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# FCC & Industry Canada Certification Test Report
# For the
# Cooper Power Systems
# RFN420CL Module

## FCC ID: P9X-RFN420CL
## IC: 6766A-RFN420CL

WLL JOB# **11896-01**
**June 7, 2011**

Prepared for:

**Cooper Power Systems**
**20201 Century Blvd. Suite 250**
**Germantown, MD 20874**

Prepared By:

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

ACCLASS ACCREDITED TESTING

**Testing Certificate AT-1448**

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Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

 

# Abstract

This report has been prepared on behalf of Cooper Power Systems to support the attached Application for Equipment Authorization. The test report and application are submitted for a Direct Sequence Spread Spectrum Transmitter under Part 15.247 (10/2009) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 issue 8 of Industry Canada. This Certification Test Report documents the test configuration and test results for the Cooper Power Systems RFN420CL Module.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Cooper Power Systems RFN420CL Module complies with the limits for a Direct Sequence Spread Spectrum Transmitter under FCC Part 15.247 and Industry Canada RSS-210.

| Revision History | Description of Change | Date |
|---|---|---|
| Rev 0 | Initial Release | June 7, 2011 |
| | | |

 

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# 1 Introduction

## 1.1 Compliance Statement

The Cooper Power Systems RFN420CL Module complies with the limits for a Direct Sequence Spread Spectrum Transmitter device under FCC Part 15.247 (10/2009) and Industry Canada RSS-210 issue 8.

## 1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with FCC Public Notice FCC97-114, Guidance on Measurements for Direct Sequence Spread Spectrum Systems & KDB558074: "Measurement of Digital Transmission Systems operating under Section 15.247." The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

## 1.3 Contract Information

| | |
|---|---|
| Customer: | Cooper Power Systems<br>20201 Century Blvd. Suite 250<br>Germantown, MD 20874 |
| Purchase Order Number: | 31472 |
| Quotation Number: | 66065 |

## 1.4 Test Dates

| | |
|---|---|
| Testing was performed on the following date(s): | 5/23/2011 to 6/2/2011 |

## 1.5 Test and Support Personnel

| | |
|---|---|
| Washington Laboratories, LTD | James Ritter |
| Client Representative | Steve Seymour |

## 1.6 Abbreviations

| | |
|---|---|
| **A** | **A**mpere |
| **ac** | **a**lternating **c**urrent |
| **AM** | Amplitude Modulation |
| **Amps** | **Amp**eres |
| **b/s** | **b**its per **s**econd |
| **BW** | **B**and**W**idth |
| **CE** | **C**onducted **E**mission |
| **cm** | **c**enti**m**eter |
| **CW** | **C**ontinuous **W**ave |
| **dB** | **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 RFN420CL is a radio communications device designed for use in L+G Focus meters. It can also be used in Cooper Power Systems Gateways and Relay Nodes. The RFN420CL provides a 915 MHz radio Interface to an RF mesh network, and a Zigbee interface for HAN applications.

This report covers only the Zigbee radio, the 915MHz band FHSS radio is covered in a separate report.

**Table 1: Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Cooper Power Systems |
| FCC ID: | P9X-RFN420CL |
| IC: | 6766A-RFN420CL |
| Model: | RFN420CL |
| FCC Rule Parts: | §15.247 |
| Industry Canada: | RSS210 issue 8 |
| Frequency Range: | 2405 – 2475MHz |
| Maximum Output Power: | 19.99 dBm (99.77mW) |
| Modulation: | DSSS(QPSK) |
| Occupied Bandwidth: | 1.62MHz |
| Maximum Spurious TX: | 307.9uV/m @ 3m -2483.5MHz (with unit tuned to 2475MHz) |
| Maximum Spurious RX: | NA (receiver above 960MHz) |
| Emission Designator: | 1M62G1D |
| Keying: | Automatic |
| Type of Information: | Data |
| Number of Channels: | 15 |
| Antenna Connector | integral |
| Antenna Type | 0 dBi wire antenna |
| Power Output Level | Fixed |
| Interface Cables: | None (plug- in board) |
| Power Source & Voltage: | 120/230VAC |

## 2.2 Test Configuration

The Cooper Power Systems RFN420CL Module, Equipment Under Test (EUT), was operated from a 115Vac power supply. Programming commands were sent from a support laptop via an ember ISA3 InSight port adaptor to a header on the EUT module.

## 2.3 Testing Algorithm

The RFN420CL Module was programmed for DSSS operation from a support laptop via an ember ISA3 InSight port adaptor to a header on the EUT module. The Insight windows program allowed entry for channel selection during 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 ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

## 2.5 Measurements

### 2.5.1 References

FCC Public Notice FCC97-114, Guidance on Measurements for Direct Sequence Spread Spectrum Systems

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

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

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

## 2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in

Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

**Equation 1: Standard Uncertainty**

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + .....}$$

Where $u_c$ = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

**Equation 2: Expanded Uncertainty**

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

$u_c$ = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

**Table 2: Expanded Uncertainty List**

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

# 3 Test Equipment

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

**Table 3: Test Equipment List**

| Test Name: | **Bench Conducted RF Tests** | : | |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 728 | HP – 8564EC | ANALYZER SPECTRUM | 4/28/2012 |

| Test Name: | **Radiated Emissions** | | |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 728 | AGILENT - 8564EC | SPECTRUM ANALYZER 30HZ - 40GHZ | 4/28/2012 |
| 522 | HP - 8449B | PRE-AMPLIFIER 1-26.5GHZ | 7/27/2011 |
| 425 | ARA - DRG-118/A | ANTENNA DRG 1-18GHZ | 9/9/2011 |
| 280 | ITC - 21C-3A1 | WAVEGUIDE 3.45-11.0GHZ | 3/24/2012 |
| 282 | ITC - 21X-3A1 | WAVEGUIDE 6.8-15GHZ | 3/24/2012 |
| 283 | ITC - 21KU-3A1 | WAVEGUIDE 9.8-20.5GHZ | 3/24/2012 |
| 382 | SUNOL SCIENCES CORPORATION - JB1 | ANTENNA BICONLOG | 1/12/2012 |
| 71 | HP - 85685A | PRESELECTOR RF | 7/1/2011 |
| 73 | HP - 8568B | ANALYZER SPECTRUM | 7/1/2011 |
| 69 | HP - 85650A | ADAPTER QP | 7/1/2011 |

| Test Name: **Conducted Emissions Voltage** | | | |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 125 | SOLAR - 8028-50-TS-24-BNC | LISN | 7/10/2011 |
| 126 | SOLAR - 8028-50-TS-24-BNC | LISN | 7/10/2011 |
| 53 | HP - 11947A | LIMITER TRANSIENT | 3/11/2012 |
| 69 | HP - 85650A | ADAPTER QP | 7/1/2011 |
| 73 | HP - 8568B | ANALYZER SPECTRUM | 7/1/2011 |
| 71 | HP - 85685A | PRESELECTOR RF | 7/1/2011 |

# 4 Test Results

## 4.1 Test Summary

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

**Table 4: Test Summary**

| TX Test Summary (Direct Sequence Spread Spectrum) | | | |
|---|---|---|---|
| **FCC Rule Part** | **IC Rule Part** | **Description** | **Result** |
| 15.247 (2) | RSS-210 [A8. 2 (a)] | 6dB Bandwidth | Pass |
| 15.247 (2)(b)(3) | RSS-210 [A8.4 (4)] | Transmit Output Power | Pass |
| 15.247 (e) | RSS-210 [A8.2 (b)] | Power Spectral Density | Pass |
| 15.247 (d) | RSS-210 [A8. 5] | Out-of-Band Emissions (Band Edge @ 20dB below) | Pass |
| 15.205<br>15.209 | RSS-210 Sect.2.2<br>RSS-Gen 7.2.2 | General Field Strength Limits (Restricted Bands & RE Limits) | Pass |
| 15.207 | RSS-Gen [7.2.4] | AC Conducted Emissions | Pass |
| **RX/Digital Test Summary (Direct Sequence Spread Spectrum)** | | | |
| **FCC Rule Part** | **IC Rule Part** | **Description** | **Result** |
| 15.207 | RSS-Gen [7.2.2] | AC Conducted Emissions | Pass |
| 15.209 | RSS-210 sect 2.5 | General Field Strength Limits | Pass |

## 4.2 Occupied Bandwidth: (FCC Part §15.247 (2))

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

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

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

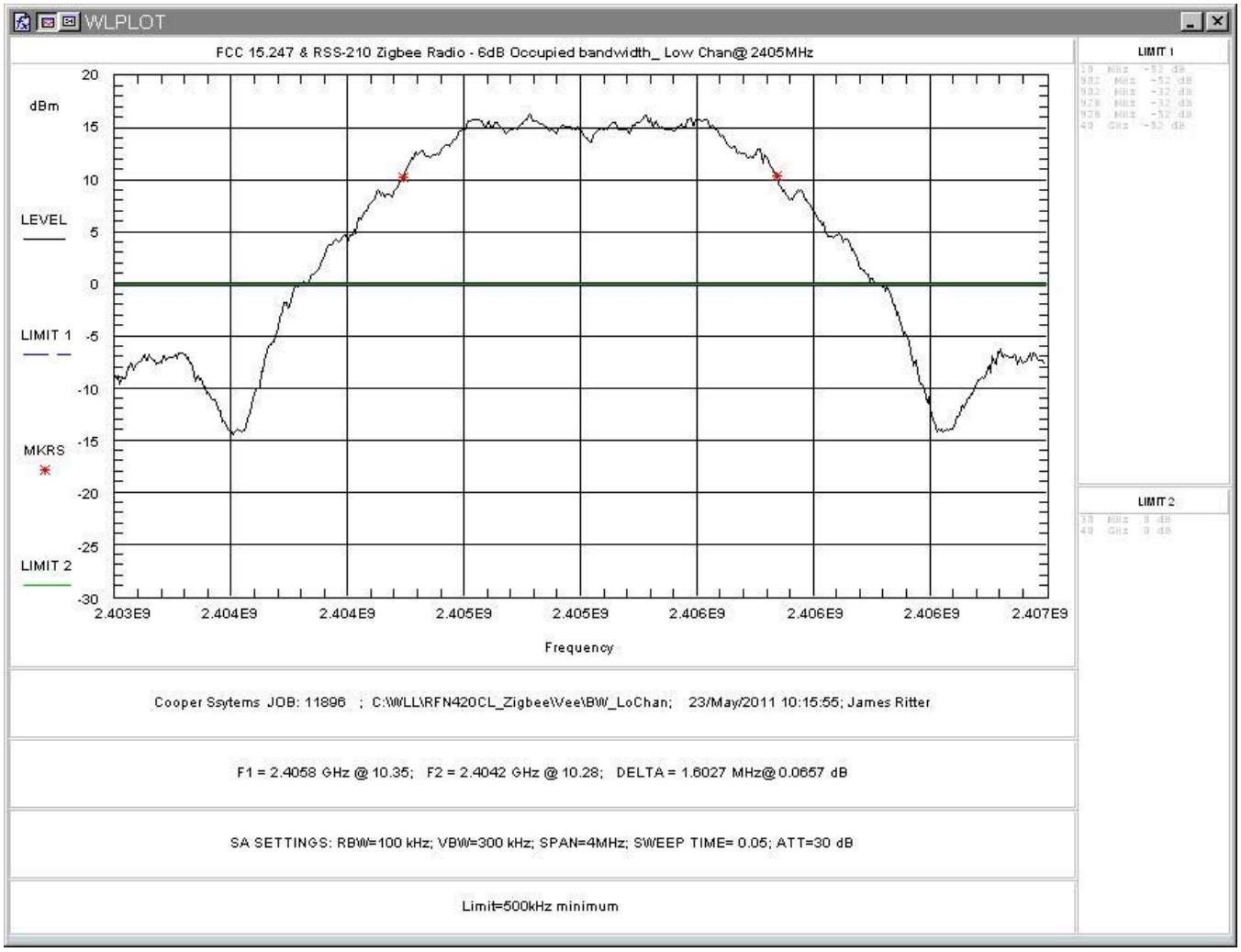



**Figure 1: Occupied Bandwidth, Low Channel**

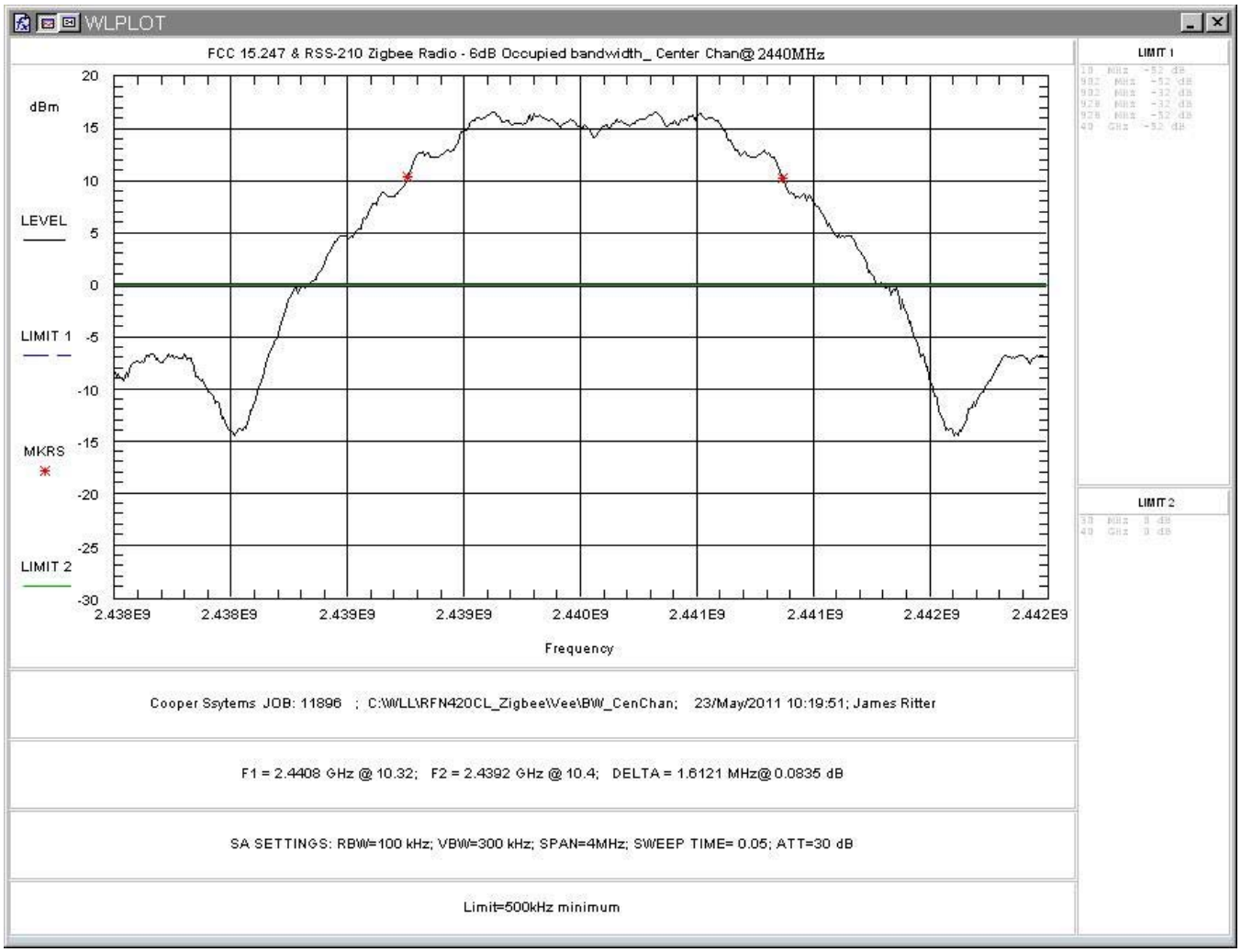



**Figure 2: Occupied Bandwidth, Center Channel**

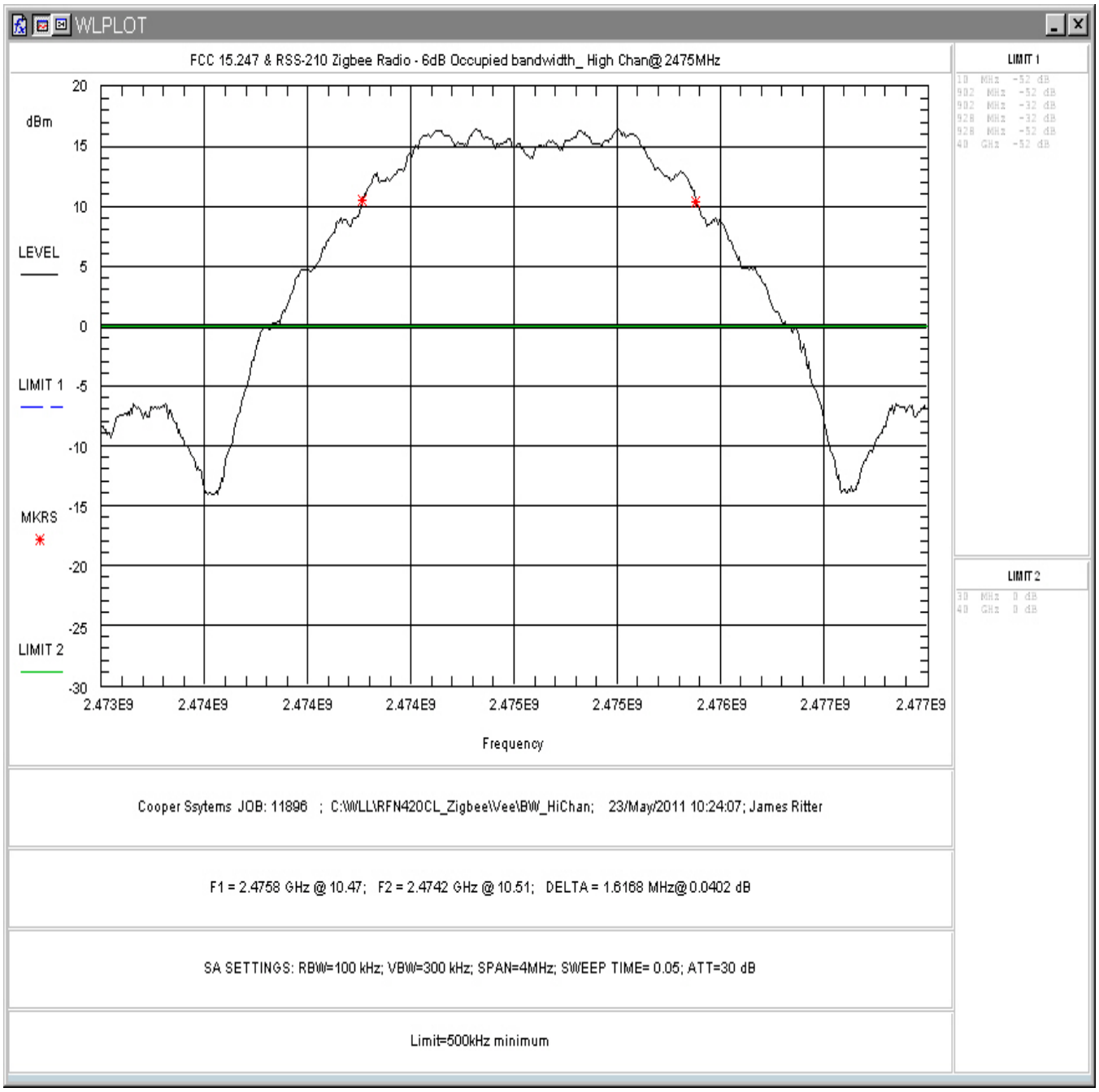



**Figure 3: Occupied Bandwidth, High Channel**

Table 5 provides a summary of the Occupied Bandwidth Results.

