Washington Laboratories, Ltd.

# FCC Certification Test Report
# For the
# Mine Safety Appliance
# FireHawk M7 2.4 GHz Reader /ID Tag Writer Transceiver
# FCC ID: P9R-10083876

WLL REPORT# **9849-03 Rev 1**
**9/21/2007**

Prepared for:

**Mine Safety Appliance**
**1000 Cranberry Woods Drive**
**Cranberry Township, PA 16066**

Prepared By:

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

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Prepared by:

Steven Dovell
Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

 

# Abstract

This report has been prepared on behalf of Mine Safety Appliance to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System Transmitter under Part 15.247 of the FCC Rules and Regulations.

This Certification Test Report documents the test configuration and test results for a Mine Safety Appliance FireHawk M7 2.4 GHz Reader /ID Tag Writer Transceiver operating in the 802.11b mode.

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

The Mine Safety Appliance FireHawk M7 2.4 GHz Reader /ID Tag Writer Transceiver complied with the limits for a Digital Transmission System Transmitter device under FCC Part 15.247.

 

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# 1 Introduction

## 1.1 Compliance Statement

The Mine Safety Appliance FireHawk M7 2.4 GHz Reader /ID Tag Writer Transceiver complied with the limits for a Digital Transmission System Transmitter device under FCC Part 15.247.

## 1.2 Test Scope Summary

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with the 2003 version of ANSI C63.4. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

| Test Specification | Specific Description | Date Completed | Result | Modifications? (Y/N) |
|---|---|---|---|---|
| CFR47 Part 2.1046 | RF Power Output | 8/20/07 | Complied | No |
| CFR47 Part 2.1049 | Occupied Bandwidth | 8/20/07 | Complied | No |
| CFR47 Part 2.1051 | Conducted Spurious Emissions at Antenna Terminals | 8/20/07 | Complied | No |
| CFR47 Part 2.1053 | Radiated Spurious Emissions | 8/21/07 | Complied | No |
| CFR47 Part 15.247 | Power Spectral Density | 8/20/07 | Complied | No |

## 1.3 Contract Information

Customer: Mine Safety Appliance
1000 Cranberry Woods Drive
Cranberry Township, PA 16066

Quotation Number: 63621

## 1.4 Test Dates

Testing performed on the following date(s): 8/20/2007 to 8/21/2007

## 1.5 Test and Support Personnel

Washington Laboratories, LTD Steven Dovell

Client Representative Greg Imblum

# 2 Equipment Under Test

## 2.1 EUT Identification & Description

**Firehawk® M7 - Reader / ID Tag Writer –** The Tag Writer serves as an interface between a PC and the Control Module (CM) and helps facilitate the communications between the two. Data and settings can be downloaded from the CM to a PC and the CM can be configured by the PC through the Reader/ID Tag Writer interface. The Reader/ ID Tag Writer functionality is transparent to the user. All of these functions are controlled by the Link PC software. The function blocks of the Reader/ ID Tag Writer circuit are described below:

**PC Link -** The Reader/ID Tag Writer is powered and controlled via a USB port. The ICM Tx Tag Writer is compatible with the USB 1.1 standard. The maximum current drawn by the Tag Writer can exceed one unit load of current as specified by the USB 1.1 standard. If the host PC can not supply the unit load, the Tag Writer has a 6V DC auxiliary power input supplied by a wall adapter.

**Table 1. Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Mine Safety Appliance |
| FCC ID: | P9R-10083876 |
| Model: | FireHawk M7 2.4 GHz Reader /ID Tag Writer Transceiver |
| FCC Rule Parts: | §15.247 |
| Frequency Range: | 2405-24805MHz |
| Maximum Output Power: | 0.0437mW |
| Modulation: | DSSS |
| Occupied Bandwidth: | 1.624MHz (6dB BW) |
| Keying: | Automatic |
| Type of Information: | Data 802.11b |
| Number of Channels: | 16 |
| Power Output Level | Fixed |
| Antenna Type | Integral (50Ω, unbalanced SMD chip) 1.5dBi |
| Interface Cables: | None |
| Power Source & Voltage: | 6VDC USB or Wall mount Power Supply |

## 2.2 Test Configuration

The EUT was configured with the following components:

**Table 2: EUT Test Configuration**

| Description | Manufacturer/Model Number | Serial Number | Revision |
|---|---|---|---|
| FireHawk M7 Reader /ID Tag Writer | Mine Safety Appliances | N/A | 1 |
| Laptop PC | Dell/610 | CN-0M7181-48643-667-1237 | N/A |
| CRM power Supply | DSA-0151A-06/ DPS060200-PS | N/A | N/A |

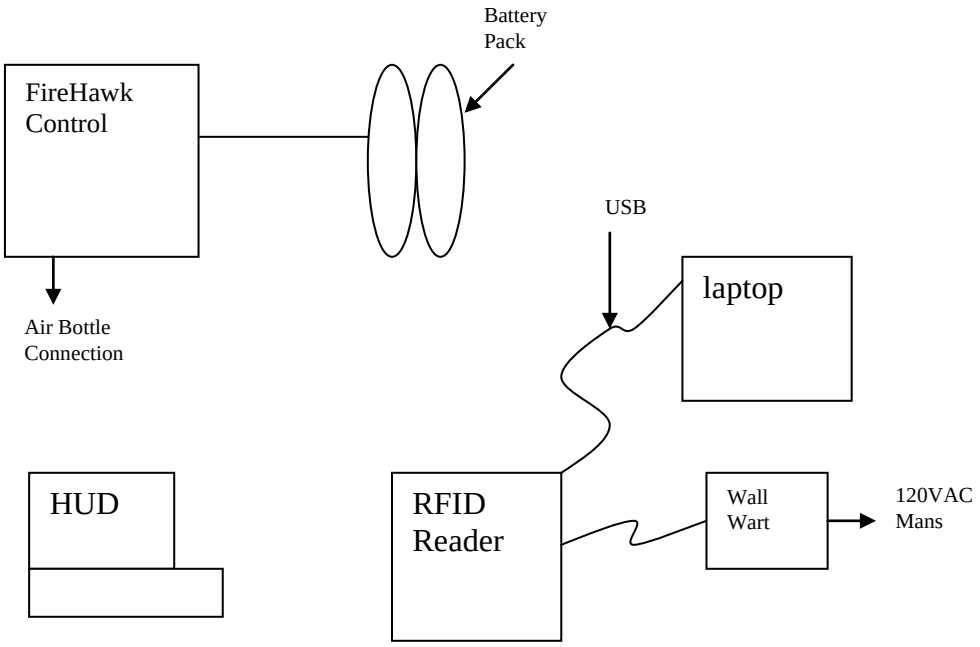



**Figure 1: Radiated Emission Test Configuration**

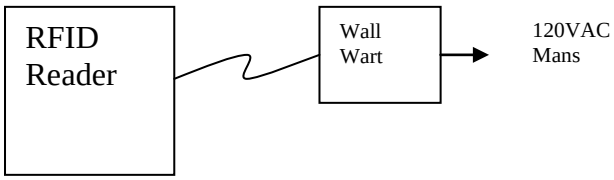



**Figure 2: Conducted Emissions Configuration**

Conducted Emission test were performed without the USB connected. The laptop was only used to power the device and did not provide any data support.

## 2.3 Testing Algorithm

The EUT was configured to constantly transmit channel 1, channel 8 or channel 16, modulated.

## 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

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:

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 = $0.5\ (2^2 + 1^2 + 4^2)^{1/2}$ = ±2.3 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**

| WLL Asset # | Manufacturer Model/Type | Function | Cal. Due |
|---|---|---|---|
| 00618 | HP 8563A | ANALYZER, SPECTRUM | 02/09/2008 |
| 00541 | MEGAPHASE, LLC TM40-K1K1-36 | CABLE, 36" BENCH TEST CABLE | 09/11/2007 |
| 00068 | HP, 85650A | ADAPTER, QP | 7/6/2008 |
| 00072 | HP, 8568B | ANALYZER, SPECTRUM | 7/6/2008 |
| 00070 | HP, 85685A | PRESELECTOR, RF W/OPT 8ZE | 7/6/2008 |
| 00382 | SUNOL, JB1 | ANTENNA, BICONLOG | 2/2/2008 |
| 00124 | SOLAR, 8012-50-R-24-BNC | LISN | 9/26/2007 |
| 00053 | HP, 11947A | LIMITER, TRANSIENT | 4/9/2008 |
| 00126 | SOLAR, 8028-50-TS-24-BNC | LISN | 2/1/2008 |
| 00125 | SOLAR, 8028-50-TS-24-BNC | LISN | 2/1/2008 |
| 00072 | HP, 8568B | ANALYZER, SPECTRUM | 7/6/2008 |
| 00068 | HP, 85650A | ADAPTER, QP | 7/6/2008 |
| 00053 | HP, 11947A | LIMITER, TRANSIENT | 4/9/2008 |

# 4 Test Results

## 4.1 Duty Cycle Correction

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

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

Duty cycle correction was not required.

## 4.2 RF Power Output: (FCC Part §2.1046)

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

**Table 4. RF Power Output**

| Channel | Frequency | dBm | Limit | mWatts | Pass/Fail |
|---|---|---|---|---|---|
| 1 | 2405MHz | -13.6 | +30dBm | 0.04365 | Pass |
| 8 | 2440MHz | -14.3 | +30dBm | 0.03715 | Pass |
| 16 | 2480MHz | -15.7 | +30dBm | 0.02692 | Pass |

