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FCC & Industry Canada Certification Test Report

For the

Ultra Electronics -3eTI

3e-523E-900

FCC ID: QVT-523E-900

IC ID: 6780A-523E900

WLL JOB#13646-01 Rev 2
November 26, 2014
Revised June 24, 2015

Prepared for:

Ultra Electronics -3eTI
9715 Key West Avenue
Rockville, MD, 20850

Prepared By:

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

ACLASS ACCREDITED TESTING

Testing Certificate AT-1448

FCC & Industry Canada Certification Test Report
for the
Ultra Electronics -3eTI
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November 25, 2014
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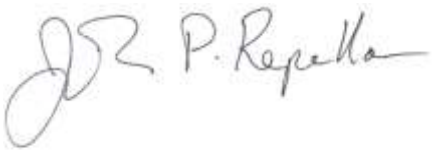
Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:



John P. Repella
EMC & Wireless Lab Manager

Abstract

This report has been prepared on behalf of Ultra Electronics -3eTI to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System (DTS) Transmitter under Part 15.247 (10/2013) 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 Ultra Electronics -3eTI 3e-523E-900.

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 Ultra Electronics -3eTI 3e-523E-900 complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 and Industry Canada RSS-210.

Revision History	Description of Change	Date
Rev 0	Initial Release	November 26, 2014
Rev 1	Corrected IC number to 6780A-523E900	June 15, 2015
Rev 2	Corrected ANSI references	June 24, 2015

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1 Introduction

1.1 Compliance Statement

The Ultra Electronics -3eTI 3e-523E-900 complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 (10/2013) and Industry Canada RSS-210 issue 8 December 2010.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with "D01 DTS Meas Guidance v03r02" June 5, 2014. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Ultra Electronics -3eTI 9715 Key West Avenue Rockville, MD, 20850
Purchase Order Number:	3448
Quotation Number:	68294

1.4 Test Dates

Testing was performed on the following date(s):	10/6/2014-11/25/2014

1.5 Test and Support Personnel

Washington Laboratories, LTD	James Ritter, Steven Dovell
Customer Representative	John Wu, Tom Dawson, William Nassauer

1.6 Abbreviations

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

2 Equipment Under Test

2.1 EUT Identification & Description

The 3e-523E-900 is a 900MHz version of a WiFi data access point / bridge networking wireless data transmission device. It is powered by 120VAC and offers a direct wired connection to 10/100 Ethernet interface, if desired.

The unit encrypts the data flowing to/from the unit to form a FIPS-validated secure network through both wired and wireless interface. 900MHz, 1W, transmission is used for long range wireless communications.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Ultra Electronics -3eTI
FCC ID:	QVT-523E-900
IC:	6780A-523E900
Model:	3e-523E-900
FCC Rule Parts:	§15.247
Industry Canada:	RSS210
Frequency Range:	916MHz (Single Channel)
Maximum Output Power:	890mW (29.5dBm)
Modulation:	DSSS (802.11b down converted to 900MHz)
Occupied Bandwidth:	12.53MHz
Keying:	Automatic, Manual
Type of Information:	Data
Number of Channels:	1
Power Output Level	Variable
Antenna Connector	Standard N-type, bulkhead jack
Antenna Type	Omni-Directional, L-Com HGV906U, 6-dBi gain Yagi , L-Com HGV906YE, 6-dBi gain
Interface Cables:	LMR-240 or LMR-400
Power Source & Voltage:	120VAC
Emission Designator	12M5G1D
Highest TX spurious Emission	1536MHz @3m , 410.4uV/m
Highest RX spurious Emission	1536MHz @3m , 410.4uV/m

2.2 Test Configuration

The 3e-523E-900 was configured powered from public mains 120V 60Hz. The device was controlled via Ethernet from a support laptop.

2.3 Testing Algorithm

Unit must be set into “FCC Mode”.

Set up the IP address of a laptop or PC as 192.168.254.100.

Open a web browser and type 192.168.254.254 in the address bar.

Log into the 3e-523-3 with:

User Name: CryptoOfficer

Password: CryptoFIPS1

Select one of the pages on the selection bar on the left side of the screen.

Select the address bar and replace the last 3 digits with "411".

This sets the unit into FCC mode, constant transmission.

The shielded RJ-45 cable connected to the 3e-523-3 unit must have the shield terminated as it will be in normal use.

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

- D01 DTS Meas. Guidance v03r02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247"
- ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation
- ANSI C63.4:2009 Methods of Measurement of Radio Noise from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. (for site validation)
- ANSI C63.4:2014 Methods of Measurement of Radio Noise from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
- ANSI C63.10:2013 Procedures for Compliance Testing of Unlicensed Wireless Devices (see Section 2.6 below)

2.6 Deviations to Measurements

For measurement procedures D01 DTS Meas. Guidance v03r02 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247" is being used as a deviation to ANSI63.10:2013 per certification.bureau@ic.gc.ca response letter of 5/19/2015

2.7 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2012) 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 ≤ 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:	**RF Bench Conducted**	Test Date:	**11/25/14**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
728	AGILENT - 8564EC	SPECTRUM ANALYZER 30HZ - 40GHZ	9/17/2015
605	AGILENT HP - N1911A	POWER METER	9/2/2016

Test Name:	**Conducted Emissions Voltage**	Test Date:	**11/24/2014**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
125	SOLAR - 8028-50-TS-24-BNC	LISN	8/1/2015
126	SOLAR - 8028-50-TS-24-BNC	LISN	8/1/2015
68	HP - 85650A	ADAPTER QP	1/2/2015
72	HP - 8568B	ANALYZER SPECTRUM	1/2/2015
53	HP - 11947A	LIMITER TRANSIENT	3/18/2015

Test Name:	**Radiated Emissions**	Test Date:	**10/09/2014**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
68	HP - 85650A	ADAPTER QP	1/2/2015
72	HP - 8568B	ANALYZER SPECTRUM	1/2/2015
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	1/2/2015
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	12/6/2014
522	HP - 8449B	PRE-AMPLIFIER 1-26.5GHZ	12/14/14
280	ITC - 21C-3A1	WAVEGUIDE 3.45-11.0GHZ	8/01/2016
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	8/01/2016
337	WLL - 1.2-5GHZ	FILTER BAND PASS	4/19/2016
742	PENN ENGINEERING - WR284	2.2-4.15GHZ BANDPASS FILTER	8/01/2016
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/26/2014
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/20/2015

4 Test Summary

The Table Below shows the results of testing for compliance with a Frequency Hopping System in accordance with FCC Part 15.247 10/2013 and RSS210 issue 8, 12/2010. Full results are shown in section 5.

Table 4: Test Summary Table

TX Test Summary (Digital Transmission System (DTS))			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (2)	RSS-210 [A8. 2 (a)]	6dB DTS 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]	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-210 Sect.2.2 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 (Digital Transmission System (DTS))			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	Pass
15.209	RSS-210 sect 2.5 RSS-Gen [4.1]	General Field Strength Limits	Pass

5 Test Results

5.1 Occupied Bandwidth:

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 be at least 500 kHz.

DTS Guidance section 8.0 DTS bandwidth option 1 used for measurements.

Table 5: Occupied Bandwidth Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

Frequency	Data Rate	Bandwidth	Limit	Pass/Fail
916 MHz	1Mbps	12.53MHz	>500kHz	Pass
916MHz	11Mbps	12.07MHz	>500kHz	Pass

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

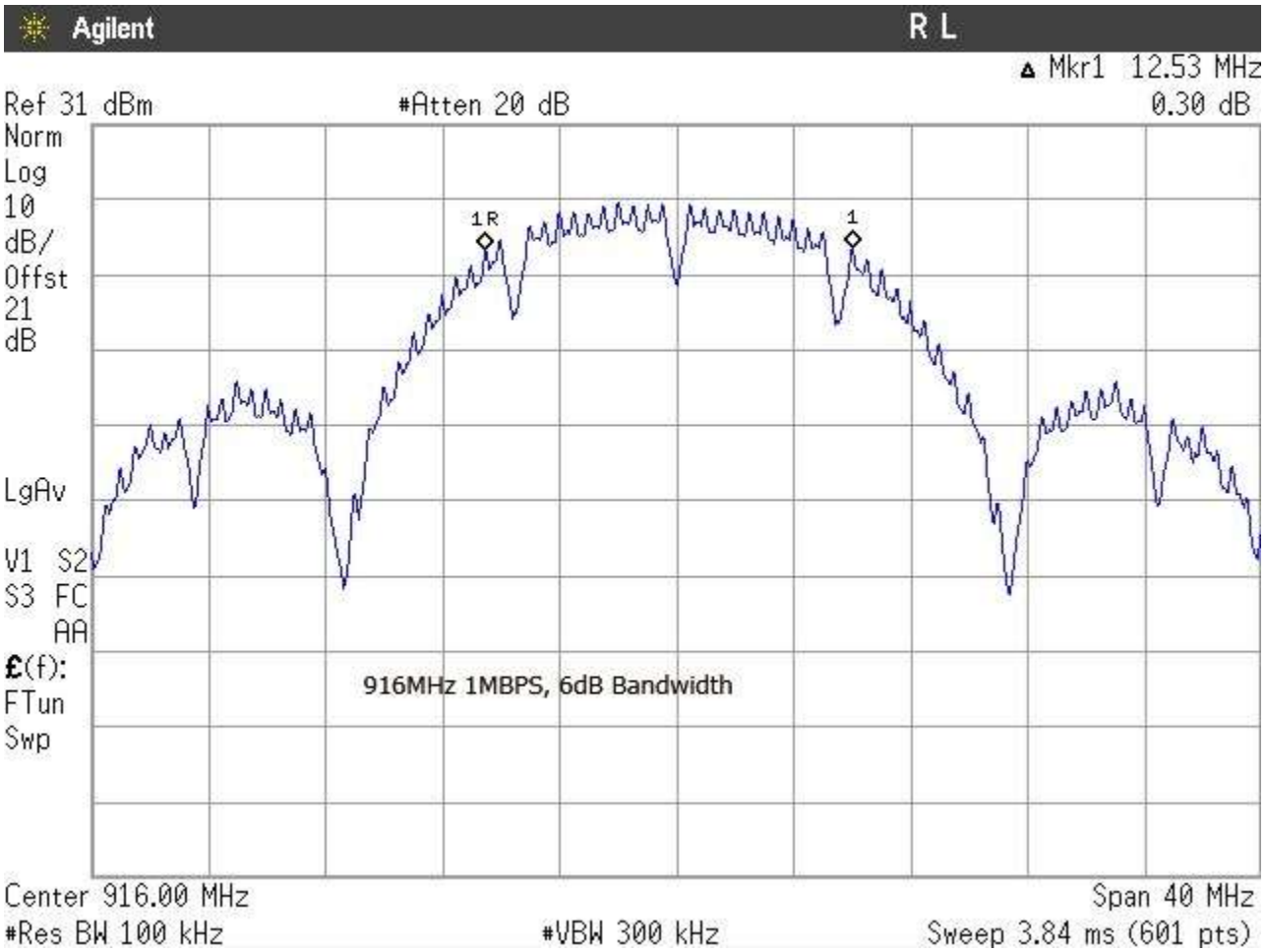

Figure 1: Occupied Bandwidth, 916MHz, 1Mbps

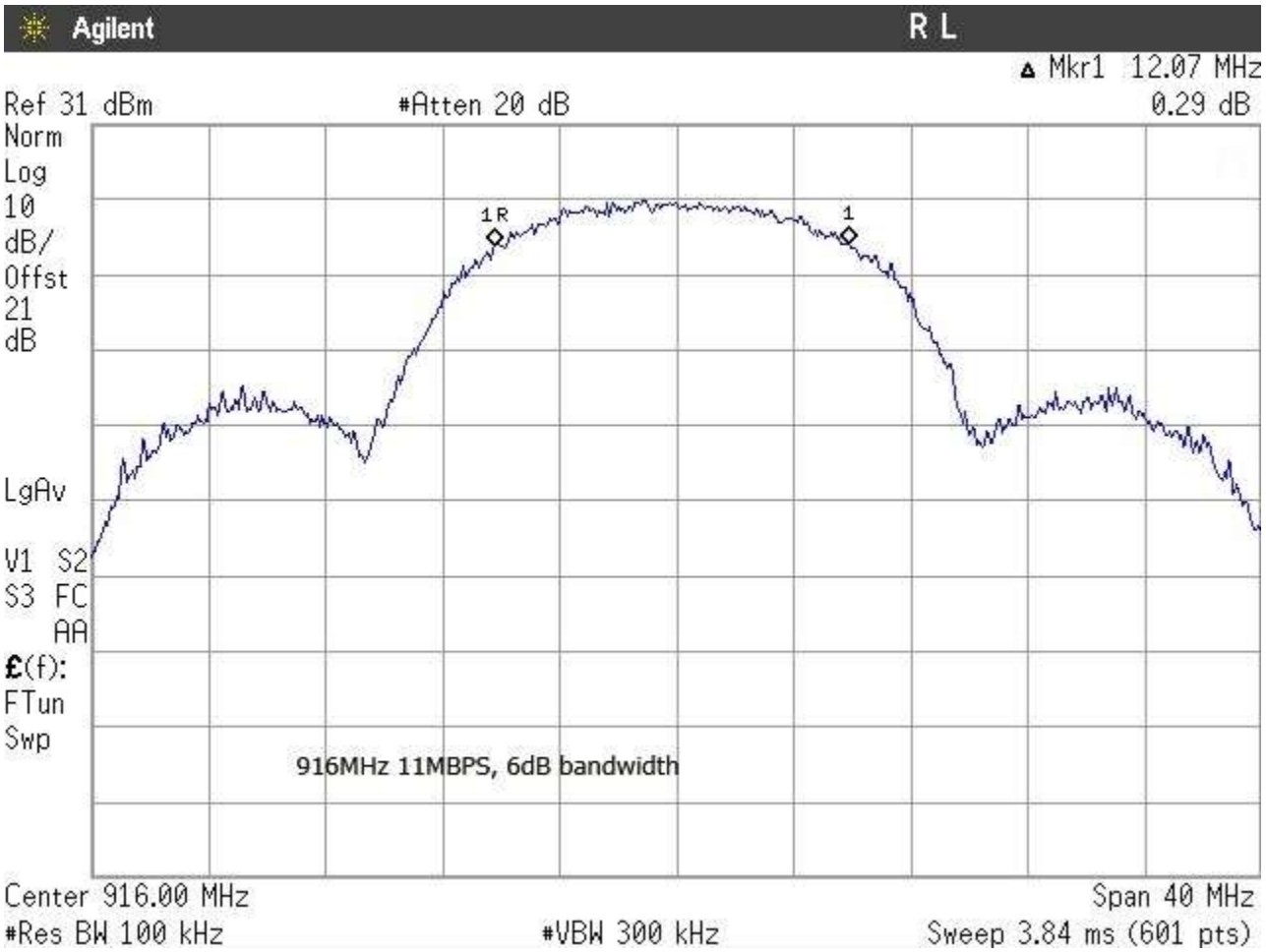

Figure 2: Occupied Bandwidth, 916MHz, 11Mbps

5.2 RF Power Output:

To measure the output power the output from the transmitter was connected to an attenuator and then to the input of the Wideband RF Power meter. The power meter offset was adjusted to compensate for the attenuator.

The Unit was tested at 2 power levels (1 & 5) and 2 data rates (1 & 11Mbps).

DTS Guidance section 9.1.2 PKPM1 Peak power meter method used for measurements

Table 7: RF Power Output

Channel and/or Frequency	Pwr Level Setting	Peak Measured Level (dBm)	Peak Measured Level (Watts)	Limit (Watts)	Results (P/F)
916 MHz-1Mbps	5	29.5	0.89	1	Pass
916 MHz -11Mbps	5	29.5	0.89	1	Pass
916 MHz-1Mbps	1	22.7	0.19	1	Pass
916 MHz -11Mbps	1	22.7	0.19	1	Pass

5.3 Power Spectral Density

Measurements for power spectral density were taken in accordance with 15.247(e). The measurements were performed using D01 DTS Meas Guidance v03r02 section 10.2, Method PKPSD (peak PSD). The spectrum analyzer was set to peak detect mode with a RBW of 3kHz ,VBW of 10kHz across an 18.8 MHz span using an auto sweep time.

The highest level detected across any 3 kHz 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.

Testing was performed at the highest power level (level 5).