**Table 5: Occupied Bandwidth Results**

| Frequency | Bandwidth | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel (11): 2405MHz | 1.603MHz | >500kHz | Pass |
| Mid Channel (18): 2440MHz | 1.612MHz | >500kHz | Pass |
| High Channel (25): 2475MHz | 1.617MHz | >500kHz | Pass |

## 4.3 RF Power Output: (FCC Part §15.247(b))

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

**Table 6: RF Power Output**

| Frequency | Level | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel (11): 2405MHz | 19.92 dBm | 30 dBm | Pass |
| Center Channel (18): 2440MHz | 19.99 dBm | 30 dBm | Pass |
| High Channel (25): 2475MHz | 19.66 dBm | 30 dBm | Pass |

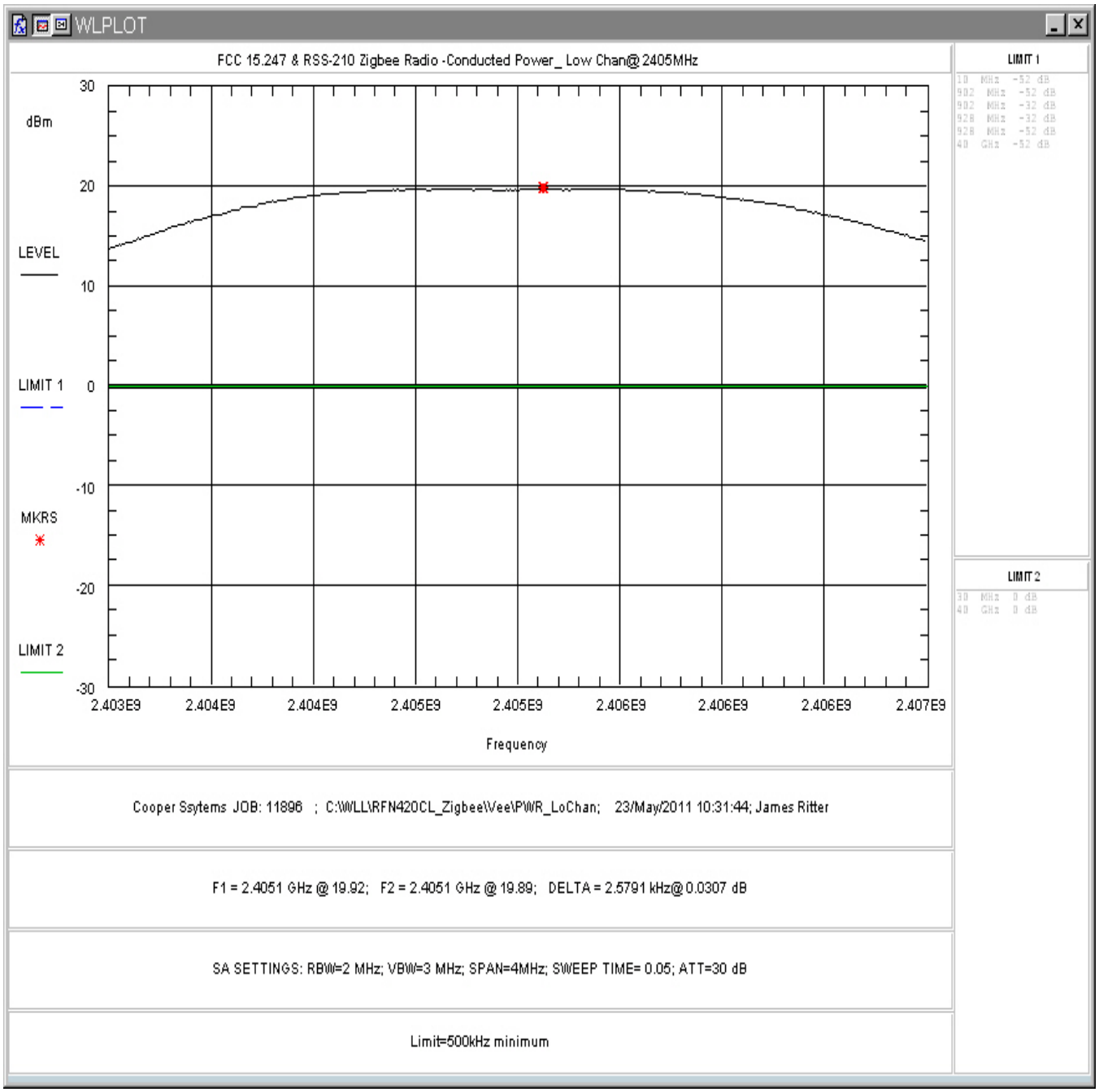



**Figure 4: RF Peak Power, Low Channel**

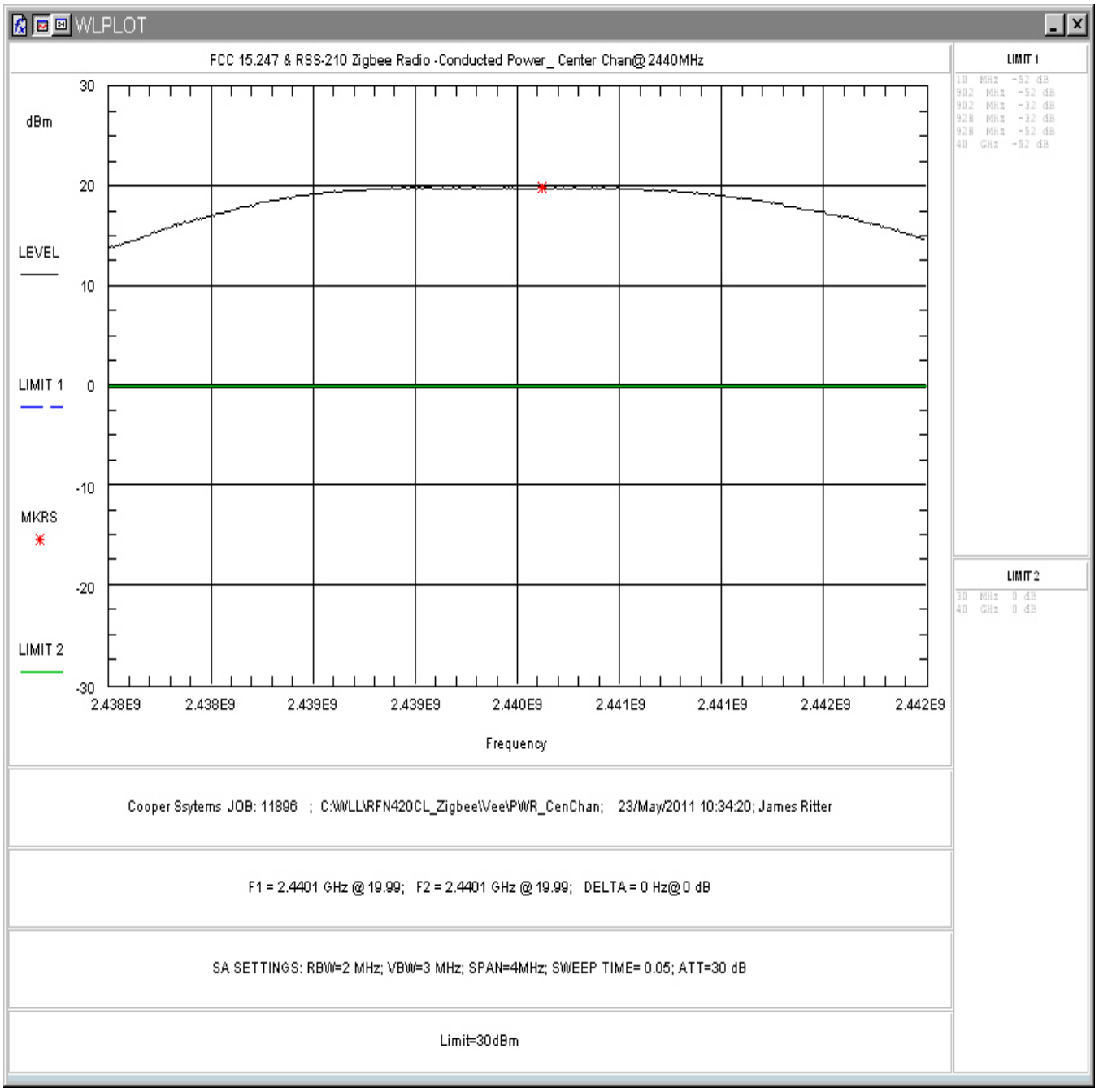



**Figure 5: RF Peak Power, Center Channel**

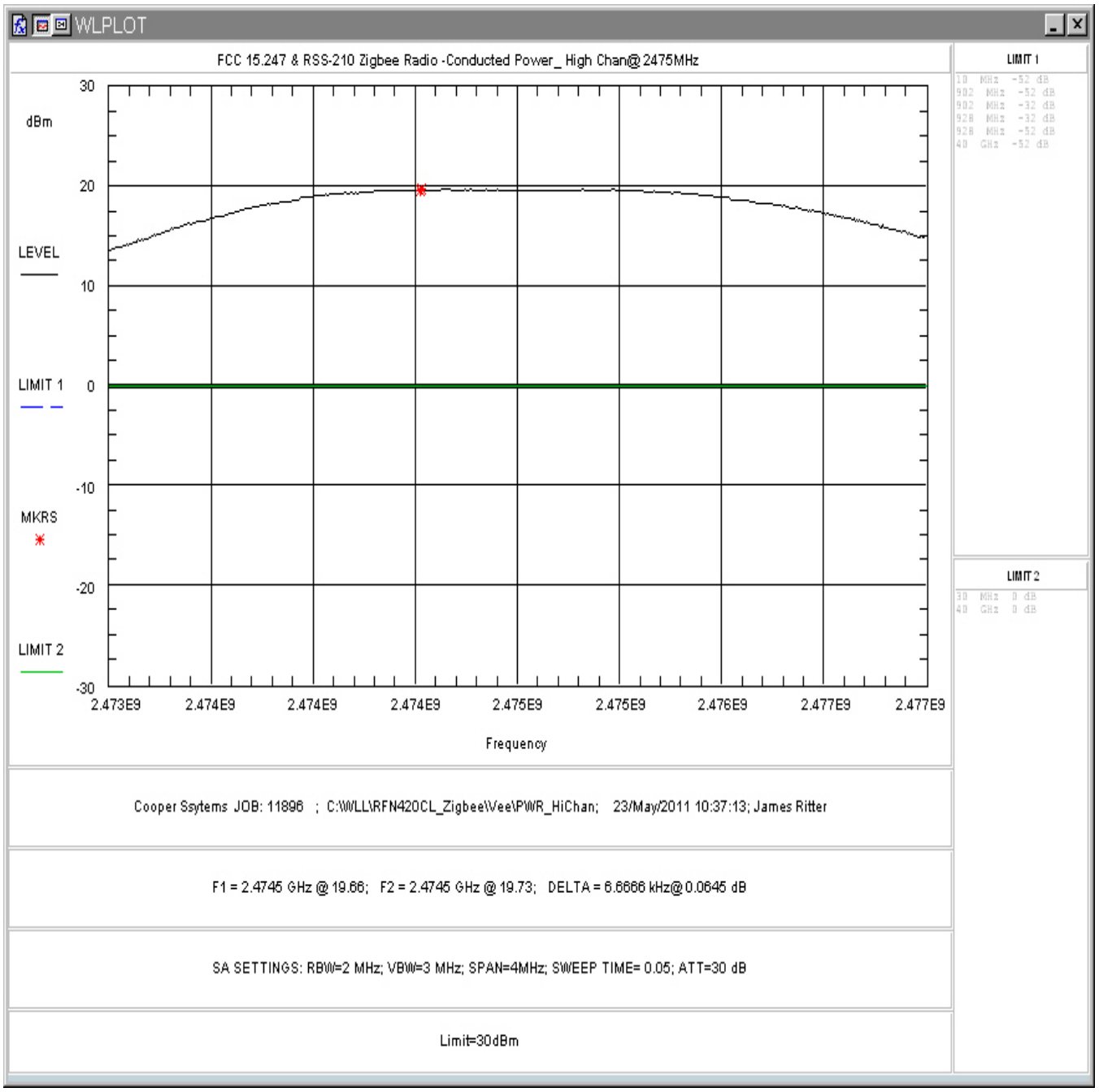



**Figure 6: RF Peak Power, High Channel**

## 4.4 Power Spectral Density (Section §15.247(e))

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

The spectrum analyzer was set to peak detect mode with a RBW of 3kHz ,VBW of 10kHz across a 1.5MHz span using a 500 second sweeptime. The highest level detected across any 3kHz band for continuous transmission was then recorded and compared to the limit 8dBm. The following table and plots give the results for power spectral density testing.

**Table 7: Power Spectral Density**

| Frequency | Peak Level | Limit | Pass/Fail |
|---|---|---|---|
| Low Channel (11): 2405MHz | 5.24 dBm | 8 dBm | Pass |
| Center Channel (18): 2440MHz | 5.38 dBm | 8 dBm | Pass |
| High Channel (25): 2475MHz | 5.04 dBm | 8 dBm | Pass |

