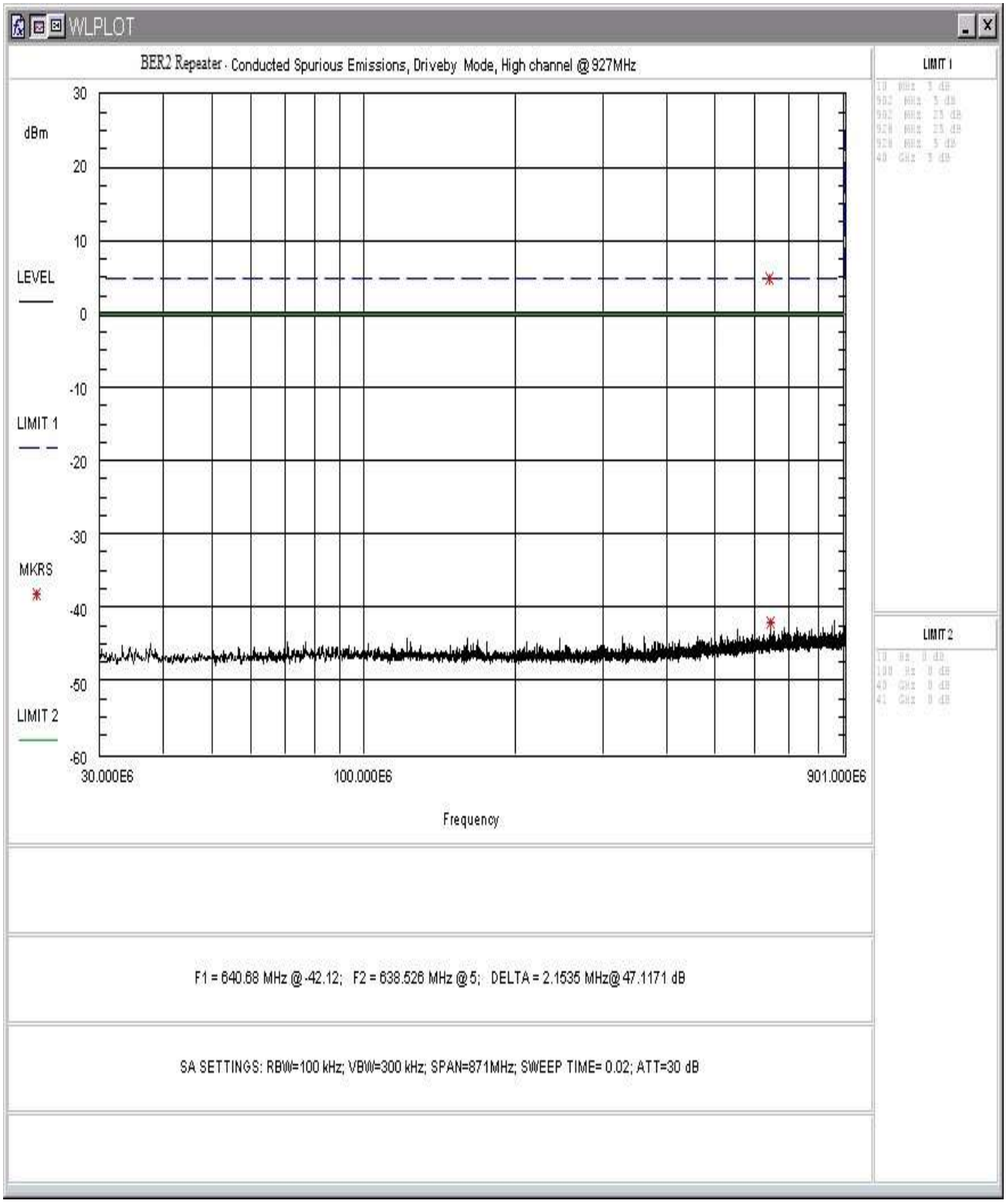

Figure 41. Conducted Spurious Emissions, Drive-by Mode, High Channel 30-901MHz

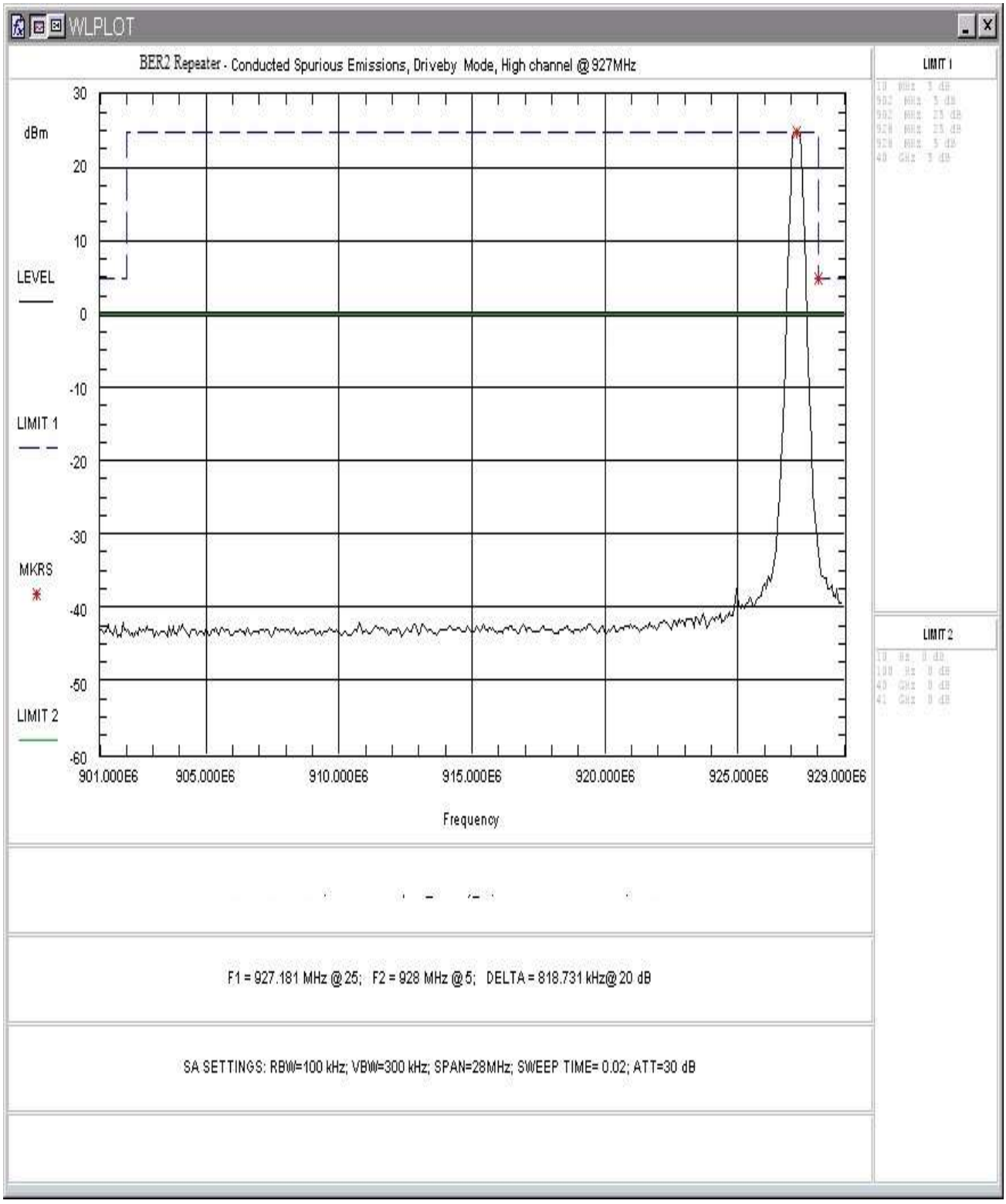

Figure 42. Conducted Spurious Emissions, Drive-by Mode, High Channel 901-929MHz

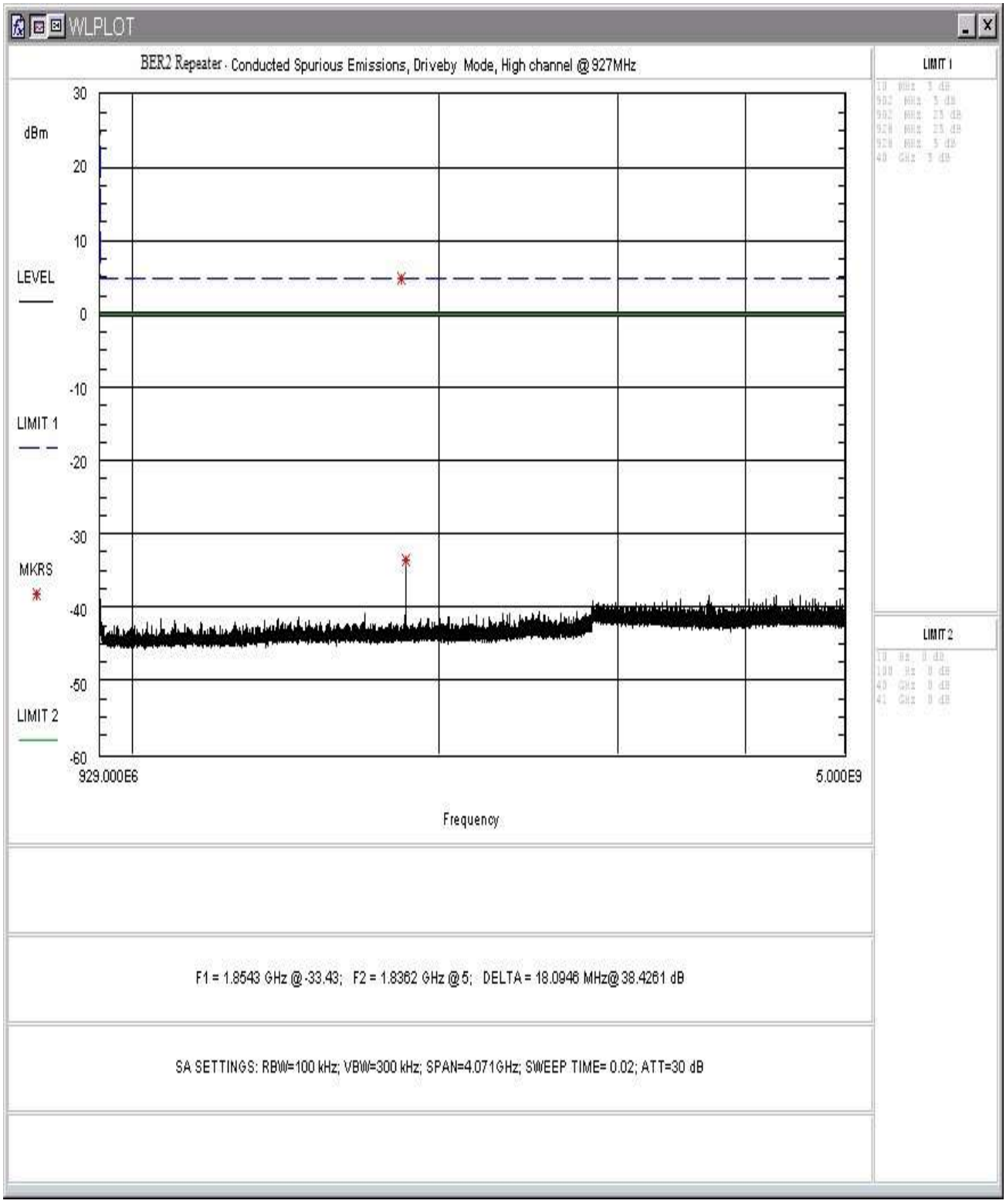