Table 8: Power Spectral Density

Frequency	Peak Level	Limit	Pass/Fail
916MHz - 1Mbps	1.09	8 dBm	Pass
916MHz - 11Mbps	5.13	8 dBm	Pass

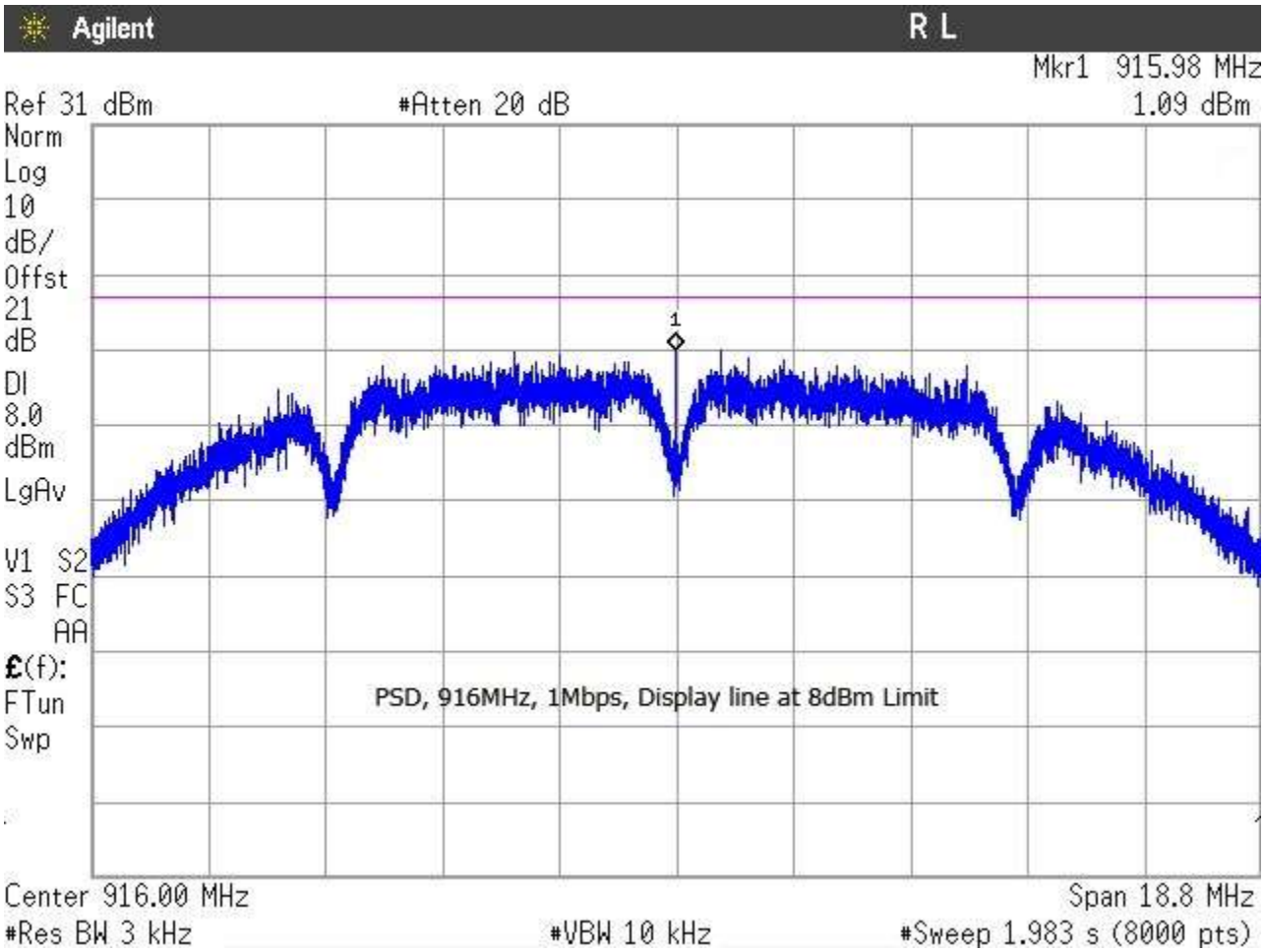

Figure 3: Power Spectral Density, 916MHz, 1Mbps

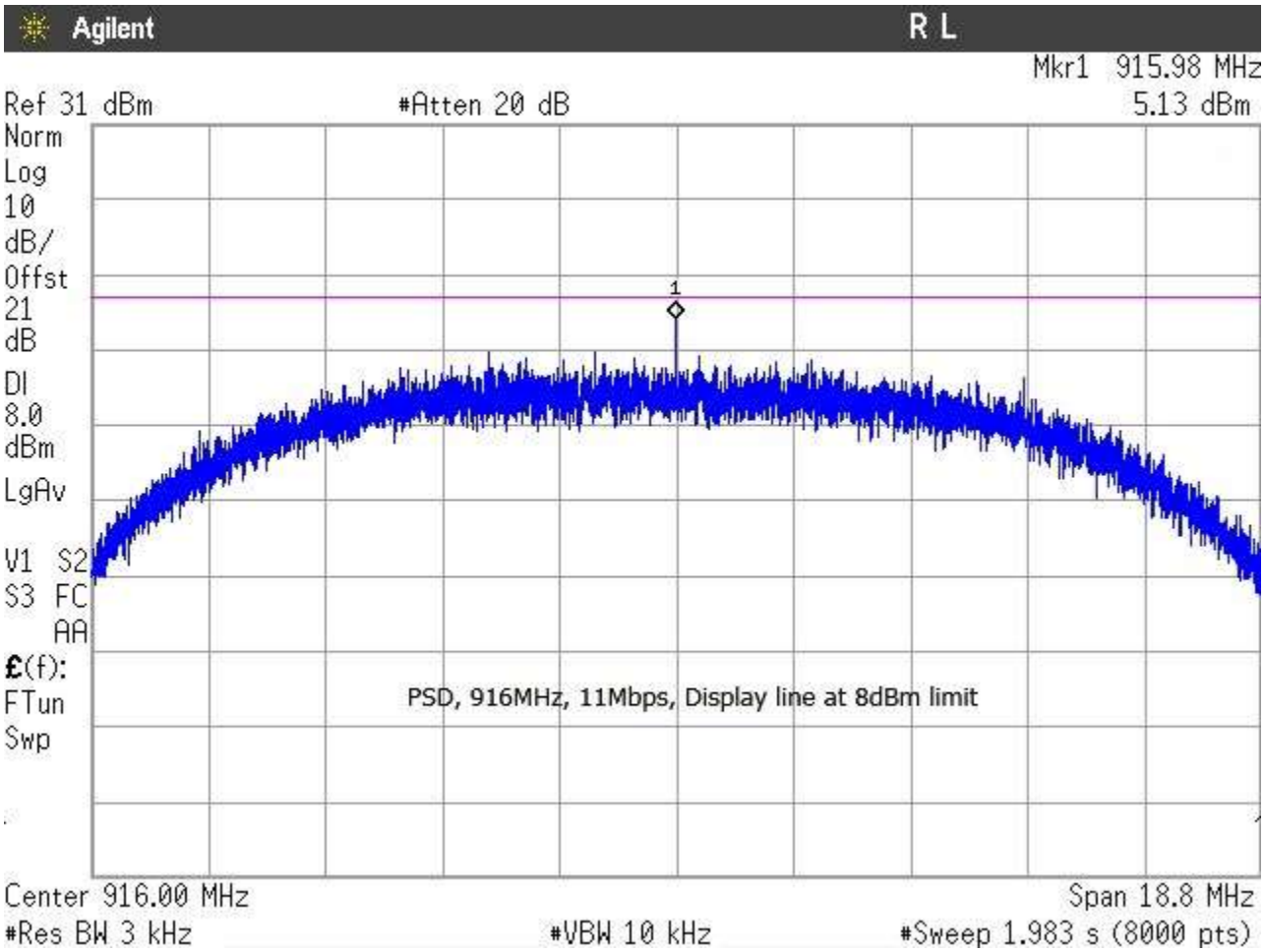

Figure 4: Power Spectral Density, 916MHz, 11Mbps

5.4 Conducted Spurious Emissions at Antenna Terminals

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.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer. An offset was programmed into the spectrum analyzer to compensate for the loss of any external attenuators and cabling. 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.

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Table 9: Conducted Spurious Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

