*FCC & IC Certification Test Report*

# FCC & Industry Canada Certification Test Report

# for

# Symbol Technologies Inc.

# MR100 Modular Transceiver

# FCC ID: HP9MR100A

# IC ID: 1549D-MR100A

**February 14, 2004**

Prepared for:

**Symbol Technologies Inc.**
**One Symbol Plaza**
**Holtsville, NY 11742**

Prepared By:

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

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# Symbol Technologies Inc.
# MR100 Modular RFID Transceiver
# FCC ID: HP9MR100A
# IC ID: 1549D-MR100A

**February 14, 2004**

WLL JOB# 8355/6

Prepared by: Brian J. Dettling
Documentation Specialist

Reviewed by: Gregory M. Snyder
Chief EMC Engineer

# Abstract

This report has been prepared on behalf of Symbol Technologies Inc. to support the attached Application for Equipment Authorization. Symbol Technologies request modular approval of the MR100. The test report and application are submitted for a modular Frequency Hopping Spread Spectrum Transmitter under Part 15.247 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 of Industry Canada. This Certification Test Report documents the test configuration and test results for a Symbol Technologies Inc. MR100 RFID Transceiver.

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 NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

The Symbol Technologies Inc. MR100 RFID Transceiver module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

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# 1 Introduction

## 1.1 Compliance Statement

The Symbol Technologies Inc. MR100 RFID Transceiver module complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

## 1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with FCC Public Notice DA 00-705 and the 2001 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

## 1.3 Contract Information

| | |
|---|---|
| Customer: | Symbol Technologies Inc.<br>One Symbol Plaza<br>Holtsville, NY 11742 |
| Quotation Number: | 61906 |

## 1.4 Test Dates

Testing was performed from September 22, 2004 to November 17, 2004.

## 1.5 Test and Support Personnel

| | |
|---|---|
| Washington Laboratories, LTD | Greg Snyder, James Ritter |
| Client Representative | Albert Owens |

## 1.6 Abbreviations

| | |
|---|---|
| A | Ampere |
| Ac | alternating current |
| AM | Amplitude Modulation |
| Amps | Amperes |
| b/s | bits per second |
| BW | Bandwidth |
| CE | Conducted Emission |
| Cm | Centimeter |
| CW | Continuous Wave |
| dB | Decibel |
| Dc | direct current |
| EMI | Electromagnetic Interference |
| EUT | Equipment Under Test |
| FM | Frequency Modulation |
| G | giga - prefix for $10^9$ multiplier |
| Hz | Hertz |
| IF | Intermediate Frequency |
| K | kilo - prefix for $10^3$ multiplier |
| M | Mega - prefix for $10^6$ multiplier |
| M | Meter |
| μ | micro - prefix for $10^{-6}$ multiplier |
| NB | Narrowband |
| LISN | Line Impedance Stabilization Network |
| RE | Radiated Emissions |
| RF | Radio Frequency |
| Rms | root-mean-square |
| SN | Serial Number |
| S/A | Spectrum Analyzer |
| V | Volt |

# 2 Equipment Under Test

## 2.1 EUT Identification & Description

The Symbol Technologies Inc. MR100 RFID Transceiver module is a single port Reader designed for embedded applications, such as RFID printers, handhelds and applicators. The unit has adjustable output power from 15dBm to 30dBm.

**Table 1. Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Symbol Technologies Inc. |
| FCC ID: | HP9MR100A |
| IC: | 1549D-MR100A |
| EUT Name: | RFID Transceiver |
| Model: | MR100 |
| FCC Rule Parts: | §15.247 |
| Industry Canada: | RSS210 |
| Frequency Range: | 902.75 – 927.25 MHz |
| Maximum Output Power: | Adjustable 15dBm to 30dBm (0.032 Watt to 1 Watt) |
| Modulation: | FSK |
| Occupied Bandwidth: | 177.25kHz |
| Keying: | Automatic |
| Type of Information: | Data |
| Number of Channels: | 50 |
| Power Output Level | Adjustable |
| Antenna Connector | U.FL |
| Antenna Type | MAXRAD 5.25dBi Patch Antenna |
| Interface Cables: | None (A com port is available for programming the unit) |
| Power Source & Voltage: | 6Vdc provided from a 120Vac adapter |

## 2.2 Test Configuration

The MR100 module was configured with an AC/DC adapter, a support laptop, and an antenna. The antenna was placed on a plastic container raised approximately 5” above the turntable.

## 2.3 Testing Algorithm

The MR100 was programmed for FHSS operation via the support laptop. The computer was used to select the output power, control the frequency hopping or select continuous transmit on a selected channel. The unit was set for maximum data rate.

The antenna was positioned in three orthogonal planes during emissions testing. 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 NIST NVLAP (NVLAP Lab Code: 200066-0) as an independent FCC test laboratory.

## 2.5 Measurements

### 2.5.1 References

FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

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

## 2.6 Measurement Uncertainty

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

The following measurement uncertainty calculation is provided:

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

where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

# 3 Test Equipment

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

**Table 2: Test Equipment List**

| Equipment | WLL Asset # | Calibration Due |
|---|---|---|
| Hewlett-Packard 8568B Spectrum Analyzer | 0073 | 7/08/05 |
| Hewlett-Packard 85650A Quasi-Peak Adapter | 0069 | 7/08/05 |
| Hewlett-Packard 8593A Spectrum Analyzer | 0074 | 8/17/05 |
| Hewlett-Packard 8449B Microwave Preamp | 0312 | 9/29/05 |
| Solar Electronics 8012-50-R-24BNC LISN | 0124 | 12/24/04 |
| ARA LPB-2520 BiconiLog Antenna | 0007 | 9/14/05 |
| ARA DRG118/A Microwave Horn Antenna | 0425 | 4/17/05 |
| Hewlett-Packard 85685A RF Preselector | 0071 | 7/08/05 |
| EMCO 3110B Biconical Antenna | 0026 | 6/22/05 |
| EMCO 3146A Log Periodic Antenna | 0029 | 6/24/05 |

# 4 Test Results

## 4.1 Occupied Bandwidth: (FCC Part §2.1049)

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

For Frequency Hopping Spread Spectrum Systems operating in the 902M – 928MHz band the maximum 20 dB channel bandwidth shall not exceed 500kHz.

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

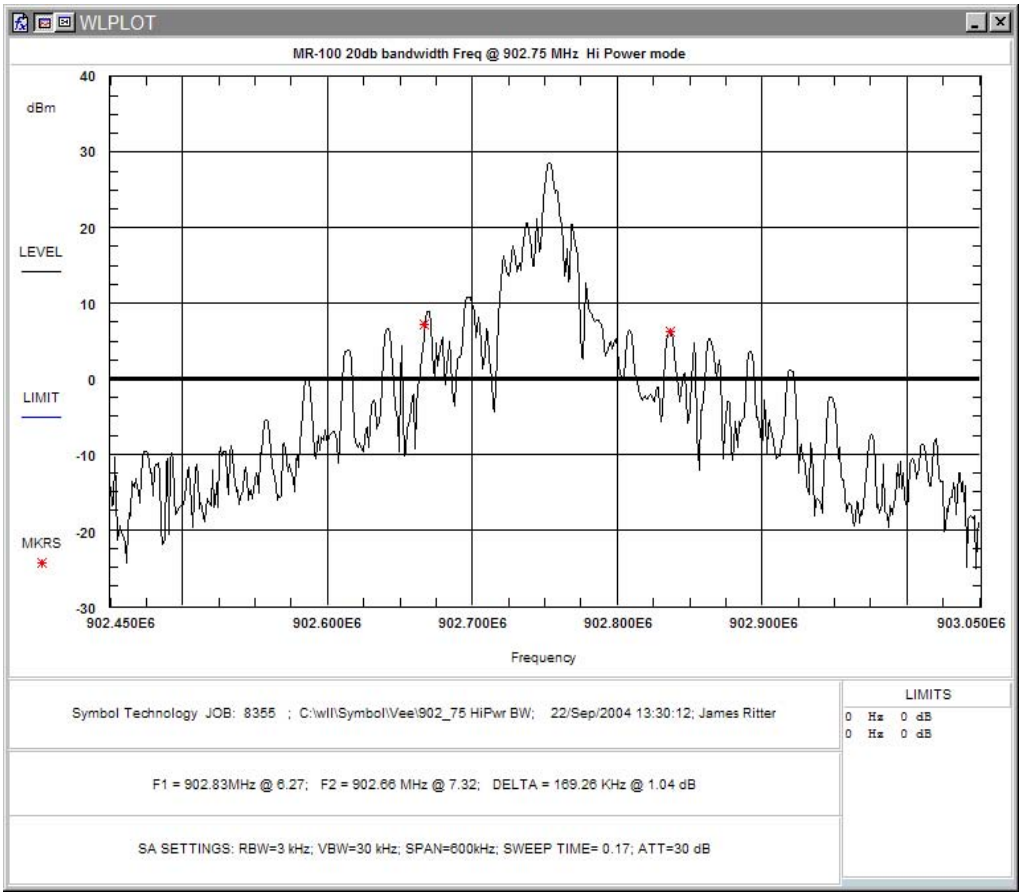


**Figure 4-1. Occupied Bandwidth, Low Channel**

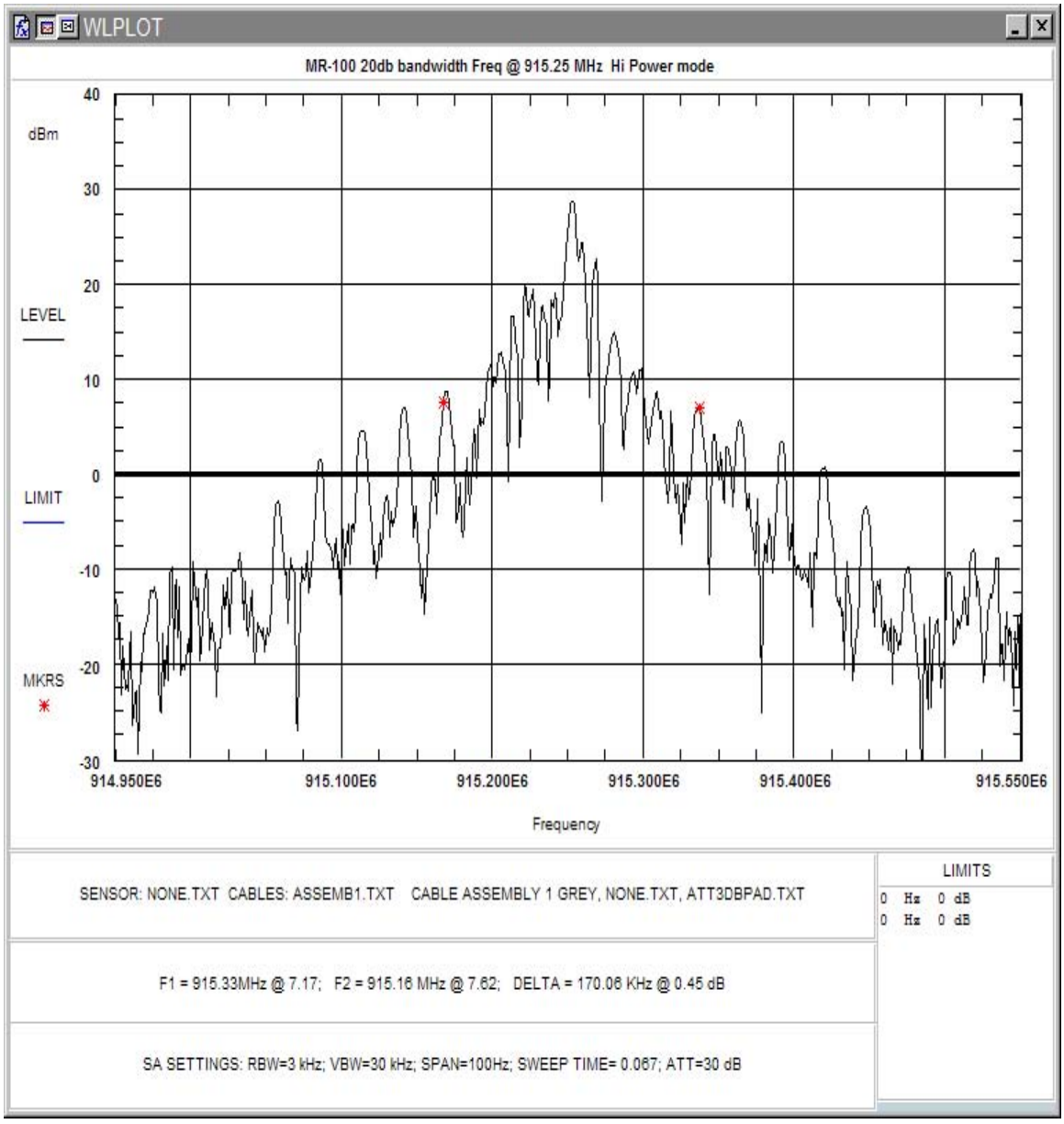


**Figure 4-2. Occupied Bandwidth, Mid Channel**

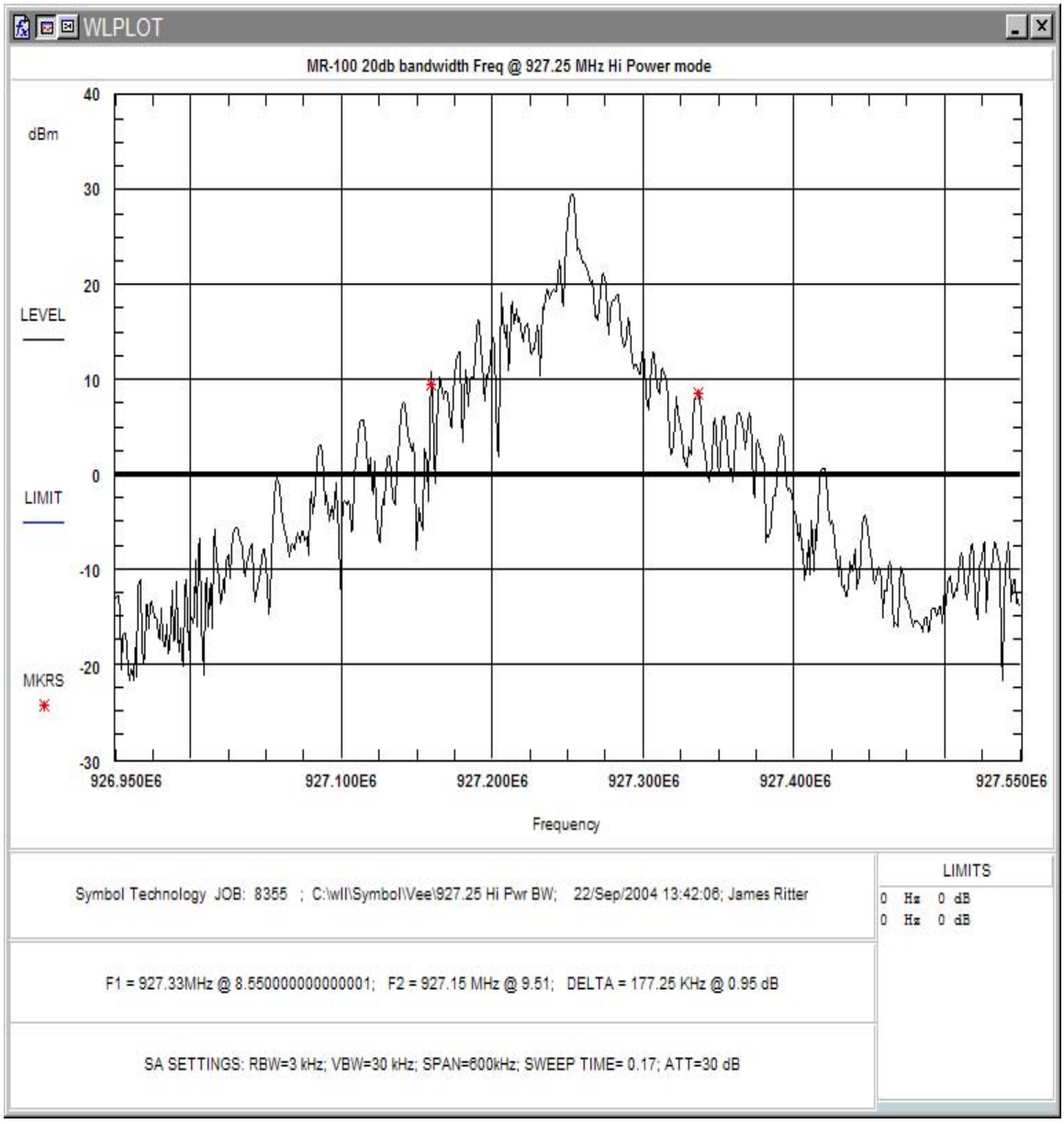


**Figure 4-3. Occupied Bandwidth, High Channel**

Table 3 provides a summary of the Occupied Bandwidth Results.

**Table 3. Occupied Bandwidth Results**

| Frequency | Bandwidth | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel 902.75MHz | 169.26kHz | 500kHz | Pass |
| Mid Channel 915.25MHz | 170.02kHz | 500kHz | Pass |
| High Channel 927.25MHz | 177.25kHz | 500kHz | Pass |

## 4.2 Number of Hopping Frequencies: (FCC Part §15.247(a)(1)(i))

In accordance with §15.247(a)(1)(i) a frequency hopping system in the 902M – 928MHz band with a 20dB bandwidth less than 250kHz shall use at least 50 hopping frequencies.

With the unit set to the hopping mode, the number of hopping frequencies were measured. As shown in Figure 4-4 the unit uses 50 channels.

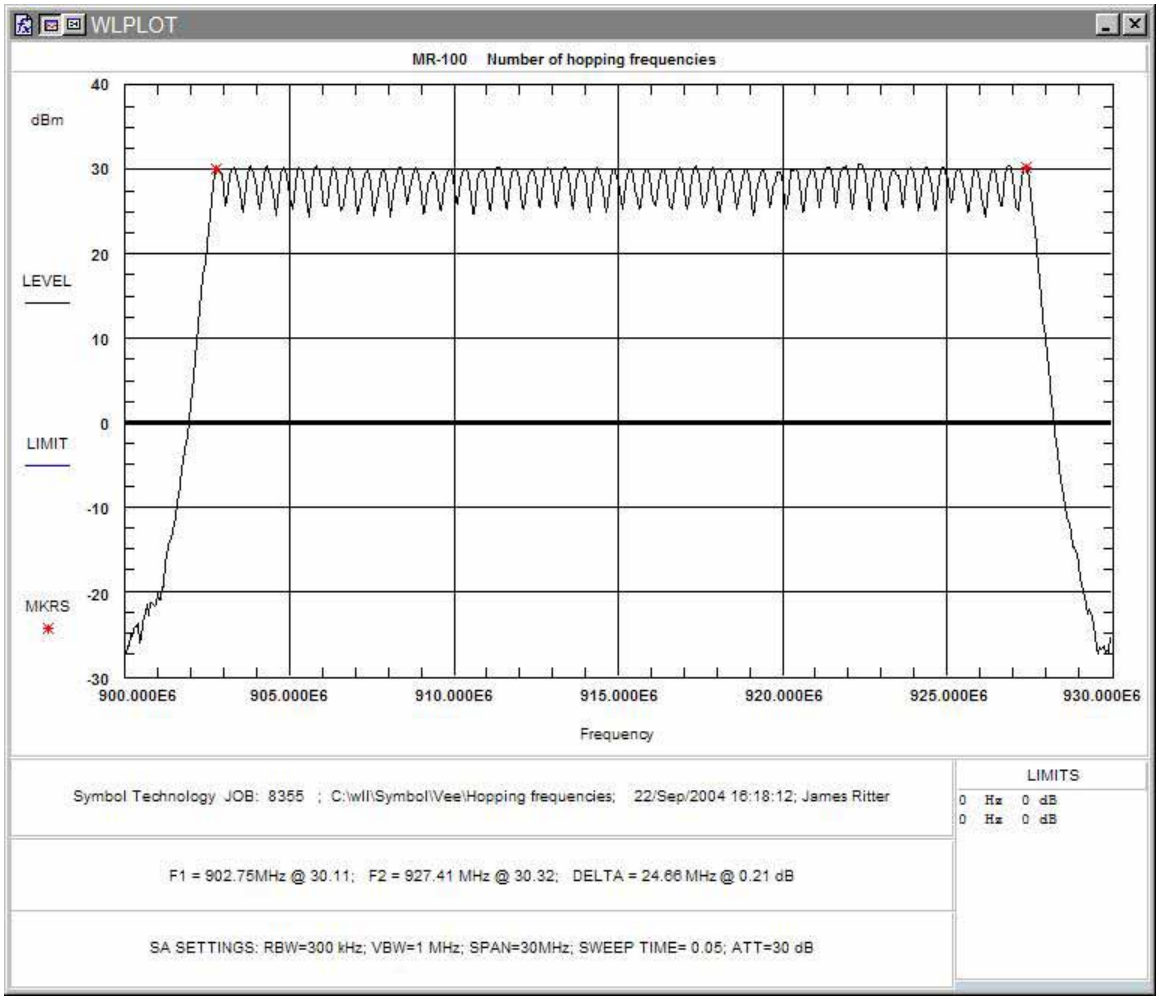


**Figure 4-4. Number of Hopping Channels**

## 4.3 Carrier Frequency Separation: (FCC Part §15.247(a)(1))

In accordance with the FCC Rules a frequency hopping system shall have hopping channel carriers frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

As the maximum 20dB channel bandwidth of the EUT was measured at 177.25kHz the channel spacing must also be greater than 177.25kHz.

Figure 4-5 is a plot of the EUT in the hopping mode which shows the spacing between adjacent channels. The carrier frequency separation was measured at 501.66kHz and therefore is compliant with the requirements.