Figure 43. Conducted Spurious Emissions, Drive-by Mode, High Channel 929-5000MHz

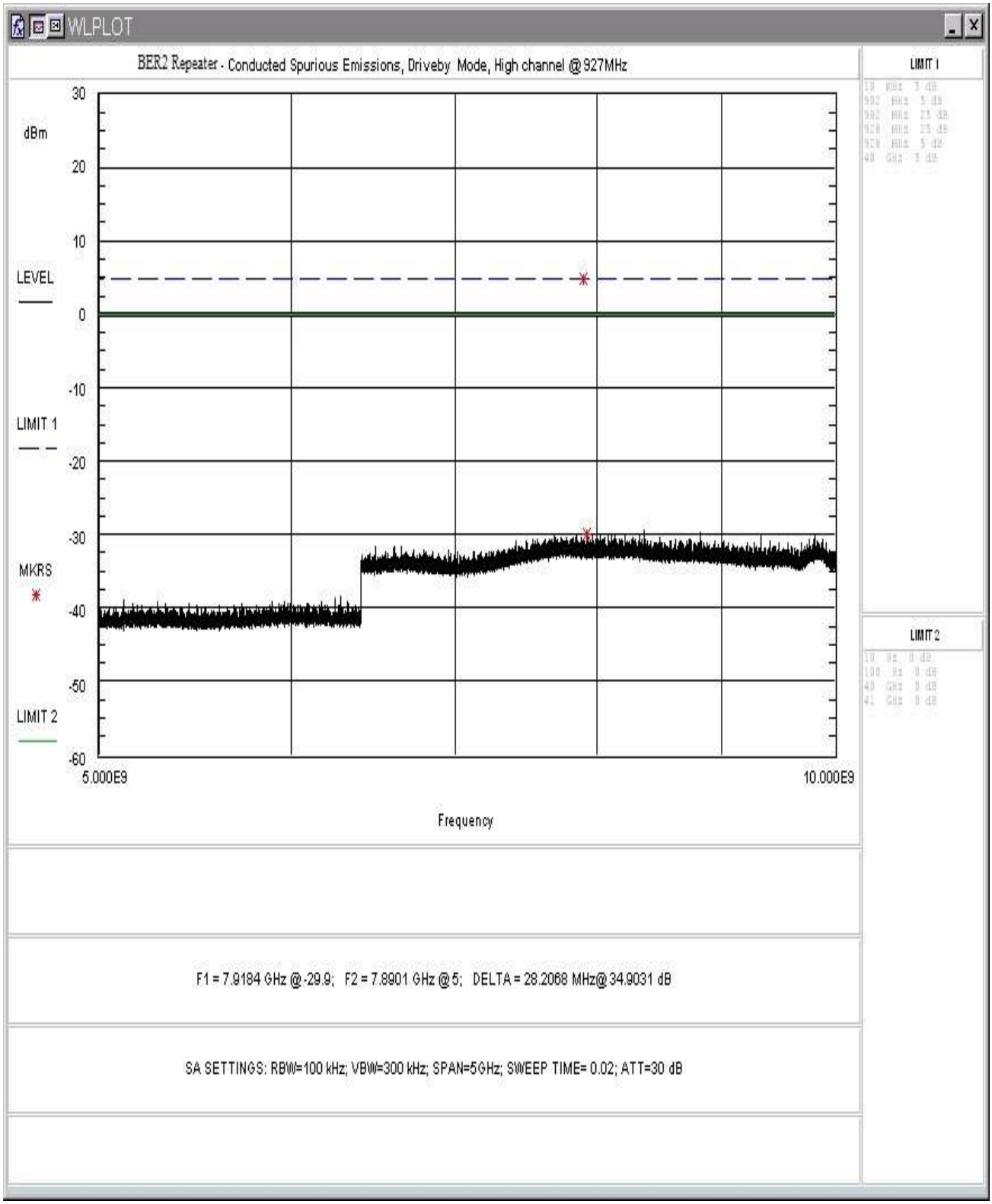

Figure 44. Conducted Spurious Emissions, Drive-by Mode, High Channel 5-10GHz

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.