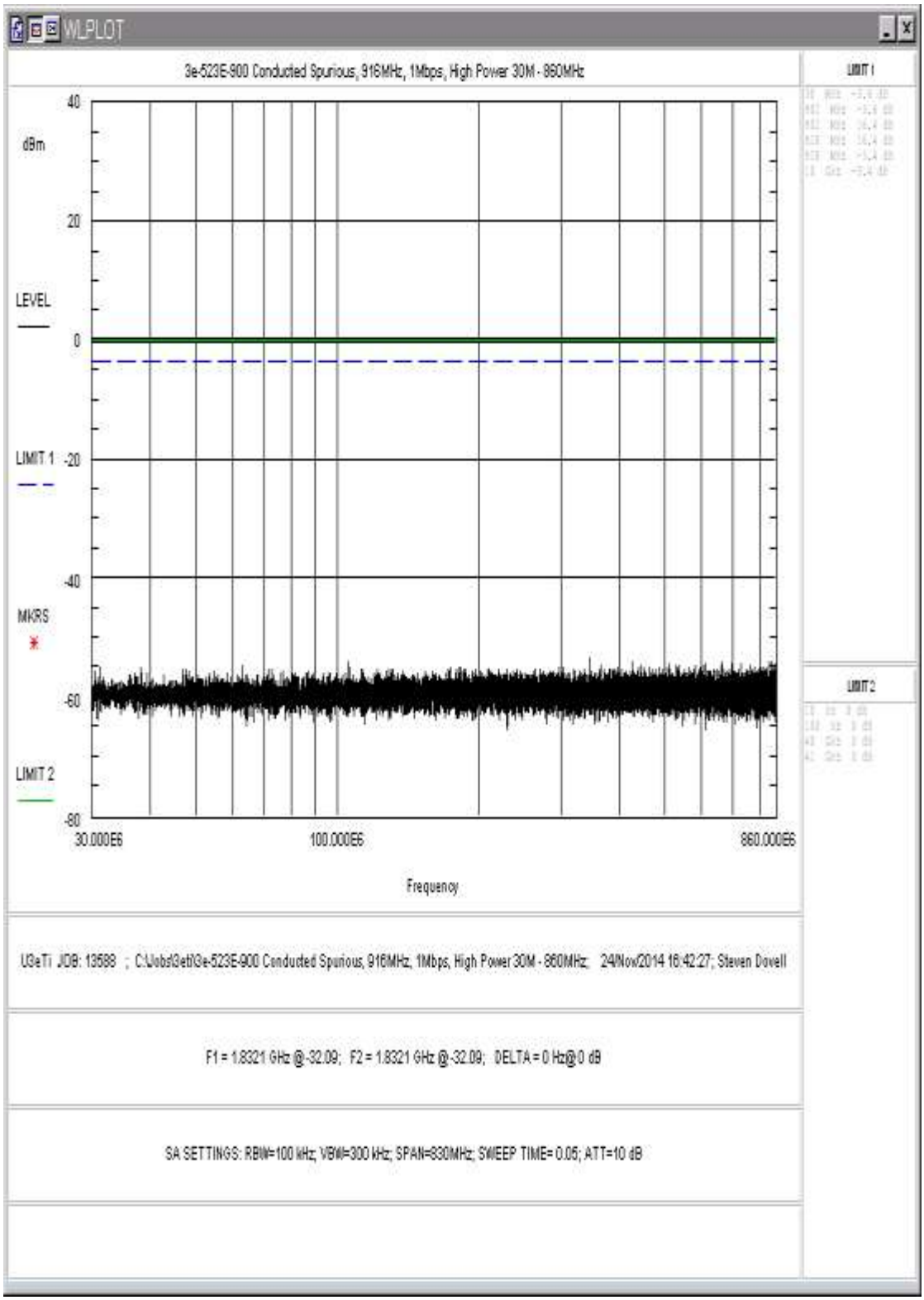

Figure 5: Conducted Spurious Emissions, 1Mbps, High Power, 30 - 890MHz

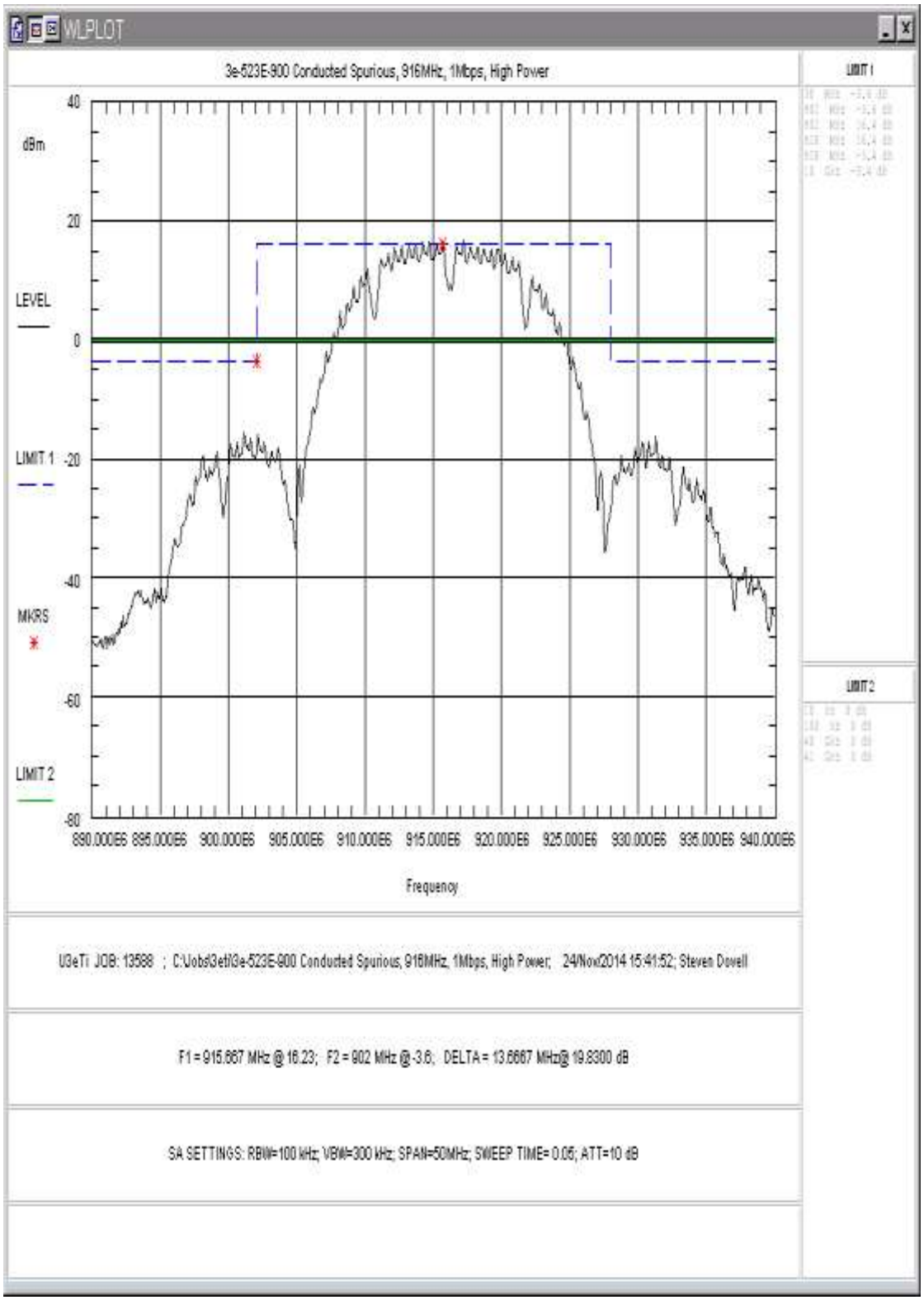

Figure 6: Conducted Spurious Emissions, 1Mbps, High Power, 890 -940MHz

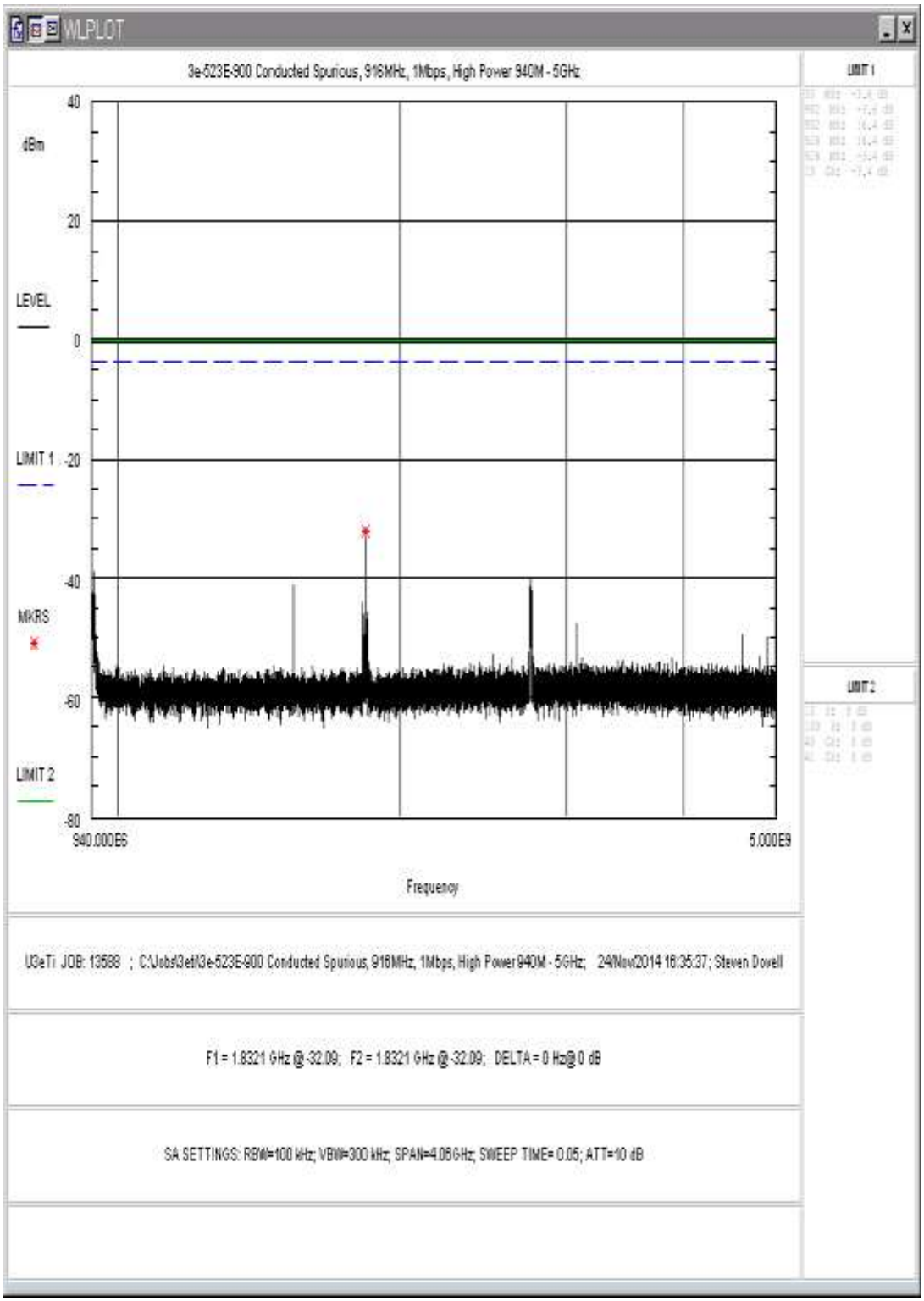

Figure 7: Conducted Spurious Emissions, 1Mbps, High Power, 940 – 5000MHz

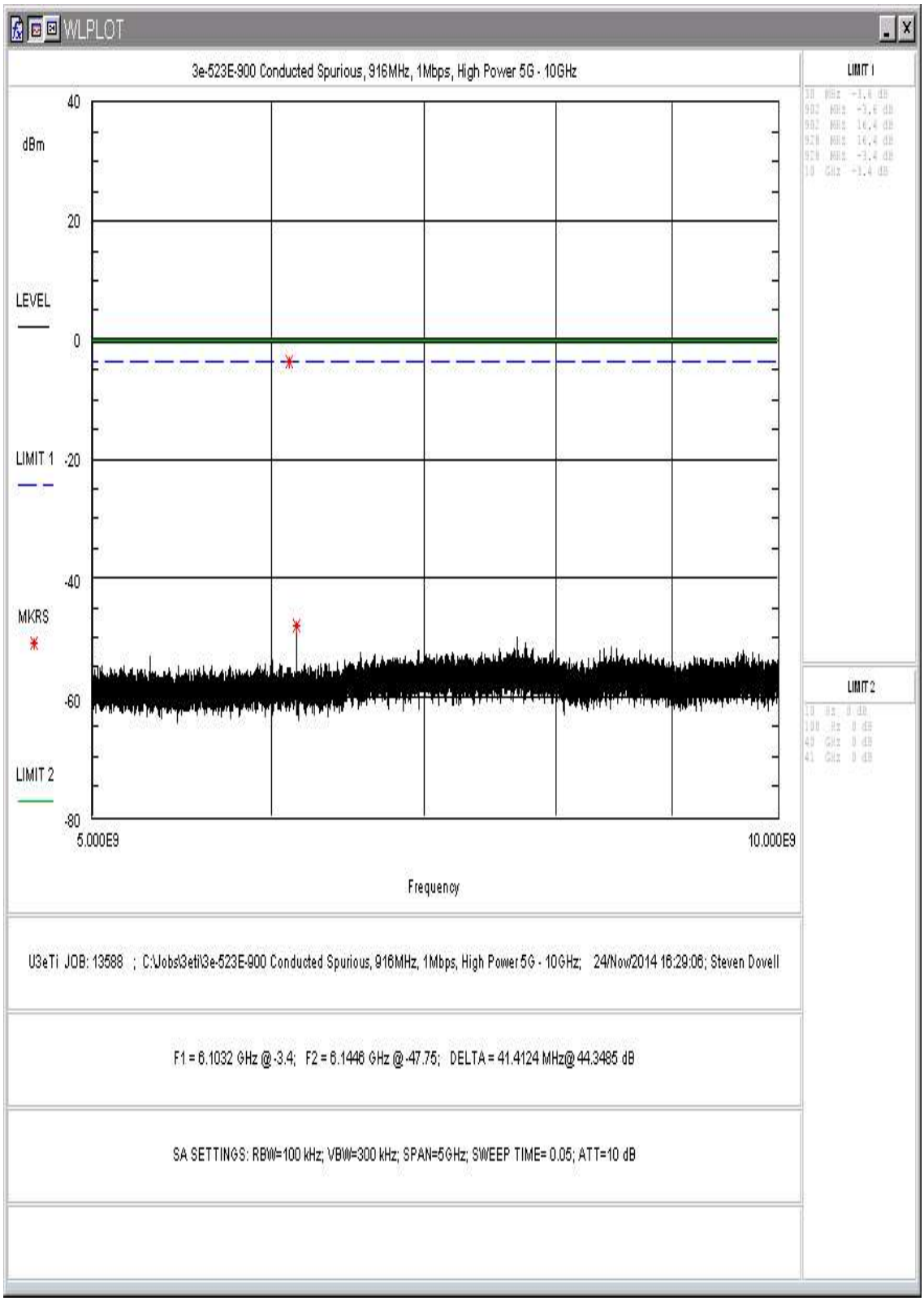

Figure 8: Conducted Spurious Emissions, 1Mbps, High Power, 5 - 10GHz

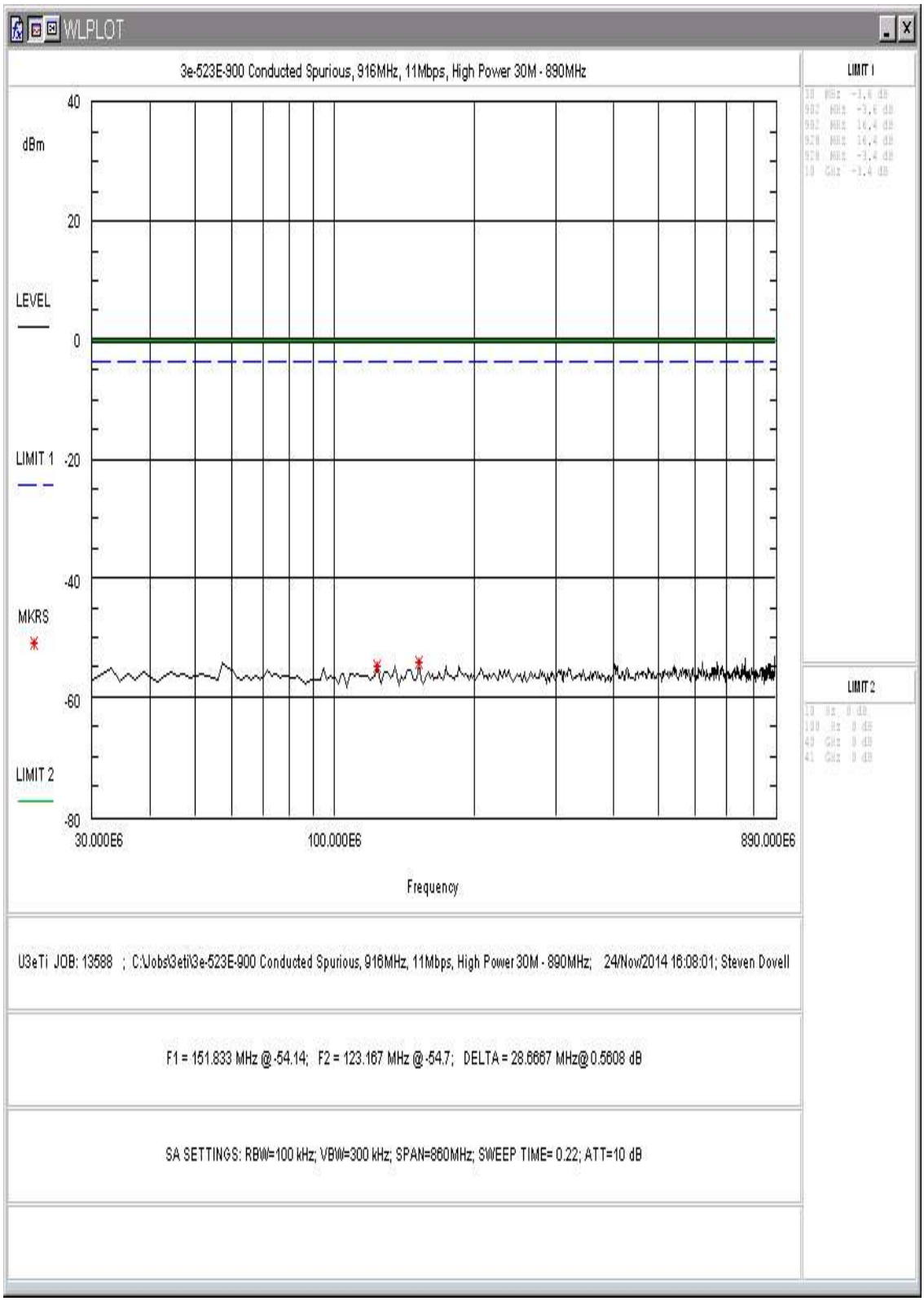

Figure 9: Conducted Spurious Emissions, 11Mbps, High Power, 30 - 890MHz

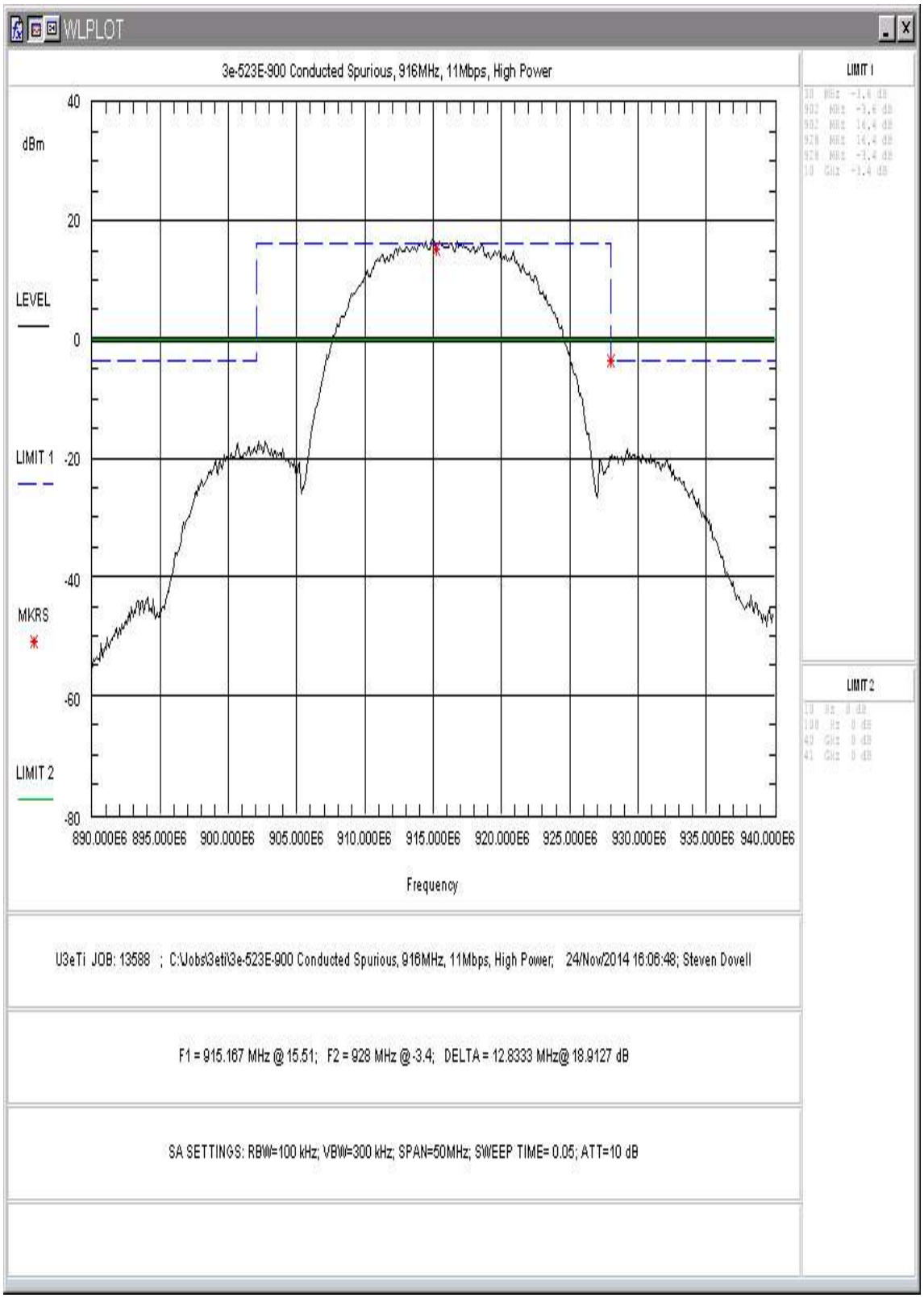