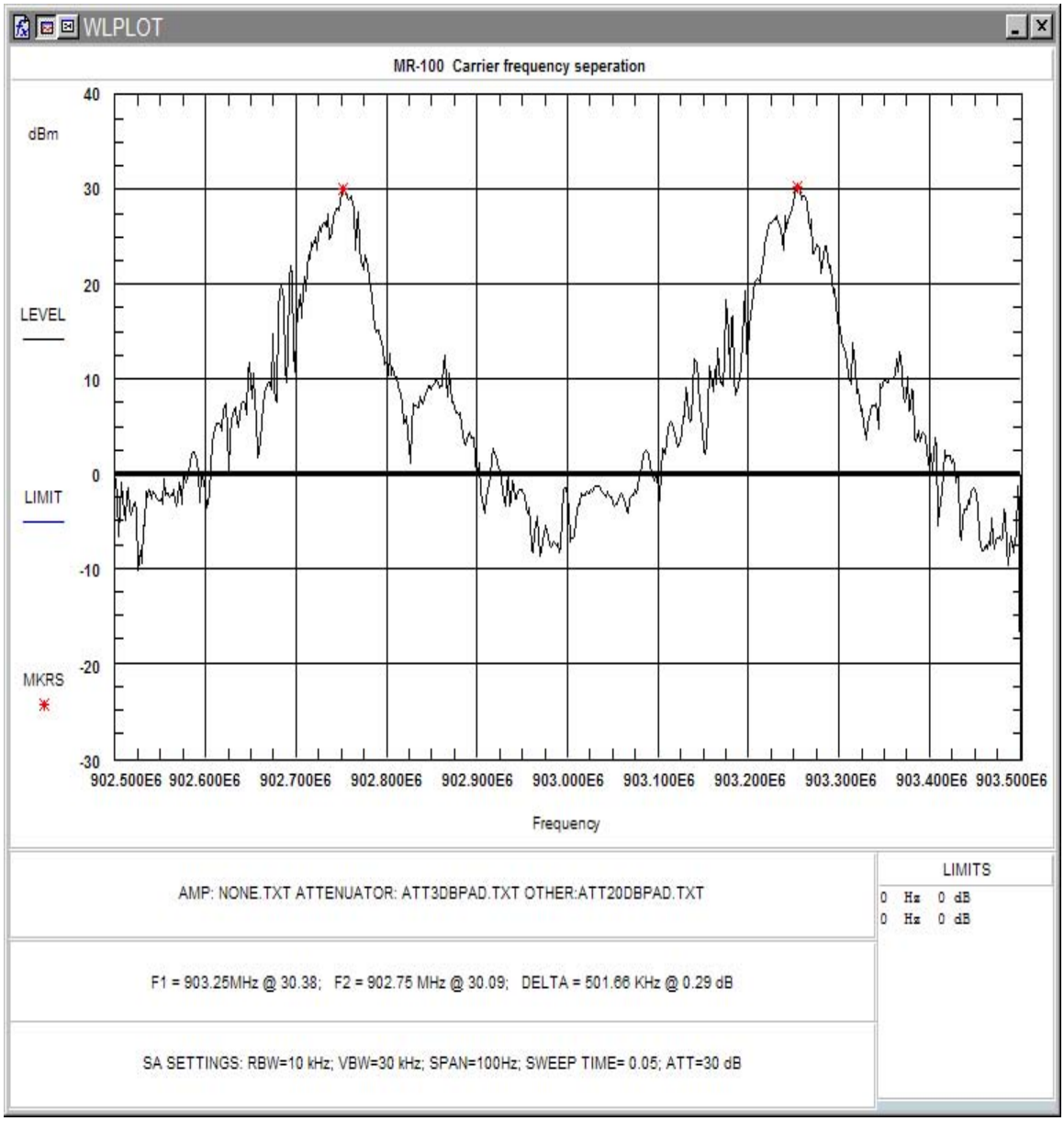


**Figure 4-5. Carrier Frequency Separation**

## 4.4 Time of Occupancy and Duty Cycle Correction: (FCC Part §15.247(a)(1)(i))

Per FCC Part 15.247(a)(1)(i), the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Additionally, 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)

The dwell time of the transmitter was measured and is shown in **Error! Reference source not found.**. Based on this plot the dwell time per hop is 19.15ms. The signal was then observed for a period of 20 seconds to determine the total channel occupancy time. With all channels being used equally Figure 4-7 shows that the channel will used every 1.5 seconds (14 times/20seconds) for a total occupancy time of 257.6ms. Since only one pulse will appear on the channel in any 100ms period, the duty cycle is calculated as:

20 x LOG(19.15ms/100ms) = -14.4dB

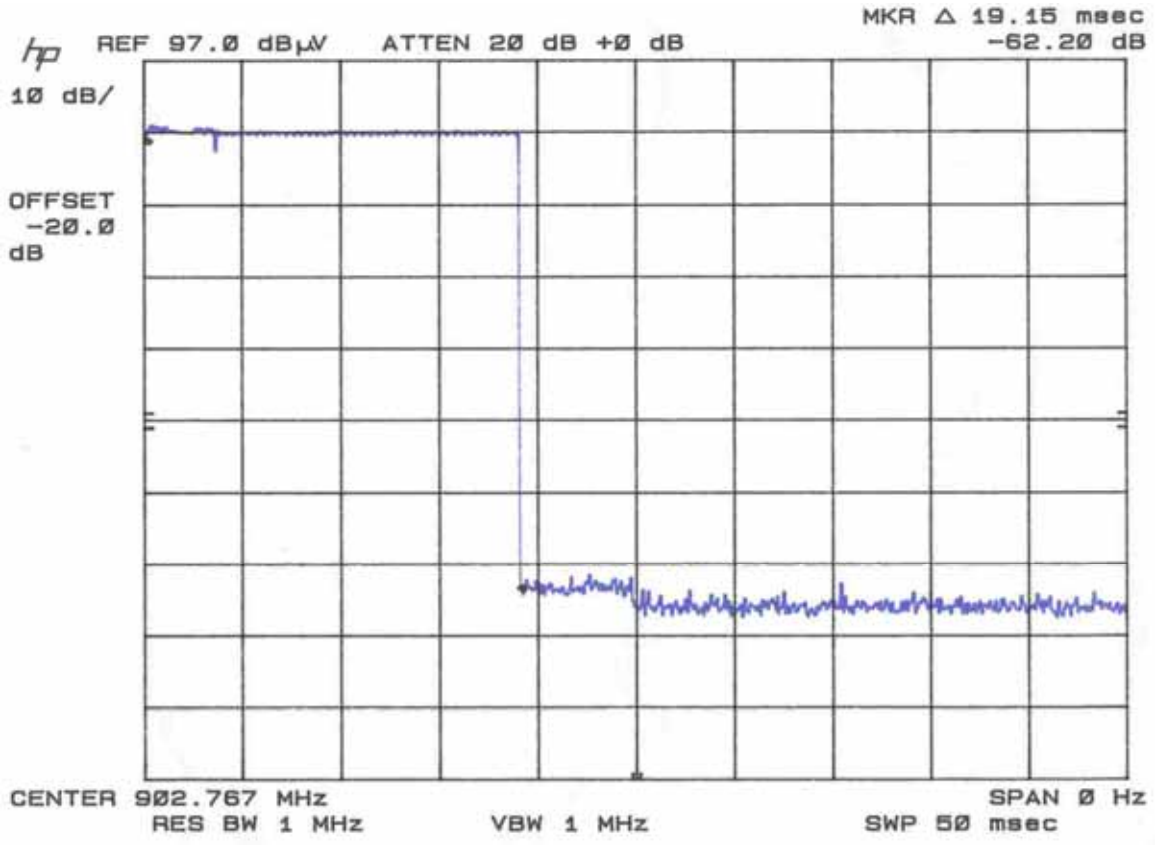


**Figure 4-6. Dwell Time Plot**

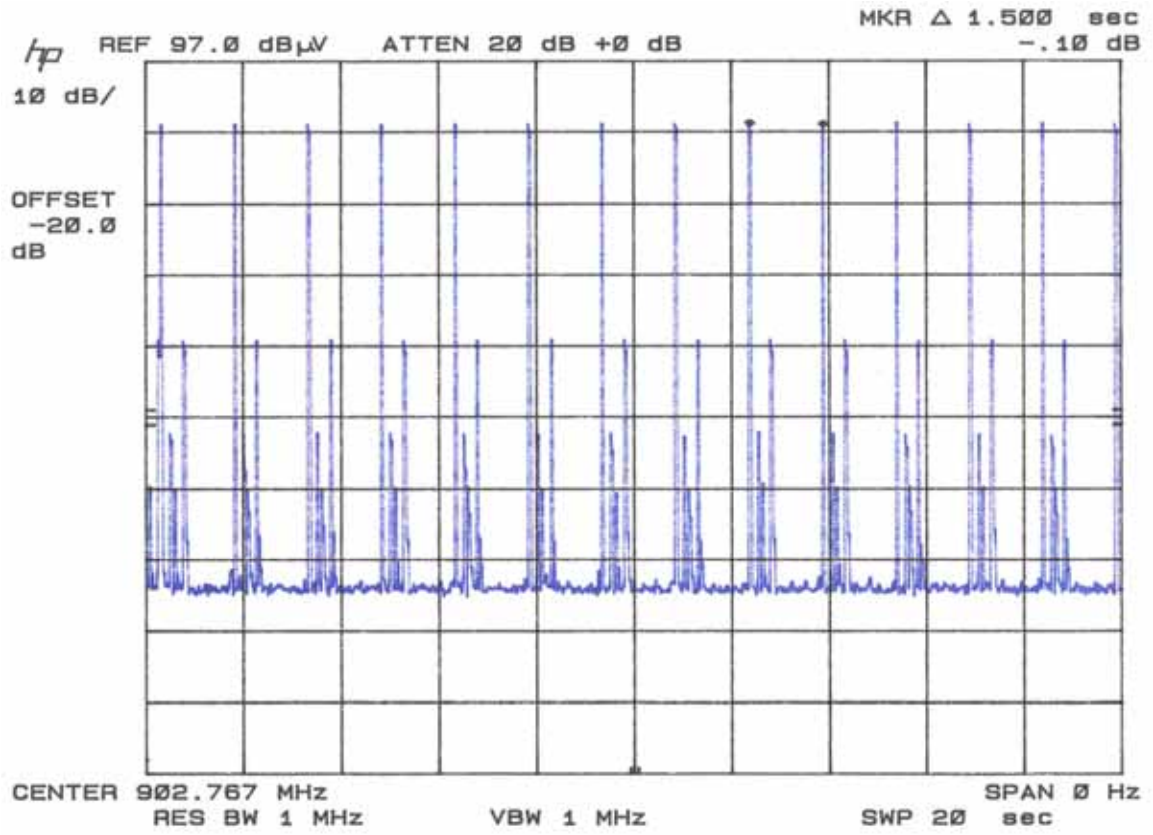


**Figure 4-7. Occupancy per 20 Second Period**

## 4.5 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 was set to the center frequency of the selected channel with a span greater than 5 times the 20dB bandwidth. The RBW was set to a value greater than the 20dB bandwidth while the VBW was set much higher than the RBW. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system. Both the Low Power (15dBm) and High Power (30dBm) settings were tested.

The limit for systems operating in the 902M – 928MHz band with atleast 50 hopping channels is 1 watt.

**Table 4. RF Power Output, Low Power**

| Frequency | Level | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel 902.75MHz | 14.68 dBm | 30 dBm | Pass |
| Mid Channel 914.75MHz | 15.02 dBm | 30 dBm | Pass |
| High Channel 927.25MHz | 14.68 dBm | 30 dBm | Pass |

**Table 5. RF Power Output, High Power**

| Frequency | Level | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel 902.75MHz | 29.86 dBm | 30 dBm | Pass |
| Mid Channel 914.75MHz | 29.77 dBm | 30 dBm | Pass |
| High Channel 927.25MHz | 29.35 dBm | 30 dBm | Pass |