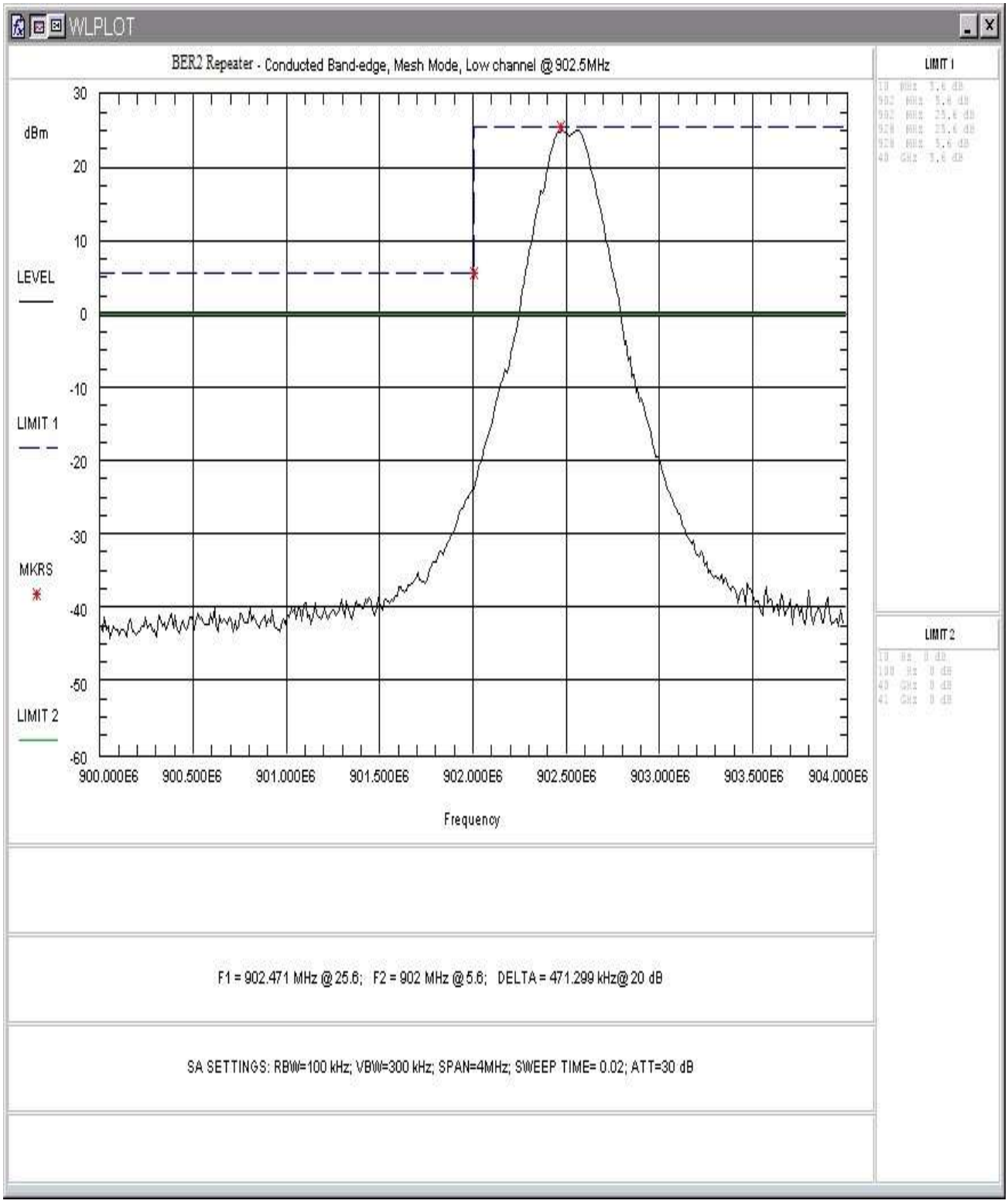

Figure 45. Conducted Lower Band-edge, Mesh Mode, Low Channel

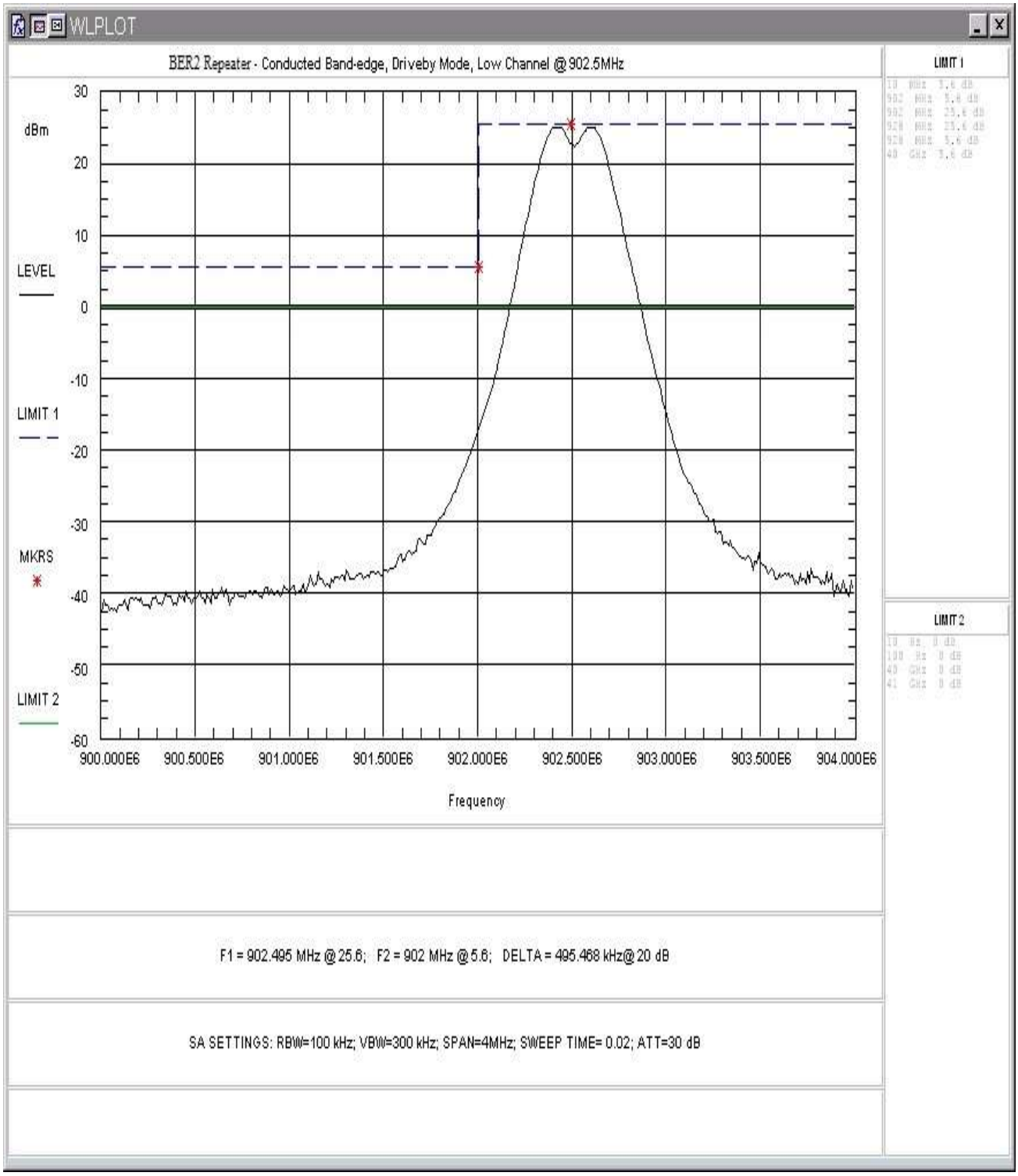

Figure 46. Conducted Lower Band-edge, Drive-by Mode, Low Channel

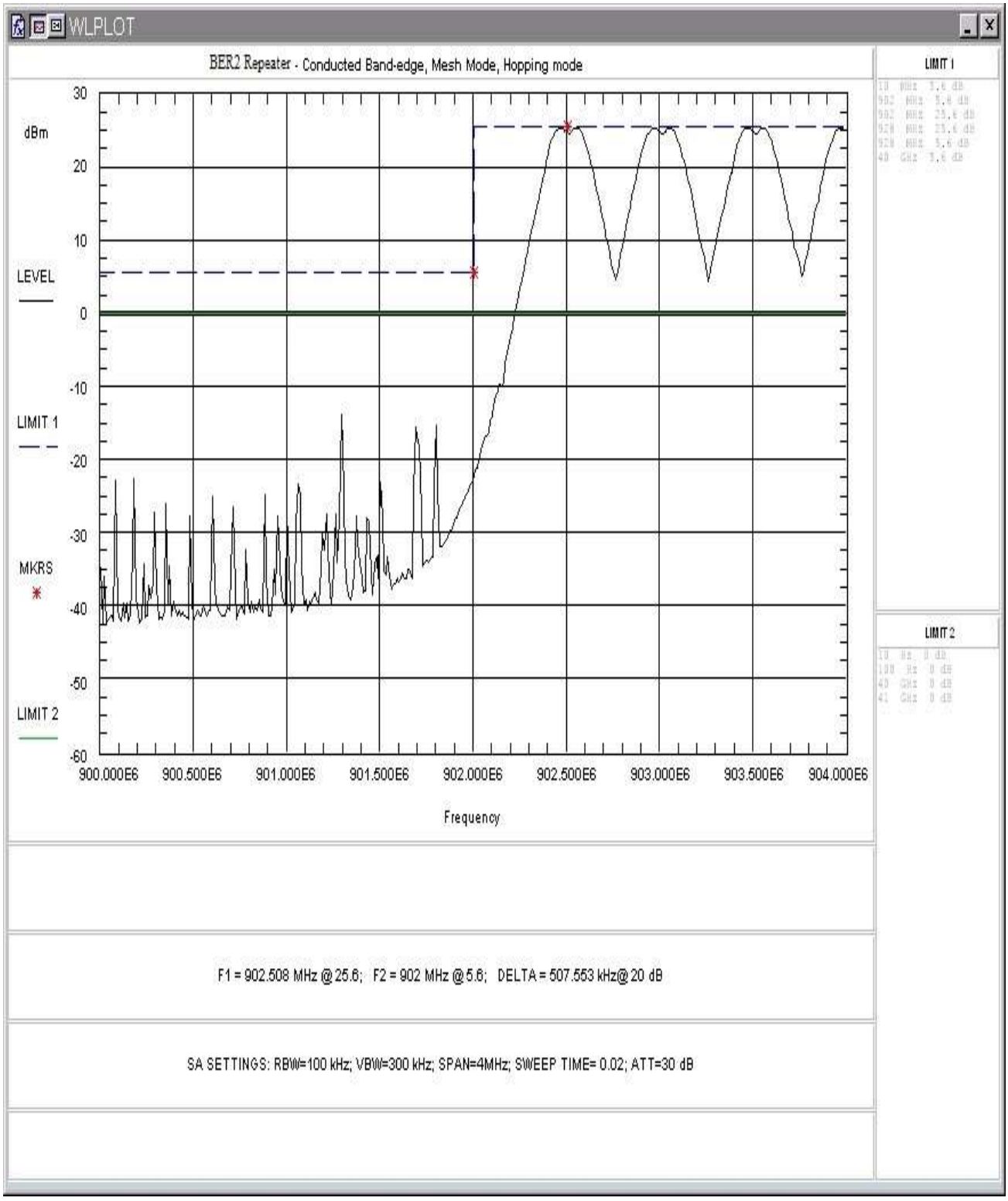

Figure 47. Conducted Lower Band-edge, Mesh Mode, Hopping

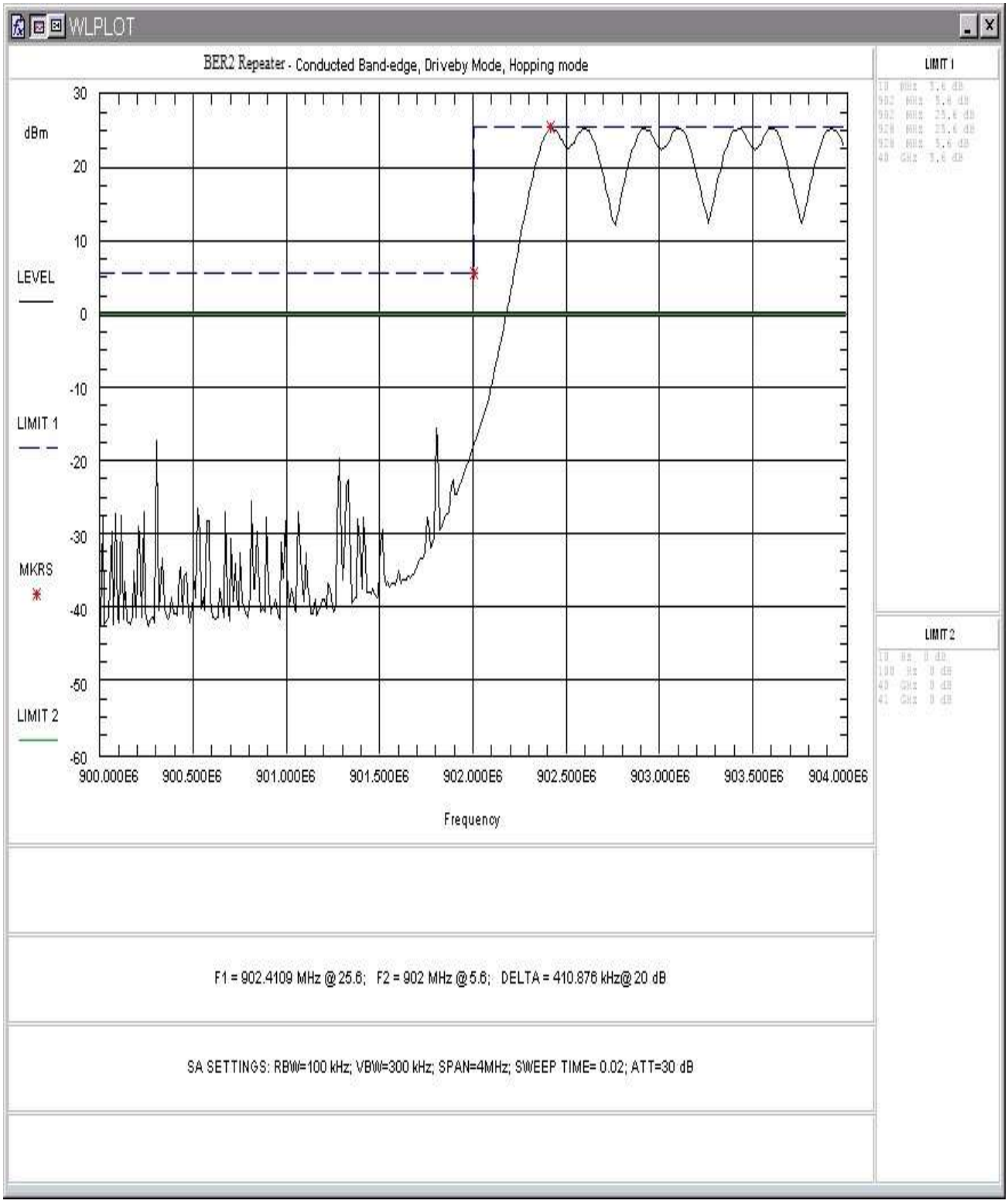

Figure 48. Conducted Lower Band-edge, Drive-by Mode, Hopping

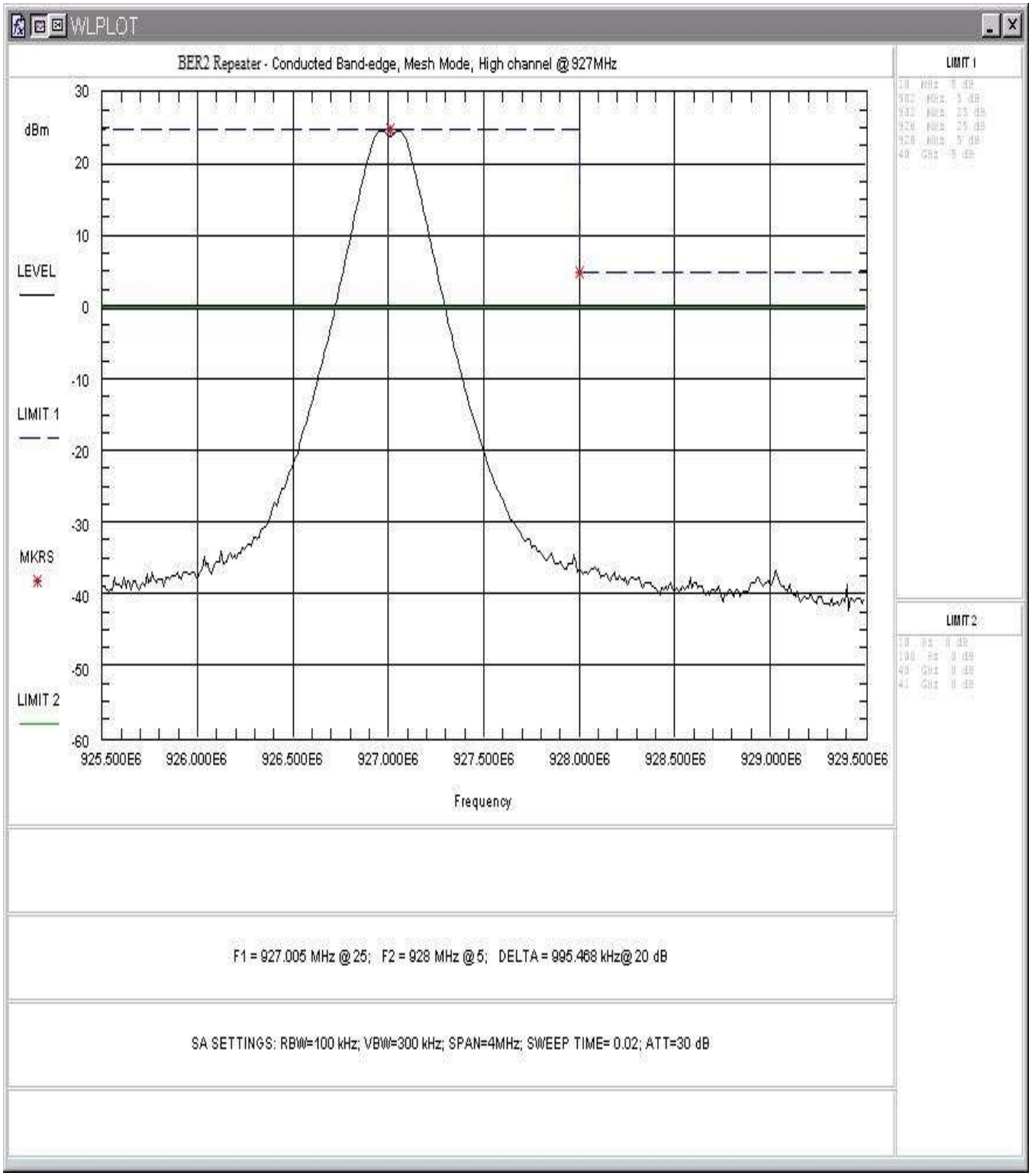

Figure 49. Conducted Upper Band-edge, Mesh Mode, High Channel

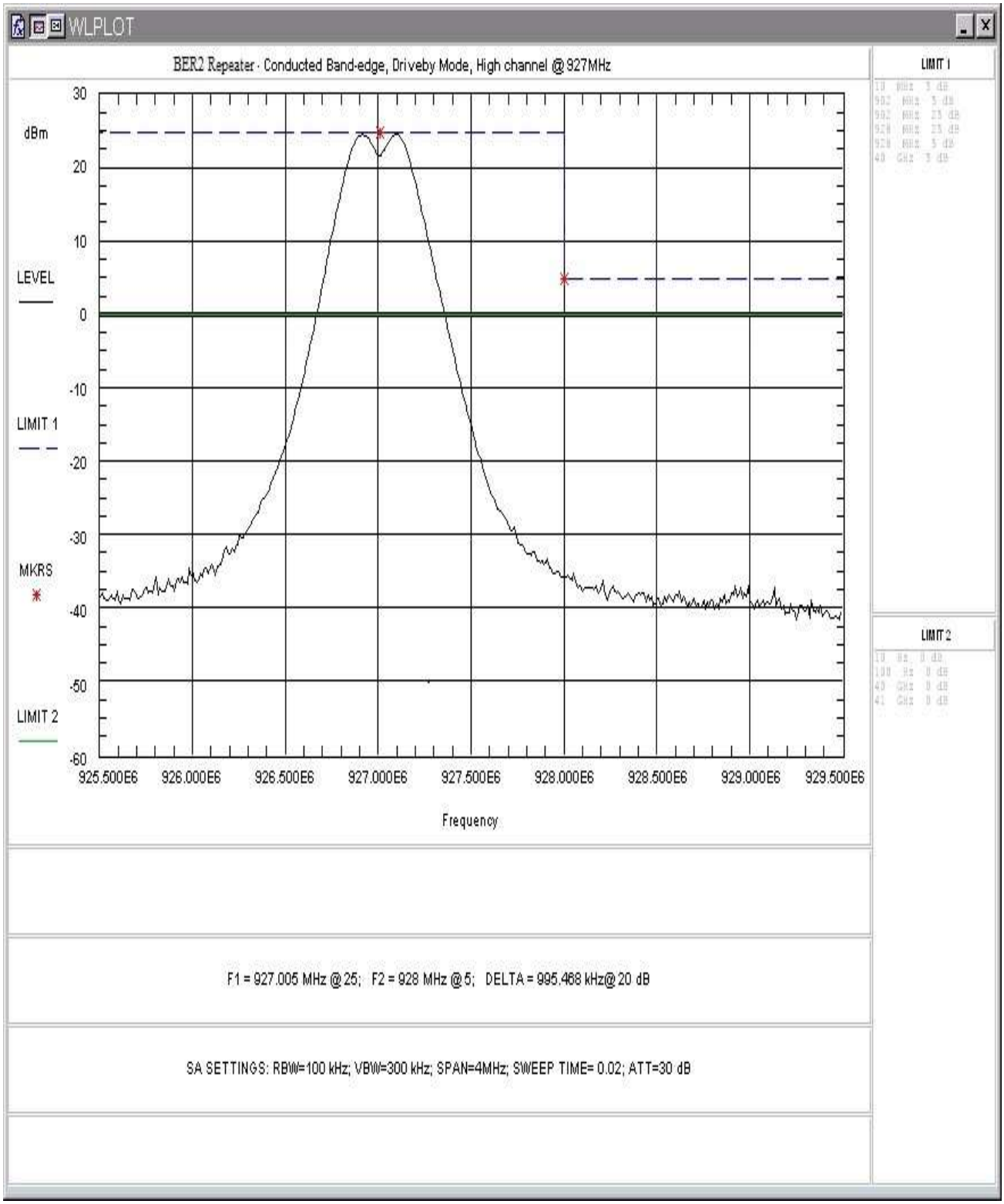