**Test Engineer(s):** Steven Dovell

**Test Date(s):** 8/20/07 & 8/20/07

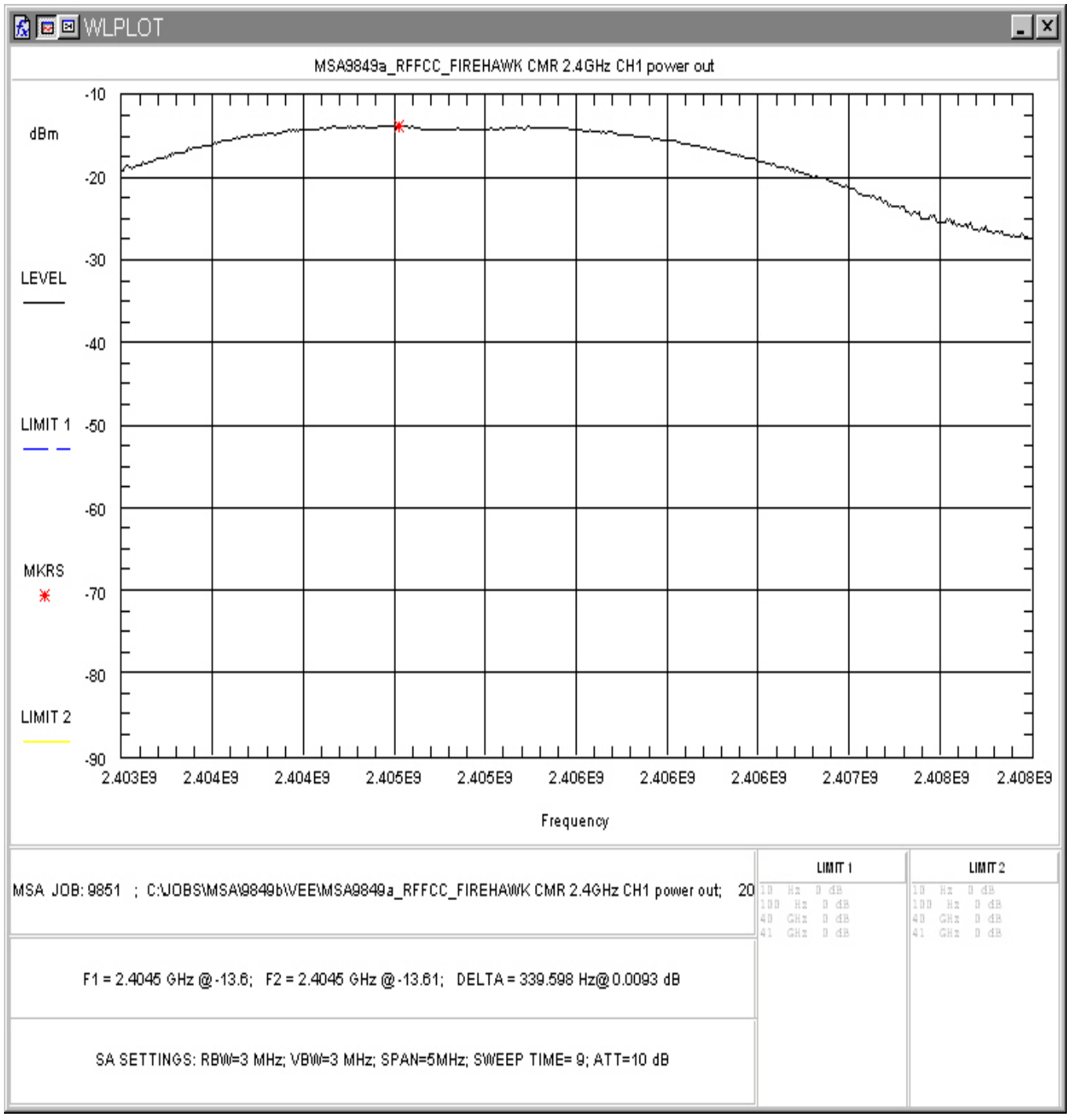



**Figure 3: RF Peak Power, Low Channel**

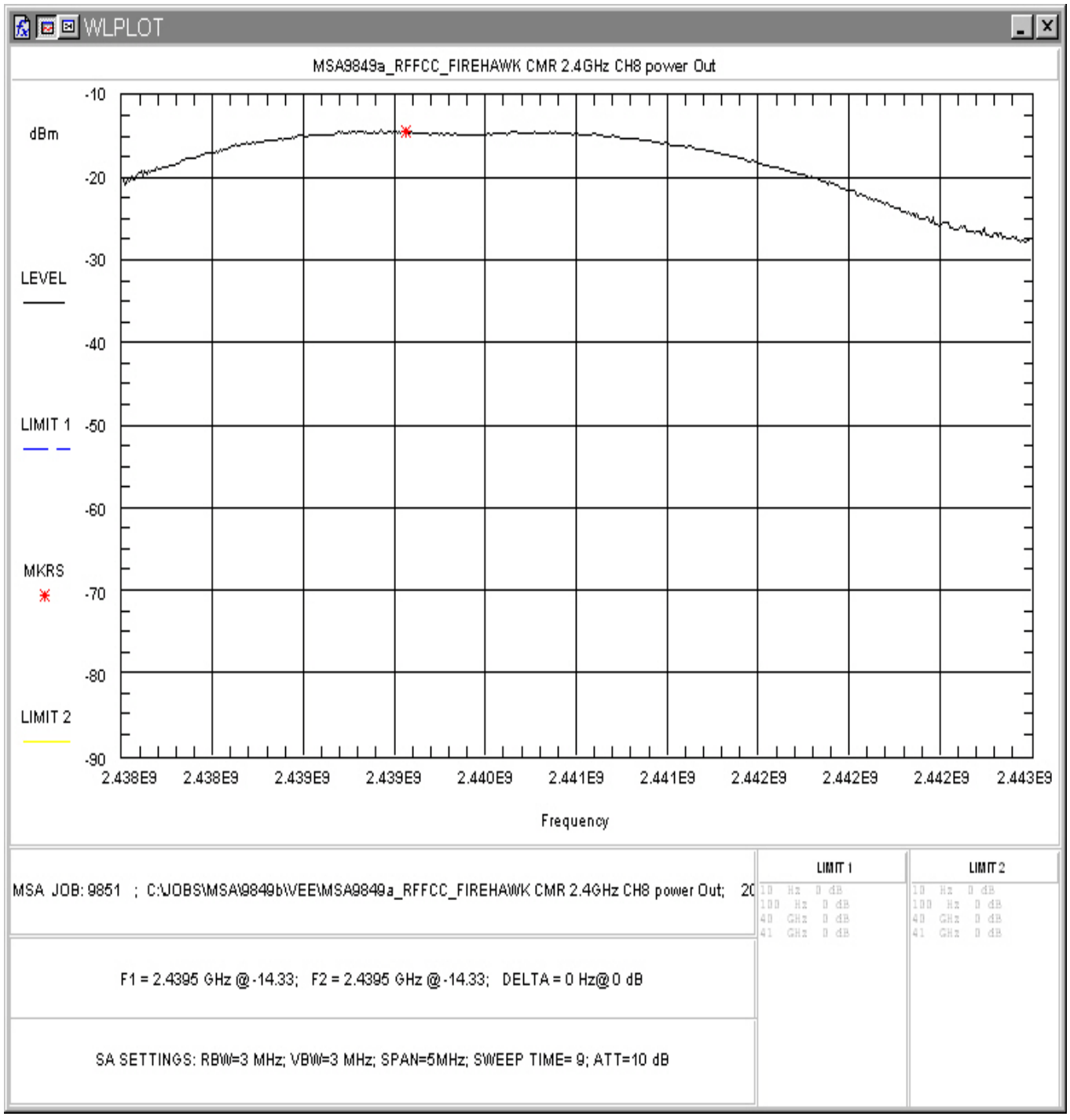



**Figure 4: RF Peak Power, Mid Channel**

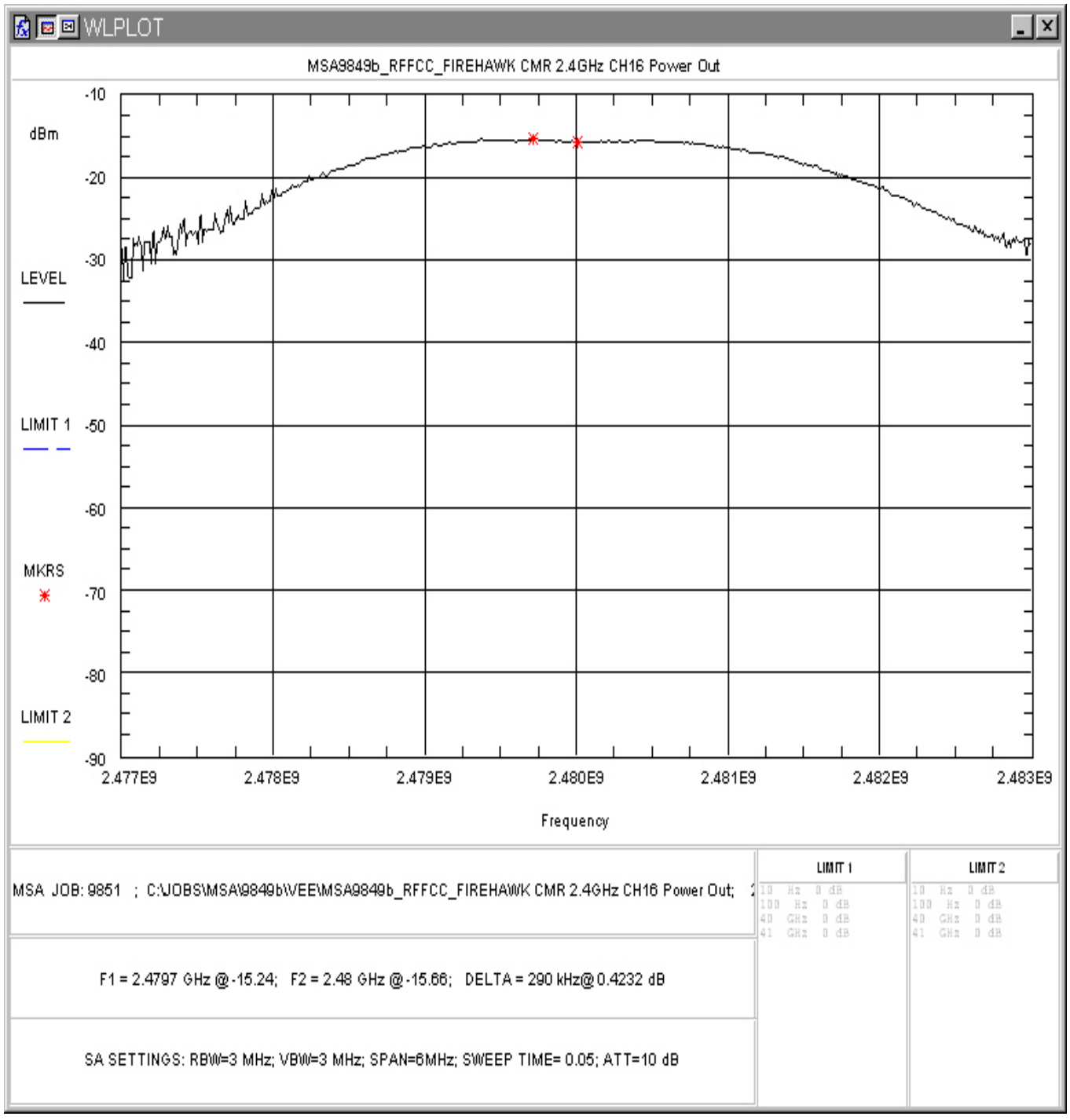



**Figure 5: Peak Power, High Channel**

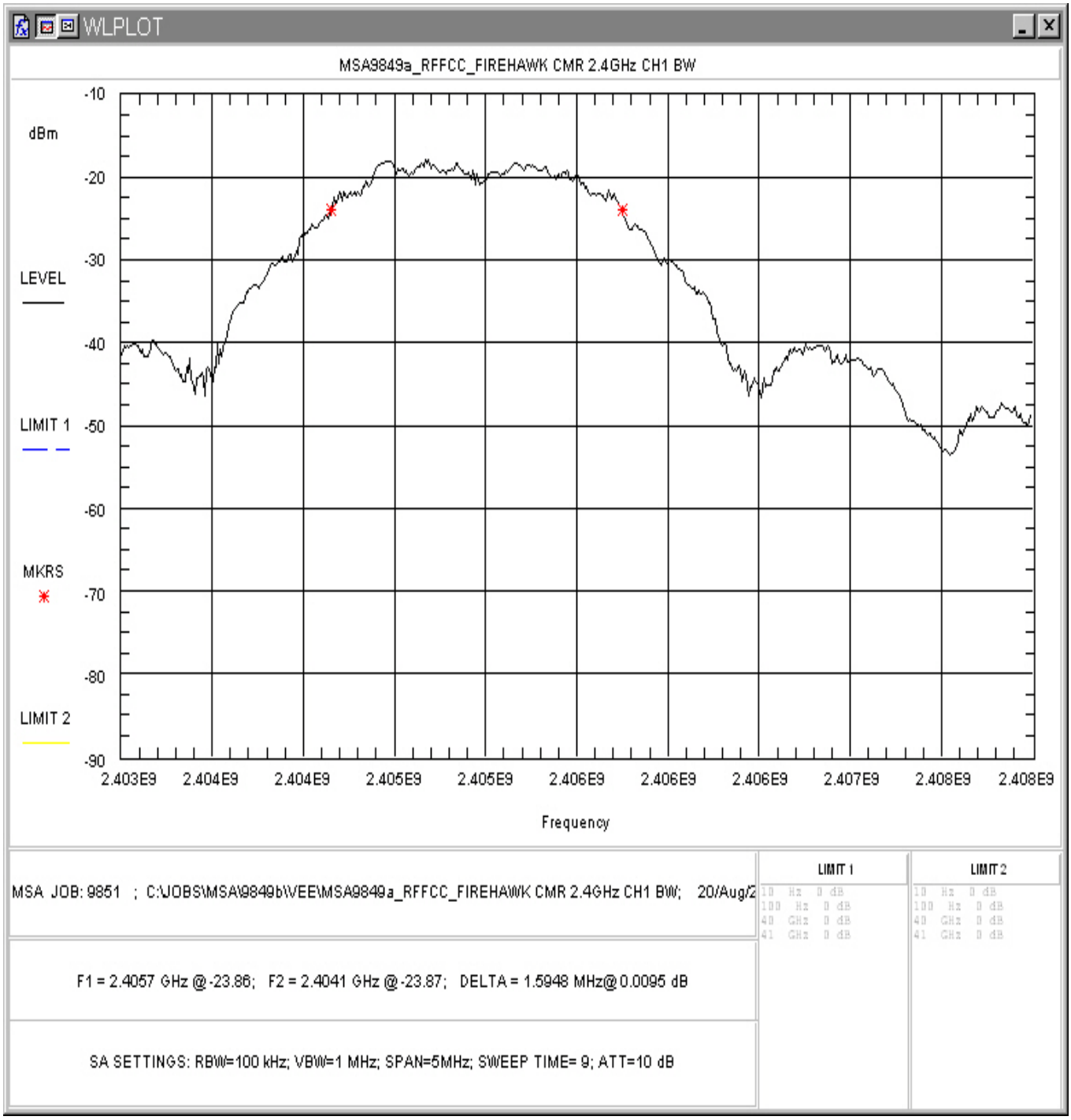
 

## 4.3 Occupied Bandwidth: (FCC Part §2.1049)

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

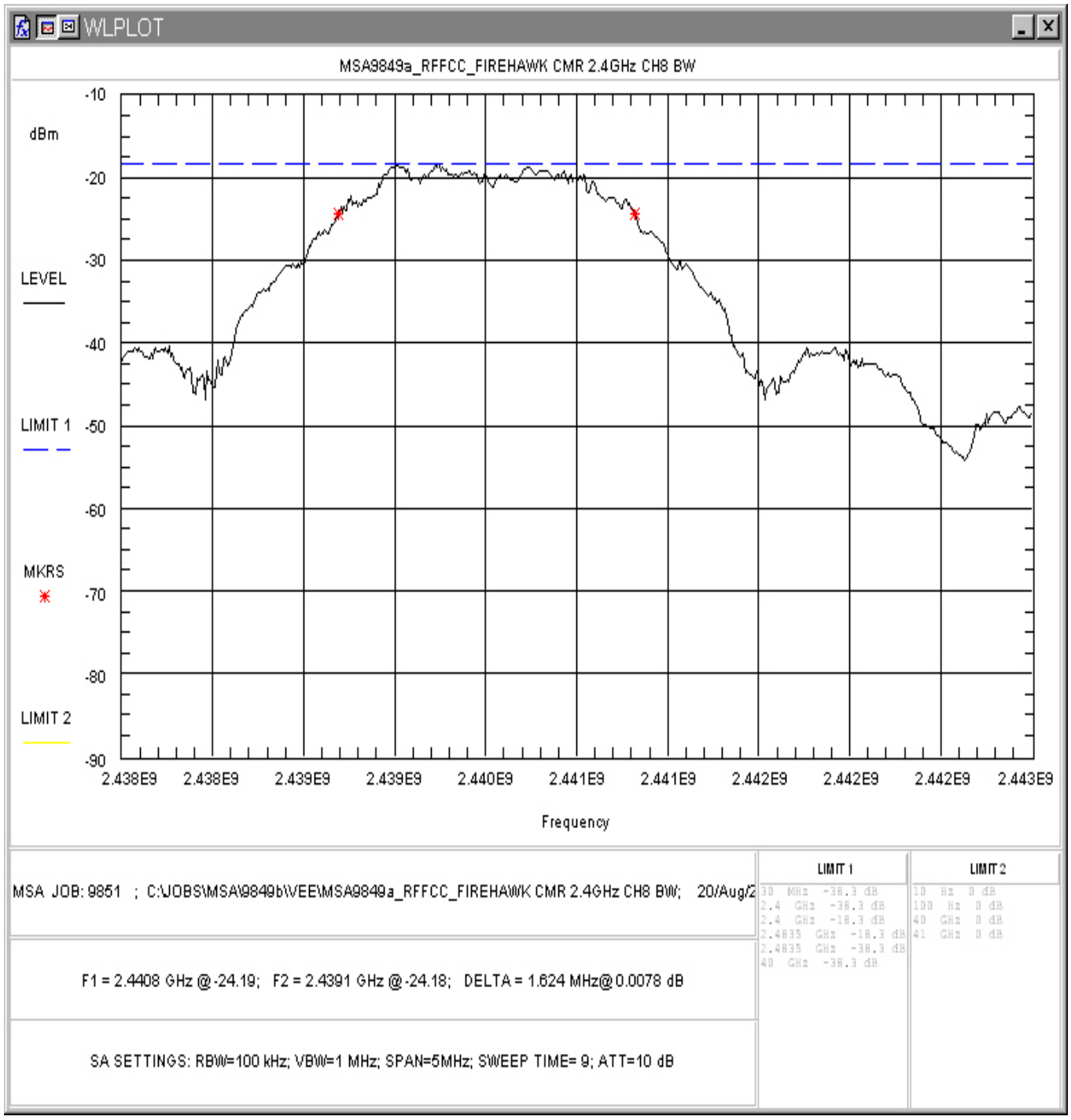
For Direct Sequence spread spectrum Systems, FCC Part 15.247 requires the maximum -6 dB bandwidth must be greater the 500kHz.

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



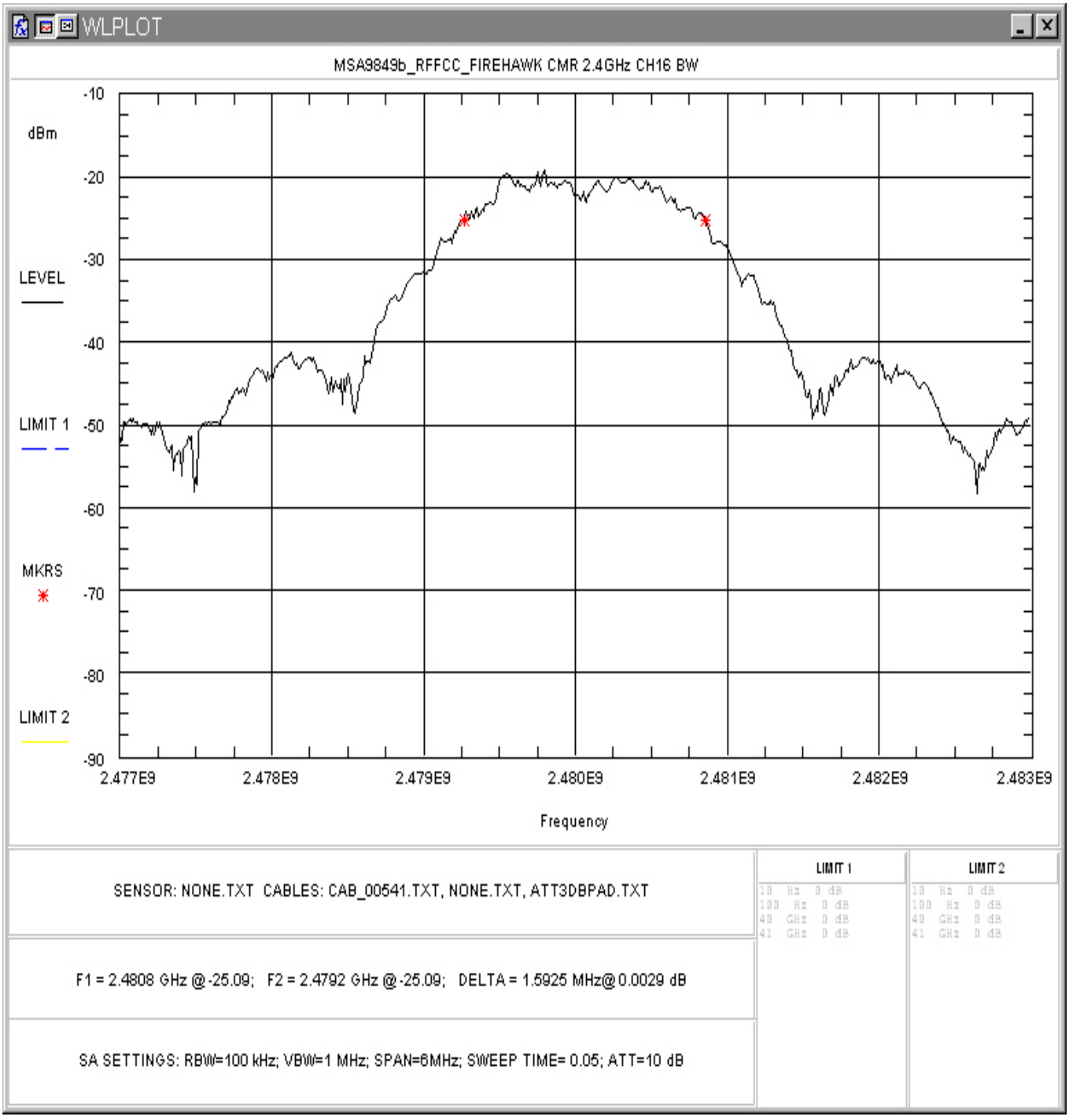

 

## Figure 6: Occupied Bandwidth, Low Channel



## Figure 7: Occupied Bandwidth, Mid Channel




## Figure 8: Occupied Bandwidth, High Channel

Table 5 provides a summary of the Occupied Bandwidth Results.

**Table 5. Occupied Bandwidth Results**

| Channel | Frequency | -6dB Bandwidth |
|---|---|---|
| 1 | 2405MHz | 1.548MHz |
| 8 | 2440MHz | 1.624MHz |
| 16 | 2480MHz | 1.592MHz |

**Test Engineer(s):** Steven Dovell

**Test Date(s):** 8/20/07 & 8/21/07

## 4.4 Power Spectral Density (FCC Part 15.247/RSS-210)

For DSSS devices, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band.

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.