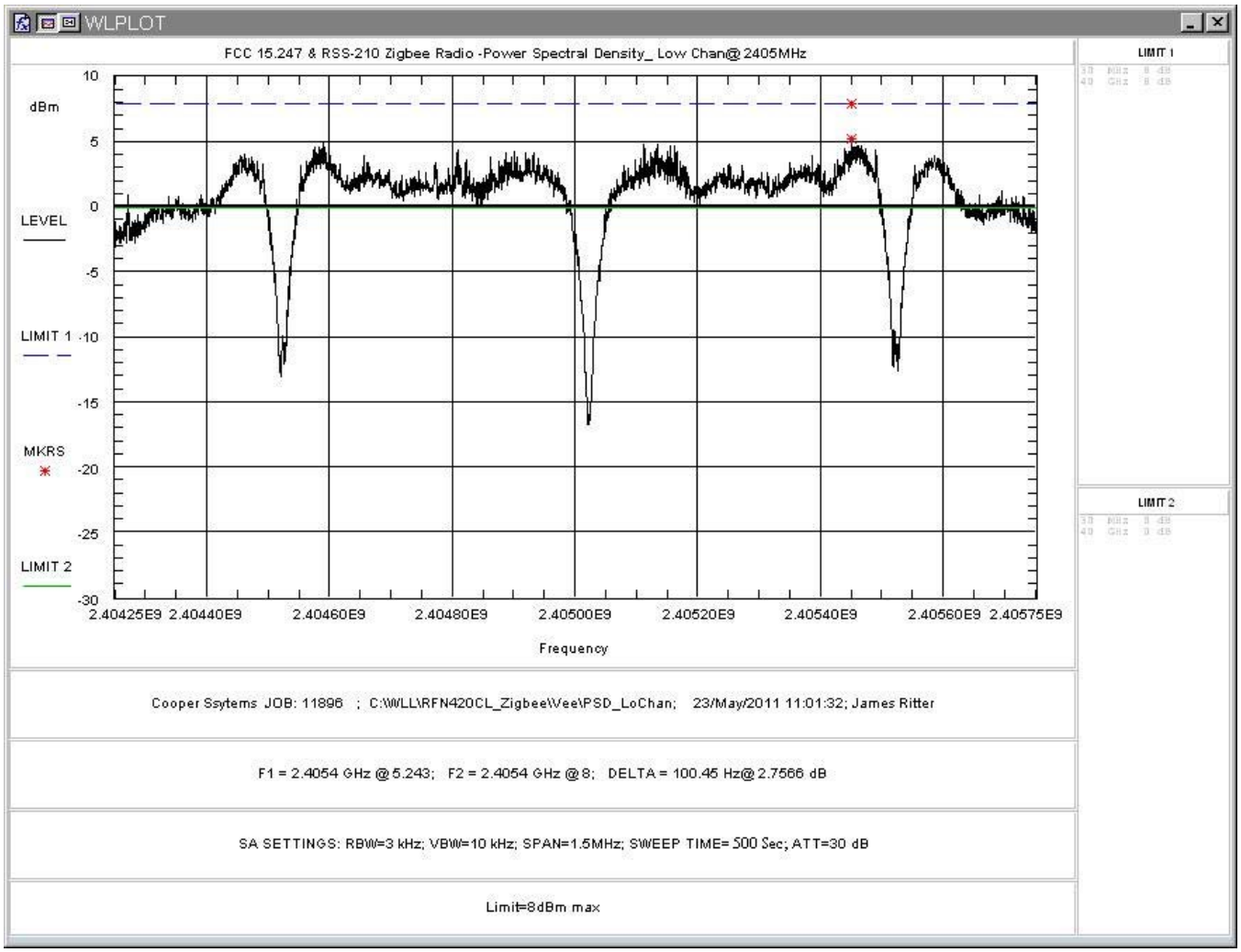



**Figure 7: Power Spectral Density, Low Channel**

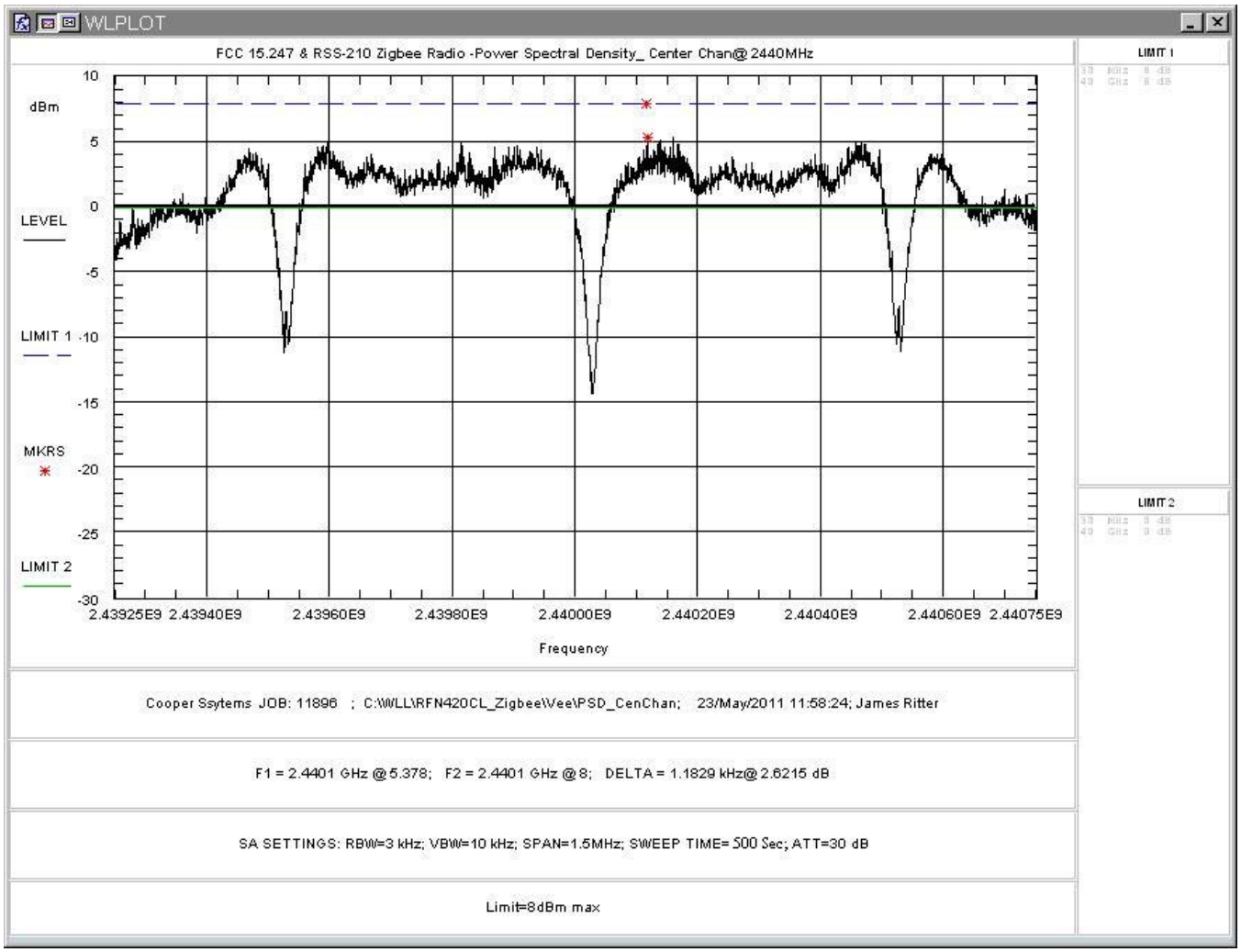



**Figure 8: Power Spectral Density, Center Channel**

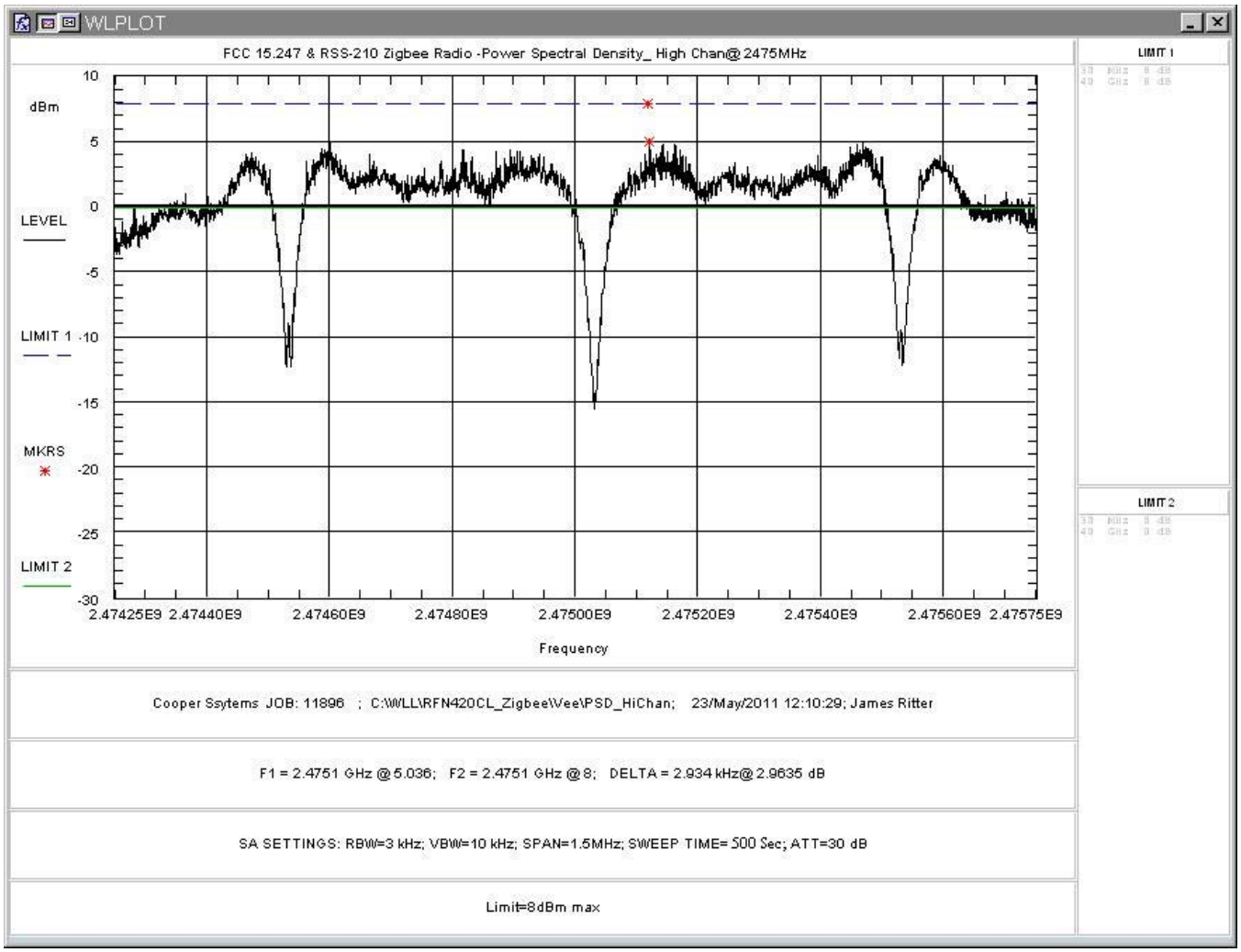



**Figure 9: Power Spectral Density, High Channel**

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

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

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 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.