Figure 10: Conducted Spurious Emissions, 11Mbps, High Power, 890-940MHz

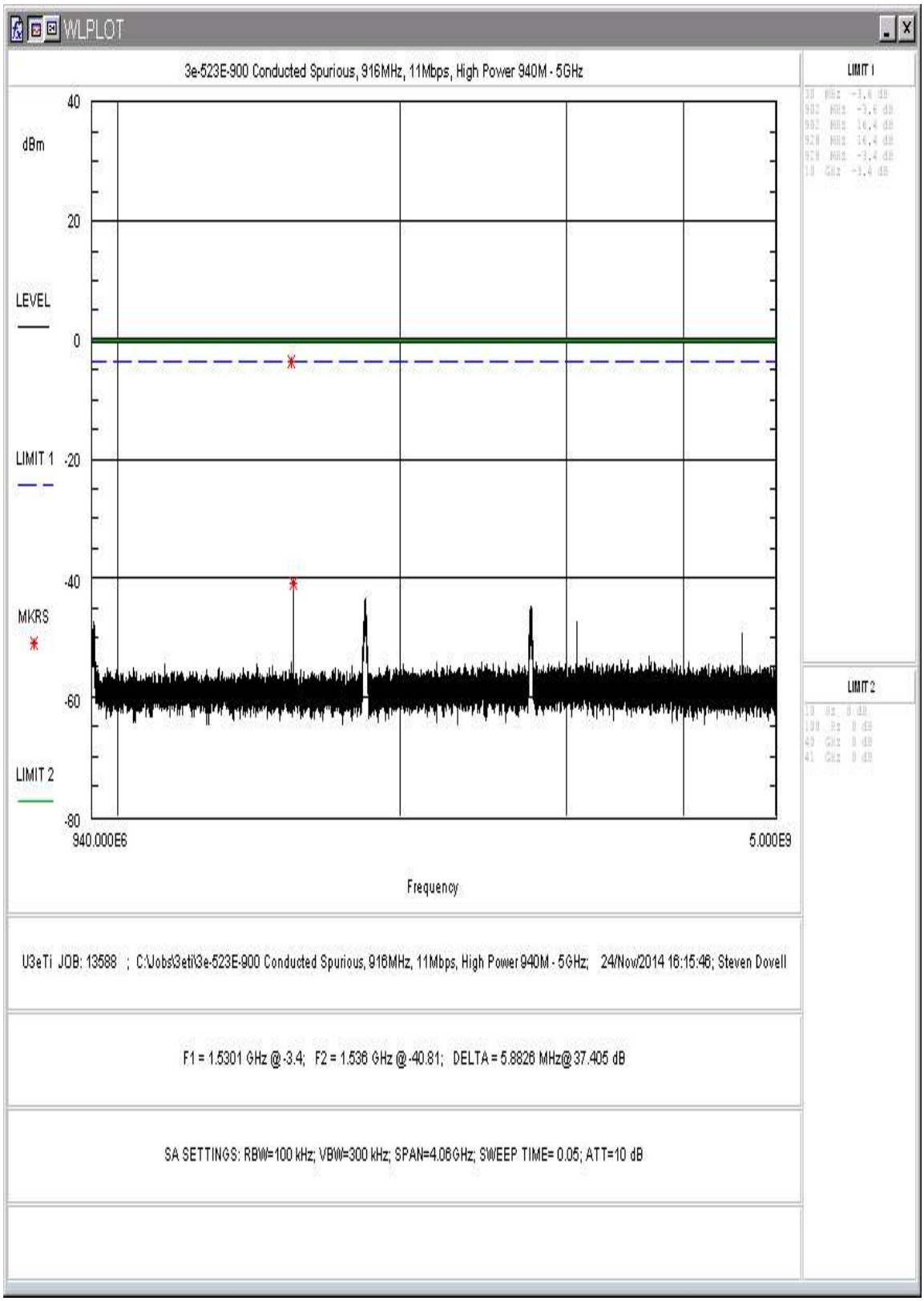

Figure 11: Conducted Spurious Emissions, 11Mbps, High Power, 940-5000MHz

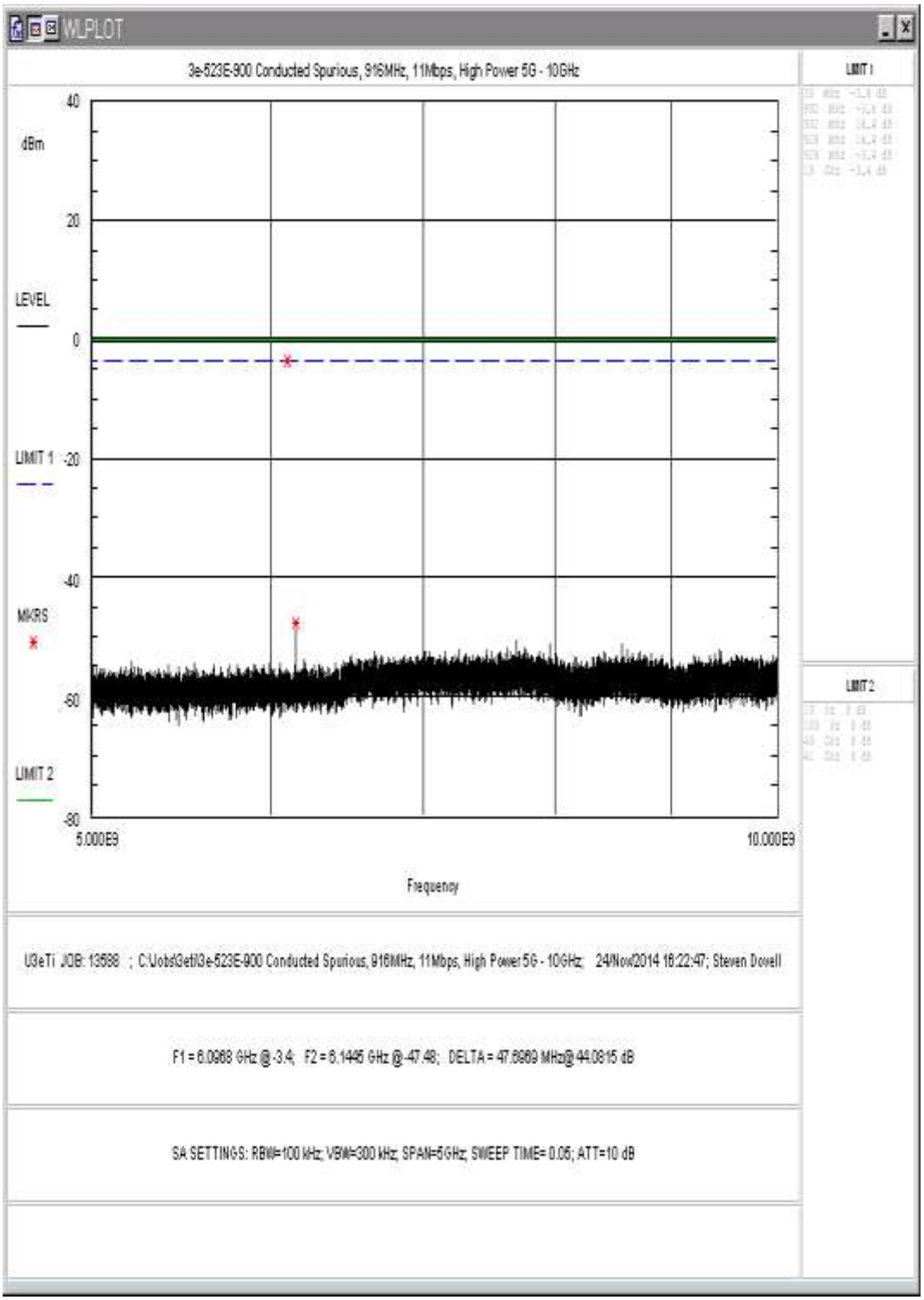

Figure 12: Conducted Spurious Emissions, 11Mbps, High Power, 5-10GHz

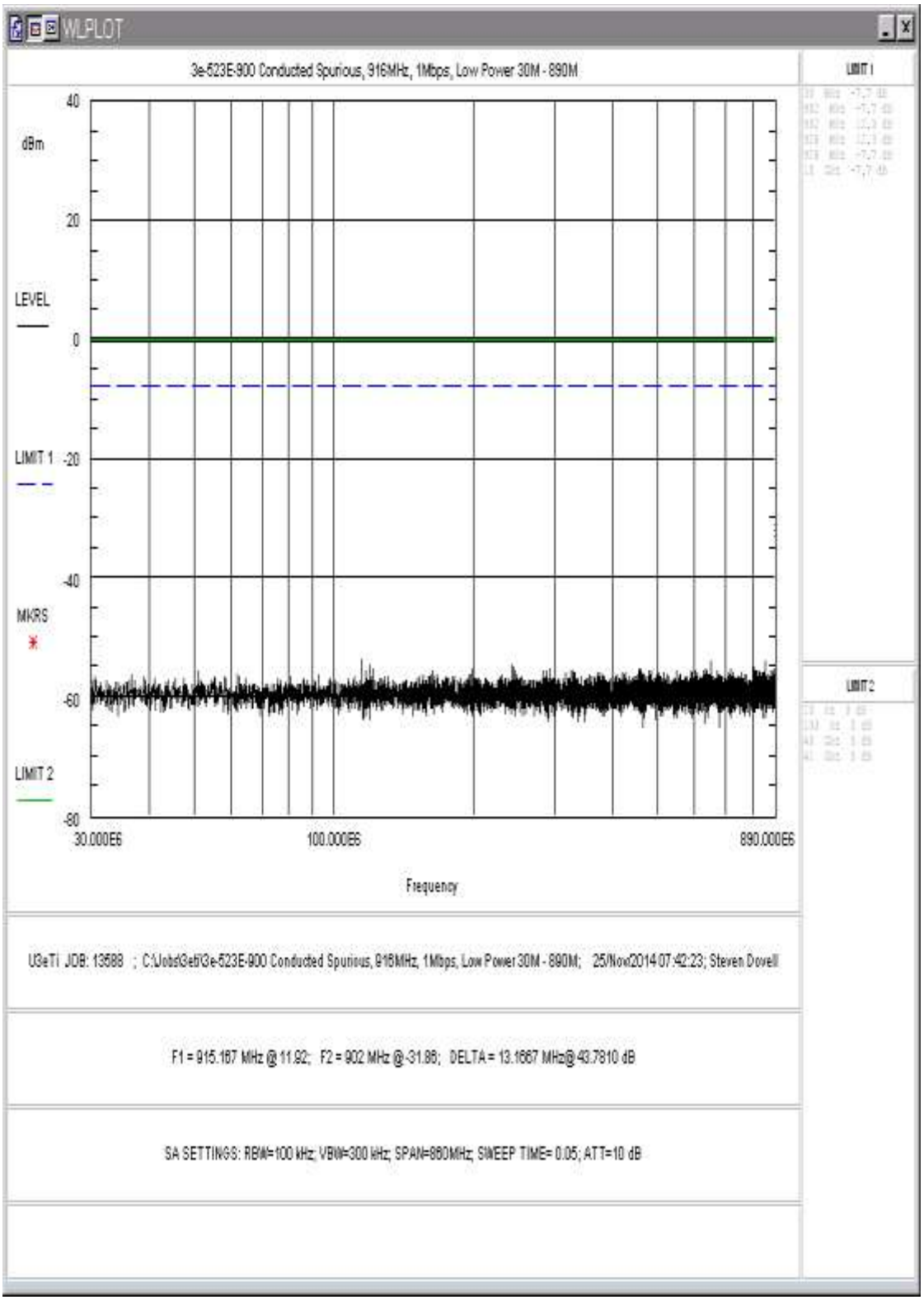

Figure 13: Conducted Spurious Emissions, 1Mbps, Low Power, 30 - 890MHz

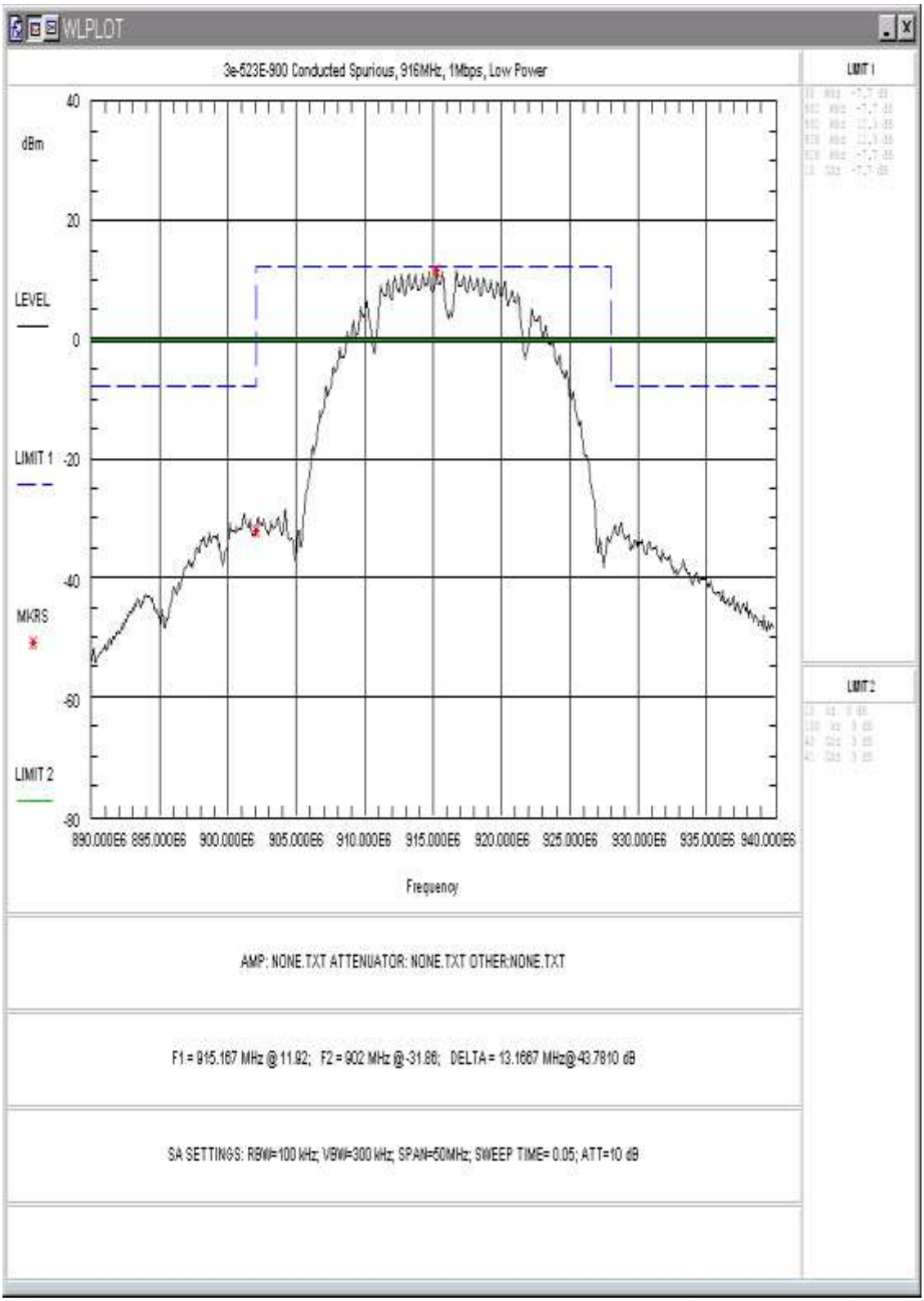

Figure 14: Conducted Spurious Emissions, 1Mbps, Low Power, 890-940MHz

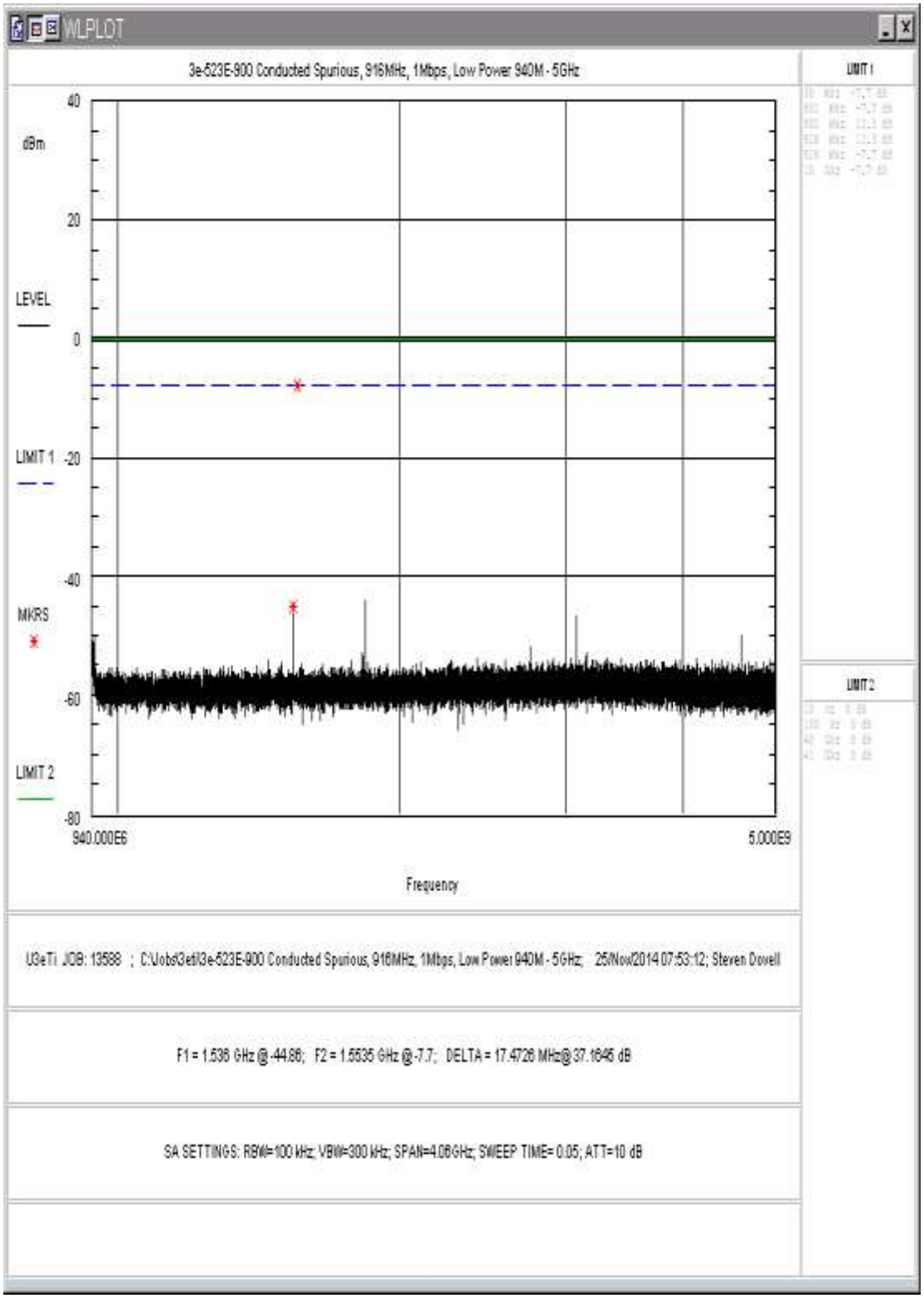

Figure 15: Conducted Spurious Emissions, 1Mbps, Low Power, 940-5000MHz