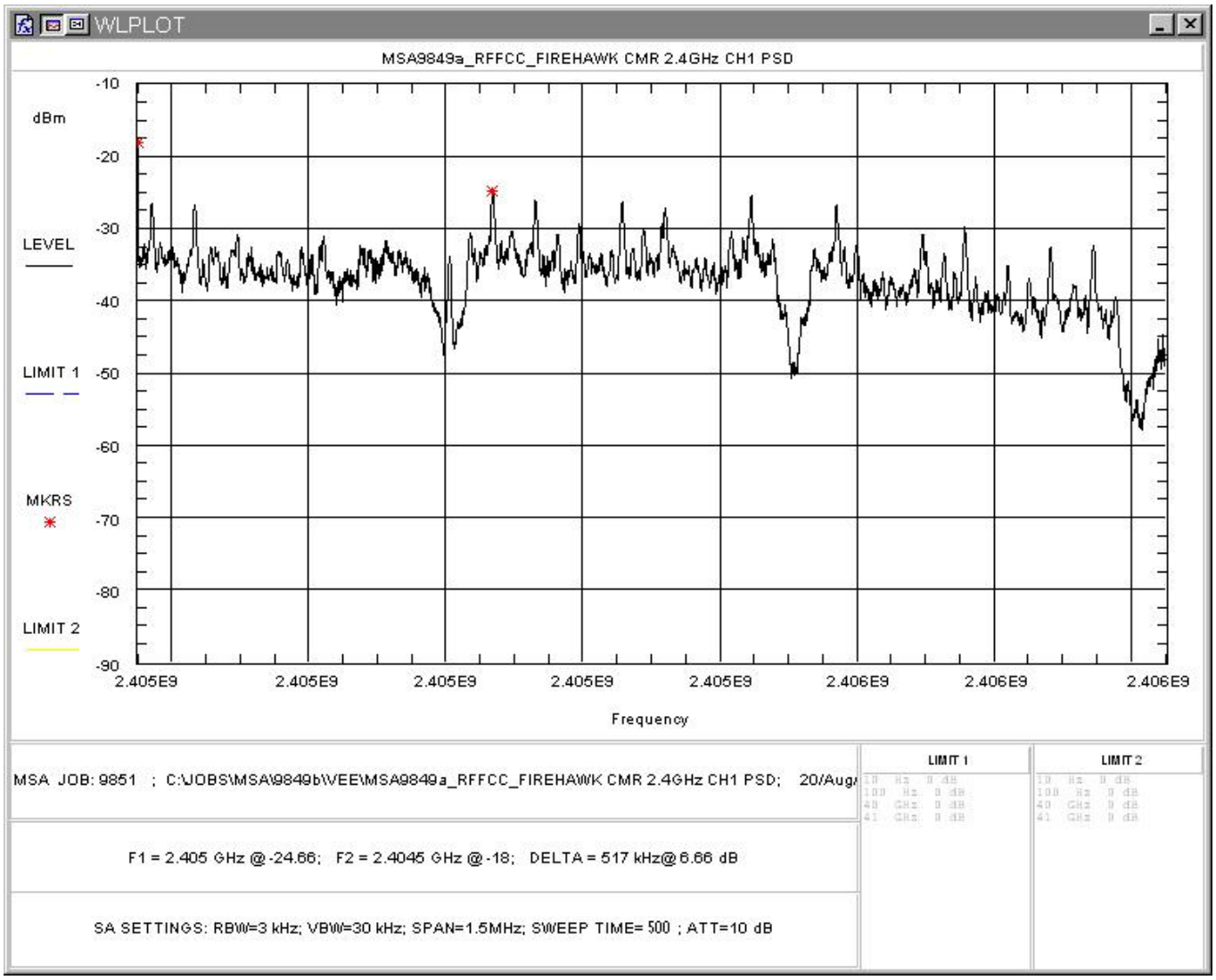



**Figure 9: Power Spectral Density Plot, Low Channel**

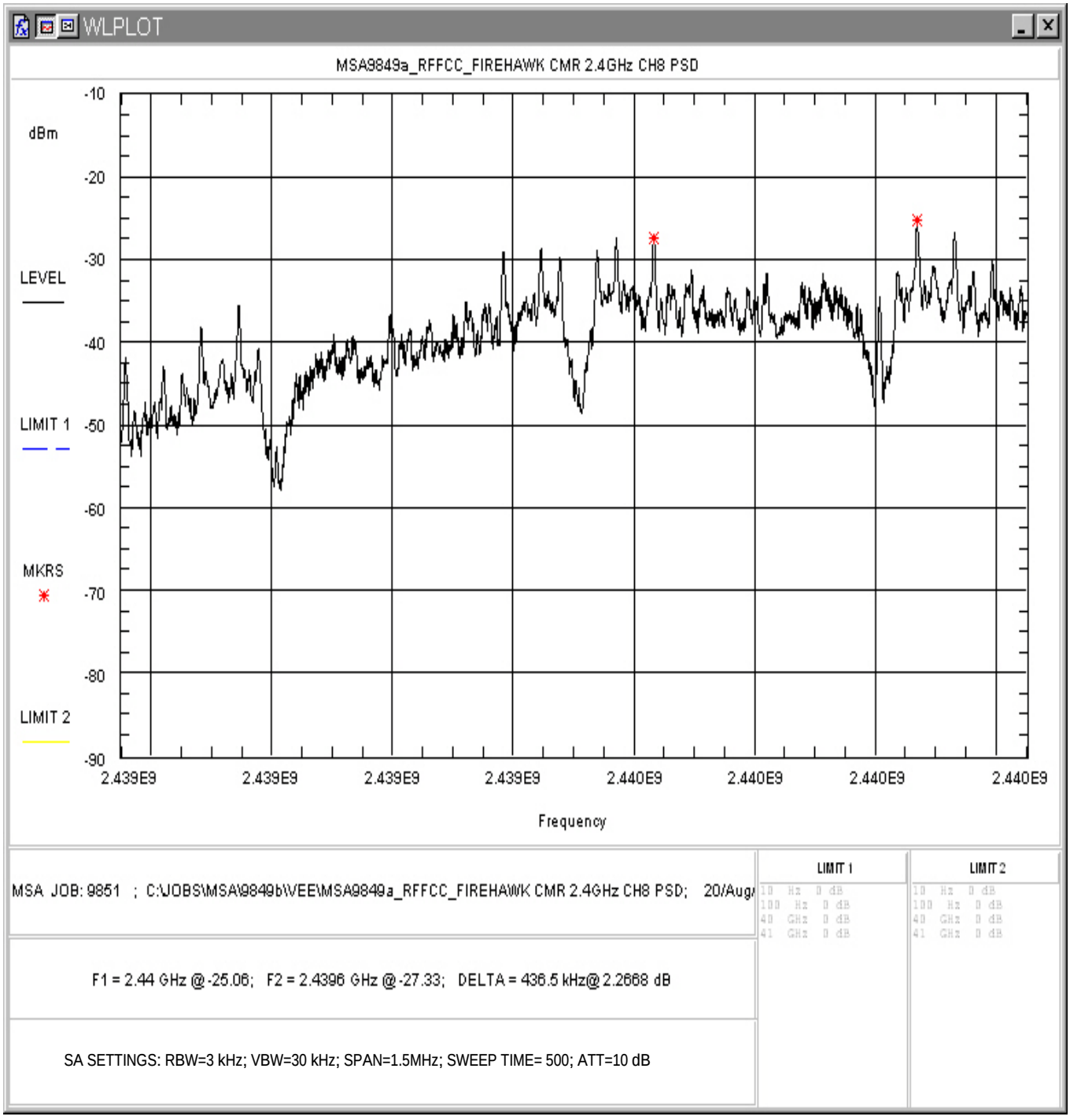



**Figure 10: Power Spectral Density Plot, Mid Channel**

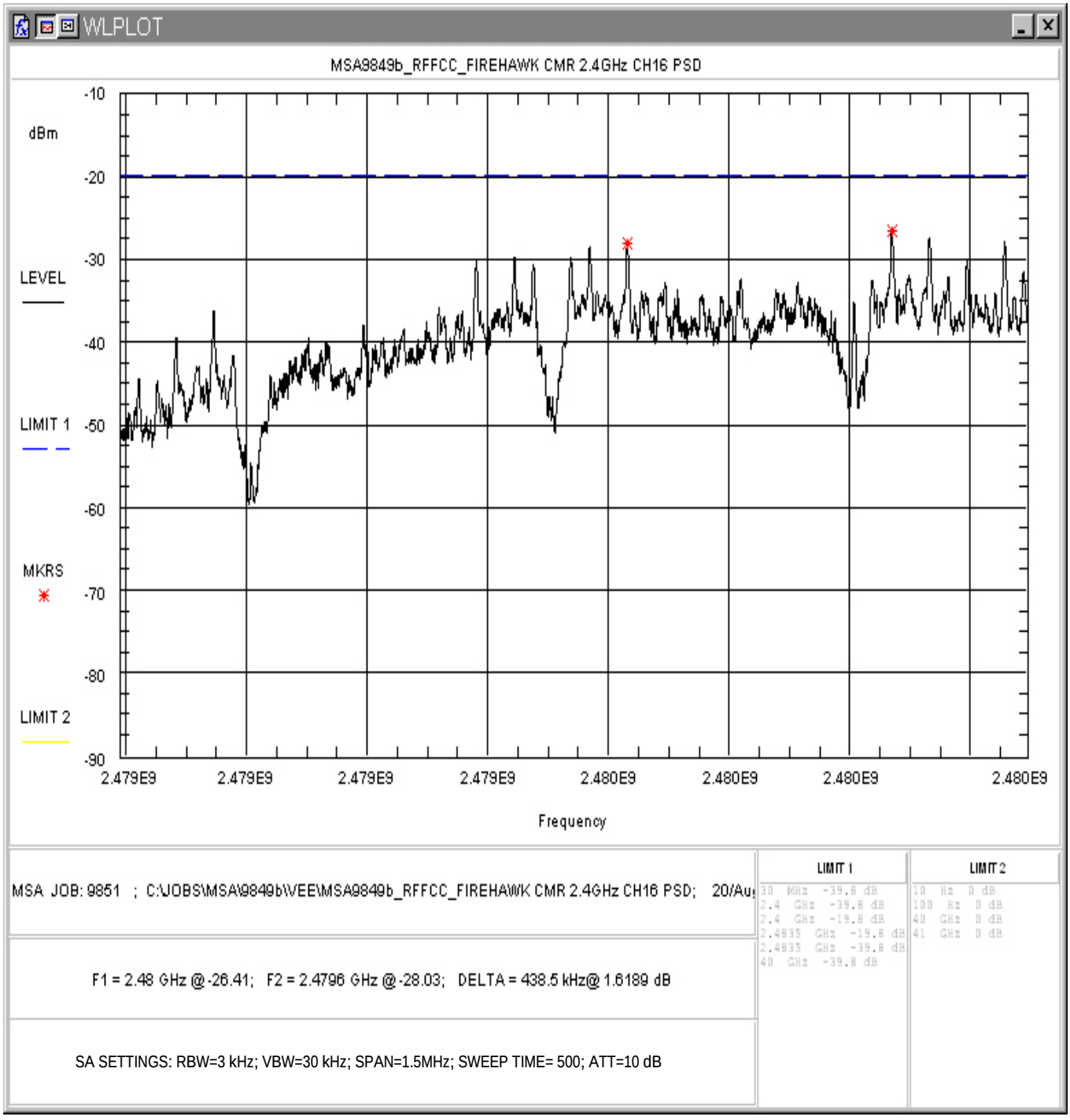



**Figure 11: Power Spectral Density Plot, High Channel**

Table 6 provides a summary of the Power Spectral Density results.

**Table 6 Power Spectral Density results**

| Channel | Peak | Limit | Pass/Fail |
|---|---|---|---|
| 1 | -18.0dBm | +8dBm | Pass |
| 8 | -25.0dBm | +8dBm | Pass |
| 16 | -26.4dBm | +8dBm | Pass |

**Test Engineer(s):** Steven Dovell

**Test Date(s):** 8/20/07 & 8/21/07

## 4.5 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 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

The following are plots of the conducted spurious emissions data.

