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FCC Certification Test Report
For the
REUTECH Mining
Movement and Surveying Radar

FCC ID: YSD-5840-GR-1000

WLL JOB# **13134 Rev 3**
August 28, 2013
Revised May 15, 2014

Prepared for:

REUTECH Mining
PO Box 686
Stellenbosch 7599 South Africa

Prepared By:

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

ACCLASS ACCREDITED TESTING
Testing Certificate AT-1448

FCC Certification Test Report
For the
REUTECH Mining
Movement and Surveying Radar
FCC ID: YSD-5840-GR-1000

August 28, 2013

WLL JOB# 13134 Rev 2
Revised May 15, 2014

Prepared by:

Steven Dovell
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Reviewed by:

James Ritter
EMC Laboratory Manager

Abstract

This report has been prepared on behalf of REUTECH Mining to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Transmitter under Part 90 of the FCC Rules and Regulations (10/2012). This Certification Test Report documents the test configuration and test results for a REUTECH Mining Movement and Surveying Radar.

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.

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

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by the ANSI-ASQ National Accreditation Board/ACLASS. Refer to certificate and scope of accreditation AT-1448.

The Testing completed by Washington Laboratories LTD. for the REUTECH Movement and Surveying Radar complies with the limits for a Licensed Transmitter device under FCC Part 90..

Revision History	Reason	Date
Rev 0	Initial Release	August 28, 2013
Rev 1	Removed References to MSR 060	September 10, 2013
Rev 2	Updated per ACB Comments	February 19, 2014
Rev 3	Changed MALA to Reutech	May 15, 2014

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Compliance Statement

The REUTECH Movement and Surveying Radar complies with the limits for a Licensed Transmitter device under FCC Part 90 (10/2012).

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with ANSI C63.4-2003 and ANSI/TIA/EIA-603C. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	REUTECH Mining PO Box 686 Stellenbosch 7599 South Africa
Purchase Order Number:	Check
Quotation Number:	67167

1.4 Test Dates

Testing was performed on the following date(s):	8/26/13 – 8/28/2013

1.5 Test and Support Personnel

Washington Laboratories, LTD	Steven Dovell
Client Representative	Herschel Appel, Gregory Djoboulian

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 REUTECH Movement and Surveying Radar (EUT) is intended to be used as a monitor to detect surface movement. The EUT then generates a warning of impending failure so that mine personnel and equipment maybe moved prior to the failure. The Movement and Surveying Radar can also be used to generate survey data for the mine; this unit is not your typical radar system. It is a FMCW (frequency-modulated continuous wave). It does not use a pulse width or rep rate. It scans from 9.2GHz to 10GHz repeatedly with no modulation, just a CW signal.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	REUTECH Mining
FCC ID:	YSD-5840-GR-1000
Model:	Movement and Surveying Radar
FCC Rule Parts:	§90.103
Frequency Range:	9.2GHz – 10.00GHz
Maximum Output Power:	0.00809 W (9.08 dBm)
Modulation:	FMCW
Necessary Bandwidth:	0 Hz
Keying:	Automatic
Type of Information:	None
Number of Channels:	Swept
Power Output Level	Fixed
Antenna Connector	Waveguide
Antenna Type	Parabolic dish reflector, 38dB
Frequency Tolerance:	specified by station authority
Emission Type(s):	F0N
Power Source & Voltage:	24VDC

2.2 Test Configuration

The Movement and Surveying Radar was configured as a self-contained trailer mounted unit. See Figure 1.

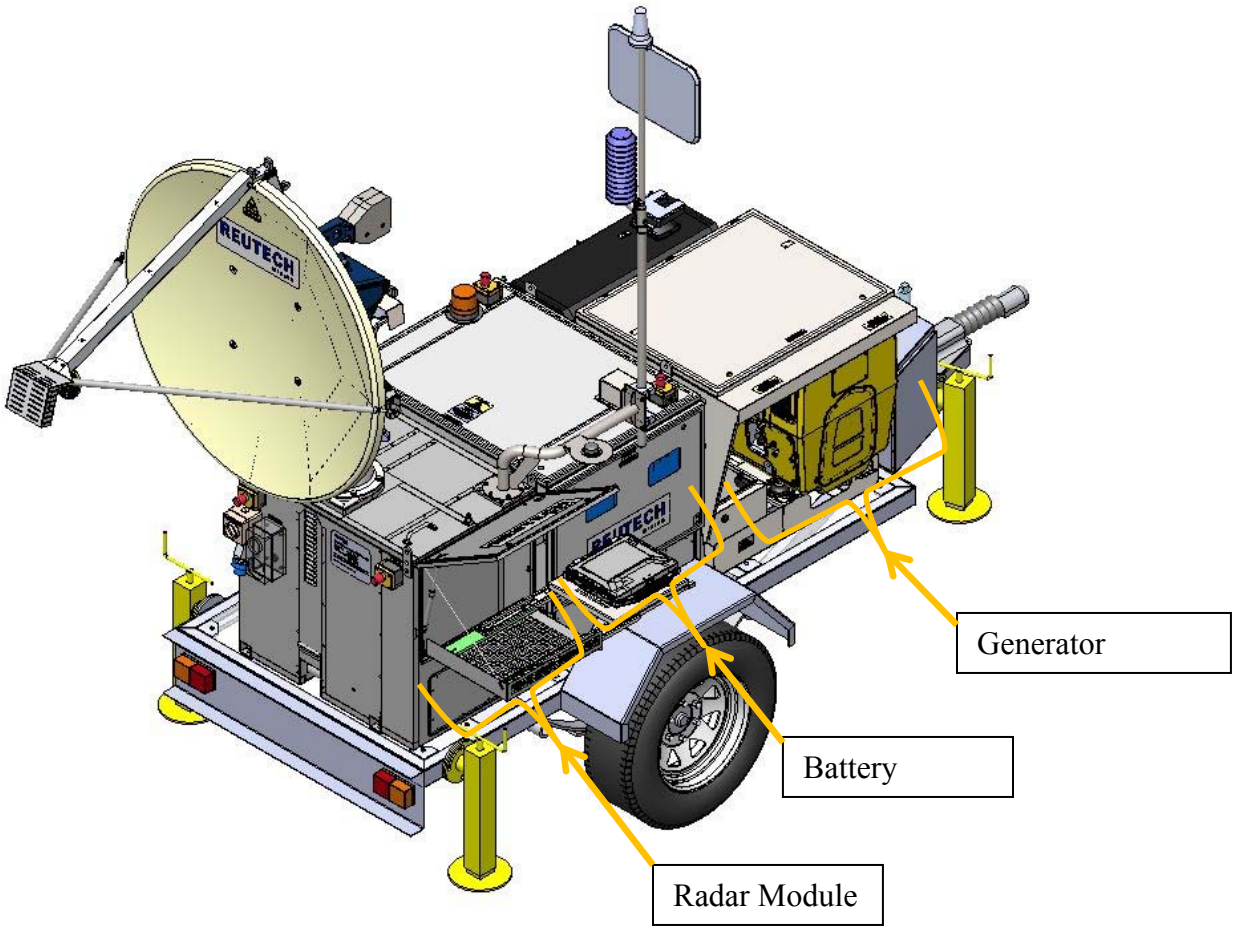

Figure 1: Test Configuration

Under normal operation, the EUT sweeps a CW signal from 9.2GHz to 10GHz. Figure 2 is a plot of the normal operational output of the EUT.