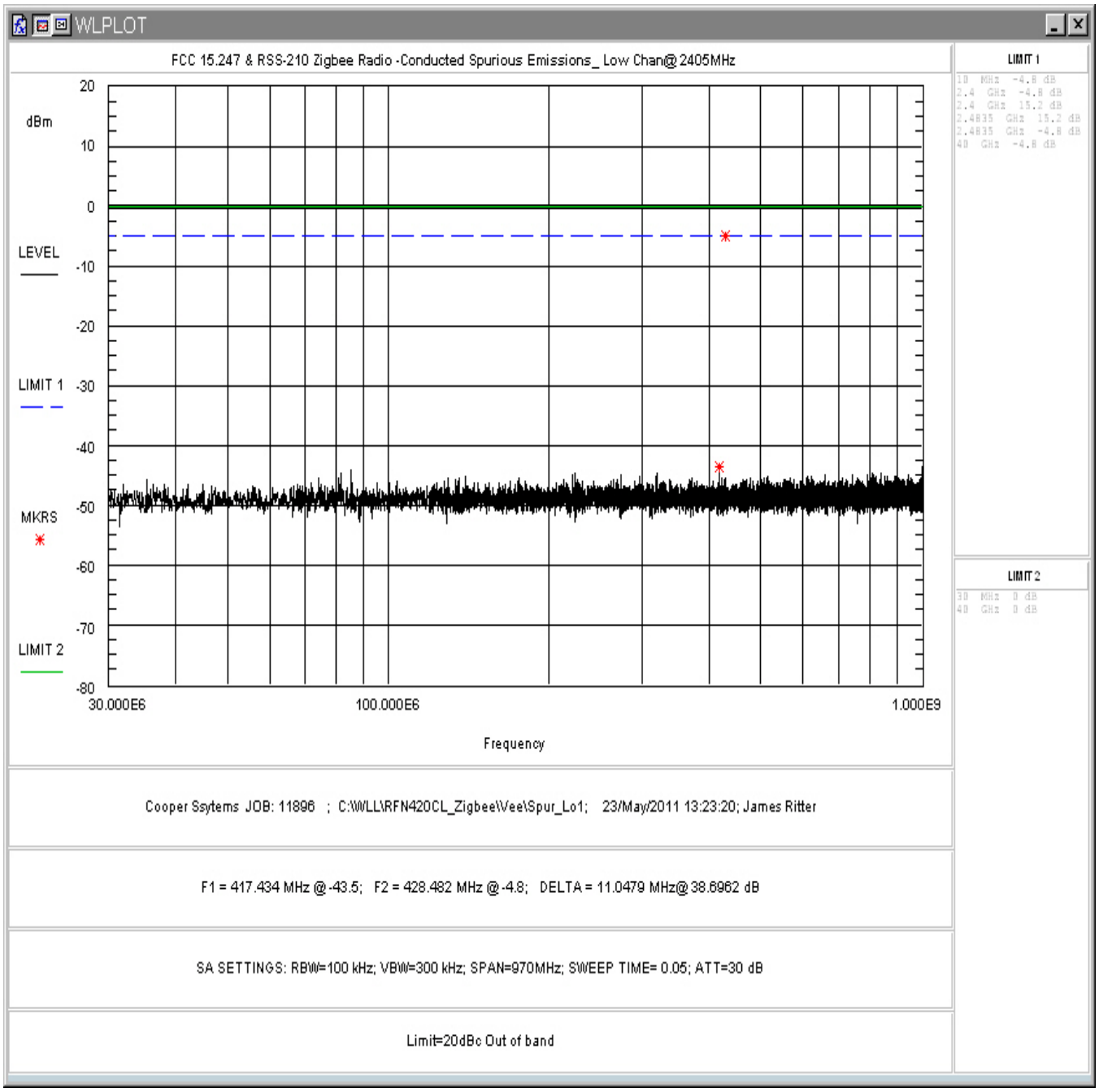



**Figure 10: Conducted Spurious Emissions, Low Channel, 30 - 1000MHz**

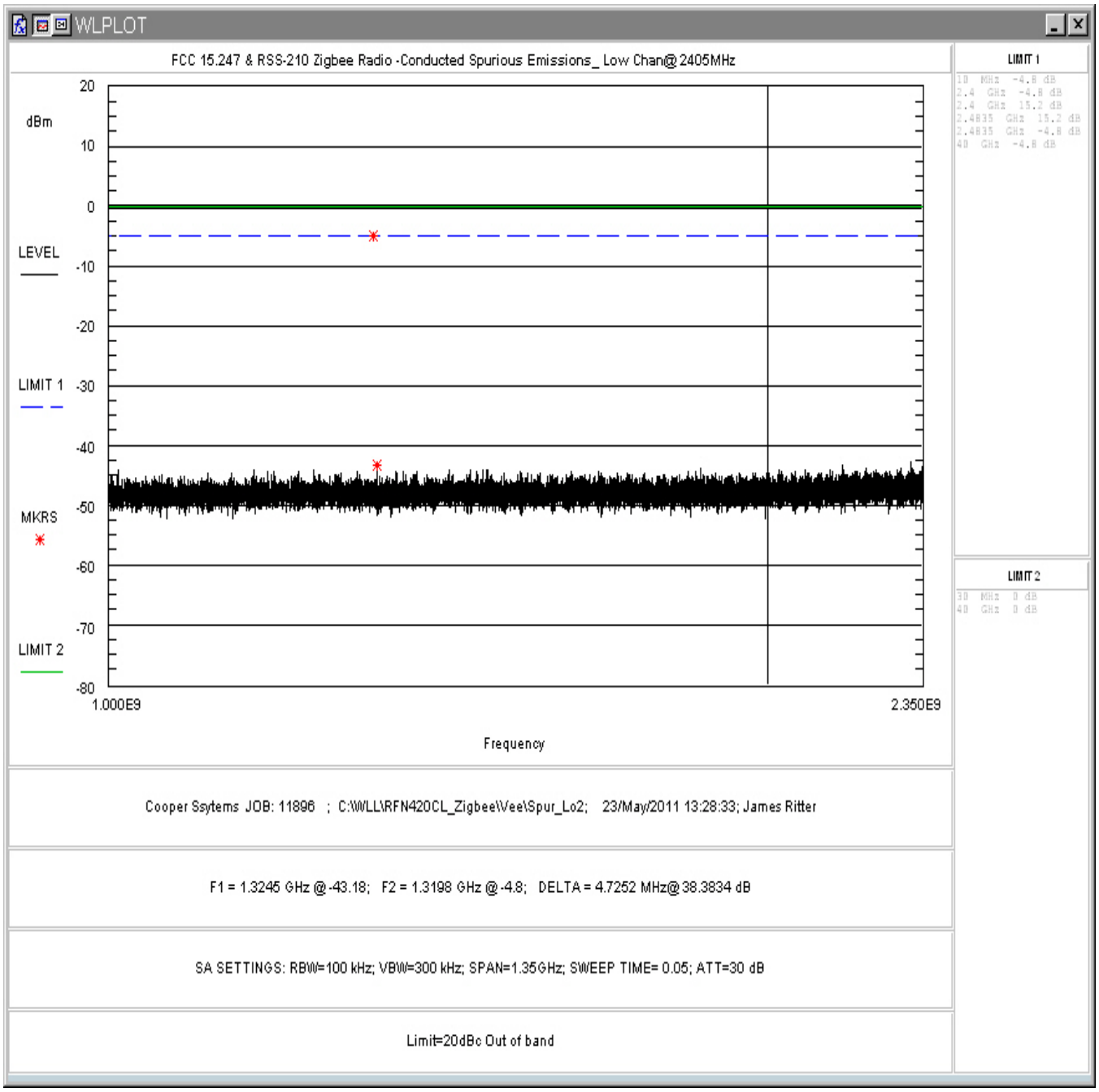



**Figure 11: Conducted Spurious Emissions, Low Channel, 1 – 2.35GHz**

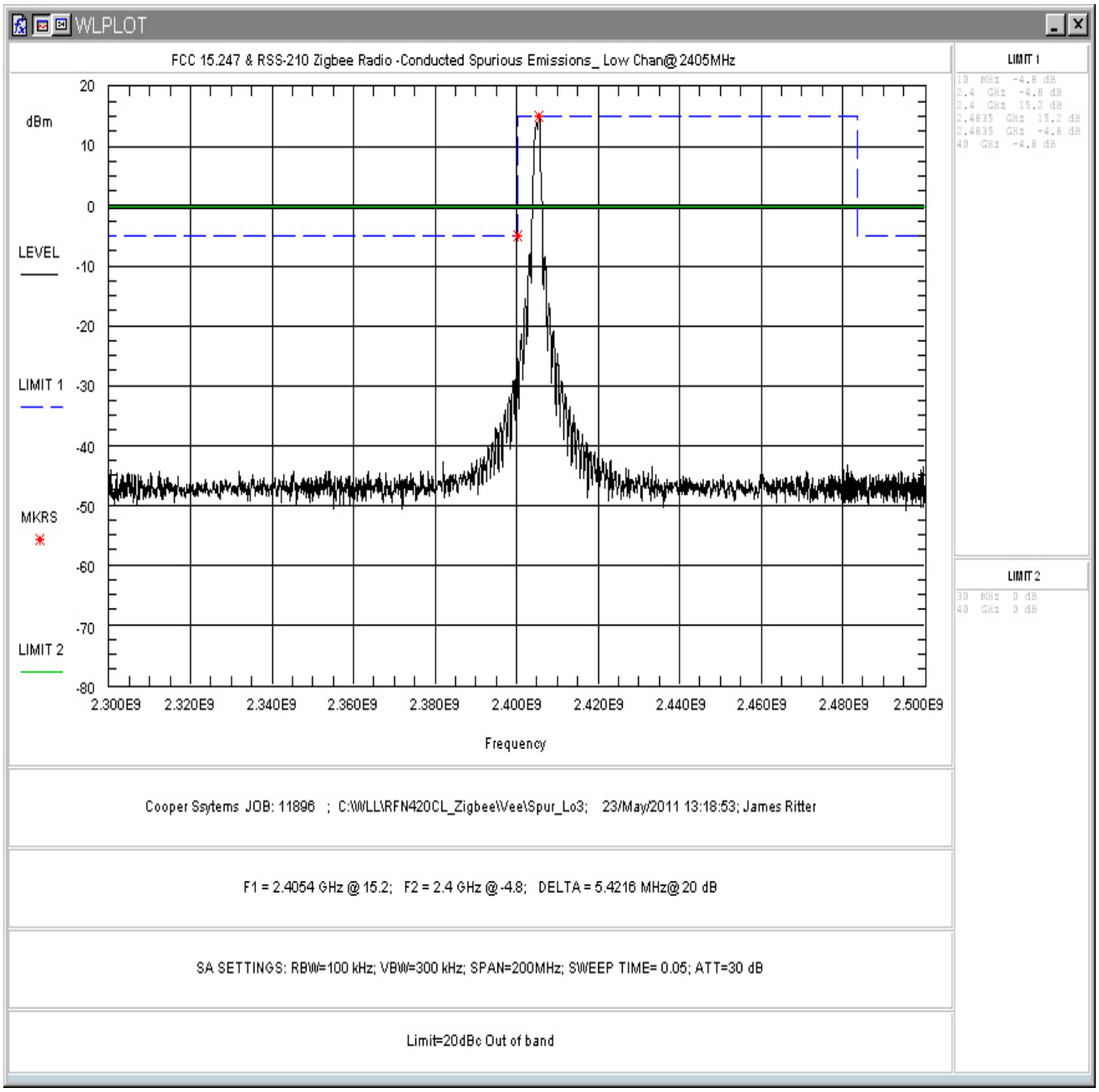



**Figure 12: Conducted Spurious Emissions, Low Channel, 2.3 – 2.5GHz**

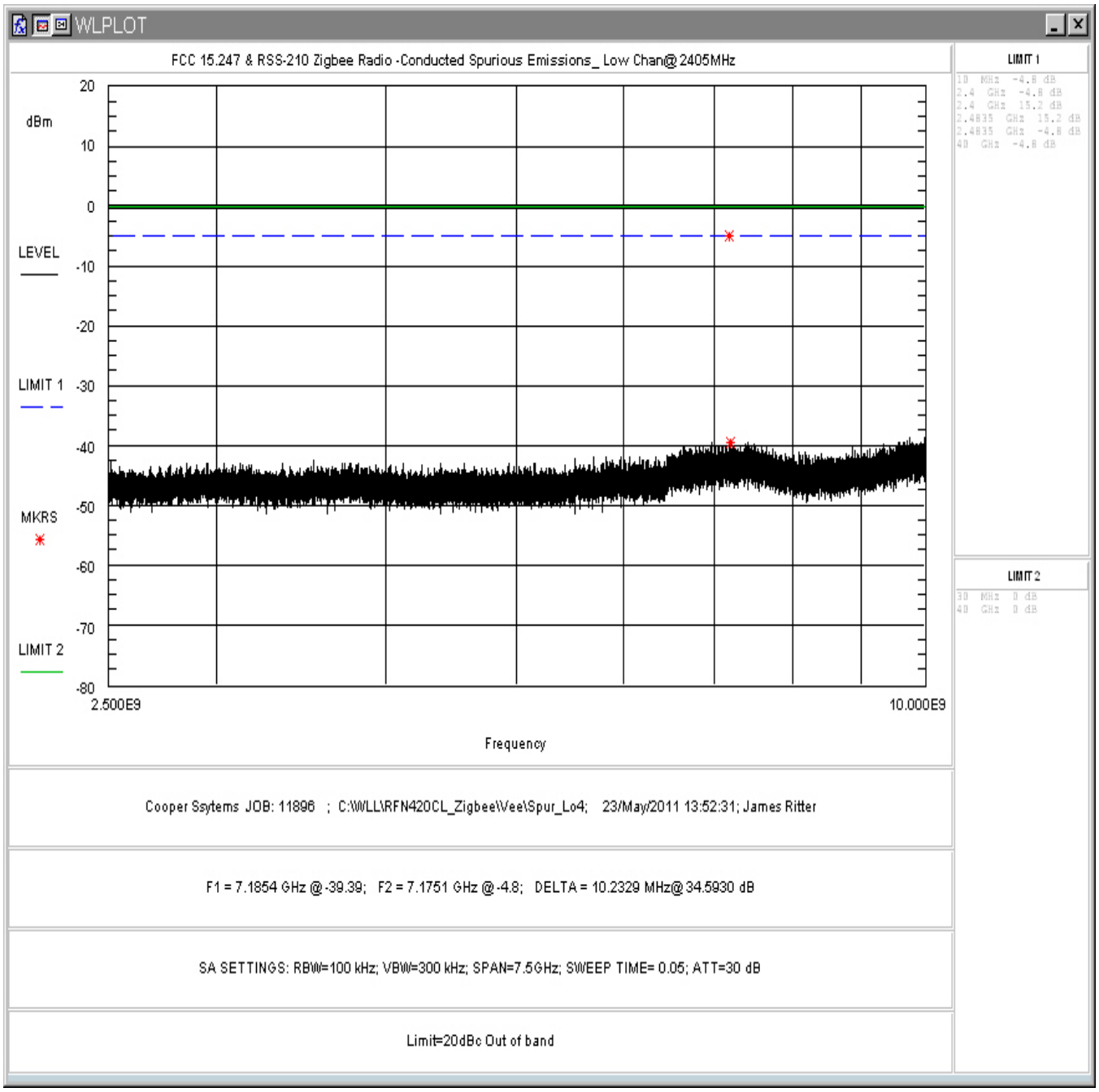



**Figure 13: Conducted Spurious Emissions, Low Channel, 2.5 - 10GHz**

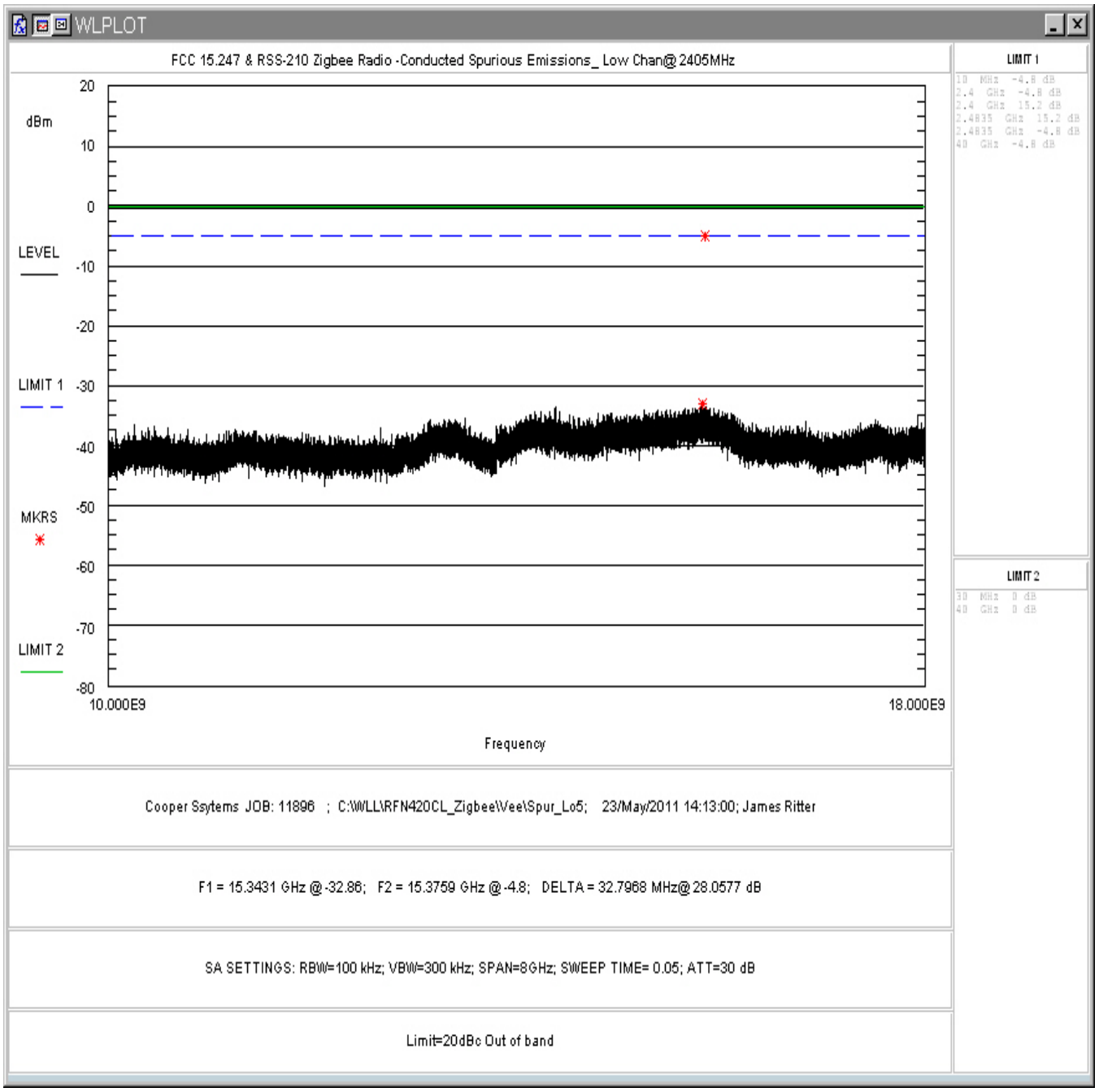



**Figure 14: Conducted Spurious Emissions, Low Channel, 10 - 18GHz**

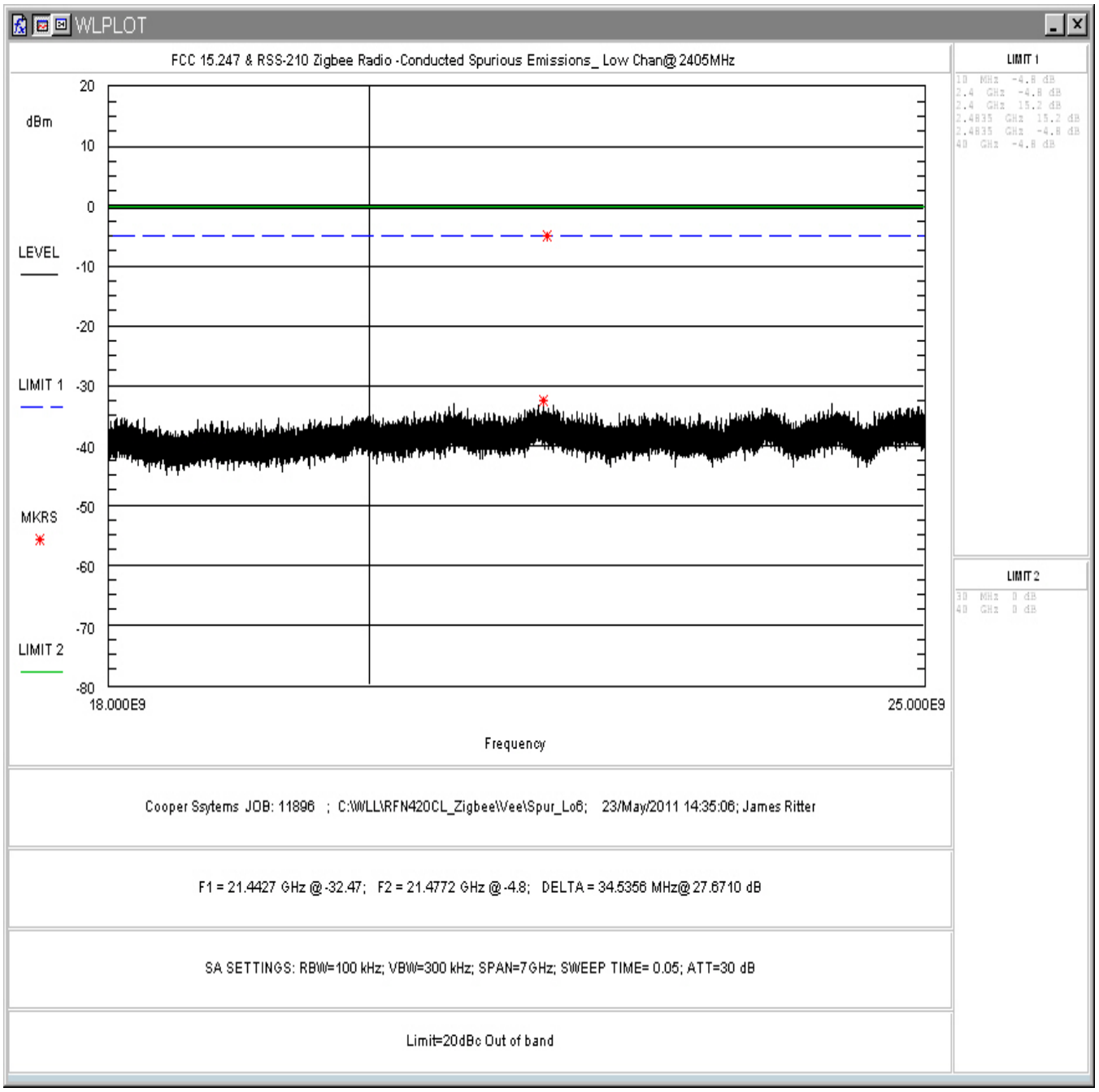



**Figure 15: Conducted Spurious Emissions, Low Channel, 18 - 25GHz**

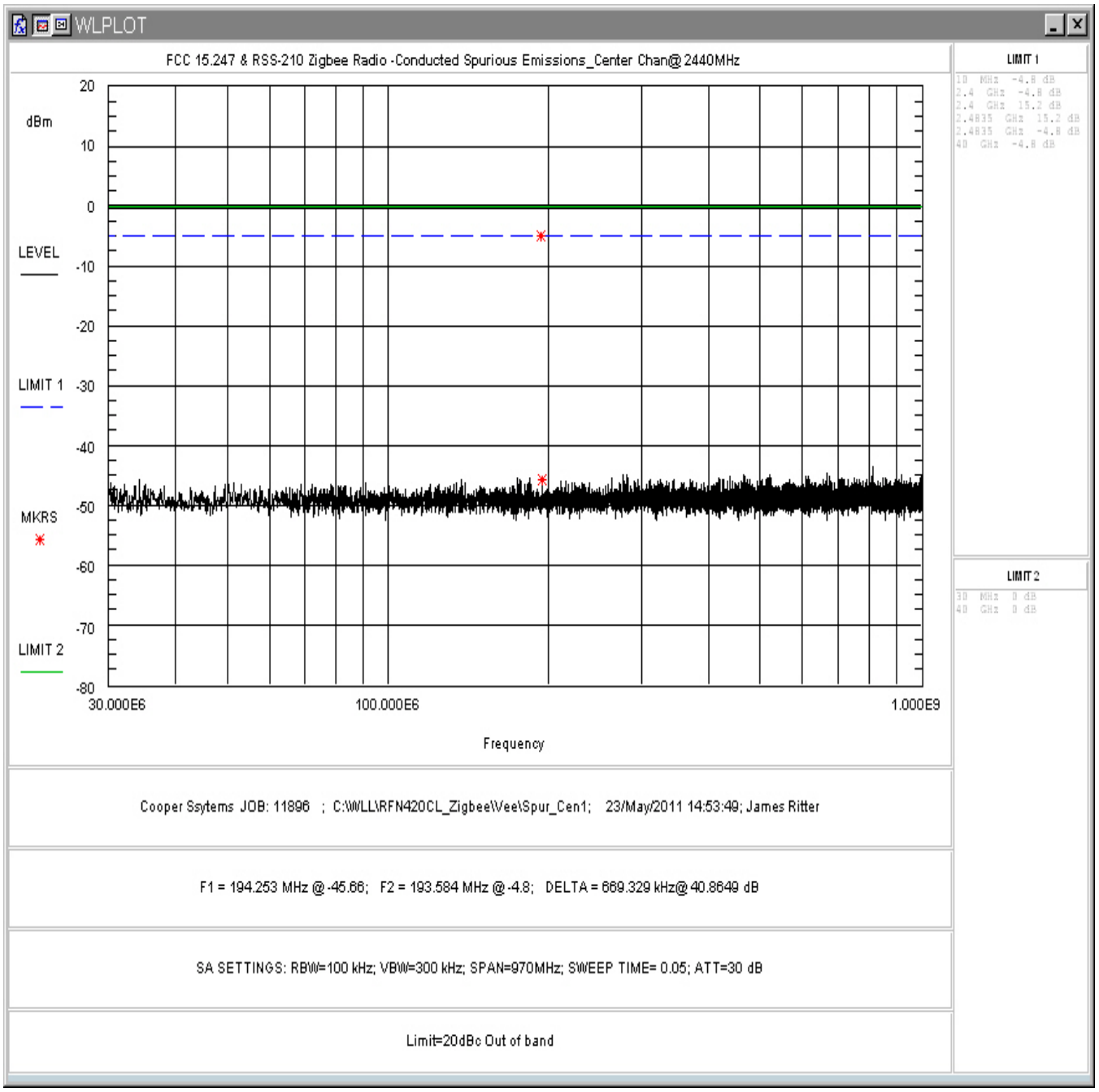