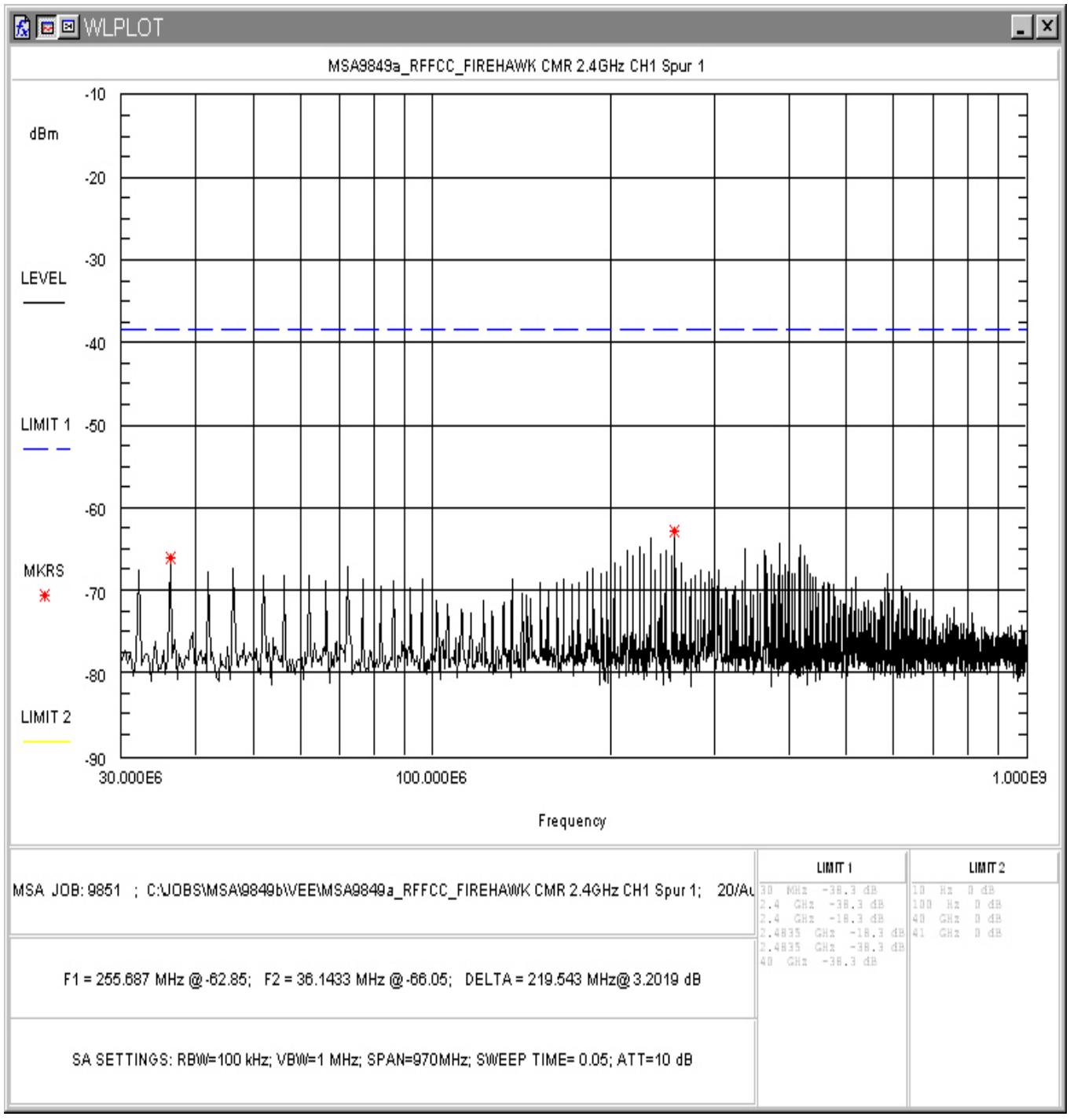



**Figure 12: Conducted Spurious Emissions, Low Channel, 30 - 1000MHz**

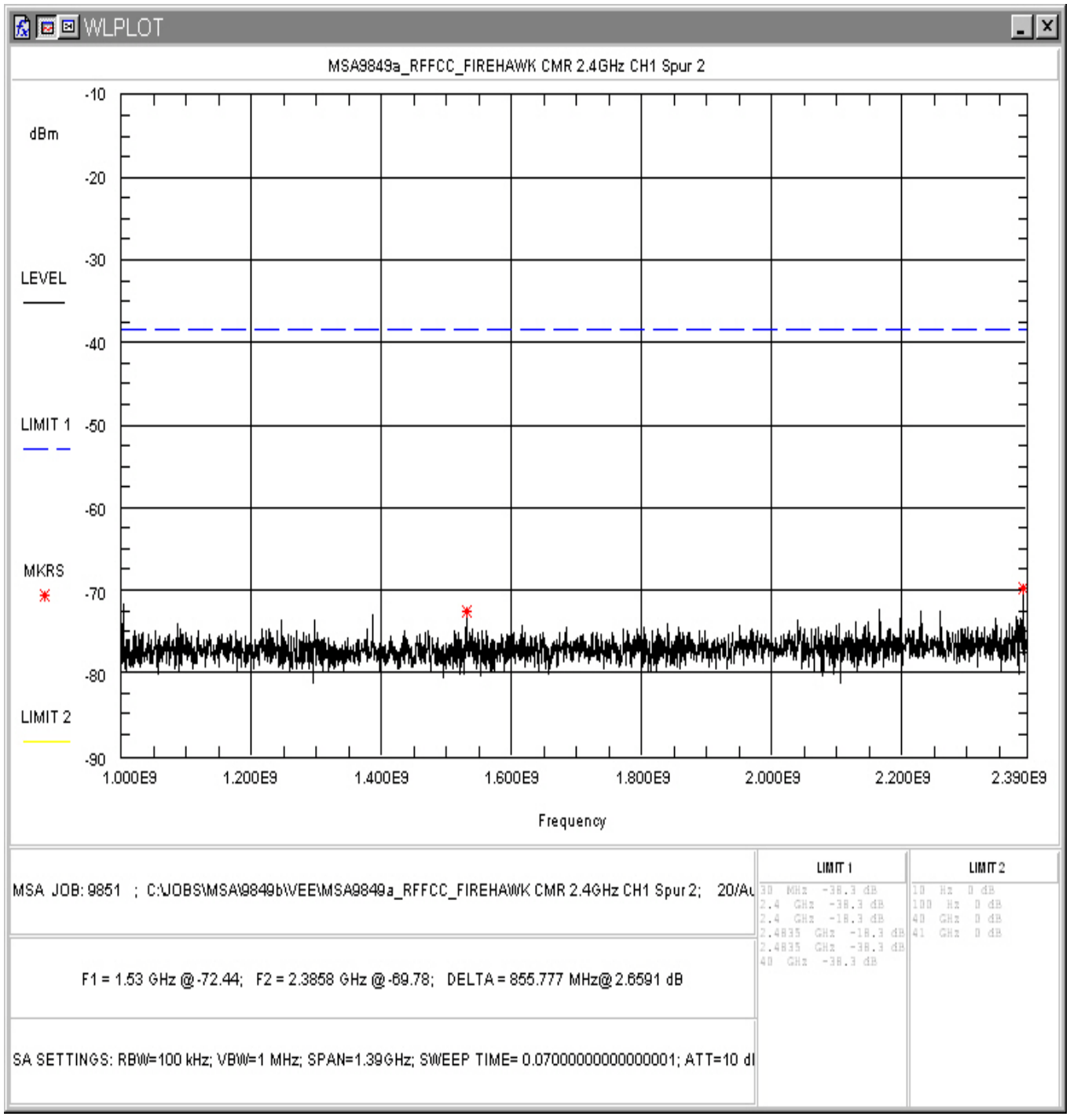



**Figure 13: Conducted Spurious Emissions, Low Channel, 1 – 2.3GHz**

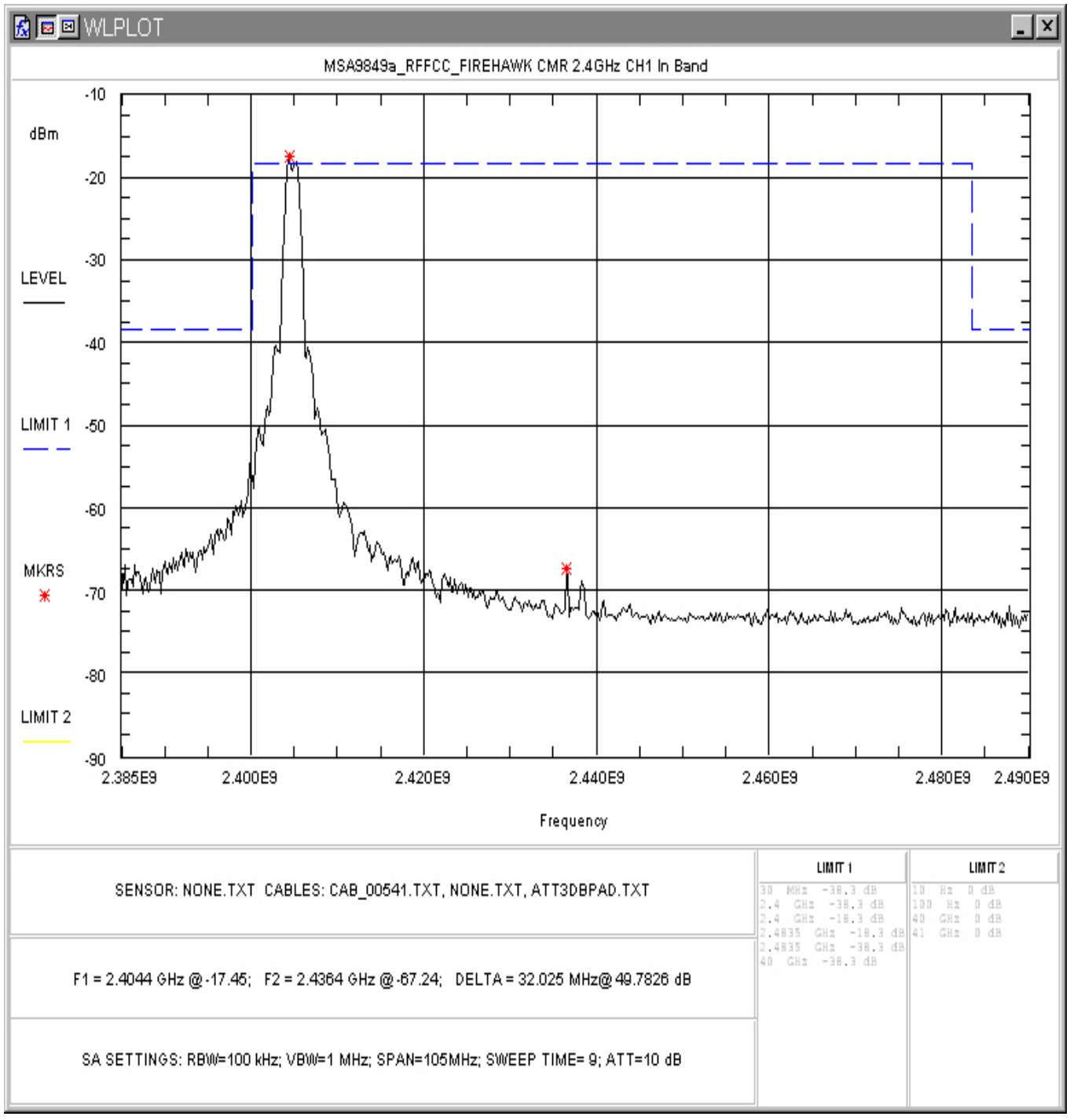



**Figure 14: Conducted Spurious Emissions, Low Channel, 2.3 – 2.5GHz**

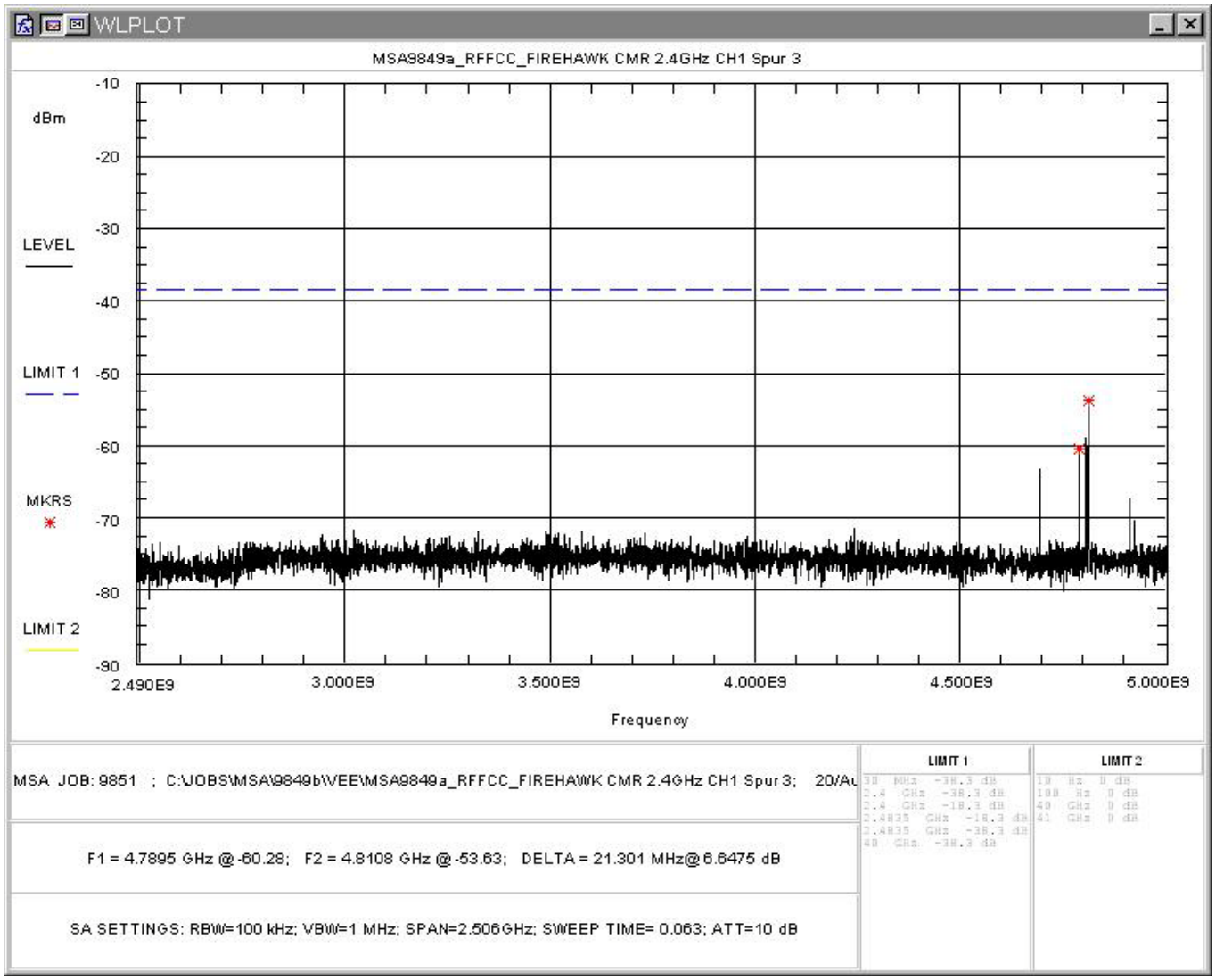



**Figure 15: Conducted Spurious Emissions, Low Channel, 2.5 - 5GHz**

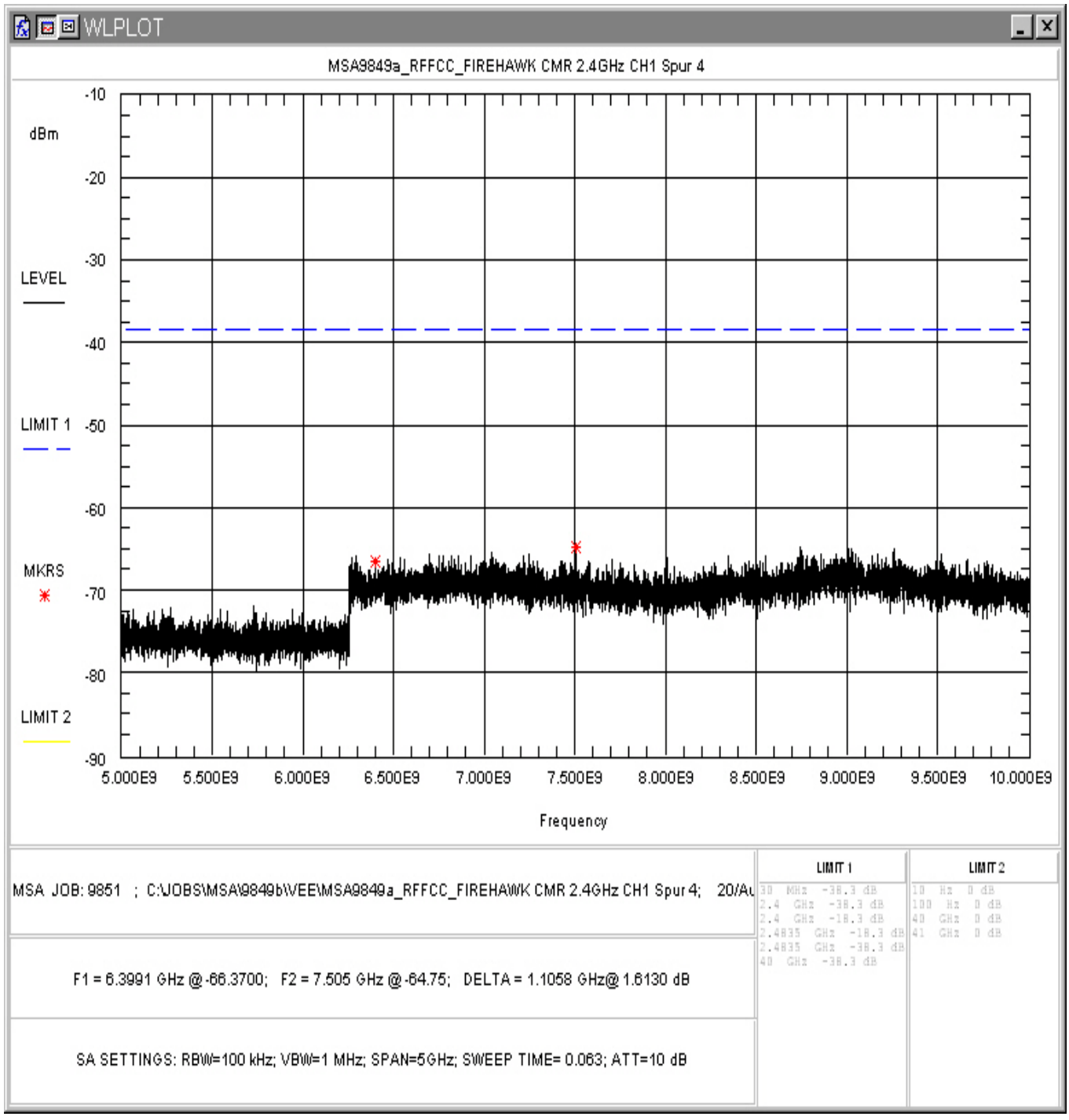



**Figure 16: Conducted Spurious Emissions, Low Channel, 5 - 10GHz**

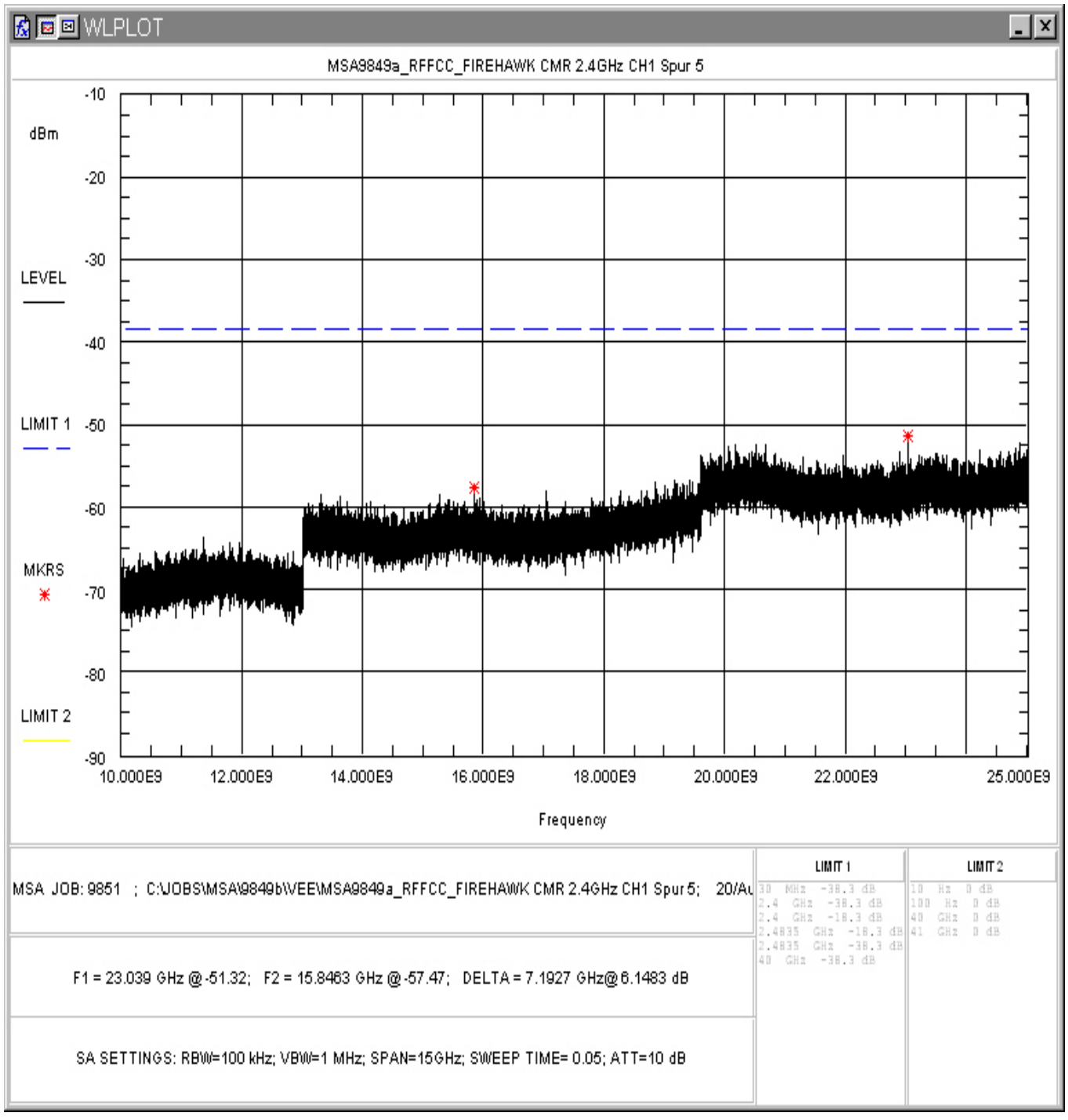