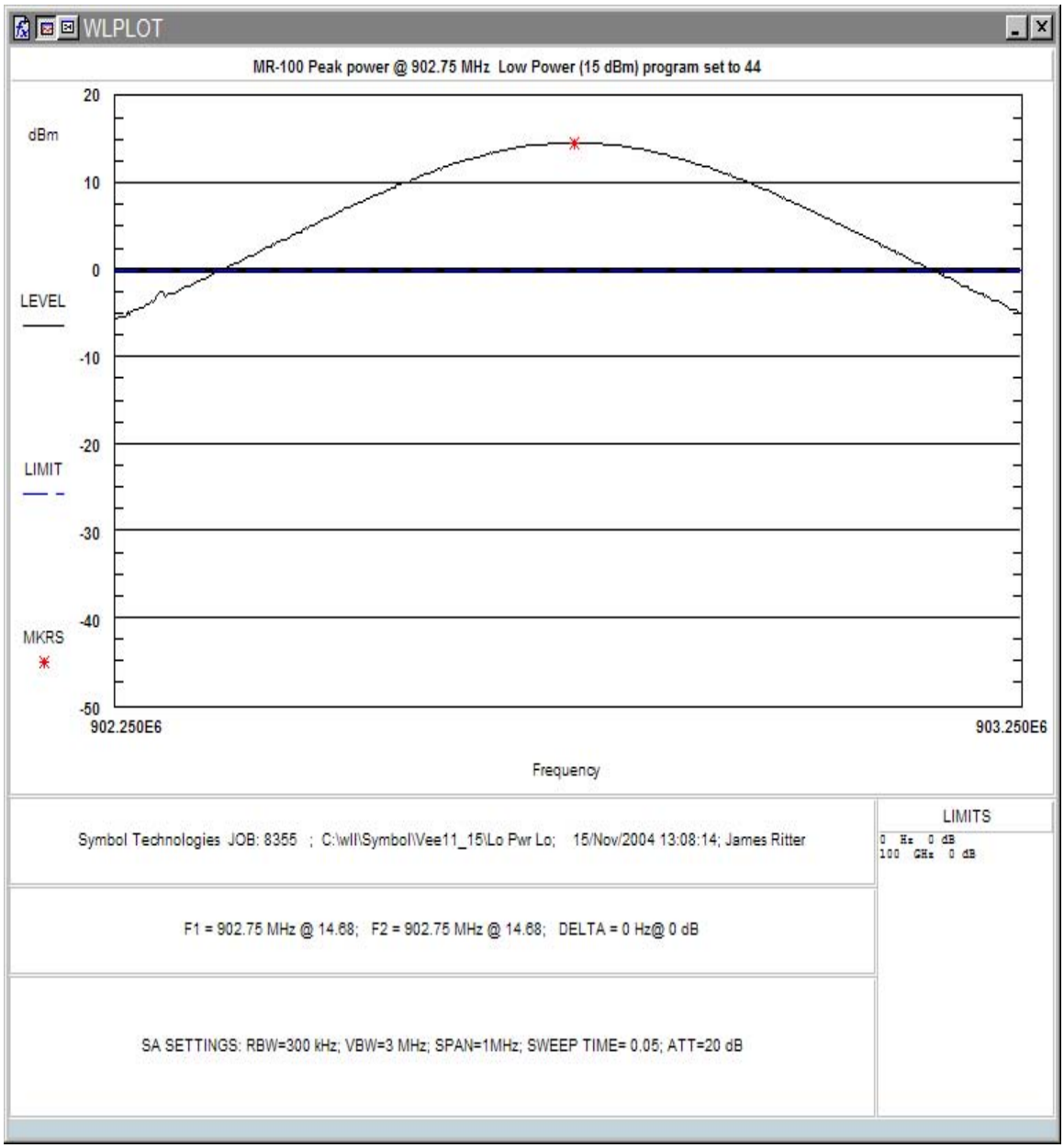


**Figure 4-8. Low Power RF Peak Power, Low Channel**

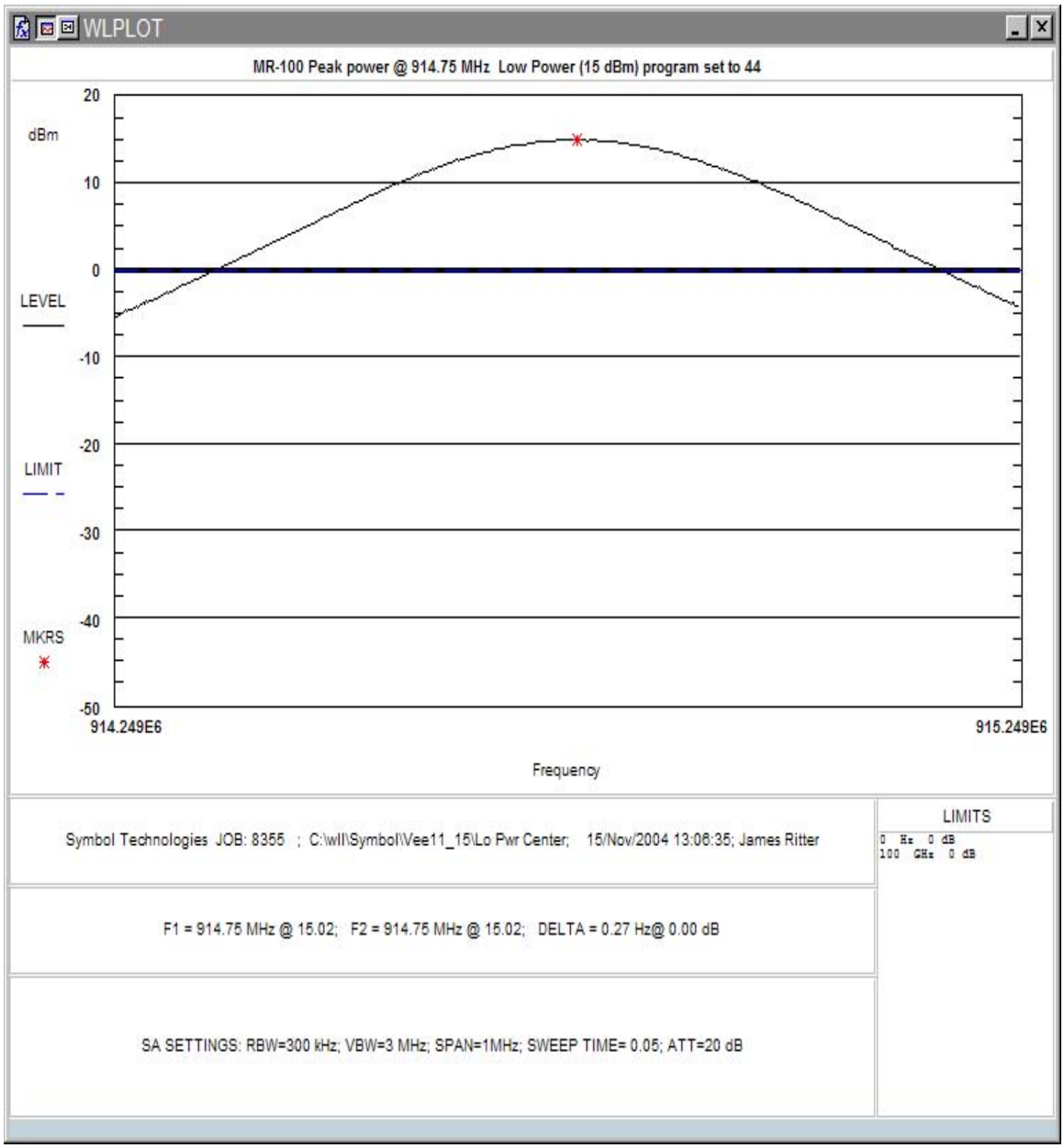


**Figure 4-9. Low Power RF Peak Power, Mid Channel**

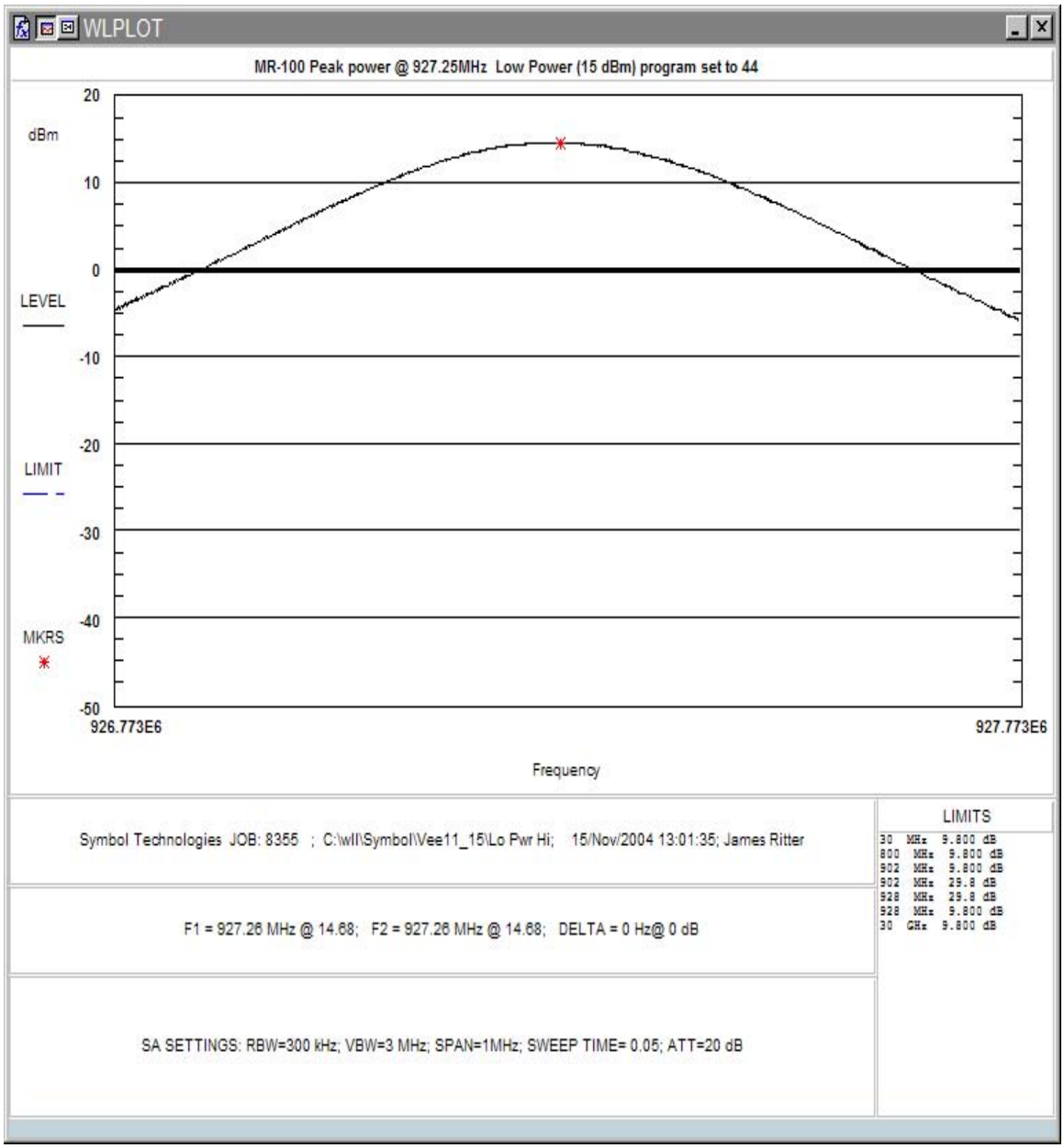


**Figure 4-10. Low Power RF Peak Power, High Channel**

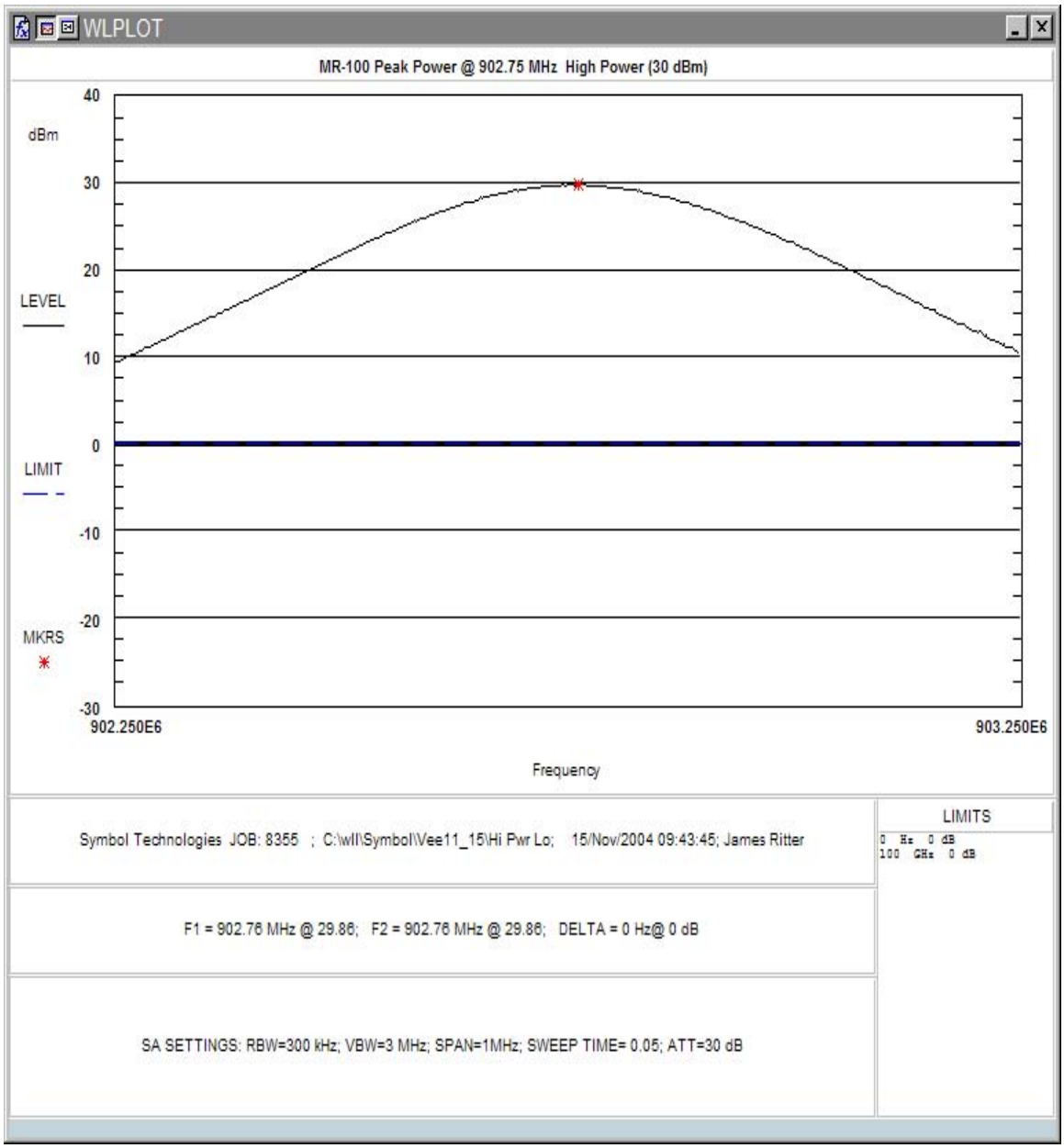


**Figure 4-11. High Power RF Peak Power, Low Channel**

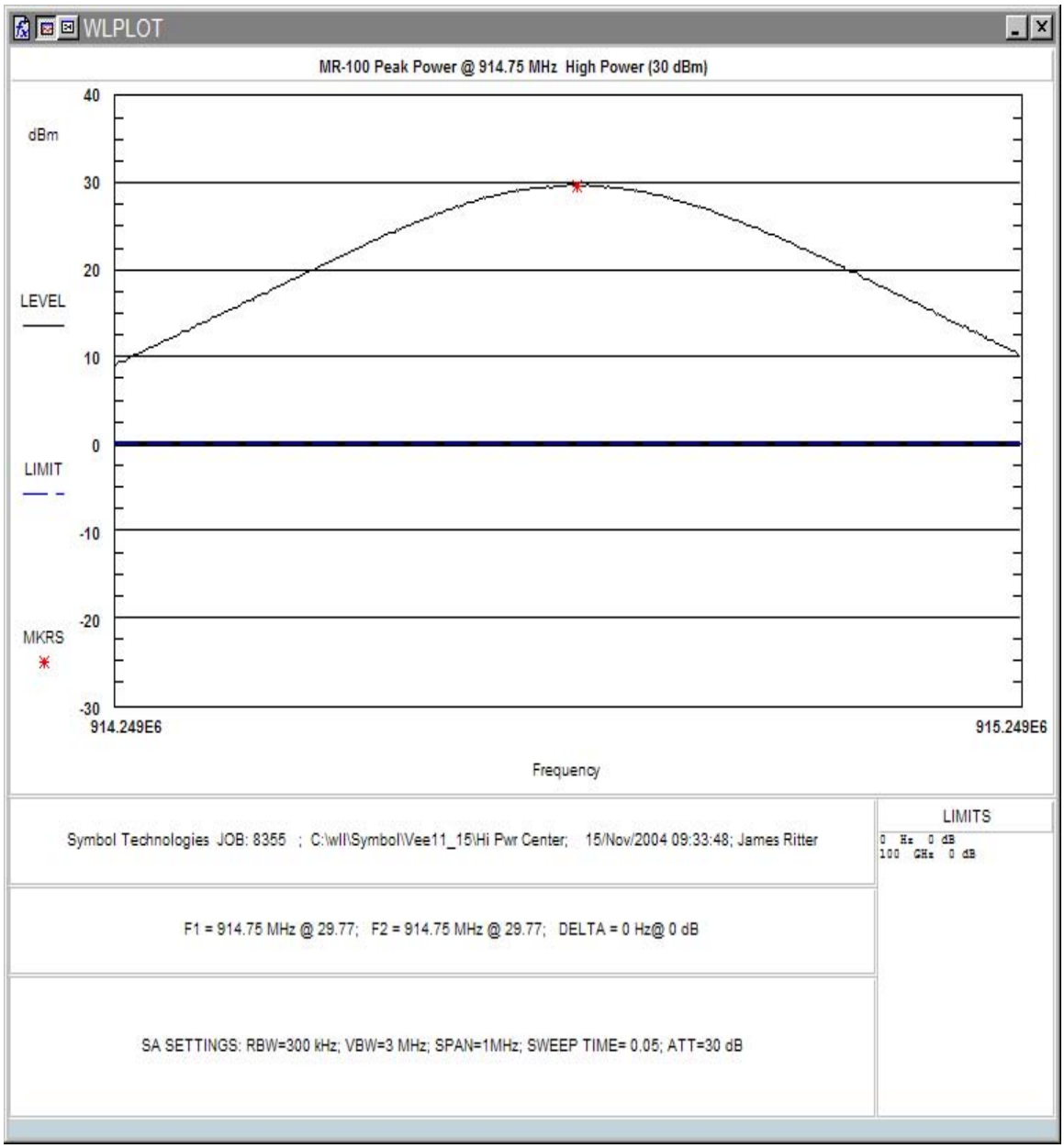


**Figure 4-12. High Power RF Peak Power, Mid Channel**

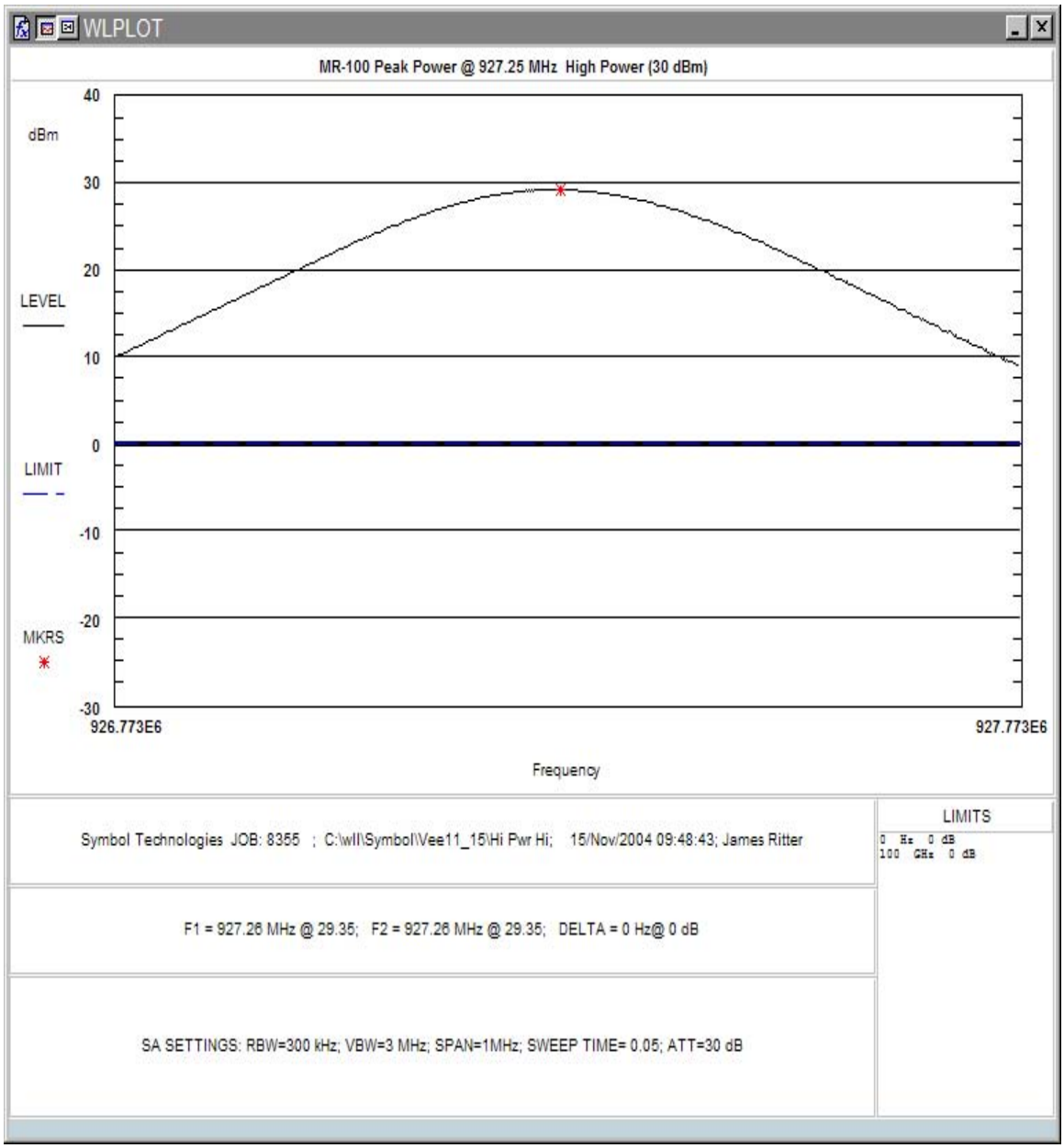


**Figure 4-13. High Power RF Peak Power, High Channel**

## 4.6 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(d) 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.

To perform the conducted spurious emissions testing, the EUT antenna was removed and the cable was connected directly into a spectrum analyzer through an attenuator. The correction for the external attenuator and test cable(s) are corrected in the data collection software. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 1 MHz. To determine the limit, the amplitude of the EUT carrier frequency was measured using the same settings. The limit was then set to 20 dB below the carrier frequency amplitude. The emissions outside of the allocated frequency band of 902M – 928MHz were then scanned from 30 MHz up to the tenth harmonic of the carrier. Both the Low Power and High Power settings were tested.

The following are plots of the conducted spurious emissions data.