Figure 50. Conducted Upper Band-edge, Drive-by Mode, High Channel

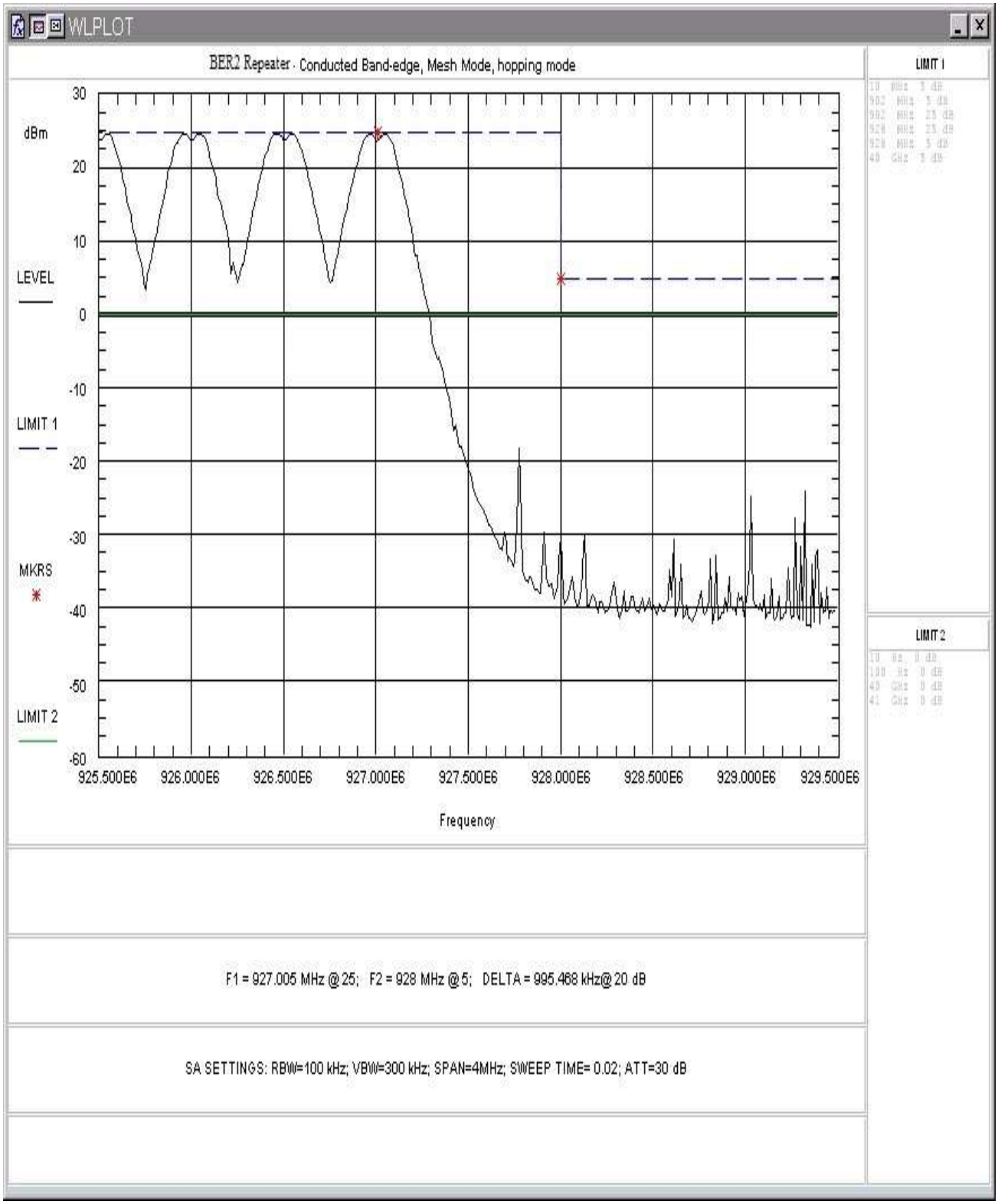

Figure 51. Conducted Upper Band-edge, Mesh Mode, Hopping

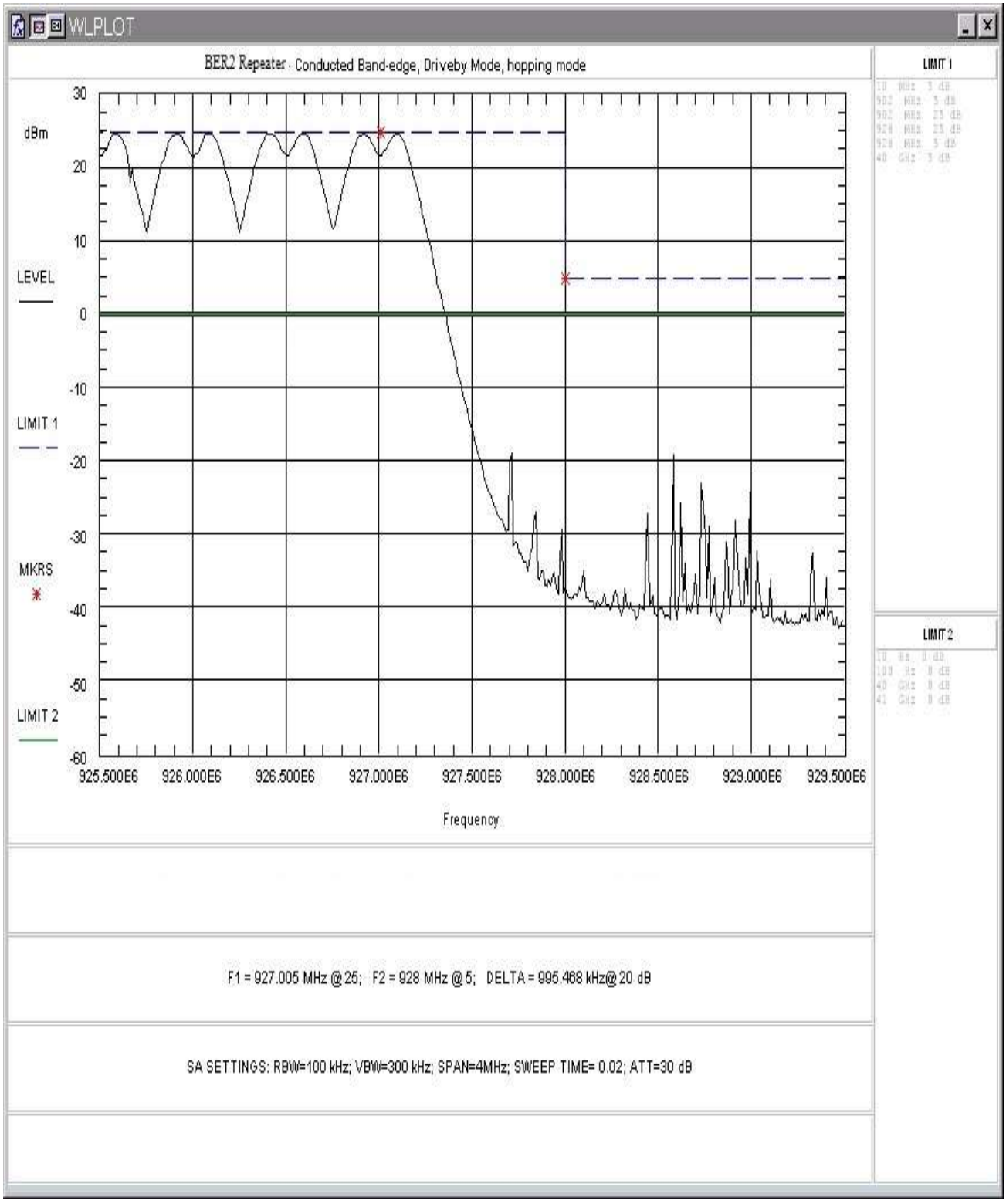

Figure 52. Conducted Upper Band-edge, Drive-by Mode, Hopping

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 emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>120 kHz
>1000 MHz	1 MHz	10 Hz (Avg.) 1MHz (Peak)

Table 7: Radiated Emission Test Data (Restricted Bands) <1GHz

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
127.47	V	45.00	1.15	6.50	15.4	12.5	150.0	-21.6	