**Figure 17: Conducted Spurious Emissions, Low Channel, 10 - 25GHz**

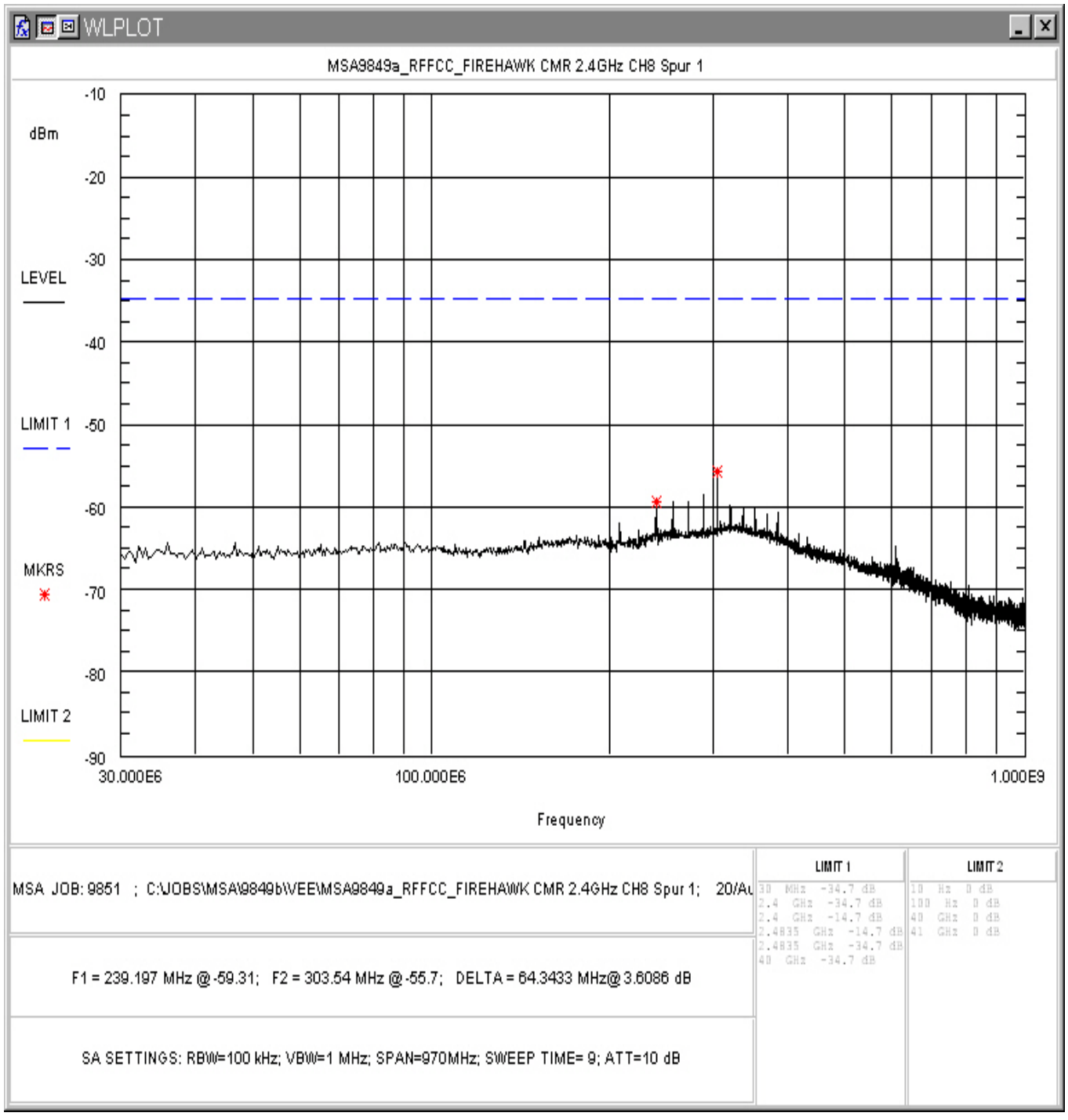



**Figure 18: Conducted Spurious Emissions, Mid Channel, 30 - 1000MHz**

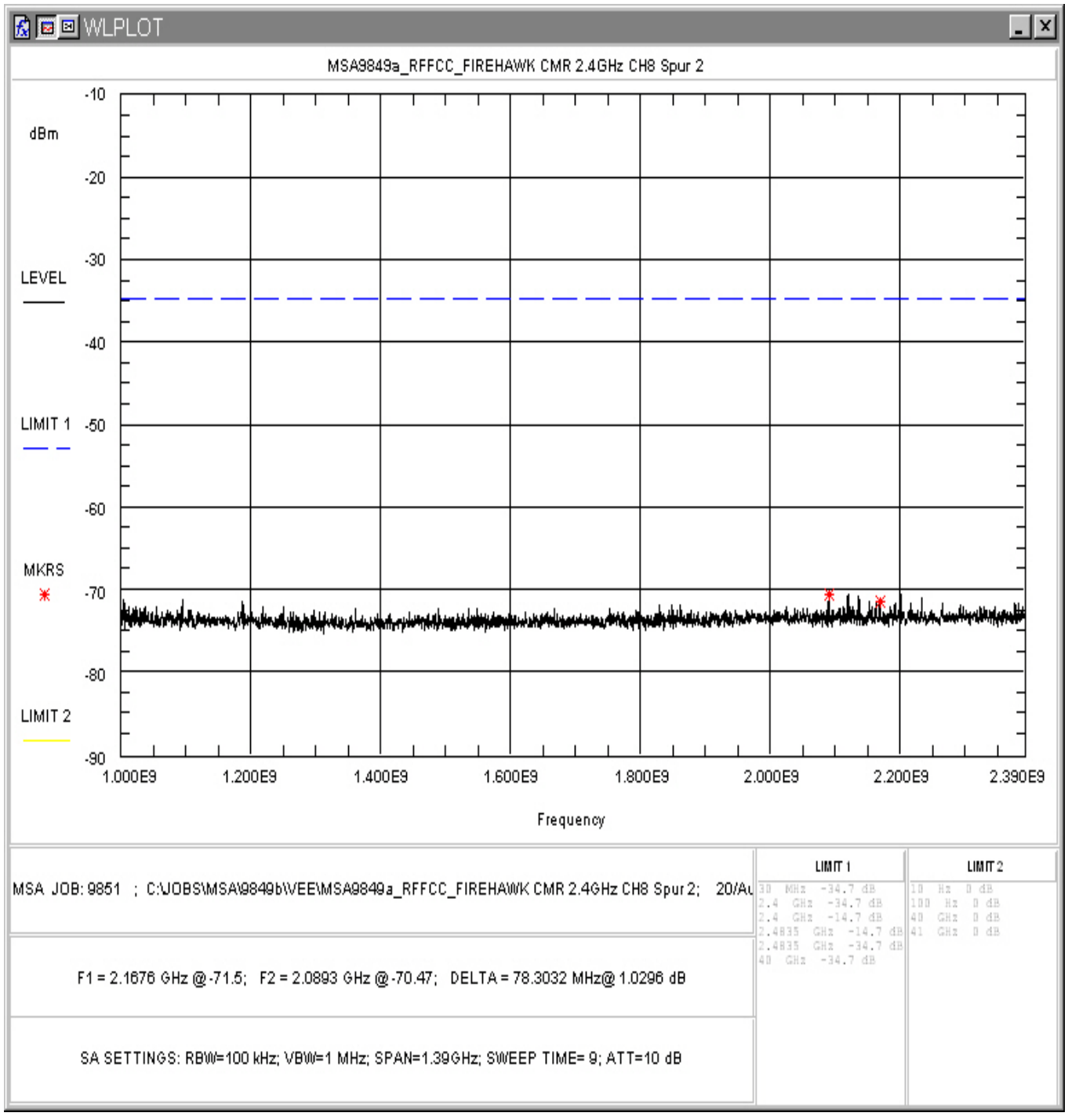



**Figure 19: Conducted Spurious Emissions, Mid Channel, 1 – 2.3GHz**

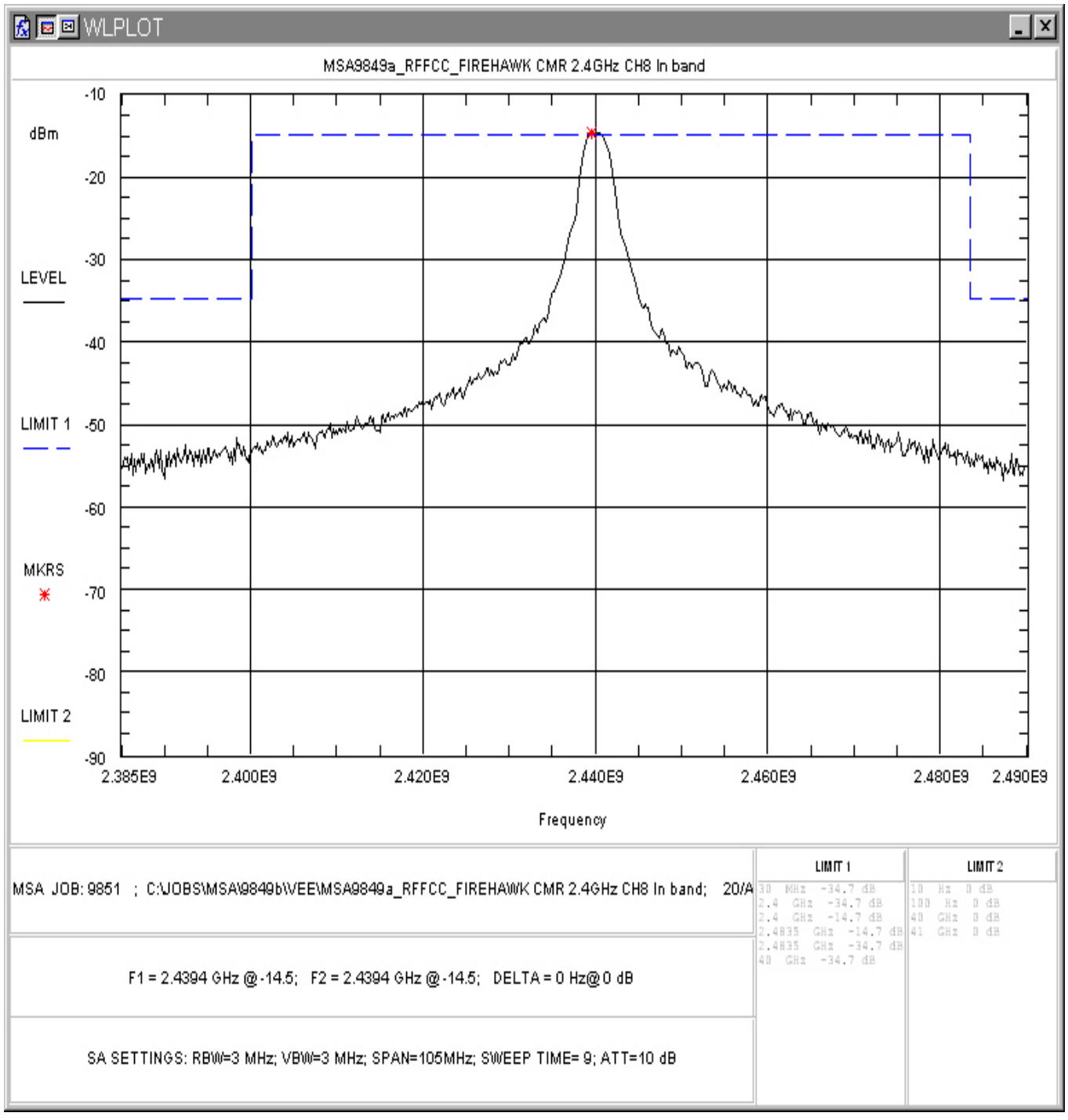



**Figure 20: Conducted Spurious Emissions, Mid Channel, 2.3 – 2.5GHz**

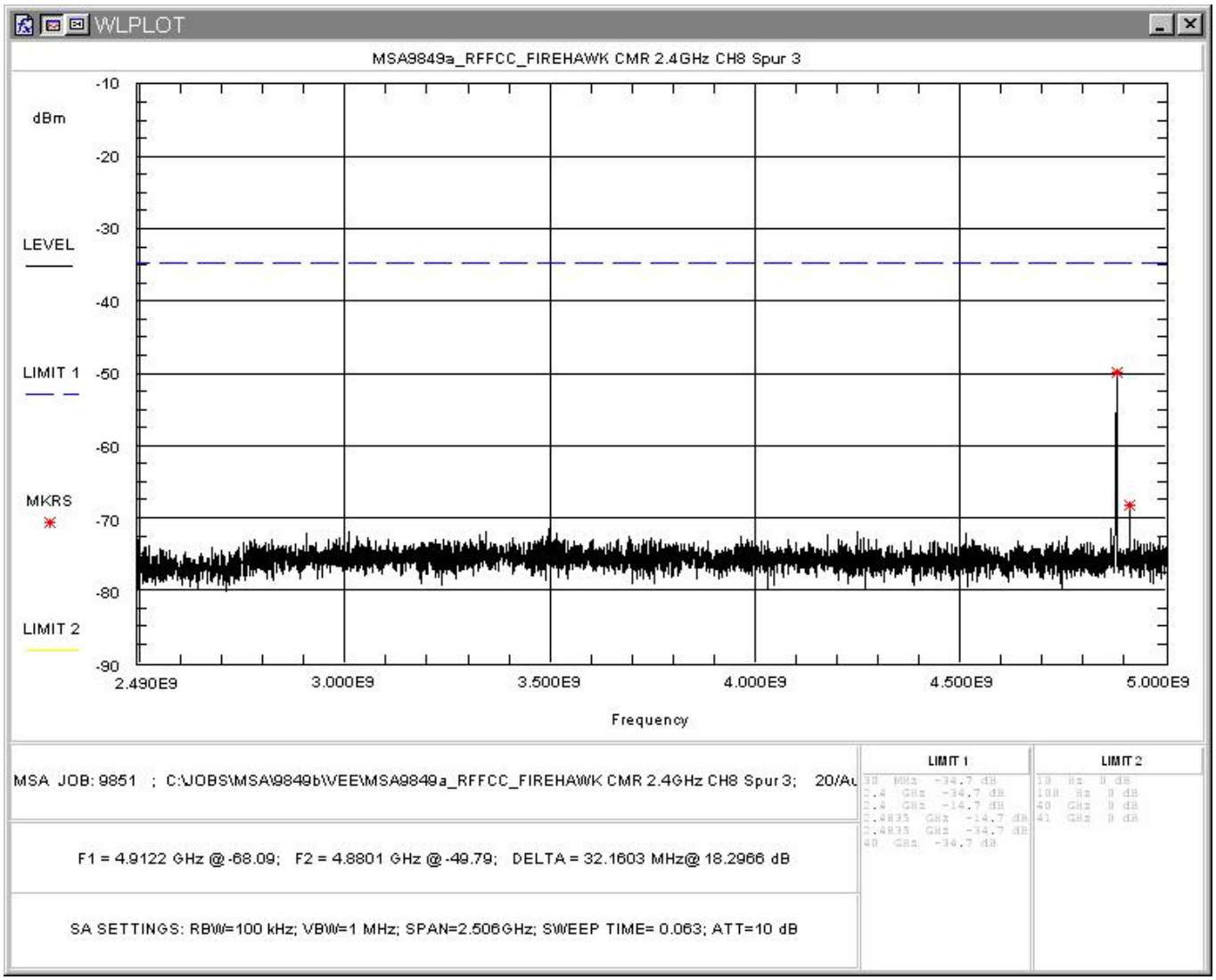



**Figure 21: Conducted Spurious Emissions, Mid Channel, 2.5 - 5GHz**

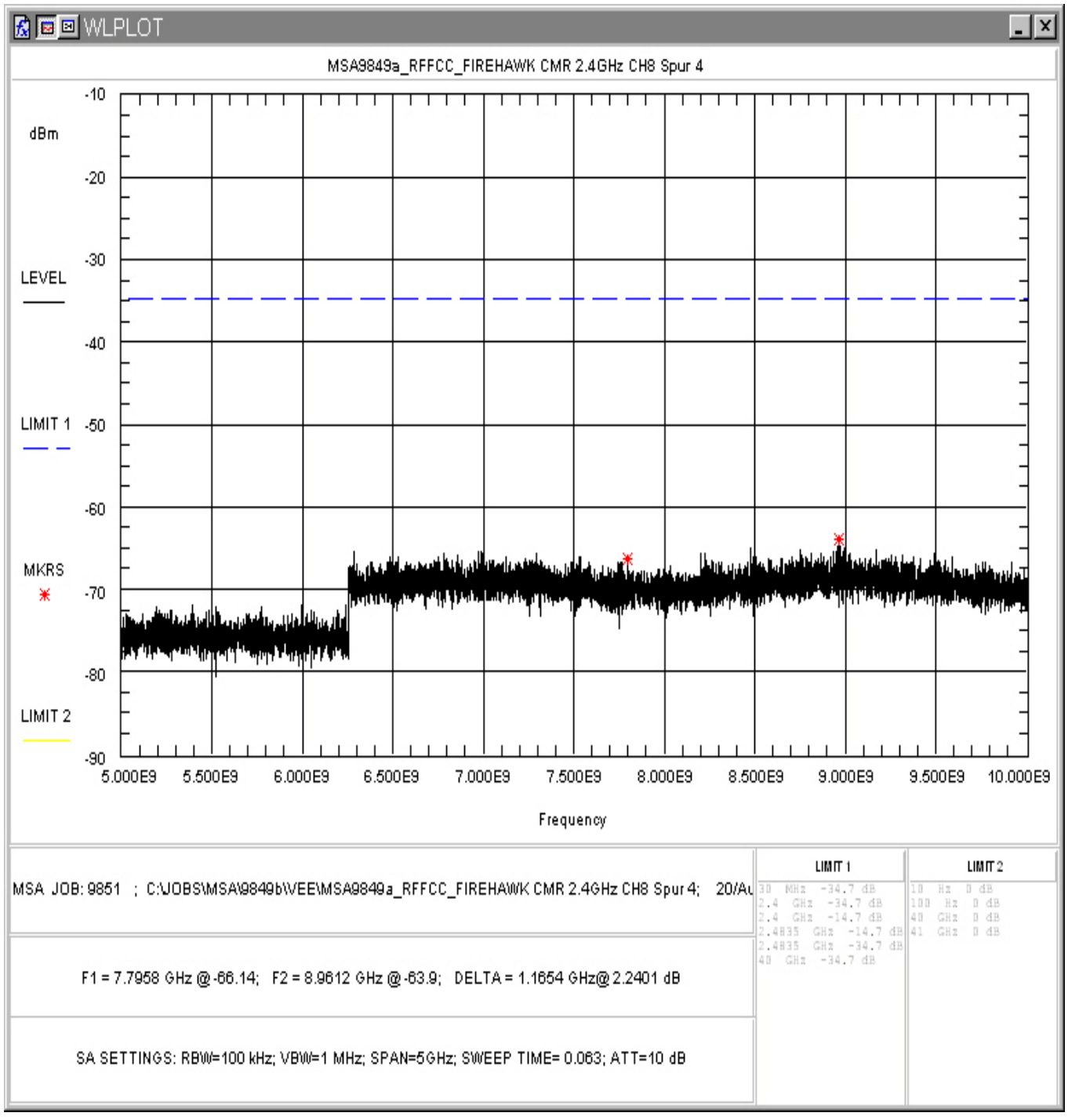