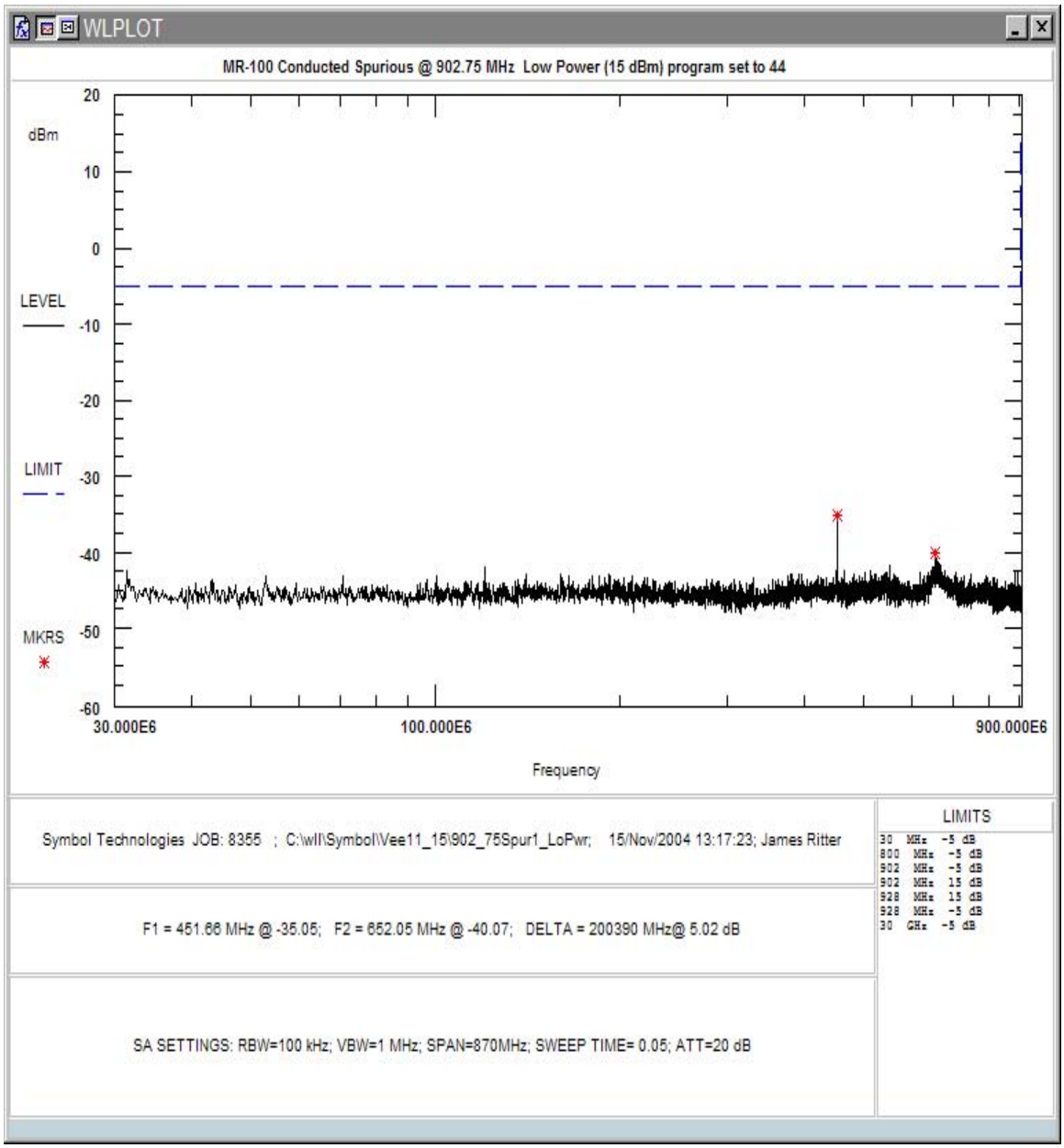


**Figure 4-14. Low Power Conducted Spurious Emissions, Low Channel 30 - 900MHz**

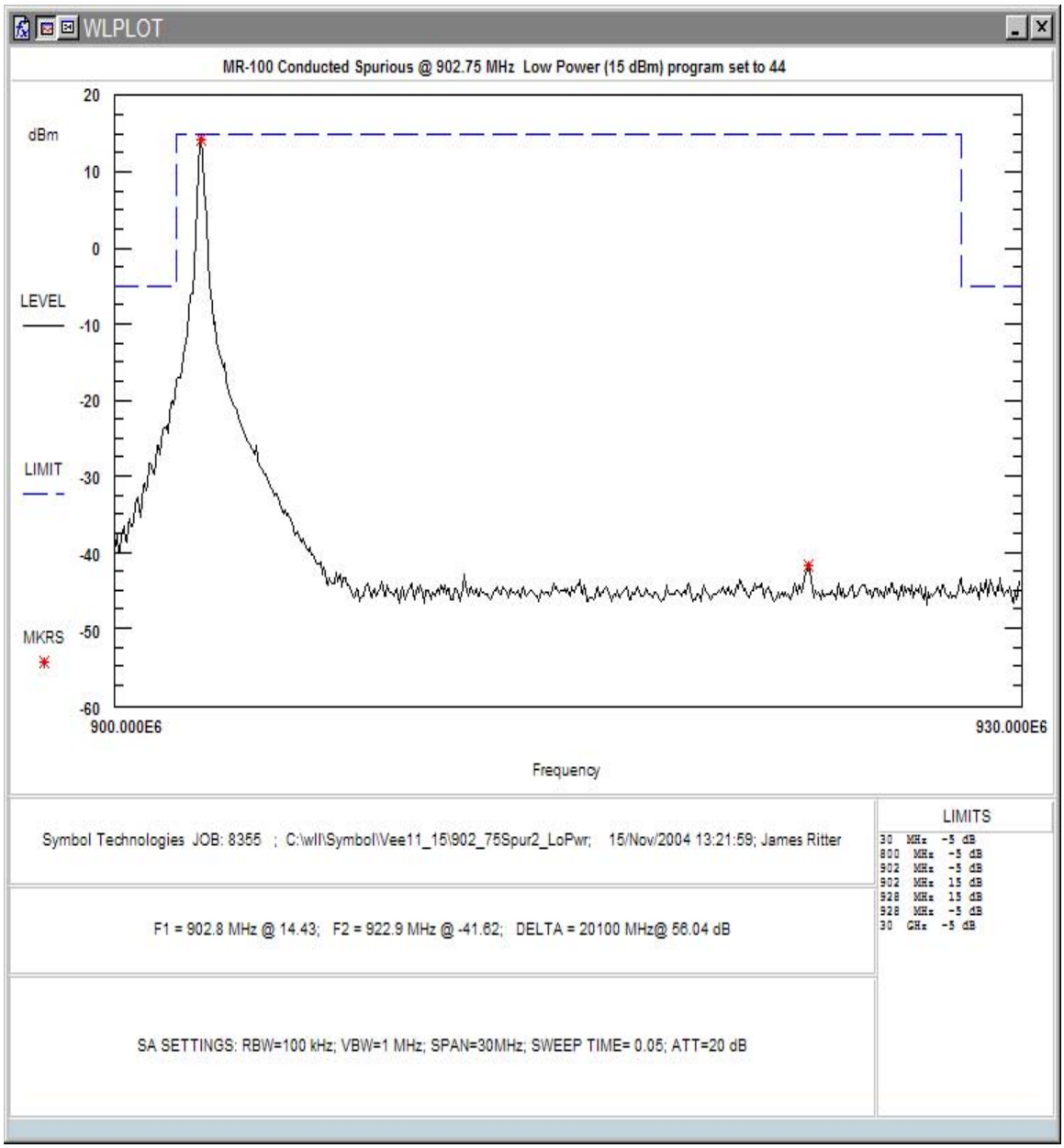


**Figure 4-15. Low Power Conducted Spurious Emissions, Low Channel 900 – 930MHz**

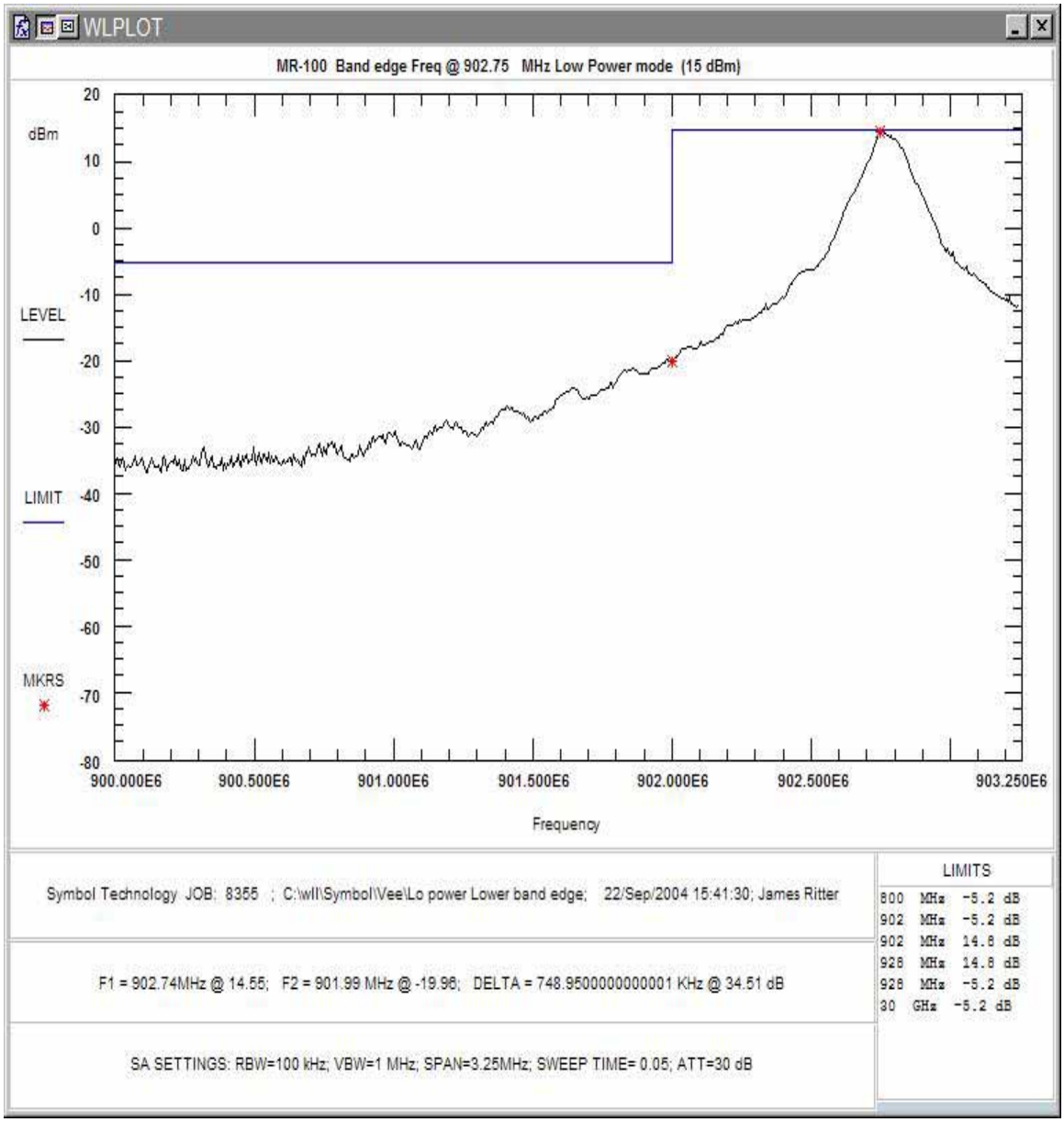


**Figure 4-16. Low Power Conducted Spurious Emissions, Low Channel, Bandedge**

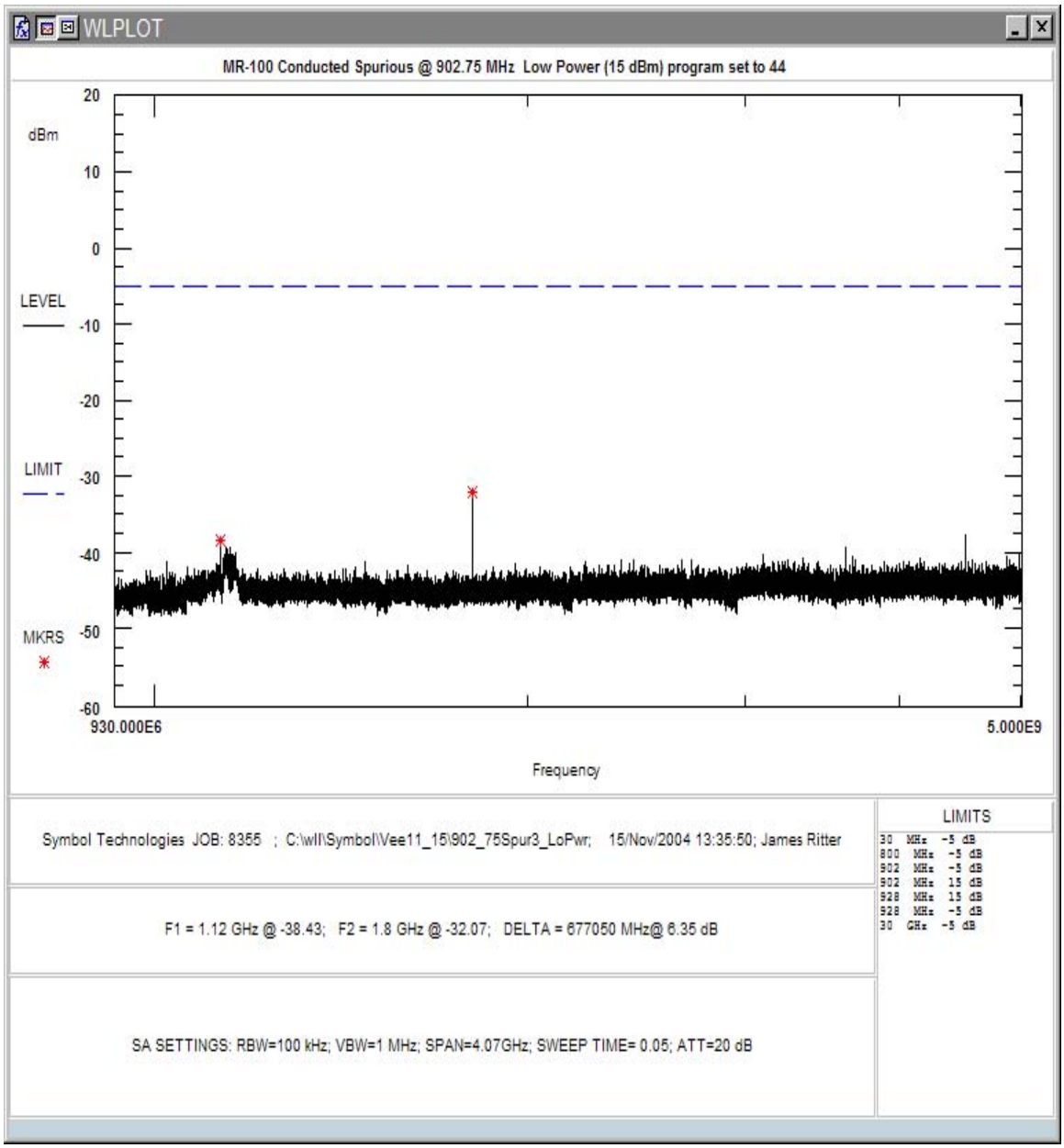


**Figure 4-17. Low Power Conducted Spurious Emissions, Low Channel 930MHz – 5GHz**

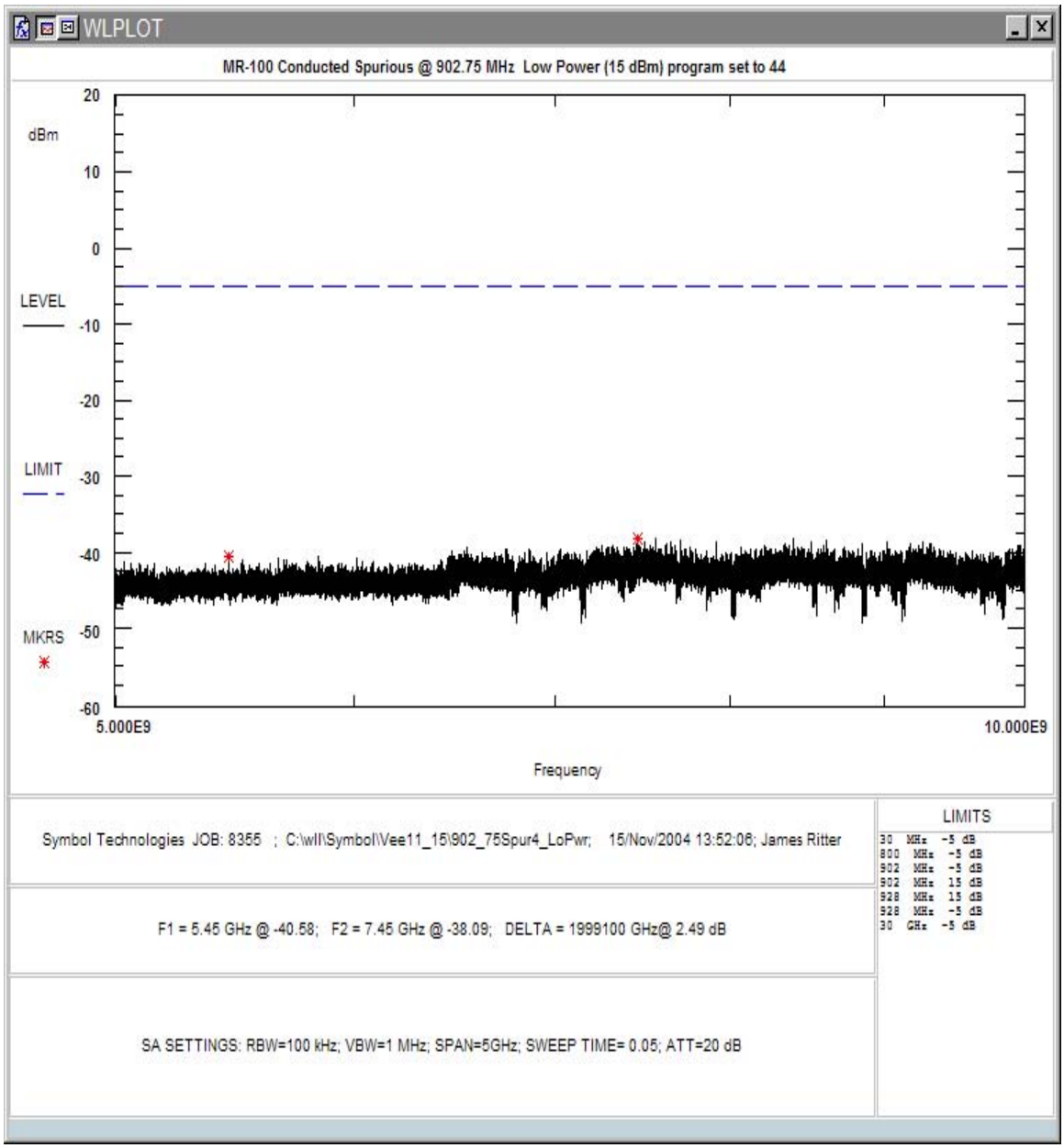


**Figure 4-18. Low Power Conducted Spurious Emissions, Low Channel 5 - 10GHz**

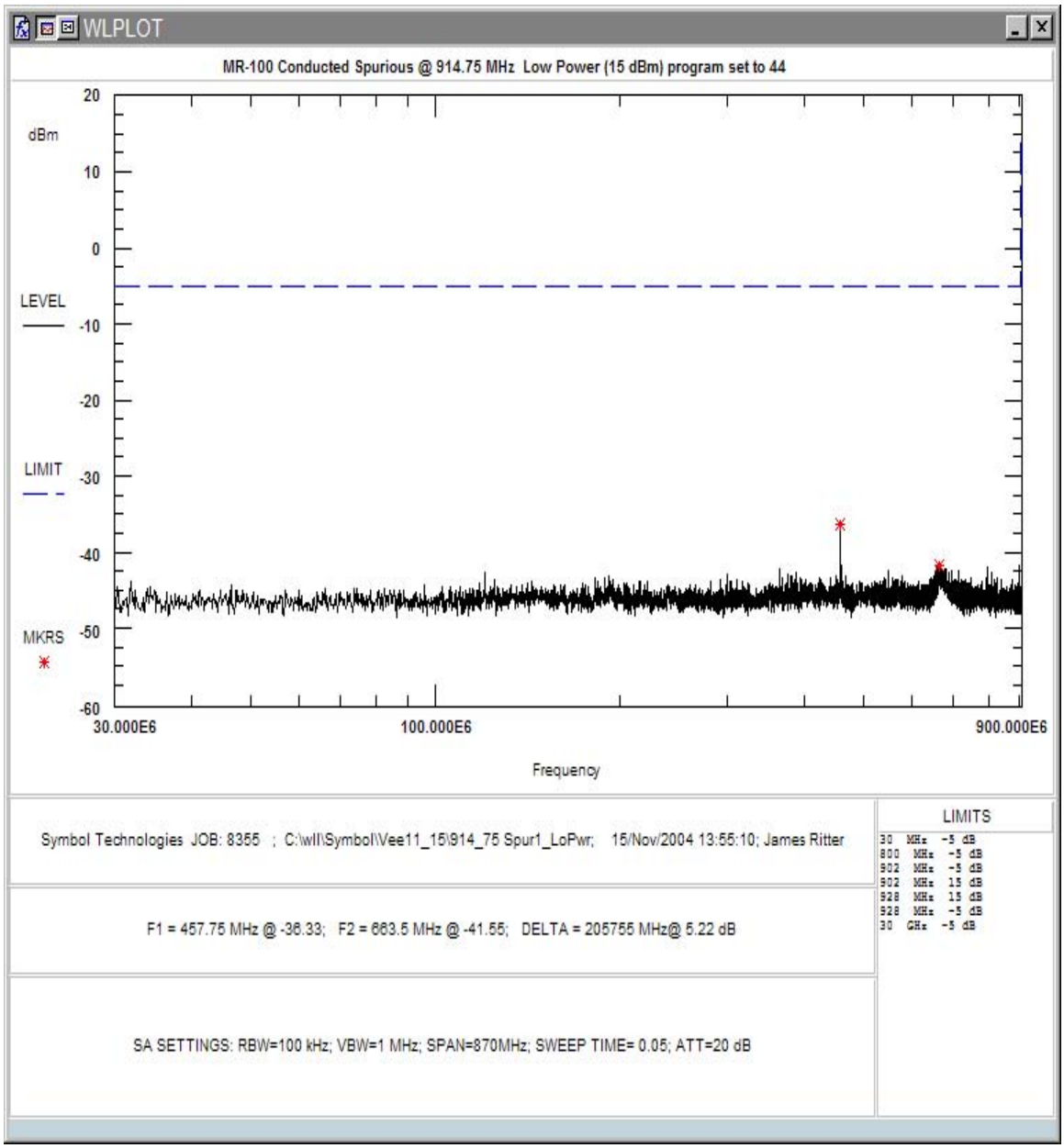


**Figure 4-19. Low Power Conducted Spurious Emissions, Mid Channel 30 - 900MHz**

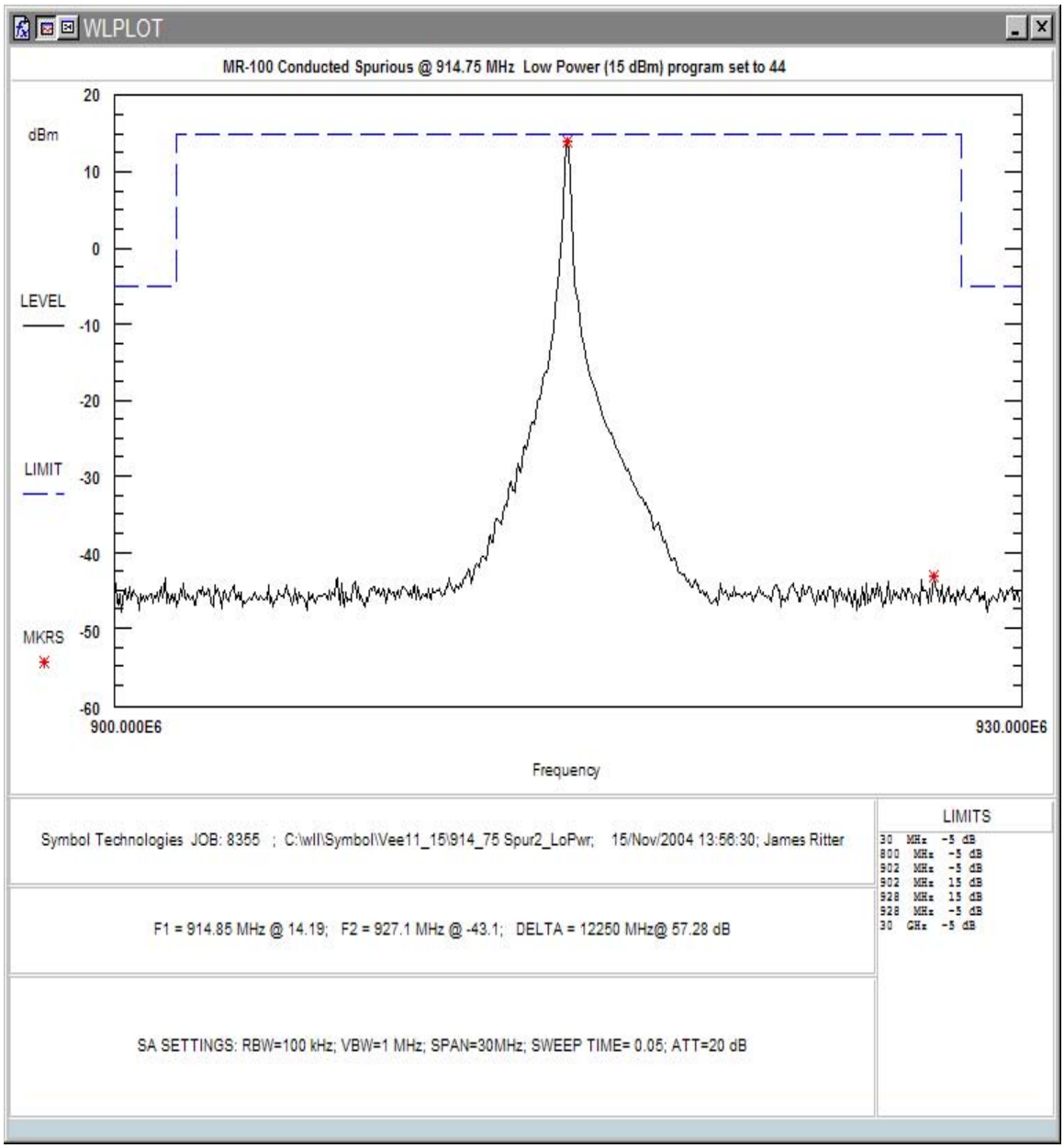


**Figure 4-20. Low Power Conducted Spurious Emissions, Mid Channel 900 – 930MHz**

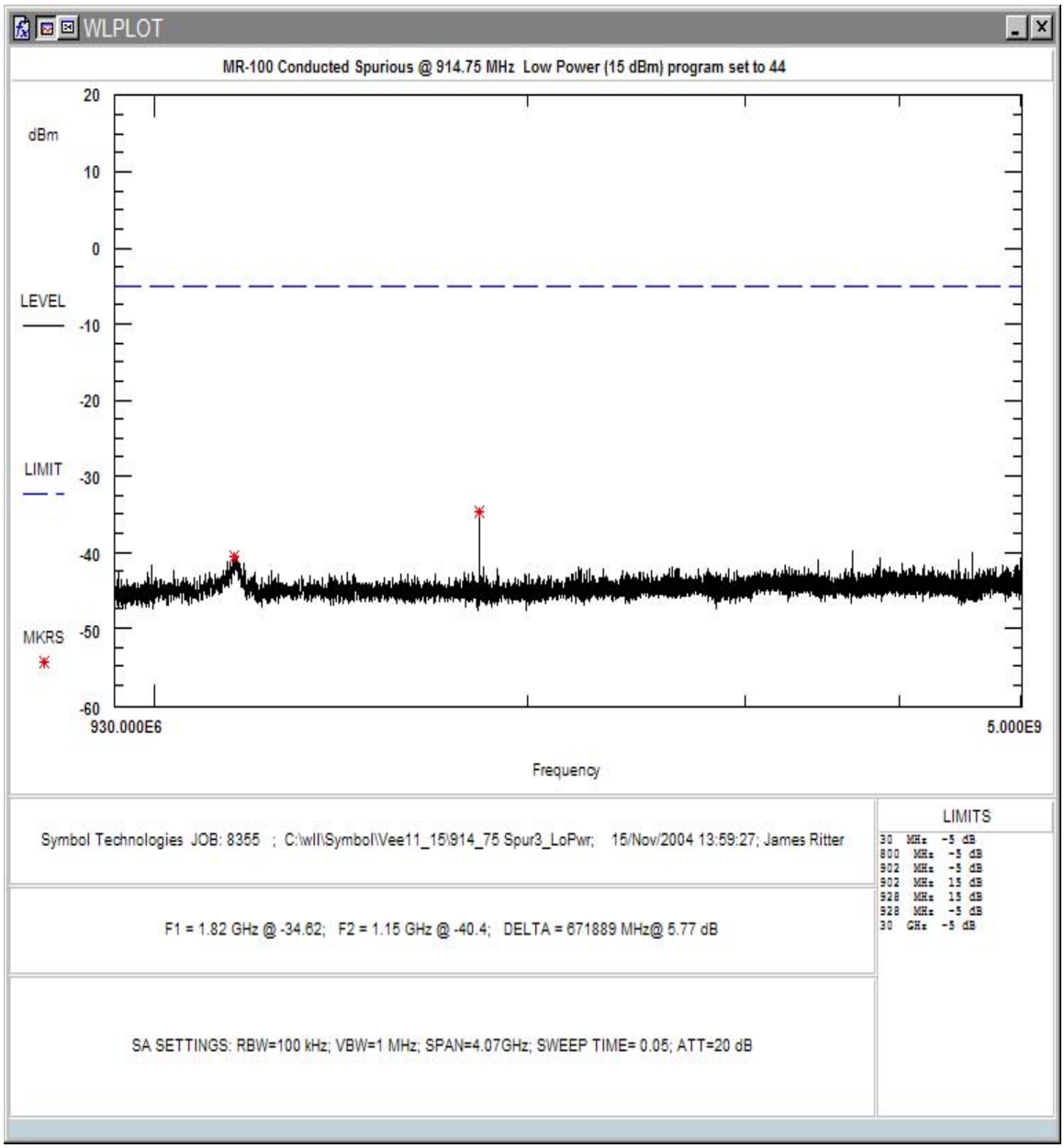


**Figure 4-21. Low Power Conducted Spurious Emissions, Mid Channel 930MHz – 5GHz**

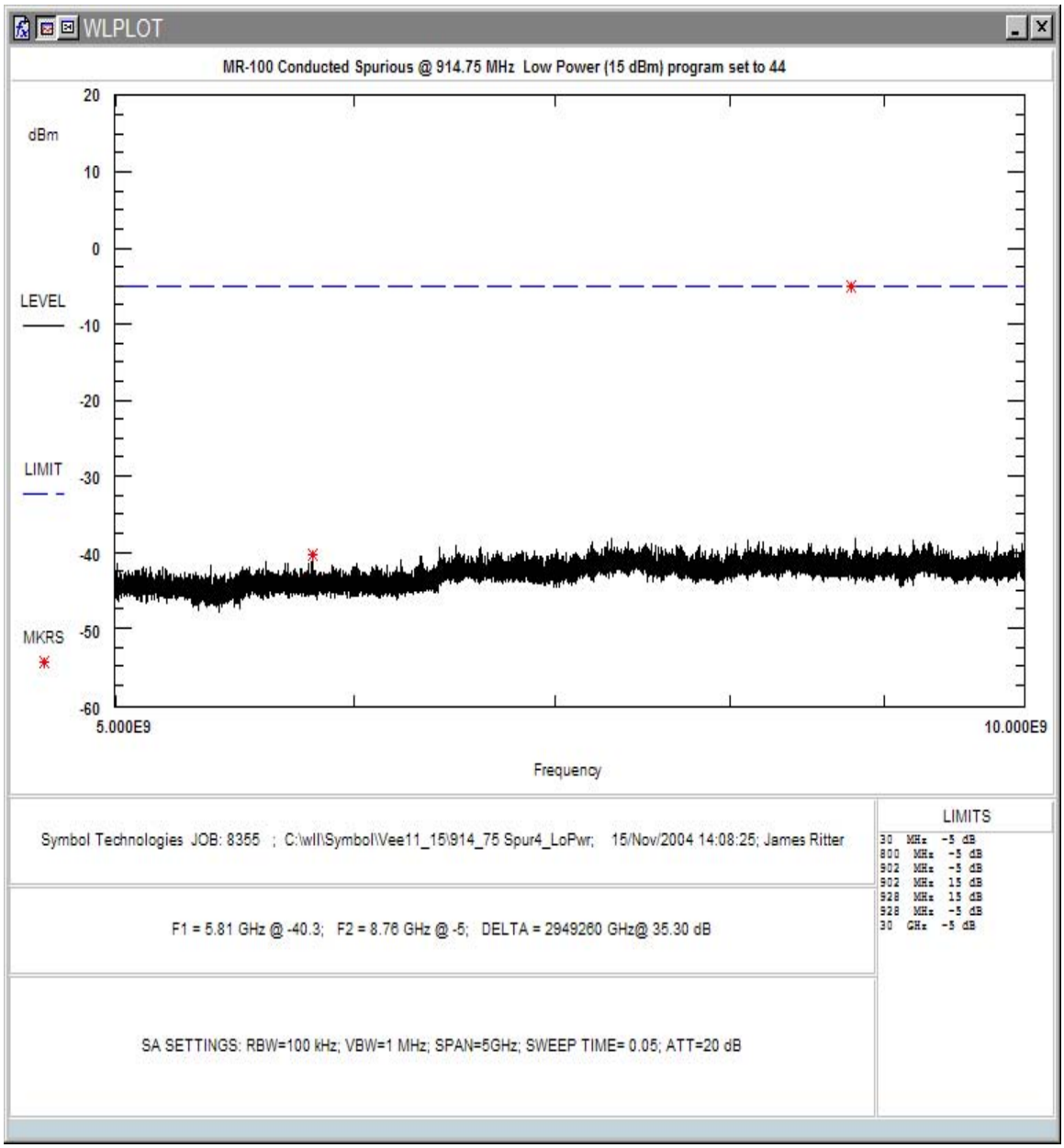


**Figure 4-22. Low Power Conducted Spurious Emissions, Mid Channel 5 - 10GHz**

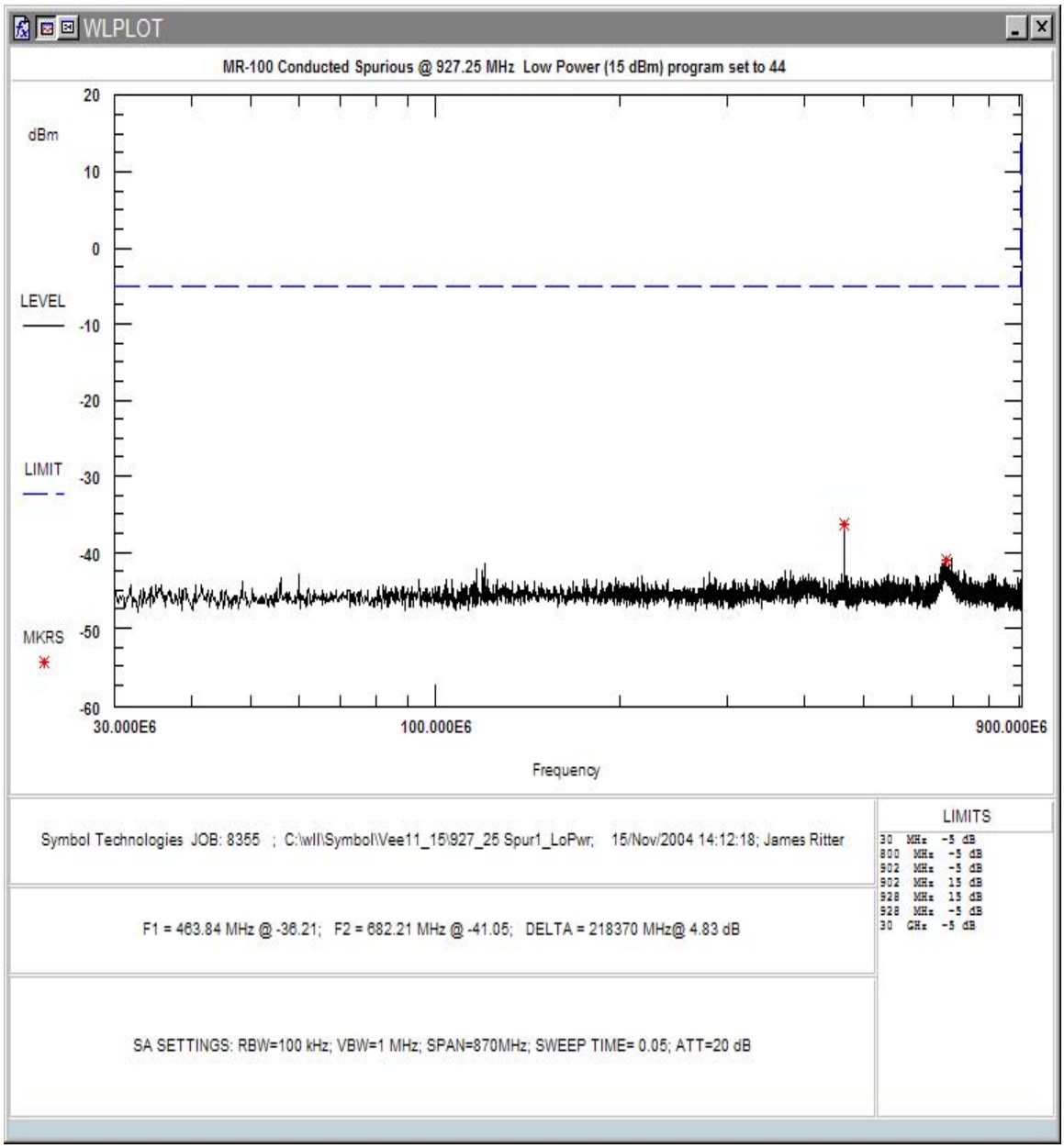