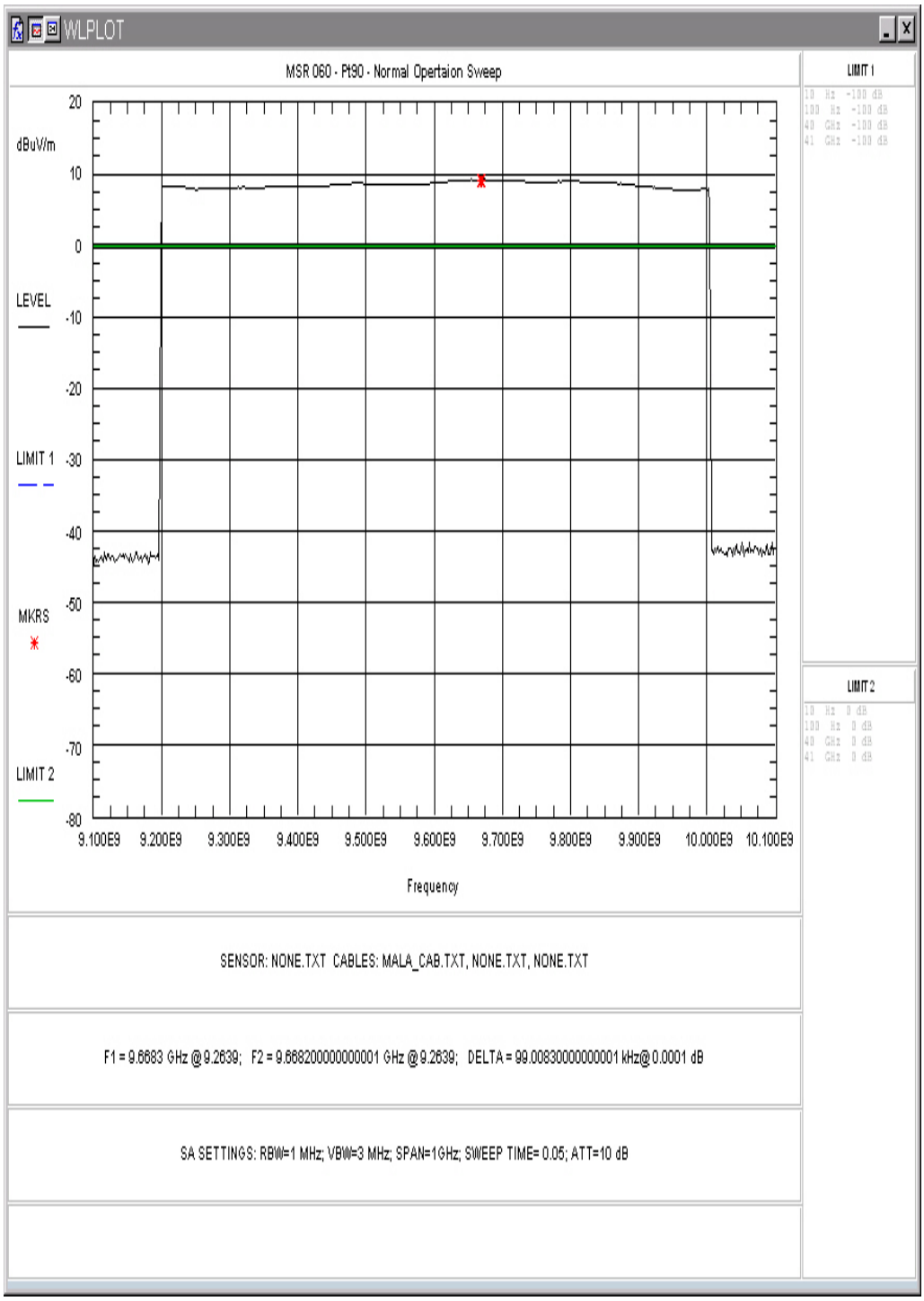

Figure 2: Normal Operation Output Signal

2.3 Testing Algorithm

The Movement and Surveying Radar was operated by selecting the operating mode, individual CW frequency or Sweep mode, by utilizing the test software provided.

Conducted measurements were taken by removing the feed horn from the circulator and a waveguide-to-coax adapter was connected to port 2 of the circulator. A low-loss cable was connected between the waveguide-to-coax output and the spectrum analyzer input and the power was measured using the spectrum analyzer. ERP measurements were made with on the completed trailer.

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 Assured Calibration and Laboratory Accreditation Select Services (ACLASS) under Testing Certificate AT-1448 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

Land Mobile FM or PM Communications Equipment Measurement and Performance Standards (ANSI/TIA/EIA-603C)

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: **Various**		Test Date:	**08/28/2013**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
220595	AGILENT - 8565EC	SPECTRUM ANALYZER 30HZ - 40GHZ	5/22/2014
00815	MASTECH - HY5005-2	DUAL 050VDC POWER SUPPLY	CNR
00685	FLUKE - 115	MULTIMETER DIGITAL	9/10/2013
00083	AGILENT - 11970U	MIXER HARMONIC 40 - 60GHZ	CNR
00528	AGILENT - E4446A	ANALYZER SPECTRUM	2/28/2014
00065	HP - 8447D	PRE-AMPLIFIER RF 50KHZ-1GHZ	5/21/2014
00725	B-Z TECHNOLOGIES - BZP118UD1X2	1 - 18GHZ LOW NOISE AMP	1/28/2014
00453	AH SYSTEMS - PAM1840	PRE-AMPLIFIER 18GHZ-40 GHZ	2/13/2014
00007	ARA - LPB-2520	ANTENNA BICONILOG ANTENNA	10/10/2014
00209	NARDA - V637	HORN STANDARD GAIN	CNR
00210	NARDA - V638	HORN STANDARD GAIN	CNR
00425	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	9/7/2013
00776	TENNY - TJR-A-WS4	1.22 CUFT	1/28/2014
00029	EMCO - 3146A	ANTENNA LOG PERIODIC	1/22/2015
00034	EMCO - BIA-30	ANTENNA BICONICAL	4/26/2014
00477	HP - 8648C	GENERATOR RF SIGNAL	12/15/2013
00125	SOLAR - 8028-50-TS-24-BNC	LISN	6/11/2014
00124	SOLAR - 8012-50-R-24-BNC	LISN	6/11/2014

4 Test Results

4.1 RF Power Output: (FCC Part §2.1046)

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.

The carrier was not modulated.

Table 4. RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel 9.2GHz	8.68 dBm	Not specified	Pass
Center Channel 9.8GHz	9.08 dBm	Not specified	Pass
High Channel 10GHz	8.47 dBm	Not specified	Pass