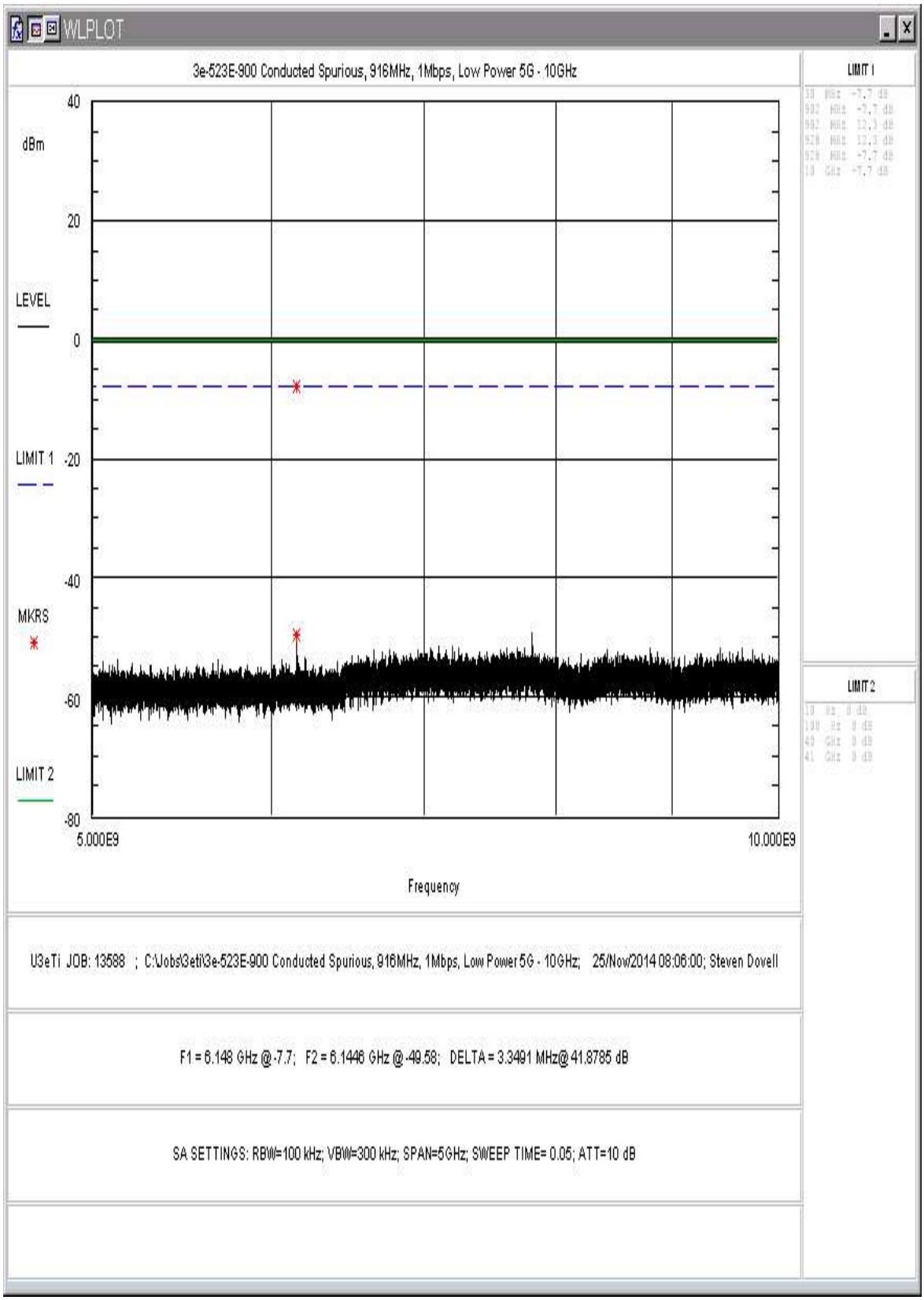

Figure 16: Conducted Spurious Emissions, 1Mbps, Low Power, 5-10GHz

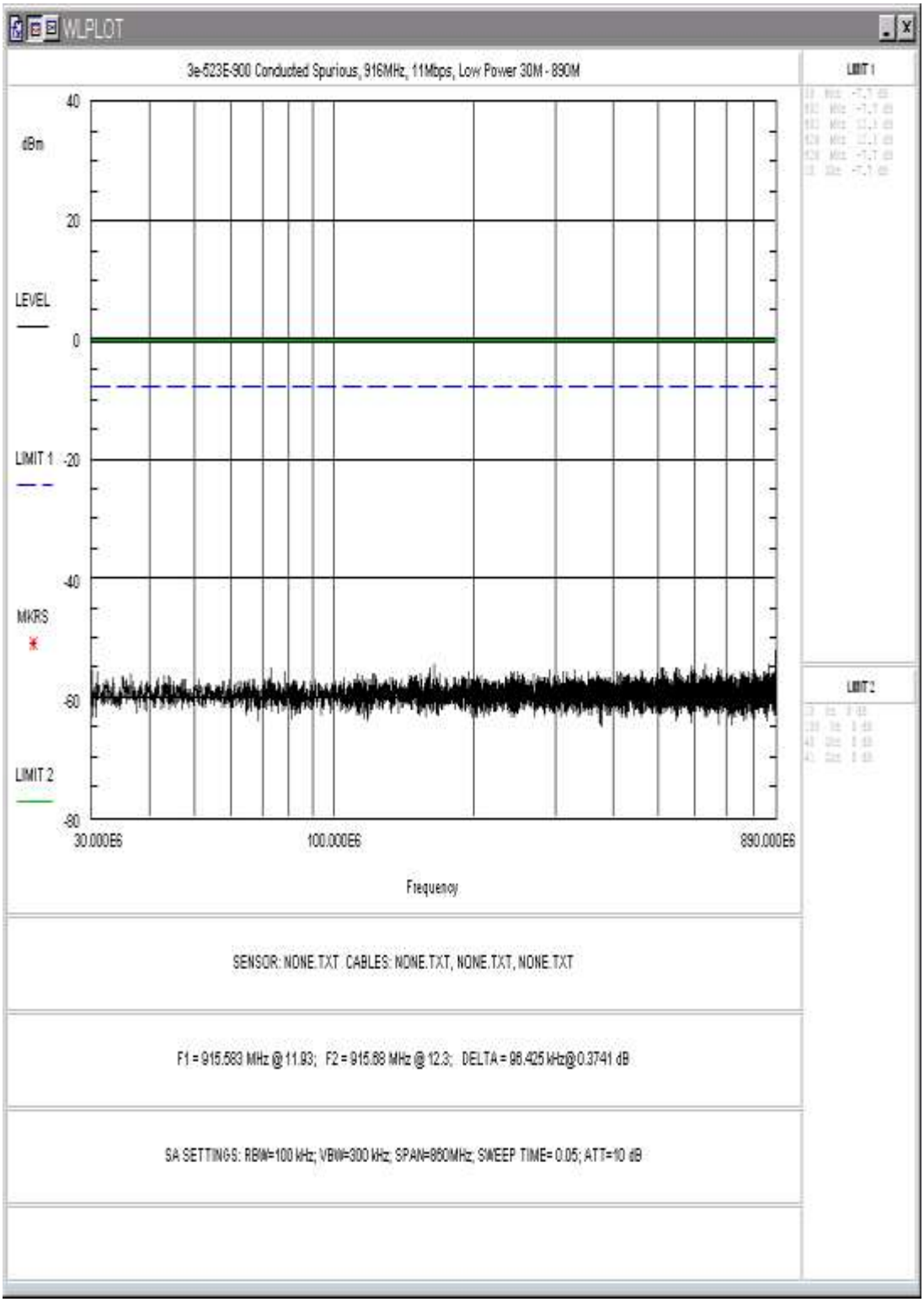

Figure 17: Conducted Spurious Emissions, 11Mbps, Low Power, 30 - 890MHz

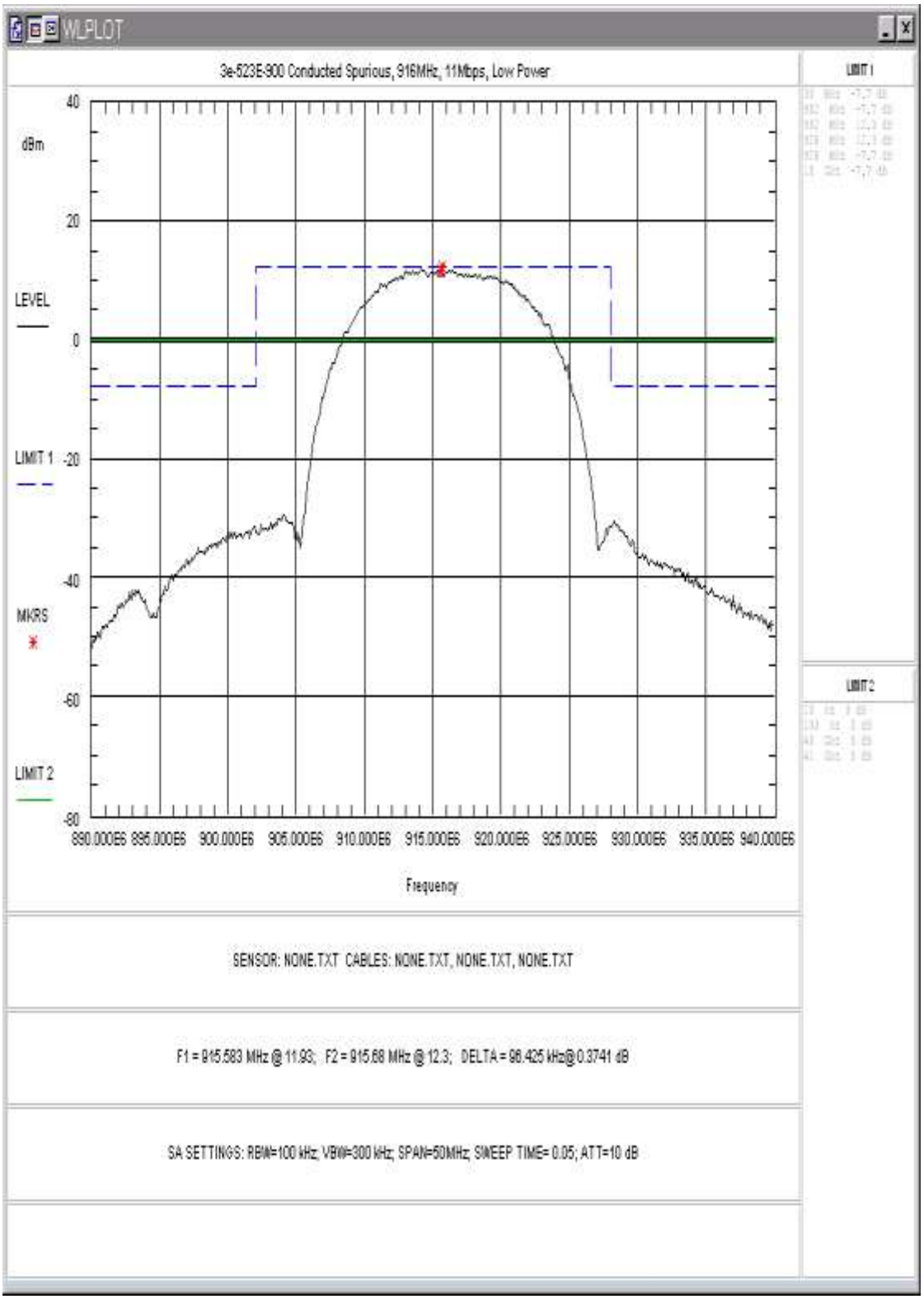

Figure 18: Conducted Spurious Emissions, 11Mbps, Low Power, 890-940MHz

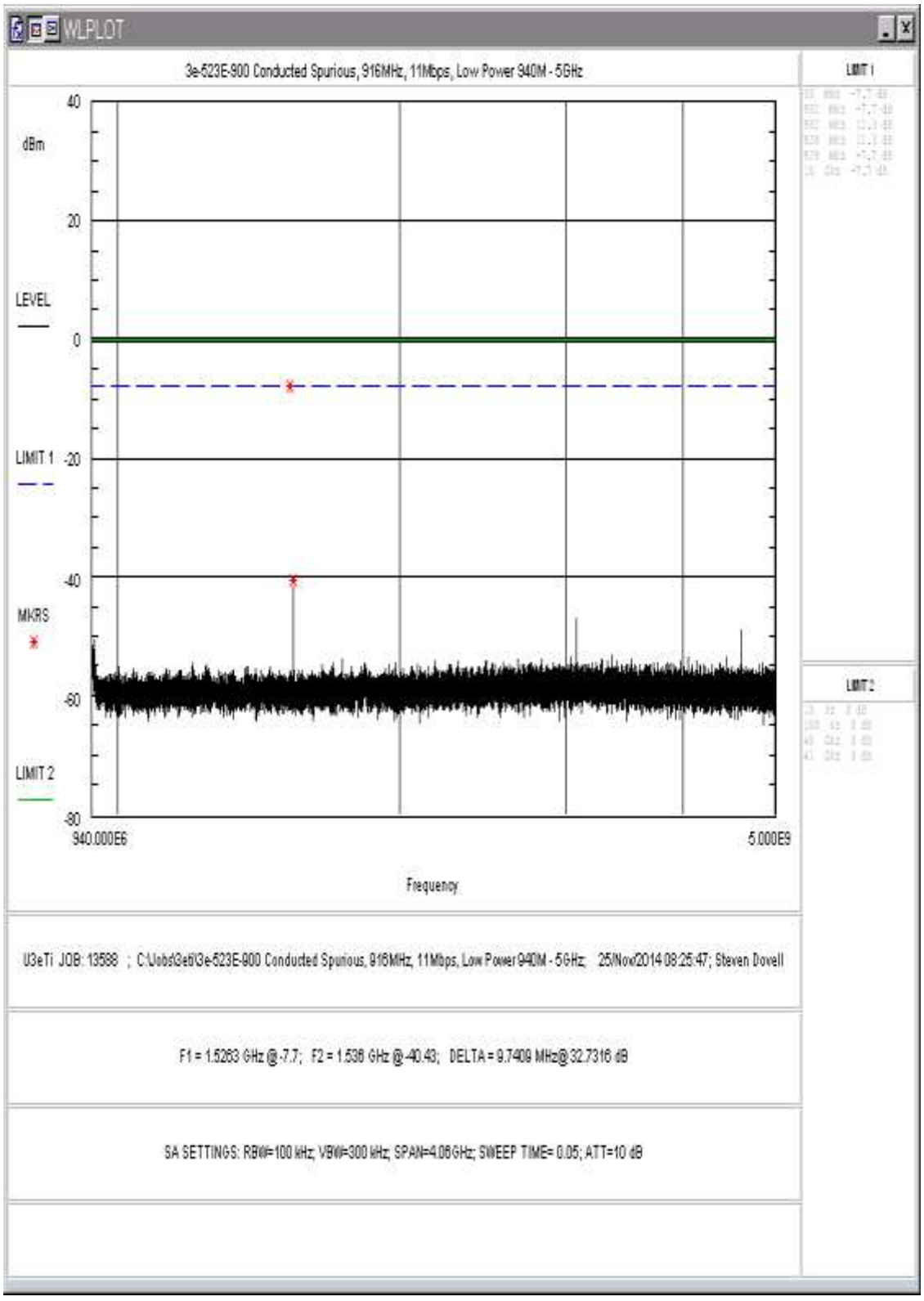

Figure 19: Conducted Spurious Emissions, 11Mbps, Low Power, 940-5000MHz

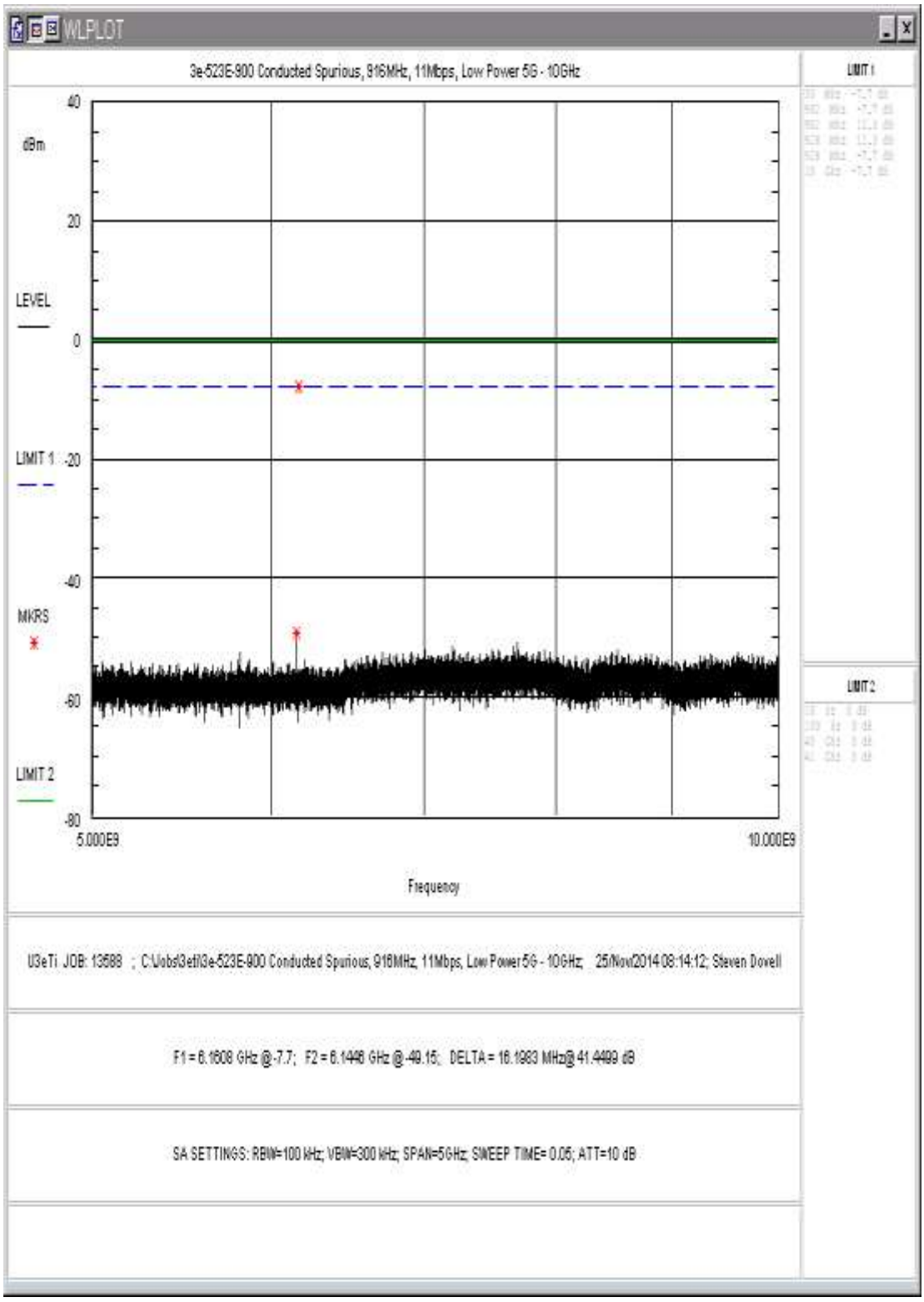

Figure 20: Conducted Spurious Emissions, 11Mbps, Low Power, 5-10GHz

5.4.1 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.