**Figure 16: Conducted Spurious Emissions, Center Channel, 30 – 1000MHz**

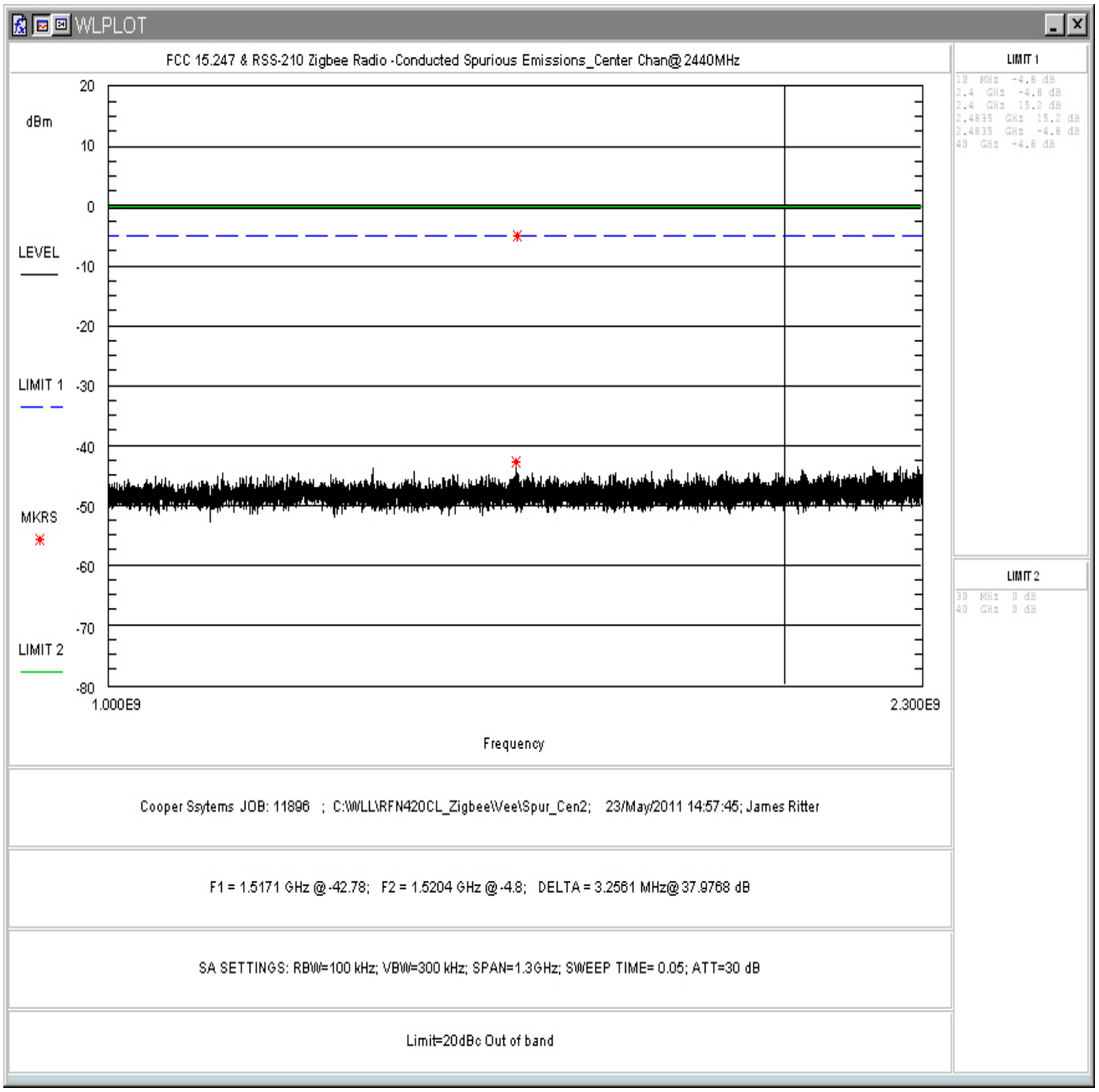



**Figure 17: Conducted Spurious Emissions, Center Channel, 1 – 2.3GHz**

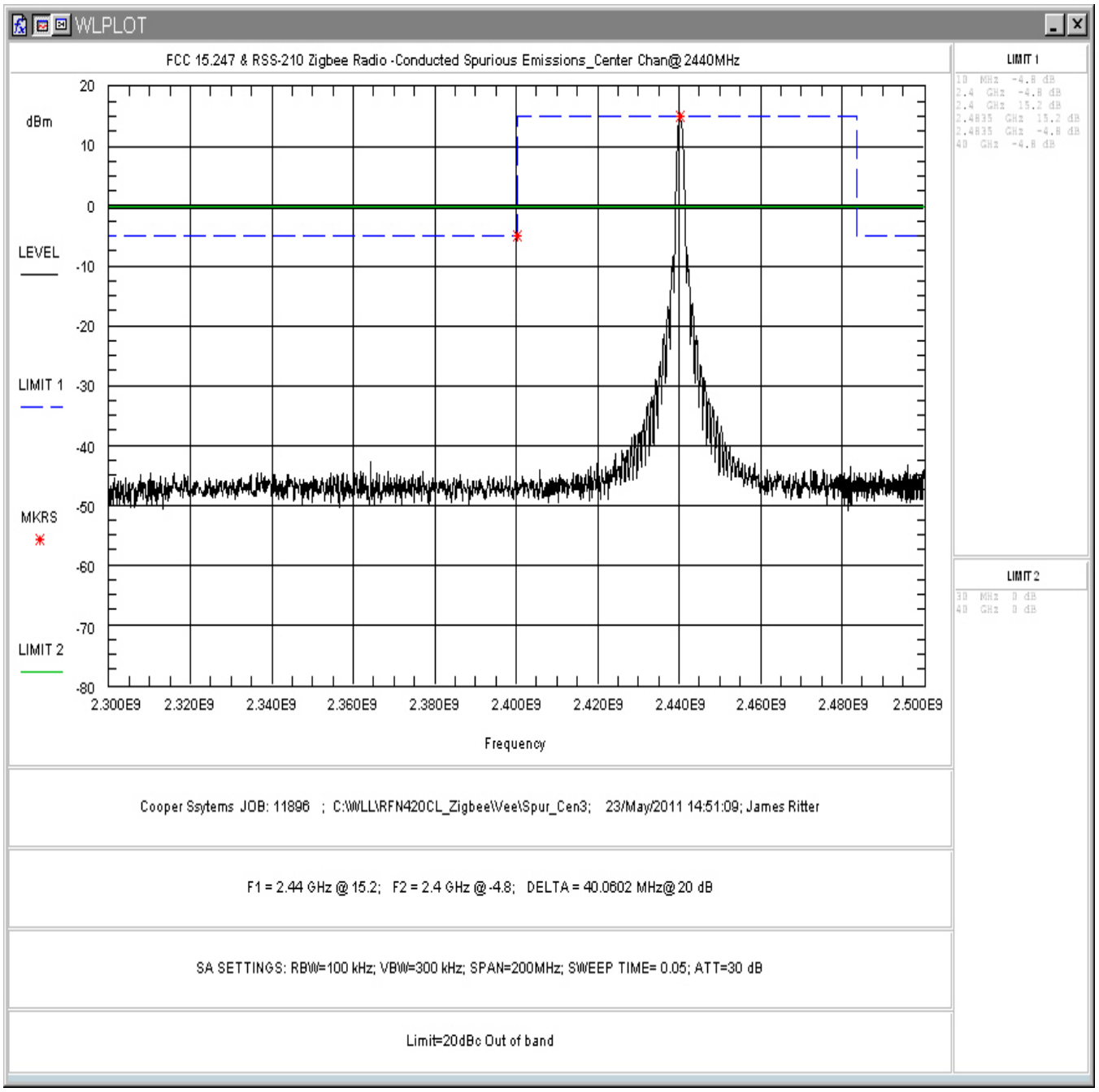



**Figure 18: Conducted Spurious Emissions, Center Channel, 2.35 – 2.5GHz**

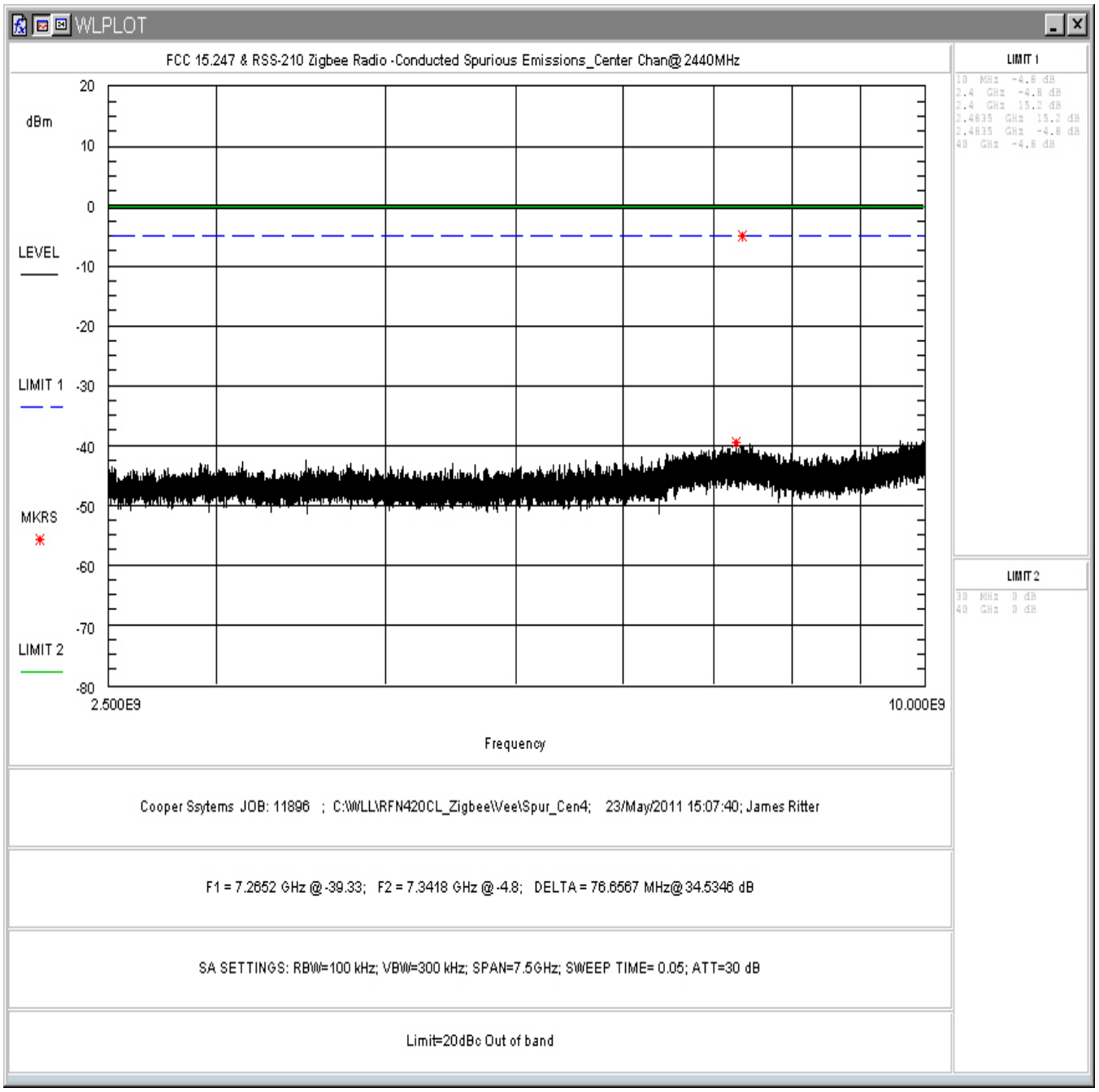



**Figure 19: Conducted Spurious Emissions, Center Channel, 2.5 – 10GHz**

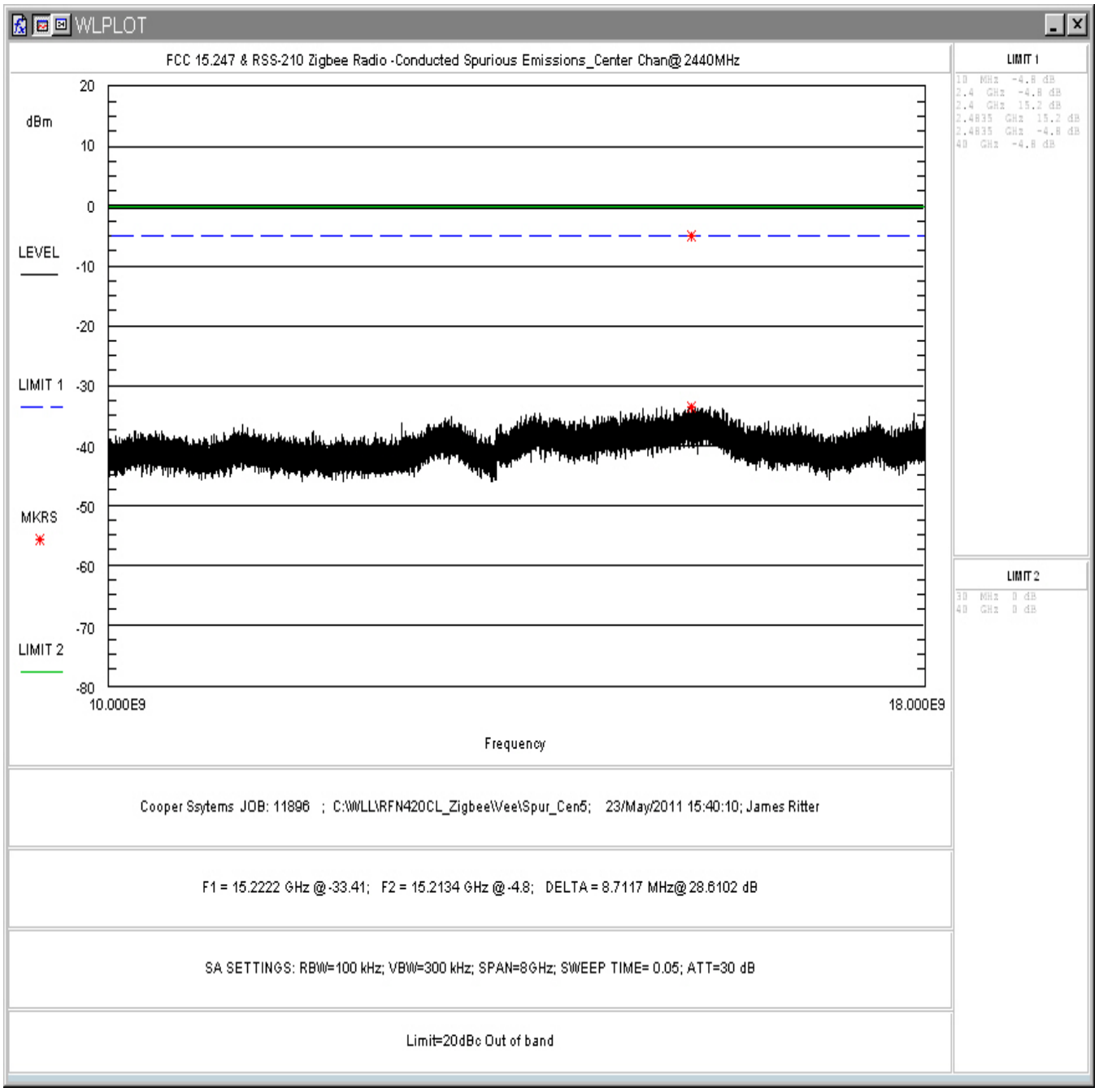



**Figure 20: Conducted Spurious Emissions, Center Channel, 10 -18GHz**

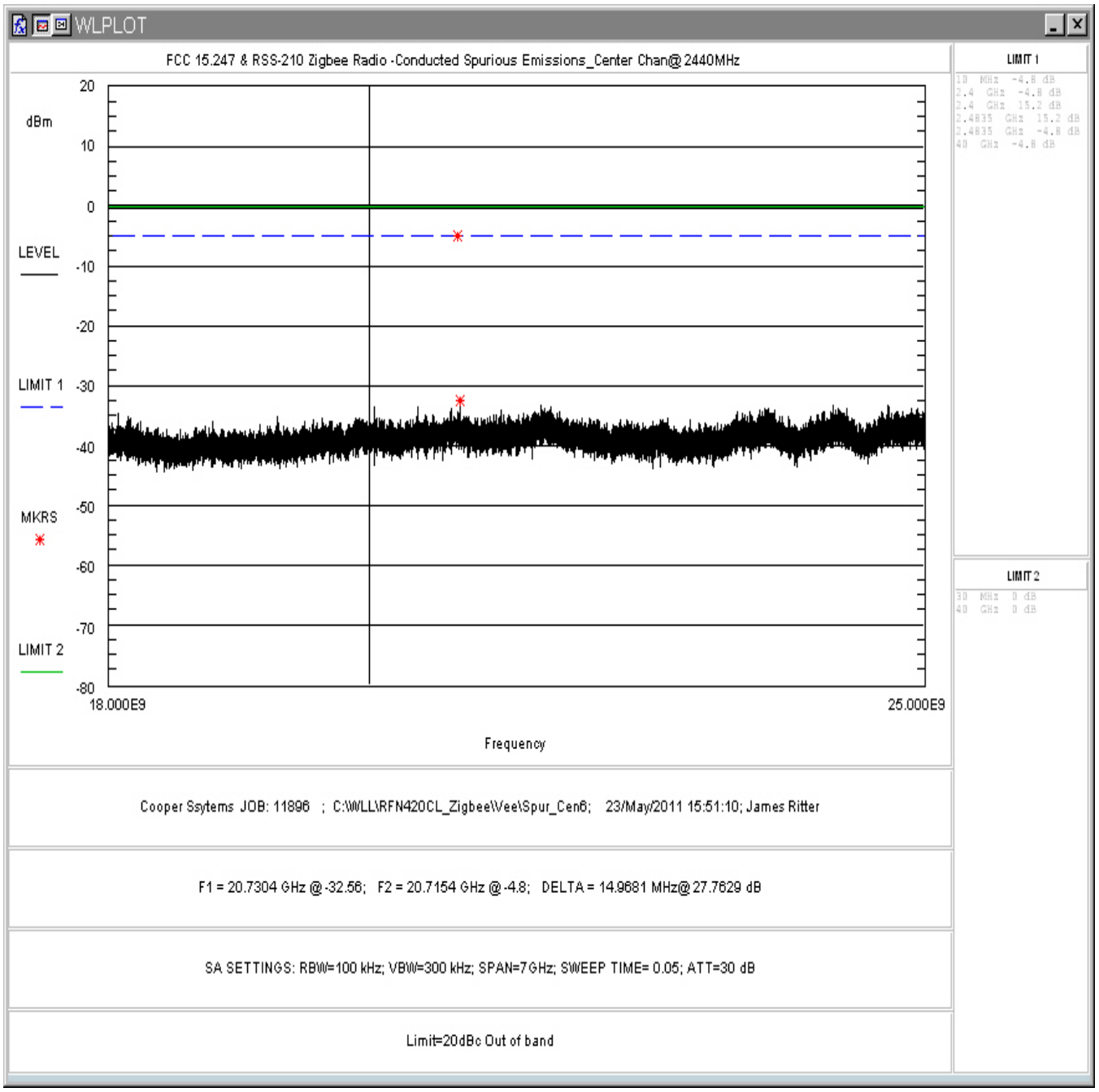



**Figure 21: Conducted Spurious Emissions, Center Channel, 18 – 25GHz**

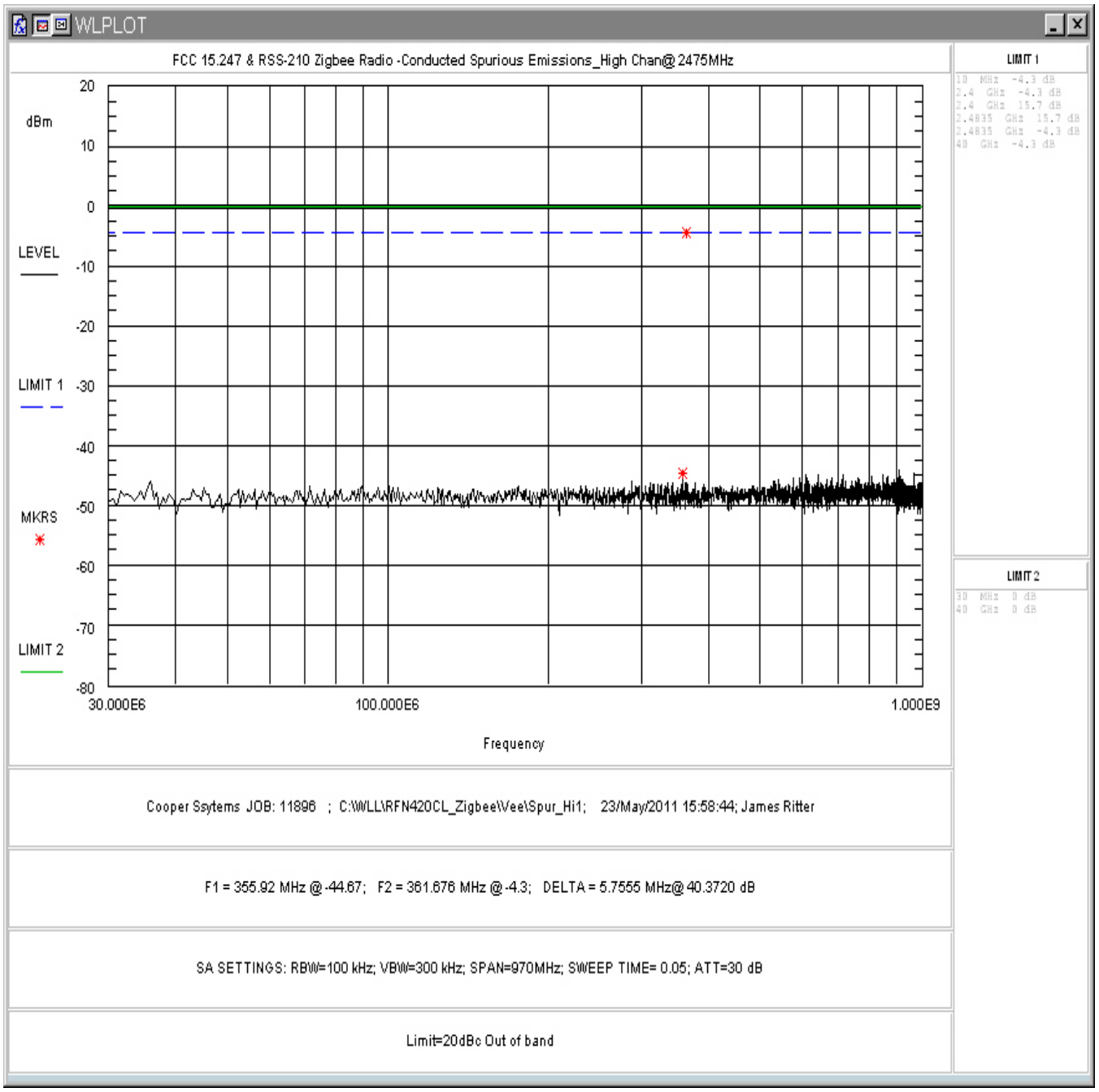



**Figure 22: Conducted Spurious Emissions, High Channel, 30 - 1000MHz**

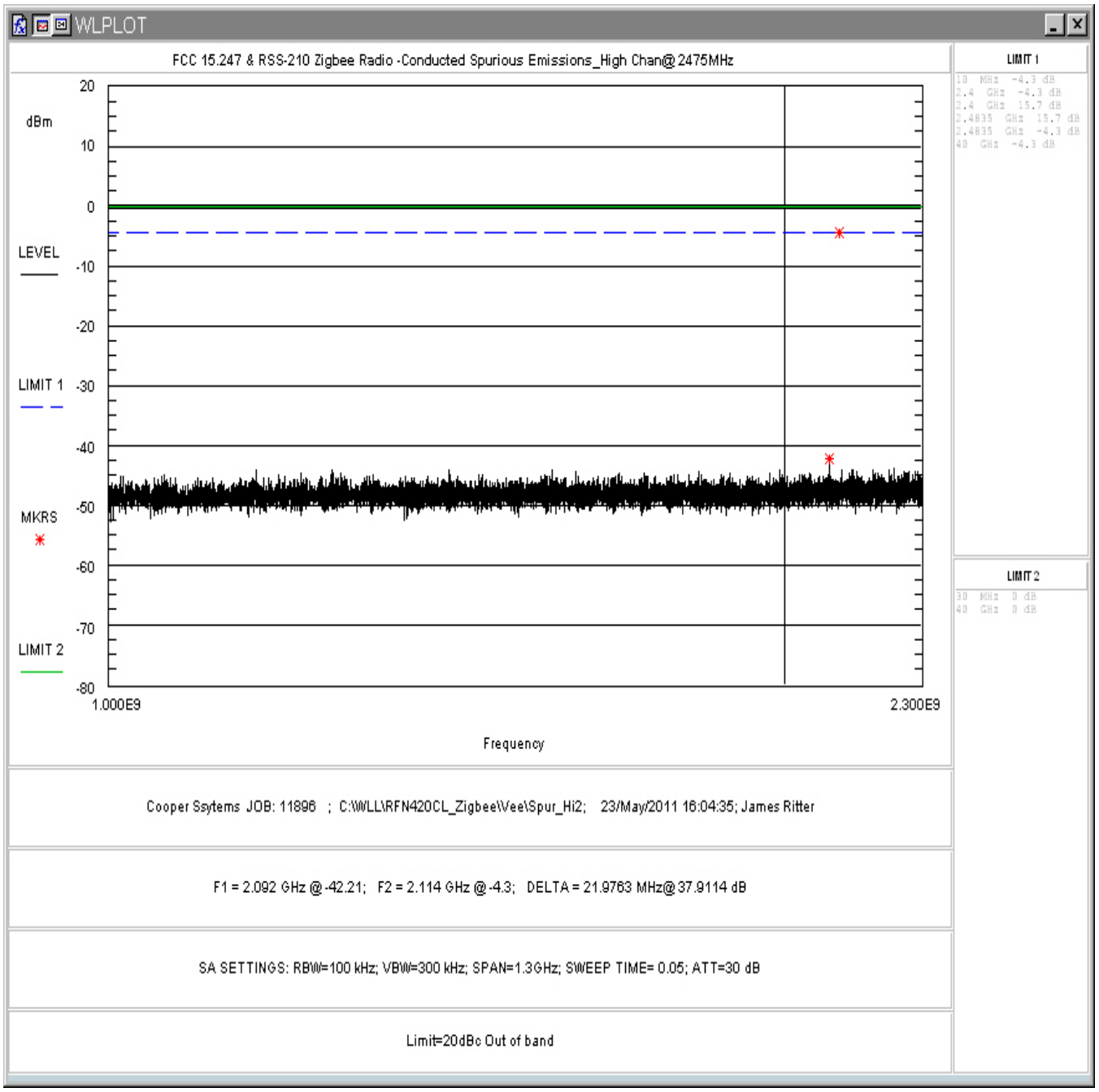