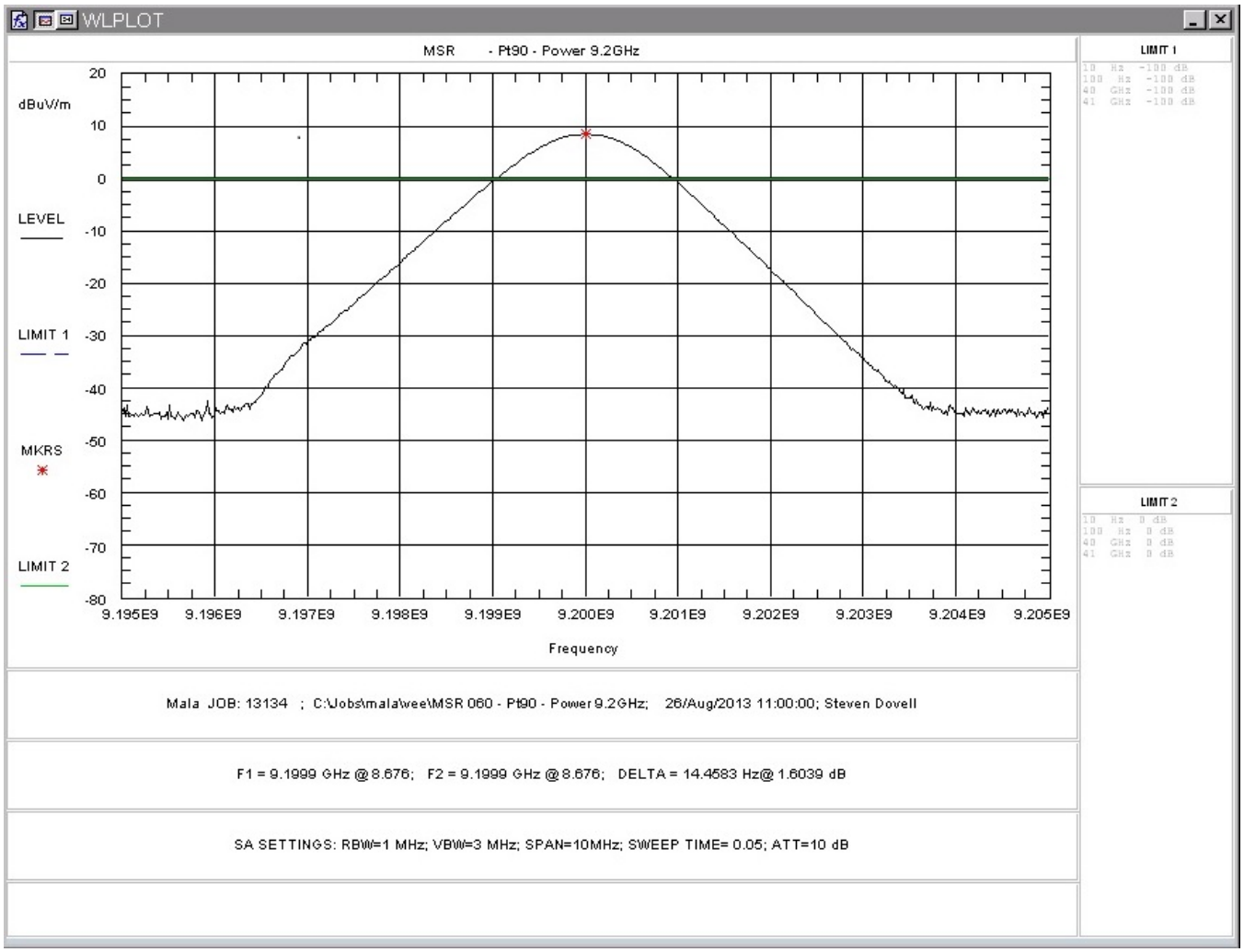

Figure 4-1. RF Peak Power, Low Channel

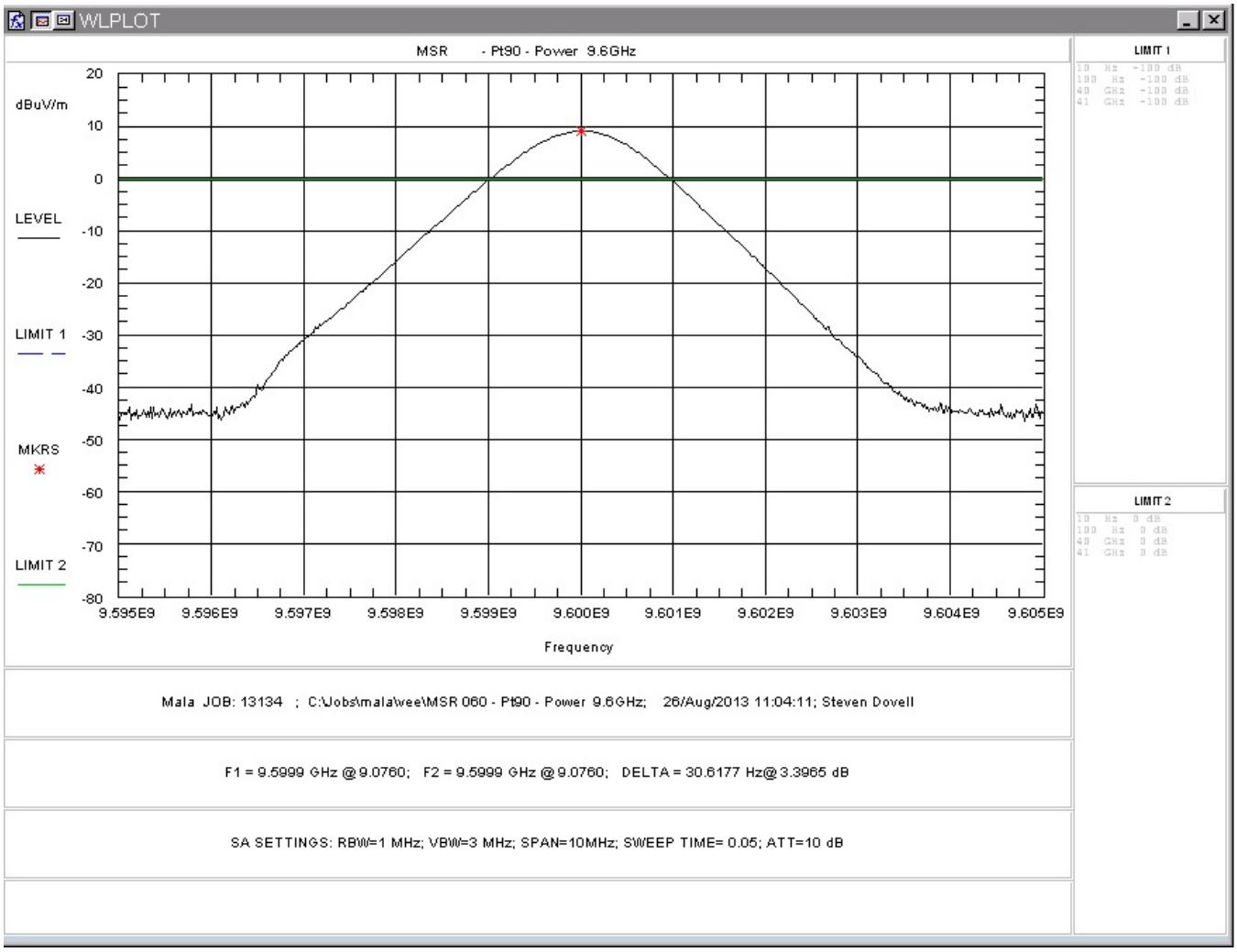

Figure 4-2. RF Peak Power, Mid Channel

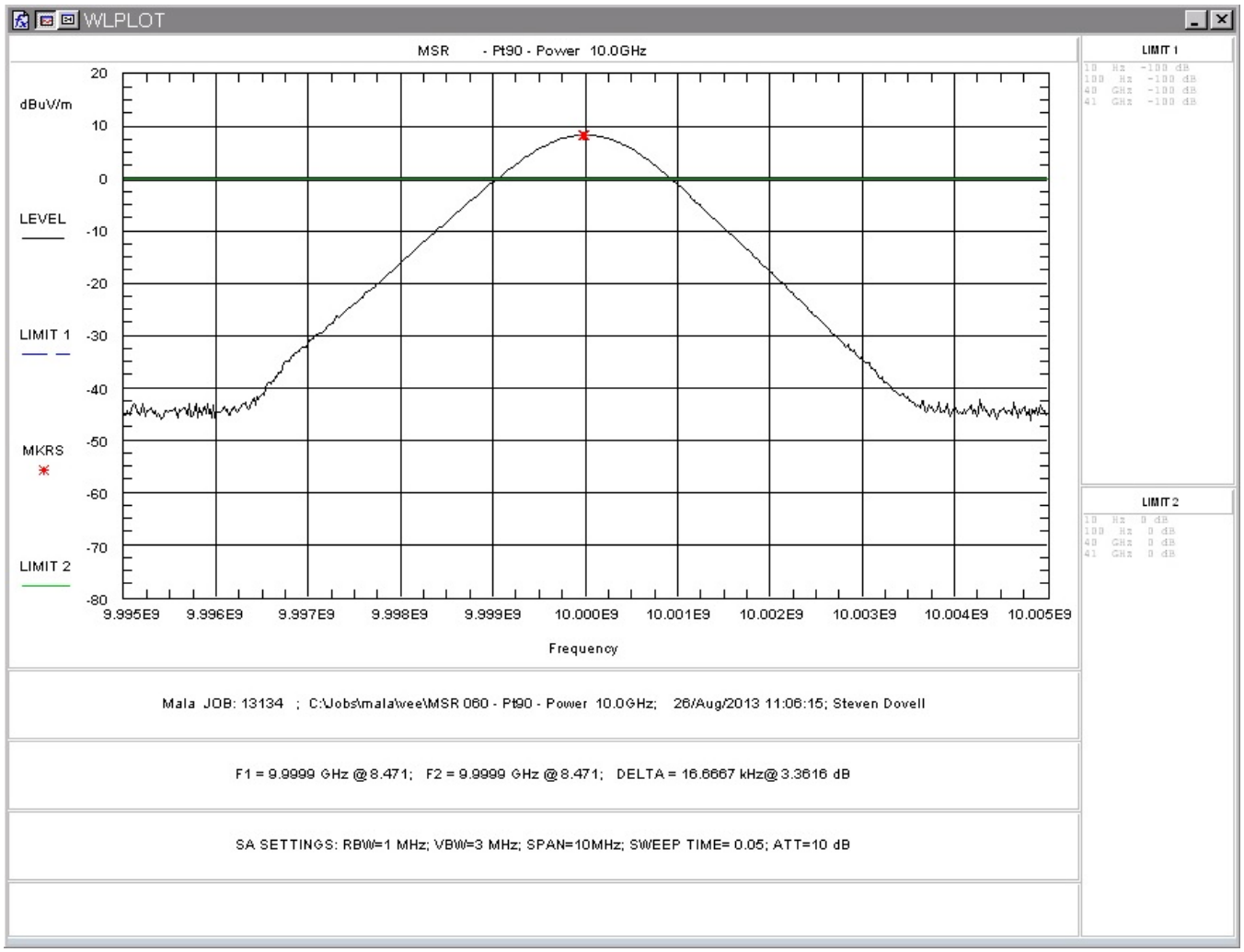

Figure 4-3. RF Peak Power, High Channel

4.2 Occupied Bandwidth: (FCC Part §90.210(c))

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer. The mask was determined using the criteria specified in FCC Part §90.210(c).

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd 2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

Note: As the signal is a swept CW signal, there isn't a bandwidth. The plots below are to demonstrate this.

The occupied bandwidth was measured as shown below:

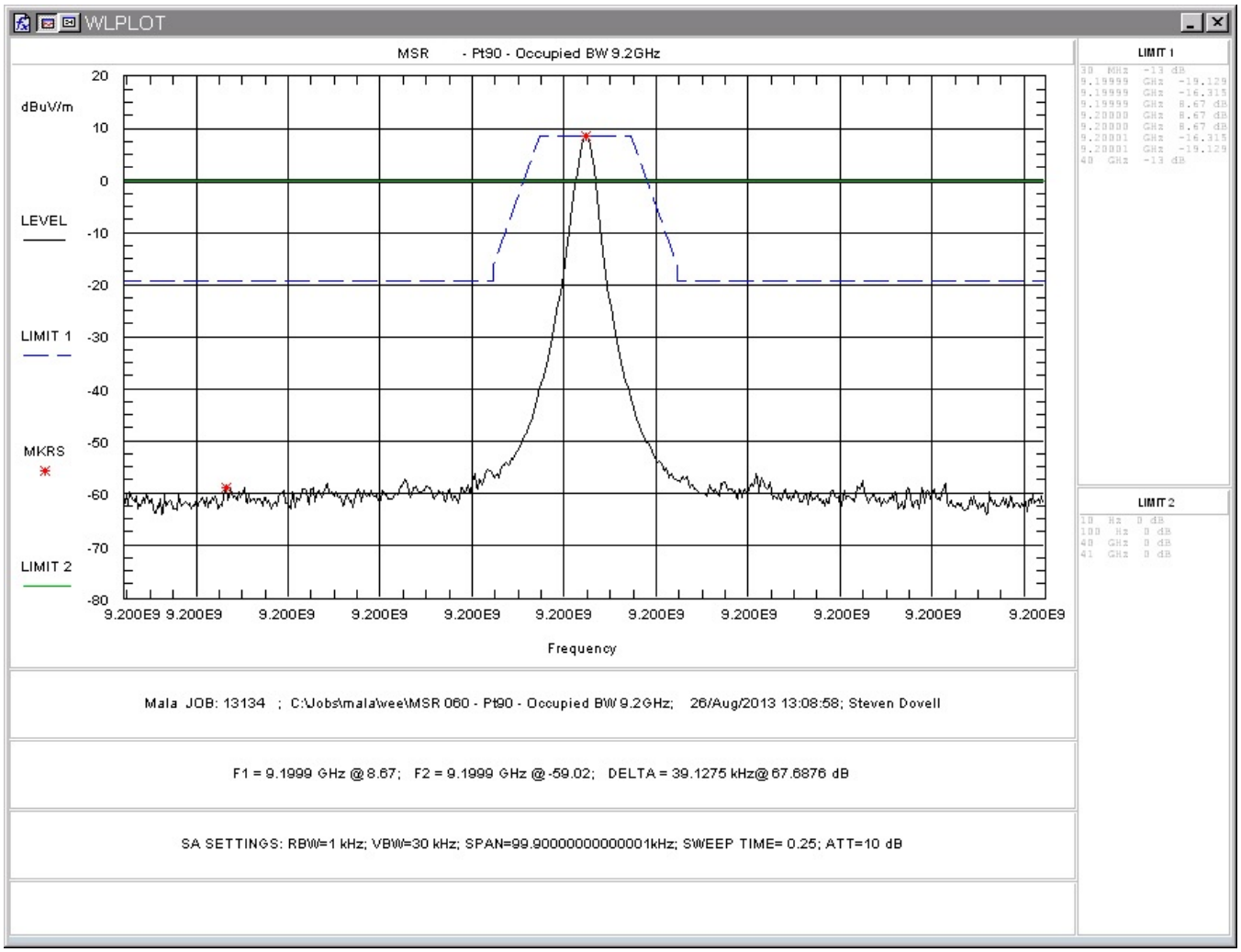

Figure 4: Occupied Bandwidth, Low Channel

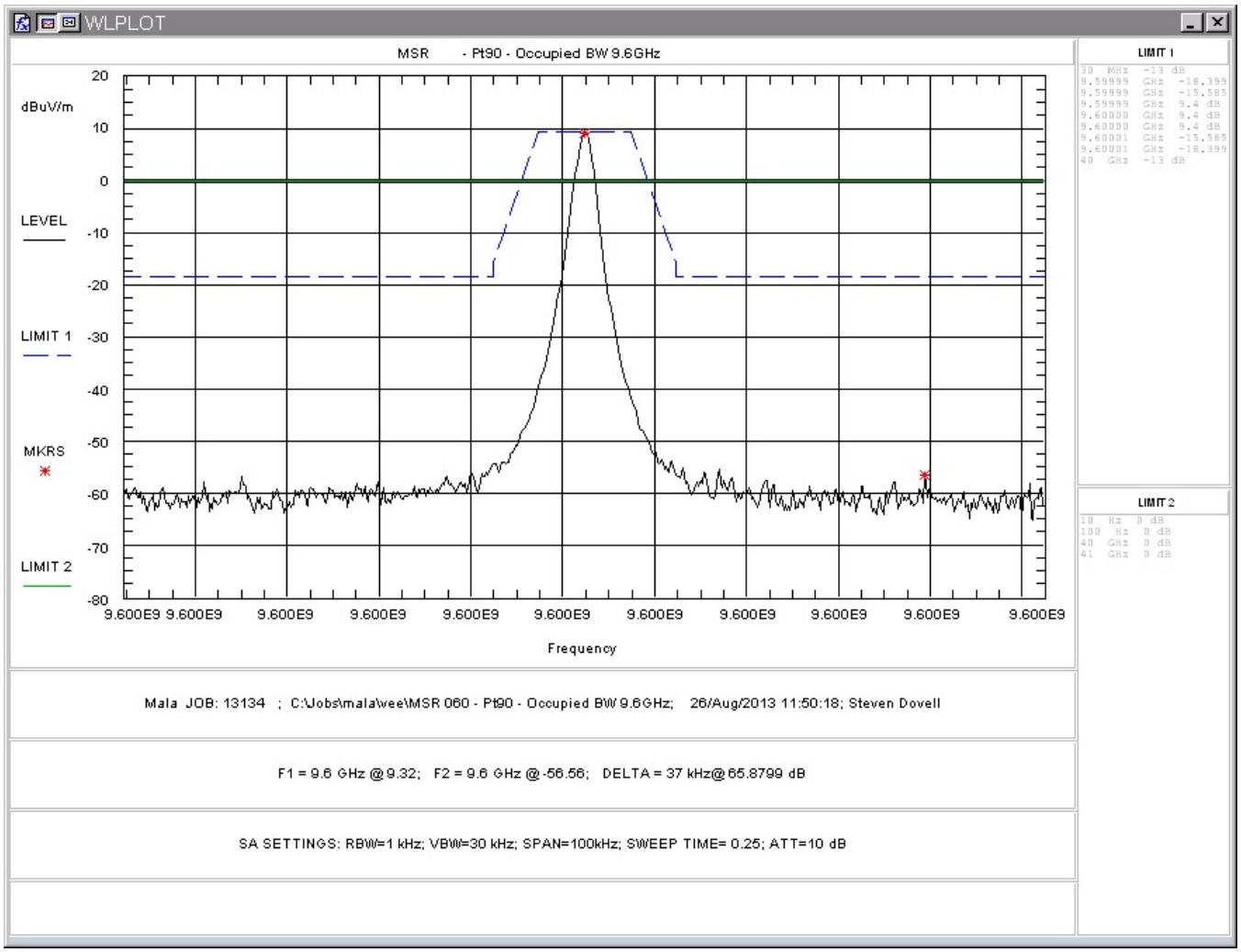

Figure 5: Occupied Bandwidth, Mid Channel

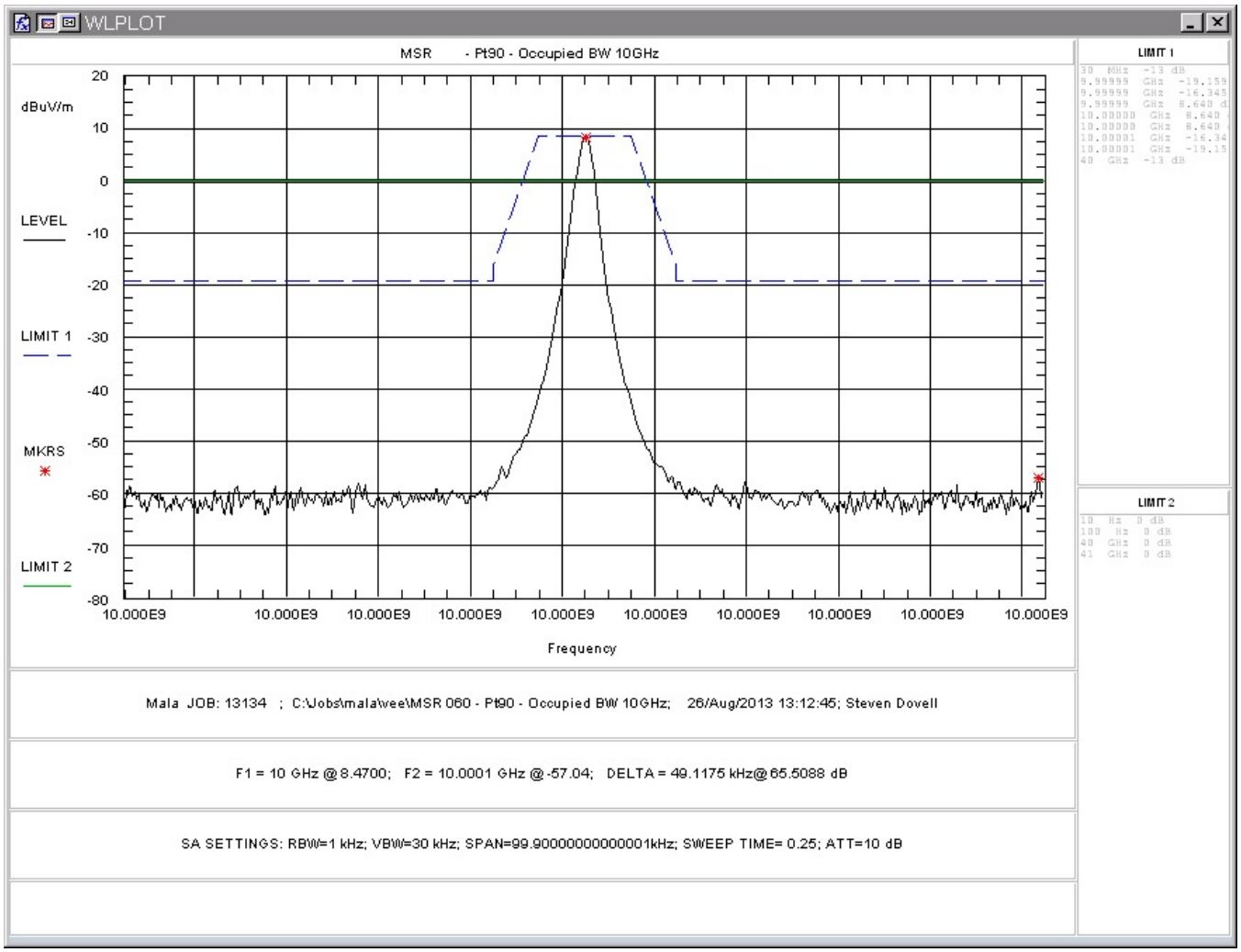

Figure 6: Occupied Bandwidth, High Channel

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Low Channel 9.2 GHz	CW	5kHz	Pass
Mid Channel 9.6 GHz	CW	5kHz	Pass
High Channel 10.0 GHz	CW	5kHz	Pass

4.3 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

FCC Part §90.210(c) states:

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd 2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

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 and cables. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 1MHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit. The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier (50GHz).

The following are plots of the conducted spurious emissions data.