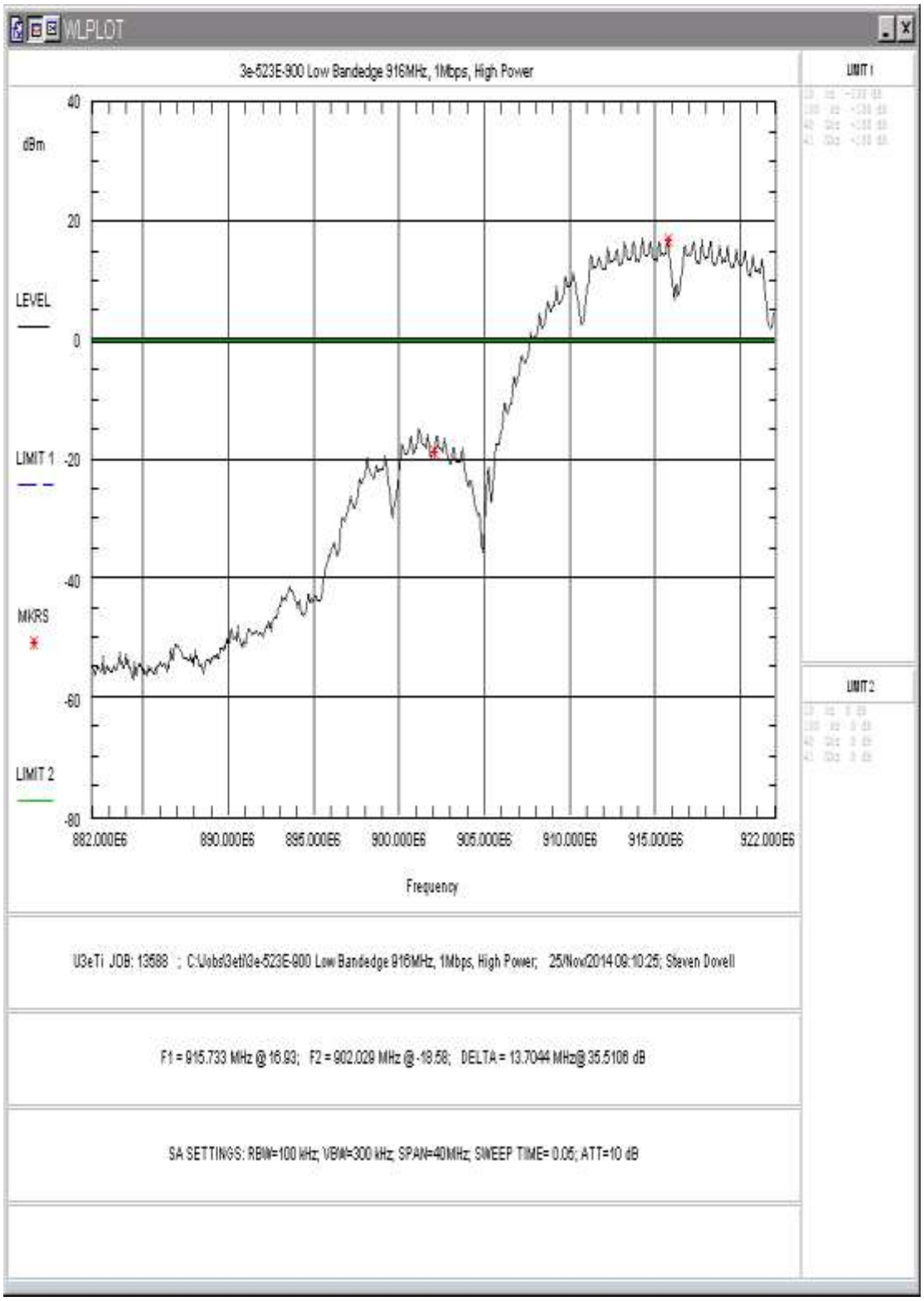

Figure 21: Lower Band-edge, 1Mbps, High Power

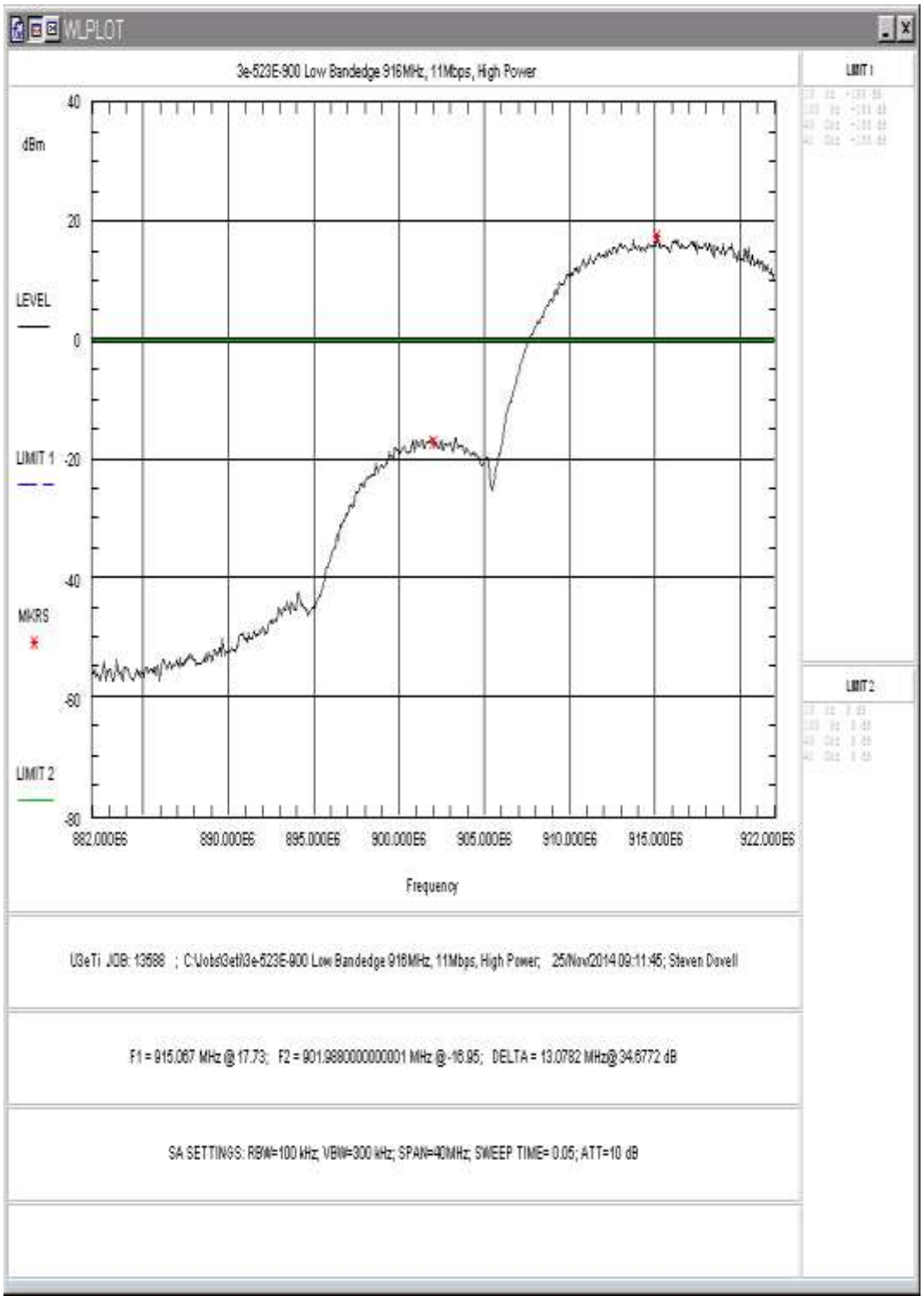

Figure 22: Lower Band-edge, 11Mbps, High Power

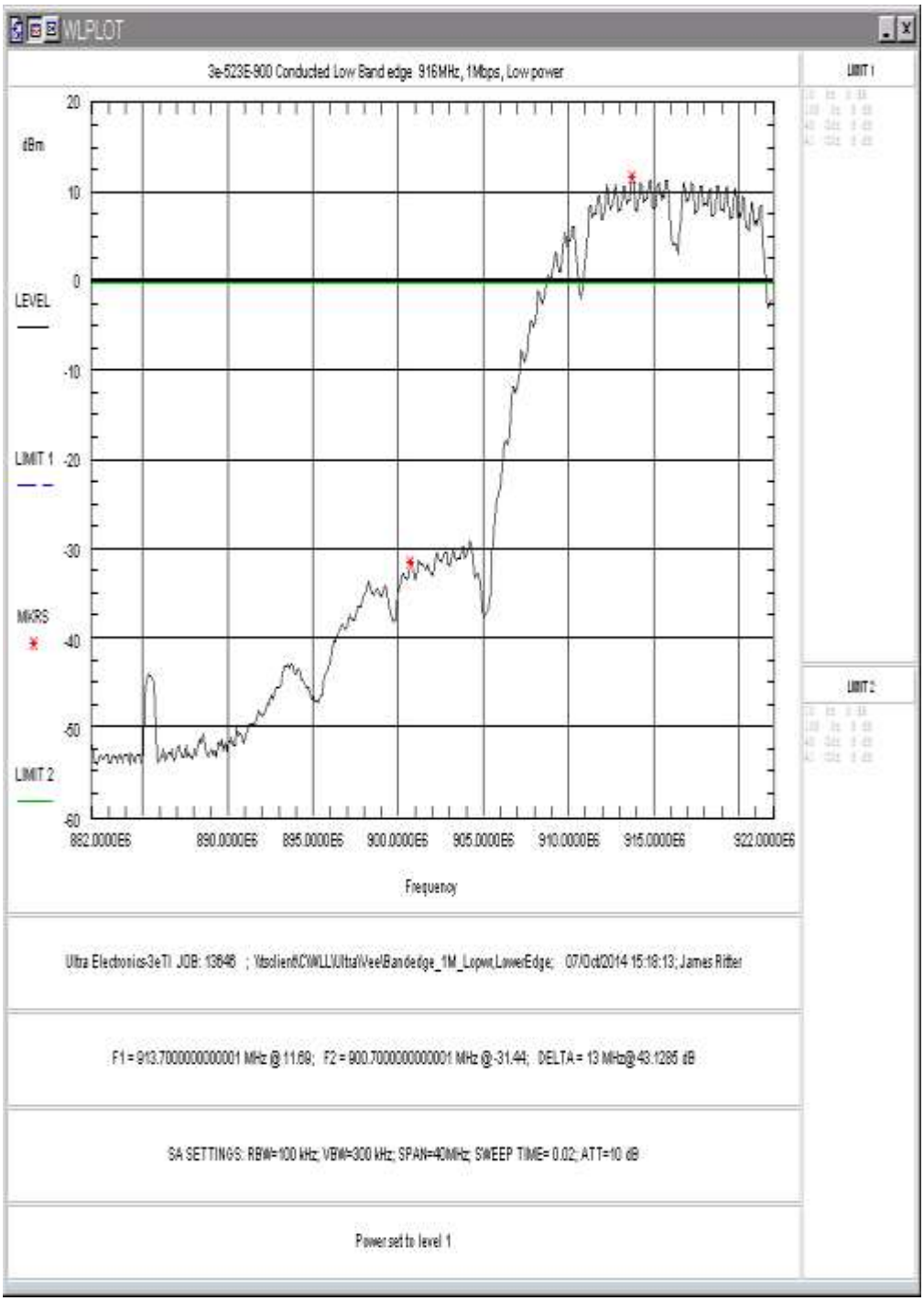

Figure 23: Lower Band-edge, 1Mbps, Low Power

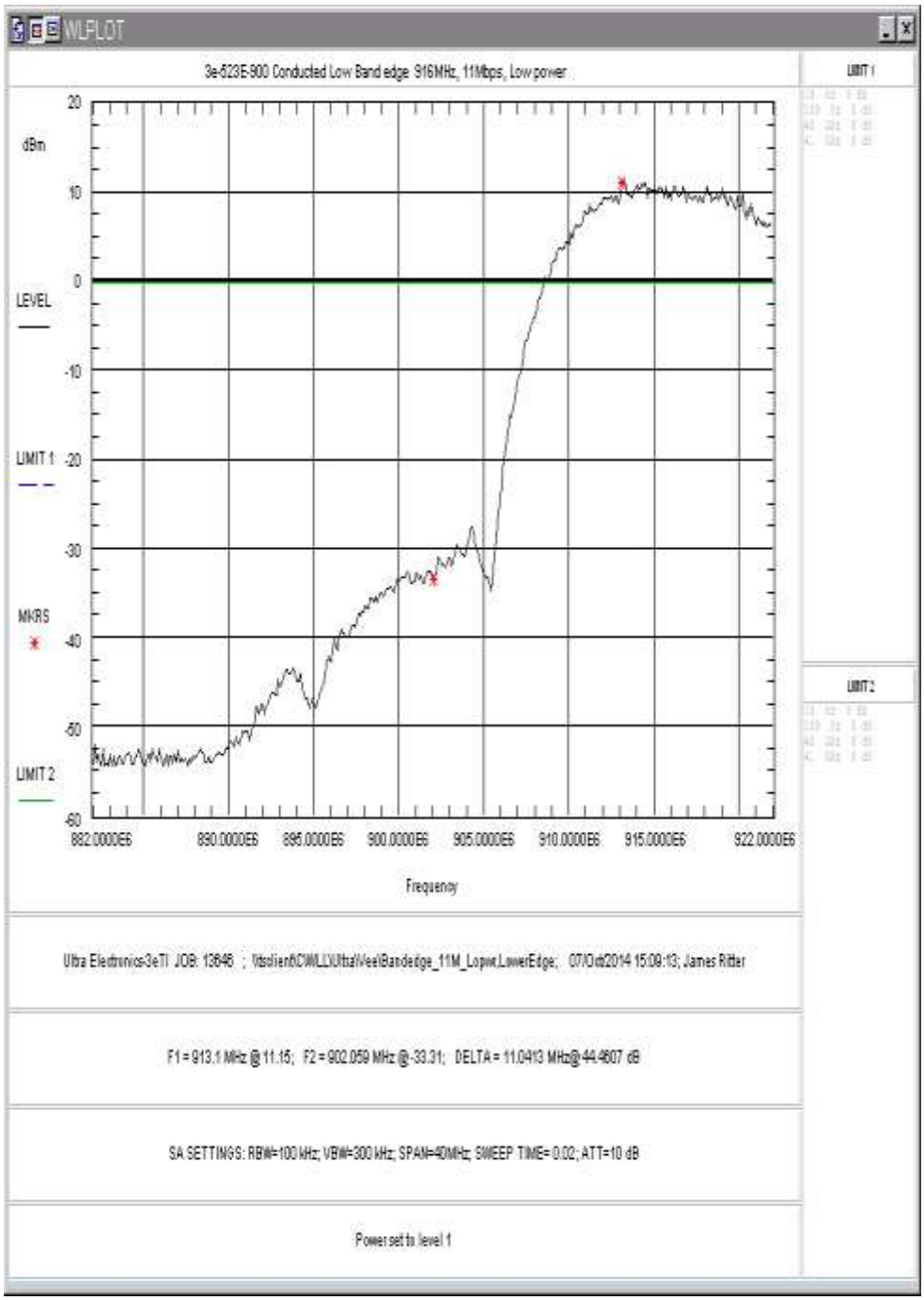

Figure 24: Lower Band-edge, 11Mbps, Low Power

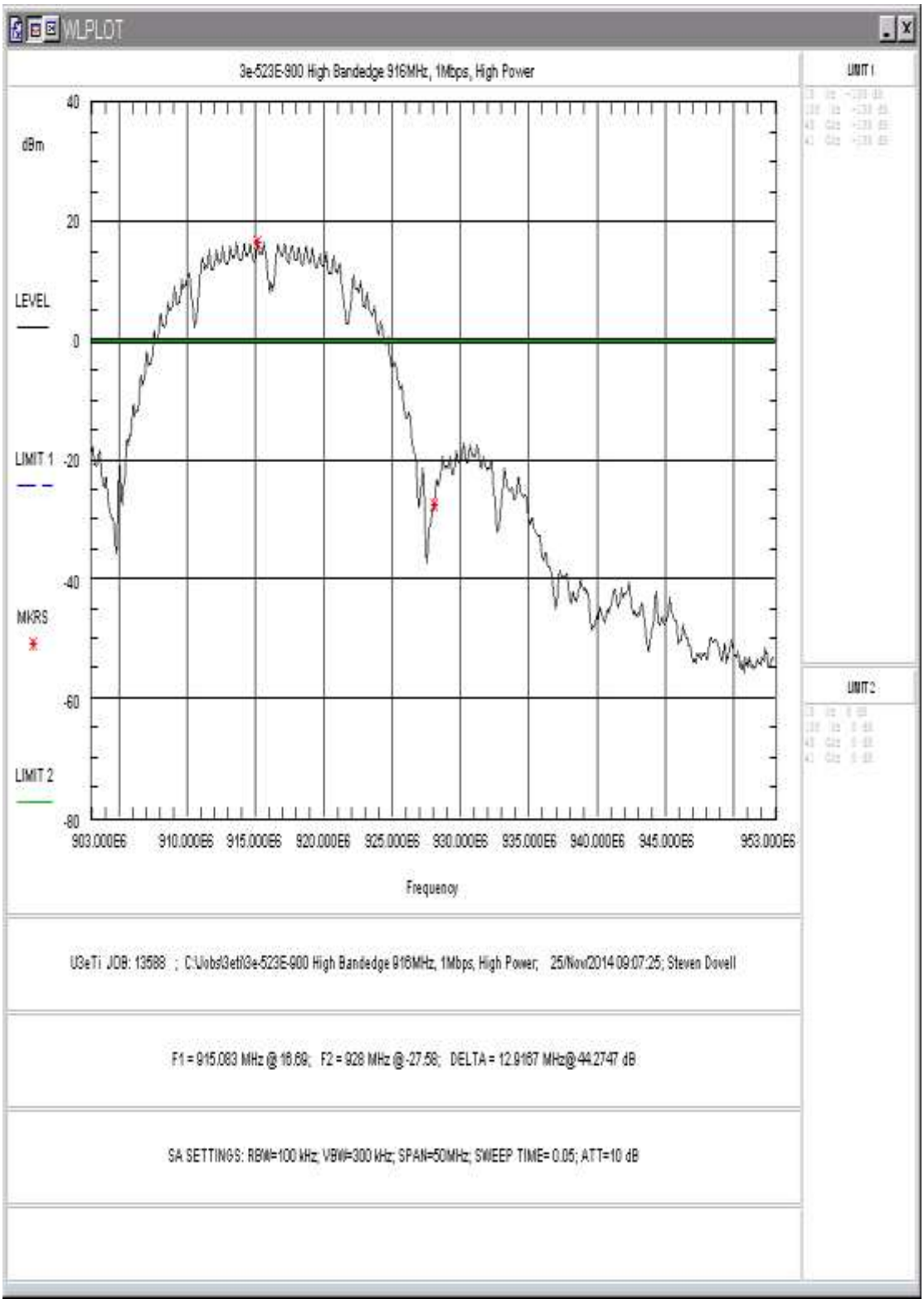

Figure 25: Upper Band-edge, 1Mbps, High Power

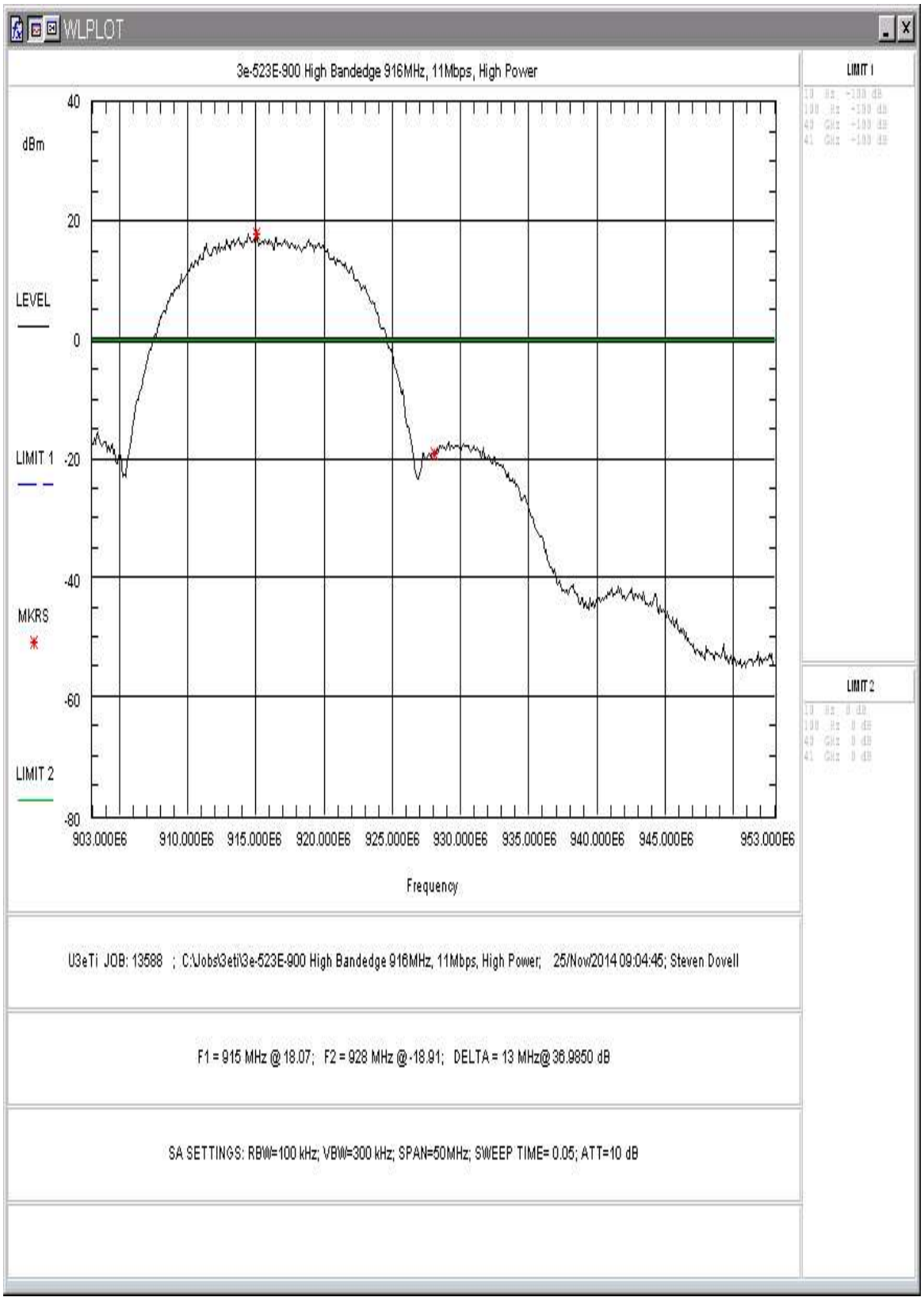

Figure 26: Upper Band-edge, 11Mbps, High Power

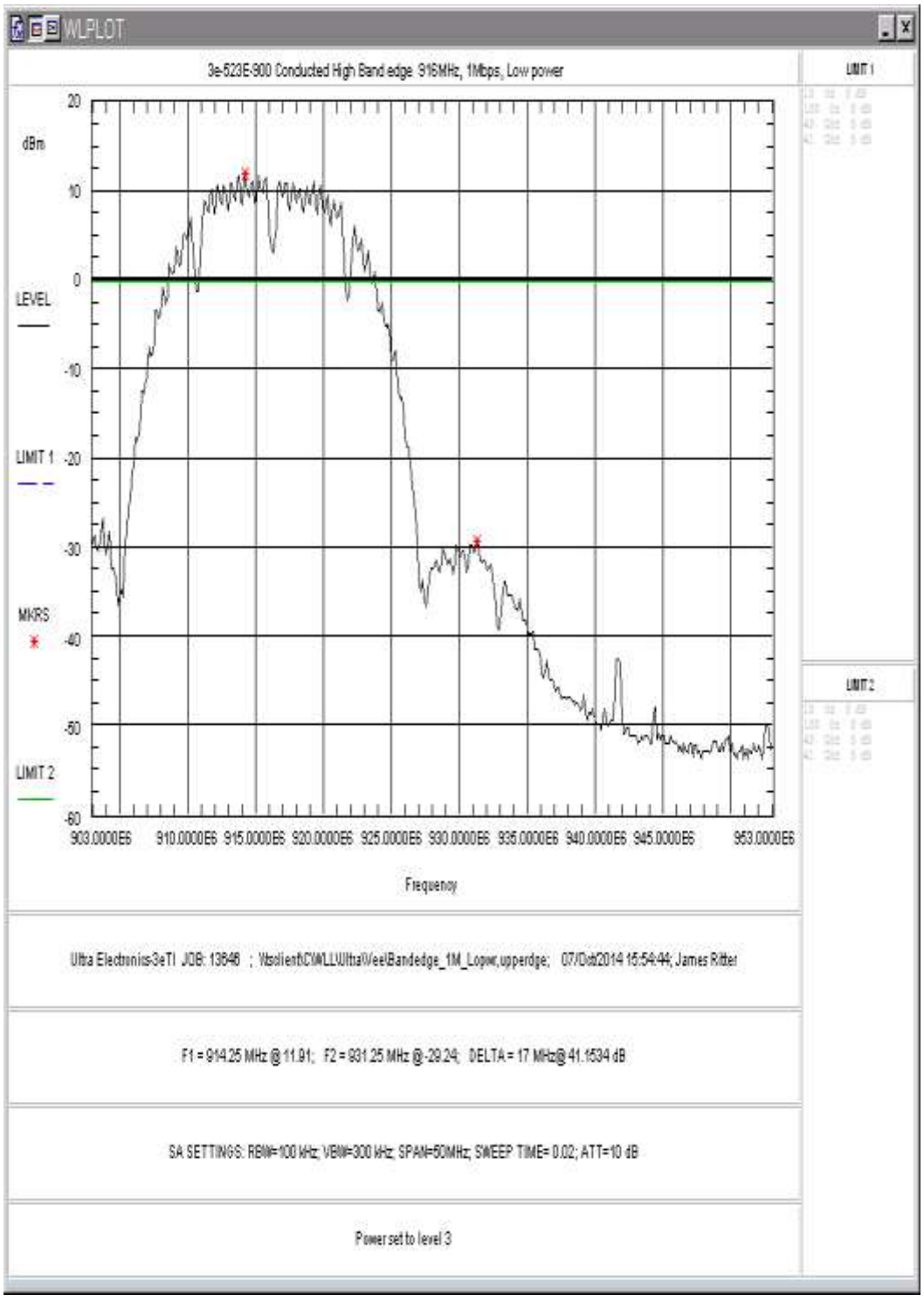

Figure 27: Upper Band-edge, 1Mbps, Low Power

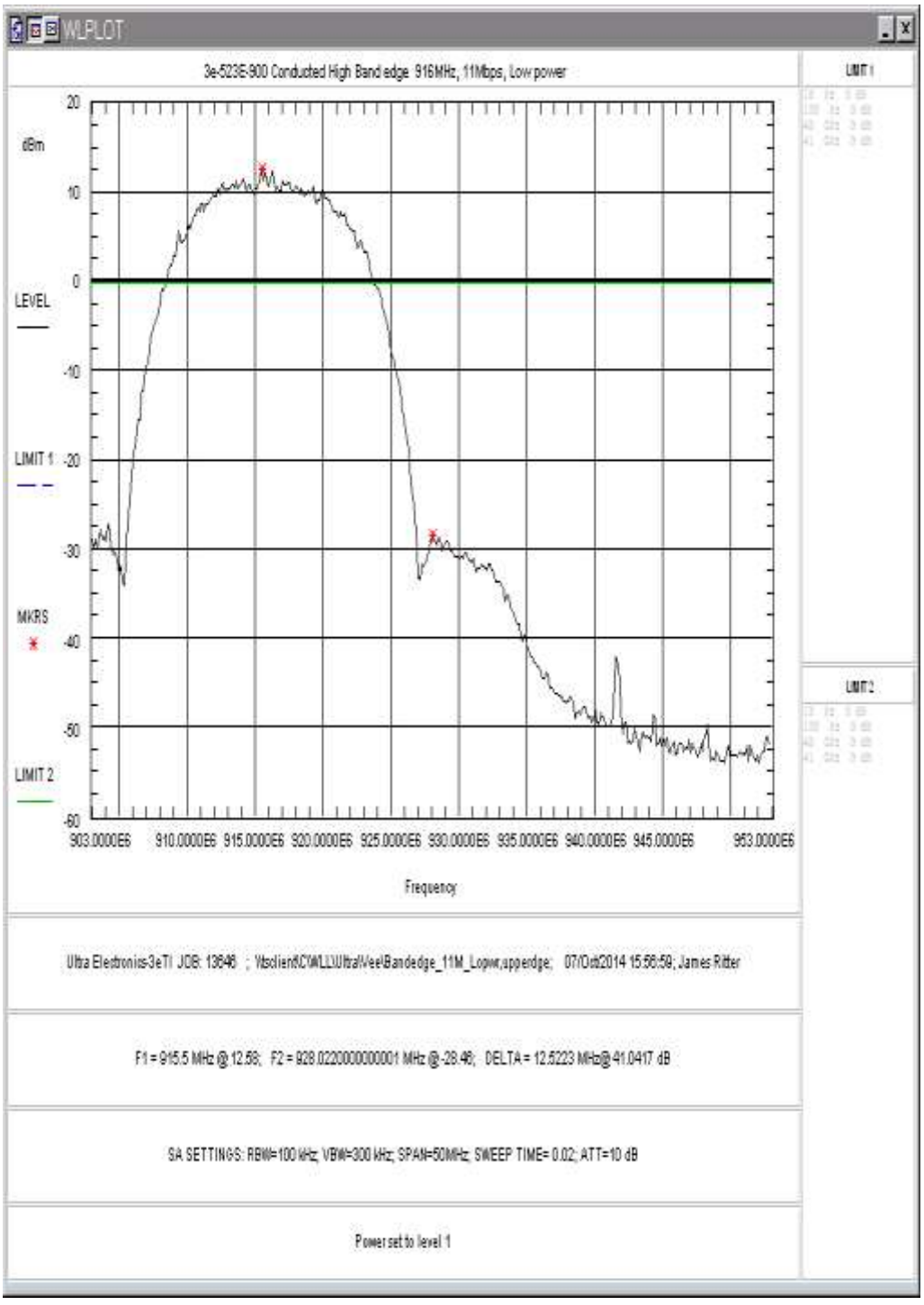

Figure 28: Upper Band-edge, 11Mbps, Low Power

5.5 Radiated Spurious Emissions:

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

5.5.1 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 C63.4-2014. 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:

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)

Average measurements above 1GHz were made with the Spectrum analyzer set to the linear mode with a Video bandwidth of 10Hz, and the resultant reading mathematically converted to dBuV. Correction factors were then applied and the resulting value was compared to the limit.

By examination, it was found that there were no differences in radiated emissions between 1Mbps data rate and 11Mbps data rate. Worst case numbers were recorded.