**Figure 22: Conducted Spurious Emissions, Mid Channel, 5 - 10GHz**

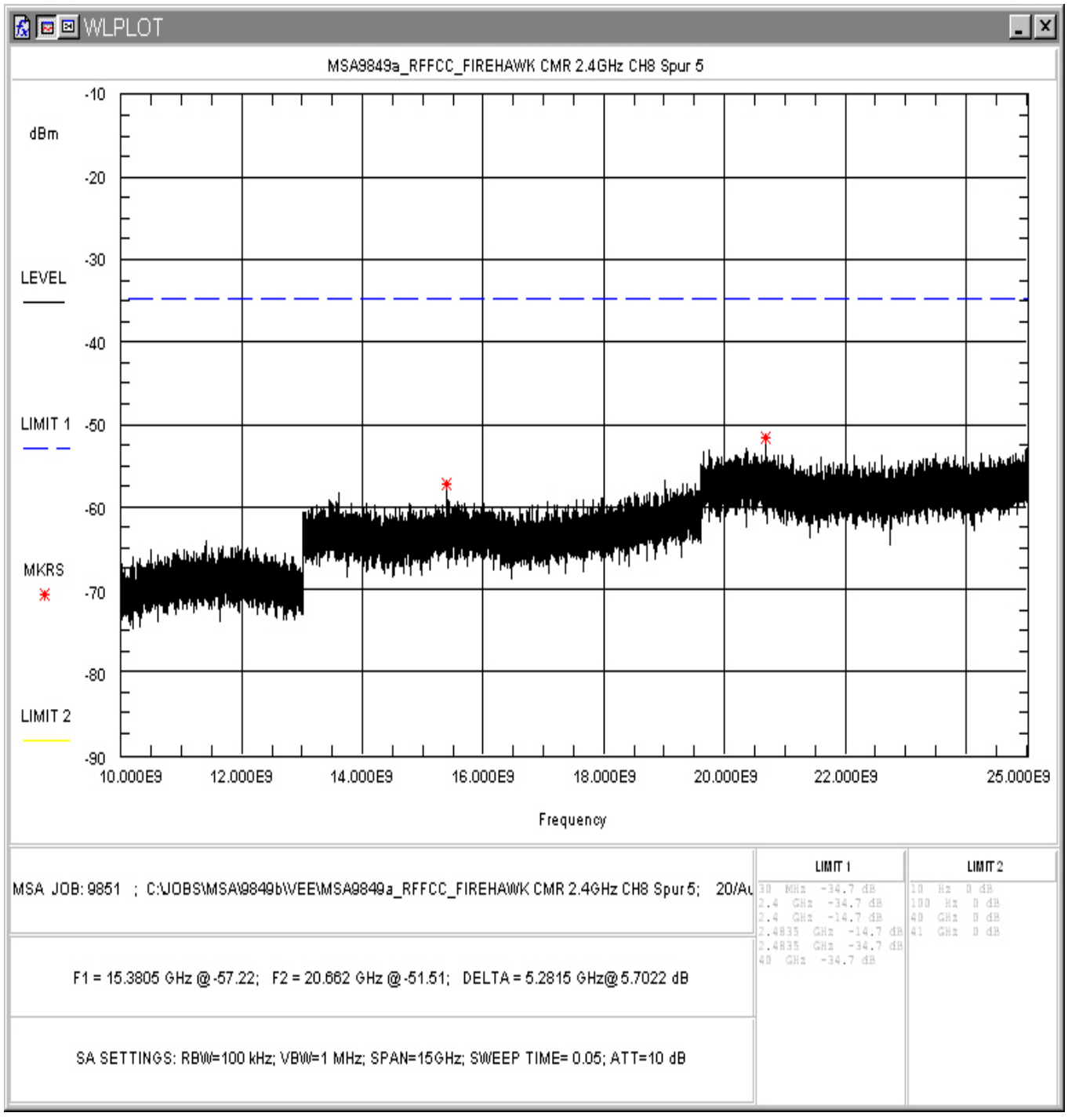



**Figure 23: Conducted Spurious Emissions, Mid Channel, 10 - 25GHz**

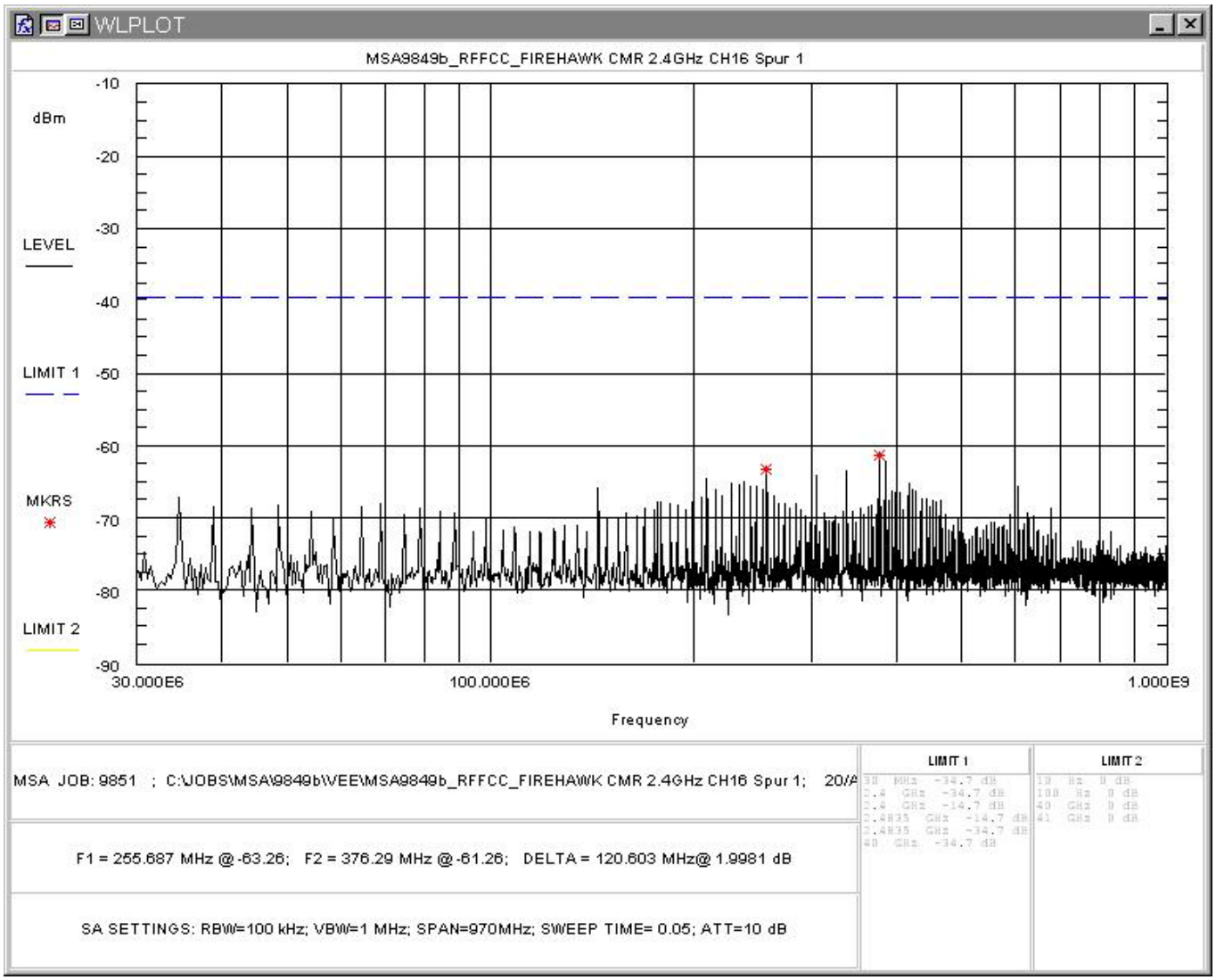



**Figure 24: Conducted Spurious Emissions, High Channel, 30 - 1000MHz**

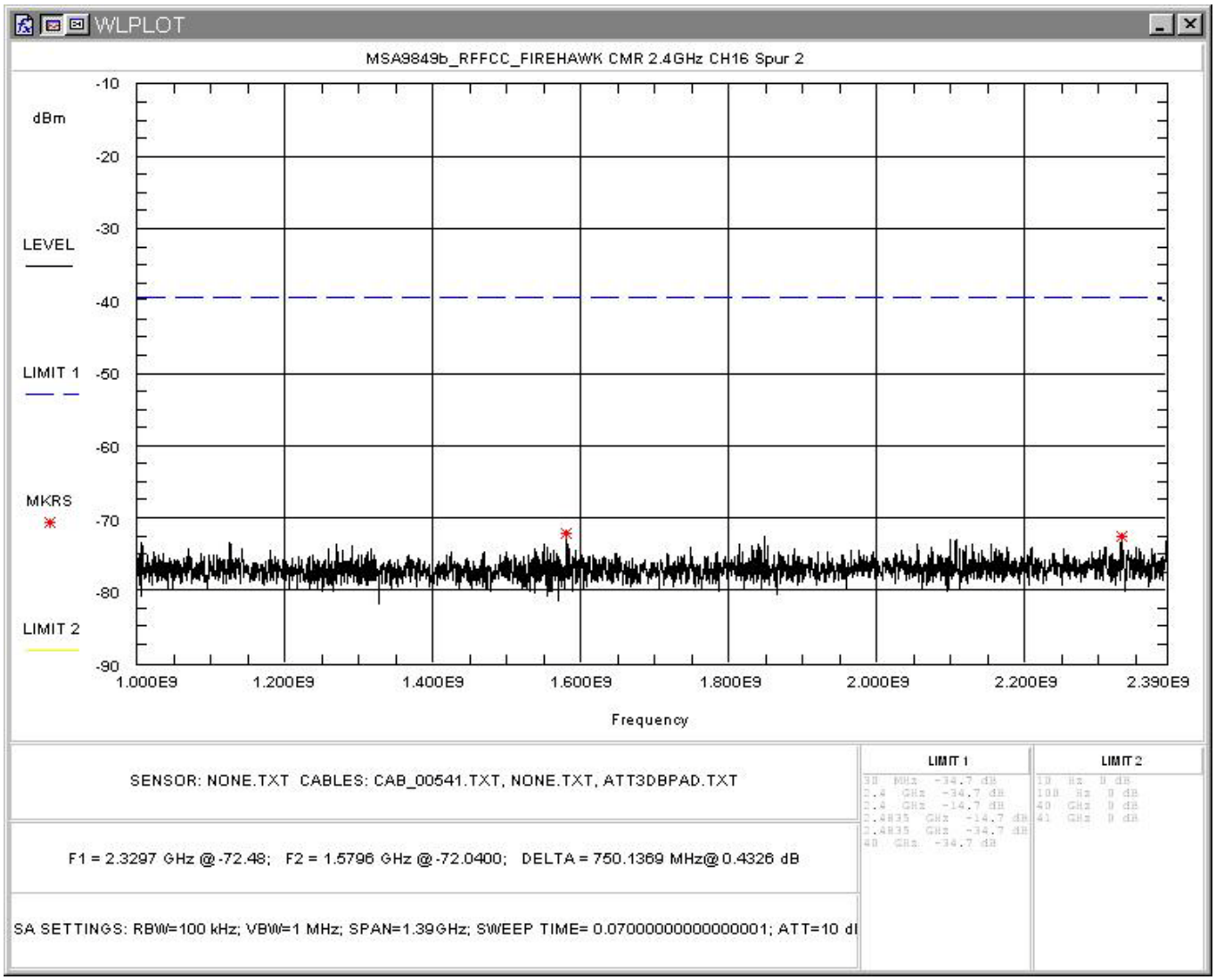



**Figure 25: Conducted Spurious Emissions, High Channel, 1 – 2.3GHz**

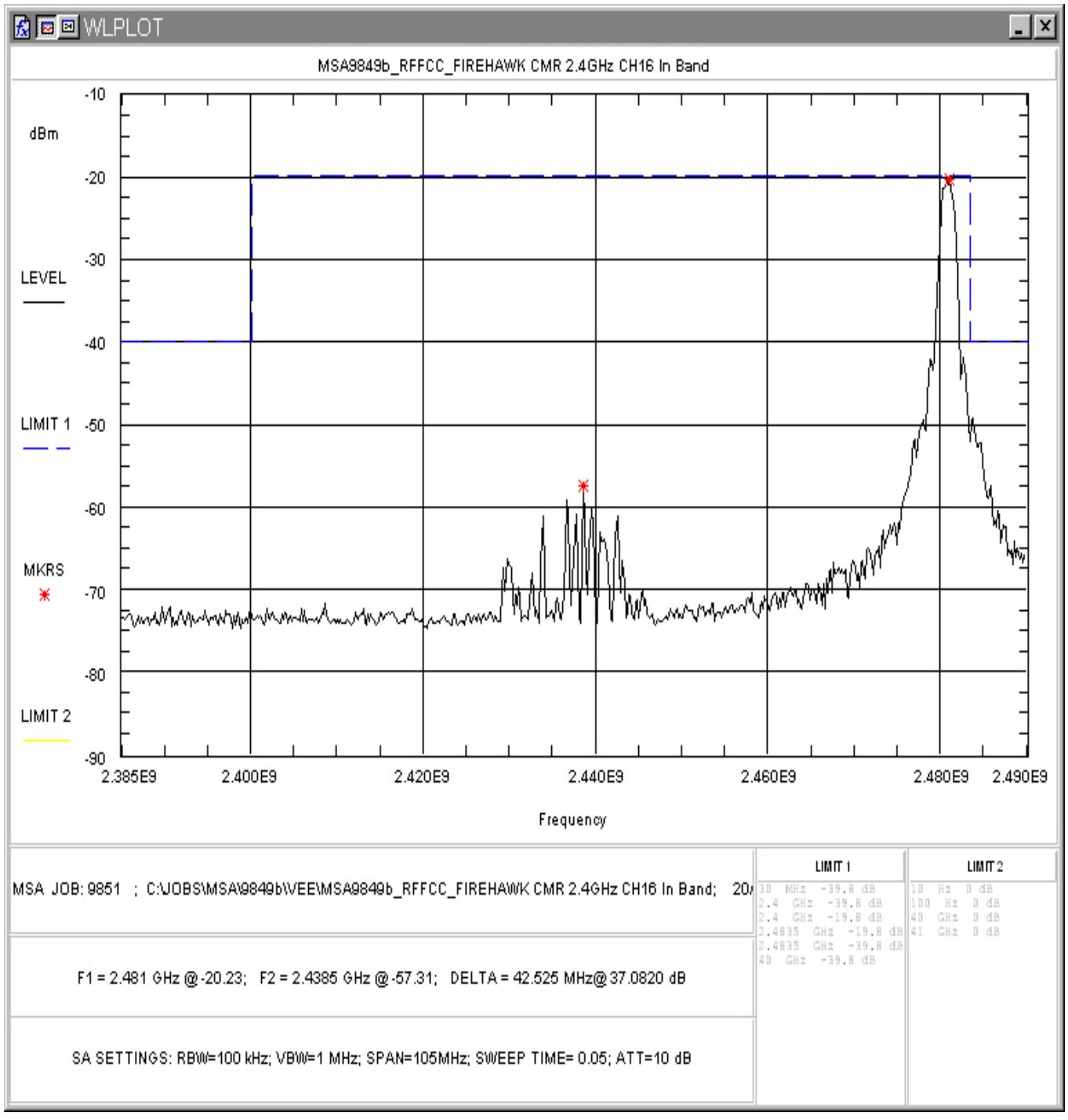



**Figure 26: Conducted Spurious Emissions, High Channel, 2.3 – 2.5GHz**

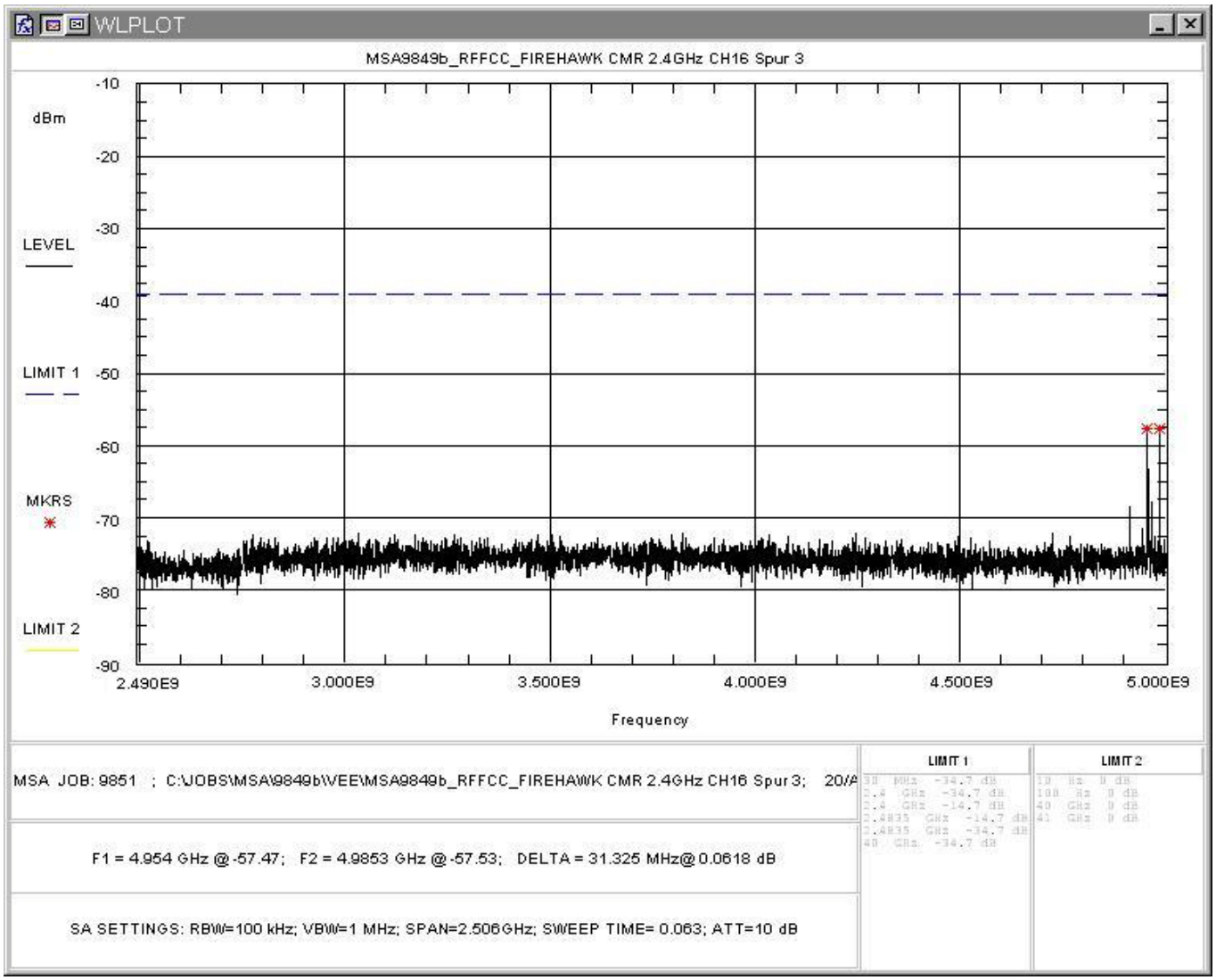