**Figure 23: Conducted Spurious Emissions, High Channel, 1 – 2.3GHz**

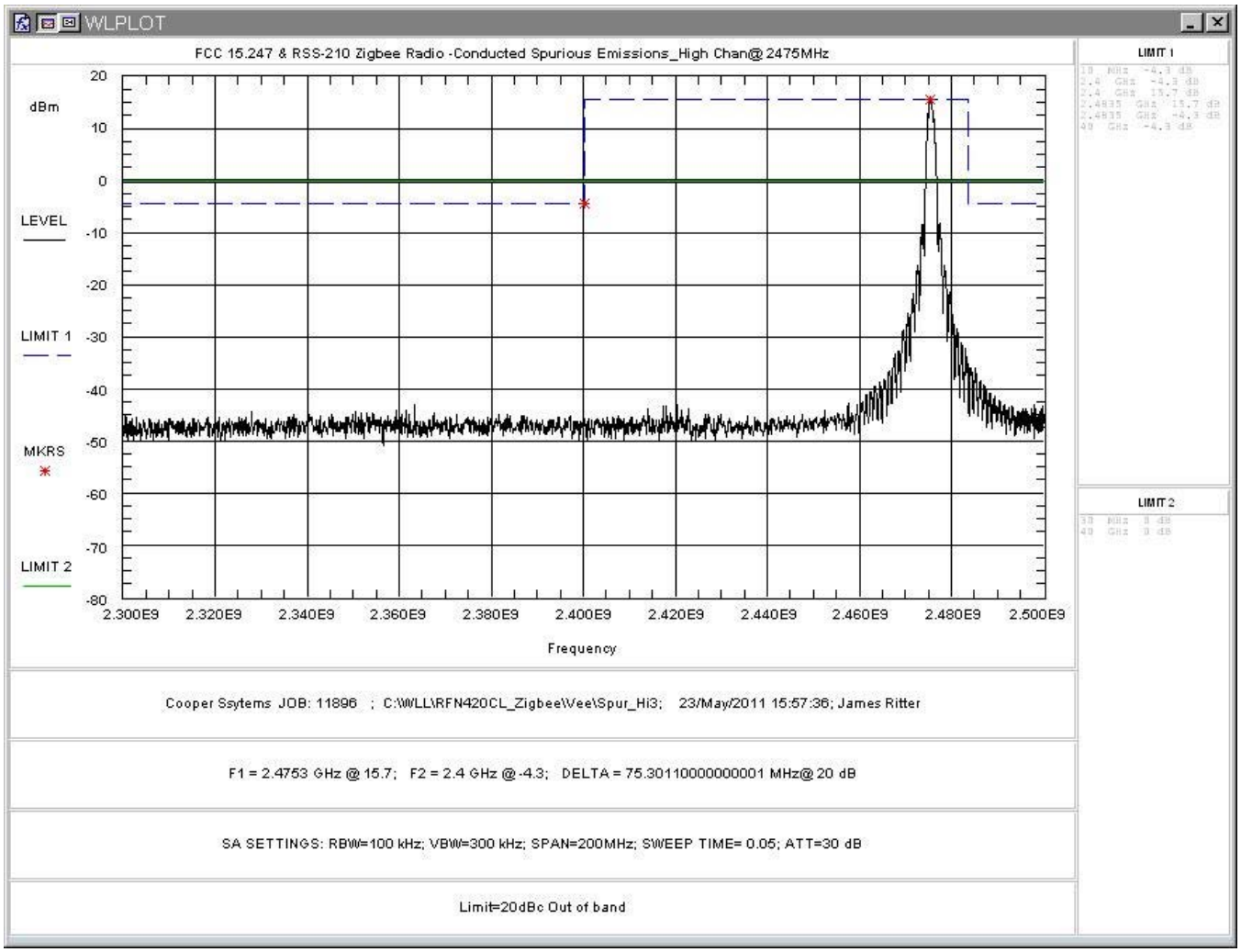



**Figure 24: Conducted Spurious Emissions, High Channel, 2.3 – 2.5GHz**

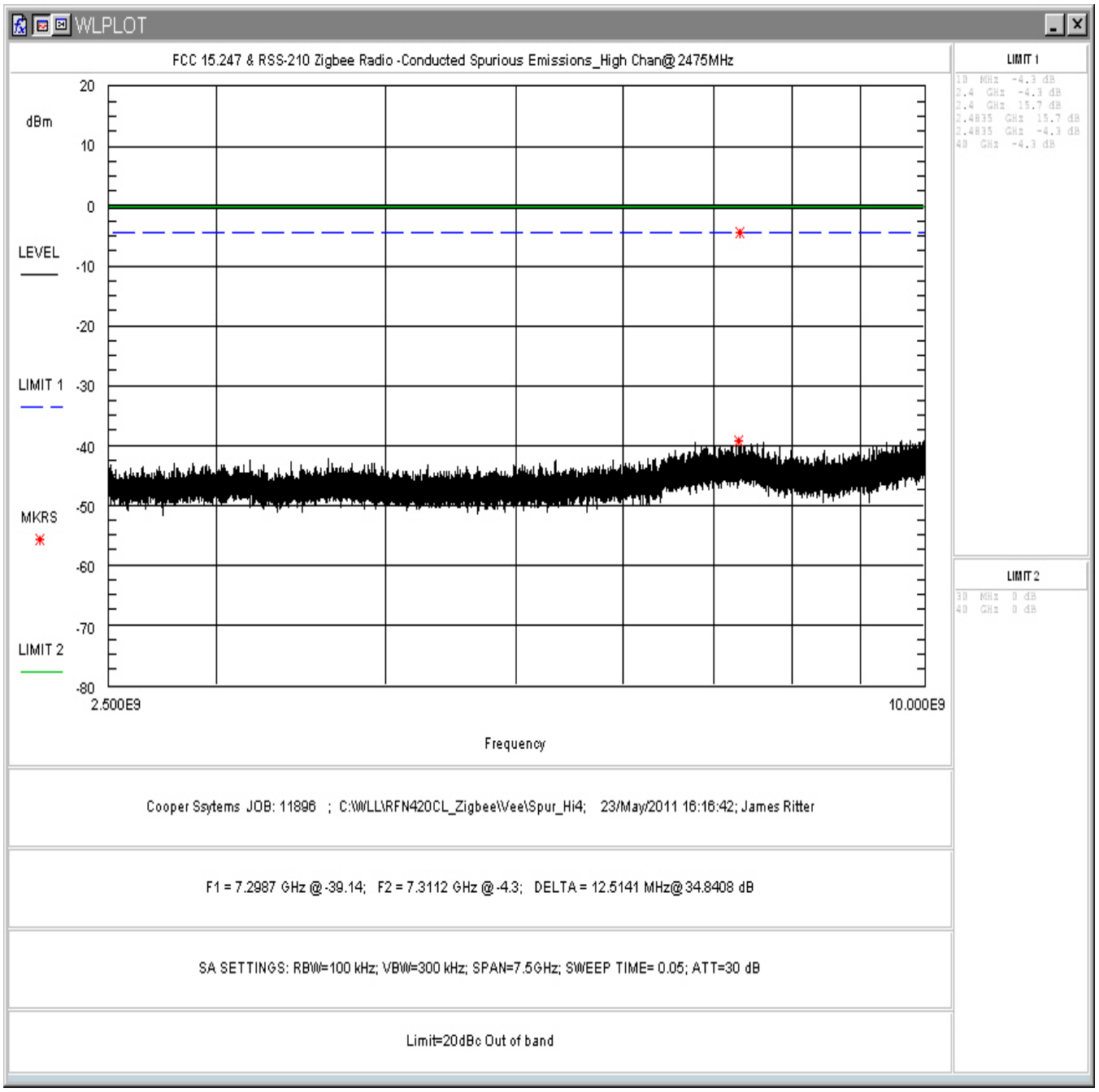



**Figure 25: Conducted Spurious Emissions, High Channel, 2.5 - 10GHz**

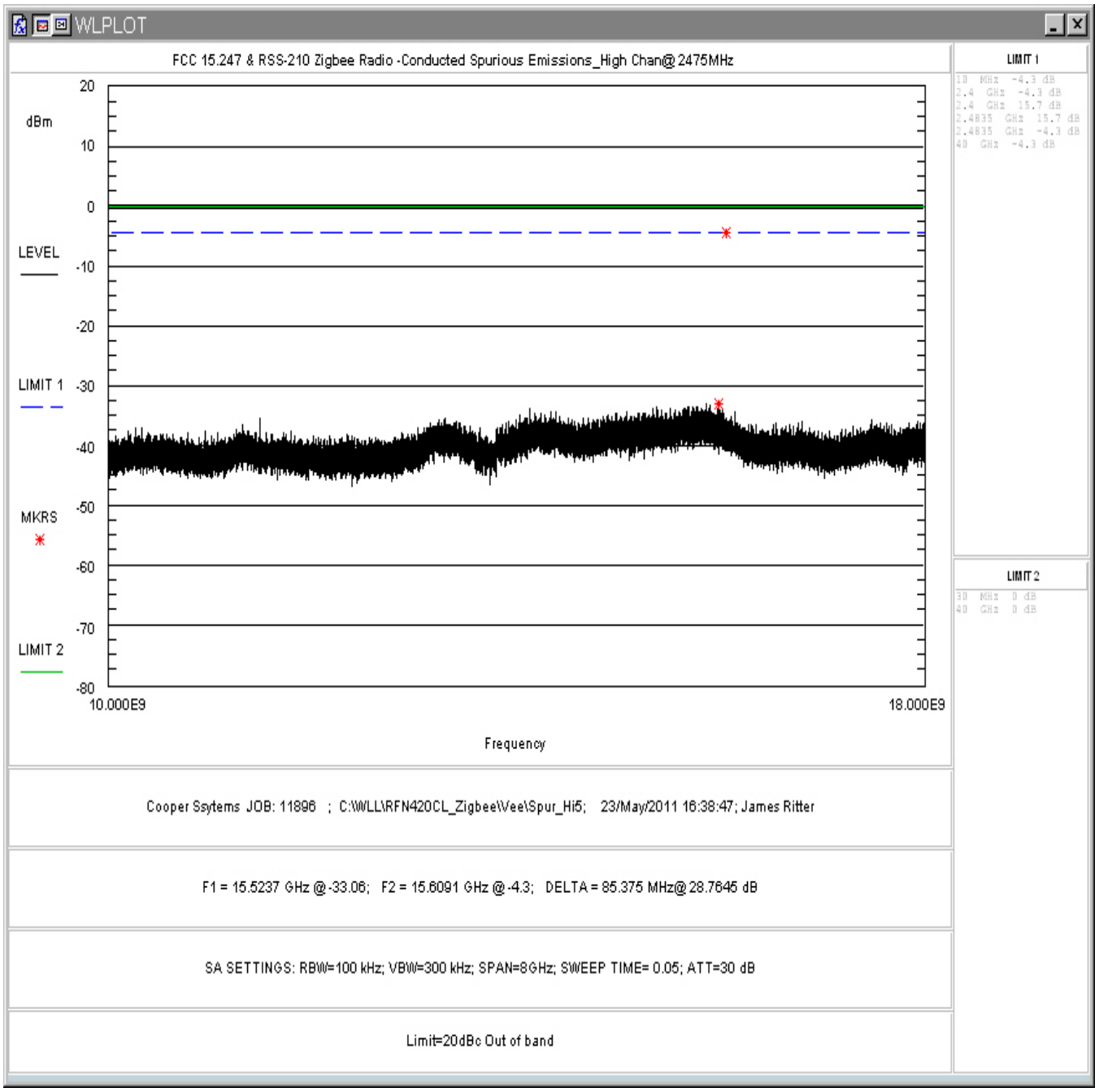



**Figure 26: Conducted Spurious Emissions, High Channel, 10 - 18GHz**

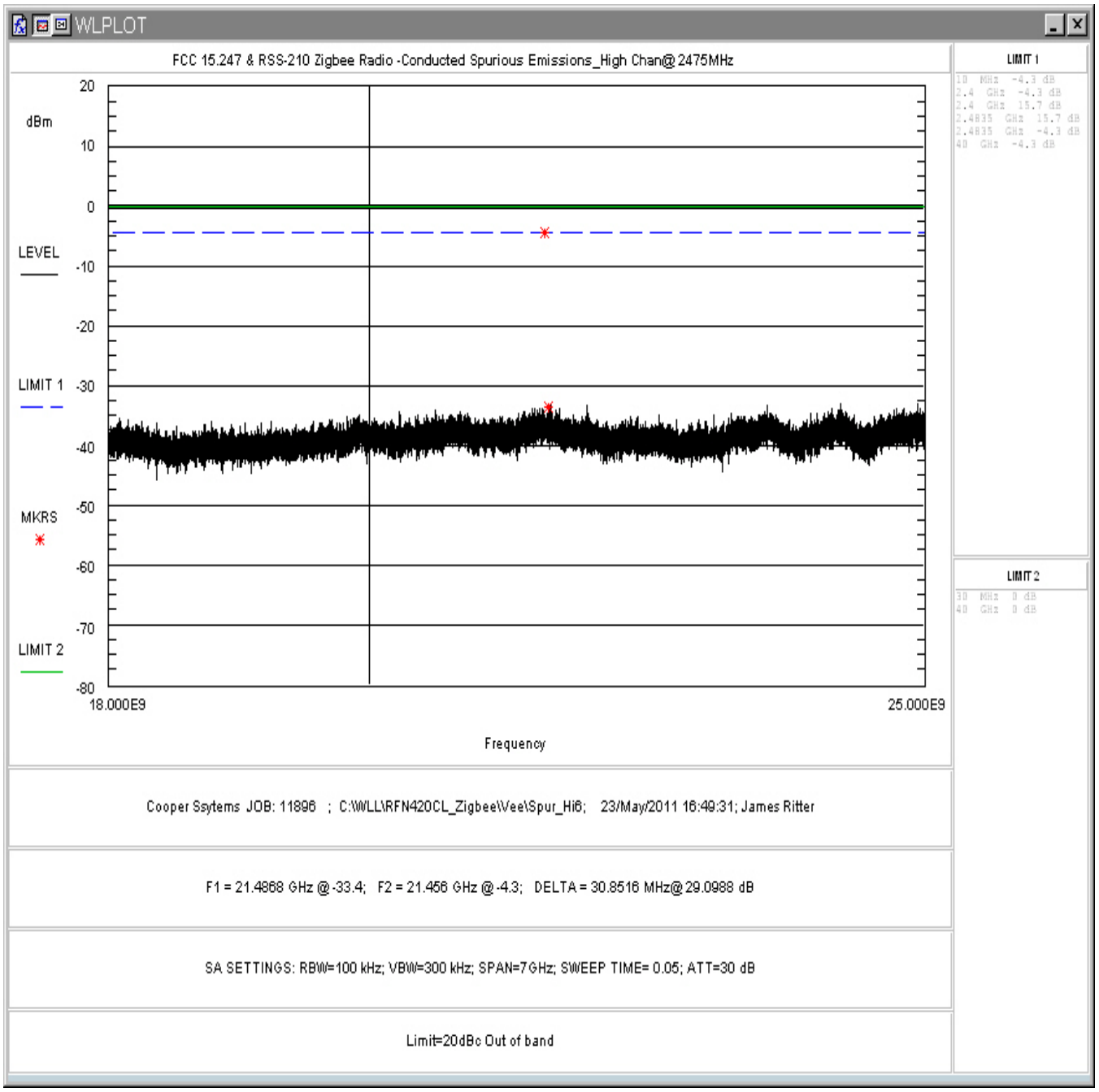



**Figure 27: Conducted Spurious Emissions, High Channel, 18 - 25GHz**

### 4.5.1 Band Edge Compliance

Close-up plots of the upper and lower channels with respect to the nearest authorized band-edges are provided below. The tests were performed in the same manner as the above conducted spurious emissions tests