Table 11: Radiated Emission Test Data, Low Frequency Data (<1GHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
54.32	V	45.00	1.00	26.60	7.8	52.2	100.0	-5.6	
39.52	V	45.00	1.00	16.00	14.8	34.5	100.0	-9.2	
68.24	V	90.00	1.00	24.60	9.0	48.0	100.0	-6.4	
81.52	V	100.00	1.00	21.10	8.8	31.4	100.0	-10.1	
198.09	V	190.00	1.24	20.30	13.9	51.5	150.0	-9.3	
220.07	V	190.00	1.70	26.24	13.1	92.7	200.0	-6.7	
242.06	V	180.00	1.88	20.70	14.1	54.9	200.0	-11.2	
264.03	V	180.00	1.90	20.10	15.3	58.8	200.0	-10.6	
285.88	V	180.00	2.02	20.70	16.3	70.7	200.0	-9.0	
307.98	V	10.00	2.10	22.10	16.6	85.8	200.0	-7.3	
325.04	V	340.00	1.72	18.90	17.2	63.6	200.0	-10.0	
330.11	V	270.00	1.75	17.20	17.2	52.5	200.0	-11.6	
352.08	V	190.00	2.24	23.60	17.8	117.8	200.0	-4.6	
396.05	V	180.00	1.80	22.53	18.9	118.5	200.0	-4.5	
440.00	V	180.00	2.72	15.50	20.8	65.3	200.0	-9.7	
462.12	V	190.00	1.90	19.40	20.7	101.5	200.0	-5.9	
506.08	V	170.00	2.96	15.80	22.2	79.3	200.0	-8.0	
660.06	V	180.00	2.09	13.40	24.7	80.4	200.0	-7.9	
725.99	V	270.00	1.42	6.20	26.0	40.7	200.0	-13.8	
792.06	V	270.00	1.78	12.10	26.7	87.5	200.0	-7.2	
814.04	V	90.00	2.43	5.60	27.3	44.1	200.0	-13.1	
960.00	V	180.00	2.90	0.80	28.8	30.2	500.0	-24.4	ambient restricted edge
81.52	H	170.00	3.78	16.80	8.8	19.2	100.0	-14.4	
111.60	H	90.00	3.31	19.10	14.3	47.0	150.0	-10.1	
198.09	H	45.00	1.90	25.30	13.9	91.6	150.0	-4.3	
220.07	H	90.00	2.40	28.40	13.1	118.9	200.0	-4.5	
242.06	H	20.00	2.20	16.70	14.1	34.6	200.0	-15.2	
264.03	H	90.00	1.20	17.50	15.3	43.6	200.0	-13.2	
286.02	H	45.00	2.40	26.80	16.3	142.8	200.0	-2.9	
307.98	H	45.00	1.60	25.40	16.6	125.5	200.0	-4.0	
325.04	H	45.00	1.50	24.60	17.2	122.6	200.0	-4.3	
330.11	H	0.00	1.40	25.10	17.2	130.3	200.0	-3.7	
352.08	H	45.00	1.30	24.90	17.8	136.8	200.0	-3.3	
396.05	H	10.00	2.75	22.30	18.9	115.4	200.0	-4.8	
440.00	H	90.00	1.50	19.60	20.8	104.6	200.0	-5.6	
462.12	H	10.00	2.31	16.70	20.7	74.4	200.0	-8.6	
506.08	H	180.00	1.30	11.30	22.2	47.3	200.0	-12.5	
660.06	H	10.00	1.82	12.90	24.7	75.9	200.0	-8.4	
725.99	H	180.00	1.22	8.90	26.0	55.5	200.0	-11.1	
792.06	H	350.00	1.10	14.10	26.7	110.1	200.0	-5.2	
814.04	H	0.00	1.18	4.80	27.3	40.2	200.0	-13.9	
960.00	H	0.00	1.00	-0.70	28.8	25.4	500.0	-25.9	ambient restricted edge

Table 12: Radiated Emission Test Data, High Frequency Data (>1GHz), Omni Antenna (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
1034.00	V	300.00	3.00	59.12	-10.8	259.3	5000.0	-25.7	peak
1034.00	V	300.00	3.00	57.00	-10.8	203.1	500.0	-7.8	Average
1188.00	V	350.00	3.00	59.50	-9.8	306.5	5000.0	-24.3	peak
1188.00	V	350.00	3.00	57.30	-9.8	237.9	500.0	-6.5	Average
1536.00	V	90.00	3.36	59.54	-9.2	327.5	5000.0	-23.7	peak
1536.00	V	90.00	3.36	55.90	-9.2	215.4	500.0	-7.3	Average
2748.00	V	180.00	3.20	46.90	-2.7	162.4	5000.0	-29.8	peak
2748.00	V	180.00	3.20	35.63	-2.7	44.4	500.0	-21.0	Average
3072.00	V	45.00	3.60	42.10	-2.1	100.2	5000.0	-34.0	peak
3072.00	V	45.00	3.63	39.40	-2.1	73.5	500.0	-16.7	Average
3664.00	V	180.00	3.29	41.36	-0.1	115.2	5000.0	-32.8	peak
3664.00	V	180.00	3.29	33.96	-0.1	49.1	500.0	-20.2	Average
4580.00	V	190.00	3.20	40.88	1.8	136.8	5000.0	-31.3	peak
4580.00	V	190.00	3.20	30.77	1.8	42.7	500.0	-21.4	Average
4608.00	V	0.00	3.10	41.60	1.9	150.1	5000.0	-30.5	peak
4608.00	V	0.00	3.10	33.10	1.9	56.4	500.0	-19.0	Average
4904.00	V	0.00	3.34	44.53	3.2	244.0	5000.0	-26.2	peak
4904.00	V	0.00	3.34	37.36	3.2	106.9	500.0	-13.4	Average
1034.00	H	40.00	3.20	56.70	-10.8	196.2	5000.0	-28.1	peak
1034.00	H	40.00	3.20	54.80	-10.8	157.7	500.0	-10.0	Average
1188.00	H	45.00	3.20	57.00	-9.8	229.8	5000.0	-26.8	peak
1188.00	H	45.00	3.20	55.60	-9.8	195.6	500.0	-8.2	Average
1536.00	H	200.00	3.50	56.00	-9.2	217.9	5000.0	-27.2	peak
1536.00	H	200.00	3.50	52.00	-9.2	137.5	500.0	-11.2	Average
4904.00	H	90.00	2.50	40.50	3.2	153.5	5000.0	-30.3	peak
4904.00	H	90.00	2.50	31.10	3.2	52.0	500.0	-19.7	Average

Table 13: Radiated Emission Test Data, High Frequency Data (>1GHz), Yagi Antenna (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
1034.00	V	180.00	3.60	57.50	-10.8	215.2	5000.0	-27.3	peak
1034.00	V	180.00	3.60	54.00	-10.8	143.8	500.0	-10.8	Average
1188.00	V	270.00	3.45	56.31	-9.8	212.3	5000.0	-27.4	peak
1188.00	V	270.00	3.45	53.50	-9.8	153.6	500.0	-10.3	Average
1536.00	V	200.00	3.50	61.50	-9.2	410.4	5000.0	-21.7	peak
1536.00	V	200.00	3.50	57.50	-9.2	259.0	500.0	-5.7	Average
2748.00	V	300.00	3.50	42.50	-2.7	97.8	5000.0	-34.2	peak
2748.00	V	300.00	3.50	31.70	-2.7	28.2	500.0	-25.0	Average
3072.00	V	275.00	3.60	42.90	-2.1	109.9	5000.0	-33.2	peak
3072.00	V	275.00	3.60	31.00	-2.1	27.9	500.0	-25.1	Average
3664.00	V	275.00	3.41	45.10	-0.1	177.1	5000.0	-29.0	peak
3664.00	V	275.00	3.41	31.80	-0.1	38.3	500.0	-22.3	Average
4580.00	V	90.00	3.50	42.20	1.8	159.3	5000.0	-29.9	peak
4580.00	V	90.00	3.50	31.70	1.8	47.6	500.0	-20.4	Average
4608.00	V	300.00	3.34	44.70	1.9	214.4	5000.0	-27.4	peak
4608.00	V	300.00	3.34	33.50	1.9	59.1	500.0	-18.6	Average
4904.00	V	45.00	3.38	44.50	3.2	243.2	5000.0	-26.3	peak
4904.00	V	45.00	3.38	38.60	3.2	123.3	500.0	-12.2	Average
1034.00	H	95.00	3.06	53.50	-10.8	135.8	5000.0	-31.3	peak
1034.00	H	95.00	3.06	50.50	-10.8	96.1	500.0	-14.3	Average
1188.00	H	0.00	3.20	58.30	-9.8	266.9	5000.0	-25.5	peak
1188.00	H	0.00	3.20	55.90	-9.8	202.5	500.0	-7.9	Average
1536.00	H	0.00	3.30	61.32	-9.2	402.0	5000.0	-21.9	peak
1536.00	H	0.00	3.30	57.30	-9.2	253.1	500.0	-5.9	Average
4904.00	H	180.00	3.48	42.70	3.2	197.7	5000.0	-28.1	peak
4904.00	H	180.00	3.48	34.64	3.2	78.2	500.0	-16.1	Average

5.6 Receiver Radiated Spurious Emissions

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

5.6.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4-2014. 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:

Table 14: Spectrum Analyzer Settings

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

Average measurements above 1GHz were made with the Spectrum analyzer set to the linear mode with a Video bandwidth of 10Hz, and the resultant reading mathematically converted to dBuV. Correction factors were then applied and the resulting value was compared to the limit.

Table 15: Radiated Emission Test Data < 1GHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
54.32	V	45.00	1.00	26.60	7.8	52.2	100.0	-5.6	
39.52	V	45.00	1.00	16.00	14.8	34.5	100.0	-9.2	
68.24	V	90.00	1.00	24.60	9.0	48.0	100.0	-6.4	
81.52	V	100.00	1.00	21.10	8.8	31.4	100.0	-10.1	
198.09	V	190.00	1.24	20.30	13.9	51.5	150.0	-9.3	
220.07	V	190.00	1.70	26.24	13.1	92.7	200.0	-6.7	
242.06	V	180.00	1.88	20.70	14.1	54.9	200.0	-11.2	
264.03	V	180.00	1.90	20.10	15.3	58.8	200.0	-10.6	
285.88	V	180.00	2.02	20.70	16.3	70.7	200.0	-9.0	
307.98	V	10.00	2.10	22.10	16.6	85.8	200.0	-7.3	
325.04	V	340.00	1.72	18.90	17.2	63.6	200.0	-10.0	
330.11	V	270.00	1.75	17.20	17.2	52.5	200.0	-11.6	
352.08	V	190.00	2.24	23.60	17.8	117.8	200.0	-4.6	
396.05	V	180.00	1.80	22.53	18.9	118.5	200.0	-4.5	
440.00	V	180.00	2.72	15.50	20.8	65.3	200.0	-9.7	
462.12	V	190.00	1.90	19.40	20.7	101.5	200.0	-5.9	
506.08	V	170.00	2.96	15.80	22.2	79.3	200.0	-8.0	
660.06	V	180.00	2.09	13.40	24.7	80.4	200.0	-7.9	
725.99	V	270.00	1.42	6.20	26.0	40.7	200.0	-13.8	
792.06	V	270.00	1.78	12.10	26.7	87.5	200.0	-7.2	
814.04	V	90.00	2.43	5.60	27.3	44.1	200.0	-13.1	
960.00	H	180.00	2.90	0.80	28.8	30.2	500.0	-24.4	ambient restricted edge
81.52	H	170.00	3.78	16.80	8.8	19.2	100.0	-14.4	
111.60	H	90.00	3.31	19.10	14.3	47.0	150.0	-10.1	
198.09	H	45.00	1.90	25.30	13.9	91.6	150.0	-4.3	
220.07	H	90.00	2.40	28.40	13.1	118.9	200.0	-4.5	
242.06	H	20.00	2.20	16.70	14.1	34.6	200.0	-15.2	
264.03	H	90.00	1.20	17.50	15.3	43.6	200.0	-13.2	
286.02	H	45.00	2.40	26.80	16.3	142.8	200.0	-2.9	
307.98	H	45.00	1.60	25.40	16.6	125.5	200.0	-4.0	
325.04	H	45.00	1.50	24.60	17.2	122.6	200.0	-4.3	
330.11	H	0.00	1.40	25.10	17.2	130.3	200.0	-3.7	
352.08	H	45.00	1.30	24.90	17.8	136.8	200.0	-3.3	
396.05	H	10.00	2.75	22.30	18.9	115.4	200.0	-4.8	
440.00	H	90.00	1.50	19.60	20.8	104.6	200.0	-5.6	
462.12	H	10.00	2.31	16.70	20.7	74.4	200.0	-8.6	
506.08	H	180.00	1.30	11.30	22.2	47.3	200.0	-12.5	
660.06	H	10.00	1.82	12.90	24.7	75.9	200.0	-8.4	
725.99	H	180.00	1.22	8.90	26.0	55.5	200.0	-11.1	
792.06	H	350.00	1.10	14.10	26.7	110.1	200.0	-5.2	
814.04	H	0.00	1.18	4.80	27.3	40.2	200.0	-13.9	
960.00	H	0.00	1.00	-0.70	28.8	25.4	500.0	-25.9	ambient restricted edge

Table 16: Radiated Emission Test Data, High Frequency Data (>1GHz), Omni Antenna (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
1034.00	V	300.00	3.00	59.12	-10.8	259.3	5000.0	-25.7	peak
1034.00	V	300.00	3.00	57.00	-10.8	203.1	500.0	-7.8	Average
1188.00	V	350.00	3.00	59.50	-9.8	306.5	5000.0	-24.3	peak
1188.00	V	350.00	3.00	57.30	-9.8	237.9	500.0	-6.5	Average
1536.00	V	90.00	3.36	59.54	-9.2	327.5	5000.0	-23.7	peak
1536.00	V	90.00	3.36	55.90	-9.2	215.4	500.0	-7.3	Average
3072.00	V	45.00	3.60	42.10	-2.1	100.2	5000.0	-34.0	peak
3072.00	V	45.00	3.63	39.40	-2.1	73.5	500.0	-16.7	Average
4608.00	V	0.00	3.10	41.60	1.9	150.1	5000.0	-30.5	peak
4608.00	V	0.00	3.10	33.10	1.9	56.4	500.0	-19.0	Average
4904.00	V	0.00	3.34	44.53	3.2	244.0	5000.0	-26.2	peak
4904.00	V	0.00	3.34	37.36	3.2	106.9	500.0	-13.4	Average
1034.00	H	40.00	3.20	56.70	-10.8	196.2	5000.0	-28.1	peak
1034.00	H	40.00	3.20	54.80	-10.8	157.7	500.0	-10.0	Average
1188.00	H	45.00	3.20	57.00	-9.8	229.8	5000.0	-26.8	peak
1188.00	H	45.00	3.20	55.60	-9.8	195.6	500.0	-8.2	Average
1536.00	H	200.00	3.50	56.00	-9.2	217.9	5000.0	-27.2	peak
1536.00	H	200.00	3.50	52.00	-9.2	137.5	500.0	-11.2	Average
4904.00	H	90.00	2.50	40.50	3.2	153.5	5000.0	-30.3	peak
4904.00	H	90.00	2.50	31.10	3.2	52.0	500.0	-19.7	Average

Table 17: Radiated Emission Test Data, High Frequency Data (>1GHz), Yagi Antenna (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
1034.00	V	180.00	3.60	57.50	-10.8	215.2	5000.0	-27.3	peak
1034.00	V	180.00	3.60	54.00	-10.8	143.8	500.0	-10.8	Average
1188.00	V	270.00	3.45	56.31	-9.8	212.3	5000.0	-27.4	peak
1188.00	V	270.00	3.45	53.50	-9.8	153.6	500.0	-10.3	Average
1536.00	V	200.00	3.50	61.50	-9.2	410.4	5000.0	-21.7	peak
1536.00	V	200.00	3.50	57.50	-9.2	259.0	500.0	-5.7	Average
3072.00	V	275.00	3.60	42.90	-2.1	109.9	5000.0	-33.2	peak
3072.00	V	275.00	3.60	31.00	-2.1	27.9	500.0	-25.1	Average
4608.00	V	300.00	3.34	44.70	1.9	214.4	5000.0	-27.4	peak
4608.00	V	300.00	3.34	33.50	1.9	59.1	500.0	-18.6	Average
4904.00	V	45.00	3.38	44.50	3.2	243.2	5000.0	-26.3	peak
4904.00	V	45.00	3.38	38.60	3.2	123.3	500.0	-12.2	Average
1034.00	H	95.00	3.06	53.50	-10.8	135.8	5000.0	-31.3	peak
1034.00	H	95.00	3.06	50.50	-10.8	96.1	500.0	-14.3	Average
1188.00	H	0.00	3.20	58.30	-9.8	266.9	5000.0	-25.5	peak
1188.00	H	0.00	3.20	55.90	-9.8	202.5	500.0	-7.9	Average
1536.00	H	0.00	3.30	61.32	-9.2	402.0	5000.0	-21.9	peak
1536.00	H	0.00	3.30	57.30	-9.2	253.1	500.0	-5.9	Average
4904.00	H	180.00	3.48	42.70	3.2	197.7	5000.0	-28.1	peak
4904.00	H	180.00	3.48	34.64	3.2	78.2	500.0	-16.1	Average

5.7 AC Conducted Emissions

5.7.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

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

5.7.2 Test Procedure

The EUT was placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Power and data cables were moved about to obtain maximum emissions.

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

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

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

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

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

5.7.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. This system runs off of 120VAC. The following tables provide the test results for phase and neutral line power line conducted emissions.

Conducted Emissions was tested with the radio in the “transmit on” state.

Table 18: Conducted Emissions Data 120VAC, Transmit On

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)
0.165	34.6	22.2	10.2	0.3	45.0	32.6	65.2	55.2	-20.2	-22.6
0.509	28.0	28.2	10.2	0.2	38.5	38.7	56.0	46.0	-17.5	-7.3
2.497	22.7	8.9	10.1	0.3	33.1	19.3	56.0	46.0	-22.9	-26.7
11.190	20.0	8.5	11.2	0.3	31.4	19.9	60.0	50.0	-28.6	-30.1
17.760	36.8	20.5	11.4	0.8	49.1	32.8	60.0	50.0	-10.9	-17.2
18.300	36.5	31.4	11.5	0.9	48.8	43.7	60.0	50.0	-11.2	-6.3
23.250	32.5	30.0	11.6	1.1	45.2	42.7	60.0	50.0	-14.8	-7.3
26.600	32.6	29.7	11.8	1.2	45.6	42.7	60.0	50.0	-14.4	-7.3

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)
0.169	30.9	27.2	10.2	0.1	41.2	37.5	65.0	55.0	-23.8	-17.5
0.504	29.7	29.1	10.2	0.2	40.1	39.5	56.0	46.0	-15.9	-6.5
2.541	21.5	7.3	10.1	0.3	31.9	17.7	56.0	46.0	-24.1	-28.3
17.760	34.5	18.8	11.4	0.5	46.5	30.8	60.0	50.0	-13.5	-19.2
18.360	34.8	28.6	11.5	0.6	46.8	40.6	60.0	50.0	-13.2	-9.4
27.310	31.2	25.7	11.8	1.3	44.3	38.8	60.0	50.0	-15.7	-11.2
28.800	29.9	16.1	11.9	1.4	43.3	29.5	60.0	50.0	-16.7	-20.5