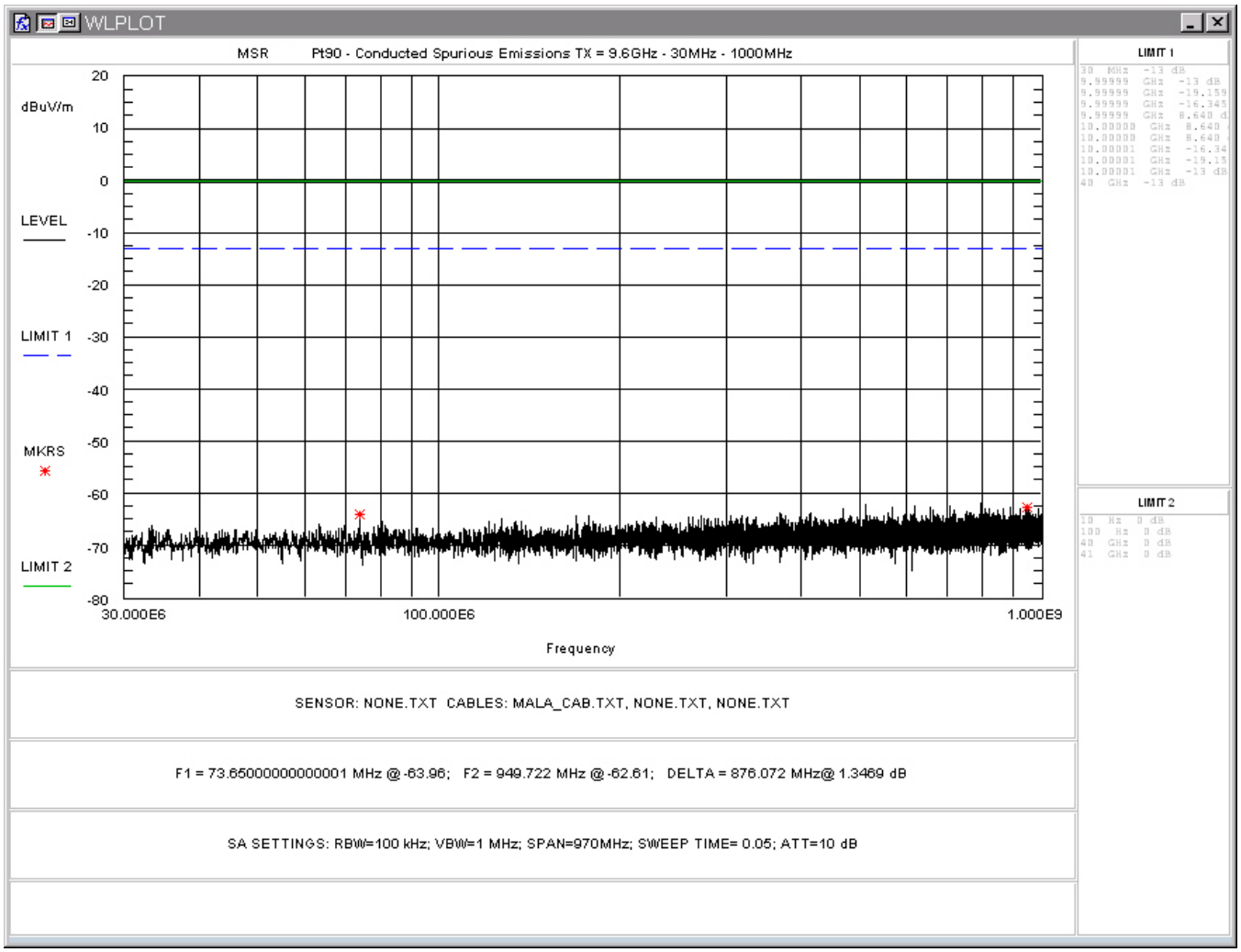

Figure 7: Conducted Spurious Emissions, Center Channel 30 - 1000MHz

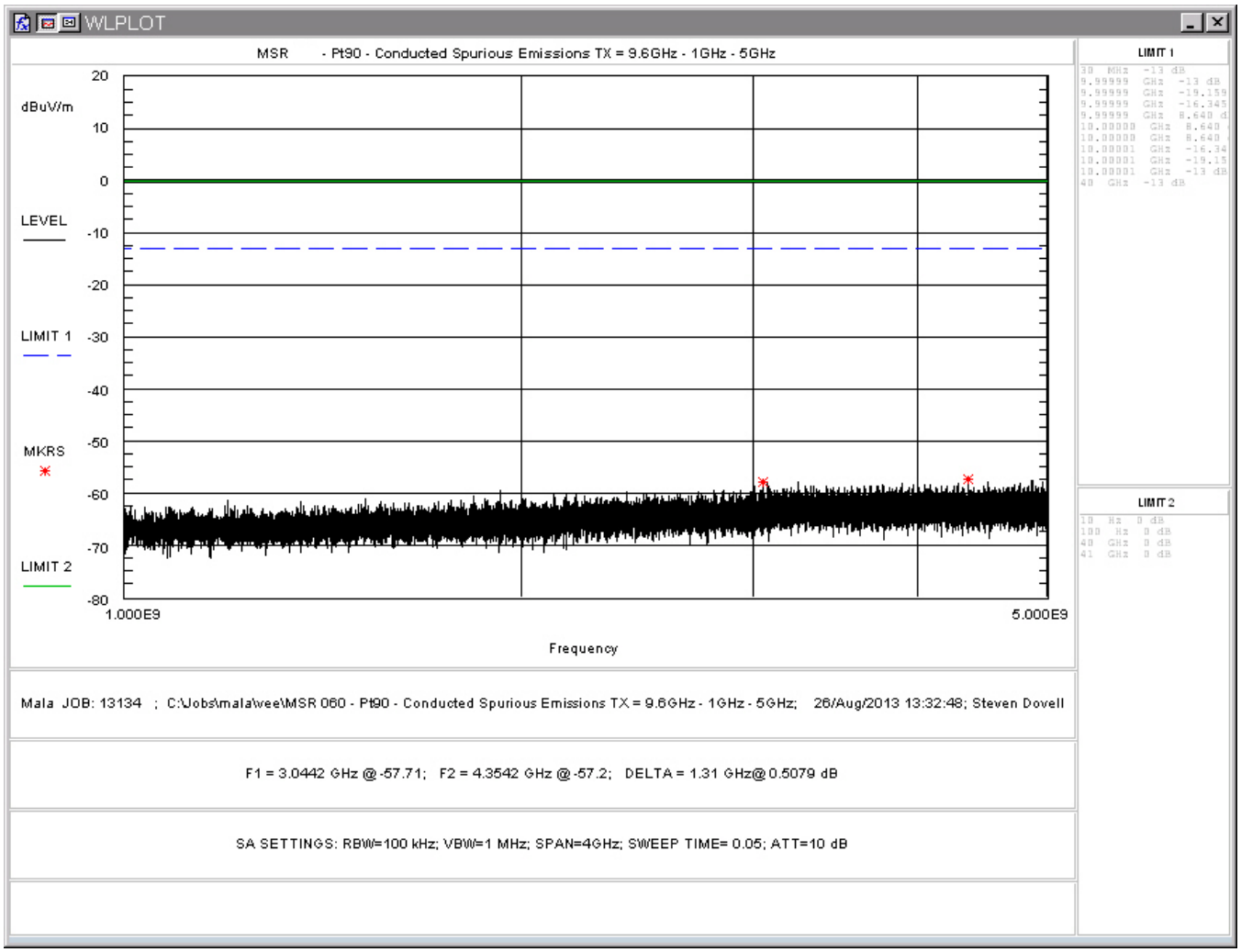

Figure 8: Conducted Spurious Emissions, Center Channel 1 – 5GHz

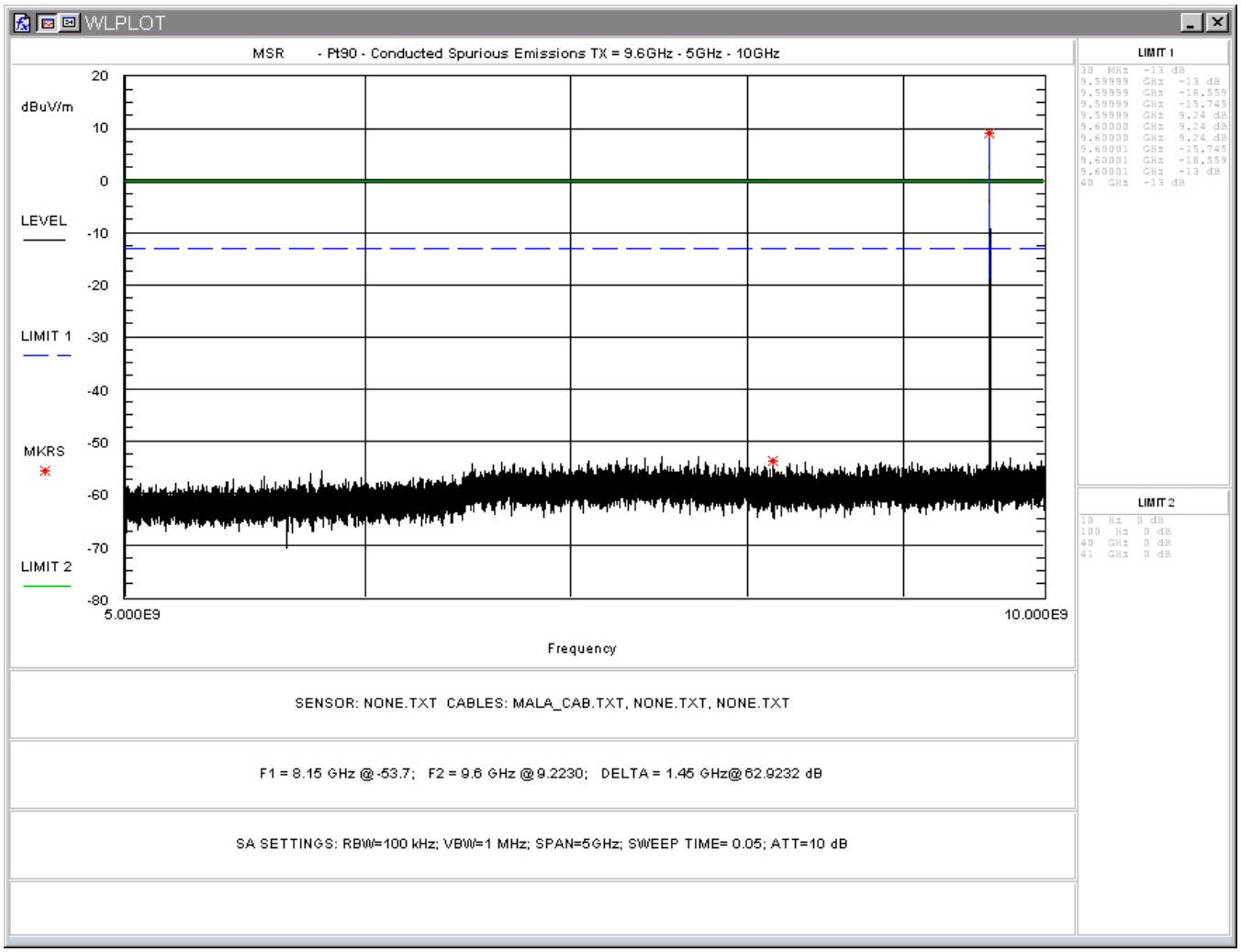

Figure 9: Conducted Spurious Emissions, Center Channel 5 – 10GHz

Signal at Marker above indicates radar fundamental (allowed)