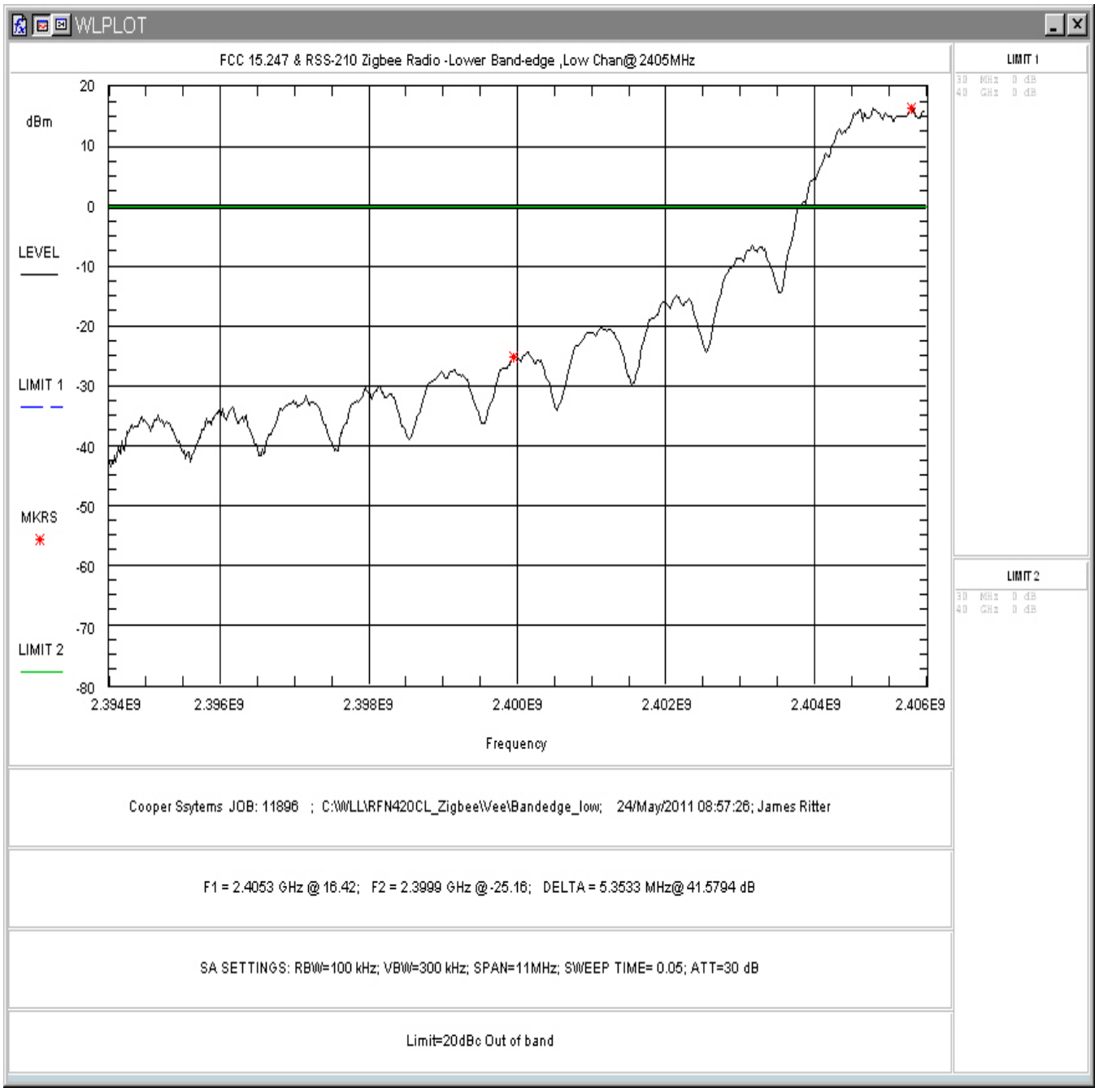



**Figure 28: Lower Band-edge, Low Channel**

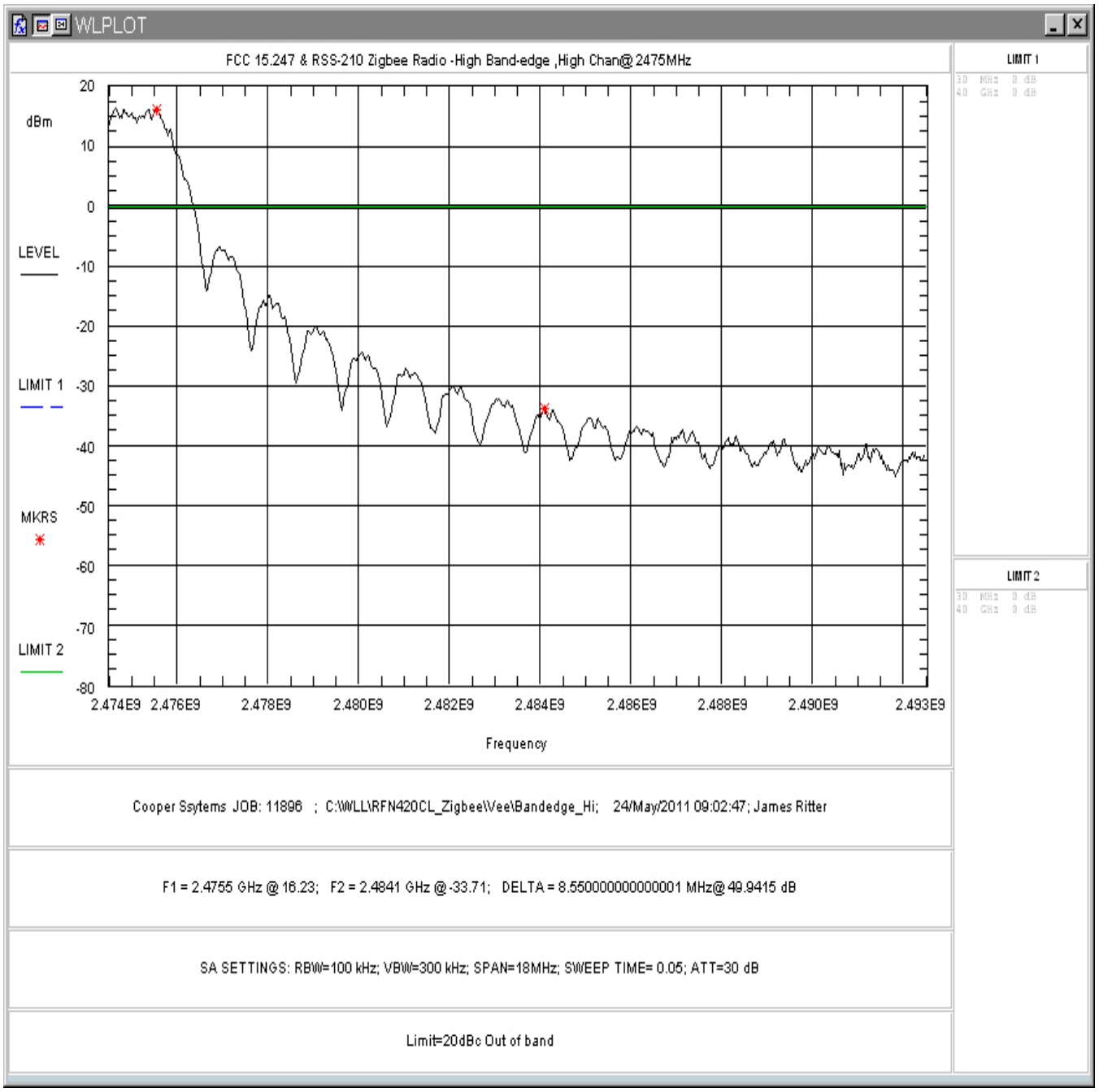



**Figure 29: Upper band-edge, High Channel**

## 4.6 AC Conducted Emissions (FCC Part §15.207)

### *4.6.1 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 |

### *4.6.2 Test Procedure*

The EUT was placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements the post-detector filter was set to 10 Hz.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

### *4.6.3 Test Data*

The EUT complied with the Class B Conducted Emissions requirements. This system runs off of 100-240VAC providing 12VDC. Table 7 provides the test results for phase and neutral line power line conducted emissions.

As this unit contains 2 radios, Zigbee 2400MHz Band and 902-928MHz band, emissions were tested with both radios transmitting as a worst case.

**Table 8: Conducted Emissions Data 120VAC, Transmit On**

120 VAC 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.192 | 28.9 | 9.8 | 10.3 | 0.4 | 39.6 | 20.5 | 63.9 | 53.9 | -24.4 | -33.5 |
| 0.275 | 23.0 | 9.5 | 10.2 | 0.5 | 33.7 | 20.2 | 61.0 | 51.0 | -27.2 | -30.7 |
| 0.476 | 27.1 | 10.3 | 10.2 | 0.4 | 37.7 | 20.9 | 56.4 | 46.4 | -18.7 | -25.5 |
| 0.967 | 20.4 | 6.9 | 10.4 | 0.4 | 31.1 | 17.6 | 56.0 | 46.0 | -24.9 | -28.4 |
| 1.585 | 18.8 | 6.9 | 10.5 | 0.4 | 29.7 | 17.8 | 56.0 | 46.0 | -26.3 | -28.2 |
| 11.353 | 24.4 | 13.5 | 11.1 | 0.8 | 36.3 | 25.4 | 60.0 | 50.0 | -23.7 | -24.6 |

120 VAC 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.192 | 29.9 | 18.2 | 10.3 | 0.7 | 40.9 | 29.2 | 63.9 | 53.9 | -23.0 | -24.7 |
| 0.275 | 30.0 | 20.1 | 10.2 | 0.6 | 40.8 | 30.9 | 61.0 | 51.0 | -20.1 | -20.0 |
| 0.476 | 38.3 | 26.5 | 10.2 | 0.4 | 48.9 | 37.1 | 56.4 | 46.4 | -7.5 | -9.3 |
| 0.967 | 33.1 | 19.4 | 10.4 | 0.4 | 43.8 | 30.1 | 56.0 | 46.0 | -12.2 | -15.9 |
| 1.585 | 30.4 | 16.8 | 10.5 | 0.4 | 41.3 | 27.7 | 56.0 | 46.0 | -14.7 | -18.3 |
| 11.760 | 24.1 | 13.3 | 11.1 | 1.4 | 36.6 | 25.8 | 60.0 | 50.0 | -23.4 | -24.2 |

## Table 9: Conducted Emissions Data 230VAC, Transmit On

230 VAC 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.204 | 31.6 | 12.8 | 10.3 | 0.3 | 42.2 | 23.4 | 63.4 | 53.4 | -21.2 | -30.0 |
| 0.275 | 30.0 | 11.1 | 10.2 | 0.5 | 40.7 | 21.8 | 61.0 | 51.0 | -20.2 | -29.1 |
| 0.469 | 27.6 | 8.5 | 10.2 | 0.4 | 38.2 | 19.1 | 56.5 | 46.5 | -18.4 | -27.5 |
| 0.813 | 24.2 | 7.1 | 10.3 | 0.4 | 34.9 | 17.8 | 56.0 | 46.0 | -21.1 | -28.2 |
| 1.218 | 19.9 | 7.2 | 10.4 | 0.4 | 30.7 | 18.0 | 56.0 | 46.0 | -25.3 | -28.0 |
| 10.927 | 22.4 | 9.5 | 11.1 | 0.8 | 34.2 | 21.3 | 60.0 | 50.0 | -25.8 | -28.7 |

230 VAC 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.205 | 36.6 | 25.2 | 10.3 | 0.7 | 47.6 | 36.2 | 63.4 | 53.4 | -15.8 | -17.2 |
| 0.276 | 38.7 | 27.3 | 10.2 | 0.6 | 49.5 | 38.1 | 60.9 | 50.9 | -11.4 | -12.8 |
| 0.472 | 39.1 | 24.8 | 10.2 | 0.4 | 49.7 | 35.4 | 56.5 | 46.5 | -6.8 | -11.1 |
| 0.814 | 36.9 | 16.9 | 10.3 | 0.4 | 47.6 | 27.6 | 56.0 | 46.0 | -8.4 | -18.4 |
| 1.150 | 34.0 | 14.7 | 10.4 | 0.4 | 44.8 | 25.5 | 56.0 | 46.0 | -11.2 | -20.5 |
| 1.179 | 33.5 | 16.6 | 10.4 | 0.4 | 44.3 | 27.4 | 56.0 | 46.0 | -11.7 | -18.6 |

## 4.7 Radiated Spurious Emissions: (FCC Part §15.205 & §15.209)

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 C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The unit was pre-scanned in 3 orthogonal positions with full testing performed in the worst case position.

The emissions were measured using the following resolution bandwidths:

**Table 10: Spectrum Analyzer Settings**

| Frequency Range | Resolution Bandwidth | Video Bandwidth |
|---|---|---|
| 30MHz-1000 MHz | 120kHz | >100 kHz |
| >1000 MHz | 1 MHz | 10 Hz (Avg.), 1MHz (Peak) |

Worst case emissions are presented.

#### 4.7.1.1 Duty Cycle Corrections

In accordance with KDB558074: "Measurement of Digital Transmission Systems operating under Section 15.247" and FCC part 15.35 systems that are normally pulsed are allowed a duty cycle correction based on the calculation: 20 $Log_{10}$([longest transmission time in any 100ms window]/100ms).

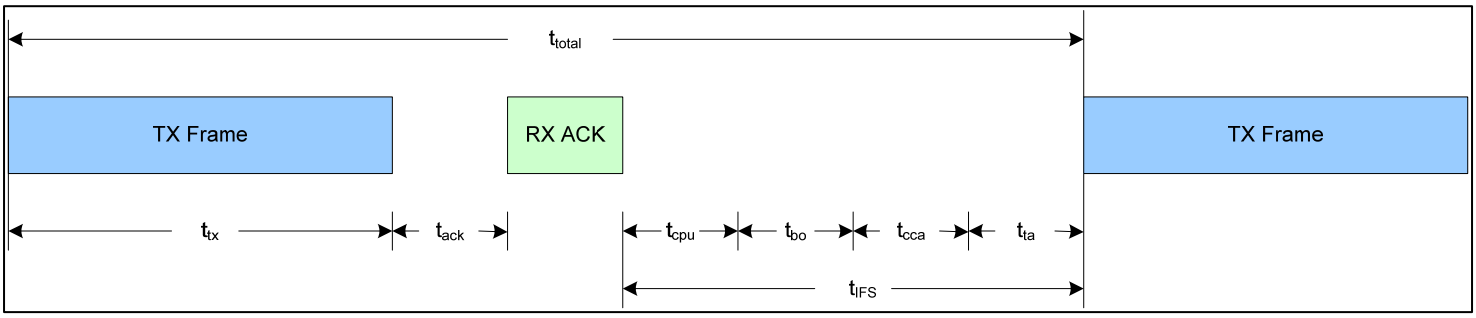
This EUT is allowed -7.4dB of correction based on a 42% duty cycle with a worst case transmit time of 42.56mSec per 100mSec. The EUT was set to a continuously modulated mode and the duty cycle correction added to the Average measurement Radiated emission measurements for the harmonics and band edges of the transmitted signal.

The transmit time was provided by the Zigbee manufacturer and is re-printed below with the permission of Ember Corporation.