**Figure 4-23. Low Power Conducted Spurious Emissions, High Channel 30 - 900MHz**

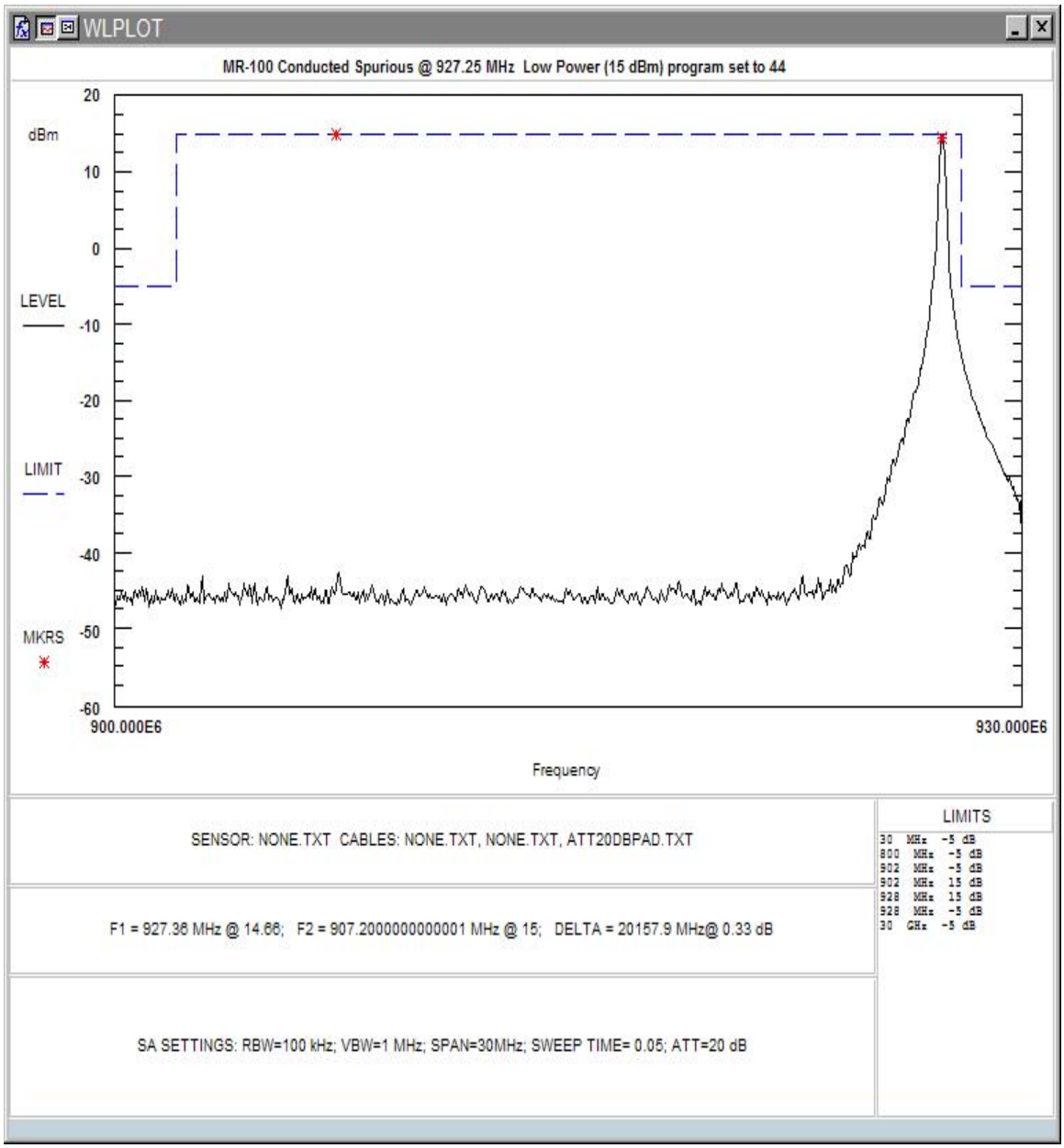


**Figure 4-24. Low Power Conducted Spurious Emissions, High Channel 900 – 930MHz**

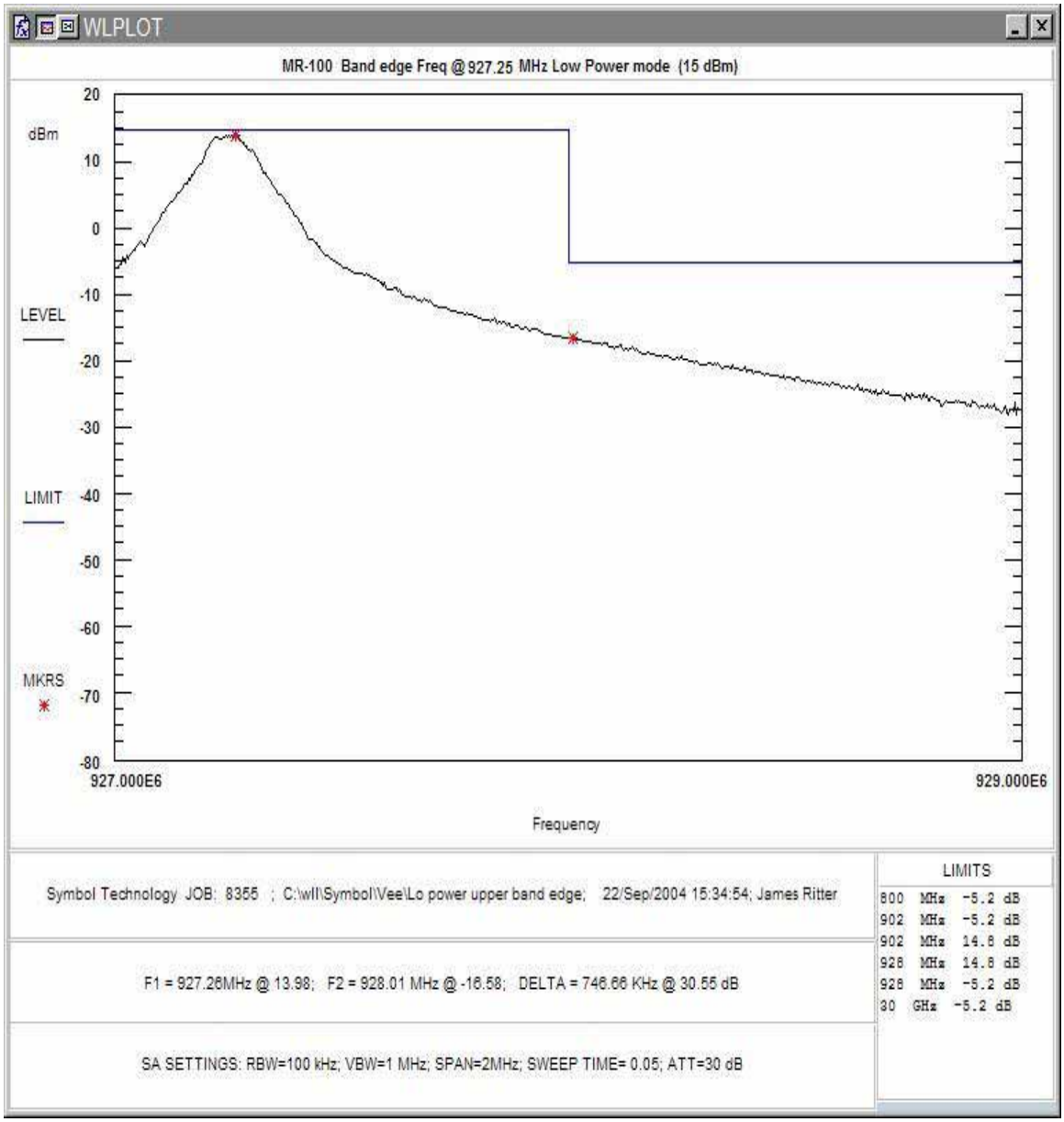


**Figure 4-25. Low Power Conducted Spurious Emissions, High Channel, Bandedge**

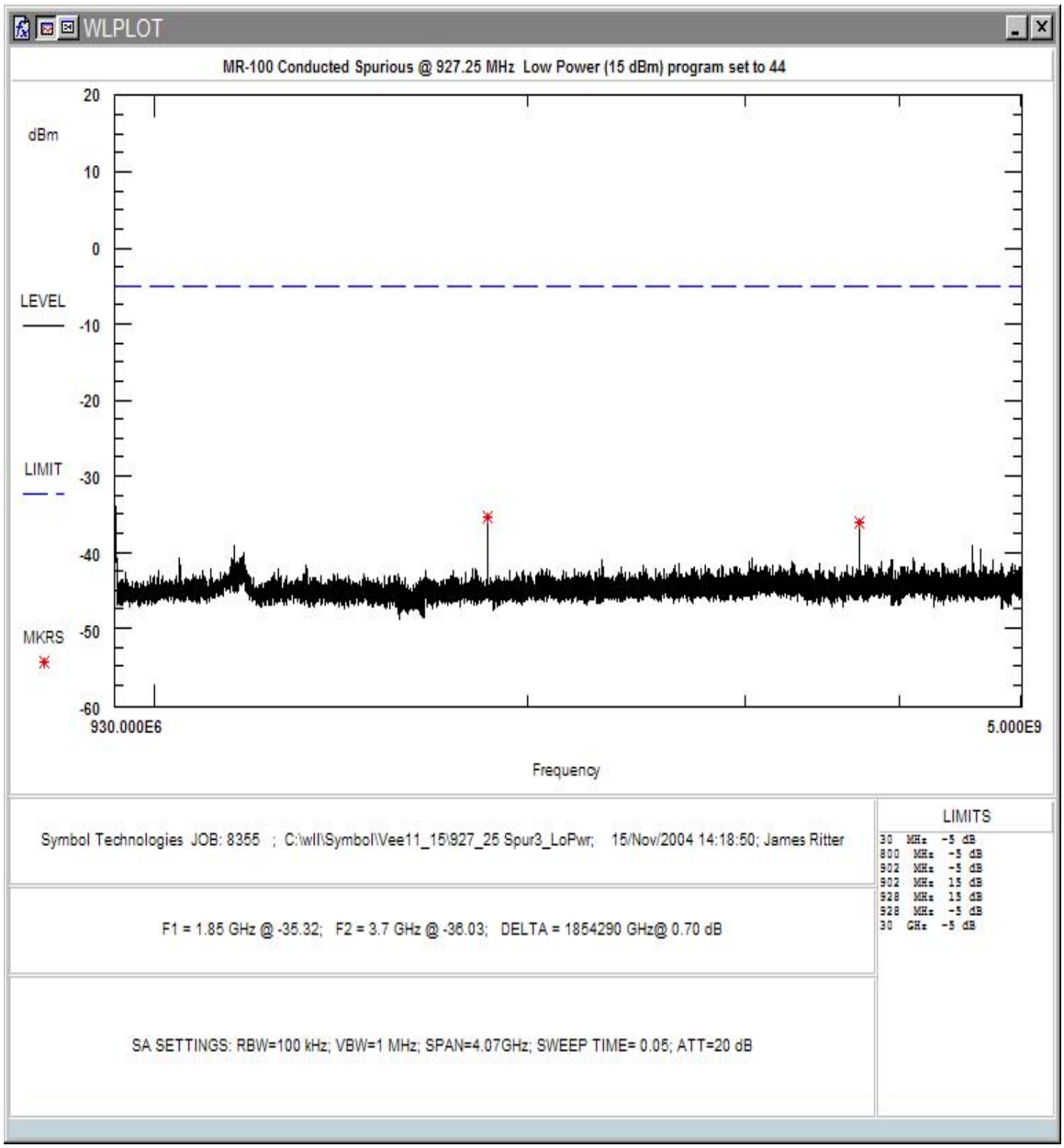


**Figure 4-26. Low Power Conducted Spurious Emissions, High Channel 930MHz – 5GHz**

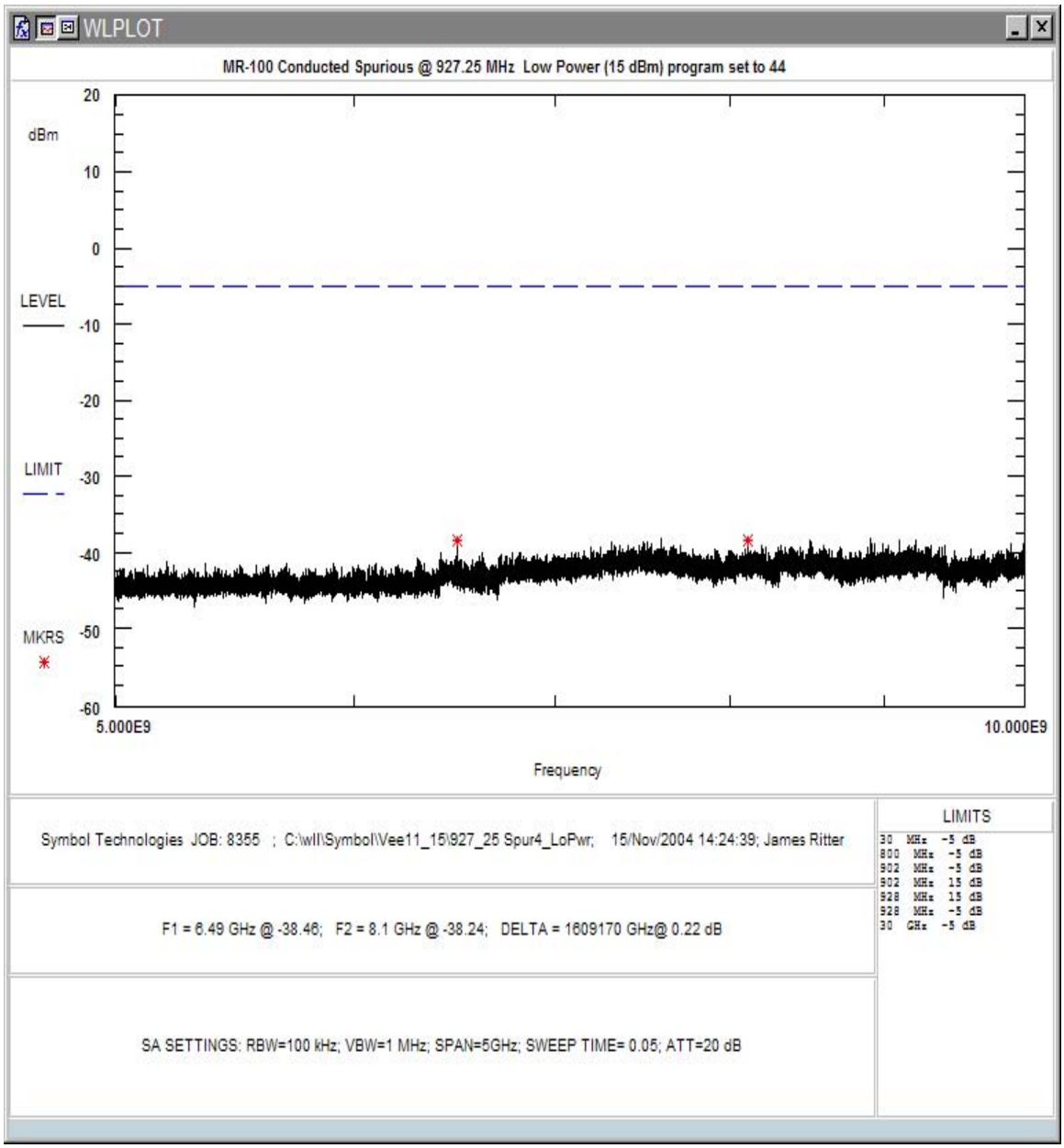


**Figure 4-27. Low Power Conducted Spurious Emissions, High Channel 5 - 10GHz**

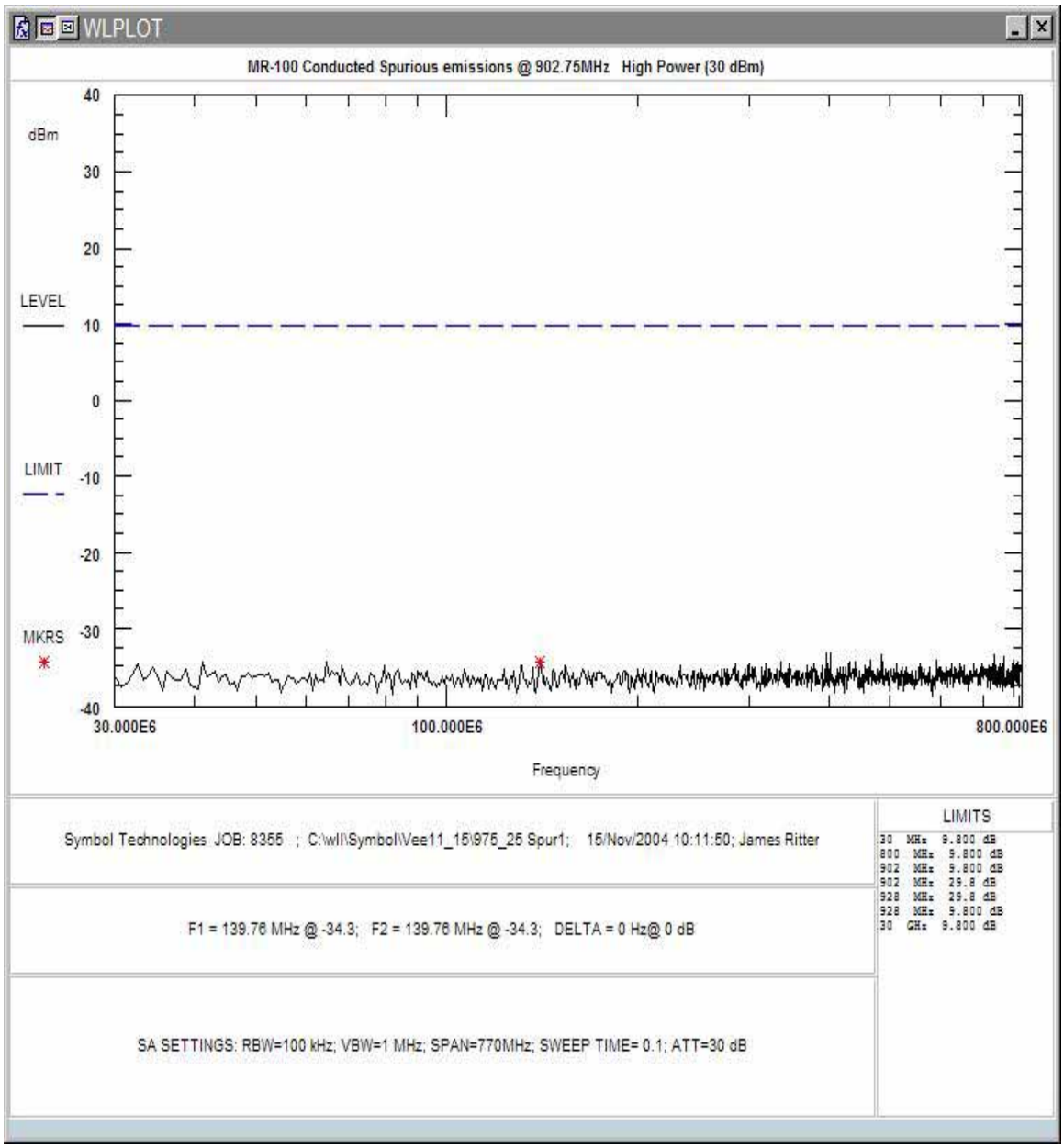


**Figure 4-28. High Power Conducted Spurious Emissions, Low Channel 30 - 800MHz**

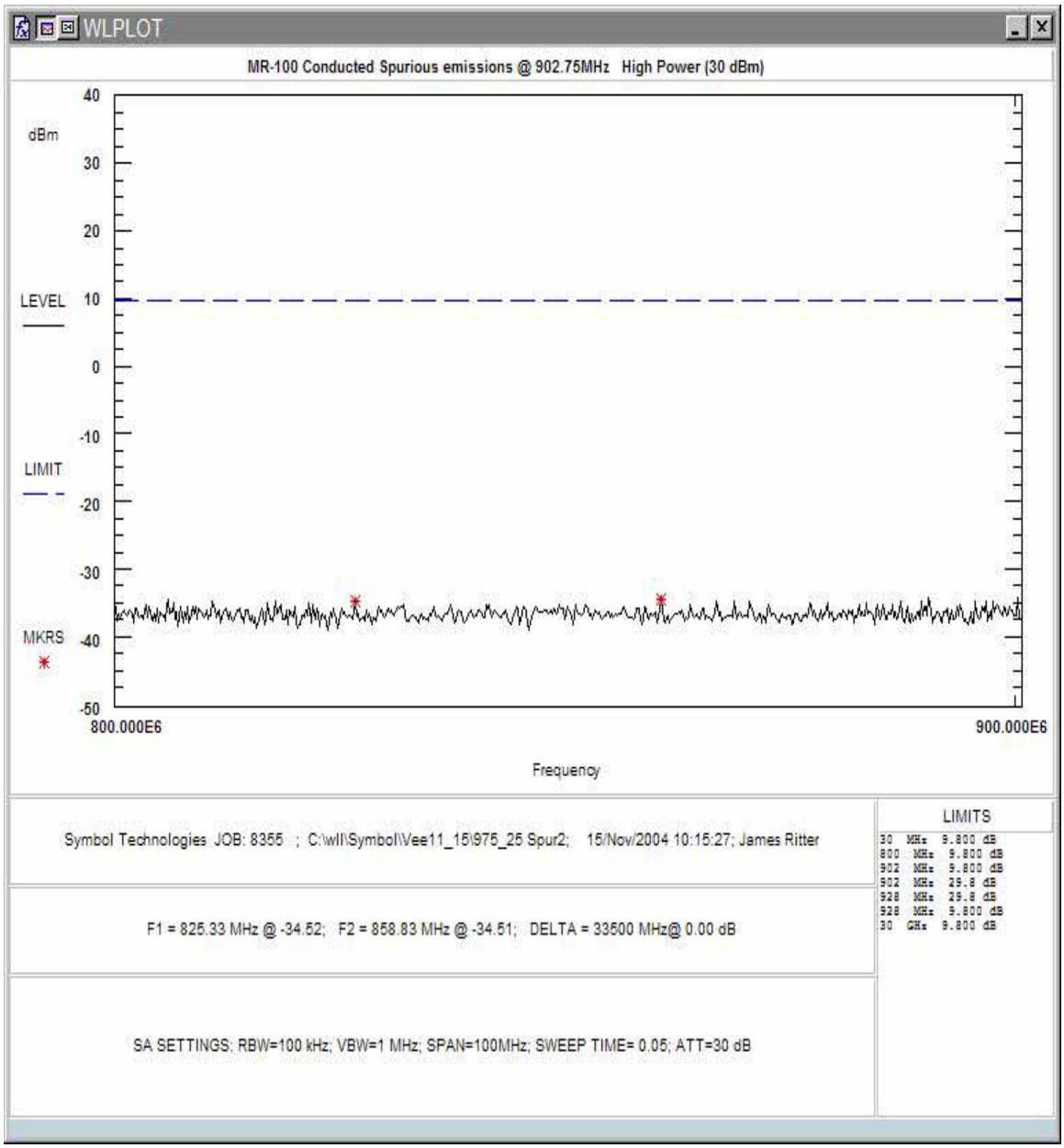


**Figure 4-29. High Power Conducted Spurious Emissions, Low Channel 800 – 900MHz**

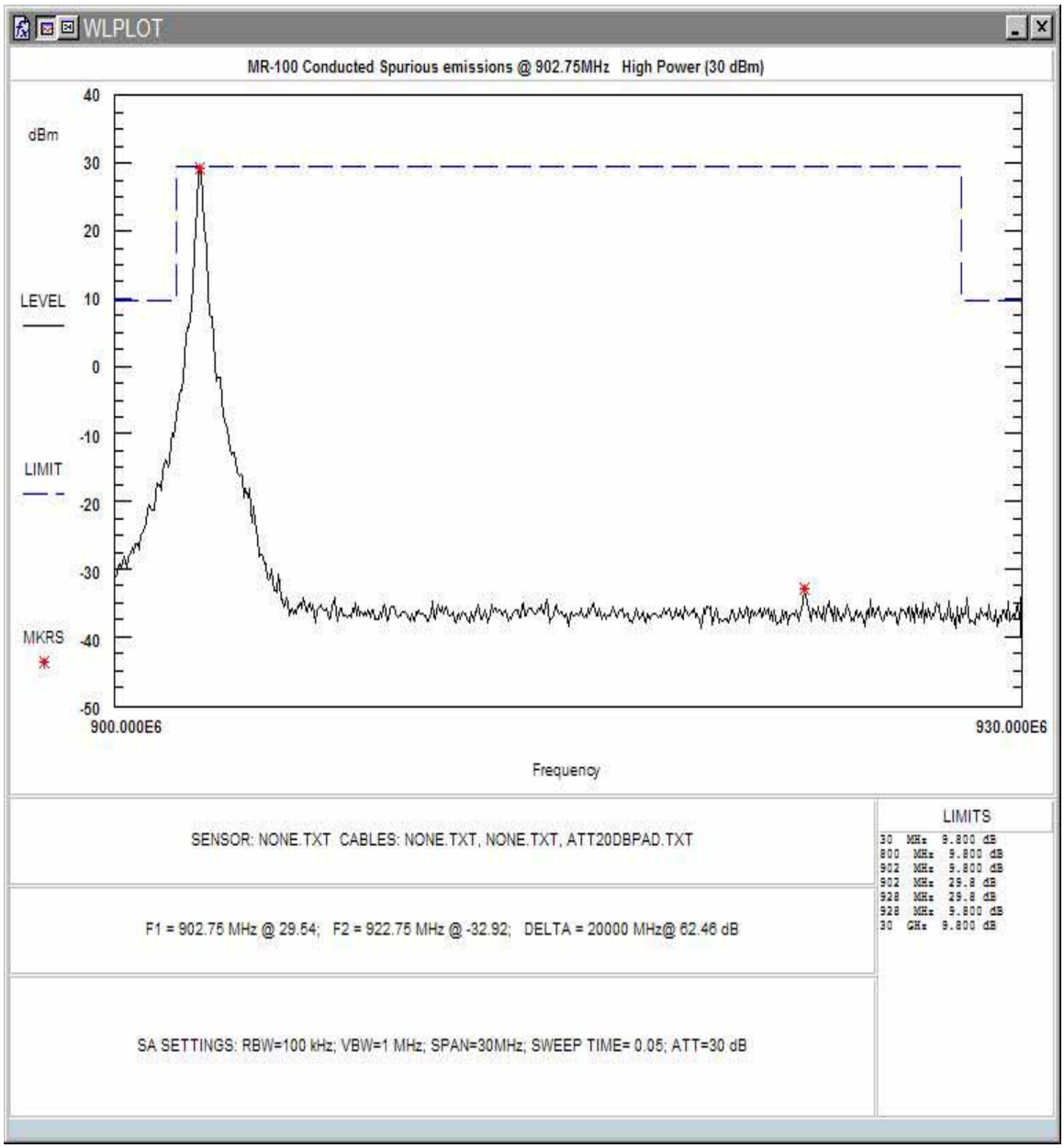


**Figure 4-30. High Power Conducted Spurious Emissions, Low Channel 900 – 930MHz**

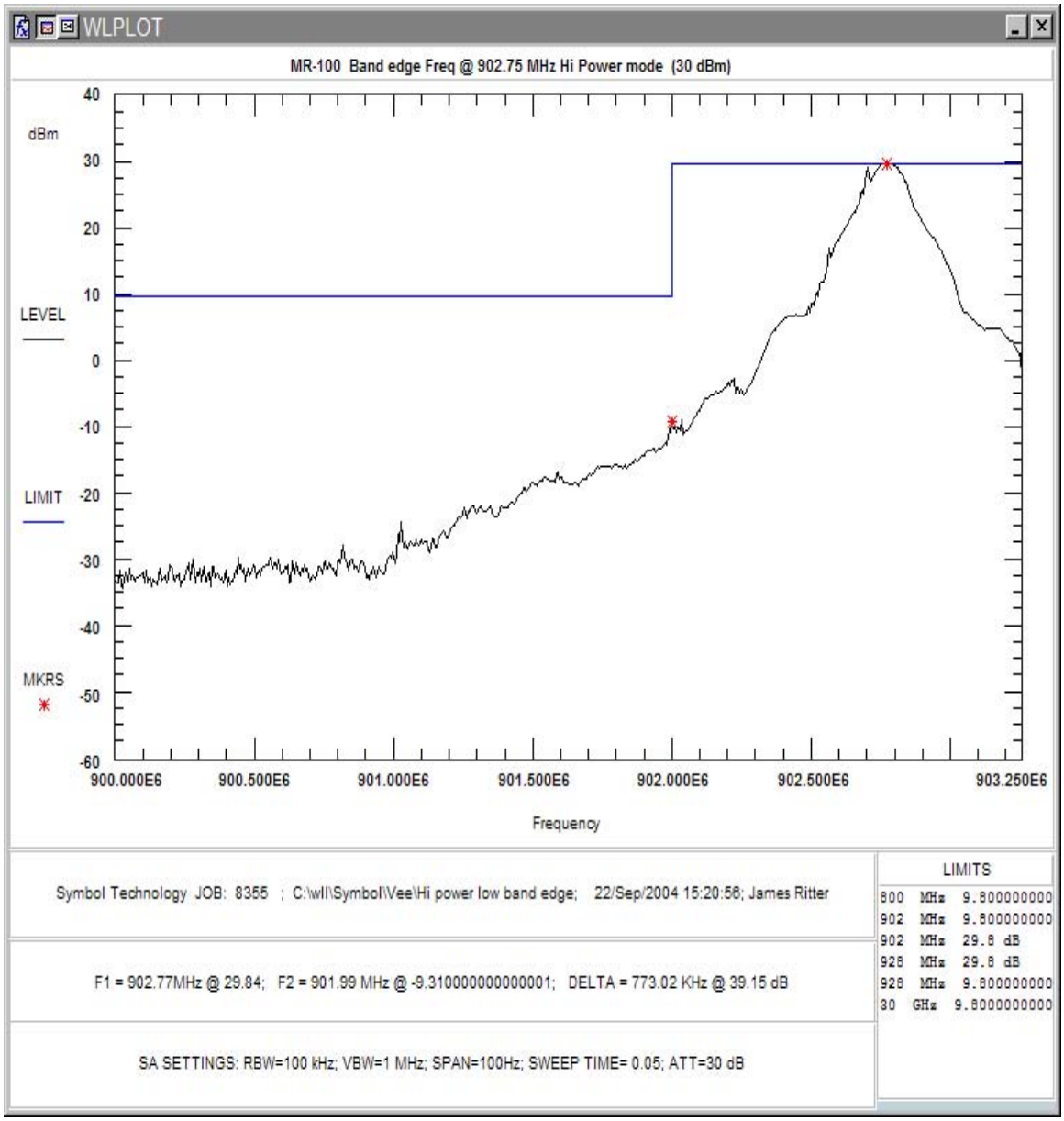


**Figure 4-31. High Power Conducted Spurious Emissions, Low Channel, Bandedge**

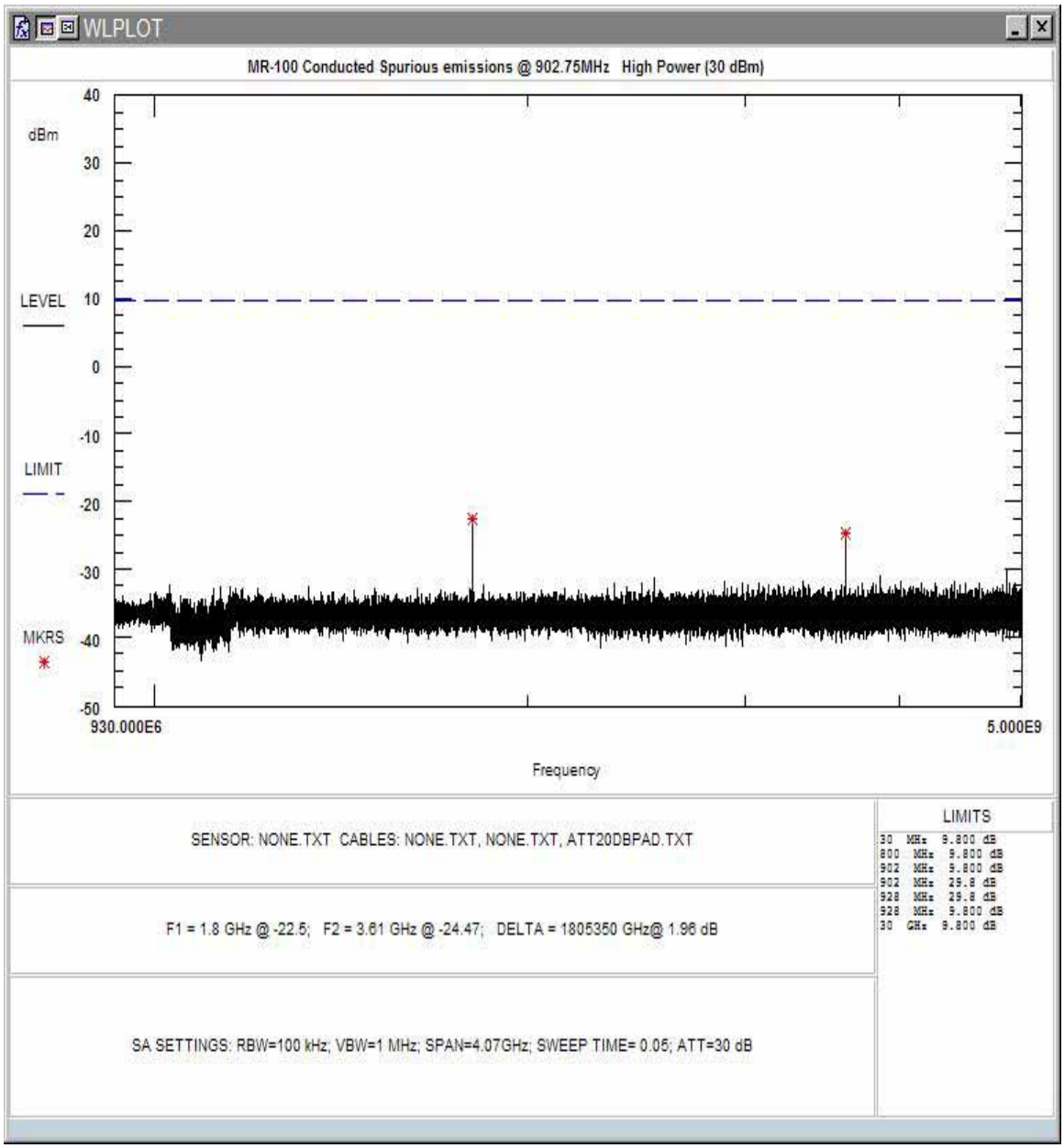


**Figure 4-32. High Power Conducted Spurious Emissions, Low Channel 930MHz – 5GHz**

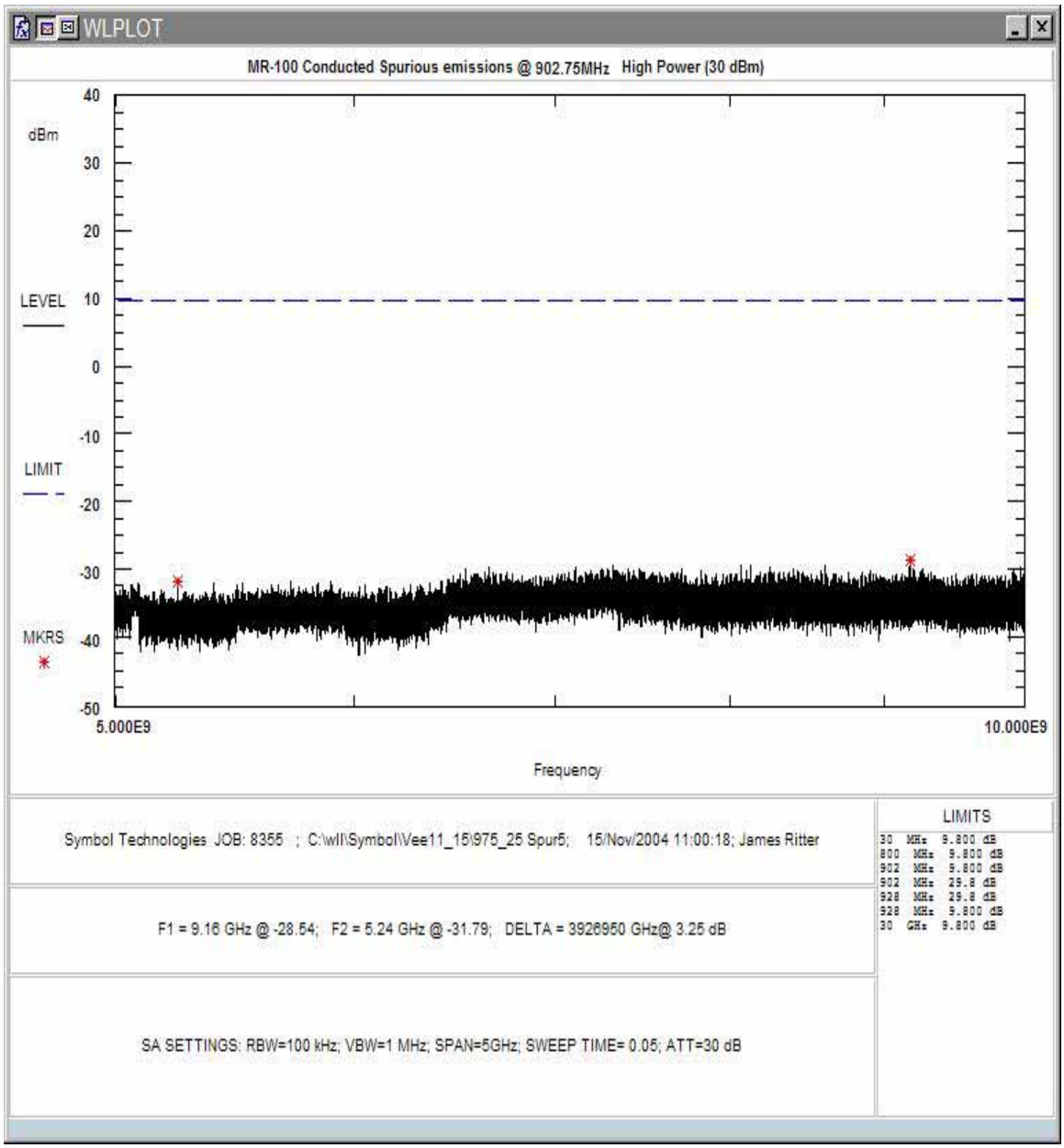