256.03	V	200.00	2.45	8.90	14.2	14.3	200.0	-22.9	
273.10	V	45.00	1.59	5.80	15.9	12.2	200.0	-24.3	
400.00	V	180.00	2.12	5.10	19.2	16.4	200.0	-21.7	
73.00	H	50.00	4.00	6.50	9.2	6.1	100.0	-24.3	
127.47	H	65.00	3.80	5.20	15.4	10.8	150.0	-22.9	
400.00	H	270.00	2.12	4.90	19.2	16.0	200.0	-21.9	

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

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
TX = 902.5									
2707.50	V	270.00	2.45	41.83	-3.2	85.5	5000.0	-35.3	Peak
3610.00	V	270.00	2.79	44.61	-1.5	143.2	5000.0	-30.9	Peak
4512.50	V	0.00	2.86	44.63	1.1	194.2	5000.0	-28.2	Peak
5415.00	V	45.00	3.19	45.17	4.2	294.7	5000.0	-24.6	Peak
8122.50	V	270.00	3.10	44.30	8.1	415.4	5000.0	-21.6	Peak
9025.00	V	290.00	3.13	41.33	10.5	388.5	5000.0	-22.2	Peak
2707.50	V	270.00	2.45	30.67	-3.2	23.7	500.0	-26.5	Average
3610.00	V	270.00	2.79	34.00	-1.5	42.2	500.0	-21.5	Average
4512.50	V	0.00	2.86	33.33	1.1	52.9	500.0	-19.5	Average
5415.00	V	45.00	3.19	33.67	4.2	78.4	500.0	-16.1	Average
8122.50	V	270.00	3.10	33.00	8.1	113.1	500.0	-12.9	Average
9025.00	V	290.00	3.13	32.90	10.5	147.2	500.0	-10.6	Average
2707.50	H	90.00	2.92	46.66	-3.2	149.1	5000.0	-30.5	Peak
3610.00	H	270.00	2.80	46.50	-1.5	178.0	5000.0	-29.0	Peak
4512.50	H	90.00	2.65	45.00	1.1	202.6	5000.0	-27.8	Peak
5415.00	H	0.00	2.68	45.10	4.2	292.4	5000.0	-24.7	Peak
8122.50	H	240.00	3.23	45.67	8.1	486.4	5000.0	-20.2	Peak
9025.00	H	190.00	3.19	47.33	10.5	775.1	5000.0	-16.2	Peak
2707.50	H	90.00	2.92	35.83	-3.2	42.9	500.0	-21.3	Average
3610.00	H	270.00	2.80	37.67	-1.5	64.4	500.0	-17.8	Average
4512.50	H	90.00	2.65	32.34	1.1	47.2	500.0	-20.5	Average
5415.00	H	0.00	2.68	33.60	4.2	77.8	500.0	-16.2	Average
8122.50	H	240.00	3.23	32.80	8.1	110.5	500.0	-13.1	Average
9025.00	H	90.00	3.08	32.17	10.5	135.3	500.0	-11.4	Average