# Table 11: Duty Cycle Calculations

***IEEE 802.15.4-2003 2.4 GHz PHY***
***Constants***

| | | | |
|---|---|---|---|
| Data Rate | 250000 | bits / sec | |
| | 31250 | bytes / sec | |
| Symbols/byte | 2 | sym / bytes | |
| Symbol Timing | 62500 | sym / sec | |
| | 0.000016 | sec / sym | |
| Byte Timing | 0.000032 | sec / byte | |
| | | | |
| PHY PSDU | 6 | bytes | 4 Preamble, SPD, Length |
| Max Length | 127 | bytes | |
| Total Packet Length | 133 | bytes | |
| Maximum Time TX PKT | 0.004256 | sec | |




***Long Frame Scenario:***

1) TX Frame — Assume Frame is Data Frame
2) Wait for ACK
3) RX ACK
4) CPU Processing of ACK
5) Wait for Backoff
6) Repeat 1)

## MAC-Level Calculation (LIFS)

| Long InterFrame Spacing (Slotted w/ ACK) | | | |
|---|---|---|---|
| Long Frame | 127 | bytes | |
| Data Frame Payload | 102 | bytes | |
| ACK Frame | 5 | bytes | |
| tack | 12 | sym | |
| LIFS | 40 | sym | |
| Backoff Period | 20 | sym | |
| Maximum Backoff | 31 | | Random between 0 and 31 |
| Backoff Required | 2 | | |
| Backoff Time | 300 | sym | Average at 15 |

| ***Transmit Time*** | |
|---|---|
| TX Time (Packet) | 0.004256 |
| Total TX Time (sec) | 0.004256 |

| ***NOT Transmit time (RX or Idle)*** | | |
|---|---|---|
| Wait for ACK (tack) | 0.000192 | |
| RX Time (ACK) | 0.000352 | |
| Backoff Time (tbo) | 0.0048 | (Backoff Time * Backoff Period) |
| CPU Processing (tcpu) | 0.0002 | (0.2ms average on EM2xx running EmberZNet) |
| CCA Assessment (tcca) | 0.000128 | (averaged over 8 symbols in RX Mode) |
| Turn Around Time (RX to TX) | 0.000192 | (After CCA, Radio turns over to TX in 12 symbols) |
| Total Off Time (sec) | 0.005864 | |

| | |
|---|---|
| Total Time (ttotal) | 0.01012 |
| | 9.8814229 |
| Number of RX / TX cycles in 100ms | 2 |
| | |
| Worse Case (100ms window) | |
| TX Frame 10 times | 0.04256 |
| RX or IDLE 10 Times | 0.05864 |
| Sum | 0.1012 |

| | | | |
|---|---|---|---|
| **MAC TX Duty Cycle (On /total)** | 42.06% | | Represents theoretical ZigBee / MAC performance |
| | | | (This number should be used for FCC compliance testing.) |

## Table 12: Radiated Emission Test Data, Low Channel (Restricted Bands)

### TX channel 11 @ 2405MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Peak** | | | | | | | | | | |
| 4810.00 | H | 190.00 | 3.20 | 61.33 | 3.0 | 0.0 | 1646.2 | 5000.0 | -9.6 | |
| 12025.00 | H | 270.00 | 2.80 | 45.17 | 9.8 | 0.0 | 557.8 | 5000.0 | -19.1 | |
| **Average** | | | | | | | | | | |
| 4810.00 | H | 190.00 | 3.20 | 50.50 | 3.0 | -7.4 | 201.8 | 500.0 | -7.9 | |
| 12025.00 | H | 270.00 | 2.80 | 33.50 | 9.8 | -7.4 | 62.1 | 500.0 | -18.1 | |
| **Non harmonics** | | | | | | | | | | |
| 74.98 | H | 190.00 | 3.62 | 13.80 | 9.4 | 0.0 | 14.5 | 100.0 | -16.8 | |
| 110.81 | H | 100.00 | 3.28 | 6.80 | 14.3 | 0.0 | 11.3 | 150.0 | -22.4 | |
| 112.85 | H | 10.00 | 3.08 | 8.30 | 14.5 | 0.0 | 13.9 | 150.0 | -20.7 | |
| 133.58 | H | 180.00 | 2.58 | 5.80 | 15.4 | 0.0 | 11.5 | 150.0 | -22.3 | |
| 255.97 | H | 0.00 | 1.84 | 12.30 | 15.3 | 0.0 | 24.1 | 200.0 | -18.4 | |
| 275.00 | H | 180.00 | 1.34 | 17.40 | 17.6 | 0.0 | 56.3 | 200.0 | -11.0 | |
| 1000.00 | H | 0.00 | 3.43 | 66.80 | -12.6 | 0.0 | 513.9 | 5000.0 | -19.8 | peak |
| 1000.00 | H | 0.00 | 3.43 | 47.83 | -12.6 | 0.0 | 57.9 | 500.0 | -18.7 | average |
| 1541.36 | H | 45.00 | 3.54 | 68.33 | -10.6 | 0.0 | 769.1 | 5000.0 | -16.3 | peak |
| 1541.36 | H | 45.00 | 3.54 | 54.50 | -10.6 | 0.0 | 156.5 | 500.0 | -10.1 | average |
| 2390.00 | H | 180.00 | 2.54 | 59.20 | -6.3 | 0.0 | 441.8 | 5000.0 | -21.1 | peak |
| 2390.00 | H | 180.00 | 2.54 | 48.56 | -6.3 | -7.4 | 55.4 | 500.0 | -19.1 | average |
| 2483.50 | H | 180.00 | 2.43 | 56.10 | -5.6 | 0.0 | 333.8 | 5000.0 | -23.5 | peak |
| 2483.50 | H | 180.00 | 2.43 | 46.18 | -5.6 | -7.4 | 45.4 | 500.0 | -20.8 | average |
| **Peak** | | | | | | | | | | |
| 4810.00 | V | 180.00 | 2.50 | 63.50 | 3.0 | 0.0 | 2113.4 | 5000.0 | -7.5 | |
| 12025.00 | V | 100.00 | 3.40 | 46.33 | 9.8 | 0.0 | 637.5 | 5000.0 | -17.9 | |
| **Average** | | | | | | | | | | |
| 4810.00 | V | 180.00 | 2.50 | 52.83 | 3.0 | -7.4 | 263.9 | 500.0 | -5.5 | |
| 12025.00 | V | 100.00 | 3.40 | 33.50 | 9.8 | -7.4 | 62.1 | 500.0 | -18.1 | |
| **Non harmonics** | | | | | | | | | | |
| 38.14 | V | 220.00 | 1.00 | 5.20 | 14.8 | 0.0 | 10.0 | 100.0 | -20.0 | |
| 74.98 | V | 190.00 | 1.00 | 14.00 | 9.4 | 0.0 | 14.9 | 100.0 | -16.6 | |
| 110.81 | V | 200.00 | 1.19 | 11.40 | 14.3 | 0.0 | 19.2 | 150.0 | -17.8 | |
| 112.85 | V | 200.00 | 1.19 | 10.90 | 14.5 | 0.0 | 18.7 | 150.0 | -18.1 | |

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 133.58 | V | 270.00 | 1.34 | 14.30 | 15.4 | 0.0 | 30.5 | 150.0 | -13.8 | |
| 255.97 | V | 0.00 | 2.72 | 9.80 | 15.3 | 0.0 | 18.0 | 200.0 | -20.9 | |
| 275.00 | V | 270.00 | 2.95 | 14.70 | 17.6 | 0.0 | 41.3 | 200.0 | -13.7 | |
| 1000.00 | V | 180.00 | 2.50 | 64.50 | -12.6 | 0.0 | 394.3 | 5000.0 | -22.1 | peak |
| 1000.00 | V | 180.00 | 2.50 | 46.83 | -12.6 | 0.0 | 51.6 | 500.0 | -19.7 | average |
| 1541.36 | V | 90.00 | 2.42 | 77.00 | -10.6 | 0.0 | 2086.8 | 5000.0 | -7.6 | peak |
| 1541.36 | V | 90.00 | 2.42 | 59.50 | -10.6 | 0.0 | 278.3 | 500.0 | -5.1 | average |
| 2390.00 | V | 180.00 | 2.54 | 60.50 | -6.3 | 0.0 | 513.1 | 5000.0 | -19.8 | peak |
| 2390.00 | V | 180.00 | 2.54 | 50.32 | -6.3 | -7.4 | 67.8 | 500.0 | -17.4 | average |
| 2483.50 | V | 190.00 | 2.43 | 56.90 | -5.6 | 0.0 | 366.0 | 5000.0 | -22.7 | peak |
| 2483.50 | V | 190.00 | 2.43 | 47.56 | -5.6 | -7.4 | 53.3 | 500.0 | -19.5 | average |

## Table 13: Radiated Emission Test Data, Center Channel (Restricted Bands)

### TX Channel 18 @ 2440MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Peak** | | | | | | | | | | |
| 4880.00 | H | 180.00 | 2.90 | 58.33 | 3.7 | 0.0 | 1262.1 | 5000.0 | -12.0 | |
| 7320.00 | H | 190.00 | 3.10 | 60.00 | 7.6 | 0.0 | 2408.6 | 5000.0 | -6.3 | |
| 12200.00 | H | 180.00 | 3.00 | 43.67 | 11.0 | 0.0 | 539.1 | 5000.0 | -19.3 | |
| **Average** | | | | | | | | | | |
| 4880.00 | H | 180.00 | 2.90 | 48.83 | 3.7 | -7.4 | 180.3 | 500.0 | -8.9 | |
| 7320.00 | H | 190.00 | 3.10 | 48.33 | 7.6 | -7.4 | 268.1 | 500.0 | -5.4 | |
| 12200.00 | H | 180.00 | 3.00 | 32.17 | 0.0 | -7.4 | 17.3 | 500.0 | -29.2 | |
| **Non harmonics** | | | | | | | | | | |
| 74.98 | H | 190.00 | 3.62 | 13.80 | 9.4 | 0.0 | 14.5 | 100.0 | -16.8 | |
| 110.81 | H | 100.00 | 3.28 | 6.80 | 14.3 | 0.0 | 11.3 | 150.0 | -22.4 | |
| 112.85 | H | 10.00 | 3.08 | 8.30 | 14.5 | 0.0 | 13.9 | 150.0 | -20.7 | |
| 133.58 | H | 180.00 | 2.58 | 5.80 | 15.4 | 0.0 | 11.5 | 150.0 | -22.3 | |
| 255.97 | H | 0.00 | 1.84 | 12.30 | 15.3 | 0.0 | 24.1 | 200.0 | -18.4 | |
| 275.00 | H | 180.00 | 1.34 | 17.40 | 17.6 | 0.0 | 56.3 | 200.0 | -11.0 | |
| 1000.00 | H | 270.00 | 2.35 | 69.33 | -12.6 | 0.0 | 687.6 | 5000.0 | -17.2 | peak |
| 1000.00 | H | 270.00 | 2.35 | 44.33 | -12.6 | 0.0 | 38.7 | 500.0 | -22.2 | average |
| 1500.49 | H | 0.00 | 2.30 | 55.50 | -10.8 | 0.0 | 171.2 | 5000.0 | -29.3 | peak |
| 1500.49 | H | 0.00 | 2.30 | 39.33 | -10.8 | 0.0 | 26.6 | 500.0 | -25.5 | average |
| 2390.00 | H | 170.00 | 2.54 | 54.60 | -6.3 | 0.0 | 260.1 | 5000.0 | -25.7 | peak |
| 2390.00 | H | 170.00 | 2.54 | 42.60 | -6.3 | -7.4 | 27.9 | 500.0 | -25.1 | average |
| 2483.50 | H | 180.00 | 2.43 | 53.90 | -5.6 | 0.0 | 259.1 | 5000.0 | -25.7 | peak |
| 2483.50 | H | 180.00 | 2.43 | 41.82 | -5.6 | -7.4 | 27.5 | 500.0 | -25.2 | average |
| **Peak** | | | | | | | | | | |
| 4880.00 | V | 180.00 | 2.60 | 57.50 | 3.7 | 0.0 | 1147.1 | 5000.0 | -12.8 | |
| 7320.00 | V | 190.00 | 2.80 | 60.17 | 7.6 | 0.0 | 2456.2 | 5000.0 | -6.2 | |
| 12200.00 | V | 180.00 | 3.40 | 45.50 | 11.0 | 0.0 | 665.5 | 5000.0 | -17.5 | |
| **Average** | | | | | | | | | | |
| 4880.00 | V | 180.00 | 2.60 | 47.63 | 3.7 | -7.4 | 157.1 | 500.0 | -10.1 | |
| 7320.00 | V | 190.00 | 2.80 | 47.83 | 7.6 | -7.4 | 253.1 | 500.0 | -5.9 | |
| 12200.00 | V | 180.00 | 3.40 | 33.17 | 3.40 | -7.4 | 28.7 | 500.0 | -24.8 | |

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Non harmonics** | | | | | | | | | | |
| 38.14 | V | 220.00 | 1.00 | 5.20 | 14.8 | 0.0 | 10.0 | 100.0 | -20.0 | |
| 74.98 | V | 190.00 | 1.00 | 14.00 | 9.4 | 0.0 | 14.9 | 100.0 | -16.6 | |
| 110.81 | V | 200.00 | 1.19 | 11.40 | 14.3 | 0.0 | 19.2 | 150.0 | -17.8 | |
| 112.85 | V | 200.00 | 1.19 | 10.90 | 14.5 | 0.0 | 18.7 | 150.0 | -18.1 | |
| 133.58 | V | 270.00 | 1.34 | 14.30 | 15.4 | 0.0 | 30.5 | 150.0 | -13.8 | |
| 255.97 | V | 0.00 | 2.72 | 9.80 | 15.3 | 0.0 | 18.0 | 200.0 | -20.9 | |
| 275.00 | V | 270.00 | 2.95 | 14.70 | 17.6 | 0.0 | 41.3 | 200.0 | -13.7 | |
| 1000.00 | V | 190.00 | 2.54 | 60.17 | -12.6 | 0.0 | 239.5 | 5000.0 | -26.4 | peak |
| 1000.00 | V | 190.00 | 2.54 | 42.33 | -12.6 | 0.0 | 30.7 | 500.0 | -24.2 | average |
| 1500.49 | V | 150.00 | 2.51 | 67.00 | -10.8 | 0.0 | 643.3 | 5000.0 | -17.8 | peak |
| 1500.49 | V | 150.00 | 2.51 | 50.33 | -10.8 | 0.0 | 94.4 | 500.0 | -14.5 | average |
| 2390.00 | V | 190.00 | 2.64 | 56.90 | -6.3 | 0.0 | 339.0 | 5000.0 | -23.4 | peak |
| 2390.00 | V | 190.00 | 2.64 | 43.80 | -6.3 | -7.4 | 32.0 | 500.0 | -23.9 | average |
| 2483.50 | V | 190.00 | 2.51 | 55.30 | -5.6 | 0.0 | 304.4 | 5000.0 | -24.3 | peak |
| 2483.50 | V | 190.00 | 2.51 | 43.73 | -5.6 | -7.4 | 34.3 | 500.0 | -23.3 | average |

## Table 14: Radiated Emission Test Data, High Channel (Restricted Bands)

### TX Channel 25 @2475MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| **Peak** | | | | | | | | | | |
| 4950.00 | H | 165.00 | 2.75 | 55.00 | 4.4 | 0.0 | 934.0 | 5000.0 | -14.6 | |
| 7425.00 | H | 190.00 | 2.90 | 58.50 | 7.6 | 0.0 | 2015.3 | 5000.0 | -7.9 | |
| 12375.00 | H | 300.00 | 3.10 | 43.33 | 11.4 | | 546.6 | 5000.0 | -19.2 | |
| **Average** | | | | | | | | | | |
| 4950.00 | H | 165.00 | 2.75 | 44.83 | 4.4 | -7.4 | 123.6 | 500.0 | -12.1 | |
| 7425.00 | H | 190.00 | 2.90 | 46.50 | 7.6 | -7.4 | 215.9 | 500.0 | -7.3 | |
| 12375.00 | H | 300.00 | 3.10 | 31.50 | 11.4 | -7.4 | 59.7 | 500.0 | -18.5 | |
| **Non harmonics** | | | | | | | | | | |
| 74.98 | H | 190.00 | 3.62 | 13.80 | 9.4 | 0.0 | 14.5 | 100.0 | -16.8 | |
| 110.81 | H | 100.00 | 3.28 | 6.80 | 14.3 | 0.0 | 11.3 | 150.0 | -22.4 | |
| 112.85 | H | 10.00 | 3.08 | 8.30 | 14.5 | 0.0 | 13.9 | 150.0 | -20.7 | |
| 133.58 | H | 180.00 | 2.58 | 5.80 | 15.4 | 0.0 | 11.5 | 150.0 | -22.3 | |
| 255.97 | H | 0.00 | 1.84 | 12.30 | 15.3 | 0.0 | 24.1 | 200.0 | -18.4 | |
| 275.00 | H | 180.00 | 1.34 | 17.40 | 17.6 | 0.0 | 56.3 | 200.0 | -11.0 | |
| 1000.00 | H | 180.00 | 2.30 | 50.20 | -12.6 | 0.0 | 76.0 | 5000.0 | -36.4 | peak |
| 1000.00 | H | 180.00 | 2.30 | 37.20 | -12.6 | 0.0 | 17.0 | 500.0 | -29.4 | average |
| 2390.00 | H | 190.00 | 2.52 | 59.70 | -6.3 | 0.0 | 467.9 | 5000.0 | -20.6 | peak |
| 2390.00 | H | 190.00 | 2.52 | 47.80 | -6.3 | -7.4 | 50.7 | 500.0 | -19.9 | average |
| 2483.50 | H | 170.00 | 2.48 | 71.10 | -5.6 | 0.0 | 1876.8 | 5000.0 | -8.5 | peak |
| 2483.50 | H | 170.00 | 2.48 | 60.40 | -5.6 | -7.4 | 233.6 | 500.0 | -6.6 | average |
| **Peak** | | | | | | | | | | |
| 4950.00 | V | 90.00 | 2.60 | 54.50 | 4.4 | 0.0 | 881.8 | 5000.0 | -15.1 | |
| 7425.00 | V | 200.00 | 2.92 | 60.83 | 7.6 | 0.0 | 2635.4 | 5000.0 | -5.6 | |
| 12375.00 | V | 190.00 | 3.20 | 43.60 | 11.4 | 0.0 | 563.9 | 5000.0 | -19.0 | |
| **Average** | | | | | | | | | | |
| 4950.00 | V | 90.00 | 2.60 | 43.83 | 4.4 | -7.4 | 110.1 | 500.0 | -13.1 | |
| 7425.00 | V | 200.00 | 2.92 | 49.33 | 7.6 | -7.4 | 299.1 | 500.0 | -4.5 | |
| 12375.00 | V | 190.00 | 3.20 | 32.10 | 3.40 | -7.4 | 25.4 | 500.0 | -25.9 | |
| **Non harmonics** | | | | | | | | | | |
| 38.14 | V | 220.00 | 1.00 | 5.20 | 14.8 | 0.0 | 10.0 | 100.0 | -20.0 | |

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 74.98 | V | 190.00 | 1.00 | 14.00 | 9.4 | 0.0 | 14.9 | 100.0 | -16.6 | |
| 110.81 | V | 200.00 | 1.19 | 11.40 | 14.3 | 0.0 | 19.2 | 150.0 | -17.8 | |
| 112.85 | V | 200.00 | 1.19 | 10.90 | 14.5 | 0.0 | 18.7 | 150.0 | -18.1 | |
| 133.58 | V | 270.00 | 1.34 | 14.30 | 15.4 | 0.0 | 30.5 | 150.0 | -13.8 | |
| 255.97 | V | 0.00 | 2.72 | 9.80 | 15.3 | 0.0 | 18.0 | 200.0 | -20.9 | |
| 275.00 | V | 270.00 | 2.95 | 14.70 | 17.6 | 0.0 | 41.3 | 200.0 | -13.7 | |
| 1000.00 | V | 10.00 | 2.35 | 49.10 | -12.6 | 0.0 | 67.0 | 5000.0 | -37.5 | peak |
| 1000.00 | V | 10.00 | 2.35 | 35.80 | -12.6 | 0.0 | 14.5 | 500.0 | -30.8 | average |
| 2390.00 | V | 180.00 | 2.64 | 64.20 | -6.3 | 0.0 | 785.6 | 5000.0 | -16.1 | peak |
| 2390.00 | V | 180.00 | 2.64 | 52.90 | -6.3 | -7.4 | 91.2 | 500.0 | -14.8 | average |
| 2483.50 | V | 180.00 | 2.48 | 73.50 | -5.6 | 0.0 | 2474.2 | 5000.0 | -6.1 | peak |
| 2483.50 | V | 190.00 | 2.48 | 62.80 | -5.6 | -7.4 | 307.9 | 500.0 | -4.2 | average |

## 4.8 Transceiver Co-location Attestation

The 902-928 transceiver antenna (except for the 8dBi omni whip) may be located within 20cm of the Zigbee transceiver antenna, which is located on the same module. Testing was performed to measure any potential spurious interactions between these 2 devices. The 902-928 MHz radio was tested with the highest gain of the antennas that could be used within 20cm of the Zigbee antenna (TRA9023NP - Antenex Phantom 902-928MHz, 3dBi). This testing was performed in a radiated fashion with both transceivers continuously transmitting on a stationary frequency. The module was then scanned up to 25GHz verifying that all spurious products that fall within the restricted bands remain under class B limits. This device complied with this requirement. Plots of this data are held at Washington laboratories