**Figure 4-33. High Power Conducted Spurious Emissions, Low Channel 5 - 10GHz**

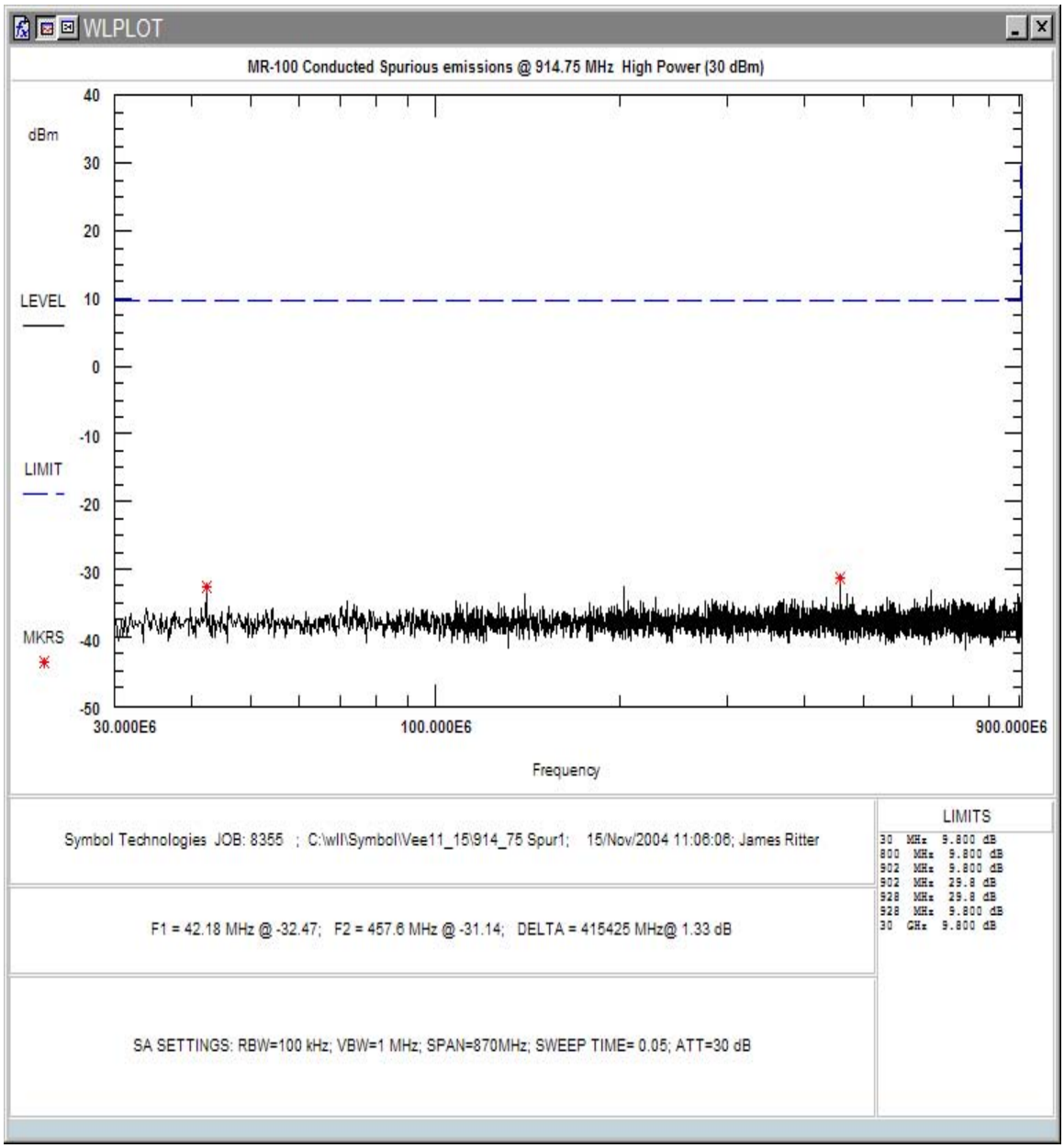


**Figure 4-34. High Power Conducted Spurious Emissions, Mid Channel 30 - 900MHz**

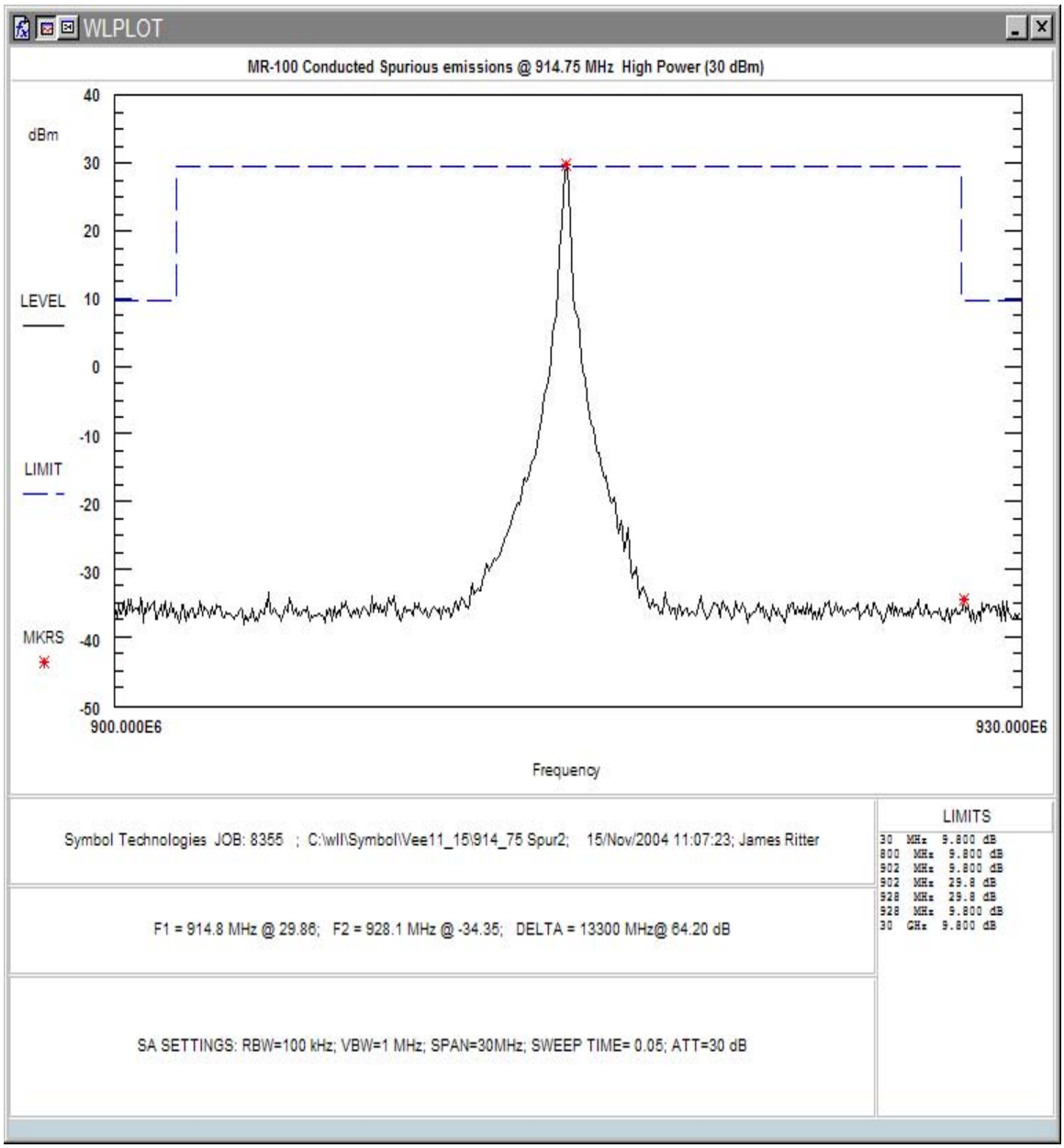


**Figure 4-35. High Power Conducted Spurious Emissions, Mid Channel 900 – 930MHz**

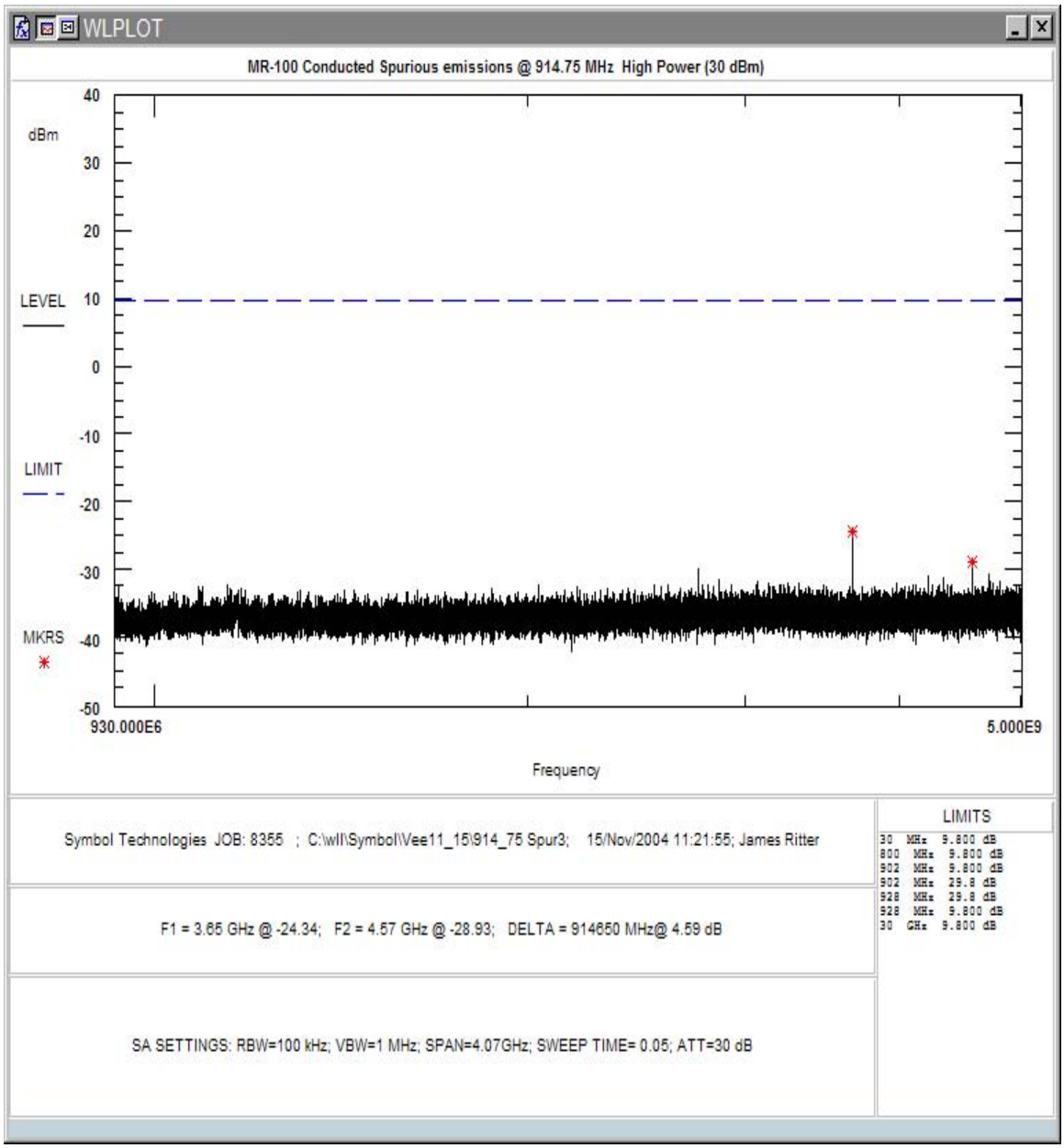


**Figure 4-36. High Power Conducted Spurious Emissions, Mid Channel 930MHz – 5GHz**

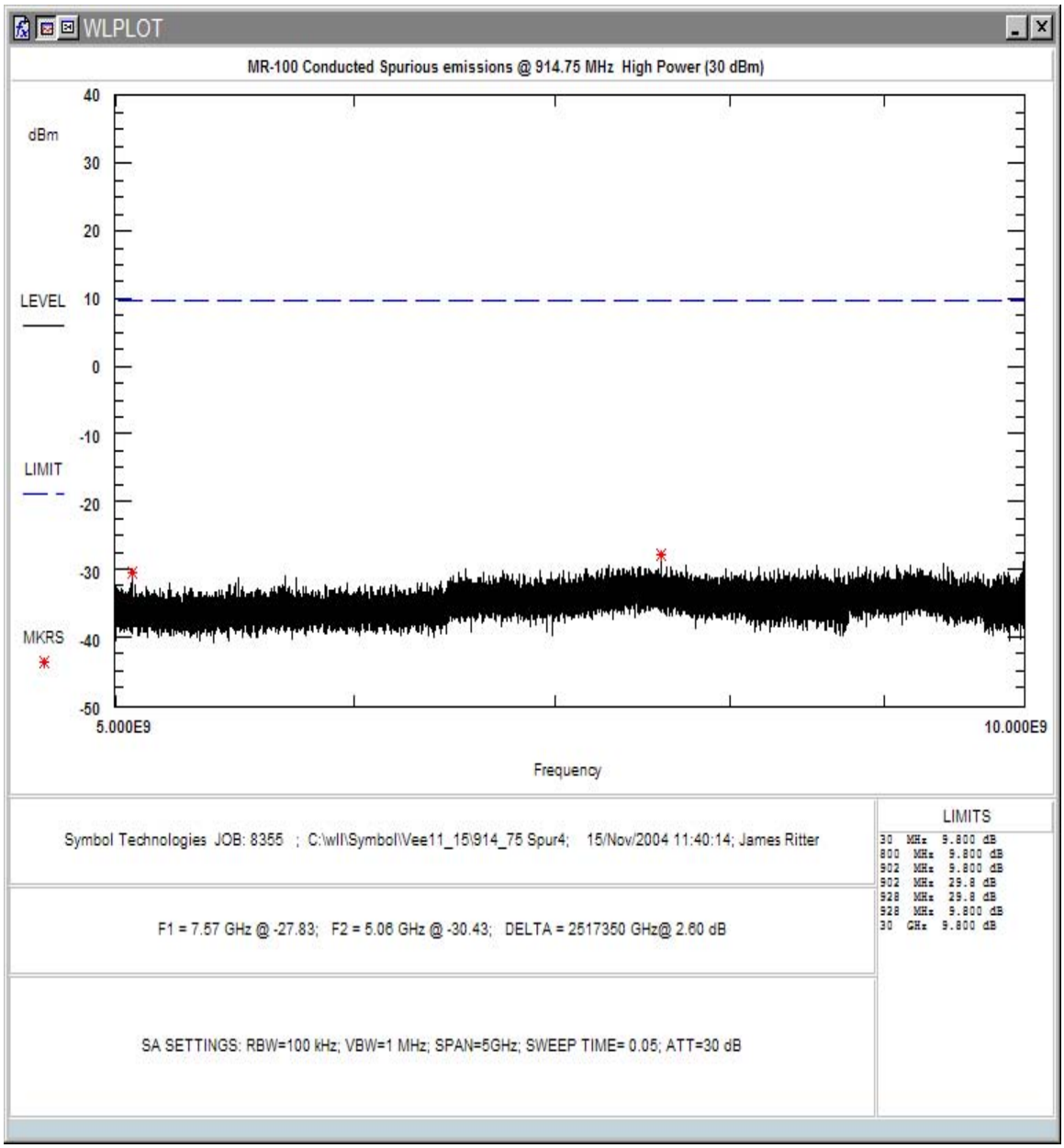


**Figure 4-37. High Power Conducted Spurious Emissions, Mid Channel 5 - 10GHz**

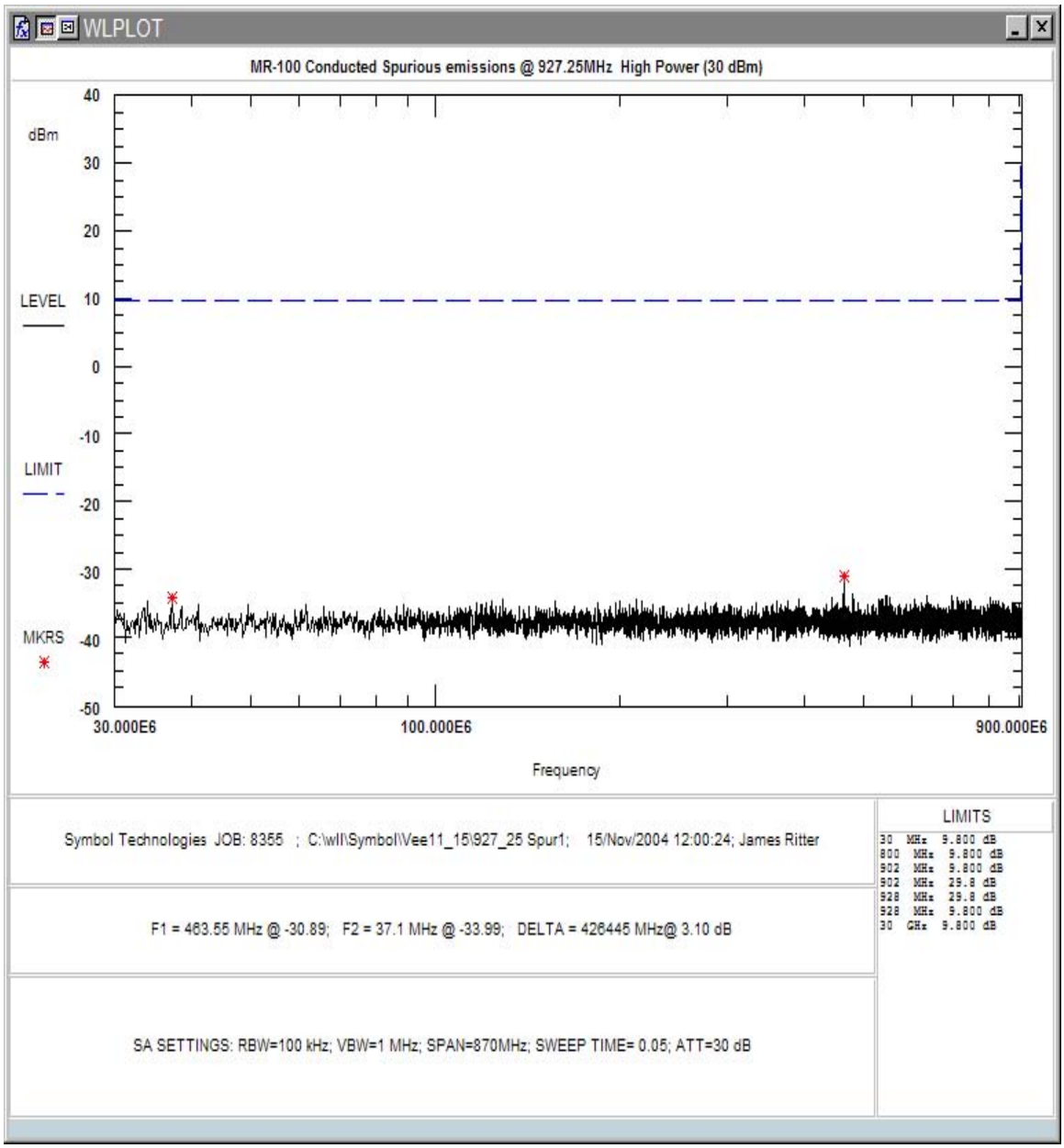


**Figure 4-38. High Power Conducted Spurious Emissions, High Channel 30 - 900MHz**

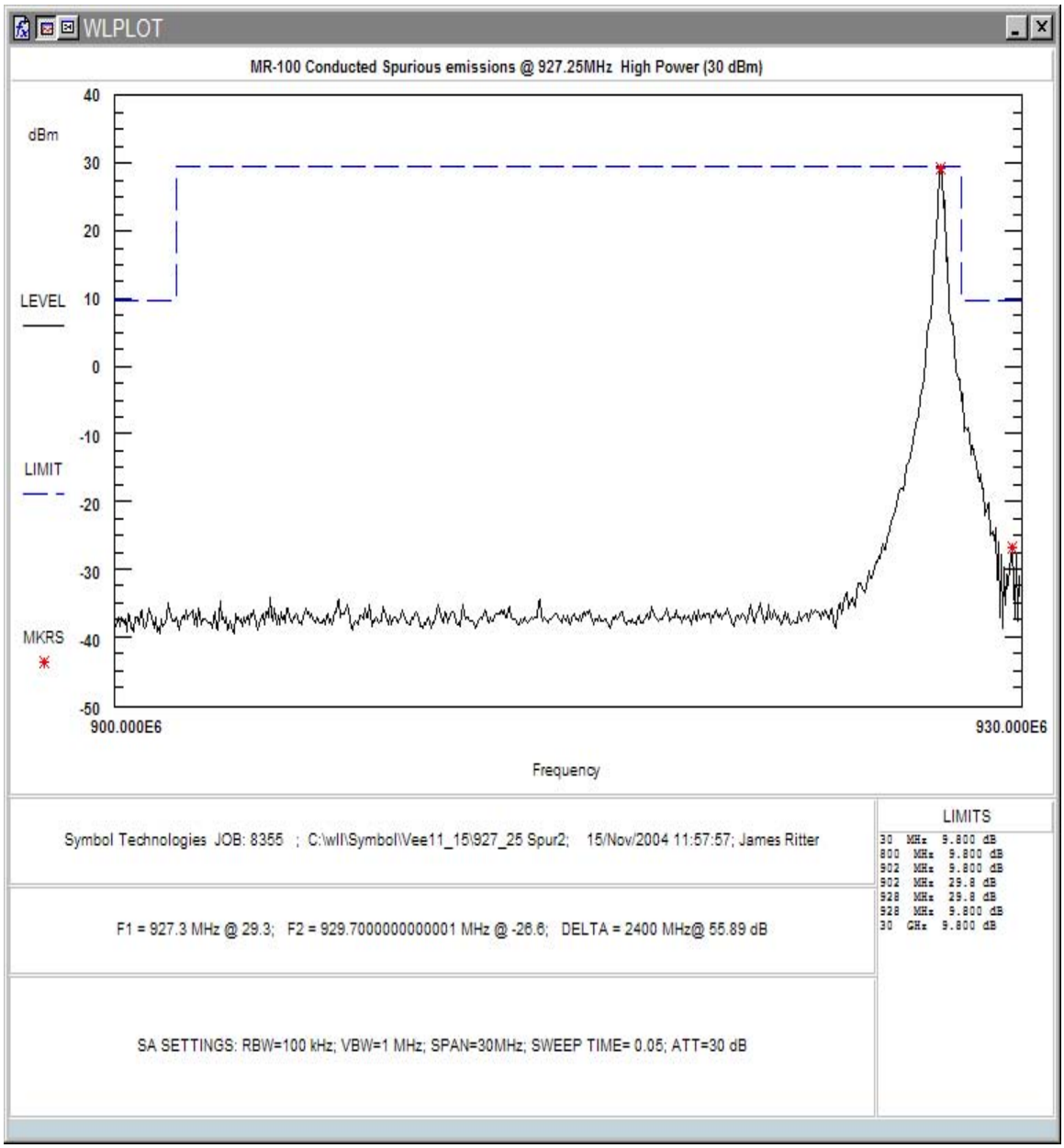


**Figure 4-39. High Power Conducted Spurious Emissions, High Channel 900 – 930MHz**

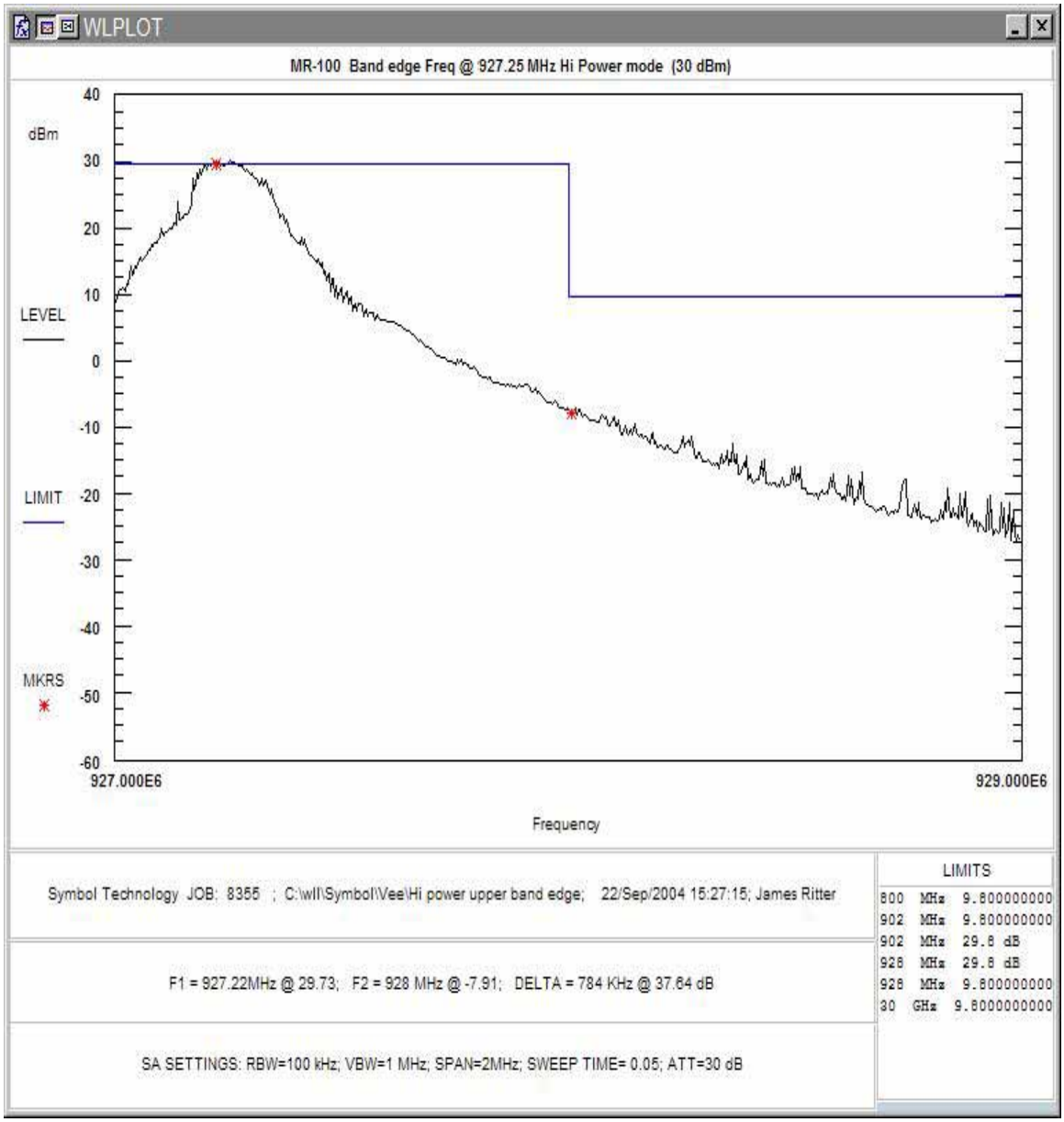


**Figure 4-40. High Power Conducted Spurious Emissions, High Channel, Bandedge**

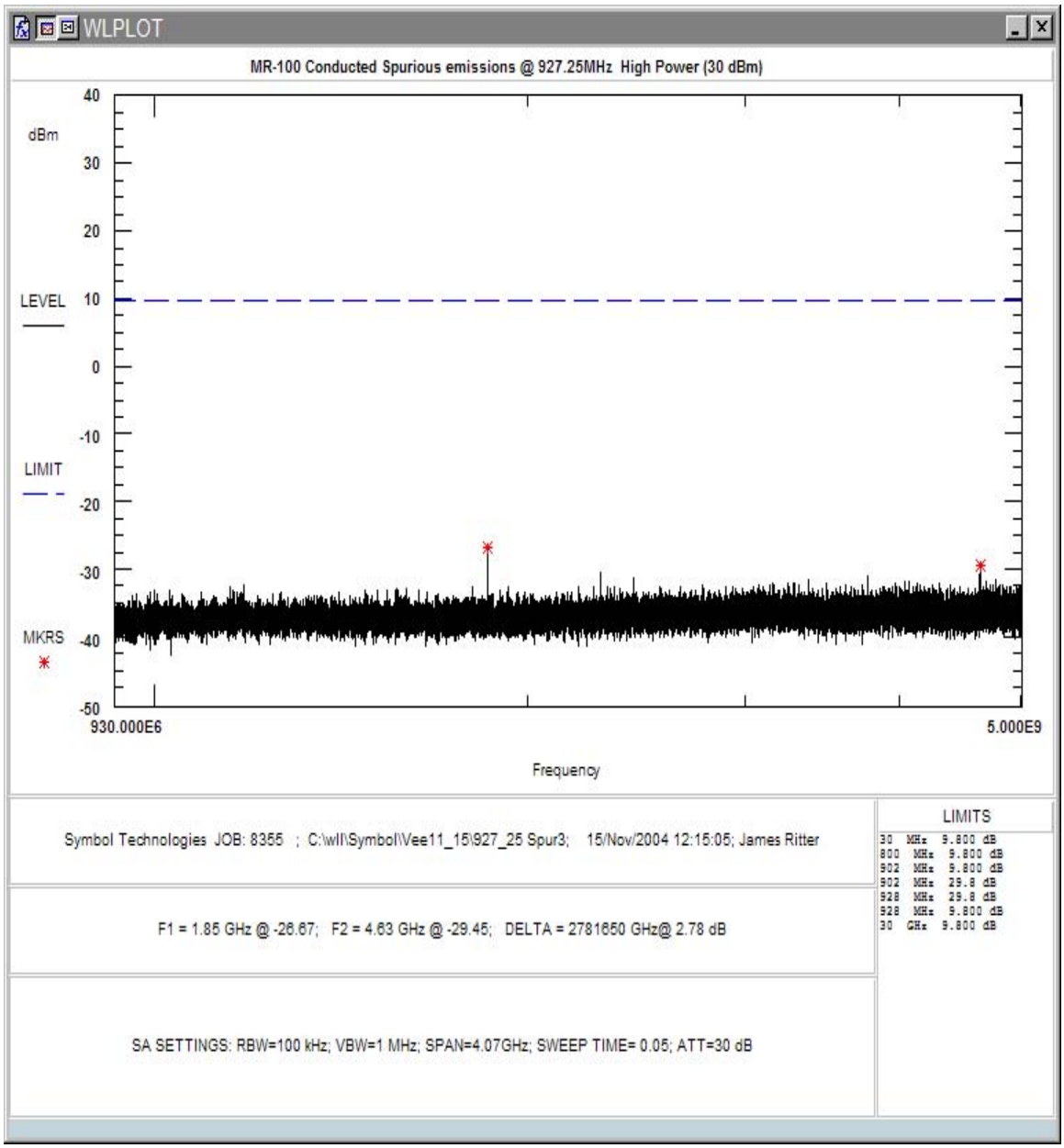


**Figure 4-41. High Power Conducted Spurious Emissions, High Channel 930MHz – 5GHz**

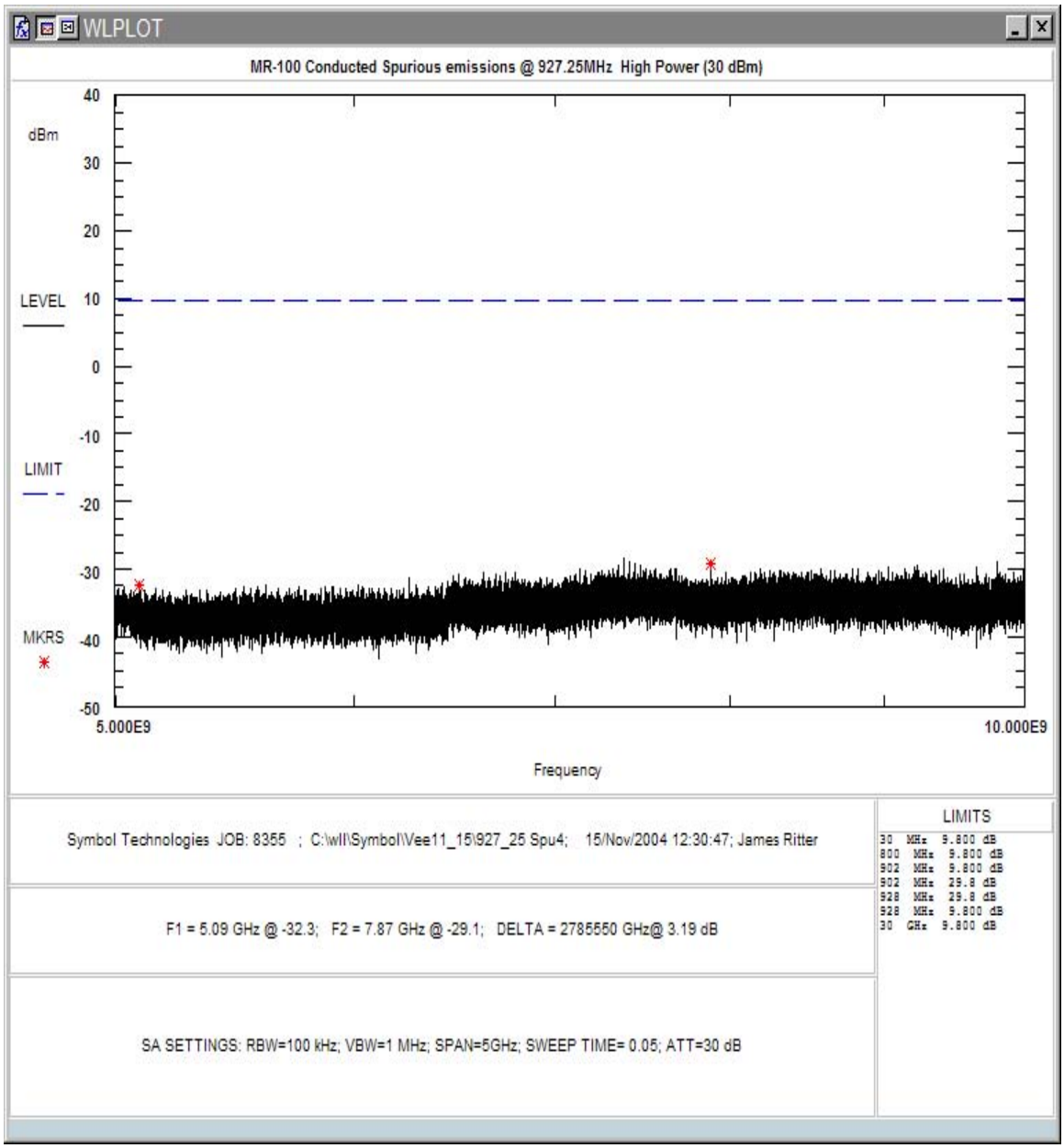


**Figure 4-42. High Power Conducted Spurious Emissions, High Channel 5 - 10GHz**

## 4.7 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.

### 4.7.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2001. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Measurements were made in accordance with the procedure described in the Public Notice DA 00-705. The unit was set to the selected channel for continuous transmissions at the maximum rate. For the average measurements the VBW was set to 100Hz based on the maximum transmit on time of 19.15ms.

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 | 100 Hz (Avg.)<br>1MHz (Peak) |

The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

| | |
|---|---|
| Spectrum Analyzer Voltage (SA Level): | V dBμV |
| Antenna Factor (Ant Corr): | AFdB/m |
| Cable Loss Correction (Cable Corr): | CCdB |
| Amplifier Gain: | GdB |
| Duty Cycle Correction Factor: | DCCFdB (if applicable) |
| Electric Field (Corr Level): | EdBμV/m = VdBμV + AFdB/m + CCdB – GdB-DCCFdB |
| To convert to linear units: | EμV/m = antilog (EdBμV/m/20) |

Worst case data are supplied in the following tables. Testing was performed to the tenth harmonic at the highest power setting. Both peak and average measurements are listed.