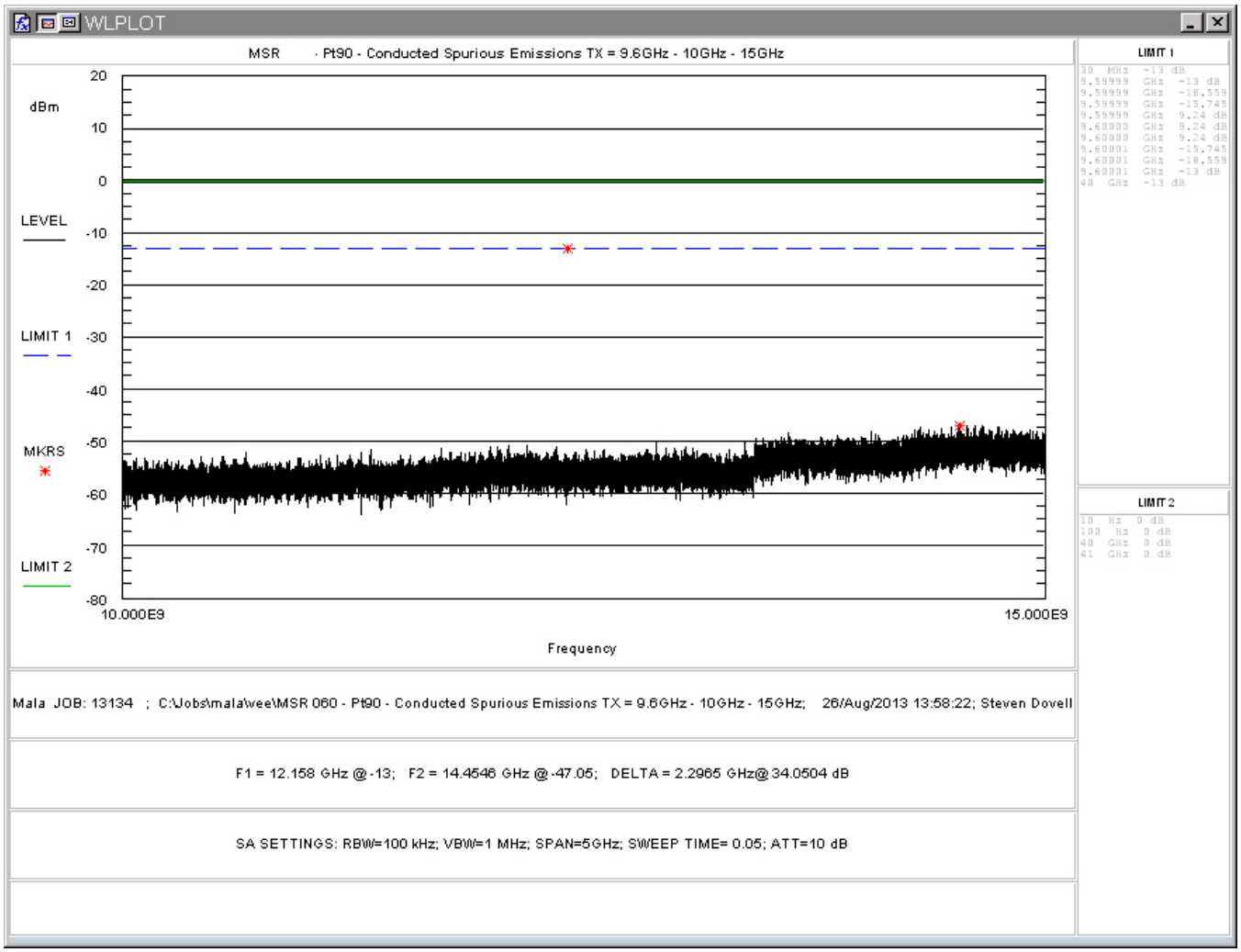

Figure 10: Conducted Spurious Emissions, Center Channel 10 - 15GHz

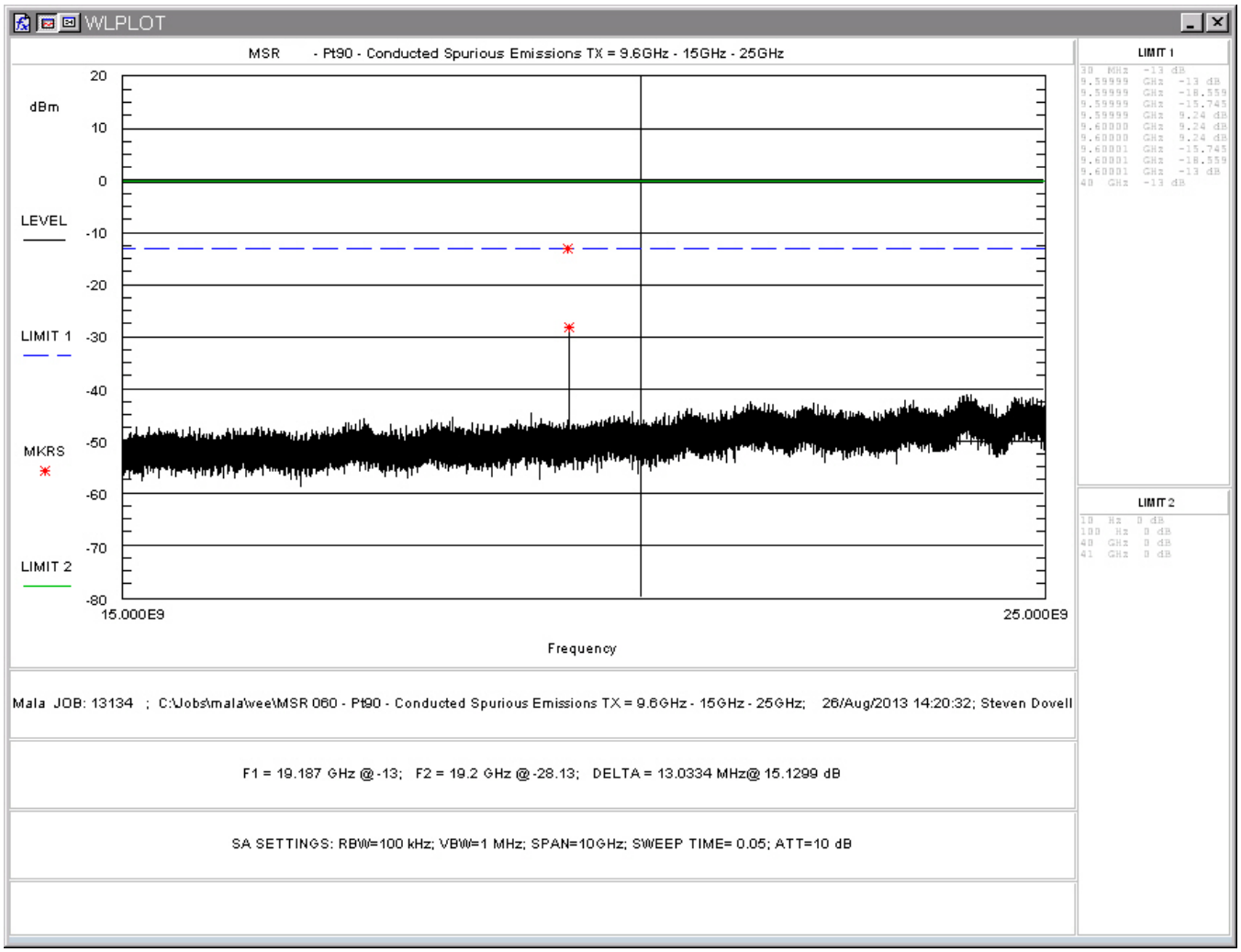

Figure 11: Conducted Spurious Emissions, Center Channel 15 - 25GHz

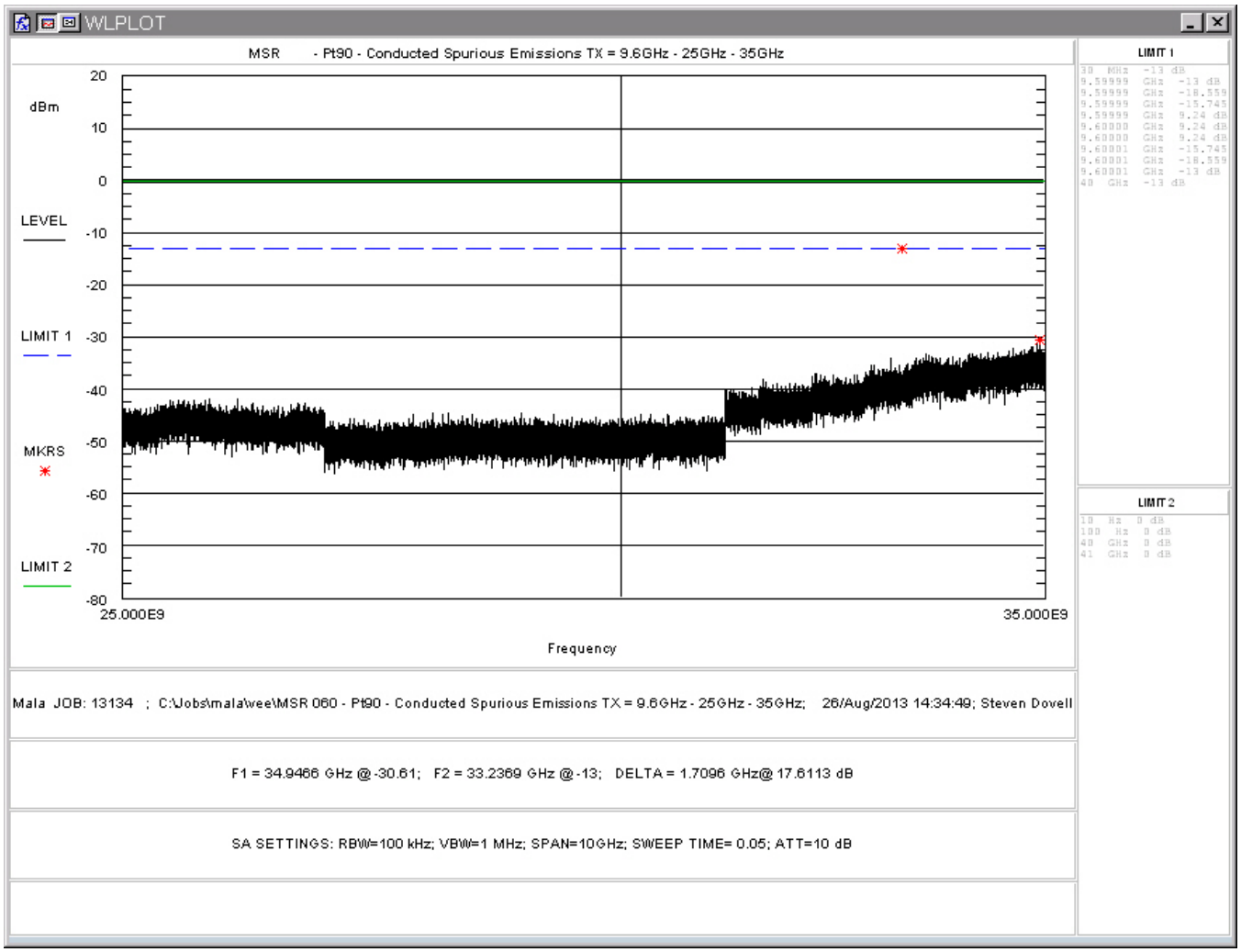

Figure 12: Conducted Spurious Emissions, Center Channel 25 - 35GHz

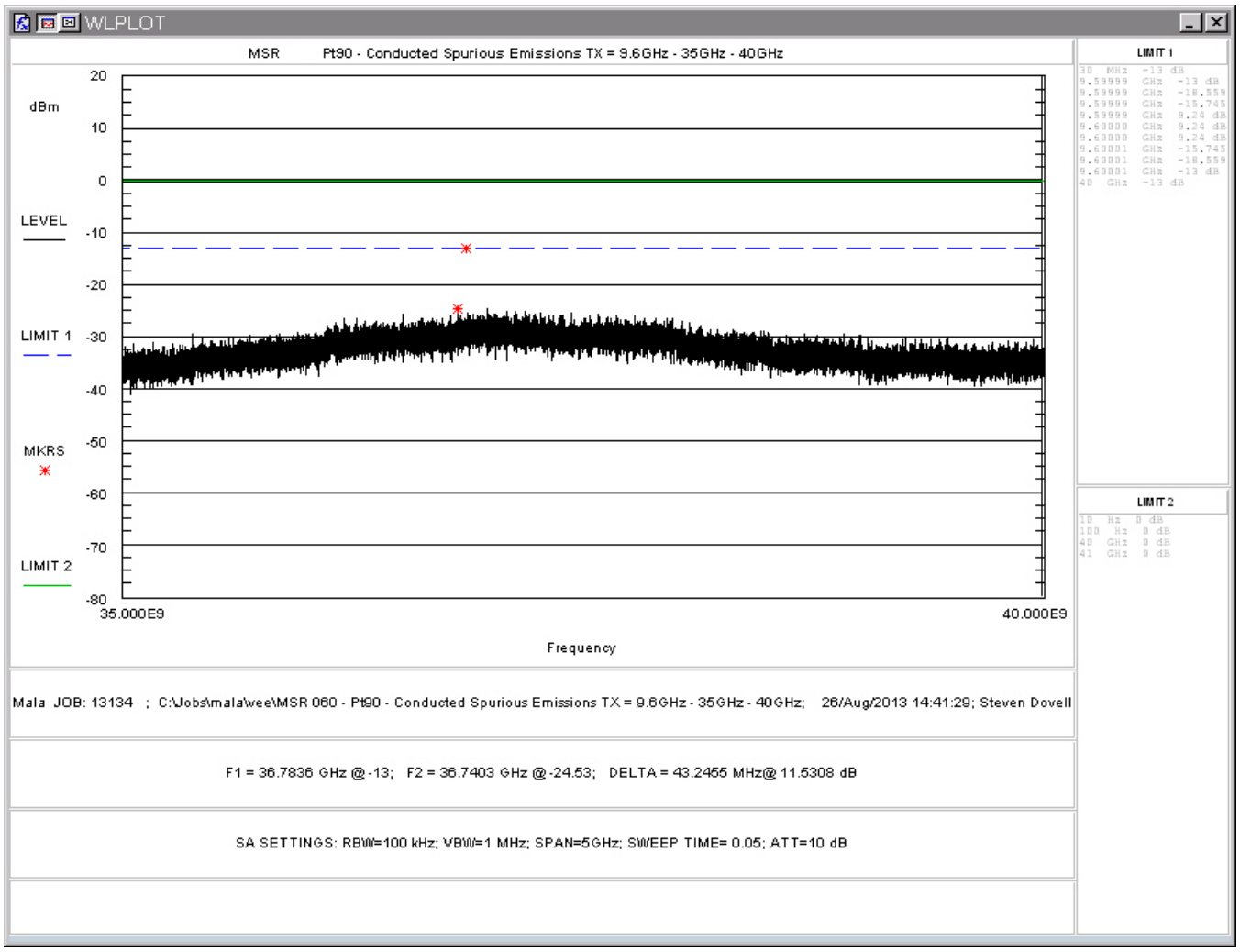

Figure 13: Conducted Spurious Emissions, Center Channel 35 – 40GHz

The EUT was examined from 40GHz – 50GHz using a Harmonic Mixer. No emissions were noted.

4.4 Radiated Spurious Emissions: (FCC Part §2.1053)

The EUT must comply with the requirements for radiated spurious emissions. These emissions must meet the limits specified in §90.210 (c) for peak measurements.

4.4.1 Test Procedure

Due to the size of the EUT, the EUT was stationary and the antennas were moved around the EUT in approximately 22 degree arcs at a distance of 3-meter open field test site. The emissions from the EUT were measured and recorded. Both the horizontal and vertical field components were measured. The frequency range of 30MHz to 50GHz was examined.

Once all emissions were measured, a substitute antenna was used to transmit frequencies and levels that matched the EUT emissions and EIRP was determined. ERP was calculated by subtracting 2.15 from the EIRP results and compared to the limit of -13dBm. Test results are tabulated in Table 6.