**Figure 27: Conducted Spurious Emissions, High Channel, 2.5 - 5GHz**

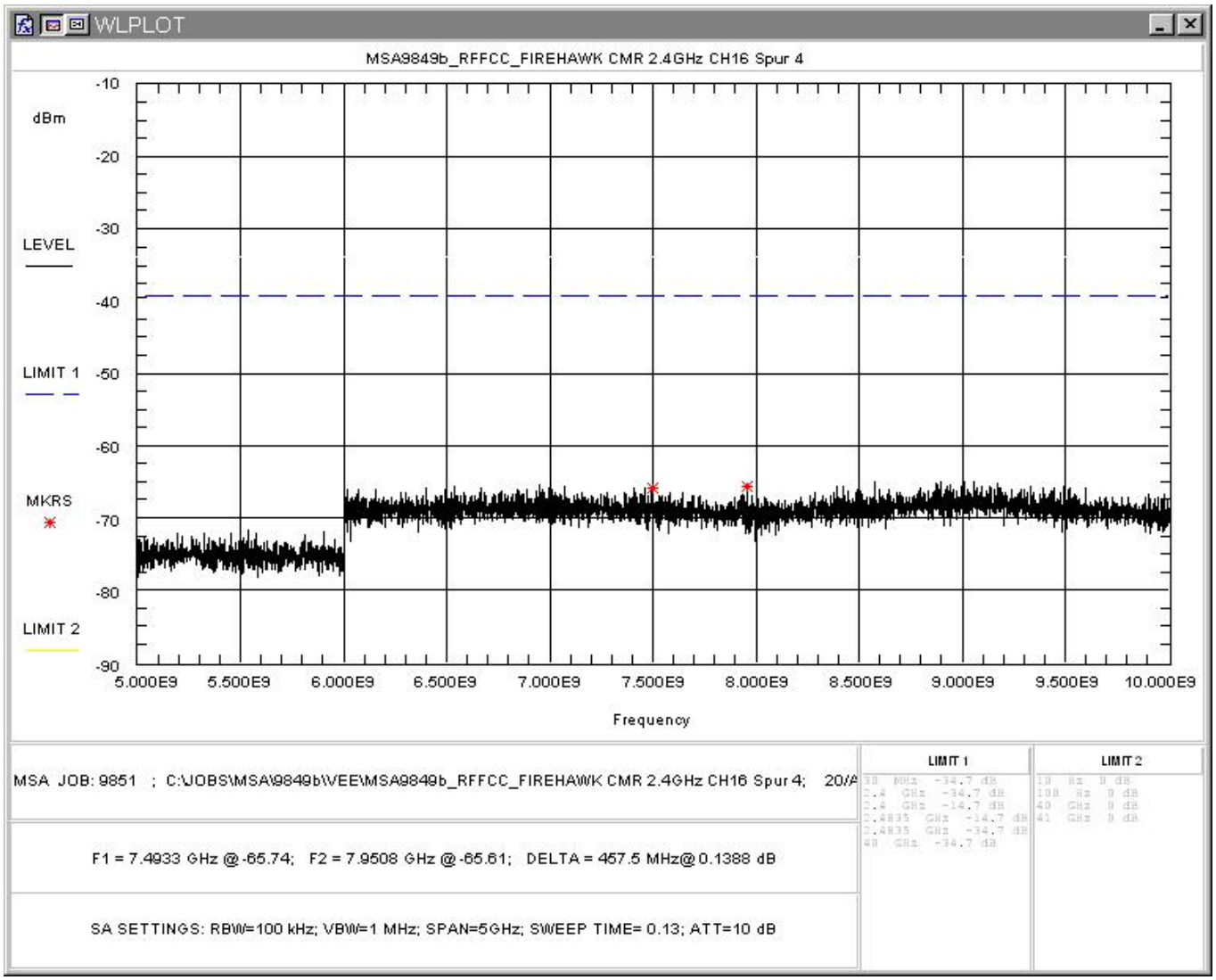



**Figure 28: Conducted Spurious Emissions, High Channel, 5 - 10GHz**

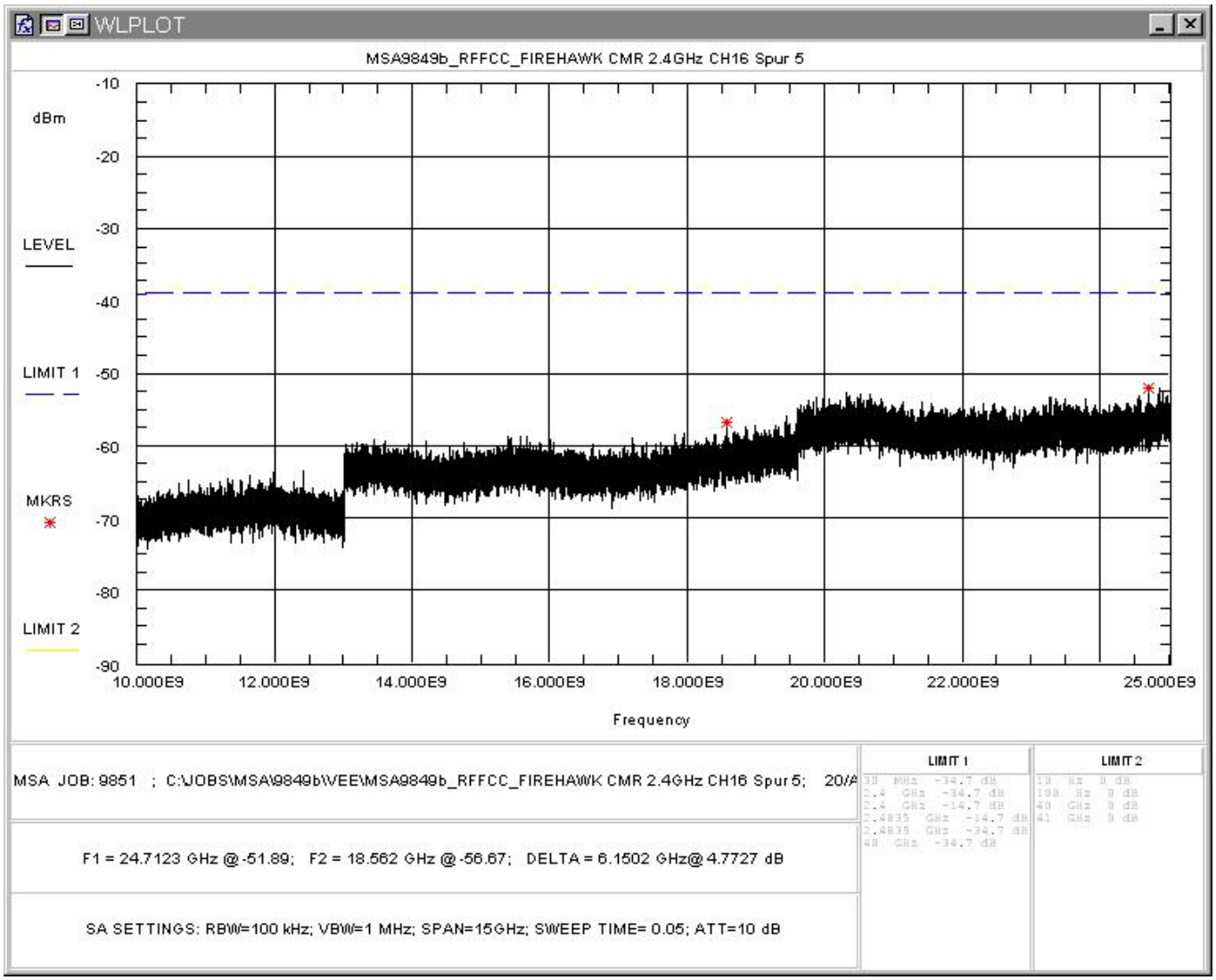



**Figure 29: Conducted Spurious Emissions, High Channel, 10 - 25GHz**

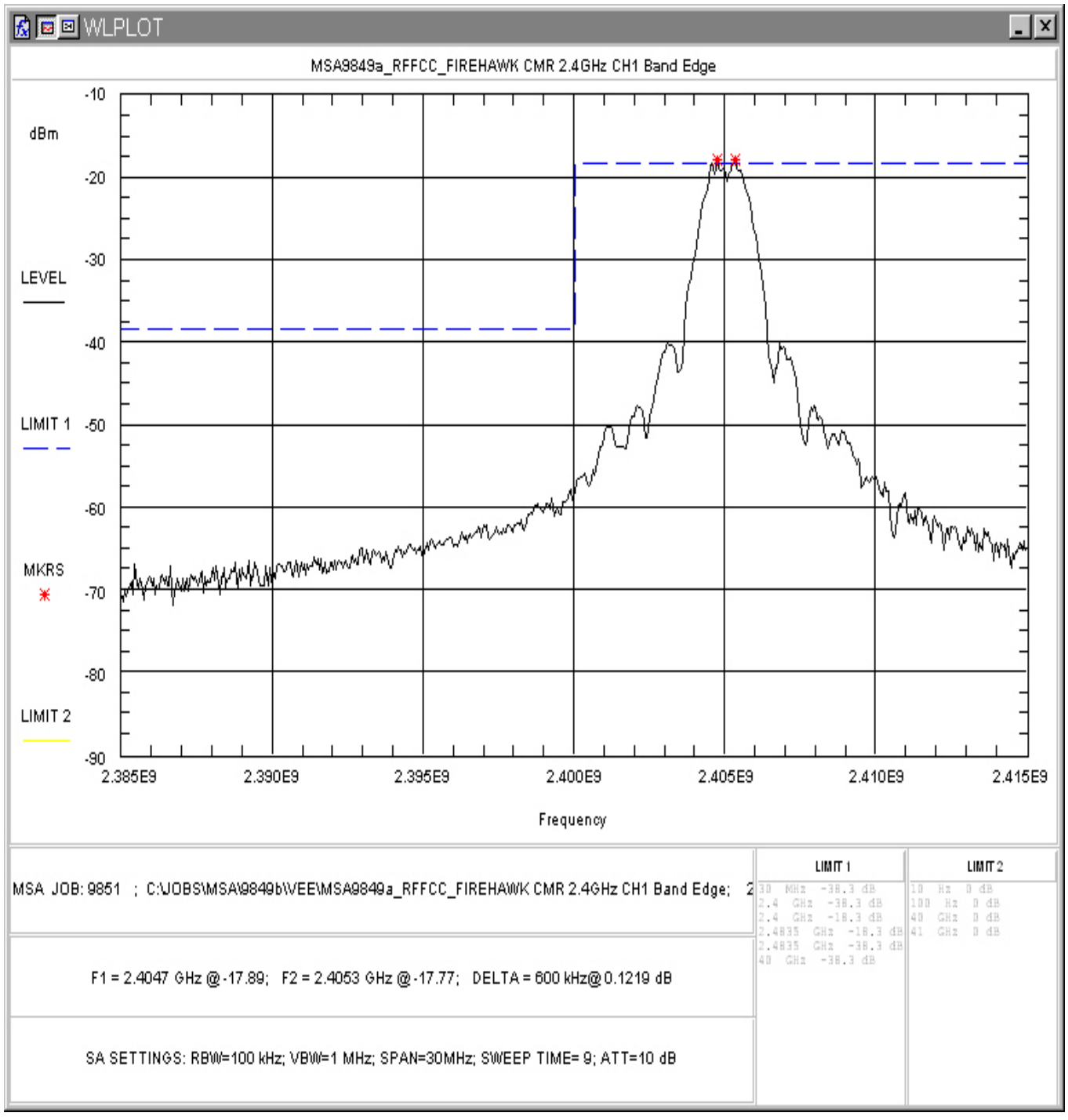



**Figure 30: Band Edge 2.4GHz**

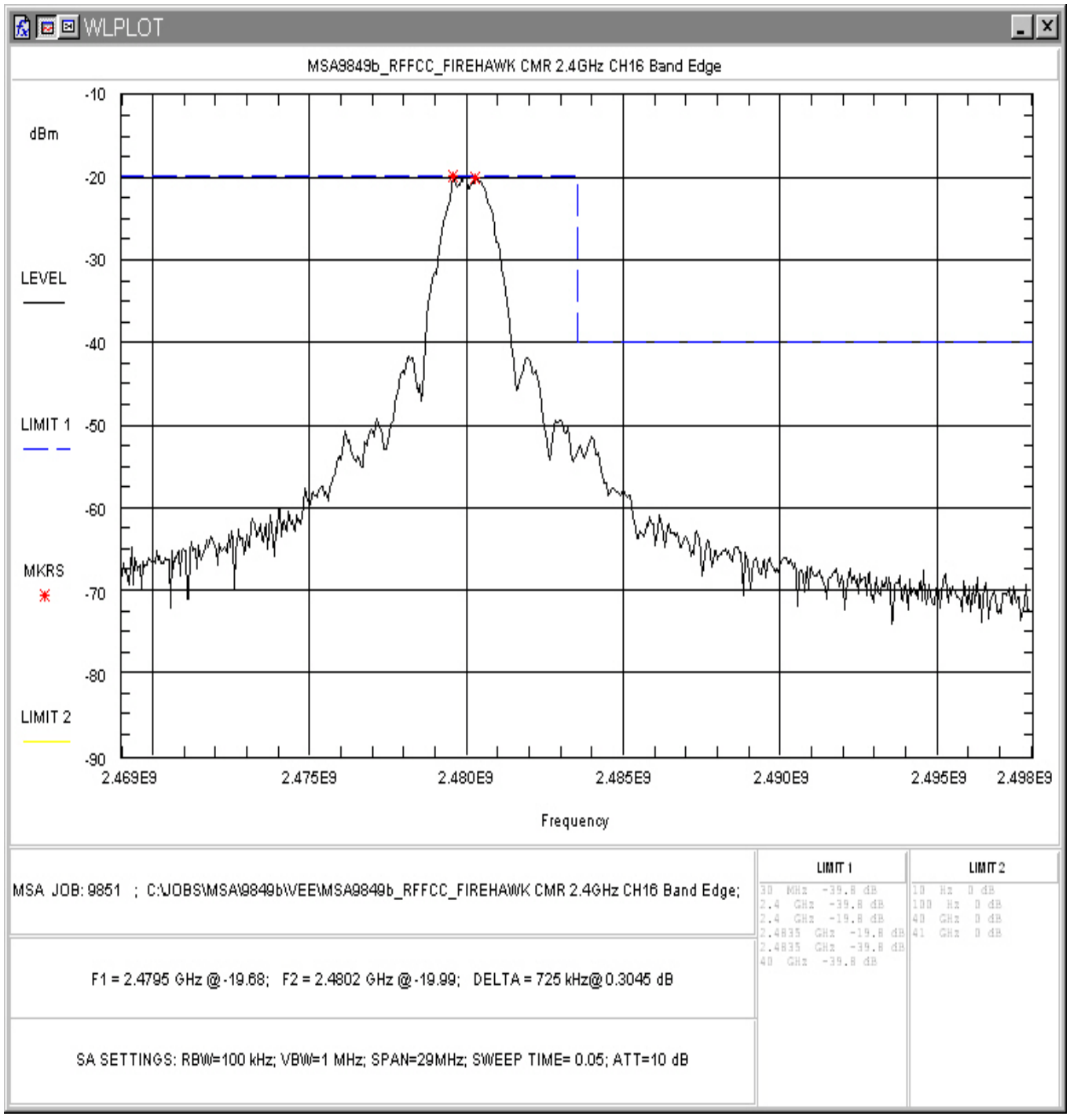



**Figure 31: Band Edge 2.485GHz**

## 4.6 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.

### 4.6.1 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 | >100 kHz |
| >1000 MHz | 1 MHz | <30 Hz (Avg.)<br>1MHz (Peak) |