## Table 6: Radiated Emission Test Data, Low Channel

| | | | |
|---|---|---|---|
| CLIENT: | Symbol Tech. | DATE: | 11/5/2004 |
| TESTER: | Greg Snyder | JOB #: | 8355 |
| **EUT Information:** | | **Test Requirements:** | |
| EUT: | MR100 | TEST STANDARD: | FCC Part 15 |
| CONFIGURATION: | Low Channel 902.75MHz | DISTANCE: | 3m |
| Antenna: | Panel Antenna | CLASS: | 9 |
| S/N: | 30 | | |
| **Test Equipment/Limit:** | | | |
| ANTENNA: | A_00425 | LIMIT: | 15.209 |
| CABLE: | CSITE2_HF | AMPLIFIER (dB) | A_00066 |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. (100Hz VBW) | | | | | | | | | | | | |
| 2708.21 | V | 270.0 | 1.0 | 59.0 | 30.3 | 2.9 | 35.6 | -14.4 | 42.2 | 128.8 | 500.0 | -11.8 |
| 2708.21 | H | 180.0 | 1.0 | 61.2 | 30.3 | 2.9 | 35.6 | -14.4 | 44.4 | 166.0 | 500.0 | -9.6 |
| 3610.95 | V | 0.0 | 1.0 | 59.2 | 31.0 | 2.8 | 35.5 | -14.4 | 43.1 | 142.7 | 500.0 | -10.9 |
| 3610.95 | H | 90.0 | 1.0 | 61.3 | 31.0 | 2.8 | 35.5 | -14.4 | 45.2 | 182.4 | 500.0 | -8.8 |
| 4513.82 | V | 180.0 | 1.0 | 52.5 | 32.6 | 3.7 | 35.7 | -14.4 | 38.6 | 85.3 | 500.0 | -15.4 |
| 4513.82 | H | 225.0 | 1.0 | 61.0 | 32.6 | 3.7 | 35.7 | -14.4 | 47.1 | 226.9 | 500.0 | -6.9 |
| 5416.43 | V | 225.0 | 1.0 | 45.0 | 34.4 | 4.3 | 35.8 | -14.4 | 33.5 | 47.1 | 500.0 | -20.5 |
| 5416.43 | H | 225.0 | 1.0 | 46.0 | 34.4 | 4.3 | 35.8 | -14.4 | 34.5 | 52.8 | 500.0 | -19.5 |
| 6319.16 | V | 270.0 | 1.0 | 38.7 | 35.9 | 4.2 | 35.6 | -14.4 | 28.8 | 27.6 | 500.0 | -25.2 |
| 6319.16 | H | 270.0 | 1.0 | 44.3 | 35.9 | 4.2 | 35.6 | -14.4 | 34.4 | 52.6 | 500.0 | -19.6 |
| 7221.90 | V | 225.0 | 1.0 | 42.2 | 37.6 | 4.5 | 35.9 | -14.4 | 34.1 | 50.4 | 500.0 | -19.9 |
| 7221.90 | H | 225.0 | 1.0 | 47.0 | 37.6 | 4.5 | 35.9 | -14.4 | 38.9 | 87.7 | 500.0 | -15.1 |
| 8124.64 | V | 180.0 | 1.0 | 46.7 | 38.4 | 4.9 | 36.1 | -14.4 | 39.4 | 93.5 | 500.0 | -14.6 |
| 8124.64 | H | 180.0 | 1.0 | 46.8 | 38.4 | 4.9 | 36.1 | -14.4 | 39.5 | 94.6 | 500.0 | -14.5 |
| 9027.28 | V | 180.0 | 1.0 | 47.7 | 39.0 | 4.9 | 36.2 | -14.4 | 41.0 | 112.6 | 500.0 | -13.0 |
| 9027.28 | H | 180.0 | 1.0 | 47.3 | 39.0 | 4.9 | 36.2 | -14.4 | 40.6 | 107.5 | 500.0 | -13.4 |
| Peak | | | | | | | | | | | | |
| 2708.21 | V | 270.0 | 1.0 | 63.5 | 30.3 | 2.9 | 35.6 | 0.0 | 61.1 | 1135.2 | 5000.0 | -12.9 |
| 2708.21 | H | 180.0 | 1.0 | 65.5 | 30.3 | 2.9 | 35.6 | 0.0 | 63.1 | 1429.1 | 5000.0 | -10.9 |
| 3610.95 | V | 0.0 | 1.0 | 65.2 | 31.0 | 2.8 | 35.5 | 0.0 | 63.5 | 1494.7 | 5000.0 | -10.5 |
| 3610.95 | H | 90.0 | 1.0 | 66.8 | 31.0 | 2.8 | 35.5 | 0.0 | 65.1 | 1803.3 | 5000.0 | -8.9 |
| 4513.82 | V | 180.0 | 1.0 | 55.3 | 32.6 | 3.7 | 35.7 | 0.0 | 55.8 | 620.0 | 5000.0 | -18.1 |
| 4513.82 | H | 225.0 | 1.0 | 63.0 | 32.6 | 3.7 | 35.7 | 0.0 | 63.5 | 1499.3 | 5000.0 | -10.5 |
| 5416.43 | V | 225.0 | 1.0 | 51.3 | 34.4 | 4.3 | 35.8 | 0.0 | 54.2 | 510.0 | 5000.0 | -19.8 |
| 5416.43 | H | 225.0 | 1.0 | 51.5 | 34.4 | 4.3 | 35.8 | 0.0 | 54.4 | 521.9 | 5000.0 | -19.6 |
| 6319.16 | V | 270.0 | 1.0 | 51.0 | 35.9 | 4.2 | 35.6 | 0.0 | 55.5 | 596.6 | 5000.0 | -18.5 |
| 6319.16 | H | 270.0 | 1.0 | 53.8 | 35.9 | 4.2 | 35.6 | 0.0 | 58.3 | 823.5 | 5000.0 | -15.7 |
| 7221.90 | V | 225.0 | 1.0 | 50.0 | 37.6 | 4.5 | 35.9 | 0.0 | 56.3 | 649.8 | 5000.0 | -17.7 |
| 7221.90 | H | 180.0 | 1.0 | 47.0 | 37.6 | 4.5 | 35.9 | 0.0 | 53.3 | 460.0 | 5000.0 | -20.7 |
| 8124.64 | V | 180.0 | 1.0 | 46.7 | 38.4 | 4.9 | 36.1 | 0.0 | 53.8 | 490.7 | 5000.0 | -20.2 |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8124.64 | H | 180.0 | 1.0 | 46.8 | 38.4 | 4.9 | 36.1 | 0.0 | 53.9 | 496.4 | 5000.0 | -20.1 |
| 9027.28 | V | 180.0 | 1.0 | 47.7 | 39.0 | 4.9 | 36.2 | 0.0 | 55.4 | 590.7 | 5000.0 | -18.6 |
| 9027.28 | H | 180.0 | 1.0 | 47.3 | 39.0 | 4.9 | 36.2 | 0.0 | 55.0 | 564.1 | 5000.0 | -19.0 |

## Table 7: Radiated Emission Test Data, Mid Channel

| | | | |
|---|---|---|---|
| CLIENT: | Symbol Tech. | DATE: | 11/5/2004 |
| TESTER: | Greg Snyder | JOB #: | 8355 |
| **EUT Information:** | | **Test Requirements:** | |
| EUT: | MR100 | TEST STANDARD: | FCC Part 15 |
| CONFIGURATION: | Mid Channel 914.75MHz | DISTANCE: | 3m |
| Antenna: | Panel Ant | CLASS: | 9 |
| S/N: | 30 | | |
| **Test Equipment/Limit:** | | | |
| ANTENNA: | A_00425 | LIMIT: | 15.209 |
| CABLE: | CSITE2_HF | AMPLIFIER (dB) | A_00066 |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. (100Hz VBW) | | | | | | | | | | | | |
| 2744.25 | V | 270.0 | 1.0 | 59.0 | 30.4 | 2.9 | 35.6 | -14.4 | 42.2 | 129.1 | 500.0 | -11.8 |
| 2744.25 | H | 180.0 | 1.0 | 59.2 | 30.4 | 2.9 | 35.6 | -14.4 | 42.4 | 132.1 | 500.0 | -11.6 |
| 3659.13 | V | 0.0 | 1.0 | 62.3 | 31.0 | 2.8 | 35.5 | -14.4 | 46.2 | 204.9 | 500.0 | -7.7 |
| 3659.13 | H | 90.0 | 1.0 | 67.8 | 31.0 | 2.8 | 35.5 | -14.4 | 51.7 | 385.9 | 500.0 | -2.2 |
| 4573.70 | V | 180.0 | 1.0 | 51.4 | 32.7 | 3.8 | 35.8 | -14.4 | 37.7 | 77.0 | 500.0 | -16.3 |
| 4573.70 | H | 225.0 | 1.0 | 60.7 | 32.7 | 3.8 | 35.8 | -14.4 | 47.0 | 224.6 | 500.0 | -7.0 |
| 5488.50 | V | 225.0 | 1.0 | 49.8 | 34.5 | 4.2 | 35.7 | -14.4 | 38.4 | 82.9 | 500.0 | -15.6 |
| 5488.50 | H | 225.0 | 1.0 | 55.5 | 34.5 | 4.2 | 35.7 | -14.4 | 44.1 | 159.7 | 500.0 | -9.9 |
| 6403.25 | V | 270.0 | 1.0 | 40.0 | 36.1 | 4.2 | 35.6 | -14.4 | 30.3 | 32.8 | 500.0 | -23.7 |
| 6403.25 | H | 270.0 | 1.0 | 48.8 | 36.1 | 4.2 | 35.6 | -14.4 | 39.1 | 90.2 | 500.0 | -14.9 |
| 7318.00 | V | 225.0 | 1.0 | 51.8 | 37.7 | 4.6 | 35.9 | -14.4 | 43.8 | 154.1 | 500.0 | -10.2 |
| 7318.00 | H | 225.0 | 1.0 | 49.0 | 37.7 | 4.6 | 35.9 | -14.4 | 41.0 | 111.6 | 500.0 | -13.0 |
| 8232.75 | V | 180.0 | 1.0 | 50.0 | 38.5 | 4.9 | 36.1 | -14.4 | 42.8 | 137.9 | 500.0 | -11.2 |
| 8232.75 | H | 180.0 | 1.0 | 48.5 | 38.5 | 4.9 | 36.1 | -14.4 | 41.3 | 116.0 | 500.0 | -12.7 |
| 9147.50 | V | 180.0 | 1.0 | 48.7 | 39.2 | 5.0 | 36.2 | -14.4 | 42.2 | 128.7 | 500.0 | -11.8 |
| 9147.50 | H | 180.0 | 1.0 | 48.7 | 39.2 | 5.0 | 36.2 | -14.4 | 42.2 | 128.7 | 500.0 | -11.8 |
| Peak | | | | | | | | | | | | |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2744.25 | V | 270.0 | 1.0 | 63.5 | 30.4 | 2.9 | 35.6 | 0.0 | 61.1 | 1137.7 | 5000.0 | -12.9 |
| 2744.25 | H | 180.0 | 1.0 | 63.5 | 30.4 | 2.9 | 35.6 | 0.0 | 61.1 | 1137.7 | 5000.0 | -12.9 |
| 3659.13 | V | 0.0 | 1.0 | 68.2 | 31.0 | 2.8 | 35.5 | 0.0 | 66.5 | 2120.8 | 5000.0 | -7.4 |
| 3659.13 | H | 90.0 | 1.0 | 73.7 | 31.0 | 2.8 | 35.5 | 0.0 | 72.0 | 3994.8 | 5000.0 | -1.9 |
| 4573.70 | V | 180.0 | 1.0 | 55.3 | 32.7 | 3.8 | 35.8 | 0.0 | 56.0 | 633.0 | 5000.0 | -18.0 |
| 4573.70 | H | 225.0 | 1.0 | 63.5 | 32.7 | 3.8 | 35.8 | 0.0 | 64.2 | 1627.1 | 5000.0 | -9.8 |
| 5488.50 | V | 225.0 | 1.0 | 56.0 | 34.5 | 4.2 | 35.7 | 0.0 | 59.0 | 888.0 | 5000.0 | -15.0 |
| 5488.50 | H | 225.0 | 1.0 | 60.3 | 34.5 | 4.2 | 35.7 | 0.0 | 63.3 | 1456.8 | 5000.0 | -10.7 |
| 6403.25 | V | 270.0 | 1.0 | 51.6 | 36.1 | 4.2 | 35.6 | 0.0 | 56.3 | 653.7 | 5000.0 | -17.7 |
| 6403.25 | H | 270.0 | 1.0 | 48.8 | 36.1 | 4.2 | 35.6 | 0.0 | 53.5 | 473.6 | 5000.0 | -20.5 |
| 7318.00 | V | 225.0 | 1.0 | 51.8 | 37.7 | 4.6 | 35.9 | 0.0 | 58.2 | 808.7 | 5000.0 | -15.8 |
| 7318.00 | H | 180.0 | 1.0 | 49.0 | 37.7 | 4.6 | 35.9 | 0.0 | 55.4 | 585.9 | 5000.0 | -18.6 |
| 8232.75 | V | 180.0 | 1.0 | 50.0 | 38.5 | 4.9 | 36.1 | 0.0 | 57.2 | 723.7 | 5000.0 | -16.8 |
| 8232.75 | H | 180.0 | 1.0 | 48.5 | 38.5 | 4.9 | 36.1 | 0.0 | 55.7 | 608.9 | 5000.0 | -18.3 |
| 9147.50 | V | 180.0 | 1.0 | 48.7 | 39.2 | 5.0 | 36.2 | 0.0 | 56.6 | 675.2 | 5000.0 | -17.4 |
| 9147.50 | H | 180.0 | 1.0 | 48.7 | 39.2 | 5.0 | 36.2 | 0.0 | 56.6 | 675.2 | 5000.0 | -17.4 |

## Table 8: Radiated Emission Test Data, High Channel

| | | | |
|---|---|---|---|
| CLIENT: | Symbol Tech. | DATE: | 11/5/2004 |
| TESTER: | Greg Snyder | JOB #: | 8355 |
| **EUT Information:** | | **Test Requirements:** | |
| EUT: | MR100 | TEST STANDARD: | FCC Part 15 |
| CONFIGURATION: | Hi Channel 927.25MHz | DISTANCE: | 3m |
| Antenna: | Panel Ant (H Polarity Only) | CLASS: | 9 |
| S/N: | 30 | | |
| **Test Equipment/Limit:** | | | |
| ANTENNA: | A_00425 | LIMIT: | 15.209 |
| CABLE: | CSITE2_HF | AMPLIFIER (dB) | A_00066 |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. (100Hz VBW) | | | | | | | | | | | | |
| 2781.75 | V | 270.0 | 1.0 | 58.3 | 30.4 | 2.9 | 35.7 | -14.4 | 41.5 | 119.4 | 500.0 | -12.4 |
| 2781.75 | H | 180.0 | 1.0 | 61.2 | 30.4 | 2.9 | 35.7 | -14.4 | 44.4 | 166.7 | 500.0 | -9.5 |
| 3709.00 | V | 0.0 | 1.0 | 57.5 | 31.1 | 2.8 | 35.5 | -14.4 | 41.5 | 118.4 | 500.0 | -12.5 |
| 3709.00 | H | 90.0 | 1.0 | 64.0 | 31.1 | 2.8 | 35.5 | -14.4 | 48.0 | 250.3 | 500.0 | -6.0 |
| 4636.25 | V | 180.0 | 1.0 | 47.0 | 32.9 | 3.9 | 35.8 | -14.4 | 33.5 | 47.6 | 500.0 | -20.4 |

| Frequency (MHz) | Polarity H/V | Az Deg | Ant. Hght (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Duty Cycle dB | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin dB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4636.25 | H | 225.0 | 1.0 | 57.0 | 32.9 | 3.9 | 35.8 | -14.4 | 43.5 | 150.4 | 500.0 | -10.4 |
| 5563.50 | V | 225.0 | 1.0 | 48.0 | 34.6 | 4.2 | 35.7 | -14.4 | 36.7 | 68.3 | 500.0 | -17.3 |
| 5563.50 | H | 225.0 | 1.0 | 50.9 | 34.6 | 4.2 | 35.7 | -14.4 | 39.6 | 95.4 | 500.0 | -14.4 |
| 6490.75 | V | 270.0 | 1.0 | 42.0 | 36.3 | 4.2 | 35.6 | -14.4 | 32.5 | 42.2 | 500.0 | -21.5 |
| 6490.75 | H | 270.0 | 1.0 | 42.8 | 36.3 | 4.2 | 35.6 | -14.4 | 33.3 | 46.3 | 500.0 | -20.7 |
| 7418.00 | V | 225.0 | 1.0 | 47.3 | 37.8 | 4.6 | 35.9 | -14.4 | 39.4 | 92.9 | 500.0 | -14.6 |
| 7418.00 | H | 225.0 | 1.0 | 46.7 | 37.8 | 4.6 | 35.9 | -14.4 | 38.8 | 86.7 | 500.0 | -15.2 |
| 8345.25 | V | 180.0 | 1.0 | 47.3 | 38.6 | 4.9 | 36.1 | -14.4 | 40.2 | 101.9 | 500.0 | -13.8 |
| 8345.25 | H | 180.0 | 1.0 | 47.0 | 38.6 | 4.9 | 36.1 | -14.4 | 39.9 | 98.5 | 500.0 | -14.1 |
| 9272.50 | V | 180.0 | 1.0 | 46.8 | 39.3 | 5.0 | 36.3 | -14.4 | 40.5 | 105.4 | 500.0 | -13.5 |
| 9272.50 | H | 180.0 | 1.0 | 47.1 | 39.3 | 5.0 | 36.3 | -14.4 | 40.8 | 109.1 | 500.0 | -13.2 |
| Peak | | | | | | | | | | | | |
| 2781.75 | V | 270.0 | 1.0 | 64.5 | 30.4 | 2.9 | 35.7 | 0.0 | 62.1 | 1279.4 | 5000.0 | -11.8 |
| 2781.75 | H | 180.0 | 1.0 | 65.7 | 30.4 | 2.9 | 35.7 | 0.0 | 63.3 | 1468.9 | 5000.0 | -10.6 |
| 3709.00 | V | 0.0 | 1.0 | 63.2 | 31.1 | 2.8 | 35.5 | 0.0 | 61.6 | 1198.0 | 5000.0 | -12.4 |
| 3709.00 | H | 90.0 | 1.0 | 70.2 | 31.1 | 2.8 | 35.5 | 0.0 | 68.6 | 2682.1 | 5000.0 | -5.4 |
| 4636.25 | V | 180.0 | 1.0 | 51.3 | 32.9 | 3.9 | 35.8 | 0.0 | 52.3 | 410.9 | 5000.0 | -21.7 |
| 4636.25 | H | 225.0 | 1.0 | 60.3 | 32.9 | 3.9 | 35.8 | 0.0 | 61.2 | 1154.1 | 5000.0 | -12.7 |
| 5563.50 | V | 225.0 | 1.0 | 53.4 | 34.6 | 4.2 | 35.7 | 0.0 | 56.5 | 667.4 | 5000.0 | -17.5 |
| 5563.50 | H | 225.0 | 1.0 | 55.6 | 34.6 | 4.2 | 35.7 | 0.0 | 58.7 | 859.7 | 5000.0 | -15.3 |
| 6490.75 | V | 270.0 | 1.0 | 51.3 | 36.3 | 4.2 | 35.6 | 0.0 | 56.2 | 646.2 | 5000.0 | -17.8 |
| 6490.75 | H | 270.0 | 1.0 | 51.3 | 36.3 | 4.2 | 35.6 | 0.0 | 56.2 | 646.2 | 5000.0 | -17.8 |
| 7418.00 | V | 225.0 | 1.0 | 47.3 | 37.8 | 4.6 | 35.9 | 0.0 | 53.8 | 487.5 | 5000.0 | -20.2 |
| 7418.00 | H | 180.0 | 1.0 | 46.7 | 37.8 | 4.6 | 35.9 | 0.0 | 53.2 | 454.9 | 5000.0 | -20.8 |
| 8345.25 | V | 180.0 | 1.0 | 47.3 | 38.6 | 4.9 | 36.1 | 0.0 | 54.6 | 535.0 | 5000.0 | -19.4 |
| 8345.25 | H | 180.0 | 1.0 | 47.0 | 38.6 | 4.9 | 36.1 | 0.0 | 54.3 | 516.8 | 5000.0 | -19.7 |
| 9272.50 | V | 180.0 | 1.0 | 46.8 | 39.3 | 5.0 | 36.3 | 0.0 | 54.9 | 553.0 | 5000.0 | -19.1 |
| 9272.50 | H | 180.0 | 1.0 | 47.1 | 39.3 | 5.0 | 36.3 | 0.0 | 55.2 | 572.5 | 5000.0 | -18.8 |

## 4.8 AC Powerline Conducted Emissions: (FCC Part §15.207)

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 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 or peak, 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.

Data is recorded in Table 9.

**Table 9. Conducted Emissions Test Data Sheet**

| | | | |
|---|---|---|---|
| CLIENT: | Symbol Technologies | DATE: | 11/17/2004 |
| TEST STANDARD: | FCC Part 15 | JOB #: | 8355 |
| MODEL: | MR100 w plate antenna | CLASS: | FCC_B |
| TESTER: | James Ritter | TEST SITE: | CSITE2_CE |
| TEST VOLTAGE: | 120 VAC | | |

LINE 1 - NEUTRAL

| Frequency MHz | Level QP dBuV | Cable Loss dB | Limit QP dBuV | Level Corr dBuV | Margin QP dB | Level AVG dBuV | Cable Loss dB | Level Corr dBuV | Limit AVG dBuV | Margin AVG dB |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.16 | 44.3 | 10.7 | 65.7 | 55.0 | -10.7 | 13.8 | 10.7 | 24.5 | 55.7 | -31.2 |
| 0.66 | 38.0 | 10.8 | 56.0 | 48.8 | -7.2 | 26.9 | 10.8 | 37.7 | 46.0 | -8.3 |
| 1.39 | 30.0 | 10.9 | 56.0 | 40.9 | -15.1 | 23.3 | 10.9 | 34.2 | 46.0 | -11.8 |
| 2.78 | 28.5 | 11.2 | 56.0 | 39.7 | -16.3 | 20.8 | 11.2 | 32.0 | 46.0 | -14.0 |
| 5.83 | 28.1 | 11.6 | 60.0 | 39.7 | -20.3 | 28.1 | 11.6 | 39.7 | 50.0 | -10.3 |
| 6.83 | 32.0 | 11.6 | 60.0 | 43.6 | -16.4 | 25.8 | 11.6 | 37.4 | 50.0 | -12.6 |
| 8.16 | 28.8 | 11.8 | 60.0 | 40.6 | -19.4 | 28.8 | 11.8 | 40.6 | 50.0 | -9.4 |
| 23.16 | 26.0 | 12.8 | 60.0 | 38.8 | -21.2 | 26.0 | 12.8 | 38.8 | 50.0 | -11.2 |

LINE 2 – PHASE

| Frequency MHz | Level QP dBuV | Cable Loss dB | Limit QP dBuV | Level Corr dBuV | Margin QP dB | Level AVG dBuV | Cable Loss dB | Level Corr dBuV | Limit AVG dBuV | Margin AVG dB |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.16 | 44.0 | 10.7 | 65.7 | 54.7 | -11.0 | 14.4 | 10.7 | 25.1 | 55.7 | -30.6 |
| 0.66 | 37.4 | 10.8 | 56.0 | 48.2 | -7.8 | 28.8 | 10.8 | 39.6 | 46.0 | -6.4 |
| 1.39 | 28.6 | 10.9 | 56.0 | 39.5 | -16.5 | 28.6 | 10.9 | 39.5 | 46.0 | -6.5 |
| 2.78 | 28.8 | 11.2 | 56.0 | 40.0 | -16.0 | 28.8 | 11.2 | 40.0 | 46.0 | -6.0 |
| 5.83 | 29.0 | 11.6 | 60.0 | 40.6 | -19.4 | 29.0 | 11.6 | 40.6 | 50.0 | -9.4 |
| 6.83 | 31.4 | 11.6 | 60.0 | 43.0 | -17.0 | 31.4 | 11.6 | 43.0 | 50.0 | -7.0 |
| 8.16 | 30.6 | 11.8 | 60.0 | 42.4 | -17.6 | 30.6 | 11.8 | 42.4 | 50.0 | -7.6 |
| 23.16 | 24.6 | 12.8 | 60.0 | 37.4 | -22.6 | 24.6 | 12.8 | 37.4 | 50.0 | -12.6 |