Table 6: Radiated Emission Test Data, < 1GHz

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	EIRP to ERP	Limit (dBm)	Margin (dB)
39.57	V	270.00	1.00	22.00	-84.0	-85.0	10.4	-8.2	-93.2	-95.3	-13	-82.3
53.92	V	270.00	1.00	44.70	-60.2	-61.3	10.6	-5.8	-67.1	-69.3	-13	-56.3
68.77	V	270.00	1.00	53.00	-57.2	-58.5	9.1	-2.2	-60.7	-62.8	-13	-49.8
109.37	V	270.00	1.00	47.90	-49.2	-50.7	14.5	-3.5	-54.2	-56.3	-13	-43.3
116.92	V	270.00	1.00	35.90	-66.2	-67.8	13.2	-1.6	-69.4	-71.6	-13	-58.6
140.62	V	300.00	1.00	50.40	-55.0	-56.8	12.5	0.7	-56.1	-58.2	-13	-45.2
146.72	V	300.00	1.00	49.10	-55.6	-57.4	13.0	0.5	-56.9	-59.1	-13	-46.1
156.18	V	270.00	1.00	48.20	-53.9	-55.8	14.2	-0.1	-55.9	-58.0	-13	-45.0
164.43	V	270.00	1.00	47.90	-54.6	-56.5	14.6	-0.1	-56.6	-58.7	-13	-45.7
194.33	V	270.00	1.00	38.70	-66.9	-69.0	17.4	-1.5	-70.4	-72.6	-13	-59.6
217.57	V	270.00	1.00	44.20	-64.1	-66.3	15.9	1.0	-65.3	-67.4	-13	-54.4
218.70	V	270.00	1.00	39.30	-67.3	-69.5	15.8	1.2	-68.3	-70.5	-13	-57.5
250.00	V	270.00	1.00	47.20	-55.7	-58.0	16.1	2.1	-56.0	-58.1	-13	-45.1
265.64	V	270.00	1.00	43.60	-59.8	-62.2	18.6	0.1	-62.1	-64.2	-13	-51.2
287.98	V	200.00	1.00	46.39	-48.5	-51.0	24.2	-4.8	-55.8	-57.9	-13	-44.9
328.14	V	250.00	1.00	47.38	-57.5	-60.2	13.5	7.0	-53.2	-55.3	-13	-42.3
359.39	V	270.00	1.00	43.54	-60.2	-63.0	15.4	6.0	-57.1	-59.2	-13	-46.2
410.54	V	270.00	1.00	40.98	-63.1	-66.1	16.0	6.4	-59.7	-61.8	-13	-48.8
500.00	V	270.00	1.00	38.00	-64.4	-67.8	17.0	7.2	-60.6	-62.8	-13	-49.8
515.62	V	270.00	1.00	30.85	-72.2	-75.7	16.7	7.8	-67.9	-70.1	-13	-57.1
578.14	V	270.00	1.00	30.91	-69.4	-73.1	18.0	7.5	-65.6	-67.8	-13	-54.8
1000.00	V	270.00	1.00	29.20	-62.1	-67.0	23.8	6.4	-60.6	-62.7	-13	-49.7
51.08	H	270.00	1.00	37.62	-59.8	-60.9	10.7	-6.3	-67.2	-69.4	-13	-56.4
68.25	H	270.00	1.00	47.60	-59.0	-60.3	9.2	-2.4	-62.6	-64.8	-13	-51.8
109.37	H	200.00	1.00	48.00	-56.8	-58.3	14.5	-3.5	-61.8	-63.9	-13	-50.9
119.72	H	270.00	1.00	47.80	-58.1	-59.7	13.2	-1.4	-61.1	-63.3	-13	-50.3
140.62	H	250.00	1.00	49.20	-58.5	-60.3	12.5	0.7	-59.6	-61.7	-13	-48.7
159.28	H	270.00	1.00	35.10	-70.4	-72.3	14.3	0.0	-72.3	-74.5	-13	-61.5
197.27	H	270.00	1.00	33.50	-68.8	-70.9	18.0	-1.9	-72.8	-75.0	-13	-62.0
250.00	H	270.00	1.00	43.40	-54.3	-56.6	16.1	2.1	-54.6	-56.7	-13	-43.7
265.60	H	250.00	1.00	30.56	-68.0	-70.4	18.6	0.1	-70.3	-72.4	-13	-59.4
288.00	H	270.00	1.00	38.04	-59.5	-62.0	24.2	-4.8	-66.8	-69.0	-13	-56.0
328.14	H	270.00	1.00	44.70	-63.3	-66.0	13.5	7.0	-59.0	-61.1	-13	-48.1
359.34	H	270.00	1.00	45.50	-59.6	-62.4	15.4	6.0	-56.5	-58.6	-13	-45.6
375.00	H	270.00	1.00	38.95	-64.5	-67.4	16.4	5.3	-62.1	-64.2	-13	-51.2
500.00	H	270.00	1.00	33.50	-70.7	-74.1	17.0	7.2	-66.9	-69.1	-13	-56.1
515.70	H	270.00	1.00	40.70	-63.2	-66.7	16.7	7.8	-58.9	-61.1	-13	-48.1
578.12	H	300.00	1.00	37.50	-62.1	-65.8	18.0	7.5	-58.3	-60.5	-13	-47.5

Table 7: Radiated Emissions Test Data, > 1GHz

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	EIRP to ERP	Limit (dBm)	Margin (dB)
1015.62	V	270.00	1.00	39.10	-66.9	-68.2	24.7	5.7	-62.5	-64.7	-13	-51.7
1630.00	V	270.00	1.00	43.00	-63.9	-65.7	25.5	9.0	-56.7	-58.9	-13	-45.9
3346.00	V	270.00	1.00	44.00	-57.1	-59.8	30.4	10.3	-49.6	-51.7	-13	-38.7
4412.33	V	270.00	1.00	40.30	-58.6	-61.8	31.6	11.5	-50.3	-52.5	-13	-39.5
4814.67	V	270.00	1.00	42.65	-53.9	-57.3	32.5	11.4	-45.9	-48.1	-13	-35.1
10728.23	V	270.00	1.00	33.60	-53.6	-60.9	39.2	11.6	-49.3	-51.4	-13	-38.4
1015.60	H	270.00	1.00	46.40	-59.5	-60.8	24.7	5.7	-55.1	-57.3	-13	-44.3
1078.25	H	225.00	1.00	40.20	-65.4	-66.8	25.1	5.8	-61.0	-63.1	-13	-50.1
1375.00	H	250.00	1.00	38.50	-68.5	-70.1	25.5	7.5	-62.6	-64.8	-13	-51.8
1625.33	H	270.00	1.00	36.78	-70.9	-72.7	25.5	9.0	-63.7	-65.9	-13	-52.9
10728.09	H	270.00	1.00	33.70	-50.8	-58.1	39.2	11.6	-46.5	-48.6	-13	-35.6

4.5 Frequency Stability: (FCC Part §2.1055)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The radio circuitry has several supplies. 24VDC is supplied to the System Data Processor card, which provides the 1GHz clock to the Up Converter/Receiver module. The Up converter/Receiver is powered via 12VDC. To demonstrate the frequency stability of the system due to voltage variations, both power supplies were varied using an external adjustable power supply to 85% of the normal input voltage and 115% of the normal voltage. The frequency of the Center channel was measured and recorded at each voltage setting. Results are found in Table 9.

The frequency stability of the transmitter was examined for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the spectrum analyzer. The results are found in Table 8.

Frequency tolerance is specified by the station authority.

Table 8: Frequency Deviation as a Function of Temperature

Temperature (Celsius)	Frequency (GHz)	Deviation (Hz)
Center Channel	9.6	
-30	9.600002890	1073
-20	9.600002483	666
-10	9.600002409	592
0	9.600002112	295
10	9.600001874	57
20	9.600001817	0
30	9.600001626	-191
40	9.600001533	-284
50	9.600001504	-313

Table 9: Frequency Deviation as a Function of Voltage

Channel	Voltage (DC)	Frequency (Hz)	Deviation (Hz)
Center Channel (9.6GHz)	10.2 & 20.4	9600000208	0
	12 & 24	9600000208	0
	13.8 & 27.6	9600000208	0

4.6 Conducted Emissions

4.6.1 Requirements

Compliance Standard: FCC Part 15 (10/2012), Class B

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

4.6.2 Test Procedure

Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a ground plane.

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 detector was set to for RMS Average.

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

4.6.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 10 provides the test results for phase and neutral line power line conducted emissions. Conducted Data Reduction and Reporting

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

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

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

Table 10: Conducted Emission Test Data

NEUTRAL

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.414	43.7	41.2	1.0	0.3	45.0	42.5	57.6	47.6	-12.6	-5.1
1.346	50.7	40.2	1.1	0.3	52.0	41.5	56.0	46.0	-4.0	-4.5
2.556	34.7	24.6	1.1	0.3	36.1	26.0	56.0	46.0	-19.9	-20.0
3.810	42.2	40.3	1.2	0.3	43.6	41.7	56.0	46.0	-12.4	-4.3
4.396	40.8	40.3	1.2	0.2	42.2	41.7	56.0	46.0	-13.8	-4.3
20.500	39.0	39.0	1.3	1.0	41.3	41.3	60.0	50.0	-18.7	-8.7
24.740	27.6	24.5	1.3	1.2	30.1	27.0	60.0	50.0	-29.9	-23.0

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)
0.401	42.6	30.7	1.0	0.2	43.8	31.9	57.8	47.8	-14.0	-15.9
0.869	48.2	40.1	1.0	0.2	49.4	41.3	56.0	46.0	-6.6	-4.7
4.402	40.6	38.7	1.2	0.2	42.0	40.1	56.0	46.0	-14.0	-5.9
6.460	44.5	37.3	1.2	0.1	45.7	38.5	60.0	50.0	-14.3	-11.5
9.920	40.5	32.9	1.2	0.2	41.9	34.4	60.0	50.0	-18.1	-15.6
16.420	37.0	34.2	1.3	0.5	38.8	36.0	60.0	50.0	-21.2	-14.0
23.750	36.7	30.5	1.3	1.0	39.0	32.8	60.0	50.0	-21.0	-17.2

4.7 Final RF Output Voltage and Current: (FCC Part §2.1033 (c) (8))

FCC Part §2.1033 (c) (8)) states:

(c) Applications for equipment other than that operating under parts 15 and 18 of the rules shall be accompanied by a technical report containing the following information:
(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

The manufacture attests that the voltage and current supplied to the Final amplifier is 5V, 114mA.