## Table 7: Radiated Emission Test Data, Low Frequency Data (<1GHz)

| Frequency (MHz) | Polarity H/V | Azimuth Degree | Ant. Height (m) | SA Level (QP) (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 51.900 | H | 348.0 | 1.0 | 7.3 | 8.0 | 1.3 | 16.6 | 6.7 | 100.0 | -23.4 |
| 62.170 | H | 198.0 | 2.0 | 3.3 | 7.6 | 1.5 | 12.3 | 4.1 | 100.0 | -27.7 |
| 117.900 | H | 304.0 | 218.0 | 5.7 | 13.7 | 2.0 | 21.4 | 11.8 | 150.0 | -22.1 |
| 136.380 | H | 65.0 | 4.0 | 12.0 | 13.2 | 2.2 | 27.4 | 23.5 | 150.0 | -16.1 |
| 240.000 | H | 223.0 | 1.3 | 8.4 | 11.3 | 2.9 | 22.6 | 13.6 | 200.0 | -23.4 |
| 268.920 | H | 333.0 | 3.5 | 7.3 | 12.9 | 3.2 | 23.3 | 14.7 | 200.0 | -22.7 |
| 300.000 | H | 298.0 | 1.0 | 3.4 | 13.3 | 3.4 | 20.1 | 10.1 | 200.0 | -26.0 |
| 332.440 | H | 234.0 | 1.0 | 4.8 | 14.0 | 3.6 | 22.4 | 13.1 | 200.0 | -23.6 |
| 365.560 | H | 248.0 | 1.0 | 6.5 | 14.7 | 3.7 | 24.9 | 17.6 | 200.0 | -21.1 |
| 44.980 | V | 325.0 | 1.0 | 12.0 | 10.7 | 1.3 | 24.0 | 15.8 | 100.0 | -16.0 |
| 51.982 | V | 83.0 | 1.0 | 17.5 | 8.0 | 1.3 | 26.8 | 21.8 | 100.0 | -13.2 |
| 62.170 | V | 193.0 | 1.0 | 10.0 | 7.6 | 1.5 | 19.0 | 8.9 | 100.0 | -21.0 |
| 136.380 | V | 221.0 | 1.0 | 9.6 | 13.2 | 2.2 | 25.0 | 17.8 | 150.0 | -18.5 |
| 240.000 | V | 298.0 | 1.0 | 4.7 | 11.3 | 2.9 | 18.9 | 8.9 | 200.0 | -27.1 |
| 268.920 | V | 126.0 | 4.0 | 14.0 | 12.9 | 3.2 | 30.0 | 31.7 | 200.0 | -16.0 |
| 300.000 | V | 223.0 | 1.7 | 3.2 | 14.7 | 3.4 | 21.2 | 11.5 | 200.0 | -24.8 |
| 332.440 | V | 177.0 | 186.0 | 5.7 | 14.0 | 3.6 | 23.3 | 14.6 | 200.0 | -22.7 |
| 365.560 | V | 200.0 | 2.0 | 9.5 | 14.7 | 3.7 | 27.9 | 24.9 | 200.0 | -18.1 |

## Table 8: Radiated Emission Test Data, High Frequency Data (>1GHz)

## Lo Channel (Restricted Bands)

| Frequency (MHz) | Polarity H/V | Azimuth Degree | Ant. Height (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin (dB) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2405 (X) | | | | | | | | | | | | |
| 4810.000 | V | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | V | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | V | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | V | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |
| 4810.000 | H | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | H | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | H | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | H | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |
| 2405 (Y) | | | | | | | | | | | | |
| 4810.000 | V | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | V | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | V | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | V | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |
| 4810.000 | H | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | H | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | H | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | H | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |
| 2405 (Z) | | | | | | | | | | | | |
| 4810.000 | V | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | V | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | V | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | V | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |
| 4810.000 | H | 0.0 | 1.0 | 38.8 | 32.5 | 6.1 | 34.3 | 43.1 | 143.5 | 5000.0 | -30.8 | Peak AMB |
| 4810.000 | H | 0.0 | 1.0 | 31.7 | 32.5 | 6.1 | 34.3 | 36.0 | 63.4 | 500.0 | -17.9 | Avg AMB |
| 12025.000 | H | 180.0 | 1.0 | 47.0 | 40.0 | 12.3 | 34.8 | 64.5 | 1674.5 | 5000.0 | -9.5 | Peak AMB |
| 12025.000 | H | 180.0 | 1.0 | 31.7 | 40.0 | 12.3 | 34.8 | 49.2 | 287.7 | 500.0 | -4.8 | Avg AMB |

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

## Mid Channel (Restricted Bands)

| Frequency (MHz) | Polarity H/V | Azimuth Degree | Ant. Height (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin (dB) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2440 (X) | | | | | | | | | | | | |
| 4880.000 | V | 0.0 | 1.0 | 44.2 | 32.6 | 6.2 | 34.3 | 48.7 | 271.4 | 5000.0 | -25.3 | Peak AMB |
| 4880.000 | V | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 500.0 | -17.5 | Avg AMB |
| 7320.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |
| 4880.000 | H | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 5000.0 | -37.5 | Peak AMB |
| 4880.000 | H | 0.0 | 1.0 | 38.8 | 32.6 | 6.2 | 34.3 | 43.3 | 145.7 | 500.0 | -10.7 | Avg AMB |
| 7320.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |
| 2440 (Y) | | | | | | | | | | | | |
| 4880.000 | V | 0.0 | 1.0 | 44.2 | 32.6 | 6.2 | 34.3 | 48.7 | 271.4 | 5000.0 | -25.3 | Peak AMB |
| 4880.000 | V | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 500.0 | -17.5 | Avg AMB |
| 7320.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |
| 4880.000 | H | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 5000.0 | -37.5 | Peak AMB |
| 4880.000 | H | 0.0 | 1.0 | 38.8 | 32.6 | 6.2 | 34.3 | 43.3 | 145.7 | 500.0 | -10.7 | Avg AMB |
| 7320.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |
| 2440 (Z) | | | | | | | | | | | | |
| 4880.000 | V | 0.0 | 1.0 | 44.2 | 32.6 | 6.2 | 34.3 | 48.7 | 271.4 | 5000.0 | -25.3 | Peak AMB |
| 4880.000 | V | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 500.0 | -17.5 | Avg AMB |
| 7320.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |
| 4880.000 | H | 0.0 | 1.0 | 32.0 | 32.6 | 6.2 | 34.3 | 36.5 | 66.6 | 5000.0 | -37.5 | Peak AMB |
| 4880.000 | H | 0.0 | 1.0 | 38.8 | 32.6 | 6.2 | 34.3 | 43.3 | 145.7 | 500.0 | -10.7 | Avg AMB |
| 7320.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.0 | 34.7 | 49.5 | 297.6 | 5000.0 | -24.5 | Peak AMB |
| 7320.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.0 | 34.7 | 43.4 | 147.4 | 500.0 | -10.6 | Avg AMB |
| 12200.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 12.7 | 34.6 | 63.3 | 1464.9 | 5000.0 | -10.7 | Peak AMB |
| 12200.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 12.7 | 34.6 | 50.5 | 335.6 | 500.0 | -3.5 | Avg AMB |

## Table 10: Radiated Emission Test Data, High Frequency Data (>1GHz)

## Hi Channel (Restricted Bands)

| Frequency (MHz) | Polarity H/V | Azimuth Degree | Ant. Height (m) | SA Level (dBµV) | Ant. Corr. (dB/m) | Cable Corr. (dB) | Amp Gain (dB) | Corr. Level (dBµV/m) | Corr. Level (µV/m) | Limit (µV/m) | Margin (dB) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2480 (X) | | | | | | | | | | | | |
| 4960.000 | V | 0.0 | 1.0 | 44.2 | 32.7 | 6.2 | 34.3 | 48.8 | 276.2 | 5000.0 | -25.2 | Peak AMB |
| 4960.000 | V | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 500.0 | -17.4 | Avg AMB |
| 7440.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |
| 4960.000 | H | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 5000.0 | -37.4 | Peak AMB |
| 4960.000 | H | 0.0 | 1.0 | 38.8 | 32.7 | 6.2 | 34.3 | 43.4 | 148.3 | 500.0 | -10.6 | Avg AMB |
| 7440.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |
| 2480 (Y) | | | | | | | | | | | | |
| 4960.000 | V | 0.0 | 1.0 | 44.2 | 32.7 | 6.2 | 34.3 | 48.8 | 276.2 | 5000.0 | -25.2 | Peak AMB |
| 4960.000 | V | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 500.0 | -17.4 | Avg AMB |
| 7440.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |
| 4960.000 | H | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 5000.0 | -37.4 | Peak AMB |
| 4960.000 | H | 0.0 | 1.0 | 38.8 | 32.7 | 6.2 | 34.3 | 43.4 | 148.3 | 500.0 | -10.6 | Avg AMB |
| 7440.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |
| 2480 (Z) | | | | | | | | | | | | |
| 4960.000 | V | 0.0 | 1.0 | 44.2 | 32.7 | 6.2 | 34.3 | 48.8 | 276.2 | 5000.0 | -25.2 | Peak AMB |
| 4960.000 | V | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 500.0 | -17.4 | Avg AMB |
| 7440.000 | V | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | V | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |
| 4960.000 | H | 0.0 | 1.0 | 32.0 | 32.7 | 6.2 | 34.3 | 36.6 | 67.8 | 5000.0 | -37.4 | Peak AMB |
| 4960.000 | H | 0.0 | 1.0 | 38.8 | 32.7 | 6.2 | 34.3 | 43.4 | 148.3 | 500.0 | -10.6 | Avg AMB |
| 7440.000 | H | 0.0 | 1.0 | 39.1 | 37.1 | 8.1 | 34.8 | 49.5 | 299.7 | 5000.0 | -24.4 | Peak AMB |
| 7440.000 | H | 0.0 | 1.0 | 33.0 | 37.1 | 8.1 | 34.8 | 43.4 | 148.5 | 500.0 | -10.5 | Avg AMB |
| 12400.000 | V | 0.0 | 1.0 | 45.3 | 40.0 | 13.1 | 34.5 | 63.9 | 1570.8 | 5000.0 | -10.1 | Peak AMB |
| 12400.000 | V | 0.0 | 1.0 | 32.5 | 40.0 | 13.1 | 34.5 | 51.1 | 359.9 | 500.0 | -2.9 | Avg AMB |

## 4.7 Conducted Emissions

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.

AC Power Line (Wall Charger) conducted emissions test data are included in Table 11. USB port conducted emissions data is presented in Table 12.

### Table 11: AC Power Line (Wall Charger) Conducted Emissions Test Data Sheet

**LINE 1 - NEUTRAL**

| Frequency (MHz) | Level QP (dBµV) | Cable Loss (dB) | LISN Corr (dB) | Limit QP (dBµV) | Level Corr (dBµV) | Margin QP (dB) | Level AVG (dBµV) | Cable Loss (dB) | Level Corr (dBµV) | Limit AVG (dBµV) | Margin AVG (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.153 | 44.3 | 10.3 | 0.8 | 65.8 | 55.3 | -10.5 | 30.7 | 10.3 | 41.7 | 55.8 | -14.1 |
| 0.306 | 43.3 | 10.1 | 0.3 | 60.1 | 53.8 | -6.3 | 27.2 | 10.1 | 37.7 | 50.1 | -12.4 |
| 0.445 | 42.0 | 10.2 | 0.3 | 57.0 | 52.5 | -4.5 | 20.2 | 10.2 | 30.7 | 47.0 | -16.3 |
| 0.612 | 32.6 | 10.2 | 0.3 | 56.0 | 43.1 | -12.9 | 22.6 | 10.2 | 33.1 | 46.0 | -12.9 |
| 7.400 | 24.8 | 11.0 | 1.0 | 60.0 | 36.8 | -23.2 | 17.6 | 11.0 | 29.6 | 50.0 | -20.4 |
| 19.050 | 25.4 | 11.7 | 3.0 | 60.0 | 40.1 | -19.9 | 7.1 | 11.7 | 21.8 | 50.0 | -28.2 |

**LINE 2 - PHASE**

| Frequency (MHz) | Level QP (dBµV) | Cable Loss (dB) | LISN Corr (dB) | Limit QP (dBµV) | Level Corr (dBµV) | Margin QP (dB) | Level AVG (dBµV) | Cable Loss (dB) | Level Corr (dBµV) | Limit AVG (dBµV) | Margin AVG (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.153 | 45.3 | 10.3 | 0.4 | 65.8 | 56.0 | -9.9 | 31.1 | 10.3 | 41.8 | 55.8 | -14.1 |
| 0.306 | 42.1 | 10.1 | 0.2 | 60.1 | 52.4 | -7.7 | 27.1 | 10.1 | 37.4 | 50.1 | -12.7 |
| 0.445 | 39.8 | 10.2 | 0.2 | 57.0 | 50.2 | -6.8 | 20.5 | 10.2 | 30.9 | 47.0 | -16.1 |
| 0.612 | 32.8 | 10.2 | 0.2 | 56.0 | 43.2 | -12.8 | 21.5 | 10.2 | 31.9 | 46.0 | -14.1 |
| 7.400 | 24.6 | 11.0 | 1.4 | 60.0 | 37.0 | -23.0 | 16.6 | 11.0 | 29.0 | 50.0 | -21.0 |
| 19.050 | 24.3 | 11.7 | 3.9 | 60.0 | 39.9 | -20.1 | 6.9 | 11.7 | 22.5 | 50.0 | -27.5 |

# Table 12: USB Conducted Emissions Test Data Sheet

## LINE 1 - NEUTRAL

| Frequency (MHz) | Level QP (dBµV) | Cable Loss (dB) | LISN Corr (dB) | Limit QP (dBµV) | Level Corr (dBµV) | Margin QP (dB) | Level AVG (dBµV) | Cable Loss (dB) | Level Corr (dBµV) | Limit AVG (dBµV) | Margin AVG (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.156 | 44.3 | 10.2 | 1.0 | 65.7 | 55.5 | -10.2 | 30.6 | 10.2 | 41.8 | 55.7 | -13.9 |
| 0.233 | 41.5 | 10.3 | 0.8 | 62.3 | 52.6 | -9.7 | 28.2 | 10.3 | 39.3 | 52.3 | -13.0 |
| 0.330 | 35.8 | 10.4 | 0.7 | 59.5 | 46.9 | -12.6 | 25.0 | 10.4 | 36.1 | 49.5 | -13.4 |
| 3.850 | 35.9 | 11.1 | 0.5 | 56.0 | 47.5 | -8.5 | 13.0 | 11.1 | 24.6 | 46.0 | -21.4 |
| 11.200 | 26.5 | 11.5 | 0.2 | 60.0 | 38.1 | -21.9 | 14.0 | 11.5 | 25.6 | 50.0 | -24.4 |
| 16.510 | 25.6 | 11.3 | 0.1 | 60.0 | 37.0 | -23.0 | 13.8 | 11.3 | 25.2 | 50.0 | -24.8 |

## LINE 2 - PHASE

| Frequency (MHz) | Level QP (dBµV) | Cable Loss (dB) | LISN Corr (dB) | Limit QP (dBµV) | Level Corr (dBµV) | Margin QP (dB) | Level AVG (dBµV) | Cable Loss (dB) | Level Corr (dBµV) | Limit AVG (dBµV) | Margin AVG (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.168 | 42.3 | 10.2 | 0.8 | 65.1 | 53.3 | -11.8 | 27.9 | 10.2 | 38.9 | 55.1 | -16.2 |
| 0.233 | 40.8 | 10.3 | 0.7 | 62.3 | 51.8 | -10.5 | 28.5 | 10.3 | 39.5 | 52.3 | -12.8 |
| 0.330 | 35.8 | 10.4 | 0.6 | 59.5 | 46.8 | -12.7 | 21.9 | 10.4 | 32.9 | 49.5 | -16.6 |
| 3.850 | 37.1 | 11.1 | 0.5 | 56.0 | 48.7 | -7.3 | 12.9 | 11.1 | 24.5 | 46.0 | -21.5 |
| 11.200 | 25.4 | 11.5 | 0.2 | 60.0 | 37.1 | -22.9 | 13.7 | 11.5 | 25.4 | 50.0 | -24.6 |
| 16.510 | 23.9 | 11.3 | 0.2 | 60.0 | 35.4 | -24.6 | 13.8 | 11.3 | 25.3 | 50.0 | -24.7 |