Table 9: Radiated Emission Test Data (Restricted Bands), Center Channel

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
TX = 915.00	V								
2745.00	V	90.00	2.76	48.50	-3.2	183.8	5000.0	-28.7	Peak
3660.00	V	45.00	2.88	45.50	-1.2	164.9	5000.0	-29.6	Peak
4575.00	V	10.00	2.71	43.50	1.0	167.0	5000.0	-29.5	Peak
7320.00	V	10.00	2.74	46.67	8.8	596.1	5000.0	-18.5	Peak
8235.00	V	0.00	3.05	44.17	8.3	418.3	5000.0	-21.5	Peak
9150.00	V	0.00	3.37	43.50	11.0	527.9	5000.0	-19.5	Peak
2745.00	V	90.00	2.76	39.67	-3.2	66.5	500.0	-17.5	Average
3660.00	V	45.00	2.88	34.67	-1.2	47.4	500.0	-20.5	Average
4575.00	V	10.00	2.71	32.50	1.0	47.1	500.0	-20.5	Average
7320.00	V	10.00	2.74	34.67	8.8	149.7	500.0	-10.5	Average
8235.00	V	0.00	3.05	31.83	8.3	101.0	500.0	-13.9	Average
9150.00	V	0.00	3.37	33.50	11.0	166.9	500.0	-9.5	Average
2745.00	H	80.00	2.94	47.67	-3.2	167.1	5000.0	-29.5	Peak
3660.00	H	270.00	3.27	46.83	-1.2	192.2	5000.0	-28.3	Peak
4575.00	H	45.00	3.09	44.50	1.0	187.4	5000.0	-28.5	Peak
7320.00	H	10.00	2.58	45.50	8.8	521.0	5000.0	-19.6	Peak
8235.00	H	0.00	2.65	43.50	8.3	387.3	5000.0	-22.2	Peak
9150.00	H	0.00	2.91	45.33	11.0	651.7	5000.0	-17.7	Peak
2745.00	H	80.00	2.94	38.17	-3.2	56.0	500.0	-19.0	Average
3660.00	H	270.00	3.27	36.33	-1.2	57.4	500.0	-18.8	Average
4575.00	H	45.00	3.09	32.83	1.0	48.9	500.0	-20.2	Average
7320.00	H	10.00	2.58	35.67	8.8	168.0	500.0	-9.5	Average
8235.00	H	0.00	2.65	31.67	8.3	99.2	500.0	-14.0	Average
9150.00	H	0.00	2.91	32.33	11.0	145.9	500.0	-10.7	Average

Table 10: Radiated Emission Test Data (Restricted Bands), High Channel

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
TX = 927.00									
2781.00	V	45.00	2.51	47.67	-3.2	166.7	5000.0	-29.5	Peak
3708.00	V	40.00	3.29	46.60	-0.8	194.3	5000.0	-28.2	Peak
4635.00	V	20.00	3.23	45.17	1.2	208.3	5000.0	-27.6	Peak
7416.00	V	45.00	3.21	44.50	8.7	458.9	5000.0	-20.7	Peak
8343.00	V	0.00	2.52	43.67	8.4	399.5	5000.0	-21.9	Peak
2781.00	V	45.00	2.51	38.17	-3.2	55.8	500.0	-19.0	Average
3708.00	V	40.00	3.29	33.50	-0.8	43.0	500.0	-21.3	Average
4635.00	V	20.00	3.23	32.67	1.2	49.4	500.0	-20.1	Average
7416.00	V	45.00	3.21	33.00	8.7	122.1	500.0	-12.2	Average
8343.00	V	0.00	2.52	31.17	8.4	94.7	500.0	-14.4	Average
2781.00	H	0.00	2.43	48.17	-3.2	176.6	5000.0	-29.0	Peak
3708.00	H	90.00	2.65	44.83	-0.8	158.5	5000.0	-30.0	Peak
4635.00	H	45.00	2.64	43.50	1.2	171.9	5000.0	-29.3	Peak
7416.00	H	10.00	2.98	45.50	8.7	514.9	5000.0	-19.7	Peak
8343.00	H	180.00	3.04	42.67	8.4	356.1	5000.0	-22.9	Peak
2781.00	H	0.00	2.43	37.83	-3.2	53.7	500.0	-19.4	Average
3708.00	H	90.00	2.65	32.83	-0.8	39.8	500.0	-22.0	Average
4635.00	H	45.00	2.64	32.60	1.2	49.0	500.0	-20.2	Average
7416.00	H	10.00	2.98	34.33	8.7	142.3	500.0	-10.9	Average
8343.00	H	180.00	3.04	31.00	8.4	92.9	500.0	-14.6	Average

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 requirements of FCC Part 15 (10/2012) call for the EUT to be 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.

5.7.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 11 provides the test results for phase and neutral line power line conducted emissions.

The EUT was powered via a USB cable through an AC to USB adaptor (Barnes & Noble, model number BNRP5-850) and the EUT was set to transmit at 902.5MHz.

5.7.4 Conducted Data Reduction and Reporting

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

Table 11: Conducted Emission Test Data

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)
0.494	26.0	6.1	10.2	0.4	36.6	16.7	56.1	46.1	-19.5	-29.4
0.150	27.4	10.9	10.2	0.2	37.8	21.3	66.0	56.0	-28.2	-34.7
0.295	20.7	4.1	10.2	0.3	31.2	14.6	60.4	50.4	-29.2	-35.8
4.515	15.4	3.9	10.6	0.1	26.1	14.6	56.0	46.0	-29.9	-31.4
9.340	20.2	7.8	11.1	0.2	31.5	19.1	60.0	50.0	-28.5	-30.9
24.360	22.7	8.3	11.6	1.5	35.9	21.5	60.0	50.0	-24.1	-28.5

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)
0.496	25.0	5.8	10.2	0.1	35.3	16.1	56.1	46.1	-20.7	-29.9
0.150	22.7	11.3	10.2	0.3	33.1	21.7	66.0	56.0	-32.9	-34.3
0.235	16.8	6.6	10.2	0.4	27.3	17.1	62.3	52.3	-34.9	-35.1
4.520	14.0	1.1	10.6	0.1	24.7	11.8	56.0	46.0	-31.3	-34.2
8.375	20.2	5.5	11.0	0.3	31.5	16.8	60.0	50.0	-28.5	-33.2
25.020	22.7	6.5	11.7	1.8	36.1	19.9	60.0	50.0	-23.9	-30.1